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CANADA
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GEOLOGICAL SURVEY OF CANADA
WATER SUPPLY PAPER No. 305

GROUND-WATER RESOURCES
OF
RAMA TOWNSHIP, ONTARIO COUNTY,
ONTARIO

By

R. E. Deane and E. I. K. Pollitt



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PART I

INTRODUCTION

This report deals with the ground-water conditions of part of an area in south-central Ontario investigated by the Geological Survey. The work was begun in 1945 and continued to 1948. The entire area covers approximately 1,600 square miles, and consists of Rama, Mara, Thorah, and Brock townships, Ontario county; Georgina, Gwillimbury North, and Gwillimbury East, York county; Gwillimbury West, Tecumseth, Adjala, Innisfil, Essa, Tosorontio, Oro, Orillia South, Orillia North, and parts of Vespra and Medonte townships, Simcoe county.¹ Similar reports

¹The material contained in Part I of this report refers to the entire area comprising all the townships mentioned. The general discussion of ground water is universally applicable. Part II deals specifically with the ground-water conditions of one township.

covering townships to the south of this area in York and Ontario counties have already been published².

²See Water Supply Paper Nos. 284, 285, 287, 288, 289, 290, 293, 294.

The water supplies throughout the entire area are derived mainly from ground water and are in many cases inadequate. The present report is an attempt to assemble the data in a form that will be useful to well drillers, farmers, municipal authorities, and others interested in obtaining new or additional water supplies.

This report does not contain a record of every well in the area. In some instances the information was not obtainable where wells had been abandoned and no records kept, or the wells were dug or drilled before the present owners gained possession of

the property. In other instances where the wells were closely spaced, as in villages and summer resorts, only a representative number of wells were surveyed. However, records were obtained on sufficient wells to depict the ground-water conditions.

As ground water is directly related to geology, both bedrock and surficial deposits were studied and mapped. All available information pertaining to some 8,450 wells was recorded and 323 water samples were collected for analysis. R. E. Deane mapped the surficial geology, and also directed the collection of water data. J. F. Caley studied the bedrock formations and aided in the organization of the work. Dr. Deane was ably assisted in the field by E. Kostener in 1945; E. B. Owen, J. A. Elson, and R. R. S. Miller in 1946; E. C. Halstead, N. Pring, D. K. Erb, and R. K. Mudford in 1947; and E. I. K. Pollitt, A. A. McGregor, K. E. Turner, R. C. Nelson, and D. H. Henshaw in 1948.

Thanks are here extended to the farmers throughout the area for their co-operation and willingness to supply information regarding their wells. Valuable assistance was given by the well drillers and by several municipal authorities who willingly supplied all available data.

To H. C. Rickaby, Deputy Minister of Mines for Ontario, and R. B. Harkness, Ontario Natural Gas Commissioner, thanks are here expressed for their hearty co-operation in the work.

Publication of Results

The essential information pertaining to ground-water conditions is being issued in reports covering each township in the area, and township authorities will be supplied with the information covering their respective townships. In addition, pertinent data on

each well have been compiled, and may be obtained from the Chief Geologist, Geological Survey of Canada, Ottawa. When requesting such additional information, the applicant should clearly state the exact location, giving the lot and concession, of the district about which data are required.

With each report is a map consisting of two figures. Figure 1 shows the glacial deposits and the bedrock formations, and Figure 2 shows the position of all wells for which records are available, the class of well at each location, topography, and bedrock surface contours.

The well records are compiled from data obtained by interviewing farmers and drillers, and in many cases the accuracy of the records depends on the memory of the farmer or driller. The wells are tabulated by lots and concessions in the townships, and the total depth of the well, depth to the water level, and, where possible, the depth at which the water-bearing horizon occurs are all listed. Wherever possible data were checked by plumb-line measurements to the nearest foot. The general character of the water is stated, and the use to which it can be put. Wells from which samples were taken for analysis are indicated on the well-record sheets. An idea of how much water a well can be expected to yield is suggested by the number of stock (cattle and horses only) that can be watered from it. One head is assumed to consume between 8 and 15 gallons of water a day. Unless followed by the word "only" the figure for the number of stock watered is not necessarily the maximum yield of the well, but simply the greatest amount that the present user has required. The word "only" indicates that the figure given is the maximum yield of the well.

To obtain the position of an aquifer at any given point, the elevation of the point should be determined from the surface

contours on Figure 2 of the map. Elevations of adjacent wells may be found in the well records and the depth to the aquifer can usually be determined from them. By comparing elevations, the depth of the aquifer below the unknown point may be estimated. This method is particularly applicable to bedrock wells, but may not be successful where information is too limited, or where the glacial drift is thick and of an irregular character. In such instances a person searching for water should refer to the text for information on the nature of the deposits in that area. The thickness of drift at any place may be obtained by subtracting the elevation of the bedrock surface from the surface elevation in Figure 2 of the map.

GLOSSARY OF TERMS USED

Alluvium. Recent deposits of clay, silt, sand, gravel, and other material 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, or springs.

Bedrock. Bedrock, as here used, refers to consolidated deposits of shale, limestone, dolomite, sandstone, granite, or granite-gneiss that underlie and are older than the glacial drift.

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

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

Escarpment. A cliff or relatively steep slope, usually of bedrock, separating two level or gently sloping areas.

Flood Plain. A flat part of a river valley ordinarily above water, but submerged when the river is in flood.

Glacial Drift. A general term that includes all the loose, unconsolidated materials that were deposited by the ice-sheet, or by the waters associated with it. Clay containing boulders usually forms a large part of the glacial drift in an area, and is called till, and is not to be confused with the more general term glacial drift, which occurs in the following forms:

(1) End (Recessional) Moraine. A ridge or series of ridges, usually of sandy or boulder-clay till, that was laid down at the margin of a moving ice-sheet. The surface is characterized by irregular hills and undrained basins.

(2) Kame Moraine. Similar in origin to an end moraine except that the material is assorted sand and gravel. The topography is similar to that of an end moraine.

(3) Ground Moraine. A sandy or boulder-clay till plain deposited beneath the ice-sheet. The topography may vary from flat to gently rolling.

(4) Drumlin. A ridge-like, or smooth, oval hill composed mainly of glacial till, which has its long axis parallel with the direction of ice movement at that place. They seldom are found singly, usually in groups or 'fields'.

(5) Ice-block Ridge. A sinuous, branching, or elliptical ridge from 4 to 8 feet high, composed of sandy till. Small swamps or ponds are usually found within the elliptical ridges or between the sinuous types.

(6) 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.

(7) Kame Terrace. Flat, discontinuous deposits of assorted sand and gravel deposited in water at the front of a glacier. Generally found along the sides of valleys.

(8) Outwash. Sand and gravel plains or deltas formed by streams that flowed from the continental ice-sheet.

(9) Esker. Long, sinuous, sometimes discontinuous, ridge of assorted sand and gravel deposited in a glacial stream that flowed beneath the continental ice-sheet.

(10) Lacustrine or Glacial-lake Deposits. Sand, silt, and clay deposited in glacial lakes during the retreat of the ice-sheet.

(11) Bay-mouth Bar. A ridge of assorted sand and gravel formed across the mouth of a glacial-lake bay.

(12) Beach Ridge. A ridge of assorted sand and gravel formed parallel with, and close to, the shoreline of a glacial lake.

(13) Spit. A ridge of assorted sand and gravel extending out from the shoreline of a glacial lake.

Ground Water. The subsurface 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 in the well.

Impervious or Impermeable. Beds of such material as fine clay 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 sands, 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.

Shoreline. A continuous, or discontinuous, steep slope or bluff that indicates the former margin of a glacial lake.

Unconsolidated Deposits. The loose material overlying the bedrock. It consists of Glacial or Recent deposits of boulders, gravel, sand, silt, or 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. A water-table is said to be perched when a zone of saturated material is held above the main water-table by a zone or zones of impervious material.

Wells. The term refers to any hole sunk in the ground by any means for the purpose of obtaining water. If 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 (Subartesian) Wells. Wells in which the water is under sufficient hydrostatic pressure 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.

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 as run-off; part evaporates, either directly from the surface and from the upper mantle of soil, or indirectly through transpiration of plants; the remainder sinks into the ground to be added to the ground-water supplies.

The proportion of the total precipitation that sinks below the ground will depend largely upon the type of soil or surface rock, and on the topography. More water will sink into sand and gravel, for example, than into clay, and if the region is hilly and dissected by numerous streams, more water will be immediately drained from the surface than in a relatively flat area. Light, continued precipitation will furnish more water to the underground supply than brief torrential downpours, during which the run-off may be nearly equal to the precipitation. Moisture falling on frozen ground will not usually find its way below the surface, and, therefore, will not materially replenish the ground-water supplies. Light rains falling during the growing season may be wholly absorbed by plants. The quantity of moisture lost through direct evaporation depends largely upon temperature, wind, and humidity.

Because of the large consumption of ground water in settled areas, it may seem surprising that precipitation can furnish an adequate supply. The average monthly and annual precipitation in

inches at Orillia, observed over a period of 38 years, is as follows:¹

¹Data from Climatic Summaries for Selected Meteorological Stations in the Dominion of Canada, Vol. 1, Meteorological Division, Department of Transport, Canada.

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
2.63	2.21	2.00	1.95	2.68	2.80	2.79	2.56	3.09	3.16	3.40	2.99	32.26

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, it will be seen that each year some 468,400,000 gallons fall on each square mile in the Orillia area. If we estimate that only 10 per cent of this, namely 46,840,000 gallons per square mile, is contributed to the underground supplies, it seems reasonable to conclude that precipitation is adequate to furnish ample supplies of ground water to the area, particularly when estimates based on per capita consumption show it to be only about one-tenth of the annual recharge as shown above. However, several factors complicate the problem.

The annual precipitation within the area varies considerably from place to place and from year to year. The precipitation at meteorological stations within the area is given on page 11. It will be seen that in 1946 and 1948 it was less than in 1945 and 1947. More water is used during the summer months when, in general, there is less precipitation; in Barrie and Orillia up to 2,000,000 gallons per day is used. Shallow dug wells may become dry due to a lowering of the water-table, which may result from periods of drought, excessive rain run-off on cleared land, and wastage of water, particularly by unnecessary artesian flow.

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 water-saturation. Water that sinks into the ground finds its way downward to where it either reaches this water-table or comes in contact with an impervious layer such as clay or shale. Such a layer may stop further downward percolation, resulting in perched water. If the 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.

All soils and rocks are to some degree porous, that is, the individual grains or particles of which they are composed are partly surrounded by minute open spaces or pores. Water stored within the soil and rocks fills these spaces. A clay or a fine-grained rock such as shale, or limestone, may have such small pores that the contained water will not flow readily. Such material is considered impervious and wells sunk in it may obtain little or no water. Material with larger pores, on the other hand, readily yields its water to wells and beds of it are called water-bearing beds or aquifers. Sand, gravel, and porous sandstone form good aquifers, a clean gravel being one of the best as it is sufficiently porous to yield its water freely. In places, limestone may contain solution channels or cracks through which the water can pass and thus be a good aquifer.

Many shallow wells that derive their water from just below the water-table become dry because of lowering of the water-table below the bottom of the well. So long as the annual recharge is equal to or greater than the loss through consumption and underground drainage, there will be no permanent lowering of the watertable, and hence wells sunk below this level will have a permanent supply. If, however, the annual precipitation were to decline over a period

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PRECIPITATION IN INCHES AT VARIOUS OBSERVATION STATIONS¹

Station	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Angus	1945	2.5	3.5	2.6	4.6	4.7	4.4	3.2	0.6	4.3	3.4	1.6	1.7	37.1
	1946	2.6	1.8	0.6	0.5	3.4	1.0	2.4	2.1	-	2.3	1.3	2.4	-
	1947	2.4	0.8	2.5	0.3	2.7	3.6	5.0	-	-	-	2.1	2.6	-
	1948	2.4	0.6	3.1	2.7	2.4	2.3	-	-	-	-	-	1.5	-
Beaverton	1948	-	-	-	3.0	2.3	3.1	4.3	1.8	1.4	3.2	3.2	2.0	-
Beeton	1945	1.1	1.8	2.0	3.1	5.3	3.4	4.6	0.9	4.3	3.8	2.0	1.3	33.6
	1946	2.2	2.4	0.7	0.6	2.5	1.8	1.8	2.0	1.5	2.7	1.2	2.3	21.7
	1947	2.8	0.7	2.1	1.7	5.3	3.7	4.5	0.1	-	0.1	1.0	1.4	-
	1948	1.6	0.7	5.8	3.0	2.4	4.2	3.2	2.3	2.0	2.3	3.4	3.0	34.1
Coldwater	1945	6.1	4.9	-	-	-	-	-	-	-	3.6	2.9	3.5	-
	1946	5.6	5.8	-	-	-	-	-	-	2.8	2.7	2.8	-	-
	1947	7.6	4.0	3.4	4.6	4.1	5.2	-	-	-	0.9	6.9	2.5	-
	1948	3.6	2.7	4.5	-	-	-	-	-	2.3	3.6	2.8	3.6	-
Collingwood	1945	3.2	1.6	1.3	1.8	2.0	1.5	1.6	0.6	2.5	2.5	1.4	2.4	22.4
	1946	4.4	1.8	-	0.1	1.5	0.4	2.2	0.8	0.5	1.3	0.6	4.7	-
	1947	3.8	1.2	3.0	1.4	1.9	1.1	5.1	2.1	0.8	1.0	1.8	3.9	27.1
	1948	2.0	0.8	1.7	0.8	1.2	0.6	1.1	0.6	0.9	1.3	1.2	2.7	14.9
Orillia	1945	1.4	2.2	3.0	2.8	4.5	3.0	3.1	2.6	4.9	3.5	2.8	-	-
	1946	3.8	2.3	1.1	1.3	3.6	2.1	1.8	1.7	1.6	2.8	3.2	5.7	31.0
	1947	-	1.1	2.8	3.7	-	4.3	4.2	-	1.9	0.9	-	-	-
	1948	-	-	3.9	2.5	2.8	1.3	2.6	3.1	1.8	3.2	3.4	2.4	-
Pefferlaw	1948	-	-	-	-	2.1	6.0	3.8	1.8	0.9	3.0	3.0	-	-
Washago	1945	2.4	1.8	2.1	2.8	4.4	4.1	2.4	1.3	4.7	4.2	2.7	1.8	34.7
	1946	3.5	3.2	1.3	1.2	3.9	2.2	1.4	1.4	3.0	2.8	2.8	4.6	31.3
	1947	4.0	1.2	2.5	4.0	4.4	3.0	4.8	1.0	2.5	1.3	3.9	3.5	36.1
	1948	2.7	1.2	4.0	2.6	2.8	1.9	3.1	2.1	2.4	3.2	4.3	2.6	32.9

¹Extracts from the Monthly Weather Map, Meteorological Service, Dominion of Canada

of years, the quantity of water available for recharging the underground supply would necessarily decrease, and if it were to decrease to a point where loss through consumption and underground drainage was greater than the annual recharge, the level of the water-table would be lowered and wells would go dry.

Although springs are utilized in some parts of the area, the chief method of recovering the ground water is by means of wells. Two types of wells are in common use, namely, dug wells and drilled wells, the former outnumbering the latter. Sand points, or driven wells are used in certain localities. In places where the aquifer yields its water slowly, dug wells, because of their greater storage capacity, are more satisfactory than drilled wells. However, if proper precautions are not taken, dug wells are more likely to become contaminated by polluted surface waters, especially in barnyards. Ground water for industrial and commercial uses, where larger quantities are required, is commonly obtained from the deeper drilled wells. When drilling such wells, the shallow and unsatisfactory supplies can be cased off and drilling continued to where adequate supplies are encountered.

The wells have been classified as artesian and non-artesian, and artesian wells are further subdivided into flowing artesian and non-flowing artesian. A fourth class, called intermittent non-artesian, comprises those wells that dry up periodically.

DESCRIPTIONS OF FORMATIONS AND THEIR WATER-BEARING PROPERTIES

Bedrock Formations

The bedrock formations that underlie the area are listed in the following table:¹

¹Caley, J. F.: Geology and Economic Minerals of Canada, 3rd edition; Geol. Surv., Canada, Econ. Geol. Ser. No. 3, p. 163 (1947).

Table of Formations

Period	Formation	Thickness (feet)	Lithology
Ordovician	Queenston	349-400	Red, in part sandy, shale
	Meaford	120 †	Grey, bluish, and brownish shale, with thin layers of limestone; calcareous sandstone and arenaceous shale
	Dundas	250 †	Grey and blue shale; thin sandy beds; thin, lenticular limestone beds
	Gloucester (Blue Mountain) and Collingwood	100-250	Dark grey to nearly black, slightly bituminous shale
	Cobourg and Trenton Leray Lowville and Pamela	550	Chiefly grey limestone, in places dolomitic and shaly; red and green shale, sandstone, and arkose locally found at the base
Precambrian			Granite and granite-gneiss; altered volcanic and sedimentary rocks

Precambrian. These rocks consist of granite, granite-gneiss, and altered volcanic and sedimentary formations that underlie the Palaeozoic sediments unconformably. They are not an important source of water in the area except in the northern parts of the counties of Simcoe, Ontario, and Victoria, where the water occurs in joints and fissures. Where these rocks lie close to the surface the water is potable, but where deeply buried by drift or Palaeozoic strata the water is reported to be highly mineralized. Within the area, the Precambrian rocks are exposed only in Orillia North and Rama townships.

Pamelia, Lowville, Leray, Trenton, and Cobourg Formations.

This succession of Ordovician strata consists predominantly of grey and blue-grey limestone and varies from a few feet thick in the northern part of the area to at least 550 feet thick in the southern part. Red and green shale, and coarse sandstone and arkose, probably representing the Pamelia formation, rest unconformably on the Precambrian rocks, and are exposed in parts of Rama and Orillia North townships. In places these basal beds are missing and limestone or dolomitic limestone of the Lowville formation rests directly on the granitic rocks. Lowville and Leray strata are exposed in parts of Medonte, Orillia North, Rama, and Mara townships; elsewhere within these townships, and in the northern part of Orillia South township, these two formations underlie the drift. The grey limestone of the Trenton formation, underlying the drift in more townships than any other formation, outcrops only in Mara and Thorah townships. It underlies the southern parts of Medonte, Orillia South, and Mara townships; all of Oro, Innisfil, Gwillimbury North, and Thorah townships; and the northern parts of Tosorontio, Essa, Georgina, Brock, Gwillimbury West and Gwillimbury East townships. The grey, argillaceous limestone of the Cobourg formation is exposed only in Pefferlaw Brook in Georgina township.

Water found in these rocks occurs along the joint and bedding planes and in fracture and solution openings. The limestone generally yields abundant water, but in places is too fine grained and compact to transmit water freely. The coarse sandstone or arkose also contains a considerable quantity of water. Where these rocks lie close to the surface they generally contain potable water, but where deeply buried by drift the water is commonly highly mineralized and may be unfit for domestic use.

Collingwood and Gloucester (Blue Mountain) Formations. The Collingwood formation, about 30 feet thick, consists of black shale with some limestone bands and is overlain by about 120 feet of thin, and evenly bedded, soft, bituminous shale of the Gloucester or Blue Mountain formation. These strata are not exposed anywhere within the area, but underlie the drift in parts of Gwillimbury East, Gwillimbury West, Tecumseth, Essa, and Tosorontio townships.

Some water occurs along the bedding planes of these strata, but the quantity recoverable is small and the water saline.

Dundas and Meaford Formations. The Dundas formation is prevailingly a bluish grey, thin-bedded shale that weathers to a somewhat lighter colour. There is, however, some variation from compact, blue, argillaceous shale to buff or yellowish, silty, and frequently arenaceous rock. Hard bands, both calcareous and arenaceous, occur interbedded with the shale; they rarely exceed a foot in thickness, the average being only a few inches. The formation is about 250 feet thick. It is exposed nowhere within the area, but underlies the drift in parts of Tosorontio, Adjala, and Gwillimbury West townships and in most of Tecumseth township. In this report the Dundas formation is not separated from the Meaford formation, which consists of grey to bluish and even brownish, fissile shale with interstratified hard

layers that vary in composition from impure calcareous sandstone to rather pure crystalline limestone. The Meaford formation is not exposed within the area but underlies the drift in Adjala township.

Water occurs along the bedding and joint planes of these two formations, but generally they are not good sources as the water is saline and not suitable for domestic needs.

Queenston Formation. The Queenston formation consists of brick-red, thin-bedded, compact shale. It outcrops or underlies the drift only in the western part of Adjala township. The rock is a poor source of water, which is commonly too saline for domestic use.

Unconsolidated Deposits

During the Pleistocene or glacial epoch, great accumulations of ice formed at various centres in northern Canada. This ice moved out in all directions from these centres and covered large regions with what has been called the continental ice-sheet. As the glacier advanced, it picked up great quantities of loose debris and bedrock, which was deposited when the ice finally melted. This material is unconsolidated, and is commonly called glacial drift. The ice-sheet advanced and retreated several times, and on each retreat left an accumulation of drift on the surface over which it passed.

In the northern part of the area the mantle of glacial drift is thin or entirely absent, but increases in thickness towards the south where it reaches a maximum of about 400 feet. The drift is composed of: (1) glacial material deposited directly by the ice, mainly as till; (2) glacio-fluvial material deposited in streams flowing off the ice, mainly as silt, sand, and gravel; and (3) glacio-lacustrine material deposited in lakes, mainly as clay, silt, and sand. This drift, together with Recent deposits of alluvium and

swamp muck, constitutes the unconsolidated deposits in the area. The **till** consists of boulders and pebbles of various compositions and sizes embedded in a matrix of sand, silt, or clay. If the matrix is silt or clay the till may be more or less impervious to water. Irregularly intermingled with an impervious till, and also lying above, below, and between successive till sheets, are beds, pockets, and lenses of sand and gravel that form the water-bearing members or **aquifers** of the drift. The sand and gravel deposits of glacio-fluvial and glacio-lacustrine origin are pervious to water. Fine silt and **clay** of glacio-lacustrine deposits may be impervious, but again sandy lenses or beds intermingled with the finer material permit a slow but steady passage of water.

The following types of drift occur in the area:

Ground Moraine. Ground moraine is the most extensive of all the glacial deposits and is found covering the surface to varying extent in all townships. The material is generally a heterogeneous mixture of clay, silt, sand, pebbles, and boulders, although one or more of these constituents may predominate. The till may enclose irregularly distributed lenses and pockets of sand and gravel, or overlie beds of water-laid sand and gravel.

Because of the flat to gently undulating topography of ground moraine, much of the precipitation that falls on the surface seeps into the ground and becomes available as ground water. This water is generally to be found at depths of 40 feet or less; in depressions the water-table is closer to the surface, whereas in heights of land it may be deeper. Dug wells are generally the most satisfactory for domestic supplies, particularly in a clay or boulder-clay till. Larger supplies for industrial and municipal purposes can be expected from the included lenses and pockets of sand and gravel.

Because of the erratic distribution of the lenses and pockets it is not possible to predict the depth at which water may be encountered in any particular locality, nor the quantity a well will produce.

End Moraine. Part of the load carried by the continental ice-sheet was dropped as end moraine at the front or margin of the glacier during pauses in the general retreat of the melting ice. One such pause is marked by a low end moraine ridge in Rama and Mara townships. The material is mainly a boulder-clay till mixed with silt, sand, and gravel. Water may be obtained from the ridge, but the water-table is farther from the surface on the ridge than it is on the plain on either side of the moraine.

Kame Moraine. A deposit that also marks a pause in the retreat of the ice-front is the kame moraine. It differs from the end moraine in that the material is mainly sand and gravel, the silt and clay being carried away by the melt waters in which the sand and gravel were deposited. The hilly topography of the region in the northern part of Oro township and the southern part of Medonte township is typical of kame moraine. The sand and gravel of the kame moraine overlies till of either ground moraine or end moraine, hence the thickness of the deposit varies considerably. Owing to the porous nature of the material, rain is readily absorbed into the ground and the potential water supply should be adequate. On the hills the water-table may be from 150 to 200 feet below the surface, whereas in the depressions or kettles good water supplies are obtained at depths as shallow as 15 feet.

Kame Terraces. These sand and gravel deposits were laid down in temporary lakes or streams between high land on one side and the ice-front on the other. When the ice melted streams washed away the steep face of the terraces until now only remnants remain. These dissected terraces are common in Adjala and Tosorontio townships

where the water was ponded between the ice and the Niagara escarpment. Smaller terraces occur along the finger-like valley walls south and west to Lake Simcoe. Owing to excessive drainage in the porous sand and gravel the water-table is low at the top of the terrace near its face, although springs and swamps are common at the base of the slopes.

Glacial-lake Deposits. These deposits include layered clay, called varved clay, that was carried by glacial streams into Lakes Schomberg and Algonquin, and the sand that accumulated on the shore and bottom of Lake Algonquin. These deposits vary in thickness from a few feet to over 200 feet. Erosion has dissected the varved clay and silt deposits of Lake Schomberg leaving a rolling topography. In places the water-table is about 50 feet below the surface and the fine-grained material yields its water slowly. The Lake Algonquin clay, silt, sand, and gravel occur in valley bottoms and depressions, and hence the water-table is within a few feet of surface and shallow dug wells procure an adequate water supply. Sand points may be utilized in thick surface deposits of sand and fine gravel.

Eskers. These are long sinuous ridges of sand and gravel laid down in glacial streams flowing under the ice-sheet. Such ridges occur in the southeast part of Brock township. Owing to the porous nature of the coarse sand and gravel the water drains out of the ridges into the low areas on either side and water may be obtained at shallower depths in these adjacent low areas than on the ridge.

Outwash. Small flat-lying areas of sand and gravel washed out from the front of the melting ice-sheet occur in Innisfil and Oro townships. These deposits are porous and readily absorb rain

falling upon them. They rest on an undulating surface of ground or end moraine, and hence the depth to the water-table is variable.

Drumlin. These oval hills are usually found in groups or 'fields'. One such field is in Mara and Rama townships, and another in Brock township. Drumlins are found in all of the other townships but not as concentrated as in the two above fields. Drumlins are formed beneath advancing ice and the material may have been deposited, layer on layer, to give the present shape, or the drumlin fields may have originally been covered with thick drift and the drumlins represent that part of the drift not eroded away by the ice. They are usually composed of till, but many of the larger drumlins contain some sand and gravel. Farm houses are commonly situated on the tops of drumlins. The water-table may be 50 or 60 feet from the surface on the top of a drumlin, whereas on the side or in the swale between adjacent drumlins 15 to 20 feet may suffice to reach water. Springs are common near the base of the slope along the sides of the drumlins.

GENERAL DISCUSSION OF GROUND-WATER ANALYSES

Both the kind and quantity of mineral matter dissolved in a natural water depend upon the texture and chemical composition of the rocks and upon the time during which the water has been in contact with them. Pollution is caused by contact with organic matter or its decomposition products.

Three hundred and twenty three samples of well water from the area were analysed for their mineral content in the Laboratory of the Bureau of Mines, Department of Mines and Technical Surveys, Ottawa. No examination was made for bacteria, and hence a water that may be termed suitable for use on the basis of its mineral

content might be condemned by reason of its bacterial content. Bacteriological analyses are made by the Provincial Department of Health, Toronto. As a rule waters high in bacteria have been contaminated by polluted surface water.

The analyses are given in parts per million, that is, in parts by weight of the constituents in 1,000,000 parts by volume of water. Salts when dissolved in water separate into two chemical groups; one group includes the metallic elements of calcium (Ca), magnesium (Mg), sodium (Na), and iron (Fe), and the other group includes the radicals; sulphate (SO_4), chloride (Cl), bicarbonate (HCO_3), carbonate (CO_3), and nitrate (NO_3). The radicals listed in the analyses tabulated in the second part of this report can be combined with the elements to give the actual quantity of the particular salts present in the water, although this is not done here as the radicals alone give enough information to identify the water types.

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

Silica (SiO_2) is dissolved in small quantities from almost all rocks. It is not objectionable except in so far as it contributes to the formation of boiler scale.

Iron (Fe) in combination is dissolved from many rocks as well as from iron sulphide deposits with which the water comes in contact. It may also be dissolved from well casings, water pipes, and other fixtures in quantities large enough to be objectionable. The iron separates as the hydrated oxide upon exposure of the water to the atmosphere. Excessive iron in water causes staining on porcelain or enamelled ware, and renders the water unsuitable for

laundry purposes. Water is usually considered not potable if the iron content is more than 0.5 part per million.

Calcium (Ca) is dissolved from almost all rocks, although the chief sources are limestone, dolomite, and gypsum. The common compounds of calcium are calcium carbonate (CaCO_3) and calcium sulphate (CaSO_4), both of which cause hardness in water. Calcium salts in minor quantities have no injurious effects.

Magnesium (Mg). Dolomite and many of the igneous rocks are sources of magnesium. The sulphate of magnesium ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$) is known as 'Epsom salts' and renders the water unwholesome if present in large amounts.

Sodium (Na) is found in all natural waters in various combinations, although in this area it is usually combined with chloride to form NaCl (common salt). Sodium salts may be present as a result of pollution by sewage, or they may be derived from contact of the water with marine sediments. No estimate of potassium (K) has been made, and any that may be present has been included as sodium. Moderate quantities of these constituents have little effect upon the suitability of a water for ordinary uses, but waters containing sodium in excess of about 100 parts per million when used in steam boilers may require careful operation 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.

Sulphates (SO_4) referred to in this report are those of calcium, magnesium, and sodium, and have been mentioned above in referring to these elements. The sulphate is derived from deposits such as hydrous calcium sulphate (gypsum) and sodium sulphate, and to a minor extent from the oxidation of iron sulphide. Sulphates in

combination with calcium and magnesium cause permanent hardness in water and injurious boiler scale. They also increase the cost of softening the water.

Chloride (Cl) is a constituent of all natural waters. Waters from wells that penetrate brine or salt deposits contain large quantities of chloride, usually as sodium chloride (common salt) and less commonly as calcium chloride and magnesium chloride. Sodium chloride is a characteristic constituent of sewage, and any locally abnormal quantity may suggest pollution from this source. However, such abnormal quantities should not, in themselves, be taken as positive proof of pollution in view of the many sources from which chloride may be derived. Chlorides impart a salty taste to water, and if present much in excess of 300 parts per million render it unfit for domestic use.

Nitrates (NO_3) found in ground water are decomposition products of organic materials. They are not harmful in themselves, but they do point to probable pollution. It is recommended that a bacterial test be made on water showing an appreciable nitrate content if it is to be used for domestic purposes.

Carbonates (CO_3) in water are indicated in the table of analyses as 'alkalinity'. Calcium and magnesium carbonate cause temporary hardness in water, which may be partly removed by boiling. Sodium carbonate causes softness in waters, and is referred to under 'Sodium' above.

Bicarbonate (HCO_3). Carbon dioxide dissolved in water renders the insoluble calcium and magnesium carbonates soluble as bicarbonates. The latter are decomposed by boiling the water, which changes them back to insoluble carbonates.

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 amount of soap that must first be used to precipitate the above compounds before a lather is produced. The hardness of water in its original state is its total hardness, which may be either 'permanent hardness' or 'temporary hardness'. Permanent hardness remains after the water has been boiled. It is caused by mineral salts that cannot be removed from solution by boiling, but that 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. Waters containing large quantities of sodium carbonate and small amounts of calcium and magnesium compounds are soft, but if the proportion is reversed the water is hard. The following table¹

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

may be used to indicate the degree of hardness of a water.

<u>Total Hardness</u>		
<u>Parts per million</u>		<u>Character</u>
0-50		Very soft
50-100		Moderately soft
100-150		Slightly hard
150-200		Moderately hard
200-300		Hard
300 and over		Very hard

The water samples analysed were taken from wells that varied in depth from a few feet to over 400 feet. All of the dug wells are in drift, but many of the drilled wells penetrate the bedrock. The water showed slight variation in both total dissolved solids and the quantities of the individual constituents. In general all the waters are hard, due to the dissolved calcium carbonate, but with few exceptions the waters are quite suitable for domestic and stock purposes as well as for industrial uses. Softening would be desirable for laundry purposes. None of the water analysed from

wells in drift contains sufficient salts to render it injurious to crops and so unsuitable for irrigation.

The term 'total dissolved solids' 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 this figure provided they are otherwise satisfactory. Residents accustomed to the waters may use those carrying considerably over 1,000 parts per million of total dissolved solids without inconvenience, although persons not used to highly mineralized waters would find them objectionable.

PART II

RAMA TOWNSHIP, ONTARIO COUNTY, ONTARIO

Physical Features

Rama is the most northerly township of Ontario county. That part of the township north of latitude $44^{\circ}45'$ is not included in this report, as it has not been mapped on the same scale as the remainder of the township. The topographic features and water conditions of the unmapped part are similar to those of the area lying immediately south of it.

Three distinct physiographic divisions can be recognized. The first is the area lying north of the Precambrian-Palaeozoic contact shown in Figure 1. Innumerable granite outcrops occur in this area and give it a rugged appearance although it is actually a plain, for the relief is low with few outcrops rising more than 25 to 30 feet above the intervening flats. The drift in these flats is relatively thin, rendering this part of the township generally unsuitable for agriculture. The second division is the plain in the east half of the township south of the Precambrian-Palaeozoic contact that is underlain by limestone. The small, flat area between Lakes St. John and Couchiching is a continuation of this limestone plain. The surface is flat, but broken here and there by small escarpments from 3 to 25 feet high that give a step-like appearance to the plain. This part of the township is best suited to cattle grazing. The third division is the drumlin field in the west half of the township south of Lake St. John. This field extends southward into Mara township. The long, ridge-like hills of the drumlins and the clay-floored flats between them are suitable for agriculture.

The township as a whole has very little relief. The lowest part, along the shoreline of Lake Couchiching, is at an elevation of 718 feet above sea-level. From the lake the land rises

gently towards the limestone plain where the highest part is about 850 feet.

Because of the flatness drainage is generally poor. Depressions in the Precambrian area, in the limestone plain, and between many of the drumlins are occupied by swamps. Black River, with its tributary Head River, are the main streams in the township. Head River closely follows the Precambrian-Palaeozoic contact until it joins Black River, which flows between low banks of granite rocks to join Severn River east of Washago. In addition to Lake Couchiching there are two small lakes, St. John and Mud. The outlets of Lake St. John are St. Johns Creek and a canal, both emptying into Black River. Lake Couchiching is an ideal summer resort and its shoreline in Rama township is thickly populated with summer residents.

Geology

Bedrock Formations. Precambrian granite and granite-gneiss lie at or near the surface north of the contact shown in Figure 1. The outcrops are usually low and smoothly rounded near the contact, but become increasingly more rugged farther to the north. Sedimentary rocks of Ordovician age are exposed or thinly covered with drift south of the contact. Arkose or sandstone of the Pamela formation occurs on the east side of Lake St. John. A small outcrop of red and green shale of this formation is found just west of the Atherley branch of the Canadian National Railway $1\frac{1}{4}$ miles north of Lake St. John, and other isolated patches outcrop in parts of the limestone plain. Limestone of the Lowville and Leray formations comprises the greatest extent of Ordovician rocks, with minor amounts of Trenton limestone in the higher parts of the limestone plain.

Unconsolidated Deposits. All of Rama township was covered by the waters of glacial Lake Algonquin; consequently, much of the

bedrock surface and glacial drift have been covered by lacustrine deposits or otherwise modified. Wave action during the existence of Lake Algonquin washed the thin drift covering from the outcrops in the Precambrian and limestone plain areas, and flooded the depressions with sand, silt, or clay of various thicknesses. The lacustrine deposits are mainly sand in the Precambrian area and clay in the Palaeozoic area. The material thus reflects the underlying bedrock, as sand is the main product of glacial abrasion of granite and clay of limestone.

Small patches of ground moraine are found in the Precambrian area, between the outcrops of granite. The material is mainly a sandy till with numerous igneous boulders. In the area underlain by Palaeozoic rocks ground moraine is sparse, most of it being covered by various thicknesses of sand and clay. Where ground moraine is found at the surface it resembles a boulder pavement where waves of the glacial lake washed the fine material away. Here the material varies from a sandy to a boulder-clay till.

Two low end moraines are found in the township. The largest moraine begins just east of Lake St. John and trends to the southeast. The ridge is well defined at the northern end but low and broad in its extension to the southeast. A smaller parallel ridge lies about $1\frac{1}{2}$ miles to the northeast of the first. The second ridge is broken by many gaps. The material is a sandy to boulder-clay till with lenses and pockets of sand and gravel.

An isolated kame deposit of sand and gravel occurs at Fawkham and is used extensively for sand and gravel. The material is well sorted and stratified.

Drumlins are numerous in the southwest part of the township and belong to a large field that extends southward to Lake Simcoe. The drumlins are in long ridges rather than the usual oval hill.

The sides are moderately steep and the western sides of some of them have been further steepened by wave action. The material is mainly a boulder-clay till. Many of the drumlins are wave-washed and the tops and sides strewn with boulders. The swales between the drumlins are floored with lacustrine clay.

Extensive deposits of sand occur in the eastern half of the township along the southern border and just north of Sebright. The sand is stratified and interbedded with gravel. In part, these deposits may be eskers and deltaic deposits but are here mapped as lacustrine because they have been modified greatly by the waters of Lake Algonquin.

Water Supply

Rama township is fairly well supplied with ground water for both domestic and stock purposes. Fifty-eight per cent of the wells are dug, 36 per cent drilled, and the remainder are driven wells or springs. The water-table is generally close to the surface throughout the township and 61 per cent of the wells obtain their water supply from depths of 20 feet or less. Ninety per cent of the wells have a permanent water supply, but the remainder, the intermittent wells, are usually dry near the close of a summer drought. Deepening the intermittent wells that are dug in drift would, in many instances, ensure for them a permanent water supply.

The water supply is fairly evenly divided between bedrock and glacial drift. Of the 98 wells recorded, 48 wells and springs obtain their water from bedrock and 32 from glacial drift. The remaining 18, for which the source is not known, probably derive their water from the drift.

Granitic rocks and the thin drift lying between the granite outcrops in the Precambrian part of the township are not good sources

of water. The water in the rocks is confined to cracks and joints, and extensive aquifers do not appear to exist. The limestone, on the other hand, is generally a good aquifer. Where the limestone is exposed, the water enters the joints and cracks directly, but where the limestone is thinly covered with a mantle of drift the water seeps through the drift before entering the joints and cracks in the limestone. From there it follows solution channels, bedding planes, or joints that allow free migration of the water in the limestone. The water in the bedrock wells is found to rise, on the average, to within 13 feet of the surface, and in most instances it is under a slight hydrostatic pressure. The average depth of wells obtaining their water from bedrock is 29 feet, exclusive of three wells that reach depths of 80, 90, and 150 feet respectively. Only one well, drilled 30 feet in granite, in lot 31, Front range, is reported to produce salty water. All other bedrock wells contained potable water.

As mentioned above, about half the water supply of the area comes from the unconsolidated deposits. The average depth of the wells dug in glacial drift is 12 feet, and the water rises in them, on the average, to within 6 feet of the surface. Some of the drift wells obtain their water from immediately above the top of the limestone, and it would appear that the water in these wells rises through a split or crack in the limestone and is under sufficient hydrostatic pressure to be forced up through a joint or series of joints into the drift. The main source of water supply of wells in the drift is, however, the lacustrine deposits, which cover much of the township. Sand is the principal aquifer in these deposits, and may either reach the surface or underlie silt and clay. The water supply is generally adequate. Two sand points have been driven in sandy deposits in the southeast corner of the township. Both are shallow and have proved satisfactory.

Ground moraine is usually a good reservoir for ground-water storage. The surface is flat to gently undulating and not conducive to rapid run-off. The material, moreover, is generally a sandy till that permits the water to percolate downwards. In many places the lenses and pockets of sand are extensive enough to yield large quantities of water, but because of their erratic distribution it is impossible to predict their location. Some of the intermittent wells in the ground moraine only require deepening to ensure permanent supplies, but in places the drift is so thin that the water soaks through into the underlying bedrock.

The two end moraine ridges contain layers or pockets of sand and gravel that may be good aquifers, but, because of the relatively steep sides of the ridges, the run-off is excessive and the water-table in the moraine is no higher than that in the ground on either side of the ridge.

The kame near Fawkham is composed mainly of sand and gravel and is an excellent intake area. Only three wells are located on this deposit and all have a sufficient and permanent supply of water.

The bedrock surface contours show that there are no buried stream channels in Rama township. Such channels, should they exist, would contain much sand and gravel, and hence form favourable source beds for large supplies of water.

The possibilities of obtaining flowing artesian wells in Rama township are not good. Intake areas in the form of kame and lacustrine deposits are present, but the relief in this area is so slight that there is very little possibility of building up the pressure necessary to produce artesian wells.

Relatively few springs occur in the township, and these are not considered an important source of water. Springs generally

occur where porous sand and gravel beds or lenses in till are exposed by natural slopes or stream valleys. However, because of the low relief, there are only a few places where such conditions exist. Of the four springs reported, one is used for domestic and stock purposes, two for stock only, and one is intermittent.

Analyses of Water Samples

Twelve samples of well waters from Rama township were analysed for their mineral content in the Laboratory of the Bureau of Mines. The samples were taken from depths of from 10 to 56 feet. The aquifers are both in drift and in bedrock. Most of the waters sampled were found to be suitable for domestic and farm use.

Amounts of Dissolved Mineral Matter in parts per million in Waters Collected in Rama Township

Constituent	Water from glacial drift and bedrock (12 analyses)		
	Maximum	Average	Minimum
Total dissolved solids	787	375.6	154
Silica	20	11.5	4.5
Iron	2.0	0.84	0.10
Calcium	161	75.6	26
Magnesium	35	21.4	6
Sodium	77	16.0	1.9
Sulphate	203	43.9	4.1
Chloride	46	17.0	0
Nitrate	133	30.8	0.62
Bicarbonate	450	251.0	93
Total hardness	524	273.9	159

Conclusions

This investigation warrants the following conclusions:

1. Ground-water supplies in Rama township are adequate for domestic and stock purposes.
2. Precipitation appears sufficient to furnish adequate supplies of ground water. In times of seasonal drought, or during extended periods of decreased rainfall, consumption may be greater than recharge, resulting in a lowering of the water-table. Some wells may go dry at times, and it may be necessary to deepen such wells.
3. The water-bearing beds in the ground and end moraine areas consist of irregular lenses and pockets of sand and gravel.
4. The water-bearing beds in the glacial lake Algonquin deposits consist of silt, sand, and gravel deposits overlying relatively impervious boulder clay or bedrock.
5. The quality of ground water derived from the glacial drift and bedrock is quite suitable for domestic and farm use.
6. It is possible to obtain ground water nearly everywhere in the township, but it is not always possible to predict the depth at which favourable aquifers may be reached.
7. Even though the water-table may occur within a few feet of the surface, the material penetrated may be so impervious that it yields water too slowly for the well to produce an adequate supply.
8. Relatively few springs occur in the township, and these are not considered an important source of water.
9. There is little possibility of obtaining flowing artesian wells in Rama township.
10. In order to assure a sufficient and constant supply of ground water for future years, some means of reforestation, however small, should be carried out in areas where the water-table is lowering due to continual lumber operations.

Rema Township

Wells and Springs

CONCESSIONS

Wells and Springs	Front Range														Total No. in Township	Percentage of total	
	A	B	C	D	E	F	G	H	I	J	K	L	V	VII			
Total number	34	17	0	16	1	18	12	2	1	0	1	0	32	1	1	98	58.2
Dug	9	5	1	2	1	7	2	0	0	0	0	0	8	3	2	57	2.0
Driven	8	2	0	0	0	5	1	2	1	0	0	0	1	0	0	2	35.7
Drilled	4	2	2	4	0	2	0	1	0	0	0	0	0	0	0	4	4.1
Springs	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	60	61.2
Wells 0-20 feet deep	2	1	0	1	0	4	5	3	1	1	2	1	8	3	2	27	27.6
21-40	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	6.1
41-60	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2.1
61-80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1.0
81-100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1.0
101-120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1.0
Depth unknown	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1.0
Wells that yield hard water	8	8	4	7	6	3	0	1	2	1	2	1	13	1	0	92	93.9
Soft water	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5.1
Salty water	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1.0
Wells with aquifer in sand	2	3	1	0	1	2	0	1	0	1	0	0	2	0	0	17	17.3
In gravel	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	5	5.1
In clay	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2.1
In drift	3	1	0	1	0	0	0	0	0	0	0	0	1	0	0	8	8.2
In bedrock	18	3	2	3	5	2	0	0	0	1	0	0	9	2	0	48	48.9
Unknown	9	1	2	0	1	2	0	0	0	1	0	0	1	0	0	18	18.4
Flowing wells (includes springs)	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	4	4.1
Non-flowing wells	33	8	4	6	6	3	1	2	2	1	2	2	13	2	3	94	95.9
Wells with permanent supply	32	8	4	7	6	3	1	2	2	1	2	2	10	2	2	88	89.8
Non-permanent supply	1	1	0	0	0	0	0	0	0	0	0	0	4	0	0	7	7.1
Wells not used	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	3.1

1 Sandy till, clay till, or sand and gravel

Sample Number	Owner	Lot	Concession	Depth of well (feet)	Aquifer	pH	Colour	Total dissolved solids (parts per million)	Constituents as Analysed (parts per million)													Hardness as CaCO ₃ (pts. per million)				
									Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Alkalies (as Na)	Sulphate (SO ₄)	Chloride (Cl)	Nitrate (NO ₃)	Nitrite (NO ₂)	Nitrate (NO ₃)	Phosphate (PO ₄)	Bicarbonate (HCO ₃)	Alkalinity (as CaCO ₃)	Ca hardness (as CaCO ₃)	Mg hardness (as CaCO ₃)	Total hardness (as CaCO ₃)		
1	W. R. MacRae	18	F.R.	20	L.S.	7.7	5	298	14	0.05	77	14	13	21	9.0	0	0.89	0	0.89	0	0.89	0	235	191	45	236
2	W. R. MacRae	18	F.R.	7	L.S.	7.4	15	423	14	1.9	100	22	18	47	17	0	0.89	0	0.89	0	0.89	0	314	250	89	339
3	H. Hunt	40	F.R.	56	Gr.	7.8	5	387	7.5	1.8	84	35	5.8	30	4.0	0	0.62	0	0.62	0	0.62	0	334	210	146	356
4	J. Clarke	24	1	20	7	8.1	0	423	4.5	0.10	106	16	2.9	37	13	0.001	77	0.05	77	0.05	77	233	264	64	328	
5	J. Clarke	24	1	20	G.	7.1	15	787	130	1.9	161	30	32	79	40	0.001	133	0.15	133	0.15	133	369	402	122	524	
6	J. Clarke	24	1	Sp.	G.	7.2	15	338	5.5	0.25	82	14	5.5	26	4.0	0.001	22	0.15	22	0.15	22	220	203	45	248	
7	W. Davey	17	7	35	Gr.	7.5	5	438	20	0.37	48	19	24	38	38	0.001	89	0	89	0	89	93	117	79	196	
8	W. Brooks	22	K	22	G.	7.3	10	652	18	0.37	85	28	77	203	46	0	18	0	18	0	18	204	211	116	327	
9	A. Langman	28	L	20	Gr.	7.5	50	228	7.5	2.0	50	6.5	7.8	20	3.5	0	1.77	0	1.77	0	1.77	152	124	38	159	
10	L. A. Vyse	17	B	13	S.			172	10.0		55.5	6	1.9	4.1	0							168	133.5	25.5	189	
11	G.E. Walters	21	C	33	La.			207	14.0		34	30	4.3	9.8	0							144	85	123.5	208	
12	R. J. Arthurs	18	E	10	Sh.			154	10.0		26	34	2.3	11.5	20.8							101	65	141	306	

S - Sand
Gr - Granite
Sh - Shale
Sp - Springs

1-9: 1946
10-12: 1947

C - Clay
G - Gravel
H - Hardpan
La - Limestone

WELL RECORDS

Rama

Township

Ontario

County, Province Ontario

Well No.	LOCATION			DESCRIPTION					WATER LEVEL		PRINCIPAL WATER-BEARING BED			WATER		REMARKS
	Conc.	Lot	Owner	Type	Topographic Situation	Elevation*	Depth	Classification +	June 1946 Above + Below - Surface	Elevation	Depth	Elevation	Aquifer	Quality	Used for °	
1	Front Range	1	D.F. McDonald	Dug	Hilltop	751	40'E	N.A.	-24E	727	40	711	Glacial Drift	Hard, clear	D.S.	Sufficient for 20 head
2	"	1	O. Badour	spring	lakeshore	720		spring		720			"	"	D	"
3	"	1	Wilkinson	dug	plain	721	13M	N.A.	-21	719	13	708	"	"	D	"
4	"	2	Adams & Hannah	drilled	slope	724	20'E	N.A.			20E	704	limestone	"	D	" 17' to bedrock
5	"	11	Jameson	dug	slope	731	26'E	N.A.	-5'E	726	26	705	glacial gravel	"	D.S.	" for 18 head
5A	"	11	Jameson	"	"	736	11'M	N.A.	-7'E	729	11	725	"	"	S	" " " " 3500
6	"	11	H. Martin	drilled	"	728	30'E	N.F.A.	-5'E	723	30	698	limestone	"	D	" 20' to bedrock (chickens)
7	"	12		dug	"	726	16'E	N.A.	-6'E	720	16	710	glacial	"	D	"
8	"	16		"	"	727	10'E	N.A.	-5'E	722	10E	717	"	"	D	"
9	"	16	H. Clarke	"	"	727	9'E	N.A.	-4'E	723	9	718	"	"	D	"
10	"	18	W. McCrae	drilled	plains	720	20'E	N.F.A.	-4E	716	20	700	limestone	"	D	" 7' to bedrock 46-24 (Temp. 46°F)
10A	"	18	W. McCrae	dug	slight slope	720	11'E	N.A.	-4'E	716	11	709	glacial	hard, clear	D	" 46-25 Temp. 46°F
11	"	19	Y.M.C.A.	drilled	Steep rise	738	40'E	N.F.A.	-10E	728	40	698	limestone	"	D	" 5' to bedrock
12	"	19	Smith	"	slope	731	35'E	N.A.	-15E	716	35	696	"			Not used 10' to bedrock
15	"	19	L. Burke	"	"	728	35'E	N.A.	-15E	713	35	693	"	hard, clear	D	Sufficient 46°F 10' to bedrock
14	"	19	I. Johnson	dug	"	723	12'E	N.A.	-5E	718	12	711	glacial	"	D	"
14A	"	20	I. Johnson	drilled	"	727	17'E	N.A.	-13E	714	17	710	limestone	"	D.S.	" for 50 head 6' to bedrock
15	"	21	H. Featherstone	"	slight slope	728	32'E	N.F.A.	-10'E	718	32	690	"	"	D.S.	" for 2400 chickens
16	"	21	W. Needler	"	"	732	25'E	"	-18'E	714	25	707	"	"	D.S.	" for 5 head 18' to bedrock
17	"	22	Goldstein	"	"	736	30'E	"	-12E	724	30	706	"	"	S	" for 80 head 4' to bedrock
18	"	23	Camp B'nai Brith	"	"	724	35'E	"	-5E	719	35	689	"	"	D	" Summer Camp
19	"	24	B. Goldstein	"	"	755	105'E	"			105	650	"	"	D.S.	" 2' to bedrock
20	"	25	"Rose Marie"	dug	"	723	9'E	N.A.	-3'E	720	9	714	glacial	"	D	"
21	"	25	E.R. Cleland	"	"	726	4'E	"	-1'E	725	4	722		hard, cloudy		Not used
22	"	30	O.A. C.	drilled	steep slope	731	50'E	N.F.A.?			50	681	limestone ?	" clear	D.S.	Sufficient
23	"	30	A. Anderson	"	slight slope	735	70'E	"	-35E	700	70	665	granite ?	"	D	Not sufficient. Drilled to granite 6' to bedrock
23A	"	3-	A. Anderson	dug	steep slope	725	30'E	N.A.			30	695	Glacial clay	"	D	Sufficient
23B	"	31	A. Anderson	drilled		741	30'E	"			30	711	granite	salty, clear	D	Not used. 28' to granite 10' to (to bedrock)
24	"	32	E. Goring	dug	slope	748	10'M	"	-4'M	744	10	738	glacial	hard, clear	D	

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†Sample taken for analysis.

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D—Domestic. G—Greenhouse or Garden.

WELL RECORDS

Rama

Township

Ontario

County, Province

Ontario

LOCATION				DESCRIPTION					WATER LEVEL		PRINCIPAL WATER-BEARING BED			WATER		REMARKS
Well No.	Conc.	Lot	Owner	Type	Topographic Situation	Elevation*	Depth	Classification +	June 1946		Depth	Elevation	Aquifer	Quality	Used for °	
									Above +	Below -						Elevation
25	Ft. Range	36	H. Buchanan	dug		724	12'E	N.A.	-5E	719	12	712	granite	soft, clear	D.S.	Sufficient for 700 chickens 12' to bedrock
26	"	36	A. Finnis	"	plain	727	18'E	N.A.	-9E	718	18	709	glacial clay	hard, clear	D	"
26A	"	36	A. Finnis	"	"	727	12'E	N.A.	-6'E	716	12	710	" sand	" "	S	Sufficient for 2000 chickens 12' to bedrock
26B	"	36	A. Finnis	"	"	723	10'E	N.A.	-3E	720	10	713	granite	" "	D	" 6' to granite
27	"	40	H. Hunt	drilled	flat hilltop	743	56'E	N.F.A.	-17E	-726	56	687	"	" "	D	" 2' to granite 46-26 45op.
28	A	1	E. Callaghan	dug		810	8'E	N.A.	-5E	805	8	802	glacial clay	" "	D	Sufficient 8' to bedrock
28A	A	1	E. Callaghan	"	plain	812	5'E	N.A.	-3E	809	5	807	" "	" "	D	" 5' to bedrock
29	A	6	H. Delovigne	sand point	"	814	10'E	N.A.			10	804	" sand	" "	D	" 21-47
30	A	9	E. Reid	dug	"	819	8'E	N.A.			8	811	" gravel & sand	" "	D	" 20-47
31	A	11	D. MacInnes	drilled	slope	818	35'E	N.F.A.			35	783	limestone	" "	D. S.	Sufficient for 30 head 19-47 4' to bedrock
32	A	13	J. Hargrave	"	plain	817	30'E	N.F.A.			30	787	"	" "	D	Sufficient 18-47
33	A	15	H. SNider	spring		826							"	" "	D.S.	" 17-47
34	A	16	R. Black	dug	plain	821	7'E	N.A.			7'	814	glacial sand	" "	D	" 16-47
35	A	17	Mrs. N. Docharty	"	"	830	16'M	N.A.	-6'M	824	16	814	" "	soft(?) clear	D	" 15-47
36	B	9	J. MacDonald	dug	plain	830	8'M	N.A.	-3'E	827	8	822	glacial sand	hard, clear	D	Sufficient 9-47
37	B	17	P. Ainsworth	"	"	822	12'M	N.A.	-3'M	819	12	810	" "	" "	D	" 14-47
38	B	17	L. Nickleson	"	"	824	8.5M	N.A.	-2'	822	8.5	815	" "	" "	D	Dry in summer 13-47
39	B	17	L.A. Vyse	"	"	821	13'M	N.A.	-2'	819	13	808	" "	" "	D	Sufficient 12-47
40	B	18	C. MacKenzie	sand point	"	823	?	N.A.					" "	" "	D	"
41	B	20		dug	slope	819	8'M	N.A.	-6'	813	8	811	" "	" "		Not used
42	B	21	H. Giles	drilled		787	65'E	N.F.A.			65	722	limestone	hard, clear	D	Sufficient 2' to bedrock
43	B	21	N. McDonald	dug & drilled	slope	786	35'E	"			35	751	"	" "	D	Sufficient 2' to bedrock
44	C	1	J. A. O'connor	dug	slope	776	15'M	N.A.	-7 M	769	15	761	glacial	hard, clear	D	Sufficient 2' to bedrock
45	C	5	R. Snoddon	drilled	plain	795	40'E				40	755	limestone	" "	D.S.	Sufficient for 50 head 11-47
46	C	9	R. Cleavelly	dug	"	823	8'M	N.A.	-5'M	818	8	815	glacial sand	" "	D.S.	Sufficient for 4 head 10-47
47	C	21	E. Walters	drilled	hill	777	33'E	N.F.A.	-13'	764	33	744	limestone and shale	" "	D.S.	Sufficient 5' to bedrock 8-47

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Rama

Township

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County, Province

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LOCATION				DESCRIPTION					WATER LEVEL		PRINCIPAL WATER-BEARING BED			WATER		REMARKS
Well No.	Conc.	Lot	Owner	Type	Topographic Situation	Elevation*	Depth	Classification +	June 1947		Depth	Elevation	Aquifer	Quality	Used for °	
									Above +	Below -						
									Surface							
48	D	4	Mrs. Wingo	drilled	hill	791	36'E	N.F.A.	-29'	762	36	755	limestone	hard, clear	D	Sufficient 10' to bedrock
49	D	6	T. Cleavelly	"	slope	778	60'E	N.F.A.			60	718	"	" "	D	"
50	D	16	M. Nickleson	dug	"	757	14'E	N.A.	-8'	749	14	743	shale	" "	D.S.	" 14' to granite
51	D	19	J. Oxby	drilled	hill	760	20'E	N.F.A.			20	740	limestone	" "	D	" 6-47
51A	D	19	J. Oxby	spring	slope	757							glacial	" "	S	"
52	D	21	A. McMillan	dug	hill	771	18'M	N.A.	-15'	756	18	753	glacial clay	" "	D	"
52A	D	21	A. McMillan	drilled	"	784	60'E	N.F.A.	-40'	744	60	724	limestone	" "	S	" 45' to bedrock for 30 head 60' granite
53	E	2	D. McFee	dug	slope	744	13'E	N.F.A.	-4'	740	13'	731	limestone	" "	D.S.	" 13' to bedrock for 44 head
54	E	18	J. Arthurs	"	"	759	10'M	N.A.	-8'	751	10	749	shale	" "	D	" 7' to bedrock
55	E	19	R. Adams	"	plain	747	12'E	N.A.	-8'	739	12	735	glacial quick-sand	" "	D.S.	" 12' to granite
56	E	21	Catheart	"	hill	773	17'M	N.A.	-10'	763	17	756	"	" "	D	" 42°F
56A	E	21	Catheart	"	slope	753	8'M	N.A.	-3'	750	8	745	"	" "	S	" 10 head
57	E	21	C. Baker	drilled	hill	784	40'E				40	744	" gravel	" "	D.S.	" 5 head
58	H	1	D. Weir	dug	slight ridge	755	8'E	N.A.	-4'	751	8	747	glacial sand	" "	D.S.	" 18 head
59	H	2	Mrs. A. Carrick	"	ridge	760	11'E	N.A.	-5'E	755	11	749	" gravel	" "	D	"
59A	H	2	Mrs. A. Carrick	"	"	757	14'E	N.A.	-7'E	750	14	743	" sand	" "	S	" 30 head
60	I	3	Mrs. S. Cleavelly	dug	plain	757	6'E	N.A.	-3'E	754	6	751	glacial sand	soft clear	D	Sufficient
61	K	4	W. Barnhart	dug	valley	750	12'E	N.A.	-5'E	745	12	738	glacial quick-sand	soft clear	D	Sufficient
62	K	22	W. Brooks	"	flat	731	22'E	N.A.	-9'E	722	22	709	glacial gravel	hard clear	D.S.	Sufficient 22' to bedrock 40 head. 44°F. 46-29
63	L	23	H. MacDonald	dug	flat	730	17'E	N.A.	-5'E	725	17	713	glacial	hard clear	D.S.	Sufficient 35 head
64	L	28	A. Langman	drilled	valley	721	20'E	N.F.A.	-5'	716	20	701	granite	" "	D	Sufficient 48°F 1' to bedrock 46-27
65	I	15	V. Dewell	dug	gravel pit	814	8'M	N.A.	-5'M	809	8	806	glacial sand	hard, clear		Used for steam engine
66	I	15	J. Dewell	"	plain	822	6'E	N.A.		822	6	816	" "	" "	D	Sufficient

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LOCATION				DESCRIPTION					WATER LEVEL		PRINCIPAL WATER-BEARING BED			WATER		REMARKS
Well No.	Conc.	Lot	Owner	Type	Topographic Situation	Elevation*	Depth	Classification +	June 1946		Depth	Elevation	Aquifer	Quality	Used for °	
									Above + Below - Surface	Elevation						
67	1	15	N. Johnston	dug & drilled	plain	812	45'E	N.F.A.	-28 E	784	45	767	limestone	hard, clear	D.S.	Sufficient - 8 head. 35' to bed-rock
68	1	16	W. Newman	drilled	hill	812	40'E	N			40	772	limestone (?)	" "		
69	1	16	W. Norris	"	plain	791	90'E	"			90	701	"	hard, clear	D.S.	Sufficient 3 head. 40' to bed-rock
70	1	17	F. Doyle	dug	"	782	13'E	N.A.	-5 E	777	13	769	"	" "	D.S.	Not sufficient 25 head 13' "
71	1	17	R. James	"	"	779	13'E	N.A.	-10'	769	13	766	"	" "	D.S.	Sufficient 25 head 10' bedrock water enters through crack in (rock)
71A	1	17	R. James	"	"	764	11'M	N.A.	-3'	761	11	753	Glacial gravel	" "		
72	1	18	B. Smith	"	Top of Drumlin	776	42'E	N.A.	-18E	758	42	734	"	" "	D.S.	Sufficient 50 head, 42' to Bed-rock
73	1	23	A.L. MacDonald	drilled	"	761	40'E	N.F.A.	-15E	746	40	721	limestone	" "	D.S.	" " " , 10' to bedrock
74	1	23	D. McKinnon	"	Rise	747	23'E	"	-10E	737	23	724	"	" "	D.S.	" 46°F 30 head 8' to bed-rock
75	1	24	J. Clarke	dug	top of Drumlin	753	20'E	N.A.	-15E	738	20	733	Glacial	soft, clear	D	Dry in summer. 45.5°F 46-19
75A	1	24	J. Clarke	"	"	757	20'E	N.A.	-15E	742	20	737	" sand	hard, clear	S	Not sufficient 40 head 46-20
75B	1	24	J. Clarke	spring		735				735				" "		Sufficient 46-21
76	II	15	M. McDonald	drilled	flat	772	27'E	N.F.A.	-12E	760	27	745	limestone	" "	D	Sufficient 12' to bedrock
77	II	17	P. Hayes	"	rise	750	35'E	"	-10E	740	35	715	"	" "	D	" 2' to bedrock
78	III	15	R. Windott	dug		778	12'E	N.A.	-6'	772	12	766	"	" "	S	Sufficient 30 head
79	III	16	M. Duffy	"	rise	778	25'E	N.A.	-22'	756	25	753	"	" "	D.S.	Sufficient 50 head. Water enters through crack in lime-stone
80	V	15	J. Kennedy	dug	rise	753	12'E	N.A.	-8'E	745	12	741	glacial clay	" "	D.S.	Sufficient 25 head
81	V	16	N. Campbell	"	slope	751	15.5M	"	-8.5M	742.5	15.5	735.5	" sand	" "	D.S.	" 30 head
81A	V	16	N. Campbell	"	"	753	10'M	N.A.	-71M	746	10	743		" "		Not used
82	VII	17	W. Davy	dug & drilled	plan	722	35'E	N.F.A.	-8E	714	35	687	granite	" "	D.S.	Sufficient 17 head - 49°F 46-28 9' to bedrock

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