CANADA

DEPARTMENT OF MINES

AND

TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 316

GROUND-WATER RESOURCES OF EDWARDSBURGH TOWNSHIP, GRENVILLE COUNTY, ONTARIO

By

E. B. Owen

OTTAWA

1953

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER NO. 316

GROUND-WATER RESOURCES OF EDWARDSBURGH TOWNSHIP, GRENVILLE COUNTY, ONTARIO

By

E. B. Owen

OTTAWA
1951

CONTENTS

PART I

PART II

Illustrations

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 <u>till</u>, 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. <u>Kame terraces</u> 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 ($MgSO_4 \cdot 7H_2O$), 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 compounds 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

EDWARDSBURGH TOWNSHIP, GRENVILLE COUNTY, ONTARIO

Physical Features

Edwardsburgh township is in the southeast part of Grenville county, and has an area of approximately 112 square miles. The township extends along the northwest side of the St. Lawrence River from a point approximately 1 mile east of the town of Prescott to $1\frac{1}{2}$ miles east of the town of Cardinal. Cardinal, the largest community in the township, lies about 118 miles west of Montreal.

The topography of Edwardsburgh township is that of a flat sand plain upon which are scattered numerous, large, elongated ridges of clay till and smaller knolls and hills of kame sand. The general trend of the topography varies from south 10 degrees west to south 30 degrees west. Bedrock, which consists of flat-lying Ordovician sedimentary formations, is reflected in the surface wherever the overburden is thin. A poorly marked divide between the basins of Ottawa and St. Lawrence Rivers crosses the south part of the township in an east-west direction. Near Cardinal, the divide is only 2 miles from the St. Lawrence River, and farther west in the township the distance is about 3 miles.

The large area north of the divide is drained by South Nation River, which, together with its numerous small tributaries, crosses the north half of the township in a northeast direction. The drop in South Nation River between the Canadian Pacific Railway bridge west of Spencerville and the bridge at Hyndman, a distance of 8 miles, is 22.2 feet. This indicates an average gradient across the township of 2.8 feet a mile.

The township as a whole has a relief of more than 125 feet. The highest elevation is in the northwest part where an altitude of more than 375 feet is attained. The lowest part is on the St. Lawrence River in the southwest corner of the township where the altitude is less than 250 feet above sea-level.

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 Edwardsburgh township, and the fluctuations in the water-table, as measured at an observation well near the town of Morrisburg for the same period. The latter was provided through the courtesy of the Ontario Department of Mines. From these graphs, it will be noted that, during the months when the ground is not frozen, the elevation of the water-table depends, to a large extent, on 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 that period that the water-table shows a steady decling, commonly reaching its lowest point in October.

In the subsequent months, there are periods of considerable precipitation, but, because the frozen condition of the ground prevents downward percolation of water, and the fact that a great deal 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 May and June. This is normally due to the supplementing of the regular precipitation with water from melting snow and ice accumulated on the surface during the winter months.

Precipitation in Inches X

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	[illegible]
	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	3.6	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	3.1	50.1
	1946	3.0	2.0	1.8	2.6	2.6	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
(Feet above sea-level)

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	-

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. The general dip is extremely low and in a northwest direction.

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, some sand at base
		Disconformity			
		Chazy	St.Martin	20-155	Impure limestone
			Rockcliffe	150-165	Shale with sand-stone lenses
		Disconformity			
		Beekman-town	Oxford	240(±)	Dolomite with a little shale at top; interbedded sandstone and dolomite
			March	30(+)	
	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, Mem. 241, p. 9 (1946).

The March formation underlies a small area in the southwest part of the township in the vicinity of Domville station on the Canadian Pacific railway. The remainder of the township is underlain by the succeeding Oxford formation, except for an extremely small area along the east boundary in the northeast part of the township, which is underlain by the Rockcliffe. The Precambrian rocks are represented by one small outcrop of white quartzite located in lot 33, con. IV.

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

Glacial materials in the township occur chiefly as ground moraine. In most instances they are completely buried beneath glacio-fluvial material and marine sediments and, accordingly, are only encountered during excavating or drilling operations, although in somw localities they outcrop 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. They often have the appearance of 'islands' of clay till in a 'sea' of marine sand and clay. Thin layers of till reworked by invading marine waters occur on some of the higher ground. They are frequently associated with accumulations of large boulders.

Glacio-fluvial material in the form of kames, is extensive throughout Edwardsburgh township. The kames occur as scattered knolls and irregular ridges of sand and fine gravel, the relief of which has been considerably lowered by the planing action of the waves. In most instances, the kame material directly overlies clay till or bedrock.

The invasion and subsequent withdrawal of the Champlain Sea, which followed the retreat of the ice-sheet in the region, formed various deposits of marine origin. The most extensive of these in Edwardsburgh township are the beds of sand and clay that occur in the flat areas between the higher ridges of clay till and kame material.

The March formation underlies a small area in the southwest part of the township in the vicinity of Domville station on the Canadian Pacific railway. The remainder of the township is underlain by the succeeding Oxford formation, except for an extremely small area along the east boundary in the northeast part of the township, which is underlain by the Rockcliffe. The Precambrian rocks are represented by one small outcrop of white quartzite located in lot 33, con. IV.

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

Glacial materials in the township occur chiefly as ground moraine. In most instances they are completely buried beneath glacio-fluvial material and marine sediments and, accordingly, are only encountered during excavating or drilling operations, although in some localities they outcrop 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. They often have the appearance of 'islands' of clay till in a 'sea' of marine sand and clay. Thin layers of till reworked by invading marine waters occur on some of the higher ground. They are frequently associated with accumulations of large boulders.

Glacio-fluvial material in the form of kames is extensive throughout Edwardsburgh township. The kames occur as scattered knolls and irregular ridges of sand and fine gravel, the relief of which has been considerably lowered by the planing action of the waves. In most instances, the kame material directly overlies clay till or bedrock.

The invasion and subsequent withdrawal of the Champlain Sea, which followed the retreat of the ice-sheet in the region, formed various deposits of marine origin. The most extensive of these in Edwardsburgh township are the beds of sand and clay that occur in the flat areas between the higher ridges of clay till and kame material.

Marine clay is extensive throughout the township, but in most instances is covered by a layer of marine sand of various thicknesses, and except for a few small areas, one in lot 20, con. VIII, and others in lots 25 to 30, con. I, can only be seen along the banks and in the bottoms of small creeks.

Marine sand covers a large part of Edwardsburgh township. It appears to overlie all other unconsolidated material in the township with the exception of the Recent. The thickness of the marine sand is not great, varying generally from a few inches to a few feet.

Alluvial clay, silt, and sand occur along the flood plain of South Nation River between the community of Ventnor and the point where the river leaves the township. These materials may overlie either bedrock, clay till, or marine clay. They are shallow beds, considered to be derived mainly from the reworking of glacial drift.

Dune sand occurs locally in Edwardsburgh township. It is usually concentrated on the east side of kame deposits, which are the source of much of the material. The material consists of a fine, white sand that is useless for farming. These deposits are not considered important as sources of ground water.

Variations in the thickness of drift throughout the township were determined in many localities as a large number of the recorded wells were reported to have encountered bedrock.

The following table indicates the minimum and maximum thicknesses of drift in several localities, as indicated by the recorded wells:

	Concession	Lot	Minimum and Maximum Thickness of Drift (feet)
	1	1	21^x - 35^x
	1	4	24^x - 30^x
	1	7	29 - ?
	1	10	0^x - 6^x
	1	13	22 - ?
1	1	16	16 - ?
	1	19	50 - ?
1	1	22	35 - ?
	1	28	22^x - 26^x
	1	31	0^x - 38^x
	1	34	12^x - ?
	2	5	10 - ?
	2	11	30^x - 49^x
	2	14	13 - ?
	2	17	21 - ?
	2	20	25 - ?
	2	23	10 - ?
	2	35	9 - ?
	3	3	20 - ?
	3	6	40^x - ?
	3	9	43 - ?
	3	12	8^x - 24
	3	15	48^x - ?
	3	18	7 - ?
	3	21	14 - ?
	3	24	4^x - 12^x
	3	27	18^x - ?

Concession	Lot	Minimum and Maximum Thickness of Drift (feet)
4	1	30^x - ?
4	4	7^x - 35^x
4	7	28^x - 29^x
4	10	36 - ?
4	19	4^x - ?
4	22	9^x - ?
4	25	10 - ?
4	28	18 - ?
4	34	78^x - ?
5	2	29 - ?
5	5	24^x - ?
5	8	40^x - ?
5	11	22 - ?
5	14	17 - ?
5	17	13 - ?
5	20	5^x - ?
5	29	18 - ?
5	32	7^x - 14^x
6	3	5^x - 23
6	3	29^x - 30^x
6	9	23 - ?
6	12	17^x - ?
6	15	4^x - ?
6	18	5^x - 6^x
6	21	23^x - ?
6	30	14^x - 33^x
6	33	50^x - 51^x
6	36	40^x - ?

Concession	Lot	Minimum and Maximum Thickness of Drift (feet	Concession	Lot	Minimum and Maximum Thickness of Drift (feet)
7	1	2^x - 3^x	9	3	7^x - 38^x
7	4	24^x - 27^x	9	6	23 - ?
7	7	9^x - 26^x	9	9	3^x - 30^x
7	10	3^x - 25^x	9	12	9^x - 14^x
7	13	12^x - 22^x	9	15	3^x - ?
7	16	20^x - 22^x	9	18	56 - ?
7	19	8^x - ?	9	21	4^x - ?
7	22	41 - ?	9	24	9^x - 35^x
7	25	? - 26^x	9	27	7^x - ?
7	31	34 - ?	9	30	9^x - ?
7	34	23 - ?	9	36	28 - ?
8	2	17 - ?	10	16	17 - ?
8	5	30 - ?	10	19	14 - ?
8	8	117 - ?	10	34	24 - ?
8	11	? - 40^x			
8	14	? - 24^x			
8	17	8^x - 27^x			
8	20	22 - ?			
8	29	115 - ?			
8	35	24 - ?			

^{x} to bedrock.

Water Supply

Except for a few localities, Edwardsburgh township appears to be fairly well supplied with ground water for both domestic and stock purposes. Exclusive of the communities, about 68.9 per cent of the wells throughout the township are of the dug type, and 31.1 per cent are drilled, chiefly into bedrock. Approximately 74.5 per cent are obtaining their water from depths of 40 feet or less. A survey of the well records shows that about 86.9 per cent of the wells have a permanent water supply sufficient for the present demands made upon them; the remainder constitute dry holes and wells that go dry intermittently, especially during periods of extended drought. 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. It is reported that shallow wells, dug 18 to 20 feet in clay till, are seldom satisfactory, especially when called upon to water 50 to 65 head of stock. The reason is the low permeability of the clay till that causes it to yield water slowly to the well. Consequently, a well deriving its ground water from it can be easily pumped dry and takes an exceedingly long time to refill. 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 drawn from the well. For instance, most wells dug an average of 34 feet in clay till are reported to provide a sufficient supply of ground water for 10 head of stock. The depth of the wells depends largely upon their topographic location. On higher ground, such as on or near the crest of a drumlin where many farm buildings are located, the wells should generally be deeper than those located on the lower, surrounding ground moraine.

In lots 26 and 27, con. VII, wells dug to depths of 35 to 52 feet in clay till are reported to be yielding excellent supplies of ground water.

A number of shallow wells dug in clay till reportedly encountered sand that for a time yielded water in sufficient quantities to satisfy the needs of the owner. However, after a period of time had elapsed, many of these wells assumed the properties of a well deriving its entire ground water supply from clay till, often going dry during the late summer or extended periods of drought, and yielding only limited supplies during normal times. It is thought that the sand encountered is in small isolated lenses of pockets in the till and that these sand beds, not being extensive, are drawing their limited supply of ground water from the confining till. Consequently, the quantity of water yielded by the sand would be no greater than if it were coming directly from the till into the well.

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 where reworked clay till occurs on the surface are more satisfactory than in those areas of undisturbed clay till. This is due to the greater specific yield of the reworked material, which has had a large quantity of its finer particles washed from it.

Sufficient supplies of ground water, some of which is under pressure, is often, but not always, obtained at the contact of clay till and bedrock.

Although many of the kame deposits in the township are reported to yield an unsatisfactory supply of ground water, the material appears to be sufficiently permeable to yield its water fast enough to satisfy a normal pumping well. The water-table in the kame areas is relatively low and, consequently, the average depth of dug wells is greater than in other parts of the township. In the extreme northeast corner of the township, where kame sand directly overlies bedrock, most shallow wells, averaging 18 feet in depth and dug to bedrock, obtain a satisfactory supply of water from the zone directly above bedrock.

A large number of intermittent wells are reported to occur in the kame area in the southwest parts of the township. The kame material here is underlain principally by clay till. Because of the loose character and excessive permeability of the kame material, it is difficult for the average farmer to dig a well far enough below the water-table into the zone of saturation to obtain a permanent supply of water. It is considered best to dig wells in this type of material during the autumn or during periods when precipitation is low and the water-table has dropped to its lowest point. Deepening a dug, non-artesian well that is intermittent, in the hope of obtaining a permanent supply of ground water, is also best accomplished while the water-table is at its lowest point. Drilled wells employing well screens appear to be the most satisfactory means of obtaining a sufficient supply of ground water from these deposits.

Outwash sand and gravel does not appear to be an important source of water in the township. One well in lot 6, con. IV, was reported to have encountered 6 feet of gravel overlying bedrock and buried beneath 60 feet of marine clay. The water in this well is under considerable hydrostatic pressure and overflows for approximately 8 months of each year. It is possible that more of the water derived by wells drilled to bedrock in the township may be from a similar source, although such information is not recorded in the well data supplied by the owners.

Although marine clay does not appear on the surface to any great extent, it underlies a large part of the areas mantled with Champlain sand, and, accordingly, assumes a greater importance toward the ground-water conditions in the township than is at first apparent. The problems encountered in attempting to obtain safisfactory 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 poor permeability of the material. For this reason a well might be dug in clay a considerable distance below the water-table before there would be any evidence of free water. It is suggested that the only method to determine accurately 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, the slow entrance of the water makes it easier to penetrate the zone of saturation below the water-table and thus create a larger reservoir. In some wells, marine clay was found to be sufficiently firm and compact that lining the well with rock or wooden cribbing was not necessary. It is doubtful, however, if wells such as these would be as satisfactory as those that have been properly lined.

A number of shallow, intermittent wells, dug in marine clay, occur in the vicinity of Wexford, near Windmill Point and again near the junctions of Nos. 2 and 16 highways, both located in the extreme southwest corner of the township. These wells should be deepened to provide a greater reservoir. It was reported that shallow wells dug in marine clay will not provide sufficient ground water for 65 head of stock. In lot 29, con. I, where a thin layer of marine sand overlies the clay, a well drilled 83 feet into the clay was reported to be unsatisfactory whereas at the same time two adjacent, shallow, dug wells were reported to yield fair quantities of water. It is considered that the source of most of the water in these latter dug wells is the overlying marine sand, and that the casing of the nearby drilled well blocks off this water, allowing only a limited supply from the clay to enter through the relatively narrow opening in the bottom. In concession V, in the area surrounding Pittson, the Champlain sand deposits overlying the clay are thin, ranging from 2 to 3 feet in thickness. Dug wells in this locality, which range from 18 to 30 feet in depth, are reported to be obtaining their water directly from the clay.

The areas of marine sand yield fair to good supplies of ground water. Marine clay is the predominant material underlying the sand whereas smaller areas are underlain by clay till and bedrock. Precipitation falling upon sandy areas rapidly sinks in and percolates downward until it reaches the more impervious clay or clay till. These materials slow the downward movement of the water to such an extent that the sand above becomes saturated with water, frequently forming a perched water-table. Many 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 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.

Shallow wells, 10 to 15 feet in depth, dug in areas where the marine sand deposits are exceptionally thick, encounter similar problems to those in kame areas. Few wells of this type are satisfactory, especially if located on a hill or ridge, where the greatest drop in the water-table occurs during a period of little precipitation. The most satisfactory wells in marine sand are those that are located in the flat sand areas between the higher areas of kame sand and glacial till. The water-table in these localities does not appear to fluctuate much and most wells can usually be depended upon to remain permanent the year round.

The few alluvial deposits in the township are not an important source of ground water. At Ventnor, however, 2 wells are believed to be deriving their water from alluvium and the supply is reported to be satisfactory for domestic uses.

Altogether, some 308 wells in the township have been drilled into bedrock, and all are reported to be deriving at least part of their ground water from that source. The depths of the wells range from 6 to 218 feet, with an average of 53 feet. All the wells are reported to be deriving their water from the March and Oxford formations with the exception of one. This well, a flowing artesian 160 feet deep, is located in lot 6, con. IV, and is reported to be deriving its water from shale, presumably of the Rockcliffe formation. The water from this well has a "mineral" taste and an oily scum forms on its surface. It is not considered satisfactory for domestic use. Another well in lot 25, con. VII, is 218 feet deep and is reported to have passed through the Oxford and to have encountered either the March formation or the Precambrian. The water rose to approximately 2 feet from surface and is reported to be satisfactory for all domestic and farm uses. A well, 120 feet in depth, drilled at the Colonial Inn on No. 2 highway 2 miles east of Prescott is reported to have encountered granite underlying the limestone. The water in this well is under considerable pressure and rises to within 20 feet of the surface.

It is difficult to determine if the ground water in wells drilled to bedrock is under pressure when the elevation of the surface of the water are comparable to those in adjacent, shallow, dug wells. It is thought that most water encountered in bedrock is under pressure and, accordingly, rises some distance in the well, but in some wells this water is being supplemented by ground water from the zone of saturation lying above the artesian aquifer in the bedrock. This water, which may or may not be contaminated, enters at some point immediately below the casing and causes the surface of the water in the well to rise to the elevation of the water-table in that locality.

Not all wells that are drilled into bedrock provide sufficient quantities of ground water. In the area about Hyndman, in the northeast corner of the township, a number of wells drilled into the Oxford formation, one of which penetrated 100 feet of rock, were reported to yield insufficient quantities of water. The cheese factory in the same area, which has a 60-foot drilled well, reported an excellent supply. This suggests that aquifers that will provide sufficient quantities of water are present in the bedrock, but that there is an element of chance that such an aquifer will be encountered during drilling operations. Water may be obtained at almost any depth in bedrock down to the Precambrian. One well, in lot 25, con. VII, obtained water that rose to within 2 feet of surface after penetrating 192 feet of rock.

Flowing-artesian wells, obtaining their water from bedrock, are not common in Edwardsburgh township. The following is a list of such wells for which information has been obtained.

Lot	Concession	Well Depth (feet)	Bedrock Depth (feet)	Formation
1	III	85	70	Oxford
6	IV	160	22	Rockcliffe
7	V	100	89	Oxford
7	VI	64	?	Oxford
31	VI	?	?	Oxford
20	VII	52	12	Oxford

Information obtained from numerous wells drilled to bedrock indicates that the surface of bedrock underlying the township consists of a series of long, narrow, parallel ridges trending in a general southwest direction across the township and separated by wide, deep valleys filled with glacial drift. The relief of the bedrock surface is approximately 195 feet, ranging from 375 feet above sea-level in the vicinity of Groveton to a minimum of 100 feet or less as indicated by a 117-foot drilled well in lot 8, con. VIII.

All the flowing artesian wells and a number of excellent non-flowing artesian wells appear to be located upon the sides or flanks of the buried valleys. It is considered that not all the ground water obtained by these wells is derived from bedrock. Surface water percolating slowly down through the unconsolidated material and encountering bedrock would tend to accumulate in the valleys and form a source of ground water for any well put down in that area.

Although no accurate information has been obtained, it is thought that the relief of the surface of the Precambrian rocks beneath the sedimentary formations underlying the township is considerable, with numerous, rounded ridges of crystalline rocks interspersed with valleys, in many instances partly filled with sandstone of the Nepean formation. The quantity of ground water that could be obtained from the larger of these sandstone beds should be considerable. Unfortunately, at present, drilling from surface appears to be the only means of locating them.

The entire surface of Edwardsburgh township acts as the intake area for the ground water yielded by both the overburden and the underlying bedrock. Some of the ground water derived from the bedrock formations may have originated southwest of the township in the areas north of Brockville, where the Precambrian rocks, which elsewhere underlie the Palaeozoic formations, appear on the surface. This is especially true in the south part of the township. The slope of the surface of the Precambrian rocks is in a general northeast direction, which is reflected by the similar low dip of the overlying sedimentary strata. There is no doubt but that a large part of the water yielded by several flowing-artesian wells in Augusta township, adjacent on the southwest, has its origin in this area.

Although numerous seepages occur around the edges of swamps and along the bases of the larger hills, no springs yielding large amounts of water were reported in the township. The seepages were considered to be indications of the outcropping of the water-table, which, in some localities, is probably perched.

Community Supplies

Ground-water conditions within the communities of Spencerville and Ventnor in the north part of the township, were investigated. Maps showing the location of all the wells within the communities for which information has been obtained accompany this report. Topographic contours, together with the contours of the bedrock surface in the case of Spencerville, and water-table contours in the case of Ventnor, are also indicated on these maps. Although these latter types of 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.

Community of Spencerville. The water supply of the community of Spencerville is derived entirely from privately owned wells. Information has been compiled on 53 wells in the community; all of which, with one exception, are drilled and obtain at least part of their water from the underlying Oxford formation. The one exception is located at Willard's Lunch where the well was dug 7 feet to bedrock and then blasted 6 feet into the rock. Because most wells are tightly sealed at the surface, it was not possible to obtain sufficient information to produce a contour map of the water-table. However, a map depicting the contours of bedrock underlying the community has been produced. This map is based chiefly upon information received from the well owners.

The depths of drilled wells in Spencerville vary from 17 to 92 feet, with an average of 42 feet. The average depth to bedrock is about 5 feet, ranging from 0 to 15 feet from surface. The overburden consists of marine sand overlying clay till and/or bedrock. Bedrock outcrops in the bottom of South Nation River where it flows through the community as well as in scattered localities within the community itself.

The underlying dolomitic limestone appears to be a good source of water. The supply of the few wells that were reported as unsatisfactory could probably be increased by proper cleaning. The water appears to follow open fissures in the joints and bedding planes of bedrock. One well, which is approximately 400 feet from South Nation River and whose bottom is 9.5 feet below the river, is reported on good authority to be deriving organic material from these aquifers. This would suggest that there are large and continuous openings in the bedrock through which water will pass with relative ease. From this, it is believed that the allowing of numerous cesspools to drain directly into bedrock in the immediate vicinity of pumping wells is likely to cause pollution of the well waters and endanger the health of the well users. Some communal system of carrying away waste material should be considered. On examination of the accompanying contour map of the bedrock surface, the area immediately to the east of the community would appear to be the most satisfactory locality for waste disposal if a public sewage system were to be constructed.

Community of Ventnor This community is solely dependent upon privately owned wells for its domestic water supply. Altogether, there are 22 wells in the community, of which 7 are dug and are deriving their water from clay till or from alluvium along the flood plain of Nation River. The remaining 15 wells are drilled and are reported to be obtaining their water from the underlying Oxford formation. The average depth of the drilled wells is 42 feet and that of the dug wells is about 15 feet. Clay till is the predominant material overlying bedrock, which does not outcrop in the community itself but does in the bottom of South Nation River.

As the water levels in most wells are higher than the surface of South Nation River, it is doubtful if there is any contamination of the wells by sub-surface movement of water from the river through influent seepage. However, during a dry season when the water-table is at its lowest point, the water in the two wells located in the flood plain of the South Nation might receive river water. At the time they were measured, the elevation of their water surface was 2 feet above that of the river. One drilled well (J. Perry), in which the elevation of the water surface is about 2 feet above that of the river, is reported to fluctuate with the river. This does not necessarily mean that the water in the well is being contaminated by river water, but that the river is being fed by exfluent seepage from the water-table. Accordingly, when the water-table drops both the water in the well and in the river will drop at the same time. It would also indicate that there are openings in bedrock sufficiently large to permit fairly rapid movement of ground water.

On the map of Ventnor, which accompanies this report, both surface and water-table contours are indicated. 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.

Analyses of Water Samples

Twelve samples of well waters from Edwardsburgh 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 varying in depth from 13 to 217 feet. The aquifers were assumed to be either in drift or in the underlying Oxford formation.

Except for wells Nos. 3 and 12, where the nitrate content appears to be abnormally high, the water from most of the wells listed in the table of analyses appears to be suitable for domestic and farm needs. It is suggested that bacteriological tests be made of the water from these two wells if they continue 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 casing or cribbing. This is especially true for wells dug in marine clay. It is thought wells such as these whose waters have a strong odour of hydrogen sulphide and a "mineral" taste should be bacteriologically examined before being used.

Except for the chloride and sulphate content, there is a distinct similarity in the chemical analyses of the waters of the three flowing-artesian wells that were sampled. These wells were all reported to derive their ground-water supply from the Oxford formation. The water from the two flowing-artesian wells located in lot 1, con. III, and lot 6, con. IV, contain relatively large amounts of chloride whereas that from a flowing well in lot 7, con. VI, contains a large amount of sulphate chiefly as the salt of calcium or magnesium. From the analyses, it appears that the sulphate, principally in the form of $CaSO_4$, is the most common mineral salt contained in the ground water derived from the Oxford formation throughout Edwardsburgh township.

Amounts of Dissolved Mineral Matter in Well Waters
Collected in Edwardsburgh Township
(Parts per million)

Constituent	Well waters from glacial drift and bedrock (12 samples)		
	Maximum	Average	Minimum
Residue on evaporation(105°C)	752	407	244
Calcium	110.9	54.3	38.3
Magnesium	45.0	28.1	21.0
Sodium	77.0	28.3	1.8
Potassium	26.0	7.4	1.4
Sulphate	148.2	56.3	20.6
Chloride	98.6	28.8	0.7
Nitrate	48.7	6.3	0
Bicarbonate	333.1	284.4	225.2
Carbonate	7.2	0.6	0
Silica (col.)	18.0	10.4	6.0
Total hardness	394.4	281.6	199.4

In answer to the requests of a number of well owners, the following method is recommended when it is desired to sterilize a well[1].

[1] Well Drilling, Technical Manuel, TM 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. Then stir this paste into 1 quart of water. Allow the mixture to stand a short time. Then pour off the clear liquid. The chlorine strength of the solution is about 1 per cent, and 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, accordingly, the correct volume 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 Edwardsburgh township are in good supply and are adequate for domestic, stock, and community purposes.

2. Because of its low permeability, few shallow wells dug in clay till areas are satisfactory when called upon to water large numbers of stock.

3. Wells in the kame areas usually yield good supplies of ground water. However, during times of drought, the water-table will drop below the bottom of the well and it will become dry. Deepening of the well during the period when the water-table is at its lowest point is suggested.

4. It is possible that a number of wells drilled into bedrock actually obtain their water from outwash sand and gravel lying directly above bedrock. There is only one authoritative confirmation of this in the township.

5. A large amount of the ground water reported to be yielded by marine clay in the township is actually coming from sand overlying the clay.

6. Except for a few wells that are improperly cased, the quality of ground water derived from glacial drift is quite suitable for domestic and farm use.

7. Bedrock appears to be a satisfactory source of ground water. In most cases the water is hard and clear with an insufficient content of total dissolved solids to render it unsatisfactory.

8. Most ground water encountered in the bedrock is under some hydrostatic pressure. However, in most cases this pressure is not sufficient to force the waters any great distance toward surface. The water in many such wells is augmented by water from the zone of saturation seeping into the well below the casing.

9. Because of the proximity of a number of cesspools to wells in the community of Spencerville there is great danger of enough pollution to endanger the health of many of the inhabitants.

10. The water from any shallow, dug well that emits a strong odour of hydrogen sulphide should be bacteriologically analysed.

Edwardsburgh Township

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

Wells and springs	CONCESSIONS										Total No in township	Per cent of total
	1	2	3	4	5	6	7	8	9	10		
Total number	193	82	102	82	117	133	109	79	77	17	991	[illegible]
Dug	134	65	75	59	94	89	70	43	40	14	683	68.90
Bored	0	0	0	0	0	0						
Drilled	59	17	27	23	23	44	39	36	37	3	308	31.10
Springs	0	0	0	0	0	0						
Wells 0-20 feet deep	73	50	57	45	62	48	37	22	37	11	442	45.10
21-40	71	15	21	19	37	48	38	29	11	3	292	29.45
41-60	22	8	9	9	5	10	14	6	7	0	90	9.15
61-80	12	6	3	3	4	14	14	7	7		64	6.45
81-100	8	2	8	4	7	6	3	5	7	1	51	5.20
over 100	4	0	1	2	1	3	3	5	1	1	21	2.15
depth unknown	3	1	3		1	4		5	7	1	25	2.50
Wells that yield hard water	192	79	98	76	113	132	107	77	75	17	966	97.90
soft water	0	0	3	6	4	1	2	2	2	0		2.10
salty water	0	0	0	0	0	0	0		0	0	0	
Wells with aquifer in clay	31	1	8	0	32	8	3	5	9	0	97	9.75
in sand	59	45	43	49	46	46	26	13	21	15	363	36.50
in gravel	28	1	14	8	15	1	13	3	1	0	84	8.50
in glacial till	16	17	0	0	0	32	27	21	10	0	123	12.40
in bedrock	45	14	26	20	18	40	35	33	35	2	268	27.10
unknown	14	4	11	5	6	6	5	4	1	0	56	5.75
Well types: Flowing artesian	0	0	1	2	1	3	1	0	0		8	0.80
Non-flowing artesian	36	10	20	15	8	22	12	14	18	1	156	15.75
Non-artesian	112	53	61	53	87	96	86	55	47	13	663	66.90
Intermittent	34	15	17	11	15	9	10	8	9	2	130	13.10
Dry holes		0	2	1	1	1	0	0	2	0	8	0.80
Not used	9	9	7	10	21	19	21	14	16	1	127	12.80

Edwardsburgh Township

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

	Communities		Total number in communities	Per cent of total
	Spencerville	Ventnor		
Total number	53	22	75	[illegible]
Dug	1	7	8	10.70
Bored	0	0	0	—
Drilled	52	14	66	88.00
Springs	0	0	0	—
Wells 0-20 feet deep	2	5	7	9.35
21-40	17	5	22	29.15
41-60	7	6	13	17.35
61-80	8	0	8	10.70
81-100	5	0	5	6.65
over 100	0	0	0	—
depth unknown	15	6	21	28.00
Wells that yield hard water	52	20	72	96.00
soft water	1	0	1	1.30
salty water	0	0	0	—
Wells with aquifer in clay	0	0	0	—
in sand	0	0	0	—
in gravel	0	0	0	—
in till	0	5	5	6.65
in bedrock	53	14	67	89.40
Well types: Flowing artesian	0	0	0	—
Non-flowing artesian	20	10	30	40.00
Non-artesian	30	5	35	46.60
Intermittent	1	2	3	4.00
Dry holes	0	0	0	—
Not used	5	2	7	9.35

Analyses of Well Waters from Edwardsburgh Township, Grenville County, Ontario

									Constituents as Analysed (parts per million)								Hardness as $CaCO_3$ (pts. per million)		
Sample Number	Owner	Lot	Concession	Depth of Well (Feet)	Aquifer	Total dissolved solids (parts per million)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Alkalis (as Na)	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Bicarbonate (HCO_3)	Alkalinity (as $CaCO_3$)	Ca hardness (as $CaCO_3$)	Mg hardness (as $CaCO_3$)	Total hardness (as $CaCO_3$)
1	R. Armstrong	1	III	85	0	306	13.6		49.9	34.1	45.2	34.6	46.5	0	272.1		124.5	140.3	264.8
2	G. A. Lane	6	IV	160	0	524	7.8		48.5	28.4	73.6	31.7	98.6	0.7	305.7		121.0	116.9	237.9
3	G. Montgomery	8	V	37	c/o	752	10.2		110.9	28.6	92.8	148.2	74.1	48.7	317.7		276.7	117.7	394.4
4	G. Montgomery	8	V	100	0	362	13.2		41.0	28.2	52.4	20.6	54.5	0	263.5		102.3	116.0	218.3
5	H. Richardson	9	V	13	s/c	244	15.2		41.0	23.6	11.70	22.6	5.8	0.7	229.4		102.3	97.1	199.4
6	H. Anderson	7	VI	64	0	454	12.2		62.3	45.0	27.0	84.8	19.3	0	314.8		155.4	185.2	340.6
7	J.S. Wallace	10	VI	15	s/c	288	6.0		51.9	28.6	3.7	29.6	2.2	2.3	278.2		129.5	117.7	247.2
8	L.W. Keeler	26	VI	27	0	496	6.4		90.7	37.8	11.3	86.4	10.6	Tr.	333.1		226.3	165.5	391.8
9	W.H. Connell	25	VII	217	0	280	9.6		56.7	28.2	5.8	21.8	0.7	0	270.2		141.5	116.0	256.5
10	J.L. Pelton	7	IX	60	0	284	18.0		38.3	21.0	8.1	38.7	9.2	0	225.2		145.5	86.4	231.9
11	C. Gilmer	10	IX	120	0	364	6.8		46.7	31.0	53.5	42.0	18.3	1.4	309.1		116.5	127.6	244.1
12	Somerville	29	IX	77	0	524	7.8		103.3	22.9	32.8	114.8	7.7	21.3	293.0		257.7	94.2	351.9

ABBREVIATIONS

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

Type:

Drl. - drilled
D. - dug

Depth to Water Surface:

M. - measured

Aquifer:

Al. - alluvium
C.T. - clay till
Ox. - Oxford formation

Quality:

C. - clear
Cl. - cloudy
H. - hard
I. - irony
S. - soft

Use:

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

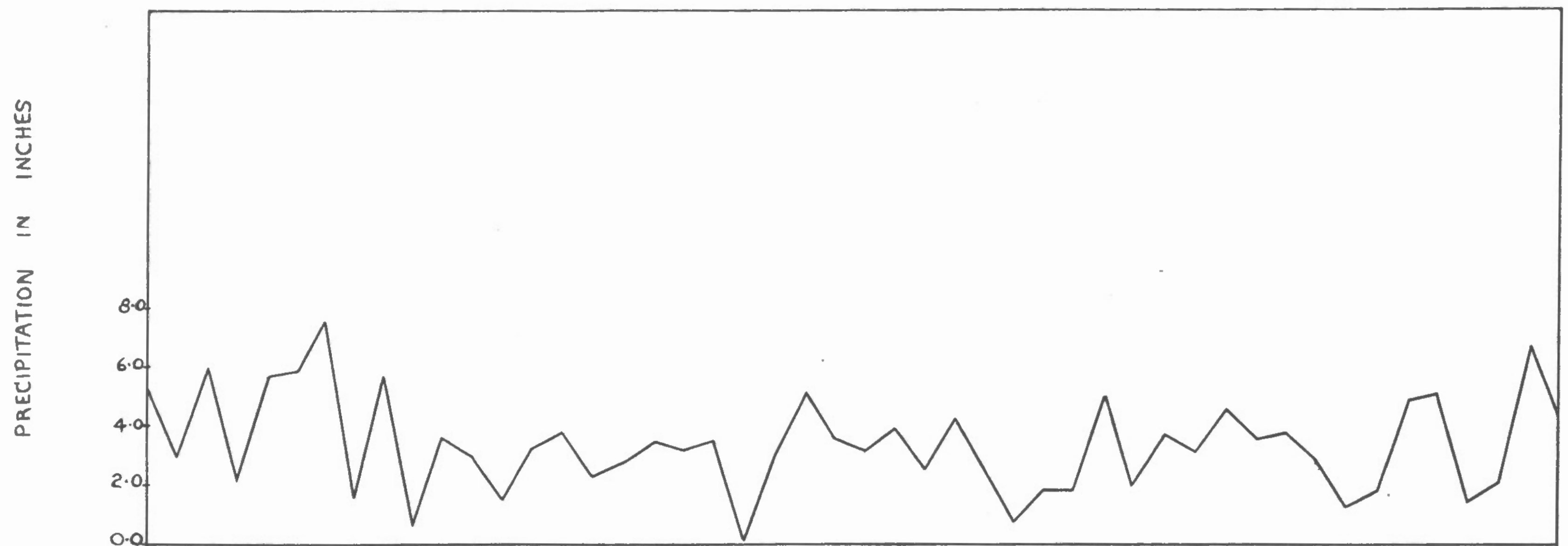
Community of Spencerville, Edwardsburgh Township, Grenville County, Ontario

1	2	3	4	5	6	7	8	9	10	11	12	13
1	6	26	Drl.	303	32	15	5	Ox.		H.C.	D.	Sufficient
2	6	26	Drl.	305	40		10	Ox		H.C.	D.	Sufficient for 2 families
3	6	26	Drl.	300			7	Ox.		H.C.	N.	
4	6	26	Drl.	290	36	8	1	Ox.		H.I.	D.	Sufficient.
5	6	27	Drl.	311	26	10	4	Ox.		H.C.	D.	"
6	6	27	Drl.	314	51	16	9	Ox.		S.C.	D.	Sufficient for 3 families
7	6	27	Drl.	316			9	Ox.		H.C.	N.	Sufficient
8	6	27	Drl.	320	90		0	Ox.		H.C.	D.	Sufficient.
9	6	27	Drl.	316	56		1	Ox.		H.C.	D.	"
10	6	27	Drl.	316	80		1	Ox.		H.C.	D.	Sufficient for 2 families
11	6	26	Drl.	305			15	Ox.		H.C.	D.	" " 3 "
12	6	26	Drl.	307	40	20	6	Ox.		H.C.	D.	Sufficient
13	6	26	Drl.	303	65	15	11	Ox.	14+	H.C.	D.	Sufficient for 5 families
14	6	27	Drl.	320	50	12	7	Ox.	10+	H.C.	D.	" " 3 "; 49°F
15	6	27	Drl.	317	65	8	10	Ox.		H.C.	D.	Sufficient
16	6	27	Drl.	310	80			Ox.		H.C.	D.	Sufficient
17	6	27	Drl.	316	45		4	Ox.		H.C.	D.	"
18	6	27	Drl.	319	30	15	3	Ox.	10+	H.C.	D.	Sufficient for 3 families
19	6	27	Drl.	302	17	3M.	7	Ox.		H.C.	D.	Goes dry in summer
20	6	26	Drl.	306	37	20	3	Ox.		H.C.	D.	Sufficient
21	6	27	Drl.	316	30		5	Ox.		H.C.	D.	"
22	6	27	Drl.	313				Ox.		H.C.	N.	
23	6	27	Drl.	312			4	Ox.		H.C.	D.	Sufficient
24	6	27	Drl.	316	39		4	Ox.		H.C.	D.	"
25	6	26	Drl.	302	32	10M	10	Ox.		H.C.	D.	Sufficient
26	6	27	Drl.	319			1	Ox.		H.C.	D.	"
27	6	27	Drl.	315	35			Ox.		H.C.	D.	"
28	6	26	Drl.	307	27	14M	3	Ox.	6+	H.C.	D.	Sufficient for 2 families; 48° F
29	6	27	Drl.	319			1	Ox.		H.Cl.	D.	Sufficient
30	6	26	Drl.	301	45		3	Ox.		H.C.	D.	" ; at house
31	6	26	Drl.	300	26			Ox.		H.Cl.	S.	" ; at barn
32	6	26	Drl.	299				Ox.	26+	H.C.	D.	Sufficient
33	6	27	Drl.	317			1	Ox.		H.C.	D.	
34	6	26	Drl.	303	90			Ox.		H.C.	D.	
35	6	26	Drl.	301		5M	7	Ox.		H.C.	N.	Vacant house
36	6	26	Drl.	302	60			Ox.	26+	H.C.	D.	Sufficient for service station

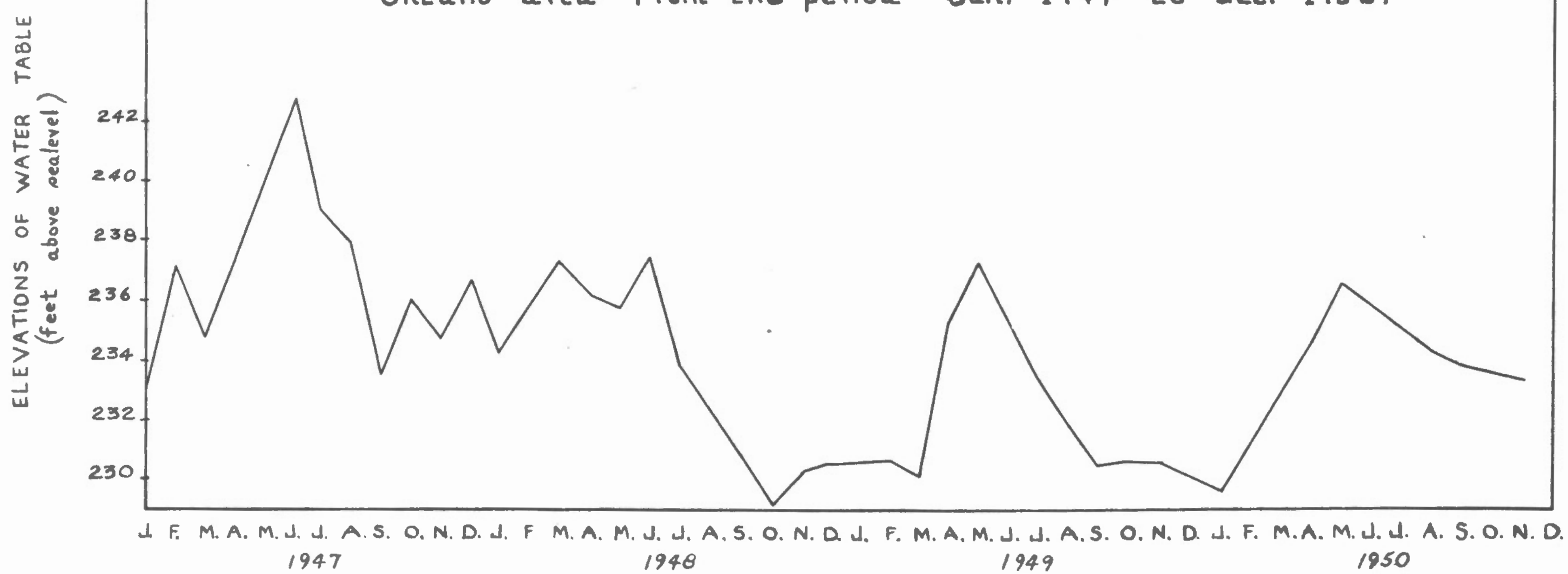
1	2	3	4	5	6	7	8	9	10	11	12	13
37	6	27	Drl.	322	22	15	4	Ox.	7+	H.Cl.	D.S.	Sufficient
38	6	26	Drl.	301	30	7	9	Ox.		H.C.	D.	Sufficient for Hotel; excellent supply
39	6	26	Drl.	302			6	Ox.		H.C.	N.	
40	6	26	Drl.	302		4M	3	Ox.		H.C.	D.	Sufficient; excellent supply
41	6	26	Drl.	304	85			Ox.	20+	H.C.	D.	Sufficient for 4 families
42	6	27	Drl.	310	44	13	1	Ox.		H.C.	D.	Sufficient
43	6	27	Drl.	305		6	6	Ox.		H.C.	D.	"
44	6	26	Drl.	303	60			Ox.		H.C.	D.	"
45	6	27	Drl.	317	85	25		Ox.		H.C.	D.	Sufficient
46	6	26	Drl.	301	21	8	4	Ox.	6+	H.C.	D.	Sufficient for 2 families
47	6	26	Drl.	304			4	Ox.	30+	H.C.	D.	Sufficient for 10 families
48	6	27	Drl.	315			4	Ox.		H.C.	D.	Sufficient for manse
49	6	27	Drl.	322	63+	25M		Ox.		H.C.	D	" " "
50	6	26	Drl.	306	66		2	Ox.		H.C.	D	" " "
51	6	27	Drl.	318	92		0	Ox.		H.C.	D.S.	Sufficient for **race track** excellent supply
52	6	25	Drl.	313	28		2	Ox.		H.C.	D.	Sufficient for school; excellent supply.
53	6	26	D.	300	13	6M	7	Ox.		H.C.	D.	"

Community of Ventnor Edwardsburgh township, Grenville county, Ontario

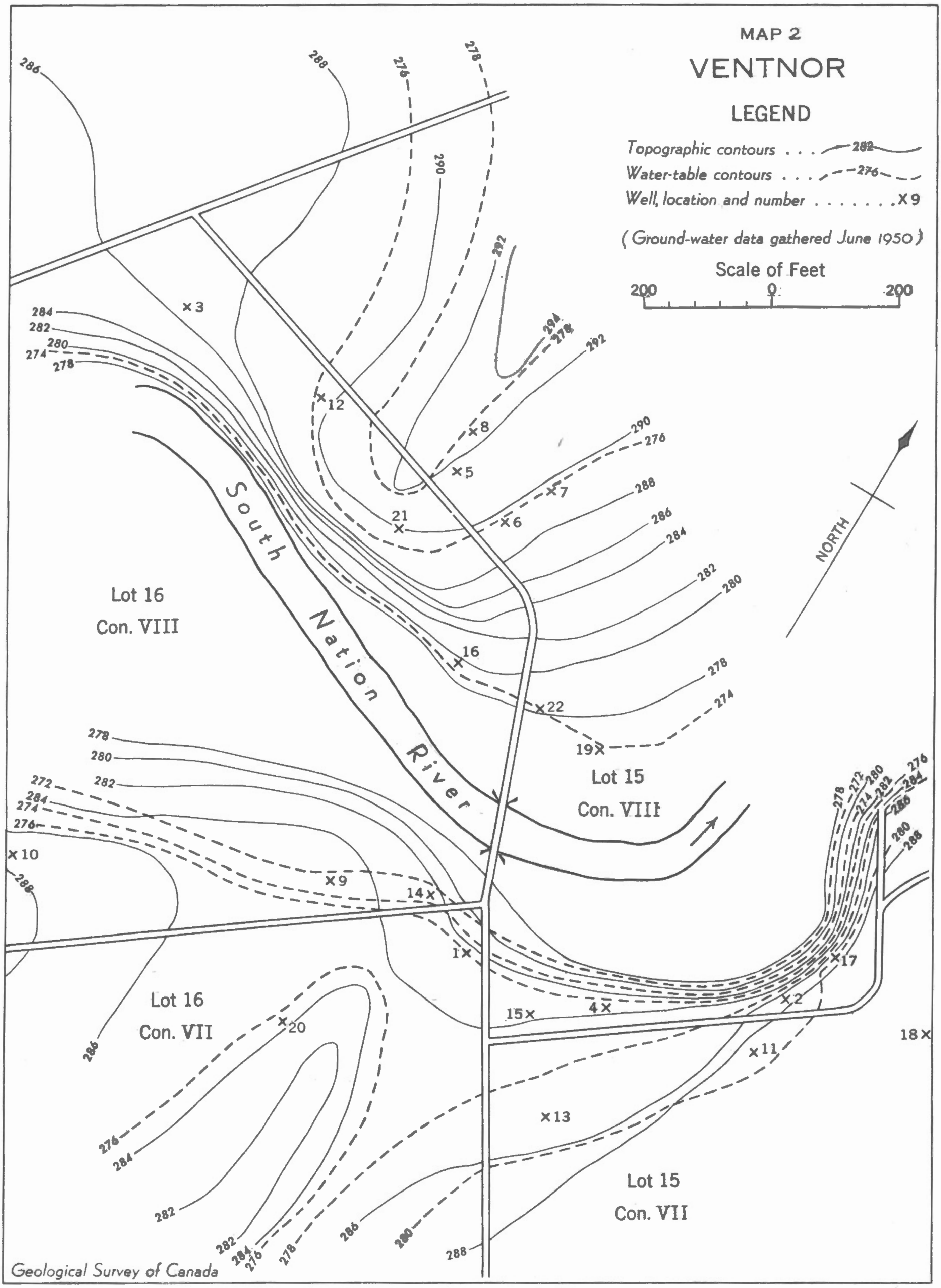
Well	Conc.	Lot	Type	Altitude in feet above sea-level	Depth (feet	Depth to Water Surface (feet) (June 1950)	Depth to Bedrock (feet)	Aquifer	Yield gals. per hour (approx)	Quality	Use	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13
1	7	16	Drl.	282	55	20	6	Ox.		H.C.	D	Excellent supply at house
2	8	15	D.	288	8	6		C.T.		H.C.	D	Goes dry during summer
3	8	16	Drl.	286	35	8	4	Ox.		H.C.	D	Sufficient for 2 families
4	8	15		284				Ox.			N.	Vacant house
5	8	16	Drl.	292	60M	15M	14	Ox.		H.C.	N	
6	8	16	D.	290			20	C.T.			N	
7	8	16	Drl.	290	60	14	20	Ox.	5+	H.C.	S	Sufficient; at barn
8	8	16	Drl.	292	60		20	Ox.		H.C.	D.S.	Excellent supply at store
9	8	16	Drl.	284	22M	11M	4	Ox.		H.C.	D.	Sufficient for 2 families
10	8	16	Drl.	288				Ox.		H.C.	D.	" " 2 "
11	7	15	D.	287	14M	8M		C.T.		H.C.	D.S.	Sufficient; at house
12	8	16	Drl.	290	29M	14M	7	Ox.		H.C.	D.	Sufficient for school and two families
13	7	15	D.	286	15M	7M		C.T.		H.C.	D.S.	Sufficient; at house
14	8	16	Drl.	280				Ox.		H.C.	D.	Low in summer; at house
15	7	15	Drl.	284			7	Ox.		H.C.	D.	" " " ; " "
16	8	16	Drl.	286	45+	2M	2	Ox.		H.C.	D.	Sufficient for cheese factory
17	7	15	D.	288	26M	8M		C.T.		H.C.	D.	Sufficient; at house.
18	7	15	Drl.	288	41M	16M	26	Ox.		H.C.	S.	Not sufficient for 11 head; at barn
19	8	15	D.	278	14M	4M		Al.(?)		H.C.	D.	Sufficient; at house
20	7	16	Drl.	284	30	12	5	Ox.	4+	H.C.	D.S.	Sufficient; at barn
21	8	16	Drl.	290		13M	13	Ox.		H.C.	D.	" ; at house
22	8	15	D.	278	14M	4M		Al.(?)		H.C.	D.	Seldom used.

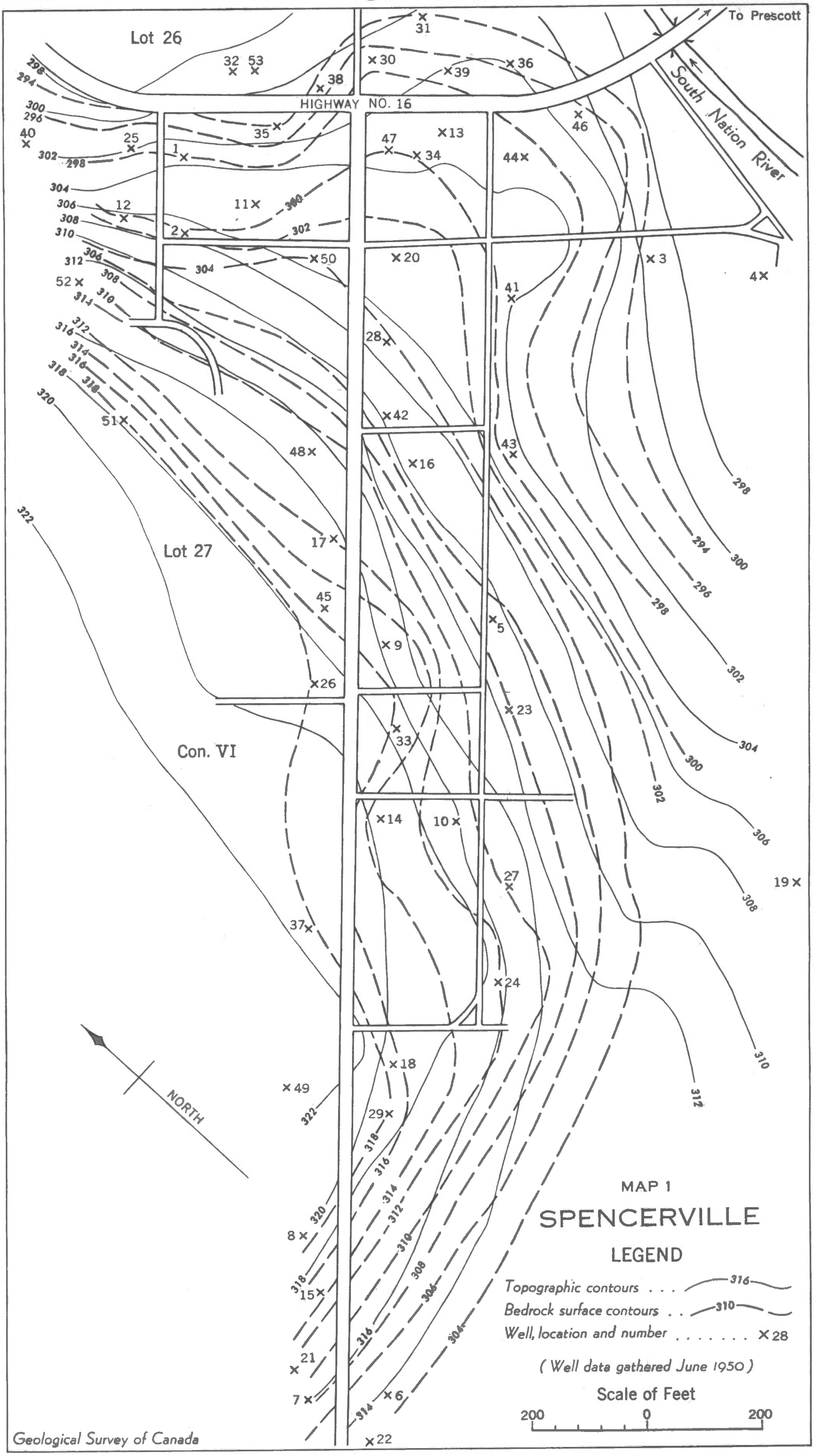


Graph depicting the amount of precipitation in the Morrisburg, Ontario area from the period Jan. 1947 to Dec. 1950.



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)


MAP 2
VENTNOR
LEGEND
Topographic contours . . . 282
Water-table contours . . . 276
Well, location and number X9
(Ground-water data gathered June 1950)
Scale of Feet
200 0 200
NORTH
South Nation River
Lot 16
Con. VIII
Lot 15
Con. VIII
Lot 16
Con. VII
Lot 15
Con. VII
Geological Survey of Canada


To Prescott
Lot 26
HIGHWAY NO. 16
South Nation River
Lot 27
Con. VI
NORTH
MAP 1
SPENCERVILLE
LEGEND
Topographic contours . . . 316
Bedrock surface contours . . 310
Well, location and number . . . . ×28
(Well data gathered June 1950)
Scale of Feet
200 0 200
Geological Survey of Canada