GROUND-WATER RESOURCES OF THE DEVILS LAKE AREA, BENSON, RAMSEY, AND EDDY COUNTIES, NORTH DAKOTA

N. D. S. W. C. PROJECT NO. 747

NORTH DAKOTA GROUND-WATER STUDIES

NO. 56

By
Q. F. Paulson
and
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Geological Survey
United States Department of the Interior

Prepared by the U. S. Geological Survey in cooperation with the N. D. State Water Commission, and the N. D. Geological Survey

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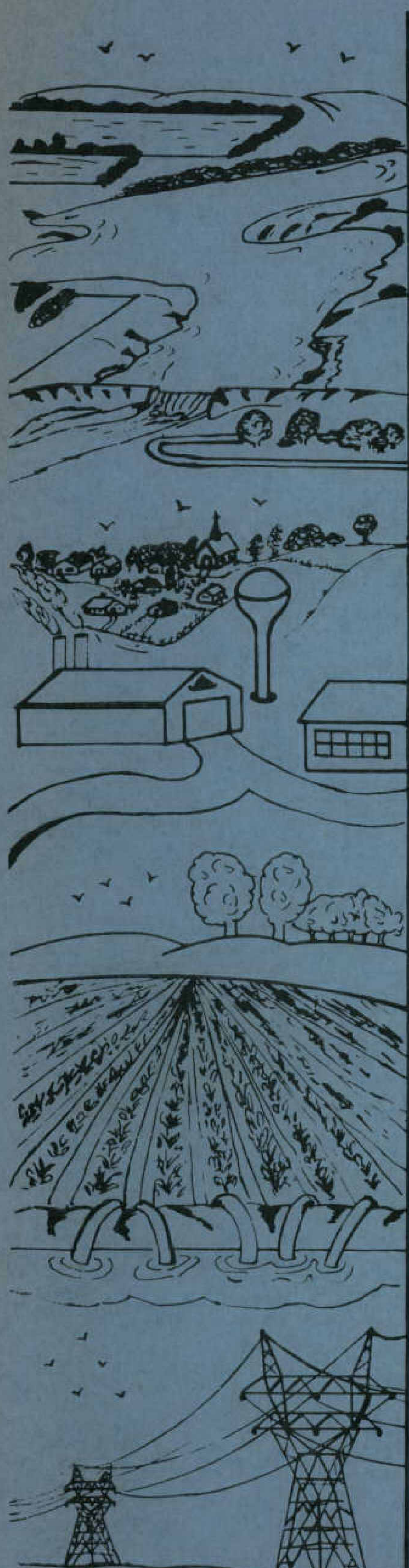

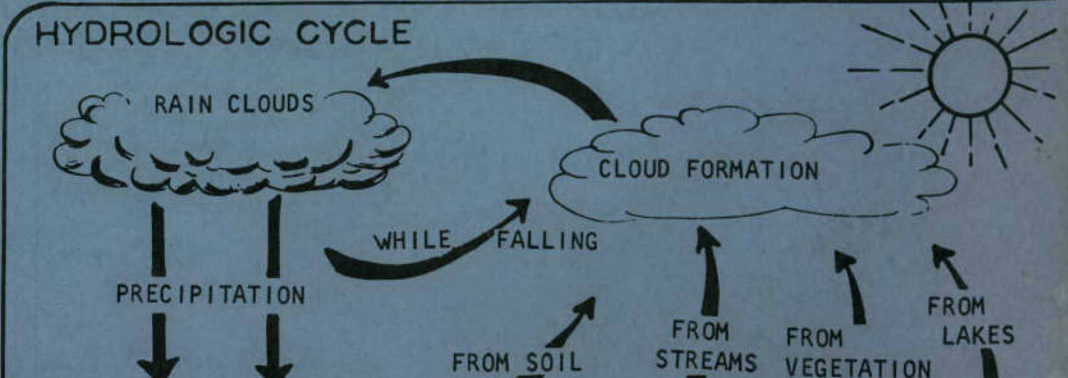

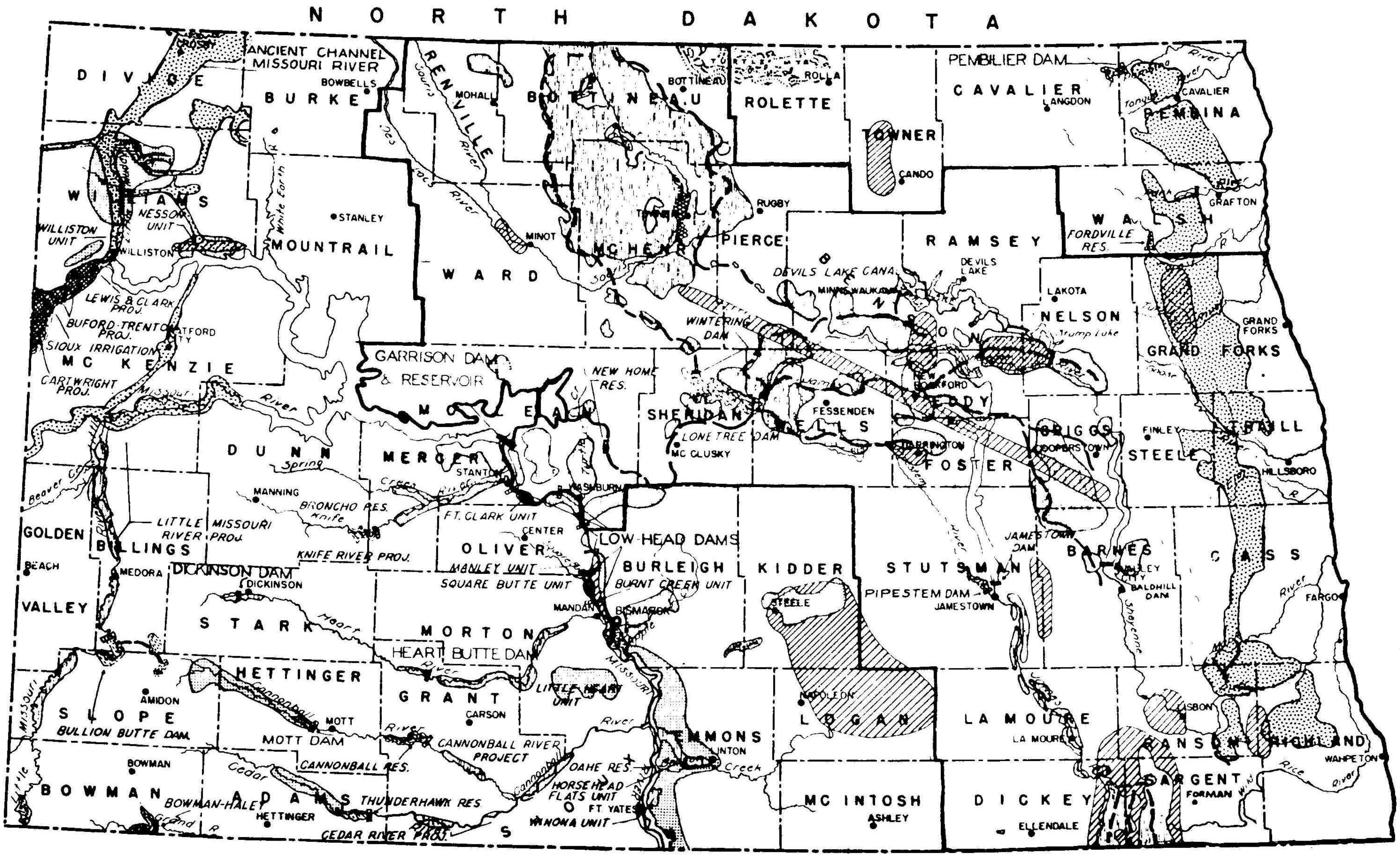

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- LANDS UNDER IRRIGATION
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GROUND-WATER RESOURCES OF THE DEVILS LAKE AREA, BENSON, RAMSEY, AND EDDY COUNTIES, NORTH DAKOTA

North Dakota Ground-Water Studies No. 56

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GROUND-WATER RESOURCES OF THE DEVILS LAKE AREA, BENSON, RAMSEY, AND EDDY COUNTIES, NORTH DAKOTA

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ABSTRACT

This report is concerned mainly with the ground-water resources of an area of about 920 square miles surrounding the city of Devils Lake, North Dakota. The major part of the area is in the Devils Lake interior drainage basin and the principal features are two chains of lakes, end moraine and ground-moraine belts, and outwash plains, all of which trend east-southeastward.

The surficial deposits consist of glacial drift, postglacial lake sediments, and thin, patchy deposits of alluvium and slopewash. These deposits are underlain by the Pierre Shale of Late Cretaceous age, which in turn is underlain by older sedimentary rocks consisting mainly of shale, sandstone, and limestone to a total depth of about 3,000 to 3,500 feet. The oldest sedimentary rocks rest on Precambrian granite.

The glacial drift contains the major aquifers in the area. The most productive aquifers consist of sand and gravel deposits, formed as glacial outwash along the south edge of the North Viking moraine, and extending to the Sheyenne River and beyond. As an outgrowth of this ground-water study, the city of Devils Lake developed a new municipal water supply from wells tapping outwash deposits in the Warwick area. Because of their large areal extent and thickness (particularly in the Warwick area), the outwash deposits have good potential for the development of additional large supplies of ground water. However, future developments should be preceded by additional test drilling and hydrologic studies to determine their effect on present usage.

Aquifers of less importance also were discovered by test drilling in other parts of the area of study. These consist of sand and gravel deposits buried by differing amounts of glacial till, but little is known concerning their capabilities to supply water to wells. The thickest and most extensive of these seem to be associated with bedrock valleys underlying the Devils Lake chain of lakes.

Aquifers in the outwash deposits are readily recharged by absorption of rain and snowmelt. Most of the recharge occurs in the spring and early summer.

Ground water in the outwash deposits is of relatively good chemical quality, but it probably would require softening for domestic and some industrial uses. Ground water in the Pierre Shale is soft to moderately hard, but generally has a higher salinity than water in the glacial drift. Water in the Dakota Sandstone is too saline for most uses.

INTRODUCTION

Since 1945, ground-water studies in North Dakota have been made by the United States Geological Survey in cooperation with the North Dakota State Water Conservation Commission and the North Dakota Geological Survey. The purpose of the studies is to determine the occurrence, movement, discharge, and recharge of the ground water, and the quantity and chemical quality of such water available for all purposes, including municipal, domestic, irrigation, and industrial.

For many years, there has been a critical need for the investigation of ground-water resources within reach of numerous towns and cities in the State lacking adequate and perennial water supplies for municipal use. Many of the towns and cities have recently constructed or are in the process of constructing municipal water-supply systems for the first time and, therefore, need pertinent information concerning available water resources in their areas. Others have needed additional sources of water to meet demands caused by population increases or modernization of existing water and sewage facilities. Still others have needed to improve the chemical quality of their water supplies.

LOCATION AND GENERAL FEATURES OF THE AREA

The area reported on here is in the central part of northeastern North Dakota and consists of about 920 square miles in Benson, Ramsey, and Eddy Counties (fig. 1). It is irregular in outline, owing to the primary needs of the study and the availability of topographic maps and other basic data during the course of the investigation. The longest dimension in an east-west direction is about 33 miles and the longest dimension in a north-south direction is about 37 miles. The area is bounded on the south by the Sheyenne River.

Devils Lake, population 6,299 (1960 census), is the largest city in the area and is the county seat of Ramsey County; it is near the central part of the report area. Other communitities include: Minnewaukan, pop. 420, county seat of Benson County; Churchs Ferry, pop. 161; Oberon, pop. 248; Crary, pop. 195; Warwick, pop. 204; Tokio, pop. 112; Hamar, pop. 105; Fort Totten, pop. 100; and St. Michael, pop. 35. The rural population is not known, but is estimated to be about 8,200 according to the average ratio of urban to rural population in the three counties -- Benson, Ramsey, and Eddy. Total population in the area, therefore, may be about 16,000.

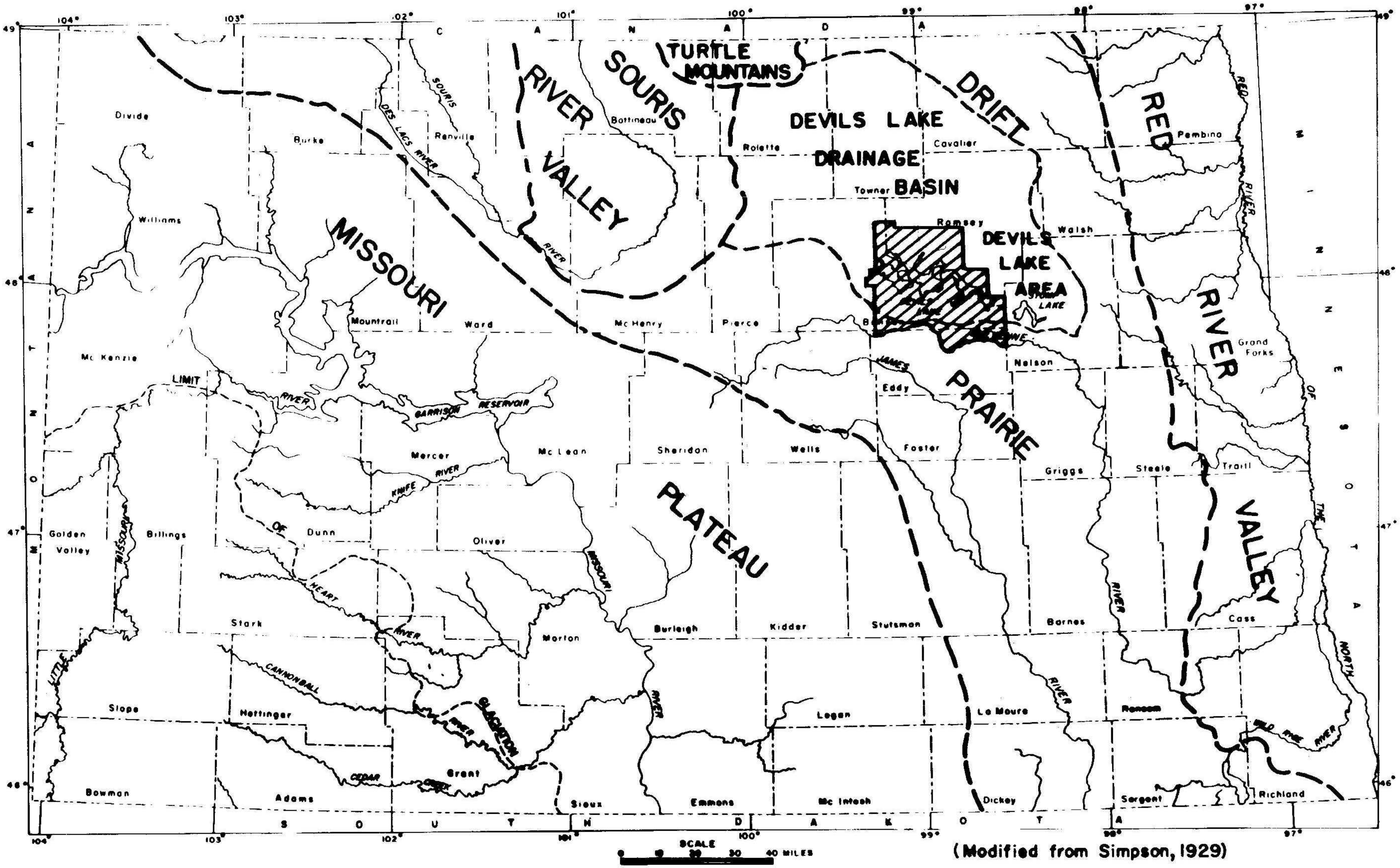

FIGURE 1--MAP OF NORTH DAKOTA SHOWING PHYSIOGRAPHIC PROVINCES AND LOCATION OF THE DEVILS LAKE AREA.

The area is served by two main lines of the Great Northern Railway, and by branch lines of the Minneapolis, St. Paul, and Sault Ste. Marie Railway and the Northern Pacific Railway. State and Federal highways supply all-weather routes across the area, and connecting county and township roads make almost every part of the area accessible most of the time.

The principal occupation in the area is farming, wheat, flax, and hay being the main crops. The communities serve as shopping and trading centers for the adjacent areas. The city of Devils Lake is the most important community in the area because of its size and because of its location with respect to other, larger communities of the State. Grand Forks is about 100 miles to the east, Minot about 130 miles to the west, and Jamestown about 100 miles to the south. It is a division point on the Great Northern Railway. One of the larger steam-generating plants of the Otter-tail Power Co. is located there. The Concrete Sectional Culbert Co., a major manufacturer of concrete products in the State, is located a few miles south of Devils Lake on State Highway 57.

PURPOSE AND SCOPE OF THE INVESTIGATION

Prior to 1962, the major source of water for the city of Devils Lake was water-bearing beds of sandstone in the Dakota Sandstone. Artesian wells tapping these beds yield sufficient water to supply the needs of the city, but the water is highly charged with sodium chloride (table salt) and sodium sulfate (Glauber's salt). The mineralization of the water is so great as to make it unsatisfactory for drinking and cooking as well as unfit for irrigation and many industrial uses. Small supplies of water for drinking and cooking were developed from privately owned shallow wells in the glacial drift and the immediately underlying Pierre Shale. Water was delivered by water companies in much the same manner that milk is delivered in most towns and cities. In the evenings many city residents would wait their turn in line, with buckets and jars, to obtain potable water from a shallow public well in the county courthouse grounds. It was not possible to obtain an adequate supply of water for municipal use from shallow wells within the city of Devils Lake, and the city's growth and economic prospects were inhibited because of the inferior quality of the water being supplied from the Dakota Sandstone.

The primary purpose of the study, then, was to investigate the occurrence of ground water in an area within economical pipeline distance of the city of Devils Lake and to determine whether or not an adequate supply of potable water could be obtained from ground-water sources to meet present and anticipated needs of the area.

In addition to the need for a potable municipal water supply, the decline in the level of Devils Lake during the past century has been a matter of much concern to residents of the area and of the State. This lake, the largest natural lake in North Dakota, was once its principal resort attraction. In the 1880's, northern pike and other fish species abounded in the lake and carload shipments of fish from it were not uncommon. Navigation by shallow-draft side-wheelers was carried on between Churchs Ferry, Minnewaukan, Devils Lake, and other places on the former lakeshore.

Records of the elevation of Devils Lake have been kept since about 1867, and from then until 1940 the level of the lake declined steadily and only occasionally rose slightly. In 1940, the lowest reported level was 37.4 feet below the lowest level reported in 1867. Fish life disappeared entirely from the lake about 1889 as the water became brackish and unsuitable for many purposes. Navigation ceased as the water area of the lake became smaller, leaving the former docks several miles from water. Between 1940 and 1957 the lake rose generally; the level was about 18 feet higher in 1957 than the record low in 1940.

A plan of the Department of the Interior for the conservation, control, and use of the water in the Missouri River Basin contemplates restoration of Devils Lake to a higher level and flushing of the lake to improve the chemical quality of the water by diversion of Missouri River water into the lake.

Coupled with the primary purpose of the present study has bee the need to obtain general information regarding the occurrence and movement of the ground water to assist in the planning and execution of the proposed reclamation projects in the area; to furnish data to the general public regarding the occurrence of ground water suitable for development of domestic, stock, industrial, and irrigation supplies; and to supplement existing knowledge of the general hydrology of the area.

The study was made by the U.S. Geological Survey in cooperation with the North Dakota State Water Conservation Commission, the city of Devils Lake, and the North Dakota Geological Survey. A progress report summarizing the early results of the investigation and indicating the need for additional work in parts of the area was released in 1951 (Akin).

PREVIOUS INVESTIGATIONS

The first worker concerned with the geology of the Devils Lake area was Warren Upham (1895) whose results were reported in his classic work on glacial Lake Agassiz. E. J. Babcock reported on the water resources of the Devils Lake region in 1902. H. E. Simpson (1912) prepared a report on the physiography of the Devils-Stump Lake region. Simpson's general work on the geology and ground-water resources of North Dakota (1929) contains descriptive material on the geology of the region, well data, chemical analyses of ground-water samples, and other ground-water data. In 1921, the Great Northern Railway made an investigation of the feasibility of developing Sweetwater Lake to furnish a water supply for railway use and for municipal use at Devils Lake. The report has not been published, but was loaned to the writers for their use, and has furnished valuable background information on the water-supply problems in the area. Abbott and Voedisch (1938) listed chemical analyses of ground-water samples from the area. Greenlee made a reconnaissance study of ground-water conditions in the vicinity of Camp Grafton, south of the city of Devils Lake, and performed pumping tests using camp supply wells (written communication). Geologic maps of three 15-minute quadrangles in the area were prepared by Branch (1947) on the Flora quadrangle, Tetrick (1949) on the Oberon quadrangle, and Easker (1949) on the Tokio quadrangle. Aronow and others (1953b) described the geology and ground-water resources of the Minnewaukan area in Benson County, which lies adjacent to the western edge of Devils Lake. Aronow (1957, 1959, and 1963) also made extensive studies of the Pleistocene geology and postglacial history of the Devils Lake region. Swenson and Colby (1955) studied the chemical quality of surface water in the Devils Lake region. Their report also contains an excellent summary of the hydrography of the Devils Lake region, as well as an analysis of the available hydrologic data relative to the recent desiccation of the lakes.

ACKNOWLEDGMENTS

The work was greatly facilitated by the ready cooperation of the residents of the Devils Lake area and particularly by the officials serving on the Devils Lake city council. The writers are particularly grateful for the logs, water-level data, and pumping-test facilities made available by Mr. Fred Simpson of C. A. Simpson & Son, drilling contractors, Bisbee, N. Dak., and by the Stanley S. Johnson & Associates engineering firm at Grand Forks, N. Dak. Mr. L. W. Burdick, consultant engineer, Grand Forks, N. Dak., through his early interest and cooperation, aided materially in the progress of the study.

Saul Aronow, associate professor of geology, Lamar College, Beaumont, Texas, made most of the geologic studies in the report area, and, to a large extent, supervised test-drilling operations and the collection of basic data. The writers gratefully acknowledge the importance of his contributions to the project work.

WELL-NUMBERING SYSTEM

The well-numbering system used in this report is based upon the location of the well in the Federal system of rectangular surveys of public lands. The first numeral denotes the township north, the second numeral denotes the range west, both referred to the fifth principal meridian and base line; the third numeral denotes the section in which the well is located. The letters a, b, c, and d designate respectively the northeast, northwest, southwest, and southeast quarter sections, quarter-quarter sections, and quarter-quarter-quarter sections (10-acre tracts) as shown in figure 2. Thus, a well numbered 152-65-15daa would be in the NE$\frac{1}{4}$NE$\frac{1}{4}$SE$\frac{1}{4}$ sec. 15, T. 152 N., R. 65 W.

PHYSIOGRAPHY AND DRAINAGE

The area is in that part of the Central Lowland physiographic province (Fenneman, 1938, p. 559-588) that has been called the Drift Prairie by Simpson (1929, p. 7-10). The extreme southern part, which is drained directly by the Sheyenne River, is in the Red River of the North drainage basin. The major part of the area, however, is in the Devils Lake interior drainage basin (fig. 1). This basin is about 3,940 square miles in area and is between the drainage basins of the Red River of the North on the north, east, and south, and the Souris River on the west. The basin is a subdivision of the Red River of the North basin, although there has been no surface flow out of the basin to the Red River in historic time.

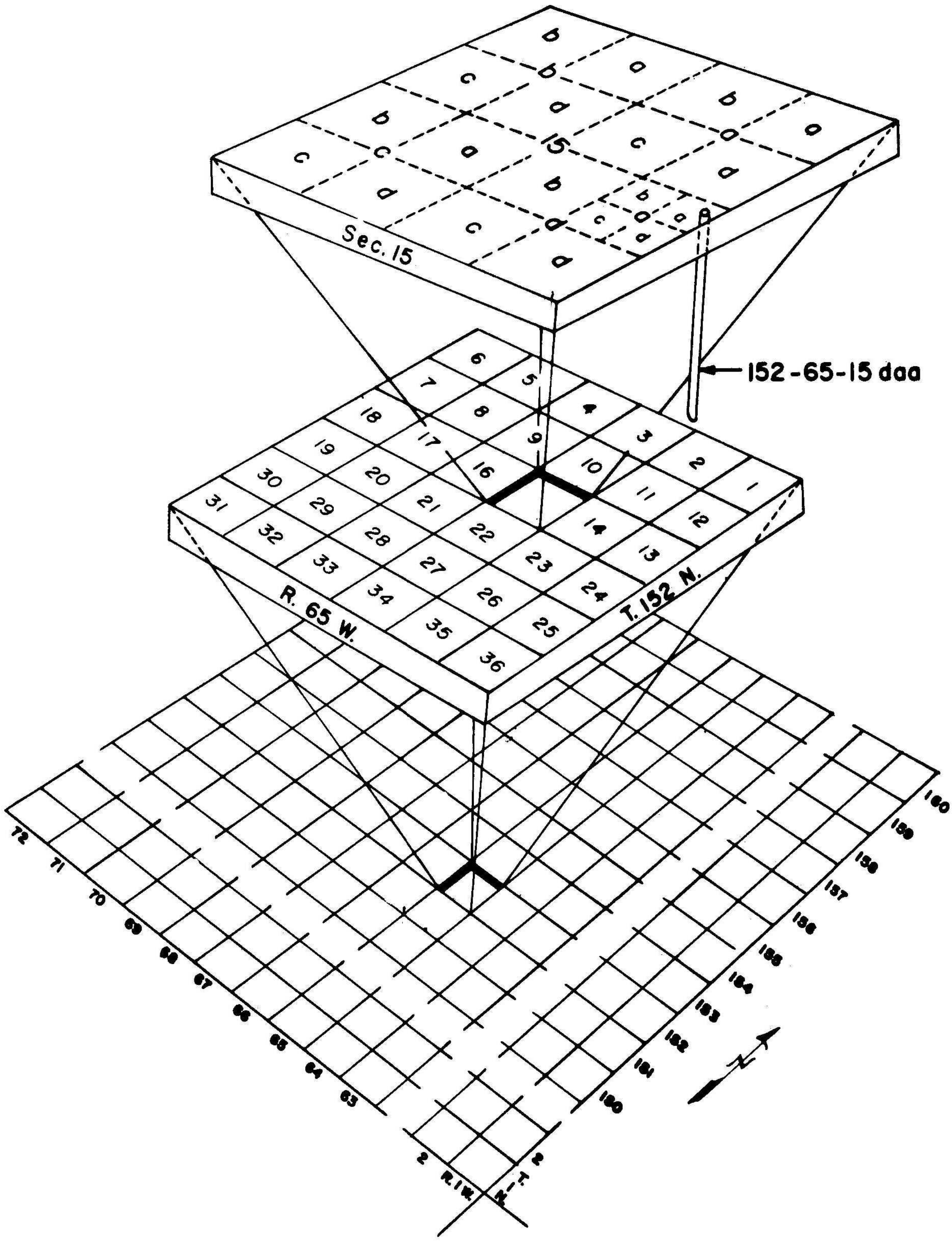

FIGURE 2--SYSTEM OF NUMBERING SPRINGS, WELLS, AND TEST HOLES.

The topography and relief of the Devils Lake basin and the surrounding region are due to glacial erosion and deposition, which were in turn influenced by the topography of the eroded bedrock surface. Glacial deposits now cover the entire area except for a few small exposures of bedrock. The principal features are two chains of lakes, end-moraine and ground-moraine belts, and outwash plains, all of which trend roughly east-southeast (fig. 3). The northernmost chain of lakes, herein called the Sweetwater chain, includes Sweetwater Lake, Morrison Lake, Dry Lake, Lac Aux Mortes (T. 156 N., R. 66 W., north of the Devils Lake area), and Lake Irvine. When filled to spillway threshhold levels, and only then, these lakes discharge one into the other from Sweetwater Lake to Lake Irvine. Lake Irvine in turn discharges through Mauvais Coulee into the Devils Lake chain, which is in the southern chain of lakes and from which the region takes its name.

The southern chain of lakes, herein referred to as the Devils Lake chain, roughly parallels the Sweetwater chain. It is about 45 miles long and includes the various bays of Devils Lake, East Devils Lake, and West and East Stump Lake (West and East Stump Lake, together, are commonly referred to simply as Stump Lake and are a few miles east of the Devils Lake area). As is the case in the northern chain, water flows from one lake to another only at high stages. The flow is from Devils Lake to East Devils Lake to West Stump Lake. Prehistorically, there was drainage from West Stump Lake to the Sheyenne River (Aronow, 1957, p. 412).

Between the Devils Lake chain and the Sheyenne River are a group of glacial outwash deposits and end moraines; the most prominent of the moraines is termed the North Viking moraine. Between the chains of lakes is a belt of ground moraine and other groups of end moraines, of which the Sweetwater moraine is the most prominent.

The greatest relief is in the end moraines; the outwash plains are relatively flat and featureless. The ground moraine has an intermediate type of rolling topography. The entire area is dotted with numerous potholes and small lakes receiving and retaining runoff from local areas.

The Sheyenne River forms the southern boundary of the report area. It is a small stream, less than 200 feet wide, which flows in a trench-type valley more than half a mile wide in places and as much as 75 feet deep. Several terraces flank the valley, and several glacial spillways traverse the outwash and moraine deposits and trend southward toward the Sheyenne River.

The depression occupied by the Devils Lake chain probably is the surface representation of an ancestral stream system cut into the shale bedrock. Detailed drilling of the drift has indicated that the underlying bedrock topography is a "butte" and "badland" type similar to that which has been developed in the unglaciated parts of western North Dakota.

Prehistorically, East Devils Lake and Stump Lake were connected by means of a narrow channel known as the Jerusalem outlet. When the lake levels were high enough, water discharged from East Devils Lake into Stump Lake through this outlet and, from Stump Lake into the Sheyenne River (which drains into the Red River) by the now unused Big Stony spillway (Aronow, 1957, p. 414). Thus, at one time the Devils Lake interior drainage basin was a part of the Red River of the North drainage basin.

When the lakes discharged into the Sheyenne River they had a high shoreline whose elevation was about 1,453 feet. Below this former shoreline are a number of others, prehistoric and recent. The outlines of Devils Lake and Stump Lake shown on most maps are those of the years of the first land surveys of the region, 1881 to 1883. Devils Lake at that time had a surface elevation of about 1,435 feet above sea level, and Stump Lake about 1,423 feet. Since then the lakes, despite minor resurgences, have been shrinking, and the lowering of their levels has caused the separation or disappearance of the various bays.

GEOLOGIC SETTING

GLACIAL AND POSTGLACIAL DEPOSITS

The surficial deposits in the Devils Lake area are mainly of glacial and postglacial origin. Those of glacial origin, termed glacial drift, range in texture from clay to large boulders several feet in diameter. In places they are sorted and stratified into beds of clay, silt, sand, or gravel, whereas in other places, they form a heterogeneous mixture of all sizes, although clay and silt generally predominate. These unsorted deposits are termed till.

Information on the thickness of the glacial drift in the Devils Lake area was obtained mainly by test drilling and analysis of existing subsurface data (tables 1 and 2; fig. 4). The glacial drift ranges from a few feet to nearly 400 feet in thickness and commonly is between 100 and 200 feet thick. The thickest deposits underlie the Devils Lake chain of lakes (fig. 5). In places in the Morrison-Sweetwater Lakes area and west of Minnewaukan the drift is less than 50 feet thick. Generally the upper 10 to 20 feet of the drift is yellowish brown, owing to oxidation of minerals containing iron; below this depth the color is bluish gray.

On the basis of landform and lithology, several main types of glacial drift were recognized and mapped in the Devils Lake area. The drift includes end-moraine, ground-moraine, outwash, and lake deposits (fig. 3). The various types of glacial deposits are believed to have been formed nearly contemporaneously, probably during the later part of the Wisconsin Glaciation in the Pleistocene Epoch.

End-moraine deposits are composed mainly of till and are characterized by rough, hilly tracts of land having an overall ridgelike, linear form. They were built up along the terminals of the ice sheet when forward movement was more or less balanced by melting along the ice margin. The surface of these deposits is commonly littered with boulders and cobbles. Some end moraines have been described as having a "knob and kettle" appearance because of the profusion of steep-sided hills and depressions.

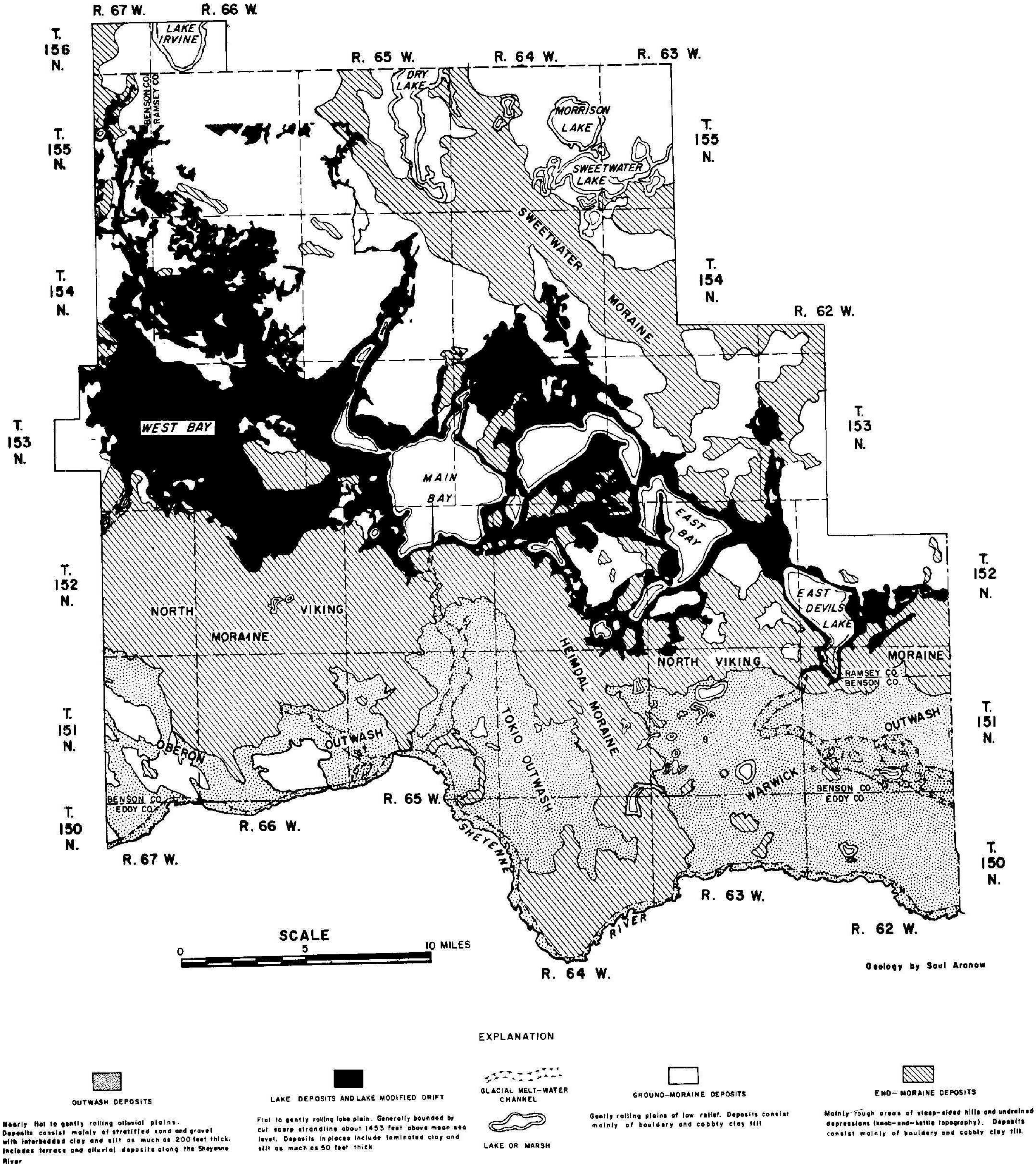

FIGURE 3.--GENERALIZED GEOLOGIC MAP OF THE DEVILS LAKE AREA.

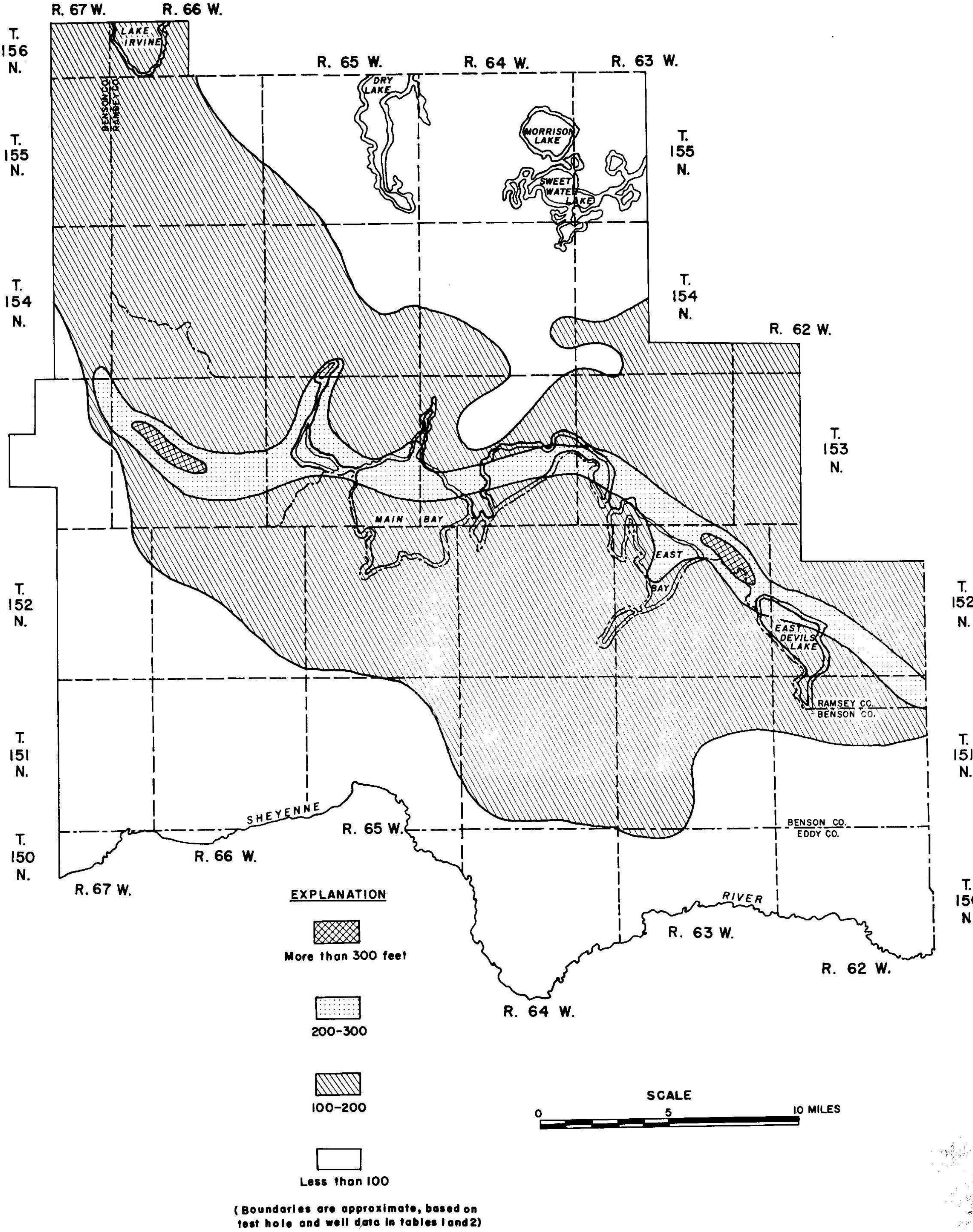

FIGURE 5.-- MAP OF DEVILS LAKE AREA SHOWING THICKNESS OF GLACIAL DRIFT

Two major belts of end moraine extend west-northwestward across the Devils Lake area. One of the end moraines lies south of the Devils Lake chain and has been named the North Viking moraine (Branch, 1947, p. 6). The other lies north of the chain and extends northwestward across the northeastern part of the area in the vicinity of Sweetwater Lake, from which the moraine derives its name (Aronow, 1955). A third short segment of end moraine, which appears to branch south-southeastward from the North Viking moraine in T. 151 N., R. 64 W., probably is part of the Heimdal moraine that has been identified in adjacent areas south of the area covered in this report (Easker, 1949, p. 19).

Ground-moraine deposits are similar to end-moraine deposits in being composed mainly of till, but are characterized by gently rolling topography of low relief. These deposits probably were formed mainly near the base of the glacier, although the mechanics of such formation are not clearly understood. Ground moraine is most extensive in the northern part of the area, but widely scattered small tracts are in the southern part also. Neither the end-moraine or the ground-moraine deposits are important sources of ground water because of their low degree of permeability (ability to transmit water).

Glacial outwash deposits are composed mainly of sorted and stratified beds of sand and gravel. In places these deposits are widespread and their surfaces form nearly flat to gently rolling plains. In other places the deposits are in channels. Outwash deposits were formed by debris-laden streams from the melting glacial ice. Large tracts of outwash deposits exist in the southern part of the Devils Lake area. They are bordered on the north by the North Viking moraine and, in most places, extend to the Sheyenne River. In places, however, they are separated into areas by segments of moraines. For convenience of discussion the areas have been named, in order from west to east, the Oberon outwash plain, Tokio outwash plain, and Warwick outwash plain. Another body of outwash east of the Devils Lake area (not discussed in this report) might aptly be called the Pekin outwash plain because of its extensive occurrence in the vicinity of that town. The outwash deposits form extensive and productive ground-water reservoirs.

A belt of lake deposits and lake-washed till extends northwestward across the central part of the area. The lake deposits consist mainly of stratified clay and silt, deposited in the Devils Lake chain in late Pleistocene and Recent time when the lakes were much more extensive and occupied higher shorelines than at present. The lake deposits and lake-washed till are too fine grained and impermeable to be of importance as aquifers.

Sand and gravel deposits are widely interspersed in the moraines as hills, ridges, and terraces and, for purposes of this report, are referred to generally as ice-contact deposits. Because of their small areal extent, they are not shown in figure 3. They include typical landforms described in the literature as kames, eskers, crevasse-fillings, and kame terraces (Flint, 1957, p. 146-159). The deposits generally show sharp changes in sorting and bedding and are closely associated with till, indicating origins within the glaciers or along the edges -- thus the term "ice-contact." In places they are water bearing and form aquifers of small to moderate potential.

BEDROCK FORMATIONS

So far as is known, the glacial drift throughout the Devils Lake area is underlain by the Pierre Shale of Late Cretaceous age. The formation is deeply eroded in places so that its thickness probably varies considerably. The lowest known elevation of the top of the Pierre Shale is 1,104 feet (test hole 185) and the highest is 1,533 feet (test hole 651). The elevation of the bottom of the Pierre, as reported in logs of several oil-well tests in the Devils Lake area, ranges from 808 feet (Hansen, 1956) to 898 feet (Anderson, 1954). The thickness of the formation, therefore, may range from about 200 to 700 feet. As the formation appears in the drill cuttings, it consists of light-gray or grayish-green to medium-dark-gray shale. Inoceramus prisms and bits of bentonite are not uncommon in the cuttings. The upper part of the formation, in places, yields small quantities of ground water, which is characteristically soft, salty, and rather high in dissolved solids.

The Pierre Shale in the Devils Lake area is underlain by a thick sequence of older Cretaceous rocks composed mainly of shale, except the basal part, which is composed of interbedded sandstone and shale. The thickness of the older Cretaceous rocks ranges from slightly less than 900 feet near the eastern edge of the area to more than 1,300 feet near the western edge. Except for the interbedded sandstone-shale section in the basal part, which contains one or more important aquifers, these rocks are not water bearing.

The sandstone-shale section has been referred to variously as the Dakota Sandstone (Simpson, 1929, p. 192); Lakota (Strassberg, 1954); Dakota, Fuson, and Lakota (Laird, 1941, p. 26-27; Anderson, 1954); and Fall River Sandstone (Hansen, 1955, pl. 2). The name Dakota Sandstone is retained in this report because of its well-established usage among water-well drillers in North Dakota and adjacent States.

The Dakota Sandstone is underlain, in descending order, by shale and siltstone of Jurassic age and limestone, dolomite, and sandstone of Paleozoic age. These rocks range in thickness from about 1,800 feet near the eastern edge of the area (Anderson, 1954) to about 2,400 feet near the western edge (Strassberg, 1954). These rocks contain aquifers but the water probably is too highly mineralized for most uses.

GROUND-WATER RESOURCES

GENERAL PRINCIPLES OF OCCURRENCE

Geologically all the solid materials of the earth's crust are called rocks. Any rock formation or stratum that will yield water in sufficient quantity to be of importance is called an aquifer (Meinzer, 1923, p. 30). The aquifers considered in this report are in sedimentary formations: the glacial drift, the Pierre Shale, and the Dakota Sandstone.

Essentially all ground water of economic importance is derived from precipitation. The water may enter the ground by direct penetration of rain or melted snow; or surface water from streams, especially during flood time, may enter the ground by downward or lateral percolation if the water level in the stream is higher than the adjacent ground-water level.

Practically all ground water is in the process of movement through the rock formations from a place of intake or recharge to a place of disposal or discharge. The rate of movement may vary considerably from one area to another or from one formation to another but velocities of a few tens to a few hundreds of feet a year probably are most common under natural conditions. The water moving through the rock formations is said to be in "transient storage."

Ground water may be discharged by direct evaporation from the soil surface or from lakes and ponds, by transpiration of plants in areas where the ground-water level is near the surface, and by seepage to streams. In some places where the physical situation is suitable, water may discharge from one aquifer to another through the separating formations.

Below the water table, under natural conditions, the open or pore spaces in the sedimentary rocks are filled with water. The quantitative measure of the open or pore space - its percentage of the whole volume of the rock - is called the "porosity" and is a measure of the capacity of the rock to store water when saturated. However, the capacity of a rock to yield water to wells by gravity drainage may be much less than would be indicated by its porosity, because part or all of the water may be held in the pore spaces by molecular attraction of the water to the rock material. If the pore spaces are large, as in coarse gravel, practically all the water stored in them can be removed by gravity drainage. If the individual particles composing the rock are small, as in clay or shale, practically none of the stored water can be removed by gravity drainage, although the porosity of the rock may be considerable. The volume of water, expressed as a percentage, that will drain from a unit volume of the saturated rock material is its "specific yield;" the volume that remains undrained is the "specific retention."

Another characteristic of a rock material that is important, insofar as water supply is concerned, is the difficulty or ease with which water can move through the material. If the pore spaces are relatively large and interconnected, as in coarse gravel, the resistance to the movement of water through the material is not great and the rock is said to be permeable. However, if the pore spaces are small, as in clay or shale, the resistance to the movement of water may become very great and the rock is said to be impermeable or to have low permeability. For field use, the "coefficient of permeability" is expressed quantitatively as the number of gallons of water per day that will flow through a cross-section area of 1 square foot under unit, or 100-percent hydraulic gradient, at local temperature of the ground water. In most ground-water studies, the coefficient of transmissibility is generally more convenient to use than the coefficient of permeability. The coefficient of transmissibility is the average field coefficient of permeability multiplied by the thickness of the aquifer in feet.

As used here, the coefficient of tansmissibility may be defined as the number of gallons of water at field temperature that will pass in 1 day through a vertical strip of the aquifer 1 foot wide under a unit hydraulic gradient (1 foot per foot). It may also be thought of as the number of gallons of water at field temperature that will pass in 1 day through a vertical strip of the aquifer 1 mile wide under a hydraulic gradient of 1 foot per mile.

The water table is that surface below which the rock materials are fully saturated at atmospheric pressure or greater. The water table in the Devils Lake area corresponds approximately to the level of the water surface in wells that tap aquifers in the glacial drift and the Pierre Shale. It is recognized that because of local artesian conditions and local perched water tables, the water levels in the wells may not always define the water table, but in general the correlation is good.

If the water in an aquifer is not confined by an impermeable stratum above, the water is said to be under water-table conditions. In such case, water may be obtained from storage in the aquifer by a lowering of the water level, as in the vicinity of a pumped well, which results in gravity drainage of the surrounding rock materials.

If the water is confined in the aquifer by an overlying impermeable stratum, however, so that the water in a well rises above the top of the aquifer under hydraulic pressure, the water is said to be under artesian conditions. It is not necessary that the well flow for it to be classed as artesian under this definition. Actually, the height to which the water rises in the well may be at, above, or below the true water table, according to local conditions.

Under artesian conditions, water is yielded because of its own expansion, at least temporarily, and because of the compression of the aquifer due to lowered pressure, rather than by gravity drainage. The water-yielding capacity is called the "coefficient of storage," which is defined as the volume of water that will be released from storage in each vertical column of the aquifer having a base of 1 square foot when the artesian pressure falls 1 foot. The amount of water released from storage in an aquifer under artesian conditions with a given lowering of water level will be much less - of the order of a hundredth or a thousandth - than by gravity drainage under water-table conditions, other factors such as transmissibility, thickness, and areal extent being equal. The term "coefficient of storage" may be applied to water-table as well as to artesian conditions, in which case it is practically equal to the specific yield.

In the Warwick outwash plain, in the area of the city of Devils Lake water-supply wells, the presence of a simple "leaky" aquifer system has been noted. This system consists of a shallow water-table aquifer underlain by a semiconfining zone of much lower permeability, which in turn is underlain by highly permeable outwash deposits. Water may move more or less vertically from the shallow aquifer through the semiconfining bed to the deeper aquifer or vice versa, according to the relative hydraulic heads in the two aquifers.

Two parameters of a simple leaky aquifer system are (1) the "leakance" or "leakage coefficient," defined by Hantush (1956) as the vertical coefficient of permeability of the semiconfining zone divided by its thickness, and (2) the leakage factor, determined from aquifer pumping tests and generally represented mathematically by the symbol B, which is defined by Hantush as the square root of the quotient of the coefficient of transmissibility of the pumped aquifer divided by the leakage coefficient. The leakage coefficient multiplied by the hydraulic head differential between the upper and lower aquifer yields the flow rate through the semiconfining bed per unit area. The leakage factor is small if the leakage coefficient is large, and it is large if the leakage coefficient is small.

In some rocks, fractures and (or) solution openings form the more permeable passageways through which water moves in the formation. As will be discussed in more detail, it is possible that the permeability of some of the aquifers in the Pierre Shale is due to fractures. If some of the limestones below the Dakota Sandstone in the area are aquifers, they may yield water through solution openings. Even the upper part of the Precambrian complex may yield small amounts of water through fractures.

The suitability of an aquifer to furnish a water supply for a given purpose depends, among other things, upon its transmissibility, volume, and capacity to store water. In addition, there must be adequate recharge to the aquifer and opportunity to capture the recharge by constructed works, if the water-supply development is to last indefinitely, because even a small draft may eventually deplete the water in storage unless there is adequate recharge that can be utilized. There have been instances, in North Dakota and elsewhere, where aquifers composed of materials of rather good permeability, but having only small areal extent and being completely enclosed in relatively impermeable materials, have been pumped nearly dry in a comparatively short time, to the detriment and disappointment of the water users. In such cases high initial yields of wells in the aquifers gave the erroneous impression that a great volume of water would be available from the aquifer indefinitely.

From the standpoint of ground-water movement it is believed that the glacial drift and the upper water-bearing part of the Pierre Shale in the Devils Lake area act as a single aquifer. From the standpoint of development and use, however, it is advisable to distinguish a number of aquifers in the glacial drift and to consider the Pierre Shale as a separate aquifer. The distinction between these aquifers is made on the basis of areal distribution of the more permeable materials, physical characteristics of the aquifers, and chemical quality of the water found in them.

Ground Water in the Glacial Drift

The aquifers in the glacial drift are mostly deposits of sand and gravel or finer sorted materials. The water is in the interstices between the individual grains that constitute the formation.

The aquifers range in size from many square miles in area and 50 or more feet in thickness, as in the case of the major outwash deposits, to small glaciofluvial deposits in the till that extend less than a few acres in area and only a few feet in thickness. Water in the aquifers in the glacial drift is found under both water-table and artesian conditions. At a few places naturally flowing wells are obtained from drift aquifers. The flows are due to local artesian conditions in the drift and are not diagnostic of a widespread region where flowing wells are likely.

Outwash Deposits

Oberon outwash deposits

The outwash deposits of the Oberon plain, partly in the extreme southwestern part of the report area (fig. 3) and partly to the west of it (Aronow and others, 1953b), form a smooth, gently southward-sloping surface between the North Viking moraine and the Sheyenne River. The deposits are separated from the Tokio outwash deposits to the east by a relatively narrow belt of end-moraine deposits. The outwash deposits skirt or surround patches of ground moraine that rise above the plain and are confined to relatively narrow widths in some places. The presence of the higher patches of ground moraine during deposition of the outwash deposits prevented the formation of a broad continuous plain. In the area of the report, the Oberon outwash plain extends over less than 30 square miles (figs. 3 and 6).

The deposits are chiefly somewhat clayey sand and gravel, in part interbedded with silt and clay, and they contain a large percentage of shale. The thickness of the outwash deposits varies considerably, owing to the irregular till surface upon which they were deposited. No test holes were drilled in the Oberon outwash deposits in the report area, but in seven test holes to the west of the area (Aronow and others, 1953b, p. 100-101) the deposits ranged from 15 to 40 feet in thickness and averaged about 24 feet.

Data from 49 wells producing water from the Oberon outwash deposits (table 2 and fig. 6) yielded the following information: The wells ranged from 8 to 44 feet in depth and averaged about 21 feet; the depth to water (mainly during September 1950) ranged from 6.1 to 25.9 feet and averaged 15.1 feet.

Most of the wells that produce water from the outwash deposits are dug and all are reported to furnish an adequate supply of water for domestic or stock use. The wells are also reported to have yielded adequate water for domestic and stock use during the drought years of the 1930's, although water levels did drop to some extent.

Wells for industrial, irrigation, or municipal use have not been developed in the Operon outwash deposits and it is doubtful if wells having capacities of much more than 50 to 100 gpm could be developed there. Even so, the possibility of developing supplies for municipal, small industrial, and small irrigation uses from the thicker parts of these deposits should not be overlooked. Test drilling and (or) intensive prospecting by one or another of the available geophysical methods would help delineate areas most favorable for such development.

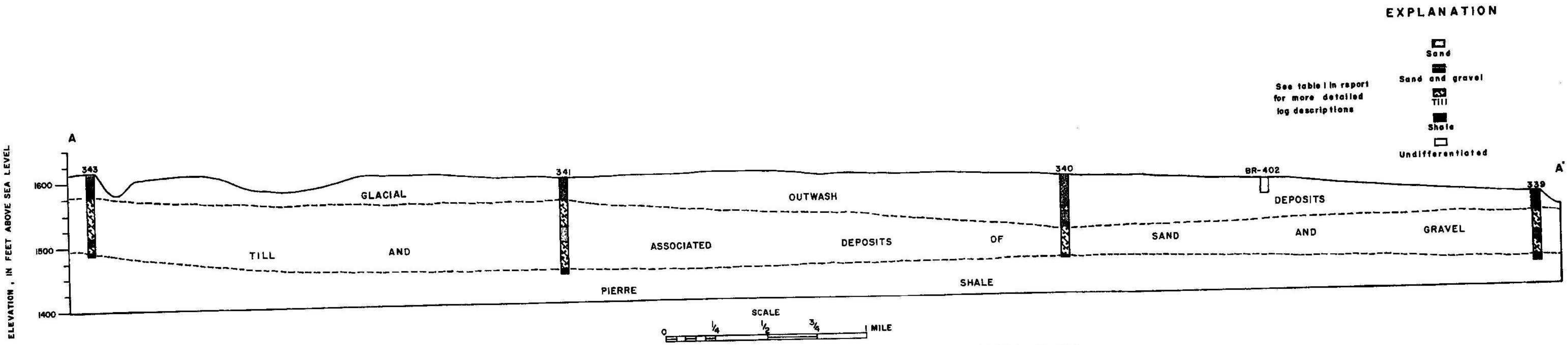

FIGURE 7 --GEOLOGIC SECTION IN THE TOKIO OUTWASH PLAIN
(Location shown in figure 4.)

Because of the apparent thinness of the Oberon outwash and its close association with the till, the quality of its water may be somewhat more variable than that in either the Tokio or Warwick outwash deposits. Owing to its lesser storage capacity, evaporation processes may concentrate the chemical constituents more rapidly than in the other outwash areas; thus more highly mineralized water percolating into the outwash deposits from the adjacent morainal deposits probably would tend to change the chemical character of the water to a greater extent than in the other outwash areas.

Tokio outwash deposits

The Tokio outwash deposits form a gently southward-sloping plain between the North Viking moraine and the Sheyenne River valley in the south-central part of the area (fig. 3). They are surrounded mainly by end-moraine deposits except along the southwestern part of their periphery where they are adjacent to the Sheyenne River valley. The greatest length of the plain along a north-south axis is a little over 11 miles, and its greatest width along an east-west axis is about 7 miles (figs. 3 and 6). Its area is about 45 square miles.

In order to obtain data regarding the character and thickness of the outwash deposits, five test holes were drilled (fig. 4). Logs of the test holes are given in table 1, and the data are shown graphically in figure 7. The Tokio outwash deposits range in texture from sand to coarse gravel and contain considerable detrital shale; they appear to be free of silt and clay.

As is typical of the other outwash deposits in the area, the thickness of the Tokio outwash deposits varies considerably owing to the irregular till surface upon which they were deposited and to their own surface irregularities. In the 5 test holes, the thickness ranged from 21 to 48 feet and averaged 34 feet. The thickest section drilled was in test hole 340, in the NW cor. sec. 29, T. 151 N., R. 61 W.

Data compiled from logs of test holes, land-surface elevations, and water-level measurements indicate that the deposits in the northern part of the outwash plain may lie mainly above the water table and may be nearly dry. The greatest known saturated thickness is about 30 feet at test hole 340, roughly in the center of the outwash plain.

Data from 25 wells believed to produce water from the Tokio outwash deposits yielded the following information: The wells ranged in depth from 14 to 80 feet and averaged about 43 feet. Depth to water ranged from 16.3 to 65.1 feet and averaged 35.2 feet.

Wells in the Tokio outwash are both dug and drilled and are used only to supply water for domestic and (or) stock use. Most of the wells were reported to yield an adequate supply of water for existing demands. Wells for industrial, irrigation, or municipal use have not been developed from these deposits, and because the saturated thickness is generally less than about 20 feet, only small to moderate supplies of ground water may be generally available for those purposes. However, these deposits probably are more permeable than the Oberon and Warwick outwash deposits, and in some places, such as in the vicinity of test hole 340, considerably larger quantities may be available. Additional exploration, aquifer tests, and collection and interpretation of other hydrologic data will be necessary before the capabilities of the aquifer will be adequately known. On the basis of available information, it appears that its potential for development of ground-water supplies is greater than that of the Oberon outwash deposits and less than that of the Warwick outwash deposits.

Warwick outwash deposits

The Warwick outwash plain is in the southeastern part of the area of this report (fig. 3). It is a remarkably flat plain, sloping gently southward and eastward, extending from the North Viking moraine to the Sheyenne River valley. That part of the outwash plain that lies within the map area adjoins end-moraine deposits on the north and west and the Sheyenne River valley on the south. The plain is interrupted by about 20 sizable lakes, some smaller ones, and by low hills or knobs of ground moraine. Parts of the plain are veneered by aeolian deposits, giving the terrain a hummocky appearance.

Within the map area, the Warwick outwash plain extends nearly 14 miles in an east-west direction, about 10 miles in a north-south direction, and covers about 85 square miles (figs. 3 and 6).

To obtain data regarding the character and thickness of the outwash deposits, five test holes were drilled in the outwash plain in 1950. Because the results of that drilling indicated a thickness of as much as 131 feet (test hole 334), and because other hydrologic data indicated possibilities of developing large ground-water supplies from the area, additional test drilling was done in the area. In 1951-52, two test wells were constructed by the city of Devils Lake from which to obtain quantitative information regarding the potential yield of wells in the area as a source of municipal supply. Also, Mr. E. W. Kjorlien had three test holes drilled on his land to obtain information for developing wells for irrigation. Two of the test holes were enlarged and finished as irrigation wells. Finally, during the period 1961-62, the city of Devils Lake constructed four new wells, which provide its municipal water supply. At the present time (1964) logs are available from 41 wells and test holes in the area, not including some wells and test holes that are so closely spaced as to yield practically duplicate logs. The 41 logs represent more than 4,000 feet of drilling (table 1). Geologic sections in the Warwick outwash plain are shown in figure 8.

In most places about a foot of sandy topsoil veneers the Warwick outwash plain; most of the outwash deposits consist of fine to coarse sand. Beds of gravel, generally containing considerable detrital shale, exist locally at various horizons but generally at depths greater than 20 feet. A few beds of clay and silt are found at various depths and some apparently extend over considerable areas.

FIGURE 8.--GEOLOGIC SECTIONS IN THE WARWICK OUTWASH PLAIN

(Location shown in figure 4.)

In the 41 wells and test holes mentioned above, the thickness of the Warwick outwash deposits ranged from 20 to 203 feet and averaged 94 feet, which probably is the approximate average thickness in the area.

In many places, the outwash deposits do not immediately overlie the Pierre Shale, but are separated from the Pierre by till. In test hole 410 (151-63-28ccd), 154 feet of till separates 40 feet of outwash deposits from the Pierre Shale. In more than half the holes drilled, however, the outwash deposits are in contact with the shale, with no till between.

Methods of development and use of water.--Data from 68 wells obtaining water from the Warwick outwash deposits are given in table 2 and shown in figs. 4 and 6. Except for the city of Devils Lake test wells and the city supply wells, which are drilled, most of the wells are dug or driven. They are used for domestic, stock, irrigation, and municipal purposes. Those that are used for domestic, stock, or irrigation needs range in depth from about 3 to 48 feet and average about 16 feet. Water levels in these wells, measured mainly in August 1950, ranged from 2.3 to 30.4 feet below land surface and averaged 9.6 feet. Average depth to water throughout the area may be somewhat less than 9 feet.

Devils Lake city test well 1 (151-63-20cdd11) is 135 feet deep and test well 2 (151-63-20cdd12) is 155 feet deep; both are 12 inches in diameter. The wells are equipped with 12-inch continuous slot, wire-wound screens at depths of 120-133 feet and 127-147 feet, respectively. During the fall of 1961 and spring of 1962, four city supply wells were constructed in the Warwick outwash deposits. For convenience of discussion in this report they are designated supply wells 1, 2, 3, and 4, in order of construction. The locations of the wells are shown in figure 4 and the construction data are given in table 3. The wells have been put into service as municipal supply wells for the city of Devils Lake and each is pumped at about 350 gpm (gallons per minute), except No. 1 which is pumped at 700 gpm.

One of Mr. E. W. Kjorlein's wells (151-62-33cad) was reported to yield several hundred gallons a minute. The depth of the completed well is not known, but a log of the test hole at the same location is given in table 1. His other well (151-63-25dd) was completed at a depth of 42 feet and is reported to yield 120 gpm with a drawdown of less than 7 feet.

Aquifer pumping tests.--In August 1951, a 1-day aquifer pumping test was made in Devils Lake city test well 1 and water levels were measured in nearby wells. When Devils Lake city test well 2 was completed, short pumping tests were made in it; observations were made in nearby wells and test holes. In August and September 1952, a 30-day test was made during which both wells were pumped continuously, except for short accidental shutdowns. The data on drawdown and recovery from all three tests were characteristic of a simple leaky-aquifer system.

In 1961-62, when the city supply wells were constructed, 1-day tests were made by pumping each supply well and observing water-level changes in nearby wells and test holes. Again, the

TABLE 3.--Summary of data obtained from aquifer pumping tests in Warwick outwash deposits

Pumped well	Date of test	Depth (feet)	Diameter (inches)	Screened interval (feet)	Discharge (gpm)	Duration of test (days)	Static water level (feet below land surface)	Drawdown (feet)	Specific capacity (gpm/ft)	Number of observation wells	Coefficient of transmissibility (gpd/ft)	Coefficient of storage	Leakage factor (feet)	Leakage coefficient (gpd/ft²/ft)
City test well 1 (Drawdown data)	8- 2-51 to 8- 3-51	135	12	120 - 133	148	1	18.23	....	..	2	65,000	1.38×10^{-3}	1,500	2.9×10^{-2}
City test well 1 (Recovery data)	8- 2-51 to 8- 3-51	135	12	120 - 133	...	1	.....	....	..	2	65,000	1.13×10^{-3}	1,500	2.9×10^{-2}
City test well 2	4-22-52	155	12	127 - 147	150	.17	19.42	4.3	35	3	58,000	7.38×10^{-4}	1,500	2.6×10^{-2}
City test well 2	4-29-52 to 4-30-52	155	12	127 - 147	320	1	19.36	10.2	31	7	52,000	7.21×10^{-4}	1,500	2.3×10^{-2}
City test well 1 City test well 2	8-15-52 to 9-16-52	135 155	12 12	120 - 133 127 - 147	200 300	30 30	21.00 22.04	28.0 14.0	7 21	4	47,000	....	[1]1,500	2.1×10^{-2}
City supply well 1	8- 9-61 to 8-10-61	112	12	58 - 64 65.5 - 70 74 - 112	650	1	16.6	6.5	99	2	78,000	3.37×10^{-4}	2,200	1.6×10^{-2}
City supply well 2	9-12-61 to 9-13-61	110	12	78 - 85 96 - 110	1,200	1	14.6	13.6	88	2	81,000	2.76×10^{-4}	2,300	1.5×10^{-2}
City supply well 3	11-15-61 to 11-16-61	...	12	....	550	1	21.4	13.6	40	1	89,000	1.69×10^{-3}	1,020	8.6×10^{-2}
City supply well 4	5-14-62 to 5-15-62	89	12	....	500	1	17.7	14.4	35	...	....	....	.....	....
Weighted average of data from city test wells											55,000	8.8×10^{-4}	1,500	2.4×10^{-2}
Weighted average of data from city supply wells											81,000	5.8×10^{-4}	2,000	2.0×10^{-2}
Weighted average of data from all determinations											61,000	8.0×10^{-4}	1,600	2.4×10^{-2}

[1] Estimated to be the same as previously calculated from individual tests on city test wells 1 and 2.

data from these tests were characteristic of a simple leaky-aquifer system. Quantitative results obtained from the pumping tests are given in table 3.

Devils Lake city test wells 1 and 2 were constructed so as to yield water only from a sand-and-gravel aquifer near the bottom of the outwash deposits. The weighted average coefficient of transmissibility determined from pumping these two wells is 55,000 gpd/ft (gallons per day per foot), which is sufficiently great to expect that wells yielding at least 1,000 gpm could be constructed in the aquifer. The weighted average coefficient of storage is 0.0009, which indicates semiconfined conditions. The coefficient of leakage, 0.024 gpd/ft^2/ft, is rather high and indicates that water can move easily from one aquifer to the other through the confining bed. The tests gave no information ragarding the characteristics of the upper water-table aquifer, but it is likely that the coefficient of storage of the upper aquifer is at least 0.20 and that the coefficient of transmissibility is small compared to that of the lower artesian aquifer -- perhaps in the range of 2,000 to 10,000 gpd/ft.

The weighted average coefficient of transmissibility of the lower artesian aquifer obtained from the tests of the city supply wells in 1961-62 is 81,000 gpd/ft, the coefficient of storage is 0.0006, and the coefficient of leakage is 0.02 gpd/ft^2/ft. The higher coefficient of transmissibility determined from the supply wells in comparison with that obtained from the test wells may indicate that the supply wells are located in more permeable parts of the aquifer. This conclusion, however, is perhaps only partly valid because the supply wells yielded some water from beds above the highly permeable aquifer in the lower outwash deposits.

Significance of aquifer pumping tests.--The significance of the results of the tests from the area is that wells with large yields can be developed in the lower aquifer. The pumping effects are spread widely and rapidly in the lower aquifer and water moves from the upper aquifer to the lower over a large area. The result is that the upper aquifer can be dewatered without the necessity of creating steep, local cones of depression.

To replace water being depleted by the developments, water levels will drop in both the upper and lower aquifers, because at the beginning of the operation water must be taken from storage. As evaporation and transpiration losses from lakes and swampy areas are reduced by lowering of the water levels, the rate of lowering will lessen. If sufficient water can be salvaged by lowering water levels in these areas and by decreasing natural discharge to the Sheyenne River valley, the development depletions will be balanced and water levels will cease to decline.

Sufficient information is not now (1964) available to determine whether the present city development can salvage enough water from natural losses to be sustained indefinitely. Thus it is recommended that continuous water-level records be obtained at the supply wells and at observation wells both in and out of the well field and that detailed records of withdrawals from the wells be maintained. The records will supply a basis for expanding production in the vicinity of the wells or for reducing production locally in favor of distributing the development over a wider area.

Till and Associated Deposits of Sand and Gravel

Till and associated deposits of sand and gravel are the surficial materials throughout the areas of ground moraine and end moraine (fig. 3). The deposits also underlie most parts of the lake basins and outwash plains, but are covered by later deposits of clay or sand and gravel. The till, which is mainly clay, yields little or no water to wells because it is so fine grained. The sand and gravel deposits are interspersed with the till and, where they lie within the zone of saturation, form aquifers of varying importance according to their volume, permeability, and accessibility to recharge. Many wells in the Devils Lake area obtain water from these aquifers for domestic, farm, and municipal uses.

Most of the test holes that were drilled completely through the glacial drift penetrated one or more sand and gravel beds having an aggregate thickness of at least 10 feet. Test drilling indicates that the thickest sand and gravel beds, and probably the most productive aquifers except those in the outwash deposits, underlie the Devils Lake chain of lakes. More than 100 feet of saturated sand and gravel was penetrated in several widely spaced areas in the Devils Lake chain. Test drilling and well-inventory data indicate that these sand and gravel bodies, although not known to be directly interconnected, seem to be associated with deeply incised channels in the underlying Pierre Shale (fig. 9). The channels may represent the courses of ancient stream valleys that were formed prior to glaciation and that trend approximately in the direction of the Devils Lake chain.

Sand and gravel bodies having thicknesses of about 50 to 100 feet were penetrated in several test holes drilled in the Sweetwater Lake area. Lesser amounts of sand and gravel were penetrated in test holes in various other parts of the Devils Lake area. In a few test holes, less than 5 feet of sand and gravel was penetrated in test holes in total drift thicknesses of more than 100 feet. For instance, only 3 feet of sand and gravel was found in test hole 185, which penetrated a total drift thickness of 343 feet.

Specific aquifers consisting of thick and extensive bodies of sand and gravel, as indicated by test drilling and well-inventory data, are discussed in the following pages. These are the Grahams Island aquifer, here named for Grahams Island, T. 153 N., Rs. 65 and 66 W., and the aquifers in the Six Mile-Creel Bays, Camp Grafton, and Sweetwater Lake areas.

Grahams Island aquifer

Thick deposits of sand and gravel were penetrated in several test holes drilled in a section across the dry West Bay of Devils Lake east of Minnewaukan (fig. 10). The thickest deposits (in aggregate) were penetrated in test holes 40 (138 feet), 41 (103 feet), and 42 (120 feet); lesser amounts were penetrated in test holes 39, 43, 44, and 45. The texture of the drill samples ranged from sand to very coarse gravel. Some sections of the sand and gravel contain considerable amounts of clay, which probably reduces the permeability of those sections. The largest permeable section was penetrated in test hole 41, which was drilled through 103 feet of mostly coarse gravel. The bottom of the gravel deposits was not reached.

FIGURE 10.--GEOLOGIC SECTION IN WEST BAY AREA OF DEVILS LAKE

(Location shown in figure 4.)

The thicker sections of sand and gravel seem to be associated with the underlying bedrock channel and possibly have a similar origin. However, it is not known whether they are freely interconnected and thus function as a single hydraulic system. Probably there is some degree of interconnection. Aronow and others (1953b, p. 77), in a report on ground-water resources in the Minnewaukan area, stated the following in regard to the productivity of part of the aquifer:

"The most productive aquifer found in all the test drilling in the Minnewaukan area is that in USGS test 41, where sand and gravel extends from the surface to a depth of more than 100 feet. This hole was cased with approximately 60 feet of 5-inch standard pipe, the lower section of which was slotted with a torch. On August 14, 1948, the hole was pumped for about 6 hours at a rate of about 42 gpm. The initial water level was 7.02 feet below the land surface and the maximum drawdown during this period was 0.90 foot. The well subsequently was pumped for a short time at a rate of about 85 gpm with a maximum drawdown of 2.72 feet. Within 3 minutes after the pump was turned off, the water level had recovered to 7.09 feet below the land surface, or to within 0.07 foot of the water level before the pumping began.

"In September 1948 the well was again pumped at a rate of about 42 gpm for a period of 24 hours. At this time, the water level before pumping was 4.55 feet below the land surface. The lowest water level recorded was 5.78 feet, which would indicate a drawdown of 1.23 feet. However, 5 minutes after pumping stopped the water level was 4.42 feet below the land surface, or 0.13 feet higher than before pumping began. Approximately 8 hours after pumping stopped the water level was 4.19 feet below the land surface. These water levels, which were higher after pumping than before, probably indicate a natural rise due to recharge. It is believed that the greater part of the drawdown during these pumping periods was due to hydraulic losses from the water entering the well casing from the aquifer rather than to loss in head in the aquifer itself. It is believed that a well capable of producing several hundred to more than 1,000 gpm could be developed at this location."

Aquifers in the Six Mile-Creel Bays area

Considerable thicknesses of sand and gravel were penetrated in many of the test holes drilled in the area bounded by State Highway 19 on the north, Six Mile Bay on the west, Main Bay on the south, and Creel Bay on the east (fig. 4). Most of these test holes penetrated 30 or more feet of sand and gravel (table 1). The thicker deposits ordinarily lie near the bottom of the drift just above the Pierre Shale. The thickest section of sand and gravel was in test hole 196 (153-65-13cab) in the interval from 107 to 238 feet, but some of the samples contained a large amount of clay. Test hole 192 (153-65-24baa), about half a mile south of 196, penetrated 47 feet of clayey sand and gravel from 65 to 112 feet; this may be a continuation of the aquifer in that direction.

Test hole 195 (153-65-12ddd), drilled less than a mile northeast of 196, penetrated sand and gravel from the surface to 31 feet and from 87 to 143 feet. The lower section rests on shale and may also be correlative with the deposits in test hole 196.

Test hole 197 (153-65-22bbb), about half a mile north of the confluence of Six Mile Bay and Main Bay, penetrated thick sand and gravel beds at various intervals to a depth of 257 feet. The deposits from 124 to 156 feet seemed to be fairly clean and permeable.

Very little is known concerning the water-bearing properties or the degree of interconnection of the sand and gravel aquifers in the Six Mile-Creel Bays area. The sites of test holes 192, 195, 196, and 197 seem to have good potential for the development of moderate quantities of ground water sufficient for small-scale municipal, industrial, or irrigation uses. However, the aquifers are covered with thick deposits of till and (or) lake clay, which could act as a seal against adequate recharge at least in the area of test drilling. On the other hand, the aquifers may extend considerably beyond the area of test drilling to areas presently covered by Devils Lake and may, in places, be in contact with the highly mineralized lake water. If so, heavy pumping might induce recharge into the well fields with a resultant deterioration of water quality. In the authors' opinion, further test drilling in conjunction with controlled aquifer pumping tests and quality-of-water studies should precede large-scale water-supply developments in the area.

Aquifers in the Camp Grafton area

Camp Grafton extends along the northeast shore of Main Bay (fig. 4). The area considered in this section, however, is the triangular-shaped area bounded by Main Bay on the southwest, East Bay on the east, and the north edge of secs. 19, 20, and 21, T. 153 N., R. 64 W. The discussion of ground water in this area is based on logs and records of wells and test holes in Camp Grafton (tables 1 and 2) and logs of test holes located in a line extending along the west shore of East Bay (fig. 11).

Many of the data concerning ground-water occurrence at Camp Grafton were obtained from an unpublished report by A. L. Greenlee, who in 1943 as a member of the U.S. Geological Survey made a ground-water reconnaissance of the campsite. The domestic water supply for Camp Grafton is obtained from 11 wells ranging in depth from 135 to 252 feet. All the wells tap sand and gravel aquifers in the glacial drift, except the one that is 252 feet deep, which obtains water from the underlying Pierre Shale. The logs of 4 of these wells are given in table 1. The data indicate that the main aquifer at the campsite is a sand and gravel deposit that begins at a depth of about 135-140 feet. The thickest known section is 32 feet, from 137-169 feet, in well 153-64-19dda2. However, well 153-65-19dad, about one-eighth of a mile northwest, is reported to be 182 feet deep, indicating a possible greater thickness at that location.

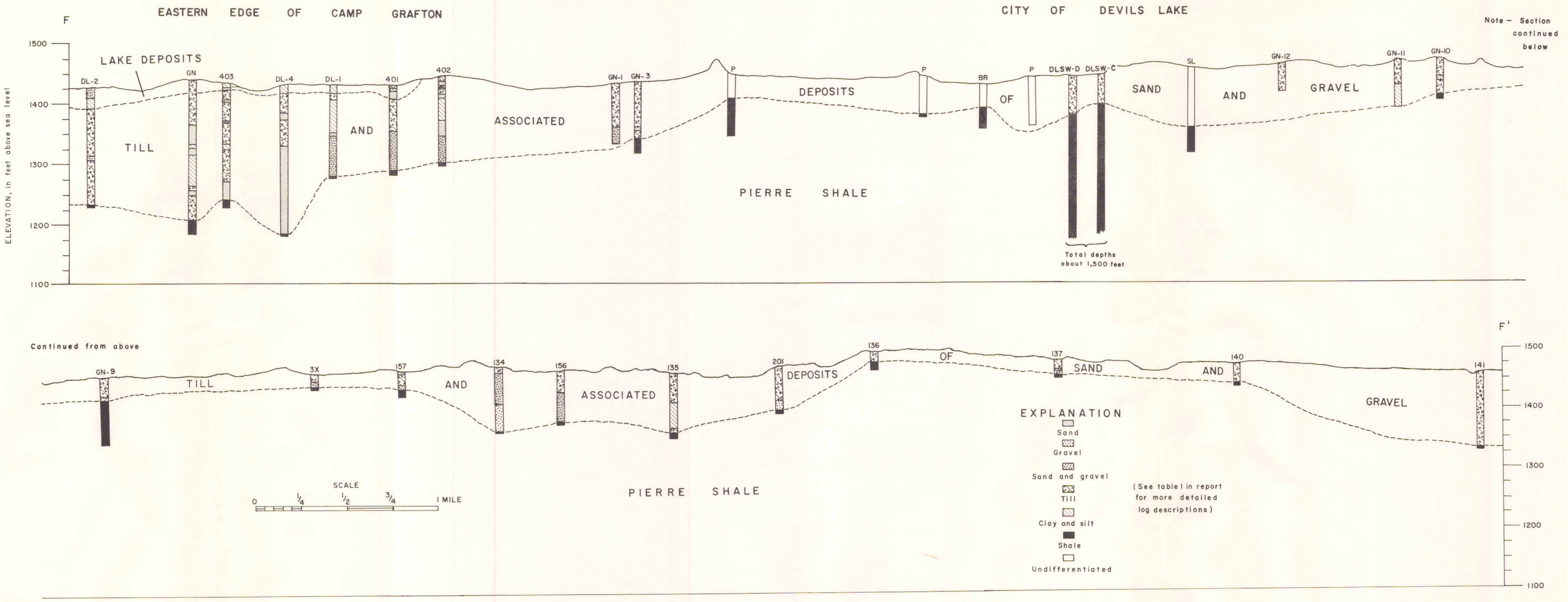

FIGURE 11.--GEOLOGIC SECTION FROM EAST BAY OF DEVILS LAKE TO MORRISON LAKE.

(Location of section shown in figure 4)

Two aquifer pumping tests were made on well 153-65-19dda3 in June 1943. During the first test the well was pumped at an average rate of 31 gpm for 25 hours, and during the second test it was pumped at an average rate of 83 gpm for 40 hours. The drawdown in the pumped well at the end of the first test was 6.3 feet and at the end of the second test was 18.1 feet. These data indicate an average specific capacity of about 5 gpm per foot of drawdown for the well. Analyses of the drawdown data in the pumped well and nearby observation wells indicate a coefficient of transmissibility of about 60,000 gpd/ft and a coefficient of storage of about 0.0002.

Test drilling in a north-south line along the west shore of East Bay about $1\frac{1}{4}$ miles east of Camp Grafton penetrated fairly thick sand and gravel deposits in the glacial drift (fig. 11). These deposits appear to correlate stratigraphically with the aquifer at Camp Grafton.

In figure 11 the main body of sand and gravel is shown in a bedrock depression. Probably the depression is part of a channel cut into the Pierre Shale prior to glaciation, and the deposits are of fluvial or glaciofluvial origin similar to those penetrated west of Grahams Island.

Aquifers in the Sweetwater Lake area

A large number of test holes were drilled in the vicinity of Sweetwater and Morrison Lakes in the northeast corner of the report area. It was hoped that they would disclose a large aquifer hydraulically connected to the lakes and receiving recharge from them. A narrow channellike deposit of sand and gravel was penetrated by test holes, and a well was drilled near the west edge of

Sweetwater Lake, east of Highway 20. This aquifer may extend north or northeastward beneath the lake from the area of test drilling. It is tapped by well 155-64-34bda and was penetrated by test holes 198, 199, 200, and 205 (fig. 4). The main part of the aquifer probably is between 40 and 90 feet in depth. The water-bearing materials consist of sand and gravel composed mainly of detrital shale. The thickest known section is 47 feet, at depth 43-90 feet, in test hole 198 (155-64-34bdd4).

The aquifer seems to be of small areal extent and probably could not support large and continued withdrawals. An aquifer pumping test on well 155-64-34bda, an industrial well owned by the Great Northern Railway Co,, indicated that the aquifer is not connected to the lake and, therefore, not recharged from the lake waters, at least in the vicinity of the well. The well was pumped at an average rate of 248 gpm for a period of 38 hours. The drawdown in an observation well 57 feet southeast of the pumped well was 36.8 feet; thus, the specific capacity could not have been greater than 8 gpm per foot of drawdown, and was doubtless considerably less.

Analyses of the test data indicate an aquifer coefficient of transmissibility of about 12,500 gpd/ft and a coefficient of storage of about 0.0006 or less, suggesting that the water occurs under confined conditions. The test data also indicate that the aquifer probably is 500 to 800 feet wide in the vicinity of the test area. Small to moderate supplies, perhaps in the order of 50,000 to 100,000 gpd, probably could be developed from the aquifer in places, but the continuance of such supplies would depend upon the ability of the glacial materials surrounding the aquifer to furnish water from storage.

Ground Water in the Pierre Shale

The Pierre Shale, which probably underlies the glacial drift throughout the area, is generally water bearing in its upper part. The yields obtained are small, rarely more than 5 or 10 gpm. Wells that obtain water from the Pierre Shale in the Devils Lake area range in depth from 49 to 365 feet and average 150 feet. There are many wells in the city of Devils Lake that have obtained water from the Pierre, and these have an average depth of about 100 feet.

Generally the water-bearing zones in the Pierre Shale are within the upper 50 feet of the formation, but some are as deep as 100 feet. The physical properties of the aquifers have not been determined. Most of the shale is fine grained and compact, has low permeability, and does not function as an aquifer. Aronow and others (1953a, p. 69) in describing the nature of aquifers in the Pierre Shale in the vicinity of Michigan City, about 25 miles east of the Devils Lake area, give evidence that the water occurs in fractures and crevices in the upper part of the formation. They state that the aquifers are found mainly in hard layers of the shale and suggest that the openings were caused by earth stresses, possibly set up by the weight of the overriding ice sheet during glaciation. Regarding the depth of the aquifers in the shale, they state, "In the Michigan City area as a whole, more than half the wells for which data are available apparently tap aquifers within the 70 to 90 foot range." This is somewhat deeper than the average depth of aquifers in the Devils Lake area.

Some drillers report obtaining water from zones of angular fragments overlain and underlain by unbroken shale. Most drillers report a complete absence of sand and all agree that there is no definite sandy bed within a given area from which water is obtained. In some places where angular fragments and sandy beds were penetrated, no aquifer was found. Most drillers classify the shale beds as "soft" or "hard" or as "slate." There is general agreement that water is more likely to be found in the "hard" shale than in the "soft." On the other hand, some wells are reported to yield water from "soft" shale and water is not always found in the "hard" shale.

No pumping tests that would shed light on the aquifer characteristics of the Pierre Shale were made in the Devils Lake area. Analyses of the data foom tests in the Michigan City area (Aronow and others, 1953a, p. 74-77), however, indicate that the aquifers have an average coefficient of transmissibility of 450 gpd per foot and a coefficient of storage of 0.0004. Probably these figures apply reasonably well to aquifers in the Pierre Shale in the Devils Lake area.

Because of the low transmissibility it is likely that only small yields can be obtained from aquifers in the Pierre Shale through individual wells. However, the aquifers are extensive and would yield considerable amounts of water to properly spaced well systems (two or more connected wells).

The following table from Aronow and others (1953, p. 80) gives data that would be useful in the design of such a well system. The data are theoretical and are based on aquifer coefficients of transmissibility of 450 gpd per foot and storage of 0.0004. Drawdowns are given for a pumping rate of 5 gpm.

Time since pumping started	Drawdowns (feet)								
	Distance from pumped well (feet)								
	10	100	300	500	700	1,000	3,000	5,000	10,000
1 day	10.3	4.5	1.9	0.9	0.4	00.1	0.0	0.0	0.0
10 days	13.2	7.4	4.6	3.4	2.6	1.6	.1	.0	.0
100 days	16.2	10.3	7.5	6.2	5.4	4.5	1.9	.9	.1
1 year	17.8	12.0	9.2	7.9	7.0	6.1	3.4	2.2	.8
2 years	18.7	12.9	10.0	8.8	7.9	7.0	4.2	3.0	1.4
3 years	19.2	13.4	10.6	9.3	8.4	7.5	4.7	3.5	1.8
5 years	19.8	14.0	11.2	9.9	9.1	8.2	5.4	4.1	2.4
7 years	20.3	14.4	11.7	10.3	9.5	8.6	5.8	4.5	2.8
10 years	20.6	14.9	12.1	10.8	9.9	9.0	6.2	5.0	3.3

It should be emphasized that the data in the table, which is in itself theoretical, are based on aquifer properties in one part of the Michigan City area. Whether these properties pertain to shale aquifers in the Devils Lake area is, of course, open to question. However, the authors of this report believe that conditions in the two areas are reasonably similar and that the predicted drawdowns probably apply to the Devils Lake area as well.

Concerning the use of the table Aronow and others (1953a, p. 81) state "...the drawdown effects at any place from the pumping of the well are simply added to the effects at the same place from pumping another well, in order to determine the combined effects of pumping both wells. Likewise, if more than two wells are involved, the effects of each well at any particular place are simply added to give the combined effects.

"The drawdowns are directly proportional to the pumping rate, so that the effect at any place and time of pumping 10 gpm would be twice that of pumping 5 gpm as listed in the table.

"The drawdown to be expected in a pumped well cannot be foretold with accuracy, but in 6-inch wells and at a pumping rate of 5 gpm, the drawdowns generally would be 10 to 15 feet more than those shown in the table for wells 10 feet away."

Ground Water in the Dakota Sandstone

The aquifers in the Dakota Sandstone consist of fine- to coarse-grained, generally loosely cemented beds of quartzose sandstone. Until 1962, the municipal water for Devils Lake was obtained from aquifers in the Dakota Sandstone at depths between 1,300 and 1,500 feet. Four wells, designated in this report as Devils Lake city supply wells A, B, C, and D, had been drilled to depths ranging from 1,496 to 1,530 feet (table 2 and fig. 6). The water in the aquifers was under sufficient pressure to flow from the wells at about 100 to 150 gpm in 1952. However, because of the larger yields required, all four wells were equipped with pumps; wells A and B reportedly were pumped at 280 and 226 gpm. The pumping water level in well A was reported to range from 23 to 27 feet below land surface.

Well A was reported to have penetrated two aquifers at depths of 1,300 and 1,500 feet and to have obtained a flow from each. The flow from the lower aquifer was later plugged off and only the upper aquifer was used.

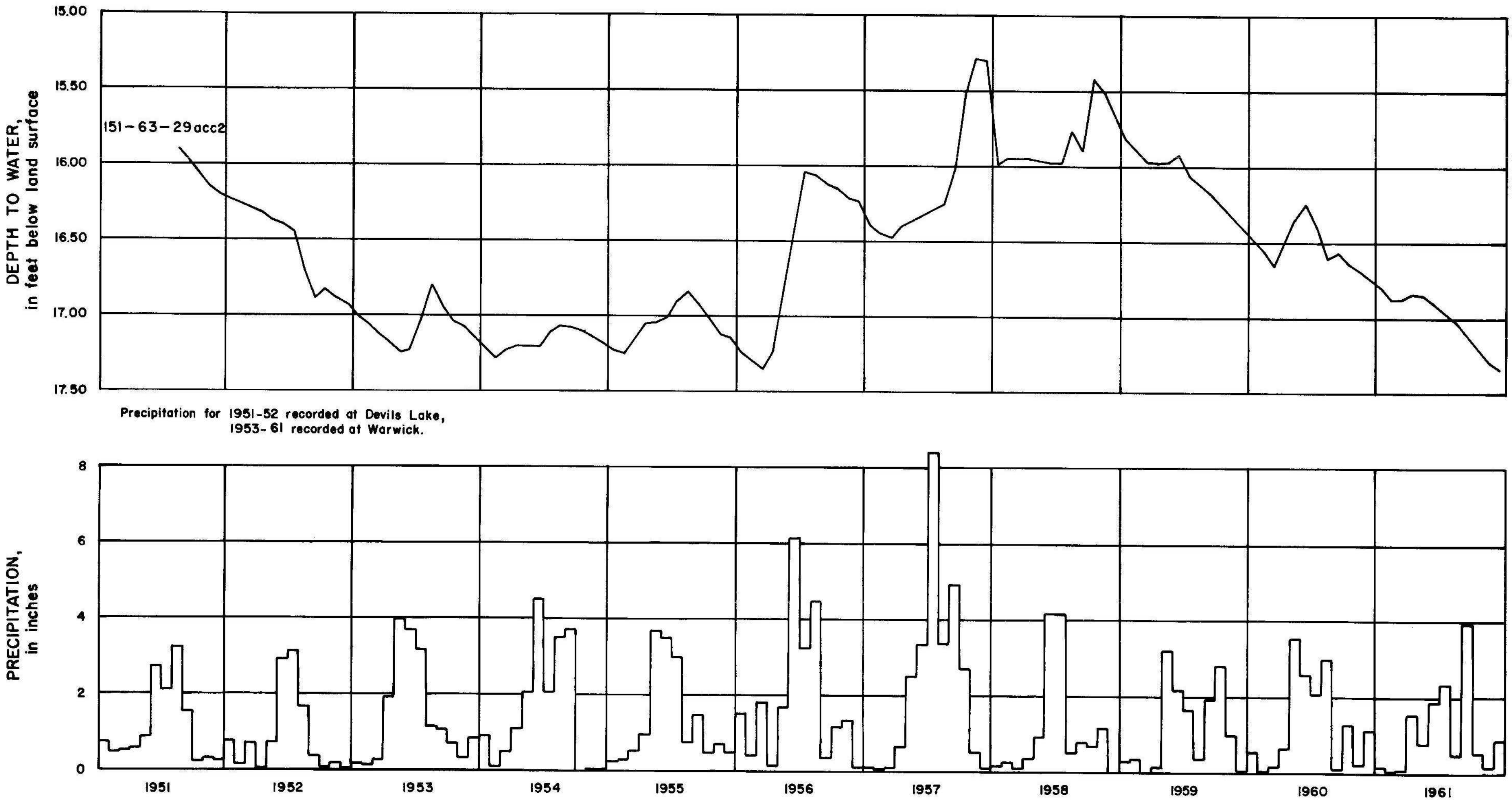

FIGURE 12.- HYDROGRAPH SHOWING WATER-LEVEL FLUCTUATION IN WELL 151-63-29acc AND PRECIPITATION AT DEVILS LAKE AND WARWICK.

RECHARGE, MOVEMENT, AND DISCHARGE OF GROUND WATER

Recharge

The ultimate source of recharge to the aquifers in the Devils Lake area is precipitation. The quantity and rate of recharge that an aquifer receives depend largely on its degree of interconnection with a source of recharge. Generally, the shallower aquifers are recharged more readily than the deeper aquifers. The largest amounts of recharge usually occur during the spring and early summer as the combined results of (1) melt water derived from accumulated snowfall from the preceding winter, (2) relatively large amounts of precipitation, and (3) low rates of evapotranspiration. Although generous showers often occur during the remainder of the summer and early fall, most of the water is taken up as soil moisture, used by the vegetation, or is evaporated because of the higher prevailing temperatures. Recharge may occur again in the late fall, although usually in smaller amounts, as the result of relatively prolonged rains when temperatures are cool and vegetation is dormant. Little or no recharge occurs during the winter and early spring largely because the upper several feet of ground is frozen, thus impeding the downward movement of water.

Aquifers in the outwash deposits are readily recharged because they are either at or near the surface and are generally covered by sandy soils, which allow absorption of precipitation and snowmelt. The hydrograph of well 151-63-29acc2 (fig. 12), drilled in the Warwick outwash plain, shows a low in the water level generally occurring in the early spring and a high in the summer or fall of each year. Comparison of the water-level data with the precipitation data shows a lagging effect, and the water-level peaks generally occur a month or several months after periods of high rainfall.

Most of the aquifers in the till and associated deposits of sand and gravel are buried by till or other fine-grained deposits. As a result, recharge to the aquifers is slow as compared to the aquifers in the outwash deposits. Hydrographs of water-level fluctuations in wells tapping buried-drift aquifers are shown in figure 13 (wells 153-64-5aa and 154-64-35cbc). Unfortunately, the hydrographs show rather limited detail because of insufficient measurements, but they indicate a considerable lag in recharge effects caused by precipitation.

The aquifers in the Pierre Shale are recharged even more slowly, particularly where the shale is overlain mainly by till or other fine-grained materials. Well 153-65-14ac (fig. 14) is 285 feet deep and obtains water from the Pierre Shale. Although this hydrograph also is lacking in sufficient detail, except for the period 1937-41, it indicates a lack of short-termed recharge effects. However, the hydrograph does illustrate a general rising trend in the water level beginning in the early 1940's. This is in response to the generally normal or above-normal precipitation received during the 1940's, after the drought years of the 1930's.

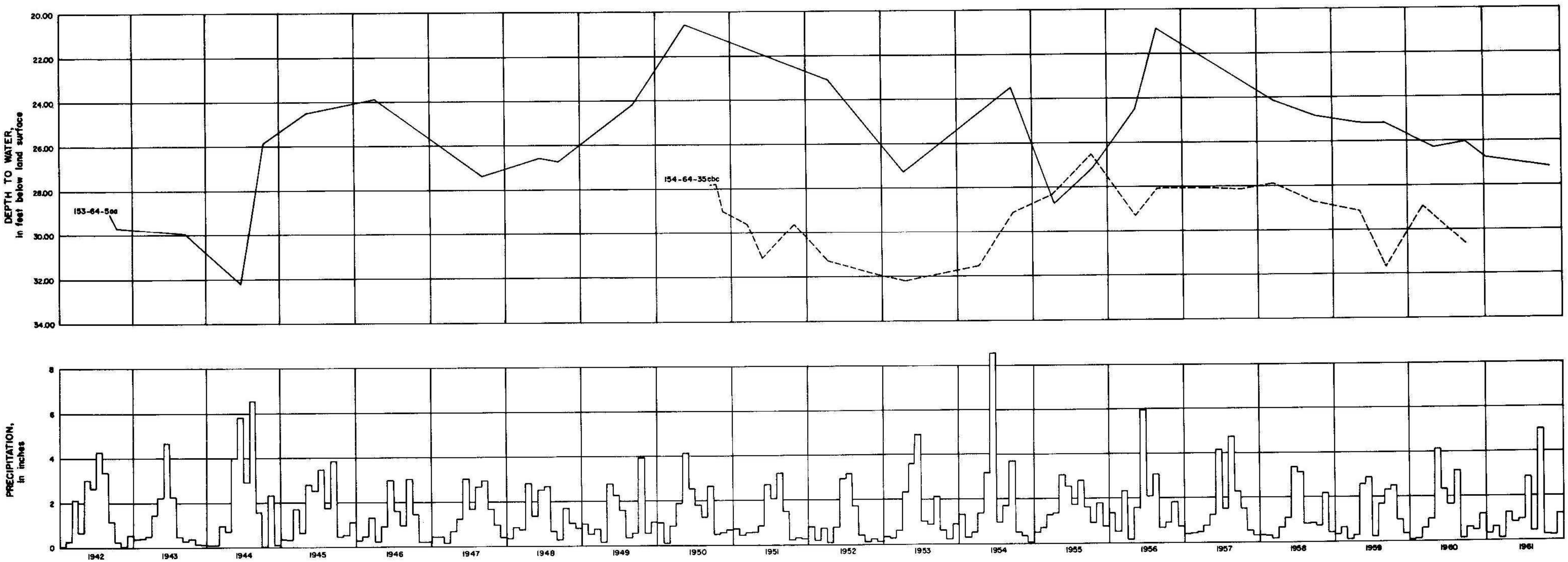

FIGURE 13.--HYDROGRAPH SHOWING WATER-LEVEL FLUCTUATION IN WELLS 153-64-5aa AND 154-64-35cbc AND PRECIPITATION AT DEVILS LAKE.

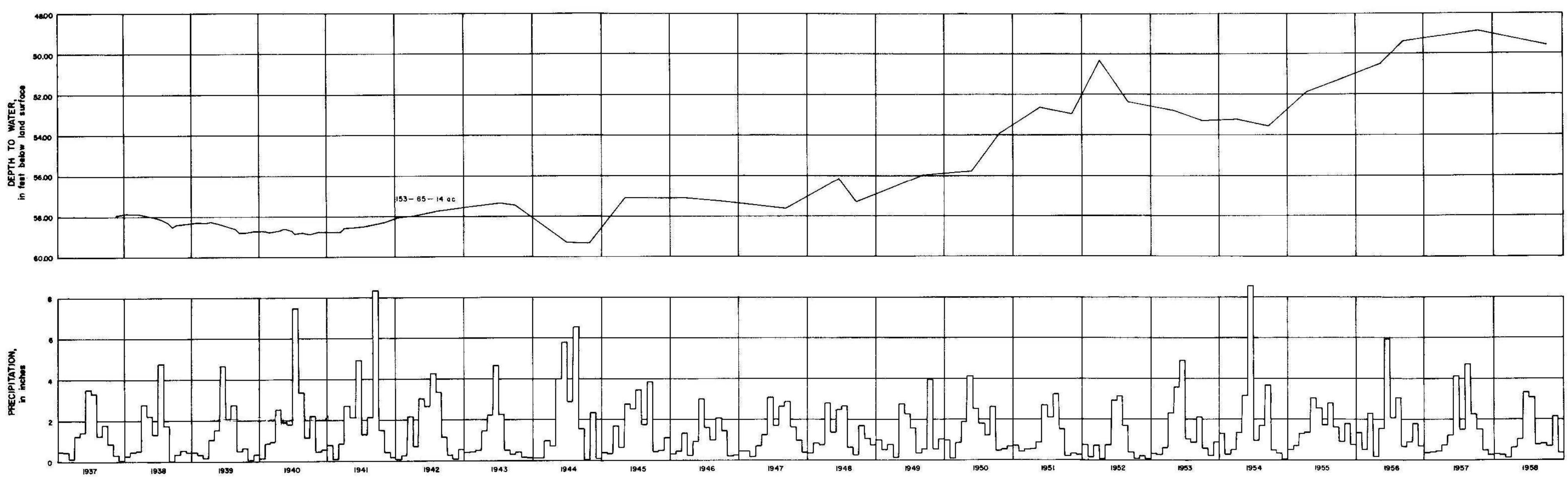

FIGURE 14.-HYDROGRAPH SHOWING WATER-LEVEL FLUCTUATION IN WELL 153-65-14ac AND PRECIPITATION AT DEVILS LAKE.

Movement

Few data are available concerning movement of ground water in the outwash deposits and practically none concerning movement in the deeper aquifers. Ground-water movement in each of the three areas of outwash is indicated generally in figure 6. The contours on this map were constructed on the basis of elevations of water levels in selected wells and test holes that penetrate the deposits. Movement of the ground water is downgradient and at right angles to the contour, mainly toward the Sheyenne River valley. Also, there is probably some movement northward from the northern parts of the Tokio and Warwick outwash plains into the Devils Lake drainage basin.

Movement in the buried-drift is probably largely controlled by the orientation of the aquifers and permeability differences within them. Subsurface data indicate the presence of sand and gravel aquifers beneath the Devils Lake chain and having somewhat the same orientation. General movement in these aquifers probably is east-southeast, approximately paralleling the lake chain.

Discharge

Much of the water in the outwash deposits is discharged naturally by evaporation from the numerous lakes and ponds; by evapotranspiration in the low-lying areas, where the water table is near the land surface; and by springs along the north edge of the Sheyenne River valley. Numerous periodic measurements of a spring in the SE$\frac{1}{4}$SE$\frac{1}{4}$ sec. 16, T. 150 N., R. 63 W., during the period 1951-60 indicate a rather uniform rate of discharge generally between 600,000 and 1,000,000 gpd. Additional discharge from the outwash deposits is pumped from wells. In 1962 the largest withdrawals by wells were for the city of Devils Lake and probably averaged about a million gallons per day.

Few data are available concerning ground-water discharge from the buried aquifers. Evapotranspiration losses are probably negligible because, generally, the aquifers are covered by thick deposits of relatively impermeable materials. Discharge from these aquifers is by withdrawals from wells and by natural migration of water into other areas. Under natural conditions the water that migrates from the area of study is replaced by equal amounts of inflow, resulting in balanced hydraulic systems.

The amount of water withdrawn from the buried aquifers in the wells is relatively small. Prior to utilizing aquifers in the Warwick outwash deposits, moderately large quantities were withdrawn in the city of Devils Lake area from aquifers in the Pierre Shale and Dakota Sandstone. The average metered use from wells in Devils Lake tapping aquifers in the Dakota Sandstone during the period September 1952 through August 1953 was 500,000 gpd. Records of ground-water discharge from aquifers in the Pierre Shale are not available. However, withdrawals from this formation probably have been considerably lessened in the vicinity of the city of Devils Lake because of the availability of better quality water from the Warwick outwash deposits.

QUALITY OF WATER

Ground water dissolves a part of the soluble mineral constituents of the rock particles as the water moves into and through an aquifer. The amount of mineral matter dissolved depends mostly upon the amount of soluble materials in the aquifer, the length of time the water is in contact with them, and the amount of carbon dioxide in the water. Water that has been stored underground a long time or that has traveled a long distance from the recharge area generally is more highly mineralized than water that has been stored a short time and recovered relatively near the recharge area.

In many instances the chemical quality of the water is the determining factor in regard to its suitability for use. The quality of water for public supply and domestic use commonly is evaluated in relation to standards of the U.S. Public Health Service for drinking water. The standards, adopted in 1914 to protect the health of the traveling public, were revised several times in subsequent years. The latest revision (U.S. Department of Health, Education, and Welfare, 1962) is, in part, as follows:

Constituent	Maximum concentration (ppm)
Zinc (Zn)	5
Iron (Fe)	0.3
Manganese (Mn)	.05
Sulfate (SO_4)	250
Chloride (Cl)	250
Fluoride (F)	1.7*
Nitrate (NO_3)	45
Dissolved solids	500

* Varies for different parts of the country.

Soft water is desirable for washing clothes or for any washing operation in which soap is used. Practically all natural water contains calcium and magnesium, which cause hardness, the degree depending upon the concentration of the constituents. The following table has been adopted by the U.S. Geological Survey for use in hardness classification throughout the United States.

Hardness range (ppm)	Rating
0 - 60	Soft
61 - 120	Moderately hard
121 - 180	Hard
181 +	Very hard

For general irrigation of crops or for watering lawns, trees, and gardens, water of a high overall salinity is undesirable. Water containing a large percentage of sodium, with respect to the total cation concentration, is undesirable because it causes the soil to become impermeable. The tolerable sodium percentage is greater for water containing smaller amounts of dissolved solids (lower salinity) and less for highly mineralized water. As a general guide, it may be stated that when sodium exceeds about 50 percent of the total cations, the water would be harmful to the soil if applied over an extended period of time. This would be especially true if the soil were heavy and subsurface drainage poor. In a soil with good subsurface drainage, the effects would not be so marked.

Eaton (1950) has shown that if water containing relatively large amounts of carbonate and bicarbonate, as compared to the calcium and magnesium present, is used for irrigation, a soil-water solution containing principally sodium salts may result. The danger of developing a soil solution of high sodium content is increased if the water is applied sparingly and if good soil drainage is not provided. If the soil solution contains considerable sodium carbonate or sodium bicarbonate, a "black-alkali" soil may result.

Table 4 lists 63 chemical analyses of water from 58 wells, test holes, and springs in the Devils Lake area. The following table shows the distribution according to the geologic source.

Geologic source	Number of samples
Outwash deposits	11
Glacial drift other than outwash deposits	36
Pierre Shale	11
Dakota Sandstone	5

In some instances, two or more samples were obtained at different times from one well, test hole, or spring.

The results of the analyses indicate that the water in the outwash deposits has by far the best quality for most uses, which is followed by water in glacial drift other than outwash deposits, Pierre Shale, and Dakota Sandstone in that order. The water in the outwash deposits had a dissolved-solids content ranging from

118 to 364 ppm and averaging 263 ppm and a hardness ranging from 85 to 336 ppm and averaging 227 ppm (table 4). Water in the glacial drift had a dissolved-solids content ranging from 201 to 2,920 ppm and averaging 1,420 ppm; a hardness ranging from 62 to 1,780 ppm and averaging 628 ppm; and an iron content ranging from a trace to 43 ppm and averaging 2.8 ppm. If the sample that indicated 43 ppm, which is very unusual, is neglected, the average would be 1.6 ppm. Water in the Pierre Shale had a dissolved-solids content ranging from 40 to 5,790 ppm and averaging 2,117 ppm; a hardness ranging from 40 to 783 ppm and averaging 253 ppm; and an iron content ranging from a trace to 5 ppm and averaging 1.6 ppm. Water in the Dakota Sandstone had a dissolved-solids content ranging from 3,770 to 3,870 ppm; a hardness ranging from 50 to 80 ppm; and a chloride content ranging from 867 to 880 ppm. Fluoride was found to be excessive in samples from the Dakota Sandstone, averaging more than 5 ppm in those tested.

Figure 15 summarizes graphically many of the data given in table 4. It shows by means of circular diagrams the amounts and proportions of the major constituents expressed in equivalents per million. The segments of the circles are proportional to the respective percentage amounts of each constituent considered and the areas of the circles are proportional to the total of the constituents. Thus it may be seen that the water in the outwash deposits is mainly a calcium bicarbonate type that has a relatively small amount of total mineralization. Such a water would be of good quality for many uses, but for some uses probably should be treated to reduce the hardness caused by the calcium and magnesium.

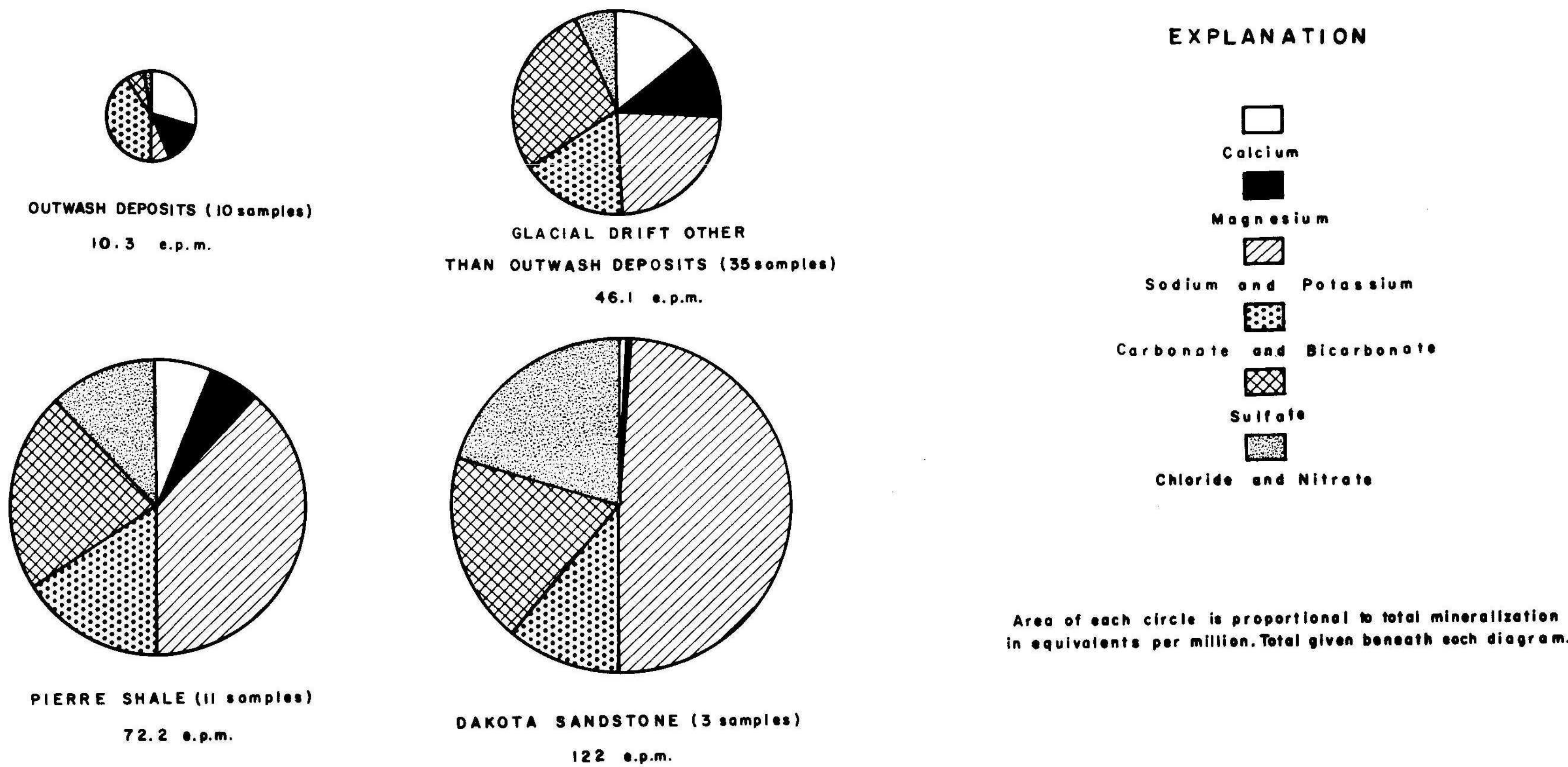

FIGURE 15. ANALYSES OF GROUND WATER IN DEVILS LAKE AREA REPRESENTED BY CIRCULAR DIAGRAMS

Water from all the geologic sources except the Dakota Sandstone generally would be rated as very hard according to the table on page 53. The diagrams for water in the glacial drift other than outwash deposits, Pierre Shale, and Dakota Sandstone, show an overall increasing salinity but decreasing proportions of calcium and magnesium and increasing proportions of sodium, in the order listed. Also, the diagrams show decreasing proportions of carbonate and bicarbonate but increasing proportions of chloride and nitrate (predominantly chloride). Thus it may be seen that, whereas water in the glacial drift other than outwash deposits would be of questionable suitability for irrigation because of the high sodium and salinity hazard, water in the Pierre Shale and Dakota Sandstone is definitely unsuitable. On the other hand, water in the Pierre Shale is generally softer than water in the glacial drift other than outwash deposits. Water in the Dakota Sandstone is soft but contains excessive amounts of dissolved solids, which limit its use for most purposes.

SUMMARY AND CONCLUSIONS

The city of Devils Lake, N. Dak., almost since its beginning has been plagued with water-supply problems. Only small quantities of potable ground water are available in the immediate vicinity of the city. Surface waters in the area are either not potable or not perennial, or both; most sources were dry or nearly dry during the drought years of the 1930's. Consequently, a study was made of the ground-water resources in an area of about 920 square miles surrounding the city.

The entire area is a part of the Drift Prairie physiographic division. The major part of the area is in the Devils Lake interior drainage basin; the principal features are two chains of lakes, end moraine and belts of ground moraine, and outwash plains, all of which trend east-southeast.

The surficial deposits consist of glacial drift and post-glacial lake sediments and thin, patchy deposits of alluvium and slopewash. These deposits are everywhere underlain, so far as is known, by the Pierre Shale of Late Cretaceous age. The Pierre Shale, in turn, is underlain by successively older sedimentary rocks consisting mainly of shale, sandstone, and limestone to a total depth of about 3,000 to 3,500 feet. The oldest sedimentary rocks rest on Precambrian granite.

The glacial drift contains the major aquifers (ground-water reservoirs). The aquifers consist mainly of sand and gravel deposits ranging in areal extent from a few acres to many square miles and, in thickness, from a few feet to more than a hundred. Test drilling showed that the most productive aquifers occur in the glacial outwash deposits in the southern part of the area, flanking the south edge of the North Viking moraine and extending southward to the Sheyenne River. The outwash deposits are separated into three main units by intervening deposits of end moraine. From west to east the units are named the Oberon, Tokio, and Warwick outwash deposits. Within the study area the outwash deposits have areas of about 30, 45, and 85 square miles, respectively. On the basis of rather scanty subsurface data, their average thicknesses are computed to be 24, 34, and 94 feet, respectively.

The most productive aquifers in the area of study occur in the Warwick outwash plain. On the basis of the test drilling part of this ground-water study, the city of Devils Lake in 1951-52 completed two test wells with a view to developing a well field in the area for a municipal supply. Pumping tests in these wells showed that the aquifer could yield water at substantial rates, and quality-of-water tests showed that the water was of relatively good chemical quality. In 1961-62, the city completed four municipal supply wells having yields of 350 to 700 gpm each and constructed a 20-mile pipeline through which the water is transmitted to the city.

Because of the great areal extent and thickness of the Warwick outwash deposits and the large amount of water stored in them, the present water-supply development by the city of Devils Lake may be expected to last a long time. However, so long as some of the water being pumped is derived from storage in the outwash deposits, water levels will decline. In order for the present development to be considered permanent, there must be diversion of water from natural discharge in an amount equivalent to the amount pumped. Natural discharge by evaporation from lakes in the area, by evapotranspiration from swampy areas, and by percolation to the Sheyenne River valley can be affected by the production for the Devils Lake supply, and part of this natural discharge can be diverted to the pumped wells. How effective the present development will be in reducing the natural discharge in order to balance the withdrawal by wells is not yet (1964) known; therefore, it is suggested that water-level records be obtained at the supply wells and at observation wells both within and outside of the well field on a continuing basis and the detailed records of well production be maintained. These records will supply a basis for expanding or otherwise modifying the present development.

The Oberon and Tokio outwash deposits, because of their smaller areal extent and lesser thickness, do not have as much potential for ground-water development as the Warwick outwash deposits. However, small to moderate yields are obtainable in many places in the deposits of the Oberon and Tokio outwash plains.

Sand and gravel deposits of considerable thickness and probably having good ground-water potential were penetrated in a number of test holes drilled in other parts of the study area. The thickest sand and gravel deposits seem to be in bedrock channels underlying the Devils Lake chain of lakes. Little is known concerning the water-bearing properties of these deposits because they are tapped by only a few wells. Probably the Grahams Island aquifer at the location of test hole 41 would be capable of yielding several hundred to a thousand gallons per minute. Aquifers of varying importance were also penetrated by test drilling in the Six Mile-Creel Bays, Camp Grafton, and Sweetwater Lake areas.

The Pierre Shale, which underlies the glacial drift throughout the area, is generally water bearing in its upper part and yields 5 to 10 gpm to individual wells. Of the rocks beneath the Pierre Shale, the Dakota Sandstone, at depths between 1,385 and 1,500 feet beneath the city of Devils Lake, probably has the most significance as an aquifer. The water in the Dakota Sandstone was under sufficient pressure to flow at land surface at rates of 100 to 150 gpm in 1952. The wells were pumped at rates of 200 to 300 gpm to supply part of the municipal needs of Devils Lake prior to 1962. The water is of poor chemical quality, and use of the wells was discontinued when the supply from the Warwick outwash plain became available.

The primary source of recharge to ground water in the Devils Lake area is precipitation. The largest amounts of recharge usually occur during the spring and early summer. Aquifers in the outwash deposits are readily recharged because of their relatively shallow occurrence and sandy soils, which allow absorption of rain and snowmelt. Aquifers in the till are recharged slowly because they are generally covered with differing thicknesses of till or other fine-grained deposits. Aquifers in the Pierre Shale and deeper bedrock formations probably are recharged at even slower rates.

Ground water in the outwash deposits is discharged naturally by evaporation from the numerous lakes and ponds, by evapotranspiration in areas of high water table, and by springs along the north edge of the Sheyenne River valley. In addition to the natural discharge, about 1,000,000 gpd is withdrawn by wells supplying the city of Devils Lake. It is expected that the natural discharge will diminish as the effects of pumping expand in the aquifers of the Warwick outwash plain.

Chemical analyses of samples from 58 wells, test holes, and springs indicate that water in the outwash deposits is of the best quality available in the area. It is mainly a calcium bicarbonate type having a relatively small amount of total mineralization, and is of good quality for most uses, particularly irrigation, although it probably should be softened for municipal and some industrial uses. Water in the glacial-drift aquifers other than outwash, in the Pierre Shale, and in the Dakota Sandstone is generally of progressively poorer quality. It has increasing salinity and sodium but decreasing calcium and magnesium, in the order listed. Water in the glacial drift other than outwash would be of questionable suitability for irrigation, and water in the Pierre Shale and Dakota Sandstone is definitely unsuitable. On the other hand, water in the Pierre Shale is generally softer than water in the glacial drift other than outwash. Water in the Dakota Sandstone is soft but contains excessive amounts of dissolved solids and has very limited usefulness.

TABLE 1.--Logs of wells and test holes*

150-63-1bcc
Test hole 333

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Sand, medium, light-brown	9	10
	Sand, medium	5	15
	Sand, medium, and gravel, fine to medium, larger material detrital shale	5	20
	Gravel, fine to coarse, mainly detrital shale, and some sand, some detrital lignite	10	30
	Gravel, fine, and sand	5	35
	Sand, medium, and gravel, fine to coarse, mainly detrital shale	10	45
	Gravel, fine to medium, about two-thirds detrital shale, and about one-third limestone-dolomite, and sand	15	60
	Gravel, fine to medium, and sand, gray, clayey; material is increasingly clayey toward bottom, may be sand and gravel reworked as till	22	82
Pierre Shale:			
	Shale, gray	18	100

150-63-10dda
Test hole 332

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Sand, light-brown, medium, gravelly	24	25
	Sand, medium to very coarse, and gravel, fine to medium, mainly detrital shale, some lignite	45	70
	Gravel, fine, mainly detrital shale, and sand, medium to very coarse	20	90
Pierre Shale:			
	Shale, gray	10	100

*Note: The term "till" used in many of these logs refers to a heterogeneous mixture of clay, silt, sand, gravel, and boulders. Generally clay and silt are the predominant constituents.

TABLE 1.--Logs of wells and test holes -- Continued

150-64-5aaa
Test hole 339

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Sand, fine to very coarse, and some gravel, fine to medium, coarser material detrital shale, clayey and silty	8	10
	Sand, medium to very coarse, and gravel, fine to coarse, gravel content and coarseness increase toward bottom, coarser material detrital shale	18	28
	Till, gray	34	62
	Gravel, fine, and sand, very coarse, gray, clayey	8	70
	Gravel, coarse, contains no detrital shale	7	77
	Till, gray	20	97
Pierre Shale:			
	Shale, gray	13	110

151-62-3add
Test hole 337

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown, silt and clay, sandy and gravelly	27	28
	Silt and clay, light-brown	9	37
	Silt and clay, gray	22	59
	Sand, coarse, and gravel, fine, gray, clayey	6	65
	Till, gray	33	98
Pierre Shale:			
	Shale, gray	42	140

TABLE 1.--Logs of wells and test holes -- Continued

151-62-16cbc
Test hole 336

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Sand and gravel, light-brown, fine to medium, mainly detrital shale	14	15
	Gravel, medium to coarse, and sand; gravel mainly detrital shale	16	31
	Till, gray	12	43
Pierre Shale:			
	Shale, gray	7	50

151-62-20ccb
Test hole 335

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Sand, medium to very coarse, coarser material mainly detrital shale	8	10
	Sand, medium to very coarse, and gravel, fine to medium, coarser sand and gravel mainly detrital shale	20	30
	Gravel, fine to medium, and sand, medium to very coarse, coarser sand and gravel mainly detrital shale; material coarser toward bottom	40	70
	Gravel, fine to coarse, and sand, coarse to very coarse, material mainly detrital shale	46	116
Pierre Shale:			
	Shale, gray	9	125

TABLE 1.--Logs of wells and test holes -- Continued

151-62-33cad
E. W. Kjorlein test 2
(driller's log)

Formation	Material	Thickness (feet)	Depth (feet)
	Fine and medium sand	10	10
	Mostly coarse sand, some fine gravel	15	25
	Fine and medium sand	5	30
	Gravel and coarse sand	5	35
	Coarse shale gravel and coarse sand	5	40
	Fine and medium sand	15	55
	Fine gravel and coarse sand	10	65
	Fine and medium gravel and coarse sand	8	73
	Clay	3	76
	Fine and medium gravel and coarse sand	3	79
	Clay	21	100

151-63-10ccc3
Test hole 415

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, light-brown, sandy	2	2
	Sand, light-brown, very fine to fine, very clayey	1	3
	Sand, medium to very coarse, and gravel, fine to medium, coarser material mainly detrital shale	6	9
	Gravel, fine to coarse, and some very coarse sand; material coarser toward bottom; mainly detrital shale	11	20
	Till, gray	54	74
	Silt and clay, gray, sandy and gravelly	23	97
	Sand, very fine to very coarse, and gravel, fine to medium, gray, coarser material mainly detrital shale, very clayey	50	147
Pierre Shale:			
	Shale, gray	13	160

151-63-14aaa3
Test hole 338

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Sand, coarse to very coarse, and gravel, fine to coarse light-grayish-brown, coarser material about two-thirds detrital shale, clayey	11	12
	Sand, light-brown, medium	14	26
	Sand, medium to very coarse, coarser material detrital shale	12	38
	Sand, coarse to very coarse, and gravel, fine, gray, mainly detrital shale, clayey	10	48
	Till, gray, sandy and gravelly	49	97
Pierre Shale:			
	Shale, gray	3	100

151-63-16daa
Test hole 416

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, light-brown, sandy	1	1
	Sand and gravel, brown, fine to medium, mainly detrital shale	8	9
	Sand, medium to very coarse, and gravel, fine to coarse; coarser material mainly detrital shale	11	20
	Till, gray	59	79
Pierre Shale:			
	Shale, gray	6	85

TABLE 1.--Logs of wells and test holes -- Continued

151-63-16ddd
Test hole 414

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy	2	2
	Silt and clay, gray, sandy	1	3
	Sand, medium	19	22
	Gravel, fine to medium, mainly detrital shale, sandy	10	32
	Sand, coarse, and gravel, fine, gray, mainly detrital shale, clayey	5	37
	Till, gray	34	71
	Gravel, fine to medium, and sand, very coarse, mainly detrital shale, clayey	11	82
	Till, gray	8	90
	Gravel, fine to medium, and sand, very coarse, gray, about two-thirds detrital shale, clayey	5	95
Pierre Shale:			
	Shale, gray	5	100

151-63-19aba
Test hole 406

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay and silt, brown, sandy	2	3
	Sand, medium to very coarse, and gravel, brown, mainly detrital shale	14	17
	Sand, fine to coarse, and gravel, gray, mainly detrital shale, clayey; upper part may be till	9	26
Pierre Shale:			
	Shale, gray	14	40

TABLE L.--Logs of wells and test holes -- Continued

151-63-20bcb
Test hole 407

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Sand and gravel, gray, clayey	3	4
	Sand, fine to very coarse, and gravel, fine to medium, gray-brown, clayey and silty	11	15
	Sand, fine to very coarse, and gravel, fine, gray, mainly detrital shale, some detrital lignite, fairly clean	5	20
	Sand, gray, fine to very coarse, clean	10	30
	Sand, gray, fine, some detrital shale and lignite, clayey	10	40
	Silt and sand, very fine to fine, gray, some detrital shale and lignite, clayey	15	55
	Sand, gray, very fine to medium, some detrital shale and lignite, fairly clean	40	95
	Thin beds of clay, silt, sand, fine to very coarse, and some gravel, fine, gray, some detrital shale and lignite	21	116
	Gravel, gray, fine to medium, about two-thirds detrital shale, clean	11	127
	Gravel, gray, medium to coarse, mainly detrital shale, cleaner towards bottom	18	145
Pierre Shale:			
	Shale, gray	5	150

TABLE 1.--Logs of wells and test holes -- Continued

151-63-20bcd
Test hole 408

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay and silt, brown, sandy	1	2
	Sand and gravel, gray, mainly detrital shale	2	4
	Sand, fine to very coarse, and gravel, fine, brown	5	9
	Sand, medium to very coarse, and gravel, fine to medium, brown, coarser material mainly detrital shale	6	15
	Sand, gray, fine to medium, some detrital lignite	5	20
	Sand, gray, fine to medium, seom detrital lignite, fairly clean though clayey toward bottom	50	70
	Sand, fine to medium, and gravel, gray, medium, about two-thirds detrital shale, some detrital lignite; more clayey toward bottom; lower part may include some till	37	107
Pierre Shale:			
	Shale, gray	13	120

TABLE 1.--Logs of wells and test holes -- Continued

151-63-20cac
Test hole 409

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black------------------------------	1	1
	Sand and gravel, brown, clayey and silty----	2	3
	Sand, medium to very coarse, and gravel, fine, brown, about one-third of coarser material detrital shale----------------------------	7	10
	Sand, brown, very fine to medium; clean-----	10	20
	Gravel, coarse, and sand, medium to very coarse, brown, coarser material detrital shale, clayey----------------------------	5	25
	Sand, medium, and some gravel, fine to medium, gray, coarser material detrital shale, some detrital lignite--------------------	10	35
	Thin beds of sand, clay, silt and detrital shale, gravel, gray----------------------	5	40
	Sand, gray, fine to medium, fairly clean----	30	70
	Interbedded sand, fine, silt and clay, gray-	51	121
	Sand, very coarse, and gravel, fine, gray, mainly detrital shale, clayey toward bottom	12	133
Pierre Shale:			
	Shale, gray---------------------------------	12	145

TABLE 1.--Logs of wells and test holes -- Continued

151-63-20cda
Test hole 422

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, brown, sandy----------------------	1	1
	Gravel, fine to coarse, and sand, medium to very coarse; coarser material mainly detrital shale--------------------------	9	10
	Gravel, medium to coarse, mainly detrital shale-------------------------------------	5	15
	Sand, fine to very coarse, gravelly, coarser material mainly detrital shale-----------	20	35
	Sand, fine to medium, gravelly-------------	35	70
	Sand, gray, fine to very coarse, gravelly and clayey; coarser material detrital shale	10	80
	Sand, gray, very fine to very coarse, silty and clayey, coarser material mainly detrital shale; gravelly interval from 70 to 118 feet probably includes several thin beds of silt and clay----------------------------	38	118
	Gravel, fine to medium, mainly detrital shale	9	127
	Gravel, fine to medium, and some sand, very coarse gray, clayey---------------------	3	130
	Gravel, fine, and sand, very coarse, gray, about one-half detrital shale, clayey-----	11	141
	Till, gray, very sandy and gravelly---------	9	150
	Sand, very coarse, and gravel, fine, gray; clayey or till, very sandy and gravelly---	38	188
Pierre Shale:			
	Shale, gray--------------------------------	7	195

TABLE 1.--Logs of wells and test holes -- Continued

151-63-20cdd1
Test hole 423

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy	1	1
	Sand, very fine to very coarse, and gravel, medium, light-brown, very clayey	2	3
	Sand, fine to very coarse, and gravel, fine to medium, coarser material mainly detrital shale	22	25
	Sand, fine to medium	50	75
	Interbedded sand, very fine to medium, gravel, fine to coarse, silt and clay	20	95
	Clay and silt, gray	22	117
	Gravel, fine to coarse, about two-thirds detrital shale and one-third limestone and dolomite, and some sand, very coarse	17	134
	Sand, very fine to very coarse, and gravel, fine, gray, coarser material mainly detrital shale, silty and clayey	16	150
	Sand, coarse to very coarse and gravel, fine, gray, coarser material is mainly detrital shale, clayey, less clayey towards bottom	27	177
	Sand, very fine to very coarse, and some gravel, fine, gray, coarser material mainly detrital shale, silty and clayey	9	186
Pierre Shale:			
	Shale, gray	4	190

TABLE 1.--Logs of wells and test holes -- Continued

151-63-20cdd2
Test hole 454

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black------------------------------	1	1
	Sand, fine to very coarse, and gravel, fine to medium, light-brown-------------------	6	7
	Gravel, fine to coarse, and some sand, fine to very coarse, light-brown, coarser material detrital shale------------------	13	20
	Gravel, fine to medium, mainly detrital shale, sandy------------------------------	10	30
	Sand, medium to very coarse, and gravel, fine; coarser material mainly detrital shale----	10	40
	Sand, medium to coarse, considerable detrital lignite toward bottom-------------------	76	116
	Gravel, fine to coarse, mainly detrital shale, sandy------------------------------	9	125

151-63-20cdd3
Test hole 455

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black------------------------------	1	1
	Sand, medium to very coarse, gravelly-------	19	20
	Gravel, fine to medium, and some sand, very coarse, gray, clayey and silty------------	10	30
	Interbedded sand, fine to very coarse, and clay, silt, and some gravel, fine, gray---	10	40
	Sand, gray, fine to medium------------------	25	65
	Interbedded sand, fine, silty, clay and some gravel, fine to medium-------------------	30	95
	Sand, gray, fine to coarse------------------	21	116
	Gravel, fine to coarse, and sand, medium to very coarse, material about two-thirds detrital shale, finer with higher shale content toward bottom-------------------	9	125

151-63-20cdd4
Test hole 456

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Sand, light-brown, gravelly and clayey	3	4
	Sand, light-brown, medium to very coarse, gravelly	4	8
	Sand, medium to very coarse, and gravel, fine to medium; coarser material mainly detrital shale	12	20
	Sand, medium to coarse, gravelly	45	65
	Interbedded silty, clay, sand, very fine to fine, and gravel, fine to medium, gray; coarser material largely detrital shale	5	70
	Sand, medium to coarse, gravelly; gravel content higher toward bottom	45	115
	Clay and silt, and sand, very fine to fine	5	120
	Gravel, fine to coarse, and some sand, medium to very coarse; material about two-thirds detrital shale, about one-third limestone and dolomite, coarser toward bottom	20	140

151-63-20cdd5
Test hole 486

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, brown, sandy	1	1
	Sand, medium to very coarse, gravelly	19	20
	Sand, very fine to medium, silty and gravelly	70	90
	Sand, medium to very coarse, and some gravel, fine, gray, mainly detrital shale, clayey, more clayey toward bottom	44	134
	Sand, very coarse, and gravel, fine, some boulders	5	139
Pierre Shale:			
	Shale, gray	11	150

TABLE 1.--Logs of wells and test holes -- Continued

151-63-20cdd6
Test hole 501

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy	1	1
	Sand, fine to very coarse, and some gravel, fine, gray	29	30
	Sand, medium to very coarse, and gravel, fine, gray	10	40
	Sand, gray, fine to medium, gravelly	10	50
	Sand, very fine to coarse, and some gravel, fine to medium, gray, silty	10	60
	Sand, gray, very fine to coarse, silty and gravelly	40	100
	Sand, medium to very coarse, and gravel, fine, gray, silty and clayey; may include some thin layers of clay and silt	24	124
	Sand, very coarse, and gravel, fine to medium, gray, about two-thirds detrital shale	16	140
	Sand, very coarse, and gravel, fine, gray, mainly detrital shale, clayey; more clayey toward bottom; lower part may be till	38	178
Pierre Shale:			
	Shale, gray	8	186

TABLE 1.--Logs of wells and test holes -- Continued

151-63-20cdd7
Test hole 502

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, brown, sandy	1	1
	Sand, medium to very coarse, and gravel, fine to medium, mainly detrital shale	21	22
	Sand, medium to very coarse, gravelly, coarser material mainly detrital shale	12	34
	Gravel, fine to coarse, and sand, medium to very coarse, mainly detrital shale	14	48
	Sand, medium to coarse, gravelly, coarser material mainly detrital shale	52	100
	Sand, very fine to very coarse, and gravel, fine to medium, gray, coarser material mainly detrital shale, clayey	20	120
	Gravel, fine to coarse, about one-half detrital shale, clean	9	129
	Sand, very coarse, and gravel, fine, gray, clayey, many cobbles and boulders; may include some till	44	173
	Till, gray, sandy and gravelly	10	183
Pierre Shale:			
	Shale, gray	5	188

151-63-20cdd8
Test hole 503
(driller's log)

Note: The site of this test hole is a few feet from the site of test hole 502. No samples were collected.

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, brown, sandy	1	1
	Sand, fine to coarse, and gravel; gravel largely detrital shale	39	40

151-63-20cdd9
Test hole 504

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, brown, sandy	1	1
	Sand, brown, fine to medium, gravelly	27	28
	Sand, medium to coarse, and gravel, fine, coarser material mainly detrital shale	38	66
	Sand, medium to coarse, and gravel, medium, coarser material mainly detrital shale	10	76
	Sand, medium to coarse, gray, gravelly and clayey	14	90
	Sand, medium to very coarse, and gravel, fine, coarser material mainly detrital shale	8	98
	Sand, medium to very coarse, and gravel, fine, gray, coarser material mainly detrital shale, clayey	20	118
	Gravel, medium to coarse, about one-half detrital shale, sandy	13	131
	Sand and gravel, gray, coarser material mainly detrital shale, poorly sorted, very clayey	41	172
	Till, gray, sandy and gravelly	6	178
Pierre Shale:			
	Shale, gray	11	189

151-63-20cdd10
Test hole 505
(driller's log)

Note: The site of this test hole is a few feet from the site of test hole 504. No samples were collected.

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, brown, sandy	1	1
	Sand, fine to medium	39	40

TABLE .--Logs of wells and test holes -- Continued

151-63-20cdd11
Devils Lake city test well 1
(driller's log)

Material	Thickness (feet)	Depth (feet)
Topsoil	2	2
Yellow sand (upper part dry)	54	56
Muddy gray sand, some sand loose at 85 feet	54	110
Very clayey sand	6	116
Slightly cleaner sand	6	122
Good sand and gravel	2	124
Very muddy sand and gravel	2	126
Cleaner sand and gravel but with chunks of clay, drilled open hole	3	129
As above except siltier	6	135

Samples were available for the lower part of the test well; descriptions and depths at which samples were taken are given below:

Material	Depth (feet)
Sand, gray, very fine to fine	118
Sand, coarse to very coarse, and gravel, fine to coarse, gray, mainly detrital shale	122
Sand, fine to very coarse, and gravel, fine to medium, gray, clayey	123
Sand, very fine to fine, and very coarse, and gravel, fine to coarse, gray	125 & 126
Sand, very fine to very coarse, and gravel, fine to medium, gray, coarser material mainly detrital shale	126 & 129
Sand, very fine to very coarse, and some gravel, fine to medium, gray, coarser material mainly detrital shale	131 & 135
Sand, gray, very fine to medium	134 & 136

TABLE .--Logs of wells and test holes -- Continued

151-63-20cdd12
Devils Lake city test well 2
(driller's log)

Material	Thickness (feet)	Depth (feet)
Topsoil	1	1
Brown sand and gravel with clay	2	3
Brown sand with a little clay	35	38
Fine gray sand	19	57
Slightly coarser gray sand with some gravel	20	77
Fine gray sand with clay	25	102
Very clayey fine sand	8	110
Medium fine shale sand	6	116
Soft gray clay	3	119
Fine gray sand, slightly clayey with some coarser sand and gravel	5	124
Coarse sand	1	125
Fine and coarse sand, gravel and stones	8	133
Coarse gravel and sand, stones and a few chunks of clay	6	139
Fine sand, clayey, with small amount of coarser sand and gravel	8	147
Very clayey sand and gravel	3	150
Soft gray gravelly clay	5	155

Samples were available for the upper part of the test well; descriptions and depths at which samples were taken are given below:

Sand, fine to very coarse, and some gravel, fine, brown; coarser material mainly detrital shale, clayey	4
Sand, gray-brown, fine to very coarse, gravelly	10
Sand, brown, very fine to fine, gravelly	20
Sand, brown, medium	30
Sand, gray, very fine to fine	40
Sand, gray, fine to medium	50
Sand, gray, very fine to fine	60
Sand, gray, fine to coarse, gravelly	70
Sand, gray, fine to coarse	80 & 90

TABLE .--Logs of wells and test holes -- Continued

151-63-20dcc
Test hole 404

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy and gravelly--------	1	1
	Sand, brown, medium to coarse, gravelly, fairly clean--------------------------	14	15
	Sand, brown, fine to medium, gravelly-----	10	25
	Sand, gray, fine to medium gravelly-------	6	31
	Clay and silt, gray, sandy----------------	11	42
	Sand, white to gray, fine to medium-------	13	55
	Sand, gray, fine to coarse, fairly clean; coarser material detrital shale; some detrital shale gravel toward bottom-----	25	80
	Sand, medium to very coarse, and gravel, fine, gray, mainly detrital shale, some detrital lignite, clayey----------------	17	97
	Clay and silt, gray, sandy----------------	10	107
	Sand, gray, very coarse, and gravel, fine, gray, mainly detrital shale, clayey-----	3	110
	Gravel, gray, fine to coarse, about one-half detrital shale, fairly clean-------	26	136
	Sand, medium to very coarse, and gravel, gray, fine; coarser material mainly detrital shale, clayey-------------------------	13	149
	Sand, gray, fine to very coarse; coarser material mainly detrital shale----------	27	176
	Sand, gray, very fine to fine, clayey and silty----------------------------------	11	187
Pierre Shale:			
	Shale, gray------------------------------	7	194

TABLE .--Logs of wells and test holes -- Continued

151-63-21daa
Test hole 417

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy	1	1
	Sand, light-brown, fine to medium, very clayey	1	2
	Sand, very fine to very coarse, and gravel, fine to coarse, light-brown, clayey	2	4
	Sand, medium to very coarse, and gravel, fine to medium, coarser material mainly detrital shale	15	19
	Gravel, fine to coarse, and sand, medium to very coarse, coarser material mainly detrital shale	11	30
	Sand, medium to very coarse, gravelly, coarser material mainly detrital shale	15	45
	Sand, medium to very coarse, and gravel, fine, coarser material mainly detrital shale	7	52
	Gravel, medium to coarse, mainly detrital shale, sandy	16	68
	Gravel, fine, and sand, very coarse, gray, mainly detrital shale, clayey	19	87
Pierre Shale:			
	Shale, gray	8	95

151-63-25dd
E. W. Kjorlein test 3
(driller's log)

Material	Thickness (feet)	Depth (feet)
Sandy soil	5	5
Fine sand	10	15
Clay and sand	5	20
Clay	18	38
Fine sand	2	40
Coarse sand and some fine	2	42
Shale	42	84

TABLE .--Logs of wells and test holes -- Continued

151-63-28aaa
Test hole 418

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, brown, sandy--------------------	1	1
	Sand, gray, very fine to medium, very clayey----------------------------------	2	3
	Sand, fine to medium---------------------	45	48
	Clay and silt, gray----------------------	4	52
	Sand, very fine to fine------------------	13	65
	Sand, fine to medium, and gravel, fine, mainly detrital shale------------------	5	70
	Sand, fine to medium---------------------	10	80
	Clay, silt, and sand, very fine, gray, gravelly--------------------------------	43	123
	Sand, gray, very fine to very coarse, clayey and silty, coarser material detrital shale	13	136
	Sand, very coarse, and gravel, fine, gray, mainly detrital shale, clayey-----------	6	142
	Till, gray-------------------------------	58	200

151-63-28ccb
Test hole 412

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy--------------------	1	1
	Sand, light-brown, very fine to fine, very clayey----------------------------------	2	3
	Sand, light-brown, fine to medium---------	12	15
	Sand, medium to coarse, gravelly----------	27	42
	Sand, medium to very coarse, and gravel, fine, very clayey, gray, coarser material mainly detrital shale, clayier toward bottom----------------------------------	11	53
	Till, gray-------------------------------	30	83
Pierre Shale:			
	Shale, gray------------------------------	7	90

TABLE .--Logs of wells and test holes -- Continued

151-63-28add
Devils Lake city test 3

Formation	Material	Thickness (feet)	Depth (feet)
	Sand, very fine to medium, silty and clayey, light-brown----------------------------	12	12
	Sand, very fine to fine, silty and clayey, occasional gravel and grains of medium to very coarse sand, gray--------------	23	35
	Sand, very fine, gray--------------------	29	64
	Till, gray-------------------------------	11	75
	Shale, gray------------------------------	3	78

151-63-28ccd
Test hole 410

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, peaty--------------------	1	1
	Clay and silt, brown, sandy and gravelly--	2	3
	Sand, brown, medium to coarse, some of coarser material detrital shale, clean--	23	26
	Sand, very coarse, and gravel, fine, gray, about two-thirds detrital shale, about one-third dolomite-limestone, clayey toward bottom-------------------------	14	40
	Till, gray, very sandy and gravelly-------	30	70
	Till, gray-------------------------------	124	194
Pierre Shale:			
	Shale, gray------------------------------	6	200

TABLE .--Logs of wells and test holes -- Continued

151-63-29aac1
Test hole 411

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy--------------------	1	1
	Sand and gravel, brown, mainly detrital shale, weathered, clayey---------------	2	3
	Sand, medium to very coarse, and gravel, fine to medium, gray-brown, coarser material detrital shale, some detrital lignite, slightly clayey------------------------	47	50
	Sand, gray, medium to coarse, slightly clayey----------------------------------	13	63
	Gravel, gray, medium to coarse, clean-----	14	77
	Clay and silt, gray----------------------	4	81
	Gravel, gray, fine to medium, mainly detrital shale------------------------	13	94
	Thin beds of gravel, sand, clay and silt, gray------------------------------------	38	132
	Gravel, gray, fine to medium, mainly detrital shale, slightly clayey---------	8	140
	Sand, very coarse, and gravel, fine, gray, mainly detrital shale, clayey; some boulders and cobbles of dolomite-limestone	58	198
	Cobbles and boulders, limestone-dolomite, and gravel, fine, mainly detrital shale-	5	203
Pierre Shale:			
	Shale, gray-----------------------------	7	210

151-63-29aac2
Test hole 424

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, brown, sandy---------------------	1	1
	Sand, light-brown, fine to coarse, clayey--	2	3
	Sand, gray, medium to very coarse and gravel, fine, coarser material mainly detrital shale--------------------------	12	15
	Sand, medium to very coarse, gravelly, coarser material mainly detrital shale---	50	65
	Gravel, fine to medium, and some sand, very coarse; material is mainly detrital shale	15	80

TABLE .--Logs of wells and test holes -- Continued

151-63-29abb
Test hole 419

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy	1	1
	Sand, light-brown, very fine to coarse, clayey	2	3
	Sand, light-brown, medium to coarse	22	25
	Sand, very fine to fine	5	30
	Sand, very fine to medium	5	35
	Sand, medium to coarse	30	65
	Sand, medium to very coarse, gravelly	5	70
	Gravel, fine to medium, and sand, medium to very coarse, coarser material mainly detrital shale	25	95
	Sand, medium to very coarse	10	105
	Sand, gray, very fine to fine, silty	15	120
	Sand, very fine to very coarse, and some gravel, fine to medium, gray, coarser material mainly detrital shale, clayey	3	123
	Gravel, fine to medium, and some sand; coarser material mainly detrital shale	9	132
Pierre Shale:			
	Shale, gray	8	140

TABLE .--Logs of wells and test holes -- Continued

151-63-29baa1
Test hole 420

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy	1	1
	Sand, light-brown, clayey	2	3
	Sand, medium to very coarse, and some gravel, fine to medium, mainly detrital shale	7	10
	Sand, medium to very coarse	10	20
	Sand, gray, very fine to medium, silty, clayey and gravelly	10	30
	Gravel, fine to coarse, and some sand, gray, coarser material mainly detrital shale	10	40
	Sand, gray, very fine to medium, clayey and gravelly	20	60
	Sand, very fine to very coarse, and gravel, fine to medium; coarser material mainly detrital shale	10	70
	Gravel, fine, and sand, very coarse, gray, silty and clayey, probably includes thin beds of clay and silt	10	80
	Sand, very fine to very coarse, and some gravel, fine; coarser material mainly detrital shale	20	100
	Sand, very coarse, and gravel, fine, gray, clayey and silty, probably includes thin beds of clay and silt	18	118
	Clay, silt, sand, and gravel, probably interbedded	34	152
	Gravel, fine, and sand, very coarse, gray, clayey	29	181
Pierre Shale:			
	Shale, gray	9	190

TABLE .--Logs of wells and test holes -- Continued

151-63-29baa2
Test hole 487

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, brown, sandy----------------------	1	1
	Sand, medium to very coarse, brown, gravelly	13	14
	Sand, fine to medium, brown, gravelly------	6	20
	Sand, very fine to medium, gray, clayey towards bottom---------------------------	65	85
	Sand, very fine to medium, gray, very clayey and gravelly----------------------------	15	100
	Sand, very fine to very coarse, gray, clayey	16	116
	Sand, very fine to very coarse, and gravel, fine, gray, clayey, coarser material about one-half detrital shale-----------------	12	128
	Sand, very fine to very coarse, and gravel, fine, gray, coarser material about one-half detrital shale, clayey, more clayey toward bottom--------------------------	22	150

TABLE .--Logs of wells and test holes -- Continued

151-63-29daa
Test hole 405

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay and silt, brown, sandy	2	3
	Sand, brown, fine to medium, clean	18	21
	Sand, brown, fine to medium, clayey and gravelly	18	39
	Sand, gray, mostly fine, some medium and coarse, slightly clayey	7	46
	Sand, gray, fine to very coarse, coarser material mainly detrital shale	4	50
	Sand, fine to very coarse, and gravel, gray, fine, mainly detrital shale	8	58
	Gravel, gray, fine to medium, mainly detrital shale, sandy	13	71
	Dolomite(?) boulder	1	72
	Gravel, gray, mainly detrital shale and probably some thin beds of sand and clay	5	77
	Sand, very coarse, and gravel, gray, fine to medium, gray, mainly detrital shale, clayey	7	84
	Sand and gravel, gray, clayey; may include some thin beds of clay	6	90
	Sand, very coarse, and gravel, fine, gray, mainly detrital shale	37	127
Pierre Shale:			
	Shale, gray	13	140

151-63-33dbb
Test hole 413

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy	3	3
	Sand, very fine to medium, and some gravel, gray-brown, mainly detrital shale	10	13
	Gravel, fine to coarse, and sand, medium to very coarse, coarser material mainly detrital shale	13	26
	Till, gray	53	79
	Gravel, fine, and sand, very coarse, gray; about one-third detrital shale, clayey	11	90
	Gravel, medium to coarse, about one-third detrital shale, sandy	6	96
	Till, gray	2	98
	Gravel, fine, and sand, very coarse, mainly detrital shale	3	101
	Till, gray, sandy and gravelly	5	106
Pierre Shale:			
	Shale, gray	4	110

151-63-36ada
Test hole 334

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Top soil, black	1	1
	Sand, medium, light-brown	9	10
	Gravel, fine to coarse, mainly detrital shale, and some sand	14	24
	Silt and clay, gray, sandy, and gravelly	18	42
	Sand, coarse to very coarse, and gravel, fine to medium, sand and gravel, mainly detrital shale	58	100
	Sand, coarse to very coarse, and gravel, fine, sand and gravel mainly detrital shale	31	131
Pierre Shale:			
	Shale, gray	9	140

TABLE .--Logs of wells and test holes -- Continued

151-64-18bbb1
Test hole 341

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Gravel, fine to coarse, and sand, coarse to very coarse, coarser material detrital shale	24	25
	Gravel, coarse, sandy, detrital shale	10	35
	Till, light-brown, sandy and gravelly	25	60
	Till, gray, sandy and gravelly	17	77
	Sand, gray, very fine to medium, clayey	23	100
	Till, gray	42	142
Pierre Shale:			
	Shale, gray	8	150

151-64-29bbb
Test hole 340

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Sand, medium to very coarse, and gravel, fine to coarse, light-brown, clayey, coarser material detrital shale	9	10
	Gravel, fine to coarse, and sand, coarse to very coarse, coarser material detrital shale	10	20
	Gravel, fine to coarse, and sand, coarse to very coarse, mainly detrital shale	20	40
	Sand, coarse to very coarse, and gravel, fine, mainly detrital shale	8	48
	Silt and clay, gray, sandy and gravelly, till	9	57
	Sand, medium to coarse, gravelly, some of coarser material detrital shale	19	76
	Sand, very coarse, and gravel, fine, about one-half detrital shale	5	81
	Till, gray, gravel content increases toward bottom	45	126
Pierre Shale:			
	Shale, gray	4	130

151-65-2aaa
Test hole 343

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, light-brown, sandy	1	1
	Gravel, fine to coarse, detrital shale, and sand	35	36
	Till, light-grayish-brown, sandy and gravelly	40	76
	Till, gray, sandy and gravelly	24	100
	Sand, very coarse, and gravel, fine, gray, mainly detrital shale, clayey	10	110
	Till, gray	13	123
Pierre Shale:			
	Shale, gray	7	130

151-65-2dcc
Test hole 342

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Sand, medium to very coarse, and gravel, fine to medium, coarser material detrital shale	8	10
	Gravel, fine to coarse, and sand, coarse to very coarse, mainly detrital shale	11	21
	Till, gray, sandy and gravelly	68	89
Pierre Shale:			
	Shale, gray	11	100

152-61-30bcb
Test hole 421

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	21	22
Pierre Shale:			
	Shale, very light brown	29	51
	Shale, gray	9	60

TABLE .--Logs of wells and test holes -- Continued

153-62-16cba1
Vernon Hilgers
(driller's log)

Material	Thickness (feet)	Depth (feet)
Topsoil	1	1
Yellow clay	22	23
Gravelly blue clay	25	48
Coarse dirty sand (heaves)	5	53
Gravelly blue clay and rocks	6	59
Coarse and fine sand (dirty)	5	64
Gravelly blue clay	26	90
Gray clay	10	100
Blue clay and rocks	20	120
Fine sand and gravel	5	125
Blue clay and rocks	17	142
Broken shale or shale gravel	1	143
Blue shale	7	150
Shale gravel	1	151

153-62-16cbb4
Community well (Crary)
(driller's log)

Material	Thickness (feet)	Depth (feet)
Clay, gravelly clay, muddy gravel, and some rocks	151	151
Dirty fine and coarse sand	10	161
Blue clay	4	165
Shale	10	175
Fine mushy sand (water, but sand heaves)	23	198
Sandy shale and shale	34	232
Shale gravel	1	233
No log	37	270

TABLE .--Logs of wells and test holes -- Continued

153-62-21bba
J. P. Davis
(driller's log)

Formation	Material	Thickness (feet)	Depth (feet)
	Topsoil	1	1
	Yellow clay	19	20
	Blue clay	20	40
	Hard gravelly blue clay with rocks	38	78
	Sand and gravel with clay	74	152
	Sand and gravel	7	159
	No log	5	164

153-64-3bdd
Bureau of Reclamation substation well
(driller's log)

Formation	Material	Thickness (feet)	Depth (feet)
	Brown clay and sand and medium gravel	4.2	4.2
	Silty brown sand and gravel	.6	4.8
	Brown clay and sand and medium gravel	7.7	12.5
	Silty brown gravel	2.1	14.6
	Sandy gray till	10.4	25
	Gray silty till	13	38
	Gray shale	10	48

153-64-7bbb
Test hole 194

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-gray	3	4
	Till, light-brown	25	29
	Till, gray	87	116
	Sand, gray, coarse, very clayey	14	130
	Sand, coarse, and gravel, gray, fine, very clayey	18	148
Pierre Shale:			
	Shale, gray	7	155

153-64-16aab
Great Northern test 3
(driller's log)

Material	Thickness (feet)	Depth (feet)
Hard clay and sand----------------------------	30	30
Blue clay-------------------------------------	40	70
Clay and sand---------------------------------	6	76
Dark shale (a little water at 82 feet)------	15	91
Blue shale------------------------------------	4	95
Hard sand (water)----------------------------	2	97
Blue shale------------------------------------	8	105
Shale---	15	120

153-64-16aac1
Great Northern test 2
(driller's log)

Blue clay-------------------------------------	45	45
Gray clay-------------------------------------	22	67
Quicksand-------------------------------------	12	79
Hard sand (water)----------------------------	1	80
Quicksand-------------------------------------	4	84
Sand with some gravel------------------------	9	93

(Pumped 60 gpm with 12 feet of drawdown. Static water level 29 feet from surface.)

153-64-16aac2
Great Northern test 1
(driller's log)

Blue clay-------------------------------------	15	15
Dark clay and sand---------------------------	8	23
Sand and gravel - some water----------------	1	24
Gray clay-------------------------------------	51	75
Sand and water. Unable to bail water down; water stands 35 feet from surface---------	3	78
Blue clay-------------------------------------	4	82
Quicksand-------------------------------------	12	94
Gravel (water)-------------------------------	8	102
Blue clay-------------------------------------	1	103

(Pumped at 65 gpm with 8 feet of drawdown. Static water level 29 feet from surface.)

TABLE .--Logs of wells and test holes -- Continued

153-64-16aac3
Great Northern test 4
(driller's log)

Material	Thickness (feet)	Depth (feet)
Clay and sand	20	20
Blue clay	60	80
Clay and sand	10	90
Quicksand	7	97
Gravel	4	101

153-64-16ccb
Great Northern test 6
(driller's log)

Material	Thickness (feet)	Depth (feet)
Clay and sand	13	13
Boulders	22	35
Clay and sand	25	60
Gravel and clay	20	80
Blue clay	10	90
Shale	5	95

(No water)

153-64-16ccc1
Great Northern test 5
(driller's log)

Material	Thickness (feet)	Depth (feet)
Clay and sand	20	20
Clay	33	53
Sand and a little water	14	67
Quicksand	23	90
Sand	7	97
Blue clay	3	100
Sand and clay	4	104
Shale	2	106

TABLE .--Logs of wells and test holes -- Continued

153-64-19dda1
Camp Grafton Military Reservation
(driller's log)

Material	Thickness (feet)	Depth (feet)
Topsoil	1	1
Yellow boulder clay, some gravel	49	50
Iron-stained clay, sand, some gravel	9	59
Sand, some water	3	62
Iron-stained sandy clay	6	68
Soft sandy clay, brown to dark brown	20	88
Blue shale getting hard with depth. (Note: This may be drift composed principally of shale fragments)	50	138
Some gravel layers	6	144
Good sand	6	150

153-64-19dda2
Camp Grafton Military Reservation
(driller's log)

Material	Thickness (feet)	Depth (feet)
Topsoil	1	1
Yellow clay, some gravel	61	62
Blue shale (glacial drift)	75	137
Sand and some gravel; sand getting coarser with depth	32	169

153-64-19dda3
Camp Grafton Military Reservation
(driller's log)

Material	Thickness (feet)	Depth (feet)
Hard gumbo	15	15
Sand and clay	5	20
Boulders	10	30
Gravel and clay	35	65
Blue clay	30	95
Shale	35	130
Blue shale	5	135
Sand	2	137
Sand and gravel	7	144
Gravel	11	155

(Pumped 45 gpm with 62 feet of drawdown; static water level 63 feet below surface.)

TABLE .--Logs of wells and test holes -- Continued

153-64-19bbc
Great Northern test 8
(driller's log)

Formation	Material	Thickness (feet)	Depth (feet)
	Clay and boulders	20	20
	Clay and gravel	20	40
	Clay	10	50
	Sand and a little water	15	65
	Blue clay	35	100
	Clay and gravel	15	115
	Sand and clay a little water	25	140
	Clay with sand and gravel, some water	8	148
	Shale	4	152
	Clay and sand	30	182
	Shale	3	185

153-64-21bab2
Test hole 402

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, brown, stony	1	1
	Till, gray, sandy and gravelly	4	5
	Till, brown, sandy and gravelly	3	8
	Sand, brown, fine to medium, clayey and gravelly	6	14
	Till, brown	3	17
	Sand and gravel, brown	2	19
	Till, brown	2	21
	Till, gray	7	28
	Sand, gray, some detrital lignite	4	32
	Till, gray	4	36
	Clay and silt, gray	38	74
	Sand, gray, very fine to fine, silty and clayey	6	80
	Sand, gray, medium to coarse, gravelly	20	100
	Sand, medium to very coarse, and gravel, gray, mainly detrital shale, fine to medium	10	110
	Sand, gray, medium to very coarse, and gravel, gray, about one-half detrital shale; more gravel toward bottom	35	145
Pierre Shale:			
	Shale, gray	5	150

TABLE .--Logs of wells and test holes -- Continued

153-64-21bca
Test hole 401

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Sand and gravel, brown	6	6
	Gravel, brown, fine, very clayey	4	10
	Sand, very coarse, and gravel, fine, brown, about one-half detrital shale, clayey	15	25
	Till, brown, sandy and gravelly	18	43
	Till, gray, sandy	33	76
	Sand and gravel, gray, about two-thirds detrital shale, some detrital lignite, clayey	66	142
Pierre Shale:			
	Shale, gray	8	150

153-64-21cbd
Devils Lake city test 1

	Sand, very fine, and silt, light-brown	15	15
	Till, gray	10	25
	Clay, gravelly, gray	43	68
	Sand, very fine, and silty, clayey, gray	12	80
	Sand, very fine to fine, silty and clayey, gray	5	85
	Sand, medium to very coarse, and gravel, fine to medium	20	105
	Sand, medium to very coarse, and gravel, fine to medium, slightly clayey and silty, gray; material is coarser toward bottom	47	152
	Pierre Shale, gray	3	155

TABLE .--Logs of wells and test holes -- Continued

153-64-21cdc
Devils Lake city test 4
(driller's log)

Material	Thickness (feet)	Depth (feet)
Clay	1	1
Sand	2	3
Clay	4	7
Sandy clay	10	17
Brown sandy clay	18	35
Gray sandy clay	5	40
Sticky clay	6	46
Sand with a little clay	12	58
Sticky clay	7	65
Sandy clay	7	72
Clay	6	78
Fine sand	24	102
Coarse sand	4	106
Brown mushy sand	11	117
Good water-bearing sand	26	143
Sand, somewhat finer and mixed, not so good to screen for water	12	155
Good sand	22	177
Fine sand	15	192
Coarser sand	2	194
Good coarse sand	4	198
Fine sand	12	210
Good water-bearing sand	10	220
Finer sand	28	248
Shale	1	249

153-64-28bca
Test hole 403

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, gray, sandy	2	2
	Clay and silt, brown	7	9
	Sand, very coarse, and gravel, fine, brown, clayey	4	13
	Till, gray	16	29
	Sand and gravel, gray	7	36
	Till, gray	29	65
	Sand and gravel, gray	3	68
	Till, gray	35	103
	Clay and silt, gray	10	113
	Till, gray; sandy and gravelly toward bottom	53	166
	Sand, very coarse, and gravel, fine to medium, gray, fairly clean	13	179
	Sand, very coarse, and gravel, fine, gray, about two-thirds detrital shale, clayey toward bottom	16	195
Pierre Shale:			
	Shale, gray	15	210

153-64-28bcd
Great Northern well at Fort Totten station
(driller's log)

Material	Thickness (feet)	Depth (feet)
Cinders (backfill)	5 1/2	5 1/2
Yellow clay	17 1/2	23
Soft blue clay	54	77
Quicksand	31	108
Blue clay	6	114
Quicksand	12	126
Clay and flour sand	51	177
Blue clay	8	185
Quicksand	9	194
Hard blue clay	40	234
Hard shale, water bearing	24	258

TABLE .--Logs of wells and test holes -- Continued

153-64-28cdc
Devils Lake city test 2

Formation	Material	Thickness (feet)	Depth (feet)
	Sand, gravel, silty and clay, light-brown---	18	18
	Silt, clay and fine sand, gravelly---------	17	35
	Till or silty, clay and fine sand, gravelly, gray------------------------------------	40	75
	Till, gray---------------------------------	40	115
	Gravel, fine to medium, and sand-----------	5	120
	Till, gray---------------------------------	75	195
	Shale, gray--------------------------------	5	200

153-65-1bba
Test hole 182

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black-----------------------------	1	1
	Sand, light-brown, medium, fairly clean, gravelly----------------------------------	4	5
	Gravel, coarse, and sand, fine to coarse, about one-half detrital shale------------	10	15
	Gravel, fine, and some sand, gray, about one-half detrital shale----------------------	12	27
	Till, gray---------------------------------	105	132
	Sand, coarse, and gravel, fine, gray, about one-quarter detrital shale---------------	13	145
Pierre Shale:			
	Shale, gray--------------------------------	5	150

TABLE .--Logs of wells and test holes -- Continued

153-65-2ccc
Test hole 188

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, or clay, gray	1	2
	Till, light-brown	25	27
	Till, gray	25	52
	Sand and gravel, gray, very clayey	3	55
	Till, gray	11	66
	Sand and gravel, gray	3	69
	Till, gray	68	137
	Sand, coarse, and gravel, fine, gray, about one-half detrital shale, clayey	8	145
	Gravel, coarse, and sand, coarse, gray, about one-fourth detrital shale, fairly clean	5	150
	Till, gray	26	176
Pierre Shale:			
	Shale, gray	12	188

153-65-12bbb
Test hole 193

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, gray	3	4
	Till, light-brown	24	28
	Till, gray	3	31
	Sand, gray, coarse, very clayey	4	35
	Till, gray, sandy	35	70
	Till, gray	58	128
	Sand, coarse, and gravel, fine, gray, very clayey	28	156
	Till, gray, sandy and gravelly	21	177
Pierre Shale:			
	Shale, gray	8	185

153-65-12ccd
Test hole 191

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, or clay, light-gray	2	4
	Till, light-brown	15	19
	Till, gray	149	168
Pierre Shale:			
	Shale, gray	7	175

TABLE .--Logs of wells and test holes -- Continued

153-65-12ddd
Test hole 195

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Clay, sand, and gravel	1	1
	Gravel, coarse, clean	4	5
	Gravel, coarse, and sand, fine to medium	7	12
	Gravel, fine to coarse, and sand, fine to coarse, light-brown	12	24
	Gravel, sand, and clay, light-brown	7	31
	Clay, gray	17	48
	Till, gray	39	87
	Sand, coarse, and gravel, fine, gray, about one-half detrital shale, fairly clean toward bottom	56	143
Pierre Shale:			
	Shale, gray	7	150

153-65-13cab
Test hole 196

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy	1	1
	Clay, light-gray, sandy	4	5
	Clay and sand, light-gray	4	9
	Clay and sand, light-brown	7	16
	Till, light-brown	26	42
	Till, gray	7	49
	Sand, coarse, and gravel, fine, gray, clayey	9	58
	Gravel, fine to coarse, very little detrital shale, clean	14	72
	Till, gray	3	75
	Gravel, fine to coarse, very little detrital shale, clean	3	78
	Till, gray	29	107
	Sand and gravel, gray, clayey	8	115
	Sand, coarse, and gravel, fine, gray, about one-third detrital shale, fairly clean	20	135
	Sand, coarse and gravel, fine, gray, clayey	10	145
	Sand, coarse and gravel, fine, gray, fairly clean	15	160
	Sand, fine to coarse, and gravel, fine to medium, gray, poorly sorted, clayey	78	238
Pierre Shale:			
	Shale, gray	12	250

TABLE .--Logs of wells and test holes -- Continued

153-65-14bbb
Test hole 189

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-gray	1	2
	Till, light-brown	22	24
	Till, gray	3	27
	Sand and gravel, gray	3	30
	Till, gray	13	43
	Sand, gray	2	45
	Till, gray	12	57
	Sand, gray	2	59
	Till, gray	64	123
	Sand, very coarse, and gravel, fine, gray, clayey	7	130
	Till, gray	17	147
	Sand, very coarse, and gravel, fine, gray, clayey	23	170
	Sand, very coarse, and gravel, fine, gray, fairly clean	22	192
	Till, gray	45	237
Pierre Shale:			
	Shale, gray	13	250

153-65-14ccc
Test hole 190

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil	1	1
	Till, light-brown	24	25
	Sand and gravel, brown, clayey	5	30
	Sand, coarse, and gravel, fine, clean	6	36
	Till, gray	50	86
	Sand, gray, medium, very clayey	4	90
	Till, gray	10	100
	Sand and gravel, gray, mainly detrital shale, very clayey	10	110
Pierre Shale:			
	Shale, gray	5	115

TABLE .--Logs of wells and test holes -- Continued

153-65-22bbb
Test hole 197

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy, and gravelly----------	1	1
	Sand and gravel, very light-brown, very clean	3	4
	Till, light-gray----------------------------	2	6
	Till, light-brown---------------------------	13	19
	Till, light-gray, brown---------------------	7	26
	Till, gray----------------------------------	62	88
	Sand and gravel, gray-----------------------	2	90
	Till, gray----------------------------------	22	112
	Sand and gravel, gray-----------------------	5	117
	Till, gray----------------------------------	7	124
	Sand, coarse and gravel, fine, gray, about one-half detrital shale, fairly clean----------	16	140
	Gravel, medium and coarse, and sand, coarse, gray, fairly clean------------------------	16	156
	Till, gray----------------------------------	7	163
	Sand, coarse, and gravel, fine, gray, mainly detrital shale, very clayey---------------	31	194
	Till, gray, sandy and gravelly--------------	31	225
	Sand, fine, and gravel, coarse, gray, very clayey----------------------------------	32	257
Pierre Shale:			
	Shale, gray---------------------------------	8	265

153-65-24baa
Test hole 192

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Till, brown---------------------------------	4	4
	Gravel and sand-----------------------------	10	14
	Till, gray----------------------------------	45	59
	Till, gray, sandy and gravelly--------------	6	65
	Sand and gravel, gray, clayey---------------	47	112
Pierre Shale:			
	Shale, gray---------------------------------	68	180

TABLE .--Logs of wells and test holes -- Continued

153-66-15dcc
Test hole 45

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Silt, gray, sandy	7	7
	Silt, light-brown, clayey	12	19
	Silt, brown-gray, clayey	11	30
	Till, gray, many shale pebbles	37	67
	Gravel and sand, gray, clayey, with shale and limestone-dolomite pebbles	18	85
	Till, gray	50	135
Pierre Shale:			
	Shale, gray	11	146

153-66-19bbb
Test hole 39

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Clay, light-brown, silty, (till?)	21	21
	Gravel and sand, gray, shale	30	51
Pierre Shale:			
	Shale	15	66

153-66-20bab
Test hole 42

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Silt and clay, gray, pebbly (till?)	28	28
	Sand, gray, fine to medium, well sorted	29	57
	Gravel, gray, fine to medium, with coal and shale pebbles	35	92
	Clay and silt, gray	35	127
	Till, gray, silty	53	180
	Gravel, gray, fine to medium, with shale pebbles	22	202
	Sand and gravel, gray, shale	7	209
	Gravel, gray, fine to medium	18	227
	Gravel, gray, coarse	9	236
Pierre Shale:			
	Shale	3	239

TABLE 1.--Logs of wells and test holes -- Continued

153-66-21aab
Test hole 41

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Sand, brown, medium to coarse, well sorted-	5	5
	Gravel and sand, gray, angular-------------	6	11
	Gravel gray, coarse, angular, with many large shale pebbles---------------------	92	103

153-66-21bab
Test hole 43

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Clay and silt, light-gray-----------------	26	26
	Sand, brown, medium to coarse-------------	12	38
	Gravel, fine to coarse, with shale pebbles-	3	41
	Till, gray, silty-------------------------	65	106
	Gravel, gray, fine to coarse, with angular shale fragments-----------------------	4	110
	Gravel, gray, medium to coarse, angular, clayey----------------------------------	20	130
	Till, gray, silty-------------------------	92	222
Pierre Shale:			
	Shale-------------------------------------	8	230

153-66-21bbb
Test hole 40

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Clay and silt, light-brown----------------	22	22
	Clay and silt, gray-----------------------	29	51
	Till, gray--------------------------------	11	62
	Gravel, gray, shale-----------------------	28	90
	Till, gray--------------------------------	22	112
	Gravel, gray, very coarse, many shale pebbles---------------------------------	36	148
	Sand and gravel, gray, clayey, with coal and shale pebbles----------------------	35	183
	Till or clay, gray------------------------	97	280
	Sand and gravel, gray, clayey, with coal and shale pebbles----------------------	39	319
Pierre Shale:			
	Shale-------------------------------------	5	324

TABLE .--Logs of wells and test holes -- Continued

153-66-22bab
Test hole 44

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Clay and silt, light-brown	4	4
	Clay and silt, gray-brown	8	12
	Sand, gray, clayey	5	17
	Till, gray, with shale and limestone-dolomite pebbles	29	46
	Sand and gravel, gray, clayey	9	55
	Gravel, gray, coarse, angular, with shale and limestone-dolomite pebbles	13	68
	Till, gray	44	112
Pierre Shale:			
	Shale	18	130

153-67-2dca
Minnewaukan test 2

Formation	Material	Thickness (feet)	Depth (feet)
	Till, yellow, sand	7	7
	Till, light-brown, sandy	27	34
	Gravel, light-brown, coarse, with limestone and granite pebbles somewhat rounded	1	35
	Till, gray	1	36
	Sand, brown, coarse, with a few pebbles	2	38
	Till, gray	30	68
	Sand, gray, shale	3	71
	Shale	1	72

153-67-15bbc2
Test hole 647

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay, gray	1	2
	Till, light-brown or tan	11	13
	Sand and gravel	3	16
	Till, gray	7	23
	Sand and gravel, clayey	15	38
	Till, gray	8	46
Pierre Shale:			
	Shale, gray	4	50

TABLE .--Logs of wells and test holes -- Continued

153-67-15bbc3
Test hole 648

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay, gray	2	3
	Till, light-brown or tan	8	11
	Sand, fine, clayey, light-brown	4	15
	Till, light-brown or tan	8	23
	Sand, fine to medium, clayey	15	38
	Till, gray	5	43
Pierre Shale:			
	Shale, gray	7	50

153-67-15bbc4
Test hole 649

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay, gray	1	2
	Till or lake clay, light-brown or tan	10	12
	Till, gray	5	17
	Sand and gravel, clayey, gray, coarser material toward bottom	27	44
Pierre Shale:			
	Shale, gray	6	50

153-67-15bbc5
Test hole 650

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay, gray	1	2
	Till, light-brown or tan	11	13
	Sand and gravel, gray	1	14
	Till, gray	13	27
	Sand and gravel	18	45
Pierre Shale:			
	Shale, gray	5	50

TABLE .--Logs of wells and test holes -- Continued

153-67-15bbc6
Minnewaukan Supply well 1
(driller's log)

Material	Thickness (feet)	Depth (feet)
Topsoil	1	1
Yellow clay	11	12
Sandy yellow clay	3	15
Very sandy blue clay	5	20
Muddy fine sand	12	32
Muddy fine and coarse sand	13	45

153-67-15bda2
Minnewaukan test 11

Material	Thickness (feet)	Depth (feet)
Fill	3	3
Sandy clay	9	12
Blue sand and clay	18	30
Sand and gravel	4	34
Sand and gravel	4	38
Blue clay	56	94
Shale	4	98

153-67-15dba3
F. Rising

Material	Thickness (feet)	Depth (feet)
Topsoil	1	1
Clay, yellow	9	10
Clay, blue	12	22
Gravel	3	25

153-67-15dbb3
Minnewaukan test 10

Material	Thickness (feet)	Depth (feet)
Topsoil	2	2
Sandy clay	26	28
Sand and gravel	1	29
Blue clay with rocks	22	51
Blue clay, sticky	40	91
Shale, hard	5	96

TABLE .--Logs of wells and test holes -- Continued

153-67-15dcc2
Test hole 523

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	3	3
	Clay, sandy and gravelly, gray	2	5
	Till, silty, light-brown	11	16
	Sand, medium to very coarse, and gravel, fine, clayey, gray	2	18
	Till, gray	26	44
Pierre Shale:			
	Shale, gray	6	50

153-67-16dcd
Test hole 515

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Silt, clay and sand, very fine, light-brown	3	3
	Sand, fine to very coarse, and some gravel, fine to coarse, slightly clayey, light-brown	19	22
	Gravel, fine to medium, and sand, medium to very coarse, slightly clayey, gray; gravel about one-third shale	6	28
	Sand, medium to very coarse, and gravel, fine to medium, very clayey, gray; coarse material is shale	8	36
	Till, gray	14	50

153-67-21aaa
Test hole 517

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Till, silty, light-brown, or silt and sand, very fine, clayey and gravelly	15	15
	Sand, medium to very coarse and some gravel, fine, very clayey, gray; about one-third shale	5	20
	Till, gray	18	38
Pierre Shale:			
	Shale, gray	12	50

153-67-21aab
Test hole 516

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Silt and very fine sand, clayey and gravelly, light-brown	25	25
	Silt and very fine sand, clayey and gravelly, gray; more gravel toward bottom	40	65
	Till, gray, sandy and gravelly, or very clayey sand and gravel	7	72
Pierre Shale:			
	Shale, gray	68	140

153-67-22baa
Test hole 520

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay, sandy and gravelly, gray	1	2
	Till, light-brown	9	11
	Till, gray	17	28
Pierre(?) Shale:			
	Shale(?), gray	22	50

153-67-22bab
Test hole 519

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, light-brown	1	1
	Clay, sandy and gravelly, gray	1	2
	Till, silty, light-brown	10	12
	Till, gray	24	36
Pierre Shale:			
	Shale, gray	14	50

TABLE .--Logs of wells and test holes -- Continued

153-67-22bbb
Test hole 518

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, gray	1	1
	Till, silty, light-brown or silt and sand, very fine, gravelly and clayey	7	8
	Sand, fine to coarse, clayey, gray; mostly shale	8	16
	Till, gray	22	38
Pierre Shale:			
	Shale, gray	12	50

153-67-23aaa
Test hole 28

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Silt, light-brown	10	10
	Clay, gray, with fresh-water gastropod	15	25
	Till, light-brown	30	55
Pierre Shale:			
	Shale	4	59

153-67-23bab
Test hole 36

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Silt, light-brown	18	18
	Silt, gray	27	45
Pierre Shale:			
	Shale	35	80

153-67-24abb
Test hole 37

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Silt and clay, light-brown	8	8
	Sand, brown, fine to medium, well sorted	12	20
	Till, gray, many shale pebbles	50	70
Pierre Shale:			
	Shale	16	86

TABLE .--Logs of wells and test holes -- Continued

153-67-24bab
Test hole 38

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Clay and silt, light-brown (till?)	23	23
	Till, gray, silty, with shale pebbles	45	68
Pierre Shale:			
	Shale	7	75

154-63-5ccc
Test hole 127

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	18	19
	Till, gray	7	26
	Sand and gravel, gray	1	27
	Till, gray	11	38
Pierre Shale:			
	Shale, gray	12	50

154-63-6aaa
Test hole 126

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Sand, gray-brown, medium to coarse, and some gravel, fairly clean	4	5
	Till, light-brown	2	7
	Till, gray	17	24
	Sand, medium, and gravel, fine to coarse, gray, poorly sorted, clayey	3	27
	Gravel, gray, coarse, mainly detrital shale, clean	9	36
Pierre Shale:			
	Shale, gray	4	40

TABLE .--Logs of wells and test holes -- Continued

154-63-7abb
Test hole 128

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, and clay	1	1
	Till, light-brown	21	22
	Sand and gravel, light-brown	3	25
	Till, gray	31	56
Pierre Shale:			
	Shale, gray	14	70

154-63-19daa
Test hole 588

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, brown	1	1
	Till, light-brown, very sandy and gravelly	3	4
	Sand and gravel, light-brown, mainly detrital shale, very clayey	14	18
	Sand, light-brown, very fine to medium, clayey and gravelly	24	42
	Till, light-brown, silty	13	55
	Sand, medium to very coarse, and gravel, fine, light-brown, coarse material mainly detrital shale, very clayey	10	65
	Sand, very coarse, and gravel, fine, gray, clayey; coarser material detrital shale	10	75
	Gravel, fine to medium, mainly detrital shale	6	81
Pierre Shale:			
	Shale, gray	9	90

TABLE .--Logs of wells and test holes -- Continued

154-64-1cdd
Test hole 130

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay, gray	2	3
	Clay and silt, very light-brown	7	10
	Till, light-brown	2	12
	Sand and gravel, light-brown	1	13
	Till, gray	46	59
	Sand, coarse to medium, and gravel, fine, gray, very clayey	6	65
	Till, gray	34	99
Pierre Shale:			
	Shale, gray	11	110

154-64-1ddd
Test hole 129

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, light-brown	15	17
	Till, gray	49	66
	Sand, coarse and gravel, fine, gray, mainly detrital shale, fairly clean	4	70
	Till, gray	14	84
	Till, gray; contains large detrital shale pebbles, up to one inch in length	30	114
Pierre Shale:			
	Shale, gray	6	120

154-64-2cdd
Test hole 132

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, or clay, gray	2	3
	Till, light-brown	8	11
	Till, gray	2	13
	Sand, medium to coarse, and gravel, fine, gray, about one-half detrital shale, poorly sorted, fairly clean	8	21
	Till, gray	30	51
Pierre Shale:			
	Shale, gray	9	60

154-64-3baa
Test hole 135

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, light-brown	10	12
	Till, gray	38	50
	Sand, fine, and clay, gray	20	70
	Clay, and sand, fine, gray	23	93
	Till, gray	6	99
Pierre Shale:			
	Shale, gray	11	110

154-64-3bba
Test hole 203

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-tan	13	14
	Till, gray	14	28
	Sand	2	30
	Till, gray	16	46
	Sand, gray, medium and fine, mainly detrital shale, clayey	14	60
	Till, gray	48	108
Pierre Shale:			
	Shale, gray	5	113

154-64-3cad
Test hole 156

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	13	14
	Till, gray	8	22
	Sand and gravel, gray	1	23
	Till, gray, very sandy and gravelly	17	40
	Sand, coarse, and gravel, mostly fine, gray, fairly clean	47	87
Pierre Shale:			
	Shale, gray	3	90

154-64-3cdd
Test hole 134

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, or clay, light-brown	2	3
	Till, light-brown, very sandy and clayey	7	10
	Sand, medium to coarse, and some gravel, fine; coarser material detrital shale	20	30
	Sand, very coarse, and gravel, fine, mainly detrital shale; material coarser toward bottom	30	60
	Gravel, fine to coarse, about two-thirds detrital shale	48	108
Pierre Shale:			
	Shale, gray	2	110

154-64-3ddd
Test hole 133

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil,black	1	1
	Till, light-brown	11	12
	Till, gray	21	33
	Sand, medium to coarse, and gravel, fine to coarse, about one-third detrital shale, poorly sorted, fairly clean	7	40
	Till, gray	15	55
	Till, gray, gravelly	5	60
Pierre Shale:			
	Shale, gray	10	70

154-64-4ccc
Test hole 2X

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-gray, sandy	10	11
	Sand, gray, medium to fine, mostly medium, clayey	7	18
	Sand, fine, and gravel, coarse, gray, mainly detrital shale, very clayey	4	22
	Till, gray, gravelly, and sandy	10	32

TABLE .--Logs of wells and test holes -- Continued

154-64-4cdd
Test hole 1X

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil	2	2
	Till, light-brown	11	13
Pierre Shale:			
	Shale, gray	2	15

154-64-9dcc
Test hole 176

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-gray	2	3
	Sand and gravel, light-brown, very clayey	3	6
	Till, light-brown	12	18
	Till, gray	23	41
	Till, gray, sandy and gravelly	9	50
	Till, gray	96	146
Pierre Shale:			
	Shale, gray	9	155

154-64-10bbb
Test hole 158

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, light-brown	12	14
	Till, gray	21	35
	Sand and gravel, gray	2	37
	Till, gray, sandy and gravelly	12	49
	Sand, coarse and gravel, fine to medium, gray, mainly detrital shale, fairly clean	21	70
	Sand, coarse, and gravel, medium, gray, mainly detrital shale, fairly clean	10	80
	Sand, coarse, and gravel, coarse, gray, mainly detrital shale, clean	10	90
	Gravel, gray, coarse, about one-half detrital shale, clean	11	101
Pierre Shale:			
	Shale, gray	4	105

TABLE .--Logs of wells and test holes -- Continued

154-64-10caa
Test hole 157

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	1	2
	Sand and gravel, light-brown	3	5
	Till, light-brown	10	15
	Till, gray	8	23
	Sand, coarse, and gravel, coarse, fairly clean	7	30
Pierre Shale:			
	Shale, gray	14	44

154-64-12bbb
Test hole 131

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, or clay, gray	2	3
	Till, light-brown	10	13
	Till, gray	16	29
	Sand, coarse, and gravel, fine to coarse, gray, very clayey, poorly sorted	11	40
	Till, gray	10	50
	Gravel, gray, coarse, mainly detrital shale, very clean	5	55
Pierre Shale:			
	Shale, gray	5	60

154-64-15abb
Test hole 3X

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	12	13
	Sand and gravel, mainly detrital shale, clayey	10	23
Pierre Shale:			
	Shale, gray	4	27

TABLE .--Logs of wells and test holes -- Continued

154-64-16aaa
Test hole 175

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, light-brown	15	17
	Till, gray	23	40
	Sand, coarse and gravel, fine, gray, mainly detrital shale, clayey	23	63
	Till, gray	20	83
Pierre Shale:			
	Shale, gray	12	95

154-64-22abb2
Great Northern test well 9
(driller's log)

	Thickness (feet)	Depth (feet)
Yellow clay	14	14
Blue clay	22	36
Gravel	1	37
Slate	19	56
Rock	1	57
Blue clay	13	70
Slate	10	80
Sandy clay	5	85
Blue clay	20	105
Slate rock	1	106
Blue shale	6	112

TABLE .--Logs of wells and test holes -- Continued

154-64-22dcc
Great Northern test well 10
(driller's log)

Material	Thickness (feet)	Depth (feet)
Yellow clay	20	20
Blue clay	9	29
Medium gray sand	3	32
Blue clay	1	33
Fine gravel	2	35
Blue clay	4	39
Fine gray sand	5	44
Broken shale	1/2	44 1/2
Boulder	1	45 1/2
Blue clay	4	49 1/2
Sandy blue clay	5	54 1/2
Coarse gray sand	1 1/2	56
Shale and sand	4	60
Shale	10	70

154-64-27abc
Great Northern test well 11
(driller's log)

Material	Thickness (feet)	Depth (feet)
Clay and gravel	38	38
Sand and gravel	7	45
Gray water-bearing sand	1	46
Gray clay and gravel	13	59
Soft black clay	1	60
Blue clay	20	80
Shale	?	

154-64-27dcb
Great Northern test well 12
(driller's log)

Material	Thickness (feet)	Depth (feet)
Yellow clay	22	22
Blue clay and boulders	11	33
Hard blue clay	8	41
Fine black sand	1	42
Sand and gravel	3	45
Clay	3	48

154-64-34dac1
Devils Lake city supply well 1
(from Simpson, 1929, p. 192)

Material	Thickness (feet)	Depth (feet)
Glacial drift, till as on the surface	25	25
Dark shale, nearly alike through its whole thickness, including Pierre and Benton shales, with no noticeable calcareous beds at the intermediate Niobrara horizon	1,403	1,428
Gravel, of granite pebbles up to half an inch in diameter, firmly cemented with nodular pyrite	3	1,431
Dakota Sandstone:		
Loose sand, very fine, white or light gray, the base of which was not reached	80	1,511

TABLE 1. --Logs of wells and test holes -- Continued

154-64-34dcb1
Devils Lake city supply well 2
(from Laird, 1941, p. 25-27)

Material	Thickness (feet)	Depth (feet)
Pleistocene		
Drift	10	10
Coarse sand	10	20
Fine gravel	30	50
Cretaceous		
Pierre		
Shale with silt and gravel	20	70
Shale with sand and gravel	10	80
Soft tan shale	10	90
Sand and shale	20	110
Soft gray shale with shell fragments and gypsum	80	190
Dark-gray shale, lignite with sulphur and gypsum	10	200
Light-gray shale with gypsum and shells	100	300
Dark-gray shale with lignite, gypsum	20	320
Light-gray shale with lignite	10	330
Dark gray shale with lignite, sulphur, gypsum	20	350
Light-gray shale with lignite	10	360
Dark-gray shale	10	370
Light-gray blocky shale, gypsum, lignite	10	380
Light-gray shale and lignite	10	390
Blocky and tan shale, little lignite, satin-spar and prisms, gypsum and spherules	110	500
Dark-gray shale with selenite	10	510
Gray and tan shale, rare prisms and selenite	10	520
Gray and tan shale with gypsum and sulphur	20	540
Gray and tan shale with gypsum, sulphur rare, satinspar	10	550
Light- and dark-gray shale with selenite and satinspar	40	590
Light-gray to black shale with abundant sulphur and gypsum, prisms rare	10	600
Medium gray shale	10	610
Niobrara		
Gray and tan shale with lignite, selenite and abundant fossils	50	660
Soft gray shale, less fossils, much gypsum	10	670
Dark and light-gray shale	10	680

TABLE 1.--Logs of wells and test holes -- Continued

154-64-34dcbl - Continued

	Material	Thickness (feet)	Depth (feet)
	Soft gray shale, some gypsum and lignite	20	700
	Dark-gray shale, abundant selenite, fossils rare--	30	730
Benton			
	Soft light-gray shale------------------------	130	860
	Light to medium gray shale--------------------	40	900
	Blocky medium gray shale with abundant selenite, pyrite, fossils, rare----------------------	20	920
	Flaky gray shale with granular gypsum---------	60	980
	Gray shale with sulphur and selenite----------	10	990
	Flaky gray shale with a little pyrite---------	10	1,000
	Flaky gray shale with selenite and pyrite-----	20	1,020
	Gray shale, abundant prisms and gypsum--------	10	1,030
	Flaky medium gray shale, selenite, fossils----	50	1,080
	Medium gray shale, fossils, sulphur, prisms---	20	1,100
	Flaky gray shale, prisms and fossils----------	10	1,110
	Gray shale with prisms, fossils, pyrite-------	30	1,140
	Flaky gray shale------------------------------	20	1,160
	Gray shale------------------------------------	10	1,170
	Flaky gray shale------------------------------	50	1,220
	Light to dark-gray shale----------------------	10	1,230
	Flaky gray shale, few fossils-----------------	20	1,250
	Gray shale------------------------------------	10	1,260
	Flaky gray shale------------------------------	10	1,270
	Gray shale with prisms------------------------	20	1,290
	Flaky gray shale------------------------------	30	1,320
Dakota			
	Gray shale and coarse sand--------------------	10	1,330
	Dark-gray shale, sulphur, selenite------------	10	1,340
	Dark-gray shale and sand, pyrite--------------	10	1,350
	Gray sandy shale with gypsum and sulphur------	20	1,370
Fuson			
	Flaky gray shale with gypsum------------------	30	1,400
	Dark-gray shale, gypsum and sulphur-----------	10	1,410
Lakota			
	Sand and shale with little gypsum and pyrite--	10	1,420
	Sand and shale with sulphur-------------------	10	1,430
	Coarse sand with pyrite-----------------------	81	1,511

TABLE .--Logs of wells and test holes -- Continued

154-64-34dcb1
Devils Lake city supply well 2
(driller's log)

Material	Thickness (feet)	Depth (feet)
Clay------------------------------------	55	55
Fine gravel-----------------------------	6	61
Blue clay-------------------------------	24	85
Sand------------------------------------	5	90
Dark shale with occasional thin lime shells----------------------------------	1,320	1,410
Sandstone, mostly soft------------------	70	1,480
Gray sandy shale------------------------	20	1,500
Sandstone-------------------------------	15	1,515
Gray shale (drilled but not cased)------	5	1,520

154-64-34dcb2
Devils Lake city supply well 3
(driller's log)

Material	Thickness (feet)	Depth (feet)
Clay and shale--------------------------	43	43
Sand and gravel-------------------------	7	50
Shale-----------------------------------	1,270	1,320
Muddy shale and sand (loose)------------	25	1,345
Shale (hard)----------------------------	40	1,385
Hard streaks of shale and streaks of sand	95	1,480
Good clean, white sand------------------	16	1,496
Shale very much like bentonite, gray and chocolate color----------------------	24	1,520

Devils Lake Well No. 4
154-64-34dcc
Samples examined by S. B. Anderson, geologist
North Dakota Geological Survey
Colors determined from the National Research Council Rock Color Chart

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Till, pale yellow-brown (10YR 6/2), sand, shale pebbles, clay	30	30
	Till, green-gray (5GY 6/1), rounded quartz grains, clay matrix, shale pebbles	70	100
Pierre Shale:			
	Shale, green-gray (5GY 6/1), small amounts of fine sand	40	140
	Shale, green-gray (5GY 6/1), mostly coarse, rounded pebbles	40	180
	Shale, medium gray (N5), small amount of sand	20	200
	Shale, green-gray (5GY 6/1), on fresh fracture, medium gray (N5)	200	400
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture, few rounded quartz grains	30	430
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture, little sand	10	440
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture, some sand and sandstone	20	460
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture	50	510
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture, very few sand grains, a few calcite shell fragments	20	530
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture, very few sand grains, some pyrite. Piece of limestone	10	540
Niobrara Formation and Carlile Shale:			
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture. Very few sand grains, some pyrite. Calcareous	10	550
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture, white specks. Very small amount of sand. Inoceramus replaced by calcite	10	560

TABLE 1.--Logs of wells and test holes -- Continued

154-64-34dcc - Continued

Formation	Material	Thickness (feet)	Depth (feet)
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture. Few white specks, and a few sand grains	40	600
	Shale, green-gray (5GY 6/1), both before and after fracture. Some pyrite	10	610
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture. Small amount of fine sand	10	620
	Shale, green-gray (5GY 6/1), both before and after fracture. Small amount of sand, and fossil plant stem	10	630
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture. Some fine sand	10	640
	Shale, green-gray (5GY 6/1), medium gray (N5) to medium dark gray on fracture. Some calcite, very little sand	10	650
	Shale, green-gray (5GY 6/1), medium gray (N5) on fracture. Inoceramus	20	670
	Shale, green-gray (5GY 6/1), medium gray (N5) on fracture. White specks	20	690
	Shale, green-gray (5GY 6/1), medium gray on fracture, calcareous	20	710
	Shale, green-gray (5GY 6/1), and medium gray (N5). White specks	10	720
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture. Small, rounded quartz grains	10	730
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture. Irrid. shell fragments	10	740
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture. White specks	10	750
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture. Small amounts of fine sand	10	760
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture. Pyrite	20	780
	Shale, green-gray (5GY 6/1), medium gray (N5) on fresh fracture. White specks. Inoceramus	20	800
	Shale, green-gray (5GY 6/1), medium dark gray, (N4) on fracture	40	840
	Shale, green-gray (5GY 6/1), medium gray (N5) on fracture. Occasional white specks	180	1,020

TABLE 1.--Logs of wells and test holes -- Continued

154-64-34dcc - Continued

Formation	Material	Thickness (feet)	Depth (feet)
Greenhorn Limestone and Graneros Shale:			
	Shale, green-gray (5GY 6/1), medium gray (N5) on fracture------------------------	20	1,040
	Shale, green-gray (5GY 6/1), medium gray (N5) on fracture, calcareous calcite fragments-------------------------------	10	1,050
	Shale, green-gray (5GY 6/1), medium gray on fracture, white specks------------------	10	1,060
	Shale, green-gray (5GY 6/1), medium gray (N5) on fracture------------------------	30	1,090
	Shale, green-gray (5GY 6/1), medium gray (N5) on fracture, calcareous------------	10	1,100
	Shale, green-gray (5GY 6/1), medium gray (N5) on fracture. Few sand grains and pyrite----------------------------------	100	1,200
	Shale, green-gray (5GY 6/1), medium gray (N5) on fracture, white specks----------	80	1,280
	Shale, green-gray (5GY 6/1)---------------	30	1,310
Dakota Sandstone:			
	Shale, green-gray (5GY 6/1), a few quartz grains-----------------------------------	10	1,320
	Sandstone, quartzose. Shale, flaky. Pyrite	10	1,330
	Sandstone, quartzose. Shale, medium gray, flaky------------------------------------	20	1,350
	Shale and sandstone. Pyrite---------------	10	1,360
	Shale and limestone, flaky. Some sand-----	30	1,390
	Shale, flaky, sandy. Pyrite---------------	10	1,400
	Shale and sandstone, green-gray (5GY 6/1), flaky. Some pyrite and loose sand grains	80	1,480
	Sandstone, quartzose----------------------	20	1,500

TABLE .--Logs of wells and test holes -- Continued

154-65-13bcc
Test hole 4X

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Sand, medium to coarse, and some gravel, fine, light-brown, clayey	17	18
	Till, gray	33	51
Pierre Shale:			
	Shale, gray	6	57

154-65-23baa
Test hole 6X

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	14	15
	Till, gray	27	42
Pierre Shale:			
	Shale, gray	5	47

154-65-23daa
Test hole 7X

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, gray-black	1	1
	Till, light-brown	23	24
	Till, gray	11	35
	Gravel, fine, and sand, coarse, gray, mainly detrital shale, fairly clean	8	43
	Till, gray	6	49
	Gravel, fine, and sand, coarse, gray, mainly detrital shale, fairly clean	9	58
	Till, gray	44	102
	Sand, coarse, and gravel, fine, very clayey	24	126
	Till, gray	3	129

TABLE .--Logs of wells and test holes -- Continued

154-65-24bbb
Test hole 5X

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	15	16
	Till, gray, sandy and gravelly	5	21
	Sand and gravel, gray, very clayey	13	34
	Till, gray, very sandy and gravelly	4	38
	Till, gray	3	41
	Sand, gray, fine to coarse, very clayey	4	45

154-65-33aab
Test hole 187

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Gravel, fine to coarse, very little detrital shale, very clean	5	5
	Till, light-brown	17	22
	Till, gray	12	34
	Sand, coarse, and gravel, fine, gray, about one-half detrital shale, very clayey	8	42
	Till, gray	55	97
	Sand and gravel, gray, very clayey	5	102
Pierre Shale:			
	Shale, gray	8	110

154-65-33aad
Test hole 186

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Gravel, medium, and sand, medium to coarse, very little detrital shale, clean	9	10
	Thin beds of gravel, medium, and clay, sandy, gray	20	30
	Gravel, medium and sand, coarse	10	40
	Till, gray	30	70
	Clay, light-gray; brown-gray towards bottom	37	107
	Till, gray	89	196
Pierre Shale:			
	Shale, gray	19	215

154-65-34bcd
Test hole 185

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, or clay, gray	2	3
	Sand, light-brown, fine to coarse, clayey	3	6
	Till, light-brown	28	34
	Till, gray	15	49
	Till, or clay, gray	19	68
	Till, gray	122	190
	Till, or clay, gray	62	252
	Till, gray	94	346
Pierre Shale:			
	Shale, gray	4	350

154-65-34ccd
Test hole 184

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, or clay, light-gray	2	3
	Sand and gravel, light-brown	1	4
	Till, light-brown	18	22
	Till, gray, sandy and gravelly	18	40
	Till, gray	58	98
	Till, gray, very sandy and gravelly	37	135
	Sand, coarse, and gravel, fine, gray, clayey	37	172
Pierre Shale:			
	Shale, gray	8	180

TABLE .--Logs of wells and test holes -- Continued

154-65-35ccc
Test hole 183

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black----------------------------	2	2
	Till, or clay, gray-----------------------	1	3
	Till, light-brown-------------------------	18	21
	Till, gray--------------------------------	11	32
	Sand and gravel, gray---------------------	3	35
	Till, gray--------------------------------	22	57
	Sand, coarse, and gravel, fine, gray, mainly detrital shale, clayey------------	30	87
	Till, gray--------------------------------	31	118
	Sand, coarse, and gravel, fine, gray, about one-half detrital shale, clayey----------	20	138
	Sand, coarse, and gravel, fine, gray, about one-quarter detrital shale, fairly clean-	11	149
Pierre Shale:			
	Shale, gray-------------------------------	6	155

154-65-36ddd
Test hole 181

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black----------------------------	2	2
	Till, light-gray--------------------------	3	5
	Till, light-brown-------------------------	12	17
	Till, gray--------------------------------	48	65
	Till, gray, sandy and gravelly------------	5	70
	Sand and gravel, gray, very clayey--------	7	77
	Till, gray--------------------------------	42	119
Pierre Shale:			
	Shale, gray-------------------------------	6	125

TABLE .--Logs of wells and test holes -- Continued

154-66-32acc
Test hole 359

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy	1	1
	Silt, clay and sand, light-brown, very fine to fine, probably laminated	23	24
	Sand, very fine to fine, and some clay, and silt, gray, probably laminated	29	53
	Till, gray	24	77
	Sand and gravel, gray, clayey	4	81
	Till, gray	15	96
	Sand and gravel, gray, clayey	3	99
	Till, gray	45	144
	Sand and gravel, gray, clayey	4	148
	Till, gray	20	168
Pierre Shale:			
	Shale, gray	7	175

154-66-34adc
Test hole 355

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Clay, light-brown, silt and some sand	8	10
	Clay, gray, silt and some sand	4	14
	Till, gray	16	30
	Till, gray	16	46
	Sand and gravel, gray, clayey	4	50
Pierre Shale:			
	Shale, gray	10	60

TABLE .--Logs of wells and test holes -- Continued

154-66-35bca
Test hole 356

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, light-brown, sandy and gravelly---	1	1
	Sand, light-brown, clayey and gravelly-----	3	4
	Sand, coarse to very coarse, and gravel, fine, silt and clay, light-brown; probably thin alternating beds of various materials----	17	21
	Sand, medium to very coarse, and gravel, fine to medium, gray, coarser material about one-half detrital shale, clayey----------	9	30
	Till, gray----------------------------------	51	81
	Sand, medium to very coarse and gravel, fine, gray, material is about one-half detrital shale, also considerable detrital lignite, clayey------------------------------------	28	109
Pierre Shale:			
	Shale, gray---------------------------------	6	115

154-66-34bcc
Test hole 358

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black------------------------------	1	1
	Silt and clay, light-brown-----------------	11	12
	Till, light-brown--------------------------	4	16
	Till, gray, clay and silt------------------	15	31
	Sand and gravel, gray, very clayey---------	2	33
	Till, gray---------------------------------	18	51
Pierre Shale:			
	Shale, gray--------------------------------	4	55

TABLE .--Logs of wells and test holes -- Continued

154-66-34caa
Test hole 354

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay and silt, light-brown, sandy	6	7
	Sand, light-brown, fine to very coarse, silty and gravelly	4	11
	Silt, light-brown, clay and sand, gravelly, probably in thin, alternating beds	9	20
	Sand, gray, very fine to fine	5	25
	Sand, gray, very fine to medium	5	30
	Sand, very fine to very coarse, gravelly, coarser material detrital shale, limestone, and dolomite	10	40
	Gravel, medium to coarse; about one-half detrital shale	10	50
	Sand and gravel, clayey	5	55
	Gravel, fine to medium, and sand, very coarse, coarser material mainly detrital shale	25	80
	Gravel, fine to coarse, and sand, medium to coarse	24	104
	Till, gray	8	112
	Gravel, fine to coarse, and sand, coarse to very coarse	4	116
Pierre Shale:			
	Shale, gray	4	120

154-66-36aaa
Test hole 357

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Sand, light-brown, very fine to very coarse, gravelly	15	15
	Sand, light-brown, very fine to very coarse, gravelly, clayey and silty	18	33
	Till, gray, sandy and gravelly	71	104
	Sand, gray, very clayey	20	124
	Till, sandy and gravelly	22	146

TABLE .--Logs of wells and test holes -- Continued

154-67-2ddd
Test hole 353

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	7	8
	Till, gray	76	84
Pierre Shale:			
	Shale, gray	11	95

154-67-36bcc
Test hole 33

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Silt, light-brown, with a few shale pebbles	18	18
	Silt, gray	22	40
	Till, gray, with shale pebbles	5	45
	Gravel and sand	2	47
	Till, gray, with shale pebbles	10	57
	Sand and gravel, gray, clean, angular, poorly sorted, with some shale pebbles	79	136
	Gravel, gray, shale, with some clay	8	144
	Gravel, gray, shale, coarse, round	16	160
	Sand and gravel, gray, with some shale pebbles and coal, clayey	25	185
Pierre Shale:			
	Shale, gray	15	200

155-63-6ddd
Test hole 146

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	3	3
	Till, light-brown	19	22
	Till, gray	81	103
Pierre Shale:			
	Shale, gray	7	110

155-63-7ddd
Test hole 147

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till or clay, light-gray	4	5
	Till, light-brown	2	7
	Sand and gravel, light-brown	1	8
	Till, light-brown	7	15
	Sand, medium to coarse, and some gravel, fine, light-brown, clayey	4	19
	Till, gray	20	39
Pierre Shale:			
	Shale, gray	11	50

155-63-18ddd
Test hole 121

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, light-brown	15	17
	Till, gray	63	80
Pierre Shale:			
	Shale, gray	30	110

155-63-19cdd
Test hole 123

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, light-brown	13	15
	Till, gray	15	30
	Sand, coarse, and gravel, fine, gray, mainly detrital shale, clean	7	37
	Till, gray	19	56
Pierre Shale:			
	Shale, gray	4	60

TABLE 1.--Logs of wells and test holes -- Continued

155-63-19ddd
Test hole 122

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	13	14
	Till, gray	21	35
Pierre Shale:			
	Shale, gray	35	70

155-63-21dcc
Test hole 120

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, light-brown	10	12
	Till, gray	18	30
Pierre Shale:			
	Shale, gray	20	50

155-63-27bbb
Test hole 119

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, or clay, light-brown	2	4
	Sand and gravel, light-brown	3	7
	Till, light-brown	9	16
	Sand and gravel, light-brown, very clayey	9	25
	Till, gray	14	39
	Sand, fine to medium, and gravel, fine, gray, clayey, poorly sorted	6	45
	Gravel, fine to coarse, clean	60	105
Pierre Shale:			
	Shale, gray	30	135

TABLE 1.--Logs of wells and test holes -- Continued

155-63-29aba
Test hole 124

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, light-brown	16	18
	Till, gray	13	31
	Sand and gravel, gray	1	32
	Till, gray, gravelly towards bottom	37	69
Pierre Shale:			
	Shale, gray	11	80

155-63-29ccc
Test hole 125

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	17	18
	Till, gray	23	41
	Sand, medium to coarse, and gravel, fine to coarse, mainly detrital shale, clayey, material coarser towards bottom	16	57
	Till, gray	27	84
Pierre Shale:			
	Shale, gray	6	90

155-64-9dad
Test hole 141

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, or clay, gray	1	3
	Till, or clay, light-brown	2	5
	Till, light-brown	15	20
	Till, brown	9	29
	Till, gray	96	125
Pierre Shale:			
	Shale, gray	5	130

TABLE 1.--Logs of wells and test holes -- Continued

155-64-10ada
Test hole 142

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	25	26
	Till, gray	44	70
	Till, gray, sandy and gravelly	30	100
Pierre Shale:			
	Shale, gray	4	104

155-64-10ddd
Test hole 148

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, or clay, light-gray	2	4
	Till, light-brown	14	18
	Till, dark-brown	4	22
	Till, gray	15	37
	Sand and gravel, gray, very clayey	4	41
	Till, gray, very sandy and gravelly	29	70
	Till, gray	36	106
Pierre Shale:			
	Shale, gray	2	108

155-64-11aad
Test hole 144

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, light-brown	12	14
	Sand and gravel, light-brown	3	17
	Till, gray	38	55
Pierre Shale:			
	Shale, gray	3	58

TABLE 1.--Logs of wells and test holes -- Continued

155-64-11bda
Test hole 143

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black----------------------------	1	1
	Till, or clay, gray-----------------------	2	3
	Till, light-brown-------------------------	13	16
	Sand and gravel, light-brown--------------	2	18
	Boulder-----------------------------------	2	20
	Till, gray--------------------------------	10	30
Pierre Shale:			
	Shale, gray-------------------------------	10	40

155-64-12ada2
Test hole 145

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black----------------------------	2	2
	Till, light-brown-------------------------	16	18
	Till, gray--------------------------------	5	23
	Sand, coarse, and gravel, fine, gray, mainly detrital shale, very clayey-------------	5	28
	Sand, coarse and gravel, fine, gray, mainly detrital shale, fairly clean------------	8	36
	Limestone boulder-------------------------	1	37
	Till, gray--------------------------------	62	99
Pierre Shale:			
	Shale, gray-------------------------------	8	107

155-64-16bba
Test hole 150

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black----------------------------	1	1
	Sand, light-gray, medium, clayey----------	2	3
	Till, light-brown-------------------------	16	19
	Till, gray--------------------------------	8	27
	Sand, gray, fine to coarse, mainly detrital shale, fairly clean--------------------	20	47
Pierre Shale:			
	Shale, gray-------------------------------	23	70

155-64-21aaa
Test hole 140

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, or clay, light-gray	1	2
	Till, light-brown	11	13
	Till, gray	19	32
Pierre Shale:			
	Shale, gray	8	40

155-64-22ccc
Test hole 137

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	14	15
	Sand and gravel, gray-brown, about one-third detrital shale, very clayey	4	19
	Till, gray	5	24
Pierre Shale:			
	Shale, gray	6	30

155-64-22cdd
Test hole 139

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, or clay, gray	2	3
	Till, light-brown	11	14
	Sand and gravel, gray-brown, very clayey	5	19
	Till, gray	5	24
Pierre Shale:			
	Shale, gray	16	40

TABLE 1.--Logs of wells and test holes -- Continued

155-64-22ddc
Test hole 138

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black----------------------------	2	2
	Sand, light-brown, fine to medium, clayey--	2	4
	Sand, medium to coarse, slightly clayey----	1	5
	Till, light-brown-------------------------	13	18
	Sand and gravel, light-brown--------------	3	21
	Till, light-brown-------------------------	3	24
	Till, gray--------------------------------	4	28
	Sand and gravel, gray---------------------	4	32
	Till, gray--------------------------------	38	70
Pierre Shale:			
	Shale, gray-------------------------------	50	120

155-64-23daa
Test hole 149

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black----------------------------	1	1
	Till or clay, gray------------------------	3	4
	Till, light-brown-------------------------	11	15
	Till, gray--------------------------------	3	18
	Sand and gravel, gray---------------------	4	22
	Till, gray--------------------------------	8	30
	Sand, gray, medium, very clayey-----------	6	36
	Sand, coarse, and gravel, fine, gray, very clayey--------------------------------	3	39
Pierre Shale:			
	Shale, gray-------------------------------	11	50

155-64-27ccc
Test hole 136

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black----------------------------	2	2
	Till, light-brown-------------------------	8	10
	Till, brown-------------------------------	8	18
Pierre Shale:			
	Shale, gray-------------------------------	12	30

155-64-34acc
Test hole 205

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, or clay, dark-brown	2	3
	Till, light-brown	14	17
	Till, gray	20	37
	Sand, coarse and medium, and gravel, fine, gray,very clayey	9	46
	Till, gray, very sandy and gravelly	14	60
	Gravel, coarse, and sand, coarse, gray, mainly detrital shale, clean	20	80
	Till, gray, gravelly	59	139
Pierre Shale:			
	Shale, gray	6	145

155-64-34bcd
Test hole 201

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, light-brown	19	21
	Till, gray	22	43
	Sand and gravel, gray	2	45
	Till, gray	13	58
	Sand, coarse, and gravel, fine, gray, mainly detrital shale, very clayey	16	74
Pierre Shale:			
	Shale, gray	6	80

155-64-34bdd1
Test hole 200

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, or clay, gray	1	2
	Till, light-brown	16	18
	Till, gray	19	37
	Sand and gravel, gray	1	38
	Till, gray	26	64
	Sand, coarse, and gravel, fine, gray, mainly detrital shale, clayey	18	82
	Till, gray	13	95
	Sand, coarse and gravel, fine, gray, mainly detrital shale, clayey	11	106
	Till, gray	32	138
Pierre Shale:			
	Shale, gray	7	145

155-64-34bdd2
Test hole 204

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-gray	1	2
	Till, light-brown	18	20
	Till, gray	11	31
	Gravel and sand, gray, mainly detrital shale	2	33
	Till, gray	113	146
Pierre Shale:			
	Shale, gray	4	150

155-64-34bdd3
Test hole 199

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, brown-gray	2	3
	Till, light-brown	14	17
	Till, gray	13	30
	Sand and gravel	2	32
	Till, gray	18	50
	Sand, very coarse, shale and gravel, gray, fine, mainly detrital shale	15	65
	Gravel, gray, coarse, mainly detrital shale	15	80
	Till, gray	48	128
Pierre Shale:			
	Shale, gray	7	135

155-64-34bdd4
Test hole 198

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, or clay, light-gray	5	6
	Till, gray-brown	11	17
	Till, gray	10	27
	Sand, gray, mainly detrital shale, clayey	3	30
	Till, gray, sandy	13	43
	Sand and gravel, gray, mainly detrital shale	27	70
	Sand and gravel, gray, clayey, mainly detrital shale	15	85
	Gravel and sand, gray, mainly detrital shale	5	90
	Till, gray	40	130
Pierre Shale:			
	Shale, gray	5	135

155-64-34ccc
Test hole 159

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Sand, brown, coarse and medium	3	5
	Till, brown	19	24
	Sand, gray, very coarse, mainly detrital shale	5	29
	Till, gray	2	31
Pierre Shale:			
	Shale, gray	29	60

155-64-34dcd
Test hole 202

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-gray	4	5
	Till, light-brown	13	18
	Till, gray	14	32
	Sand, coarse, and gravel, fine, gray, about one-half detrital shale, clean	5	37
	Till, gray	21	58
Pierre Shale:			
	Shale, gray	7	65

155-64-34ddc
Test hole 151

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, brown	15	16
	Sand, brown, medium to coarse, some detrital shale	3	19
	Till, gray	46	65
Pierre Shale:			
	Shale, gray	10	75

TABLE 1.--Logs of wells and test holes -- Continued

155-64-35adc
Test hole 155

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay, light-brown	8	9
	Till, light-brown	7	16
	Sand and gravel, light-brown, very clayey	6	22
	Till, gray	29	51
	Sand and gravel, gray, very clayey	3	54
	Till, gray	6	60
	Sand and gravel, gray, mainly detrital shale, clayey	5	65
	Till, gray	50	115
Pierre Shale:			
	Shale, gray	5	120

155-64-35bab
Test hole 154

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till or clay, gray	2	4
	Till, light-brown	11	15
	Till, gray	36	51
	Sand, coarse, and gravel, fine, gray, mainly detrital shale, very clean	9	60
	Sand, coarse, and gravel, coarse, mainly detrital shale, very clean	6	66
	Till, gray	50	116
	Till, gray, sandy and gravelly	5	121
Pierre Shale:			
	Shale, gray	4	125

155-64-35bcd
Test hole 153

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black and clay, gray	2	2
	Till, light-brown	15	17
	Till, gray	39	56
	Sand, very coarse, and gravel, fine, gray, clean	9	65
	Till, gray	11	76
Pierre Shale:			
	Shale, gray	10	86

TABLE 1.--Logs of wells and test holes -- Continued

155-64-35cdc
Test hole 152

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Clay, gray-brown	4	6
	Till, light-brown	10	16
	Till, gray	2	18
	Sand and gravel, gray	2	20
	Till, gray	31	51
Pierre Shale:			
	Shale, gray	9	60

155-65-35bac
Test hole 651

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Till, yellowish-gray	40	40
	Till, light-gray	12	52
Pierre Shale:			
	Shale, light-gray, silty	8	60

155-66-7aaa
Test hole 347

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay and silt, light-brown, sandy	2	3
	Sand, fine to medium	26	29
	Till, gray	17	46
	Sand, coarse and very coarse, gray, clayey and gravelly	4	50
	Till, gray	26	76
	Till, gray, numerous pieces of detrital lignite	14	90
	Till, gray	9	99
	Till, gray, numerous pieces of detrital lignite	8	107
	Till, gray	36	143
Pierre Shale:			
	Shale, gray	7	150

155-67-1ddd
Test hole 346

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	23	24
	Sand, coarse to very coarse, and gravel, fine, gray-brown, clayey	7	31
	Till, gray	58	89
	Sand, medium to coarse, mainly detrital shale, clayey and gravelly	13	102
	Till, gray, sandy and gravelly	3	105
Pierre Shale:			
	Shale, gray	5	110

155-67-3ddd
Test hole 349

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Till, or silt and clay, brown to light-gray, gravelly	8	10
	Sand, very coarse, and gravel, fine, light-brown, clayey	7	17
	Till, gray, sandy and gravelly	13	30
	Till, gray	71	101
	Sand, coarse to very coarse, and gravel, fine, gray, about one-half detrital shale, includes some clayey beds	23	124
Pierre Shale:			
	Shale, gray	6	130

TABLE 1.--Logs of wells and test holes -- Continued

155-67-11aaa
Test hole 348

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1/2	1/2
	Till, light-brown	12 1/2	13
	Till, gray	46	59
	Sand, medium to very coarse, and gravel, fine to medium, coarser material is mainly detrital shale	29	88
	Sand, fine to very coarse, mainly detrital shale	17	105
	Sand, medium to very coarse, and some gravel, fine, coarser material is mainly detrital shale, clayey	18	123
Pierre Shale:			
	Shale, gray	7	130

155-67-14cdd
Test hole 350

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Till, light-brown, sandy and gravelly	6	6
	Till, gray	57	63
	Sand, medium to very coarse, and some gravel, fine, gray, mainly detrital shale, clayey	7	70
	Sand, coarse to very coarse, mainly detrital shale	5	75
	Sand, coarse to very coarse, and gravel, fine to medium, about one-half detrital shale	51	126
Pierre Shale:			
	Shale, gray	4	130

TABLE 1.--Logs of wells and test holes -- Continued

155-67-26aaa
Test hole 352

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	5	6
	Till, gray	37	43
	Till, gray-brown	4	47
	Till, gray	4	51
	Sand and gravel, gray, very clayey	3	54
	Till, gray	17	71
	Sand and gravel, gray, very clayey	3	74
	Till, gray	17	91
Pierre Shale:			
	Shale, gray	9	100

155-67-26ddc
Test hole 351

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, light-brown	5	6
	Till, gray	15	21
	Sand, gray, coarse to very coarse, about one-half detrital shale, clayey	5	26
	Till, gray	49	75
	Clay, silt and very fine sand, gravelly, gray	18	93
Pierre Shale:			
	Shale, gray	7	100

156-66-30bbb
Test hole 344

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1/2	1/2
	Silt and sand, light-brown	2 1/2	3
	Till, gray-brown	5	8
	Till, gray	15	23
	Sand, gray, medium, very clayey	4	27
	Till, gray, gravelly	9	36
	Sand, coarse, and gravel, fine, gray, very clayey	4	40
	Till, gray	50	90
	Sand, coarse to very coarse, and gravel, fine, gray, about one-half detrital shale, very clayey	24	114
Pierre Shale:			
	Shale, gray	11	125

156-67-36ddd
Test hole 345

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Till, or silt and clay, light-brown, gravelly	4	5
	Till, light-brown	12	17
	Till, gray	39	56
	Till, or, sand, silt and clay, gray, gravelly	16	72
	Sand, medium to very coarse, and gravel, fine to medium, about one-half detrital shale	9	81
	Till, gray	15	96
Pierre Shale:			
	Shale, gray	4	100

TABLE 2.--Records of

Depth of well and depth to water: Depths given to hundredths or tenths are measured; those given in units only are reported.

Date of measurement: For measured depths to water. For reported depths to water this is date of report, not date of measurement.

Use of water: D, domestic; Ind, industrial; Irr, irrigation; M, municipal; O, observation; S, stock; T, test hole only, water not used; U, unused.

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
150-62					
1dad	Mrs. Maude	8	12	Du	....
2dbb	....	.....	....	Dn	....
3aaa	USBR auger hole 416	24	....	Dr	1952
3abc	Irwin Johnson	9	24	Du	....
3abd	Earl Johnson	6	1¼	Dn	....
3aca	S. Clute	12	30	Du	....
3acb	C. C. Brudeseth	10	1¼	Dn	....
3ddd	USBR auger hole 417	11	....	Dr	1952
7bab	M. E. Quam	8	12	Du	1908
8bbb	USBR auger hole 412	10	....	Dr	1952
8dcc	Irvin Newhouse	17	1¼	Dn	....
17baa	Norman Forde	17	1¼	Dn	....
17caa	Gerald Forde	18	2	Dn	....
18aaa	USBR auger hole 413	19	....	Dr	1952
21lba	John Hanson	12	....	Dn	....
22aaa	E. E. Jurgenson	.....	24	Du	....
22ddd	USBR auger hole 418	13	....	Dr	1952
24aaa	USBR auger hole 419	9	....	Dr	1952
24bcc	Earling Steiberg	10	36	Du	....
24da	A. B. Dahl	67	36	Dr	....

wells, springs, and test holes

Geologic source: Kd, Dakota Sandstone; Kp, Pierre Shale; Qg, glacial drift except outwash deposits; Qo, outwash deposits.

Elevation at land surfaces: Land surface elevations at most USGS test holes and USBR auger holes were determined by instrumental leveling; other elevations were determined from topographic maps and may be in error by several feet.

Type of well: Du, dug; Dr, drilled; Dn, driven.

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
3.90	10-13-50	D	Qo	1,462	Water reported to be very good. Supply not affected during drought in 1930's.
5.45	10-13-50	U	Qo	1,472	
3.9	6-26-52	O	Qo	.....	
7.2	4- 3-53	O	Qo	1,470	See chemical analysis.
4	10-26-50	S	Qo	1,472	Water reported hard, adequate.
4.50	10-27-50	D	Qo	1,472	..Do....
6	10-27-50	D	Qo	1,472	..Do....
6	10-26-50	Irr	Qo	1,472	Used to irrigate yard and garden. Water reported hard, adequate.
4.5	6-26-52	O	Qo	1,475	
6.0	4- 3-53				
......	10-13-50	D,S	Qo	1,470	Good supply during drought years.
5.0	6-26-52	O	Qo	1,471	See chemical analysis.
6.5	4- 6-53				
14	10-14-50	D,S	Qo	1,470	Good supply during drought years.
14	10-15-50	D,S	Qo	1,470	
6	10-14-50	D,S	Qo	1,462	..Do....
15.3	6-26-52	O	Qo	1,478	See chemical analysis.
16.3	4- 6-53				
......	10-13-50	S	Qo	1,460	
5.82	10-13-50	D,S	Qo	1,463	
5.5	6-26-52	O	Qo	1,463	Depth to shale, 13 ft. Till at 12 ft.
6.8	4- 3-53				
3.6	6-26-52	O	Qo	1,460	Till at 9 ft.
3.4	4- 3-53				
8.90	10-13-50	D,S	Qo	1,462	Good supply during drought years.
49.00	10-13-50	S	..	1,464	

TABLE 2.--Records of wells,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
150-63					
1ada	James Forde	20	....	Dn	1930
1bcc	Test hole 333	100	5	Dr	1950
1dba	Calmet Loe	16	....	Dn	1906
2bbb	State of N. Dak.	12	42 x 42	Du	1934
2ddd	USBR auger hole 409	15	....	Dr	1952
3cbb	E. T. Brudeseth	14	....	Dn	1927
4daa	Ruth Stubson	11	....	Du	1945
6ccd1	Elmer Kolstead	28.6	36	Du	1928
6ccd2	..do....	25.8	24	Du	1911
6dcd1	J. E. Langley	27.6	24	Du	1935
6dcd2	..do....	10.4	72	Du	1935
7bbb	Mrs. J. Olson	50.6	18	Dr	1912
9abb1	Iver Johnson	22	....	Dn	....
9abb2	USBR auger hole 406	13	....	Dr	1952
9bdd	Jacobson estate	24	24	Du	1917
10bcc	Emil Hultgren	16	....	Dn	1935
10dda	Test hole 332	100	5	Dr	1950
13ada	Arnie Wessell	9.7	36 x 36	Du	1928
13bbb	USBR auger hole 408	17	....	Dr	1952
14bab	Henry Kiefer	89	....	Dr	....
15cbc	....	Spring	....	..	....
15ccb	....	Spring	....	..	....
16bbb	USBR auger hole 407	12	....	Dr	1952
16dad	....	Spring	....	..	....
17abb	Walter Hatlestad	14.8	....	Dn	....
18cad	....	33.2	18	Dr	....
19bdd	Martin Christianson	35	....	Du	1916

springs, and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
10	8-25-50	D,S	Qo	1,467	See chemical analysis.
......	....	T	..	1,470	See log. Depth to shale, 82 ft.
10	8-25-50	D	Qo	1,470	Water reported moderately hard, adequate.
5.95	8-25-50	S	Qo	1,473	..Do....
9.4	6-26-52	O	Qo	1,475	
10	8-25-50	D	Qo	1,480	..Do....
9	8-25-50	S	Qo	1,470	Water reported soft, adequate.
20.92	8-26-50	D,S	Qg	1,500	Water reported moderately hard, adequate.
11.10	8-26-50	D,S	Qg	1,500	..Do....
21.95	8-26-50	D,S	Qg	1,495	Water reported soft, adequate.
6.08	8-26-50	S	Qg	1,495	..Do....
43.15	8-26-50	D,S	Qg	1,510	Water reported moderately hard, adequate.
20	8-25-50	D	Qo	1,476	Water reported soft, adequate.
10.2	4- 6-53				
9.1	6-26-52	O	Qo	1,475	
15.21	8-25-50	D,S	Qo	1,476	Water reported moderately hard, adequate.
13	8-28-50	D,S	Qo	1,476	Water reported soft, adequate.
......	....	T	..	1,477	See log. Depth to shale, 90 ft.
5.80	8-25-50	S	Qo	1,460	Water reported moderately hard, adequate.
10.7	6-26-52	O	Qo	1,477	
12.0	4- 6-53				
70	8-26-50	D,S	Qg	1,510	..Do....
......	....	...	Qg	1,400	See chemical analysis.
......	....	...	Qg	1,400	
7.2	6-26-52	O	Qo	1,475	
8.0	4- 6-53				
......	....	...	Qg	1,400	..Do....
10.10	8-26-50	D,S	Qo	1,480	Water reported hard, adequate.
25.17	8-26-50	U	Qg	1,490	
25	8-26-50	D,S	Qg	1,510	..Do....

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
150-64					
5aaa	Test hole 339	110	5	Dr	1950
151-62					
1dcd1	Glenn Wyman	235	5	Dr	1940
1dcd2	..do....	48	24	Dr	....
2abc	H. J. Anderson	268	3	Dr	1947
2ccd	Olaf Joramo	67.0	48	Du	1910
3add	Test hole 337	140	5	Dr	1950
3bbb	Marvin Christopherson	21.5	14	Dr	1947
3bdc	Henry Baker	55.3	22	Dr	1929
3dad	J. P. Murphy	310	6	Dr	....
4bbb	Louise Longie	Spring	....	..	....
5adc	....	59.0	24	Du	....
6acc	S. Senger	72.7	4	Dr	1915
7ccc	Ingermund Peterson	52	22	Du	....
7cdc	W. Peoples	50.8	....	Dr	....
8dcd	Mary Rustin	63.5	22	Dr	1925
9aad	Alfred Brennan	50.6	....	Dr	1915
9baa	Donald Wessell	32.5	24	Du	....
9dcd1	Charles Christopherson	187.6	4	Dr	....
9dcd2	..do....	50.4	36	Du	1937
13cdc	A. J. Pare	26.2	30	Du	....
14abb	..do....	32.4	30	Du	1936
15aaa	Jim O'Hara	23.0	48	Du	....
15ccd	G. F. Drews	12.7	40	Du	....
16cbc	Test hole 336	50	5	Dr	1950
19aaa	USBR auger hole 411	24	....	Dr	1952
19aba	M. J. Hartle	22.2	48 x 48	Du	....

and test holes -- Continued

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
....	....	T	..	1,542	See log. Depth to shale, 97 ft.
62.80	7- 7-50	S	Qg	1,515	Water reported hard, adequate. Aquifer, gravel above shale. Depth to shale, 235 ft.
......	....	U	Qg	.....	Water unfit for stock.
116	7- 7-50	D,S	Qg	1,550	Aquifer, quicksand. Water reported hard, adequate.
65.03	7- 7-50	D,S	Qg	1,547	Water reported moderately hard, inadequate during drought years.
......	....	T	..	1,611	See log.
5.60	7- 7-50	S	Qg	1,475	Water reported moderately hard, adequate.
53.70	7- 7-50	D,S	Qg	1,517	Water reported hard, adequate.
109.27	7- 7-50	D,S	Qg	1,555	Water reported hard, inadequate.
......	....	D	Qg	.....	
56.41	7- 8-50	...	..	1,497	
46.15	8-19-50	D,S	Qg	1,470	Water reported moderately hard, adequate.
50.0	8-16-50	D,S	Qg	1,501	..Do....
44.03	8-11-50	U	Qg	1,445	
59.26	8-10-50	D,S	Qg	1,525	Water reported hard, adequate.
42.85	8- 8-50	D,S	Qg	1,522	..Do....
20.47	8- 8-50	D	Qg	1,496	..Do....
35.45	8-10-50	D,S	Qg	1,522	Aquifer, fine sand and clay. Water reported hard, adequate.
49.39	8-10-50	D,S	Qg	1,522	Aquifer, sand. Water reported hard, inadequate.
18.90	8- 9-50	U	Qo	1,490	
30.40	8- 9-50	D	Qo	1,502	Aquifer, sand.
17.50	8- 9-50	S	Qo	1,492	Water reported hard, adequate.
5.80	8- 9-50	D,S	Qo	1,472	..Do....
......	....	T	..	1,490	See log. Depth to shale, 43 ft.
19.9	6-17-52	O	Qo	1,486	See chemical analysis.
21.26	8-12-50	D,S	Qo	1,483	Water reported moderately hard, adequate.

TABLE 2.--Records of wells,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
151-62 (Cont.)					
20ccb	Test hole 335	125	5	Dr	1950
20cdc	Rudolph Swenson	7.4	48	Du	1947
21aad	G. F. Drews	13.8	48 x 48	Du	....
23bbb	School	9.5	40	Dr	....
25abb	Clarence Rude	24.4	36	Du	....
26bba	USBR auger hole 415	13	....	Dr	1952
27ddd	Elwood Christopherson	15	24	Du	....
29cbb	E. W. Kjorlein	9.8	2	Dn	1942
30aad	..do....	14.1	42 x 42	Du	....
31dac	Henry Forde	10	....	Dn	....
33cad	E. W. Kjorlein test 2	100	....	Dr	1953
34ada	Bert Verstag	185	6	Dr	....
34cad	Joe Jormo	15.4	40	Du	....
36acc	Ray Hass	225	....	Dr	1940
151-63					
1caa	Ray Papachek	23.4	36 x 36	Du	....
1ccd	..do....	32.8	36	Du	1943
2aaa	F. E. Clift	165	4	Dr	1915
2ddc	Ben & Phyllis Papachek	184.2	4	Dr	....
3bbb1	Herman Anderson	107	....	Dr	1914
3bbb2	..do....	200	4	Dr	1932
3cdd	August Carlson	62.8	24	Du	....
bad	Jack Beckstrand	200	5	Dr	1919
cbc	Albert G. Berg	135	4	Dr	1916

springs, and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
......	....	T	..	1,465	See log.
6.80	8-12-50	D,S	Qo	1,470	Water reported moderately hard, adequate.
9.80	8- 9-50	U	Qo	1,476	
7.00	8- 9-50	D	Qo	1,471	
16.70	8- 9-50	D,S	Qo	1,483	Water reported hard, adequate.
5.0	6-26-52	O	Qo	1,469	See chemical analysis.
11	8- 9-50	S	Qo	1,464	Water reported moderately hard, adequate.
6.60	8-10-50	D,S	Qo	1,465	
......	....	S	Qo	1,478	Water reported hard, adequate.
......	....	D	Qo	1,469	..Do....
......	....	T	Qo	1,472	Irrigation well, subsequently constructed at this location. Reportedly capable of yielding several hundred gpm. See log.
12	8-12-50	D,S	Kp	1,465	Aquifer reported to be fine sand. Water reported soft, adequate.
7.87	8-10-50	S	Qo	1,465	Water reported hard, adequate.
13	8- 9-50	D,S	Kp	1,467	Water reported moderately hard, adequate.
19.81	8-18-50	U	Kd	1,495	
28.35	8-18-50	D,S	Kd	1,495	Water hardness reported 20 grains per gallon; supply adequate. Aquifer, coarse gravel.
50	8-18-50	D,S	Qg	1,500	Water reported hard, adequate.
58.03	8-18-50	D,S	Kp	1,517	Water reported soft, adequate.
40	8-23-50	D,S	Kp	1,500	Water reported moderately soft, adequate; aquifer, gravel.
100	8-23-50	D,S	Kp	1,500	Water reported soft, adequate. Reported clay 0-100 feet, shale, 100-200 feet.
56.92	8-21-50	D,S	Kd	1,515	Water reported hard, adequate.
100	8-23-50	D	Kp	1,510	Water reported soft, adequate.
39.28	8-18-50	D,S	Kd	1,500	Water reported hard, adequate.

TABLE 2.--Records of wells,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
151-63 (Cont.)					
4cdd	Gus Beckstrand	178	5	Dr	1918
6cbb	Ralph Berg	36.1	36	Dr	....
7aac	Herman Thelen	57.8	24	Du	....
7abb	Marlin Pulst	118.0	4	Dr	....
8adc	Bob Wood	112.3	4	Dr	....
10ccc1	..do....	28	4	Dr	1948
10ccc2	..do....	7.5	60 x 36	Du	1942
10ccc3	Test hole 415	160	5	Dr	1951
10ccc4	USBR auger hole 403	18	.....	Dr	1952
12bcc	C. W. Moran	169.3	4	Dr	1925
13add	Carl Swenson	30	.....	Dn	....
14aaa1	R. L. Schlieve	150	4	Dr	1928
14aaa2	..do....	28	36	Du	1948
14aaa3	Test hole 338	100	5	Dr	1950
14aaa4	USBR auger hole 410	24	....	Dr	1952
14dad	John Manage	47.7	4	Dr	1952
15aaa	S. Papachek	15.1	24	Dr	....
15cbb	Alfred Carlson	32	24	Du	1938
16daa	Test hole 416	85	5	Du	1907
16ddd	Test hole 414	100	5	Dr	1951
7aab	Melvin Beckstrand	15.5	24	Du	....
7caa1	Reeves Bros.	50	4	Dr	1937
7caa2	..do....	175	5	Dr	1920
3bbd	Elizabeth Frederick	47.9	24	Du	1920
9aba	Test hole 406	40	5	Dr	1951
0bcb	Test hole 407	150	5	Dr	1951
0bcd	Test hole 408	120	5	Dr	1951
0cac	Test hole 409	145	5	Dr	1951

springs, and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
70	8-18-50	D,S	Kp	1,525	Water reported soft, adequate. Aquifer reported to be gravel.
33.10	8-23-50	U	Kd	1,490	Water reported hard.
55.03	8-28-50	D,S	Kd	1,500	Water reported hard, adequate. Aquifer fine sand and gravel
39.57	8-23-50	D,S	Kp	1,500	Water reported soft, adequate. Aquifer reported to be sand.
44.93	8-17-50	U	Kp	1,505	
7	8-17-50	D	Qo	1,470	Hardness reported to be 38 grains per gallon. Aquifer, gravel.
6.29	8-17-50	S	Qo	1,470	Water reported hard, adequate. Aquifer, fine sand.
......	....	T	..	1,471	See log. Depth to shale, 147 ft.
12.1	6-26-52	O	Qo	1,469	
12.9	3-30-53				
60.3	8-18-50	D,S	Kp	1,525	Water reported soft, adequate.
22.00	8-12-50	D,S	Qo	1,490	Water reported hard, adequate.
80	8-12-50	S	Kp	1,486	Water reported soft, salty to taste, adequate.
21	8-12-50	D,S	Qo	1,486	Water reported hard, adequate.
......	....	T, O	Qo	1,488	See log. Depth to shale, 97 ft.
19.9	6-26-52	O	Qo	1,488	
19.60	8-12-50	U	Qo	1,480	
10.31	8-17-50	S	Qo	1,472	Water reported hard, adequate.
23	8-17-50	D,S	Qo	1,482	..Do....
......	....	T	..	1,480	See log. Depth to shale, 79 ft.
......	....	T	..	1,464	See log. Depth to shale, 95 ft.
5.39	8-17-50	S	Qo	1,485	Water reported hard, adequate.
35	8-17-50	D	Kp	1,500	Water reported soft, adequate.
75	8-17-50	S	Kp	.....	..Do....
42.09	8-28-50	S	Kp	1,490	..Do....
......	....	T	..	1,477	See log. Depth to shale, 26 ft.
......	....	T	Qo	1,468	See log. Depth to shale, 145 ft.
......	....	T	..	1,478	See log. Depth to shale, 107 ft.
......	....	T	..	1,481	See log. Depth to shale, 133 ft.

TABLE 2.--Records of wells,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
151-63 (Cont.)					
20cda	Test hole 422	195	5	Dr	1951
20cdd1	Test hole 423	190	5	Dr	1951
20cdd2	Test hole 454	125	5	Dr	1951
20cdd3	Test hole 455	125	5	Dr	1951
20cdd4	Test hole 456	140	5	Dr	1951
20cdd5	Test hole 486	150	5	Dr	1951
20cdd6	Test hole 501	186	5	Dr	1952
20cdd7	Test hole 502	188	5	Dr	1952
20cdd8	Test hole 503	40	5	Dr	1952
20cdd9	Test hole 504	189	5	Dr	1952
20cdd10	Test hole 505	40	5	Dr	1952
20cdd11	Devils Lake city test well 1	135	12	Dr	1951
20cdd12	Devils Lake city test well 2	155	12	Dr	1952
20dcc	Test hole 404	194	5	Dr	1951
21daa	Test hole 417	95	5	Dr	1951
22bcc	USBR auger hole 404	18	....	Dr	1952
22bdb	Sigrid Carlson	10.6	24 x 24	Dr	....
23dcd	Fred Maurer	14	$1\frac{1}{4}$	Dn	1934
25dd	E. W. Kjorlien test 3	84	5	Dr	1953

springs, and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
......	....	T	..	1,483	See log. Depth to shale, 188 ft.
......	....	T	..	1,482	See log. Depth to shale, 186 ft.
19.08	8-14-52	O	Qo	1,482	See log.
18.96	8-14-52	O	Qo	1,484	..Do....
19.01	8-14-52	O	Qo	1,483	..Do....
18.62	8-14-52	O	Qo	1,482	See log. Depth to shale, 139 ft.
19.95	8-14-52	O	Qo	1,483	See log. Depth to shale, 178 ft.
19.07	8-14-52	O	Qo	1,482	See log. Depth to shale, 183 ft.
19.23	8-14-52	O	Qo	1,482	See log.
19.99	8-14-52	O	Qo	1,483	See log. Depth to shale, 178 ft.
20.26	8-14-52	O	Qo	1,484	See log.
19.02	8-14-52	T,O	Qo	1,482	See log and chemical analysis. May be used later for municipal supply for Devils Lake.
19.02	8-14-52	T,O	Qo	1,482	See log. May be used later for municipal supply for Devils Lake.
......	....	T	..	1,480	See log. Depth to shale, 187 ft.
......	....	T	..	1,477	See log. Depth to shale, 87 ft.
14.0	6-26-52	O	Qo	1,477	See chemical analysis.
14.7	3-30-53				
10.20	8-17-50	U	Qo	1,470	
10	11-4-50	D,S	Qo	1,470	
6.40	7-17-50	T	Qo	1,470	See log. Depth to shale, 42 ft. This test hole subsequently drilled larger to develop irrigation well 42 feet deep, 17 inches in diameter. Reportedly pumped 120 gpm. with 6.91 feet drawdown.

TABLE 2.--Records of wells,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
151-63 (Cont.)					
26dab	Wilfred Peoples	3.4	36 x 36	Du	1943
27ccd1	Mike Bosch	15	..	Dn	....
27ccd2	..do....	15	..	Dn	....
28aaa	Test hole 418	200	5	Dr	1951
28add	Devils Lake city test 3	78	4	Dr	1951
28ccb	Test hole 412	90	5	Dr	1951
28ccd	Test hole 410	200	5	Dr	1951
28dda	USBR auger hole 405	16	..	Dr	1952
29aac1	Test hole 411	210	5	Dr	1951
29aac2	Test hole 424	80	6	Dr	1951
29abb1	Test hole 419	140	5	Dr	1951
29abb2	Devils Lake city supply well No. 3	...	12	Dr	1961
29abc1	Devils Lake city supply well No. 1	112	12	Dr	1961
29abc2	Devils Lake city supply well No. 4	89	12	Dr	1962
29acb	Devils Lake city supply well No. 2	110	12	Dr	1961
29baa1	Test hole 420	190	5	Dr	1951
29baa2	Test hole 487	150	5	Dr	1951
29bba	Gothard Jacobson	22	..	Dn	1940
29daa	Test hole 405	140	5	Dr	1951
30bbb	Carl Jacobson	46	..	Du	1934
31dad	Ester and Warren Smith	14.1	36 x 36	Du	1921
32cbb	Clarence Molstead	18	..	Dn	1945
33dbb	Test hole 413	110	5	Dr	1951
34bbc	C. J. Monson	18	..	Dn	1944

springs, and test holes

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
2.29	8-14-50	D	Qo	1,470	Water reported hard, adequate.
10	8-14-50	D	Qo	1,470	..Do....
10	8-14-50	S	Qo	1,470	Water reported moderately soft, adequate.
.....	....	T	..	1,468	See log.
.....	....	T	Qo	1,476	See log and chemical analysis. Depth to shale, 75 ft.
.....	....	T	..	1,468	See log. Depth to shale, 83 ft.
.....	....	T	..	1,465	See log. Depth to shale, 194 ft.
10.3	6-26-52				
11.7	3-30-53	O	Qo	1,473	
.....	....	T	..	1,481	See log. Depth to shale, 203 ft.
15.87	8-17-51	O	Qo	1,481	See log. Hole cased with 6 inch pipe and 5 foot screen, to 67 feet for use as recorder well. Location is very near test hole 411.
.....	....	T	..	1,482	See log. Depth to shale, 132 ft.
21.4	11-15-61	M	Qo	.....	See table 3 for further data.
16.6	8- 9-61	M	Qo	.....	..Do....
17.7	5-14-62	M	Qo	.....	..Do....
14.6	9-12-61	M	Qo	.....	..Do....
.....	....	T	..	1,480	See log. Depth to shale, 181 ft.
18.99	8-14-52	O	Qo	1,483	See log.
15	8-28-50	D,S	Qo	1,480	See chemical analysis.
.....	....	T	..	1,476	See log. Depth to shale, 127 ft.
31	8-28-50	D,S	Qg	1,500	Water reported hard, adequate.
8.05	8-28-50	D,S	Qo	1,475	..Do....
9.6	8-28-50	D,S	Qo	1,475	Water reported moderately soft, adequate.
.....	....	T	..	1,474	See log. Depth to shale, 106 ft.
10	8-14-50	D	Qo	1,471	Water reported moderately hard, adequate.

TABLE 2.--Records of wells,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
151-63 (Cont.)					
34bca	G. H. Pincott	15.5	28	Du	1930
34bcd	John Kolstead	8.6	36	Du	1905
34bdb	Albert Klinkhammer	35	10	Dr	1930
34bdc	G. H. Pincott	10.3	36 x 36	Du	1943
34cac	Great Northern Railway	14	..	Dn	....
34cba	G. H. Pincott	7.5	36 x 36	Du	1948
34cdb	Elmer Alberg	11	..	Dn	1933
34dab	Siever Enstead	20	..	Dn	1910
34dbc	Great Northern Railway	10.7	44 x 44	Du	....
36ada	Test hole 334	140	5	Dr	1950
151-64					
1aac	Myron C. Munger	65	4	Dr	1946
1dbc	Miles L. Johnson	51.3	36	Du	....
2acc	Clifford Carlson	26.3	36	Du	....
2bda	Morris Brown	65	24	Dr	....
2cab	School District	11.7	24 x 24	Du	....
2cac	Tokio Community	44.0	48	Dr	1939
2cba	Joe Redday	32.8	24	Du	....
2cbd	Grace Wallace	36.7	..	Du	1940
3aad	Warren Adams	23.4	..	Du	....
4cdd	Henry One Bear	23.1	24	Dr	....
5ccb	Jim Cuddigan	18	36	Du	1942
5ddd	Anton Kurtz	64	24	Du	....
6bad	John Thompson	49.9	18	Dr	....
7aaa	E. J. Lander Co.	33	18	Dr	1912
7cbb	Melvin Morris	45	24	Dr	1944
10aaa	George Ross	40.7	24	Dr	....
10ada	Christine Ross	40.5	36	Du	....
10ccc	Boy Scouts of America	87	4	Dr	1947
11cbb	....	15.4	36	Du	....
11ccc	Frank Jetty	9.1	48 x 48	Du	....
14bbb	Rose Marie Guy	9.3	18	Du	....
14dbd	Edmond Frederick	20	36	Du	1945
15bac	Bill Nortz	18	..	Du	....
15bba	..do....	10.2	36 x 36	Du	....
15bbd	Floyd Johnson	14	30	Du	1948
15bdb	H. Curry	24	24	Du	....
16aaa	Woodlake Park	13.3	..	Dr	....
16dcc	Louis Tornow	34.3	48 x 48	Du	1946
18bbbl	Test hole 341	150	5	Dr	1950

springs, and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
5.20	8-14-50	D,S	Qo	1,471	Water reported hard, adequate.
5.24	8-14-50	D	Qo	1,471	Water reported hard, inadequate.
8	8-15-50	D	Qo	1,471	Water reported hard, adequate.
6.65	8-15-50	D	Qo	1,471	..Do....
5	8-14-50	D	Qo	1,471	Water reported moderately soft, adequate.
4.60	8-14-50	S	Qo	1,471	Water reported moderately hard, adequate.
9	8-16-50	D	Qo	1,471	Water reported hard, adequate.
10	8-17-50	D,S	Qo	1,471	..Do....
5.89	8-16-50	S	Qo	1,471	
.....	....	T	..	1,468	See log.
35	10-3-50	D	Qg	1,450	Water reported hard, adequate.
44.36	9-27-50	D,S	Qg	1,500	Water reported moderately hard, adequate.
18.3	8-22-47	...	Qg	1,505	
30	9-28-50	D,S	Qg	1,500	Water reported hard, adequate.
2.66	9- 1-50	D	Qg	1,498	
36.48	9- 1-50	M	Qg	1,500	Water reported moderately soft.
25.13	9- 1-50	D,S	Qg	1,494	Water reported hard, adequate.
28.96	9- 1-50	D,S	Qg	1,500	..Do....
18.95	9-27-50	U	Qg	1,480	
14.80	9-25-50	U	Qg	1,545	
15	9-29-50	D,S	Qg	1,560	Water reported hard, adequate.
55	9-29-50	D,S	Qg	1,575	..Do....
41.71	10-9-50	D,S	Qo	1,580	
29	9-22-42	D,S	Qo	1,580	Water reported hard, inadequate.
30	9-29-50	D,S	Qo	1,590	Water reported moderately hard, adequate.
17.4	8-23-47	...	Qg	1,490	
14.95	10-3-50	S	Qg	1,510	Water reported hard, adequate.
10	10-11-50	D	Qg	1,540	Water reported soft, adequate.
7.12	10-3-50	D,S	Qg	1,492	
6.25	10-3-50	D,S	Qg	1,510	
7.15	10-3-50	U	Qg	1,520	
17.1	8-25-47	D,S	Qg	1,535	
12	10-10-50	D	Qg	1,530	Water reported hard, adequate.
8.85	10-10-50	U	Qg	1,540	
10	10-10-50	D	Qg	1,525	..Do....
6	10-10-50	D	Qg	1,525	..Do....
5.35	9-29-50	D	Qg	1,530	
31.52	8-31-50	S	Qo	1,580	..Do....
.....	....	T	..	1,593	See log. Depth to shale, 142 ft.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
151-64 (Cont.)					
18bbb2	N. H. Nelson	46.8	36 x 36	Du	....
20cbc	Vernon Hanson	68.7	6	Dr	1940
21cbc	State of North Dakota	53.5	36	Du	1920
21dda	John Chance	19.7	..	Du	1947
22cdc	August Possen	35.2	48	Du	1925
23bad	Russell Hopkins	9	36	Du	....
24aca1	C. H. Carlson	15	24	Du	....
24aca2	..do....	58	18	Dr	....
25bda	Jim Montieth	33.9	24	Dr	....
26abc	Clarence Tiegen	31.4	24	Du	....
26bba	W. S. Williams	200	6	Dr	....
28aca	E. R. Brininger	14	48 x 48	Du	1946
29bbb	Test hole 340	130	5	Dr	1950
29bcc	Ray Kester	55.4	18	Dr	....
29cba	A. Doyle	49.0	18	Dr	1910
31aaa	USBR auger hole 402	24	..	Dr	1952
34aaa	George Wallace	24	18	Dr	....
35abb	Joe Merrick	53.0	24	Dr	....
151-65					
2aaa	Test hole 343	130	5	Dr	1950
2dcc	Test hole 342	100	5	Dr	1950
4cdc	Emil Nelson	20	36 x 36	Du	....
4dcd	Bernard Haukom	20.1	48 x 48	Du	1935
5bcd	Elias Bodal	30	24	Du	1908
5ddd1	H. Belcher	20	18	Du	....
5ddd2	..do....	22	36	Du	....
6bcc	A. Garness	60	..	Du	....
6cbb	E. M. Zetter	50	36	Du	....
7abb	..do....	30.7	24 x 24	Du	....
7bcc	Albert Thompson	18.7	36	Du	....
8bcc	Clarence Cetter	10	24	Du	....
9aba	Bernard Haukom	22	24	Du	1913
9dad	Frank E. Harris	20	48	Du	1906
12ada1	F. R. Stevens Estate	56.5	48 x 48	Du	1938
12ada2	..do....	55	48 x 48	Du	1920

and test holes -- Continued

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
44.17	8-29-50	U	Qo	1,590	
32.78	8-30-50	D,S	Qo	1,584	
40.32	8-31-50	D,S	Qo	1,584	Water reported hard, adequate.
17.84	8-31-50	D,S	Qo	1,560	Water reported soft, adequate.
32.98	8-31-50	D,S	Qg	1,585	Water reported hard, adequate.
2	9-29-50	D,S	Qg	1,525	Water reported soft, adequate.
0	10-10-50	D,S	Qg	1,490	
15	10-10-50	D,S	Qg	1,505	
30.80	10-10-50	D,S	Qg	1,517	Water reported hard, adequate.
27.68	10-3-50	D,S	Qg	1,620	..Do....
140	9-29-50	D,S	Kp	1,640	Water reported soft, adequate.
10	8-21-50	S	Qo	1,560	
.....	....	T	..	1,583	See log. Depth to shale, 126 ft.
35.50	8- 3-50	D,S	Qo	1,600	
33.10	8-31-50	D,S	Qo	1,600	Water reported hard, adequate.
21.4	6-26-52	O	Qo	1,572	
21.2	4- 6-53				
10	10-10-50	D,S	Qg	1,580	Water reported soft, adequate.
48.58	9-28-50	D	Qg	1,570	Water reported hard, adequate.
.....	....	T	..	1,615	See log. Depth to shale, 123 ft.
.....	....	T	..	1,543	See log. Depth to shale, 89 ft.
10	10-4-50	D,S	Qg	1,545	Water reported hard, adequate.
14.3	7-24-47	D,S	Qg	1,550	..Do....
29	10-4-50	D,S	Qg	1,540	..Do....
18	10-4-50	D	Qg	1,540	..Do....
10	9- 4-50	S	Qg	1,540	..Do....
.....	....	D,S	Qg	1,553	..Do....
30.35	10-4-50	D,S	Qg	1,544	..Do....
25.09	10-4-50	D,S	Qg	1,532	..Do....
11.73	10-4-50	S	Qo	1,529	..Do....
8	10-4-50	D	Qo	1,518	..Do....
14	10-4-50	D,S	Qg	1,550	Water reported moderately hard, adequate.
15.6	7-24-46	D,S	Qg	1,543	..Do....
53.0	9-28-42	D,S	Qo	1,595	Water reported soft, inadequate.
41.7	8-23-47	D,S	Qo	1,595	..Do....

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter of size (inches)	Type	Date completed
151-65 (Cont.)					
13dbc	Clarence Peterson	80.5	4	Dr	....
14bda	Hannah K. Lynn	91.8	6	Dr	1940
17abb	M. Carlson	50.0	24	Du	....
18bbc	R. J. Nyland	29	..	Du	1946
18dad	Mike Carlson	26.2	24	Du	....
18dcd	R. J. Nyland	20	..	Du	....
21cad	L. Lamrose	22.5	18	Dr	....
22dbc	Dennis Cavanaugh	19.4	36	Du	1910
23bcc	Simon Goulet	99.7	4	Dr	1939
24dac	John Skugland	42.3	24	Du	....
25acd	John Berkland	44.7	18	Dr	....
25bbb	School District	.....	..	Dr	....
25bcb	Floyd J. Brown	62.6	24	Dr	....
25cdd	Pete Nelson	29.8	48 x 48	Du	1930
26bbb	School District	47.7	24	Dr	....
26dad	John Berkland	39.4	18	Dr	1945
151-66					
2acb	Julius Nelson	21.4	36	Du	....
2bba	..do....	30	24	Du	....
2cdc	Joe Bushling	33.2	24	Du	....
3aaa	Pete Homelvig	34.0	30	Du	....
3bab	Clinton Allen	30	36 x 36	Du	....
4ccc	Knudson	60	36 x 36	Du	....
5add	Tom Logan	42	..	Du	....
9cdb	....	69.1	36 x 36	Du	....
10bcc	Tom Logan	30	24	Du	....
12cda	Henry Mustaph	50.9	24 x 24	Du	....
12dad	Leonard Nelson	32	24	Du	....
14abd	Ed Lawrence	19.1	24 x 24	Du	....
15bdc1	John K. Olson	24	4	Dr	....
15bdc2	..do....	30	..	Du	....
16add1	Erling Anderson	50	30	Du	....
16add2	..do....	25	18	Dr	....
17aaa	Thorman Logan	60	36 x 36	Du	....
17cca1	H. Bell	224	4	Dr	1949
17cca2	..do....	20	..	Du	....
18acd	Fred Grandahl	54	..	Du	....
18dac	Emil J. Anderson	56	36 x 36	Du	....
18dcd	..do....	40	36 x 36	Du	....

and test holes -- Continued

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
59.69	8-29-50	D,S	Qo	1,595	Water reported soft, inadequate.
27.09	8-29-50	D,S	Qo	1,560	..Do....
42.05	10-4-50	D	Qg	1,555	
27	10-4-50	D	Qo	1,510	Water reported hard, adequate.
20.33	10-4-50	U	Qo	1,510	
15	10-4-50	U	Qo	1,510	
18.5	8-26-50	D,S	Qo	1,500	..Do....
16.3	8-26-50	D,S	Qo	1,520	..Do....
31.72	8-30-50	D,S	Qg	1,604	..Do....
33.58	8-30-50	D,S	Qo	1,580	..Do....
35.87	8-30-50	U	Qo	1,540	
43.72	9-24-42	D	Qo	1,540	
47.12	8-30-50	D,S	Qo	1,545	Water reported soft, adequate.
27.07	8-30-50	D,S	Qo	1,560	Water reported hard, adequate.
33.83	8-30-50	D	Qo	1,562	..Do....
32.68	8-30-50	D,S	Qo	1,558	..Do....
5.00	10-20-50	U	Qg	1,520	
27	10-20-50	D,S	Qg	1,510	..Do....
23.55	10-23-50	D,S	Qg	1,530	..Do....
13.28	10-24-50	D,S	Qg	1,520	..Do....
15	10-25-50	S	Qg	1,510	..Do....
55	10-20-50	D,S	Qg	1,570	
22	10-20-50	D,S	Qg	1,562	..Do....
45.64	10-23-50	U	Qg	1,560	
24	10-20-50	D,S	Qg	1,518	..Do....
38.25	10-20-50	D,S	Qg	1,558	
28	10-20-50	D,S	Qo	1,520	..Do....
16.00	10-20-50	D,S	Qo	1,530	
22	10-20-50	D	Qg	1,540	..Do....
28	10-20-50	S	Qg	1,540	..Do....
35	10-24-50	D,S	Qg	1,560	..Do....
21	10-24-50	S	Qg	1,560	Water reported soft, adequate for 10 head of stock.
40	10-23-50	S	Qg	1,570	
......	....	U	Kp	1,590	
18	10-24-50	D	Qg	1,590	Water reported hard, adequate.
42	10-24-50	D,S	Qg	1,600	..Do....
52	10-24-50	D,S	Qg	1,590	..Do....
35	10-24-50	U	Qg	1,590	

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
151-66 (Cont.)					
20abb1	Ole Loken	40.4	24	Du	....
20abb2	..do....	50.2	36	Du	....
20add	John Loken	40	30 x 30	Du	....
21bad	Olaf Brenden	40	24	Du	....
21bdd	Andrew Thompson	19.7	48 x 48	Du	....
21cdc1	Harold Knudson	15	36	Du	....
21cdc2	..do....	20	30	Du	....
23add	....	25.4	24	Du	....
23cdc	W. H. Bell Estate	25	..	Du	....
24cad	Mary L. Owens	14.7	24	Du	....
25cdc	Helen Kennedy	106	6	Dr	1910
25cdd	..do....	15	24	Du	....
25dcd	Fred Swenson	125	6	Dr	....
26bcb1	John Krueger	100	4	Dr	....
26bcb2	..do....	12	24	Du	....
26ccc	School District	26.5	12	Du	....
27ccd1	Ola Nyhusmeon	130	..	Dr	....
27cdd2	..do....	15	..	Du	....
28dbc	Leo Nelson	30	..	Du	....
29ada	Earl Melin	12	18	Dr	....
29cdc	O. M. Erickson	8.3	36	Du	....
30aba	Paul Melin	27	30	Du	....
30cca	O. M. Erickson	18	..	Du	....
30ccb	..do....	26	24	Du	....
31caa1	Alfred Rud	18	36	Du	....
31caa2	..do....	15	..	..	....
31ddd	P. I. Nelson	18	24	Du	....
32add	L. B. Garness	26	24	Du	....
33cbc	Melvin Erickson	28	18	Dr	1947
33ddd	Verna Hancock	10	48 x 48	Du	....
34acc	C. W. Fine	13.9	24	Du	....
35abb	Fred Swenson	100	6	Dr	....

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
29.60	10-26-50	D	Qg	1,565	Water reported hard, adequate for home use only.
43.32	10-26-50	S	Qg	1,570	Water reported hard, adequate.
35	10-24-50	U	Qg	1,570	
30	10-23-50	D,S	Qg	1,560	..Do....
14.79	10-24-50	U	Qg	1,543	
8	10-24-50	D	Qo	1,530	Water reported hard, inadequate.
10	10-24-50	S	Qo	1,530	Reported adequate for 35 head of stock.
11.34	10-24-50	D,S	Qo	1,515	
20	10-24-50	U	Qg	1,530	
11.80	10-24-50	D,S	Qo	1,510	Water reported hard, adequate.
35	10-24-50	S	Kp	1,478	Water reported soft, adequate.
10	10-24-50	D	Qg	1,475	..Do....
110	10-24-50	D,S	Kp	1,525	Water reported soft, salty, and inadequate.
25	10-20-50	S	Kp	1,525	Water reported salty, adequate.
5	10-20-50	D	..	1,520	Water reported hard, adequate.
11.96	10-20-50	D	Qg	1,525	
.....	....	S	Kp	1,525	Water reported salty, adequate.
10	10-20-50	D	Qg	1,525	Water reported hard, adequate.
0	10-24-50	D	Qg	1,525	Water reported soft, adequate.
5	10-24-50	U	Qo	1,520	
6.07	10-24-50	S	Qo	1,500	Water reported hard, adequate.
24	10-24-50	D	Qo	1,520	..Do....
8	10-24-50	D,S	Qo	1,520	..Do....
20	10-24-50	S	Qg	1,532	Water reported hard, inadequate.
6	10-24-50	S	Qo	1,500	Water reported hard, adequate.
1	10-24-50	D,S	Qo	1,495	..Do....
15	10-19-50	D,S	Qg	1,455	..Do....
16	10-19-50	D,S	Qo	1,495	..Do....
27	10-19-50	D,S	Qo	1,500	Water reported hard, inadequate.
5	10-19-50	D,S	Qg	1,440	Water reported soft, adequate.
13.50	10-24-50	D	Qg	1,525	
60	10-24-50	S	Kp	1,510	Water reported salty.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
151-67					
1ddb	Anton Mitzel	34	24 x 24	Du	....
2bbc	Horace Compton	34.8	..	Du	....
2bda	Carl E. Goranson	30	36	Du	1920
2bdc	Horace Narueson	28	30	Du	....
2cab	Oberon School	44.1	48 x 48	Du	....
2cac	C. H. Goranson	35.2	48	Du	1940
2cba	Hartley Nenson	28.5	48	Du	1920
2cbd	Olaf Sorenson	25.9	36	Du	1928
2cca	Congregational Church	19.7	24	Du	....
2cdb	H. E. Moyes	26.1	36	Du	1910
2cdc	Henry Ulmuss	21.8	36	Du	....
4aaa	Lars Jenson	18	18	Du	....
4ddd	Jens Jensen	27.8	36 x 36	Du	....
9aaa	..do....	27	48	Du	....
10aaa1	Edmond Buehler	9	24	Du	....
10aaa2	..do....	10.1	36	Du	....
10bad	Virgil Hansen	21.4	36	Du	....
10ddd	Edmond Buehler	180	4	Du	....
12abb	George Buehler	180	4	Dr	....
12bbb	Clarence Nielson	69.6	36	Du	....
13bcc	Alvin Stenberg	31.0	..	Du	....
14bbb1	Ivar Jorde	35	..	Du	....
14bbb2	..do....	150	4	Du	....
14dbc	Mrs. Clarence Nielson	10	..	Du	....
14ddc1	Clarence Nielson	18.9	30	Du	....
14ddc2	..do....	23.4	36	Du	....
14ddd	..do....	20.4	24	Du	....
15add1	Ivar Jorde	35	..	Du	....
15add2	..do....	270	4	Dr	1926
15add3	..do....	145	..	Dr	....
21aba	Hans Narveson	8	..	Dn	....
22ada	George Hoeffner	28	24	Du	....

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
17	10-17-50	D,S	Qg	1,570	Water reported moderately hard, adequate.
27.03	10-26-50	D,S	Qg	1,565	..Do....
25	9-12-50	S	Qo	1,568	Water reported hard, adequate.
25	9-12-50	D	Qo	1,560	..Do....
25.90	9-11-50	D	Qo	1,562	..Do....
21.50	9-13-50	D	Qo	1,565	..Do....
21.13	9-11-50	D	Qo	1,558	..Do....
18.46	9-11-50	D	Qo	1,558	Water reported moderately hard, adequate.
13.4	9-11-50	D	Qo	1,555	Water reported hard, adequate.
18.45	9-12-50	D	Qo	1,560	..Do....
16.30	9-13-50	D	Qo	1,558	..Do....
5	10-16-50	D	Qo	1,554	Water reported soft, adequate.
22.50	10-16-50	S	Qo	1,540	..Do....
8	10-16-50	D	Qo	1,540	..Do....
6	10-16-50	D	Qo	1,542	Water reported hard, adequate.
7.04	10-16-50	S	Qo	1,541	..Do....
9.82	10-16-50	D,S	Qo	1,535	..Do....
.....	....	U	Kp	1,535	..Do....
.....	....	U	Kp	1,582	Water reported salty and inadequate in quantity.
63.67	10-17-50	S	Qg	1,590	Water reported hard, adequate.
24.88	10-17-50	D,S	Qg	1,560	..Do....
7	10-17-50	D,S	Qo	1,534	..Do....
.....	....	S	Kp	1,534	Water reported salty, hard, adequate.
7	10-17-50	U	Qg	1,525	
9.45	10-17-50	D	Qo	1,532	..Do....
10.05	10-17-50	D	Qo	1,534	..Do....
10.90	10-17-50	S	Qg	1,536	Water reported hard, adequate.
30	10-17-50	D	Qg	1,545	..Do....
.....	....	S	Kp	1,545	Water reported salty, inadequate.
.....	....	U	Kp	1,545	..Do....
6	10-17-50	D,S	Qo	1,520	Water reported soft, adequate.
14	10-18-50	D,S	Qg	1,530	Water reported hard, adequate.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
151-67 (Cont.)					
23bcb	George Schafner	34.4	24	Du	....
23cbb	V. E. Paulson	20.9	24	Du	....
25bdd	Henry Stenberg	26	24	Du	....
25cba	Archer Drummond	14	96	Du	....
25cbb1	..do....	125	4	Dr	....
25cbb2	..do....	125	4	Dr	....
26bcc	William Drummond	13.5	24	Du	....
26cbc	Steve Keyes	150	4	Dr	....
27aba	John Paulsen	29.9	36	Du	....
27cbc	A. N. Kindem	20	24	Du	....
27daa1	John Paulsen	20	24	Du	....
27daa2	..do....	22.3	24	Du	....
28dad	A. N. Kindem	20	..	Du	....
152-61					
30bcb	Test hole 421	60	5	Dr	1951
152-62					
7aab	David Brown	38.6	30	Du	....
7dbd	B. A. Osborne	47.1	30	Du	....
9cbb	J. C. Coe	110	6	Dr	1944
10ccc	Rebecca Calderwood	125	4	Dr	1920
11dba	..do....	37.3	..	Du	....
12cad	Margaret Blaufuss	108	5	Dr	1925
13acc1	James Fisk	112.4	6	Dr	1915
13acc2	..do....	113	4	Dr	1950
13ddc1	..do....	55.8	24	Du	....
13ddc2	..do....	27.0	24	Du	....
14abb	Martin Rasmussen	43.6	24	Dr	1917
15bda	Carl A. Rasmussen	45.3	24	Du	1936
15dcb	Charles Starkhouse	40.2	4	Dr	1910
17ada	Ben Zbytovsky	155	4	Dr	1910
17cbd	M. J. Kirk	150	4	Dr	1920
21bca1	Morris Peters	45	20	Du	1901
21bca2	..do....	170	4	Dr	1948

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
14.47	10-18-50	D	Qg	1,525	Water reported hard, adequate.
14.46	10-18-50	S	Qg	1,520	..Do....
16	10-17-50	D,S	Qg	1,535	..Do....
3	10-17-50	S	Qg	1,535	..Do....
40	10-17-50	S	Kp	1,540	Water reported soft, salty, inadequate.
40	10-17-50	S	Kp	1,542	Water reported soft, salty, adequate.
8.70	10-18-50	D,S	Qg	1,530	Water reported hard, adequate for 30 head of stock.
.....	....	S	Kp	1,545	Water reported salty, adequate.
11.14	10-17-50	U	Qg	1,530	
10	10-18-50	D,S	Qg	1,502	
7	10-18-50	D	Qg	1,545	Water reported hard, adequate.
7.88	10-18-50	U	Qg	1,545	
10	10-18-50	D,S	Qo	1,502	Water reported soft, adequate.
.....	....	T	..	1,495	See log. Depth to shale, 22 ft.
18.77	6-28-50	S	Qg	1,502	
20.73	6-28-50	S	Qg	1,495	Reported stock do not like water.
23.57	6-29-50	D,S	Qg	1,497	See chemical analysis. Water reported hard, adequate.
.....	....	S	Qg	1,470	Water reported hard, adequate.
16.12	6-29-50	U	Qg	1,497	Water reported hard.
.....	....	D,S	Kp	1,525	Water reported soft, adequate.
41.62	7- 6-50	S	Kp	1,527	Water reported hard, adequate.
22	7- 6-50	D	Kp	1,527	..Do....
17.08	7- 4-50	S	Qg	1,500	Water reported hard, inadequate.
15.84	7- 6-50	U	Qg	1,500	
21.68	6-29-50	D,S	Qg	1,500	Water reported hard, adequate.
34.58	7- 4-50	D,S	Qg	1,505	..Do....
25.86	7- 7-50	U	Qg	1,495	Water reported hard.
57.65	6-29-50	D,S	Qg	1,490	Water reported hard, adequate.
.....	....	U	Qg	1,470	Water reported soft.
32.48	6-29-50	S	Qg	1,480	Water reported hard, inadequate.
.....	....	D	Qg	1,480	Water reported hard, adequate.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
152-62 (Cont.)					
23bdbl	Hans T. Rasmussen	68	4	Dr	1935
23bdb2	..do....	28.3	24	Du	1897
25ddc	Walter Martin	50	4	Dr	1929
26acb	Hubert Thelin	36.6	24	Du	1948
26acc	..do....	40.2	67	Du	1930
27dcd	Julius Rust	300	4	Dr	1908
28abc	Charles Starkhouse	100	..	Dr	....
28caa	Bob Martin	130	4	Dr	1938
31bda	Roger Fields	143.7	4	Dr	....
34bcbl	Russell Walker	165	4	Dr	1945
34bcb2	..do....	65	15	Du	....
152-63					
2cbdl	Ray Rutten	365	..	Dr	1905
2cbd2	..do....	135	6	Dr	1945
2cdbl	Lloyd Fleming	22.0	36 x 36	Du	....
2cdb2	..do....	140	4	Dr	1915
12aac	John Brown	100	4	Dr	1918
13adc	M. S. Kirk	175	4	Dr	1912
13cab	Jim Lunes	31.4	24	Dr	....
14bcc	O. B. Wood	160	4	Dr	1910
16adb	Merrick	101.1	4	Dr	....
20cad	V. L. Rice	55.4	28 x 28	Du	1928
21baa	Paul E. Wood	94.8	4	Dr	....
24bd	Bruno Holtz	Spring	..	..	....
25acd	Stanley Azure	37.8	24	Dr	....
25bab	Bruno Holtz	148.1	4	Dr	1945
28acd	Herman Anderson	83	4	Dr	1928
31dba	Gust Berg	144	4	Dr	1922
32acc	Ed Allard	35	36	Dr	....
33cbc	..do....	125	6	Dr	....
34baa	Carroll Anderson	64.0	4	Dr	....
35aaa	B. A. Rider	65	4	Dr	....
36bcb	Dr. Galloway	177.4	4	Dr	1930

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
22.37	6- 6-50	D,S	Qg	1,490	Water reported hard, adequate.
18.18	7- 6-50	U	Qg	1,490	Water reported hard.
30	7- 6-50	D,S	Kp	1,495	Water reported hard, adequate.
11.02	7- 6-50	S	Qg	1,493	..Do....
17.17	7- 6-50	D,S	Qg	1,487	Water reported hard, inadequate during drought.
40.64	7- 8-50	D,S	Qg	1,485	Water reported hard, adequate.
26.74	7- 4-50	D,S	Qg	1,463	Water reported hard, inadequate.
.....	....	D,S	Qg	1,450	Water reported hard, adequate.
48.17	8-19-50	D,S	Qg	1,465	..Do....
.....	....	D,S	Qg	1,485	..Do....
36.88	7- 4-50	U	Qg	1,485	Reported inadequate for stock.
.....	....	U	Kp	1,465	Water reported soft. Depth to shale, 300 ft.
37.28	7-26-49	S	Qg	1,465	Water reported hard.
13.41	7-26-49	U	Qg	1,455	..Do....
29.9	7-27-49	D,S	Qg	1,455	Water reported hard, adequate.
39.19	7-28-49	D,S	Qg	1,470	..Do....
50.16	7-28-49	D,S	Qg	1,477	..Do....
13.40	8-21-50	S	Qg	1,425	
.....	....	D,S	Qg	1,477	..Do....
54.79	8-23-50	U	Qg	1,457	
25.19	8-22-50	D,S	Qg	1,454	..Do....
43.12	8-22-50	D,S	Qg	1,467	..Do....
.....	....	S	Qg	1,405	Water reported soft.
14.32	8-21-50	D,S	Qg	1,472	
52.88	8-21-50	D,S	Qg	1,473	Water reported hard, adequate.
20	8-23-50	S	Qg	1,467	Water reported hard, well capable of yielding 300 gpm.
55	8-23-50	D,S	Qg	1,492	Water reported hard, adequate.
32	8-23-50	D,S	Qg	1,475	..Do....
32	8-23-50	D	Kp	1,490	Water reported soft, adequate.
38.50	8-23-50	D,S	Qg	1,503	Water reported hard, adequate.
50	8-21-50	D,S	Qg	1,483	..Do....
52.09	8-21-50	D,S	Kp	1,515	Water reported soft, adequate.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
152-64					
1bbb	Mrs. J. Abraham	32	24	Dr	1936
2aca	..do....	26	2	Dr	....
2acd	..do....	28	2	Dr	1930
2cdd	C. Peterson	28	21	Du	1941
3baa1	John Schela	40	24	Du	....
3baa2	..do....	36	..	Du	....
3bcc	Lambert Kraft	50	2	Dr	....
3ddd	Bureau of Indian Affairs	123	4	Dr	1935
4dad	Lambert Kraft	80	4	Dr	1938
4ddd	N. E. Nelson	55	..	Du	....
5caa	C. L. Young	150	4	Dr	1922
5ddd	A. Dewan	65	..	Dr	1941
6ccd	Peter Fields	150	4	Dr	1943
7bcd	E. F. Palmer	150	6	Dr	....
8acc	Mrs. Eva Kraft	36	36	Du	1932
9bda	..do....	14	36 x 36	Du	....
9ddd1	John Kraft	60	24 x 24	Du	1927
9ddd2	..do....	20	..	Du	....
10aab	Joseph Matohin	160	4	Dr	1940
10adb	Arie Geske	40	18	Dr	1930
10bdd	Phyllis Feather	14.6	36	Du	....
11bda	Clarence Cavanaugh	115	4	Dr	1936
11ccc	J. P. Kraft	28.4	24	Du	1948
12cab	Clarence Cavanaugh	150	6	Dr	....
13bac	Ed Millerke	198	4	Dr	1925
16cdd	Clem Lohnes	150	..	Dr	....
16dcb	Mrs. Head	3.5	36	Du	....
17aba	St. Michael's Mission	Spring	..	..	....
17dab1	..do....	72	6	Dr	1940
17dab2	..do....	132	6	Dr	1930
19dad	Bureau of Indian Affairs	244	4	Dr	1937
20abb	National Geophysical Co. shothole	85	5	Dr	1952
20baa	..do....	105	5	Dr	1952

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
30.59	8-13-49	D,S	Qg	1,465	Water reported hard, adequate.
23.42	8-13-49	U	Qg	1,450	
15.41	8-13-49	D,S	Qg	1,437	
14.43	8-13-49	D,S	Qg	1,445	Water reported hard, inadequate.
.....	....	S	Qg	1,453	..Do....
33	8-11-49	U	Qg	1,453	
14.98	8-12-49	S	Qg	1,435	..Do....
58	9-16-42	S	..	1,453	
.....	....	D,S	Qg	1,455	Water reported hard, adequate.
.....	....	D,S	Qg	1,457	Water reported soft, inadequate.
.....	....	D,S	Qg	1,475	Water reported hard, adequate.
57	9-22-42	D,S	Qg	1,427	..Do....
.....	....	D,S	Qg	1,455	..Do....
75	9-11-42	D,S	Qg	1,425	..Do....
.....	....	D,S	Qg	1,447	..Do....
11.65	8-12-49	U	Qg	1,425	
51	10-6-50	D,S	Qg	1,455	Water reported hard, inadequate.
3	10-6-50	S	Qg	1,455	Water reported soft, adequate.
30	10-6-50	D,S	Kp	1,455	..Do....
20	10-6-50	S	Qg	1,441	Water reported hard, adequate.
10.92	10-6-50	D,S	Qg	1,435	..Do....
.....	....	D,S	Kp	1,470	Water reported soft, adequate.
16.25	10-6-50	D,S	Qg	1,465	Water reported hard, adequate.
80	10-9-50	D,S	Qg	1,430	Water reported soft, adequate.
.....	....	D,S	Qg	1,485	Water reported moderately hard, adequate.
41.87	10-9-50	S	Qg	1,480	Water reported hard, adequate.
1.00	10-6-50	D,S	Qg	1,490	..Do....
.....	....	S	Qg	1,408	Spring flows during entire year.
20	9-17-42	D	Qg	1,530	Water reported hard, adequate. Furnishes about 1,000 gpd.
.....	....	D	Kp	1,530	Water reported hard, but softer than that from 17dcc1. Called inadequate. Furnishes 1,000 to 3,000 gpd.
154	9-16-42	...	..	1,520	
Flow	9- 3-52	U	Qg	1,500	
Flow	9- 3-52	U	Qg	1,480	

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
152-64 (Cont.)					
22cda1	John Solway	60	24	Du	....
22cda2	..do....	14.6	8	Dr	....
22dad	William Leaf	31.7	36	Du	....
25bdb	H. Sharp	60	24	Du	....
26dcd1	Hilda Beham	40	18	Dr	....
26dcd2	..do....	15	18	Dr	....
27dad	School District	23.8	24	Du	....
27dbd	Dave Lamont	28	..	Dr	....
28bab	Mrs. W. J. Neil	90	4	Dr	....
28ccc	R. M. Doyle	44.8	28	Du	....
31dbd	Alex Smith	35	18	Dr	....
32bad	Kelly	30	..	Du	....
33bad	Mrs. Bob Cavanaugh	59	18	Dr	....
33cad	John Skuglan	11.0	36 x 30	Du	....
34cbb	Mrs. L. Goodhouse	41	18	Dr	1942
34dbd	Mrs. A. B. Smith	24	..	Du	....
35aca	Henry Henderscheit	21.3	18	Dr	....
152-65					
1dda	Walter Christianson	30	36 x 36	Du	1937
5bdb	Archie Borstad	48	48 x 48	Du	1936
7bab	Ella Smith	23	..	Du	1948
12adb1	Concrete Sectional Culvert Co.	69	6	Dr	1937
12adb2	..do....	65	4	Dr	1935
12daa	Tony Lohness	26	36	Du	1943
16cbc	....	14.6	..	..	....
16ddd	U.S. Fish and Wildlife Service	49	4	Dr	1935
17bca	Bureau of Indian Affairs	112	4	Dr	1935
17dcb	Richard Cavanaugh	25.7	36	Dr	....
17dcc	Bureau of Indian Affairs	24.1	18	Du	1937
17dcd	..do....	28.9	18	Du	1937
17ddb	..do....	40.9	18	Dr	1939

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
40	10-9-50	D,S	Qg	1,450	Water reported hard, adequate.
10.60	10-9-50	U	Qg	1,450	
9.35	10-6-50	D,S	Qg	1,447	Water reported soft, adequate.
25.5	8-22-47	...	..	1,480	
.....	....	D,S	Qg	1,460	Water reported hard, adequate.
.....	....	D,S	Qg	1,460	Water reported soft, adequate.
16.34	10-6-50	U	Qg	1,450	Water reported hard.
16	10-6-50	D,S	Qg	1,455	Water reported hard, adequate.
.....	....	D,S	Kp	1,480	Water reported soft, adequate.
20.49	10-9-50	D,S	Qg	1,530	Water reported hard, adequate.
20	10-9-50	D,S	Qg	1,575	Water reported hard, adequate for 30 to 40 head of stock.
5	10-9-50	D,S	Qg	1,570	Water reported soft.
50	10-9-50	D,S	Qg	1,520	Water reported hard, adequate.
5.26	10-10-50	S	Qg	1,560	
23	9-22-42	D,S	Qg	1,515	Water reported hard, inadequate.
16	10-9-50	D	Qg	1,445	
18.08	10-6-50	D,S	Qg	1,440	Water reported hard, adequate.
23.07	8-16-49	S	Qg	1,455	Water reported hard, inadequate.
45	7-19-49	S	..	1,463	
19	7-19-49	D,S	Qg	1,485	
22	8-10-49	Ind	Qg	1,435	Water reported hard. Reported pumps 100 gpm for many days at a time with only a small drawdown.
.....	....	D	Qg	1,435	See chemical analysis. Located about 6 feet from 12abd1.
9.62	8-10-49	D,S	Qg	1,450	Water reported hard, adequate.
6.80	8- 8-50	D	Qg	1,470	..Do....
2	9-22-42	D	Kp	1,530	Water reported soft, adequate for picnic grounds.
102	9-16-42	D	Qg	1,450	Inadequate for domestic use.
13.6	9- 8-50	D	Qg	1,500	
9.98	8- 6-50	U	Qg	1,502	Water reported hard.
14.92	8- 6-50	D	Qg	1,498	Water reported hard, adequate.
30.56	8- 4-50	D	Qg	1,500	..Do....

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
152-65 (Cont.)					
17ddd	Bureau of Indian Affairs	35.7	24	Dr	....
18cad	Agnes Corbine	28.9	36	Du	1936
18dcd	Bureau of Indian Affairs	20.7	36	Du	....
20ada	..do....	60	4	Dr	1935
21aaa	Jerome Kings	20	24	Du	....
21bbc	Bureau of Indian Affairs	19.4	36	Du	....
26bcd	Art Lance	130	4	Dr	....
28bbd	Julius Jabs	116	36	Du	1909
28ccd	Howard Jabs	60.8	24	Du	....
29aad	Julius Jabs	52	36	Du	1919
31cba	E. M. Zetter	47	36	Du	....
32ccc1	Archie Rohrer	38	48 x 48	Du	....
32ccc2	..do....	52.6	18	Dr	....
34bbb	Frances LeDuc	84.8	24	Du	1932
35daa1	Dr. G. F. Drew	75.0	36 x 36	Du	1900
35daa2	..do....	34.7	24	Dr	....
152-66					
1cab	Glen Geske	51.2	18	Dr	1944
1ccb	Rowan Kennedy	110	4	Dr	1949
2ddc	Charles Geske	38.8	42	Du	....
7cbb	Hanna Haskin	48.5	60 x 60	Du	....
10ccc	George Hunt	10.7	42	Du	1946
12bcc	Sigrid Olson	83.0	24	Dr	1930
12dbc	Mrs. Henry Longre	22.5	21	Du	1938
13acc	Cordelia Little	30.3	36	Du	....
13bbc	Rose Bigtrack	21.6	18	Dr	....
13bdc	Phillip Bigtrack	20.8	36 x 36	Du	....
15cbd	F. Little	7.0	18	Du	....
17dcd	Harold Bevven	90	4	Dr	1928
18aca1	Earl T. Graham	57.4	..	Du	1932
18aca2	..do....	206.2	4	Dr	1916
18bbd	Hilding Carlson	86.0	4	Dr	1916
18ccc	John H. Kelly	27.3	24	Du	1910
20aba	Roger Kelly	56.3	24	Du	1916

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
22.78	8- 4-50	D	Qg	1,500	Water reported moderately soft, inadequate.
13.90	8- 4-50	D,S	Qg	1,475	Water reported hard, adequate.
11.30	8- 4-50	D,S	Qg	1,502	..Do....
18	8- 8-50	U	Qg	1,520	
0	10-5-50	D	Qg	1,500	..Do....
13.30	8- 8-50	S	Qg	1,505	..Do....
.....	....	D,S	Qo	1,630	Water reported soft, adequate.
111.5	10-5-50	D,S	Qg	1,640	Water reported hard, adequate for 130 head of stock.
55.33	10-5-50	D,S	Qg	1,600	Water reported hard, adequate.
47.5	10-5-50	S	Qg	1,630	..Do....
.....	....	U	Qg	1,553	
35	10-5-50	D,S	Qg	1,550	Water reported hard, adequate for 100 head of stock.
32.43	10-5-50	D,S	Qg	1,550	Water reported hard, adequate.
77.21	8-29-50	D,S	Qg	1,630	..Do....
65.15	8-29-50	D,S	Qo	1,612	..Do....
27.10	8-29-50	D,S	Qo	1,612	..Do....
18.76	8- 3-50	D,S	Qg	1,445	..Do....
20	8- 4-50	D,S	Kp	1,445	Water reported soft, salty, adequate.
31.40	8- 3-50	D,S	Qg	1,463	Water reported hard, adequate.
31.20	8- 1-50	D,S	Qg	1,475	..Do....
9.20	8- 3-50	D,S	Qg	1,460	Water reported soft, adequate.
58.80	8- 3-50	D,S	Qg	1,515	Water reported hard, adequate.
5.25	8- 4-50	D,S	Qg	1,485	Water reported soft, adequate.
15.50	8- 3-50	U	Qg	1,500	
11.89	8- 3-50	U	Qg	1,493	
12.80	8- 3-50	D,S	Qg	1,500	..Do....
6.60	8- 3-50	D,S	Qg	1,500	..Do....
50	8- 3-50	D,S	Kp	1,490	Water reported soft, salty, adequate.
36.74	8- 2-50	D,S	Qg	1,500	Water reported hard, adequate.
40.90	8- 2-50	S	Kp	1,500	Water reported hard, salty, adequate.
66.05	8- 2-50	U	Kp	1,515	Water reported soft, salty.
17.14	8- 2-50	D,S	Qg	1,525	Water reported hard, adequate.
37.20	8- 2-50	D,S	Qg	1,485	..Do....

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
<u>152-66</u> (Cont.)					
20bdb	Charles Blackmer	5.8	36 x 36	Du	....
20cdd	Mrs. Carl Saunders	41.5	36	Du	....
21bbb	Jerome DeWolf	48.1	18	Dr	....
21caa	Mrs. Rosalie Sherman	12	..	Du	....
22acc	Robert Cody	54	36	Du	1937
22ddb	Mary Ann Clarke	18	18	Dr	1947
23abb	....	18.9	36 x 36	Du	....
24aab	C. J. Ryan	26	24	Du	1919
24bcc	George Young	33.3	24	Du	....
25acb	Mrs. Alvin Alberts	11.5	24	Du	....
25bba	Rosalie Thomas	165	4	Dr	....
25bdb	Alma Robertson	89.53	4	Dr	....
25cbc	Episcopalion Church	150	4	Dr	....
26aad	....	108.0	4	Dr	....
26bcc	J. Littleone	54.1	..	Dr	....
26bdd	Martin	15.5	9	Du	....
26cdd	Frieda Jabs	47.1	18	Dr	....
30bdb	Anton Wetsil	52	4	Dr	....
31baa	Henry Hanson	68.6	36 x 36	Du	....
33aab	Richard Woolley	24	24	Du	1933
33cdd	Carl Logan	63	18	Dr	1946
<u>152-67</u>					
1bcc	Dr. Stickelberger	35.5	48 x 48	Du	1916
1dad	A. A. Taylor	50	..	Dn	1910
2bcc	Fritz Stein	40.6	42 x 42	Du	....
3abb	Cowlie	40	36 x 36	Du	....
9bba	Griffith	22.0	36	Du	1945
9dcc	Carter Wright	26	36 x 36	Du	....
10ccb	Melvin Sieverson	26.2	36 x 36	Du	....
11dbb	Lester Roberts	35.8	48	Du	1925
12acc	Harvey Taylor	41.75	43	Du	1915
13cca1	Howard Schmidt	30.8	24	Dr	1925
13cca2	..do....	54.4	24	Du	1912
13dcc	Test hole 23	90	5	Dr	1946
15dcd	Burt Plummer	35	36 x 36	Du	....
15ddd	John R. Hasel	28.4	48	Du	....

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
4.90	8- 2-50	U	Qg	1,465	
30.12	10-12-50	D	Qg	1,543	
29.01	8- 3-50	D,S	Qg	1,470	Water reported hard, adequate.
3	10-12-50	D	Qg	1,465	Water reported soft, adequate.
42	10-12-50	D,S	Qg	1,470	Water reported hard, adequate.
15	10-12-50	D,S	Qg	1,455	Water reported soft, adequate.
8.74	8- 3-50	U	Qg	1,525	
.....	....	D,S	..	1,513	Reported inadequate.
16.62	10-11-50	D,S	Qg	1,565	Water reported hard, adequate.
4.32	10-11-50	D,S	Qg	1,550	
.....	....	U	Kp	1,580	Water level below 69 ft.
41.90	10-11-50	D,S	Kp	1,525	Water reported soft, inadequate.
.....	....	D	Kp	1,640	Water reported hard, adequate.
57.67	10-11-50	U	Kp	1,520	
29.97	10-11-50	U	Qg	1,470	
12.15	10-11-50	D,S	Qg	1,473	
36.10	10-12-50	D	Qg	1,590	..Do....
43	10-12-50	D,S	Qg	1,525	..Do....
63.35	10-12-50	S	Qg	1,542	..Do....
20	10-12-50	D,S	Qg	1,542	Water reported hard, adequate for 50 head of stock.
20	10-12-50	D,S	Qg	1,490	Water reported soft, adequate.
25.35	8- 1-50	D,S	Qg	1,480	Water reported hard, adequate.
.....	....	D,S	Qg	1,472	..Do....
32.69	8- 1-50	D,S	Qg	1,495	..Do....
.....	....	D,S	Qg	1,497	..Do....
11.54	7- 5-46	D,S	Qg	1,530	Water reported hard, inadequate.
6	10-13-50	D,S	Qg	1,580	Water reported hard, adequate for 30 head of stock.
11.26	10-13-50	D,S	Qg	1,557	Water reported hard.
27.65	8- 2-50	D,S	Qg	1,520	Water reported hard, adequate.
34.90	8- 1-50	D,S	Qg	1,503	
10.15	8- 2-50	D,S	Qg	1,535	..Do....
10.29	8- 2-50	D,S	Qg	1,535	..Do....
.....	....	T	..	1,515	See log. Depth to shale, 75 ft.
30	10-13-50	D,S	Qg	1,565	Water reported hard, adequate.
6.42	10-13-50	U	Qg	1,560	Water reported hard.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
152-67 (Cont.)					
21bad	Albert Gustofson	30	36 x 36	Du	....
21cdb1	Walter Johnson	37.5	36 x 36	Du	....
21cdb2	..do....	41.0	36 x 36	Du	....
22aab	Peavey Elevators	40	36 x 36	Du	....
22bad	Ike Kindem	30	24	Du	....
22daa	Olaf Severenson	35	24	Dr	....
23abb	Lawrence Donaldson	53.0	24	Dr	....
23bdd	..do....	28.5	24	Du	....
24cba	Howard Schmidt	.....	24	Du	....
25dda	William Lansman	80	36	Du	....
27dbc1	Abe Griffin	44.2	36 x 36	Du	....
27dbc2	..do....	46.1	36 x 36	Du	....
27dbc3	..do....	66.5	4	Dr	....
34dba	Horace Compton	38.3	36	Du	....
34ddc	Hartley Nelson	41.4	24	Du	....
35aad1	Albert Wetzel	32.7	..	Du	....
35aad2	..do....	42.2	30	Du	....
153-62					
4cdd	Roy Steinhaus	63.7	4	Dr	....
5bbd1	Joe Roggenbuck	200	6	Dr	1946
5bbd2	..do....	340	4	Dr	....
5dab	Oscar and Sam Holgren	83.3	4	Dr	....
6baa	Mrs. W. M. Nelson	20.9	30	Du	1920
7abc	John Nesseth	189	4	Dr	1915
7dbc	P. D. Norton	57.8	4	Dr	1920
8abc1	S. P. Mahoney	243.5	4	Dr	....
8abc2	..do....	82	4	Dr	1949
8dcc	John Wickum	161	4	Dr	1919
16bcc	Vernon Hilgers	37.7	18	Dr	1920
16cab	John Hilgers	180	4	Dr	1910
16cba	Vernon Hilgers	151	4	Dr	1946

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
15	10-13-50	D,S	Qg	1,550	Water reported hard, adequate.
32.32	10-13-50	D	Qg	1,575	..Do....
29.02	10-13-50	S	Qg	1,575	..Do....
20	10-13-50	D	Qg	1,560	..Do....
10	10-13-50	D,S	Qg	1,550	..Do....
10	10-13-50	D,S	Qg	1,562	..Do....
16.20	8- 2-50	D,S	Qg	1,558	..Do....
10.59	8- 2-50	S	Qg	1,555	Water reported hard.
.....	....	D,S	Qg	1,570	Water reported hard, adequate.
50	10-12-50	D,S	Qg	1,560	..Do....
10.97	10-13-50	D	Qg	1,580	..Do....
40.94	10-13-50	S	Qg	1,577	Water reported hard, inadequate for 20 head of stock.
66.05	10-13-50	U	Kp	1,575	Water reported salty.
33.04	10-26-50	S	Qg	1,590	Water reported adequate.
36.47	10-26-50	S	Qg	1,585	
16.84	10-26-50	S	Qg	1,585	Water reported hard, adequate.
25.97	10-26-50	D,S	Qg	1,585	..Do....
24.15	7- 7-50	D,S	Qg	1,505	..Do....
20	7- 4-50	D	Kp	1,487	Water reported soft, salty.
20.00	7- 4-50	S	Kp	1,487	..Do....
20.83	7- 4-50	U	..	1,493	Water reported soft.
15.90	7- 4-50	D,S	Qg	1,497	Water reported hard, adequate.
22	7-10-50	D,S	Qg	1,480	..Do....
14.40	7- 4-50	D,S	Qg	1,477	Water reported soft, adequate.
28.90	7- 6-50	U	Kp	1,493	Water reported hard, very salty.
15	7- 6-50	D,S	Qg	1,493	Water reported soft, adequate.
22	7- 6-50	S	Kp	1,479	Water reported hard, adequate.
6.48	7-18-50	D	Qg	1,483	..Do....
25	7-17-50	S	Kp	1,500	Water reported soft, adequate.
14.90	7-18-50	D,S	Kp	1,487	See log. Depth to shale, 143 ft. Water reported hard, salty. adequate. Reportedly yields about 4 3/4 gpm with about 40 feet drawdown.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
153-62 (Cont.)					
16cbb	Community well (Crary)	270	4	Dr	1946
16cbc	Wheatland School	32.5	48	Du	1937
16ccb	Edward Neibauer	32.4	24	Dr	....
17acd	Louis Setter	26.5	36 x 36	Du	1920
17daa	John Loften	18.3	18	Dr	....
17dac	Community well (Crary)	40.5	48 x 48	Du	1937
17ddb	Bernard Neibauer	28.1	48	Du	1900
18bad1	Edward Keck	60	4	Dr	1900
18bad2	Clem Keck	82.9	4	Dr	1948
19cdb	Mrs. Harold Viken	69	4	Dr	1919
20dda	C. A. Rye	82.5	4	Dr	1915
20ddd	Richard Conlon	193	4	Dr	1947
21bba	J. P. Davis	164.0	4	Dr	1946
30aad1	Maher	38.5	30	Du	....
30aad2	..do....	180	4	Dr	1927
31aaa	George Brown	119	4	Dr	1949
32daa	David Brown	105	4	Dr	1930
153-63					
1cbb	M. Setter	...	24 x 24	Du	1920
2aab	F. Foster	165	4	Dr	1917
3bbb	W. Halle	120	6	Dr	1916
5abb	T. R. Thelin	40	36	Du	1936
6bab1	W. Frith	35	36	Du	....
6bab2	..do....	150	..	Dr	1917
7ccc	R. E. Ruger	124	6	Dr	1920 ?

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
20.44	7-18-50	D	Kp	1,486	See log. Depth to shale, 165 ft. Water reported soft, salty, adequate. Well reportedly yields about 3 1/3 gpm with about 80 ft. of drawdown.
9.80	7-19-50	D	Qg	1,483	Water reported hard, adequate.
4.69	7-19-50	U	Qg	1,480	
5.48	7- 7-50	S	Qg	1,480	..Do....
6.70	7-18-50	U	Qg	1,482	
9.06	7-19-50	D	Qg	1,483	..Do....
15.28	7- 7-50	D,S	Qg	1,483	..Do....
17	7- 4-50	D,S	Kp	1,475	Water reported soft, salty, adequate.
19.18	7- 7-50	U	Kp	1,473	Water reported soft.
.....	....	D,S	Qg	1,471	Water reported hard, adequate.
19.88	7- 7-50	D,S	Qg	1,493	..Do....
40	7- 7-50	D	Kp	1,491	Depth to shale, 130 ft. Water reported hard, adequate.
19.00	7- 7-50	D,S	Qg	1,481	See log. Water reported hard, adequate. Well reportedly yields about 4 2/3 gpm with about 80 ft. of drawdown.
24.74	7-22-50	D,S	Qg	1,512	Water reported hard, adequate.
.....	....	D,S	Kp	1,507	Water reported hard, salty, adequate.
.....	....	D	Kp	1,480	Water reported soft, adequate.
.....	....	D,S	Qg	1,497	Water reported hard, adequate.
10.05	7-26-49	U	Qg	1,485	Water reported hard, inadequate.
.....	....	D,S	Qg	1,502	See chemical analysis. Water reported hard, adequate.
.....	....	D,S	Qg	1,482	Water reported hard, adequate.
10.16	7-30-48	U	Qg	1,475	Water reported hard, inadequate.
.....	....	D	Qg	1,470	..Do....
.....	....	S	Kp	1,472	Water reported soft, salty, adequate.
.....	....	D,S	Kp	1,470	Water reported hard, adequate.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
153-63 (Cont.)					
8daa	A. Olson	88	..	Dr	....
9abb	C. Brudeseth	85	..	Dr	....
9aca	C. Herda	40	24	Du	1910 ?
11aaa	F. Foster	112	4	Dr	1915
11cba	H. Marquardt	154	4	Dr	1928
12cab1	G. Brick	36	36	Dr	1900
12cab2	..do....	92	4	Dr	1949
13cbc	H. Jack	133	5	Dr	1949
14abb	H. Marquardt	100	4	Dr	....
14ada	C. Jack	72	4	Dr	1926
15cdc	G. Fjelstad	112	4	Dr	1920
15dda	T. Olson	175	4	Dr	....
16bcc	M. Olson	150	6	Dr	1915
17dda	..do....	180	4	Dr	....
20bba	H. Thoe	92	..	Dr	1925
20bdd	A. M. Anderson	165	4	Dr	1925
20dbd	..do...	130	4	Dr	1926
21cdb	T. Hanson	148	4	Dr	1917
21ddc	A. Newhouse	100	4	Dr	1916
22bab	E. Kjelden	88	4	Dr	....
23ada	W. Marquardt	120	4	Dr	....
23dcb	E. Hefti	119	4	Dr	1923
25abc	E. Erikson	125	4	Dr	1918
26bac	H. Kindervag	130	4	Dr	1919

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	S	Qg	1,475	Water reported hard, adequate.
.....	....	D,S	Kp	1,487	Water reported soft, adequate.
22.74	7-28-49	S	Qg	1,483	Water reported hard, inadequate.
10.08	7-28-49	S	Kp	1,480	Water reported soft, inadequate.
28	7-25-49	D,S	Kp	1,500	Water reported soft, inadequate. Pumps dry at about 2 gpm.
11.81	7-25-49	D,S	Qg	1,485	Water reported hard, adequate; well originally deeper - partly caved in.
.....	....	D,S	Qg	1,485	Water reported soft, adequate; drift here at least 150 ft. thick - well originally drilled in drift to 150 ft.
32	7-25-49	D	Kp	1,500	Water reported soft, adequate; depth to shale, 110 ft.
24.96	7-28-49	U	Kp	1,480	Water reported soft.
10	7-26-49	D,S	Qg	1,490	Water reported soft, adequate.
.....	....	D,S	Kp	1,483	Water reported hard, adequate; water reported soft when well was drilled. Water from glacial drift aquifer may be seeping into well.
35.24	7-27-49	D	Kp	1,500	Water reported soft, inadequate.
.....	....	S	Kp	1,467	Water reported hard, adequate.
46.78	7-30-48	U	Kp	1,480	Water reported slightly hard, salty, adequate.
.....	....	D	Kp	1,480	Water reported soft, inadequate.
.....	....	D,S	Qg	1,463	Water reported hard, adequate.
.....	....	D	Kp	1,455	Water reported soft, adequate.
.....	....	D,S	..	1,468	Water reported hard, adequate.
39.14	7-28-49	D	Qg	1,460	..Do....
28.17	7-27-49	S	Qg	1,487	Water reported hard.
15	7-25-49	D,S	Kp	1,495	Water reported soft, adequate.
18	7-26-49	D,S	Kp	1,500	..Do....
.....	....	D,S	Kp	1,505	Water reported hard, adequate.
20	7-26-49	D,S	Kp	1,487	Water reported soft, adequate; pumps about 6 gpm.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
153-63 (Cont.)					
26dcb	H. Rutten	110	4	Dr	....
27aaa	C. Conroy	160	6	Dr	....
27dbc1	T. Olson	27.2	36 x 36	Du	1890
27dbc2	..do....	145	4	Dr	1900
28add	..do....	40	4	Dr	1945
30cab	John Smoke	95	4	Dr	1944
31cda	Ray Rutten	Spring	..	..	....
33add	C. Thompson	130	4	Dr	....
34cdb	Ray Rutten	Spring	..	..	....
35abb	H. R. Rutten	40.5	24	Du	....
35ccc	Anna Wagner	152	4	Dr	....
36bbd	P. M. Sagvang	101	4	Dr	1918
36ddb	Robert Taylor	140	4	Dr	1920
153-64					
2abc	H. Maher	114	4	Dr	1907
2bba	T. C. Sabie	86	4	Dr	1946
2bcd	Dukes	72	4	Dr	1940
2bda	L. Overvold	86	5	Dr	1949
2cab	Artclare Motel	52	4	Dr	1951
2ccc	R. Young	86	4	Dr	....
2dac	H. Maher	100	4	Dr	1918
3aaa	A. R. Peterson	105	4	Dr	1929
3aac	J. Jaeger	68	4	Dr	....
3aba	A. Swenson	110	4	Dr	....

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	D,S	Kp	1,475	Water reported soft, adequate.
20	7-26-49	D,S	Kp	1,496	..Do....
16.64	7-28-49	U	Qg	1,472	Water reported hard.
25	7-28-49	D,S	Kp	1,472	Water reported hard, slightly salty, adequate.
8.05	7-28-49	S	Qg	1,460	Water reported hard, adequate.
.....	....	D,S	Qg	1,440	..Do....
.....	....	...	Qg	1,447	See chemical analysis.
44.93	7-26-49	D,S	Qg	1,470	Water reported hard, adequate; driller reported shale from 40 to 125 ft. and gravel from 125 to 130 ft.
.....	....	...	Qg	1,430	
5.95	7-27-49	U	Qg	1,467	
.....	....	D	Kp	1,473	Water reported hard, adequate; pumps about 1 gpm.
.....	....	...	Kp	1,490	Water reported hard. Depth to shale, 80 ft.
46.40	7-27-49	D,S	Kp	1,475	Water reported hard, adequate.
.....	....	D,S	Kp	1,463	Water reported soft, adequate, pumps about 12 gpm.
.....	....	D	Kp	1,465	See chemical analysis. Water reported soft, adequate.
12	11-1-48	D	Kp	1,455	Depth to shale, 60 ft.
14	7- 7-49	D	Kp	.....	Water reported soft, adequate.
.....	....	D	Kp	1,454	See chemical analysis. Water reported soft, adequate.
.....	....	S	Kp	1,450	
3.78	8-24-49	O	Kp	1,443	
.....	....	D	Kp	.....	Water reported soft, adequate.
15	7-14-49	D	Kp	.....	Water reported soft, adequate. Well reportedly pumps 10 gpm with less than 5 ft. drawdown.
15	7-11-49	D	Kp	.....	Water reported soft, adequate. Water hauled from this well to residents in Devils Lake for domestic use.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
153-64 (Cont.)					
3abc	J. Singer	35	42	Dr	1929
3aca	City Shops	90	4	Dr	1947
3acb	Bergstrom Cabins	85	4	Dr	1936
3adb	Holbeck Water Works well 4	84	5	Dr	1947
3adc	C. Schmaltz	82	4	Dr	1947
3bdd	Bureau of Reclamation substation	75	5	Dr	1951
3cba	E. Smith	102	4	Dr	1910
3cbd	L. Engh	70	4	Dr	1941
3cdb	I. Clapp	130	4	Dr	1909
3daa	C. L. Amour	76	..	Dr	1945
3dca	I. Clapp	126	4	Dr	....
5aab	R. Young	45	48	Du	1933
5cdc1	G. Belcher	150	4	Dr	1919
5cdc2	..do....	175	4	Dr	1937
6abb	M. Meier	220	6	Dr	1932
6cbd1	F. Jager	180	4	Dr	....
6cbd2	..do....	40	24 x 24	Du	....
6ccc	S. Peterson	120	6	Dr	....
7bbb	Test hole 194	155	5	Dr	1949
7bcb	E. F. Palmer	150	4	Dr	1947
7dcb	Devils Lake Town and Country Club	100	4	Dr	1900

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
28	7-11-49	U	Qg	.....	Water reported hard; formerly supplied hotels and restaurants in Devils Lake with water for making coffee.
.....	....	D	Qg	1,450	See chemical analysis. Water reported hard, adequate.
6	7-12-49	D	Qg	.....	See chemical analysis. Water reported soft, adequate.
11	5- 3-49	D	Kp	1,443	Depth to shale, 52 ft. Water reported soft, adequate; water hauled from this well to residents in Devils Lake for domestic use.
6	7-12-49	D	Kp	.....	Water reported soft, adequate; pumps 1,000 gpd.
.....	....	...	Kp	1,435	See log. Depth to shale, 38 ft. Log given only to 48 ft.
40	9-13-49	D	Kp	.....	Water reported soft, adequate; pumps 2½ gpm.
15	8- 4-48	D	Kp	1,447	Depth to shale, 65 ft; Water reported hard, adequate.
12	8-31-49	D	Kp	.....	Water reported soft.
8	7-29-48	D,S	Kp	1,445	See chemical analysis. Depth to shale, 60 ft; Water reported hard, adequate.
.....	....	D,S	Kp	.....	Water reported soft, adequate.
24.16	9-12-49	D,S	Qg	1,452	Water reported hard, adequate.
.....	....	D	Kp	1,450	Water reported soft, adequate.
.....	....	U	Kp	1,450	Water reported soft, salty, adequate.
.....	....	S	Kp	1,450	Water reported soft, salty.
.....	....	S	Kp	1,450	Water reported hard.
16.80	7-29-48	D	Qg	1,455	..Do....
38	9-11-42	D,S	Qg	1,473	..Do....
.....	....	T	...	1,476	See log. Depth to shale, 148 ft.
.....	....	D,S	Qg	1,485	Water reported hard, adequate; pumps 2½ gpm.
75	7-13-49	Irr	Qg	1,455	Water reported soft, adequate; used to irrigate golf course.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
153-64 (Cont.)					
8aac	S. B. Barr	94	6	Dr	1920
8cdd	E. Wilcox, Jr.	136	6	Dr	....
9acd	J. Frison	118	6	Dr	1908
9bad	W. G. Rigger	119	6	Dr	1917
9cda	L. A. Roberts	119	6	Dr	1902
9daa	M. Rogers	104	4	Dr	1951
9dab	A. Peterson	104	4	Dr	1951
9dad	C. Montieth	80	4	Dr	....
10cbb	L. W. Ford	175	5	Dr	....
10ddd	H. Maher	36	30	Du	....
11bbc1	M. J. Cowley	98	4	Dr	1912
11bbc2	..do....	104	4	Dr	1924
11dcd	P. Mandy	80	4	Dr	1936
12dbc	..do....	160	4	Dr	1923
16aab	Great Northern test 3	120	6	Dr	1938
16aac1	Great Northern test 2	93	6	Dr	1938
16aac2	Great Northern test 1	103	6	Dr	1938
16aac3	Great Northern test 4	101	6	Dr	1938
16cad	D. Jacobson	20	..	Du	1949
16ccb	Great Northern test 6	95	6	Dr	1938
16ccc1	Great Northern test 5	106	6	Dr	1938
16ccc2	R. Culter	100	5	Dr	1946
16cdc	W. H. Summers	100	4	Dr	1932
17aaa	H. Monteith	168	4	Dr	1949
17add	R. Hanson	129	4	Dr	1933
17bbc	E. Wilcox	124	4	Dr	1907
17dbc	O. R. Hanson	150	5	Dr	....
18aaa	T. J. Eide	80	24	Dr	1928
18aba	Carl Rype	123	4	Dr	1949
18abc	C. Paulson	132	4	Dr	1921
18ada	Oline	52	6	Dr	1928
18bdd	H. A. Samuelson	52	18	Dr	1935
18cac	Community of Greenwood	64.0	18	Dr	1930

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
20	9- 5-42	D,S	Qg	1,447	Water reported hard, adequate.
36	7- 7-49	D,S	Qg	1,450	Water reported soft, adequate.
20	9-15-42	D,S	Kp	1,455	..Do....
60	9-16-42	D,S	Kp	1,444	..Do....
15	9-15-42	D,S	Kp	1,460	..Do....
.....	....	D	Kp	1,445	
.....	....	D,S	Kp	1,448	Depth to shale, 40 ft.
.....	....	...	Kp	1,445	
.....	....	D,S	Kp	1,443	Water reported soft, salty, adequate.
4.76	9- 3-43	S	Qg	1,445	Water reported hard, adequate.
.....	....	S	Kp	1,455	Water reported soft, inadequate.
.....	....	D	Kp	1,455	Water reported soft, adequate.
40	9- 3-43	D,S	Qg	1,465	..Do....
35	7-29-48	D,S	Kp	1,457	Water reported soft, salty, adequate.
.....	....	T	..	1,430	See log. Depth to shale, 76 ft.
29	10-11-38	T	..	1,430	See log.
29	10-4-38	T	..	1,430	..Do....
.....	....	T	..	1,430	..Do....
10.6	7- 7-49	D	Qg	1,440	Well being dug when visited.
.....	....	T	..	1,445	See log. Depth to shale, 90 ft.
.....	....	T	..	1,440	See log. Depth to shale, 104 ft.
.....	....	D,S	Qg	1,445	Water reported hard, adequate.
49.28	9-15-48	O	Qg	1,450	Water reported hard; adequate with excess iron.
40	10-17-49	D	Kp	1,453	Water reported hard, salty, adequate. Capacity to be about 6 gpm.
.....	....	U	Qg	1,463	Water reported hard, adequate.
45.77	7- 7-49	U	Qg	1,445	..Do....
.....	....	D,S	Qg	1,473	..Do....
.....	....	U	Qg	1,444	Water reported hard.
.....	....	D,S	Qg	1,462	See chemical analysis; Water reported hard, adequate.
.....	....	D,S	Qg	1,460	Water reported hard, salty.
.....	....	U	Qg	1,457	Water reported soft.
.....	....	S	Qg	1,450	Water reported hard, adequate.
58.65	9-23-49	U	Qg	1,450	Water reported hard.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
153-64 (Cont.)					
18cdc	M. Latham	110	4	Dr	1948
18cdd	E. Smith	140	4	Dr	1935
18dbc	Devils Lake Park Board	132	4	Dr	1934
18dcb	Community of Greenwood	55.0	18	Dr	1930
19aab	A. Miller & C. Scholes	160	4	Dr	1949
19add	Camp Grafton Military Reservation	135	4	Dr	1948
19bad1	..do....	158	4	Dr	1906
19bad2	..do....	252	4	Dr	1948
19bbc	Great Northern test 8	185	6	Dr	1938
19dab1	Camp Grafton Military Reservation	148	4	Dr	1931
19dab2	..do....	144	4	Dr	1926
19dab3	..do....	148	4	Dr	1925
19dab4	..do....	138	4	Dr	1905
19dac	..do....	148	4	Dr	1925
19dad	..do....	182	4	Dr	1934
19dda1	..do....	150	4	Dr	1943
19dda2	..do....	169	4	Dr	1943
19dda3	..do....	155	6	Dr	1938
21bab1	John Palmer	145	3	Dr	1938
21bab2	Test hole 402	150	5	Dr	1951

and test holes -- Continued

Depth to water (feet below land surface	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	D	Qg	1,460	Water reported hard.
70	11-1-48	D	Qg	1,460	Water reported hard, adequate; pumps 3 to 5 gpm.
60	7-15-49	D	Qg	1,475	Water reported hard, adequate; used for community water supply; pumps about 450 gallons an hour.
50.32	9-23-49	D	Qg	1,465	Water reported hard, adequate; used for water supply at picnic grounds.
56.93	10-17-49	D	Qg	1,467	See chemical analysis.
.....	....	D	Qg	1,467	Supply well at Camp Grafton; water reported hard; pumps 12 gpm.
.....	....	D	Qg	1,457	Supply well at Camp Grafton; water reported hard.
.....	....	D	Kp	1,457	Supply well at Camp Grafton; water reported soft; pumps 6 gpm.
.....	....	T	..	1,470	See log. Depth to shale, 182 ft.
48.92	6-18-43	D	Qg	1,467	Supply well at Camp Grafton; water reported hard; pumps 7 gpm.
.....	....	U	Qg	1,467	..Do....
40	9-16-42	D	Qg	1,467	..Do....
.....	....	D	Qg	1,467	..Do....
53.68 53.97	9-12-49 7- 1-43	D,O	Qg	1,465	Supply well at Camp Grafton; water reported hard; pumps about 20 gpm.
56.56	6-18-43	D	Qg	1,465	Supply well at Camp Grafton; water reported hard; pumps about 7 gpm.
66.68	6-18-43	T,D	Qg	1,467	See log.
65.36	6-18-43	T,D	Qg	1,467	..Do....
65.08	6-18-43	D	Qg	1,467	See log. Supply well at Camp Grafton; water reported hard; pumped as much as 120 gpm; now pumps about 54 gpm.
.....	....	D,S	Qg	1,450	Water reported hard, adequate.
.....	....	T	..	1,445	See log. Depth to shale, 145 ft.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
153-64 (Cont.)					
21bca	Test hole 401	150	5	Dr	1951
21cbd	Devils Lake city test 1	155	4	Dr	1950
21cdc	Devils Lake city test 4	249	4	Dr	1950
26cca	W. Comer	110	4	Dr	1943
28bca	Test hole 403	210	5	Dr	1951
28bcd	Great Northern Railway	258	4	Dr	1928
28cdc	Devils Lake city test 2	200	4	Dr	1950
35bdb	C. E. Simon	35	48 x 48	Du	....
36abd	E. T. Nelson	130	4	Dr	1920
153-65					
1bba	Test hole 182	150	5	Dr	1949
2acc	C. W. Buttz	142	4	Dr	1939
2bcc	H. Charbonneau	160	4	Dr	1912
2ccc	Test hole 188	188	5	Dr	1949
3ccb	R. Weed	40	30	Du	1900
3dad	G. Sloman	120	6	Dr	1912
4abd	H. Oram	165	4	Dr	1927
4cdb	P. Oram	165	4	Dr	1941
4ccc	..do....	43	..	Dr	....
5baa1	I. Bo	32	48	Du	....
5baa2	..do....	150	4	Dr	1928
5dca	S. Thompson	10.5	36	Du	....
5dbd	I. Bo	.....	48 x 48	Du	1925
6aab	M. Timbal	37.0	30	Dr	....
6ada	S. Thompson	110	4	Dr	....
6ccc	A. Moen	90	4	Dr	1918
7aac	I. Bo	.....	36 x 36	Du	....
9ddd1	J. Kostecki	180	4	Dr	....
9ddd2	..do....	28	30	Du	1948

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	T	..	1,435	See log. Depth to shale, 142 ft.
.....	....	T	..	1,440	See log. Depth to shale, 152 ft.
.....	....	T	Qg	1,440	See log and chemical analysis. Depth to shale, 248 ft.
.....	....	D	Qg	1,445	Water reported hard, adequate.
.....	....	T	..	1,435	See log. Depth to shale, 195 ft.
30	8- 8-49	D	Kp	1,440	See log. Depth to shale, 234 ft.; Water reported soft, adequate.
.....	....	T	..	1,430	See log. Depth to shale, 195 ft.
.....	....	S	Qg	1,485	Water reported hard.
.....	....	D,S	Qg	1,450	Water reported hard, adequate.
.....	....	T	..	1,485	See log. Depth to shale, 145 ft.
30	9-12-42	D,S	Qg	1,481	
.....	....	S	Qg	1,475	See chemical analysis. Water reported hard, adequate.
.....	....	T	..	1,481	See log. Depth to shale, 176 ft.
.....	....	D,S	Qg	1,475	Water reported hard, adequate.
20	9-11-42	D,S	Qg	1,476	..Do....
.....	....	D,S	Qg	1,455	See chemical analysis. Water reported hard, adequate.
.....	....	D,S	Qg	1,450	Water reported hard, adequate.
41	9-12-42	D,S	Qg	1,415	Water reported hard; well dug in 1940.
.....	....	S	Qg	1,453	
.....	....	D,S	Qg	1,453	Water reported hard, adequate.
8.69	9-16-43	S	Qg	1,415	In spring area.
6.68	8-14-50	S	Qg	1,420	Water reported adequate.
16.85	9-15-43	D,S	Qg	1,460	Water reported hard, adequate.
.....	....	D,S	Qg	1,454	..Do....
.....	....	D,S	Qg	1,447	..Do....
13.67	7-15-49	U	Qg	1,451	
.....	....	S	Qg	1,463	..Do....
.....	....	D	Qg	1,463	..Do....

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
153-65 (Cont.)					
10aaa	M. and H. Hanson	150	4	Dr	1949
10aba	H. Fitzpatrick	93	6	Dr	1927
10dbb	C. Peterson	125	..	Dr	1926
11cdd	C. Verschuri	75	4	Dr	1913
12bbb	Test hole 193	185	5	Dr	1949
12ccd	Test hole 191	175	5	Dr	1949
12dbb	J. Weed	100	6	Dr	1917
12ddd	Test hole 195	150	5	Dr	1949
13caa	P. C. Way	175	4	Dr	....
13cab	Test hole 196	250	5	Dr	1949
14acc	B. Boland	285	4	Dr	....
14bbb	Test hole 189	250	5	Dr	1949
14ccc	Test hole 190	115	5	Dr	1949
14cda	F. Walford	92	6	Dr	1912
14dab	R. Johnson	98	4	Dr	1926
15dac	H. Mayney	100	4	Dr	....
16bba	T. McDonnell	200	6	Dr	1905
18ddd	W. E. Hocking	240.0	4	Dr	....
19bab	Sauer	100	4	Dr	....
22bbb	Test hole 197	265	5	Dr	1949
24baa	Test hole 192	180	5	Dr	1949
28dda	R. Brown	49.0	24	Dr	....
30bba	W. E. Hocking	154.3	4	Dr	....
30bdc	B. Arnold	159	4	Dr	1937
30daa	C. Elstad	72	4	Dr	1934
31bbb	L. Brown	24.1	36	Du	1917
32ccd	B. Knudson	34	24	Dr	....
32dda	A. Barstad	49	24	Dr	1946

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	S	Qg	1,480	See chemical analysis. Water reported hard, adequate.
53	9-12-42	D,S	Qg	1,475	Water reported hard, adequate.
.....	....	D,S	Qg	1,472	..Do....
.....	....	D,S	Kp	1,485	..Do....
.....	....	T	..	1,482	See log. Depth to shale, 177 ft.
.....	....	T	..	1,443	See log. Depth to shale, 168 ft.
.....	....	D,S	Qg	1,445	See chemical analysis. Water reported hard, adequate.
.....	....	T	..	1,440	See log. Depth to shale, 143 ft.
.....	....	D,S	Qg	1,460	See chemical analysis. Water reported hard, adequate.
.....	....	T	..	1,442	See log. Depth to shale, 238 ft.
56.00	9-12-49	O	Kp	1,470	
.....	....	T	..	1,470	See log. Depth to shale, 237 ft.
.....	....	T	..	1,443	See log. Depth to shale, 110 ft.
48.41	9-12-42	D,S	Qg	1,465	Water reported hard, adequate.
.....	....	D,S	Qg	1,460	..Do....
.....	....	D,S	Qg	1,455	..Do....
.....	....	S	Kp	1,461	..Do....
9.38	9- 6-50	S	Kp	1,414	Water reported hard, salty, adequate.
.....	....	D	Qg	1,420	Water reported hard.
.....	....	T	..	1,439	See log. Depth to shale 257 ft.
.....	....	T	..	1,421	See log. Depth to shale, 112 ft.
22.76	7- 7-50	U	Kp	1,420	Water reported salty.
43.32	9- 6-50	U	Kp	1,485	
12.14	7-20-49	D,S	Kp	1,485	Depth to shale, 80 ft. Water reported soft.
24	7-20-49	D,S	Kp	1,460	Water reported hard, adequate.
20.50	9- 6-50	D,S	Qg	1,452	..Do....
27.0	7-20-49	D,S	Qg	1,463	
26	7-20-49	D,S	Qg	1,452	

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
153-66					
2aab1	T. O. Moen	103	4	Dr	1915
2aab2	..do....	130	4	Dr	1949
8dab	R. D. Ward	20.0	24	Du	....
8ddd	..do....	22.0	30	Du	....
13cca	E. F. Zimmer	60.8	24	Dr	1937
14bcd	L. A. Doheny	120	4	Dr	1925
14cdd1	R. D. Ward	70	24	Dr	1934
14cdd2	..do....	220	4	Dr	1917
15ccb1	S. Ward	130	6	Dr	1920
15ccb2	..do....	30	54	Du	1930
15dcb	R. D. Ward	130	4	Dr	1920
15dcc	Test hole 45	146	5	Dr	1948
19bbb	Test hole 39	66	5	Dr	1946
19caa	....	8.8	48 x 48	Du	....
20bab	Test hole 42	239	5	Dr	1946
21aab	Test hole 41	103	5	Dr	1948
21bab	Test hole 43	230	5	Dr	1946
21bbb	Test hole 40	324	5	Dr	1946
22aaa	R. Burdick	160	24	Dr	1921
22abc	R. D. Ward	50	48	Du	1936
22bab	Test hole 44	130	5	Dr	1946
22dad1	R. Burdick	44.4	50	Du	....
22dad2	..do....	67.0	24	Dr	1930
23aad	School	33.7	4	Dr	1938
23adc	R. Burdick	46.4	24	Dr	1934

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
15.91	7-15-49	U	Qg	1,457	See chemical analysis.
.....	....	D,S	Kp	1,457	Depth to shale, 104 ft. Water reported soft, adequate.
.....	....	S	Qg	1,431	Water reported hard; adequate for 1,000 head stock.
12.36	9-12-46	S	Qg	1,427	See chemical analysis.
20.28	9- 9-50	D,S	Qg	1,447	Water reported hard, adequate.
30	9- 9-50	D,S	Qg	1,457	..Do....
50	9- 8-50	S	Qg	1,477	..Do....
.....	....	U	Qg	1,477	Aquifer reported to be gravel; water reported too salty for stock.
50	7-20-49	D,S	..	1,430	
7	7-20-49	S	Qg	1,430	
60	9- 9-50	D,S	Kp	1,457	Water reported soft, adequate.
.....	....	T	..	1,445	See log. Depth to shale, 135 ft.
.....	....	T	..	1,435	See log. Depth to shale, 51 ft.
3.99	9-28-50	U	Qg	1,433	
.....	....	T	Qg	1,425	See log and chemical analysis. Depth to shale, 236 ft.
1.25	10-7-50	T,D	Qg	1,425	See log and chemical analysis.
.....	....	T	..	1,425	See log. Depth to shale, 222 ft.
.....	....	T	..	1,424	See log. Depth to shale, 319 ft.
15.25	9- 8-50	S	Kp	1,450	Aquifer reported to be sand; water reported soft, salty, adequate.
16.18	9- 9-50	S	Qg	1,447	Water reported hard.
.....	....	T	..	1,435	See log. Depth to shale, 112 ft.
38.48	9- 8-50	U	Qg	1,505	Depth to shale, 250 ft. Reported inadequate. Test hole drilled to 250 ft. but no water found. Did not get to shale.
34.32	9- 8-50	D,S	Qg	1,503	Water reported hard, adequate.
11.32	9- 8-50	D	Qg	1,475	Water reported adequate.
36.85	9- 9-50	S	Qg	1,480	Water reported hard, inadequate for 10 head of stock.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
153-66 (Cont.)					
23ddc1	Michaels	211.9	4	Dr	....
23ddc2	..do....	49.1	24	Dr	1936
24bac	C. Griffin	30.2	24	Dr	....
24dbb1	W. E. Hocking	49.4	6	Dr	....
24dbb2	..do....	52.1	4	Dr	....
25dad	W. Howard	100	..	Dr	....
27aaa	Michaels	59.6	24	Dr	1923
29ddb1	H. Howard	35.0	30	Dr	....
29ddb2	..do....	20.2	30	Dr	....
30dcd1	L. Martinson	28.3	36	Dr	1926
30dcd2	..do....	23.4	30 x 30	Du	1930
31bdb	E. Johnson	26.9	42 x 42	Du	1919
32bba	H. Howard	113.5	4	Dr	1944
35aaa	W. Howard	42.9	36	Du	1946
35bba	M. Lanore	16.1	24	Du	....
36bbd	E. Frank	35.7	36 x 36	Du	1910
153-67					
2dca	Minnewaukan test 2	72	4	Dr	1947
3aaa1	G. D. Lagrare	30	6	Dr	1917
3aaa2	..do....	180	6	Dr	1917
3abb	W. Hahn	50	42	Du	1928
3dcd	N. Zacher	96	4	Dr	1943
13bad	A. Dickenson	24.0	3	Dr	....
13caa	B. M. Knowlton	18	36	Du	1926
15acb	W. Palmer	19	36	Du	1939
15acd	A. Lindstrom	28	24	Du	1943
15ada	Fairgrounds	20	48	Du	1935
15bad	A. R. Foss	14	..	Du	1882
15bbc	Minnewaukan supply well 1	44	10	Dr	1953
15bda1	J. H. Archer	25	36	Du	....

and test holes -- Continued

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
41.92	9- 8-50	U	Kp	1,500	Aquifer reported to be sand; water reported salty.
37.50	9- 8-50	S	Qg	1,497	Water reported hard, adequate.
9.44	9-27-50	U	Qg	1,455	
10.13	9- 6-50	D,S	Qg	1,457	..Do....
11.24	9- 6-50	U	Qg	1,457	
32.30	7-20-50	...	Kp	1,492	Depth to shale, 95 ft.
43.21	9- 8-50	U	Qg	1,503	
18.55	7-31-50	D,S	Qg	1,445	Water reported hard, adequate.
8.80	7-31-50	S	Qg	1,435	..Do....
22.15	7-31-50	D,S	Qg	1,457	Water reported hard, inadequate.
9.47	7-31-50	S	Qg	1,450	Water reported hard, adequate.
19.02	7-31-50	D,S	Qg	1,463	..Do....
10.22	9-27-50	S	Kp	1,447	Water reported soft, salty, inadequate.
30.98	9- 7-50	D,S	Qg	1,454	Water reported hard, adequate.
1.72	9- 7-50	D	Qg	1,425	Water reported soft.
28.86	9- 7-50	S	Qg	1,457	Water reported hard, adequate.
5.38	6-13-47	T	Qg	1,430	See log and chemical analysis. Depth to shale, 71 ft.
.....	....	D	Qg	1,460	Water reported hard, inadequate.
.....	....	S	Kp	1,460	Water reported salty.
.....	....	D,S	Qg	.....	Water reported soft, adequate.
.....	....	D,S	Qg	1,463	See chemical analysis. Water reported hard.
.....	....	S	Qg	1,439	Water reported soft, adequate.
13.60	7- 3-46	D,S	Qg	1,433	See chemical analysis. Depth to shale, 18 ft. Water re-ported hard, inadequate in dry years.
14	7- 3-46	D	Qg	.....	Water reported hard.
10	7- 3-46	D	Qg	1,450	Water reported unfit for drinking.
7.95	7- 3-46	S	Qg	1,440	Water reported hard, inadequate.
5.15	7- 2-46	S	Qg	.....	Water reported hard, adequate.
10.75	1- 2-53	M	Qg	1,461	See log and chemical analysis. Pumped 50 gpm during 24 hour test.
6.98	7- 2-46	D,S	Qg	.....	Water reported hard, inadequate.

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
153-67 (Cont.)					
15bda2	Minnewaukan test 11	98	..	Dr	1951
15bdd	R. B. Hoffman	22	48	Du	1928
15caa	H. Hanson	26	18	Du	1910
15dab	B. M. Knowlton	114	6	Dr	1914
15dba	H. S. Herman	22	30	Du	1939
15dbb	City of Minnewaukan	40	10	..	....
15dbd	Courthouse	60	..	Dr	....
15dca	F. Johnson	20	36	Dr	1900
15dcc1	J. Hager	25	36	Du	1936
15dcc2	Test hole 523	50	5	Dr	1952
15dcd	S. L. Burgess	25	30	Du	1900
16caa	J. Hoffart	50	36	Du	....
16dcd	Test hole 515	50	5	Dr	1952
21aaa	Test hole 517	50	5	Dr	1952
21aab	Test hole 516	140	5	Dr	1952
21dcc	F. Anderson	35	24	Dr	1939
22baa	Test hole 520	50	5	Dr	1952
22bab	Test hole 519	50	5	Dr	1952
22bbb	Test hole 518	50	5	Dr	1952
23aaa	Test hole 28	59	5	Dr	1946
23bab	Test hole 36	80	5	Dr	1946
23bdd	D. Burgess	22	36	Du	....
23dbb	R. Newcomb	14	60	Du	1937
23dbd	..do....	16.3	36 x 36	Du	....

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	T	Qg	1,449	See log and chemical analysis. Depth to shale, 38 ft.
6.85	7- 2-46	S	Qg	.....	Water reported hard, inadequate.
6.23	7- 2-46	S	Qg	.....	..Do....
2.77	7- 3-46	D,S	Kp	1,460	..Do....
14.43	7- 3-46	D	Qg	1,460	Water reported hard, inadequate.
8.30	7- 3-46	D	Qg	.....	See chemical analysis. Water reported hard, not always adequate.
11.4	7- 1-46	D	Kp	1,463	See chemical analysis. Water reported hard, adequate.
7.60	7- 3-46	D,S	Qg	1,460	Water reported hard, inadequate.
10.27	7- 2-46	D,S	Qg	1,460	See chemical analysis. Water reported hard, inadequate.
10.9	5-20-52	T	..	1,461	See log. Depth to shale, 44 ft.
9.15	7- 2-46	S	Qg	1,455	Water reported hard, inadequate.
25.95	7- 3-46	D,S	Qg	.....	Water reported hard.
22.2	5-20-52	T	Qg	1,494	See log.
12.9	5-20-52	T	Qg	1,472	See log and chemical analysis. Depth to shale, 38 ft.
31.3	5-20-52	T	Qg	1,503	See log. Depth to shale, 72 ft.
18.00	7- 4-46	D,S	Qg	.....	Water reported hard, inadequate.
8.5	5-20-52	T	Qg	1,461	See log. Depth to shale, 28 ft.
4.1	5-20-52	T	Qg	1,462	See log. Depth to shale, 36 ft.
4.4	5-20-52	T	Qg	1,463	See log. Depth to shale, 38 ft.
.....	....	T	..	1,433	See log. Depth to shale, 55 ft.
.....	....	T	..	1,445	See log. Depth to shale, 45 ft.
15.75	7- 5-46	D,S	Qg	1,434	Water reported hard, inadequate.
7.94	7- 5-46	S	Qg	1,434	..Do....
14.27	9-27-50	D,S	Qg	1,440	..Do....

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
153-67 (Cont.)					
24abb	Test hole 37	86	5	Dr	1946
24bab	Test hole 38	75	5	Dr	1946
25caa	E. Johnson	22.3	36 x 42	Du	....
25cab	A. Johnson	48	36	Du	....
34dcc	E. J. Nottestad	48	..	Du	....
35dac	Nick Hisler	112.8	4	Dr	....
35dbb	L. Rickansrude	100	6	Dr	1926
36baa	E. Johnson	31.5	30	Du	....
154-62					
30dcc	Howard Maher	162.3	4	Dr	....
31ccc	..do....	110.7	4	Dr	1916
32aad	C. J. Kalinowski	190	5	Dr	1910
32cdb1	Edward Kalinowski	36.8	24	Dr	....
32cdb2	..do....	190	4	Dr	....
154-63					
4bcd	H. Weiser	95	4	Dr	....
4ccc	A. Swenson	120	6	Dr	1922
4ddc	L. C. Johnson	160	4	Dr	1910
5ccc	Test hole 127	50	5	Dr	1949
5dba	Halgren Bros.	115	4	Dr	1910
6aaa	Test hole 126	40	5	Dr	1949
6abb	H. Storman	75	4	Dr	1923
7abb	Test hole 128	70	5	Dr	1949
7ccb	C. K. Jerbertson	125	4	Dr	1912
8bdb	Serumjand Estate	72	4	Dr	....
8cdc	Peterson Bros.	133	4	Dr	1914
17abb	G. Jenson	100	4	Dr	1925
17cba	G. Evenson	147	4	Dr	1950

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	T	..	1,430	See log. Depth to shale, 70 ft.
.....	....	T	..	1,434	See log. Depth to shale, 68 ft.
20.4	7-31-50	S	Qg	1,455	Water reported hard, adequate.
24.55	7- 5-46	D,S	Qg	1,465	See chemical analysis.
19.40	7- 5-46	D,S	Qg	.....	Water reported hard.
31.51	8- 1-50	S	Kp	1,470	Water reported soft, salty.
.....	....	S	Kp	1,450	Water reported salty.
18.1	7-31-50	U	Qg	1,462	Water reported hard.
26.25	6-28-50	D,S	Kp	1,500	Water reported soft, adequate.
12.90	7- 4-50	U	Kp	1,497	
15	6-28-50	D,S	Kp	1,505	..Do....
16.76	7- 4-50	U	Qg	1,486	
.....	....	U	Kp	1,486	Water reported soft, salty.
.....	....	D,S	..	1,475	Water reported hard, adequate.
.....	....	D,S	Kp	1,485	Water reported soft, adequate.
.....	....	D,S	Kp	1,485	Water reported soft, salty, adequate.
.....	....	T	..	1,487	See log. Depth to shale, 38 ft.
.....	....	D,S	Kp	1,518	See chemical analysis. Depth to shale, 20 ft. Water reported soft, adequate.
.....	....	T	..	1,471	See log. Depth to shale, 36 ft.
.....	....	D,S	Kp	1,483	Water reported soft, adequate except in dry years.
.....	....	T	..	1,485	See log. Depth to shale, 56 ft.
.....	....	D,S	Kp	1,485	Water reported hard, salty, adequate.
.....	....	D,S	Kp	1,500	Water reported soft, adequate.
.....	....	D,S	Kp	1,491	Water reported soft, slightly salty, adequate.
.....	....	D,S	Kp	1,496	Water reported slightly hard, adequate.
.....	....	D	Kp	1,513	Water reported soft, adequate.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
154-63					
18aaa	R. Thompson	75	4	Dr	1938
18dba	P. O. Thompson	258	4	Dr	1912
19daa	Test hole 588	90	5	Dr	1952
20bbb	A. J. Anderson	130	4	Dr	1922
28bba	K. Miller	40	36 x 36	Du	1936
28bbc	..do....	165	4	Dr	1900
29bcd	M. Larson	176	4	Dr	1948
30bcc	B. Olson	110	6	Dr	1910
30daa	O. Warmark	...	4	Dr	....
31aaa	P. Riplinger	...	..	Dr	....
32bba	R. Halle	58	20	Dr	1925
32dbc1	T. R. Thelin	150	6	Dr	1938
32dbc2	..do....	40	36	Du	1936
32dca	..do....	40	36	Du	1936
32dcc	..do....	150	6	Dr	1935
33cbb	C. V. Landis	163	4	Dr	1943
34bba	E. Brash	82	4	Dr	1947
36ccd	S. G. Mahoney	240	4	Dr	1919
154-64					
1cdd	Test hole 130	110	5	Dr	1949
1dda	B. Moran	31.0	24	Du	....
1ddd	Test hole 129	120	5	Dr	1949
2cdd	Test hole 132	60	5	Dr	1949
3baa	Test hole 135	110	5	Dr	1949
3bba	Test hole 203	113	5	Dr	1949
3caa	J. Bragg	72	6	Dr	1940
3cad	Test hole 156	90	5	Dr	1949
3cdd	Test hole 134	110	5	Dr	1949

and test holes -- Continued

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	D,S	Kp	1,493	Water reported soft, adequate.
.....	....	D,S	Kp	1,533	Water reported soft, adequate. See chemical analysis. Depth to shale, 30 ft.
.....	....	T	..	1,556	See log. Depth to shale, 81 ft.
.....	....	D,S	Kp	1,537	Water reported soft, adequate.
5.46	7-23-48	S	Qg	1,475	Water reported hard, adequate.
.....	....	D	Kp	1,521	..Do....
27	5- 5-49	D	Kp	1,497	Water reported soft, adequate. Depth to shale, 128 ft.
.....	....	D,S	Kp	1,475	Water reported soft, adequate.
.....	....	D,S	..	1,497	Water reported hard, adequate.
.....	....	D,S	..	1,475	..Do....
30.13	7-23-48	D,S	Kp	1,485	..Do....
.....	....	S	Kp	1,483	Water reported soft, adequate; Depth to shale, 70 ft.
18.64	7-30-48	D	Qg	1,483	Water reported hard, adequate.
14.10	7-30-48	S	Qg	1,478	..Do....
.....	....	D	Kp	1,480	Water reported soft, adequate.
.....	....	D,S	Kp	.....	..Do....
.....	....	D	Qg	.....	..Do....
.....	....	D,S	Kp	.....	Water reported soft, slightly salty, adequate.
.....	....	T	..	1,461	See log. Depth to shale, 99 ft.
8.65	9- 1-49	S	..	1,467	
.....	....	T	..	1,469	See log. Depth to shale, 114 ft.
.....	....	T	..	1,463	See log. Depth to shale, 51 ft.
.....	....	T	..	1,465	See log. Depth to shale, 99 ft.
.....	....	T	..	1,467	See log. Depth to shale, 108 ft.
.....	....	D,S	Qg	1,475	Water reported hard, adequate.
.....	....	T	..	1,466	See log. Depth to shale, 87 ft.
.....	....	T	..	1,479	See log. Depth to shale, 108 ft.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
154-64 (Cont.)					
3dba	C. L. Winnegge	160	6	Dr	1920
3dcc	Hyland	150	4	Dr	....
3ddd	Test hole 133	70	5	Dr	1949
4ccc	Test hole 2X	32	4	Dr	1949
4cdd	Test hole 1X	15	4	Dr	1949
5ccd	J. Nahinurk	37.0	30	Dr	....
5dbd	W. Hocking	26.0	48	Du	....
6bcb	B. C. Steies	29	..	Du	1936
6ddd	B. Baker	120	..	Dr	....
7add	E. Jodoin	36.0	24	Du	....
7dcc	J. Ziegler	27.5	48 x 48	Du	....
8aad	W. Hocking	Spring	..	..	....
9dcc	Test hole 176	155	5	Dr	1949
10bbb	Test hole 158	105	5	Dr	1949
10caa	Test hole 157	44	5	Dr	1949
10cdd	A. Kleven	85	4	Dr	....
12bbb	Test hole 131	60	5	Dr	1949
12cdc	I. Clapp	39.0	40	Du	....
14acc1	G. Shipley	26.0	36	Du	....
14acc2	..do....	158	4	Dr	....
14cdc	A. Senger	18.2	30	Du	....
15abb	Test hole 3X	27	4	Dr	1949
15caa	M. C. Huffman	25.9	36	Du	....
16aaa	Test hole 175	95	5	Dr	1949
16adc	T. Brill	...	4	Dr	....
17bbc	H. VanLien	29.0	28	Dr	....
18dcc1	W. Frank	93	4	Dr	1920
18dcc2	..do....	24.0	14	Dr	....

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	D,S	Kp	1,480	Water reported soft, adequate.
.....	....	D	Qg	1,485	Water reported hard, adequate.
.....	....	T	..	1,467	See log. Depth to shale, 60 ft.
.....	....	T	..	1,465	See log.
.....	....	T	..	1,430	See log. Depth to shale, 13ft.
25.39 26.34	9- 7-43 8-18-48	D,S	..	1,485	Water reported hard, adequate.
13.60	9- 8-43	S	Qg	1,475	Water reported hard, inadequate in drought years.
27.36	7- 7-48	D,S	Qg	1,505	Water reported hard, adequate.
30	8-18-48	D,S	Kp	1,480	Water reported soft, adequate.
23.41	9- 7-43	S	Qg	1,485	
15.51	7-30-49	D	Qg	1,475	Water reported hard, adequate.
.....	....	S	Qg	1,467	
.....	....	T	..	1,504	See log. Depth to shale, 146 ft.
.....	....	T	..	1,470	See log. Depth to shale, 101 ft.
.....	....	T	..	1,471	See log. Depth to shale, 30 ft.
.....	....	D,S	Kp	1,467	Water reported soft, inadequate in drought years.
.....	....	T	..	1,463	See log. Depth to shale, 55 ft.
30.98	9- 8-43	S	Qg	1,490	Water reported hard, inadequate in drought years.
16.84	8-26-43	D	Qg	1,480	Water reported hard.
15	8-26-43	S	Kp	1,478	Water reported salty, adequate.
15.85	8-26-43	S	Qg	1,470	Water reported hard, inadequate.
.....	....	T	..	1,467	See log. Depth to shale, 23 ft.
11.01	9- 4-43	D,S	Qg	1,468	See chemical analysis. Water reported hard, adequate.
.....	....	T	..	1,466	See log. Depth to shale, 83 ft.
27.62	7-30-49	D,S	Kp	1,485	Water reported soft, adequate.
16.02	9- 7-43	D,S	Qg	1,475	Water reported hard.
.....	....	D,S	Kp	1,470	Water reported soft, adequate.
20.89	8- 3-48	U	Qg	1,475	

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
154-64 (Cont.)					
20bbc	Kerberg	204	5	Dr	1923
21ada	B. Fisher	125	..	Dr	....
21baa	S. Blanchfield	63	4	Dr	1936
22abb1	G. Gergans	120	4	Dr	....
22abb2	Great Northern Railroad	112	12	Dr	1939
22bcb	G. Thelin	156	4	Dr	....
22dcc	Great Northern Railroad - 10	70	12	Dr	1939
23aca	E. Nootnagle	26.9	24	Dr	....
23cad	C. Swanson	28	18	Du	....
23dbc	M. Bloomquist	135	4	Dr	....
24dba	J. Frank	42	36	Du	....
24ddd	M. Kenner	110	4	Dr	1947
25bcd1	C. Spiesman	196	4	Dr	....
25bcd2	..do....	96	4	Dr	....
25dba	Ryan Estate	30.5	36	Du	....
26bac	M. Iverson	124	4	Dr	1938
26dcd	O. Sletheland	200	4	Dr	....
27abc	Great Northern - 11	80	12	Dr	1939
27cdd1	North Dakota State School for the Deaf	76	4	Dr	1946
27cdd2	..do....	125	2.5	Dr	....
27dbc	C. Hager	100	4	Dr	1908
27dbd	W. A. Sprague	30.8	36	Dr	1926
27dcb	Great Northern - 12	48	12	Dr	1939
28add	W. Hocking	78	4	Dr	1927

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	S	Kp	1,480	Water reported salty, and barely adequate.
22	7- 3-48	D,S	Kp	1,505	Water reported soft, adequate.
.....	....	D,S	Qg	1,510	Water reported hard, adequate. Pumps 4½ gpm.
5.50	8- 5-43	D,S	Kp	1,465	Water reported soft, adequate.
8.62	8-27-43	T	Qg	1,465	See log. Depth to shale, 105 ft. Reported pumped 20 gpm with 93 ft. drawdown when tested.
.....	....	D,S	Kp	1,488	Water reported soft, adequate.
16.15	8-28-43	T	Qg	1,475	See log. Depth to shale, 60 ft. Reported pumped 11 gpm with 29 ft. drawdown when tested.
18.22	8-27-43	D,S	Qg	1,470	Water reported hard, adequate.
.....	....	D	Qg	1,470	Water reported hard, inadequate.
.....	....	D,S	Kp	1,470	See chemical analysis. Depth to shale, 45 ft. Water reported soft, adequate.
34.17	9- 3-43	D,S	Qg	1,492	Water reported hard, adequate.
.....	....	D,S	Qg	1,495	..Do....
.....	....	S	Kp	1,478	Water reported salty, adequate.
.....	....	D	..	1,478	Water reported adequate.
22.73	9- 3-43	S	Qg	1,480	Water reported hard, adequate.
.....	....	...	Kp	1,470	Water reported hard, salty.
19.42	8-26-43	D,S	Kp	1,465	Water reported soft, salty, adequate.
.....	....	T	..	1,470	See log. Depth to shale, 80 ft.
.....	....	D	Qg	1,465	Water reported soft, adequate.
.....	....	Irr	Kp	1,465	See chemical analysis. Water reported adequate.
.....	....	D,S	Kp	1,470	See chemical analysis. Water reported soft, adequate.
15.31	8-27-43	D,S	Qg	1,470	Water reported hard, inadequate.
17.87	8-28-43	U	Qg	1,465	See log. Reported pumped 35 gpm with 29 ft. drawdown when tested.
.....	....	U	Qg	1,468	Water reported hard.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
154-64 (Cont.)					
29abc	Moffet	21.3	30	Dr	....
29bac1	H. Kenner	31.0	48	Du	1905
29bac2	..do....	150	..	Dr	....
31aaa	M. G. Graham	97	6	Dr	1920
31aca	R. M. Young	136	6	Dr	....
32bbb	City of Devils Lake	56	48 x 48	Du	1914
32bbd	..do....	137	4	Dr	1931
33ada	Davis Bros.	11.9	30 x 30	Du	1939
33daa	..do....	84	4	Dr	1942
33ccc	City of Devils Lake	52	..	Dr	1946
34aca	Minn., St. Paul and Sault Ste. Marie	143	6	Dr	1945
34acd	Central High School	96	6	Dr	1948
34adb	Seven-up Bottling Co.	155	6	Dr	1946
34baa	Lincoln School	25	..	Dr	....
34bad	Farmers Union Coop.	142	4	Dr	1938
34bda	K. Kurtz	21	24	Du	1929
34cda	M. Eisenzimmer	80	4	Dr	1913
34daa	R. Barrickman	96	4	Dr	1927
34dab	City of Devils Lake	125	..	Dr	....
34dac	Devils Lake City Supply well A	1,530	8 to 3½	Dr	1889

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
12.03	8-24-43	U	Qg	1,463	
16.34	9- 7-43	S	Qg	1,467	Water reported hard.
.....	....	...	Kp	1,467	Water reported soft, soda taste
.....	....	...	Kp	1,467	Water reported soft, salty, adequate.
.....	....	D,S	Kp	1,470	Water reported soft.
.....	....	...	Qg	1,469	Water reported hard.
.....	....	...	Kp	1,458	Water reported soft, salty.
5.69	8-24-43	S	Qg	1,445	Water reported hard, inadequate
.....	....	D,S	Qg	1,435	See chemical analysis. Water reported hard, adequate.
.....	....	D	Qg	1,440	Water reported adequate.
.....	....	Ind	Kp	1,458	Depth to shale, 98 ft. Water reported soft, adequate.
31.93	7- 7-49	D	Kp	1,468	Depth to shale, 54 ft. Water reported barely adequate.
20	5- 4-49	Ind	Kp	1,458	Water reported hard, salty, adequate.
13.97	8-31-49	D	Qg	1,450	Water reported adequate.
20	7-13-49	U	Kp	1,457	
.....	....	D,Irr	Qg	1,450	Water reported hard.
65	7-11-49	D	Kp	1,442	Water reported soft, adequate.
22	7- 8-49	D	Kp	1,465	..Do....
.....	....	D	Kp	1,467	See chemical analysis. Water reported soft, adequate. Supplies domestic water to people who come to well after it.
Flows	....	M	Kd	1,472	See log. Depth to shale, 25 ft. Water reported soft, adequate. Total depth reported to be 1,530 ft. but log available for only 1,511 ft. Well flows about 100 gpm but is pumped at a rate of about 280 gpm with a pumping water level 23 to 27 ft. below land surface. Two "flows" apparantly found in well: one at about 1,300 ft. and one at about 1,500 ft. Lower flow plugged; water produced from upper flow only.

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
154-64 (Cont.)					
34dad	K. Olson	110	4	Dr	1948
34dba	Grayson Hotel	110	..	Dr	....
34dbd	Mann Building	115	4	Dr	1915
34dca	Coca-Cola Bottling Co.	115	6	Dr	1936
34dcb1	Devils Lake city supply well B	1,515	8 to 4½	Dr	1930
34dcb2	Devils Lake city supply well C	1,496	12 to 6	Dr	1950
34dcc	Devils Lake city supply well D	1,500	12 to 6	Dr	1951
34dda	Holbeck Water Works well 1	122	4	Dr	1919
34ddd1	Fairmount Foods	118	6	Dr	1936
34ddd2	..do....	117	6	Dr	1930
35bcd	Mercy Hospital	112	4	Dr	1935
35cac	P. E. Abrahamson	110	4	Dr	1929
35cbc	Evangelical Lutheran Church	140	3	Dr	1918
35ccb	G. J. McIntosh	130	4	Dr	1924

and test holes -- Continued

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
20	7- 7-49	D	Kp	1,475	Water reported soft, adequate. Depth to shale, 56 ft.
.....	....	D	Kp	1,470	
.....	....	D	Kp	1,468	Water reported hard, adequate.
44	5- 3-49	Ind	Kp	1,467	Water reported salty, adequate. Depth to shale, 60 ft.
Flows	....	M	Kd	1,462	See log and chemical analysis. Depth to shale, 90 ft. Water reported soft, adequate. Total depth reported to be 1,515 ft.; log from sample study to 1,511 ft. Well flows about 150 gpm; has been pumped at a rate of 350 gpm; present pumping rate about 225 gpm.
Flows	....	M	Kd	1,462	See log and chemical analysis. Depth to shale, 50 ft. Depth reported to be 1,496 ft; drillers log given to 1,520 ft. Well flows naturally but is pumped for municipal use.
Flows	....	M	Kd	1,442	See log and chemical analysis. Depth to shale, 100 ft. Well flows naturally, but is pumped for municipal use.
.....	....	D	Kp	1,470	Depth to shale, 65 ft. Water reported soft, adequate. Water hauled from this well to residents in Devils Lake for domestic use.
55	11-1-48	Ind	Kp	1,462	Depth to shale, 55 ft. Water reported soft.
50	....	Ind	Kp	1,462	Water reported soft, inadequate; pumps about 6 gpm; also have four other wells of comparable depth and production.
.....	....	D	Kp	1,475	Water reported soft, adequate.
40	7- 7-49	D	Kp	1,470	Water reported soft, inadequate.
20	8-23-49	D	Kp	1,470	Water reported soft, adequate.
.....	....	D	Kp	1,465	..Do....

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
154-64 (Cont.)					
35ccc1	Lake Region Bottling Co.	100	6	Dr	....
35ccc2	Holbeck Water Works well 3	112	..	Dr	1938
35cdb	F. Moffet	78	4	Dr	1938
36cdc	B. Imberg	20	..	Dr	1920
154-65					
2ddd	J. M. McKay	32	48	Du	1893
3aca	L. Bellows	180	..	Dr	....
5ddc	A. Skramstad	125	4	Dr	....
6acd1	P. Stoeser	135	4	Dr	1935
6acd2	..do....	166	4	Dr	1913
7daa	M. Johnson	67	4	Dr	1925
9cdc	A. MacDiarmid	76	4	Dr	....
10cac	R. V. Ketterman	71	..	Dr	1922
10dda	Ole Moen	...	48	Du	....
11bdd	M. MacDonald	190	..	Dr	....
12bdc1	R. Frith	160	..	Dr	....
12bdc2	..do....	20	..	Du	....
13bba	W. H. Wilson	140	4	Dr	1925
13bcc	Test hole 4X	57	5	Dr	1949
14add	G. Jahnke	47.0	24	Dr	1937
14bad	Konzak Bros.	82	4	Dr	1944
14dca	Minn., St. Paul, and Sault Ste. Marie Railway	180	..	Dr	....
14ddb	G. Jahnke	45	24	Dr	1940
14ddc	C. B. Halle	45	36 x 36	Du	....
15aaa	H. P. Moen	96	4	Dr	....
15ddc1	Konzak Bros.	50	4	Dr	1943

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	Ind	Kp	1,465	Water reported soft, adequate. Water treated and used in manufacturing soft drinks.
45	5- 3-49	D	Kp	1,465	Depth to shale, 60 ft. Water reported soft, adequate. Water from this well hauled to residents in Devils Lake for domestic use.
10	7-14-49	D	Kp	1,470	See chemical analysis. Water reported soft, adequate.
.....	....	D	Qg	1,463	Water reported hard, adequate.
21.88	9-13-43	D,S	Qg	1,472	Water reported hard, adequate; inadequate in drought years.
.....	....	D,S	Kp	1,466	Water reported soft.
.....	....	D,S	Qg	1,466	Water reported hard, adequate.
.....	....	D,S	Qg	1,477	..Do....
31.49	7-15-49	U	Qg	1,475	Water reported hard.
47	7-12-49	D,S	Qg	1,476	..Do....
52	7-12-49	D,S	Qg	1,480	Water reported hard, adequate; well originally 110 ft. deep.
25	7-13-49	D,S	Kp	1,466	Water reported hard, adequate; well originally 81 ft. deep.
13.00	9-11-43	U	..	1,470	
.....	....	S	Kp	1,460	Water reported hard, salty, adequate.
.....	....	S	Kp	1,480	Water reported soft.
.....	....	D	Qg	1,480	Water reported hard, adequate.
22.95	8-17-48	S	Kp	1,475	Water reported hard, very salty.
.....	....	T	..	1,465	See log. Depth to shale, 51 ft.
15.75	9- 9-43	D,S	Qg	1,466	Water reported hard, adequate.
10.59	9-24-49	S	Qg	1,450	..Do....
.....	....	U	Kp	1,465	Water reported hard.
30	8-17-48	D,S	Qg	1,460	Water reported hard, salty, adequate.
18	8-17-48	D,S	Qg	1,465	Water reported hard, adequate.
.....	....	D	Kp	1,460	Water reported soft, adequate.
.....	....	D	Qg	1,455	Water reported hard, adequate.

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date Completed
154-65 (Cont.)					
15ddc2	Konzak Bros.	30	24	Dr	1929
16ada1	O. E. Moen	56.5	24	Du	....
16ada2	..do....	220	..	Dr	....
16ccd	A. Bryn	68	4	Dr	1926
17ddd	..do....	150	..	Dr	1931
18aaa	J. C. Hatter	60	4	Dr	1914
19dbc	A. Johnston	99	..	Dr	1938
20ddd	Bryn Estate	144	4	Dr	1926
21bcb	T. A. Bryn	...	4	Dr	....
22abb	O. N. Dion	27.0	48	Du	....
22ddc	L. Kenner	172	4	Dr	1945
23ada	A. Huth	39.0	24	Dr	1940
23baa	Test hole 6X	47	5	Dr	1948
23daa	Test hole 7X	129	5	Dr	1948
24bbb	Test hole 5X	45	5	Dr	1948
25acb1	I. Stater and E. O'Connell	200 +	..	Dr	....
25acb2	..do....	40	36	Du	....
25bdc	I. Weed	38.4	24	Dr	1932
25ddd	W. Kenner	110	..	Dr	1933
26add	I. Weed	110	4	Dr	1935
27dcc	Ericson and Hoakson Estate	150	4	Dr	....
28add	Oium Estate	101	4	Dr	1925
28cbb	J. Peterson	45	24 x 24	Du	1900
30aba	Farbod Estate	140	4	Dr	1921
30cba	J. Aasmundstadt	25.5	24	Dr	1924
30ddd	W. Adahl	36	24	Dr	1928
32acd	H. A. Moen	147	4	Dr	1926
32bab	M. Moen	33.5	36	Du	....
32dac	H. A. Moen	Spring	..	..	....
33aab	Test hole 187	110	5	Dr	1949
33aad	Test hole 186	215	5	Dr	1949

and test holes -- Continued

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
18.59	9-13-43	U	Qg	1,455	Water reported hard, adequate.
46.49	9-17-43	U	Qg	1,482	
.....	....	...	Kp	1,482	Water reported salty.
36	7-12-49	D,S	Qg	1,480	Water reported hard, adequate.
42.65	7-12-49	D,S	Qg	1,480	..Do....
25	7-12-49	D,S	Qg	1,460	Water reported hard, adequate; well originally 130 ft. deep.
39	7-12-49	D,S	Qg	1,475	Water reported hard, adequate.
.....	....	D,S	Qg	1,480	Water reported hard.
.....	....	D,S	Qg	1,477	Water reported hard, adequate.
15.48	9-13-43	D,S	Qg	1,455	Water reported hard, inadequate.
.....	....	S	Qg	1,460	Water reported hard, adequate.
17.17	9- 9-43	D,S	Qg	1,466	..Do....
.....	....	T	..	1,475	See log. Depth to shale, 42 ft.
.....	....	T	..	1,465	See log.
.....	....	T	..	1,465	..Do....
.....	....	S	Kp	1,475	Water reported soft, salty, adequate.
27.19	9- 9-43	S	Qg	1,475	Water reported hard, bitter.
19.82	9- 9-43	S	Qg	1,480	..Do....
.....	....	D,S	Qg	1,475	Water reported hard, adequate.
.....	....	D	Kp	1,467	Water reported soft, adequate.
.....	....	D,S	Qg	1,470	Water reported hard, adequate.
.....	....	D,S	Qg	1,465	Water reported hard, inadequate.
32.46	7-14-49	S	Qg	1,465	Water reported hard, adequate.
54	7-15-49	D,S	Qg	1,475	Water reported soft, adequate.
16.92	9-17-43	D,S	Qg	1,457	Water reported hard, adequate.
13.05	7-12-49	D,S	Qg	1,457	Water reported hard, adequate; inadequate during drought years.
40	9-16-43	D,S	Qg	1,460	Water reported hard, adequate.
18.28	9-15-43	D,S	Qg	1,470	..Do....
.....	....	S	Qg	1,420	Small trickle of water only in wet season.
.....	....	T	..	1,439	See log. Depth to shale, 102 ft.
.....	....	T	..	1,417	See log. Depth to shale, 196 ft.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
154-65 (Cont.)					
33bab	A. Oium and C. Bryn	140	4	Dr	1935
34bcd	Test hole 185	350	5	Dr	1949
34ccd	Test hole 184	180	5	Dr	1949
35abc	A. Kenner	136	4	Dr	....
35cab	C. Kenner	136	4	Dr	....
35ccc	Test hole 183	155	5	Dr	1949
35dcd	H. Frank	100	4	Dr	1917
36cdd1	E. Vanderlin	...	16	Dr	1910
36cdd2	..do....	136	..	Dr	....
36ddd	Test hole 181	125	5	Dr	1949
154-66					
1bbb	B. Kaeding	40	36	Du	1900
3aab1	L. Gessner	36.0	18	Dr	....
3aab2	..do....	9.9	22	Du	1940
3dac	R. Schiff	25.7	32	Du	1920
5adb	A. Stoe	28.9	36 x 36	Du	1931
6ccd	J. Blegen	100	4	Dr	....
7adb	O. Tollefson	43.4	30	Du	....
7dac	E. Tollefson	39.6	36 x 42	Du	1927
8bba	M. Pederson	44.9	36	Du	1935
8dcd	R. Ronning	32.1	18	Dr	....
9aaa	E. Sowatzki	107	6	Dr	1945
9abb	H. Stoe	32.3	42 x 42	Du	1900
9bab	Ellingson Bros.	30.2	24 x 24	Du	....
10bbd	L. Digness	25.7	36	Du	1940
11aba	E. Motschenbacker	150	6	Dr	1930
11bbd	R. Steinke	34.0	24	Dr	....
13aad	R. Ruger	...	..	Dr	....
13bcd	O. & E. Elevator Co.	...	36 x 36	Du	....
13dda	O. Larson	106	5	Dr	1938
14adc	L. F. Miller	34.5	42 x 42	Du	....
14ccd	L. Gunnerud	22.7	42 x 42	Du	....
14ccc	..Do....	16.6	24 x 24	Du	....

and test holes -- Continued

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	D,S	Qg	1,455	See chemical analysis. Water reported hard, adequate.
.....	....	T	..	1,450	See log. Depth to shale, 346 ft.
.....	....	T	..	1,452	See log. Depth to shale, 172 ft.
.....	....	D,S	Qg	1,486	Water reported hard, adequate.
.....	....	D,S	Qg	1,475	..Do....
.....	....	T	..	1,472	See log. Depth to shale, 149 ft.
.....	....	D,S	Kp	1,481	Water reported soft, adequate. Partly caved in; was 150 ft. deep originally.
16.50	9- 9-43	D,S	Kp	1,475	Water reported soft, adequate.
.....	....	...	Qg	1,475	Water reported soft.
.....	....	T	..	1,470	See log. Depth to shale, 119 ft.
25	6- 8-50	D,S	Qg	1,455	Water reported hard, adequate.
18.55	6- 3-50	S	Qg	1,465	..Do....
3.10	6- 3-50	D	Qg	1,460	Water reported soft, adequate.
12.40	6- 7-50	S	Qg	1,462	Water reported hard, adequate.
13.05	6- 6-50	U	Qg	1,455	Water reported hard.
19.60	6- 6-50	D,S	Qg	1,470	Water reported hard, adequate.
18.05	6- 7-50	D,S	Qg	1,462	..Do....
15.70	6- 7-50	D,S	Kp	1,455	..Do....
7.71	6- 7-50	...	Qg	1,462	Water reported hard.
27.26	6- 7-50	...	Qg	1,455	
20	6- 7-50	D,S	Qg	1,455	Water reported hard, adequate.
23.55	6- 3-50	U	Qg	1,455	Water reported hard.
8.08	6- 7-50	D,S	Qg	1,455	Water reported hard, adequate.
11.00	6- 7-50	S	Qg	1,455	..Do....
10	6- 7-50	D,S	Qg	1,446	..Do....
15.87	9-15-43	U	Qg	1,450	Water reported hard.
.....	....	D,S	Qg	1,455	Water reported hard, adequate.
14.75	7-12-49	D,S	Qg	1,460	Water reported hard.
.....	....	D,S	Qg	1,455	Water reported hard, adequate.
22.94	6- 8-50	D,S	Qg	1,465	..Do....
13.30	6- 8-50	S	Qg	1,450	..Do....
3.65	6- 8-50	D	Qg	1,445	..Do....

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
154-66 (Cont.)					
15bbb	O. Bye	21.8	30 x 30	Du	....
15ccc1	L. Tollefson	32.1	48	Du	1916
15ccc2	..do....	115	..	Dr	....
17aba	R. Ronning	21.4	24	Du	....
18aaa1	T. Tollefson	14.2	36	Du	....
18aaa2	..do....	100	18	Dr	1935
18bbb	C. Nestegard	129	4	Dr	1927
18bbd	L. Nestegard	48	18	Dr	1900
19caa	F. Johnson Sr.	30.5	36	Du	....
21add	....	7.0	24	Du	....
23aad	O. L. Volden	30	..	Du	....
23dab	G. Volden	35	48	Du	....
24aba	C. H. Volden	38	48 x 48	Du	1918
25bab1	O. Bye	40	72	Du	1948
25bab2	..do....	40	36	Du	1939
26bba	H. Halvorson	23.5	48	Du	....
26ddd1	E. Foss	33	4	Dr	1941
26ddd2	..do....	46	36	Du	1896
26ddd3	..do....	52	4	Dr	1896
28abb	O. Gunnerud	49.3	48	Du	1938
29ccd	Godman	25.7	30	Du	....
29dda	..do....	30	18	Dr	....
31dcb1	L. Johnston	180	6	Dr	....
31dcb2	..do....	41.7	30	Dr	1928
31dda	O. Solheim	140	4	Dr	1936
32acc	Test hole 359	175	5	Dr	1950
33ccb	L. Tollefson	85.2	4	Dr	....
34abc	M. Teigen	35	24	Dr	....
34adc	Test hole 355	60	5	Dr	1950
34bcc	Test hole 358	55	5	Dr	1950

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
7.16	6- 7-50	U	Qg	1,450	
23.22	9-17-43	S	Qg	1,465	Water reported hard, adequate.
.....	....	...	Qg	1,465	..Do....
2.88	6- 7-50	...	Qg	1,447	
3.26	6- 7-50	D	Qg	1,470	..Do....
8.62	6- 7-50	S	Qg	1,470	..Do....
20	6- 6-50	D,S	Kp	1,467	Water reported soft, salty, adequate.
21.20	6- 6-50	S	Qg	1,462	Water reported hard, bitter, adequate.
6.60	6- 8-50	U	Qg	1,447	Water reported hard.
5.45	9-14-50	...	Qg	1,435	
.....	....	S	Qg	1,455	Water reported hard, adequate.
24.90	9-17-43	D,S	Qg	1,465	Water reported hard, inadequate.
13.65	7-12-49	U	Qg	1,454	Water reported hard.
.....	....	D	Qg	1,470	..Do....
19.32	7-12-49	S	Qg	1,470	..Do....
14.86	9-15-43	S	Qg	1,465	Water reported hard, adequate.
.....	....	S	Qg	1,455	Water reported hard, salty, inadequate.
17.00	7-12-49	S	Qg	1,455	Water reported hard, adequate.
20	11-17-49	S	Qg	1,455	
41.34	6- 8-50	U	Qg	1,470	Water reported hard.
14.34	6- 8-50	D	Qg	1,455	Water reported hard, adequate.
15	11-17-49	D,S	Qg	1,445	..Do....
60	6- 9-50	D,S	Kp	1,457	Water reported hard, salty, adequate.
11.98	6- 9-50	U	Qg	1,457	Water reported hard.
40	6- 8-50	D,S	Qg	1,455	Water reported hard, adequate.
.....	....	T	..	1,472	See log. Depth to shale, 168 ft.
35.85	6- 8-50	U	...	1,450	
35.32	9- 8-50				
28	11-17-49	D,S	Qg	1,455	Water reported hard, adequate.
.....	....	T	..	1,434	See log. Depth to shale, 50 ft.
.....	....	T	..	1,440	See log. Depth to shale, 51 ft.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
154-66 (Cont.)					
34caa	Test hole 354	120	5	Dr	1950
35bca	Test hole 356	115	5	Dr	1950
35cda	D. Christianson	138	4	Dr	1943
36aaa	Test hole 357	146	5	Dr	1950
36aac	J. Aasmundstad	35	36	Du	....
154-67					
1cba	K. S. Anderson	21.8	30	Du	1927
1ccb	O. B. Foss	170	4	Dr	1916
2aca1	..do....	94	4	Dr	1916
2aca2	..do....	38.9	24	Dr	....
2bdd	J. T. Johnson	21.1	6	Dr	....
2cab	R. O. Foss	.....	30	Du	1926
2ddd	Test hole 353	95	5	Dr	1950
3aad	V. Yri	106	4	Dr	1920
3dcd	..do....	40.3	48 x 48	Du	....
10ddb	S. Yndersdal	13.1	30	Du	1940
12bcb	K. S. Anderson	65	4	Dr	1916
14bdb	W. Thompson	57.7	18	Dr	....
15dad	Woodworth Elevator Co.	125	4	Dr	....
15dda	J. Molitor	58.0	4	Dr	1914
25aad	O. Ranger	16.7	30 x 30	Du	....
25bbb	G. Dugas	80	4	Dr	....
25ddd	A. Yri	150	4	Dr	....
35add1	Test hole 34	140	5	Dr	1946
35add2	Test hole 31	150	5	Dr	1946
35cca1	P. Gefroh	37.4	30	Du	1900
35cca2	..do....	100	4	Dr	....
36bcc	Test hole 33	200	5	Dr	1946
36daa	Test hole 32	126	5	Dr	1946

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	T	...	1,475	See log. Depth to shale, 116 ft.
.....	....	T	...	1,442	See log. Depth to shale, 109 ft.
.....	....	D,S	Kp	1,465	Water reported soft, adequate.
.....	....	T	...	1,465	See log.
12.98	7-12-49	D,S	Qg	1,455	Water reported hard, adequate.
7.46	6-13-50	D,S	Qg	1,457	..Do....
13.80	6-13-50	S	Kp	1,455	Water reported fairly hard, salty, adequate.
10.63	6-13-50	D,S	Qg	1,455	Water reported hard, adequate.
15.80	6-13-50	U	Qg	1,455	Water reported hard.
16.32	6-13-50	U	Qg	1,457	Water reported soft.
27.70	6-13-50	D,S	Qg	1,470	Water reported soft, adequate.
.....	....	T	..	1,444	See log. Depth to shale, 84 ft.
17.80	6-10-50	D,S	Qg	1,465	Water reported hard, adequate.
19.50	6-10-50	U	Qg	1,475	Water reported soft.
2.78	6- 9-50	D,S	Qg	1,470	Water reported hard, adequate.
12.30	6-13-50	U	Qg	1,452	Water reported hard.
32.92	6- 9-50	D,S	Qg	1,482	Water reported soft, adequate.
35.80	6- 9-50	D	Qg	1,469	Water reported hard, adequate.
35.39	6- 9-50	D,S	Qg	1,475	..Do....
13.36	6- 8-50	D,S	..	1,450	..Do....
30	6- 9-50	D,S	Qg	1,460	..Do....
30.00	6- 9-50	D,S	Qg	1,475	..Do....
.....	....	T	..	1,436	See log. Depth to shale, 133 ft.
.....	....	T	..	1,435	See log. Depth to shale, 141 ft.
28.62	6- 9-50	D	Qg	1,465	Water reported hard, adequate.
33.00	6- 9-50	S	Kp	1,465	Water reported soft, salty, adequate.
.....	....	T	Qg	1,434	See log and chemical analysis. Depth to shale, 185 ft.
.....	....	T	..	1,439	See log. Depth to shale, 120 ft.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
155-63					
4aac1	Lang Bros.	180	4	Dr	....
4aac2	..do....	19.7	32	Du	....
4aac3	..do....	115	4	Dr	1948
5cdc	H. F. Miller	112	4	Dr	1948
6dcd1	C. W. Maxwell	147	4	Dr	1945
6dcd2	..do....	200	4	Dr	....
6ddd	Test hole 146	110	5	Dr	1949
7dbb1	J. P. Burgess	40	4	Dr	1900
7dbb2	..do....	92	4	Dr	1946
7ddd	Test hole 147	50	5	Dr	1949
8ddb	H. Mikkleson	120	4	Dr	1919
9bdc	A. Hanson	110	4	Dr	1941
18bad	P. W. Syrup & J. L. Whitnack	120	4	Dr	1937
18ddd	Test hole 121	110	5	Dr	1949
19bac	J. W. Place	119	4	Dr	1927
19cdd	Test hole 123	60	5	Dr	1949
19ddd	Test hole 122	70	5	Dr	1949
20abb1	V. Keogh	96	4	Dr	1943
20abb2	..do....	26	4	Dr	1925
21dcc	Test hole 120	50	5	Dr	1949
27bbb	Test hole 119	135	5	Dr	1949
28bdd	B. Fischer	135	6	Dr	1920

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
80	7-19-49	D,S	Kp	.....	Water reported soft, salty; adequate for 60 head of stock.
6.42	7-19-49	S	Qg	.....	Water reported hard, adequate for 60 head of stock.
30	7-19-49	D	Kp	.....	Water reported hard, adequate; Depth to shale, 55 ft.
.....	....	D	Kp	.....	Water reported slightly hard, slightly salty, adequate. Depth to shale, 60 ft.
.....	....	D	Kp	.....	Water reported soft, salty, adequate; Depth to shale, 144 ft.
.....	....	D,S	Kp	.....	Water reported adequate for 30 head of stock.
.....	....	T	..	1,476	See log. Depth to shale, 103 ft.
20	7-19-49	S	Qg	.....	Water reported hard, adequate.
.....	....	D	Kp	.....	Water reported soft, adequate; Depth to shale, 54 ft.
.....	....	T	..	1,468	See log. Depth to shale, 39 ft.
.....	....	D,S	Kp	.....	Water reported soft, adequate.
25	7-19-49	S	Kp	.....	..Do....
36.80	5-11-49	D	Kp	1,482	Water reported slightly hard, slightly salty.
.....	....	T	..	1,465	See log. Depth to shale, 80 ft.
20	7-28-48	D	Kp	1,475	Water reported soft, salty, adequate.
.....	....	T	..	1,464	See log. Depth to shale, 56 ft.
.....	....	T	..	1,465	See log. Depth to shale, 35 ft.
.....	....	D	Kp	1,465	Water reported soft, salty, inadequate.
.....	....	S	Qg	1,465	Water reported hard, adequate.
.....	....	T	..	1,463	See log. Depth to shale, 30 ft.
.....	....	T	..	1,473	See log. Depth to shale, 105 ft.
.....	....	D,S	Kp	1,475	Water reported hard, adequate.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
155-63 (Cont.)					
29aba	Test hole 124	80	5	Dr	1949
29abc	Halgren Bros.	140	6	Dr	1895
29ccc	Test hole 125	90	5	Dr	1949
155-64					
4aaa	I. Wertenberger	132	4	Dr	1908
4aab	Community of Webster	70	..	Dr	1901
9abc	L. Leet	130	5	Dr	1908
9dad	Test hole 141	130	5	Dr	1949
9ddd	W. Miller	145	4	Dr	1944
10ada	Test hole 142	104	5	Dr	1949
10dab	E. Webster	...	5	Dr	....
10ddd	Test hole 148	108	5	Dr	1949
11aad	Test hole 144	58	5	Dr	1949
11bad1	D. D. Coleman	35	4	Dr	1895
11bad2	..do....	110	4	Dr	1938
11bda	Test hole 143	40	5	Dr	1949
12ada1	J. S. Burgess	105	4	Dr	1944
12ada2	Test hole 145	107	5	Dr	1949
15cdc	N. Magnuson	90	6	Dr	....
16bba	Test hole 150	70	5	Dr	1949
16bdb	H. Haig	200	5	Dr	....
17aad1	R. D. Young	300	4	Dr	....
17aad2	..do....	65	4	Dr	....
19adb	H. G. Otis	32	18	Dr	....
19bbc	R. Rader	45	6	Dr	1925

and test holes -- Continued

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	T	..	1,462	See log. Depth to shale, 69 ft.
14	7-28-48	D,S	Kp	1,476	Water reported soft, adequate.
.....	....	T	..	1,462	See log. Depth to shale, 84 ft.
17	9-15-50	D	Kp	.....	Water reported soft, salty, adequate; pumped at rate of 425 gallons per hour.
.....	....	U	Kp	.....	
20	9- 4-43	D,S	Kp	.....	Water reported slightly hard, salty, adequate.
.....	....	T	..	1,458	See log. Depth to shale, 125 ft.
.....	....	D	Qg	.....	Water reported hard, adequate.
.....	....	T	..	1,463	See log. Depth to shale, 100 ft.
14.91	5-11-49	U	Kp	.....	Water reported soft, salty.
.....	....	T	..	1,463	See log. Depth to shale, 106 ft.
.....	....	T	..	1,462	See log. Depth to shale, 55 ft.
15	7-28-49	D,S	Qg	.....	Water reported hard, adequate.
.....	....	D	Kp	.....	Water reported soft, adequate.
.....	....	T	..	1,465	See log. Depth to shale, 30 ft.
16	1944	D,S	Kp	.....	Water reported slightly salty, soft, adequate.
.....	....	T	..	1,469	See log. Depth to shale, 99 ft.
18	5-11-49	D	Qg	1,480	Water reported slightly hard, adequate.
.....	....	T	..	1,472	See log. Depth to shale, 47 ft.
.....	....	D,S	Kp	1,475	Water reported soft, salty, adequate.
.....	....	S	Kp	.....	Water reported hard, salty, adequate.
.....	....	D	Qg	.....	Water reported hard, adequate.
26	7- 8-48	D,S	Qg	1,465	..Do....
.....	....	D,S	Qg	1,472	See chemical analysis. Water reported soft, adequate.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
155-64 (Cont.)					
21aaa	Test hole 140	40	5	Dr	1949
22bab	N. Magnuson	150	6	Dr	....
22ccc	Test hole 137	30	5	Dr	1949
22cdd	Test hole 139	40	5	Dr	1949
22ddc	Test hole 138	120	5	Dr	1949
23bab	C. Webster	109	4	Dr	1935
23cbc1	..do....	135	5	Dr	....
23cbc2	..do....	137	4	Dr	1934
23daa	Test hole 149	50	5	Dr	1949
24dbd	G. Belford	126	4	Dr	1939
27cac	W. Haley	172	..	Dr	....
27ccc	Test hole 136	30	5	Dr	1949
28abd1	J. Ehler	50	20	Dr	....
28abd2	..do....	190	6	Dr	1944
28bbc	J. Tollefson	46	5	Dr	1900
29bca	J. Spiegler	100	..	Dr	....
29bcb1	..do....	27	6	Dr	1932
29bcb2	..do....	50	5	Dr	....
30dad	R. Ruger	24.0	24	Du	....
33bcc	C. Wittkop	175	4	Dr	1918
33cca	Prudential Life Insurance Co.	50	24	Dr	....
34acc	Test hole 205	145	5	Dr	1949
34bba	M. M. Borg	63	4	Dr	1940

and test holes -- Continued

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	T	..	1,474	See log. Depth to shale, 32 ft.
.....	....	S	Kp	1,482	Water reported slightly hard salty, adequate.
.....	....	T	..	1,481	See log. Depth to shale, 24 ft.
.....	....	T	..	1,480	..Do....
.....	....	T	..	1,471	See log. Depth to shale, 70 ft.
8.21	5-11-49	U	Kp	1,465	Water reported soft, slightly salty. Depth to shale, 40 ft.
.....	....	S	Kp	1,467	Water reported soft, slightly salty, adequate.
.....	....	D	Kp	1,467	..Do....
.....	....	T	..	1,461	See log. Depth to shale, 39 ft.
.....	....	D,S	Kp	1,465	Water reported hard, salty, adequate.
.....	....	S	Kp	1,475	Water reported hard, salty, adequate. Depth to shale, 95 ft.
.....	....	T	..	1,498	See log. Depth to shale, 18 ft.
10.80	7-14-48	S	Kp	1,500	Water reported soft, inadequate.
.....	....	S	Kp	1,500	See chemical analysis. Water reported hard, adequate. Depth to shale, 90 ft.
.....	....	D,S	Qg	1,480	Water reported hard, adequate.
.....	....	S	Kp	1,470	Water reported soft, salty, adequate.
.....	....	D	Qg	1,470	Water reported hard, inadequate.
17.74	7-12-48	U	Qg	1,470	Water reported hard, adequate
12.53	8-10-43	D,S	Qg	1,472	..Do....
.....	....	D,S	Kp	1,471	Water reported hard, salty, inadequate.
23.81	8- 8-43	S	Qg	1,460	Water reported hard, adequate.
.....	....	T	..	1,464	See log. Depth to shale, 139 ft.
.....	....	D	Qg	1,475	Water reported hard.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
155-64 (Cont.)					
34bcd	Test hole 201	80	5	Dr	1949
34bda	Great Northern Railway	79	12	Dr	1939
34bdd1	Test hole 200	145	5	Dr	1949
34bdd2	Test hole 204	150	5	Dr	1949
34bdd3	Test hole 199	135	5	Dr	1949
34bdd4	Test hole 198	135	5	Dr	1949
34ccc	Test hole 159	60	5	Dr	1949
34dcd	Test hole 202	65	5	Dr	1949
34ddc	Test hole 151	75	5	Dr	1949
35ada	I. McCarthy	80	5	Dr	1938
35adc	Test hole 155	120	5	Dr	1949
35bab	Test hole 154	125	5	Dr	1949
35bcd	Test hole 153	86	5	Dr	1949
35cdc	Test hole 152	60	5	Dr	1949
155-65					
4aaa	T. W. Mitchel	25	24	Du	1920
5bbc	B. Riggin	...	4	Dr	....
5dcb	O. O. Siverson	...	24	Du	....
6ccc	G. Lannoye	73	4	Dr	1928
6dab	V. Horne	35	24	Dr	1936
8bcb	J. Elgaen	79	4	Dr	1926
9add	H. B. Kendall	29.0	48	Du	....
9bba	J. Swanyack	60	4	Dr	....
10cab	W. R. Murray	31.8	48	Du	....
12ada	H. Johanson	125	4	Dr	....
13bbc	Dr. B. Hocking	...	24	Dr	....
15cca	R. C. Lake	124	4	Dr	1918

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
.....	....	T	..	1,474	See log. Depth to shale, 74 ft.
4.10	8-28-43	Ind	Qg	1,465	See chemical analysis.
.....	....	T	..	1,467	See log. Depth to shale, 138 ft.
.....	....	T	..	1,472	See log. Depth to shale, 146 ft.
.....	....	T	..	1,463	See log. Depth to shale, 128 ft.
1.63	10-11-49	T	..	1,462	See log. Depth to shale, 130 ft.
.....	....	T	..	1,490	See log. Depth to shale, 31 ft.
.....	....	T	..	1,470	See log. Depth to shale, 58 ft.
.....	....	T	..	1,458	See log. Depth to shale, 65 ft.
14.86	5-11-49	D,S	Qg	1,472	Water reported hard, adequate.
.....	....	T	..	1,463	See log. Depth to shale, 115 ft.
.....	....	T	..	1,462	See log. Depth to shale, 121 ft.
.....	....	T	..	1,458	See log. Depth to shale, 76 ft.
.....	....	T	..	1,463	See log. Depth to shale, 51 ft.
15.57	7-16-49	D,S	Qg	.....	Water reported hard, adequate.
9.28	7-16-49	U	Kp	.....	Water reported soft.
16.71	7-16-49	D,S	Qg	.....	Water reported hard, adequate.
.....	....	D,S	Kp	.....	Water reported soft, adequate. Depth to shale, 70 ft.
15.38	7-16-49	U	Qg	.....	Water reported hard, adequate.
20.00	7-16-49	D,S	Qg	.....	..Do....
17.59	9-11-43	S	Qg	.....	Water reported hard, inadequate.
9.19	7-16-49	U	Qg	.....	
17.21	9-11-43	S	Qg	.....	..Do....
.....	....	D,S	Kp	.....	Water reported soft, adequate.
12.82	9-10-43	U	..	1,466	
.....	....	D,S	Kp	1,475	..Do....

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
155-65 (Cont.)					
16bdd1	V. A. Horne	94	4	Dr	1920
16bdd2	..do....	98	4	Dr	1920
16cab	..do....	56	4	Dr	1920
16dad	G. Gilbertson	123	4	Dr	....
18ada	E. Bergeth	40	36	Du	1928
19aba	W. Kline	37	24	Dr	1908
20bbb	O. W. Gustafson	45	36 x 36	Du	....
20ddd	J. Graichen	27	36 x 36	Du	1945
21ccc	H. Horne	86	4	Dr	1918
22add	H. Connolly	60	4	Dr	1920
23daa1	G. Jeryen	26.2	36	Du	1908
23daa2	..do....	163	4	Dr	....
24ddb1	M. and R. Lake	46.0	48	Du	....
24ddb2	..do....	146	4	Dr	....
27dda	F. Johnson	110	4	Dr	....
29aaa	E. Forness	50	18	Dr	....
29ccb	J. M. Kraminger	100	4	Dr	....
30bbc1	G. A. Miller	104	4	Dr	....
30bbc2	..do....	50	48 x 48	Du	....
34cdc	C. V. Sullivan	119	4	Dr	1946
34daa	I. J. Johnson	40	..	Du	1896
35aab	R. R. Riggin	60	48	Du	....
35bac	Test hole 651	60	5	Dr	1952
36caa1	R. Cochrane	63.0	5	Dr	....
36caa2	..do....	350	..	Dr	....
155-66					
1add	E. Baldwin	180	4	Dr	....
2dcc	C. N. Barrett	39.0	24	Dr	1947
3adc	M. Webster	24.4	24	Dr	1937
4bdc	R. Young	36.1	24	Dr	....
5bbc	C. Nord	120	6	Dr	....
6cbb	Village of Church's Ferry	36.0	6	Dr	....

and test holes -- Continued

Depth to water (feet below land surface)	Date of measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
14.10	7-16-49	U	Kp	1,462	Water reported soft, adequate.
17	7-16-49	D,S	Kp	1,462	..Do....
.....	....	S	Qg	.....	Water reported hard, adequate.
.....	....	D,S	Kp	1,470	Water reported soft, adequate.
18.79	7-16-49	S	Qg	1,466	Water reported hard, adequate.
20.76	7-15-49	D,S	Qg	1,466	..Do....
.....	....	S	Qg	1,470	Water reported soft, inadequate.
8.59	7-18-49	U	Qg	1,460	Water reported hard, inadequate.
.....	....	D,S	Qg	1,460	Water reported hard, adequate.
16	6-18-49	D,S	Qg	1,455	..Do....
13.09	9-10-43	U	Qg	1,478	..Do....
10	9-10-43	D,S	Kp	1,478	Water reported soft. Depth to shale, 157 ft.
25.98	9-10-43	U	Qg	1,492	
.....	....	S	Kp	1,492	Water reported hard.
20	9-11-43	S	Kp	1,505	Water reported hard, adequate.
20	7-18-49	D,S	Qg	1,460	..Do....
.....	....	D,S	Kp	1,465	Water reported soft, adequate.
21.51	7-18-49	D	Qg	1,462	Water reported hard, adequate.
.....	....	U	Qg	1,462	
24.21	8-24-48	D,S	Kp	1,465	Water reported soft, adequate; Depth to shale, 90 ft.
.....	....	D,S	Qg	1,522	Water reported inadequate.
37.15	9-13-43	D,S	Qg	1,487	Water reported hard, adequate.
.....	....	T	..	1,585	See log. Depth to shale, 52 ft.
14.47	9-13-43	D	Qg	1,475	Water reported soft, adequate.
.....	....	U	Kp	1,475	Water reported slightly salty.
20	6- 1-50	D,S	Kp	.....	Water reported soft, salty, adequate.
14.90	6- 1-50	D,S	Qg	.....	Water reported hard, inadequate.
6.16	6- 1-50	U	Qg	.....	
10.71	6- 1-50	U	Qg	.....	
14	6- 1-50	D,S	Kp	.....	Water reported soft, adequate.
15.15	6-20-50	D	Qg	.....	Water reported hard, adequate. Water used for domestic purposes by people living in near vicinity.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
155-66 (Cont.)					
6cbc	Farmer's Coop. Association	106	4	Dr	1949
6cca	Village of Church's Ferry	100	4	Dr	1949
6ccc	Zion Lutheran Church	23.0	24 x 24	Du	....
6cdb	D. Rohrer	165	4	Dr	1910
7aaa	Test hole 347	150	5	Dr	1950
7bba	T. Helgeseth	158	4	Dr	1949
7cbc	L. G. Sykora	180	6	Dr	1914
8bdb	C. Sorlie	96	6	Dr	1917
8ccb	S. Knutson	100	4	Dr	1949
9acd	H. Sletten	160	4	Dr	....
10bbb	A. Overland	150	6	Dr	....
11cbb	E. Henke	160	6	Dr	....
11ccd	E. Kaeding	180	6	Dr	1918
11dcc	C. Kaeding	25.0	36 x 36	Du	....
12add	J. McCormack	75	..	Dr	....
14aad	H. Goodwill	11.1	48 x 48	Du	1916
14ddd	C. Adahl	36.4	36 x 36	Du	....
16cbb	J. McLean	29.9	18	Dr	....
16ddd	P. Miller	170	6	Dr	1914
17daa	J. McLean	110	4	Dr	....
20adc	L. Flath	160	6	Dr	1926
22adc	J. Conners	84.2	6	Dr	1944
22bba	A. Hove	29.5	42	Du	....
23bbb	P. Bergeth	200	6	Dr	1935
24ccd	A. Gessner	189	6	Dr	1915
24dab	..do....	140	4	Dr	....
24dac1	L. H. Gessner	165	6	Dr	1946
24dac2	..do....	28.3	24	Du	1900
25acb	A. C. Anderson	75	6	Dr	1926
25bbc	H. Gessner	26.0	12	Dr	1910

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
18	6-20-50	D	Qg	.....	Water reported hard, adequate.
15.64	6-20-50	D	Qg	.....	Water reported fairly soft, adequate.
5.50	6-20-50	D	Qg	.....	Water reported hard, adequate.
20	6-21-50	D	Kp	.....	Water reported soft, salty, adequate.
.....	....	T	..	1,450	See log. Depth to shale, 143 ft.
12.30	6-17-50	D	Kp	.....	Water reported fairly soft, adequate.
16	6- 2-50	D,S	Kp	.....	Water reported fairly hard, salty.
14	6- 1-50	S	Kp	.....	Water reported soft, salty, adequate.
20	6- 2-50	D,S	Qg	.....	Water reported hard, adequate.
12.15	6- 1-50	D,S	Qg	.....	..Do....
10.96	6- 1-50	D,S	Qg	.....	..Do....
15	6- 1-50	D,S	Qg	.....	Water reported hard, salty, adequate.
20	6- 1-50	D,S	Qg	.....	Water reported hard, adequate.
4.15	6- 2-50	U	Qg	.....	Water reported soft.
.....	....	S	Qg	.....	Water reported hard.
10.50	6- 2-50	U	Qg	.....	..Do....
12.40	6- 2-50	D,S	Qg	1,457	Water reported hard, adequate.
8.40	6- 2-50	S	Qg	1,464	..Do....
50	6- 2-50	D,S	Qg	1,457	..Do....
16	6- 2-50	D	Qg	1,462	..Do....
20.50	6- 2-50	D,S	Qg	1,460	Water reported hard, inadequate.
1.65	6- 2-50	U	Qg	1,459	Water reported soft.
14.35	6- 2-50	D,S	Qg	1,462	Water reported hard, adequate.
25.00	6- 2-50	D,S	Kp	1,460	Water reported hard, salty, adequate.
30	6- 2-50	D,S	Kp	1,461	..Do....
40	11-1-48	S	Kp	1,455	Water reported salty. Depth to shale, 100 ft.
20	6- 2-50	D,S	Kp	1,461	Water reported soft, adequate.
17.70	6- 2-50	U	Qg	1,461	Water reported hard.
20	6- 2-50	D,S	Qg	1,461	Water reported hard, adequate.
16.23	6-21-50	D,S	Qg	1,467	..Do....

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
155-66 (Cont.)					
25bbd	Penn School	100.1	4	Dr	....
26add	T. McLean	31.0	26 x 26	Du	....
26bcb	B. Halvorson	155	6	Dr	1929
26ccc	R. Steinke	227	6	Dr	1925
26daa	E. Gessner	150	6	Dr	1935
28add	E. Thompson	73.3	46 x 46	Du	....
28dbb	T. Stoeser	38.0	25 x 25	Du	1900
29dcb	J. Bergeth	43.1	18	Dr	1900
30ccc	M. Blegen	26.0	24 x 24	Du	....
31dac	D. Stenberg	46.2	4	Dr	....
32baa	..do....	23.3	36 x 36	Du	....
32cab1	A. Stoe	27.8	24 x 24	Du	1915
32cab2	..do....	99	4	Dr	1950
33abb	B. Halvorson	51.1	21	Dr	1915
33bdd	J. Bergeth	44.7	18	Dr	....
34cdd	P. Stoe	175	6	Dr	....
36abd	X. Peryl	180	6	Dr	1910
36bab	..do....	160	6	Dr	1927
155-67					
1bbc	G. Smith	160	4	Dr	....
1dda1	H. F. Copeland	87	6	Dr	....
1dda2	Great Northern Railway	72.0	6	Dr	1945
1ddd	Test hole 346	110	5	Dr	1950
2bdd1	L.H. & R. W. Havsmann	45.3	48 x 48	Du	1900
2bdd2	..do....	200	4	Dr	1916
3aab	L. C. Halvorson	62	4	Dr	1936
3ddd	Test hole 349	130	5	Dr	1950
11aaa	Test hole 348	130	5	Dr	1950
12add	A. F. Solberg	110	4	Dr	1948
13aba1	R. Jolly	150	4	Dr	1920
13aba2	..do....	26.1	20 x 20	Du	....
13cac	P. Helgeseth	28.3	48 x 48	Du	1926
14cdd	Test hole 350	130	5	Dr	1950

and test holes -- Continued

Depth to water (feet below land surface)	Date of Measure-ment	Use of water	Geologic source	Elevation at land surface	Remarks
22.80	6-21-50	D	Qg	1,472	Water reported hard, adequate. Water used by people of community for domestic purposes.
10.65	6- 2-50	U	Qg	1,462	
22	6- 3-50	D,S	Qg	1,462	Water reported hard, adequate.
22	6- 3-50	D,S	Kp	1,465	..Do....
30	6- 2-50	D	Qg	1,461	..Do....
22.75	6- 3-50	D,S	Qg	1,470	..Do....
19.14	6- 3-50	D,S	Qg	1,460	..Do....
28.84	6- 6-50	S	Qg	1,475	..Do....
11.67	6- 6-50	D,S	Qg	1,455	..Do....
11.35	6- 6-50	D,S	Qg	1,450	..Do....
19.57	6- 6-50	U	Qg	1,467	
12.35	6- 6-50	S	Qg	1,455	Water reported hard, inadequate.
15	6- 6-50	D	Qg	1,455	Water reported hard, adequate.
17.19	6- 3-50	U	Qg	1,465	
35.00	6- 6-50	U	Qg	1,482	Water reported hard.
20	6- 3-50	S	Qg	1,483	Water reported hard, adequate.
25	6- 3-50	D,S	Qg	1,464	..Do....
25	6- 3-50	D,S	Qg	1,463	..Do....
21.10	6-16-50	D,S	Kp	.....	Water reported soft, adequate.
17	6-16-50	D,S	Qg	.....	Water reported fairly soft, adequate.
17.64	6-20-50	D	Qg	.....	Water reported soft, adequate.
.....	....	T	..	1,459	See log. Depth to shale, 105 ft.
16.60	6-16-50	U	Qg	.....	Water reported hard.
20	6-16-50	D,S	Kp	.....	Water reported soft, salty, adequate.
20	6-16-50	D,S	Qg	.....	Water reported hard.
.....	....	T	..	1,457	See log. Depth to shale, 124 ft.
.....	....	T	..	1,452	See log. Depth to shale, 123 ft.
14.20	6-15-50	D,S	Qg	.....	Water reported soft, adequate.
12.50	6-15-50	D	Qg	.....	..Do....
7.44	6-15-50	S	Qg	.....	Water reported hard.
13.54	6-15-50	U	Qg	1,455	..Do....
.....	....	T	..	1,450	See log. Depth to shale, 126 ft.

TABLE 2.--Records of wells, springs,

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
155-67 (Cont.)					
15aab1	L. Studness	72.4	18	Dr	....
15aab2	..do....	104	4	Dr	1948
22ddd1	R. O. Studness	51.6	4	Dr	....
22ddd2	..do....	80	4	Dr	....
23aca	M. Blegen	49.6	48 x 36	Du	....
24add	C. Torgeson	33.4	12	Dr	....
24cca	H. Tufsrud	48.8	4	Dr	....
25add	M. B. Bye	45.5	30	Dr	1905
26aaa	Test hole 352	100	5	Dr	1950
26bbc	J. L. Hiaason	28.6	42 x 42	Du	....
26ccb	J. Blegen	70.3	4	Dr	1938
26dda	G. Schwartz	120	4	Dr	....
26ddc	Test hole 351	100	5	Dr	1950
27aaa	J. L. Hiaason	30.2	24	Dr	....
35acd	A. Eide	18.3	30	Du	1920
35dba	M. Olava	118	6	Dr	1949
36bac	J. Kirkiede	50.8	18	Dr	1908
156-66					
30bbb	Test hole 344	125	5	Dr	1950
30ccd	H. Ritterman	102	4	Dr	1948
31cca1	L. H. Hausman	290	4	Dr	....
31cca2	..do....	40	24	Du	....
156-67					
26cab1	W. C. Hillerman	125	4	Dr	1949
26cab2	..do....	52	21	Dr	....
26dcc	W. Michaels	33.1	48	Du	1949
35dac	F. Hausmann Estate	35.1	42	Du	1900
36ddd	Test hole 345	100	5	Dr	1950

and test holes -- Continued

Depth to water (feet below land surface)	Date of measurement	Use of water	Geologic source	Elevation at land surface	Remarks
56.70	6-15-50	S	Qg	.....	Water reported hard, adequate.
40.83	6-15-50	D,S	Qg	.....	..Do....
28.83	6-14-50	S	Qg	1,470	..Do....
20	6-14-50	D	Qg	1,470	..Do....
17.57	6-14-50	D,S	Qg	1,455	..Do....
20.46	6-14-50	U	Qg	1,470	
18.80	6-14-50	U	Qg	1,460	
9.20	6-14-50	D,S	Qg	1,455	..Do....
.....	....	T	..	1,452	See log. Depth to shale, 91 ft.
27.68	6-14-50	D,S	Qg	1,467	Water reported hard, adequate.
18.10	6-10-50	D,S	Qg	1,460	..Do....
20	6-13-50	D,S	Kp	1,460	Water reported soft, adequate.
.....	....	T	..	1,450	See log. Depth to shale, 93 ft.
24.00	6-14-50	U	Qg	1,468	
7.98	6-13-50	S	Qg	1,450	Water reported hard, adequate.
15.10	11-1-49	D,S	Kp	1,455	Water reported soft, salty, adequate.
21.45	6-13-49	D,S	Qg	1,464	Water reported hard, adequate.
.....	....	T	..	1,455	See log. Depth to shale, 114 ft.
27	9-22-50	D,S	Qg	.....	Water reported hard, adequate.
20	9-22-50	D,S	Kp	.....	Water reported soft, salty, adequate.
30	9-22-50	S	Qg	.....	
16	9-25-50	D	Qg	.....	Water reported hard, adequate.
26	9-25-50	S	Qg	.....	..Do....
24.70	9-25-50	D,S	Qg	.....	..Do....
15.55	6-16-50	U	Qg	.....	Water reported hard.
.....	....	T	..	1,456	See log. Depth to shale, 96 ft.

TABLE 4.--Chemical analyses of water

(Results in parts per million

Geologic source: Kd, Dakota Sandstone; Kp, Pierre Shale; Qg, glacial drift except outwash deposits; Qo, glacial outwash deposits.

SAR: Sodium-adsorption-ratio. See U.S. Dept. of Agriculture, 1954, Agriculture Handbook No. 60.

Location No.	Owner or name	Depth of well (ft.)	Geologic source	Date sample collected or date of analysis	Source of analysis	Iron (Fe)	Calcium (Ca)
150-62							
3aaa	USBR auger hole 416	24	Qo	7-14-52	USBR	.....	81
8bbb	USBR auger hole 412	10	Qo	7-14-52	USBR	.....	32
18aaa	USBR auger hole 413	19	Qo	7-14-52	USBR	.....	70
150-63							
1ada	James Forde	20	Qo	1-18-51	NDSH	2.2	42
15cbc	....	Spring	Qg	1-18-51	NDSH	.30	59
16dad	....	Spring	Qg	1-18-51	NDSH	.01	62
151-62							
19aaa	USBR auger hole 411	24	Qo	7-14-52	USBR	.....	85
26bba	USBR auger hole 415	13	Qo	6-16-52	USBR	.....	57
151-63							
20cdd11	Devils Lake city test well 1	135	Qo	8-15-51	NDSH	.25	57
20cdd11	..do....	135	Qo	8-23-51	NDSH	.10	61
22bcc	USBR auger hole 404	18	Qo	7-14-52	USBR	.....	60
28add	Devils Lake city test well 3	78	Qo	4- 6-51	NDSH	8.2	54
29bba	Gothard Jacobson	22	Qo	5-22-51	NDSH	.64	59
152-62							
9cbb	J. C. Coe	110	Qg	5-18-49	NDSH	.70	104

from wells, springs, and test holes

except as indicated)

Source of analysis: ABVD, Abbott, G. A., and Voedisch, F. W., 1938, p. 72-73; NDSH, North Dakota State Health Department, Bismarck, N. Dak.; NDSL, North Dakota State Laboratories Department, Bismarck, N. Dak.; SPSN, Simpson, H. E., 1929, p. 294-295; USBR, United States Bureau of Reclamation, Bismarck, N. Dak.; USGS, United States Geological Survey, Lincoln, Nebraska.

Magnesium (Mg)	Sodium and Potassium (Na & K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Total hardness as $CaCO_3$	Dissolved solids (calculated)	Percent sodium	Sodium-adsorption-ratio (SAR)
19	30	27	232	84	2.1	...	....	280	357	19	0.8
1.2	7.5	6	49	45	1.8	...	....	85	118	16	0.4
20	10	36	183	48	1.8	...	....	257	276	8	0.3
25	35	0	318	1	2	0	4.3	208	267	27	1.1
15	11	0	248	1	1	0	2.1	209	211	10	0.3
14	4.6	0	232	1	3.6	0	2.1	212	201	5	0.4
30	12	36	195	84	21	...	....	336	364	7	0.3
20	18	36	177	42	3.6	...	....	225	264	15	0.5
12	18	0	281	0	1	0	0	192	226	17	0.6
11	26	0	295	0	8	0	1	198	252	22	0.8
19	10	21	183	67	4.3	...	....	228	271	9	0.3
18	10	0	283	0	1	...	....	209	230	9	0.3
24	1	0	254	1	10	.1	22	246	243	...	...
39	223	0	547	423	13	0	11	420	827	54	4.7

TABLE 4.--Chemical analysis of water

Location No.	Owner or name	Depth of well (ft.)	Geologic source	Date sample collected or date of analysis	Source of analysis	Iron (Fe)	Calcium (Ca)
152-65							
12adb2	Concrete Sectional Culvert Co.	65	Qg	1-20-50	NDSH	.35	173
12adb2	..do....	65	Qg	1-19-51	NDSH	1.2	204
153-63							
2aab	Frank Foster	165	Qg	1-31-50	NDSH	.85	129
31cda	Ray Rutten	Spring	Qg	1-20-50	NDSH	4.7	107
153-64							
2bba	T. C. Sabie	86	Kp	9- 3-46	NDSH	.....	61
2cab	Artclare Motel	52	Kp	8-23-51	NDSH	.2	67
3aca	Devils Lake city shops	90	Qg	11-21-49	NDSH	.53	61
3acbl	Bergstrom Cabins	85	Qg	1-19-51	NDSH	1.3	10
3caa	C. L. Armour	76	Kp	4-23-47	NDSH	6.0	106
18aba	Carl Rype	123	Qg	6- 4-51	NDSH	1.4	127
19aab	A. Miller & C. Scholes	160	Qg	6- 4-51	NDSH	4.5	102
21cdc	Devils Lake city test 4	145	Qg	4-20-51	NDSH	4.4	196
21cdc	..do....	248	Qg	4-20-51	NDSH	1.9	132
153-65							
2bcc	Howard Charbonneau	160	Qg	11-20-50	NDSH	.....	121
4abd	H. Oram	165	Qg	1-20-50	NDSH	2.0	120
10aaa	M. and H. Hanson	150	Qg	11-20-50	NDSH	.....	305
12dbb	Julius Weed	100	Qg	1-20-50	NDSH	12	84
153-66							
2aabl	T. O. Moen	103	Kp	11-20-50	NDSH	.....	9
8ddd	R. D. Ward	22	Qg	9-1 -46	NDSL	1.0	250
20bab	Test hole 42	239	Qg	5- 4-48	NDSH	.4	110
21aab	Test hole 41	103	Qg	8-17-48	NDSH	1.9	140

from wells, springs, and test holes --Continued

Magnesium (Mg)	Sodium and Potassium (Na & K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Total hardness as $CaCO_3$	Dissolved solids (calculated)	Percent sodium	Sodium-adsorption-ratio (SAR)
91	224	0	388	768	128	0	4.3	806	1,580	38	3.4
63	324	0	366	922	116	.1	4.3	769	1,810	48	5.1
49	298	0	466	741	13	0	1	524	1,460	55	5.7
59	123	0	268	530	11	.2	4.3	510	971	34	2.4
15	755	0	868	1,000	25	...	....	214	2,280	88	21
25	510	0	578	726	102	0	0	270	1,710	80	13
56	465	0	573	740	114	0	6.5	383	1,730	73	10
8.9	536	18	451	631	114	.2	4.3	62	1,550	95	94
5.8	613	0	592	962	96	.1	....	288	2,080	82	16
58	227	0	545	526	32	.1	11	556	1,250	47	4.19
68	122	0	246	581	25	0	8.6	534	1,030	33	2.3
82	272	0	513	709	182	0	....	827	1,700	42	4.1
51	427	0	546	708	200	0	....	540	1,790	63	8.0
146	140	0	710	522	94	...	....	903	1,370	25	2.0
78	112	0	380	514	10	0	13	620	1,040	28	2.0
186	58	0	549	1,100	83	...	....	1,530	2,000	8	0.6
69	6.2	9	312	212	26	.4	4.3	494	577	3	0.1
66	455	0	734	491	100	...	....	294	1,480	77	11
97	350	0	560	1,160	140	...	....	1,020	2,270	43	4.8
47	400	0	590	700	80	0	6.4	470	1,630	65	8.0
70	430	0	560	870	150	0	22.0	640	1,960	59	7.4

TABLE 4.--Chemical analyses of water from

Location No.	Owner or name	Depth of well (ft)	Geologic source	Date sample collected or date of analysis	Source of analysis	Iron (Fe)	Calcium (Ca)
153-67							
2dca	Minnewaukan test 2	72	Qg	6-12-47	NDSH	0	25
3dcd	N. Zacher	96	Qg	9- 1-46	NDSL	43	140
13caa	B. M. Knowlton	18	Qg	9- 1-46	NDSL	2.0	130
15bbc6	Minnewaukan supply well 1	..	Qg	1- 3-53	NDSH	1.8	90
15bda2	Minnewaukan test 11	98	Qg	9-24-51	NDSH	.4	130
15dbb2	City of Minnewaukan	40	Qg	7-12-46	NDSL	1.2	420
15dbd1	Courthouse	60	Qg	7-12-46	NDSL	2.8	420
15dcc1	J. Hager	25	Qg	7-12-46	NDSL	.4	430
21aaa	Test hole 517	50	Qg	5- 9-52	NDSH	.7	95
25cab	A. Johnson	48	Qg	9- 1-46	NDSL	1.1	114
154-63							
5dba	Halgren Bros.	115	Kp	11-23-48	NDSH	.42	17
18dba	P. O. Thompson	258	Kp	3-25-49	NDSH	1.2	19
154-64							
15caa	M. C. Huffman	26	Qg	11-23-48	NDSH	.20	96
23dbc	Matt Bloomquist	135	Kp	11-23-48	NDSH	1.4	31
27cdd2	N. Dak. State School for the Deaf	125	Kp	2-17-50	NDSH	.....	71
33daa	Davis Bros.	96	Qg	12-31-48	NDSH	3.2	168
34dab	City of Devils Lake	125 1/	Kp	5- 4-21	SPSN	.20	8.4
34dcb1	Devils Lake city supply well B	1,514	Kd	5- 4-21	SPSN	.....	13
34dcb1	..do....	1,514	Kd	7-15-37	ABVD	.2	29
34dcb1	..do....	1,514	Kd	6-21-49	USGS	.06	12
34dcb2	Devils Lake city supply well C	1,496	Kd	11-13-50	USGS	.....	12
34dcc	Devils Lake city supply well D	1,500	Kd	6-14-52	USGS	.....	8
35cdb	Floyd Moffett	78	Kp	3-23-49	NDSH	2.9	6.4

1/ Depth reported as 136 in Simpson, 1929, p. 294.

wells, springs, and test holes -- Continued

Magnesium (Mg)	Sodium and Potassium (Na & K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Total hardness as $CaCO_3$	Dissolved solids (calculated)	Percent sodium	Sodium-adsorption-ratio (SAR)
7	750	0	820	400	450	0	....	90	2,040	95	34
36	230	19	440	460	140	...	....	500	1,280	50	4.5
35	60	0	410	260	40	...	....	470	730	22	1.2
51	95	0	480	210	20	.1	4.3	436	710	32	2.0
63	59	0	410	300	50	.2	....	580	810	18	1.1
170	66	48	230	1,300	200	...	....	1,750	2,320	8	0.7
97	380	7	350	1,680	160	...	....	1,450	2,920	36	4.3
170	110	25	320	1,450	260	...	....	1,780	2,600	12	1.1
84	250	0	370	680	86	...	2.1	580	1,380	48	4.5
55	95	0	460	310	17	...	....	510	820	29	1.8
7	246	0	430	216	20	0	3.5	71	722	88	13
16	404	25	700	298	38	.6	20	113	1,170	89	16
76	245	0	526	604	19	0	3.5	552	1,300	49	4.5
20	1,620	43	767	0	2,140	0	0	160	4,230	96	56
80	560	19	607	758	150	.2	2.1	506	1,940	71	11
27	247	24	376	548	90	0	4.3	531	1,300	50	4.7
4.7	357	29	727	107	32	...	7.2	40	967	95	24
9.1	1,390	22	825	1,090	885	...	....	70	3,840	98	....
12	1,360	0	872	1,050	888	4.0	1.5	121	3,770	96	54
4.8	1,400	0	843	1,090	828	4.5	4.0	50	3,770	98	86
5	1,370	0	868	1,050	880	6.0	1.4	51	3,770	98	84
7.3	1,407	41	749	1,130	878	5.0	1.4	50	3,870	99	87
6.8	329	0	572	274	12	.2	6.5	44	919	94	22

TABLE 4.--Chemical analyses of water from

Location No.	Owner or name	Depth of well (ft)	Geologic source	Date sample collected or date of analysis	Source of analysis	Iron (Fe)	Calcium (Ca)
154-65							
33bab	A. Oium and C. Bryn	140	Qg	11-20-50	NDSH	.....	190
154-67							
36bcc	Test hole 33	200	Qg	5- 4-48	NDSH	2.3	93
155-64							
19bbc	Raymond Rader	45	Qg	12-31-48	NDSH	2.2	14
28abd2	John Ehler	190	Kp	12-31-48	NDSH	5.0	195
34bda	Great Northern Railway	79	Qg	11-3-50	NDSH	.....	13

wells, springs, and test holes -- Continued

Magnesium (Mg)	Sodium and Potassium (Na & K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Total hardness as $CaCO_3$	Dissolved solids (calculated)	Percent sodium	Sodium-adsorption-ratio (SAR)
128	121	0	634	600	45	...	....	1,000	1,400	21	1.7
29	530	0	600	860	110	0	....	350	1,920	77	13
9.2	642	65	545	595	210	0	4.3	73	1,810	95	33
72	1,610	72	594	3,490	42	0	8.7	783	5,790	82	25
19	330	14	303	460	64	...	....	111	1,050	87	14

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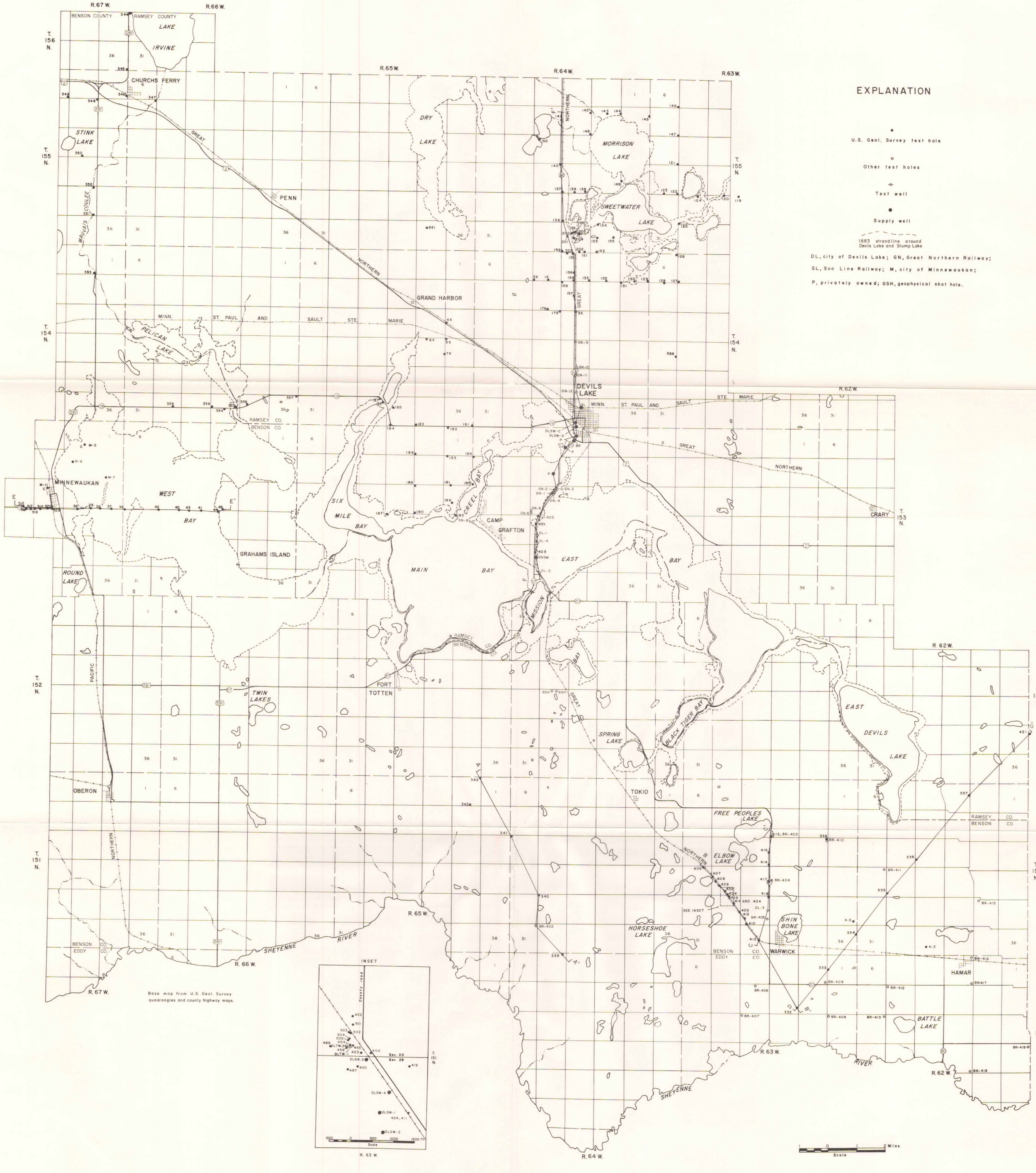


FIGURE 4.-- MAP OF DEVILS LAKE AREA SHOWING LOCATION OF TEST HOLES, SELECTED WELLS, AND GEOLOGIC SECTIONS

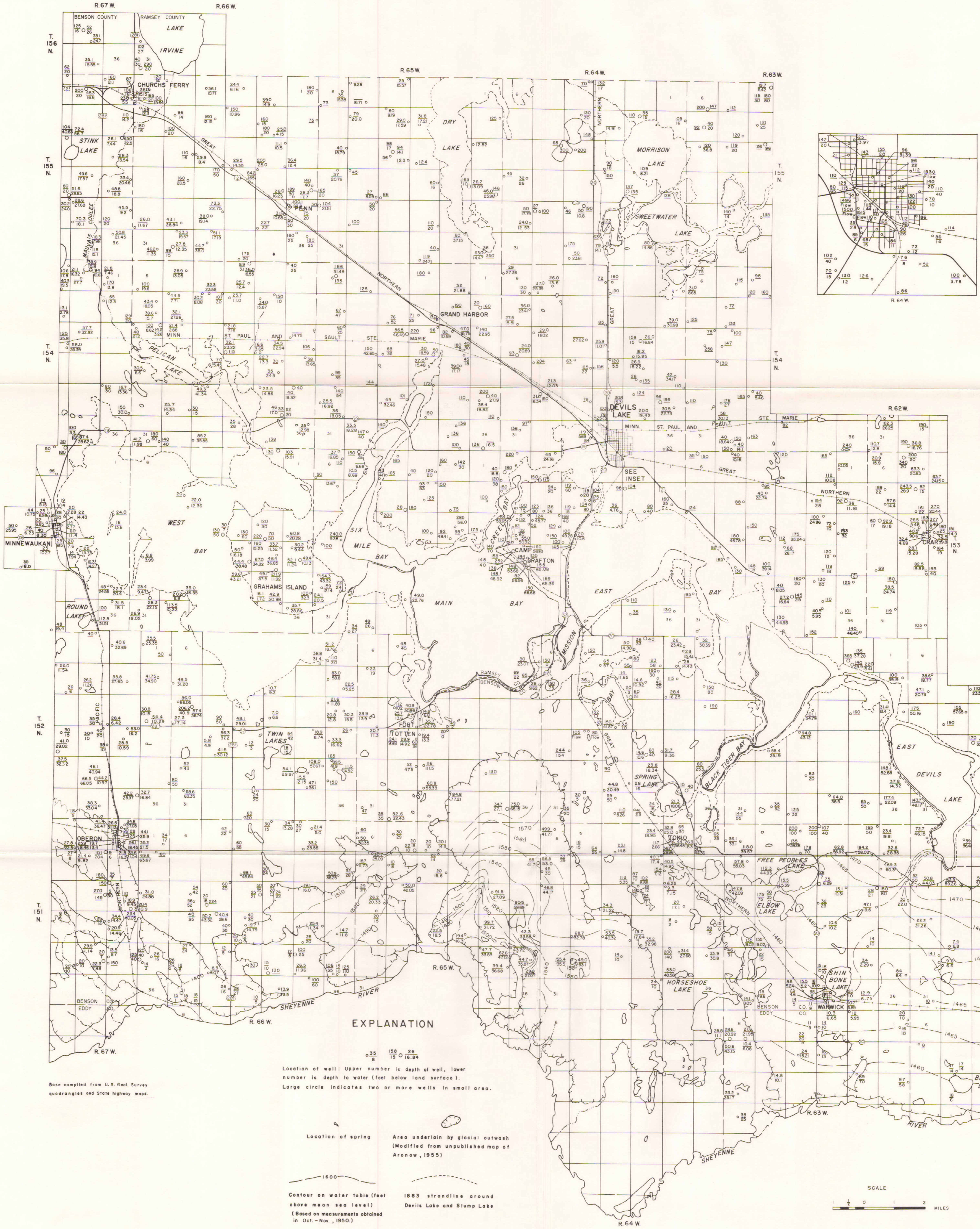
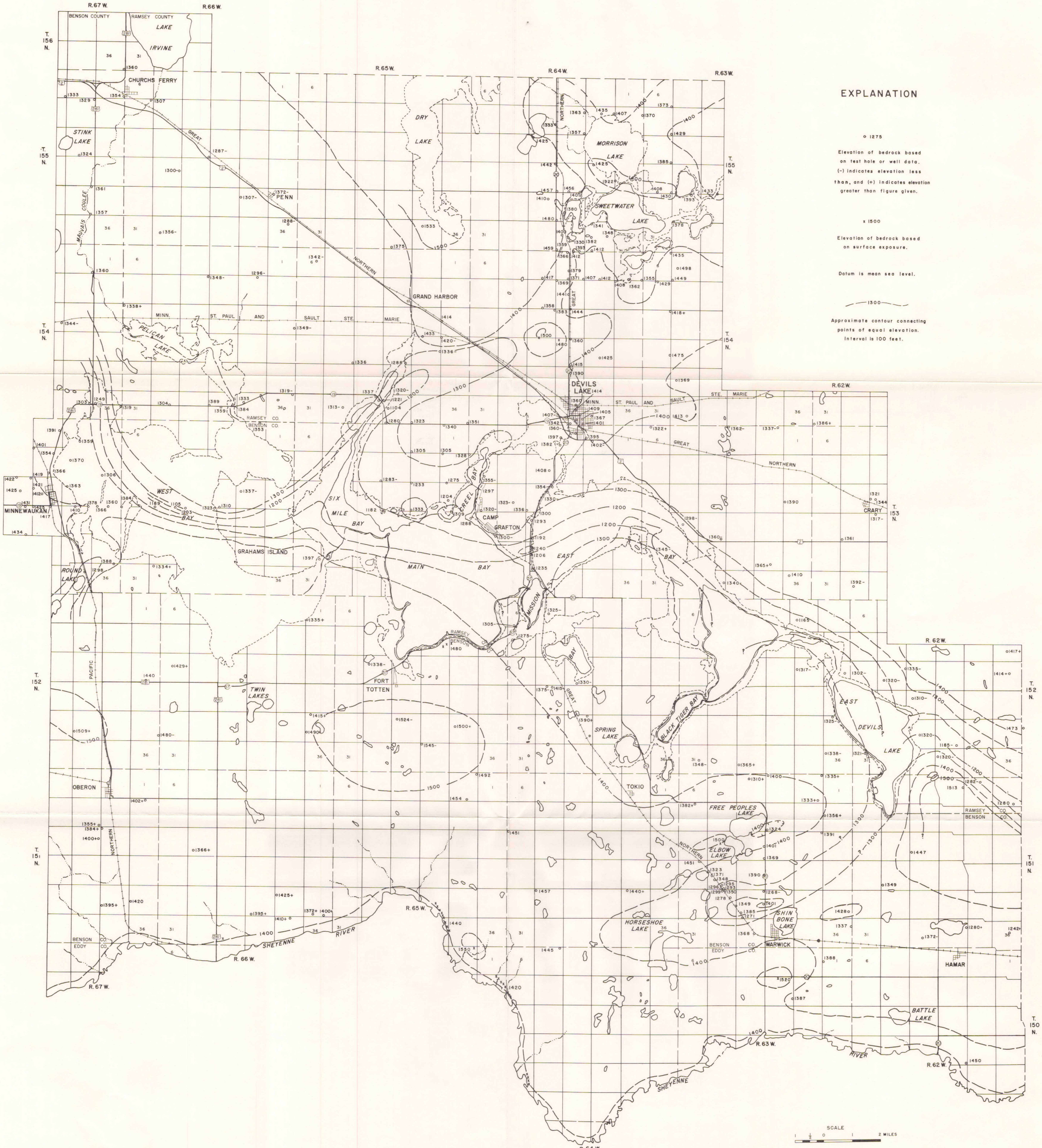


FIGURE 6.-- MAP OF DEVILS LAKE AREA SHOWING LOCATION OF WELLS AND OTHER HYDROLOGIC DATA.



EXPLANATION

o 1275

Elevation of bedrock based on test hole or well data. (-) indicates elevation less than, and (+) indicates elevation greater than figure given.

x 1500

Elevation of bedrock based on surface exposure.

Datum is mean sea level.

—1300—

Approximate contour connecting points of equal elevation. Interval is 100 feet.

FIGURE 9.-- MAP OF DEVILS LAKE AREA SHOWING CONFIGURATION OF TOP OF PIERRE SHALE