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# Gosper County Test Hole Logs

Larry D. Cast

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# **GOSPER COUNTY Test-Hole Logs**

**Larry D. Cast**

**Nebraska Water Survey  
Test-Hole Report No. 37**

**Conservation and Survey Division  
Institute of Agriculture and Natural Resources  
University of Nebraska-Lincoln**



**February 2000**



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UNIVERSITY OF NEBRASKA-LINCOLN CREDITS

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The division is authorized to enter into agreements with federal agencies to engage in cooperative surveys and investigations in the state. Publications of the division and the cooperating agencies are available from the Conservation and Survey Division, University of Nebraska, Lincoln, Nebraska 68588-0517.

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Publication and price lists are furnished upon request.

February 2000



## ACKNOWLEDGMENTS

The author gratefully acknowledges the contributions of the following Conservation and Survey Division personnel for production of this test-hole log book: Frank Smith and Duane Eversoll for assistance in geological interpretations, Duane Mohlman for computer assistance, Melba Stemm for typing the logs, and Jerry Leach, Ann Mack, and Dee Ebbeka for drafting the illustrations.

## INTRODUCTION

In 1930, the Conservation and Survey Division of the University of Nebraska and the U.S. Geological Survey began a program of cooperative groundwater studies in Nebraska. Since then test drilling by use of rotary drilling equipment has been an integral part of that program. This report contains logs of all the test holes drilled in the county under the program as well as those drilled by the Conservation and Survey Division with financial assistance from other government agencies.

The map in this report shows the location of all test holes drilled in the county since 1933 (Figure 1).

Present techniques of test-hole logging and sampling include use of drilling mud suitable to drilling conditions, timing by stopwatch of the drilling of each 5-foot increment of depth, and removal of all cuttings from the test hole at intervals of 5 feet or less. During the drilling of the hole, cuttings from each interval are examined immediately; samples representing each 5-foot interval and each recognizable change in material are retained. After samples are washed, they are described lithologically and the color is evaluated by comparison with standard color charts. The samples then are dried, stored, and cataloged. Beginning in September 1951, the test holes have been logged electrically. Figure 2 is an example of a geophysical log from Gosper County. All samples are processed and kept on open file in the offices of Conservation and Survey Division, 113 Nebraska Hall, University of Nebraska-Lincoln, 68588.

During 1947 and 1987 the United States Bureau of Reclamation (USBR) drilled 10 test holes in Gosper County at the site of the proposed Plum Creek Damsite. Logs of these test holes are included in this report. Note that the Unified Soil Classification System is the basis for the physical description of the materials. The complete geologic logs and e-logs for these 10 holes are located in the "Engineering Appendix of the USBR Regional Director's Planning Report/Environmental Statement" dated May, 1989.

This publication is one of a series being issued to make more readily available the record of test holes drilled since 1930. The series of publications is made on a county basis and includes, with some exceptions, logs of all test holes drilled in each of the counties. The logs have not been reviewed for conformance with editorial standards and nomenclature.

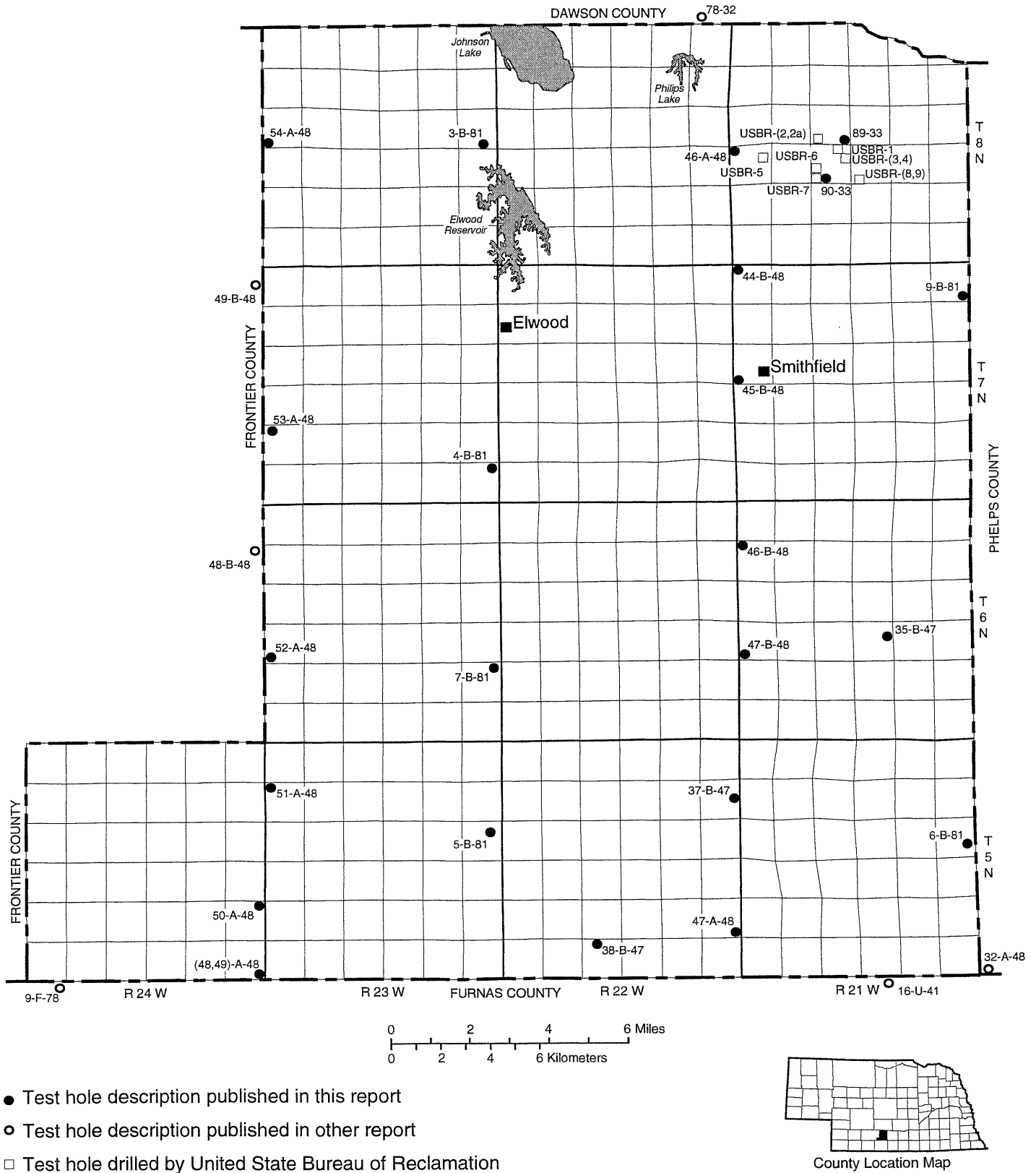


Fig. 1 Test-hole location map of Gosper County.

Figure 2. Gosper County sample geophysical log (9-B-81)

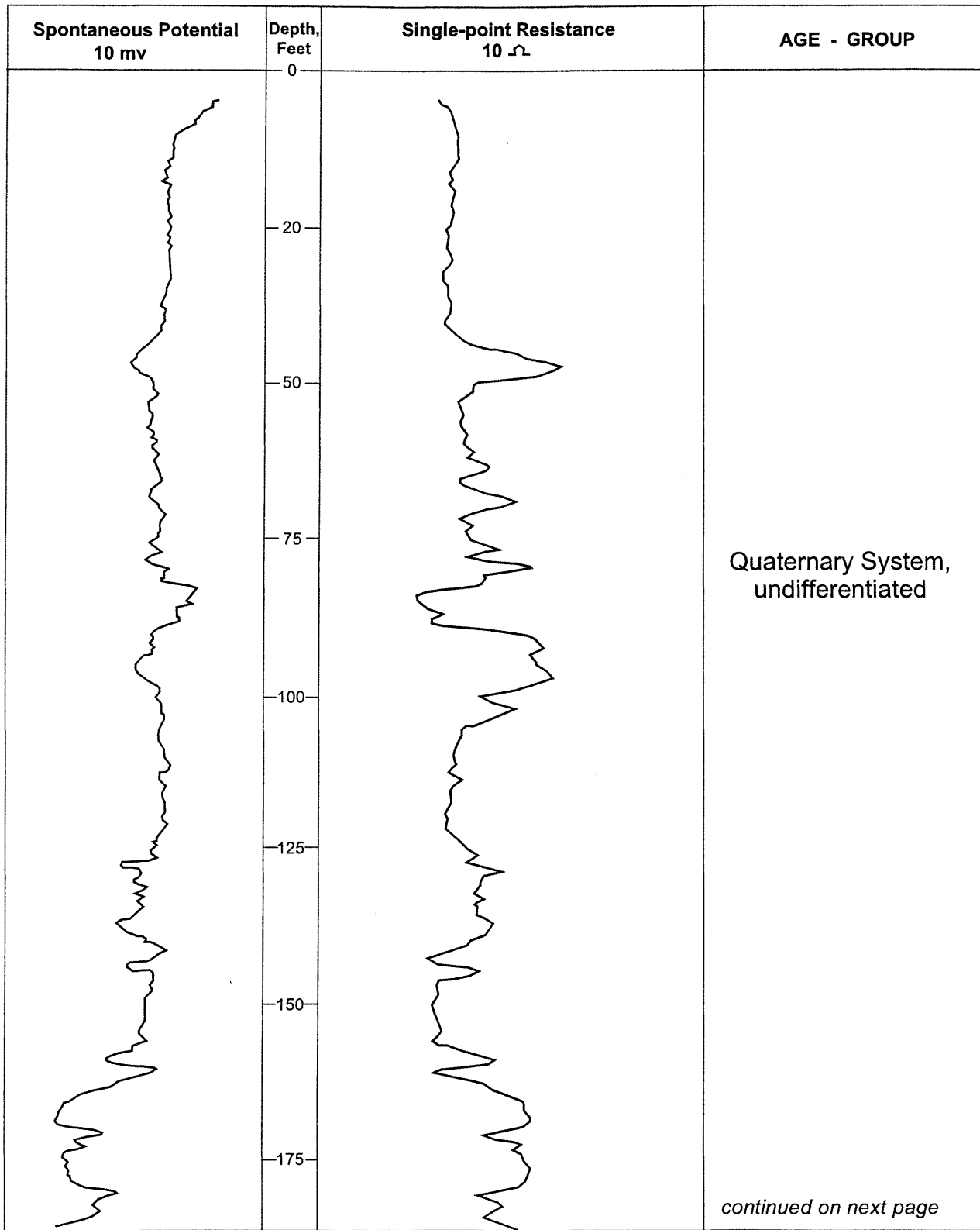
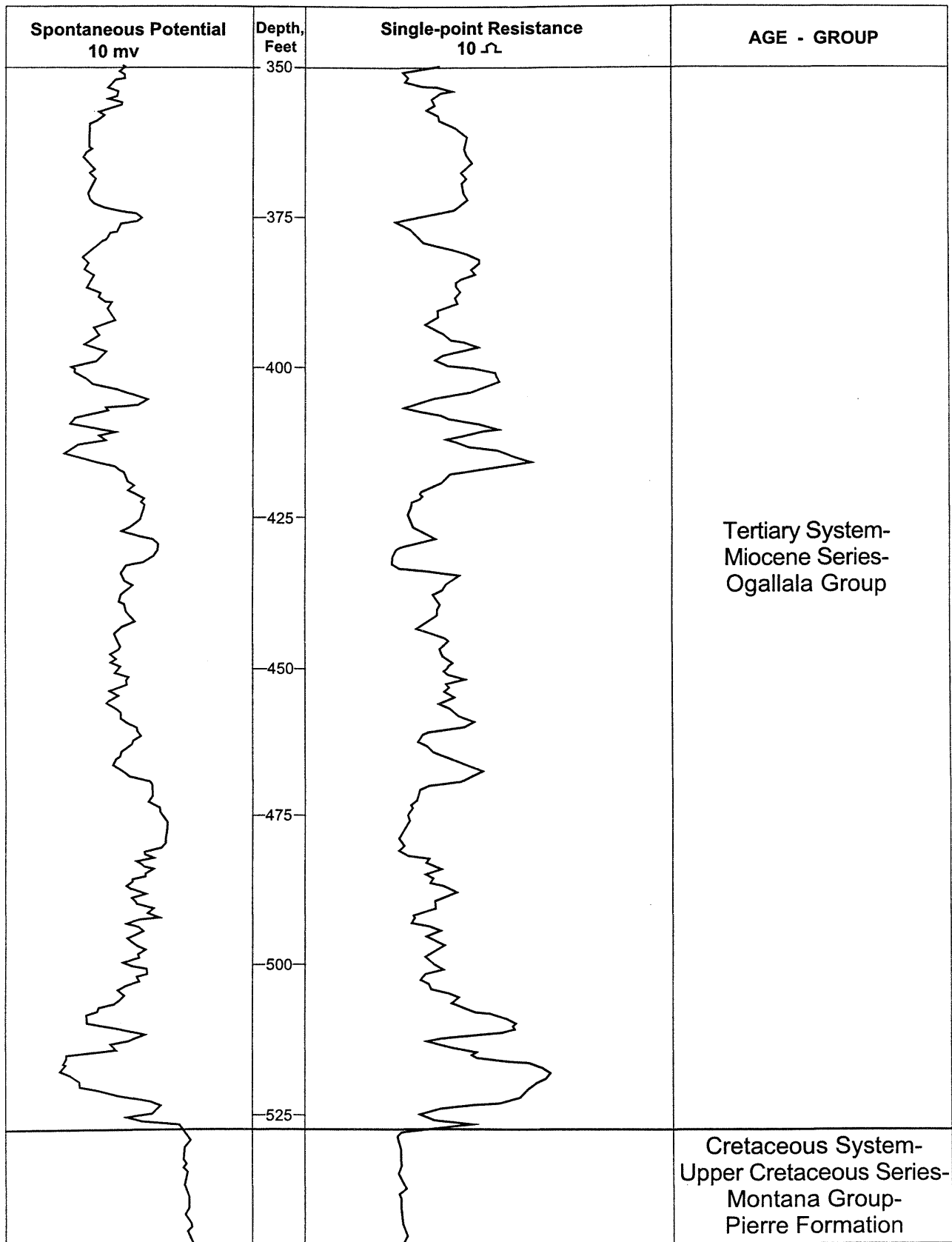






Figure 2. (Continued) Gosper County sample geophysical log (9-B-81)



The method whereby the altitude of the land surface at testhole sites was determined is indicated in the heading of each log, as follows: a = altimeter, h = hand leveling, i = instrumental, t = estimated from topographic map.

The test-hole records accurately reflect subsurface conditions only at the locations where the test holes were drilled. Interpretive data reflecting probable subsurface conditions between test-holes are being compiled for publication in county reports and are available for inspection in the office of the Conservation and Survey Division.

Each test hole is identified by a number assigned in the field (for example #3-B-67, #41-79), and most are also identified by a number indicating its location within the land divisions of the U.S. Bureau of Land Management's survey of Nebraska. Location numbers of test holes east of the 6th principal meridian, which passes through Columbus in a north-south direction, are preceded by the capital letter A; those west of the principal meridian have no preceding letter. The first numeral indicates the township, the second the range, and the third the section. As shown in figure 3, the letters that follow the section number indicate the location of the test hole within the section, the first letter indicating the quarter section and the second letter indicating the quarter-quarter section. The letters A, B, C, and D are applied in counterclockwise direction beginning with A in the northeast quadrant. The last numeral is the serial number of the test hole within the quarter-quarter section. No number is shown unless more than one test hole is within the given quarter-quarter section.

USGS test hole identification  
5N-4E-15CADC

CSD test hole identification  
SW SE NE SW Sec. 15, 5N, 4E

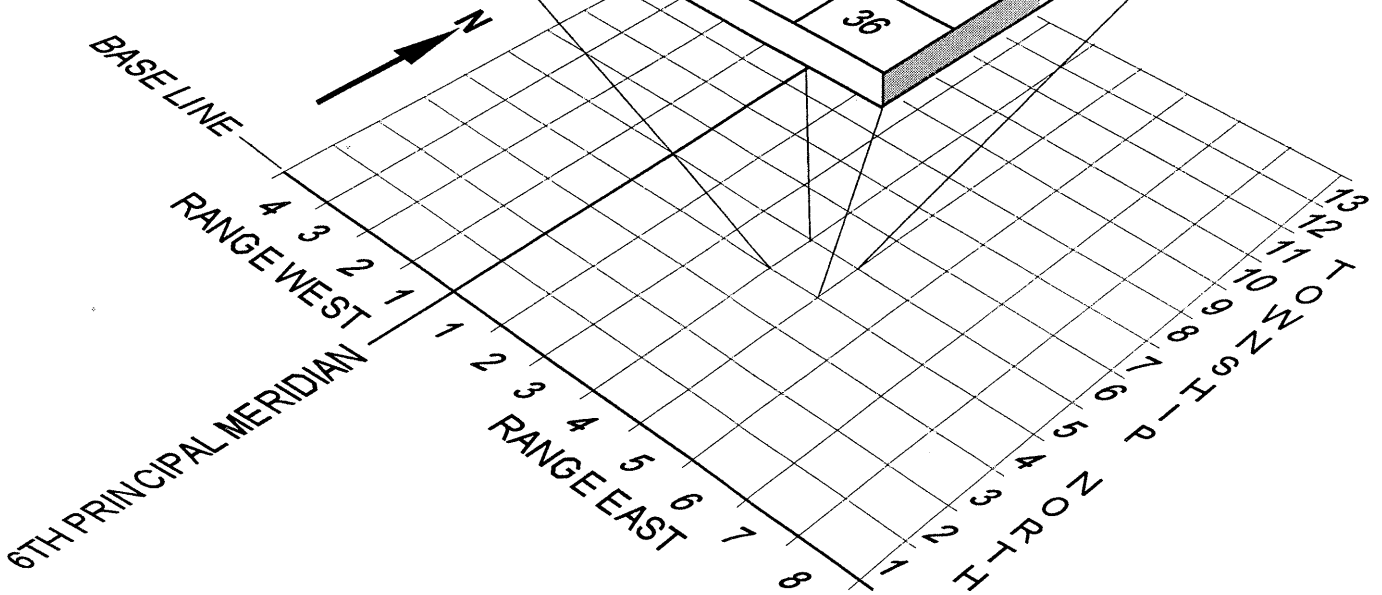
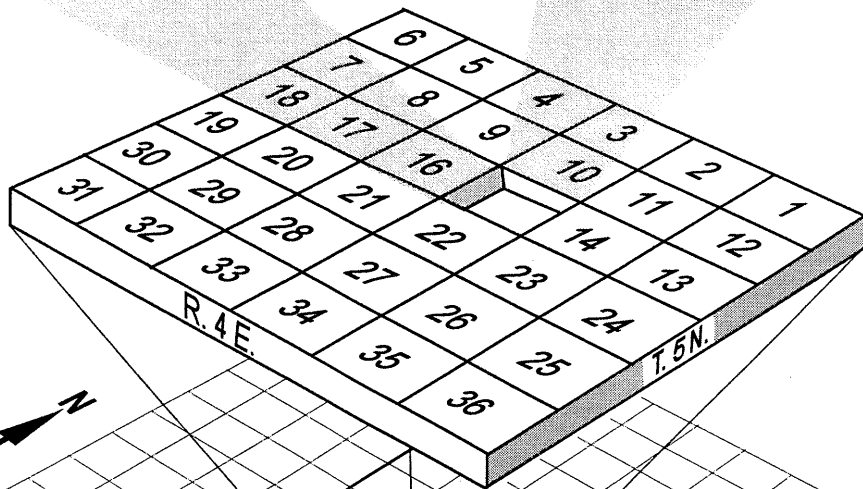
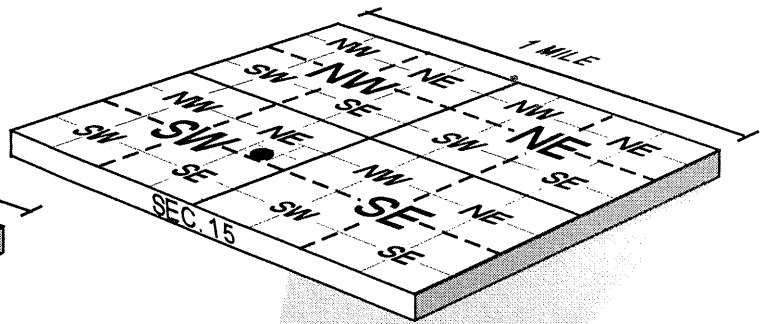
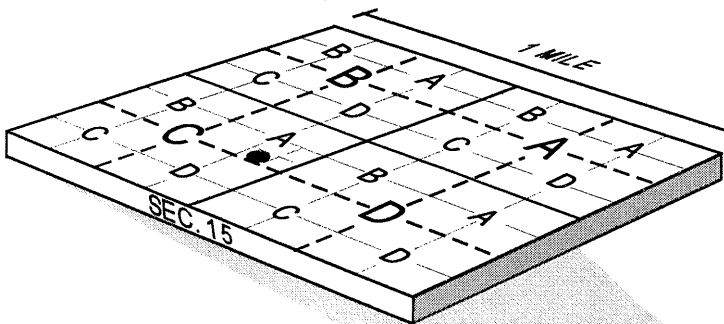


Fig. 3. System for identifying test-hole according to its location.



## SELECTED REFERENCES

A few of the most recently published selected references to geology, soils and groundwater resources of Gosper County are included below. The interested reader may find citations to earlier published studies noted in these references.

### Some Publications that are Guides to Earth Resources of Gosper County

- Johnson, C. R., *Geology and Ground Water in the Platte-Republican Rivers Watershed and the Little Blue River Basin Above Angus, Nebraska*, with a section on Chemical Quality of the Ground Water, by R. Brennan, U.S. Geological Survey Water-Supply Paper 1489, 1960.
- Goeke, J. W., Peckenpaugh, J. M., Cady, R. E., and Dugan, J. T., *Hydrogeology of Parts of the Twin Platte and Middle Republican Natural Resources Districts, Southwestern Nebraska*, with a section on water quality by R. A. Engberg, Nebraska Water Supply Paper No. 70, Conservation and Survey Division, University of Nebraska-Lincoln, prepared in cooperation with the U.S. Geological Survey, 1992.
- Hiergesell, R. A., *Descriptive, Geologic, and Borehole Geophysical Logs for 23 Test Holes in South-Central Nebraska*, U.S. Geological Survey Open-File Report 84-073.
- U.S. Bureau of Reclamation, *Regional Directors Planning Report/Draft Environmental Statement*, May 1989.

**Gosper County  
Test-Hole Table of Contents**

Legal Descrip Twp Rge Sec	Test-Hole Number	Page
05N 21W 13DDAA	06-B-81	1
05N 22W 12ADDD	37-B-47	3
05N 22W 25DDDD	47-A-48	5
05N 22W 33BAAA	38-B-47	7
05N 23W 07BBBB	51-A-48	9
05N 23W 13AABC	05-B-81	11
05N 24W 25AAAB	50-A-48	13
05N 24W 36DDCC	49-A-48	15
05N 24W 36DDDD	48-A-48	17
06N 21W 07BBBC	46-B-48	18
06N 21W 19CCCC	47-B-48	21
06N 21W 22ADDD	35-B-47	24
06N 23W 19CCCC	52-A-48	27
06N 23W 25AAAA	07-B-81	29
07N 21W 01DDDD	09-B-81	31
07N 21W 06BBBB	44-B-48	34
07N 21W 18CCCC	45-B-48	38
07N 23W 30BBBB	53-A-48	41
07N 23W 36AAAA	04-B-81	43
08N 21W 16CDDC	USBR-2	45
08N 21W 16CDDD	USBR-2A	46
08N 21W 16D	89-33	47
08N 21W 19ADAD	USBR-5	48
08N 21W 19BBBB	46-A-48	50
08N 21W 21AADD	USBR-3	53
08N 21W 21ABAA	USBR-1	54
08N 21W 21ADDD	USBR-4	55
08N 21W 21C	90-33	56
08N 21W 21CBBC	USBR-6	57
08N 21W 21CDDD	USBR-7	59
08N 21W 22CCCD	USBR-8	60
08N 21W 22CCDD	USBR-9	61
08N 23W 13DDCC	03-B-81	63
08N 23W 18CCCC	54-A-48	66

Test-holes are arranged in this publication by township, range and section.

Gosper County  
Test-Hole Table of Contents

Arranged by year drilled, test-hole number.

1933

08N 21W 16D	89-33	. . . . .	47
08N 21W 21C	90-33	. . . . .	56

1947

06N 21W 22ADDD	35-B-47	. . . . .	24
05N 22W 12ADDD	37-B-47	. . . . .	3
05N 22W 33BAAA	38-B-47	. . . . .	7

1948

07N 21W 06BBBB	44-B-48	. . . . .	34
07N 21W 18CCCC	45-B-48	. . . . .	38
08N 21W 19BBBB	46-A-48	. . . . .	50
06N 21W 07BBBC	46-B-48	. . . . .	18
05N 22W 25DDDD	47-A-48	. . . . .	5
06N 21W 19CCCC	47-B-48	. . . . .	21
05N 24W 36DDDD	48-A-48	. . . . .	17
05N 24W 36DDCC	49-A-48	. . . . .	15
05N 24W 25AAAB	50-A-48	. . . . .	13
05N 23W 07BBBB	51-A-48	. . . . .	9
06N 23W 19CCCC	52-A-48	. . . . .	27
07N 23W 30BBBB	53-A-48	. . . . .	41
08N 23W 18CCCC	54-A-48	. . . . .	66

1981

08N 23W 13DDCC	03-B-81	. . . . .	63
07N 23W 36AAAA	04-B-81	. . . . .	43
05N 23W 13AABC	05-B-81	. . . . .	11
05N 21W 13DDAA	06-B-81	. . . . .	1
06N 23W 25AAAA	07-B-81	. . . . .	29
07N 21W 01DDDD	09-B-81	. . . . .	31

United States Bureau of Reclamation (USBR)  
Drilled in 1947 and 1987

08N 21W 21ABAA	USBR-1	. . . . .	54
08N 21W 16CDDC	USBR-2	. . . . .	45
08N 21W 16CDDD	USBR-2A	. . . . .	46
08N 21W 21AADD	USBR-3	. . . . .	53
08N 21W 21ADDD	USBR-4	. . . . .	55
08N 21W 19ADAD	USBR-5	. . . . .	48
08N 21W 21CBBC	USBR-6	. . . . .	57
08N 21W 21CDDD	USBR-7	. . . . .	59
08N 21W 22CCCD	USBR-8	. . . . .	60
08N 21W 22CCDD	USBR-9	. . . . .	61



**Test Hole #6-B-81 (E-log)**  
**(5-21-13ddaa)**  
**Gosper County**

Location: NE NE SE SE sec. 13, T. 5 N., R. 21 W., approximately  
 1,006 ft. north and 12.5 ft. west of southeast section corner  
 Ground elevation: 2,350 ft. (t) (Oxford NW 7.5 minute quadrangle)  
 Depth to water: 88.3 ft. (Date not available)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Roadfill, not sampled.....	0.0	2.5
Silt, clayey, slightly sandy, contains very fine sand, slightly calcareous, yellowish brown.....	2.5	25.0
Silt, very clayey, trace of very fine sand, slightly calcareous, brown to dark brown.....	25.0	35.0
Silt, very clayey, slightly sandy, contains very fine sand, slightly calcareous, yellowish brown...	35.0	46.0
Silt, very sandy, contains very fine sand, contains fine to medium sand below 64 ft., slightly clayey, hard limy concretion at 59.4 ft., slightly calcareous, yellowish brown to light yellowish brown.	46.0	65.0
Sand, very fine to fine grained, very silty.....	65.0	68.0
Silt, clayey, sandy, contains very fine sand, slightly calcareous, light yellowish brown to yellowish brown.....	68.0	83.5
Silt, very clayey, trace of very fine sand, limy, very calcareous, light yellowish brown.....	83.5	95.0
Silt, slightly clayey, sandy, contains very fine sand, becomes very sandy below 105 ft., very calcareous, light yellowish brown, becoming very pale brown below 105 ft.....	95.0	113.0
Sand, fine to coarse grained, predominantly medium, brown.....	113.0	118.0
Silt, very sandy, contains very fine to fine sand, several firm zones, very pale brown.....	118.0	125.0
Silt, clayey and sandy, contains scattered siltstone fragments, light brown.....	125.0	133.3
Sand, fine to medium grained with some coarse.....	133.3	135.2
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Silt, with gradational changes to siltstone, very sandy, contains very fine to fine sand, light yellowish brown.....	135.2	145.0
Sandstone, very fine to fine grained with trace of medium sand, scattered silt lenses below 159 ft., light yellowish brown.....	145.0	185.0
Sandstone, with gradational change to sand, rootlets, light brown.....	185.0	190.0

Sand, very fine to medium grained, predominantly fine, rootlets, pale olive silt lenses below 205 ft., light brown.....	190.0	211.1
Silt, limy, hard, some sandstone lenses, white.....	211.1	215.0
Sand, very fine to coarse grained, predominantly fine, a few thin silt seams, light brown.....	215.0	225.0
Silt, sand and sandstone, interbedded, sand and sandstone is very fine to medium grained but predominantly fine, pale yellow to pale olive.....	225.0	230.0
Sandstone, very fine to fine grained with trace of medium sand; hard, thin siltstone seams below 250 ft.; very pale brown to pale olive.....	230.0	257.0
Silt, very sandy, contains very fine to fine sand, very calcareous, pale yellow.....	257.0	267.0
Sandstone, very fine to fine grained, moderately calcareous, pale olive.....	267.0	270.0
Silt, very sandy, contains very fine to fine sand, very limy, very calcareous, pale olive.....	270.0	278.0
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, weathered shale, pale yellow to yellow, very calcareous.....	278.0	300.0

**Test Hole #37-B-47 (No e-log)  
(5-22-12addd)  
Gosper County**

Location: SE SE SE NE sec. 12., T. 5 N., R. 22 W., approximately  
2,640 feet south and 6 feet west of northeast section corner, west  
shoulder of road.  
Ground elevation: 2,362.7 ft. (i) (Arapahoe NE 7.5 minute quadrangle)  
Depth to water: 112.6 ft. (8-15-47)

Depth, in feet  
From            To

**Quaternary System, undifferentiated:**

Silt, slightly calcareous, light brownish gray; lighter from 2 to 18 ft.; contains a few gastropods from 2 to 10 ft.; rootlets from 5 to 7 ft.; granular texture from 5 to 7 ft.;		
slightly clayey from 7 to 18 ft.....	0.0	18.0
Silt, clayey, to clay, silty, medium reddish brown..	18.0	20.0
Silt, clayey, very dark reddish brown.....	20.0	22.0
Clay, silty, to silt, clayey, medium reddish brown; lighter from 23 to 24 ft.....	22.0	24.0
Silt, very slightly clayey, buff-tan with slight gray tint; slight pink tint and very slightly calcareous from 25 to 27.5 ft.....	24.0	27.5
Silt, clayey, highly calcareous, very light tan-gray, less calcareous from 30 to 32 ft.....	27.5	33.0
Silt, slightly to moderately calcareous, tan-gray...	33.0	40.0
Silt, very slightly clayey, very slightly calcareous, gray to tan; contains some embedded sand and gravel in lower part; very calcareous zone from 46 to 46.5 ft.....	40.0	46.5
Sand and gravel, pink and tannish gray; texture grades from fine sand to coarse gravel; contains iron stains and limy zones; texture slightly coarser at 55 ft.....	46.5	68.0

**Tertiary System - Miocene Series - Ogallala Group:**

Marl, sandy, light brownish gray.....	68.0	70.0
Sand and gravel, pink; contains some brownish tan silt.....	70.0	72.0
Silt, moderately calcareous, light tan-gray; contains some sand and some thin limy layers.....	72.0	80.0
Clay, silty, pinkish tan; contains intermittent thin hard limy beds and some sand and gravel.....	80.0	90.0
Clay, silty, moderately calcareous, pinkish tan; contains thin hard limy layers and some silt.....	90.0	95.0
Sand and gravel, brownish tan; contains some inter- bedded silty clay, grayish green.....	95.0	112.0
Silt, slightly sandy to slightly clayey, light grayish green; contains some interbedded sand and gravel.....	112.0	119.0

Silt, slightly clayey, light grayish green.....	119.0	121.0
Sand and gravel, tan-gray; texture grades from fine sand to coarse gravel.....	121.0	132.0
Marl, very slightly sandy, yellow to brownish gray..	132.0	133.5
Sand, silty, grayish green to brownish gray.....	133.5	140.0
Sand, tan-gray; texture grades from fine to coarse sand and a trace of fine gravel; contains an occasional silty sand layer, grayish green; contains thin limy zones from 160 to 180 ft.....	140.0	184.0
Silt, sandy, to sand, silty, grayish green with light tan-gray tints.....	184.0	188.0
Sandstone, moderately calcareous, green to brownish gray; lighter color from 193.5 to 198 ft.....	188.0	198.0
Silt, very slightly clayey, grayish green to green; contains thin limy layers; blocky texture; contains some interbedded reddish brown clay from 200.5 to 205 ft.....	198.0	210.0
Silt, slightly clayey to sandy, brownish gray with green tint.....	210.0	213.0
Sandstone, in part silty, moderately calcareous, light brownish gray; contains interbedded marl; yellowish buff from 220 to 233 ft.....	213.0	233.0
Silt, clayey, to sand, moderately calcareous, light gray to light brownish gray.....	233.0	238.0
Sand, silty, brownish gray-green; in part consolidated, texture grades from very fine to medium with trace of coarse sand; yellowish gray-green from 254 to 257 ft.; contains bentonite from 257 to 259 ft.....	238.0	259.0
Marl, grayish white.....	259.0	259.5
Sand and gravel, brownish gray with green tint; texture grades from fine sand to medium gravel....	259.5	263.0
Clay, slightly calcareous, grayish green; contains interbedded pinkish tan limy zones from 263 to 270 ft.....	263.0	278.0
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, slightly to moderately calcareous, light-gray to yellowish gray; weathered; slightly less yellow with depth; contains some aragonite from 290 to 297 ft.; pink tint and bentonitic from 300 to 305 ft.....	278.0	305.0
Clay shale, dark-gray.....	305.0	310.0



**Test Hole #47-A-48 (No e-log)  
(5-22-25ddddd)  
Gosper County**

Location: SE SE SE SE sec. 25, T. 5 N., R. 22 W., approximately  
105 feet west and 10 feet north of southeast section corner,  
north shoulder of road.  
Ground elevation: 2,312.8 ft. (i) (Edison 7.5 minute quadrangle)  
Depth to water: 123.1 ft. (10-22-48)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Silt, dark brownish gray.....	0.0	1.0
Silt, slightly clayey, medium brown-gray.....	1.0	1.5
Silt, slightly to very calcareous, buff-gray with slight brownish tint; noncalcareous from 1.5 to 2 ft.; contains some snail shells from 8 to 15 ft.; limonitic flecks from 10.5 to 15 ft.....	1.5	33.0
Silt, dark reddish brown.....	33.0	36.0
Silt, very slightly clayey, tan-gray with very slight pink tint; moderately to highly calcareous and very light buff-gray from 40 to 44 ft.....	36.0	44.0
Silt, sandy, tan-gray; contains very fine sand with trace of coarse sand; moderately to very calcareous from 45.5 to 86 ft.; buff-gray from 45.5 to 53 ft., and 55 to 86 ft.; white from 53 to 55 ft; intermittent hard calcareous zones from 57 to 73 ft.; contains limy fragments and some fine gravel from 80 to 86 ft.....	44.0	86.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Silt and sandstone, very calcareous, white-gray; texture grades from very fine to fine sand with some coarser grains.....	86.0	90.0
Sandstone, very calcareous, white; texture grades from fine to coarse sand; darker in color from 100 to 103.5 ft.....	90.0	104.5
Silt, sandy, to sand, silty; in part clayey, very calcareous, light-gray with greenish tint; texture grades from fine to medium sand.....	104.5	110.0
Sand, silty, light-gray with slight green tint; texture grades from fine to medium sand; contains some calcareous spots and grades to very calcareous at bottom.....	110.0	130.0
Silt, slightly sandy to clayey, light greenish gray; contains many light-gray limy nodules.....	130.0	136.0
Silt, clayey, light greenish gray with trace of tan tint; contains limy nodular fragments from 141.5 to 144.5 ft.....	136.0	144.5
Sandstone, tan-brown; texture grades from very fine to fine sand with some coarser grains.....	144.5	147.0

Sand, slightly silty, to sandstone, moderately to very calcareous, light grayish green; texture grades from fine to medium sand with some coarse grains.....	147.0	160.0
Sandstone, light-gray; texture grades from very fine to fine sand with some medium sand, slight tan tint from 167.5 to 173 ft.....	160.0	173.0
Sand, silty, very calcareous, white; texture grades from very fine to fine sand.....	173.0	175.0
Sandstone, moderately calcareous, light brownish gray; texture grades from very fine to fine sand with some medium sand.....	175.0	177.0
Sand, silty, moderately calcareous, very light brownish gray; very fine texture.....	177.0	180.0
Silt, slightly sandy, light brownish tan; contains very fine sand.....	180.0	190.0
Silt, clayey, brownish gray.....	190.0	196.0
Silt, slightly clayey to sandy, brownish gray with tan tint; contains very fine to fine sand.....	196.0	200.0
Silt, sandy, to sand, silty; brownish gray; texture grades from very fine to fine sand and some medium sand.....	200.0	205.0
Sand, silty, brownish gray; texture grades from very fine to fine sand.....	205.0	217.0
Silt, sandy, very calcareous, very light brownish gray.....	217.0	219.5
Sand to sandstone, light brownish gray; texture grades from very fine to medium sand.....	219.5	225.5
Silt, clayey, brownish tan; contains thin white calcareous zone, more consolidated and coarser with depth.....	225.5	236.0
Sand, brownish gray; texture grades from fine to coarse sand with some fine to medium gravel; contains some limonitic fragments.....	236.0	238.5
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, very light-gray; contains limonitic staining; silty from 238.5 to 240 ft.; shale fragments from 244 to 245 ft.; less staining from 255 to 258 ft.....	238.5	258.0
Clay shale, medium gray.....	258.0	262.0
Clay shale, moderately calcareous, light-gray to medium-gray.....	262.0	270.0

**Test Hole #38-B-47 (No e-log)**  
**(5-22-33baaa)**  
**Gosper County**

Location: NE NE NE NW sec. 33, T. 5 N., R. 22 W., approximately  
 5 feet south and about 2,548 feet east of northwest section  
 corner.

Ground elevation: 2,281.6 ft. (i) (Edison 7.5 minute quadrangle)

Depth to water: 73 ft. (8-19-47)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Silt, sandy, dark brownish gray; contains very fine to fine sand.....	0.0	1.0
Silt, slightly clayey to sandy, medium brownish gray	1.0	2.0
Silt, very slightly clayey, slightly calcareous, brownish buff-gray; contains a few gastropod shells; contains rootlets from 5 to 10 ft.; grades more gray with depth; contains a few limonitic flecks from 20 to 26 ft.....	2.0	26.0
Silt, clayey, light pinkish tan-gray.....	26.0	28.0
Clay, silty, to silt, clayey, dark reddish brown; slightly darker at 29.5 ft.....	28.0	30.0
Clay, silty, tan-gray with pink tint.....	30.0	31.0
Silt, very slightly clayey, tan-gray with pink tint.	31.0	34.0
Silt, very slightly sandy, slightly to moderately calcareous, tan-gray.....	34.0	39.0
Silt, slightly clayey to sandy, slightly to mod- erately calcareous, tan-gray to slightly pinkish tan; limy rootlets from 45 to 50 ft.; trace of moderately calcareous green clay from 50 to 53 ft.; some embedded gravel and rounded limy frag- ments from 53 to 55 ft.; no clay from 55 to 64 ft.; some embedded gravel from 60 to 64 ft.; no sand from 64 to 66.5 ft.....	39.0	66.5
Sand and gravel, pinkish gray; texture grades from fine sand to fine gravel; contains rounded limy fragments.....	66.5	69.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Sandstone, moderately calcareous, buff to light greenish gray.....	69.0	70.5
Siltstone and sandstone, dark grayish green; con- tains dark interbedded reddish brown clay layer and thin limy layer.....	70.5	76.0
Clay, slightly silty, grayish green with much tan...	76.0	80.0
Clay, silty, to silt, sandy, light grayish green; contains soft white limy layers and intermittent hard layers.....	80.0	90.0

Sandstone, slightly calcareous, grayish green grading to light tan-gray; contains fossil hackberry seeds; some rootlets from 95 to 100.5 ft.; moderately calcareous 99 to 111 ft.; more green from 100.5 to 111 ft.....	90.0	111.0
Silt, sandy, grayish green to green.....	111.0	113.5
Sandstone, slightly calcareous, light tan-gray with slight greenish tint.....	113.5	116.0
Sand, silty, grayish green to green; partially consolidated.....	116.0	120.0
Sand, brownish gray with some green and pink; contains a few green silt layers; some fine gravel and pebbles.....	120.0	125.5
Sand, silty, light grayish green; texture grades from fine to medium sand; contains hard light yellowish gray limy layer at 131 ft.; intermittent limy layers from 135 to 142 ft.; coarse sand and green silty clay pebbles from 135 to 140 ft.....	125.5	142.0
Silt, clayey to sandy, greenish to buff-gray; contains limy layers.....	142.0	145.0
Sand, brownish gray with a greenish tint; contains silt layer from 159 to 160 ft.; slightly coarser in lower part.....	145.0	165.0
Sand and gravel, brownish gray with slight greenish tint; contains silt pebbles and limonitic fragments; finer texture and contains angular fragments from 175 to 180 ft.; limy layer at 178.5 ft.....	165.0	180.0
Sand, brownish gray; texture grades from fine to coarse sand; contains many brown and green silt pebbles and a thin limy layer at top; contains some fine to medium gravel with trace of coarse, mostly pink and subangular.....	180.0	199.0
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, moderately to very calcareous, light-gray to yellowish gray; weathered; contains aragonite; contains limy zones.....	199.0	208.0
Clay shale, moderately to very calcareous, medium dark-gray; grades darker with depth; contains much limonitic material.....	208.0	230.0

**Test Hole #51-A-48 (No e-log)**  
**(5-23-7bbbb)**  
**Gosper County**

Location: NW NW NW NW sec. 7, T. 5 N., R. 23 W., approximately  
 313 feet south and 5 feet east of northwest section corner.  
 Ground elevation: 2,375.3 ft. (i) (Arapahoe NW 7.5 minute quadrangle)  
 Depth to water: 98.1 ft. (10-28-48)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Roadfill: silt.....	0.0	0.5
Silt, dark brownish gray.....	0.5	2.0
Silt, medium brownish gray; lighter from 2.5 to 4 ft.....	2.0	4.5
Silt, very slightly sandy, slightly calcareous, light buff-gray; contains fine sand, slight limo- nitic stains and a few snail shells; contains a few rootlets from 10 to 15 ft.....	4.5	33.5
Silt, dark reddish brown.....	33.5	36.5
Silt, tan-gray; slightly sandy from 40 to 43.5 ft...	36.5	43.5
Silt, sandy, very calcareous, whitish gray; contains some reddish tan silty sand and light-gray silty sand from 45 to 50 ft.....	43.5	50.0
Silt, sandy, moderately to very calcareous, light tan-gray; contains very fine sand; contains a few calcareous nodules from 55 to 60 ft.; light-gray spots and embedded sand and gravel grains from 60 to 65 ft.; limy nodules and an occasional rootlet from 65 to 70 ft.; more sandy and gravelly from 72 to 75 ft., and 78 to 80 ft.....	50.0	80.0
Sand and gravel, silty, tan-gray; texture grades from fine sand to medium gravel; less silty from 85 to 91.5 ft.....	80.0	91.5
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Sandstone, moderately to very calcareous, very light tannish gray; texture grades from fine to coarse sand with some gravel; slightly darker 95.5 to 98 ft.; white from 98 to 105 ft.....	91.5	105.0
Sandstone, very calcareous, very light tannish gray; texture grades from fine to medium with some coarse sand.....	105.0	113.5
Silt, slightly sandy, reddish tan and light gray; contains some sandstone and reworked limy frag- ments.....	113.5	115.0
Sandstone, very calcareous, very light tannish gray; texture grades from fine to medium with a little coarse sand.....	115.0	129.0
Silt, slightly clayey, reddish tan.....	129.0	130.5

Sand, silty, to sandstone, light gray with tan tint; texture grades from very fine to fine with medium sand; very calcareous from 134 to 135.5 ft.....	130.5	135.5
Silt, sandy, moderately to very calcareous, whitish gray to light gray.....	135.5	139.0
Sandstone, moderately calcareous, tannish gray; texture grades from fine to medium sand, slightly consolidated.....	139.0	143.0
Silt, sandy and sandstone, moderately calcareous; light gray.....	143.0	151.0
Sandstone, moderately calcareous, brownish gray; texture grades from fine to medium sand.....	151.0	158.0
Silt and sandstone, white; texture grades from very fine to fine with some medium sand.....	158.0	160.0
Sandstone, in part silty, white; texture grades from very fine to fine with some medium sand; contains a limy layer between 165 to 170 ft.....	160.0	170.0
Silt and sandstone, moderately calcareous, white; more silty from 173 to 175 ft.....	170.0	175.0
Silt, slightly sandy, moderately calcareous, white..	175.0	180.0
Silt, clayey, intermittently calcareous, white with interbedded light gray with green tint.....	180.0	185.0
Silt, slightly clayey, moderately to very calcareous, light greenish gray; contains very fine to fine sand; some thin hard zones.....	185.0	190.0
Sand, slightly silty, light gray with slight green tint; texture grades from very fine to fine sand with a trace of medium sand; contains some interbedded tan-gray sandstone from 195 to 200 ft.....	190.0	200.0
Silt, sandy, to sand, silty; moderately calcareous, light gray; texture grades from very fine to fine sand; contains some limonitic fragments 205 to 217 ft.....	200.0	217.0
Silt, slightly clayey to sandy, moderately calcareous, yellow to buff-gray; contains very fine sand; some limonitic stain.....	217.0	225.0
Silt, sandy, yellow to buff-gray; contains very fine sand with some coarser grains; some limonitic stain.....	225.0	235.0
Sand and gravel, yellowish gray; texture grades from fine sand to coarse gravel, contains limonite, jasper, and aragonite.....	235.0	237.0
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, very light gray; contains some limonitic stain	237.0	240.0
Clay shale, slightly silty, very slightly calcareous, black.....	240.0	249.0
<b>Cretaceous System - Upper Cretaceous Series - Colorado Group:</b>		
<b>Niobrara Formation:</b>		
Shale, chalky, very calcareous, brown; contains thin light blue-gray bentonitic clay.....	249.0	260.0

**Test Hole #5-B-81 (E-log)**  
**(5-23-13aabc)**  
**Gosper County**

Location: SW NW NE NE sec 13, T. 5 N., R. 23 W., approximately 1,312 ft. west and 625 ft. south of northeast section corner.  
 Ground elevation: 2,346 ft. (t) (Arapahoe NE 7.5 minute quadrangle)  
 Depth to water: 82.5 ft. (date not available)

	Depth, in feet	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Roadfill, not sampled.....	0.0	2.0
Topsoil, very dark gray.....	2.0	4.0
Silt, slightly sandy, contains very fine sand, slightly clayey below 25 ft., pale brown.....	4.0	30.0
Silt, slightly clayey, dark grayish brown to brown..	30.0	36.7
Silt, clayey, slightly sandy below 40 ft., light yellowish brown.....	36.7	45.0
Silt, very sandy, contains medium to coarse sand with trace of gravel, light yellowish brown.....	45.0	55.0
Sand, very fine to coarse grained, predominantly fine to medium, light gray to very pale brown....	55.0	68.3
Sand, varies from slightly to very silty, light gray to very pale brown.....	68.3	75.0
Silt, very sandy, contains very fine to medium sand; fine to coarse silty sand interbed from 80 to 80.5 ft., very light brown.....	75.0	81.5
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Sand, interbedded with sandstone, very fine to fine grained to 90 ft., very fine to coarse grained below 90 ft., brown.....	81.5	110.0
Silt, very sandy, contains very fine to fine sand; fine to coarse grained limy sandstone layers below 112.7 ft, pale brown.....	110.0	115.0
Sandstone, very fine to medium grained, predominantly medium.....	115.0	121.0
Silt, very sandy, several gradations to siltstones, very fine to fine grained, very calcareous in spots, pale brown to 127 ft., pale yellow and pale olive below 127 ft.....	121.0	144.5
Sandstone, fine to medium grained areas of nonconsolidation, pale brown.....	144.5	151.2
Silt, with scattered thin interbeds of fine grained sandstone, moderately to very calcareous, pale brown.....	151.2	157.5
Sandstone, with intervals of sand, mostly fine to medium grained, fine to coarse sand occurs from 157.5 to 160 ft., very calcareous and lime cemented below 165 ft.....	157.5	170.0

Silt, sandy, contains very fine to fine sand, scattered thin sandstone layers from 177.5 to 179 ft., sandstone interbed from 185.5 to 188.3 ft., slightly calcareous in areas, pale brown to brown, becoming light yellowish brown below 188 ft.....	170.0	203.5
Silt, interbedded with siltstone, silt is slightly clayey, moderately calcareous, pale brown.....	203.5	220.0
Clay, very silty, slightly calcareous, very pale brown.....	220.0	225.0
Silt, clayey, grading to clay with some siltstones below 229 ft., slightly to moderately calcareous, very pale brown.....	225.0	230.0
Clay, slightly silty, slightly to moderately calcareous, scattered thin siltstones to 235 ft., hard yellow fragments 244.5 to 245.8 ft., very pale brown to yellow.....	230.0	245.8
Silt, very clayey, sandy, contains very fine to medium sand, predominantly fine, yellow.....	245.8	249.0
Sand, fine to coarse grained, predominantly medium, larger grains are mostly siltstone particles and fragments of Niobrara Chalk, a few large rootlets.	249.0	262.0
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, weathered shale, yellow to light gray.....	262.0	266.0
Clay shale, dark gray.....	266.0	280.0



**Test Hole #50-A-48 (No e-log)  
(5-24-25aaab)  
Gosper County**

Location: NW NE NE NE sec. 25, T. 5 N., R. 24 W., approximately  
68 feet south and 344 feet west of northeast section corner.  
Ground elevation: 2,314.5 ft. (i) (Arapahoe NW 7.5 minute quadrangle)  
Depth to water: Unknown, hole caved at 90.1 ft. (10-28-48)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Silt, dark brownish gray; less gray from 1 to 2.5 ft.....	0.0	2.5
Silt, light brownish gray; buff-gray from 4.5 to 35 ft.; slightly calcareous from 5.5 to 30 ft., contains snail shells from 9 to 15 ft.; slight tan tint from 34.5 to 35 ft.....	2.5	35.0
Silt, very slightly clayey, slightly calcareous, dark reddish tan.....	35.0	38.5
Silt, slightly to moderately calcareous, light tan to buff-gray.....	38.5	51.0
Silt, very slightly sandy, slightly to very calcareous, light brownish tan to brownish gray; contains very fine sand; semiconsolidated with occasional rootlets from 56.5 to 58.5 ft.; some gravel embedded from 65.5 to 68.5 ft.....	51.0	68.5
Sand and gravel, brownish gray with pink grains; texture grades from fine sand to medium gravel; contains some reworked fragments.....	68.5	70.0
Silt, slightly clayey, tan-gray; more gray about 74 ft.....	70.0	75.0
Silt, moderately clayey, light gray; brown from 77 to 80 ft.....	75.0	80.0
Silt, very slightly clayey, light gray with slight greenish tint; contains embedded sand and gravel..	80.0	87.5
Sand, brownish gray with some pink grains; texture grades from fine to coarse sand with some fine to medium gravel; contains much reworked material....	87.5	93.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Silt, slightly sandy, moderately calcareous, light greenish gray.....	93.0	95.0
Silt, very calcareous, white; more silty from 99 to 105.0 ft.; contains some embedded greenish gray silt from 105 to 108 ft.....	95.0	108.0
Sandstone, greenish gray; texture grades from very fine to fine sand.....	108.0	110.0
Silt, sandy, light greenish gray; contains fine to medium sand.....	110.0	139.5

**Cretaceous System - Upper Cretaceous Series - Montana Group:  
 Pierre Formation:**

Clay, moderately to very calcareous, very light gray, contains many limonitic stains; slightly darker from 147.5 to 150.5 ft.; slightly silty and light gray to light yellow-gray from 150.5 to 172.5 ft..	139.5	172.5
Clay shale, slightly to moderately calcareous, medium gray; dark gray to black and non-calcareous from 174 to 180 ft.....	172.5	180.0

**Test Hole #49-A-48 (No e-log)  
(5-24-36ddcc)  
Gosper County**

Location: SW SW SE SE sec. 36, T. 5N., R. 24 W., approximately 21 feet north and about 1,197 feet west of southeast section corner.

Ground elevation: 2,341.6 ft. (i) (Arapahoe 7.5 minute quadangle)

Depth to water: Unknown, hole caved at 126.9 ft. (10-22-48)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Silt, dark brownish gray.....	0.0	1.0
Silt, slightly clayey, light brownish gray.....	1.0	2.0
Silt, slightly to very calcareous, buff-gray with slight brown tint; non-calcareous from 2 to 4 ft.; slightly sandy and contains some snail shells and rootlets from 5 to 15 ft.; finer texture and non-calcareous from 15 to 20 ft.; noncalcareous with color becoming more tan from 25 to 32 ft.....	2.0	32.0
Silt, very slightly sandy, medium reddish brown.....	32.0	34.5
Silt, very slightly clayey to sandy, buff-gray; contains very fine sand; moderately to very calcareous from 37 to 40 ft.....	34.5	40.0
Silt, sandy, moderately calcareous, light buff-gray; very calcareous from 48.5 to 50 ft.; contains very fine sand, intermittently calcareous from 50 to 66 ft.; brownish tan from 50 to 53 ft.; light gray from 53 to 55 ft.....	40.0	66.0
Silt, sandy, to sand, silty; dark reddish brown; contains very fine sand.....	66.0	67.0
Silt, sandy, moderately calcareous, light gray to light buff-gray; contains very fine sand.....	67.0	69.0
Siltstone, sandy, very calcareous, light yellowish gray; contains very fine sand.....	69.0	70.0
Silt, sandy, slightly calcareous, light brownish tan with grayish tint; contains very fine sand; light gray and very calcareous from 76 to 79.5 ft.....	70.0	79.5
Sand and gravel, very light brownish gray with some pink grains; texture grades from medium sand to medium gravel.....	79.5	87.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Sand, silty, light greenish gray, very fine texture.	87.0	97.0
Sandstone, light greenish gray; very fine texture; consists principally of small rootlets.....	97.0	105.5
Silt, sandy, very calcareous, light gray; contains very fine sand; light brownish gray and moderately calcareous from 107 to 110 ft.....	105.5	110.0
Sand, silty, to silt, sandy; very calcareous, light gray; contains very fine sand; grades less calcareous downward.....	110.0	115.0

Silt, to sand, slightly calcareous, light brownish gray; contains very fine sand; lighter from 120 to 126 ft.....	115.0	126.0
Sand, slightly silty, brownish gray; texture grades from fine to medium with some coarse sand and fine gravel; not silty and slightly more coarse from 137.5 to 142 ft.....	126.0	142.0
Silt, sandy, moderately calcareous, buff-tan with gray tint; clayey silt from 146 to 147 ft. and 157 to 160 ft.; sandy and clayey from 150 to 155 ft. and 160 to 173 ft.; contains limy fragments from 154 to 155 ft. and 160 to 165 ft.....	142.0	173.0
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, very calcareous, whitish gray; contains many limonitic stains from 173 to 180 ft.....	173.0	188.5
Clay shale, moderately to very calcareous, medium gray; darker and less calcareous with depth.....	188.5	200.0

**Test Hole #48-A-48 (No e-log)  
 (5-24-36dddd)  
 Gosper County**

Location: SE SE SE SE sec. 36, T. 5 N., R. 24 W., approximately 21 ft. north and 87 ft west of southeast section corner.

Ground elevation: 2,364.7 ft. (a) (Arapahoe 7.5 minute quadrangle)

Depth to water: Dry (10-19-48)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Silt, coarse grained, dark brownish gray.....	0.0	1.0
Silt, very slightly clayey, dark brown.....	1.0	2.0
Silt, very dark brown to black.....	2.0	3.5
Silt, very coarse grained, brownish gray.....	3.5	4.5
Silt, moderately coarse grained, slightly clayey, firm, light grayish tan.....	4.5	34.0
Note: Lost circulation at 34 ft; hole was abandoned and backfilled		

**Test Hole #46-B-48 (No e-log)  
(6-21-7bbbc)  
Gosper County**

Location: SW NW NW NW sec. 7, T. 6 N. R. 21 W., approximately  
 505 feet south and 18 feet east of northwest section corner.  
 Ground elevation: 2,496.1 ft. (i) (Elwood 7.5 minute quadrangle)  
 Depth to water: Unknown, hole caved at 183.3 ft. (10-22-48)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Silt, very dark brownish gray.....	0.0	2.0
Silt, light brownish gray; slightly lighter from 2.5 to 3.5 ft.....	2.0	3.5
Silt, buff-gray with yellow tint; slightly to moderately calcareous from 5 to 36 ft.; few snail shells from 5 to 20 ft.; slightly darker from 35 to 36 ft.....	3.5	36.0
Silt, dark reddish brown.....	36.0	40.0
Silt, tan-gray with slight red tint.....	40.0	46.0
Silt, very slightly sandy, very calcareous, light tan-gray; contains very fine sand; few limy nodules from 50 to 65 ft.....	46.0	74.5
Silt, very slightly clayey, slightly to moderately calcareous, brownish tan.....	74.5	90.0
Silt, slightly to very calcareous, brownish tan- gray.....	90.0	100.0
Silt, moderately calcareous, buff-gray.....	100.0	112.0
Sand, brownish gray; texture grades from very fine sand at top to medium with trace of coarse sand...	112.0	127.0
Silt, sandy, moderately calcareous, light buff-gray; contains very fine to fine sand; slightly darker from 130 to 136.5 ft.; texture grades from medium sand at 140 ft. to gravel at 178 ft.; noncalcar- eous from 167 to 178 ft.....	127.0	178.0
Sand, silty, light brownish gray; texture grades from fine to coarse sand.....	178.0	180.0
Sand and gravel, brownish gray with some pink grains; texture grades from fine sand to medium gravel; contains a hard calcareous layer at 247.5 ft. and much reworked limy material, sand- stone at 253.5 ft.....	180.0	260.5
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Silt, light brownish tan with gray tint.....	260.5	262.5
Sand, to sandstone, brownish gray with some pink grains; texture grades from fine sand to medium gravel; contains some calcareous material and rootlets.....	262.5	266.5

Sandstone, intermittently calcareous, light gray; fine texture; brown tint and fossil seeds from 268 to 286 ft.....	266.5	286.0
Silt and sandstone, moderately calcareous, white with very slight tan tint; texture grades from fine to medium sand.....	286.0	288.5
Sandstone, moderately calcareous, light tan-gray; texture grades from fine to medium sand.....	288.5	299.0
Silt, slightly sandy, moderately calcareous, white..	299.0	305.5
Silt, clayey, light greenish gray to reddish tan....	305.5	307.5
Sandstone, light brownish gray; texture grades from very fine to medium sand.....	307.5	315.5
Sand, silty, to silt, sandy, very light greenish gray; texture grades from very fine to fine with some medium sand.....	315.5	320.0
Sand, slightly silty, to sandstone, very light brownish gray with slight green tint; texture grades from fine to medium sand.....	320.0	325.0
Silt, sandy, light greenish gray; contains very fine to fine sand; brownish tan-gray from 328.5 to 336.5 ft.....	325.0	336.5
Sand and gravel, brownish gray with green grains; texture grades from fine sand to medium gravel....	336.5	361.0
Silt, sandy, very light greenish gray; contains very fine to fine sand.....	361.0	367.5
Sandstone, light brownish tan; contains sandy silt, moderately calcareous; light gray from 373.5 to 375 ft.....	367.5	375.0
Sand, brownish gray; texture grades from fine to coarse sand with traces of gravel; contains reworked limy and brownish tan clayey silt particles.....	375.0	381.0
Silt, sandy, intermittently calcareous, light gray with green tint; contains very fine to fine sand; contains a thin limestone layer at 381 ft.....	381.0	388.0
Sand, brownish gray; texture grades from fine to coarse with trace of gravel; contains reworked limy fragments.....	388.0	392.0
Clay, silty, mottled green and tan-gray.....	392.0	394.5
Sand, silty, light greenish gray; texture grades from very fine to medium sand.....	394.5	400.0
Sandstone to sandy silt; sandstone, brownish tan; sandy silt, in part calcareous, light brownish gray; very fine textured sand, in part gravelly...	400.0	406.0
Sand, brownish gray with some pink and light green grains; texture grades from fine to coarse sand with some gravel; contains some white clay fragments from 410 to 416 ft.....	406.0	416.0

**Cretaceous System - Upper Cretaceous Series - Montana Group:  
Pierre Formation:**

Clay, very calcareous, whitish gray to light yellow- ish gray; very limonitic stained at top.....	416.0	431.5
Clay shale, moderately calcareous, medium dark gray; contains ironstone zones from 435 to 440 ft.....	431.5	450.0



**Test Hole #47-B-48 (No e-log)  
(6-21-19cccc)  
Gosper County**

Location: SW SW SW SW sec. 19. T. 6 N. R. 21 W., approximately  
37 feet north and 25 feet east of southwest section corner.  
Ground elevation: 2,391 ft. (i) (Arapahoe NE 7.5 minute quadrangle)  
Depth to water: 94.2 ft. (10-22-48).

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Silt, very dark brownish gray.....	0.0	1.5
Silt, dark brownish gray.....	1.5	2.0
Silt, medium brownish gray; lighter from 3 to 4 ft..	2.0	4.0
Silt, moderately to very calcareous, buff-gray with yellow limonitic tint; slightly calcareous with some snail shells 6 to 15 ft., darker and finer texture with depth.....	4.0	33.5
Silt, very slightly clayey, dark reddish brown.....	33.5	35.0
Silt, very slightly clayey, buff-gray.....	35.0	40.0
Silt, very slightly sandy, very calcareous, brownish tan-gray; contains very fine sand and a few limy nodules.....	40.0	42.0
Silt, very slightly sandy, very calcareous, brown- ish tan-gray; contains very fine sand and a few limy nodules.....	42.0	45.0
Silt, slightly to very calcareous, brownish gray; buff-gray from 46.5 to 48.5 ft.; limy zone at 58 ft.; slightly sandy from 59 to 62.5 ft.....	45.0	62.5
Silt, sandy, very slightly calcareous, light brown- ish tan with gray tint; contains very fine to fine sand with some medium and coarse sand.....	62.5	68.0
Sand, slightly silty; texture grades from very fine to fine sand with a few medium grains.....	68.0	71.5
Silt, slightly sandy, light brownish tan with gray tint; contains very fine to fine sand and cal- careous nodules.....	71.5	79.0
Sand, light brownish gray; texture grades from fine to medium sand with some coarse sand; contains a few gravel grains from 80 to 93.5 ft.....	79.0	93.5
Silt, very slightly sandy, brownish buff with gray tint; contains limy nodules; more sand and some gravel from 110 to 116 ft.....	93.5	116.0
Sand and gravel, brownish gray with some pink grains; texture grades from fine sand to medium gravel.....	116.0	121.5
Silt, clayey, brownish tan; contains white limy layers.....	121.5	125.5
Clay, brownish tan with reddish tint; contains a limy layer at 127.5 ft.....	125.5	128.0

Sand and gravel, brownish gray with pink grains; texture grades from fine sand to fine gravel.....	128.0	134.0
Silt, sandy, to sand, silty, light greenish gray; texture grades from fine to medium sand.....	134.0	137.0
Sand and gravel, brownish gray with some pink grains; texture grades from fine sand to fine gravel with some coarser gravel.....	137.0	141.0
Silt, brownish tan; micaceous; thin limy layer at top.....	141.0	143.5
Sand and gravel, light brownish gray with yellow and pink grains; texture grades from fine sand to fine gravel with some coarser gravel.....	143.5	150.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Sandstone, very light brownish gray grading to very light greenish gray; texture grades from fine to coarse sand; contains calcareous zones.....	150.0	157.5
Sand, silty, light gray with slight green tint; texture grades from very fine to fine with some medium sand.....	157.5	166.0
Sand, silty, to sandstone, in part moderately calcareous, very light brownish gray; contains a few rootlets.....	166.0	170.0
Sand, silty, to silt, sandy, light greenish gray; contains intermittent sandstone and limy nodular layers.....	170.0	174.0
Sandstone, very calcareous, very light brownish gray; texture grades from fine to medium sand; more brown from 175 to 178.5 ft.; green tint from 178.5 to 187.5 ft.....	174.0	187.5
Sand, slightly silty, very light brownish gray; texture grades from fine to medium with trace of coarse sand; slightly consolidated; not silty from 190 to 200 ft.....	187.5	207.0
Sandstone, silty, in part calcareous, light gray with slight green tint; texture grades from very fine to fine with some medium sand.....	207.0	212.0
Silt, slightly clayey to very slightly sandy, light greenish gray; micaceous; contains very fine sand; thin white limy layers from 216 to 220 ft.....	212.0	220.0
Silt, very slightly sandy, light brownish gray with slight green tint; contains very fine sand; micaceous.....	220.0	224.0
Sand, brownish gray to gray to green; texture grades from fine to coarse sand with a trace of gravel; contains some silt and reworked coarse material...	224.0	235.0
Sand and gravel, light brownish gray with green and pink grains; texture grades from fine to coarse sand with some fine gravel; silt layer and a few limy fragments at 245.5 ft.....	235.0	249.5
Marl and intermittent silt, brownish gray.....	249.5	253.5

Sand, light brownish gray; texture grades from fine to coarse sand; contains limy fragments; intermittent green and tan clay layers from 273 to 278 ft.; slightly sandy clay from 278 to 280 ft.....	253.5	283.0
Silt, clayey, moderately calcareous, white.....	283.0	284.5
Sand, silty, light gray with green tint; texture grades from very fine to fine and some medium sand	284.5	289.0
Clay, silty, moderately to very calcareous, light gray; contains hard calcareous layers.....	289.0	294.0
Sand, light brownish gray, texture grades from fine to coarse sand.....	294.0	301.5
Silt, sandy, in part clayey, moderately to very calcareous, light gray with slight greenish tint; contains very fine to fine sand.....	301.5	305.0
Sand, silty, to silt, sandy, moderately to very calcareous, light buff-gray; texture grades from very fine to fine sand.....	305.0	308.0
Sand, light brownish gray with slight green tint; texture grades from fine to coarse sand.....	308.0	310.5
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, very calcareous, very light gray-orange, contains limonitic stains in upper part with thin hard ironstone layers; less weathered and light gray from 315 to 320 ft.....	310.5	320.0
Clay shale, medium dark gray, some yellowish brown..	320.0	325.5
Clay shale, very calcareous, dark gray.....	325.5	340.0

**Test Hole #35-B-47 (No e-log)  
(6-21-22addd)  
Gosper County**

Location: SE SE SE NE sec. 22, T. 6 N., R. 21 W., approximately  
2,568 feet south and 8 feet west of northeast section corner.  
Ground elevation: 2,501.6 ft. (i) (Oxford NW 7.5 minute quadrangle)  
Depth to water: 201.4 ft. (8-12-47).

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Soil: silt, clayey, dark brownish gray to black....	0.0	1.0
Silt, clayey, dark brownish black; granular.....	1.0	2.5
Clay, silty, to silt, clayey, medium brownish gray; lighter with depth.....	2.5	5.0
Silt, slightly clayey, tan-buff-gray; contains rootlets and many gastropod shells from 7.5 to 9 ft.....	5.0	9.0
Silt, buff-gray to brown; granular; contains limonitic flecks, soft nodules, limy rootlets and gastropod shells; slightly clayey from 28 to 38 ft.....	9.0	38.0
Silt, very slightly clayey, dark brown with slight red tint.....	38.0	39.5
Silt, slightly clayey to sandy, tan-gray with slight pink tint; contains very fine sand.....	39.5	46.0
Silt, clayey, moderately to very calcareous, light buff-gray; contains a few limy nodules.....	46.0	50.0
Silt, very slightly clayey, brownish gray; contains a dark soil zone and a few limy nodules from 50 to 52 ft.....	50.0	55.0
Silt, slightly clayey to sandy, brownish tan-gray; contains very fine sand.....	55.0	60.0
Silt, sandy, to sand, silty, brownish tan-gray.....	60.0	66.0
Silt, very slightly sandy, slightly calcareous, brownish tan-gray.....	66.0	70.0
Silt, very slightly clayey, moderately to very cal- careous, tan to buff-gray; slightly less gray and moderately to slightly calcareous from 75 to 85 ft.....	70.0	85.0
Silt, slightly clayey to slightly sandy, slightly calcareous, tan-buff-gray; contains limonitic and carbonaceous nodules from 90 to 94 ft.; thin limy zones 94 to 100 ft.....	85.0	100.0
Silt, very slightly clayey, slightly to very cal- careous, tan-buff-gray; nodular limy zone from 107 to 109 ft.; slight green tint from 112 to 115 ft.; thin nodular zone and becoming sandy from 125 to 130 ft.....	100.0	130.0

Silt, sandy, tan-gray; contains very fine sand; contains some very fine rootlets.....	130.0	140.0
Silt, brownish tan; contains thin limy layers; granular from 145 to 150 ft.....	140.0	160.0
Silt, clayey, dark brownish tan; contains some light gray consolidated volcanic ash.....	160.0	167.0
Clay, silty, to silt, clayey, dark brownish tan....	167.0	170.0
Silt, dark brownish tan; sandy from 175 to 180 ft...	170.0	180.0
Silt, sandy, tan-gray; contains silty sand layers...	180.0	190.0
Sand, silty, to silt, sandy, light tan-gray; contains limy layers at 193 ft.....	190.0	197.0
Sand and gravel, grayish tan; texture grades from fine sand to coarse gravel; contains clay, yellowish brown, very limonitic from 245 to 250 ft.....	197.0	289.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Silt and sandstone, interbedded; silt, slightly clayey, greenish gray; sandstone, light brown, contains rootlets and some whitish gray marl.....	289.0	300.0
Sandstone, moderately calcareous, whitish gray to very light greenish gray; contains some rootlets..	300.0	304.0
Sandstone, very slightly calcareous in part, brownish gray with slight green tint.....	304.0	307.5
Sandstone, clayey, moderately calcareous, whitish gray; contains thin hard limy layer from 308 to 308.5 ft.....	307.5	308.5
Sandstone, grayish green; contains a few rootlets...	308.5	312.0
Silt, very slightly sandy, grayish green; contains some interbedded silty clay, reddish brown.....	312.0	314.0
Silt, sandy, to sandstone, grayish green; contains a few seeds and rootlets.....	314.0	318.0
Sandstone, slightly to moderately calcareous, greenish gray; contains some tan color and a few rootlets; contains some sandstone, calcareous, grayish white and some limestone, pink, interbedded, from 333 to 338 ft.....	318.0	338.0
Sand, silty, to silt, sandy, light greenish gray; some light reddish tan from 338 to 343 ft.....	338.0	360.0
Sandstone, brownish gray-green.....	360.0	370.0
Sand, silty, very light greenish gray; fine texture; partially consolidated; contains rootlets.....	370.0	374.0
Sand, brownish gray; texture grades from fine to coarse sand; contains some interbedded silt, greenish gray from 374 to 390 ft.; some fine gravel from 390 to 397 ft.....	374.0	397.0
Siltstone, in part clayey, medium brown with slight gray tint.....	397.0	410.0
Sand, brownish tan-gray; contains some fine to medium gravel.....	410.0	415.0

Sand and gravel, brownish tan-gray; texture grades from medium sand to coarse gravel; contains clayey silt layers, yellowish green, limonite stained; slightly finer texture from 420 to 427 ft.; slightly coarser texture with some pink grains from 427 to 430 ft..... 415.0 430.0

**Cretaceous System - Upper Cretaceous Series - Montana Group:**

**Pierre Formation:**

Clay, moderately calcareous, light gray with limonitic stains; contains some bentonitic clay..... 430.0 444.0

Clay shale, moderately calcareous, medium gray grading to dark gray; upper portion weathered to yellowish brown; contains thin ironstone layers from 450 to 455 ft. and from 460 to 470 ft..... 444.0 470.0

**Test Hole #52-A-48 (No e-log)  
(6-23-19cccc)  
Gosper County**

Location: SW SW SW SW sec. 19, T. 6 N., R. 23 W., approximately  
96 feet north and 73 feet east of southwest section corner.

Ground elevation: 2,429.7 ft. (i) (Arapahoe NW 7.5 minute quadrangle)

Depth to water: 109 ft. (10-28-48)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Soil: silt, dark brownish gray.....	0.0	0.6
Silt, medium brown.....	0.6	3.0
Silt, medium buff-gray; contains gastropod shells from 5 to 15 ft. and is lighter from 15 to 37 ft..	3.0	37.0
Silt, medium reddish brown.....	37.0	40.0
Silt, light reddish buff.....	40.0	45.0
Silt, mottled light gray and reddish buff; contains a few gravel grains and limy nodules.....	45.0	50.0
Silt, sandy, light to medium gray.....	50.0	56.0
Sand and gravel, silty; texture grades from medium sand to coarse gravel.....	56.0	58.0
Silt, light brownish gray; contains limy nodules....	58.0	60.0
Sandstone, medium reddish brown; fine texture.....	60.0	64.0
Silt, clayey, moderately to very calcareous, light gray with reddish tint.....	64.0	67.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Sandstone, medium reddish brown; texture grades from fine to medium sand.....	67.0	72.0
Silt, slightly reddish brown; granular in part.....	72.0	75.0
Marl, light gray to reddish brown; contains inter- bedded silt layers.....	75.0	80.0
Sand; texture grades from medium to very coarse sand	80.0	81.0
Claystone, medium reddish brown; contains thin sand layers.....	81.0	85.0
Siltstone, moderately calcareous; contains cal- careous layer.....	85.0	90.0
Sand, light pinkish gray; texture grades from fine to coarse sand with some fine gravel.....	90.0	95.0
Silt and siltstone, moderately calcareous.....	95.0	97.0
Sandstone, light reddish brown; texture grades from fine to medium sand; contains intermittent hard calcareous layers.....	97.0	113.5
Silt, sandy, moderately calcareous, light grayish white; contains fine sand.....	113.5	115.0
Sandstone, moderately calcareous; fine texture, hard layer at 115 ft.....	115.0	120.0
Silt, sandy, light grayish brown; contains fine sand; hard layer from 120 to 122 ft.....	120.0	126.0

Sand and gravel, reddish brown to dark gray; texture grades from coarse sand to fine gravel....	126.0	133.0
Silt, slightly clayey to sandy, medium brown.....	133.0	136.0
Silt, sandy, moderately calcareous, light gray; con- tains fine to coarse sand; hard layer at 136 ft...	136.0	138.0
Sand and gravel, gray to reddish brown; texture grades from medium sand to fine gravel.....	138.0	160.0
Sandstone, moderately calcareous, light gray-tan; texture grades from fine to medium sand; contains a hard limy layer at 167 ft.....	160.0	170.0
Sandstone and sand, light brownish gray; texture grades from fine to coarse sand.....	170.0	174.0
Siltstone, medium brown.....	174.0	175.0
Siltstone with some sandstone, very calcareous, light gray.....	175.0	180.0
Sandstone, texture grades from fine to coarse sand..	180.0	194.0
Sandstone, light bluish gray, fine texture.....	194.0	200.0
Silt, moderately calcareous, light gray.....	200.0	205.0
Sandstone and silt, interbedded; moderately calcar- eous.....	205.0	210.0
Sand, slightly silty, light yellowish gray.....	210.0	215.0
Marl, light gray to white; contains some calcareous sandstone.....	215.0	220.0
Sandstone, moderately calcareous; fine texture; interbedded thin silt layers.....	220.0	225.0
Marl to sandstone, moderately calcareous; fine textured sand; contains thin silt layer at 226 ft.	225.0	230.0
Sandstone, moderately calcareous, light gray with tan tint; fine texture, more tan from 240 to 245 ft.....	230.0	245.0
Sand, silty, very calcareous, light grayish white...	245.0	250.0
Sandstone, slightly silty, light tannish gray; fine texture.....	250.0	263.0
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, moderately calcareous, light gray; orange zone at top; contains limonitic nodules.....	263.0	270.0
Silt, clayey, dark black, carbonaceous.....	270.0	290.0



**Test Hole #7-B-81 (E-log)**  
**(6-23-25aaaa)**  
**Gosper County**

Location: NE NE NE NE sec. 25, T. 6 N., R. 23 W., approximately  
 295 ft. south and 7 ft. west of northeast section corner.  
 Ground elevation: 2410 ft. (t) (Arapahoe NE 7.5 minute quadrangle)  
 Depth to water: 95.6 ft. (date not available)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Topsoil, dark gray.....	0.0	2.0
Silt, slightly clayey, slightly sandy, contains very fine to fine sand, slightly calcareous, light yellowish brown to brown.....	2.0	34.0
Silt, slightly clayey, dark brown to yellowish brown.....	34.0	36.0
Silt, sandy, contains very fine to fine sand, grades to sand toward base of interval, siltstone interbed from 45.8 to 48 ft., a few sand seams from 48 to 50 ft., siltstone layers from 55 to 56.5 ft., non to very calcareous, very pale brown to light brown.....	36.0	56.5
Sand, slightly silty, fine to medium grained.....	56.5	61.6
Silt, very sandy from 61.6 to 74 ft. and 75.3 to 89 ft., remainder of interval is moderately sandy, sand is very fine to medium grained, interbedded with siltstones from 74 to 80 ft., silty sand interbed from 82 to 85 ft, non to very calcareous, light brown to very pale brown.....	61.6	89.0
Sand, fine to coarse grained, predominantly medium, scattered limestone and siltstone fragments.....	89.0	98.0
Silt, very sandy, contains very fine sand, light brown.....	98.0	110.0
Sand, very fine grained, sandy silt interbed from 113.5 to 115 ft., very silty and very calcareous below 115 ft.....	110.0	120.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Sandstone and siltstone, interbedded, very fine to fine grained, very calcareous, pale to very pale brown, some siltstone and very sandy below 132.7 ft.....	120.0	136.5
Silt and siltstone, interbedded, very sandy, contains very fine sand, some sandstone interbeds from 136.5 to 140 ft., very calcareous, light brown to very pale brown.....	136.5	145.7
Sandstone, very fine grained, scattered rootlets, light yellowish brown.....	145.7	170.0
Sand, very fine to medium grained, scattered rootlets, light yellowish brown.....	170.0	180.7

Silt, very sandy, contains very fine to very coarse sand from 187.7 to 190 ft., very calcareous siltstone layers from 190 to 193 ft., very pale brown.	180.7	193.0
Sand, very fine to very coarse grained, trace of fine gravel, rootlets, light yellowish brown.....	193.0	218.0
Silt, very sandy, very calcareous below 230 ft., light yellowish brown.....	218.0	237.0
Sandstone, very fine to fine grained, slightly calcareous, light yellowish brown.....	237.0	247.2
Silt, very sandy, very calcareous, very pale brown..	247.2	254.0
Sandstone, very fine to fine grained, interbedded with silt below 260 ft., very calcareous, pale brown.....	254.0	265.0
Silt, very sandy, contains very fine to medium sand, very calcareous, very pale brown.....	265.0	269.0
Sand, very fine to coarse grained, pale brown.....	269.0	271.5
Silt, very sandy, very calcareous below 278.5 ft., very pale brown.....	271.5	280.0
Limestone and sandy silt, interbedded, very calcareous, very pale brown.....	280.0	287.5
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, weathered shale, very pale brown.....	287.5	290.0
Clay to claystone, light yellowish brown, moderately calcareous from 290 to 295 ft.....	290.0	310.0

**Test Hole #9-B-81 (E-log)**  
**(7-21-1dddd)**  
**Gosper County**

Location: SE SE SE SE sec. 1, T. 7 N., R. 21 W., approximately 6 ft. north and 146 ft. west of southeast section corner.

Ground elevation: 2,489 ft. (t) (Bertrand 7.5 minute quadrangle)

Depth to water: Unknown, hole caved at 114.5 ft. (Date not available)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Roadfill and topsoil, not sampled.....	0.0	2.5
Silt, slightly clayey, slightly to moderately calcareous, iron stains and calcium carbonate coatings below 30 ft., light yellowish brown to light olive brown.....	2.5	41.5
Silt, slightly clayey, dark brown to brown.....	41.5	47.4
Silt, very sandy, contains very fine to fine sand, less sand and slightly clayey below 50 ft., dark brown to dark grayish brown.....	47.4	53.5
Silt, slightly sandy to 60 ft., very sandy below 60 ft., sand lens at 80.3 ft., light yellowish brown to yellowish brown.....	53.5	85.0
Silt, moderately clayey, firm, yellowish brown.....	85.0	87.4
Silt, moderately sandy, contains very fine to fine sand, yellowish brown.....	87.4	90.0
Sand, very fine to fine grained, contains medium sand below 95 ft., pale brown.....	90.0	100.2
Silt, slightly sandy, yellowish brown.....	100.2	125.0
Silt, sandy to very sandy, contains very fine to fine sand, some thin interbeds of sand, sand interbed from 129.3 to 130 ft., yellowish brown...	125.0	140.0
Sand, very fine to fine grained, sandy silt interbed from 142.5 to 144.9 ft., yellowish brown.....	140.0	147.0
Clay, very silty, yellowish brown.....	147.0	158.8
Sand, very fine to fine grained, silt interbeds from 161 to 163.2 ft., 171 to 172.8 ft., and 184.4 to 185 ft., contains some medium sand and fine gravel below 185 ft., yellowish brown.....	158.8	190.0
Gravel, texture grades from very coarse sand to medium gravel.....	190.0	200.0
Sand and gravel, texture grades from medium sand to fine gravel.....	200.0	207.5
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Silt, sandy, slightly to moderately clayey, moderately calcareous, very pale brown to light brownish gray.....	207.5	217.3
Sandstone and silt, interbedded, very fine to fine grained, moderately calcareous, very pale brown...	217.3	221.8
Limestone and silt, interbedded.....	221.8	225.0

Silt, sand, and clay, interbedded, moderately calcareous, very pale brown.....	225.0	227.3
Sandstone, very fine to fine grained, pale brown....	227.3	233.8
Silt, moderately sandy, contains very fine sand, slightly clayey, moderately calcareous in areas, pale brown to light olive, becomes light gray below 240 ft.....	233.8	260.0
Sand and sandstone, very fine to fine grained, silt interbed from 261.9 to 265 ft., very pale brown...	260.0	267.3
Silt, clayey and sandy, scattered thin sandstone interbeds from 270 to 277 ft., very calcareous at 269 and 283 ft., very pale brown to pale brown....	267.3	284.0
Sand and sandstone, gradual variations, very fine to fine grained, brown.....	284.0	290.0
Silt, very sandy, contains very fine to fine sand, a few sandstone seams, slightly calcareous, very pale brown.....	290.0	295.0
Sandstone and sand, gradual variations, rootlets....	295.0	298.0
Silt, moderately to slightly sandy to 305 ft., very sandy below 305 ft., contains very fine to fine sand, slightly to very calcareous, very pale brown.....	298.0	315.0
Sandstone, very fine to fine grained, limy silt interbed from 319.7 to 320 ft., rootlets, slightly to moderately calcareous.....	315.0	328.3
Sandstone and very sandy silt, interbedded, very fine to fine grained, white limestone interbeds from 340.5 to 341.0 ft., very calcareous below 340.5 ft., very pale brown to yellowish brown....	328.3	341.0
Silt, sandy, contains very fine to fine sand, pale brown.....	341.0	352.5
Clay, very silty, very calcareous, light yellowish brown to pale yellow.....	352.5	355.5
Silt, very sandy, contains very fine to fine sand, pale olive.....	355.5	362.0
Sand, moderately to very silty, very fine to fine grained, light yellowish brown.....	362.0	375.0
Silt, moderately sandy, olive.....	375.0	382.0
Sand, very fine to fine grained, trace of medium sand to very coarse sand, very silty.....	382.0	390.6
Silt, very sandy, contains very fine to fine sand, pale olive.....	390.6	397.6
Limestone and limy silt, very calcareous, white....	397.6	399.0
Silt, sandy, contains very fine to fine sand, white.	399.0	407.9
Limestone, very calcareous, pale brown.....	407.9	409.2
Silt, moderately sandy, contains very fine to medium sand, moderately clayey below 410 ft., moderately calcareous, white to light gray.....	409.2	415.5
Sand, fine to coarse grained, predominantly medium..	415.5	418.0
Silt, moderately sandy, contains fine sand, very calcareous, light gray.....	418.0	420.0

Sand, very silty, with gradations to sandy silt, pale olive to olive.....	420.0	426.1
Silt, slightly clayey and sandy, more clayey toward bottom, very pale brown.....	426.1	430.0
Silt, very sandy, contains very fine to fine sand, slightly clayey, mostly very calcareous, very pale brown to light yellowish brown.....	430.0	453.9
Silt, clayey, sandy, contains very fine to fine sand with some medium, moderately calcareous, very pale brown.....	453.9	461.0
Clay, very silty, interbedded with silt, slightly to very calcareous, very pale brown.....	461.0	468.5
Silt, sandy, clayey with high lime content below 470 ft., very calcareous, pale brown.....	468.5	480.0
Clay, silty zones, moderately calcareous, very pale brown.....	480.0	485.0
Silt, slightly sandy, contains very fine to fine sand, clayey in areas, pale brown to very pale brown.....	485.0	510.3
Sand, fine to medium grained, predominantly medium, a few silt layers below 514.8 ft., pale brown.....	510.3	520.0
Sand, fine to very coarse grained, trace of fine gravel and fragments of chalk, some clayey silts below 525 ft.....	520.0	526.8
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, weathered shale, slightly calcareous, yellow to 530 ft., yellow gray below 530 ft.....	526.8	535.0
Clay, grading to shale at 540 ft., slightly calcareous, gray to 540 ft., dark gray below 540 ft.....	535.0	550.0

**Test Hole #44-B-48 (No e-log)  
(7-21-6bbbb)  
Gosper County**

Location: NW NW NW NW sec 6, T. 7 N. R. 21 W., approximately  
 131 feet east and 21 feet south of northwest section corner.  
 Ground elevation: 2,492.5 ft. (i) (Elwood 7.5 minute quadangle)  
 Depth to water: 134.2 ft. (10-8-48)

	Depth, in feet	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Silt, dark brownish gray; slightly clayey and darker from 1 to 2 ft.....	0.0	2.0
Silt, very slightly clayey, medium brownish gray....	2.0	3.0
Silt, buff-gray with yellow tint; coarser from 5 to 10 ft.; contains gastropod shells from 10 to 25 ft., grades darker with depth.....	3.0	48.5
Silt, sandy, brownish gray with slight red tint; contains very fine sand.....	48.5	50.0
Silt, sandy, tan-gray with red tint; contains very fine sand; trace of coarse sand from 60 to 69 ft..	50.0	69.0
Silt, very slightly clayey to slightly sandy, light gray.....	69.0	70.0
Sand, slightly silty, brown-gray; texture grades from very fine to fine with some medium sand.....	70.0	74.0
Silt, clayey, tan-gray with red tint; contains some limonitic stain.....	74.0	84.5
Sand, silty, dark reddish brown; texture grades from fine to coarse sand.....	84.5	85.0
Sand, silty, light brownish gray; texture grades from very fine to fine with some medium sand.....	85.0	88.5
Sand, very light brownish gray; texture grades from fine to coarse sand and some fine gravel.....	88.5	104.5
Silt, sandy, tan-buff with gray tint; contains very fine to fine sand.....	104.5	114.0
Sand, silty, light tan-gray; texture grades from fine to coarse sand with some gravel; less silty from 120 to 125 ft.....	114.0	125.0
Sand, light tan-gray; texture grades from fine to coarse sand with a trace of gravel.....	125.0	133.0
Silt, very slightly sandy, buff to tan-gray; contains very fine sand.....	133.0	136.5
Sand, light brownish gray; texture grades from fine to coarse sand with trace of gravel.....	136.5	144.5
Sand and gravel, brownish gray with pink grains; texture grades from fine sand to coarse gravel....	144.5	172.5
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Silt, very slightly sandy, light brownish gray; contains very fine sand; whitish gray calcareous zones from 176 to 182 ft.....	172.5	182.0

Silt, sandy, light gray with greenish tint; contains fine to coarse sand; in part calcareous and reddish tint from 185 to 189 ft.....	182.0	189.0
Silt, slightly sandy, moderately calcareous, whitish gray.....	189.0	190.0
Silt, slightly clayey to slightly sandy, very calcareous, light greenish gray to whitish gray; contains fine to medium sand, not clayey from 195 to 200 ft.....	190.0	200.0
Silt and sandstone, moderately calcareous, whitish gray; contains fine to coarse sand.....	200.0	203.0
Silt, slightly sandy, brownish gray; contains very fine sand; some fossil seeds.....	203.0	207.5
Sandstone, brownish gray; texture grades from fine to coarse sand; contains a few rootlets.....	207.5	210.0
Sand, brownish gray with some pink grains; texture grades from fine to coarse sand with some fine gravel.....	210.0	215.0
Sandstone and sandy silt; sandstone, moderately calcareous, whitish yellow, texture grades from fine to medium sand; sandy silt, light gray, contains thin calcareous zones.....	215.0	223.0
Sandstone, reddish tan; fine textured sand with a few coarser grains.....	223.0	225.0
Silt, light greenish gray and reddish tan.....	225.0	227.5
Silt, sandy, reddish tan; contains very fine to fine sand with some gravel in upper part.....	227.5	230.0
Sandstone, brownish tan; very fine texture.....	230.0	233.5
Sand and gravel, brownish gray with pink grains; texture grades from fine sand to medium gravel....	233.5	239.0
Silt, very calcareous, light gray; contains some hard limy zones.....	239.0	244.0
Silt, clayey, light greenish gray.....	244.0	246.0
Sand, silty, light gray with some green grains; texture grades from very fine to fine with some medium sand.....	246.0	250.0
Sand to sandstone, brownish gray; texture grades from fine to medium sand.....	250.0	256.0
Silt, sandy, and sandstone, interbedded; moderately to very calcareous, light tan-gray.....	256.0	263.0
Silt to marl, light gray with slight tan tint; contains clayey silt layers; reddish tan with blocky structure from 265 to 269 ft.....	263.0	269.0
Silt, sandy, tan-gray with pink tint; contains calcareous layer from 273 to 274 ft.; reddish tan below 274 ft.; greenish gray interbedded with reddish tan below 280 ft.....	269.0	286.0
Sandstone, moderately calcareous, whitish gray with slight tan tint.....	286.0	288.0
Silt, clayey, mottled reddish tan and green; contains thin limy zones from 290 to 296 ft.....	288.0	296.0

Silt, sandy, reddish tan; contains fine to medium sand; hard limy layers.....	296.0	301.0
Sandstone, light tan to gray; texture grades from very fine to fine sand, contains some calcareous silt zones.....	301.0	315.5
Sandstone, silty, light brownish gray to light tan-gray.....	315.5	330.0
Sand, slightly silty, light gray; texture grades from fine to medium sand and some coarse sand.....	330.0	370.0
Sand to sandstone, very light brownish gray; texture grades from fine to medium sand; silty from 375 to 380 ft.; contains few rootlets from 380 to 385 ft.; intermittent sandy silt layers from 385 to 395 ft.; moderately calcareous and lighter in color from 395 to 397 ft.....	370.0	397.0
Silt, sandy, light gray; contains very fine to fine sand.....	397.0	400.0
Silt, clayey, moderately calcareous, whitish gray; contains thin hard limy layers.....	400.0	402.0
Sandstone, brownish tan; texture grades from fine to medium sand.....	402.0	405.0
Sandstone, moderately to very calcareous, light tan-gray.....	405.0	409.5
Sandstone, light brownish gray; texture grades from fine to coarse sand with some fine gravel; contains intermittent silt and calcareous layers.....	409.5	415.0
Sand, silty, light gray; texture grades from fine to coarse sand with a trace of gravel.....	415.0	418.0
Silt, sandy, and sandstone, very calcareous, whitish gray; texture grades from fine to medium sand.....	418.0	424.0
Sand, silty, to silt, sandy, light gray with green tint; texture grades from fine to medium sand; trace of tan sandstone from 430 to 435 ft.; thin calcareous zones from 435 to 446.5 ft.....	424.0	446.5
Silt, very slightly sandy, light gray with brown tint; contains very fine to medium sand.....	446.5	450.0
Sandstone, whitish gray with slight tan tint; texture grades from fine to medium with some coarse sand.....	450.0	458.0
Silt and sandstone, very calcareous; texture grades from fine to medium sand.....	458.0	464.0
Silt, slightly sandy, to marl, very calcareous, white.....	464.0	468.0
Silt and sandstone, very calcareous, white; contains fine to medium sand.....	468.0	470.0
Sandstone, very calcareous, whitish gray with slight brown tint; texture grades from fine to medium sand.....	470.0	474.0
Silt, sandy, light gray with slight tan tint; in part calcareous.....	474.0	480.0



Silt, slightly clayey to sandy, very calcareous, light gray with slight pink to tan tint.....	480.0	485.5
Silt and sandstone, very calcareous, whitish gray...	485.5	487.0
Silt, sandy, light gray; contains very fine to fine sand; a few limonitic fragments.....	487.0	489.5
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, slightly silty, whitish gray; contains lim- onitic and limy fragments.....	489.5	494.0
Clay, very light gray.....	494.0	498.0
Clay shale, silty, in part moderately calcareous, yellowish brown; contains red shale and some yellow bentonite.....	498.0	500.0
Shale, slightly silty clay, very calcareous, yellowish brown; contains two thin limestone layers; grades lighter with depth.....	500.0	520.0
<b>Cretaceous System - Upper Cretaceous Series - Colorado Group:</b>		
<b>Niobrara Formation:</b>		
Shale, chalky, light yellow to white.....	520.0	526.5
Shale, chalky silty clay, medium brownish gray.....	526.5	530.0

**Test Hole #45-B-48 (No e-log)  
(7-21-18cccc)  
Gosper County**

Location: SW SW SW SW sec. 18, T. 7 N., R. 21 W., approximately  
71 feet north and 25 feet east of southwest section corner.

Ground elevation: 2,583.6 ft. (i) (Elwood 7.5 minute quadrangle)

Depth to water: 241.1 ft. (10-13-48)

Depth, in feet  
From To

**Quaternary System, undifferentiated:**

Soil: silt, dark brownish gray; slightly granular below 1 ft.....	0.0	2.0
Silt, very slightly clayey, light to medium grayish brown.....	2.0	2.5
Silt, very slightly calcareous, medium buff-gray; noncalcareous from 2.5 to 5 ft. and 25 to 43.5 ft.; slightly granular from 5 to 7 ft.; contains limy rootlets from 7 to 10 ft.; gastropod shells from 7.6 to 20 ft.; limonitic nodules from 7 to 7.6 ft. and 20 to 25 ft.....	2.5	43.5
Silt, soil-like, very slightly clayey, brownish tan to reddish brown.....	43.5	50.0
Silt, tan-gray to pink; slightly clayey from 55 to 60 ft.....	50.0	65.0
Silt, sandy, tan-gray; contains fine to coarse sand.	65.0	125.5
Sand, slightly silty; texture grades from fine to coarse sand with trace of fine gravel.....	125.5	129.5
Silt, moderately calcareous, buff-gray.....	129.5	130.5
Sand, brownish gray; texture grades from very fine to coarse sand, silty from 137 to 139 ft. and 173 to 180 ft.; texture grades from very fine to medium sand from 180 to 184.5 ft.....	130.5	184.5
Sand, silty, to silt, sandy, light brownish gray; texture grades from very fine to medium with some coarse sand; contains a few limonitic flecks and rootlets.....	184.5	192.0
Silt, sandy, light brownish tan; contains very fine sand.....	192.0	195.0
Silt, brownish gray with slight tan tint; contains some calcareous zones and a few limy nodular fragments; no limy nodules from 200 to 205 ft.; embedded sand from 205 to 220 ft.....	195.0	220.0
Silt, sandy, slightly calcareous, light brownish gray; contains fine sand.....	220.0	223.0
Sand, light brownish gray; texture grades from fine to medium sand.....	223.0	232.0
Silt, sandy, light brownish gray; contains fine sand.....	232.0	235.0

Sand, light brownish gray; texture grades from fine to medium sand.....	235.0	240.0
Silt, very calcareous, light tan-gray; embedded sand grains.....	240.0	244.0
Sand and gravel, reddish brown; texture grades from medium sand to coarse gravel.....	244.0	329.0
Silt, sandy, light brownish gray; contains fine sand.....	329.0	340.0
Sand, silty, light tan-gray.....	340.0	345.0
Sand and gravel, reddish brown with grayish orange grains.....	345.0	350.0
Sand, silty, light tan-gray.....	350.0	357.0
Sand and gravel; texture grades from medium sand to coarse gravel.....	357.0	362.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Sand and silt, moderately calcareous, light grayish white; contains fine sand.....	362.0	367.0
Sandstone, moderately calcareous, light gray; texture grades from fine to medium sand; hard layer at 367 ft.....	367.0	372.0
Sand and gravel; texture grades from medium sand to coarse gravel.....	372.0	378.0
Silt, moderately calcareous, light gray with pinkish tan tint.....	378.0	380.0
Sandstone, moderately calcareous, light brownish gray; texture grades from fine to medium sand....	380.0	400.0
Silt, very calcareous, light gray to white.....	400.0	413.0
Sand, silty, light gray with yellow tint; texture grades from fine to medium sand.....	413.0	420.0
Sand, texture grades from fine to medium; contains white calcareous sandstone layers.....	420.0	430.0
Sand, slightly silty, light gray with greenish yellow tint; texture grades from fine to medium sand.....	430.0	450.0
Siltstone, sandy, light gray with yellowish green tint; contains fine sand.....	450.0	459.0
Silt, sandy, light grayish white; contains fine sand and a consolidated layer at 467 ft.....	459.0	475.0
Sand, slightly silty, light brownish gray; texture grades from fine to coarse sand.....	475.0	480.0
Sand, light gray with green tint; texture grades from fine to coarse sand.....	480.0	486.0
Sandstone and siltstone, interbedded, light tan-gray; contains fine to coarse sand.....	486.0	490.0
Siltstone and silt, interbedded, light gray-green...	490.0	494.0
Siltstone, clayey, light pinkish brown.....	494.0	500.0
Silt and siltstone, sandy, light gray to white; contains fine sand.....	500.0	505.0
Silt, sandy, moderately calcareous, light grayish white; contains hard calcareous layer at 527 ft...	505.0	540.0

Silt, clayey, very calcareous, light brownish tan- gray.....	540.0	573.0
<b>Cretaceous System - Upper Cretaceous Series - Colorado Group:</b>		
<b>Niobrara Formation:</b>		
Clay, very calcareous, very light gray; limonitic stains from 573 to 575 ft.....	573.0	589.0
Clay shale, very calcareous, medium gray.....	589.0	600.0

**Test Hole #53-A-48 (No e-log)**  
**(7-23-30bbbb)**  
**Gosper County**

Location: NW NW NW NW sec. 30, T. 7 N., R. 23 W., approximately  
 130 feet south and 40 feet east of northwest section corner.  
 Ground elevation: 2,564.7 ft. (i) (Elwood SW 7.5 minute quadrangle)  
 Depth to water: 170.7 ft. (11-1-48)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Soil: silt, dark brownish gray; grades slightly darker.....	0.0	3.0
Silt, dark buff-gray; slightly granular from 5 to 10 ft.; contains a few gastropod shells from 5 to 25 ft.; limonitic stains and nodules from 10 to 25 ft.; slightly darker from 25 to 37.5 ft.....	3.0	37.5
Silt, dark reddish brown; light reddish brown below 42 ft.....	37.5	45.0
Silt, moderately calcareous, light gray-buff; slightly calcareous from 55 to 60 ft.; contains hard calcareous zones from 60 to 65 ft., 70 to 75 ft., and 85 to 88 ft.....	45.0	88.0
Silt, slightly clayey, very calcareous, light gray with buff tint; more clayey and calcareous zones from 96 to 98 ft.....	88.0	105.0
Silt, medium buff-gray; very coarse texture.....	105.0	110.0
Silt, moderately calcareous, medium buff-gray; calcareous zone at 118.5 ft.; slightly calcareous and contains a few limestone nodules from 120 to 125 ft.....	110.0	129.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Silt, embedded sand.....	129.0	133.0
Silt, sandy, moderately calcareous, light grayish white.....	133.0	134.0
Clay, sandy, moderately calcareous, light gray; contains fine to coarse sand.....	134.0	140.0
Sand and gravel, orange to pink-gray; texture grades from medium sand to medium gravel.....	140.0	159.0
Silt, medium reddish brown; embedded sand.....	159.0	165.0
Silt, very calcareous, light pinkish gray; contains fine to coarse sand.....	165.0	168.0
Sand and gravel, dark reddish brown; texture grades from medium sand to medium gravel.....	168.0	177.0
Marl, white.....	177.0	177.5
Silt, sandy, light reddish brown, mottled light gray; contains fine to coarse sand.....	177.5	190.0
Silt, sandy, light gray; contains intermittent hard calcareous zones.....	190.0	198.0
Silt, medium reddish brown.....	198.0	202.0

Marl, light grayish white.....	202.0	203.5
Sandstone, medium gray; fine texture; contains interbedded silt.....	203.5	205.0
Silt, sandy, medium gray; contains fine sand.....	205.0	210.0
Silt, very slightly clayey, medium gray.....	210.0	214.0
Silt, moderately calcareous, light grayish white....	214.0	215.0
Silt, light grayish white.....	215.0	217.0
Silt, sandy, moderately calcareous, medium gray; contains fine to medium sand.....	217.0	222.0
Sandstone, slightly calcareous, light reddish brown; texture grades from fine to medium sand; contains thin silt layers; moderately calcareous from 240 260 ft.....	222.0	260.0
Sandstone, slightly silty, moderately calcareous, light gray; contains intermittent hard calcareous zones.....	260.0	275.0
Silt, sandy, light gray; contains fine sand.....	275.0	280.0
Sand, slightly silty; contains hard calcareous layers.....	280.0	290.0
Sandstone, moderately calcareous, light tannish gray; texture grades from fine to medium sand.....	290.0	300.0
Sand and gravel; texture grades from fine sand to medium gravel; contains hard zone below 336 ft....	300.0	336.5
<b>Cretaceous System - Upper Cretaceous Series - Colorado Group:</b>		
<b>Niobrara Formation:</b>		
Silt, sandy, very calcareous, light yellowish white; contains hard zone 336.5 to 340 ft.....	336.5	360.0
Marl, white.....	360.0	361.0
Silt, very calcareous, light yellowish gray; contains thin red layer between 370 to 375 ft.....	361.0	380.0
Silt and siltstone, light yellow; contains hard white calcareous particles.....	380.0	385.0
Silt, very calcareous, light yellow; granular and slightly darker from 390 to 400 ft.....	385.0	410.0
Shale, silty, very calcareous; dark brown.....	410.0	430.0
Shale, silty, very calcareous, dark gray.....	430.0	470.0

**Test Hole #4-B-81 (E-log)**  
**(7-23-36aaaa)**  
**Gosper County**

Location: NE NE NE NE sec. 36, T. 7 N., R. 23 W., approximately  
 46 ft. south and 9 ft. west of northeast section corner.  
 Ground elevation: 2,555 ft. (t) (Elwood 7.5 minute quadrangle)  
 Depth to water: 168 ft. (date not available)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Roadfill and topsoil.....	0.0	4.0
Silt, clayey, slightly calcareous, a few thin shell fragments below 30 ft., light brownish gray to pale brown.....	4.0	37.0
Silt, varies from slightly to moderately clayey, dark brown to dark grayish brown.....	37.0	47.3
Silt, slightly clayey, contains very fine sand, sandy zone from 55 to 57 ft., moderately calcareous, limy concretions from 60 to 65 ft., pale brown to brown.....	47.3	90.0
Silt, very sandy, contains very fine sand, trace of medium sand from 100 to 110 ft., slightly clayey, slightly calcareous, pale brown to yellowish brown.....	90.0	141.4
Silt, clayey, slightly sandy, contains very fine sand, slightly calcareous to 160 ft., moderately to very calcareous below 160 ft., light yellowish brown to very pale brown.....	141.4	179.7
Sand, very fine to very coarse grained with trace of fine gravel, pale brown.....	179.7	187.8
Silt, very sandy, yellowish brown, very calcareous..	187.8	190.0
Sand, very fine to medium grained, predominantly medium, pale brown.....	190.0	192.0
Silt, very sandy, very calcareous, limy zones, pale brown.....	192.0	201.5
Sand, very fine to coarse grained, contains some very coarse sand below 205 ft., predominantly medium to coarse sand.....	201.5	209.5
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Sandstone, lime-cemented, very silty, very fine to fine grained, very pale brown to white.....	209.5	211.5
Sand, very fine to very coarse grained, predominantly medium to coarse.....	211.5	214.5
Silt, moderately sandy, contains very fine to fine sand, limy seams and zones of lime cementation, slightly to moderately calcareous, pale reddish brown becoming pale olive and pale brown below 230 ft.....	214.5	245.0

Sandstone and silt, sandstone is very fine to fine grained, reddish brown.....	245.0	250.0
Sand and sandstone, interbedded, sandstone predominates, very fine to medium grained, trace of coarse sand and fine gravel above 255 ft., fine sand predominates, a few rootlets from 260 to 265 ft., pale brown to pale olive.....	250.0	270.0
Sand, very fine to medium grained, predominantly fine to medium, limy to lime cemented from 280 to 285 ft., a few rootlets below 290 ft., brown.....	270.0	302.0
Silt, slightly clayey, sand, contains hard intervals, slightly to very calcareous, pale brown to brown.....	302.0	308.0
Sand, very fine grained, silty, rootlets, brown.....	308.0	314.0
Sandstone, very fine to fine grained, limy, moderately calcareous, bottom 1 ft. is less consolidated.....	314.0	321.1
Silt, sandy to sandstone, very fine grained, slightly calcareous, brown.....	321.1	325.0
Sand with gradual variations to sandstone, scattered silt seams, pale olive to pale yellow.....	325.0	340.0
Silt, sandy, contains very fine to fine sand, clayey from 349 to 355 ft., sandstone interbeds from 355 to 360 ft., pale brown.....	340.0	368.0
Sand, very fine to fine grained, some slightly calcareous silts from 370 to 375 ft., brown.....	368.0	395.0
Silt, slightly sandy, contains very fine sand, slightly clayey, very pale olive to pale reddish brown.....	395.0	405.0
Sand, very fine to very coarse grained, predominantly medium, trace of fine gravel.....	405.0	415.0
Sand, very fine to medium grained, trace of very coarse sand, slightly silty.....	415.0	435.0
Sand, very fine to very coarse, trace of fine gravel, very calcareous sandy silt interbeds from 450 to 453 ft. and 465 to 468 ft., pale olive to green.....	435.0	477.3
<b>Cretaceous System - Upper Cretaceous Series - Montana Group:</b>		
<b>Pierre Formation:</b>		
Clay, silty, weathered chalk, white to pale yellow, dark gray below 490 ft.....	477.3	500.0



**Test Hole #USBR-2 (No e-log)  
(8-21-16cddc)  
Gosper County**

Location: SW SE SE SW sec. 16, T. 8 N., R. 21 W., approximately 2,220 ft. east and 300 ft. north of the southwest section corner.  
 Ground elevation: 2,420 ft. (t) (Bertrand NW 7.5 minute quadrangle)  
 Depth to water: 85 ft. (1947)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Topsoil, silty, some organic matter, dark gray.....	0.0	4.0
Clay, very silty, light gray.....	4.0	16.0
Sand, layers of fine and very fine, slightly compact, gray with brown, tans, and reddish shades...	16.0	35.0
Clay, very silty, contains layers of very fine sand, shades of green, gray, tan and brown.....	35.0	50.0
Sand, very fine to fine, slightly compact, gray to tan and brown.....	50.0	72.0
Silt, slightly clayey, slightly sandy, texture like flour, gray to brown and tan.....	72.0	77.0
Sand, very fine to fine, silty layer at 83 ft., slightly compact, bands of gray and tan.....	77.0	85.0
Silt, slightly sandy, gray.....	85.0	88.0
Sand, very fine to fine, slightly compact.....	88.0	97.0
Sand and gravel.....	97.0	106.0

**Test Hole #USBR-2A (No e-log)  
(8-21-16cddd)  
Gosper County**

Location: SE SE SE SW sec. 16, T. 8 N., R. 21 W., approximately  
 2,500 ft. east and 200 ft. north of southwest section corner.  
 Ground elevation: 2,405 ft. (t) (Bertrand NW 7.5 minute quadrangle)  
 Depth to water: Not recorded

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Clay, silty, gray.....	0.0	5.0
Sand, very fine, scattered silty sand seams, tan to gray.....	5.0	24.0
Silt, sandy at 26 and 41 ft., light gray to tan with greenish hues.....	24.0	42.0
Sand, very fine to fine, bands of tan, gray, and reddish shades.....	42.0	61.0
Sand, very fine, slightly silty, slightly compact to cemented, tan to brown.....	61.0	65.0
Silt, with layers of clay and fine sand, bands of gray, tan, and brown.....	65.0	78.0
Sand, very fine, gray silt at 78 ft., brown.....	78.0	80.0

**Test Hole #89-33 (No e-log)  
(8-21-16d)  
Gosper County**

Location: SE sec. 16, T. 8 N., R. 21 W.

Ground elevation: 2,400 ft. (t) (Bertrand NW 7.5 minute quadrangle)

Depth to water: Not recorded

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Clay, silty, yellow.....	0.0	46.0
Gravel, interbedded with fine to coarse sand.....	46.0	60.0

**Test Hole #USBR-5 (E-log)**  
**(8-21-19adad)**  
**Gosper County**

Location: SE NE SE NE sec. 19, T. 8 N., R. 21 W., 32.5 ft. west and  
 1,685.3 ft. south of the northeast section corner.  
 Ground elevation: 2,511.0 ft. (i) (Bertrand NW 7.5 minute quadrangle)  
 Depth to water: 99.1 ft. (5-12-87)

Depth, in feet  
 From            To

**Quaternary System, undifferentiated:**

Topsoil, clay, some roots slightly to moderately calcareous, brown.....	0.0	2.0
Silt, slightly to very calcareous from 2 to 9 ft., noncalcareous below 9 ft., scattered rust spots, scattered worm and root holes, tan.....	2.0	39.0
Silt, scattered small holes and black spots, reddish brown.....	39.0	51.9
Silt, sandy, contains fine sand, reddish brown.....	51.9	53.0
Clay, sandy, contains fine sand, thin black streaks and small holes, reddish brown.....	53.0	56.5
Sand, fine grained, silty, very calcareous to 60 ft., reddish brown.....	56.5	64.4
Sand, fine grained, slightly silty, tan.....	64.4	75.0
Sand, fine grained, silty, tan.....	75.0	77.2
Silt, tan with orange streaks.....	77.2	81.5
Silt, brown, soil horizon.....	81.5	84.0
Silt, sandy, tan.....	84.0	97.9
Clay, brown with black spots.....	97.9	98.4
Silt, gray to black with small holes, slightly calcareous.....	98.4	101.0
Sand, fine grained, silty, reddish brown.....	101.0	107.4
Silt, very slightly sandy, contains fine sand, reddish brown.....	107.4	121.4
Sand, fine grained, very silty, reddish brown.....	121.4	128.9
Sand, fine grained with trace of medium to coarse sand, arkosic, tan.....	128.9	158.0
Silt, sandy, contains fine sand, tan.....	158.0	160.0
Clay, calcium nodules present, very calcareous, gray-brown.....	160.0	162.0
Sand, fine grained, tan.....	162.0	165.9
Sand, fine to coarse grained with trace of gravel, arkosic, tan, layer of fine sand from 175.5 to 176.0 ft.....	165.9	183.0
Sand, fine to coarse grained with 10 percent gravel, arkosic, tan.....	183.0	193.2

**Tertiary System - Miocene Series - Ogallala Group:**

Siltstone, weathered, very calcareous, soft, reddish brown.....	193.2	197.0
Siltstone-sandstone, calcareous, hard, gray.....	197.0	201.1

Sand, fine grained, very slightly silty, tan.....	201.1	202.5
Sandstone-siltstone, lightly indurated, very calcareous.....	202.5	209.4
Claystone, heavily veined with lime, indurated, very calcareous, olive.....	209.4	214.1
Sandstone, fine to coarse grained, silty, lightly indurated, very calcareous, gray.....	214.1	218.9
Claystone, lightly indurated, olive-brown.....	218.9	221.8
Sand, fine grained, silty, several 0.2 ft. lime cemented zones which are very calcareous, tan.....	221.8	231.4
Claystone, lightly indurated, very calcareous, lime mottled, gray.....	231.4	234.0
Siltstone, sandy, contains fine sand, lime rich zones, very calcareous, olive.....	234.0	242.5
Sandstone, fine grained, very silty, lightly indurated, olive.....	242.5	246.5
Sand, fine grained, trace of coarse sand, very silty, tan.....	246.5	250.0
Sand, fine to coarse sand, predominantly fine, olive.....	250.0	256.0
Silt-siltstone, sandy, olive.....	256.0	260.0
Sand-sandstone, fine grained, silty, olive.....	260.0	278.0
Silt-siltstone, sandy, with 4 to 6 ft. thick interbeds of silty sand and sandstone, olive.....	278.0	314.0
Sand-sandstone, fine grained, silty, contains 2 to 8 ft. interbeds of sandy silt and siltstone below 336 ft., olive.....	314.0	366.0
Silt-siltstone, sandy, contains several 2 ft. layers of silty sand and sandstone, olive.....	366.0	400.0
Sand-siltstone, silty and silt-siltstone, sandy, interbedded in 2 to 8 ft. layers, slightly calcareous, olive.....	400.0	484.0
Silt-siltstone, sandy contains fine sand, slightly calcareous, silty sand-sandstone from 490 to 498 ft., olive.....	484.0	501.0

**Test Hole #46-A-48 (No e-log)  
(8-21-19bbbb)  
Gosper County**

Location: NW NW NW NW sec. 19, T. 8 N., R. 21 W., approximately  
92 feet east and 26 feet south of northwest section corner.  
Ground elevation: 2,598.5 ft. (i) (Johnson Lake 7.5 minute  
quadrangle)  
Depth to water: 210.0 ft. (10-22-48).

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Soil: silt, dark grayish brown; granular above 1 ft.....	0.0	2.0
Silt, slightly calcareous, light buff; contains rootlets from 5 to 10 ft.; gastropod shells from 5 to 25 ft.....	2.0	46.0
Silt, dark reddish brown.....	46.0	48.0
Silt, slightly calcareous, light reddish brown.....	48.0	57.0
Silt, very slightly clayey, slightly calcareous, light buff-yellow-gray; contains thin soil zones at top.....	57.0	60.0
Silt, medium reddish buff.....	60.0	66.0
Silt, light brownish gray; coarse textured.....	66.0	70.0
Sand, light tan-gray; texture grades from fine to coarse sand.....	70.0	97.0
Silt, sandy, medium reddish buff; contains fine sand	97.0	112.0
Sand, light reddish gray; texture grades from fine to medium sand.....	112.0	117.0
Silt, sandy, medium reddish buff; contains fine sand	117.0	126.0
Sand, light reddish tan-gray; texture grades from fine to medium sand.....	126.0	135.0
Silt, sandy, medium reddish buff; contains fine sand	135.0	140.0
Silt, medium reddish buff; coarse texture.....	140.0	165.0
Sand, light reddish tan.....	165.0	175.0
Silt, slightly clayey, medium reddish buff.....	175.0	180.0
Silt, light gray; orange from 180 to 190 ft.; some iron staining from 190 to 195 ft.; reddish tint from 195 to 200 ft.; yellow in part from 225 to 231 ft.....	180.0	231.0
Sand, slightly silty, light bluish white to gray; texture grades from fine to medium sand.....	231.0	244.0
Silt, highly calcareous, light gray with tan tint...	244.0	250.0
Sand, gray to pinkish brown and yellow; texture grades from fine to coarse sand with some fine gravel.....	250.0	260.0
Sand and gravel; texture grades from medium sand to medium gravel; hard layers from 269.5 to 271 ft...	260.0	277.0

**Tertiary System - Miocene Series - Ogallala Group:**

Silt, sandy, moderately calcareous, light gray; contains fine to coarse sand; very calcareous white layer at 280.0 ft.; hard sandstone layer at 296 ft.....	277.0	300.0
Silt and marl, interbedded, very calcareous, light grayish white.....	300.0	305.0
Silt, clayey, slightly calcareous, pink.....	305.0	306.0
Silt, sandy, light gray with green tint; contains intermittent hard layers from 312 to 317.5 ft.....	306.0	317.5
Claystone, medium brown.....	317.5	320.0
Marl, light grayish white.....	320.0	323.0
Claystone, medium light gray to green.....	323.0	324.5
Marl, light grayish white.....	324.5	327.5
Silt, sandy to slightly clayey, light greenish gray; contains very fine sand.....	327.5	330.0
Silt, sandy, light gray with yellow tint; contains fine to medium sand.....	330.0	342.5
Marl, light whitish gray.....	342.5	345.0
Sandstone, light brown; fine texture; light greenish gray from 350 to 356 ft.....	345.0	356.0
Silt, sandy, light gray with green tint; contains fine sand.....	356.0	360.0
Silt, very calcareous, white.....	360.0	361.0
Sandstone, medium brown; fine texture.....	361.0	367.5
Silt, sandy, light brown; contains sandstone layers.....	367.5	370.0
Sandstone, light gray with green tint; fine texture, contains hard calcareous layers.....	370.0	380.0
Sandstone, pinkish gray; fine texture.....	380.0	384.0
Sand, silty, light pinkish gray; fine texture.....	384.0	390.0
Silt, sandy, light pinkish brown; contains fine sand; hard calcareous layer at 397.5 ft.....	390.0	400.0
Sand and gravel, gray, orange and reddish brown; texture grades from medium sand to medium gravel.....	400.0	430.0
Silt, sandy, light gray; contains fine to medium sand.....	430.0	440.0
Sand, light tan-gray; texture grades from very fine to medium sand with some coarser grains.....	440.0	473.5
Silt, sandy, light gray; contains fine sand.....	473.5	475.0
Sand, light tan-gray; texture grades from fine to medium sand; slightly silty from 490 to 510 ft.; thin calcareous layer at 517 ft.....	475.0	527.0
Marl, light grayish white.....	527.0	540.0
Sand; texture grades from fine to coarse sand.....	540.0	552.0
Sand, silty, light gray; texture grades from fine to medium sand.....	552.0	557.0
Sand; texture grades from fine to coarse sand with some fine gravel.....	557.0	560.0

Sand and gravel; texture grades from medium sand to medium gravel; very calcareous layer from 569 to 570 ft.; coarser texture from 569 to 575 ft.....	560.0	575.0
Silt, sandy, slightly calcareous, light gray; contains fine sand.....	575.0	580.0
Silt, sandy, medium brown; contains fine sand.....	580.0	586.0
Sand and gravel, gray-pink to reddish brown; texture grades from coarse sand to medium gravel.....	586.0	596.0
Silt, slightly clayey to sandy, light gray; contains sand and gravel from 616 to 617 ft.....	596.0	620.0
Sand and gravel; texture grades from coarse sand to medium gravel.....	620.0	627.0
Silt, sandy, very calcareous, light gray; contains fine sand.....	627.0	630.0
Sand, silty, light gray; texture grades from fine to coarse sand.....	630.0	635.0
Sand and gravel; texture grades from coarse sand to medium gravel.....	635.0	637.5
Silt, slightly clayey to sandy; contains fine sand..	637.5	640.0
Gravel, gray to dark reddish brown.....	640.0	659.0
<b>Cretaceous System - Upper Cretaceous Series - Colorado Group:</b>		
<b>Niobrara Formation:</b>		
Chalk, white.....	659.0	670.0
Shale, chalky, very calcareous, dark gray-brown, darker below 680 ft.....	670.0	686.0
Shale, chalky, very dark gray.....	686.0	700.0



**Test Hole #USBR-3 (No e-log)  
(8-21-21aadd)  
Gosper County**

Location: SE SE NE NE sec. 21, T. 8 N., R. 21 W., approximately  
900 ft. west and 1,100 ft. south of northeast section corner.  
Ground elevation: 2,455 ft. (t) (Bertrand NW 7.5 minute quadrangle)  
Depth to water: 100 ft. (1947)

	Depth, in feet	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Clay, silty, greenish gray to 38 ft., gray from 38 to 41 ft., greenish gray from 41 to 42 ft., gray from 42 to 44 ft., and gray and brown from 44 to 45 ft.....	0.0	45.0
Sand, fine, gray.....	45.0	53.0
Sand, with layers of silty sand, fine to medium grained, slightly compact, sand is gray to brown, silty sand is tan.....	53.0	64.0
Sand, silty, fine to medium grained, slightly compact, gray to green and brown.....	64.0	71.0
Silt, firm, sand seam at 73 ft., gray.....	71.0	75.0
Sand, very fine to fine, slightly compact, gray to light gray.....	75.0	99.0
Silt and sand, alternating layers from 1 to 3 ft. thick, firm, sand is fine to medium, gray.....	99.0	110.0
Sand and gravel, gravel to 2 1/2 inches, fine to medium sand layer from 103 to 105 ft, gray.....	110.0	125.0
Sand, with gravel to 3 inches, slightly cemented....	125.0	129.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Sand, very fine, slightly cemented, white veinlets throughout, tan and light gray.....	129.0	131.0

**Test Hole #USBR-1 (No e-log)  
(8-21-21abaa)  
Gosper County**

Location: NE NE NW NE sec. 21, T. 8 N., R. 21 W., approximately 1,600 ft. west and 100 ft. south of northeast section corner.

Ground elevation: 2,390 ft. (t) (Bertrand NW 7.5 minute quadrangle)

Depth to water: 39 ft. (1947)

Depth, in feet  
From            To

**Quaternary System, undifferentiated:**

Silt, slightly clayey, silty sand layers at 4, 20, 24, 27, 30, 31, 32, 35, 37, 42, 43, and 46 ft., firm, greenish gray with yellow brown hues.....	0.0	51.0
Sand and gravel, texture grades from fine sand to fine cobbles, particles are rounded and semi-rounded, cobbles to 3 inches in size, gray and brown.....	51.0	70.0

**Test Hole #USBR-4 (No e-log)  
(8-21-21addd)  
Gosper County**

Location: SE SE SE NE sec. 21, T. 8 N., R. 21 W., approximately 1,400 ft. south and 50 ft. west of northeast section corner.  
 Ground elevation: 2,467 ft. (t) (Bertrand NW 7.5 minute quadrangle)  
 Depth to water: 112 ft. (4-1947)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Topsoil, silty, brown, some organic material.....	0.0	2.0
Clay, silty, hues and layers of gray, green, brown, and tan.....	2.0	53.0
Sand, fine to medium grained, slightly compact, layers of brown, green, and gray.....	53.0	82.0
Sand, fine to medium grained, gray, brown, and green, slightly cemented.....	82.0	87.0
Silt, some sandy and clayey layers, compact, greenish gray.....	87.0	93.0
Sand, fine grained, silty at top and at 101 ft., gray.....	93.0	112.0
Silt, sandy, clayey, contains ½ inch fragments of reworked Ogallala, slightly cemented, gray.....	112.0	115.0
Sand, very fine to medium grained, slightly cemented, gray.....	115.0	121.0
Sand and gravel, texture grades from fine sand to 3 inch gravels, gray.....	121.0	124.0

**Test Hole #90-33 (No e-log)  
 (8-21-21c)  
 Gosper County**

Location: SW, sec. 21, T. 8 N., R. 21 W.

Ground elevation: 2,415 ft. (t) (Bertrand NW 7.5 minute quadrangle)

Depth to water: Not recorded

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Clay, silty, yellow.....	0.0	64.0
Gravel, texture ranges from fine to coarse, and some sand.....	64.0	78.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Silt, clayey to sandy, calcareous.....	78.0	85.0

**Test Hole #USBR-6 (E-log)**  
**(8-21-21cbbc)**  
**Gosper County**

Location: SW NW NW SW sec. 21, T. 8 N., R. 21 W., 349.3 ft. south and  
 17 ft. east of west ½ mile line.

Ground elevation: 2,473.6 ft. (i) (Bertrand 7.5 NW minute quadrangle)

Depth to water: 73 ft. (E-log, 4-1-87)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Topsoil, clay, numerous roots, dark brown.....	0.0	1.5
Silt, scattered root holes and rust spots, a few snail shells, very slightly calcareous, tan.....	1.5	42.7
Silt, slightly sandy, contains fine sand, rootlet holes, white spots, reddish brown.....	42.7	54.6
Silt, very sandy, contains fine sand, reddish brown.	54.6	72.6
Sand, fine to medium grained, silty, tan to brown...	72.6	75.0
Silt, slightly sandy, contains fine sand, tan.....	75.0	81.4
Clay, reddish brown with black spots.....	81.4	88.2
Silt, slightly sandy, contains very fine sand, brown.....	88.2	94.4
Clay, slightly to very calcareous, lime nodules, gray.....	94.4	96.8
Clay, very slightly sandy, contains fine sand, reddish brown.....	96.8	97.6
Silt, very sandy, contains fine sand, reddish brown.	97.6	104.1
Clay, reddish brown.....	104.1	105.0
Silt, trace of fine sand, brown.....	105.0	106.1
Sand, fine grained, tan.....	106.1	108.5
Sand, very silty, tan.....	108.5	110.4
Sand, fine grained, tan.....	110.4	124.6
Sand, fine grained, silty, reddish brown.....	124.6	129.0
Sand, fine to medium grained, predominantly fine, layer of fine to coarse sand from 135.5 to 135.7 ft., tan with orange banding.....	129.0	136.7
Sand, fine to coarse grained, predominantly fine, with 10 percent fine gravel, tan.....	136.7	150.2
Sand and gravel, texture grades from fine sand to coarse gravel, tan.....	150.2	152.3
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Siltstone, firm, very calcareous, olive green.....	152.3	157.6
Clay, sandy, contains fine sand, slightly calcar- eous, olive.....	157.6	162.1
Sand-sandstone, fine grained, silty, slightly cal- careous, light olive.....	162.1	177.0
Siltstone, sandy, contains fine sand, slightly cal- careous, light olive.....	177.0	197.0
Sand-sandstone, fine grained, silty, slightly cal- careous, light olive.....	197.0	201.0

Silt-siltstone, sandy, contains fine sand, slightly calcareous, light olive.....	201.0	218.0
Sand-sandstone, fine grained, silty, several intervals of sandy silt, slightly calcareous, light olive.....	218.0	253.0
Sand-sandstone, silty and silt-siltstone, interbedded in 4 to 10 ft. beds, slightly calcareous, light olive.....	253.0	356.0
Sand-sandstone, fine grained, silty, slightly calcareous, light olive.....	356.0	386.0
Silt-siltstone, sandy, contains fine sand, slightly calcareous, light olive.....	386.0	395.0
Sand-sandstone, fine grained, silty, scattered 2 to 4 ft. thick silt-siltstone beds, slightly calcareous, light olive.....	395.0	451.0
Silt-siltstone, sandy, contains fine sand, slightly calcareous, light olive.....	451.0	485.0
Sand-sandstone, fine grained, silty, slightly calcareous, light olive.....	485.0	501.0

**Test Hole #USBR-7 (E-log)**  
**(8-21-21cddd)**  
**Gosper County**

Location: SE SE SE SW sec. 21, T. 8 N., R. 21 W., 301.1 ft. west and 0 ft. from south ½ mile line.

Ground elevation: 2,405.2 ft. (i) (Bertrand NW 7.5 minute quadrangle)

Depth to water: 14.3 ft. (1-23-87)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Silt, very sandy, contains fine sand, brown.....	0.0	9.0
Silt, thinly bedded, brown with dark brown spots....	9.0	11.4
Clay, fine sand seam at 12 ft., brownish gray with rust spots.....	11.4	13.0
Silt, brown.....	13.0	23.7
Sand, silty, contains fine sand, brown.....	23.7	25.0
Silt, clayey, sandy, contains fine sand, brown.....	25.0	36.0
Silt, clayey, very sandy, contains fine sand, reddish tan with scattered black streaks.....	36.0	38.0
Sand, fine grained, silty, tan.....	38.0	44.0
Sand, fine grained, very slightly silty, silty sand from 46 to 48 ft. and silt from 48 to 48.5 ft., tan.....	44.0	53.0
Sand, fine grained, silty, tan.....	53.0	70.2
Sand, fine to coarse sand with 15 percent fine to coarse gravel, slightly calcareous, tan.....	70.2	79.0
Sand, gravelly, fine to coarse sand with 40 percent fine to coarse gravel, slightly silty, arkosic, brown.....	79.0	87.5
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Siltstone, very calcareous, firm, light green.....	87.5	98.0
Sand-sandstone, fine grained, silty, lightly indurated, very calcareous, light green.....	98.0	107.0
Sand, fine grained, silty, very calcareous, light green.....	107.0	138.0
Clay, very sandy, contains fine sand, very calcareous, reddish brown.....	138.0	156.0
Sand, fine grained, very silty, very calcareous, light green.....	156.0	237.0
Sand, fine grained, silty, very calcareous, light green.....	237.0	325.0
Silt, very sandy, contains fine sand, very calcareous, olive.....	325.0	335.0
Sand, fine grained, silty, silt content increased below 455 ft., very calcareous, light green.....	335.0	498.0

**Test Hole #USBR-8 (No e-log)**  
**(8-21-22cccd)**  
**Gosper County**

Location: SE SW SW SW sec. 22, T. 8 N., R. 21 W., 577 ft. east and  
 21.5 ft. north of southwest section corner.  
 Ground elevation: 2,484.7 ft. (i) (Bertrand NW 7.5 minute quadrangle)  
 Depth to water: Not encountered (1987)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Silt, sandy, contains fine sand, brown.....	0.0	3.6
Sand, fine grained, silty, tan.....	3.6	11.9
Silt, sandy, contains fine sand, tan.....	11.9	15.4
Silt, slightly clayey, scattered snail shells, a few white spots, tan.....	15.4	33.4
Sand, fine grained, silty, a few snail shells, tan..	33.4	50.4
Sand, fine to medium grained, predominantly fine, scattered thin layers of medium sand, tan.....	50.4	65.4



**Test Hole #USBR-9 (E-log)**  
**(8-21-22ccdd)**  
**Gosper County**

Location: SE SE SW SW sec. 22, T. 8 N., R. 21 W., 1308.3 ft. east and  
 24 ft. north of the southwest section corner.  
 Ground elevation: 2,557.6 ft. (i) (Bertrand NW 7.5 minute quadrangle)  
 Depth to water: 174.1 ft. (5-12-87)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Silt, tan.....	0.0	47.2
Silt, slightly clayey, sandy, contains fine sand, brown except tan from 49 to 49.9 ft. and mottled brown and tan from 49.9 to 51.8 ft., soil horizon.	47.2	54.0
Silt, sandy, contains fine sand, reddish tan with scattered black streaks.....	54.0	66.2
Sand, fine to medium grained, predominantly fine, silty, tan with white spots.....	66.2	68.8
Silt, slightly clayey, slightly sandy, contains fine sand, very calcareous from 75.4 to 76.2 ft., tan..	68.8	84.2
Sand, fine to medium grained, predominantly fine, slightly silty, reddish tan.....	84.2	105.8
Sand, fine to medium grained, predominantly fine, silty, tan.....	105.8	114.5
Silt, sandy, contains fine sand, tan.....	114.5	121.7
Sand, fine grained, tan.....	121.7	137.5
Sand, fine grained, slightly silty, tan.....	137.5	143.7
Clay, reddish brown.....	143.7	147.0
Sand, fine to medium grained, predominantly fine, silty, reddish brown.....	147.0	152.5
Sand, fine to medium grained, predominantly fine, tan.....	152.5	169.7
Sand, fine to medium grained, predominantly fine, silty, reddish tan.....	169.7	172.9
Silt, slightly clayey, very sandy, contains fine sand, firm, gray.....	172.9	174.5
Clay, slightly sandy, contains fine sand, tan.....	174.5	176.0
Silt, very sandy, contains fine sand, tan.....	176.0	180.5
Sand, fine to medium grained, predominantly fine, tan.....	180.5	183.6
Silt, very sandy, contains fine sand, tan.....	183.6	184.5
Clay, sandy, contains fine sand, reddish brown with black streaks.....	184.5	189.1
Clay, calcium spots and black spots, very calcar- eous, gray to brown.....	189.1	193.1
Silt, sandy, contains fine sand, tan.....	193.1	193.5
Clay, slightly sandy, contains fine sand, scattered white spots, slightly calcareous, reddish brown...	193.5	196.5

Sand, fine grained, very silty, reddish tan with scattered rust spots.....	196.5	207.0
Sand, fine grained, tan.....	207.0	213.5
Sand, fine grained, silty, tan.....	213.5	222.8
Sand, fine grained with some medium, clay ball from 227.9 to 228.2 ft., tan.....	222.8	230.9
Sand, gravelly, fine to coarse sand with 20 percent fine to coarse gravel, arkosic, brown.....	230.9	231.5
Sand, fine grained, gray.....	231.5	232.3
Sand, predominantly fine grained with some medium and coarse, brown.....	232.3	239.0
Sand, gravelly, fine to coarse sand with 30 percent fine to coarse gravel, arkosic, brown.....	239.0	249.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Clay, sandy, contains fine sand, olive.....	249.0	251.0
Claystone, firm, very calcareous, olive green.....	251.0	253.3
Sandstone, fine to medium grained, lightly indurated, tan.....	253.3	254.6
Sand, fine to coarse grained, predominantly fine, trace of fine gravel.....	254.6	268.0
Sand, fine grained with scattered coarse grains, silty, gray.....	268.0	302.0
Sand, fine grained, silty, grades from lightly to non indurated throughout the interval, gray.....	302.0	482.0

**Test Hole #3-B-81 (E-log)**  
**(8-23-13ddcc)**  
**Gosper County**

Location: SW SW SE SE sec. 13, T. 8 N., R. 23 W., approximately 8 ft. north and 1,090 ft. west of southeast section corner.  
 Ground elevation: 2,644 ft. (t) (Johnson Lake 7.5 minute quadrangle)  
 Depth to water: 134 ft. (date not available)

	<u>Depth, in feet</u>	
	From	To
<b>Quaternary System, undifferentiated:</b>		
Roadfill, no sample.....	0.0	1.0
Silt, topsoil, slightly clayey, very dark brown.....	1.0	3.0
Silt, some iron staining 20 to 30 ft., yellowish brown.....	3.0	56.0
Silt, slightly clayey, dark grayish brown.....	56.0	62.0
Silt, slightly clayey, slightly calcareous, sandy at 94 ft. and slightly to moderately sandy from 128 to 160 ft., yellowish brown.....	62.0	160.0
Sand, very fine to fine grained, silty.....	160.0	169.0
Silt, slightly to moderately sandy, contains very fine sand, a few lime nodules from 165 to 170 ft. and 195 to 197 ft., pale brown to yellowish brown.	169.0	197.0
Sand, very fine to fine grained, slightly coarser below 215 ft.....	197.0	220.0
Silt, slightly sandy to 235 ft., very sandy below 235 ft., slightly calcareous, a few lime cemented sandstone seams from 232 to 233 ft., pale yellowish brown.....	220.0	240.0
Sand, very fine to medium grained with very fine to fine sand predominating.....	240.0	247.4
Silt, moderately sandy, pale brown to pale yellowish brown.....	247.4	254.0
Sand and gravel, texture grades from very fine sand to coarse gravel, predominantly medium sand to medium gravel, slightly silty from 254 to 260 ft..	254.0	304.0
Sand and gravel, silty, interbedded with siltier intervals.....	304.0	313.0
Silt, sandy, scattered seams of coarse sand and fine gravel, grayish brown.....	313.0	320.0
<b>Tertiary System - Miocene Series - Ogallala Group:</b>		
Sand and sandstone, very fine to coarse grained, predominantly fine to medium; slightly calcareous.	320.0	333.0
Silt, sandy, interbedded with interbeds of fine to medium sand, pale brown.....	333.0	338.0
Sand, fine to coarse grained, predominantly medium to coarse with trace of very coarse.....	338.0	355.0
Sand and gravel, texture varies from fine sand to fine gravel, predominantly medium to coarse sand, some limy nodules.....	355.0	365.0

Sand, very silty, fine to coarse grained, predominantly medium sand, hard at 365.5 ft., slightly calcareous.....	365.0	370.0
Sand, very fine to medium grained, predominantly fine to medium.....	370.0	375.0
Sand, very fine to medium grained, silty, interbedded with silt, some limy nodules below 379 ft..	375.0	382.4
Silt, varies from slightly to very sandy, contains very fine to fine sand, grades to silty, sand below 398 ft. pale brown.....	382.4	400.0
Sand and sandstone, interbedded, very fine to fine grained, contains hard, limy concretions.....	400.0	406.0
Silt, sandy, slightly clayey, contains very fine to medium sand, moderately calcareous, pale brown to yellowish brown.....	406.0	410.0
Sand and sandstone, interbedded, very fine to medium grained, a few limy zones.....	410.0	418.7
Silt, sandy, contains fine to medium sand, very calcareous, very pale brown.....	418.7	423.6
Sand, very fine to medium grained with some coarse sand, a few thin limy silt interbeds, harder from 428.9 to 429.5 ft., sandstone interbeds below 429.5 ft.....	423.6	440.8
Silt, sandy, contains fine to medium sand, interbedded with sand below 445 ft., very to moderately calcareous, very pale brown.....	440.8	450.0
Sand, very fine to medium grained, predominantly fine, limy silt interbeds from 465 to 470 ft.....	450.0	475.0
Silt, sandy, very calcareous, pale yellow.....	475.0	480.0
Sand, very fine to fine grained, some medium sand and brown claystone fragments below 520 ft., silty zones from 480 to 490 ft., 512.5 to 520 ft., and 525 to 530 ft., pale olive to pale yellow.....	480.0	530.0
Silt, interbedded with very fine to fine sand with trace of medium, slightly calcareous, pale olive to pale brown.....	530.0	540.0
Silt, sandy, contains fine to medium sand, slightly to very calcareous, hard at 546 ft., pale olive to pale brown.....	540.0	555.0
Sand, very fine to medium grained, predominantly medium, some coarse sand below 575 ft., olive.....	555.0	580.4
Silt, sandy, contains fine to medium sand, very calcareous, white with areas of pale yellow and very pale brown, fragments of reddish yellow chalk below 615 ft.....	580.4	620.0
Sand, very fine to medium grained with some coarse sand, scattered thin limy seams, hard at 627 ft., moderately calcareous.....	620.0	627.0
Sand, silty, interbedded with sandy silt, sand is fine to medium grained.....	627.0	635.0

Sand, fine to medium grained, predominantly medium, silty from 644 to 645 ft., some coarse sand below 645 ft., olive.....	635.0	655.8
Sand, fine to coarse grained, predominantly medium, interbedded with siltstone, very calcareous.....	655.8	660.0
Sand, fine to coarse grained, predominantly medium; white, limy siltstone from 672.8 to 675 ft.; scattered limy fragments below 670 ft.; slightly calcareous.....	660.0	688.0
<b>Cretaceous System - Upper Cretaceous Series - Colorado Group:</b>		
<b>Niobrara Formation:</b>		
Clay, weathered chalky shale, brownish green and black.....	688.0	710.0

**Test Hole #54-A-48 (No e-log)**  
**(8-23-18cccc)**  
**Gosper County**

Location: SW SW SW SW sec. 18, T. 8 N., R. 23 W., approximately

47 feet north and 12 feet east of southwest section corner.

Ground elevation: 2,638.7 ft. (i) (Elwood NW 7.5 minute quadrangle)

Depth to water: 191 ft. (11-3-48)

Depth, in feet  
From            To

**Quaternary System, undifferentiated:**

Road fill: silt, dark brownish gray.....	0.0	0.6
Soil: silt, light brownish gray.....	0.6	2.0
Silt, medium brownish gray grading to medium buff-gray; contains limy rootlets and nodules from 5 to 10 ft; limonitic nodules and a few gastropod shells from 10 to 25 ft.....	2.0	50.0
Silt, medium buff-gray; fine texture.....	50.0	55.0
Silt, very slightly clayey, mottled medium gray and reddish brown.....	55.0	58.0
Silt, very slightly clayey, mottled medium gray and reddish brown.....	58.0	60.0
Silt, very slightly clayey, medium reddish buff; less reddish from 75 to 80 ft.; more clayey from 80 to 90 ft.; non-clayey from 90 to 100 ft.....	60.0	100.0
Silt, sandy, medium reddish buff; contains very fine sand; less sandy and less red from 115 to 120 ft..	100.0	120.0
Silt, medium buff-gray with very slight reddish tint; coarse texture; finer texture from 135 to 140 ft.....	120.0	140.0
Silt, very slightly sandy, medium buff-gray with slight red tint; slightly finer texture from 155 to 160 ft.....	140.0	160.0
Silt, medium brownish gray.....	160.0	190.0
Silt, sandy; contains pebbly zone from 194 to 195 ft.....	190.0	198.5
Silt, moderately calcareous, light gray-tan; granular; contains calcareous nodules.....	198.5	206.0
Silt, light brownish gray.....	206.0	210.0
Sand and gravel, light brownish gray; texture grades from fine sand to fine gravel; some medium gravel from 215 to 220 ft.....	210.0	220.0
Sand, light brownish gray; texture grades from fine to very coarse sand.....	220.0	225.0
Sand and gravel, tan-gray; texture grades from fine sand to fine gravel.....	225.0	229.0
Sand, silty, light brownish gray with slight red tint; texture grades from fine to medium sand.....	229.0	230.0

**Tertiary System - Miocene Series - Ogallala Group:**

Silt, sandy, very calcareous, light whitish gray; contains fine to coarse sand.....	230.0	234.0
Sandstone and silty sand, interbedded, very calcareous, light reddish brown to light gray; texture grades from fine to very coarse sand with some gravel.....	234.0	247.0
Sand and gravel, light gray to yellowish and reddish brown; texture grades from medium sand to medium gravel.....	247.0	250.0
Sandstone and sandy silt, interbedded; sandstone, medium brown, texture grades from fine to coarse sand; sandy silty, calcareous, light gray.....	250.0	260.0
Siltstone and sandy silt, interbedded; siltstone, dark brown; sandy silt, very calcareous, light gray, contains fine to coarse sand.....	260.0	262.0
Sand and gravel, very calcareous, light reddish brown to medium gray; texture grades from fine sand to medium gravel; contains hard calcareous layer from 278 to 278.5 ft.....	262.0	283.0
Silt, sandy, moderately calcareous, light gray; contains fine to medium sand.....	283.0	286.0
Sandstone, medium brown; texture grades from fine to medium sand.....	286.0	296.0
Silt, sandy, very calcareous, light gray; contains fine to coarse sand; light brownish tint and calcareous nodules from 300 to 304 ft.; no sand and whitish gray color at 304 ft.....	296.0	305.0
Sand and gravel; texture grades from coarse sand to medium gravel.....	305.0	312.0
Sand, silty, light yellowish gray; texture grades from fine to medium sand.....	312.0	314.0
Silt, clayey to sandy, medium brown; contains fine sand.....	314.0	316.0
Sand, silty, light gray; contains hard calcareous zone at 319 ft.....	316.0	320.0
Silt, medium reddish brown; contains intermittent hard calcareous layers.....	320.0	325.0
Sandstone, light gray; texture grades from fine to medium sand; contains intermittent silt layers; very calcareous and no silt layers from 335 to 342 ft.....	325.0	342.0
Silt, sandy, moderately calcareous, light grayish white; contains fine to medium sand; hard calcareous layers from 350 to 355 ft.....	342.0	355.0
Sand, silty, to silt, sandy, medium brown; contains fine sand; contains very calcareous layers.....	355.0	362.5
Sand, slightly silty, light brownish gray; texture grades from fine to coarse sand; yellowish gray from 390 to 395 ft.; coarser texture from 395 to 400 ft.....	362.5	400.0

Sand, silty, light gray; texture grades from fine to medium sand.....	400.0	410.0
Sand, slightly silty; texture grades from fine to coarse sand; contains hard calcareous zones.....	410.0	420.0
Sand, light tan-gray; texture grades from fine to medium sand.....	420.0	440.0
Sand, light tan-gray; texture grades from fine to very coarse sand with trace of gravel.....	440.0	460.0
Sand, slightly silty, medium brownish gray; texture grades from fine to medium sand.....	460.0	470.0
Sand, light brownish gray; texture grades from fine to coarse sand with some fine gravel.....	470.0	484.5
Limestone, light grayish white.....	484.5	485.7