ARLAND C. GRUNSETH

GROUND WATER IN THE VICINITY OF HILLSBORO TRAILL COUNTY, NORTH DAKOTA

BY
H. M. Jensen and Edward Bradley
Geological Survey
United States Department of the Interior

NORTH DAKOTA GROUND WATER STUDIES

No. 55

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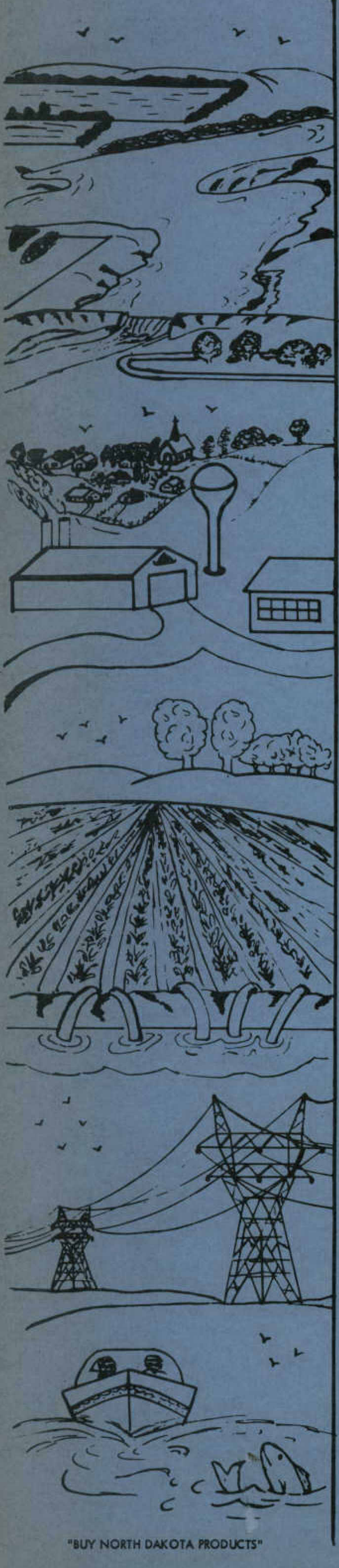

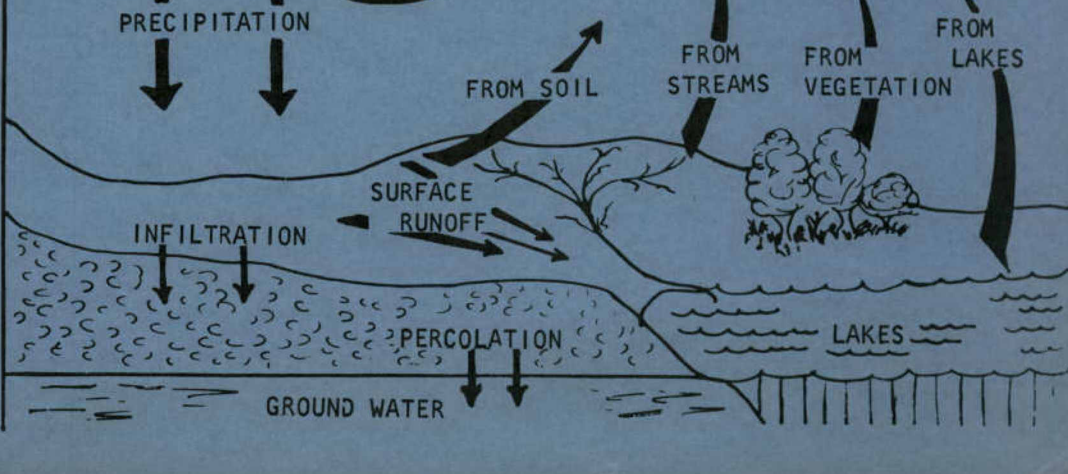

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GROUND WATER IN THE VICINITY OF HILLSBORO, TRAILL COUNTY, NORTH DAKOTA

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INTRODUCTION

The United States Geological Survey, North Dakota State Water Conservation Commission, and the North Dakota Geological Survey are making investigations of ground-water resources in North Dakota. As a part of the cooperative ground-water investigations program, areas surrounding towns that have requested aid in locating water supplies are studied. Larger areas, such as counties, are studied more completely at a later date. Reports on the larger areas may include some of the results of the municipal water-supply studies in addition to other data and a more comprehensive discussion of ground-water occurrence in the area.

The present investigation was begun in 1957 when test holes were drilled near Hillsboro. (See figure 1.) Geohydrologic data collection continued in a large part of Traill County as well as in the Hillsboro area for about 3 years following 1957. The data are being assembled in a basic-data report for Traill County. Other reports on areas in or partly in Traill County are given in the selected references of this report.

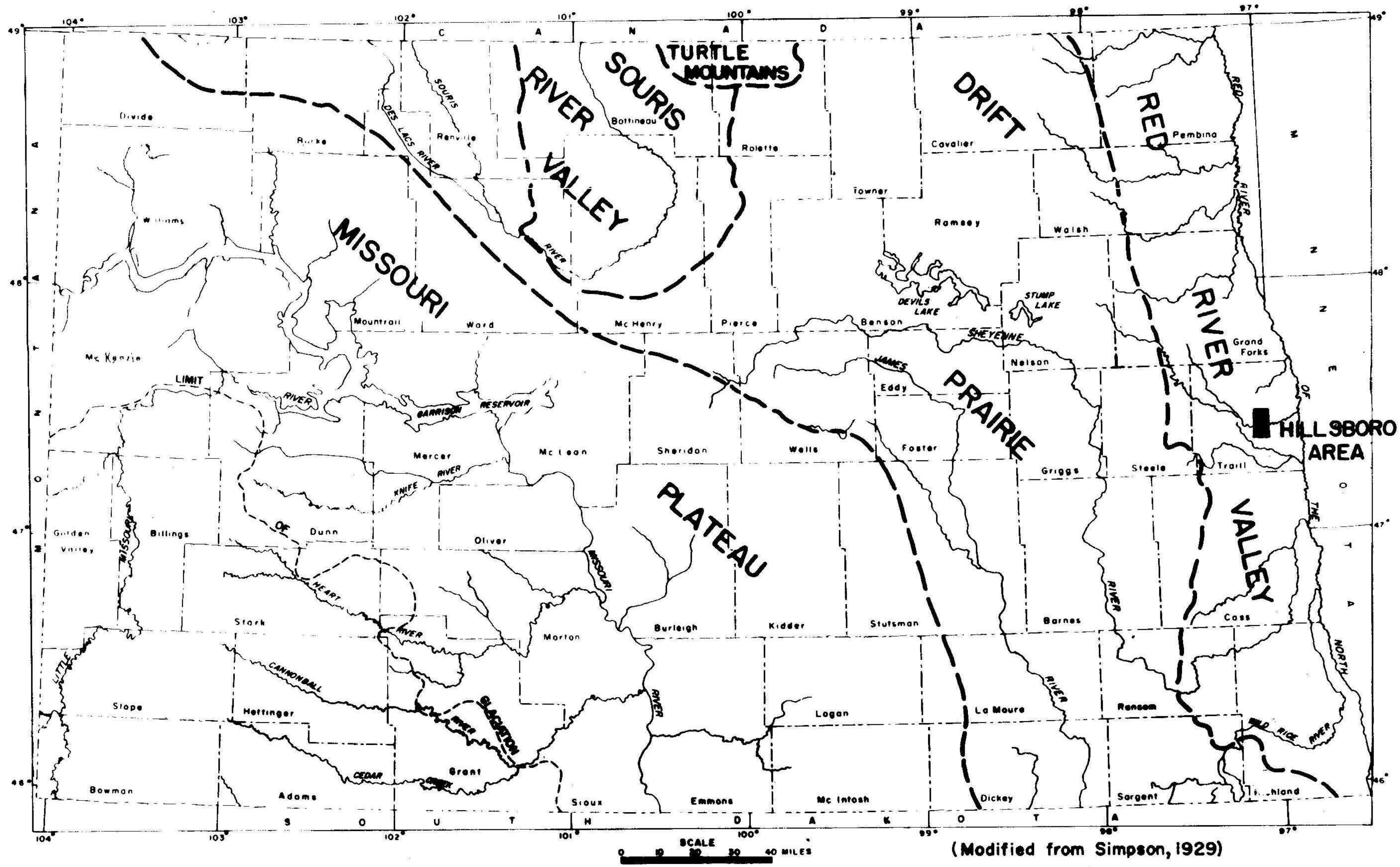

FIGURE I - MAP OF NORTH DAKOTA SHOWING PHYSIOGRAPHIC PROVINCES AND LOCATION OF THE HILLSBORO AREA.

The purpose of this report is to discuss the availability and quality of ground water in the vicinity of Hillsboro. It includes geologic and hydrologic data that are useful for further exploration of ground water for a municipal supply. Most of the test holes drilled in connection with the investigation were located along a beach ridge west of Hillsboro because the beach or shore deposits and underlying sand and gravel deposits were known to be the most likely source of good quality water.

The well-numbering system used in this report is illustrated in figure 2 and 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 tracts), as shown on figure 2. Consecutive terminal numerals are added if more than one well, test hole, or spring are shown in a 10-acre tract. Thus, well 145-50-15daa is in the NE$\frac{1}{4}$ NE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 15, T. 145 N., R. 50 W.

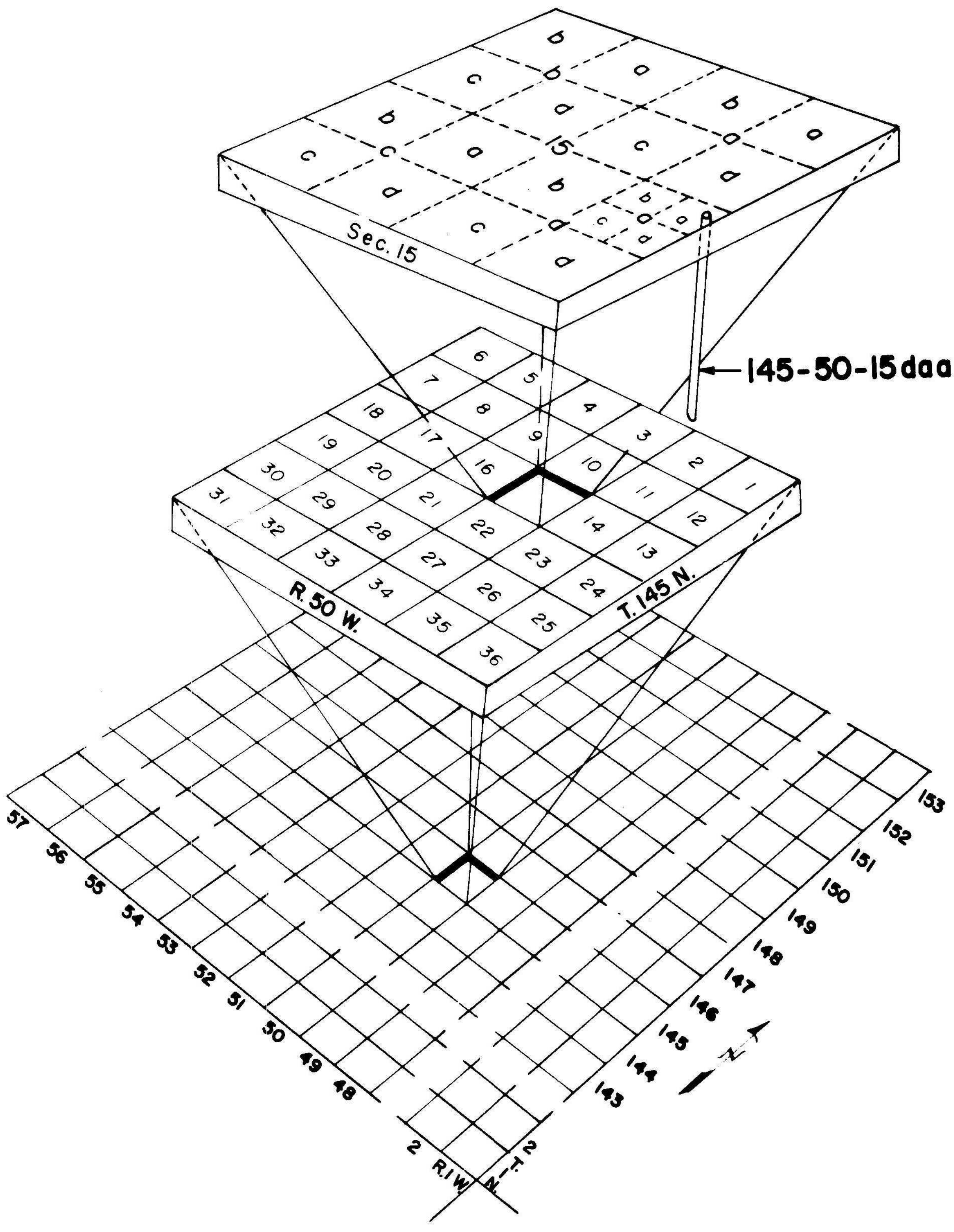

FIGURE 2--SYSTEM OF NUMBERING SPRINGS, WELLS, AND TEST HOLES.

OCCURRENCE OF GROUND WATER

Recent alluvium, Pleistocene glacial drift, and bedrock formations underlie the Hillsboro area in descending order. Alluvium occupies the valley of the Goose River, but the deposits are thin, small in areal extent, and not a source of ground water for wells. The glacial drift may be divided into deposits of glacial Lake Agassiz and deposits of till and associated sand and gravel. The Lake Agassiz deposits may be further subdivided into beach or shore deposits and lacustrine silt and clay deposits. Beach or shore deposits consist primarily of fine and coarse sand, some gravel, and minor amounts of clay and silt. Sand and gravel deposits that underlie the beach deposits and are associated with them, are the source of water for municipal supply for Hillsboro. Lacustrine silt and clay deposits are not sources of ground water because they are very fine grained. Till is relatively impermeable and does not yield water to wells readily. Stratified sand and gravel deposits interbedded in till were not penetrated in test holes. However, the considerable range in well depths in the eastern part of the area (fig. 3) suggests that numerous farm wells tap small aquifers that probably consist of stratified sand and gravel deposits interbedded in till.

The bedrock in the Hillsboro area is composed of shale and sand of Cretaceous age. The upper part is a soft clay or shale that is relatively impermeable, but sand bodies beneath the clay or shale yield water to wells in the area. The quantity of water is small and its quality is not suitable for municipal use.

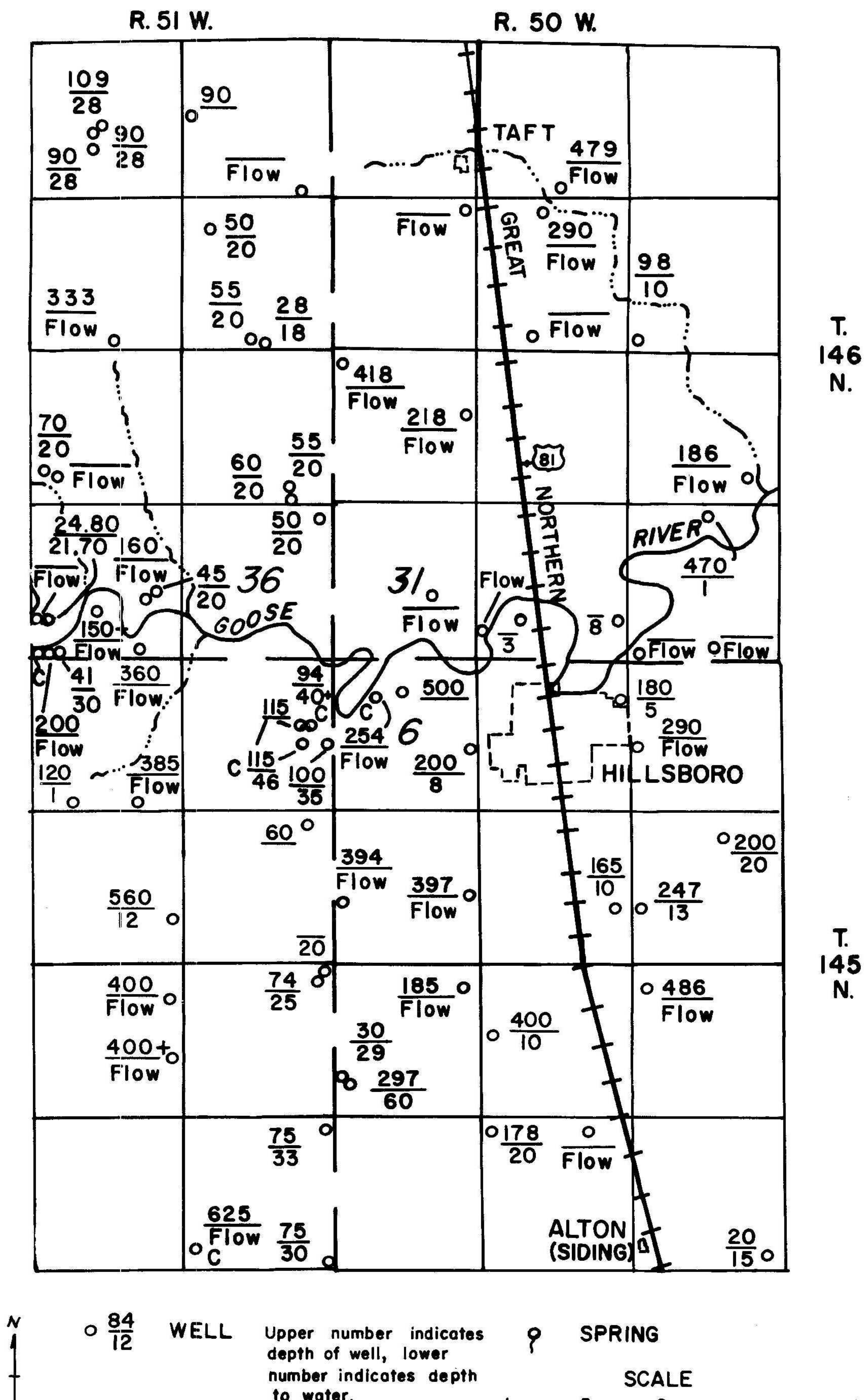

FIGURE 3-MAP OF THE HILLSBORO AREA SHOWING LOCATION OF WELLS AND SPRINGS.

In 1957 the North Dakota State Water Conservation Commission drilled 13 test holes (table 2) in the Hillsboro area. Most of the test drilling was concentrated on the Hillsboro beach described by Upham (pl. 28, 1895). The depths of the holes ranged from 94 to 202 feet. Figure 4 shows the location of the test holes and figure 5 shows graphic logs of selected test holes.

The test drilling showed that in the report area the Hillsboro beach is underlain by thick deposits of sand and gravel. Test drilling north of the report area suggests that the trend is northwestward, rather than northeastward beneath the beach as defined by Upham. The maximum known thickness of the combined beach and underlying sand and gravel deposits is 163 feet (test hole 1257, 145-50-19ccc). About 2 miles west of Hillsboro the deposits are probably thinner; only 95 feet of sand was penetrated in test hole 1198 (145-51-1abb). The Hillsboro city wells being used in 1962, which withdraw water from the aquifer underlying the Hillsboro beach, are capable of yields of approximately 100 gpm (gallons per minute) each. However, two of the wells (145-51-1adc1 and 145-51-1adc2) are spaced so close to each other as to cause mutual interference. Thus it is necessary to regulate their pumping so that drawdowns are not excessive. It is believed that properly spaced wells in these deposits would sustain yields of approximately 100 gpm each, but additional test drilling as well as aquifer testing is desirable for a more complete evaluation of the water-supply potential of the aquifer.

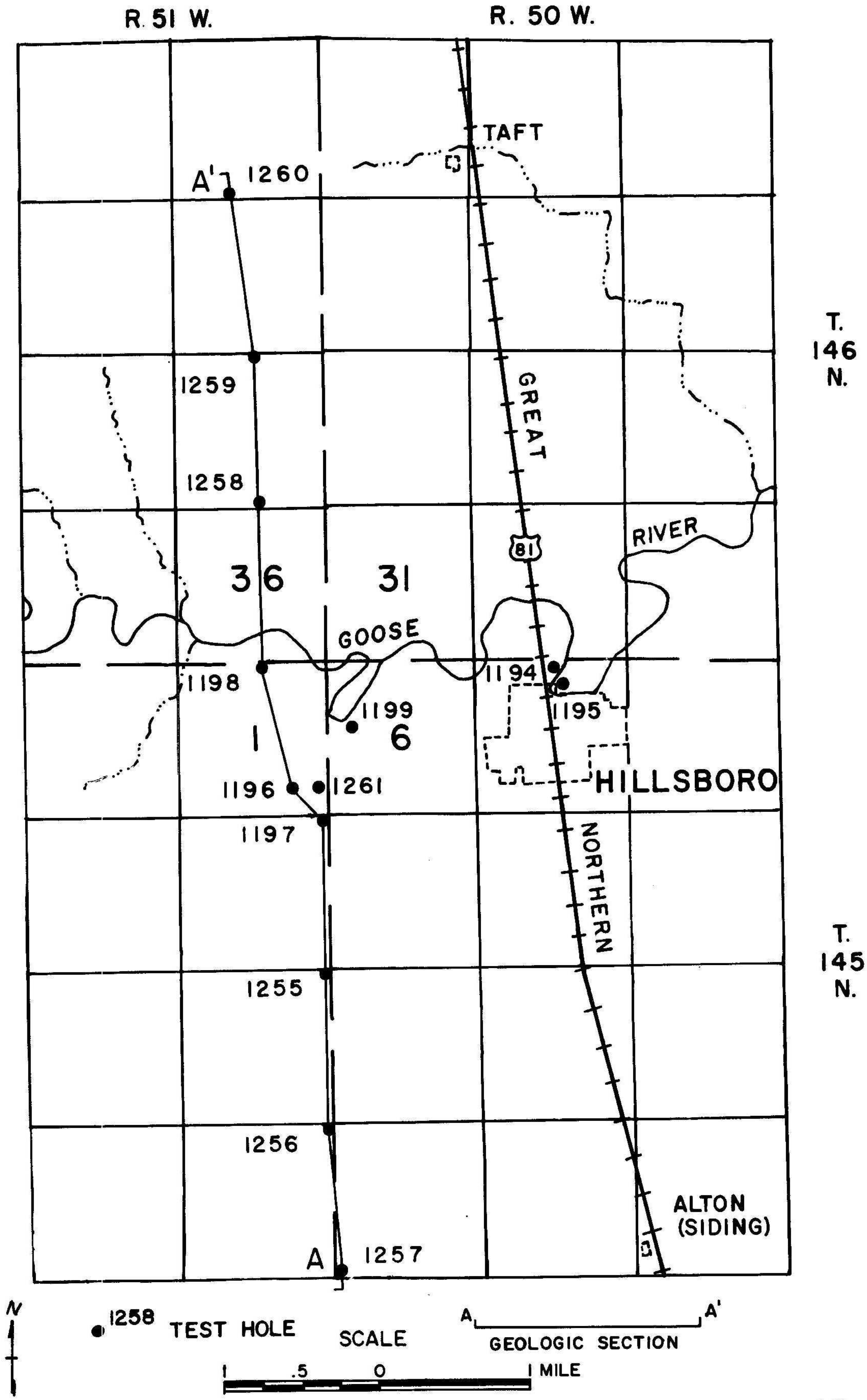

FIGURE 4- MAP OF THE HILLSBORO AREA SHOWING LOCATION OF TEST HOLES AND GEOLOGIC SECTION.

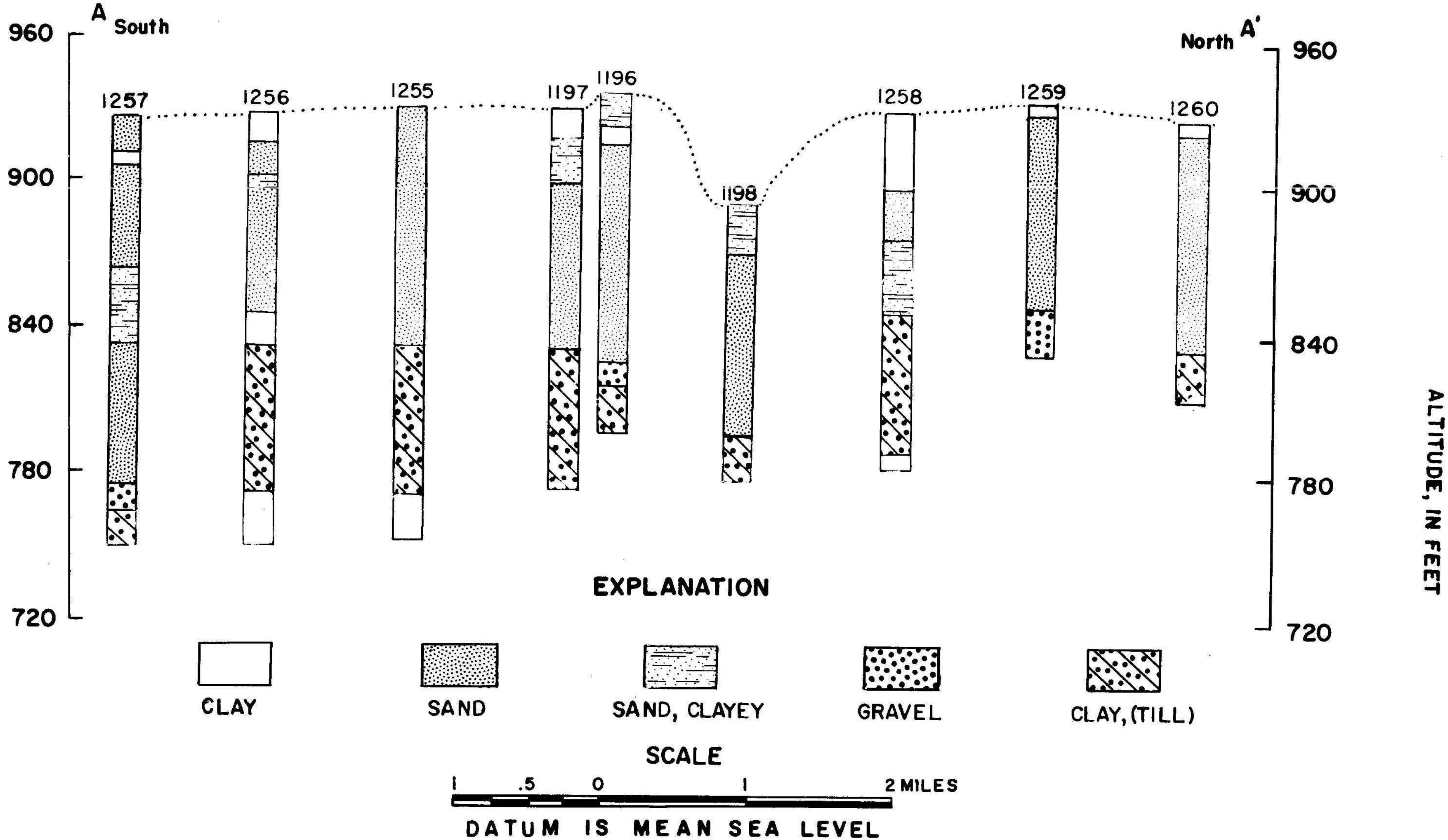

FIGURE 5 -- GEOLOGIC SECTION IN THE HILLSBORO AREA.

The relation of ground water in the aquifer in and beneath the Hillsboro beach to the flow in the Goose River should be studied. Pumping the Hillsboro wells may induce recharge by seepage from the river. Furthermore, larger quantities of water might be obtained by artificially recharging the aquifer.

CHEMICAL QUALITY OF GROUND WATER

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. These standards, adopted in 1914 to protect the health of the traveling public, were revised several times in subsequent years. The latest revisions by the U.S. Public Health Service (1962), approved by the Secretary of Health, Education, and Welfare, are, in part, as follows:

Constituent	Maximum concentration ppm
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

* Based on 5-year annual average of maximum daily air temperature at Hillsboro, North Dakota.

Table 3 shows the chemical analyses of water from 4 wells and a spring in the Hillsboro area. The recommended maximum concentration of one or more chemical constituents is exceeded in all analyses, but water that contains excessive amounts of certain chemical constituents has been used in North Dakota for many years without reported ill effects.

The chemical quality of the ground water from the Hillsboro city wells is more like water from the spring (146-51-35ccc3) than it is like the water from the two deep wells (145-50-6bac and 145-51-24ccb). The higher chloride concentration in the water from city well 145-51-1dab, however, may result from contamination by water from the aquifers in the Cretaceous rocks, the quality of which is illustrated by the analyses of samples from wells 145-50-6bac and 145-51-24ccb. The water from these wells contains high concentrations not only of chloride, but also of sulfate, sodium, fluoride, and dissolved solids; it is not suitable for public-supply use. All the ground water that was sampled in the area was very hard, but the hardness may be improved by chemical treatment.

SUMMARY

Hillsboro obtains its municipal water supply from an aquifer in sand and gravel underlying the Hillsboro beach (Upham, 1895). Test drilling during this investigation shows that the deposits extend in a generally north-south direction. Additional test drilling, aquifer tests, and a study of the relation of seepage from the Goose River to discharge by wells would be desirable for a complete evaluation of the water-yielding capacity of the aquifer.

The quality of ground water in the area is generally very hard and has concentrations of one or more constituents in excess of those recommended by the U.S. Public Health Service. Nevertheless water of similar quality has been used in North Dakota for many years without apparent ill effect.

TABLE 1.--Records of

Depth of well and water level: Reported depths below land surface are given in feet; measured depths are given in feet, tenths, and (or) hundredths.

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

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

Location No. (1)	Owner or name (2)	Depth of well (feet) (3)	Diameter or size (inches) (4)	Type (5)	Date completed (6)
145-50					
4cbb	Fred Downs	290	3	Dr	....
5aad	Carl F. Meyer	180	2	Dr	....
5abb	Test hole 1194	178	5	Dr	8-27-57
5abc	Test hole 1195	202	5	Dr	8-28-57
6bac	Abel Svebedny	254	2	Dr	....
6bad	M. Hewitt	500	2	Dr	....
6bcd	Test hole 1199	105	5	Dr	9- 7-57
6daa	Earl Henn	200	2	Dr	....
7cbb	L. Muller	394	2	Dr	1954
7daa	Fred Schafer	397	3	Dr	....
8da	Ralph Diehl	165	3	Dr	1934
9ab	R. G. Bovaird	200	3	Dr	....
9cbb	Harry Tonn	247	3	Dr	....
16bb	Elroy Schultz	486	2	Dr	1915
17bcc	Dalrymple Estate	400	2	Dr	....
18aa	Grover Forster	185	2	Dr	1954
18cbc1	Harold A. Smith	30	...	Du	....
18cbc2	..do....	297	3	Dr	....
19ccc	Test hole 1257	177	5	Dr	11-20-57
20aba	Unknown	...	2	Dr	....
20bbb	John Delrunkle	178	3	Dr	1950
21dd	Dalrymple Estate	20	36	Du	....
145-51					
1abb	Test hole 1198	115	5	Dr	9- 6-57

wells, test holes, and springs

Altitude: Altitudes determined with matched surveying altimeters.

Remarks: Unless otherwise indicated, water supply is adequate. Chemical analyses are given in table 3, and logs of test holes are given in table 2.

Depth to water below land surface (feet)	Date of measurement	Use of water	Aquifer	Altitude of land surface (feet)	Remarks
(7)	(8)	(9)	(10)	(11)	(12)
Flow	....	D,S	Sand	....	
5	....	N	..do..	....	
....	8-27-57	T	......	892	See log.
....	8-28-57	T	......	881	..Do....
Flow	7- 7-58	S	Sand	....	Flows 40 gph. See chemical analysis.
....	....	N	..do..	....	Flowed prior to "cave in".
....	9- 7-57	T	......	912	See log.
8	....	S	Sand	....	
Flow	....	S	..do..	....	
Flow	....	S	..do..	....	
10	....	S	..do..	....	
20	....	D,S	..do..	....	
13	....	S	Gravel	....	
Flow	....	S	Sand	....	Flows 1 gpm.
10	....	D,S	..do..	....	
Flow	....	D,S	Gravel	....	
29	....	D	Sand	....	Flows 15 to 20 gpd.
60	....	S	Gravel	....	
....	....	T	......	928	See log.
Flow	......	N	......	....	Flows 3 gpm.
20	....	D,S	Sand	....	
15	....	D,S	......	....	
....	9- 6-57	T	......	895	See log.

TABLE 1.--Records of wells, test

(1)	(2)	(3)	(4)	(5)	(6)
145-51 (Cont.)					
1adc1	Hillsboro City well	94	120	Dr	....
1adc2	..do....	115	12	Dr	1947
1dab	..do....	115	12	Dr	1955
1daa	S. H. Boeddeker	100	4	Dr	....
1dda	Test hole 1261	94	5	Dr	11-29-57
1ddb	Test hole 1196	139	5	Dr	8-29-57
2cdc	Bill Kozajed	120	2	Dr	....
2dcd	L. Kritzberger	385	2	Dr	1952
11dad	Sundby Bros.	560	...	Dr	1917
12aaa	Test hole 1197	157	5	Dr	9- 5-57
12aab	Ralph Mueller	60	$1\frac{1}{4}$	Dr	....
13aaa1	Alvin Muller	74	3	Dr	....
13aaa2	..do....	...	2	Dr	....
13aaa3	Test hole 1255	178.5	5	Dr	11-18-57
14aad	Brian Brenden	400	3	Dr	....
14daa	Jake C. Grable	400 +	3	Dr	....
24aaa1	K. A. Halvorson	75	3	Dr	1920
24aaa2	Test hole 1256	178	5	Dr	11-19-57
24ccb	Walter Thompson	625	2	Dr	1951
24ddd	Clarence Hagen	75	3	Dr	1950
146-50					
17dcc	Ruby Chelson	479	2	Dr	1950
19aaa	Elmer Anderson	...	...	Dr	....
20baa	A. Olson Estate	290	2	Dr	....
20cd	Arthur Klintson	...	2	Dr	....
21ccc	Oliver Nelson	98	2	Dr	1955
28ddb	E. Mergenthal	186	2	Dr	1946
30add	Darell Sorum	218	2	Dr	....
30bbb	Ervin Koering	418	...	Dr	1950
31dba	Hjelmstad Bros.	...	2	Dr	1908
32cac	Morris Smith	...	...	Dr	....
32ccb	E. Christianson	...	2	Dr	1953
32dad	John Letnas	...	...	..	....
33abb	Hanson Estate	470	2	Dr	....
33ccc	Hilda Dammin	...	...	Dr	....
33dcc	Riese Heckle	...	2	Dr	....
146-51					
13bcc	A. L. Halverson	90	4	Dr	....
13cdd	Test hole 1260	115	5	Dr	11-26-57
13ddc	Walter Koering	...	2	Dr	....

holes, and springs -- Continued

(7)	(8)	(9)	(10)	(11)	(12)
40 +	....	PS	Sand	....	See chemical analysis.
....	....	PS	Sand and gravel	....	
46	....	PS	Sand	....	..Do....
35	....	D,S	..do..	....	
....	11-29-57	T	......	925	See log.
....	8-29-57	T	......	939	..Do....
1	....	D,S	......	....	
Flow	....	D,S	Sand	....	
12	....	S	..do..	....	
....	9- 5-57	T	......	934	..Do....
....	....	D,S	......	....	
25	....	D,S	Sand	....	
20	....	D,S	..do..	....	
....	11-18-57	T	......	933	..Do....
Flow	....	N	Sand	....	Presently plugged.
Flow	....	S	..do..	....	
33	....	S	..do..	....	
....	11-19-57	T	......	938	See log.
Flow	....	S	Sand	....	See chemical analysis.
30	....	D,S	..do..	....	
Flow	....	S	..do..	....	
Flow	....	N	..do..	....	
Flow	....	N	..do..	....	
Flow	....	N	..do..	....	
10	6-27-60	S	..do..	....	
Flow	....	S	..do..	....	
Flow	....	D,S	......	....	
Flow	....	D,S	Sand	....	
Flow	....	S	..do..	....	
3	....	N	......	....	
Flow	....	S	......	....	
8	....	S	......	....	
1	....	S	......	....	
Flow	....	S	Sand	....	
Flow	....	S	..do..	....	
....	....	S	..do..	....	
....	11-26-57	T	......	930	See log.
Flow	....	D,S	Sand	....	

TABLE 1.--Records of wells, test

(1)	(2)	(3)	(4)	(5)	(6)
146-51 (Cont.)					
14caa1	C. A. Ellingson	109	4	Dr	1937
14caa2	..do....	90	4	Dr	....
14cad	..do....	90	4	Dr	....
23dcc	Raymond Mueller	333	2	Dr	1947
24bbd	Anton Skyberg	50	...	Dr	1943
24cdd	Hilman Skyberg	55	...	Dr	1938
24dcc	Ervin Koering	28	4	Dr	....
25abb	Test hole 1259	105	5	Dr	11-25-57
25dcc	Test hole 1258	147	5	Dr	11-21-57
25dcd1	Tellef Klemetson	55	2	Dr	1955
25dcd2	..do....	60	2	Dr	1956
26cca1	Manley Johnson	...	2	Dr	....
26cca2	..do....	70	...	Dr	....
35cad	Val Rohman	150 +	...	Dr	....
35cbc1	A. Dahlstrom	...	2	Dr	....
35cbc2	..do....	24.80	36	Dr	1956
35ccc1	James Kraby	200	...	Dr	1894
35ccc2	..do....	41	36	Dr	1956
35ccc3	..do....	Spring	...	..	....
35dab1	Donald R. Hanson	160	2	Dr	1897
35dab2	..do....	45	30	Dr	1954
35dcd	Raymond Hanson	360	...	Dr	1958
36aaa	Vic Kranley	50	4	Dr	1938

holes, and springs -- Continued

(7)	(8)	(9)	(10)	(11)	(12)
28	....	D,S	Sand	....	
28	....	S	..do..	....	
28	....	S	..do..	....	
Flow	....	D,S	..do..	....	
20	....	D,S	..do..	....	
20	....	D	..do..	....	
18	....	S	..do..	....	
....	11-27-57	T	......	937	See log.
....	11-21-57	T	......	933	..Do....
20	....	D,S	Sand	....	
20	....	N	..do..	....	
Flow	....	S	......	....	
20	....	D	......	....	
Flow	....	D,S	Sand	....	
Flow	....	S	..do..	....	
21.70	7-11-58	D	..do..	....	
Flow	....	S	..do..	....	
30	....	D	..do..	....	
Flow	3-28-59	...	..do..	....	Flows 10 gpm. See chemical analysis
Flow	....	D,S	..do..	....	
20	....	D,S	..do..	....	
Flow	....	D,S	..do..	....	
20	....	D,S	..do..	....	

TABLE 2.--Logs of test holes

145-50-5abb
Test hole 1194

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Clay, smooth, yellow	3	3
	Clay, sandy, brown	11	14
	Clay, light-gray, shell fragments; medium to coarse gravel (till?)	24	38
	Clay, gray; fine to medium gravel and and shale pebbles (till)	88	126
	Clay, light-gray, sandy	14	140
	Clay, light-gray; wood fragments, lignite pebbles	30	170
Cretaceous (?) rocks, undifferentiated:			
	Shale, gray	8	178

145-50-5abc
Test hole 1195

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Clay, smooth, light-brown	20	20
	Clay, smooth, light-gray	24	44
	Clay, gray; gravel, fine to medium shale pebbles (till)	118	162
	Clay, smooth, light-gray	13	175
	Clay, gray; gravel, fine to medium shale pebbles (till)	27	202

TABLE 2.--Logs of test holes -- Continued

145-50-6bcd
Test hole 1199

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay, smooth, light-brown	8	9
	Clay, smooth, light-gray	14	23
	Clay, smooth, gray	29	52
	Sand, fine, light-gray	23	75
	Clay, gray; gravel, fine to medium and and shale pebbles (till)	30	105

145-50-19ccc
Test hole 1257

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Sand, fine	15	16
	Clay, yellow, sandy	5	21
	Sand, fine	42	63
	Sand, fine, clayey	31	94
	Sand, fine to coarse; shale pebbles	58	152
	Gravel, fine to coarse	11	163
	Clay, brown; gravel, fine to medium and shale pebbles (till)	14	177

TABLE 2.--Logs of test holes -- Continued

145-51-1abb
Test hole 1198

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Sand, fine, dirty	10	11
	Sand, fine, clayey, yellow	10	21
	Sand, fine, light-brown; shale, fine pebbles	30	51
	Sand, fine to medium, light-gray; fine shale pebbles	44	95
	Clay, gray, with fine to medium gravel and shale pebbles (till)	20	115

145-51-1dda
Test hole 1261

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Clay, sandy, yellow	21	23
	Clay, gray, fine gravel and shale pebbles (till)	14	37
	Clay, sandy, gray	19	56
	Sand, fine to medium	18	74
	Clay, gray; fine to medium gravel and shale pebbles (till)	20	94

TABLE 2.--Logs of test holes -- Continued

145-51-1ddb
Test hole 1196

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Sand, fine, dirty	11	13
	Clay, sandy, yellow	7	20
	Sand, fine to medium; a few fine shale pebbles	69	89
	Sand, fine to coarse; fine and medium gravel and shale	21	110
	Gravel, fine to coarse; coarse sand and shale pebbles	10	120
	Clay, gray; fine to medium gravel and shale pebbles (till)	19	139

TABLE 2.--Logs of test holes -- Continued

145-51-13aaa3
Test hole 1255

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black-------------------------	2	2
	Sand, fine-----------------------------	10	12
	Sand, fine to medium, some shale pebbles	8	20
	Sand, fine-----------------------------	22	42
	Sand, fine; shale pebbles--------------	56	98
	Clay, gray; gravel, fine to medium, lignite and shale pebbles (till)------	61	159
	Clay, sandy, gray----------------------	19.5	178.5

145-51-24aaa2
Test hole 1256

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black, sandy------------------	1	1
	Clay, sandy, yellow--------------------	11	12
	Sand, fine-----------------------------	14	26
	Sand, fine, clayey---------------------	5	31
	Sand, fine-----------------------------	11	42
	Sand, fine to coarse; lignite pebbles---	40	82
	Clay, sandy, gray----------------------	13	95
	Clay, gray; gravel, fine to medium; lignite and shale pebbles (till)---------	61	156
	Clay, sandy, gray----------------------	22	178

TABLE 2.--Logs of test holes -- Continued

146-51-13cdd
Test hole 1260

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	3	3
	Clay, sandy, yellow	3	6
	Sand, fine to medium	45	51
	Sand, fine to coarse	44	95
	Clay, gray; gravel, fine to medium and shale pebbles (till)	20	115

146-51-25abb
Test hole 1259

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	1	1
	Clay, sandy, yellow	4	5
	Sand, fine to medium	17	22
	Sand, fine to coarse; shale pebbles	30	52
	Sand, fine to medium	33	85
	Gravel, fine to coarse	20	105

TABLE 2.--Logs of test holes -- Continued

146-51-25dcc
Test hole 1258

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Clay, smooth, yellow	30	32
	Sand, fine	21	53
	Sand, fine; clay, gray	30	83
	Clay, gray; gravel, fine to medium, shale pebbles (till)	58	141
	Clay, smooth, dark-gray	6	147

145-51-12aaa
Test hole 1197

Formation	Material	Thickness (feet)	Depth (feet)
Glacial drift:			
	Topsoil, black	2	2
	Clay, yellow; gravel, fine to medium	10	12
	Sand, fine, clayey, yellow	19	31
	Sand, fine to medium, brown	11	42
	Sand, fine to medium, light-brown	52	94
	Sand, fine to medium; gravel, fine to medium	5	99
	Clay, gray; gravel, fine to medium, shale pebbles (till)	58	157

TABLE 3.--Chemical

(Analytical results in parts

Location	Depth (feet)	Date and source of analysis	Temperature °F	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)
145-50												
6bac	254	7- 7-58 a/	..	....	.7	....	119	49	1,130	39	322	0
145-51												
1adc1	94	.... b/	..	31	3	0.3	97	37	194	....	384	..
1dab	115	3-28-59 c/	45	28	2.3	.38	131	45	175	8.2	354	0
24ccb	625	..do.. c/	44	7.7	.19	....	54	19	1,330	24	286	0
146-51												
35ccc3	Spring	..do.. c/	45	31	2.7	.16	123	42	26	8.0	602	0

a/ State Laboratories Department, Bismarck, N. Dak.
b/ Abbott, G. A., Voedisch, F. W., The municipal ground-water supplies of North Dakota: North Dakota Geol. Survey Bull. 11, p. 75, 1938.
c/ United States Geological Survey.
d/ Sum of determined constituents.

analyses of ground water

per million except as indicated)

Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (Residue on evaporation at 180°C)	Dissolved solids (Sum)	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Percent sodium	Specific conductance (micromhos per cm at 25°C)	pH
1,320	855	2.0	2.6	2.9	3,710 d/	.....	499	235	82	.....	...
194	.....	.4	40	....	921	.....	400	...	..	.....	...
382	155	.5	2.6	.45	1,150	1,100	514	224	42	1,670	7.2
1,310	1,090	3.2	.7	4.1	4,000	3,980	212	0	92	6,130	7.7
17	13	.1	14	.4	569	.....	478	0	10	931	7.0

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