GROUND WATER IN THE SHARON AREA, STEELE COUNTY

NORTH DAKOTA

By.

P. E. DENNIS

NORTH DAKOTA GROUND WATER STUDIES NO. 8

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ABSTRACT

Sharon is in the northwest corner of Steele County, North Dakota, about 50 miles southwest of Grand Forks. It is in the east-central part of the Drift Prairie on the east margin of the Fergus Falls-Leaf Hills recessional moraine. The till of the moraine is virtually non-water-bearing, as is also the Cretaceous shale bed rock which underlies the drift at depths of 15 to 130 ffeet in this area. No wells have been drilled to the Dakota sandstone, which lies about 1,200 or 1,300 feet below the surface at Sharon. However, in adjacent areas water from the Dakota sandstone is generally considered unsuitable for culinary purposes. A glacial channel 1 mile east of Sharon is cut in till and contains no water-bearing sand and gravel. Gravel is exposed at the surface of an outwash plain about 4 miles west of Sharon. It is generally only 5 to 8 feet thick. The ground-water body in this gravel receives considerable annual recharge from the precipitation upon its permeable surface and perennial springs discharge from it. Considerable ground water could probably be obtained from wells in the thicker portions of these outwash deposits.

Buried gravel underlying the till of the end moraine was found in six of the test holes drilled to the shale bedrock west and south of Sharon. The gravel is well-washed in part. It may represent pre-moraine channel filling. It ranges up to 30 feet in thickness in the holes drilled and usually rests upon the shale bedrock. No supply wells have been drilled into this aquifer in the area, although two or three farm wells may have entered the upper part of it. The aquifer may contain a fairly large amount of water, but definite information regarding the quantity available can be obtained only from pumping tests made when additional test holes and wells are constructed.

The quality of the water in the buried gravel aquifer is better than that from most of the wells in Sharon and is at least as good as that from the Saim and Gullicks springs. Analyses indicate that it probably contains between 700 and 1,000 parts per million of total dissolved solids and has a total hardness between 300 and 450 parts.

INTRODUCTION

Scope And Purpose Of The Investigation

This is a progress report on the general study of the geology and ground-water resources of Steele County being made by the U. S. Geological Survey in cooperation with the North Dakota State Water Conservation Commission and the State Geological Survey. These general studies are being made 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. 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 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 being 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 can be completed.

The work described in this report was confined chiefly to obtaining information on ground water in the part of Steele County which might be of interest to the village of Sharon in its search for sources of municipal water supply.

Location and general features of the area

Sharon is in the northwest corner of Steele County, North Dakota, about 50 miles southwest of Grand Forks. It is on a branch line of the Great Northern Railway running from Fargo to Devils Lake, and serves and a shipping point and trading center for the farming area around it. The town has a popelation of about 371 (1940 census).

The part of the Central Lowland 1/ physiographic province in which Sharon is located has been called the Drift Prairie by Simpson 2/. It is a plains area modified by uneroded glacial drift, which forms relatively rough low 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. Sharon is situated about 50 miles east of the escarpment which marks the eastern boundary of the Missouri Plateau and about 12 miles west of the highest (Herman) shore lines of Lake Agassiz, which mark the western limit of the Red River Valley 3/.

The topographic features in the vicinity of Sharon consist of end moraine, ground moraine, and outwash plains and channels (fig 1) the town is at the eastern edge of a small recessional moraine which has a general width of 3 to 4 miles. Its trend is essentially north-south in the vicinity of Sharon and for several miles north and south, but a short distance north of Aneta the moraine is shown by Upham 4/ to turn northward and to join the heavy morainal area south of Devils Lake. It is a part of his Fergus Falls - Leaf Hills moraine. Typical knob and kettle topography characterized much of the surface of the end moraine, the maximum difference in elevation between the bottoms of the kettles and the tops of the knobs amounting to a little more than 100 feet.

The end moraine grades eastward into ground moraine where the hill and swale topography is broken only by small and poorly developed glacial drainage channels. In contract, the western edge of the end moraine is generally abrupt, its front forming a definite escarpment as viewed eastward from the outwash plain.

The Sheyenne River is theonly perennial stream in the area. At its nearest point it is about 10 miles west of Sharon. The river meanders in a broad glacial channel whose floor lies about 250 feet below the general elevation at Sharon. The end moraine forms a drainage divide, the outwash plains west and south of it being tributary to the southward slowing Sheyenne whereas the glacial channels east and north of it are tributary to the eastward flowing Goose River.

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.G.S. Water Supply Paper 598, p 4, 1929.
3/ Upham, Warren, the Glacial Lake Agassiz: U.S.G.S. Mon. 25, 1896.
4/ Op. cit, pl. 19, p. 212

Previous Investigations and Acknowledgements

The geology and ground water of the Sharon region have been previously treated only in a very general way in connection with studies of broad areas. A general discussion of the ground water in Steele County, with mention of the common depth and character of wells at Sharon, is contained in Simpson's paper on the ground water resources of North Dakota 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 state.

The present study was facilitated by the ready cooperation of townspeople, farmers, and local well drillers. Thanks are due especially to those who permitted measurement of water levels in their wells and drilling operations upon their land, and to Rasmus and Gus Mikkelson for information concerning the numerous wells they have bored in the vicinity.

Present water supply and future needs

Water for domestic use in Sharon is obtained at present from several wells in town, from springs and wells in ajacent areas, and from rain water caught from the roofs of buildings and stored in cisterns. There are two city wells 70 feet deep, located half a block apart near the center of town. Only the south well is being used. The north well is reported to have been abandoned because of pollution. A well near the south edge of town, known as the McKenzie warehouse well, is also used as a community well. A well at the school furnishes sufficient water for school needs and a well at the hospital is reported adequate to meet the needs there. Considerable water is hauled from the H. E. Johnson and S. F. Ronde wells about half a mile west and northwest of town respectively. Water is also hauled from the Hans Sein spring, about 5 miles west of town and from the Charles Gullicks spring, about 2 miles southeast of town.

It is estimated that about 30,000 to 40,000 gallons of water a day would 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 rainfall 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 elevations 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, limestones, etc., 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, 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

5/ Op. cit. pp. 228-230
6/ Op. Cit.

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 obtain 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, 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 from wells in aquifers having good recharge areas, 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 the,. 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 Sharon area consists of glacial drift of Pleistocene age. It forms a thin veneer on the underlying shale bedrock, which in this area is the Pierre shale, of Cretaceous age. The Pierre shale is underlain by other Cretaceous shales and the Dakota sandstone, and beneath there are pre-cambrian crystalline rocks. No water-bearing rocks occur below the Dakota sandstone in this area. The drift may be divided conveniently into (1) glacial outwash and stream deposits consisting chiefly of sand and gravel, and (2) end and ground moraine consisting chiefly of till.

Glacial outwash and stream deposits

Outwash sand and gravel deposits occur at the surface as a broad outwash plain west of the end moraine and along glacial channels which cross the area of ground moraine east of the end moraine. Other bodies of sand and gravel of glacio-fluvial origin were encountered beneath the till of the end moraine in some of the test holes drilled west and south of Sharon.

<u>Surface Gravel</u> The outwash plain west of the end moraine is covered with poorly sorted and poorly rounded sand and gravel which is made up largely of grains and pebbles of shale. Observed thicknesses of the outwash material range between 4 and 8 feet and farm wells in this area rarely exceed 10 feet in depth. A channel or coulee about 20 to 25 feet deep, cut by a southward flowing glacial stream, crosses the outwash plain about 3 miles west of Sharon (fig. 1). Exposures along this coulee show 5 to 8 feet of gravel resting on till and on shale bedrock. The Seim spring and nearby smaller springs and seeps issue in the coulee at the contact between the outwash materials and the underlying till. Auger holes across the coulee below the spring area showed only till to a depth of 4 to 6 feet, but about half a mile south of the spring area shale bedrock is exposed in the walls of the coulee and the outwash gravel rests directly upon it. Considerable ground water could probably be obtained from the thicker portions of this outwash gravel, but no test holes were drilled in the area because of its distance from Sharon.

A large part of the precipitation on the outwash plain probably finds it way downward through the permeable surface materials to replenish the ground-water body. The Fain spring and other smaller springs and seeps, which issue at the contact between the outwash materials and underlying till, represent natural discharge from this aquifer. The springs are perennial and are reported to have had about the same flow during drought years. Only a part of the spring flow has been caught in development works. The part of the flow thus captured was at the rate of 4 gallons a minute, when measured on May 1, 1946.

Two small glacial channels, which originally connected with the Goose River eastward across the ground moraine east of Sharon. The nearer of these is only about a mile east of town, where it is about a third of a mile wide and about 60 feet deep. The bottom materials of this coulee were sectioned at three points by means of hand auger holes and by one machine-drilled hole which was put down to bedrock. The locations of these test holes are shown on the map (fig 2) and logs of the holes are given on pages 27-29 of this report. Practically no sand and gravel was encountered in any of the nine test holes; unweathered till ("blue clay" of local drillers) was encountered at depths of 9 to 10 feet, and shale bedrock at a depth of about 20 feet.

The Chester Gullicks spring occurs in a small tributary of this channel about 1¼ miles southeast of Sharon. There is a possibility that the spring may issue from surface gravel, although no gravel is present in the main channel and no surface gravel was encountered in any of the five test holes drilled immediately west of the spring. The water appears to issue from the till and may represent natural discharge from the buried gravels encountered in test hole 5 and test holes 9, 10, 11 farther west. Present information is not sufficient to establish definitely the source of the spring water.

The amount of water discharged by the spring is reported to be nearly constant from season to season and from year to year. On June 21, 1946, the discharge was measured as 12.4 gallons a minute. All or nearly all the water appears to have been caught in the development works.

Buried gravels. Buried gravel ranging in thickness between 10 and 40 feet was encountered in two test holes west of Sharon and in four holes south of town. Numerous wells drilled in Sharon indicate that the gravel is not present there, and five of the test holes drilled near the town did not encounter it (fig 3). Some farm wells, such as those of Christ Olson, S. F. Ronde, and H. E. Johnson (see table of well records) may have encountered this aquifer. The gravel generally but not always, rests upon the shale bedrock and is overlain by 20 to 90 feet of till. It varies considerably in the degree of rounding and sorting from well to well, and from bed to bed within individual wells. Pebbles and grains of crystalline rocks and limestone are generally more plentiful than those of shale but in some samples the reverse is true.

The gravels were deposited before the formation of the end moraine. For this reason they have no topographic expression and it is not known whether they were deposited as an outwash apron, as glacial channel fillings, or in some other manner. Their distribution suggests that they are more probably some types of glacial channel filling, but this is by no means established, because their original form has been at least partly destroyed by subsequent ice erosion and much of the remaining gravel has been covered by subsequent ice deposits. It is impossible to determine, without drilling many additional test holes, whether the gravels extend continuously from one hole to the other. The geographic location of the known gravel occurrences and the common stratigraphic position would suggest that all the gravel may have been deposited during the same interval of time and that originally the deposits were all interconnected. However, such interconnections, if they ever existed, may have been subsequently destroyed by the work of the ice. For these reasons there must necessarily remain a large measure of uncertainty as to the size, extent, and distribution of the aquifer or aquifers until more data can be obtained from additional drilling in the area and from hydrologic studies of producing wells when they are developed in the aquifers.

Till of the moraines.

The ground moraine east of Sharon ranges in thickness between 15 and 35 feet in areas where information is available from test holes and logs of wells. Exposures of bedrock below 6 to 10 feet of gravel in the outwash area indicate the probable thinness of the drift cover in that area also. However, in the area of the end moraine, the test holes show the drift to range between 40 and 90 feet in thickness and a few wells are reported to have encountered from 100 to 130 feet of drift overlying the shale. Both end moraine and ground moraine are composed chiefly of till.

The till is a compact clayey material composed chiefly of shale detritus with occasional boulders and pebbles of limestone and crystalline rocks. It is commonly somewhat more gravelly at the base. Practically all the wells at Sharon draw water from this gravelly till, which rests upon the shale bedrock.

Practically all the wells in town range in depth between 60 and 80 feet, and those which were drilled deeper are reported to obtain their water at a depth of about 70 feet. Drillers' reports indicate that there are few in any water bearing beds in the main body of the till. Only a few inches of dirty gravel was encountered at the base of the till at a depth of 75 feet in test hole 8, drilled near the southwest corner of town. Reports indicate that most wells drilled in town encountered only a very thin water-bearing bed, at about the same depth. The gravelly water-bearing portion of the drift yields water only very slowly to the wells drilled in town.

It is not known whether the buried gravels encountered in test holes west andsouth of Sharon are interconnected with the aquifer that supplies the wells in the town. The water from the wells in town is so much more highly mineralized that a direct, highly permeable connection appears unlikely.

Shale bedrock

The bedrock in the Sharon area is the Pierre shale of Cretaceous age. It occurs at a depth of 70 to 80 feet below the surface at Sharon and at depths ranging between 40 and130 feet throughout the area of the end moraine. It occurs at shallower depths usually between 15 and 35 feet beneath the ground moraine and the outwash plain. No wells are known to obtain water from the shale in or near Sharon, although in other parts of the State this formation yields small amounts of water from sandy beds and other permeable zones. The water generally is highly mineralized. Several wells are reported to have been drilled deeply into the shale without finding any appreciable amount of water. P. A. O'Keeffe, who operated a flour mill at Sharon years ago, is reported to have had several test wells drilled some as deep as 700 feet. Not much water was obtained from any of them below the top of the shale, which was encountered at a depth of about 75 feet. Over a wide area in this region the shale appears to contain no important water bearing beds. The Edgar Gutormson farm well, near Aneta, is reported by Simpson 7/ to have been drilled 744 feet without finding water. Simpson 8/ also reports a well

8/ Op. cit. p. 230.

7/ Simpson, H.E., Geology and ground-water resources of North Dakota; USGS Water Supply Paper 598, p. 179, 1929.

about 6 miles south of Sharon, at Finley, to be 800 feet deep. The well is reported to have been a "dry hole".

The Niobrara formation and Benton shale, which underlie the Pierre, are also chiefly shale and are non-water-bearing.

Dakota sandstone

So far as is known, no wells have been drilled in the vicinity of Sharon to the Dakota sandstone, which underlies the Cretaceous shales in this area. This artesian aquifer is encountered about 600 feet below the surface (about 300 feet above sea level) near Northwood and about 1,450 feet below the surface (about sea level) at Devils Lake. The probable depth of this aquifer at Sharon is about 1,200 or 1,300 feet. The water from the Dakota sandstone is highly mineralized near Northwood, at Devils Lake, and also west of Sharon, at Harvey and Carrington. It is generally considered unsuitable for culinary purposes.

Test holes

Test holes drilled in the Sharon area consist of 9 hand-bored auger holes and 11 deeper holes drilled to bedrock with the State-owned hydraulic rotary machine. Geologic reconnaissance of the area suggested that the glacial drainage channel or coulee, about a mile east of town, might contain a perennial supply of ground water. However, four auger holes put down to unweathered till at intervals of one-tenth of a mile across the section immediately east of town showed the channel to be cut in the till and that practically no sand and gravel was deposited upon its floor. Two other augered sections across the coulee, 1 mile and 2 miles south of the first one, also showed little or no sand and gravel flooring the old channel (fig. 2). Later machine drilled test hole 1 was put down in the coulee to determine if there might possibly be older gravel beneath the till, but the drift was found to rest directly upon shale bedrock.

Test holes 2 and 3 were drilled west of town to complete an eastward section of the area. Buried gravels were found at both locations but those in hole 3 a mile west of town were thicker and more permeable than those in hole 2 nearer town. Holes 4, 5, 6 & 7 were drilled to complete a north-south section east of town and to prospect the source of the water discharging at the Gullicks spring. Hole 5, east of the Christ Olson well, was the only one of these tests that encountered an aquifer. Holes 4 and 6 indicated that the aquifer is probably local and narrow. It is not known whether there may be a connection between this aquifer and the Gullicks spring. Holes 4 and 7 were located in shallow draws which drain toward the spring, but no aquifers were encountered at either location.

Test holes 8, 9, 10 & 11 were drilled to complete a section due south of Sharon and to determine if there might be an connection between the gravels encountered in holes 2 and 3 and those encountered in hole 5. No aquifer was encountered in hole 8 and from reports it appears that the log of this hole is quite similar to those of wells drilled in the town. Hole 9 encountered sand and gravel mixed with considerable clay at depths between 15 and 35 feet and fairly clean gravel between 35 and 40 feet. Hole 10 encountered a good aquifer between 40 and 70 feet. Samples of water were obtained for chemical analysis from holes 9 and 10.

Logs of all the test holes are given later in this book and graphic logs are shown in the sections of figure 3, attached at end of this book.

Water levels and pumping records

Water levels were measured in most of the accessible wells in Sharon and levels were run to the measuring points on each of the wells. In the absence of an established bench-mark elevation, the northeast corner of the concrete step in front of the bank was used as a bench mark with an assumed elevation of 100. Using this datum, the water surface elevations in most of the wells ranged between 58.5 and 65 feet. Of the three wells which departed considerably from this range of levels, two, the Simpson and Olson wells, are located on low ground and are unused. It is possible that surface water may run into these wells and that they may have become silted up thus producing temporary high water levels. It is not known why the Bergen well had such a low water level. The static water level in USGS test hole 9 was 92.9 feet and in No. 10 it was 77.8 feet, referred to the same datum. The water levels in the town have probably been lowered by pumping and that in test hole 10 may represent the approximate static water level in the aquifer. The high water level in test hole 9 may result from local recharge as the hole is located on the edge of a large pond and marsh area. The log of the test hole indicates that the aquifer is overlain by about 15 feet of weathered drift, which is chiefly clay at this spot but which may be sandy in nearby areas. On the other hand, the difference in water levels may indicate that the aquifers in the two wells are not connected with each other or with that from which the wells in town draw water.

The water-level fluctuations caused by pumping range widely in thewells at Sharon. The poorer wells are reported to "pump dry" after yielding only a few barrels of water, and the "stronger" wells have very large drawdowns while pumping 2 to 5 gallons a minute. The school and hospital wells are considered the "strongest" and certainly they are the most heavily pumped wells in town. The school well pumped at the rate of about 2.4 gallons a minute and had a drawdown of more than 30 feet after pumping for 2 hours at this rate during a test on September 4, 1946. Computations made from the drawdown and recovery curves obtained from the pumping tests indicate a transmissibility between 54 and 86 gpd/ft, This is low as would be expected in an aquifer reported to be only a few inches thick and composed of a mixture of clay, sand and gravel. The hospital well is said to pump at the rate of about 5 gallons a minute, but not for more than an hour or so at any one time.

Seasonal fluctuations of water levels are partly masked by the pumping effects, but in general the water levels are lowest in winter and early spring and reach their highest points in late summer following the rainy season.

Recharge, movement and discharge of the water of the buried gravels

The relatively low mineralization of the water in the buried-gravel aquifer and the tendency for the highest water levels to occur shortly after the rainy season suggest that a part or all of the recharge is locally derived. However, too little is known of the extent and exposure of the gravels to identify the areas of recharge. The log of test hole 9 shows only 15 feet of weathered till overlying dirty gravel and it is likely that some recharge reaches the gravels in this area, not only from local rainfall but also from the surface drainage which is caught in the pond and marsh area west of Sharon. The amount of till cover above the gravel differs considerably in the areas where test holes were drilled. It is not unlikely that in other areas the gravels may be at or near the land surface.

Too few wells have been drilled in the buried gravels to determine the direction and rate of movement of water in them and only conjecture can be made as to the probable regions of natural discharge. Although somewhat more highly mineralized than the waters taken from test holes 9 and 10, the [illegible] spring water may represent natural discharge from this aquifer. The area of the end moraine contains many ponds and marshes, some of which may be discharge areas for the aquifer, and the [illegible] outwash [illegible] west of the end moraine may [illegible] contribu- [illegible]. More definite information regarding the recharge, movement, and discharge of water in the aquifer [illegible] wells are completed [illegible] in [illegible].

QUALITY OF THE GROUND WATER

Water samples from eight wells and springs were collected in the Sharon area and submitted to the State Department of Health and the State Laboratories Department for mineral analysis. The results of these analyses are shown in the table on page 25. The school, hospital, city and Ronde wells and the two springs are all being used extensively to supply water for the town. All the water is rather highly mineralized, the total dissolved solids ranging between 754 and 2244 parts per million. Water from the springs and test holes is the least highly mineralized, containing between 754 and 936 parts per million of total solids. The water from the Ronde well is softest but is objectionably high in alkalinity. The analyses indicate that the water from the buried-gravel aquifer probably ranges between 700 and 1000 parts per million in total dissolved solids and between 300 and 450 parts per million in total hardness.

SUMMARY AND CONCLUSIONS

The geologic materials underlying the Sharon area consist of glacial drift, the Pierre shale and other Cretaceous shales, the Dakota sandstone and crystalline rocks. Of these materials only the drift is likely to contain water of satisfactory quality in quantities large enough to support a municipal supply. Wells drilled to depths of 700 to 800 feet in and near Sharon have failed to obtain water in the Pierre shale and other Cretaceous shales. No wells have been drilled to the Dakota sandstone in this area but it probably would be encountered at a depth of about 1,200 or 1,300 feet below the surface. Water from the Dakota in adjacent areas is generally considerdd unfit for culinary purposes. The crystalline rocks are non-water bearing.

At Sharon the drift consists of end moraine, ground moraine, and glacial outwash and stream deposits. The glacial outwash and stream deposits form (1) an outwash plain located west of the end moraine; (2) narrow glacial channels which cross the ground moraine; and (3) pre-moraine channel (?) gravel, which underlies the till of end moraine. Of these materials only the thicker parts of the surficial outwash gravel and the gravel which underlies the end moraine are likely to furnish any considerable amounts of water to wells. The till at the end and ground moraine is composed largely of clay and shale detritus and is essentially non-water bearing. The glacial channel about a mile east of Sharon is cut in till and contains little or no sand and gravel, as indicated by auger-hole sections drilled across it at three places and by one deep test hole drilled to bedrock.

The outwash plain area lies about 3 miles west of Sharon on the opposite side of the end moraine. Pipe line construction across the moraine would probably be difficult and expensive. The plain is veneered by sand and gravel generally only 3 to 6 feet thick, although it may be thicker in some areas. These permeable materials are exposed at the surface and receive considerable annual recharge from precipitation on the plain. The Seim spring and other smaller springs and seeps issue at the contact between the outwash materials and the underlying till where both have been cut by a glacial drainage channel, about 5 miles west of Sharon. The springs are perennial and represent natural discharge from the outwash aquifer. Their discharge is reported to have been about the same during drought years. Considerable water could probably be obtained from wells located in the thicker portions of the outwash deposits.

Test drilling west and south of Sharon disclosed the presence of gravel deposits as much as 30 feet thick buried beneath the till of the end moraine. Six of the test holes encountered this gravel and it is possible that the deposits are interconnected and form an aquifer of importance in this area. The gravel is well-washed in part and generally rests upon the shale bedrock. Most of the wells in Sharon obtain water from the drift near its base, and the water-bearing material may be imperfectly connected with the gravel aquifer to the south and west. Two or three farm wells may have entered the upper part of the gravel, but an aquifer of any considerable thickness and extent was not suspected in this area until the test holes were drilled. Definite information regarding the quantity of water available from this aquifer can be obtained only from pumping tests made when additional test holes and wells are constructed in the aquifer.

The ground water in the Sharon area is moderately to highly mineralized. The water from the buried gravel in two of the test holes and the water from the two springs were the least highly mineralized of the samples taken. All the samples analyzed were very hard except that from the Ronde well. That water is reasonably soft but is highly mineralized and is objectionably high in alkalinity. Water in the buried-gravel aquifer probably contains between 700 and 1000 parts per million of total dissolved solids and has a total hardness between 300 and 500 parts per million.

ANALYSES OF WATER

Owner	Location Number	Date Collected	Source of Analysis	Depth of well(ft)	Iron (Fe)	Calcium (Ca)
Charles Gullicks	147-57-1bdd	6-21-46	A	Spring	1.7	166
USGS test 10	147-57-2bbb	5-3-47	A	85	.2	73
S. F. Ronde	148-57-27dbb	6-20-47	A	86	2.4	10
Sharon town well	148-57-35bbb	6-20-46	A	71	1.1	88
Hospital Well	148-57-35bbd1	6-20-46	A	73	.6	188
School well	148-57-35bbd3	6-21-46	A	112	8.0	101
USGS test 9	148-57-35dad	4-21-47	A	67	none	129
Jens Seim	148-58-26ddd	4-21-46	A	Spring	.6	71

A- State Laboratories Department, Bismarck

B - North Dakota State Department of Health, Division of Laboratories

IN THE SHARON AREA, NORTH DAKOTA

Mg	Na	$CaCO_3$ *	CO_3	HCO_3	SO_4	Cl	Total dissolved solids	Total hardness as $CaCO_3$
50	0	332	24	356	308	Trace	906	621
62	0	124	36	78	309	Trace	756	436
4	538	510	46	550	371	21	1769	41
21	262	430	0	522	455	Trace	1131	302
65	222	304	50	268	888	32	2244	688
32	242	318	29	329	587	28	1297	385
9.5	13	292	15.4	325	323	10.8	936	361
21	11	180	47	124	328	trace	843	259

Mg Magnesium
Na Sodium
$CaCO_3$ carbonate(alkalinity) - column 3 above*
HCO_3 Bicarbonate
SO_4 Sulfate
Cl Chloride

Location Number	Owner or Name	Depth of Well (ft)	Diameter (in)	Type
147-56-1bdd	Charles Gullicks spring	-	72	-
147-57-2add	USGS test 7	66	5	Drilled
147-57-2bbb	USGS test 10	85	5	do
147-57-2daa	USGS test 4	70	5	do
147-57-3add	USGS test 11	100	5	do
147-57-12bbb	USGS test 5	57	5	do
147-57-12bbc	USGS test 6	70	5	do
147-57-12bbd	christ olson	45	24	do
148-57-22dac	Lynner Est.	62	24	dug
148-57-26dcc	Jacobsen	40	24	Bored
148-57-27ccc	USGS test 3	89	5	Drilled
148-57-27cdd	USGS test 2	99	5	do
148-57-27dbb	S.F.Ronde	86	6	do
148-57-34aab	H.E.Johnson	35	24	Bored
148-57-34add	USGS test 8	79	5	drilled
148-57-34dad	USGS test 9	67	5	do
148-57-34dba	Knute Amundson	63	24	Bored
148-57-35bba	P.A.O'Keefe	160	5	Drilled
148-57-35bbb	Carl Bergen	69	8	Bored
148-57-35bbc	James Simpson	57	24	do
148-57-35bbd1	Hospital well	73	20	do
148-57-35bbd2	Edwin Olsen	72	6	Driven
148-57-35bbd3	James McKenzie	14	24	Dug
148-57-35bca1	Town of Sharon	71	30	Drilled
148-57-35bca2	do	70	30	do
148-57-bca3	Christ Ostenson	65	24	Bored
148-57-35bca4	School well	112	4	drilled
148-57-35bcd1	McKenzie Warehouse	55	36	Bored
148-57-35bcd2	James McKenzie	65		Dug
148-57-36bbb	USGS test 1	28	5	drilled
148-58-26ddd	Jens Seim Spring			

(1) As of May 1946
(2) - D- domestic, S-stock, U-unused, PS-Public supply, C-culinary purposes at places of business
(3) Test holes drilled and refilled, date given date of refilling
(4) Completed as observation well.

SHARON AREA, STEELE COUNTY, N.D.

Completion Date	Elevation of Water above assumed datum (1)	Use (2)	Remarks
		DS	Analysis
4-17-47		U	Log
4-19-47	77.8	U	log & analysis
4-15-47		U	log
4-21-47		U	log
4-16-47		U	log
4-16-47		U	log
1925		DS	-
1946			
1929		DS	
4-14-47(3)			Log
4-12-47(3)			Log
	60.9	DS	Analysis
1937		DS	
4-17-47		U	log
4-17-47	92.9	U	log & analysis
		DS	
	65.0		
1918	35.7	D	
1908	83.0	U	Reported salty
1930	58.5	PS	Analysis
	70.2	U	
		C	
	62.5	DS	Analysis
1933	62.0	U	Reported contaminated
	63.0		
1913	60.5	PS	Analysis
1932	62.6	DS	
1926		D	Dug with post hole auger.
4-11-47(3)		U	~~Analysis~~ Log. Analysis

Logs of test holes and auger holes near Sharon, Steele County, N.D.

No. 1, 148-57-26bbb

Material	Thickness	Depth
Clay, sand & gravel yellow, unassorted	3	3
Clay sand & gravel gray unassorted	17	20
Gravel with considerable clay & silt	1	21
Shale, gray	7	28

No. 2. 148-57-27cdd

Material	Thickness	Depth
Clay, sand & gravel yellow, unassorted	26	26
Clay, sand & gravel gray, unassorted	51	77
Gravel	10	87
Gravel with considerable clay & silt	4	91
Shale, dark gray	8	99

No. 3. 148-57-27ccc

Material	Thickness	Depth
Clay, sand & gravel yellow unassorted	18	18
Clay, sand & gravel, light-gray, unassorted	29	47
Gravel & sand, with some silt and clay	13	60
Clay, sand & gravel gray, unassorted	5	65
Gravel & sand, with considerable clay	10	75
Gravel	7	82
Boulders	1	83
Clay, sand & gravel, gray, unassorted	2	85
Shale	4	89

No. 4. 147-57-2daa

Material	Thickness	Depth
Clay, sand & gravel yellow, unassorted	19	19
Clay, sand & gravel gray, unassorted	10	29
Gravel, with considerable clay & silt	1	30
Clay, sand & gravel, gray, unassorted	26	56
Shale	14	70

No. 5, 147-57-12bbb

Material	Thickness	Depth
Clay, sand & gravel, yellow, unassorted	8	8
Clay, sand & gravel, gray, unassorted	14	22
Gravel, with considerable clay & silt	9	31
Gravel, with some clay and silt	9	40
Gravel, with considerable clay & silt	7	47
Shale	10	57

No. 6. 147-57-12bbc

Material	Thickness	Depth
Clay, sand & gravel, yellow, unassorted	27	27
Clay, sand & gravel, gray, unassorted	31	58
Shale	12	70

No. 7, 147-57-2add

Material	Thickness	Depth
Top soil, black and clay, gray	6	6
Sand, medium to coarse, with some clay	2	8
Clay, sand & gravel, yellow, unassorted	11	19
Clay, sand & gravel, gray, unassorted	43	62
Shale	4	66

No. 8, 148-57-34add

Material	Thickness	Depth
Top soil, black	2	2
Clay, sand & gravel, yellow, unassorted	19	21
Clay, sand & gravel, gray, unassorted	54	75
Shale	4	79

No. 9, 148-57-34dad

Material	Thickness	Depth
Clay, sand & gravel yellow, unassorted	15	15
Gravel, with some clay and silt	11	26
Boulders and gravel	4	30
Sand & gravel	10	40
Clay, sand & gravel, gray, unassorted	25	65
Granite boulder	1	66
Shale	1	67

No. 10, 147-57-2bbb

Material	Thickness	Depth
Clay, sand & gravel, yellow, unassorted	28	28
Clay, sand & gravel, gray, unassorted	12	40
Sand & gravel	30	70
Clay, sand & gravel, gray, unassorted	4	74
Gravel with some clay and silt	7	81
Limestone boulder	1	82
Shale	3	85

No. 11, 147-57-3add

Material	Thickness	Depth
Clay, sand & gravel, yellow, unassorted	16	16
C ay, sand & gravel, gray, unassorted	38	54
Sand & gravel, with some clay	9	63
Clay, sand & gravel, gray, unassorted	13	76
Gravel with some clay	9	85
Boulders & gravel	5	90
Clay, gray and boulders	7	97
Shale	3	100

AUGER HOLES

No. 1, 148-57-36aab

Material	Thickness	Depth
Top soil, silty, black	2	2
Till, weathered, gray to brown	½	2½
Till, weathered yellow	8½	11
Till, weathered, gray	2	13

No. 2. 148-57- 36aaa

Material	Thickness	Depth
Top soil, black	½	½
Till, weathered, yellow to brown	9	9½
Till, unweathered, bluegray	6½	16

No. 3, 148-56-31bbb

Material	Thickness	Depth
Top soil, black	1	1
Sand, coarse, saturated	½	1½
Till, weathered, yellow to brown	6	7½
Till, unweathered, blue-gray	1½	9

No. 4, 148-56-31bba

Material	Thickness	Dept
Top soil, sandy, black	½	½
Till, weathered, yellow to brown	6½	7
Till, unweathered, gray	2	9
Sand & gravel	½	9½
Till, unweathered, blue-gray	1	10

No. 5, 147-56-6bcb

Material	Thickness	Dept
Top soil, silty, black	2½	2½
Clay, brown, streaks of coarse seity sand	½	3
Clay, sand & gravel, yellow to gray, poorly assorted	1	4
Sand & gravel, with some clay	2	6

No. 6, 147-56-6bcc

Material	Thickness	Dept
Top soil, silty, black	2½	2½
Silt, brown	1½	4
Till, weathered, yellow to brown	5	9
Till, unweathered, blue-gray	½	9½

No. 9, 148-56-36cdd

Material	Thickness	Dept
Top soil, sandy, black	½	½
Till, weathered, yellow to brown	7	7½
Till, unweathered, blue gray	6	13½

FIGURE I. SKETCH MAP OF ANETA, NELSON COUNTY, AND SHARON, STEELE COUNTY AND VICINITY

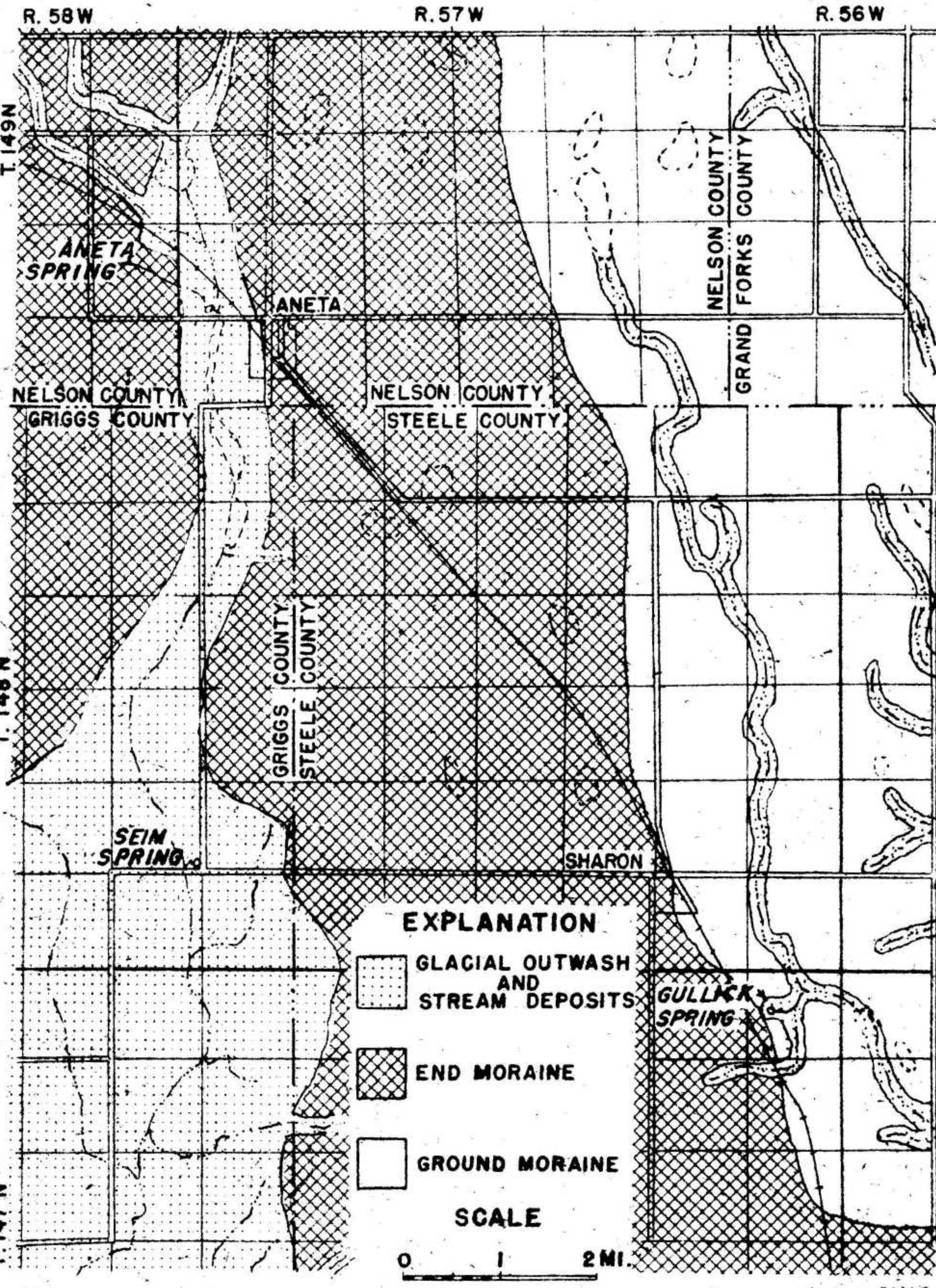

FIG. 2 MAP OF SHARON SHOWING HYDROLOGIC FEATURES

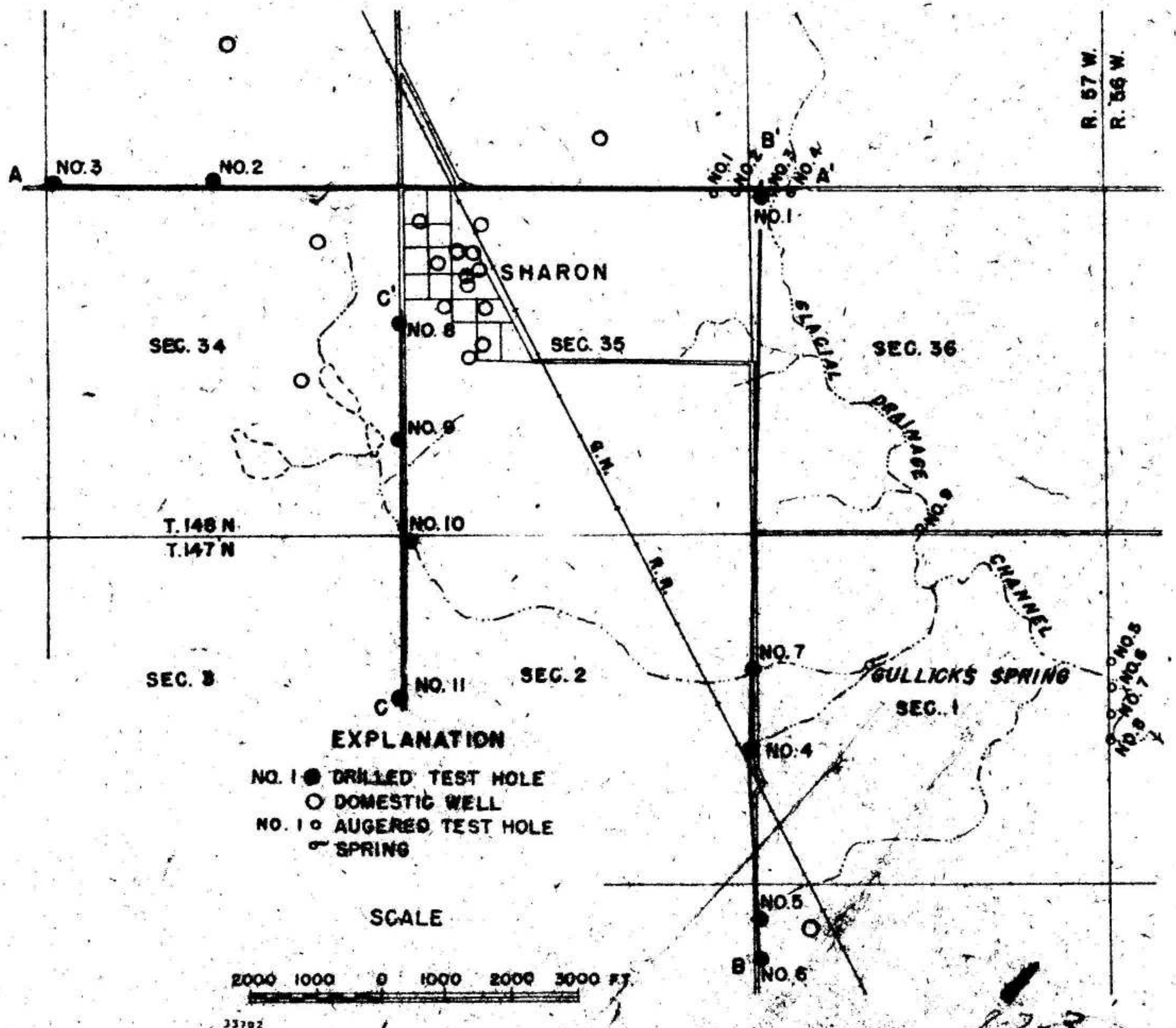

FIG. 3 GENERALIZED SECTIONS NEAR SHARON BASED ON TEST HOLES