GROUND WATER SOURCES IN THE VICINITY OF NORTHWOOD, GRAND FORKS COUNTY, NORTH DAKOTA

By
H. M. Jensen
Geological Survey
United States Department of the Interior

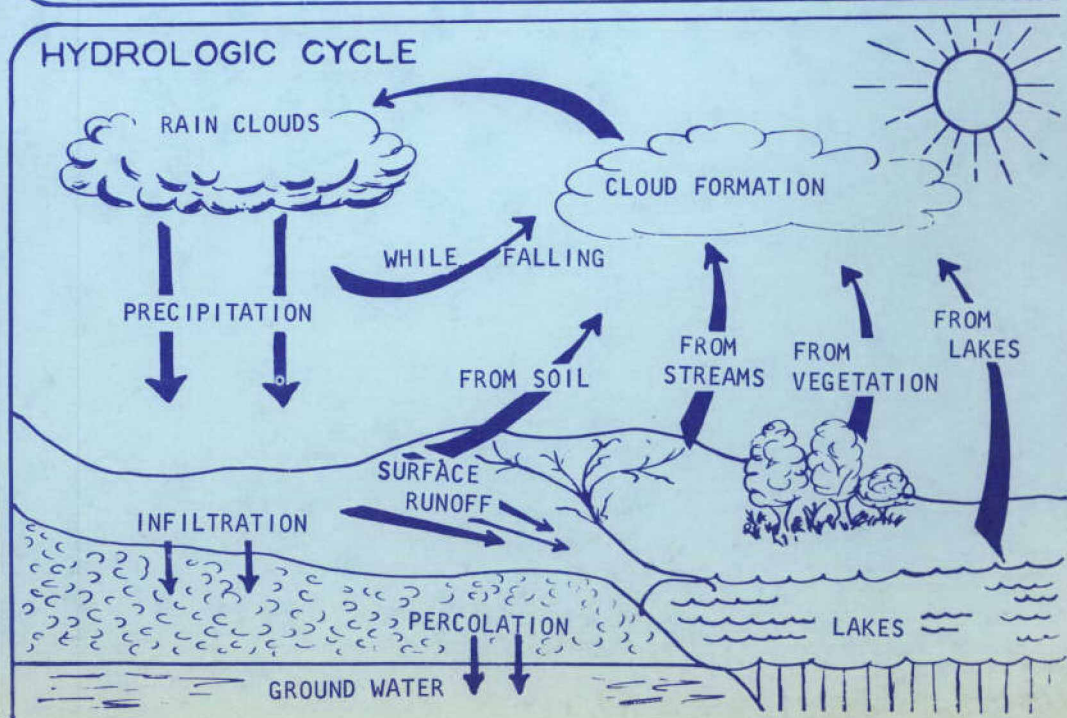
NORTH DAKOTA GROUND WATER STUDIES

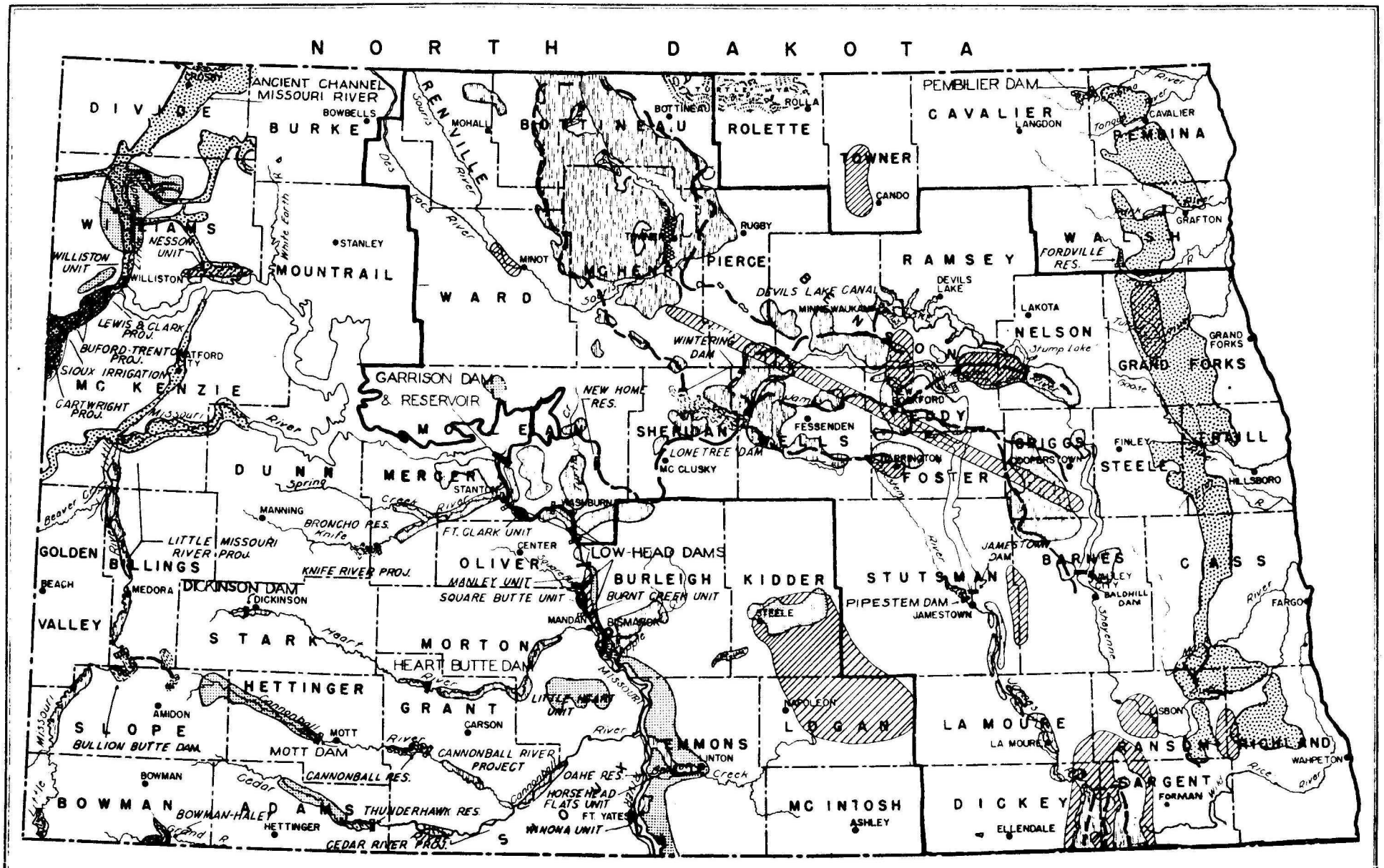
NO. 34

Prepared by the United States Geological Survey in cooperation with the North Dakota State Water Conservation Commission, and the North Dakota Geological Survey

PUBLISHED BY
NORTH DAKOTA STATE WATER CONSERVATION COMMISSION
1301 STATE CAPITOL, BISMARCK, NORTH DAKOTA

- 1961 -





NORTH DAKOTA STATE WATER CONSERVATION COMMISSION

WATER RESOURCES DEVELOPMENT PLAN

LANDS UNDER IRRIGATION

AREAS CONSIDERED IRRIGABLE

AREAS BEING INVESTIGATED

PROPOSED FOR INVESTIGATION

EXISTING

UNDER CONSTRUCTION OR PROPOSED

DAM & RESERVOIR SITES

PROPOSED CANALS

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GROUND-WATER SOURCES IN THE VICINITY OF NORTHWOOD GRAND FORKS COUNTY, NORTH DAKOTA

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Introduction

Part of the ground-water program in North Dakota consists of investigations to locate potential ground-water sources for municipal water supplies. The investigations are made cooperatively by the North Dakota State Water Conservation Commission, the North Dakota Geological Survey, and the U.S. Geological Survey. The end product of these investigations is a published report; however, the release of basic data, prior to report publication, has facilitated immediate water development in numerous areas of the State.

This report presents information on the availability of ground water for municipal use in the immediate vicinity of Northwood, N. Dak. The investigation was started in the summer of 1960. It included a field study of the surficial geology, a partial well inventory, and a test-drilling program using a State-owned rotary-drilling machine.

Early release of field data prior to this publication enabled Northwood to construct a municipal well, city well 3, that supplies their immediate (1960) needs.

Previous Investigations

The first investigation of the geology of the area was made by Upham (1895); he described the surface features of glacial Lake Agassiz. Leverett (1932) added to Upham's work on glacial Lake Agassiz. A general study of the geology and ground-water resources of Grand Forks County was made by Simpson (1929, p. 135-139). Laird (1944) discussed the geology and hydrology of the Emerado quadrangle, and his report includes secs. 30 and 31, T. 150 N., R. 53 W., and a part of sec. 6, T. 149 N., R. 53 W., of this report. Dennis and Akin (1950) present useful data of a ground-water study completed in the Portland area, 20 miles southeast of Northwood.

Supplementary information about the water supply for the city of Northwood is presented by Simpson (1927). Abbott and Voedisch (1938, p. 60-61) include a chemical analysis of water from a Northwood city well.

As the geology and physiography are well presented by the above authors, only those geologic and hydrologic characteristics pertinent to the investigation will be discussed in this report.

Well-Numbering System

The well-numbering system used in this report, illustrated in figure 1, is based upon the location of the well in the federal system of rectangular surveys of the public lands. The first numeral denotes the township north, and 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 tract), as shown on figure 1. Consecutive terminal numerals are added where more than one well is shown in a given 10-acre tract. Thus, well 149-54-6acc is in the southwest quarter of the southwest quarter of the northeast quarter sec. 6, T. 149 N., R. 54 W.

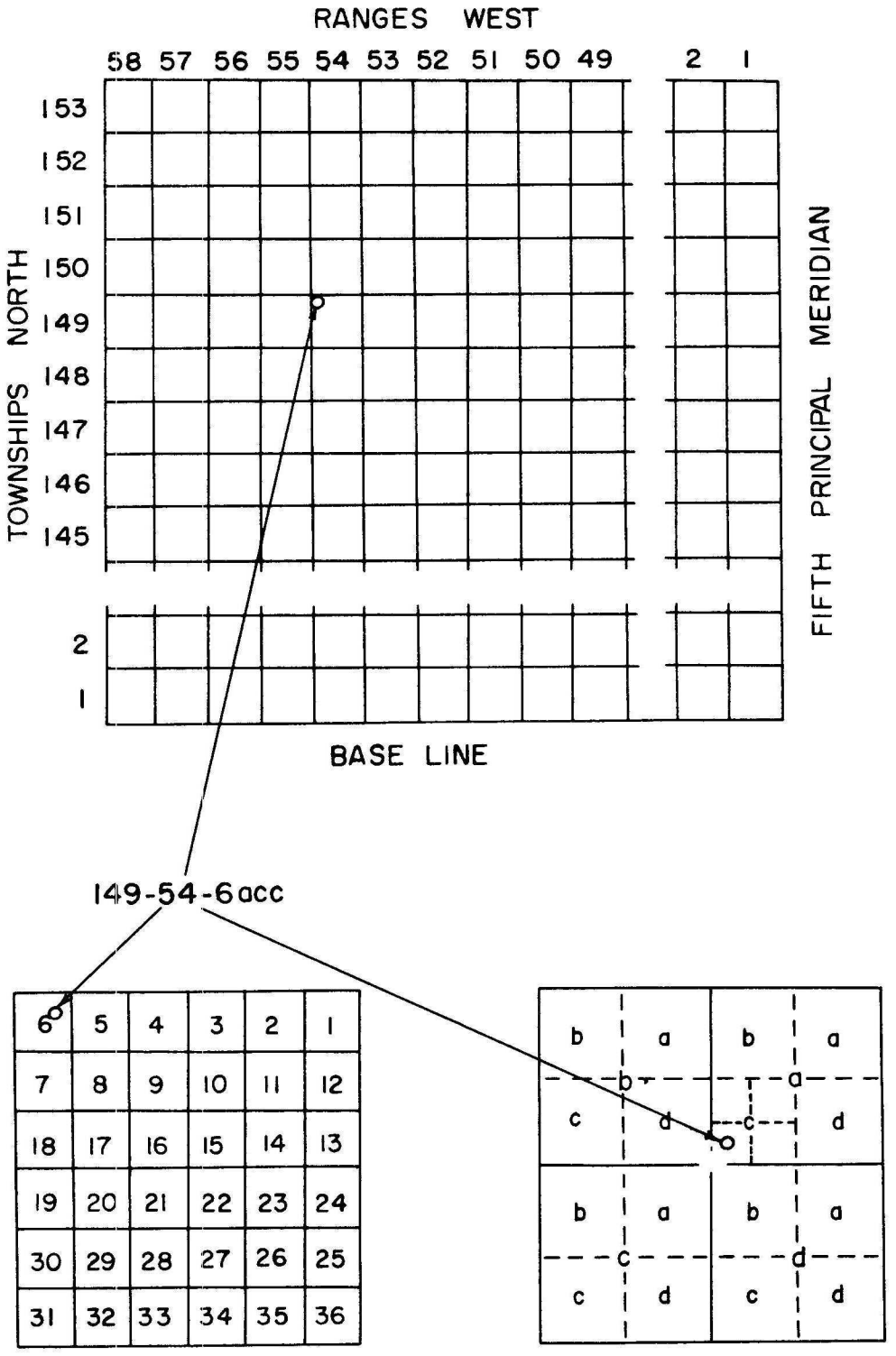

Figure 1 -- Sketch illustrating well-numbering system

Location and General Geology

The area of investigation includes 80 square miles in southwestern Grand Forks County (figs. 2 and 3) and is approximately centered about the city of Northwood, population 1,195 (1960 census). The transportation network serving the area consists of State Highways 18 and 15 and a north-south branch line of the Great Northern Railroad.

The Northwood area is in the Red River Valley and Drift Prairie physiographic provinces (fig. 2) defined by Simpson (1929, p. 4-7). The Red River Valley is a broad, flat glacial-lake plain modified chiefly by low beach ridges and deltas. The Drift Prairie is a gently rolling ground-moraine plain with typical swell and swale topography.

The surficial deposits of Quaternary age in the report area are separated into definite physical units by the upper Herman beach ridge. (See fig. 3.) The beach ridge is composed of silt, sand, and gravel and represents deposits formed at the highest stage or water level attained by ancient glacial Lake Agassiz. East of the beach is the delta of the Elk Valley. The delta accumulation consists partly of alluvium from stream erosion after the departure of the ice but mostly of modified drift supplied by streams from the melting ice in which it had been held (Upham, 1895). The delta was deposited in the water of glacial Lake Agassiz and held to the western side of the lake area by the receding ice barrier. West of the Herman beach, is the ground-moraine plain of the Drift Prairie. The ground moraine consists predominantly of till and associated sand and gravel deposits. The till is a heterogeneous mixture of clay, silt, and sand, intermixed with pebbles, cobbles,

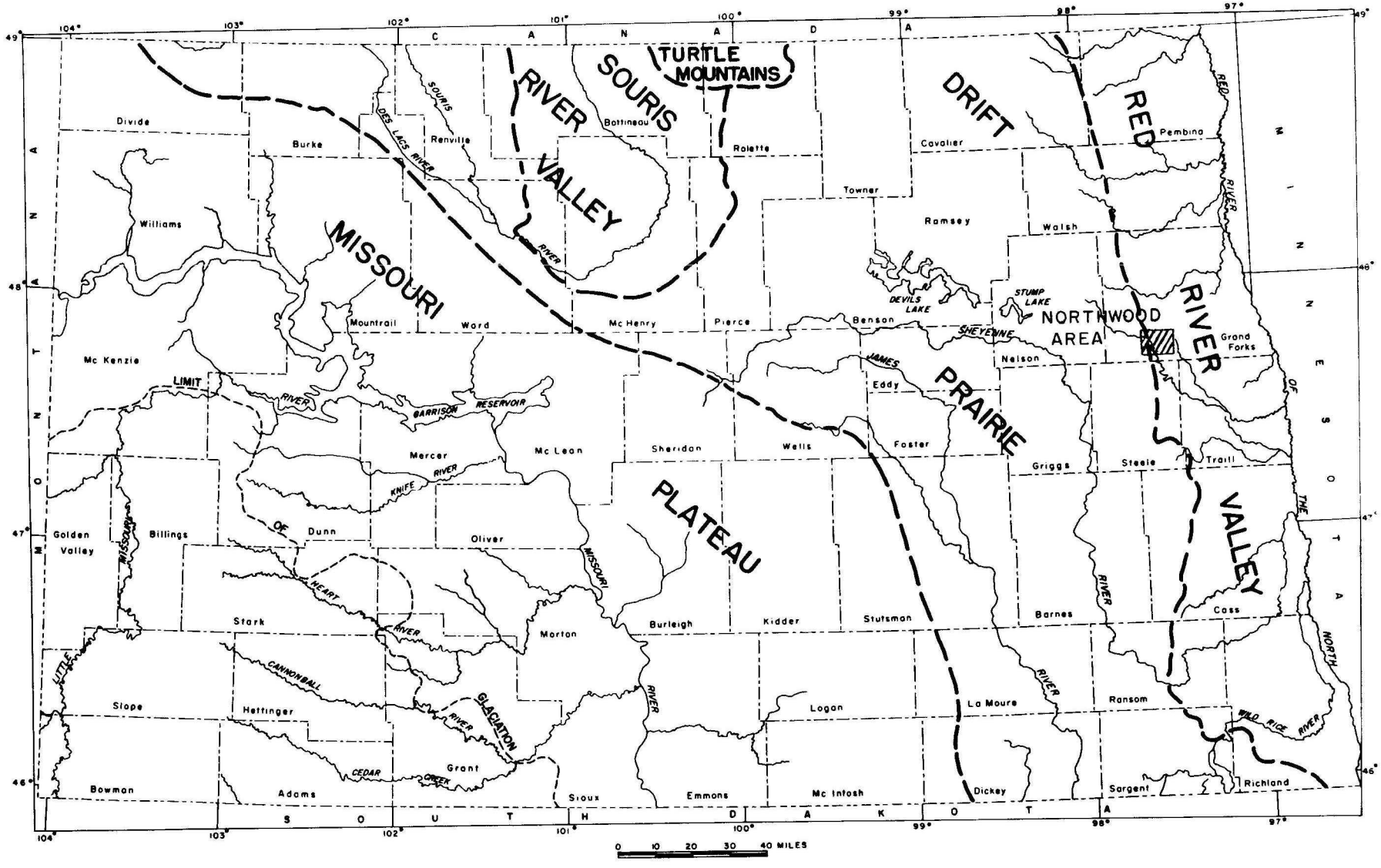

FIGURE 2--MAP SHOWING PHYSIOGRAPHIC PROVINCES IN NORTH DAKOTA (MODIFIED FROM SIMPSON, 1929) AND LOCATION OF THE NORTHWOOD AREA

and boulders. The associated sand and gravel deposits are lenticular and are interbedded in the till. The ground moraine was deposited directly by and beneath the glacial ice with little or no sorting by wind or water.

The major drainage system in the area is the Goose River and its tributary streams. Recent erosion within the drainage system has modified only slightly the physical features of the delta and the upland plain.

The bedrock underlying the area is a shale of Cretaceous age, tentatively identified as the Greenhorn(?) formation.

Ground-Water Conditions and Results of Test Drilling

Three aquifers supply ground water to residents of the area. An aquifer in the deposits composing the Herman beach ridge is the source of supply for farm wells. An aquifer in the till and associated sand and gravel deposits is a source of small supply for municipal and farm wells. An aquifer in the deposits composing the delta of the Elk Valley is a source of supply for municipal and farm wells. The test drilling in this investigation was confined to the study of only two aquifers: (1) the aquifer in the deposits of the delta of the Elk Valley and (2) the aquifer in sand and gravel deposits associated with the till.

The stratigraphic units in the report area were determined from the study of 5-foot drilling samples collected in the course of drilling 19 test holes. The test holes ranged in depth from 84 to 252 feet and averaged 180 feet. The stratigraphic position and the character of the sediments penetrated are listed in logs

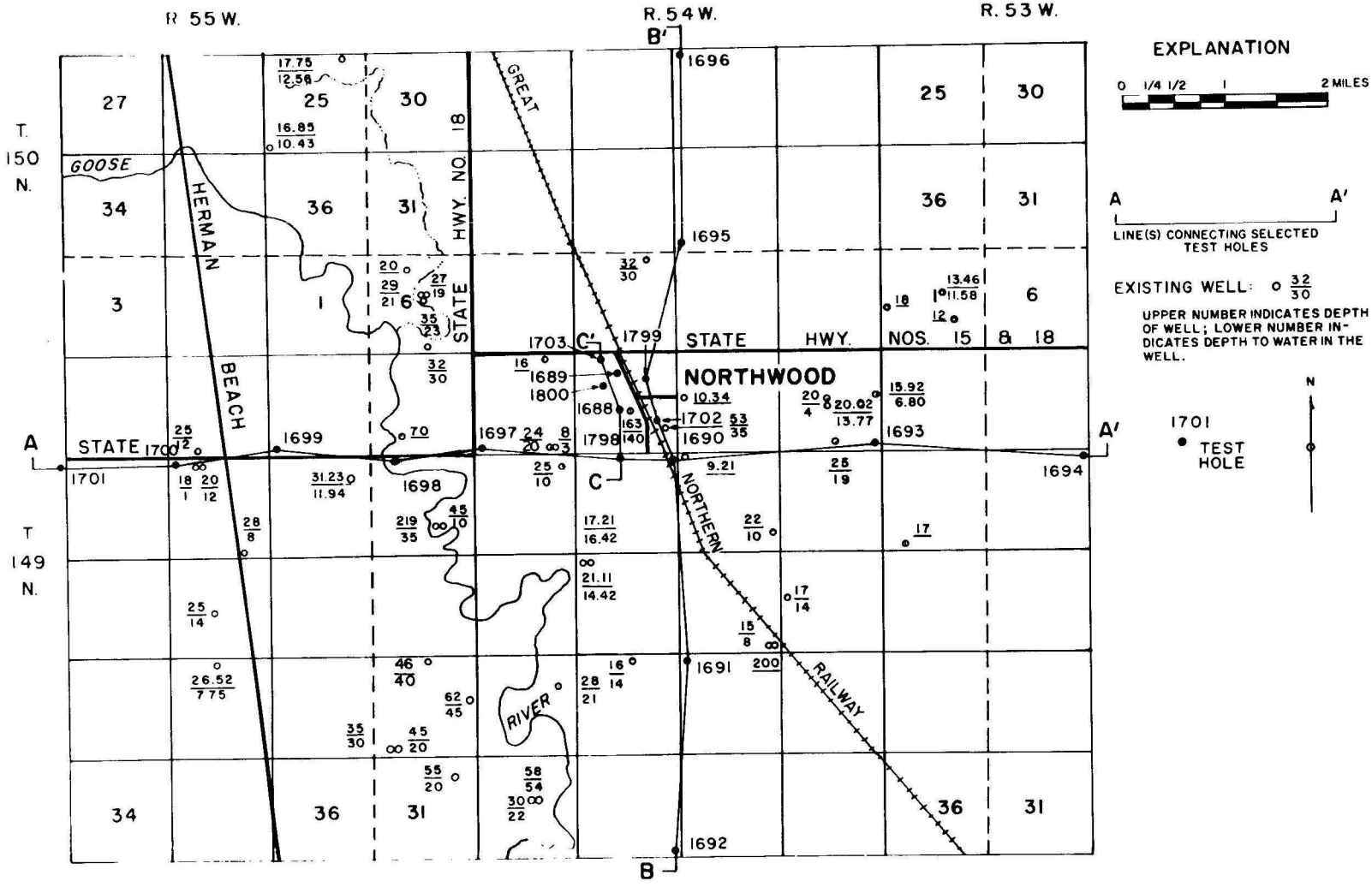

FIGURE 3--MAP OF THE NORTWOOD AREA SHOWING THE LOCATIONS OF WELLS AND TEST HOLES

of test holes (table 1) and are illustrated by graphic logs of selected test holes. (See fig. 4.) The key stratigraphic units penetrated by the test drilling were: (1) till and associated sand and gravel deposits, (2) deposits in the delta of the Elk Valley, and (3) a shale of Cretaceous age, tentatively identified as the Greenhorn(?) formation.

Till and associated sand and gravel deposits were penetrated in all test holes. Like the till of ground moraine at the surface, the till in the test holes consists primarily of clay and varying amounts of silt, sand, pebbles, cobbles, and boulders and is relatively impermeable; however, lenses and lenticular deposits of sand and gravel interbedded and associated with the till are more permeable. In the report area, a producing aquifer in this unit is a lenticular sand and gravel deposit penetrated at depths ranging from 130 to 170 feet. The sediments in the aquifer are silt, sand, and a fine gravel, consisting mostly of shale pebbles and some limestone fragments. The aquifer is thin, about 5 to 20 feet thick, and its subsurface areal extent is small; therefore, large groundwater withdrawals are not possible.

The deposits of the Elk Valley delta were penetrated in 17 test holes. In these holes, the deposits range in thickness from about 10 to more than 100 feet; they consist of clay, silt, and fine sand. The main aquifer in the deposits extends from about 10 feet to about 60 feet below the land surface; it consists primarily of sand intermixed with varying amounts of silt and clay. The sand -- composed of quartz grains, and flakes of shale and coal -- ranges in thickness from about 10 feet to as much as 50 feet. Well-inventory data locate the general extent of the aquifer in the delta deposits.

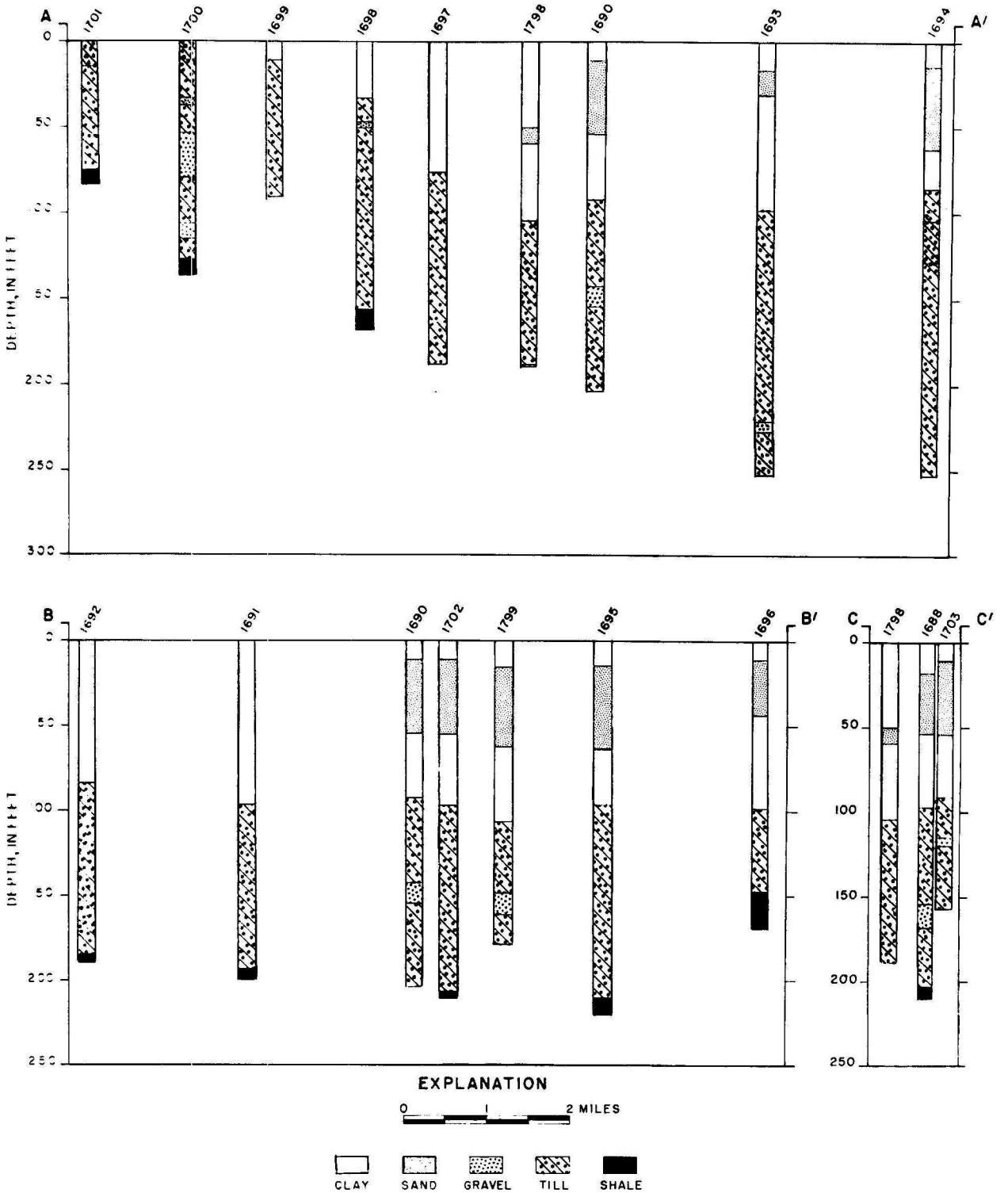

FIGURE 4-- GRAPHIC LOGS OF SELECTED TEST HOLES IN THE NORTHWOOD AREA

Nine test holes penetrated bedrock of Cretaceous age, tentatively defined as the Greenhorn(?) formation. In the report area, it is a dark-gray and light-gray sandy calcareous shale. The shale is relatively impermeable, and it is not considered to be an aquifer.

Quality of Water

Analyses of water from the present (1960) city wells are shown in table 3. Hardness of water from city wells 2 and 3 is 772 and 272 ppm (parts per million) respectively. The hardness of water from both wells exceeds the 100 ppm figure sometimes given as an upper limit for water suitable for domestic use (Hem, 1959, p. 147). High hardness causes high soap consumption, but it can be reduced by the use of softening equipment. Although water from well 3 is more desirable for municipal use than water from well 2, city well 3 cannot supply total demand; therefore, water from both wells is mixed in the city distribution system. The mixed water has a variable chemical quality intermediate between the values for the two wells.

Dissolved-solids contents and iron contents of the Northwood well waters also exceed the limits recommended by the U.S. Public Health Service (1946) (0.5 ppm for iron and 1,000 ppm for dissolved solids). The high iron content causes staining of laundry and plumbing fixtures. Water containing a total dissolved-solids concentration exceeding the limits recommended by the U.S. Public Health Service has been used in some areas, including North Dakota, for many years without noticeable ill effects.

Conclusions and Recommendations

Residents in the vicinity of Northwood obtain ground-water supplies from three sources: (1) aquifers in the sand and gravel deposits in the Herman beach ridge, (2) an aquifer in the till and associated sand and gravel deposits, and (3) an aquifer in the sand deposits composing the delta of the Elk Valley.

The investigation shows that the aquifers in the deposits of the Herman beach ridge are a source of supply for small farm operations. The aquifer in the till is small in areal extent and ranges in thickness from about 5 to 20 feet. Because the materials surrounding it are relatively impermeable, the aquifer should be considered to be only a small source of water. The aquifer in the sand deposits of the delta of the Elk Valley has a greater areal extent and ranges in thickness from 10 to 50 feet. This aquifer supplies water that is more highly mineralized than that from the aquifer in the till, but its greater extent and saturated thickness makes it the most likely future source for municipal supply.

TABLE 1.--Logs of Test Holes

149-53-18aaa
Test hole 1694

Formation	Material	Thickness (feet)	Depth (feet)
Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, black.....	2	2
	Clay, silty, sandy, yellow.....	12	14
	Sand, fine.....	48	62
	Clay, silty, sandy, gray.....	23	85
Till and associated sand and gravel deposits:			
	Clay, gray; fine gravel; shale pebbles (till).....	19	104
	Clay, silty, sandy, gray; a few shale pebbles (till).....	23	127
	Clay, gray; fine to medium gravel; shale pebbles (till).....	125	252

149-54-8ccc
Test hole 1697

Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, black.....	2	2
	Clay, silty, yellow.....	17	19
Till and associated sand and gravel deposits:			
	Clay, silty, smooth, gray.....	56	75
	Clay, gray; fine to medium gravel, shale pebbles; cobbles (till)....	112	187

TABLE 1.--Logs of Test Holes -- Continued

149-54-9aca
Test hole 1799

Formation	Material	Thickness (feet)	Depth (feet)
Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, black.....	3	3
	Clay, silty, sandy, yellow.....	12	15
	Sand, fine, silty, gray.....	47	62
	Clay, silty, gray.....	44	106
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles (till).....	42	148
	Gravel, fine to medium; clay, sandy, gray.....	13	161
	Clay, gray; fine to medium gravel; shale pebbles (till).....	17	178

149-54-9bab
Test hole 1703

Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, sandy, black.....	2	2
	Clay, silty, sandy, yellow.....	8	10
	Sand, fine, silty.....	44	54
	Clay, silty, gray.....	37	91
Till and associated sand and gravel deposits:			
	Clay, gray; fine gravel; shale pebbles (till).....	24	115
	Gravel, fine to medium; shale pebbles.....	5	120
	Clay, gray; fine to medium gravel; shale pebbles (till).....	37	157

TABLE 1.--Logs of Test Holes -- Continued

149-54-9bad
Test hole 1689

Formation	Material	Thickness (feet)	Depth (feet)
Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, sandy, black.....	4	4
	Clay, sandy, gravelly, bouldery, yellow, (fill material).....	6	10
	Sand, silty, very fine, gray.....	44	54
	Clay, very sandy and silty, gray...	31	85
	Clay, silty, smooth, gray.....	8	93
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles (till).....	35	128
	Gravel, fine, fine to coarse sand; interbedded gray silty clay.....	31	159
	Clay, gray; fine to medium gravel; shale pebbles (till).....	45	204

149-54-9bdb
Test hole 1800

Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, black.....	3	3
	Clay, silty, yellow.....	8	11
	Sand, fine, silty.....	9	20
	Sand, fine medium, silty.....	42	62
	Clay, silty, sandy, gray.....	44	106
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles (till).....	12	118
	Gravel, fine to medium, clayey; shale pebbles.....	7	125
	Clay, gray; fine to medium gravel; shale pebbles (till).....	28	153
	Clay, sandy, gray (till).....	5	158
	Gravel, fine to medium; shale pebbles, abundant.....	5	163
	Clay, gray; fine to medium gravel; shale pebbles (till).....	15	178

TABLE 1.--Logs of Test Holes -- Continued

149-54-9caa
Test hole 1688

Formation	Material	Thickness (feet)	Depth (feet)
Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, sandy, black.....	4	4
	Clay, silty, sandy, yellow.....	13	17
	Sand, very fine, silty.....	17	34
	Sand, fine.....	19	53
	Clay, sandy, gray.....	44	97
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles (till).....	57	154
	Gravel, fine to medium; shale pebbles.....	14	168
	Clay, gray; fine to medium; cobbles (till).....	35	203
Cretaceous system:			
Greenhorn(?) formation:			
	Shale, dark-gray, calcareous.....	7	210

149-54-9dbd
Test hole 1702

Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, sandy, black.....	2	2
	Clay, sandy, gray.....	3	5
	Clay, sandy, yellow.....	6	11
	Sand, fine.....	30	41
	Sand, fine to medium.....	13	54
	Clay, silty, sandy, gray.....	42	96
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles (till).....	110	206
Cretaceous system:			
Greenhorn(?) formation:			
	Shale, dark-gray.....	4	210

TABLE 1.--Logs of Test Holes -- Continued

149-54-11ddd
Test hole 1693

Formation	Material	Thickness (feet)	Depth (feet)
Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, black.....	2	2
	Clay, silty, sandy, yellow.....	14	16
	Sand, very fine to fine, very silty, gray.....	15	31
	Clay, silty, gray.....	67	98
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles; cobbles (till)....	125	223
	Gravel, fine to medium; shale pebbles.....	6	229
	Clay, gray; fine to medium gravel; shale pebbles (till).....	23	252

149-54-16aaa
Test hole 1690

Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, black.....	1	1
	Clay, silty, sandy, light-gray.....	4	5
	Clay, sandy, yellow.....	6	11
	Sand, fine, gray, large shale fraction.....	43	54
	Clay, sandy, gray.....	30	84
	Clay, silty, smooth, gray.....	8	92
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles (till).....	50	142
	Gravel, fine to coarse; fine to coarse sand; interbedded clay....	12	154
	Clay, gray; fine to medium gravel; shale pebbles; cobbles; lignite fragments (till).....	49	203

TABLE 1.--Logs of Test Holes -- Continued

149-54-16baa
Test hole 1798

Formation	Material	Thickness (feet)	Depth (feet)
Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, sandy, brown.....	4	4
	Clay, silty, sandy, yellow.....	12	16
	Clay, silty and sandy, bluish-gray.	34	50
	Sand, fine.....	9	59
	Clay, silty, gray.....	14	73
	Clay, silty, smooth, gray.....	31	104
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles; cobbles (till)....	85	189

149-54-18bba
Test hole 1698

Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, black.....	3	3
	Clay, sandy, brown.....	2	5
	Clay, silty, yellow.....	17	22
	Clay, silty, gray.....	11	33
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles (till).....	14	47
	Sand, coarse; granule gravel.....	3	50
	Clay, gray; fine to medium gravel; shale pebbles (till).....	106	156
Cretaceous system:			
Greenhorn(?) formation:			
	Shale, dark-gray, very calcareous..	12	168

TABLE 1.--Logs of Test Holes -- Continued

149-54-27bbb
Test hole 1691

Formation	Material	Thickness (feet)	Depth (feet)
Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, black.....	3	3
	Clay, sandy, silty, yellow.....	16	19
	Clay, silty, sandy, gray.....	77	96
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles; cobbles (till)....	97	193
Cretaceous system:			
Greenhorn(?) formation:			
	Shale, dark-gray, very calcareous..	6	199

149-54-33ddd
Test hole 1692

Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, black.....	2	2
	Clay, silty, sandy, yellow.....	14	16
	Clay, silty, sandy, gray.....	66	82
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles; cobbles (till)....	102	184
Cretaceous system:			
Greenhorn(?) formation:			
	Shale, dark-gray, very calcareous..	5	189

149-55-12ccc
Test hole 1699

Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, black.....	2	2
	Clay, yellow.....	9	11
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles; cobbles (till)....	79	90

TABLE 1.--Logs of Test Holes -- Continued

149-55-14bbb
Test hole 1700

Formation	Material	Thickness (feet)	Depth (feet)
Quaternary system:			
Till and associated sand and gravel deposits:			
	Topsoil, black.....	2	2
	Clay, sandy, pebbly, yellow, oxidized (till).....	9	11
	Clay, gray; fine to medium gravel; shale pebbles; cobbles (till)....	21	32
	Sand, fine to coarse; fine gravel..	4	36
	Clay, gray; fine to medium gravel; shale pebbles (till).....	17	53
	Gravel, fine to medium; about two-thirds shale gravel.....	26	79
	Clay, gray; fine to medium gravel; shale pebbles (till).....	27	106
	Gravel, fine to medium; interbedded gray clay.....	9	115
	Clay, gray; fine to medium gravel; shale pebbles (till).....	12	127
Cretaceous system:			
Greenhorn(?) formation:			
	Clay, dark-gray, calcareous.....	9	136

149-55-16aaa
Test hole 1701

Quaternary system:			
Till and associated sand and gravel deposits:			
	Topsoil, black.....	2	2
	Clay, gravelly, yellow, oxidized (till).....	13	15
	Clay, gray; fine to medium gravel; shale pebbles; cobbles (till)....	60	75
Greenhorn(?) formation:			
	Shale, dark-gray, very calcareous..	9	84

TABLE 1.--Logs of Test Holes -- Continued

150-54-27bbb
Test hole 1696

Formation	Material	Thickness (feet)	Depth (feet)
Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, black.....	2	2
	Clay, silty, sandy, yellow.....	9	11
	Sand, fine, gray.....	32	43
	Clay, silty, sandy, smooth, gray...	54	97
Till and associated sand and gravel deposits:			
	Clay, gray; fine to medium gravel; shale pebbles (till).....	50	147
Cretaceous system:			
Greenhorn(?) formation:			
	Clay, sandy, light-gray, very calcareous	21	168

150-54-34ccc
Test hole 1695

Quaternary system:			
Deposits of the Elk Valley delta:			
	Topsoil, black.....	2	2
	Clay, silty, yellow.....	12	14
	Sand, very fine to fine, silty, gray	50	64
	Clay, silty, smooth, light-gray....	32	96
Till and associated sand and gravel deposits:			
	Clay, gray; fine gravel; shale pebbles (till).....	114	210
Cretaceous system:			
Greenhorn(?) formation:			
	Shale, sandy, light-gray, very calcareous.....	10	220

TABLE 2.--Records of Wells

Depth to water: Measured water levels in feet and hundredths; reported water levels in feet.

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

Location No.	Owner or name	Depth of well (feet)	Diameter or size	Type	Date completed
149-53					
18aaa	Test hole 1694	252	5	Dr	5-10-60
149-54					
1acc	Morrisson	13.46	36	Du	.....
1cbb	Alvin I. Peterson	18	4	Dr	1915
1dbd	Hans Tufte	12	36	Du	1936
4aba	Alvin Halverson	32	30	Dr	1954
6acc1	Perden Halverson	27	48	Du	.....
6acc2	..do....	35	36	Dr	.....
6acc3	..do....	29	24	Dr	.....
6ba	Nick Brorby	20	42	Du	1930
6dcc	Gilmore Ostlie	32	36	Dr	1956
7cdb	Marie Bakke	70	36	Dr	.....
8aba	C. Sheggerud	16	...	Du	1920
8ccc	Test hole 1697	187	5	Dr	5-11-60
8ddc1	Groven Hogen	8	...	Du	.....
8ddc2	..do....	24	36	Dr	.....
9aca	Test hole 1799	178	5	Dr	8- 9-60
9bab	Test hole 1703	157	5	Dr	5-13-60
9bad	Test hole 1689	204	5	Dr	5- 7-60
9bdb	Test hole 1800	178	5	Dr	8- 9-60
9caa	Test hole 1688	210	5	Dr	5- 6-60
9dac	City of Northwood 2	53	24	Dr	.....
9bdd1	City of Northwood 3	164	12	Dr	9-30-60
9bdd2	City of Northwood 1	163	...	Dr	.....
9dbd	Test hole 1702	210	5	Dr	5-13-60
10bcc	Unknown	10.34	36	Du	.....
11add	Bob Hanson	15.92	...	Du	1948
11bdd	Art Nelson	20	36	Du	.....

and Test Holes

Depth of well: Measured depths in feet and tenths; reported depths in feet.

Use of water: D, domestic; N. none; PS, public supply; S, stock; T, test hole

Depth to water below land surface (feet)	Date of measurement	Use of water	Aquifer	Depth to shale	Remarks
.....	.....	T	.....	....	See log.
11.58	4-29-60	N	.....	....	
.....	.....	D,S	Sand	....	Supply reported adequate.
.....	.....	D	..do..	....	
30	.....	D,S	..do..	....	Do.
19	.....	S	..do..	....	Do.
23	.....	S	..do..	....	Do.
21	.....	D	..do..	....	Do.
.....	.....	D,S	..do..	....	Do.
30	.....	D	..do..	....	Do.
.....	.....	S	.....	....	Do.
.....	.....	...	..do..	....	Do.
.....	.....	T	.....	....	See log.
3	.....	D	.....	....	Supply reported adequate.
20	.....	S	.....	....	Do.
.....	.....	T	.....	....	See log.
.....	.....	T	.....	....	Do.
.....	.....	T	.....	....	Do.
.....	.....	T	.....	....	Do.
.....	.....	T	.....	203	Do.
35	.....	PS	Sand	....	Supply reported adequate, chemical analysis.
89	.....	PS	Sand and gravel	....	Chemical analysis.
140	.....	PS	Sand	....	Abandoned.
.....	.....	T	.....	206	See log.
.....	4-29-60	N	.....	....	
6.80	4-29-60	S	Sand	....	
4	.....	D,S	..do..	....	

TABLE 2.--Records of Wells

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
149-54 (Cont.)					
11caa	Bob Hanson	20.02	36	Du	1948
11dcc	Henry Johnson	25	36	Dr	.....
11ddd	Test hole 1693	252	5	Dr	5- 9-60
13ccd	Gilman Hanson	17	48	Du	.....
15bbb	Peter J. Schweitzer	9.21	48	Du	.....
15dda	Buraas Bros.	22	36	Dr	1958
16aaa	Test hole 1690	203	5	Dr	5- 7-60
17aa	Edwin Burwas	25	48	Du	1910
18bba	Test hole 1698	168	5	Dr	5-11-60
18dbd1	Paul O. Johnson	219	5	Dr	1934
18dbd2	..do....	45	30	Du	1937
21bbb1	Henry Haga	21.11	36	Dr	.....
21bbb2	..do....	17.21	36	Dr	.....
22ddd1	Hjlmer Stephenson	15	60	Du	1952
22ddd2	..do....	200	...	Dr	1940
23bcc	Mrs. John Halverson	17	48	Du	1959
27bbb	Test hole 1691	199	5	Dr	5- 9-60
28abb	Olaf Jorde	16	18	Dr	1956
29adb	Orville Bakken	28	48	Dr	1916
30abb	Percy Foss	46	36	Dr	1955
30add	N. P. Nelson	62	24	Dr	1940
30ccd1	Mrs. K. E. Thorsgard	45	30	Dr	1937
30ccd2	..do....	35	48	Dr	1920
31aad	L. P. Thompson	55	24	Dr	1945
32acc1	Noel Kolsmo	58	30	Du	1900
32acc2	..do....	30	30	Dr	1936
33ddd	Test hole 1692	189	5	Dr	5- 9-60

and Test Holes -- Continued

Depth to water below land surface (feet)	Date of measurement	Use of water	Aquifer	Depth to shale	Remarks
13.77	4-29-60	S	.....	....	
19	.....	D,S	Clay	....	Supply reported adequate.
.....	.....	T	.....	....	See log.
.....	.....	S	..do..	....	
.....	4-29-60	N	.....	....	
10	.....	D,S	..do..	....	
.....	.....	T	.....	....	Do.
10	.....	N	Sand	....	Supply reported adequate.
.....	.....	T	.....	156	See log.
35	.....	...	..do..	....	Supply reported inadequate.
10	.....	D,S	..do..	....	Supply reported adequate.
14.42	4-21-60	D	..do..	....	Do.
16.42	4-21-60	N	..do..	....	Do.
8	.....	S	..do..	....	
.....	.....	D	Gravel	....	Reported slow recovery.
14	.....	D,S	Sand	....	Supply reported inadequate.
.....	.....	T	.....	193	See log.
14	.....	S	Sand	....	Supply reported inadequate.
21	.....	D,S	Clay	....	Supply reported adequate; hard.
40	.....	S	Sand	....	Supply reported inadequate; alkaline.
45	.....	D,S	Gravel	....	Do.
20	.....	D,S	Sand	....	Supply reported adequate.
30	.....	S	..do..	....	Supply reported adequate; hard.
20	.....	N	Clay	....	Supply reported adequate.
54	.....	N	Sand	....	Supply reported inadequate.
22	.....	N	..do..	....	Supply reported adequate.
.....	.....	T	.....	184	See log.

TABLE 2.--Records of Wells

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
149-55					
11cdc	Alvin Olson	25	48	Du	.....
12ccc	Test hole 1699	90	5	Dr	5-12-60
13aac	Anton Ostmo	31.23	48	Du	.....
14babl	Johnson Bros.	20	48	Du	.....
14bab2	..do....	18	60	Du	.....
14bbb	Test hole 1700	136	5	Dr	5-12-60
14dcd	L. Johnson	28	48	Du	.....
16aaa	Test hole 1701	84	5	Dr	5-12-60
23caa	Henry Evanson	25	48	Du	.....
26baa	O. G. Olson	26.52	48	Du	.....
150-54					
27bbb	Test hole 1696	168	5	Dr	5-11-60
34ccc	Test hole 1695	220	5	Dr	5-10-60
150-55					
25aab	Unknown	17.75	36	Du	.....
25ccc	Eldred Evanson	16.85	36	Du	.....

and Test Holes -- Continued

Depth to water below land surface (feet)	Date of measurement	Use of water	Aquifer	Depth to shale	Remarks
12	.....	D,S	Gravel	....	Supply reported adequate.
.....	.....	T	.....	....	See log.
11.94	5- 5-60	D	Sand	....	Supply reported adequate.
12	.....	D,S	Gravel	....	Do.
1	5- 5-60	D	..do..	....	Supply reported adequate; flows at times.
.....	.....	T	.....	127	See log.
8	.....	D,S	..do..	....	Supply reported adequate.
.....	.....	T	.....	75	See log.
14	.....	D,S	..do..	....	
7.75	5- 5-60	N	..do..	....	
.....	.....	T	.....	147	Do.
.....	.....	T	.....	210	Do.
12.56	5- 5-60	N	.....	....	Vacant farm.
10.43	5- 5-60	D,S	Sand	....	Supply reported inadequate.

TABLE 3.--Chemical

Results in parts per million except as indicated

Location No.	Owner or name	Aquifer	Depth of well (feet)	Date reported	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)
149-54							
9dac	City of Northwood 2	Drift	53	9- 2-47	0.5	215	57
9bddl	City of Northwood 3	Drift	164	10-14-60	.5	74	21

a/Includes bicarbonate (HCO_3) as carbonate (CO_3)
b/Reported as sodium, calculated

Analyses of Ground Water

Analyses by State Laboratories, Bismarck

Sodium (Na)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Hardness as $CaCO_3$	Dissolved solids	Sum of determined constituents	pH
337 b/	345	765	302	772	1,440	---	7.1
236	433	205	154	272	1,130	904 a/	7.5

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