GROUND WATER IN THE WIMBLEDON AREA,

BARNES AND STUTSMAN COUNTIES,

NORTH DAKOTA

By

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ABSTRACT

Wimbledon, which has a population of 357, is in the northwest corner of Barnes County, North Dakota, about 28 miles northwest of Valley City. It is in an area of ground moraine near the center of the broad undrained divide between the Sheyenne and James Rivers. The town does not have a municipal water-supply system and it is estimated that 30,000 to 40,000 gallons of water a day might be required to supply such a system.

The area is underlain by glacial drift of Pleistocene age, by the Niobrara and Benton shales and Dakota sandstone of Cretaceous age, and probably by crystalline rocks of pre-Cambrian age. Only the glacial drift and the Dakota sandstone contain important aquifers. The drift consists of ground moraine, surficial glaciofluvial deposits, buried glaciofluvial deposits, and glacial-lake deposits interbedded with till. The surficial and buried glaciofluvial deposits contain aquifers of importance but the ground moraine and glacial-lake deposits are essentially non-water-bearing.

The Wimbledon area is well within the limits of the area in which artesian flows can be obtained from the Dakota sandstone aquifer. One well drilled at Wimbledon in 1889 to a depth of 1,557 feet is reported to have had an original flow of 400 gallons a minute with a closed-in pressure of 65 pounds per square inch. The well became plugged with sand about 1913 and was abandoned.

Four glacial drift aquifers of interest as possible sources of ground water for municipal supply were encountered within $2\frac{1}{4}$ miles of town by test holes drilled as a part of the investigation. The largest of these is a kame-terrace aquifer about 2 miles southeast of town. The others, described in detail in the report, are of limited extent or have highly mineralized water, or both.

Conservative estimates of the recharge over 2 square miles of the kame-terrace aquifer indicate that it is in excess of 37 million gallons a year, or more than 100,000 gallons a day. Similar estimates of the storage in this aquifer indicate that it is sufficient to support withdrawals at the rate of 40,000 gallons a day for a number of years even without recharge.

INTRODUCTION

Scope and purpose of the investigation

This is a progress report on the general study of the geology and ground-water resources of Barnes County, North Dakota, being made by the U.S. Geological Survey in cooperation with the State Water Conservation Commission and the State Geological Survey. This study is to determine the occurrence, movement, discharge, and recharge of the ground water, and the quantity and quality of such water available for all purposes, including municipal, domestic, irrigation, and industrial uses. However, the most critical need at the present time is for adequate and perennial water supplies for numerous towns and small cities throughout the State which are attempting for the first time to construct municipal water-supply systems. For this reason the county studies are being started in the vicinity of those towns which have requested the help of the State Water Conservation Commission and the State Geologist. Progress reports are released as soon as possible in order that the preliminary data may be available for use in solving water-supply problems in the towns before the general studies are completed. The work described in this report was confined chiefly to obtaining information on ground water in those parts of Barnes and Stutsman Counties which might be of interest to the village of Wimbledon in its search for sources of municipal water supply.

Location and general features of the area

Wimbledon, which has a population of 357 (1940 census), is in the northwest corner of Barnes County, North Dakota, about 28 miles northwest of Valley City. State Highways 9 and 62 connect it with U. S. Highways 10 and 52. It is on the Minneapolis, St. Paul and Sault Ste. Marie Railway and is the northern terminal of the Midland Continental Railway. Like most towns in North Dakota, it functions mainly as a shipping point and trading center for the farming area around it.

The part of the Central Lowland 1/ physiographic province in which Wimbledon is located has been descriptively referred to as the Drift Prairie by Simpson. 2/ It is a plains area modified by slightly eroded glacial drift, which forms low, relatively rough hills along the lines of the end moraines and a gently rolling topography elsewhere. The Drift Prairie is bordered on the west by the Missouri Plateau and on the east by the Red River Valley. Wimbledon is about 28 miles east of the escarpment that marks the eastern boundary of the Missouri Plateau and about 50 miles west of the highest (Herman) shore line of Lake Agassiz, which marks the western limit of the Red River Valley. 3/

1/ Fenneman, N. M., Physiography of Eastern United States, pp.559-588, McGraw-Hill Book Co., 1938.

2/ Simpson, H. E. Geology and ground-water resources of North Dakota: U.S. Geol. Survey Water-Supply Paper 598, p. 4, 1929.

3/ Upham, Warren, The glacial Lake Agassiz: U. S. Geol. Survey Mon. 25, pl. XXVIII, 1896.

Wimbledon is in an area of ground moraine, the term used to describe the boulder clay or till deposited directly from the Pleistocene continental glaciers. The topography is gently rolling, with hills and swales that have a somewhat greater relief than is common in most areas of ground moraine in North Dakota. The town is about 3 miles north of the northwest margin of a small end moraine which has a general east-northeast trend across the region. The southeast margin of this moraine forms a conspicuously abrupt escarpment on the road from Dazey to Wimbledon at a point about 3 miles west of Dazey and about 9 miles east of Wimbledon. The highest point in the area is a hill of glacial till about 2 miles southeast of Wimbledon. (See fig. 1.) It rises 40 or 50 feet above gravel terraces which flank it on the north and east, and is visible for several miles from all directions.

Wimbledon is near the center of the broad undrained divide between the Sheyenne and James Rivers, and undrained depressions containing swamps and ponds are common in the area. It is reported that a swamp originally occupied the site on which the town was later built on filled ground.

A large glacial channel, or coulee, heads about 2 miles south of Wimbledon (fig. 1). It begins as a narrow and shallow coulee near the western end of the gravel terraces and runs in a southwesterly direction into Stutsman County. One mile west of its inconspicuous head it is 1,200 feet wide and 30 feet deep. No perennial stream occupies the coulee but the map of Stutsman County shows an intermittent stream as continuous from the Wimbledon area to Spiritwood Lake. It is not known whether the coulee continues to the area of Spiritwood Lake.

The coulee is unusually wide within half a mile of its head and it does not increase in width for at least 2 miles downstream. Such a channel might have been developed by partial reexcavation of an older valley. Further evidence relating to this hypothesis is presented in the section on buried glaciofluvial deposits.

Previous investigations and acknowledgments

A manuscript report, "Ground-water resources of Wimbledon, North Dakota," was prepared by Robert Simpson in 1934. The report was not published but a copy is on file in the office of the State Geologist at the University of North Dakota. Data contained in the report concerning the depths and yields of some of the older wells and chemical analyses of water from others have proved very helpful in the preparation of this report. Most of this information on the older wells in included in the well table on page 35.

Published reports on the geology and ground water in the Wimbledon area are confined to general discussions contained in studies of broad areas. A chapter on ground water in Barnes County, with mention of the depth and character of ordinary wells at Wimbledon, is contained in Simpson's paper on the ground-water resources of North Dakota. 4/ An analysis of water

4/ Op. cit., pp. 65-70.

from one of the city wells is given in the paper by Abbott and Voedisch.5/ Other works, such as Upham's monograph 6/ and bulletins of the North Dakota Geological Survey, are useful for their treatment of the general geology of the area. The Jamestown Tower folio 7/ describes the geology and ground-water resources of three 30-minute quadrangles about 15 miles south of Wimbledon.

The present study was facilitated by the ready cooperation of towns-people and farmers in the area. Thanks are due especially to those who permitted measurement of water levels in their wells and drilling operations upon their land.

Present water supply and future needs

Wimbledon does not have a municipal water-supply system. In his report in 1934, Simpson states that "An excellent sewer system drains the village and plans for a water-works were drawn up several years ago..." 8/ The waterworks was never built and it is reported that parts of the sewer system are now in poor repair.

5/ Abbott, G. A., and Voedisch, F. W., The municipal ground-water supplies of North Dakota: Geol. Survey Bull. 11, p. 46, 1938.

6/ Op. cit.

7/ Willard, D. E., U.S. Geol. Survey. Atlas, Jamestown-Tower folio (No. 168), 1909.

Most of the water for drinking and culinary purposes is hauled by Charles Bloedel from the gravel-pit well owned by Alfred Ernie and located in the SE$\frac{1}{4}$NE$\frac{1}{4}$NE$\frac{1}{4}$ Sec. 5, T. 142 N., R. 61 W. Several of the wells in town are utilized by one or more families for all domestic purposes. Of the five city wells only the No. 3 well near the school is used extensively. The combined capacity of this well and a well at the school is reported to be barely sufficient to meet the minimum requirements of the school. The other four city wells are used primarily for fire protection because their highly mineralized waters are objectionable for most domestic uses. Rain water caught from the roofs of buildings and stored in cisterns is used in many homes for washing and other purposes requiring soft water.

It is estimated that about 30,000 to 40,000 gallons of water a day might be required for a satisfactory municipal water supply for the town, although probably less than one-half that amount is used at the present time.

GEOLOGY AND HYDROLOGY

General

Essentially all ground water is derived from precipitation. The water may enter the ground by direct penetration from rain or melting snow, and by percolation from streams that cross the area. In some areas a part of the ground water comes from adjacent regions, entering the ground at higher and moving slowly to lower elevations.

The amount of water that a rock can hold is measured by its porosity. The unconsolidated rocks, such as clay, sand, and gravel, are generally more porous than consolidated rocks, such as sandstone and limestone, although in some areas the consolidated rocks are highly porous.

If the pore spaces are large and interconnected, as they commonly are in sand and gravel, the water is transmitted more or less freely and the rock is said to be permeable, but where the pore spaces are very small and unconnected, as they are in clay, the water is transmitted very slowly or not at all and the rock is said to be impermeable. Below a relatively shallow depth in practically all regions the pore spaces in the rocks are filled with water and the rocks are said to be saturated. This is true of the clay as well as of the sand and gravel, but because of the difference in permeability it is possible to develop successful wells only in the coarser materials.

Where some part of the water-transmitting bed (aquifer) is exposed at the surface or comes in contact with another aquifer so exposed, the water discharged naturally or through wells has an opportunity to be replenished each year. Where the aquifer is more or less completely surrounded by clay or other impermeable materials, natural recharge may be very slow and the water taken by wells from storage in the aquifer is not fully replenished each year. The initial yield of wells in aquifers which are virtually cut off from natural recharge may be as large as that of wells in aquifers having adequate recharge areas, thereby giving an erroneous impression that an abundant perennial supply is available.

As ground water moves through an aquifer it dissolves a part of the more soluble mineral constituents of the rock particles. The amount of mineral matter dissolved in ground water is determined by the amount of the soluble materials present and the length of time the water is in contact with them. Therefore, the water that has been underground longest and has traveled the greatest distance is commonly more highly mineralized than that which is relatively near the recharge area.

The rock materials and their water-bearing characteristics

The surface rock in the Wimbledon area is glacial drift of Pleistocene age. The immediately underlying shale bedrock is the Niobrara shale of Cretaceous age. Beneath the Niobrara are the Benton shale and the Dakota sandstone, also of Cretaceous age, and pre-Cambrian crystalline rocks. Only the glacial drift and the Dakota sandstone are of interest as possible aquifers in this area.

Information concerning the rock materials of the glacial drift was obtained from logs of existing wells and from 13 test holes drilled in the area. Information concerning the bedrock formations was obtained from two test holes drilled into the Niobrara and from available information on wells drilled to the Dakota sandstone at Wimbledon and in nearby areas.

Glacial drift

The glacial drift of the Wimbledon area consists of ground moraine, surficial glaciofluvial deposits, buried glaciofluvial deposits, and glacial lake deposits interbedded with till. The surficial and buried glaciofluvial deposits contain aquifers of importance but the ground moraine and glacial-lake deposits are essentially non-water-bearing.

Ground moraine.-- Ground moraine composed chiefly of till is the surface rock over most of the Wimbledon area (fig.1). It is generally thin, ranging from a feather edge to 40 feet in most of the test holes where it rests upon glaciofluvial deposits. However, in test holes 2, 5, and 10 only till was encountered from the surface to a total depth of 60 to 80 feet, where it rests upon glacial-lake deposits. The cuttings and drilling characteristics were rather uniform throughout this thickness and it was not possible to determine whether the till of the ground moraine exposed at the surface extent to this depth or rests directly upon older till.

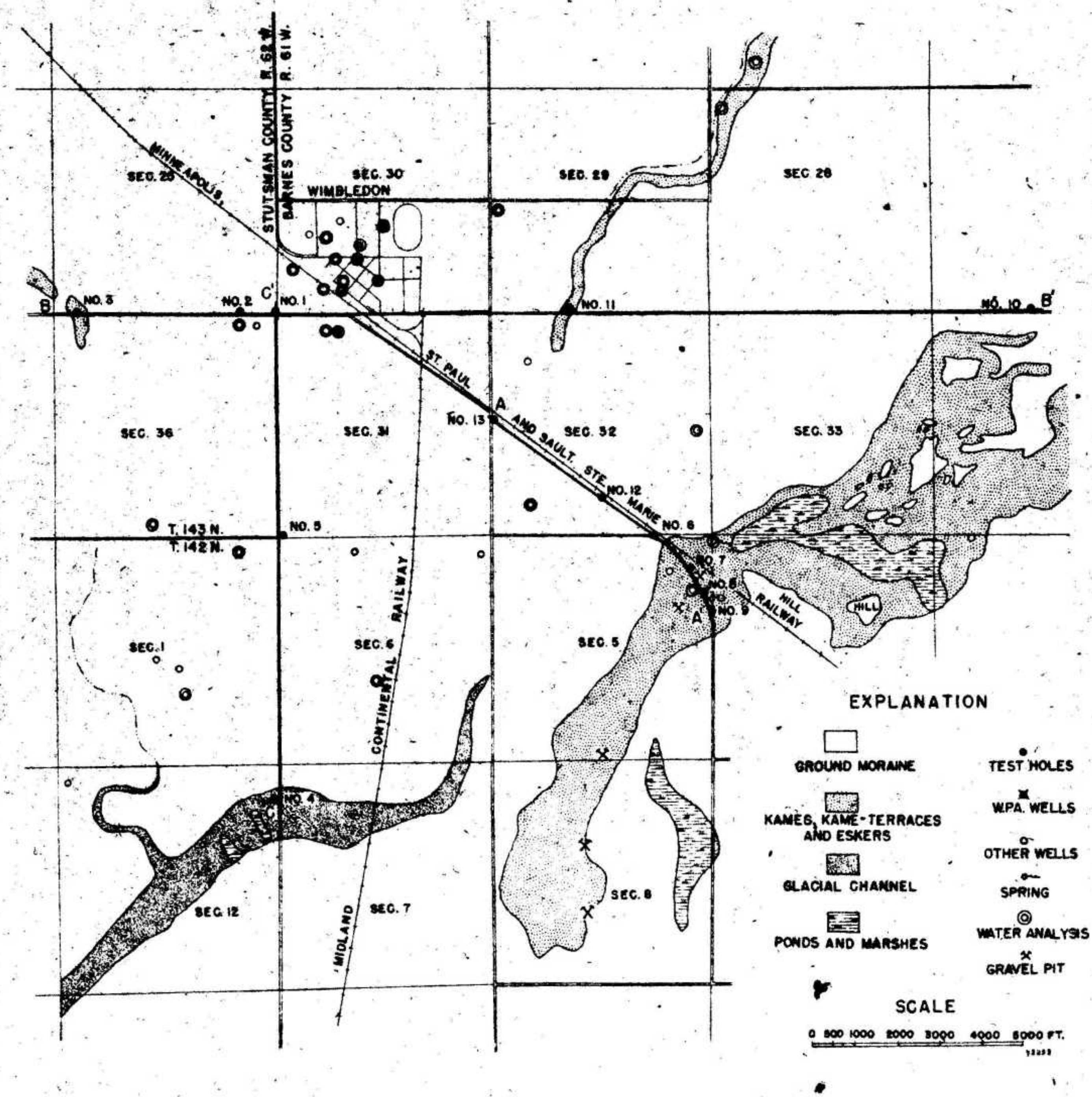
The till is a compact clayey material composed chiefly of shale detritus, with occasional boulders and pebbles of limestone and crystalline rocks. It does not yield water to wells but functions as a confining bed for water contained in underlying glaciofluvial deposits.

Surficial glaciofluvial deposits.-- The ground moraine was modified in part of the area by the work of melt waters from the retreating ice. A glacial stream of considerable size, flowing in a southwesterly direction appears to have occupied the southern part of the area. Its former course is now marked by irregular hills of gravel kame terraces, and the headward portion of a deeply incised channel. The northern part of the area is less modified by the work of melt waters, but outwash, kames, and eskers are present locally.

Glaciofluvial deposits exposed at the surface in the Wimbledon area form kames, kame terraces, eskers, and glacial-channel gravel. All these deposits consist principally of sand and gravel and all are of special interest as potential aquifers because their situation at the surface is likely to be favorable for recharge. Each glaciofluvial deposit in the Wimbledon area is described in the following paragraphs.

The southeast corner of the Wimbledon area is occupied by rather extensive sand and gravel deposits. The sand and gravel has been utilized locally for construction purposes, the larger pits being in the northeast corner of Sec. 5, T. 142 N., R. 61 W.

FIGURE I - MAP OF WIMBLEDON AREA SHOWING GEOLOGIC AND HYDROLOGIC FEATURES



Northeast of these pits, the sand and gravel deposits form a flat, even-topped surface, or terrace, pitted by numerous undrained depressions, both large and small. The pitting of the terraces is most readily explained by assuming that the sand and gravel was deposited around numerous ice blocks of varying shape and size. The terrace area is only about a quarter of a mile wide at its southwestern end in the northeast corner of section 5 and the northwest corner of section 4. Here the terraces flank the north and east sides of a hill of till which rises 40 to 50 feet above them. Northeastward the terrace area spreads out to a width of nearly a mile, and the top of the terrace is 15 to 20 feet higher than the ground moraine that borders it on the southeast. Thus the gravel deposits appear as a group of flat-topped hills when viewed from the southeast. Northeastward from the hill of till, the waters which deposited the gravel must have been confined by ice blocks on the southeast, thus permitting kame terraces to be built up above the general level of the ground surface.

Southwest of the principal gravel pits, the kame area continues for about a mile and a half, but the kames are round-topped hills of sand and gravel and till and there is no evidence of terracing. Several smaller kames, composed principally of sand and gravel, occur about a mile west of Wimbledon. The gravel of the kame terraces is well-sorted but contains from 8 to 15 percent of shale pebbles. The gravel appears to be more poorly sorted in both directions away from the constricted part of the terrace flanking the till hill in section 4; in many places boulders and clay are included with the gravel in the kame hills, and some hills are composed partly of till.

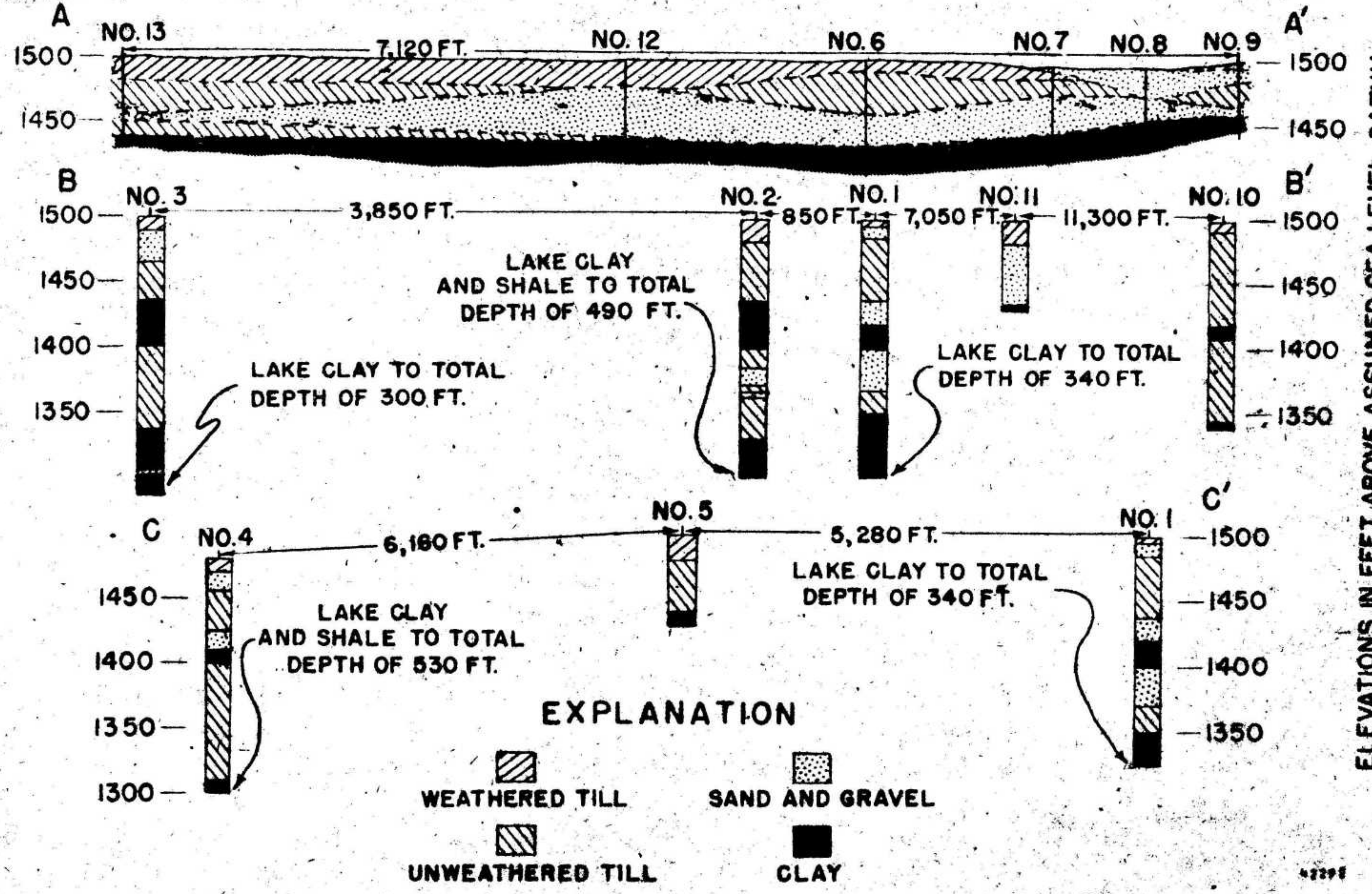
A long, narrow ridge occurs about a mile east of Wimbledon and extends in a sinuous course 2 miles or more northeastward. Where exposed in road cuts and pits, the materials of this ridge consist of cross-bedded sand and gravel covered by about 3 to 5 feet of gravelly till. About 15 feet of gravelly till overlies the sand and gravel at the site of test hole 11. A small glacial-drainage channel is present on the west side of this ridge; the direction of movement of the waters which occupied the channel was northeastward. The ridge appears to be an esker formed by water confined in a channel beneath the ice. At least two farm wells have been developed in the gravel of this esker.

There is probably some gravel fill in the large glacial channel that drains southwestward from the southwest part of the Wimbledon area. So far as known, no farm wells are in the channel and only one test hole was drilled in it. This hole penetrated 10 feet of clay and gravel overlying about 15 feet of sand and gravel.

All the surficial glaciofluvial deposits are water-bearing and are considered in the section of this report that discusses recharge, movement, and discharge of water in the principal aquifers.

Buried glaciofluvial deposits.-- In several of the test holes glaciofluvial beds were encountered below or interbedded with the till and lake clay (fig.2). Only two of these beds appear to be thick and extensive enough to warrant discussion. Probably the most important and extensive

FIGURE 2- GENERALIZED CROSS SECTIONS IN WIMBLEDON AREA



aquifer in the area was encountered at depths between 20 and 65 feet in test holes 6, 7, 8, 9, and 12, and possibly in 13. It ranged from 5 to 40 feet in thickness in the test holes (sec. A-A', fig.2). The gravel is mostly well-sorted and contains only a minor amount of shale pebbles. It appears to have been deposited in a broad channel which may have occupied approximately the same area as that occupied later by the waters that deposited the kame terraces and cut the large glacial channel (fig. 1). The gravel fill in the large glacial channel occurs at about the same elevation as this buried gravel and the deposits may be continuous.

The glacial history of the aquifer, as determined largely from section A-A' in figure 2, is as follows: The gravel was deposited in a broad valley cut in glacial lake clay. A readvance of the ice caused differential erosion of the gravel and deposited as much as 30 feet or more of till upon it. With the withdrawal of the ice, melt waters again occupied at least parts of the old channel, removing a part or all of the till cover from the gravel in some areas. Deposition of sand and gravel by these later melt waters formed the present kames and kame terraces. At the sites of test holes 6 and 12 the later melt waters did not remove the till cover; at holes 7 and 9 only a part of the cover was removed and the later gravel was deposited upon the till; but at hole 8 all the till cover was removed and the later gravel rests directly upon the older gravel.

The large pond north and east of the till hill is a natural discharge area for this buried glaciofluvial deposit and springs occur around its margin, the largest being located at its northwest corner (see fig. 1).

The other buried aquifer of possible importance was encountered in test holes 1 and 2. In test hole 1 two beds of sand and gravel, respectively 19 and 31 feet thick, were separated by 19 feet of lake clay. The sand and gravel was fairly well sorted, thepebbles consisting chiefly of shale. In test hole 2, drilled 850 feet west of No. 1, only the lower bed was present and it was only 18 feet thick. Furthermore, the gravel contained considerable clay. This aquifer was not encountered in any of the other test holes. Several of the wells drilled in town are reported to obtain water from approximately the same depth as that of this aquifer, but the water is of poor quality and the yields of the wells are small.

Glacial-lake deposits and interbedded till.-- A tough dark-gray clay is encountered by wells and test holes in the Wimbledon area at depths from 40 to 80 feet below the surface. This clay drills very much like weathered shale and it was assumed by Simpson 9/ to be the Pierre shale. However, the clay contains pebbles and boulders of limestone and crystalline rocks definitely of glacial deposition, and it probably is a lake clay. Practically all the clay contains occasional pebbles of these materials and in some parts of the holes they were so abundant as to indicate the probable interbedding of the lake clay with till. Sand and gravel deposits also occur interbedded with the lake clay, but they are generally thin.

9/ Simpson, H.E., Ground-water resources of Wimbledon, North Dakota, p.2.

The lake clay rests upon the Niobrara shale of Cretaceous age, but it was not possible in the test drilling to distinguish the lake clay from the upper portion of the shale, and the exact position of the contact is not known. From laboratory examination it appears probable that the contract is between 330 and 375 feet in test hole 4 and between 275 and 420 feet in test holes 1, 2, and 3.

The lake clay and interbedded deposits appear to be non-water-bearing throughout most of the Wimbledon area. However, the aquifer encountered in test holes 1 and 2 occurs beneath the upper part of the lake clay.

The data obtained during the present investigation are too meager and from too restricted an area to throw much light on the origin of the basin in which the lake clays accumulated. However, similar lake clays were found in the Red River Valley and it is interesting to speculate that the test holes at Wimbledon may have penetrated deposits of a lake formed by glacial ice blocking the northward drainage of a major tributary of the preglacial Red River.

Niobrara shale and other shales of Cretaceous age

A core of marl was taken from test hole 4 at a depth of 520 to 530 feet. It consisted of calcium carbonate more than 50 percent, clay, and minor amounts of quartz. A large percentage of the calcium carbonate consisted of the shells of microfossils, chiefly foraminifera. A washed sample of this microfauna was submitted to J. A. Cushman of the Geological Survey, who reports: "Abundant foraminifera, all pelagic and represented by very few species

Those I can identify are Globigerina cretacea D'Orbigny, Globigerinella aspera (Ehrenberg), Gumbelina globuslosa (Ehrenberg), G. plummera Loetterle, and G. pseudotessera Cushman. All of these are described in Loetterle's paper on the Niobrara of the Nebraska and South Dakota region and should place the age as Niobrara."

Simpson describes outcrops of the Niobrara near Valley City, about 28 miles southeast of Wimbledon: "Beneath the Pierre shale and at the base of the valley sides, immediately above and for some miles below Valley City, occur some of the few outcrops of the Niobrara shale in North Dakota. The shale is of a lighter color than the Pierre--almost cream-colored, in fact--and it reacts readily with acid, which shows the presence of considerable lime"10/ Simpson's identification of these beds as belonging to the Niobrara formation probably rests upon Leonard's earlier work11/, in which he identified the beds as probably of Niobrara age on lithologic grounds alone.

The altitude at Wimbledon, and more specifically at test hole 4, is not known but is assumed to be about 1,500 feet, from elevations of U.S. Coast and Geodetic Survey bench marks about 2 miles west of Wimbledon. Thus the Niobrara was encountered in test hole 4 at an altitude of about 1,170 feet, whereas in the Glenfield Oil Co. test in Foster County, about 30 miles

10/ Op. Cit., p. 66.

11/ Leonard, A. G., Stratigraphy of North Dakota clays: North Dakota Geological Survey 4th Bienn. Rept., p. 69, 1906.

northwest of Wimbledon, the top of the Niobrara was at an altitude of 250 feet.12/ After due allowance has been made for the regional dip of the Cretaceous formations in this area, which is about 10 feet per mile, 13/ the altitude of the Niobrara at Wimbledon is still about 750 feet higher than would be expected, suggesting a local upwarping of the Cretaceous formations in this area.

So far as known, no wells in the Wimbledon area obtain water from the Niobrara or other Cretaceous shales.

Dakota sandstone

The Wimbledon area is well within the area in which artesian flows can be obtained from the Dakota sandstone aquifer, as shown on Simpson's map.14/ One well drilled at Wimbledon by the "Soo Line" Railroad in 1889 to a depth of 1,557 feet is reported to have had an original flow of 400 gallons a minute with a closed-in pressure of 65 pounds per square inch.15/ No log of the well is available but the following quotation from a report by Robert Simpson gives a general record and history of the well as far as it has been recorded:16/ "The well has 850 feet of 8-inch casing, 400 feet

12/ Laird, W. M. Selected deep well records: North Dakota Geol. Survey Bull. 12, p. 18, 1941.
13/ Ballard, Norval, Regional geology of Dakota Basin: Am. Assoc. Petroleum Geologists Bull., vol. 26, p. 1568, 1942.
14/ Simpson, H. E., Geology and ground-water resources of North Dakota: U.S. Geol. Survey Water-Supply Paper 598, pl. 1, 1929.
15/ Op. cit., p. 69.
16/ Simpson, Robert, Ground-water resources of Wimbledon, Manuscript report on file with the State Geologist, Grand Forks, p. 8, 1934.

of 6-inch casing, and 307 feet of $4\frac{1}{2}$-inch casing. At one time 65 pounds of natural pressure and 400 gallons per minute of flow supplied excellent fire protection for the village, although the water was too highly mineralized for locomotive boiler use. In 1913, after the casing had corroded through at a depth of about 80 to 90 feet, Swanson Bros. of St. Paul were contracted by the Railroad to insert a 4-inch casing in the hole. Natural sand plugging to within 490 feet of the surface followed soon after this operation. Meanwhile the well had been given to the village by the railroad for it was unfit for locomotive use. Mr. Russell, a local driller, attempted redrilling through the sand inside the casing, but funds were exhausted before the job was finished, and the well was abandoned.

There is some question as to the stratigraphic position of the sandstone bed from which this well obtained its flow. Robert Simpson 17/ suggests that the well reached the Dakota sandstone at a depth of 1,557 feet. However, on the same page he further suggests that the "Archean granite" probably lies only a few feet below the bottom of the well although the Dakota, Fuson, and Lakota formations have a probable combined thickness in this area of nearly 300 feet according to Laird.18/ If the Niobrara shale occurs at a depth of 520 feet, as suggested by the foraminifera identified by Dr. Cushman from a core taken from test hole 4 at that depth (p. 17), it would seem that the

17/ Op. cit., p. 2.
18/ Laird, W. M., Stratigraphy and structure of North Dakota: North Dakota Geol. Survey Bull. 18, 1944.

"Soo Line" well with a total depth of 1,557 feet may have penetrated the lowermost beds of the Dakota or Lakota formations and, furthermore, that the total thickness of the Niobrara and Benton shales is considerably greater at Wimbledon than the reported thickness of these formations in the Glenfield Oil Co. test about 30 miles northwest.19/ At Dazey, about 12 miles east of Wimbledon, Simpson20/ reports the Dakota artesian horizon as about 900 feet below the surface, and the same horizon should not be much over 1,000 feet at Wimbledon.

The "Soo Line" well has demonstrated that moderately large quantities of rather highly mineralized water are available in the Wimbledon area at a depth in the neighborhood of 1,557 feet. It appears that other artesian horizons may occur several hundred feet above that which produced the flow in the "Soo Line" well, but water from such beds, if they are present, probably would be highly mineralized also.

Existing and abandoned wells

Records of over 60 existing and abandoned wells and test holes in the Wimbledon area are given in the table on Page 35. For the data on many of the older wells the writer is indebted to the manuscript of Robert Simpson, referred to previously. In that report Simpson pointed out the inadequate quantities of water produced by wells in town from all geological horizons except the Dakota sandstone. He suggested that the drift be

19/ Laird, W. M., Selected deep well records: North Dakota Geol. Survey Bull. 12. p. 19, 1941.
20/ Simpson, H. E., op. cit., p. 70.

further prospected by drilling several test holes at locations in town which he designated. The locations of the W. P. A. wells were selected largely on the basis of these recommendations. The inadequate quantity and poor quality of the water obtained from the W. P. A. wells, and from other wells dug or drilled in town since Simpson made his study, serve to strengthen his conclusion that ground water adequate to support a municipal supply system is not available within the city limits in formations above the Dakota sandstone.

There is a wide range in the depths of the wells drilled in Wimbledon. The John Hartman well, 10 feet deep; the creamery wells, 18 feet deep; and other very shallow wells are developed in small outwash or kame deposits. An aquifer of this nature was encountered in test hole 1 at a depth of 6 to 16 feet. Water from such wells is generally low in mineral content (See analysis of water from Hartman well, p. 34) and suitable for domestic supplies if precautions are taken to avoid pollution. However, the deposits are thin and have very limited distribution and are therefore entirely inadequate to support a municipal supply.

Several wells draw water from an aquifer near the base of the till at depths ranging from 40 to 70 feet, including the five W. P. A. wells, the Borth well, the livery stable well, and others. Some of these wells are reported to have the largest yields of any in town, yet not sufficient to support a municipal supply. It is possible that the beds which yield water to these wells may be continuous with the rather thick body of sand and gravel encountered in test hole 1 at depths of 63 to 82 feet and 101 to 132 feet.

The schoolhouse, Murdock, Collard, and 300-foot creamery wells probably draw water from sand and gravel beds interbedded with the lake clay. The water from some of these wells is rather soft but the yield of all of them is reported to be inadequate for present use.

Aquifers encountered by test holes

Much of the information concerning the rock materials and their water-bearing characteristics in the Wimbledon area was obtained from 13 test holes drilled with the State-owned hydraulic rotary machine to depths ranging from 53 to 530 feet. The locations of these test holes are shown on figure 1, and logs of the holes are given on pages 37 and 38. Because wells and test holes already drilled in town had demonstrated the absence of important aquifers there above the Dakota sandstone, the test holes were drilled at geologically promising sites near town.

In all, four major aquifers were encountered by the test holes. Of these, the aquifer contained within and underlying the kame-terrace area, about 2 miles southeast of Wimbledon, is considered to be the most important. Test holes 6, 7, 8, 9, and 12 penetrated this aquifer. Each of the other aquifers was penetrated by only one test hole--Nos. 1, 4 and 11, respectively.

The excellent quality of the water from the Kame-terrace aquifer has been known for many years. An analysis of water from the Alfred Ernie "gravel pit" well which taps the upper part of this aquifer was made by the State

Health Department in 1934, and is given on page 34. Water is still hauled from this well for drinking and for other domestic purposes. However, until test holes were drilled during the present investigation, no information was available as to the thickness, extent, or water-bearing characteristics of the sand and gravel bodies which constitutes this aquifer. As shown on the cross-section, figure 2, and described on page 11, the kame-terrace deposits overlie, at least in the area of the test holes, an older body of sand and gravel from which they are commonly separated by a bed of till. However, at test hole 8 the surface gravel rests directly upon the older gravel body, and it seems likely that this condition exists in other parts of the kame-terrace area northeast of the section. This relationship is of great importance in providing a ready path for the recharge of the deeper aquifer. Test holes 6 and 12 encountered only the deeper gravel body and in test hole 13 this body had thinned almost to the vanishing point.

Test hole 4, located in the glacial channel about 2¼ miles south of Wimbledon, encountered 16 feet of sand and gravel at a depth of 8 to 24 feet below the surface. Presumably this sand and gravel represents channel-fill material and is present throughout the area of the channel. However, it is not known whether the conditions at test hole 4 are representative of the entire area and whether the aquifer may be thicker or thinner, or both, in various other parts of the channel.

Test hole 11 was drilled about 1 mile east of Wimbledon, near the south end of an esker. At least two farm wells, owned by Art Flohr and Carl Luther, are developed in the sand and gravel of this ridge, and test hole 11 was drilled to determine the characteristics of the aquifer where it is nearest to Wimbledon. Thick sections of sand and sand and gravel in this hole, from 19 to 66 feet indicated that considerable quantities of water might be available from this aquifer. Therefore the drill hole was washed out and bailed out and a string of 2-inch pipe with a sand point on the end was jetted nearly to the bottom of the aquifer. The well was then pumped with an air lift, 12 hours a day for 3 days. Two samples of water were taken for analysis, one after 1 day of pumping and the other after 3 days of pumping. The analyses are given on page 40. The well was pumped at the rate of about 15 gallons a minute, but because an air lift was used it was not possible to measure the drawdown. After 2 hours of pumping, the pump was shut off, the air tube removed, and the water level measured. It took 3 minutes to get a measurement after the pump was shut off. The water level was then 0.03 foot below the static level as measured before pumping began. This indicates a small drawdown and rapid recovery, and therefore a permeable aquifer. Because the analyses indicated a highly mineralized water, a more adequate pumping test was not made. Nevertheless, considerable quantities of water are probably available from this aquifer.

In test hole 1, two thick beds of sand and gravel were encountered at depths of 63 to 82 feet and 101 to 132 feet. The character and thickness of these beds indicate that a considerable quantity of water can probably be obtained from them if they have any considerable lateral extent. However, in test hole 2, only 850 feet west of No. 1, the materials of the aquifer were very thin and poorly sorted. If the aquifer was present in any of the wells drilled in town, it was very thin and clayey there also. The aquifer was not present in any of the other test holes. It seems likely that if the thick aquifer encountered in test hole 1 had any considerable lateral extent it would have been encountered by one or more of the wells in town or by the test holes, or by both. However, it is possible that it may be very narrow, yet of considerable length, and may cross the area in such a way as to have been missed by the wells and other test holes. A test well in this aquifer, to determine its productivity and the quality of its contained water, would give valuable information.

Recharge, storage, movement, and discharge of water in the principal aquifers

The kame-terrace aquifer is composed of the surface gravels of the kame-terrace area and the underlying body of older sand and gravel. It receives recharge by direct penetration of water from precipitation upon the broad area of terrace gravel that occurs in the southeastern part of the Wimbledon area, and which extends for several miles in a northeasterly direction beyond the limits of the area. The surface of the terrace gravel is highly permeable and rain water and water from melting snow are readily absorbed; a considerable portion of this percolates downward to the water table. Also, a considerable amount of water available for recharge comes from surface drainage to the kame-terrace area from adjacent high ground. The old glacial drainageway in which the kame terraces were formed is still lower than much of the surrounding region and wet-weather streams drain to it. The total amount of recharge from these sources is not known but a conservative estimate may be arrived at as follows: The total area of the kame terraces northeast of the line of test holes is in excess of 2 square miles, and the average annual precipitation over the area is about 18 inches. Assuming conservatively that about 10 percent of the water from precipitation may reach the water table and that an additional amount of water equivalent to about 2 percent of the precipitation may be recharged from stream flow, the total annual recharge in the 2 square-mile area would be in excess of 74 million gallons, or over 200,000 gallons a day. Of course, not all of this could be recovered from a practicable system of wells.

The total volume of saturated sand and gravel of the kame-terrace aquifer is large. The surface gravels cover an area in excess of 2 square miles and the buried gravels are probably equally extensive. The average thickness of saturated sand and gravel in test holes 6, 7, 8, and 12 was over 30 feet. The effective porosity, or specific yield, of the sand and gravel can be conservatively estimated to be 15 percent or more. Not all the water in storage in the aquifer can be withdrawn by wells, but if only 10 percent can be so withdrawn there is a minimum indicated storage sufficient to last for a number of years if the average withdrawal is at the rate of 40,000 gallons a day. Thus it appears that the storage is ample to support the anticipated municipal needs through extended periods of drought, when recharge to the aquifer would be greatly diminished.

As nearly as can be determined from aneroid elevations, the water level in well 142-61-3bba is 2 or 3 feet higher than that in well 142-61-5aad, indicating a slope of the water table of 3 or 4 feet per mile in a southwesterly direction. The land surface also slopes in that direction, but at a slightly greater rate. Discharge of water from the kame-terrace aquifer occurs in the pond and marsh area northeast of the till hill. Springs issue around the margins of this pond and it is reported that they support a small body of water which does not dry up even in drought years. Surface drains beneath the highway and railroad discharge water from this pond during very wet seasons, and discharge by evaporation and transpiration from the pond and marsh area occurs continuously. Continuous discharge to the large glacial channel southwest of the kame-terrace area probably occurs also.

The glacial-channel gravel encountered in test hole 4, and presumed to underlie all of that channel, receives recharge from direct penetration of precipitation upon its surface, from drainage into it from its immediate slopes and longer tributaries, and probably also as indicated above by percolation from the kame-terrace aquifer. Movement of water in the aquifer is southwestward in the direction of the surface drainage. Discharge of the ground water from the aquifer is by percolation downstream out of the area and by evaporation and transpiration from numerous ponds and marshes which occur in the channel, most of which are too small to show on the map (fig.1).

Recharge to the esker aquifer penetrated by test hole 11 probably comes from direct penetration of rainfall upon its surface and from percolation of water from the ephemeral stream that follows the course of the esker in the northern part of the area. Because of the small area of its exposed surface, the total amount of available recharge would be rather small. No data were obtained as to the movement or discharge of water in this aquifer.

The aquifer encountered in test hole 1 is covered by 53 feet of relatively impermeable till, and it is not likely than an important amount of recharge to the aquifer occurs in the vicinity of the test hole. No evidence was obtained to indicate that the aquifer has any considerable extent, and it is not known if it is exposed to recharge elsewhere.

QUALITY OF THE GROUND WATER

Water samples from 21 wells and springs in the Wimbledon area were collected during the present investigation and mineral analyses were made by the State Health Department. In addition, six analyses of ground waters made in 1934 by the Health Department for Dr. H. E. Simpson were available. All these analyses are given in the table on page 35. They show a wide range in mineral quality of the ground waters of this area, the total dissolved solids ranging from 245 to 21,108 parts per million and the hardness from 54 to 2,280 parts per million. Of the 27 samples, 18 had total dissolved solids in excess of 1,000 parts per million and only four samples contained less than 500 parts per million.

The least mineralized water was obtained from the gravel-pit well (142-61-5aad) owned by Alfred Ernie, and there are no significant differences between the analysis made in 1947 and that made in 1934. Only the school and Murdock wells yield softer water than the gravel-pit well and they are both developed in aquifers of small yield interbedded with the lake clays. The quality of the water from the gravel-pit well probably is somewhat better than that of the average water to be expected from the kame-terrace aquifer, because it is withdrawn from the upper part of the aquifer in an area where considerable freshening occurs from rain-water recharge. The spring (142-61-4bbb), which is believed to represent natural discharge from deeper parts of the aquifer, yields more highly mineralized water. The average quality of the water from the kame-terrace aquifer would probably be somewhere between these extremes. Wells drawing from the exposed, near-surface parts of the gravel body would yield the least mineralized water, whereas those in the buried parts of the gravel body farthest from the recharge areas would yield the most highly mineralized water.

The water from the esker aquifer is rather highly mineralized, as indicated by analyses of the Flohr well (143-61-21cca), the Luther well (143-61-28bbb), and test hole 11. Also, it appears that the water becomes more highly mineralized toward the south end of the aquifer, where it lies within a mile of wells containing the most highly mineralized waters sampled (143-61-29cbb and 143-61-30cda$_2$). Two samples were taken from test hole 11, one after pumping 1 day, the other after pumping 3 days. Mr. W. Van Heuvelen, the chemist who made the analyses, commented on the water as follows: "A highly mineralized and very hard water. It contains large amounts of calcium bicarbonate, calcium sulfate, and magnesium sulfate. The iron content is very high and will cause considerable staining of fixtures. The high sulfate ion concentration will make this water highly laxative. Pumping the well for two extra days increased total solids, sodium, and sulfate by slightly increasing the concentration of sodium sulfate in the water."

The glacial-channel aquifer penetrated by test hole 4 is recharged annually and the quality of the water would presumably be good and perhaps comparable to that in the kame-terrace aquifer. However, no analysis of water from this aquifer is available.

The quality of the water in the buried aquifer encountered in test hole 1 is not known. However, wells in town which have approximately the same depth as this aquifer yield highly mineralized water.

SUMMARY AND CONCLUSIONS

Ground water in sufficient quantity to be of interest as a possible source of municipal supply is contained in two formations beneath the Wimbledon area, the Dakota sandstone and the glaciofluvial deposits above and interbedded with the glacial drift. The water from the Dakota sandstone is so highly mineralized that it is generally considered unfit for drinking and culinary purposes. Moderately large quantities of this water are obtained in the area, as demonstrated by the "Soo Line" railroad well, drilled in 1889 to a depth of 1,557 feet and reported to have flowed 400 gallons a minute when drilled. The water from the glacial drift varies considerably in quality but that from most of the large auqifers is potable.

No large drift aquifers occur within the city limits of Wimbledon but four which may contain sizable quantities of water occur within 2¼ miles of the city. In order of probable size and importance they are: (1) The kame-terrace aquifer about 2 miles southeast of town, (2) the glacial-channel aquifer about 2¼ miles south of town, (3) the esker aquifer about 1 miles east of town, and (4) the buried aquifer near the southwest corner of town.

Information obtained during this investigation indicates that the average annual recharge to the kame-terrace aquifer is more than sufficent to replenish withdrawals of the order of 40,000 gallons a day and that the indicated storage is sufficient to support such withdrawals through periods of drought. Water obtained from shallow depths in the aquifer in the areas of recharge is far better in quality than ground water from any other source in the Wimbledon area. Water from deeper parts of the aquifer and parts somewhat distant from recharge areas is likely to be more highly mineralized. For this reason a well located in the vicinity of test hole 12, where the aquifer is nearest the town, might be expected to yield more highly mineralized water than that now obtained from the gravel-pit well near test hole 8.

From its location, near-surface exposure, and general water-bearing characteristics, the glacial-channel aquifer is thought to contain moderately large quantities of water relatively low in dissolved mineral matter. However, because of its greater distance from town it was not investigated as thoroughly as the other aquifers and its potentialities are not known.

The esker aquifer probably contains moderately large quantities of water, but it certainly would not furnish as large and dependable a supply as the kame-terrace aquifer. Furthermore, the highly mineralized character of the water makes it unsuitable as a source of municipal supply.

The buried aquifer encountered by test hole 1 near the southwest corner of town is thought to be of very limited extent, for it was not encountered in other test holes. However, not enough holes were drilled to show its areal extent, and because of its proximity to town it might be worth while to investigate the aquifer further by constructing in it a small test well upon which pumping tests could be made.

ANALYSES OF GROUND WATERS
IN PARTS

Owner or Name	Location Number	Date collected	Depth of well (feet)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)
Warren Ernie	142-61-4bbb	8-29-47	Spring	5	118	39
Alfred Ernie	142-61-5aad	5-15-47	11	0	62	24
Do.	do.	7-2-34	11	.2	43	18
Carl Paash	142-61-6cad	9-15-46	60	.2	200	44
O. T. Grunvold	142-62-1aab	9-15-46	35	.09	92	18
Oscar Patterson	142-62-1dbc	5-15-47	--	.25	72	38
Art Flohr	143-61-21cca	8-29-47	30	2.1	176	70
Carl Luther Estate	143-61-28bbb	8-29-47	92	2.2	146	83
John Bennett	143-61-29cbb	5-31-47	28	2.7	192	132
USGS test hole 11 b/	143-61-29cdc	8-29-47	70	10.0	341	115
Do. c/	do.	8-29-47	70	10.0	341	115
School well	143-61-30cac1	2-7-34	158	.2	29	7
Mrs. Murdock	143-61-30cac2	6-1-47	250	2.6	11	7
Henry Etter	143-61-30cbd1	2-7-34	35	0	38	12
John Hartman	143-61-30ccb	5-31-47	12	.77	57	42
Henry Schultz	143-61-30ccd2	2-7-34	22	.6	74	46
City of Wimbledon #4	143-61-30cda2	9-15-46	51	.3	462	213
Livery Stable	143-61-30cdb1	2-7-34	67	2.0	85	32
City of Wimbledon #3	143-61-30cdb4	9-15-46	77	.08	176	92
Do. #2	143-61-30cdc3	9-15-46	28	.06	216	46
Do. #5	143-61-30dbb	9-15-46	38	.1	192	54
Do. #1	143-61-31bab	9-15-46	45	.15	192	47
Emil Borth	143-61-31bba1	2-7-34	42	0	10	25
Elgar McKee	143-61-32cca	9-15-46	46	.1	160	25
R. H. Joos	143-61-32daa	8-29-47	185	.5	194	133
Fred Mutchler	143-62-36aab	5-15-47	42	0	95	47
Edgar Pearson	143-62-36cdd	5-15-47	26	.1	136	115

a/ All analyses were made by the State Health Dept.
Bismarck, North Dakota
b/ Sample taken after 1 day of pumping.
c/ Sample taken after 3 days of pumping.

IN THE WIMBLEDON AREA, NORTH DAKOTA
PER MILLION a/

Sodium (Na)	Alkalinity (as $CaCO_3$)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Total dissolved solids	Total hardness (as $CaCO_3$)
228	385	--	470	418	101	1,050	457
0	209	29	197	35	5	252	240
---	235	25	195	182	8	245	240
90	380	--	464	418	17	1,108	680
22	330	--	354	90	15	492	306
26	244	--	298	63	72	446	340
264	377	--	360	807	62	1,546	727
394	463	--	565	927	98	1,888	706
252	402	--	491	1,282	72	2,550	1,021
181	340	--	415	1,260	60	2,146	1,372
216	369	--	450	1,308	59	2,164	1,372
---	435	35	400	398	242	641	190
368	446	--	544	280	87	1,112	54
---	372	40	332	205	8	628	270
0	183	--	223	120	8	564	316
---	251	0	251	632	60	1,184	251
3,880	756	--	923	9,020	72	21,108	2,280
---	348	0	348	458	215	677	430
544	434	--	530	1,105	295	2,612	780
316	411	--	502	875	68	1,920	720
287	400	--	488	800	65	1,778	700
352	316	--	386	[illegible]34	112	1,994	680
---	420	0	420	284	70	1,223	460
203	410	--	500	383	68	1,180	490
133	370	--	451	796	91	1,768	1,027
17	306	15	343	128	18	613	430
42	293	--	357	549	34	1,214	814

Location number	Owner or Name	Depth of well (feet)	Diameter (inches)	Type
142-61-3bba	Alfred Ernie	18	46	Dug
142-61-4bcb	Warren Ernie	32	24	Do.
142-61-5aac	Alfred Ernie	28	3	Drilled
142-61-5aad1	Alfred Ernie	11.4	60	Dug
142-61-5aad2	USGS test hole 7	80	5	Drilled
142-61-5ada	do. 8	53	5	Do.
142-61-5add	do. 9	60	5	Do.
142-61-6aaa	Tony Falk	35	5	Do.
142-61-6baa	Old Holt Well		2	Do.
142-61-6cad	Carl Paasch	60	2.5	Do.
142-62-1aab	O. T. Grunvold	35	4	Do.
142-62-1caa	Oscar Patterson		48	Dug
142-62-1dbb	Mrs. O. Patterson	79	5	Drilled
142-62-1dbc	Oscar Patterson		48	Dug
142-62-12aad	USGS test hole 4	530	5	Drilled
142-62-12bbb	Leonard Greenly	32	48	Dug
143-61-21cca	Art Flohr	30	5	Drilled
143-61-27cdd	USGS test hole 10	160	5	Do.
143-61-28bbb	Carl Luther Est.	92	6	Drilled
143-61-29cbb	John Bennett	28	48	Dug
143-61-29cdc	USGS test hole 11	70	5	Drilled
143-61-30cac1	Schoolhouse	158	6	Do.
143-61-30cac2	Mrs. Murdock	250	6	Do.
143-61-30cad	James Collard	160	6	Do.
143-61-30cbd1	Henry Etter	35		Dug.
143-61-30cbd2	E. W. Stein	26		Do.
143-61-30cbd3	H. M. Stroud	60	4	Drilled
143-61-30cca	Geo. Seiderlinger			
143-61-30ccb	John Hartman	10	24	Dug
143-61-30ccd1	"Soo Line" R. R.	1,557	8	Drilled
143-61-30ccd2	Henry Schultz	22		Dug
143-61-30cda1	H. M. Stroud	110	6	Drilled
143-61-30cda2	Wimbledon WPA #4	51	48	Dug
143-61-30cdb1	Livery Stable Well	67	4	Drilled
143-61-30cdb2	Land O'Lake Crmy.	18	48	Dug
143-61-30cdb3	do.	300	6	Drilled
143-61-30cdb4	Wimbledon WPA#3	77	60 to 8	Dug,Drlld.
143-61-30cdc1	Charles Murray	200	6	Drilled

WIMBLEDON AREA, BARNES COUNTY, NORTH DAKOTA

Date completed	Depth to water below measuring point (feet) a/	Use b/	Remarks
1905	11.85	D,S	
		D,S	
1933		D,S	
	8.00	PS	Analysis. Pumping test made 7-28-46.
8-8-47		U	Log.
8-11-47		U	Do.
8-13-47		U	Do.
1908		D,S	
	21.96		
1904		D,S	Analysis.
	21.14	D,S	Do.
1925		S	
	22.40	U	
	22.84	S	Analysis.
8-5-47		U	Log.
1936	25.00	D,S	
1920	10.00	D,S	Analysis.
8-14-47		U	Log.
		D,S	Analysis.
1939	20.	D,S	Do.
8-17-47	19.5	U	Log and Analysis.
1930	35	PS	Analysis. Inadequate for school.
Prior to 1934		D	Analysis. Inadequate for family.
do.	25	D	
Prior to 1934		D	Analysis. Inadequate for family in August 1933.
do.		D,S	Yield approximately 1 barrel per day.
1925	17.75	D	
Prior to 1934		U	Reported dry in 1934.
1946	6	D,S	Analysis.
1889	Flow	U	Flowed 400 gpm with 65 lbs. natural pressure when drilled.
Prior to 1934		D	Analysis. Scant domestic supply.
		D	
1939	10.32	U	Analysis.
1915	15.19	D	
Prior to 1934		Ind	Insufficient for needs at creamery.
do.		Ind	Insufficient for needs at creamery. Salty.
1938	39.12	D	Analysis.
Prior to 1934			Small yield.

Location number	Owner or Name	Depth of well (feet)	Diameter (inches)	Type
143-61-30cdc2	J. F. Treitline	17		Dug
143-61-30cdc3	Wimbledon WPA #2	28.5	48	do.
143-61-30cdd	Al Nickelson	18	48	do.
143-61-30dbb	Wimbledon WPA #5	38	48 to 10	Dug,Drlld.
143-61-30dbc1	Fairgrounds	22	48	Dug
143-61-30dbc2	do.	205	6	Drilled
143-61-30dca	Gene Wilds	170	6	do.
143-61-31baa	"Soo Line" R.R. styd.	114	6	do.
143-61-31bab	Wimbledon WPA #1	45	48	Dug
143-61-31bba1	Emil Borth	42	36	do.
143-61-31bba2	W.N.A.X. Filling Sta.	54	36 to 6	Dug,Drlld.
143-61-31ccc	USGS test hole 5	80	6	Drilled
143-61-32bbd	Fred Buck	90	6	do.
143-61-32bcc	USGS test hole 13	70	6	do.
143-61-32cca	Elgan McKee	46	[illegible]	do.
143-61-32daa	R. J. Joos	185	6	do.
143-61-32dcb	USGS test hole 12	70	6	do.
143-61-32dcd	do. 6	90	6	do.
143-62-25ccc	do. 3	300	6	do.
143-62-25ddc	do. 2	490	6	do.
143-62-25ddd	do. 1	340	6	do.
143-62-36aaa	Fred Mutchler		36	Dug
143-62-36aab	do.	42	48	do.
143-62-36cdd	Edgar Pearson	26	48	do.

a/ Measurement given to hundredths of a foot were made in August 1946. Others were made by Simpson in 1934.

b/ D-domestic, PS-public supply, S-stock, U-Unused or abandoned, Ind-industrial. Most of the wells drilled prior to 1934 are now abandoned.

WIMBLEDON AREA, BARNES COUNTY, NORTH DAKOTA

Date Completed	Depth to water below measuring point (feet) a/	Use b/	Remarks
Prior to 1934		D	Reported alkaline. Small yield.
1939	16.89	PS	Analysis.
Prior to 1934		D	Reported dry in 1934.
1939	16.54	PS	Analysis.
Prior to 1934		PS	Reported slight yield.
Do.		U	No suitable aquifers encountered.
Do.		D	Reported salty.
Do.			
1939	19.89	PS	Analysis.
Prior to 1934	30.00	D	Analysis. Can be bailed dry.
Do.		D	Easily pumped dry.
8-7-47		U	Log.
1927	40.00	S	
8-19-47		U	Log.
1912	18.57	D,S	Analysis.
1914	35.00	D,S	Do.
8-19-47		U	Log.
8-8-47		U	Do.
7-29-47		U	Do.
7-24-47		U	Do.
7-22-47		U	Do.
	13.04	D,S	
1922	13.07	U	Analysis.
1936	20.00	D,S	Do.

Logs of test holes in the Wimbledon area

No. 1 143-62-25ddd

Material	Thickness (feet)	Depth
Clay, yellow, and gravel	6	6
Sand and gravel, clayey	10	16
Till, unweathered	47	63
Sand and gravel, composed chiefly of shale	19	82
Clay, sand and gravel	19	101
Gravel and sand, pebbles of shale	31	132
Till, unweathered	18	150
Clay and silt, with a few limestone and shale pebbles. Lake clay?	190	340

No. 2 143-62-25ddc

Material	Thickness (feet)	Depth
Soil	2	2
Clay, yellow, and gravel	8	10
Sand	1	11
Clay, yellow, and gravel	7	18
Till, unweathered	33	51
Sand and gravel, clayey	3	54
Clay, sand and gravel	61	115
Sand and gravel, clayey	13	128
Till	4	132
Sand and gravel, clayey	5	137
Clay, silt and fine sand	14	151
Till	19	170
Clay and silt, sandy; some limestone and shale pebbles. Lake clay and inter bedded till?	250	420
Shale?	70	490

No. 3 143-62-25ccc

Material	Thickness (feet)	Depth
Soil, sandy	5	5
Clay, yellow, and gravel	6	11
Sand	19	30
Gravel and boulders	5	35
Till, unweathered, bouldery	30	65
Clay, sand and gravel	74	139
Sand and gravel, clayey	25	164
Clay, sand and gravel	31	195
Gravel	6	201
Clay, sand and gravel	79	280
Clay (Lake clay?)	20	300

No. 4 142-62-12aad

Material	Thickness (feet)	Dept
Soil	4	4
Clay, white, calcareous	4	8
Sand, and gravel	15	23
Gravel and cobbles	1	24
Till, unweathered	33	57
Sand and gravel, clayey	11	68
Clay, sand and gravel	102	170
Lake clay, fine, sandy; may have a little interbedded gravel or till	160	330
Clay or shale	45	375
Shale (Niobrara shale)	155	530

No. 5 143-61-31ccc

Material	Thickness (feet)	Depth
Clay, yellow, and gravel	19	19
Till, unweathered	25	44
Sand and gravel	1	45
Till	15	60
Lake clay, contains a few pebbles and cobbles (ice-rafted?)	20	80

No. 6 143-61-32dcd

Material	Thickness (feet)	Depth
Till, yellow, weathered	8	8
Till, gray, unweathered	34	42
Gravel and sand	12	54
Clay and gravel	3	57
Gravel and sand	10	67
Clay, gray, fine sandy	23	90

No. 7 142-61-5aad

Material	Thickness (feet)	Depth
Sand	5	5
Clay, yellow, and gravel	3	8
Till, gray, unweathered	18	26
Gravel and sand	30	56
Clay, gray, fine, sandy	24	80

No. 8 142-61-5ada

Material	Thickness (feet)	Depth
Sand and gravel	26	26
Sand, gravel, and boulders	14	40
Clay, gray, fine, sandy	13	53

No. 9 142-61-5add

Material	Thickness (feet)	Depth
Clay, gravel and sand	5	5
Gravel and sand	11	16
Clay, gray, and gravel and sand	18	34
Gravel and sand	6	40
Clay, gray, fine, sandy	20	60

No. 10 143-61-27cdd

Soil	5	5
Sand, fine	3	8
Till, gray, unweathered	72	80
Till, possibly with interbedded lake clay	69	149
Clay, lacustrine	11	160

No. 11 143-61-29cdc

Soil, black	5	5
Till, yellow, weathered	14	19
Sand and fine gravel	6	25
Sand and gravel, some clay	17	42
Sand, fine, and detrital coal	3	45
Sand, medium to coarse	21	66
Clay	4	70

No. 12 143-61-32dcd

Material	Thickness (feet)	Depth
Soil, black	3	3
Clay, sandy yellow, and gravel	18	21
Sand and gravel, shale pebbles and considerable detrital coal	40	61
Clay	9	70

No. 13 143-61-32bcc

Soil, black	3	3
Till, weathered	14	17
Till, unweathered	21	38
Gravel	2	40
Till, bouldery	5	45
Gravel	5	50
Till	12	62
Clay	8	70