GROUND WATER OCCURRENCE IN THE ALEXANDER AREA, MCKENZIE COUNTY, NORTH DAKOTA

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

NORTH DAKOTA GROUND WATER STUDIES

NO. 35

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

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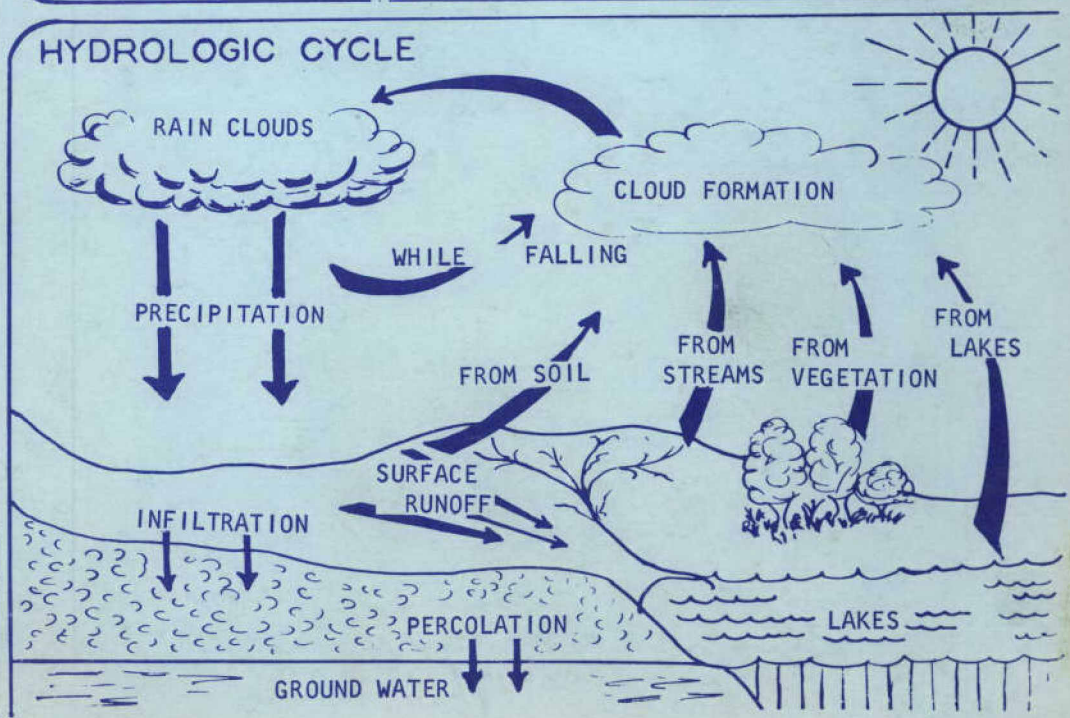

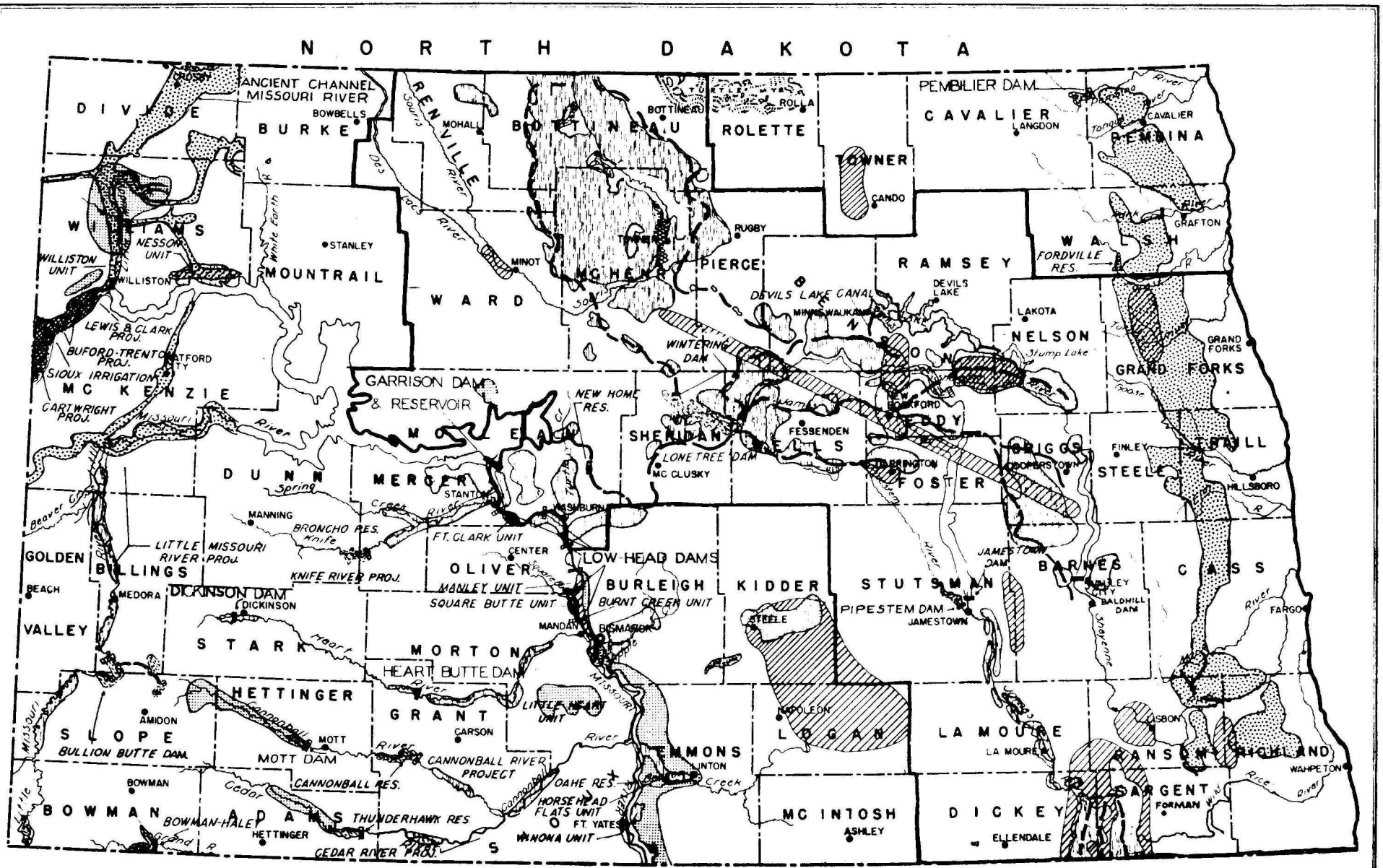

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GROUND WATER OCCURRENCE IN THE ALEXANDER AREA

McKENZIE COUNTY, NORTH DAKOTA

By
H. M. Jensen

Introduction

Communities throughout North Dakota are installing or enlarging water-supply systems. In areas where ground water is of limited quantity and poor quality, development of an adequate source may be costly. Alexander is one of the communities that has been and is now (1960) trying to expand its municipal water supply, and the conditions in the immediate vicinity of Alexander are not favorable for locating large supplies of good quality ground water.

In the summer of 1960 the village council of Alexander approached the North Dakota State Water Conservation Commission for help in locating additional water. As a result, a study of the geologic and hydrologic conditions in the area was carried out as part of the cooperative ground-water program of the North Dakota State Water Conservation Commission and the United States Geological Survey. The investigation included a partial well inventory (table 1), collection of chemical quality of water (table 2), and test drilling. Eighteen test holes were drilled for this investigation; the locations of test holes are listed in table 1. Descriptive logs of sediments penetrated in each hole are in table 3.

Location and Present Water Supply

The village of Alexander is in northwest McKenzie County, N. Dak. (fig. 1) in the Missouri Plateau physiographic province (Simpson, 1929, p. 10-11). The transportation facilities serving the community are an east-west branch line of the Great Northern Railroad and the north-south U.S. Highway 85. The population of the village as listed in the 1960 census is 269. The community is in a primarily agricultural and grazing area where the main products are wheat and cattle.

The village at the present time (1960) obtains its public water supply from a drilled well that yields approximately 17 gpm (gallons per minute). Private wells in the village are used by owners for supplemental supply and by residents not using the municipal water system. A spring that was developed before the village was incorporated is also used as a source of public supply; however, water from the spring, the flow of which ranges between about 6 and 10 gpm, is not stored but spills into the city park where it is lost by evapotranspiration and by infiltration into the ground.

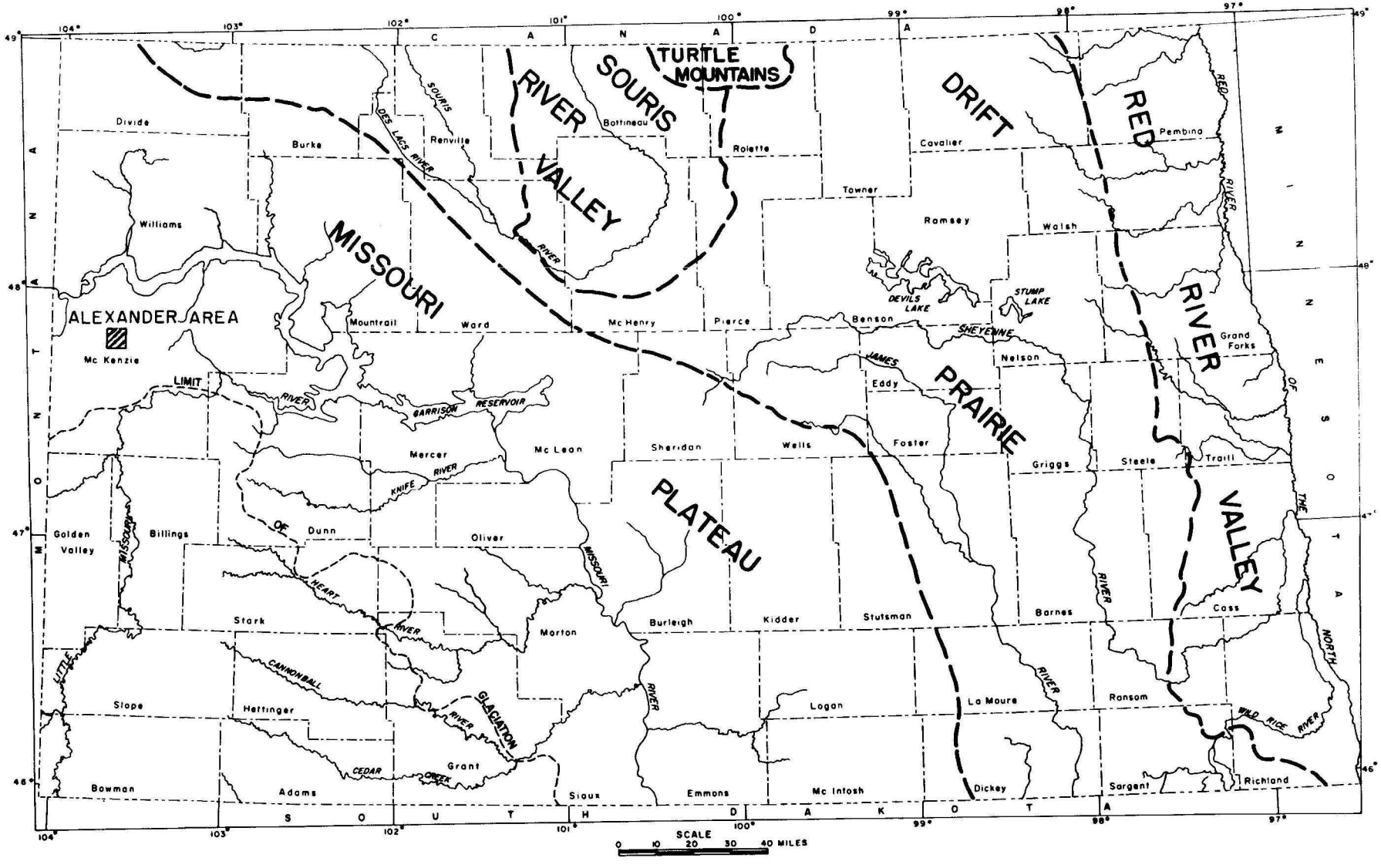

FIGURE 1--MAP SHOWING PHYSIOGRAPHIC PROVINCES IN NORTH DAKOTA (MODIFIED FROM SIMPSON, 1929) AND LOCATION OF THE ALEXANDER AREA

Well-numbering System

The well-numbering system used in this report, illustrated in figure 2, 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 is shown in a 10-acre tract. Thus, well 150-101-5bcc is in the $SW\frac{1}{4}SW\frac{1}{4}NW\frac{1}{4}$ sec. 5, T. 150 N., R. 101 W.

Geology and Ground-Water Conditions

The bedrock in the report area is the Tongue River member of the Fort Union formation of Paleocene age. It is exposed in the vicinity of Alexander in relatively steepsided hills having local relief of about 250 feet. The member consists of alternating and discontinuous layers of clay, silt, sand, shale, and lignite; the lignite beds are partly fractured. The layers range in thickness from less than a foot to several feet and because they generally are thin-bedded and discontinuous there is considerable variation in their lateral extent.

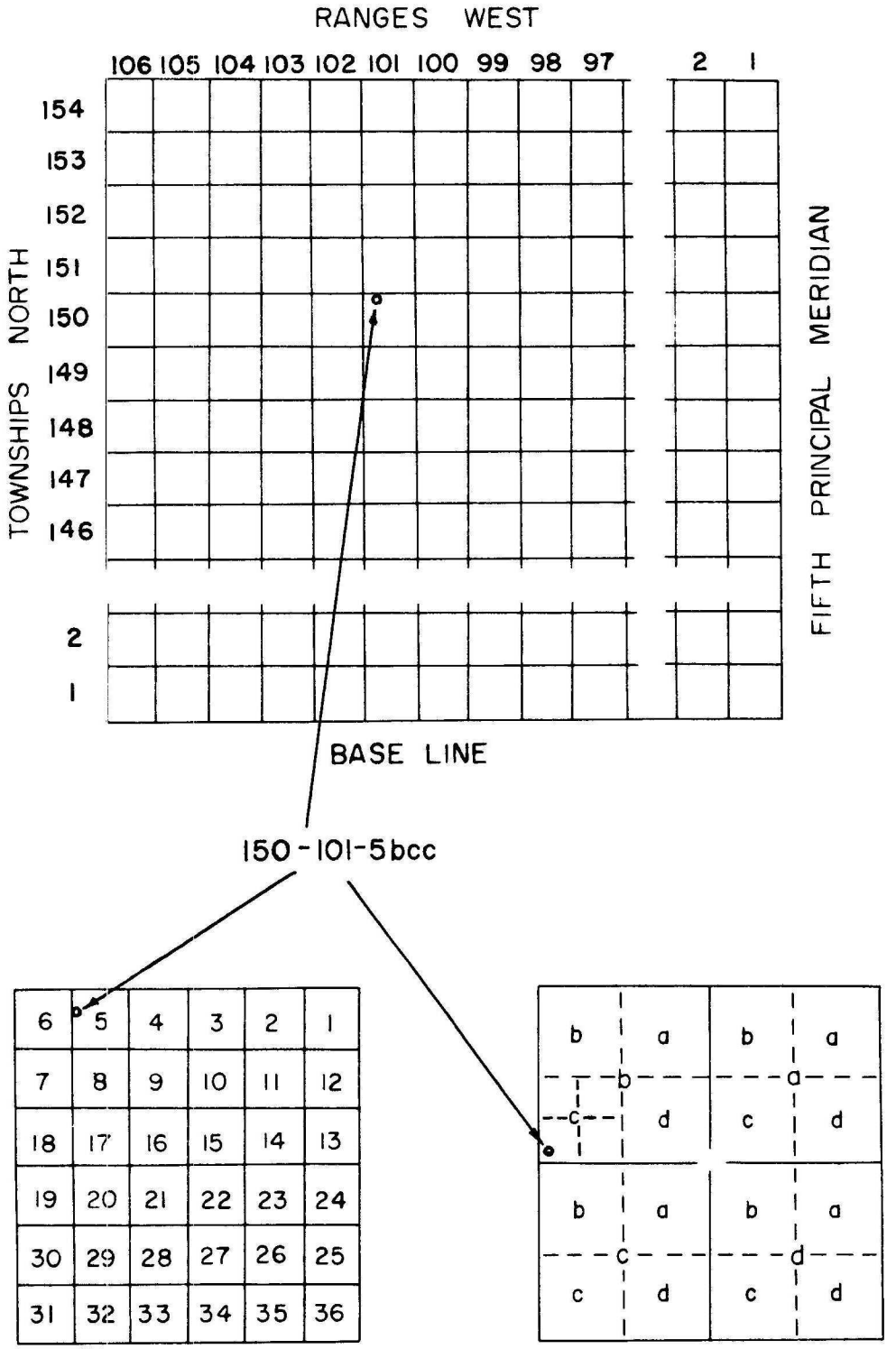

Figure 2 -- Sketch illustrating well-numbering system

Sand and lignite layers of the Tongue River member yield small to moderate quantities of ground water. Springs emanating from these layers discharge along exposed slopes of the bedrock in and near Alexander. Well owners in and near the village report a variety of depths to aquifers in the Fort Union formation; therefore, it is improbable that there is an extensive single producing zone. The test drilling in this investigation penetrated water-bearing sand and lignite layers ranging from less than 1 foot to 9 feet in thickness. Permeable material in the Tongue River member was penetrated in test hole 1833 (150-101-5bcc), but the hole had to be abandoned owing to loss of drilling fluid in the permeable layer. The village well now in use, the village spring, and an area of surface seepage are located a few rods downslope from test hole 1833. The spring and seepage area are points of natural discharge. Probably more than one permeable zone occurs in this locality and possibly the zones are interconnected through less permeable materials.

In much of the area surrounding Alexander a thin mantle of glacial drift covers the consolidated bedrock. The drift is not thick or extensive and, therefore, does not constitute a likely source for a municipal water supply.

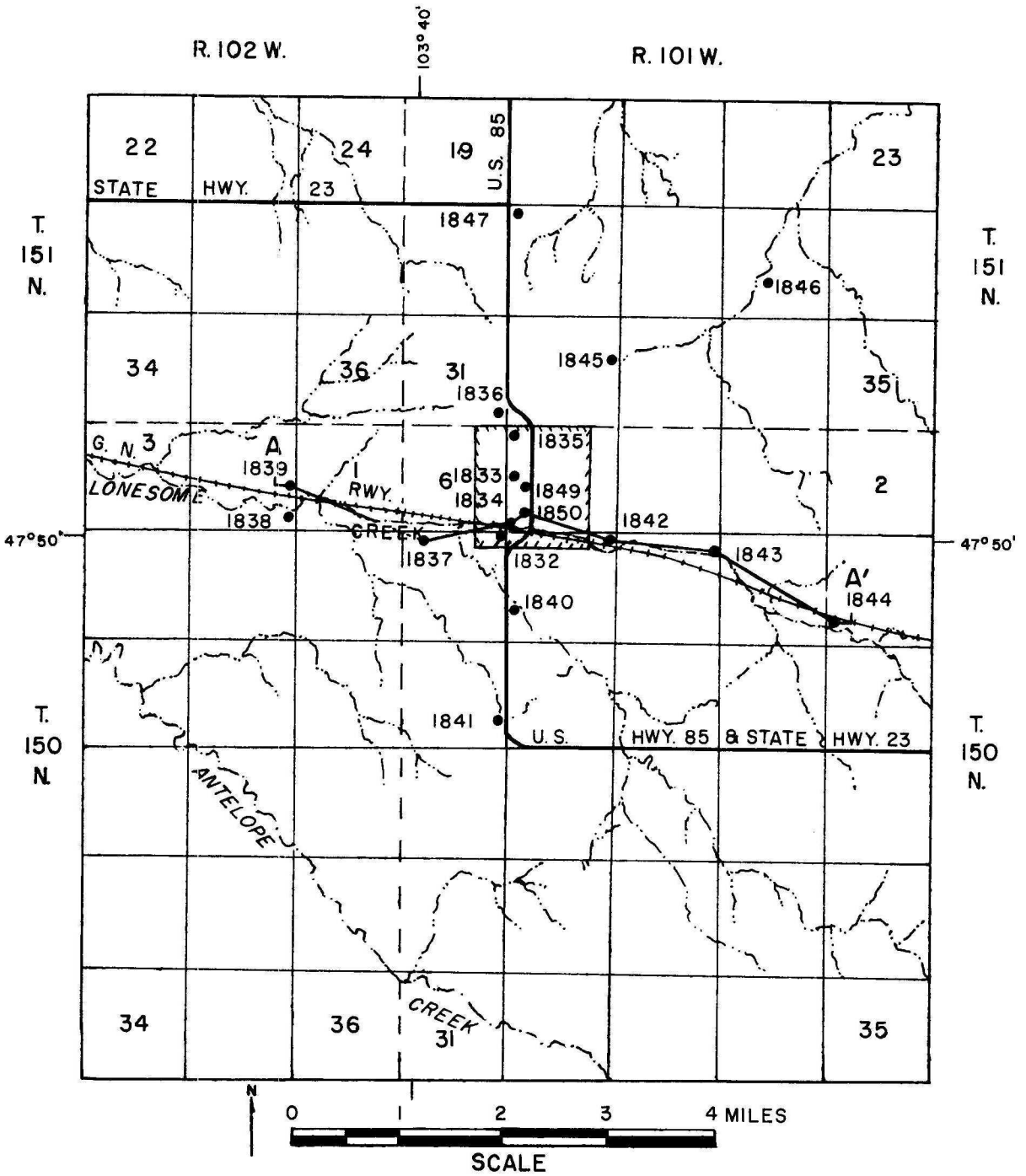

FIGURE 3-- MAP OF THE ALEXANDER AREA SHOWING THE LOCATIONS OF TEST HOLES.

Alluvium and colluvium partly fill the valleys of Lonesome Creek and its tributaries (fig. 3) and occupy the bottom parts of slopes adjacent to bedrock hills in the Alexander area. Lonesome Creek, which is an intermittent stream, is the major drainage course of the area south of Alexander. The alluvium and colluvium consist of unconsolidated clay, silt, sand, gravel, and bedrock fragments. The colluvium consists largely of bedrock particles derived locally from adjacent slopes. The alluvium, which has a more distant origin and may include glacial and some bedrock material, generally underlies the colluvium and occupies the central parts of the valleys close to the present-day stream beds.

Alluvial and colluvial deposits contain ground water of better quality and probably in larger quantities than the Fort Union formation. For this reason and because of the variety of depths to water-yielding zones in the bedrock, most of the test drilling in this investigation was done in the valley areas to locate alluvial and colluvial deposits. The proximity of test holes 1850 (150-101-5cca) and 1834 (150-101-5ccc) (fig. 4), containing clay, sand, and gravel layers, indicates a continuous aquifer in the creek valley at this location. About a mile west in test hole 1837 (150-101-7bba) a gravel layer at approximately the same depth as that in the previous two holes, shows that the same or a similar aquifer occurs in Lonesome Creek valley at other locations also.

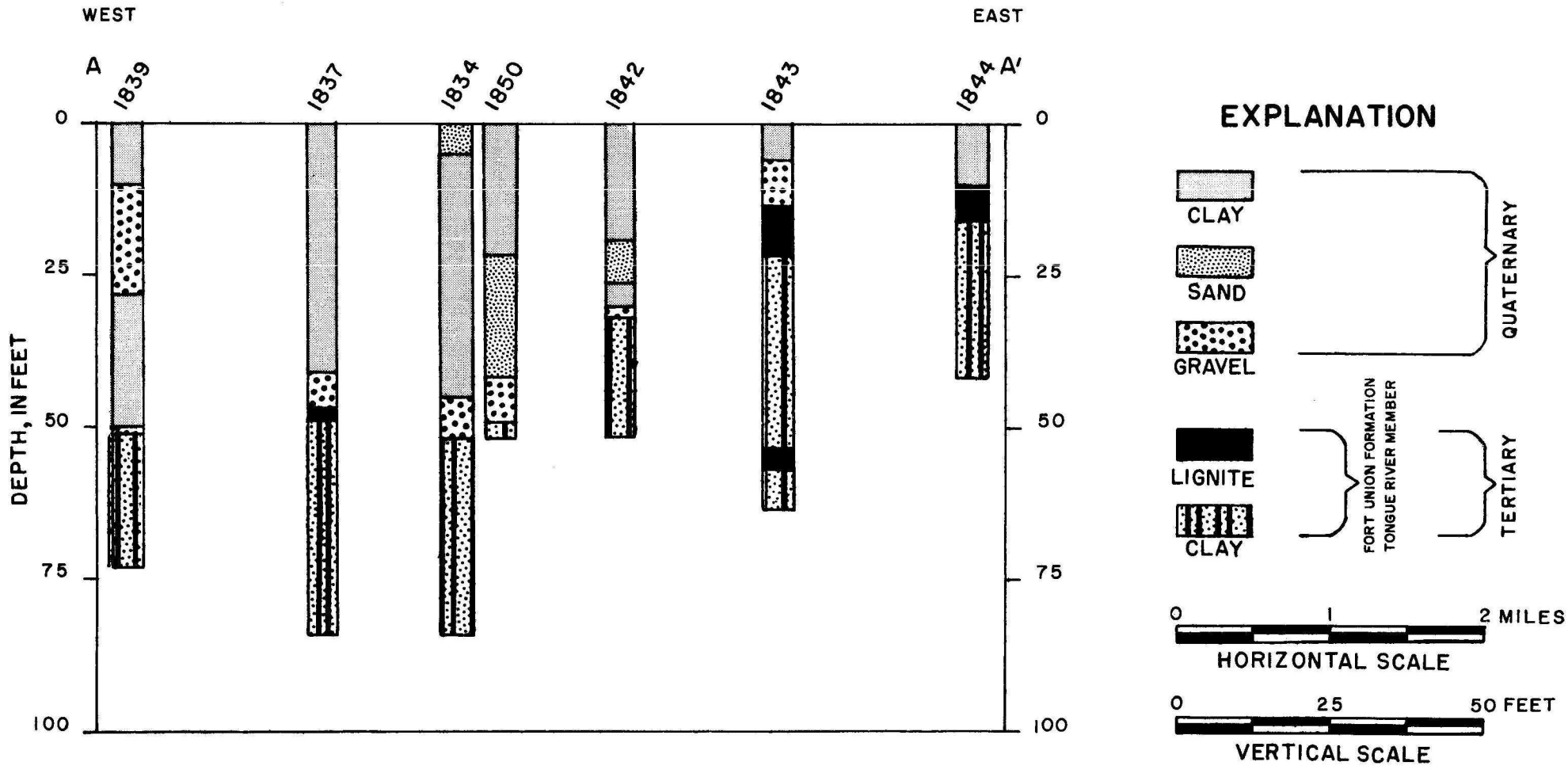

FIGURE 4--GRAPHIC LOGS OF SELECTED TEST HOLES IN THE ALEXANDER AREA ALONG LINE A-A'
(LOCATION OF TEST HOLES SHOWN ON FIGURE 3)

Quality of Water

Table 2 shows the mineral content of water from the Tongue River member and water from alluvium and colluvium. The analysis of water from city well 5 show that the water is unsuitable for municipal use according to the U.S. Public Health Service Standards (Welsh and Thomas, 1960, p. 289-299). In general, water obtained from the Fort Union formation is highly mineralized but is comparatively soft, that is, low in calcium and magnesium content which impart the property of hardness. According to reports by well owners in the area, some wells yield water that is unfit for domestic use but suitable for livestock.

The analysis of a water sample from test hole 1840 (150-101-8cbc) (table 2), showed the water to be of relatively good quality for this area, although the iron content is higher than the limit recommended by the U.S. Public Health Service (1946, p. 371-384). This sample was obtained from a hole penetrating colluvial and alluvial material about 1 mile south of Alexander in a valley tributary to Lonesome Creek. The chemical quality of water in the colluvium and alluvium in Lonesone Creek valley is probably similar.

Inasmuch as ground water moves readily through fractures in lignite layers and along the tops of clay layers overlain by permeable sand, shallow water-yielding zones in the Fort Union formation may be easily contaminated. Closely-spaced private sewage-disposal systems in the village may emit fluids that could spread pollution in the underlying bedrock aquifers in and downslope from the town.

Conclusions and Recommendations

The investigation shows that two general sources of ground water are available in the Alexander area. First are the alluvial and colluvial deposits containing saturated sand and gravel layers in the valleys of Lonesome Creek and its tributaries. These deposits would probably yield water of better quality and perhaps in larger quantity than the consolidated rocks; however, additional testing should be carried out to find a location where the aquifer will yield a dependable supply.

The second source of ground water is water-yielding sand and lignite layers of the Tongue River member of the Fort Union formation. The investigation shows that the layers are thin-bedded and discontinuous, precluding the existence of an extensive single producing zone. The development of a community supply immediately west of the village should be fully investigated. The village spring and an area of surface seepage define points of natural discharge. This discharge and ground water from deeper permeable zones offer a supply that is not yet fully developed.

If water from the bedrock formation underlying Alexander and (or) the alluvial and colluvial deposits is developed further as a source for public supply, care should be taken to select locations that will not be subject to bacterial contamination from a local concentration of privately-owned sewage-disposal units.

TABLE 1.--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 (inches)	Type	Date completed
150-101					
5bbb	Test hole 1835	63	5	Dr	1960
5bcc1	Test hole 1833	42	5	Dr	1960
5bcc2	City well 4	1,570	6	Dr	1958
5bcc3	City well 2	121	8	Dr	1948
5bcc4	City well 3	50	8	Dr	1957
5bcc5	City well 1	45	8	Dr	....
5caa	City well 5	152	6	Dr	1960
5cba1	Test hole 1849	65	5	Dr	1960
5cba2	Harvey Munson	41	...	Dr	1915
5cca	Test hole 1850	52	5	Dr	1960
5ccc	Test hole 1834	84	5	Dr	1960
5dcc	Hubert Bartram	11	7	Du	1951
7aaa	Test hole 1832	63	5	Dr	1960
7bba	Test hole 1837	84	5	Dr	1960
8aaa	Test hole 1842	52	5	Dr	1960
8bbb	Unknown	36.5	6	Dr	1910
8cbc	Test hole 1840	63	5	Dr	1960
9aad	Test hole 1843	63	5	Dr	1960
11ccb	Test hole 1844	42	5	Dr	1960
18cda	Glen Helling	160	4	Dr	1926
18dad	Test hole 1841	32	5	Dr	1960

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	Remarks
.....	.....	T	.....	See log.
.....	.....	T	.....	..Do....
192	1958	N	Sand	Sealed.
.....	.....	PS	..do..	
32	1957	N	Lignite	Plugged.
.....	.....	N	Sand and lignite	..Do....
86.45	9-27-60	N	Sand	See chemical analysis.
.....	.....	T	.....	See log.
33.25	9-27-60	D	Lignite	
.....	.....	T	.....	..Do....
.....	.....	T	.....	..Do....
.....	10-10-60	D	Sand	
.....	.....	T	.....	See log.
.....	.....	T	.....	..Do....
.....	.....	T	.....	..Do....
10.10	9-27-60	N	Sand and gravel	
.....	.....	T	..do..	See log; chemical analysis.
.....	.....	T	.....	See log.
.....	.....	T	.....	..Do....
.....	.....	D	Sand	
.....	.....	T	.....	..Do....

TABLE 1.--Records of Wells

Location No.	Owner or name	Depth of well (feet)	Diameter or size (inches)	Type	Date completed
150-102					
2dad	Test hole 1839	73	5	Dr	1960
2dda	Test hole 1838	105	5	Dr	1960
3acd	James Marchek	20	48	Du	1951
151-101					
27cad	Test hole 1846	63	5	Dr	1960
29bbb	Test hole 1847	42	5	Dr	1960
31ddd	Test hole 1836	63	5	Dr	1960
32add	Test hole 1845	105	5	Dr	1960
32dda	Gunder Skedsvold	98	5	Dr	1945

And Test Holes -- Continued

Depth to water below land surface (feet)	Date of measurement	Use of water	Aquifer	Remarks
.....	.....	T	.....	See log.
.....	.....	T	.....	..Do....
.....	10-10-60	D	Sand and gravel	
.....	.....	T	.....	..Do....
.....	.....	T	.....	..Do....
.....	.....	T	.....	..Do....
.....	.....	T	.....	..Do....
70	1945	D,S	Sand and lignite	

TABLE 2.--Chemical

Results in parts per million except as indicated

Location No.	Owner or name	Aquifer	Depth of well (feet)	Date of collection	Iron (Fe)	Calcium (Ca)
150-101						
5caa	City of Alexander 5	Sand	152	6-60	1.2	6.4
8cbc	Test hole 1840	Sand and gravel	63	10-60	2.6	64

a/Includes bicarbonate (HCO_3) as carbonate (CO_3)

Analyses of Ground Water

Analyses by State Laboratories, Bismarck

Magnesium (Mg)	Sodium (Na)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Harness as $CaCO_3$ (calcium, magnesium)	Dissolved solids residue at 180°C	Calculated from determined constituents	pH
2.9	575	1,010 a/	485	5.0	28	2,090	1,570	---
27	77	336 a/	161	...	270	556	498	8.0

TABLE 3.--Logs of Test Holes

150-101-5bbb
Test hole 1835

Unit	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, black.....	1	1
	Sand, fine, brown.....	4	5
	Clay, sandy, granular, brown.....	7	12
Fort Union formation:			
Tongue River member:			
	Clay, smooth, gray.....	3	15
	Clay, sandy, greenish-gray.....	7	22
	Clay, smooth, gray; with thin lignite beds	4	26
	Clay, sandy, gray; with thin lignite beds..	6	32
	Clay, smooth and sandy, gray; with thin lignite beds.....	31	63

Note: The unit designated alluvium and colluvium in the following tables may include glacial material and bedrock that may be only slightly reworked.

TABLE 3.--Logs of Test Holes -- Continued

150-101-5bcc
Test hole 1833

Unit	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, black.....	2	2
Fort Union formation:			
Tongue River member:			
	Clay, sandy, yellow.....	10	12
	Clay, smooth, yellow.....	4	16
	Clay, sandy, gray.....	7	23
	Lignite, black.....	6	29
	Clay, smooth, gray.....	13	42
	(Lost circulation at 42 feet. Hole abandoned.)		

150-101-5cba
Test hole 1849

Alluvium and colluvium:			
	Topsoil.....	2	2
	Clay, sandy, yellow.....	3	5
Fort Union formation:			
Tongue River member:			
	Clay, silty, smooth, yellow.....	10	15
	Clay, smooth, gray.....	13	28
	Lignite, black.....	2	30
	Clay, smooth, gray; with thin lignite beds	32	62
	Lignite, black.....	1	63
	Clay, smooth, gray.....	2	65

TABLE 3.--Logs of Test Holes -- Continued

150-101-5cca
Test hole 1850

Unit	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, clayey, grayish-black.....	2	2
	Clay, sandy, yellow.....	8	10
	Clay, sandy, gravelly.....	12	22
	Sand, fine; with interbedded gray clay and lignite fragments.....	10	32
	Sand, fine; with interbedded gray clay and gravel; lignite fragments.....	10	42
	Gravel, medium to coarse, iron stained; with interbedded gray clay.....	7	49
Fort Union formation:			
Tongue River member:			
	Clay, smooth, slightly sandy, gray.....	3	52

150-101-5ccc
Test hole 1834

Alluvium and colluvium:			
	Topsoil, black.....	2	2
	Sand, silty, fine, brown.....	3	5
	Clay, sandy, yellow; lignite fragments....	20	25
	Clay, sandy, granular, gray.....	20	45
	Gravel, medium to coarse, brown; numerous lignite fragments.....	7	52
Fort Union formation:			
Tongue River member:			
	Clay, sandy, gray; lignite fragments.....	24	76
	Clay, smooth to sandy, gray.....	8	84

TABLE 3.--Logs of Test Holes -- Continued

150-101-7aaa
Test hole 1832

Unit	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil.....	1	1
	Clay, sandy, gravelly, gray; with lignite fragments.....	16	17
Fort Union formation:			
Tongue River member:			
	Clay, sandy, smooth, gray.....	3	20
	Lignite, black.....	2	22
	Clay, sandy, gray; with interbedded lignite beds.....	38	60
	Clay, sandy, light-gray.....	3	63

150-101-7bba
Test hole 1837

Alluvium and colluvium:			
	Topsoil, black.....	1	1
	Clay, sandy, brown.....	9	10
	Clay, sandy, granular, gray; with lignite fragments.....	31	41
	Gravel, coarse, iron-stained, brown; with fine sand and lignite fragments.....	6	47
Fort Union formation:			
Tongue River member:			
	Lignite, black.....	2	49
	Clay, sandy, gray and olive-gray.....	16	65
	Clay, smooth, gray; with lignite fragments	19	84

TABLE 3.--Logs of Test Holes -- Continued

150-101-8aaa
Test hole 1842

Unit	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, very granular.....	1	1
	Clay, sandy, brown.....	5	6
	Clay, silty, yellow; with lignite fragments	13	19
	Sand, fine.....	7	26
	Clay, sandy, gray.....	4	30
	Gravel, coarse; with lignite fragments....	2	32
Fort Union formation:			
Tongue River member:			
	Clay, sandy, gray; with thin lignite beds.	20	52

150-101-8cbc
Test hole 1840

Alluvium and colluvium:			
	Topsoil, black.....	1	1
	Clay, sandy, brown.....	4	5
	Clay, sandy, granular, brown; with lignite fragments.....	10	15
	Sand, medium to coarse; interbedded gray clay and some fine gravel.....	15	30
Fort Union formation:			
Tongue River member:			
	Clay, smooth, gray.....	10	40
	Lignite, black.....	3	43
	Clay, smooth, gray; with thin lignite beds	20	63

TABLE 3.--Logs of Test Holes -- Continued

150-101-9aad
Test hole 1843

Unit	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Clay, silty, light-gray.....	6	6
	Gravel, coarse, clayey and sandy.....	7	13
Fort Union formation:			
Tongue River member:			
	Lignite, black; with interbedded gray clay beds.....	9	22
	Clay, smooth, greenish-gray; with lignite fragments.....	5	27
	Clay, smooth, gray.....	26	53
	Lignite, black.....	4	57
	Clay, smooth, gray.....	6	63

150-101-11ccb
Test hole 1844

Alluvium and colluvium:			
	Topsoil, black.....	1	1
	Clay, sandy, granular, yellow.....	9	10
Fort Union formation:			
Tongue River member:			
	Lignite, black.....	6	16
	Clay, sandy, greenish-gray; with thin lignite beds.....	19	35
	Clay, smooth, gray.....	7	42

TABLE 3.--Logs of Test Holes -- Continued

150-101-18dad
Test hole 1841

Unit	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, black.....	2	2
	Clay, sandy, yellow.....	4	6
	Clay, sandy, granular, yellow.....	16	22
Fort Union formation:			
Tongue River member:			
	Clay, smooth, yellowish-gray.....	4	26
	Clay, smooth, gray.....	6	32
	Clay, sandy, gray; with thin lignite beds.	10	42

150-102-2dad
Test hole 1839

Alluvium and colluvium:			
	Topsoil, black.....	1	1
	Clay, silty, yellow.....	4	5
	Clay, granular, yellow.....	5	10
	Gravel, medium; with interbedded gray clay beds.....	10	20
	Gravel, coarse; with much fine sand.....	8	28
	Clay, granular, gray; with thin lignite beds	22	50
	Gravel, coarse.....	1	51
Fort Union formation:			
Tongue River member:			
	Clay, smooth and sandy, gray; with thin lignite beds.....	22	73

TABLE 3.--Logs of Test Holes -- Continued

150-102-2dda
Test hole 1838

Unit	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, black	1	1
	Clay, silty, yellow	5	6
	Gravel, medium	1	7
	Clay, granular, yellow	3	10
	Sand, fine to medium, clayey; with thin beds of lignite fragments	30	40
Fort Union formation:			
Tongue River member:			
	Clay, smooth, gray; with lignite fragments	20	60
	Clay, smooth and sandy, gray; with thin lignite beds	25	85
	Clay, smooth, gray; with thin lignite beds	20	105

151-101-27cad
Test hole 1846

Alluvium and colluvium:			
	Clay, sandy, yellow	5	5
	Clay, sandy, gravelly, gray	5	10
Fort Union formation:			
Tongue River member:			
	Clay, sandy, gray; with lignite fragments.	15	25
	Clay, smooth, gray; with thin lignite beds	15	40
	Clay, sandy, gray	12	52
	Lignite, black	3	55
	Clay, sandy, greenish-gray; with lignite fragments	8	63

151-101-29bbb
Test hole 1847

Alluvium and colluvium:			
	Topsoil, black	2	2
Fort Union formation:			
Tongue River member:			
	Clay, sandy, yellow	8	10
	Clay, smooth, gray	15	25
	Lignite, black	3	28
	Clay, smooth, yellowish-gray; with thin lignite beds	14	42

TABLE 3.--Logs of Test Holes -- Continued

151-101-31ddd
Test hole 1836

Unit	Material	Thickness (feet)	Depth (feet)
Alluvium and colluvium:			
	Topsoil, brown.....	2	2
	Sand, fine, brown.....	3	5
	Clay, sandy, granular, yellow.....	6	11
	Sand, fine, yellow, brown.....	4	15
	Clay, granular, yellow.....	7	22
Fort Union formation:			
Tongue River member:			
	Clay, sandy, grayish-yellow.....	6	28
	Clay, smooth, gray.....	4	32
	Lignite black.....	4	36
	Clay, smooth, gray.....	19	55
	Clay, smooth and sandy, gray; with thin lignite beds.....	8	63

151-101-32add
Test hole 1845

Alluvium and colluvium:			
	Topsoil, black.....	2	2
	Clay, sandy, brown.....	8	10
	Clay, sandy, granular,yellow.....	40	50
Fort Union formation:			
Tongue River member:			
	Clay, smooth, gray.....	8	58
	Lignite, black; with interbedded, smooth, gray, clay.....	5	63
	Clay, sandy, greenish-gray; with lignite fragments.....	22	85
	Clay, sandy, gray; with thin lignite beds.	20	105

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