STATE OF SOUTH DAKOTA
Walter D. Miller, Governor

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
Robert E. Roberts, Secretary

DIVISION OF GEOLOGICAL SURVEY
C.M. Christensen, State Geologist

OPEN-FILE REPORT 69-UR

INVESTIGATION OF GROUND-WATER RESOURCES FOR THE TRIPP COUNTY WATER USER DISTRICT

by

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INTRODUCTION

The Tripp County Water User District has four production wells located approximately 9 miles south of the city of Winner, South Dakota. Due to increased demand for water, the Division of Geological Survey, Department of Environment and Natural Resources, was contacted in November 1991 to investigate an area located in the SE¼ sec. 12, T. 97 N., R. 77 W. to determine the ground-water quality and quantity. Field work started in July of 1992 and the results of the investigation are presented in this report. This investigation was financed by the Division of Geological Survey and the Tripp County Water User District.

Previous Investigations

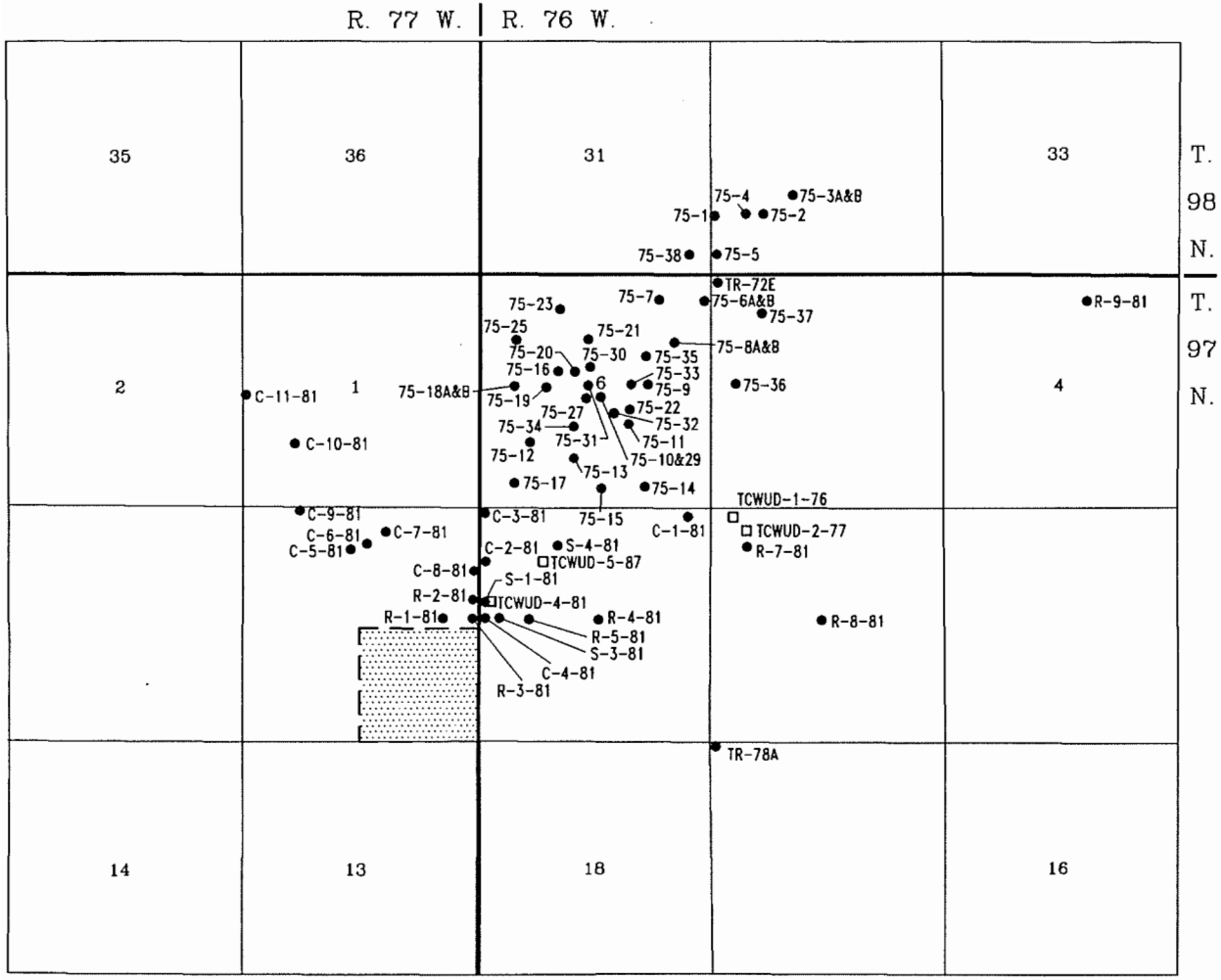
The first hydrogeologic investigation conducted by the Division of Geological Survey near the present Tripp County Water User District well field was done in June and July of 1965 for the city of Winner, South Dakota. The results of that study are presented in Barari (1966). During exploration for the city of Winner, it was found that the Valentine Formation south of Winner had sufficient saturated thickness and water quality for the construction of a municipal well field. In 1975, the newly formed Tripp County Water User District requested an investigation to further delineate the area that was previously investigated for the city of Winner. The results of that investigation are presented in Barari (1976). In that report, the Division of Geological Survey recommended the construction of a test well in section 6, T. 97 N., R. 76 W. The Tripp County Water User District could not reach an agreement with the landowners for that section and the District made the decision to locate a production well at the NW¼ sec. 8, T. 97 N., R. 76 W., where an easement agreement was reached. However, this area did not produce an adequate quantity of water for this District. In June of 1981, the Tripp County Water User District again contacted the Division of Geological Survey to find an area that could produce a higher yield of water to a production well. Results of that investigation prompted the construction of two additional production wells in NW¼ sec. 7, T. 97 N., R. 76 W. The basic data produced by that investigation are on file at the Division of Geological Survey. Figure 1 shows the location of test holes and wells drilled for previous investigations and also shows the study area for the current project.

METHODS

Drilling

In 1992, 12 test holes were drilled for this investigation. Four of those test holes were completed as observation wells (fig. 2, app. A). Drilling was accomplished by using a forward rotary drill rig with a bit diameter of 5 inches. Samples were collected at 10-foot intervals and a lithologic log was written. A geophysical log of the test holes was then made to further evaluate at what depth aquifer material might be present. The lithologic and geophysical logs were then used jointly to determine where observation wells should be placed.

Figure 1. Study area for this project and locations of test holes and wells drilled for previous investigations.



75-4 ● Test hole or well drilled in 1975 by the Division of Geological Survey. The numbers identify the year drilled and hole number. Where the letters A&B follow the last digit, more than one test hole was drilled at that location.

C-11-81 or R-6-81 ● Test hole or well drilled in 1981 by the Division of Geological Survey. The letter and numbers identify the rig name, the hole number, and the year drilled.

S-4-81 ● Test hole or well drilled in 1981 by Sargent Irrigation. The letter and numbers identify the company's first letter, the hole number, and the year drilled.

TCWUD-4-81 □ Tripp County Water User District production well. The letters and numbers identify the initials of the water district, well number, and year drilled.

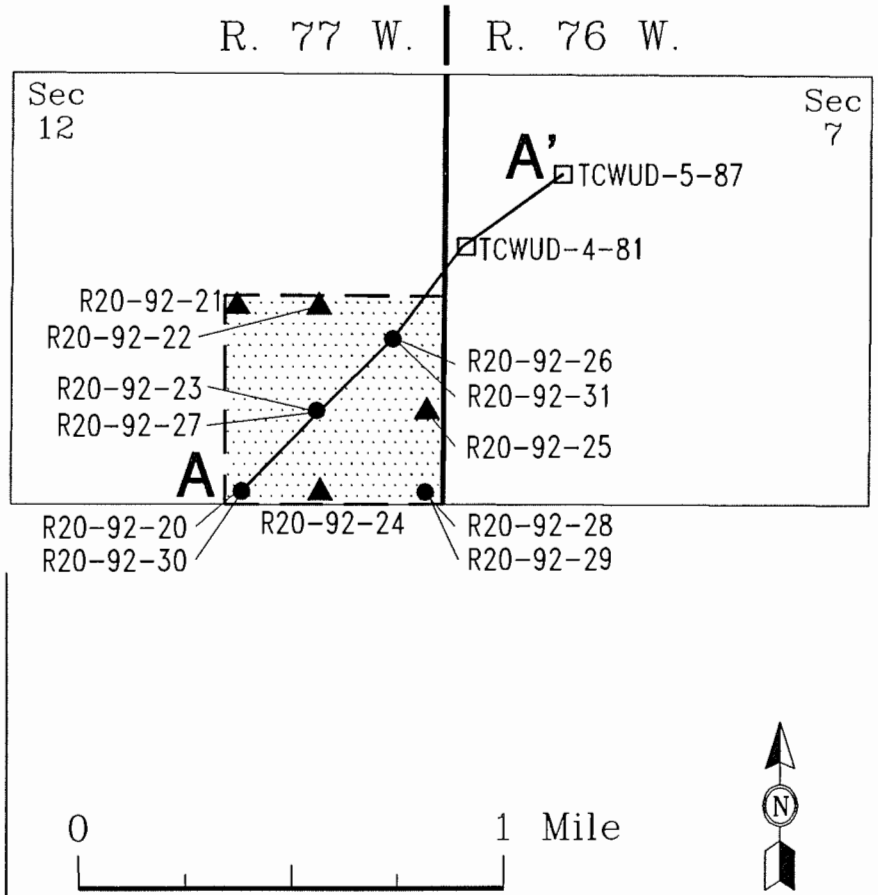
TR-78A ● Division of Water Rights observation well. The letters and number identify the well name.

All logs are on file at the Division of Geological Survey.

Study area for this project.

0 1 Mile

Figure 2. Locations of test holes and observation wells drilled for this project, current production wells, and geologic cross section.



▲ R20-92-24 — Test hole drilled by the Division of Geological Survey for this study. Number is the test-hole/well identifier.

● R20-92-20 R20-92-30 — Location where a test hole and an observation well were drilled only a few feet apart by the Division of Geological Survey for this project. The upper letter and numbers are the test-hole identifier and the lower letter and numbers are the well identifier.

□ TCWUD-4-81 — Tripp County Water User District production well. The letters and numbers identify the initials of the water district, well number, and year drilled.

A — A' — Location of geologic cross section A-A'. See figure 3 for cross section.

Study area for this project.

Well Construction

Observation wells were constructed using 2-inch diameter, schedule 80, flush-threaded, polyvinyl chloride (PVC) casing and screen. Screen length, well depth, and other well-construction information are given in appendix A. Filter pack was placed through a tremie line to a depth that covered the entire screen and provided for settlement around the screen. Bentonite grout was then placed in the remaining annular space from the top of the filter pack to a depth no less than 20 feet below ground surface. At a later date, neat cement grout was placed directly on top of the bentonite grout to land surface and a locking steel well protector was installed.

Well Development and Sampling

All wells for this study were developed using compressed air. Wells were pumped until the water temperature and conductivity had stabilized and the well water was clear. Sampling occurred immediately after each well was developed.

Sampling procedures were consistent with the *South Dakota Geological Survey Water Sampling Manual* (Coker and others, 1988). Samples were collected using a laboratory-cleaned bailer.

RESULTS OF INVESTIGATION

Geology

The geology of the study area consists of Tertiary-age sediments of the Ogallala Group overlying the older, Cretaceous-age, Pierre Shale. Table 1 provides the geologic age, formation names, and a brief description of each unit encountered during the investigation. Figure 3 shows the relative positions of the different units encountered while drilling. No attempt was made to correlate individual silt, sand, and clay layers within the Valentine Formation.

Pierre Shale

The Pierre Shale is a very fine textured, medium-gray to dark-gray clay that weathers to a yellow-brown to buff-orange in color and is marine in origin (Collins, 1958). The shale underlies the entire study area and its surface is undulatory due to post-Cretaceous erosion. A narrow channel which has been eroded into the Pierre Shale surface has been identified by test drilling. This channel crosses the study area from the northeast toward the southwest and has an approximate maximum relief of 100 feet (fig. 4). This small channel has subsequently been filled with sediments of the Valentine Formation deposited during the Tertiary period.

Ogallala Group

The Ogallala Group consists of continental deposits of fluvial and lacustrine origin. These sediments were derived from the erosion of mountains to the west (Collins, 1958). Two formations were

TABLE 1. Description of geologic units.

Geologic Age	Group Name	Formation Name	Description[1]
Tertiary	Ogallala Group	Ash Hollow Fm.	Light-gray to olive-gray fine sandstone and siltstone, mostly moderately cemented by calcite and silica to a plaster-like "mortar bed"; weathers to a light-gray.
		Valentine Fm.	Gray to olive-green fine sand and silt, slightly calcareous in part, poorly consolidated; weathers to light-tan unconsolidated silt and sand; local lenses of olive or greenish silty clay.
Cretaceous		Pierre Shale	Medium to dark-gray marine clay; mostly noncalcareous; weathers to a yellowish-brown.

[1] Modified from Collins (1958)

recognized in or near the study area: the Ash Hollow Formation and the Valentine Formation. The Valentine Formation is the lower formation of the Ogallala Group in south-central South Dakota and consists primarily of fine, poorly consolidated, gray to light-olive-green sands and silts but may contain layers of olive-drab to greenish-gray, silty clay (Agnew, 1957; Collins, 1958). The Valentine Formation is found in all test holes and wells drilled across the study area (figs. 2 and 3). The Ash Hollow Formation is the upper formation of the Ogallala Group and consists of fine olive-gray to light-gray sandstones and silts cemented to a plaster-like appearance which has earned the cemented zones the name "mortar beds" (Collins, 1958). The Ash Hollow Formation is present near the study area capping the hills to the east, west, and south but was not encountered in any test holes drilled for this investigation.

Figure 3. Geologic cross section A - A'.

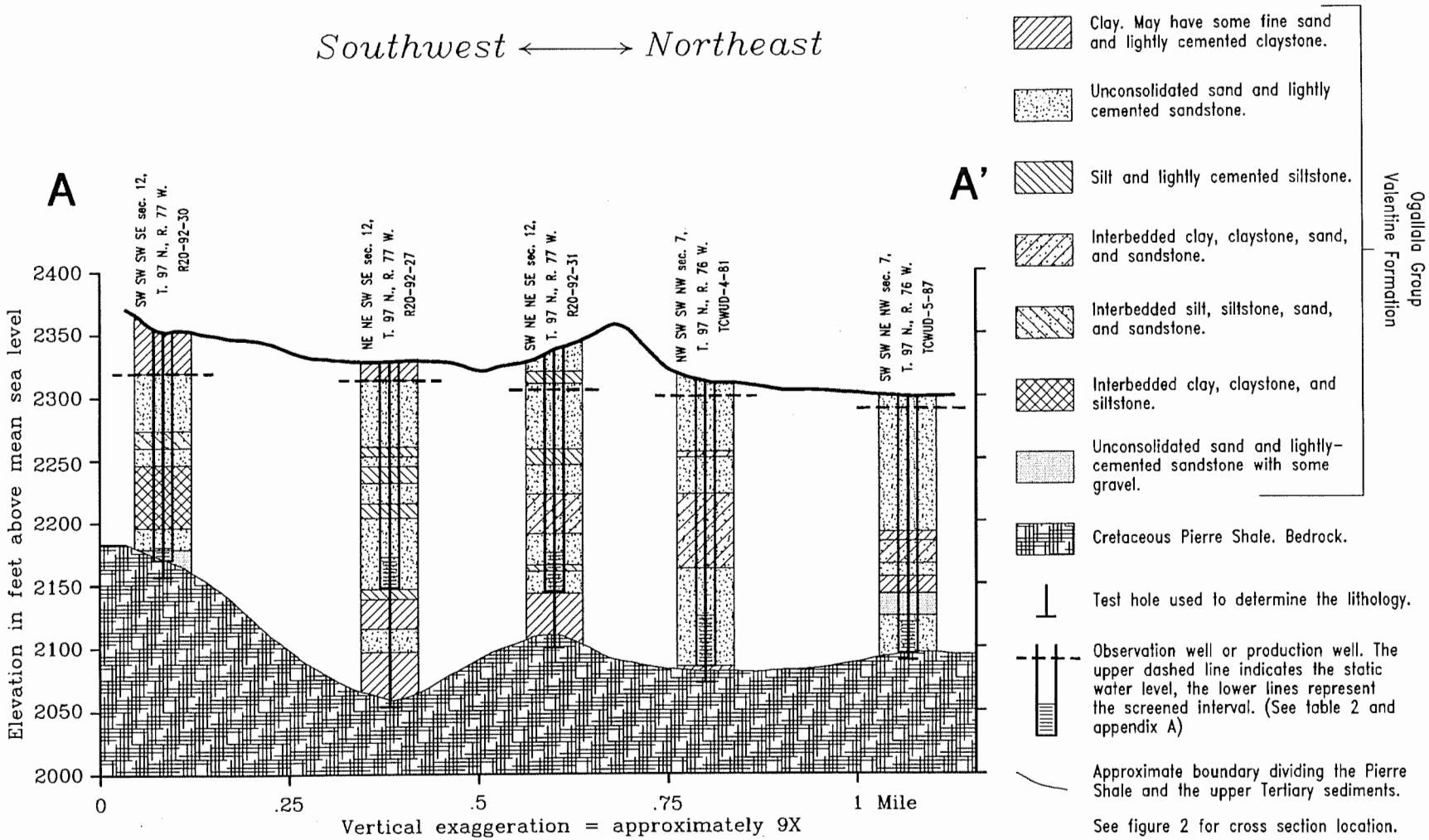
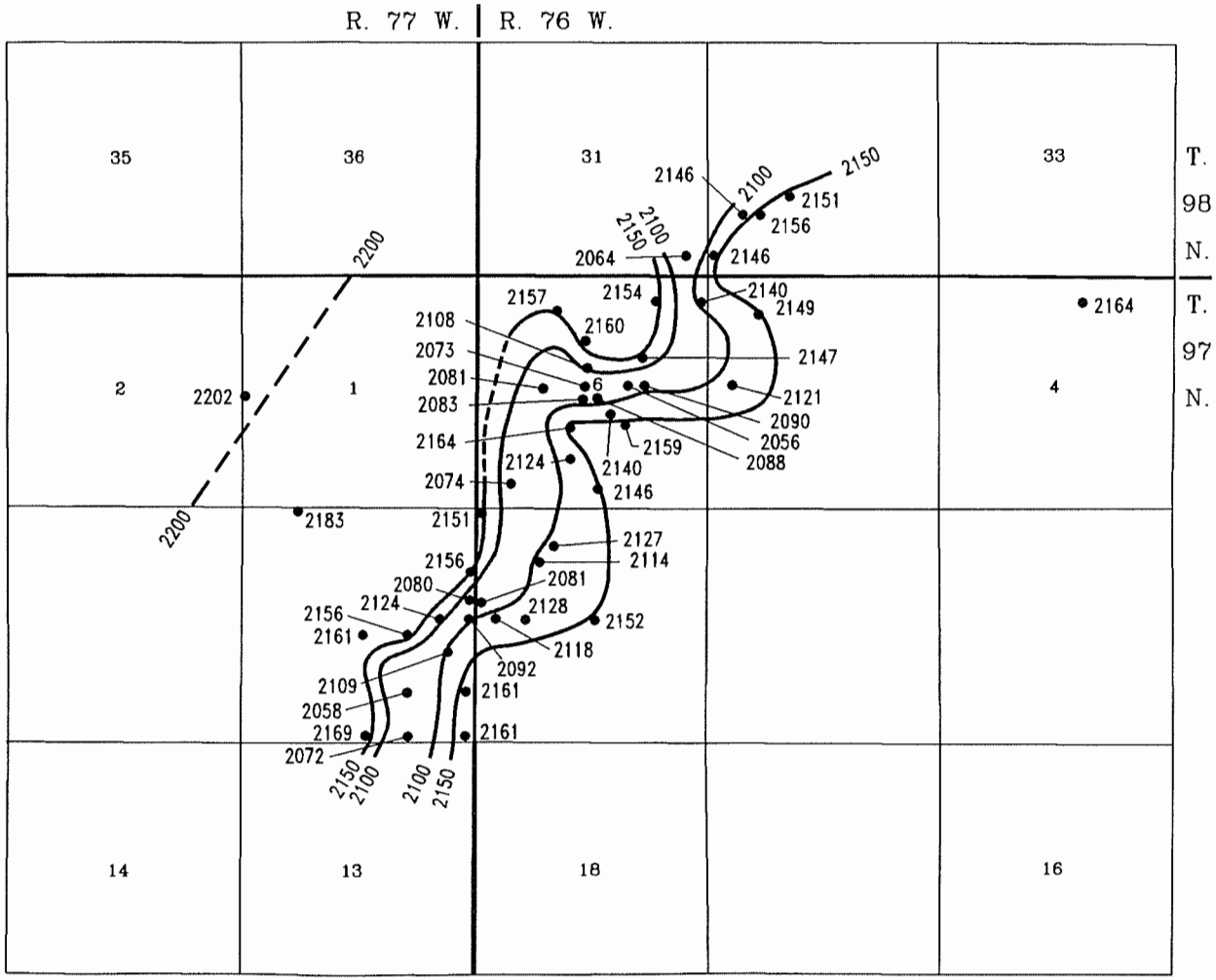


Figure 4. Configuration of the Pierre Shale surface.



2164 — Test hole used to determine the Pierre Shale surface elevation. The number represents the elevation, in feet, above mean sea level.

2150 — Contour line connecting points of equal elevation, in feet, above mean sea level. Contour interval = 50 feet. Dashed where approximate.

Test-hole logs are on file at the Division of Geological Survey.

N

0 1 Mile

Hydrogeology

The unconsolidated sands and locally cemented sandstones of the Valentine Formation are the primary source of ground water in the region. The Valentine Formation, part of the Ogallala Group, is considered as part of the Ogallala aquifer. Water levels measured in observation wells completed in this formation indicate that the aquifer is generally under unconfined conditions. Table 2 gives the well name, location, depth to water from casing top, and the date the water levels were measured. The saturated thickness of the aquifer is shown on figure 5 and given in table 2. The saturated thickness was calculated by adding the total thickness, in feet, of all sand layers below the static water level. It should be noted that the individual sand layers are not laterally continuous as shown in figure 3. It is assumed, however, that these saturated zones are hydraulically connected given the nature of their deposition. Test well R20–92–27, located near the center of the SE¼ sec. 12, T. 97 N., R. 77 W., has the greatest saturated thickness in the study area at 158 feet. A location near this test well was chosen for a new production well (fig. 6).

Water quality in the Valentine Formation is very good. All concentrations of the parameters that were analyzed were below the primary or secondary drinking water standards set forth by the U.S.

TABLE 2. Depth to water and saturated thickness of the Valentine Formation.

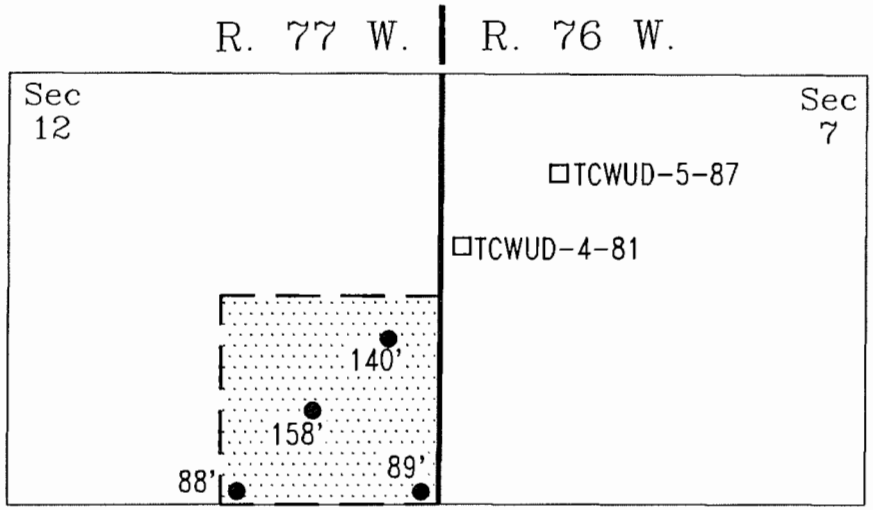
Well Name	Legal Location [1]	Depth to Water [2]	Date Measured	Saturated Thickness [3]
R20-92-31	SW NE NE SE sec. 12, T. 97 N., R. 77 W.	35.81	10/18/93	140
R20-92-27	NE NE SW SE sec. 12, T. 97 N., R. 77 W.	18.88	10/18/93	158
R20-92-30	SW SW SW SE sec. 12, T. 97 N., R. 77 W.	34.64	10/18/93	88
R20-92-29	SE SE SE SE sec. 12, T. 97 N., R. 77 W.	48.01	10/18/93	89

[1] See appendix A for explanation of legal-location format.

[2] Depth to water is presented in feet below casing top.

[3] Saturated thickness was calculated by adding the total thickness, in feet, of all sand layers below the static water level.

Figure 5. Water-sample locations and saturated thickness of the Valentine Formation in the study area.



158' Observation well constructed and sampled by the Division of Geological Survey for this study. The number is the composite saturated thickness, in feet, of all sand layers below the static water level. Water levels were measured on 10-18-1993. See appendix B for water-chemistry analyses.

TCWUD-4-81 Tripp County Water User District production well. The letters and numbers identify the initials of the water district, well number, and year drilled.

Study area for this project.

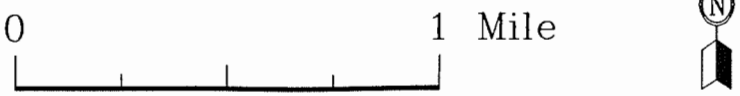
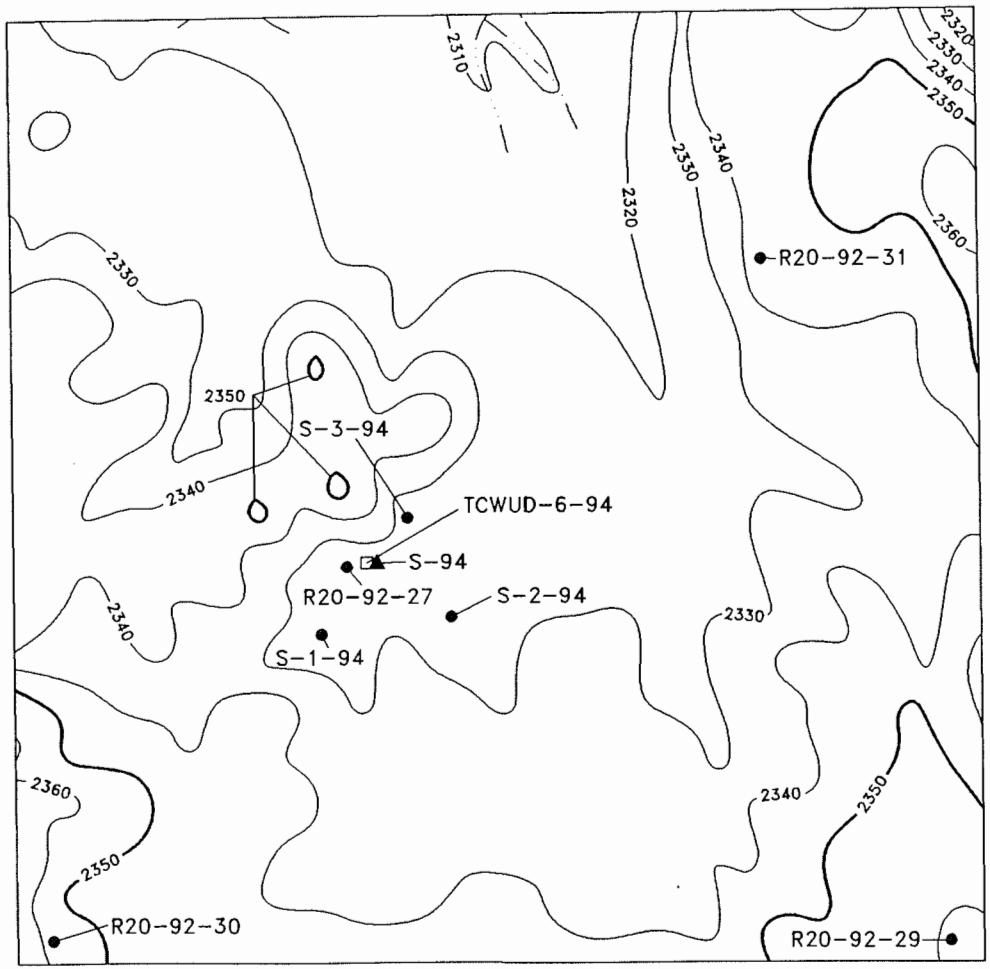


Figure 6. Location of production well TCWUD-6-94 and observation wells monitored for the Tripp County Water User District aquifer test.



Map digitized from U.S. Department of the Interior Geological Survey (1982).

TCWUD-6-94 □ — Tripp County Water User District production well. The letters and numbers identify the initials of the water district, well number, and year drilled.

S-2-94 ● — Observation well drilled in 1994 by Sargent Irrigation. The letter and numbers identify the first letter of the company's name, observation well number, and year drilled.

S-94 ▲ — Supply well drilled in 1994 by Sargent Irrigation and used to supply water for drilling of the production well. The letter and number identify the first letter of the company's name and year drilled.

R20-92-31 ● — Observation well drilled in 1992 by the Division of Geological Survey. Letter and numbers identify the drilling rig, year drilled, and well number.

2350 — Contour line connecting points of equal elevation in feet above mean sea level. Contour interval = 10 feet.

Map view is the SE1/4 sec. 12, T. 97 N., R. 77 W. See figure 1.

Well locations are approximate.

N

0 250 500 750 1000 Feet

Environmental Protection Agency. Appendix B lists the analytical results of four water samples that were collected for general chemical analysis and figure 5 shows the sample locations.

APPLICATION OF INITIAL FIELD WORK

Based on the information gathered during this study, it was recommended that a production well be drilled and an aquifer test be performed by the Tripp County Water User District in the SE¼ sec. 12, T. 97 N., R. 77 W. Upon this recommendation, the Tripp County Water User District contracted with a private firm to drill additional observation wells and one new production well near the center of the SE¼ sec. 12, T. 97 N., R. 77 W. (fig. 6). An aquifer test was performed, under the supervision of the Division of Geological Survey, at an average pumping rate of 678 gallons per minute for a 24-hour period. The analysis of data shows that the desired pumping rate of 600 gallons per minute could be achieved. All aquifer-test data are on file at the Division of Geological Survey, Department of Environment and Natural Resources, Vermillion, South Dakota.

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Coker, M.K., Wilke, K., and Coker, M., 1988, *South Dakota Geological Survey water sampling manual*: South Dakota Geological Survey Internal Document.

Collins, S.G., 1958, *Geology of the Wewela Quadrangle, South Dakota*: South Dakota Geological Survey Geologic Quadrangle Map, scale 1:62,500, text.

U.S. Department of the Interior Geological Survey, 1982, *Dog Ear Lake Quadrangle, South Dakota, Tripp Co., 7.5 minute series (topographic), provisional edition*: Denver, Colorado, U.S. Geological Survey, scale 1:24,000.

U.S. Environmental Protection Agency, 1985a, *National secondary drinking water regulations-secondary maximum contaminant levels*: Code of Federal Regulations, Title 40, Part 143, Section 143.3, p. 584.

_____ 1985b, *National interim primary drinking water regulations-maximum contaminant levels for inorganic chemicals*: Code of Federal Regulations, Title 40, Part 141, Sections 141.11 and 141.15, pp. 523-524.

APPENDIX A

Logs of test holes and observation wells

LEGAL LOCATION and **LOCATION**

The logs are listed by smallest township number, then the smallest range number, the smallest section number and then by quarter section. NE = A; NW = B; SW = C; SE = D. A comparison of **LEGAL LOCATION** and **LOCATION** is as follows. A **LEGAL LOCATION** of SW¼NE¼NE¼SE¼ sec. 12, T. 97 N., R. 77 W. is the same as a **LOCATION** of 097N–77W–12DAAC. If the smallest quarter section in the **LOCATION** is followed by a number, this indicates that more than one log may exist for that particular location.

LATITUDE and **LONGITUDE**

The format is **DD.MMSS** where **D** is degrees, **M** is minutes, and **S** is seconds.

DRILLING COMPANY

SDGS is an abbreviation for South Dakota Geological Survey.

TOTAL DRILL HOLE DEPTH, SCREEN LENGTH, TOTAL CASING AND SCREEN and **CASING STICK-UP**

The numbers are presented in feet.

SCREEN TYPE and **CASING TYPE**

PVC is an abbreviation for polyvinyl chloride. **MFG.** is an abbreviation for manufactured and indicates a product that is commercially available. **SLOT** is the size, in inches, of the openings on the screen.

CASING TOP ELEVATION and **GROUND SURFACE ELEVATION**

The numbers are presented in feet above mean sea level. **T** – the elevation was estimated from a 7.5 minute series topographic map.

CASING DIAMETER

The numbers are presented in inches.

County: TRIPP
Location: 097N-77W-12DAAC
Legal Location: SW NE NE SE sec. 12, T. 97 N., R. 77 W.
Latitude: 43.1358
Longitude: 99.5330
Land Owner: B. MULSO
Project: TRIPP RURAL WATER SYSTEM
Drilling Company: SDGS
Driller: D. IVERSON
Driller's Log:
Geologist: L. SCHULZ
Geologist's Log: X
Date Drilled: 07-28-1992
Drilling Method: ROTARY
Ground Surface Elevation: 2339 T
Total Drill Hole Depth: 239
Test Hole Number: R20-92-26
USGS Hydrological Unit Code: 10140204
Electric Log Information:
Spontaneous Potential: X
Single Point Resistivity: X
Natural Gamma: X
Extra:
Samples:

0	-	1	Topsoil
1	-	19	Sand, brown, fine-grained
19	-	28	Siltstone, green-brown, sandy; some clay
28	-	82	Sand, light-brown, fine-grained; some siltstone in cuttings
82	-	85	Siltstone, light-brown, sandy; some clay
85	-	93	Sand, tan-brown, fine-grained, silty; some clay
93	-	96	Siltstone, light-brown, sandy; some clay
96	-	115	Sand, light-brown, fine-grained, well-rounded; some siltstone and clay in cuttings
115	-	117	Clay, tan-brown, silty, sandy
117	-	118	Sand, brown, fine-grained, silty; some clay
118	-	119	Clay, tan-brown, silty, sandy
119	-	123	Sand, brown, fine-grained, silty; some clay
123	-	129	Clay, tan-brown, silty, sandy
129	-	131	Sand, brown, fine-grained, silty; some clay
131	-	136	Clay, tan-brown, silty, sandy
136	-	140	Sand, brown, fine-grained, silty; some clay
140	-	148	Clay, tan-brown, silty, sandy; some siltstone in cuttings
148	-	174	Sand, light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments
174	-	178	Siltstone, brown, sandy
178	-	196	Sand, light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some siltstone in cuttings
196	-	218	Clay, tan-brown to orange, silty, very sandy
218	-	229	Sand, light-brown, fine-grained, well-rounded
229	-	230	Clay, white, silty, sandy
230	-	239	Clay, gray to black; greasy (Pierre Shale)

Intervals between 115 and 148 feet were interpreted from the electric log only.

* * * *

County: TRIPP
Location: 097N-77W-12DAAC 1
Legal Location: SW NE NE SE sec. 12, T. 97 N., R. 77 W.
Latitude: 43.1358
Longitude: 99.5330
Land Owner: B. MULSO
Project: TRIPP RURAL WATER SYSTEM
Drilling Company: SDGS
Driller: D. IVERSON
Driller's Log:

Geologist: L. SCHULZ
Date Drilled: 08-12-1992
Ground Surface Elevation: 2339 T
Total Drill Hole Depth: 195
Water Rights Well:
Other Well Name:
Basin: WHITE
Management Unit:
Screen Type: PVC, MFG., SLOT SIZE 0.010 IN.
Casing Type: PVC
Casing Top Elevation: 2341 T
Casing Stick-up: 2.00
Well Maintenance Date:
USGS Hydrological Unit Code: 10140204
Electric Log Information:
Spontaneous Potential:
Natural Gamma:
Samples:

Geologist's Log: X
Drilling Method: ROTARY

Test Hole Number: R20-92-31
SDGS Well Name: R20-92-31

Aquifer: OGALLALA

Screen Length: 30.0
Casing Diameter: 2.0

Total Casing and Screen: 195.0

Single Point Resistivity:
Extra:

Well Information: Total casing and screen = 195 feet. 30-foot screen from 195 to 165 feet below casing top. Filter pack from 195 to 125 feet below casing top. Bentonite grout from 125 feet to land surface. 1 steel well protector installed.

0	-	1	Topsoil
1	-	19	Sand, brown, fine-grained
19	-	28	Siltstone, green-brown, sandy; some clay
28	-	82	Sand, light-brown, fine-grained, well-rounded; some siltstone in cuttings
82	-	85	Siltstone, light-brown, sandy; some clay
85	-	93	Sand, tan-brown, fine-grained, silty; some clay
93	-	96	Siltstone, light-brown, sandy, some clay
96	-	115	Sand, light-brown, fine-grained, well-rounded; some siltstone and clay in cuttings
115	-	117	Clay, tan-brown, silty, sandy
117	-	118	Sand, brown, fine-grained, silty; some clay
118	-	119	Clay, tan-brown, silty, sandy
119	-	123	Sand, brown, fine-grained, silty; some clay
123	-	129	Clay, tan-brown, silty, sandy
129	-	131	Sand, brown, fine-grained, silty; some clay
131	-	136	Clay, tan-brown, silty, sandy
136	-	140	Sand, brown, fine-grained, silty; some clay
140	-	148	Clay, tan-brown, silty, sandy; some siltstone in cuttings
148	-	174	Sand, light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments
174	-	178	Siltstone, brown, sandy; some light-olive-green sandstone in cuttings
178	-	195	Sand, light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some siltstone in cuttings

Intervals were interpreted from the driller's log and the electric log of R20-92-26. Both holes were drilled only a few feet apart.

* * * *

County: TRIPP
Legal Location: NE NE NW SE sec. 12, T. 97 N., R. 77 W.
Latitude: 43.1403
Land Owner: B. MULSO

Location: 097N-77W-12DBAA

Longitude: 99.5342

Project: TRIPP RURAL WATER SYSTEM
Drilling Company: SDGS
Driller: D. IVERSON
Geologist: L. SCHULZ
Date Drilled: 07-15-1992
Ground Surface Elevation: 2312 T
Total Drill Hole Depth: 167
USGS Hydrological Unit Code: 10140204
Electric Log Information:
Spontaneous Potential: X
Natural Gamma: X
Samples:

Driller's Log:
Geologist's Log: X
Drilling Method: ROTARY

Test Hole Number: R20-92-22

Single Point Resistivity: X
Extra:

0	-	1	Topsoil
1	-	22	Clay, olive-green, silty, very sandy
22	-	44	Sand, brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some light-green sandstone chips in cuttings
44	-	55	Clay and siltstone interbedded, olive-green clay, buff colored siltstone, sandy
55	-	73	Sand, brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some light-green sandstone chips in cuttings
73	-	118	Clay, cream-white to light-green, silty, very sandy; some dark-brown to light-pink sandstone in cuttings
118	-	129	Sand, light-brown, fine to medium, well-rounded; mainly quartz with some lithic fragments; some clay layers interbedded
129	-	144	Clay, light-brown, silty, sandy; this interval interpreted from electric log
144	-	156	Sandstone and clay interbedded, dark-brown sandstone, brown clay, silty; much fine sand
156	-	167	Clay, dark-gray to black; greasy (Pierre Shale)

* * * *

County: TRIPP
Legal Location: NW NW NW SE sec. 12, T. 97 N., R. 77 W.
Latitude: 43.1402
Land Owner: B. MULSO
Project: TRIPP RURAL WATER SYSTEM
Drilling Company: SDGS
Driller: D. IVERSON
Geologist: L. SCHULZ
Date Drilled: 07-15-1992
Ground Surface Elevation: 2322 T
Total Drill Hole Depth: 168
USGS Hydrological Unit Code: 10140204
Electric Log Information:
Spontaneous Potential: X
Natural Gamma: X
Samples:

Location: 097N-77W-12DBBB

Longitude: 99.5357

Driller's Log:
Geologist's Log: X
Drilling Method: ROTARY

Test Hole Number: R20-92-21

Single Point Resistivity: X
Extra:

0	-	1	Topsoil
1	-	21	Sand, dark-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some small clay layers
21	-	66	Clay, cream-white, silty, very sandy; thin layers of sandstone and unconsolidated sands interbedded throughout
66	-	114	Sand, tan-brown to olive-brown, fine-grained, well-rounded; mostly quartz with some lithic fragments; some small clay layers

114	-	120	Clay, tan-brown to olive-green, silty, sandy
120	-	126	Sandstone, brown; lightly cemented
126	-	156	Clay, tan-brown to olive-green, silty, sandy
156	-	161	Clay, orange-red; greasy, weathered (Pierre Shale)
161	-	168	Clay, dark-gray to black; greasy (Pierre Shale)

* * * *

County: TRIPP
Location: 097N-77W-12DCAA
Legal Location: NE NE SW SE sec. 12, T. 97 N., R. 77 W.
Latitude: 43.1350
Longitude: 99.5342
Land Owner: B. MULSO
Project: TRIPP RURAL WATER SYSTEM
Drilling Company: SDGS
Driller: D. IVERSON
Driller's Log:
Geologist: L. SCHULZ
Geologist's Log: X
Date Drilled: 07-20-1992
Drilling Method: ROTARY
Ground Surface Elevation: 2329 T
Total Drill Hole Depth: 275
Test Hole Number: R20-92-23
USGS Hydrological Unit Code: 10140204
Electric Log Information:
Spontaneous Potential: X
Single Point Resistivity: X
Natural Gamma: X
Extra:
Samples:

0	-	1	Topsoil
1	-	16	Clay, brown to light-brown, silty, very sandy; some fine sand
16	-	69	Sand, brown to light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some clay and silt
69	-	76	Siltstone, dark-olive-green, sandy; some clay and fine sand
76	-	86	Sand, light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some clay
86	-	98	Siltstone, dark-olive-green, sandy; some clay and fine sand
98	-	114	Sand, light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some interbedded clay and siltstone layers
114	-	126	Siltstone, olive-green, sandy; some interbedded sandstone, clay, and unconsolidated fine-grained sand layers
126	-	183	Sand, light-brown to white, fine- to medium-grained, well-rounded; mainly quartz with some lithic fragments; very little clay or silt
183	-	190	Siltstone, dark-olive-green, sandy
190	-	214	Clay, light-olive-green, silty, sandy; some brown sandstone chips in cuttings
214	-	236	Sand and sandstone, light-olive-green, fine sand; some siltstone and clay
236	-	271	Clay, light-pink, silty, sandy
271	-	275	Unknown; hard layer; driller reports gray clay on bit sample (Pierre Shale?)

* * * *

County: TRIPP
Location: 097N-77W-12DCAA 1
Legal Location: NE NE SW SE sec. 12, T. 97 N., R. 77 W.
Latitude: 43.1350
Longitude: 99.5342
Land Owner: B. MULSO
Project: TRIPP RURAL WATER SYSTEM
Drilling Company: SDGS
Driller: D. IVERSON
Driller's Log:
Geologist: L. SCHULZ
Geologist's Log: X

Date Drilled: 07-29-1992
Ground Surface Elevation: 2329 T
Total Drill Hole Depth: 184
Water Rights Well:
Other Well Name:
Basin: WHITE
Management Unit:
Screen Type: PVC, MFG., SLOT SIZE 0.010 IN.
Casing Type: PVC
Casing Top Elevation: 2331 T
Casing Stick-up: 2.50
Well Maintenance Date:
USGS Hydrological Unit Code: 10140204
Electric Log Information:
Spontaneous Potential: X
Natural Gamma: X
Samples:

Drilling Method: ROTARY

Test Hole Number: R20-92-27
SDGS Well Name: R20-92-27

Aquifer: OGALLALA

Screen Length: 25.0
Casing Diameter: 2.0

Total Casing and Screen: 182.5

Single Point Resistivity: X
Extra:

Well Information: Total casing and screen = 182.5 feet. 25 feet of screen from 182.5 to 157.5 feet below casing top. Filter pack from 182.5 to 123 feet below casing top. Bentonite grout from 123 feet to land surface. 1 steel well protector installed.

0	-	1	Topsoil
1	-	15	Clay, tan-brown, silty, sandy
15	-	69	Sand, brown, fine-grained, well-rounded; mainly quartz with some lithic fragments
69	-	76	Siltstone, dark-olive-green, clayey, very sandy
76	-	86	Sand, light-brown, fine-grained, well-rounded; some clay
86	-	98	Siltstone, dark-olive-green, sandy; some clay and fine sand layers interbedded
98	-	114	Sand, light-brown, fine-grained, well- rounded; mainly quartz with some lithic fragments; some interbedded claystone and siltstone layers
114	-	127	Siltstone, dark-olive-green, very sandy; some interbedded sandstone, clay, and unconsolidated sand layers
127	-	184	Sand, light-brown, fine to medium, well-rounded; mainly quartz with some lithic fragments; very little clay or silt

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County: TRIPP
Legal Location: SW SW SW SE sec. 12, T. 97 N., R. 77 W.
Latitude: 43.1338
Land Owner: B. MULSO
Project: TRIPP RURAL WATER SYSTEM
Drilling Company: SDGS
Driller: D. IVERSON
Geologist: L. SCHULZ
Date Drilled: 07-14-1992
Ground Surface Elevation: 2353 T
Total Drill Hole Depth: 197
USGS Hydrological Unit Code: 10140204
Electric Log Information:
Spontaneous Potential: X
Natural Gamma: X
Samples:

Location: 097N-77W-12DCCC

Longitude: 99.5357

Driller's Log:
Geologist's Log: X
Drilling Method: ROTARY

Test Hole Number: R20-92-20

Single Point Resistivity: X
Extra:

0	-	1	Topsoil

1	-	24	Clay, light-olive-green, silty, very sandy; some fine to medium sand
24	-	34	Clay, light-olive-green, silty, sandy; some interbedded siltstone and sandstone layers
34	-	80	Sand, light-brown to brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some clay, some lightly cemented siltstone chips in cuttings
80	-	84	Siltstone, dark-olive-green, sandy; much clay
84	-	86	Sandstone, light-olive-green, fine-grained, silty
86	-	89	Siltstone, dark-olive-green, sandy; much clay
89	-	91	Sandstone, light-olive-green, fine-grained, silty
91	-	94	Siltstone, dark-olive-green, sandy; much clay
94	-	106	Sand, brown, fine-grained, well-rounded; mainly quartz with some lithic fragments
106	-	158	Clay and siltstone, light-green clay, light-pink siltstone; some sandstone chips in cuttings; much fine sand
158	-	176	Sand, brown, fine- to medium-grained, well-rounded, silty; mainly quartz with some lithic fragments
176	-	183	Gravel, brown, medium to coarse; mainly lithic fragments of sandstone and siltstone; some quartz sand
183	-	184	Clay, orange-red to brown
184	-	197	Clay, dark-gray to black; greasy (Pierre Shale)

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County: TRIPP
Location: 097N-77W-12DCCC 1
Legal Location: SW SW SW SE sec. 12, T. 97 N., R. 77 W.
Latitude: 43.1338
Longitude: 99.5357
Land Owner: B. MULSO
Project: TRIPP RURAL WATER SYSTEM
Drilling Company: SDGS
Driller: D. IVERSON
Driller's Log:
Geologist: L. SCHULZ
Geologist's Log: X
Date Drilled: 08-11-1992
Drilling Method: ROTARY
Ground Surface Elevation: 2353 T
Total Drill Hole Depth: 182
Test Hole Number: R20-92-30
Water Rights Well:
SDGS Well Name: R20-92-30
Other Well Name:
Basin: WHITE
Aquifer: OGALLALA
Management Unit:
Screen Type: PVC, MFG., SLOT SIZE 0.010 IN.
Screen Length: 10.0
Casing Type: PVC
Casing Diameter: 2.0
Casing Top Elevation: 2355 T
Casing Stick-up: 2.00
Total Casing and Screen: 183.0
Well Maintenance Date:
USGS Hydrological Unit Code: 10140204
Electric Log Information:
Spontaneous Potential:
Single Point Resistivity:
Natural Gamma:
Extra:
Samples:

Well Information: Total casing and screen = 183 feet. 10-foot screen from 183 to 173 feet below casing top. Filter pack from 183 to 138 feet below casing top. Bentonite grout from 138 feet to land surface. 1 steel well protector installed.

0	-	1	Topsoil
1	-	24	Clay, light-olive-green, silty, very sandy; some fine to medium sand
24	-	34	Clay, light-olive-green, silty, very sandy; some interbedded siltstone and sandstone layers

34	-	80	Sand, light-brown to brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some clay, some lightly cemented siltstone
80	-	84	Siltstone, dark-olive-green, sandy; much clay
84	-	86	Sandstone, light-olive-green, fine-grained, silty
86	-	89	Siltstone, dark-olive-green, sandy; much clay
89	-	91	Sandstone, light-olive-green, fine-grained, silty
91	-	94	Siltstone, dark-olive-green, sandy; much clay
94	-	106	Sand, light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments
106	-	158	Clay and siltstone, light-green clay, light-pink siltstone, silty, sandy clay, very sandy siltstone; some sandstone chips in cuttings, much fine sand
158	-	176	Sand, light-brown, fine to medium, well-rounded; mainly quartz with some lithic fragments
176	-	182	Gravel, brown, medium to coarse; mainly lithic fragments of sandstone and siltstone; some quartz sand

Intervals were interpreted from the driller's log and the electric log of R20-92-20. Both holes were drilled only a few feet apart.

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County: TRIPP
Location: 097N-77W-12DCDD
Legal Location: SE SE SW SE sec. 12, T. 97 N., R. 77 W.
Latitude: 43.1339
Longitude: 99.5341
Land Owner: B. MULSO
Project: TRIPP RURAL WATER SYSTEM
Drilling Company: SDGS
Driller: D. IVERSON
Driller's Log:
Geologist: L. SCHULZ
Geologist's Log: X
Date Drilled: 07-27-1992
Drilling Method: ROTARY
Ground Surface Elevation: 2340 T
Total Drill Hole Depth: 288
Test Hole Number: R20-92-24
USGS Hydrological Unit Code: 10140204
Electric Log Information:
Spontaneous Potential: X
Single Point Resistivity: X
Natural Gamma: X
Extra:
Samples:

0	-	1	Topsoil
1	-	12	Clay, brown to olive-brown, silty, sandy
12	-	63	Sand, light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; small clay layer from 25 to 28 feet
63	-	86	Siltstone and sand, dark-brown siltstone, brown sand; some clay
86	-	105	Sand, brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some dark-brown siltstone in cuttings
105	-	117	Siltstone, dark-brown; some fine sand
117	-	135	Sand, dark-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments
135	-	171	Clay and siltstone, dark-brown, sandy, much fine sand in cuttings
171	-	205	Sand, brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some sandstone chips in cuttings
205	-	232	Clay, tan-brown to white, silty, very sandy
232	-	252	Sand, brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some small claystone layers
252	-	263	Clay, tan-brown, silty, very sandy

263	-	268	Clay, orange-red, silty; some sand
268	-	288	Clay, gray; greasy (Pierre Shale)

* * * *

County: TRIPP
Location: 097N-77W-12DDAA
Legal Location: NE NE SE SE sec. 12, T. 97 N., R. 77 W.
Latitude: 43.1350
Longitude: 99.5323
Land Owner: B. MULSO
Project: TRIPP RURAL WATER SYSTEM
Drilling Company: SDGS
Driller: D. IVERSON
Driller's Log:
Geologist: L. SCHULZ
Geologist's Log: X
Date Drilled: 07-28-1992
Drilling Method: ROTARY
Ground Surface Elevation: 2335 T
Total Drill Hole Depth: 188
Test Hole Number: R20-92-25
USGS Hydrological Unit Code: 10140204
Electric Log Information:
Spontaneous Potential: X
Single Point Resistivity: X
Natural Gamma: X
Extra:
Samples:

0	-	1	Topsoil
1	-	8	Clay, brown, silty, sandy
8	-	18	Sand, brown, fine-grained, silty; some clay
18	-	77	Sand and clay interbedded, tan-brown sand, tan-white clay, fine-grained sand, silty, sandy clay; some dark-green siltstone from 45 to 50 feet
77	-	101	Sand, tan-brown, fine-grained, well-rounded; some dark-green siltstone interbedded from 87 to 93 feet
101	-	117	Siltstone and clay, dark-green siltstone, tan clay, very sandy
117	-	157	Sand, light-tan-brown to white, fine- to medium-grained, well-rounded; mainly quartz with some lithic fragments, very little clay
157	-	166	Clay, cream-white, silty, sandy
166	-	174	Clay, reddish-orange-brown
174	-	188	Clay, gray to black; greasy (Pierre Shale)

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County: TRIPP
Location: 097N-77W-12DDDD
Legal Location: SE SE SE SE sec. 12, T. 97 N., R. 77 W.
Latitude: 43.1338
Longitude: 99.5323
Land Owner: B. MULSO
Project: TRIPP RURAL WATER SYSTEM
Drilling Company: SDGS
Driller: D. IVERSON
Driller's Log:
Geologist: L. SCHULZ
Geologist's Log: X
Date Drilled: 08-10-1992
Drilling Method: ROTARY
Ground Surface Elevation: 2365 T
Total Drill Hole Depth: 212
Test Hole Number: R20-92-28
USGS Hydrological Unit Code: 10140204
Electric Log Information:
Spontaneous Potential: X
Single Point Resistivity: X
Natural Gamma: X
Extra:
Samples:

0	-	1	Topsoil
1	-	6	Clay, tan-brown, silty, sandy
6	-	12	Silt, brown, sandy; some clay
12	-	27	Siltstone, cream-white, very sandy
27	-	38	Sandstone and siltstone interbedded, white sandstone, dark-olive-green siltstone; some clay
38	-	70	Sand, light-brown, fine-grained, well-rounded; some siltstone and clay layers interbedded
70	-	92	Siltstone, dark-olive-green to dark-brown, very sandy; some tan clay, some unconsolidated light-brown sand
92	-	109	Sand, light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments; some clay in cuttings
109	-	114	Siltstone, dark-olive-green, very sandy; some clay
114	-	120	Sand, light-brown, silty; some clay
120	-	121	Siltstone, dark-olive-green, very sandy; some clay
121	-	128	Sand, light-brown, silty; some clay
128	-	129	Siltstone, dark-olive-green, very sandy; some clay
129	-	136	Sand, light-brown, silty; some clay
136	-	138	Siltstone, dark-olive-green, very sandy; some clay
138	-	166	Sand, light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments
166	-	200	Clay, tan, silty, sandy; some siltstone in cuttings
200	-	204	Claystone, light-red-pink, silty, sandy
204	-	212	Clay, gray to black; greasy (Pierre Shale)

Intervals from 109 to 138 feet were interpreted from the electric log only.

* * * *

County: TRIPP
Location: 097N-77W-12DDDD 1
Legal Location: SE SE SE SE sec. 12, T. 97 N., R. 77 W.
Latitude: 43.1338
Longitude: 99.5323
Land Owner: B. MULSO
Project: TRIPP RURAL WATER SYSTEM
Drilling Company: SDGS
Driller: D. IVERSON
Driller's Log:
Geologist: L. SCHULZ
Geologist's Log: X
Date Drilled: 08-11-1992
Drilling Method: ROTARY
Ground Surface Elevation: 2365 T
Total Drill Hole Depth: 167
Test Hole Number: R20-92-29
Water Rights Well:
SDGS Well Name: R20-92-29
Other Well Name:
Basin: WHITE
Aquifer:
Management Unit:
Screen Type: PVC, MFG., SLOT SIZE 0.010 IN.
Screen Length: 10.0
Casing Type: PVC
Casing Diameter: 2.0
Casing Top Elevation: 2367 T
Casing Stick-up: 2.00
Total Casing and Screen: 167.0
Well Maintenance Date:
USGS Hydrological Unit Code: 10140204
Electric Log Information:
Spontaneous Potential:
Single Point Resistivity:
Natural Gamma:
Extra:
Samples:

Well Information: Total casing and screen = 167 feet. 10-foot screen from 167 to 157 feet below casing top. Filter pack from 167 to 128 feet below casing top. Bentonite grout from 128 feet to land surface. 1 steel well protector installed.

0	-	1	Topsoil
1	-	6	Clay, tan-brown, silty, sandy
6	-	12	Silt, brown, sandy; some clay
12	-	27	Silt, cream-white, sandy; some tan clay
27	-	38	Sandstone and siltstone interbedded, white sandstone, dark-olive-green siltstone; some clay
38	-	70	Sand, light-brown, fine-grained, well-rounded; some siltstone and clay layers interbedded
70	-	92	Siltstone and clay, dark-olive-green siltstone, tan clay; some unconsolidated fine-grained sand layers
92	-	109	Sand, light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments
109	-	114	Siltstone, dark-olive-green, very sandy; some clay
114	-	120	Sand, light-brown, silty; some clay
120	-	121	Siltstone, dark-olive-green, very sandy; some clay
121	-	128	Sand, light-brown, silty; some clay
128	-	129	Siltstone, dark-olive-green, very sandy; some clay
129	-	136	Sand, light-brown, silty; some clay
136	-	138	Siltstone, dark-olive-green, very sandy; some clay
138	-	167	Sand, light-brown, fine-grained, well-rounded; mainly quartz with some lithic fragments

Intervals were interpreted from the driller's log and the electric log of R20-92-28. Both holes were drilled only a few feet apart.

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Appendix B. Chemical analyses of water samples

Legal Location	Well Name	Date Sampled	Well Depth[2]	Conductivity[3]	Field pH[4]	Concentrations in milligrams per liter[1]													
						TDS	Hardness as $CaCO_3$	Alk-T	HCO_3	Ca	Cl	F	Fe	K	Mg	Mn	Na	NO_3-N + NO_2-N	SO_4
						500[5]	----	-----	----	--	250[5]	2.4[6]	0.3[5]	----	----	0.05[5]	----	10[6]	250[5]
Valentine Formation (Ogallala aquifer)																			
SW NE NE SE sec. 12, T. 97 N., R. 77 W.	R20-92-31	9-01-92	193	169	7.40	145	77	84	102	26	0.9	0.19	<0.05	4.7	2.9	<0.05	3.9	0.70	2.0
NE NE SW SE sec. 12, T. 97 N., R. 77 W.	R20-92-27	8-31-92	182	194	7.54	160	81	92	112	27	0.9	0.24	<0.05	5.6	3.3	<0.05	7.5	1.22	4.4
SW SW SW SE sec. 12, T. 97 N., R. 77 W.	R20-92-30	8-31-92	183	214	7.92	164	86	106	129	27	0.8	0.42	<0.05	7.1	4.6	<0.05	9.8	0.77	3.3
SE SE SE SE sec. 12, T. 97 N., R. 77 W.	R20-92-29	8-31-92	167	301	7.59	227	140	152	185	48	1.9	0.18	<0.05	7.0	5.9	<0.05	7.0	0.94	5.3
		AVERAGE		219	7.61	174	97	109	132	32	1.1	0.26	<0.05	6.1	4.2	<0.05	7.1	0.91	3.8

[1] **TDS** - total dissolved solids; **Hardness as $CaCO_3$** - hardness as calcium carbonate; **Alk-T** - total alkalinity; **HCO_3** - bicarbonate; **Ca** - calcium; **Cl** - chloride; **F** - fluoride; **Fe** - iron; **K** - potassium; **Mg** - magnesium; **Mn** - manganese; **Na** - sodium; **NO_3-N + NO_2-N** - nitrate-nitrogen plus nitrite-nitrogen; **SO_4** - sulfate

[2] Well depth is presented in feet below ground surface and represents depth to bottom of screen.

[3] Conductivity is presented in μmhos/cm (micromhos per centimeter).

[4] Field pH is on unfiltered sample.

[5] U.S. Environmental Protection Agency, 1985a.

[6] U.S. Environmental Protection Agency, 1985b.