STATE OF SOUTH DAKOTA
Ralph Herseth, Governor

STATE GEOLOGICAL SURVEY
Allen F. Agnew, State Geologist

SPECIAL REPORT 10

SHALLOW WATER SUPPLY FOR THE CITY OF PARKER, SOUTH DAKOTA

by
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UNION BUILDING
UNIVERSITY OF SOUTH DAKOTA
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CONTENTS

ILLUSTRATIONS

TABLE

APPENDIX

SHALLOW WATER SUPPLY FOR THE CITY OF PARKER, SOUTH DAKOTA

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INTRODUCTION

Present Investigation

This report contains the results of a special investigation by the South Dakota State Geological Survey during the summer of 1960 in and around the city of Parker (fig. 1), Turner County, South Dakota, for the purpose of helping the city to locate future water supplies. The city now receives its water from three wells which in the past few years have not produced the quantity of water needed by the city. The three wells produce from the Sioux quartzite and are located within the city limits (fig. 2).

A survey of the ground water possibilities was made of a 12 square-mile area around the city, and consisted of geologic mapping, a well inventory, the drilling of 48 test holes, and the taking of water samples for analysis.

The field work and preparation of this report were performed under the supervision of Dr. Allen F. Agnew, State Geologist, and with the assistance of Cleo Christensen, LaMonte Sorensen, Jerry Schweigert, and Mark McDermott. The cooperation of the residents of Parker, especially Mayor L. K. Stoddard, City Auditor F. R. Cotton, and the employees of the City Street Department, was greatly appreciated.

Location and Extent of Area

The city of Parker is located in Turner County in east-central South Dakota, and has a population of approximately 1100. The area is in the James Basin of the Central Lowlands physiographic province (fig. 3).

Climate

The climate is typically continental temperate, with large daily and seasonal fluctuations.

The average yearly temperature is 47.7 °F and the average annual precipitation is 23.5 inches at the U. S. Weather Bureau Station in Marion, 7 miles northwest of Parker.

Topography and Drainage

The topography of the area is typically youthful glacial moraine--rolling hills and valleys with numerous knobs and kettles. The area is drained to the south by the West Fork of the Vermillion River and its tributaries.

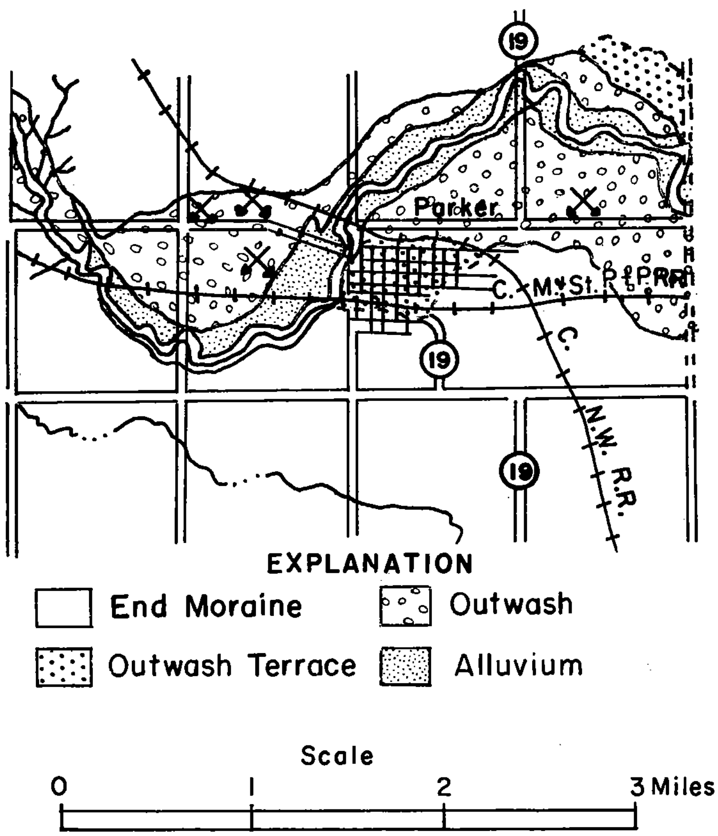


Figure 1. Geologic map of Parker and vicinity.

by

M. J. Tipton

1960

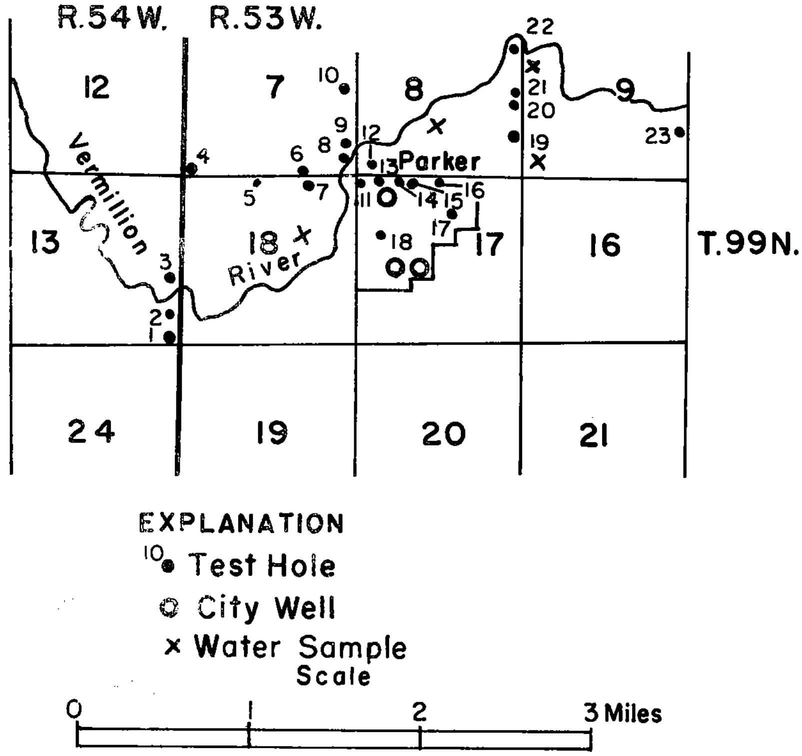
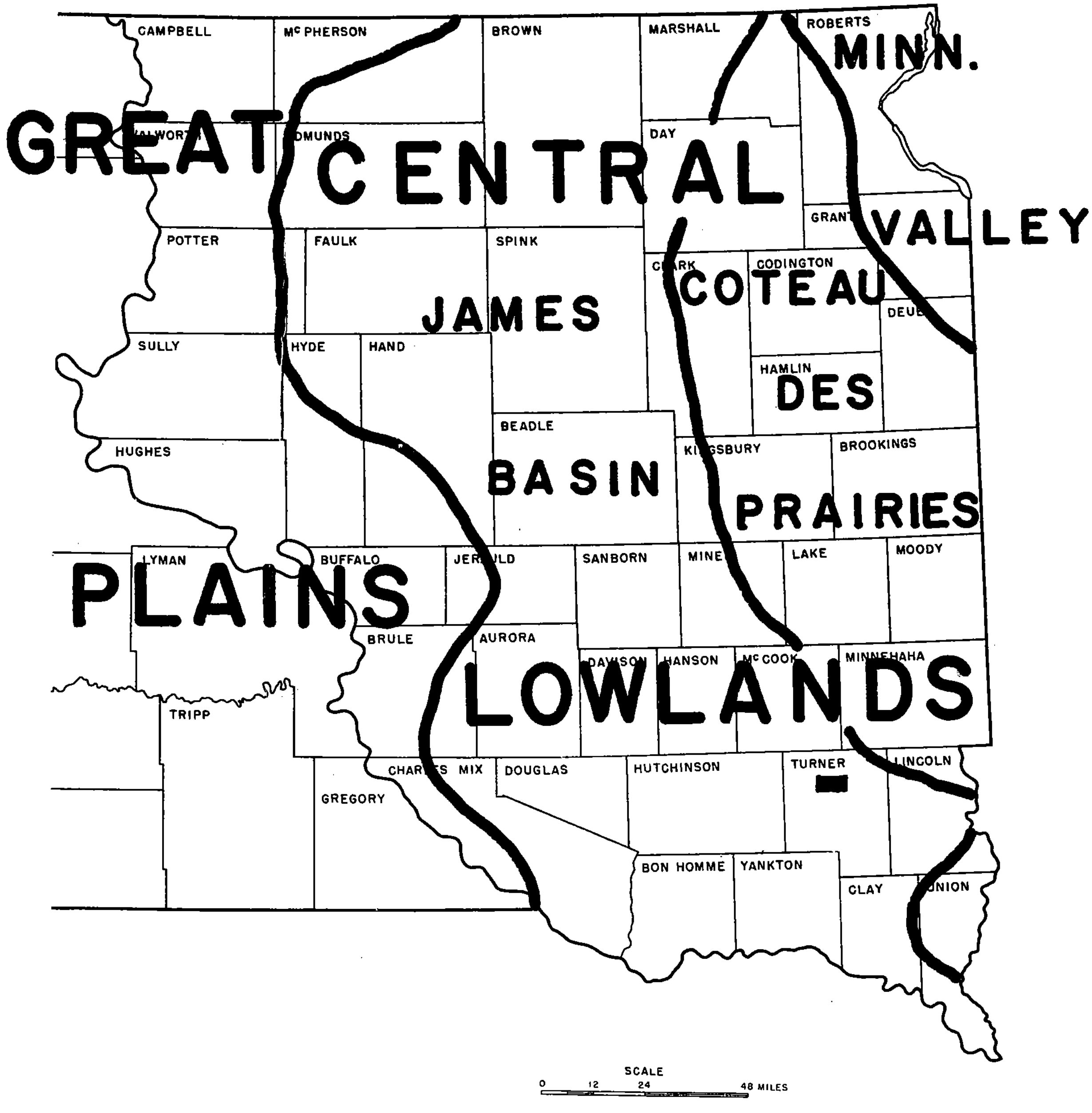


Figure 2. Data map of Parker and vicinity.

FIG. 3 MAJOR PHYSIOGRAPHIC DIVISIONS OF EASTERN SOUTH DAKOTA



▬ PARKER AREA

GENERAL GEOLOGY

Surficial Deposits

The surficial deposits of the Parker area are mostly the result of glaciation late in the Pleistocene Epoch. The glacial deposits are collectively called drift, and can be divided into till and outwash deposits. Till consists of clay and silt randomly mixed with boulders, pebbles and sand; all were carried and deposited by the ice itself. Till usually does not yield water readily because of the unsorted nature of the materials. The outwash material was deposited by meltwater streams from the ice and is better sorted, consisting mostly of pebbles and sand with minor amounts of silt and a few boulders. Outwash is usually a good water-yielding material.

Alluvial material has been deposited by streams along the West Fork of the Vermillion River since the retreat of glaciers from this area (fig. 1). This alluvium consists of silt, clay, and small amounts of sand and gravel; it does not normally yield water readily because of the large amount of fine material which makes up these deposits.

Bedrock

The Precambrian Sioux Formation crops out a few miles east of Parker, and is generally close to the surface beneath the entire area studied. The Sioux Formation is a pink to purple, very hard, quartzitic sandstone, locally called "granite" or "Sioux Falls Granite".

The Cretaceous Niobrara and Carlile Formations may overlie the Sioux Formation in some parts of the area studied. The Niobrara Formation consists of a light-gray to blue-gray marl and chalk, and the Carlile Formation consists of a medium to dark-gray bentonitic shale.

OCCURRENCE OF GROUND WATER

Principles of Occurrence

Despite the common belief that ground water is found only in veins which crisscross the country in a disconnected maze, it can be shown that water occurs almost everywhere in the ground, at a depth below the surface which varies from a few feet to several tens or, in some cases, even hundreds of feet. The top of this zone of water-saturation is known as the water table, and in the Parker area it is generally between 3 and 150 feet below the surface.

The type of deposit which contains the water governs the amount of water which can be withdrawn from the deposit and, in part, how rapidly it can be recharged. For instance, a sand and gravel (such as that found in the outwash channel along the West Fork of the Vermillion River) will yield more water to a well than till, shale, or quartzite because of the size of the particles which make up the deposit, and the lack of cement. For this reason, the object in trying to locate a good shallow water supply is not to find a vein but rather, because water occurs almost everywhere, to find a sand or gravel beneath the water table. Therefore, the main efforts of this survey were directed toward finding the best deposits of water-saturated sand and gravel in the Parker area.

Nearly all ground water is derived from precipitation. Rain or melting snow either percolates directly downward to the water table, becoming ground water, or drains off as surface water. Surface water either evaporates, escapes to the ocean by streams, or percolates downward to the ground water table. In general, ground water moves laterally down the hydraulic gradient, and is said to be in transient storage.

Recharge is the addition of water to an aquifer (water-bearing material), and is accomplished in three ways:

1. Direct precipitation of rain or snow on the ground surface.
2. Downward percolation from surface bodies of water.
3. Lateral underflow or water in transient storage.

Discharge or the removal of ground water is accomplished in four main ways:

1. Evaporation and transpiration by plants.
2. Seepage upward or laterally into surface bodies of water as by springs.
3. Lateral underflow of water in transient storage.
4. Pumping of water.

The volume of water capable of being stored in a saturated material is equal to the volume of voids or pore space of the material. A measurement of the capability of a material to store water is called porosity. Therefore porosity is the ratio of volume of voids in the material to the rock volume. The shape and arrangement of grains in a material affects the porosity greatly, but size of the grains has no effect. Therefore a container filled with sand and one filled with gravel, if the sand and gravel have the same shape and packing, would hold the same quantity of water. Sands and gravels usually have porosities that range from 20 to 40 percent. Sandstones normally have porosities of 15 to 25 percent; the lower porosity is due to closer packing and cementation.

The rate at which water will drain or pass through a material is a function of the permeability of the substance. Water will pass through a material with interconnected pores, but will not pass through a material with unconnected pores even if the latter material has a higher porosity. Therefore, permeability and porosity are not synonymous terms. As an example, till has high porosity but will yield little water because it has low permeability.

The ratio of the volume of water that will drain from a material by gravity, to the volume of the material, is called specific yield. Values for specific yields vary from zero for plastic clays to nearly the total value of the porosity for coarse sands and gravels.

Ground Water in Glacial Deposits

Outwash deposits occur as valley train and as terraces along the West Fork of the Vermillion River (fig. 1). The terrace outwash deposits occur about 10 feet above the valley train deposits, and consequently contain only small amounts of water, because any water which enters these terraces percolates downward into and recharges the valley train deposits. Therefore, the valley train deposits in this area form a better ground water aquifer than the terrace deposits.

The valley train deposits in the area mapped for this study average about 29 feet thick, the lower 16 feet being water-saturated. The thickest part of the outwash is approximately a mile northeast of Parker in the northeast quarter of Section 8, T. 99 N., R. 53 W., where it is about 54 feet thick with about 48 feet being water-saturated as shown in test hole 22 (Appendix A).

The surface of the valley train deposits slopes downward from west to east at a rate of 8 to 10 feet per mile, as does the surface of the water table. This means that the water is moving down the hydraulic gradient in the aquifer in the same direction as the flow of the river; however, it probably does not move more than a foot or two per day.

Test holes 14 and 15 (see Appendix) located in the north-central part of the city just inside the city limits (see data map), also show thick deposits of sand and gravel. However, test holes 11, 12, 13, 16 and 17 do not show thick deposits, which may mean that this thickening is local. If this is the case, it would mean a well located in this locally thickened deposit would not have the large recharge as normally expected and could possibly be pumped dry.

In the fall of 1954 the South Dakota Geological Survey located an observation well in the SW¼NW¼ sec. 9, T. 99 N., R. 53 W. which is across the road and about 50 yards south of test hole 22. The water level in this observation well in October of 1954 was 12.5 feet below the ground surface, in October of 1957 it was 12.7 feet below the surface, in April of 1959 it was 9.6 feet below the surface, and in April of 1960 it was 10.3 feet below the surface. These readings show a high and fairly stable water table in this area with a normal spring and fall fluctuation.

Ground Water in Alluvium

Alluvium is present above the valley train deposits in the Vermillion River Valley (fig. 1). The alluvial materials were deposited by the Recent streams and consist of clay and silt with minor amounts of sand and gravel. The alluvium holds large quantities of water, but yields water very slowly because of the low permeability of the silts and clays.

Ground Water in the Sioux Formation

The Sioux quartzite will yield moderate amounts of water from fractures and fissures in the rock. The three present city wells obtain water from this source, and until the past few years these wells have provided an adequate supply of water to the city. The quality of the water is generally poor (table 1).

Quality of Ground Water

Precipitated water is nearly pure before it reaches the ground. However, all ground water contains minerals which are obtained (1)

Table 1.--Chemical Analyses of Water Samples in Parker Area*

Sample	Parts per Million										Hardness	Total Solids
	Ca	Na	Mg	Cl	SO_4	Fe	Mn	N	F	pH	$CaCO_3$	
A	---	--	50 **	250 **	250 **	0.3 **	0.1 **	10 **	1.0 **	--	---	500 to 1000 **
B	150	95	46	21	436	1.1	0.2	0.0	1.0	7.3	564	1099
C	144	98	45	20	420	2.6	0.1	0.3	1.0	7.3	549	998
D	199	164	14	13	722	1.6	0.0	0.8	1.2	--	553	1420
E	97	33	52	3	228	0.8	0.0	8.7	0.0	--	458	758
F	278	68	93	5	897	6.4	1.4	0.2	0.9	7.5	1092	1686
G	122	30	48	12	304	0.0	0.0	15.6	0.2	--	501	826
H	132	65	69	60	332	0.0	0.0	23.5	0.2	--	612	1192
I	116	13	43	17	295	0.0	0.0	0.5	0.0	--	466	730

A. U. S. Dept. of Public Health Drinking Water Standards (1960)
B. City Well #1
C. City Well #2
D. City Well #3
E. State Geological Survey Observation Well; NW¼ sec. 9, T. 99 N., R. 53 W. (collected by M. J. Tipton)
F. From same well as sample E (collected by City)
G. Alvin Smith farm; SW¼ sec. 9, T. 99 N., R. 53 W.
H. Larry Van Emmerick farm; Center sec. 8, T. 99 N., R. 53 W.
I. Russell Willardsen farm; Center sec. 18, T. 99 N., R. 53 W.

* Sample B, C, and F analyzed by the State Department of Health in Pierre; other samples analyzed by State Chemical Laboratory in Vermillion, 1960

** not to exceed

from the atmosphere as the water vapor condenses and falls, (2) from soil and underlying deposits as the water moves downward to the water table, and (3) from deposits below the water table, in which the water is circulating. In general, the more minerals that a water contains, the poorer its quality.

Of the water analyses in Table 1, samples E and I show the best chemical quality. Sample E is taken from the State Geological Survey observation well northeast of Parker and sample I is from a well on the Russell Willardsen farm west of Parker. Sample E is high in iron content but contains much less than the present city water supply. Sample E is also slightly high in nitrate and even though it is still within the limits of the Public Health Drinking Water Standards this should be checked into by the State Department of Health before a city well is drilled at this location. Sample I is slightly high in sulfate content; otherwise, its quality is good.

It should be noted that samples E and F both come from the State Geological Survey observation well, the only difference being that Sample E was collected by the writer and Sample F by the City, yet Sample F shows a much poorer quality water than E. This difference could be due to the fact that the priming water was not completely pumped out of the well before Sample F was taken, or possibly it could be that the water in Sample F may have remained within the well casing for a long period of time and had become stagnant. In either case, Sample E is thought to be more representative of the water in the area as the well was properly pumped before the sample was taken.

All other samples analyzed besides E and I must be considered poor quality water, according to the Public Health drinking water standards.

Samples G and H are higher in nitrate content than the Public Health drinking water standards. This high nitrate concentration could be harmful to both animals and humans, and the cause should be searched for by the owners.

CONCLUSIONS AND RECOMMENDATIONS

It is recommended that the city of Parker develop a new water supply in the valley train outwash deposits about a mile northeast of the city. This would be either in the NE¼ sec. 8 or the NW¼ sec. 9, T. 99 N., R. 53 W., just south of the West Fork of the Vermillion River. Test holes in the area penetrated as much as 48 feet of water-saturated coarse sand and medium gravel, which should provide an adequate water supply for a city the size of Parker. The coarseness of the outwash sands and gravels should provide good permeability, and the quality of the water is also good (table 1).

One objection which will probably be raised to this location is the fact that it is situated about 3/4-mile downstream from the city sewage disposal plant. However, this situation was discussed with officials of the State Department of Health, and assurance was given that waters in the area recommended would definitely not be contaminated by the sewage disposal system (Darrell Bakken, oral communication, Aug., 1960).

A city water supply could possibly be developed just west of town in the north-central part of Section 18, T. 99 N., R. 53 W., just north of the West Fork of the Vermillion River. However, these sands and gravels average only about 30 feet thick. This is rather marginal for developing a water supply for the city of Parker. In times of low rainfall, wells in this area may possibly be pumped dry. Also, if a city water supply were developed in this area, it would require several more wells to supply enough water for the city than would be required in the area northeast of town.

In addition, the area in the north-central part of town near test holes 14 and 15 should be tested further. However, if a well is located here it should be pump-tested for a period of time of at least 72 hours in order to determine the recharge.

It is recommended that the city contract with a commercial drilling company licensed in South Dakota to do further test drilling in the areas suggested, so that the best possible location for a well can be found. The city officials should also consult the State Water Resources Commission with regard to obtaining a water right and a permit to drill a city well, and the State Department of Health should be consulted about the biological and chemical suitability of the water. A consulting engineering firm licensed in South Dakota should also be hired to carry out further testing and to design the water system.

REFERENCES CITED

Hopkins, O. C., and Gullens, Oscar, 1960, New U. S. Public Health Service Standards: Jour. Amer. Water Works Assoc., v. 52, no. 9, p. 1161-8, Sept.

APPENDIX A

LOGS OF STATE GEOLOGICAL SURVEY TEST HOLES IN THE PARKER AREA
(for location see fig. 2)

G. S. Test Hole No. 1
Surface Elevation: 1375 feet
Depth to Water: 6 feet

0- 4	clay, light brown, damp
4-14	clay, brown, moist
14-19	no sample
19-24	mud, brown, much water
24-34	clay, blue

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G. S. Test Hole No. 2
Surface Elevation: 1333 feet
Depth to Water: 12 feet

0-11	topsoil, black
11-14	sand, coarse, some gravel
14-26	gravel, fine to coarse
26-39	clay

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G. S. Test Hole No. 3
Surface Elevation: 1334 feet
Depth to Water: 6 feet

0- 1	soil, black
1- 2	gravel, coarse
2- 4	sand, coarse and reddish-brown clay
4-24	gravel, coarse with brown clay matrix, wet.
24-29	gravel, medium with blue clay

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G. S. Test Hole No. 4
Surface Elevation: 1349 feet
Depth to Water: 8 feet

0- 3	gravel, coarse
3- 5	clay, brown to reddish-brown
5- 8	clay, blue

This hole was drilled in the bottom of a gravel pit. There was 7-8 feet of coarse gravel and 1 foot of black soil above the drilling site.

G.S. Test Hole No. 5
Surface Elevation: not read
Depth to Water: ?

0- 4	soil, black
4- 9	gravel, medium to coarse
9-27	gravel, coarse and some coarse sand
27-29	clay, blue

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G. S. Test Hole No. 6
Surface Elevation: 1336 feet
Depth to Water: 10 feet

0- 1	soil, sandy
1- 3	gravel, coarse
3-29	sand, coarse with some gravel
29-34	clay, blue, wet with some fine sand

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G. S. Test Hole No. 7
Surface Elevation: 1327 feet
Depth to Water: 3 feet

0-1.5	sand, coarse
1.5-13	gravel, coarse with fine sand
13	stopped by coarse gravel

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G. S. Test Hole No. 8
Surface Elevation: 1321 feet
Depth to Water: 5 feet

0- 4	soil, black, sandy
4-14	clay, brownish
14-22	gravel, medium
22-29	clay, blue

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G. S. Test Hole No. 9
Surface Elevation: not taken
Depth to Water: 7 feet

0- 4	soil, dark brown
4- 9	clay, brown with trace of water
9-14	gravel, medium with brown clay
14-18	gravel, coarse
18	stopped by rock at 18 feet

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G. S. Test Hole No. 10
Surface Elevation: 1328 feet
Depth to Water: 16 feet

0- 1	soil, black
1-14	clay, brown
14-19	clay, reddish brown, with traces of sand and gravel
19-31	mud, sandy, brown
31-42	mud, greenish gray
	stopped at 42 feet, probably by a rock

* * * * * * * *

G. S. Test Hole No. 11
Surface Elevation: 1326 feet
Depth to Water: 4 feet

0- 4	clay and fine gravel
4-14	soil, black
14-19	sand, black, muddy
19-34	clay, blue

There was a lot of water in this hole, but it was black and had a bad odor.

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G. S. Test Hole No. 12
Surface Elevation: not taken
Depth to Water: no water in hole

0- 2	not given
2-21	gravel, fine to coarse, moist
21-24	clay, reddish brown
24-34	clay, blue

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G. S. Test Hole No. 13
Surface Elevation: 1331 feet
Depth to Water: 19 (?) feet

0- 4	loam, sandy, dark brown
4- 9	clay, light brown, with some pebbles
9-34	clay, blue
34-49	clay, with some sand and gravel layers

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G. S. Test Hole No. 14
Surface Elevation: 1330 feet
Depth to water: 19 feet

0- 1	topsoil

G. S. Test Hole No. 14 -- continued

1- 7	gravel, medium to coarse
7-14	clay, brown with some sand
14-39	gravel, medium to coarse
39-49	sand, coarse, with mud
49-59	sand, coarse and fine gravel, very wet
59-74	sand (?)
	hard zone at 74 feet, could not continue

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G. S. Test Hole No. 15
Surface Elevation: 1330 feet
Depth to Water: 19 feet

0- 3	soil, dark, sandy
3- 9	gravel
9-19	clay, red with some pebbles
19-64	gravel, fine, and water

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G. S. Test Hole No. 16
Surface Elevation: 1331 feet
Depth to Water: 19 feet

0-12	gravel and sand
12-14	gravel, coarse
14-21	sand, fine and gravel
21-24	clay, blue

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G. S. Test Hole No. 17
Surface Elevation: not taken
Depth to Water: none

0-17	gravel, medium to coarse, and fine sand
17-29	clay, blue

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G. S. Test Hole No. 18
Surface Elevation: not taken
Depth to Water: 12 feet

0- 9	topsoil, black
9-19	mud, brown, with sand
19-24	no sample
24-35	same as 9-19 except for two six-inch layers of gravel

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G. S. Test Hole No. 19
Surface Elevation: 1321 feet
Depth to Water: none

0- 1	topsoil
1-13	sand, coarse and gravel
13-14	clay, brown
14-20	no sample (bit had brown clay on it) stopped at 20 feet by boulder

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G. S. Test Hole No. 20
Surface Elevation: not taken
Depth to Water: 11 feet

0-39	gravel, medium to coarse and sand
39-44	clay, blue

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G. S. Test Hole No. 21
Surface Elevation: 1322 feet
Depth to Water: 11 feet

0- 2	gravel, medium
2- 3	sand, red, fine
3-44	gravel, fine to medium, and sand
44-54	clay, blue

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G. S. Test Hole No. 22
Surface Elevation: 1319 feet
Depth to Water: 6 feet

0- 4	loam, dark, sandy
4- 9	clay, brown
9-19	sand, coarse
19-54	gravel, fine to medium, and sand
54-69	clay, blue

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G. S. Test Hole No. 23
Surface Elevation: not taken
Depth to Water: none

0- 4	loam, dark brown, sandy
4- 9	sand and gravel, reddish-brown
9-14	clay, blue gray and sand
14-19	gravel (too coarse to continue)

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