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**HYDROGEOLOGIC INVESTIGATION FOR AN ALTERNATE WATER SOURCE
FOR THE BROOKINGS-DEUEL RURAL WATER SYSTEM
NEAR CLEAR LAKE, SOUTH DAKOTA**

by

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INTRODUCTION

The Brookings-Deuel Rural Water System is experiencing a water-quality problem which prompted the request by the rural water system for the South Dakota Geological Survey to conduct an investigation. The problem is that nitrate-nitrogen, in excess of Federal standards for human consumption, exists in water presently being withdrawn from the system's main well field (production wells 1, 2, and 3).

The rural water system has had, until recently, only three production wells (1, 2, and 3; fig. 1) in their well field northeast of Clear Lake. Recently, another one (well 4) was installed approximately one half mile north of the main well field (fig. 1). Production well 4 became operational in July, 1987, and is believed to be completed in an aquifer which may be different from that tapped by production wells 1, 2, and 3.

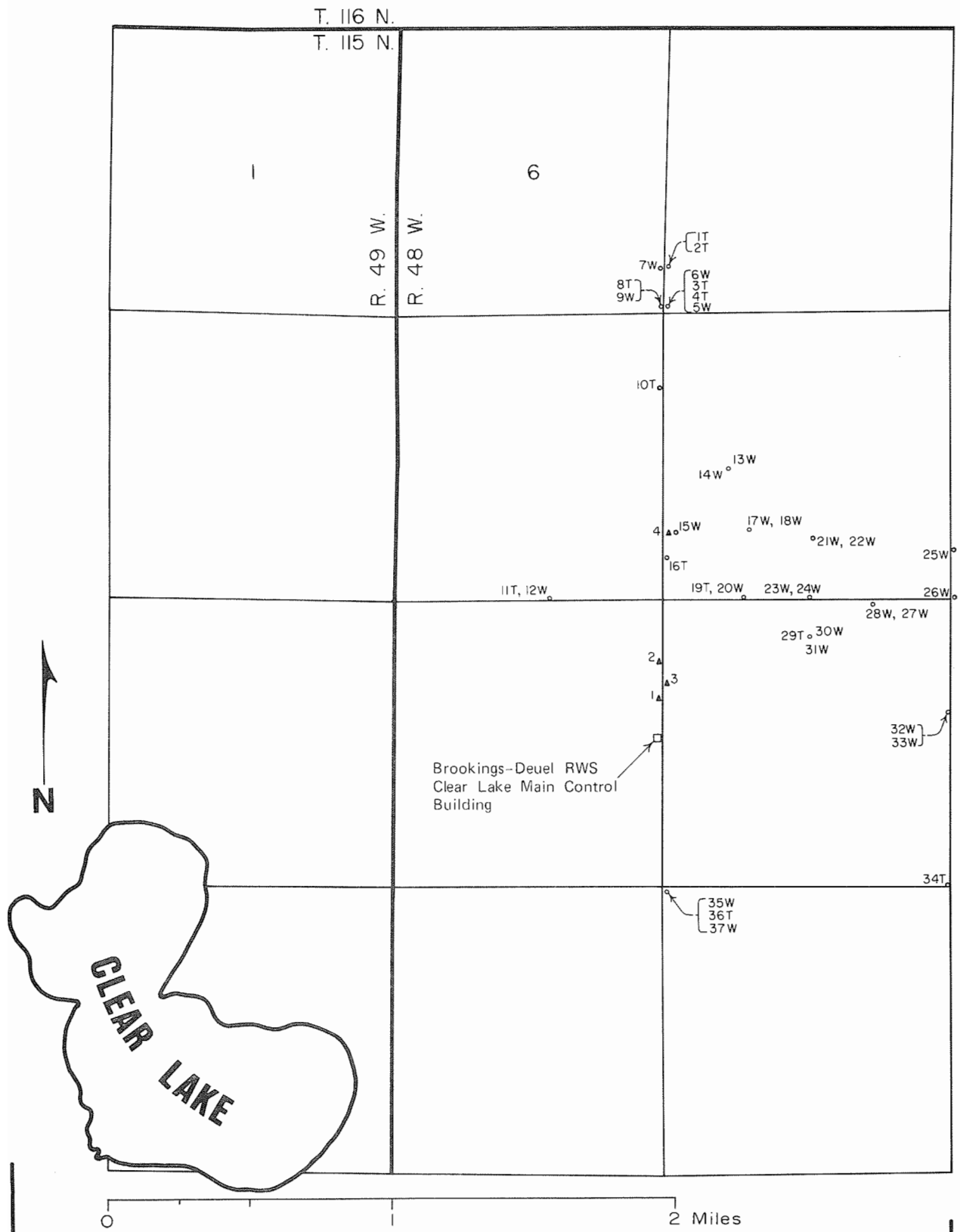
Recent water analyses for production wells 1, 2, and 3 show nitrate-nitrogen concentrations of 13.3, 10.2, and 11.5 parts per million (ppm), respectively (samples 33, 30, and 29; app. A). Figure 2 shows fluctuating but generally increasing nitrate-nitrogen concentrations, from 1979 to present, in production wells 1, 2, and 3.

Water from production well 4, which has a low nitrate-nitrogen concentration (below laboratory detection limits), is being blended with water from the other three production wells prior to distribution. This effectively reduces, to an acceptable level, the nitrate-nitrogen concentration in distributed water. An analysis of water taken from production well 4 on June 17, 1987, showed the nitrate-nitrogen concentration to be <0.04 ppm (sample 12, app. A). A sample of the blended water taken at the home of a user of the system's water on June 16, 1987, showed the nitrate-nitrogen to be 9.53 ppm or slightly less than the allowable maximum limit of 10 ppm (sample 36, app. A). Based on these data, the short-term solution appears to be working.

Purpose and Scope

The purpose of this investigation was to search for an alternate ground-water source which could supply water to the Brookings-Deuel Rural Water System near the Clear Lake distribution point. It was not the intent of this investigation to identify the source(s) of nitrate which have contaminated the rural water system's well field.

The study area is located in central Deuel County in northeastern South Dakota (fig. 1). Field work conducted for this investigation was restricted to about a 2 1/2-square mile area in the vicinity of the present water distribution point (Clear Lake Main Control Building) for the rural water system (fig. 1).

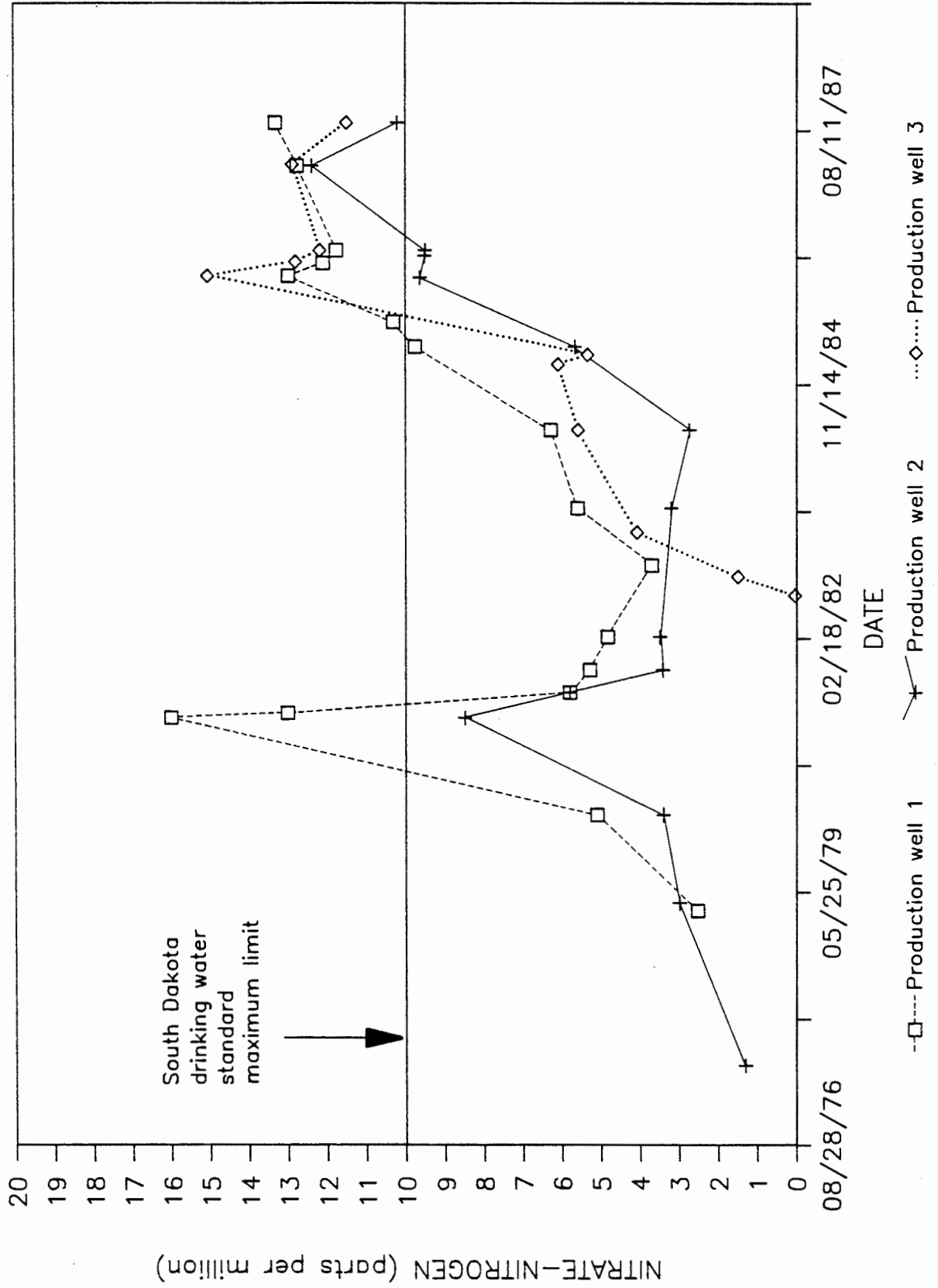


^{34T}
^{27W} Test hole or well drilled for this report. The letter "T" indicates a test hole; the letter "W" indicates a monitoring well. The number refers to Map Location (ML) numbers in Appendix B.

²▲ Brookings-Deuel Rural Water System (RWS) production well. The number is the RWS identification number.

Figure 1. Site location and data map.

Figure 2. Historic concentrations of nitrate-nitrogen in production wells 1, 2, and 3.



Methods of Investigation

During the course of this investigation, a total of 37 test holes were drilled, 25 of which were completed as monitoring wells (fig. 1, app. B). Drilling and well construction occurred during three separate times extending from May 18, 1987, to October 6, 1987. Data were evaluated after each phase of drilling to guide additional drilling efforts.

Water in monitoring wells was sampled for chemical analysis. Additional samples were taken from Brookings-Deuel Rural Water System production wells, private household and stock wells, irrigation wells, and springs. Water sample collection points are shown on figure 3. Collection of the samples was accomplished by using a bailer or a bladder pump in the monitoring wells or the existing submersible pump in the private household, stock, and irrigation wells.

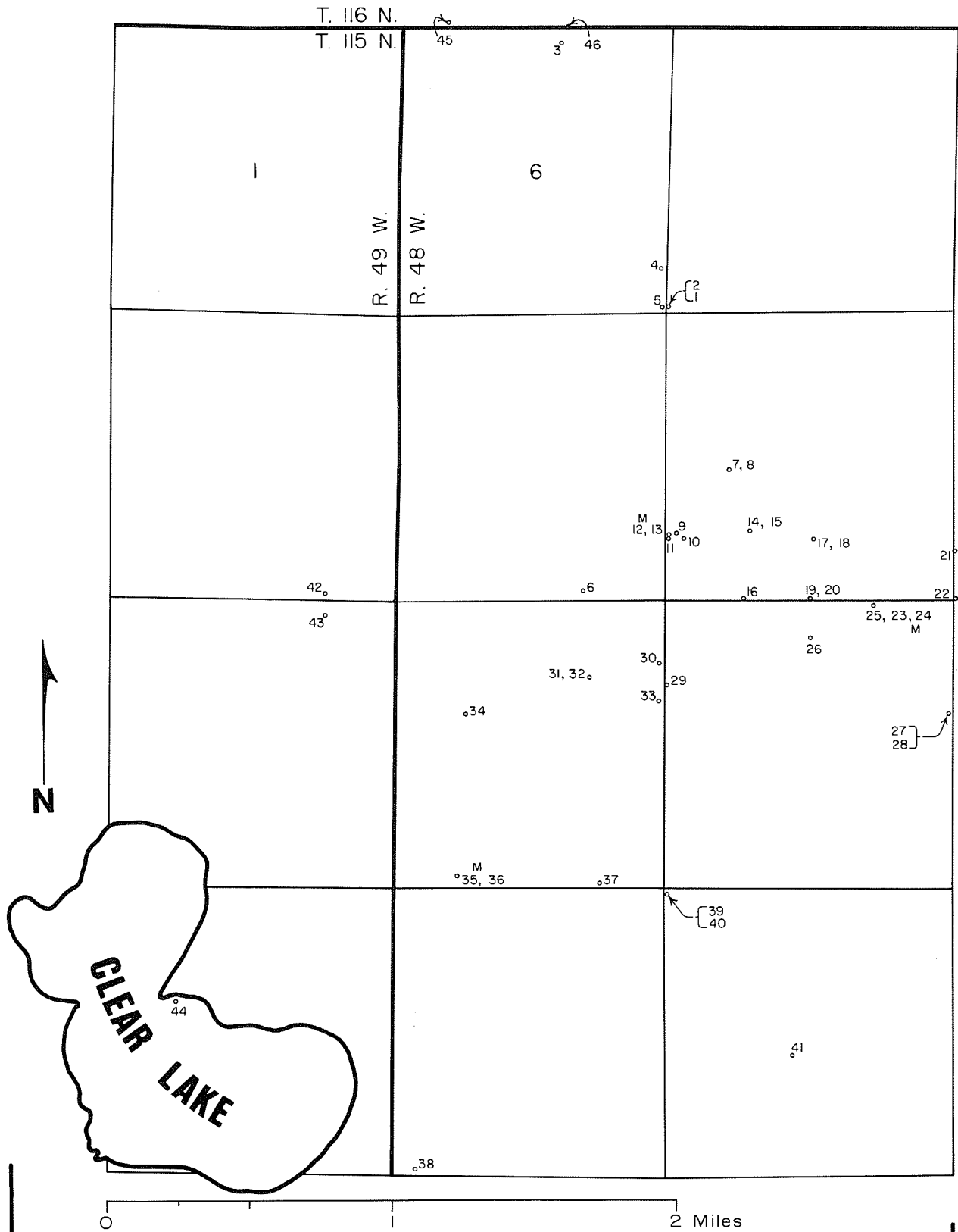
Forty-six water samples were collected and analyzed for general water chemistry by the Chemistry Laboratory at the South Dakota Geological Survey (app. A, fig. 3). A split of one of these samples (sample 24, app. A) was analyzed by the Department of Health in Pierre, South Dakota, for general water chemistry, trace metals, and radioactivity (app. C).

Analysis for tritium content was performed on three water samples by the Tritium Laboratory, University of Miami (app. D). Two of these samples were collected specifically for this purpose. The third sample was split and was also analyzed by the South Dakota Geological Survey (sample 24, app. A) and the State Health Laboratory (app. C).

Elevations of all but two of the monitoring wells (those at map locations [ML] 35 and 37, fig. 1) were surveyed to the nearest 0.01 foot, relative to an assumed elevation datum, and water levels were measured in monitoring wells on numerous occasions. Records of these elevations and measurements are presented in appendices E and F.

An aquifer test was performed by the South Dakota Geological Survey and the Brookings-Deuel Rural Water System, utilizing rural water system production well 4. Data gathered during this test are presented in appendix G.

Six prior investigations have been conducted in or near the present study area. The six investigations are Beissel and Barari (1976), Kume (1976), Schroeder (1976), Kume (1985), Beissel and Gilbertson (1987), and Hardy and Barari (in preparation). Although not all of these investigations dealt specifically with the subject or area of this investigation, they do contain information which establishes the hydrogeologic setting of the area.



^M_{31, 32}. Water sample collection point. Number refers to "Water Sample No." in Appendix A. More than one number indicates either (1) multiple wells at one location or (2) multiple samples from one well (denoted by the letter "M").

Figure 3. Water sample collection points.

Acknowledgements

The present investigation was performed under the auspices of a contract with the Brookings-Deuel Rural Water System and the East Dakota Water Development District.

We wish to express our thanks to Pat Gilligan and Don Devoe of the Brookings-Deuel Rural Water System for their assistance throughout the course of this investigation. Additionally, many land owners provided assistance by allowing the collection of water samples from their wells and by allowing access to their land for drilling purposes. The project could not have been as successful without such cooperation.

GEOLOGY

Surface geology in the area consists of Pleistocene outwash and till (fig. 4). Pleistocene outwash and till, along with a glacial-lacustrine silt, are also found in the subsurface. These three geologic units are briefly discussed below. Several cross sections were constructed to illustrate the subsurface stratigraphy and its relationship to surface geology (app. H). Logs of wells and test holes used to construct these cross sections are presented in appendices B and I.

Till

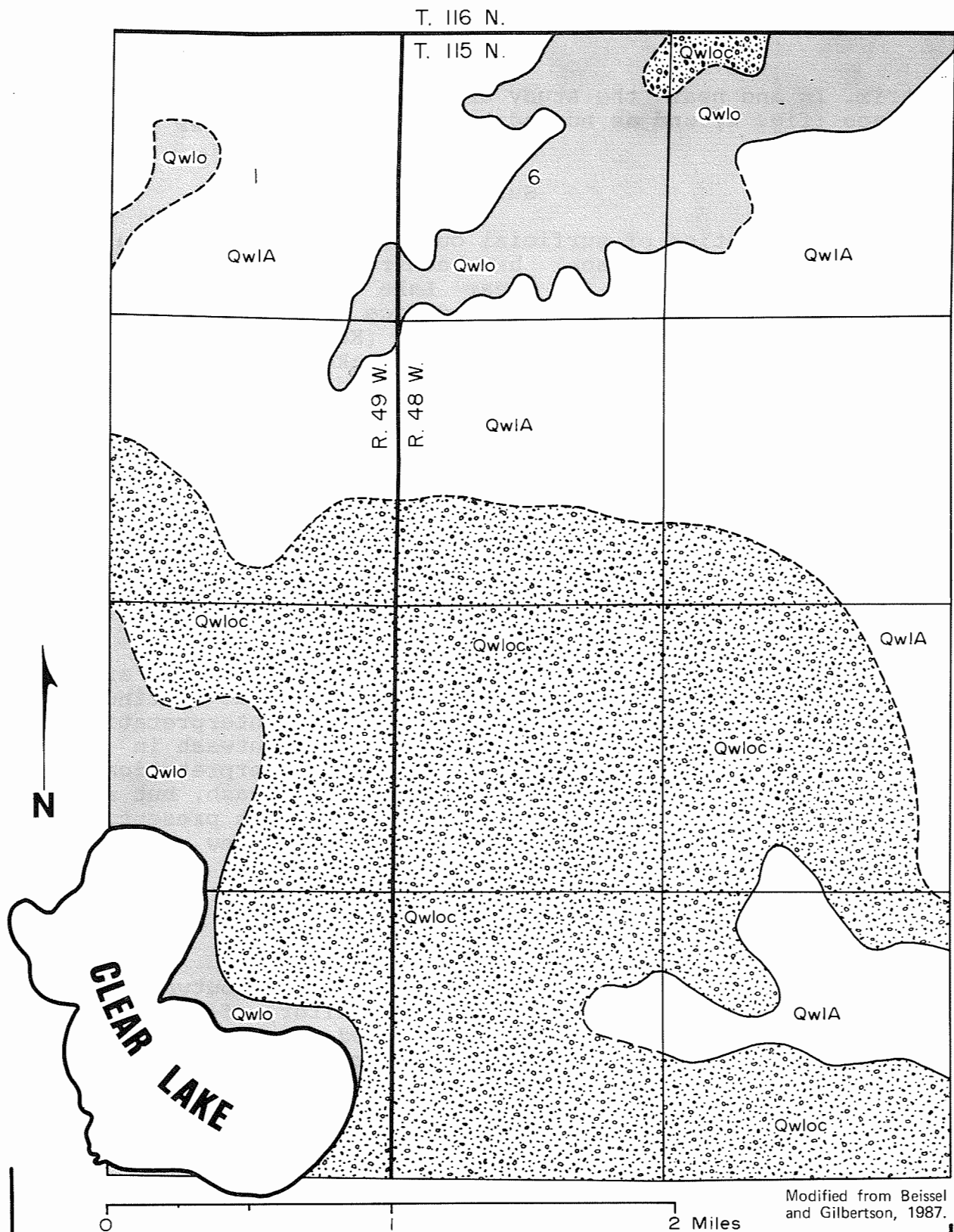
Till is a heterogeneous mixture of boulders, sand, silt, and clay, and comprises the land surface over much of the study area (fig. 4). Drill cuttings were examined on a qualitative basis and it was commonly found that silt, sand, and gravel were present in substantial proportions as part of the till matrix, although clay appeared to be predominant. Also, thin layers of silt, sand, and gravel were commonly encountered within the till.

Glacial-Lacustrine Sediments

Sandy silt was encountered in five test holes drilled at two locations (ML 29, 30, 31, 32 and 33; fig. 1). This silt may represent lacustrine sediments which were deposited during the retreat and melting of the glacier which formed the Altamont moraine shown on figure 4. The silt in the subsurface is illustrated on cross sections B-B' and F-F' (app. H).

Outwash

Outwash consists of sand and/or gravel which contains varying amounts of less permeable materials (silt and clay), either as discrete layers or dispersed throughout the sand and gravel



- Qwlo Outwash, undifferentiated—sand and gravel of glaciofluvial origin; minor amounts of silt and clay.
- Qwloc Outwash, collapsed—sand and gravel of glaciofluvial origin; minor amounts of till; irregular topography.
- QwIA Till, Altamont moraine—Heterogeneous mixture of boulders, sand, silt, and clay; isolated deposits of sand and gravel; composed of one or more high ridges or linear masses.

Figure 4. Surface Geology.

matrix. In and near the study area, outwash occurs at the land surface (fig. 4) and as buried bodies and lenses (app H).

Surficial

The distribution of surficial outwash (that which occurs at or very near the land surface) has been relatively well defined in the immediate vicinity of Clear Lake (fig. 4). It has been described as a hummocky, collapsed (ice contact) outwash which ranges in thickness from 3 to 88 feet (Kume, 1985). It averages about 20 feet in thickness near Clear Lake (Kume, 1985) and is believed to exhibit lateral hydrologic and geologic continuity.

Kume classified this surface outwash as being part of the Big Sioux aquifer. Hedges and others (1982), however, classified this surficial outwash as being distinct from the Big Sioux aquifer and named it the Antelope Valley aquifer. The only reason for making mention of this is to avoid any problems with nomenclature if the literature is examined.

Buried

Buried outwash is relatively abundant in the study area but questions remain as to the lateral and vertical continuity of some outwash encountered in test holes. Some interpretations of physical continuity, or lack thereof, between outwash in various test holes are shown in appendix H. These interpretations were based not only on the physical presence of outwash, but also on water-level and water-chemistry data. Some of the present interpretations are tenuous and may change when new data become available.

HYDROLOGY

The focus of this investigation was on buried outwash because it was felt that an outwash unit, or aquifer, of this type, as compared to a surficial aquifer, offered a greater degree of protection from surface sources of nitrate-nitrogen contamination. Protection, in this case, means limited water movement from the land surface to buried aquifers. As a result, surficial outwash was not explored as a possible water source for the rural water system and, thus, will not be discussed further.

Till and Glacial-Lacustrine Sediments

Till and glacial-lacustrine sediment (silt) are of significance to this investigation in that they are considered non-aquifer material and generally act to restrict the movement of ground water or infiltrating surface water. Generally, the higher

the clay content, the smaller the rate of ground-water movement through the till or silt.

The till and silt serve as physical boundaries (upper, lower, and lateral) to outwash examined in this investigation. The till and/or silt sometimes wholly contains an outwash body while sometimes serving only as lateral and lower boundaries.

Much of the till penetrated during this investigation appeared to contain considerable amounts of silt and/or sand, although no grain-size analyses were performed to document this condition. A relatively high percentage, by volume, of silt and/or sand would increase the potential for water movement through the till and lessen its hydraulic-confining properties. Likewise, the sandy-silt unit encountered during drilling may not be a good hydraulic-confining layer.

No wells were completed in the till or silt overlying the buried outwash and, thus, no quantitative data are available on vertical ground water gradients or the potential for water movement through the till and silt. Till and silt, because of low permeability, are not considered aquifers and were not explored as possible water sources for the rural water system.

Buried Outwash

The most vexing problem regarding buried outwash was not that it could not be found. Rather, it was in determining the continuity, or lack thereof, of the buried outwash from test hole to test hole. It is difficult to determine if the outwash encountered in a particular test hole is an isolated occurrence or whether it is part of a larger body which might constitute an aquifer of sufficient proportion to serve the needs of the rural water system. This is because of (1) rapid variation laterally in thicknesses and depths of outwash and (2) the limited number of wells and test holes in the area. The basis of this problem was recognized by Kume (1985) when he tried to describe the buried outwash which is contained within the till. This sequence of outwash was named the Prairie Coteau aquifer by Kume and was described in the following manner:

"Buried beneath till and within the thick layer of glacial drift that blankets the area are numerous lenticular bodies of outwash. Many of these deposits are included in what is herein named the Prairie Coteau aquifer. Generally, those outwash deposits buried beneath 30 ft or more of till and not otherwise part of a surface or near-surface aquifer, and not part of the Altamont aquifer at the base of the drift, are included in the Prairie Coteau aquifer.

The Prairie Coteau aquifer underlies about 1,100 mi² of Deuel and Hamlin Counties At any given site,

the aquifer usually is composed of several layers of sand and gravel separated by clayey till and enclosed within a thick section of till The beds of outwash at a given site probably are not connected hydraulically."

The Altamont aquifer referred to by Kume is an aquifer which is deeper than any which was penetrated during drilling for this investigation. This aquifer was not investigated because of potentially increased drilling costs for the rural water system if production wells were to be developed in the aquifer and because of data which suggested water of undesirable quality. The Altamont aquifer is not depicted on any figures presented herein.

The description given by Kume of the Prairie Coteau aquifer presents the main problem which was encountered during this investigation. That problem was the need to adequately define individual aquifers within the general classification of "Prairie Coteau." An adequate definition of the physical system is needed to make predictions of water availability and quality for long-term use.

Outwash tapped by Brookings-Deuel Rural Water System Production Wells 1, 2, and 3

The full extent of the outwash utilized by rural water system production wells 1, 2, and 3, is not known. This outwash is depicted in appendix H (cross sections D-D' and E-E') and may be more laterally extensive than shown. If lateral continuity exists to a much larger extent than shown on cross sections D-D' and E-E', then the outwash tapped by production wells 1, 2, and 3 may actually be part of what is described below as the Clear Lake aquifer.

Clear Lake Aquifer

There was one buried outwash, within Kume's Prairie Coteau classification, which was partially defined during the present investigation in part of the study area. This outwash, for purposes of this report, will be referred to as the Clear Lake aquifer and is labeled as such in appendix H.

Test holes drilled for the present investigation which are believed to have encountered this outwash body are those at ML 10, 13, 14, 15, 17, 19, 20, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 32, 33, and 34 (fig. 1). Additionally, rural water system production well 4 is interpreted to be completed in this same outwash (app. H, cross sections B-B' C-C' and E-E').

There may be other outwash which, although not presently shown to be part of the Clear Lake aquifer on the cross sections, is actually a part of what is called the Clear Lake aquifer.

Specifically, a lateral correlation is suggested between the outwash in the test hole at ML 18 and outwash in the "Brookings-Deuel RWS deep observation well" on cross section C-C' (app. H). If such a lateral continuity exists, then outwash in the "Brookings-Deuel RWS deep observation well" on cross sections B-B' and E-E' (app. H), and outwash at a similar depth on cross section D-D' (app. H), could also be part of the Clear Lake aquifer.

Also, outwash which is tapped by production wells 1, 2, and 3 might be part of the Clear Lake aquifer if lateral continuity exists between the test holes labeled "Brookings-Deuel RWS deep test hole" and ML 34 on cross section D-D' (app. H). This same outwash which is tapped by the production wells is also shown on cross section E-E' (app. H), but from a different perspective.

The boundary of the Clear Lake aquifer is not delineated, however, later in this report, a saturated-thickness map will be presented for known portions of this aquifer.

A clay layer was observed within the Clear Lake aquifer in seven test holes at six locations (ML 21, 26, 27, 29, 31, 32, and 34; fig. 1) ranging from 2 to 12 feet in thickness. A clay layer also exists at ML 10 (app. H, cross section A-A') which may or may not correlate with the other mentioned clay layer. The top of the clay occurs at or between the elevations of 1690 and 1677 feet (ML 10 excluded) and is illustrated on cross sections A-A', B-B', C-C', D-D', and F-F' (app. H). This clay is presently interpreted to occur within a single outwash unit. An alternate explanation is that the clay hydraulically separates the outwash into two outwash units. Data do not exist to completely rule out either explanation nor to assess the clay's potential hydraulic-confining properties.

Springs and "Flowing" Well Area

There is one area involving buried outwash which was examined that warrants separate discussion. The area is located about 1.5 miles north of the current rural water system main well field and appears to be unique in that there are many springs and seeps surrounding a valley. The source of hydraulic pressure for the springs and seeps is not very well defined, although buried outwash appears to be the source.

A test hole at ML 2 (fig. 1 and app H, cross section E-E') encountered a buried outwash at a depth of 67 feet. This outwash is believed to be contributing water to seeps and springs in the area for reasons which will be described in the "Water Levels" section of this report. Other drilling efforts at ML 3, 4, 5, 7, and 8 (fig. 1), were aimed at documenting a partial extent of the outwash. However, only the hole at ML 7 is believed to have encountered this same outwash, in spite of the short lateral distance between the hole at ML 2 and the others (fig. 1).

Water Levels

Water levels within all the various outwash bodies, surficial and buried, cannot be presented for the study area because of (1) the lack of enough, or any, wells in a particular outwash body and/or (2) the lack of an adequate physical definition of a particular outwash body. Wells constructed for this investigation were completed in buried outwash only, and primarily within a single aquifer (the Clear Lake aquifer).

Clear Lake Aquifer

A contour map of the water surface in a portion of the Clear Lake aquifer is shown in figure 5. This figure shows that the water surface generally slopes downward toward the southeast. Thus, there is the potential for a southeasterly direction of ground-water movement. Figure 5 was constructed using only those monitoring wells which are completed near the bottom portion of the aquifer, and consequently, excluded from this figure are data from wells at ML 22, 28, and 33 (fig. 1), which are completed near the top of the aquifer.

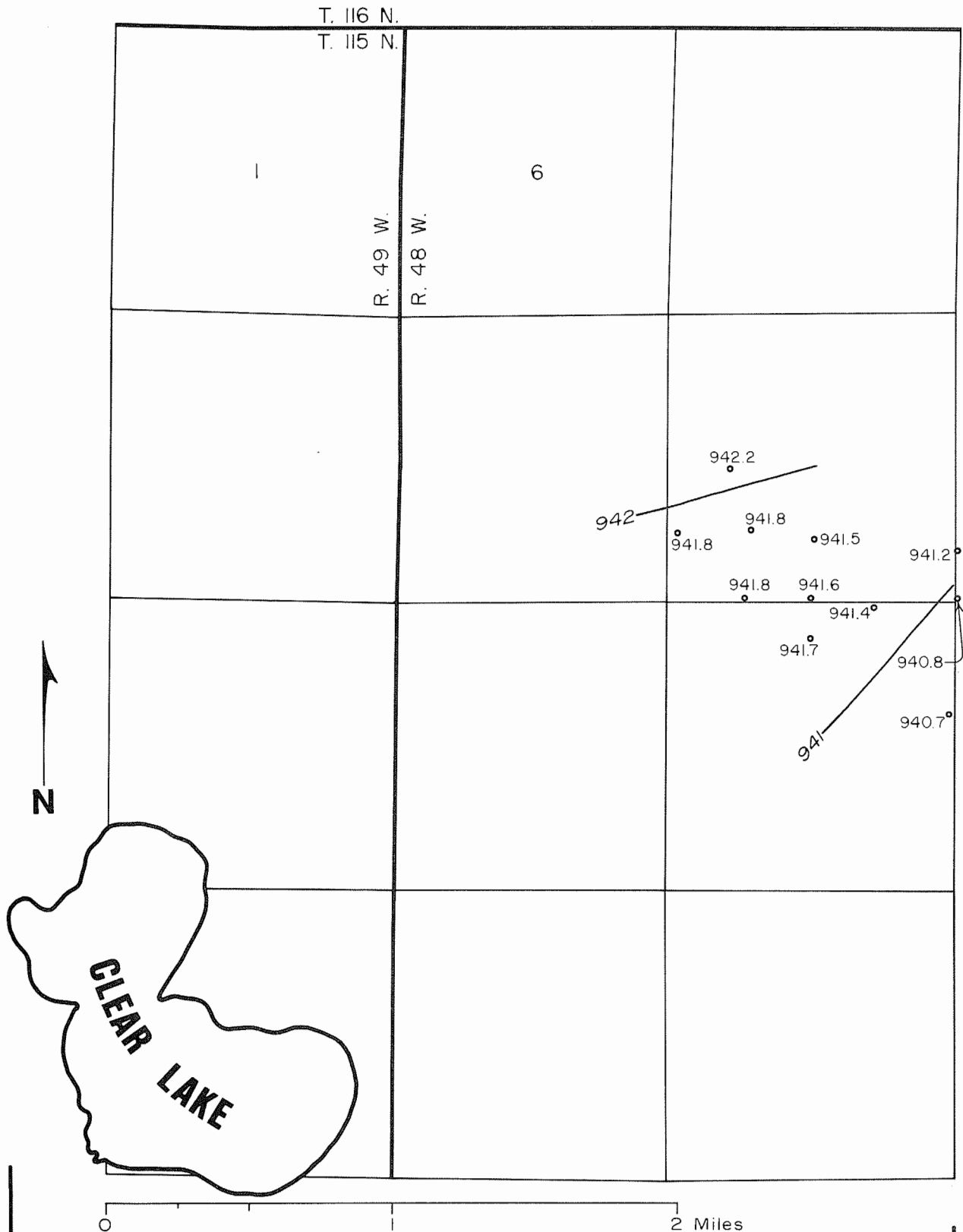
A downward hydraulic gradient exists within the Clear Lake aquifer. This is seen when comparing water levels in nested wells at ML 21 and 22, at ML 27 and 28, and at ML 32 and 33. Water-level differences in the nested wells range from 0.06 feet (ML 21 and 22) to 1.16 feet (ML 32 and 33). The downward vertical gradients range from about 0.001 foot/foot (ML 21 and 22) to 0.01 foot/foot (ML 32 and 33).

These downward gradients were measured where a clay layer exists within the aquifer with one well completed above the clay and one below. These gradients (difference in water elevation between the shallower and deeper wells) may indicate that the aquifer might actually be two distinct, or partially distinct, hydrologic units. Large-scale pumping of water from the Clear Lake aquifer with concurrent measurement of water levels in monitoring wells is necessary to determine the extent of connection between the shallower and deeper outwash.

Much of the buried outwash in which a monitoring well was installed was found to be under unconfined conditions. That is, the water does not rise above the top of the outwash in a well completed in the outwash. This condition is illustrated on cross sections A-A', B-B', C-C', and F-F' (app. H).

SATURATED THICKNESS

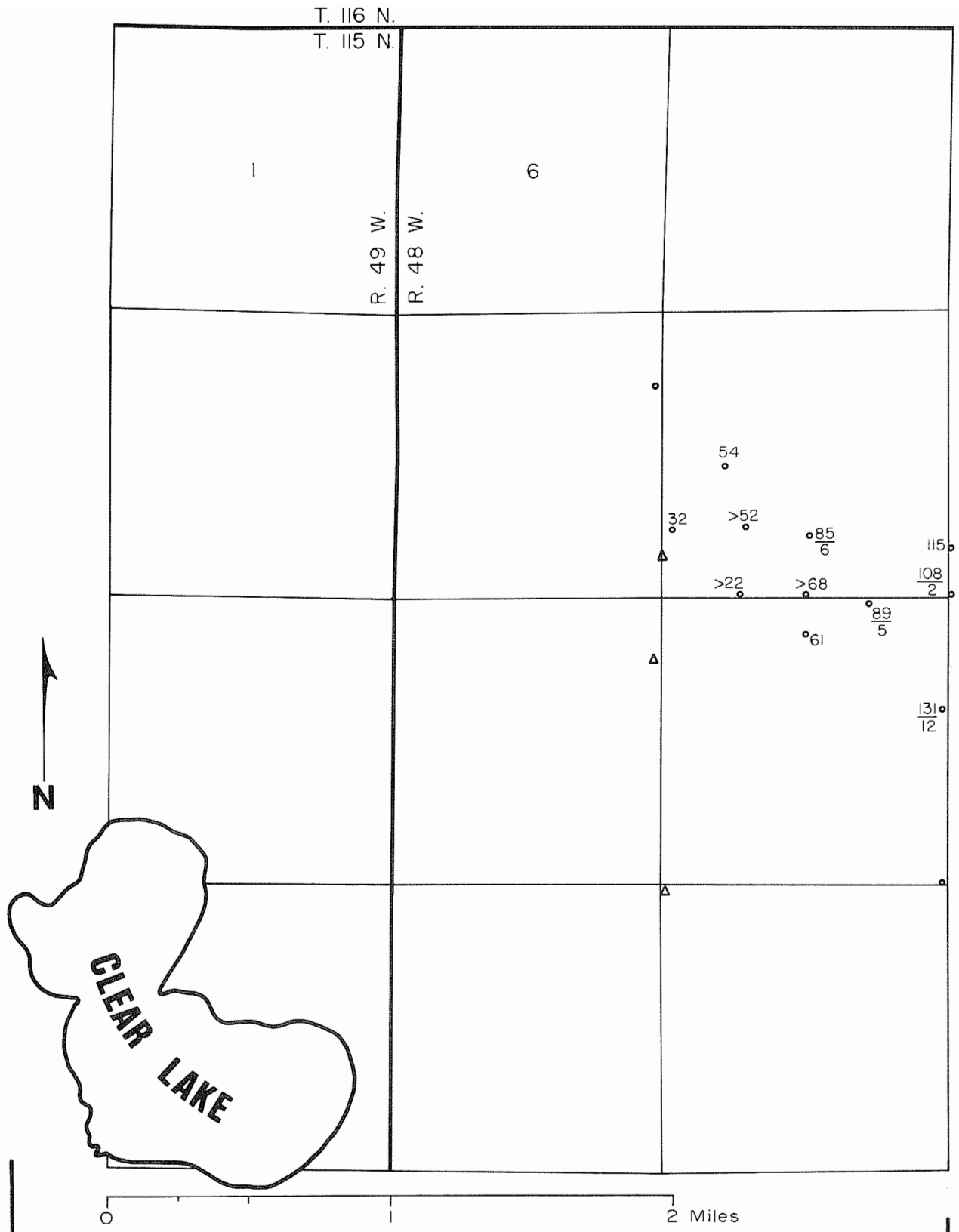
The saturated thickness of known portions of the Clear Lake aquifer is shown on figure 6. Up to 131 feet saturated thickness has been documented, however, the saturated thickness in this case includes a 12-foot thick clay layer (ML 32, app. H, cross



Monitoring well. Number is relative elevation, in feet, of the water surface in the well. See Appendix E for water level measurements.

Contour line connecting points of equal elevation on the water surface. Contour interval is 1 foot.

Figure 5. Contour map of the water surface in the Clear Lake aquifer on October 7, 1987.



$\frac{108}{2}$ Monitoring well or test hole. Upper number is saturated thickness, in feet, of the aquifer. Lower number, if present, is thickness of a clay layer included in saturated thickness. No estimate of saturated thickness is given for a test hole.

Δ Monitoring well or test hole where aquifer is absent.

Figure 6. Saturated thickness of the Clear Lake aquifer on October 7, 1987.

sections B-B' and F-F'). The saturated thicknesses on figure 6 provide a minimum areal extent of the Clear Lake aquifer.

Springs and "Flowing" Well Area

The test hole at ML 2 (fig. 1), drilled near the south rim of the valley, encountered, at a depth 67 feet, a sand and gravel body which contained sufficient hydraulic pressure to cause water to flow onto the land surface at a rate estimated to be greater than 100 gallons per minute.

Conversely, other nearby test holes (ML 5, 6, and 9) which were drilled and completed as monitoring wells in an attempt to gain more information on the extent of, and hydraulic pressure within, the outwash show a downward hydraulic gradient. This is in direct contrast to conditions observed at the "flowing" test hole.

One well was, however, completed in the "flowing" aquifer (ML 7, fig. 1). A pressure gauge attached to the well indicates that water from that aquifer would rise to about 20 feet above land surface at that location. This water-level elevation is not, however, sufficient to account for all springs and seeps observed in and around the valley.

Water Quality

Data indicate water of generally good quality in a number of monitoring wells, with total dissolved solids usually less than 500 ppm (app. A). Low concentrations of dissolved solids are not restricted to either surficial or buried outwash. If it were not for undesirable concentrations of iron and/or manganese in many monitoring wells, and nitrate-nitrogen in a few of the wells, there might be numerous options available for an alternate source of water for the rural water system.

In the study area, both surficial and buried outwash exhibit some nitrate-nitrogen contamination, however, an examination of appendix A shows that the majority of water samples collected do not have a nitrate-nitrogen problem. The sporadic occurrence of elevated concentrations of nitrate-nitrogen at a variety of depths, in presumably different aquifers, over a relatively large area cannot be fully explained with the available data. Prediction of the potential for movement of water already contaminated with nitrate-nitrogen into an uncontaminated portion of the same or different aquifer can be only as good as the understanding of the physical system. Present data do not allow accurate predictions of future contamination.

Outwash tapped by Brookings-Deuel Rural Water System Production Wells 1, 2, and 3

Table 1 lists the quality of water in the four production wells presently used by the Brookings-Deuel Rural Water System. Of these four wells, production wells 1, 2, and 3 draw water from an outwash which is presently interpreted to be different than the outwash tapped by production well 4. With the exception of nitrate-nitrogen, production wells 1, 2, and 3 contain water of good quality which has required no treatment, other than chlorination, prior to distribution by the rural water system.

There is a high level (15.80 ppm) of nitrate-nitrogen contamination in a shallow irrigation well just west of the rural water system's well field (water sample 31, fig. 3, app. A) and in the well field itself (production wells 1, 2, & 3; water samples 33, 30, & 29, respectively; fig. 3, app. A). The nitrate-nitrogen levels are higher than the recommended limit of 10 ppm. This outwash is overlain by 22 to 34 feet of sandy weathered till in the rural water system's main well field (app H, cross sections D-D' and E-E'). However, the connection of the outwash to surface contamination sources through sand lenses or weathered till might be even greater near the irrigation well (app. H, cross section D-D').

The exact source of nitrate-nitrogen and the path of movement into the outwash are not known. It may be a combination of the following that has caused the high nitrate-nitrogen; (1) application of nitrogen-based fertilizer to the overlying field, (2) movement of water with high nitrate-nitrogen content through sand lenses or weathered till into the outwash (3) pumping in irrigation and rural water system wells which cause hydraulic gradients that allow transport of contaminants into the outwash, (4) well construction techniques which have allowed migration of contaminated shallow water downward along well casing and into the water-intake of a given well, and (5) a deteriorated state of well materials which has allowed introduction of contaminated water either directly into the well or along and down the outside of the casing. As stated previously, it was not the intent of this investigation to identify the source(s) of nitrate-nitrogen contamination which have impacted three of the present rural water system wells.

Clear Lake Aquifer

Table 2 summarizes the water quality of the Clear Lake aquifer. Data show that water in the aquifer is quite acceptable for use as drinking water with perhaps the exception of manganese and sometimes iron. None of the water samples collected from the Clear Lake aquifer show concentrations of nitrate-nitrogen in excess of 0.06 ppm, and only three of these samples show concentrations to be above the detection limit (0.04 ppm) of the laboratory (table 2). Regardless of desired concentrations of

Table 1. Water quality of the Brookings-Deuel Rural Water System

Production well no.	Water sample no.	Location (3)	SDGS Lab ID (4)	Date Sampled	pH	Conductivity (mmhos) (5)	Hardness as CaCO ₃	TDS	Fe	Mn	SO ₄	NO ₃ -N	Na	Ca	Mg	K	Cl	F	HCO ₃	CO ₃	ALK	ALK	MO	P																				
																									MO	P																		
1	33	115N-48W-18 ADAD	BDR-87-041	09/09/87	6.5	676	418	343	<0.05	92	13.3	4.9	91	28	2.7	12	0.18	257	0	211	0																							
2	30	115N-48W-18 AADD	BDR-87-039	09/09/87	7	708	442	367	<0.05	96	10.2	5.4	96	31	2.6	11	0.08	293	0	240	0																							
3	29	115N-48W-17 BCBB	BDR-87-042	09/10/87	6.5	669	394	338	<0.05	84	11.5	5.2	89	28	2.4	11	0.19	268	0	220	0																							
Averages of wells 1, 2, and 3																							6.7	684	418	349	-----	91	11.7	5.2	92	29	2.6	11	0.15	273	0	224	0					
4	12	115N-48W-08 CCBB	BDR-87-009	06/17/87	7.41	649	420	352	0.49	84	<0.04	5.3	90	31	3.4	<=2	0.27	361	0	296	0																							
4	13	115N-48W-08 CCBB	BDR-87-040	09/09/87	6.5	655	399	357	0.52	80	<0.04	6.4	90	32	2.8	<=2	0.25	350	0	287	0																							
Blend																																												
(6)	36	115N-48W-18 CCDD	BDR-87-016	06/16/87	7.5	710	458	353	0.06	<0.05	89	9.53	3.9	92	30	2.7	12	0.14	278	0	228	0																						

(1) TDS - total dissolved solids; Fe - iron; Mn - manganese; SO₄ - sulfate; NO₃-N - nitrate nitrogen; Na - sodium; Ca - calcium; Mg - magnesium; K - potassium; Cl - chloride; F - fluoride; HCO₃ - bicarbonate; CO₃ - carbonate; Alk MO - alkalinity methyl orange; Alk P - alkalinity phenolphthalein. A symbol of "-----" in place of a numeric value for the averages indicates that "less than" values were reported in results of individual chemical analyses. Thus, no average could be computed.

(2) Number corresponds to number on figure 3 and in appendix A.

(3) See appendix B for explanation of location format.

(4) South Dakota Geological Survey Chemistry Laboratory identification number.

(5) mmhos - micromhos.

(6) This represents water from production well 4 blended with one of the other three production wells.

Table 2. Water quality of the Clear Lake aquifer.

(1) Chemical Constituents in Parts per Million

Water Sample no. (2)	ML no. (3)	Location (4)	Well Name	SDGS Lab ID (5)	Date Sampled (6)	Well Depth (ft)	Conductivity (mmhos) (7)	Hardness as CaCO ₃	TDS	Fe	Mn	SO ₄	NO ₃ -N	Na	Ca	Mg	K	Cl	F	HCO ₃	CO ₃	Alk	Alk MO	P																				
																									72	<0.04	5.3	87	28	3.0	3	0.24	332	0	272	0								
7	13	115N-48U-08 CBAA 1	R2-87-52	BDR-87-032	08/18/87	168	634	382	333	<0.05	0.55	72	<0.04	5.3	87	28	3.0	3	0.24	332	0	272	0	0																				
8	14	115N-48U-08 CBAA 2	R2-87-53	BDR-87-033	08/18/87	106	609	330	314	<0.05	0.50	60	<0.04	6.2	78	29	3.2	<2	0.27	328	0	269	0	0																				
9	15	115N-48U-08 CCBB 1	CO-87-12	BDR-87-007	06/17/87	84	644	413	342	0.06	0.43	85	<0.04	7.3	84	32	4.8	<=2	0.28	333	0	273	0	0																				
13	--	115N-48U-08 CCBB	BD-RUS #4	BDR-87-040	09/09/87	857	655	399	357	0.52	0.41	80	<0.04	6.4	90	32	2.8	<=2	0.25	350	0	287	0	0																				
14	17	115N-48U-08 DCBB 1	CO-87-13	BDR-87-005	06/16/87	119	593	404	307	0.20	0.39	73	<0.04	14	80	26	2.9	4	0.19	327	0	268	0	0																				
17	21	115N-48U-08 DCBB 1	R2-87-54	BDR-87-034	08/18/87	180	652	378	320	<0.05	0.42	82	0.06	11	82	28	3.2	3	0.12	325	0	267	0	0																				
18	22	115N-48U-08 DCBB 2	R2-87-55	BDR-87-035	08/19/87	136	950	614	492	<0.05	0.21	173	<0.04	22	121	46	6.0	6	0.19	438	0	359	0	0																				
19	23	115N-48U-08 DCCC 1	CO-87-06	BDR-87-011	06/18/87	180	630	418	341	<0.05	0.46	83	<0.04	6.3	87	30	3.5	3	0.21	329	0	270	0	0																				
21	25	115N-48U-09 CCBC 1	R1-87-75	BDR-87-048	10/06/87	215	632	400	350	<=0.05	0.51	60	<0.04	5.0	94	28	3.0	2	0.18	362	0	297	0	0																				
22	26	115N-48U-09 CCCC 1	R1-87-73	BDR-87-047	10/01/87	230	578	344	284	<0.05	0.36	54	0.04	13	76	23	4.2	3	0.19	321	0	263	0	0																				
24	27	115N-48U-17 ABAA 1	R2-87-49	BDR-87-046	10/01/87	200	615	380	333	0.06	0.63	75	<0.04	3.8	87	28	2.6	4	0.14	316	0	259	0	0																				
25	28	115N-48U-17 ABAA 2	R2-87-50	BDR-87-037	08/19/87	125	666	426	360	<0.05	0.61	83	<0.04	3.9	98	28	2.1	<2	0.19	346	0	284	0	0																				
26	31	115N-48U-17 ABCB 3	R2-87-58	BDR-87-031	08/17/87	148	518	300	255	<0.05	0.20	65	<0.04	6.7	66	22	2.9	3	0.17	255	0	209	0	0																				
27	32	115N-48U-17 ADDA 1	R1-87-74	BDR-87-050	10/07/87	238	608	398	340	<0.05	0.41	82	<0.04	4.0	90	28	2.9	7	0.19	304	0	249	0	0																				
28	33	115N-48U-17 ADDA 2	R1-87-76	BDR-87-049	10/06/87	125	562	376	277	<0.05	0.16	114	0.05	12	68	26	4.6	10	0.32	208	0	171	0	0																				
AVERAGES																						7.40	636	397	334	--	0.42	83	--	8.5	86	29	3.5	--	0.21	325	0	266	0	266	0	0	0	0

(1) TDS - total dissolved solids; Fe - iron; Mn - manganese; SO₄ - sulfate; NO₃-N - nitrate nitrogen; Na - sodium; Ca - calcium; Mg - magnesium; K - potassium; Cl - chloride; F - fluoride; HCO₃ - bicarbonate; CO₃ - carbonate; Alk MO - alkalinity methyl orange; Alk P - alkalinity phenolphthalein.

(2) Water sample number corresponds to number on figure 3.

(3) Map Location (ML) number - corresponds to number on figure 1 and in appendix B.

(4) See appendix B for explanation of location format.

(5) South Dakota Geological Survey Chemistry Laboratory identification number.

(6) Well depth is presented in feet below land surface.

(7) mmhos - micromhos.

manganese and iron, this water would require little treatment prior to distribution by the rural water system.

The quality of water in Brookings-Deuel Rural Water System production well 4 is also good, with the exceptions of iron and manganese (table 1 and water sample 13 in table 2). This water would likely require treatment for iron and manganese if used as the principal source of water for the rural water system.

A more complete chemical analysis of one water sample from this Clear Lake aquifer is presented in appendix C. This sample was collected from the same well (ML 27) as water samples 23 (app. A) and 24 (app. A and table 2). A comparison of these three samples shows a good correlation between data provided by the State Health Laboratory, Pierre, South Dakota, and the Chemistry Laboratory at the South Dakota Geological Survey in Vermillion, South Dakota. Data in appendix C show that the water meets all regulatory requirements for use as a public water supply.

Springs and "Flowing" Well Area

Water from three springs was sampled and analyzed for general chemical content (samples 3, 45, and 46; app. A). The quality of water from these springs is clearly inferior to that which is presently being distributed by the rural water system (Blend; table 1).

Water collected from springs had to migrate through some unknown thickness and type of sediment before flowing onto the land surface at the respective springs. Because of this, it is unlikely that this water is representative of the quality of water in the aquifer from which it originated. This is because ground water usually becomes more mineralized as it migrates along its flow path (Freeze and Cherry, 1979 and Chebotarev, 1955).

Only one water sample was collected (sample 4, app. A) from a well completed in the "flowing" aquifer. This aquifer is believed to be contributing water to the springs in the area. Due to the high concentrations of iron and manganese, this aquifer was not considered further as a potential source of water for the rural water system.

Age of Recharge Water

In an attempt to gain some information on the recharge to buried aquifers in the area, three water samples were collected and analyzed for tritium content (app. D). The three samples are assumed to be from two different aquifers; (1) the aquifer(s) which cause the springs and seeps in a valley about 1.5 miles north of the present rural water system well field, and (2) the

Clear Lake aquifer which yields water to the rural water system's production well 4.

A quote from Freeze and Cherry (1979) provides the basis for an interpretation of tritium in ground water. The quote is as follows:

"If a sample of groundwater from a location in the northern hemisphere contains tritium at concentration levels of hundreds or thousands of TU, it is evident that the water, or at least a large fraction of the water, originally entered the groundwater zone sometime after 1953. If the water has less than 5-10 TU, it must have originated prior to 1953."

The water from a spring (sample 46, fig. 3, app. A) about 2 miles north of the present rural water system well field yielded a TU content of -0.01. This indicates pre-1953 water and perhaps connate water.

The water sample from rural water system production well 4 (sample 12, fig. 3, app. A) yielded a TU content of 35.0. This indicates that at least a portion of the water in the aquifer tapped by this well represents post-1953 water. In other words, there is a component of recent recharge in that water. The amount and source of recent recharge cannot be quantified with available data.

The third sample collected for tritium analysis (sample 24, fig. 3, app. A) came from the well at ML 27 (fig. 1). This water, and the water collected from production well 4, is from the Clear Lake aquifer. The water from the well at ML 27 yielded a TU content of 6.67. A TU content such as this indicates little, if any, post-1953 water.

Water Quantity

Clear Lake Aquifer

An aquifer test was conducted on October 8 and 9, 1987, using rural water system production well 4 as the pumping well (app. G). Wells monitored included (1) the pumping well, (2) the well at ML 15 (fig. 1), and (3) a rural water system test/observation well (Brookings-Deuel RWS deep observation well, app. H, cross sections B-B' C-C' and E-E'), which is completed in a deeper outwash than the pumping well and which is 24 feet, laterally, from the pumping well.

Drawdown of water levels was measured in the deep test/observation well near the shallower pumping well (production well 4) during the test. This drawdown was due to the pumping of a well (location of water sample 6, fig. 3; the Tekronev irrigation well, app. H, cross section C-C') for an irrigation system to the

west of production well 4. At about 3:00 a.m. on October 9, 1987, during the aquifer test, the irrigation well ceased pumping. Recovery of the water level in the deep test/observation well was then recorded, while no recovery was observed in the shallower outwash (well at ML 15).

The drawdown and recovery in the deep test/observation well, without any recovery in the shallower outwash, seems to indicate that the outwash tapped by this well and that tapped by the pumping well may be hydraulically distinct. However, this is not necessarily so. A possible physical connection between the two outwashes is shown on cross section C-C' (app. H), although such a connection cannot be documented with available data.

The pumping rate of production well 4 was only 50 gallons per minute during the aquifer test due to pump-size limitations of the 4-inch diameter well casing. This low rate of pumping was not adequate to enable good predictions of long term water availability at this site. Data do indicate, however, that the rate of water withdrawal at the location of production well 4 could be at least doubled without any severe short-term effect on the pumping water level in the well.

With the exception of the data generated during the above mentioned aquifer test, no specific information is available on the water-yielding capabilities of the aquifer recommended as a possible future water source for the rural water system. However, the substantial amount of saturated thickness (fig. 6) should provide an adequate quantity of water to the rural water system.

RECOMMENDATIONS

It is recommended that the Brookings-Deuel Rural Water System attempt to develop a new well field in the aquifer herein referred to as the Clear Lake aquifer. The location recommended for development is an area near ML 26 (fig. 1). The extent, thickness, and water quality of the aquifer have already been discussed.

As part of the development efforts and prior to the installation of any permanent production facilities, additional testing should be conducted in the form of an aquifer test. This is necessary to adequately assess the long term potential of the aquifer and spacing requirements for any future wells. Additional water samples should be collected during the test and analyzed for chemical content.

The production/test well that may be installed should be screened only in the portion of the aquifer which is below the previously mentioned clay layer. Also, monitoring wells should be installed as necessary to allow measurement of water levels in portions of the aquifer above and below the clay layer. This is necessary to gain a proper understanding of hydrologic conditions

within the aquifer and to allow adequate long-term predictions of water availability.

Before permanent production wells are installed, the rural water system should contact the Division of Water Rights, Department of Water and Natural Resources, to obtain a permit for withdrawal of water from the aquifer. Also, the Office of Drinking Water, Department of Water and Natural Resources, should be contacted for final determination of biological and chemical suitability of the water.

The temporary solution to the problem of nitrate-nitrogen contamination in the main well field area of the Brookings-Deuel Rural Water System has been to blend water from production well 4 with water from one of the other three production wells. This has resulted in water which meets nitrate-nitrogen requirements but which has a slightly elevated level of iron compared to water from production wells 1, 2, and 3 (table 2).

Table 3 shows that water from the Clear Lake aquifer is very similar to water presently distributed by the rural water system, except for the differences just mentioned. Use of water from the Clear Lake aquifer would eliminate the nitrate-nitrogen problem presently confronting the rural water system. However, the water from this aquifer may require treatment to reduce the concentration of iron and manganese.

As stated previously, the distinction between (1) the outwash in which Brookings-Deuel Rural Water System production wells 1, 2, and 3 are completed and (2) the Clear Lake aquifer described in this report, cannot be said to be absolute based on available data. Some tentative stratigraphic correlations were discussed in conjunction with the cross sections presented herein which could result in an interpretation that the two outwashes are in fact part of the same hydrologic system. This raises the possibility that the area of outwash recommended for future development is connected to the area presently contaminated with nitrate-nitrogen.

The potential for contamination of the recommended area with water from near production wells 1, 2, and 3 cannot be fully assessed with available data. However, an examination of the locations of the production wells and the recommended area and also the potential for a southeasterly direction of ground water movement in the recommended area (fig. 5), yields an encouraging interpretation. Such an evaluation indicates that the natural ground water flow direction should not provide for movement of water from the contaminated area to the recommended area. Also keep in mind that the basis for this discussion is hypothetical in nature with a premise of an unproven hydraulic connection between the two areas. However, assuming a connection, the presence of a thick and generally extensive aquifer in the recommended area approximately 1 mile from the present well field would minimize the effects of nitrate-nitrogen contamination even

Table 3. Comparison of water quality between the Brookings-Deuel Rural Water System and the Clear Lake aquifer.

	Parts per Million (1)																	
	Conduc- tivity (mmhos)	TDS	CaCO ₃	Fe	Mn	SO ₄	NO ₃ -N	Na	Ca	Mg	K	Cl	F	HCO ₃	CO ₃	ALK	MO	ALK P
Clear Lake aquifer averages	636	397	334	--	0.42	83	--	8.5	86	29	3.5	--	0.21	325	0	266	0	
Production wells 1, 2, & 3 averages	684	418	349	--	--	91	11.7	5.2	92	29	2.6	11	0.15	273	0	224	0	
Blend (production well 4 blended with one of other three production wells)	710	458	353	0.06	<0.05	89	9.53	3.9	92	30	2.7	12	0.14	278	0	228	0	

(1) TDS - total dissolved solids; Fe - iron; Mn - manganese; SO₄ - sulfate; NO₃-N - nitrate nitrogen; Na - sodium; Ca - calcium; Mg - magnesium; K - potassium; Cl - chloride; F - fluoride; HCO₃ - bicarbonate; CO₃ - carbonate; Alk MO - alkalinity methyl orange; Alk P - alkalinity phenolphthalein. A symbol of "--" in place of a numeric value for the averages indicates that "less than" values were reported in results of individual chemical analyses. Thus, no average could be computed.

See table 1 and/or table 2 for results of individual analyses.

if the water would travel from the vicinity of the present well field to the recommended area. Thus, until the time when new data might show otherwise, the recommended area is believed to be a viable alternative to the water source presently used by the rural water system.

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APPENDIX A. Results of water quality analyses performed by the South Dakota Geological Survey.

Water Sample no. (2)	ML (3)	Location (4)	Sample ID (5)	SDGS Lab ID (6)	Date Sampled (7)	Well Depth (ft) (8)	Conductivity (mmhos) (9)	Hardness as CaCO ₃ (10)	TDS (11)	Fe (12)	Mn (13)	SO ₄ (14)	NO ₃ -N (15)	Na (16)	Ca (17)	Mg (18)	K (19)	Cl (20)	F (21)	HCO ₃ (22)	CO ₃ (23)	Alk (24)	ALK MO (25)	P (26)
1	5	115N-48W-05 CCCC 4	R1-87-39	BDR-87-028	06/24/87	136	602	382	319	0.71	0.37	61	0.05	13	85	26	3.5	<2	0.30	356	0	292	0	0
2	6	115N-48W-05 CCCC 5	R1-87-40	BDR-87-029	06/24/87	84	889	538	484	2.78	0.24	59	<0.04	8.4	128	40	4.9	<2	0.20	553	0	454	0	0
3	--	115N-48W-06 ABBA Spring 3		BDR-87-015	06/16/87	?	1314	1006	740	1.21	1.43	457	<0.04	12	194	62	5.2	5	0.22	446	0	366	0	0
4	7	115N-48W-06 DDAD 1	R2-87-45	BDR-87-038	08/19/87	80	637	392	333	2.30	0.45	43	<0.04	7.3	89	27	4.3	<2	0.35	368	0	302	0	0
5	9	115N-48W-06 DDDD 2	CO-87-15	BDR-87-002	06/11/87	51	783	470	417	1.46	0.57	63	<0.04	8.8	106	37	3.0	2	0.12	477	0	391	0	0
6	--	115N-48W-07 DDDD Tekrony Irr		BDR-87-026	06/22/87	130	882	614	471	<0.05	0.10	186	1.37	17	136	32	5.8	3	0.37	358	0	294	0	0
7	13	115N-48W-08 CBAA 1	R2-87-52	BDR-87-032	08/18/87	168	634	382	333	<0.05	0.55	72	<0.04	5.3	87	28	3.0	3	0.24	332	0	272	0	0
8	14	115N-48W-08 CBAA 2	R2-87-53	BDR-87-033	08/18/87	106	609	330	314	<0.05	0.50	60	<0.04	6.2	78	29	3.2	<2	0.27	328	0	269	0	0
9	15	115N-48W-08 CB88 1	CO-87-12	BDR-87-007	06/17/87	84	644	413	342	0.06	0.43	85	<0.04	7.3	84	32	4.8	<=2	0.28	333	0	273	0	0
10	--	115N-48W-08 CB8A Russow PS		BDR-87-010	06/18/87	?	608	386	323	0.82	0.23	81	<0.04	3.0	83	28	2.9	10	0.27	294	0	241	0	0
11	--	115N-48W-08 CB88 deep obs		BDR-87-008	06/17/87	163	617	394	328	1.54	0.65	64	<0.04	4.3	85	28	3.0	<2	0.19	346	0	284	0	0
12	--	115N-48W-08 CB88	BD-RWS #4	BDR-87-009	06/17/87	857	741	420	352	0.49	0.46	84	<0.04	5.3	90	31	3.4	<=2	0.27	361	0	296	0	0
13	--	115N-48W-08 CB88	BD-RWS #4	BDR-87-040	09/09/87	857	655	399	357	0.52	0.41	80	<0.04	6.4	90	32	2.8	<=2	0.25	350	0	287	0	0
14	17	115N-48W-08 CB88 1	CO-87-13	BDR-87-005	06/16/87	119	742	404	307	0.20	0.39	73	<0.04	14	80	26	2.9	4	0.19	327	0	268	0	0
15	18	115N-48W-08 CB88 2	CO-87-14	BDR-87-006	06/16/87	51	775	226	177	<0.05	<0.05	17	2.11	1.7	46	15	2.6	<=2	0.12	190	0	156	0	0
16	20	115N-48W-08 CB88 2	R2-87-48	BDR-87-030	08/17/87	108	677	416	343	<0.05	0.15	104	<0.04	10	83	33	3.6	4	0.23	334	0	274	0	0
17	21	115N-48W-08 CB88 1	R2-87-54	BDR-87-034	08/18/87	180	652	378	320	<0.05	0.42	82	0.06	11	82	28	3.2	3	0.12	325	0	267	0	0
18	22	115N-48W-08 CB88 2	R2-87-55	BDR-87-035	08/19/87	136	950	614	492	<0.05	0.21	173	<0.04	22	121	46	6.0	6	0.19	438	0	359	0	0
19	23	115N-48W-08 DCCC 1	CO-87-06	BDR-87-011	06/18/87	180	630	418	341	<0.05	0.46	83	<0.04	6.3	87	30	3.5	3	0.21	329	0	270	0	0
20	24	115N-48W-08 DCCC 2	CO-87-07	BDR-87-001	06/11/87	76	751	301	249	0.19	0.31	56	<0.04	5.3	70	18	2.1	2	0.01	250	0	205	0	0
21	25	115N-48W-09 CB8C 1	R1-87-75	BDR-87-048	10/06/87	215	632	400	350	<0.05	0.51	60	<0.04	5.0	94	28	3.0	2	0.18	362	0	297	0	0
22	26	115N-48W-09 CCCC 1	R1-87-73	BDR-87-047	10/01/87	230	578	344	284	<0.05	0.36	54	0.04	13	76	23	4.2	3	0.19	321	0	263	0	0
23	27	115N-48W-17 ABAA 1	R2-87-49	BDR-87-036	08/19/87	200	625	384	333	<0.05	0.58	72	<0.04	5.0	87	28	2.9	4	0.19	319	0	262	0	0
24	27	115N-48W-17 ABAA 1	R2-87-49	BDR-87-046	10/01/87	200	615	380	333	0.06	0.63	75	<0.04	3.8	87	28	2.6	4	0.14	316	0	259	0	0

Appendix A -- continued.

Parts per Million (1)

Water Sample no. (2) (3)	Location (4)	Sample ID (5)	SDGS Lab ID (6)	Date Sampled (7)	Well Depth (ft)	Conductivity (mmhos) (8)	Hardness as CaCO ₃ (9)	Fe (9)	Mn (9)	SO ₄ (9)	NO ₃ (10)	Na (10)	Ca (10)	Mg (10)	K (10)	Cl (10)	F (10)	HCO ₃ (10)	CO ₃ (10)	ALK MO (10)	ALK P (10)	
25	115N-48W-17 ABAA 2	R2-87-50	BDR-87-037	08/19/87	125	7.43	666	0.3	0.05	250	10	--	--	--	--	--	250	2.4	--	--	--	--
26	115N-48W-17 ABCB 3	R2-87-58	BDR-87-031	08/17/87	148	7.79	518	<0.05	0.20	65	<0.04	6.7	66	22	2.9	3	0.17	255	0	209	0	0
27	115N-48W-17 ADDA 1	R1-87-74	BDR-87-050	10/07/87	238	7.52	608	<0.05	0.41	82	<0.04	4.0	90	28	2.9	7	0.19	304	0	249	0	0
28	115N-48W-17 ADDA 2	R1-87-76	BDR-87-049	10/06/87	125	8.08	562	<0.05	0.16	114	0.05	12	68	26	4.6	10	0.32	208	0	171	0	0
29	115N-48W-17 BCBB	BD-RWS #3	BDR-87-042	09/10/87	?	6.5	669	<0.05	<0.05	84	11.5	5.2	89	28	2.4	11	0.19	268	0	220	0	0
30	115N-48W-18 AADD	BD-RWS #2	BDR-87-039	09/09/87	?	7	708	<0.05	<0.05	96	10.2	5.4	96	31	2.6	11	0.08	293	0	240	0	0
31	115N-48W-18 ACAA	Atyeo																				
32	115N-48W-18 ACAD	Irr 1	BDR-87-017	06/16/87	54	7	918	<0.05	0.07	161	15.80	5.3	119	39	5.0	20	0.10	293	0	240	0	0
33	115N-48W-18 ADAD	Atyeo																				
34	115N-48W-18 BDCB	Irr 2	BDR-87-018	06/16/87	104	7	1203	2.84	0.39	355	<0.04	22	180	42	4.4	<2	0.29	396	0	325	0	0
35	115N-48W-18 CCDD	BD-RWS #1	BDR-87-041	09/09/87	?	6.5	676	<0.05	<0.05	92	13.3	4.9	91	28	2.7	12	0.18	257	0	211	0	0
36	115N-48W-18 CCDD	Eide Irr	BDR-87-027	06/23/87	157	7	1188	3.94	0.46	365	<0.04	22	181	45	4.2	<2	0.31	399	0	327	0	0
37	115N-48W-18 DCCC	Atyeo PD	BDR-87-025	06/18/87	40	7	830	<0.05	0.23	48	28.40	23	97	34	6.3	19	0.25	324	0	266	0	0
38	115N-48W-19 CCCD	Atyeo RWS	BDR-87-016	06/16/87	--	7.5	710	0.06	<0.05	89	9.53	3.9	92	30	2.7	12	0.14	278	0	228	0	0
39	115N-48W-20 BBBBB 1	Kjelden PS	BDR-87-020	06/17/87	70	6.5	1024	1.72	0.20	285	0.16	22	164	30	5.1	<2	0.42	377	0	309	0	0
40	115N-48W-20 BBBBB 3	Eide PS	BDR-87-024	06/18/87	17	7	1990	<0.05	<0.05	142	12.80	64	218	91	9.0	270	0.15	639	0	524	0	0
41	115N-48W-20 CAAD	CO-87-09	BDR-87-004	06/16/87	54	7.03	1002	<0.05	0.61	186	<0.04	13	148	41	3.9	<2	0.35	491	0	403	0	0
42	115N-48W-20 DCCC	CO-87-11	BDR-87-003	06/16/87	166	7.22	1232	2.38	0.34	404	<0.04	32	186	36	8.9	<2	0.36	350	0	287	0	0
43	115N-48W-12 DCCC	Boeke Irr	BDR-87-023	06/17/87	70	7	641	<0.05	<0.05	43	9.72	3.1	84	27	2.3	6	0.14	300	0	246	0	0
44	115N-48W-13 AABBB	Nieman PD	BDR-87-021	06/17/87	22	7	744	<0.05	<0.05	126	9.42	3.3	108	29	0.6	13	0.20	275	0	226	0	0
45	115N-48W-24 BCDA	Nieman Irr	BDR-87-022	06/17/87	145	7.5	1220	3.82	0.53	383	<0.04	25	189	46	4.5	<2	0.35	400	0	328	0	0
46	116N-48W-31 CCDC	Clear Lake	BDR-87-019	06/17/87	---	7	847	<0.05	<0.05	253	<0.04	12	98	51	7.6	11	0.29	243	0	199	0	0
47	116N-48W-31 DCCC	Spring 2	BDR-87-014	06/16/87	?	7.5	1575	0.76	0.79	614	<0.04	20	229	81	5.7	<2	0.23	428	0	351	0	0
48	116N-48W-31 DCCC	Spring 1	BDR-87-013	06/16/87	?	7.5	1303	0.99	1.47	397	<0.04	12	189	59	5.2	6	0.24	428	0	351	0	0

Appendix A -- continued.

- (1) TDS - total dissolved solids; Fe - iron; Mn - manganese; SO₄ - sulfate; NO₃-N - nitrate nitrogen; Na - sodium; Ca - calcium; Mg - magnesium; K - potassium; Cl - chloride; F - fluoride; HCO₃ - bicarbonate; CO₃ - carbonate; Alk NO₃ - alkalinity methyl orange; Alk P - alkalinity phenolphthalein.
- (2) Water sample number corresponds to number on figure 1 and in appendix B.
- (3) Map Location (ML) number - corresponds to number on figure 3.
- (4) See appendix B for explanation of location format.
- (5) Sample source identification.
- (6) South Dakota Geological Survey Chemistry Laboratory identification number.
- (7) Well depth is presented in feet below land surface. RMS - Brookings-Deuel Rural Water System water.
- (8) mmhos - micromhos.
- (9) United States Environmental Protection Agency recommended maximum limit (U.S. Environmental Protection Agency, 1985b).
- (10) United States Environmental Protection Agency enforceable maximum limit (U.S. Environmental Protection Agency, 1985a).

APPENDIX B

Logs of test holes and monitoring wells drilled by the South Dakota Geological Survey for this investigation

MAP LOCATION (ML)

A number arbitrarily assigned to the log according to the order in which it is listed (see **LEGAL LOCATION** and **LOCATION**). This number corresponds to the numbers listed on figure 1.

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 NW SE NE SW sec. 30, T. 99 N., R. 64 W. is the same as a **LOCATION** of 099N-64W-30CADB.

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, and TOTAL CASING AND SCREEN

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.

CASING TOP ELEVATION and GROUND SURFACE ELEVATION

The numbers are presented in feet above mean sea level. I - the elevation was determined using a surveying instrument. The elevations were surveyed to the nearest 0.01 foot. T - the elevation was estimated from 7 1/2 minute series topographic map.

CASING DIAMETER

The numbers are presented in inches.

COUNTY: DEUEL LOCATION: 115N-48W-05CCBC 1
 MAP LOCATION: 1
 LEGAL LOCATION: SW NW SW SW SEC. 05, T. 115 N., R. 48 W.
 LATITUDE: 44.4734 LONGITUDE: 96.3721
 LAND OWNER:
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: D. JACOBSON DRILLER'S LOG:
 GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
 DATE DRILLED: 05-18-1987 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1705.00 T
 TOTAL DRILL HOLE DEPTH: 25.0 TEST HOLE NUMBER: CO-87-01
 USGS HYDROLOGICAL UNIT CODE: 07020003
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
 NATURAL GAMMA: EXTRA:
 SAMPLES:

0	-	4.0	CLAY, LIGHT-BROWN, SILTY, SANDY, PEBBLY (TILL)
4.0	-	15.0	SAND AND GRAVEL, MEDIUM SAND TO COARSE PEBBLE GRAVEL; OXIDIZED
15.0	-	25.0	CLAY, GRAY, SILTY, SANDY, PEBBLY; ROCK AT 25 FEET, ABANDONED HOLE (TILL)

* * * *

COUNTY: DEUEL LOCATION: 115N-48W-05CCBC 2
 MAP LOCATION: 2
 LEGAL LOCATION: SW NW SW SW SEC. 05, T. 115 N., R. 48 W.
 LATITUDE: 44.4734 LONGITUDE: 96.3721
 LAND OWNER:
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: D. JACOBSON DRILLER'S LOG:
 GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
 DATE DRILLED: 05-19-1987 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1705.00 T
 TOTAL DRILL HOLE DEPTH: 67.0 TEST HOLE NUMBER: CO-87-02
 USGS HYDROLOGICAL UNIT CODE: 07020003
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
 NATURAL GAMMA: EXTRA:
 SAMPLES:

HOLE BEGAN FLOWING APPROXIMATELY 100 GPM.

0	-	7.0	CLAY, BROWN, SILTY, PEBBLY, VERY SANDY (TILL)
7.0	-	13.0	SAND AND GRAVEL, MEDIUM SAND TO COARSE PEBBLE GRAVEL; UNOXIDIZED
13.0	-	53.0	CLAY, GRAY, SILTY, SANDY, PEBBLY (TILL)
53.0	-	60.0	CLAY, OLIVE-GREEN-BROWN, SILTY, SANDY, PEBBLY (TILL)

60.0 - 67.0 CLAY, GRAY; INTERBEDDED WITH SAND AND
GRAVEL; GRAVEL OR ROCK AT 67 FEET,
ABANDONED HOLE (TILL?)

* * * *

COUNTY: DEUEL LOCATION: 115N-48W-05CCCC 2
MAP LOCATION: 3
LEGAL LOCATION: SW SW SW SW SEC. 05, T. 115 N., R. 48 W.
LATITUDE: 44.4727 LONGITUDE: 96.3720
LAND OWNER:
PROJECT: BROOKINGS-DEUEL RWS
DRILLING COMPANY: SDGS
DRILLER: D. JACOBSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 05-20-1987 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1762.00 T
TOTAL DRILL HOLE DEPTH: 90.0 TEST HOLE NUMBER: CO-87-03
USGS HYDROLOGICAL UNIT CODE: 07030003
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES:

0	-	3.0	TOPSOIL
3.0	-	12.0	CLAY, BROWN, SILTY, SANDY; SOME SMALL GRAVEL (TILL)
12.0	-	52.0	GRAVEL, FINE TO COARSE PEBBLE; OXIDIZED
52.0	-	62.0	CLAY, BROWN, SANDY
62.0	-	80.0	CLAY, BROWN TO GRAY, SANDY; HIT ROCK AT 80 FEET
80.0	-	92.0	CLAY, GRAY, SILTY; SMALL GRAVEL STRINGERS, HIT ROCK AT 92 FEET, ABANDONED HOLE

* * * *

COUNTY: DEUEL LOCATION: 115N-48W-05CCCC 3
MAP LOCATION: 4
LEGAL LOCATION: SW SW SW SW SEC. 05, T. 115 N., R. 48 W.
LATITUDE: 44.4727 LONGITUDE: 96.3720
LAND OWNER:
PROJECT: BROOKINGS-DEUEL RWS
DRILLING COMPANY: SDGS
DRILLER: D. JACOBSON DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 05-21-1987 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1762.00 T
TOTAL DRILL HOLE DEPTH: 137.0 TEST HOLE NUMBER: CO-87-04
USGS HYDROLOGICAL UNIT CODE: 07020003
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES:

0	-	3.0	TOPSOIL
3.0	-	12.0	CLAY, BROWN, SANDY
12.0	-	30.0	GRAVEL, MEDIUM TO COARSE PEBBLE; UNOXIDIZED
30.0	-	45.0	CLAY, GRAY, SILTY
45.0	-	65.0	GRAVEL, MEDIUM TO COARSE PEBBLE; UNOXIDIZED
65.0	-	137.0	CLAY, GRAY, VERY SANDY; GRAVEL STRINGERS; HIT ROCK AT 116 FEET; PUT ROCK BIT ON AT 116 FEET; ABANDONED HOLE AT 137 FEET (TILL?)

* * * *

COUNTY: DEUEL	LOCATION: 115N-48W-05CCCC 4
MAP LOCATION: 5	
LEGAL LOCATION: SW SW SW SW SEC. 05, T. 115 N., R. 48 W.	
LATITUDE: 44.4727	LONGITUDE: 96.3720
LAND OWNER:	
PROJECT: BROOKINGS-DEUEL RWS	
DRILLING COMPANY: SDGS	
DRILLER: G. JENSEN/L. HELSETH	DRILLER'S LOG:
GEOLOGIST: P. DAWSON	GEOLOGIST'S LOG: X
DATE DRILLED: 06-23-1987	DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1762.00 T	
TOTAL DRILL HOLE DEPTH: 170.0	TEST HOLE NUMBER: R1-87-39
WATER RIGHTS WELL:	SDGS WELL NAME: R1-87-39
OTHER WELL NAME:	
BASIN: MINNESOTA/WHETSTONE	AQUIFER: PRAIRIE COTEAU
MANAGEMENT UNIT:	
SCREEN TYPE: PVC, MFG.	SCREEN LENGTH: 10.0
CASING TYPE: PVC	CASING DIAMETER: 2.0
CASING TOP ELEVATION:	
CASING STICK-UP: 3.00	TOTAL CASING AND SCREEN: 173.0
WELL MAINTENANCE DATE:	
USGS HYDROLOGICAL UNIT CODE: 07020003	
ELECTRIC LOG INFORMATION:	
SPONTANEOUS POTENTIAL:	SINGLE POINT RESISTIVITY:
NATURAL GAMMA:	EXTRA:
SAMPLES:	

0	-	2.0	TOPSOIL, BLACK
2.0	-	14.0	GRAVEL, COARSE PEBBLE
14.0	-	21.0	CLAY, BROWN, SANDY, PEBBLY (TILL)
21.0	-	40.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
40.0	-	84.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
84.0	-	92.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
92.0	-	98.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
98.0	-	111.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
111.0	-	118.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
118.0	-	170.0	CLAY, GRAY, SANDY; SAND STRINGERS

* * * *

COUNTY: DEUEL LOCATION: 115N-48W-05CCCC 5
 MAP LOCATION: 6
 LEGAL LOCATION: SW SW SW SW SEC. 05, T. 115 N., R. 48 W.
 LATITUDE: 44.4727 LONGITUDE: 96.3720
 LAND OWNER:
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: G. JENSEN DRILLER'S LOG:
 GEOLOGIST: P. DAWSON GEOLOGIST'S LOG: X
 DATE DRILLED: 06-23-1987 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1762.00 T
 TOTAL DRILL HOLE DEPTH: 93.0 TEST HOLE NUMBER: R1-87-40
 WATER RIGHTS WELL: SDGS WELL NAME: R1-87-40
 OTHER WELL NAME:
 BASIN: MINNESOTA/WHETSTONE AQUIFER: PRAIRIE COTEAU
 MANAGEMENT UNIT:
 SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
 CASING TYPE: PVC CASING DIAMETER: 2.0
 CASING TOP ELEVATION:
 CASING STICK-UP: 3.00 TOTAL CASING AND SCREEN: 93.0
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 07020003
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
 NATURAL GAMMA: EXTRA:
 SAMPLES:

0	-	2.0	TOPSOIL
2.0	-	15.0	CLAY, BROWN, SANDY, PEBBLY (TILL)
15.0	-	48.0	GRAVEL, COARSE PEBBLE
48.0	-	57.0	SAND, MEDIUM TO COARSE
57.0	-	70.0	GRAVEL, MEDIUM TO COARSE PEBBLE
70.0	-	85.0	CLAY, GRAY, SILTY, SANDY
85.0	-	93.0	SAND AND GRAVEL, MEDIUM SAND TO COARSE PEBBLE GRAVEL

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COUNTY: DEUEL LOCATION: 115N-48W-06DDAD 1
 MAP LOCATION: 7
 LEGAL LOCATION: SE NE SE SE SEC. 06, T. 115 N., R. 48 W.
 LATITUDE: 44.4733 LONGITUDE: 96.3721
 LAND OWNER: H. JACOBSON
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: T. MCCUE/L. SCHULZ DRILLER'S LOG:
 GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
 DATE DRILLED: 08-05-1987 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1713.00 T
 TOTAL DRILL HOLE DEPTH: 92.0 TEST HOLE NUMBER: R2-87-45
 WATER RIGHTS WELL: SDGS WELL NAME: R2-87-45
 OTHER WELL NAME:

BASIN: MINNESOTA/WHETSTONE AQUIFER: PRAIRIE COTEAU
 MANAGEMENT UNIT:
 SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
 CASING TYPE: STEEL CASING DIAMETER: 5.0
 CASING TOP ELEVATION:
 CASING STICK-UP: 1.50 TOTAL CASING AND SCREEN: 81.5
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 07020003
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
 NATURAL GAMMA: EXTRA:
 SAMPLES:

SET BOTTOM OF 5-INCH DIAMETER CASING AT 78 FEET,
 FILLED ANNULUS WITH CEMENT GROUT, DRILLED OUT
 CEMENT PLUG AT BOTTOM OF CASING, CONTINUED
 DRILLING TO 92 FEET, WELL INITIALLY FLOWED AT
 120 LITERS PER MINUTE, SCREEN INSTALLED IN
 UPPER 10 FEET OF CASING FOR FILTERING
 PURPOSES.

0	-	3.0	TOPSOIL, BLACK
3.0	-	8.0	CLAY, LIGHT-BROWN, SANDY, GRAVELLY; OXIDIZED
8.0	-	11.0	GRAVEL, COARSE PEBBLE
11.0	-	15.0	CLAY, GRAY, VERY GRAVELLY (TILL)
15.0	-	22.0	CLAY, YELLOW-BROWN, PEBBLY, GRAVELLY (TILL)
22.0	-	74.0	CLAY, GRAY, SILTY, SANDY
74.0	-	78.0	GRAVEL, MEDIUM TO COARSE PEBBLE
78.0	-	92.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
92.0	-	93.0	CLAY(?)

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COUNTY: DEUEL LOCATION: 115N-48W-06DDDD 1
 MAP LOCATION: 8
 LEGAL LOCATION: SE SE SE SE SEC. 06, T. 115 N., R. 48 W.
 LATITUDE: 44.4726 LONGITUDE: 96.3720
 LAND OWNER:
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: T. MCCUE/L. SCHULZ DRILLER'S LOG:
 GEOLOGIST: P. DAWSON GEOLOGIST'S LOG: X
 DATE DRILLED: 05-26-1987 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1761.00 T
 TOTAL DRILL HOLE DEPTH: 175.0 TEST HOLE NUMBER: R2-87-18
 USGS HYDROLOGICAL UNIT CODE: 07020003
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY: X
 NATURAL GAMMA: X EXTRA:
 SAMPLES:

0	-	1.0	TOPSOIL
1.0	-	9.0	CLAY, YELLOW-BROWN, SANDY; OXIDIZED
9.0	-	13.0	SAND AND GRAVEL, MEDIUM SAND TO COARSE PEBBLE GRAVEL
13.0	-	21.0	CLAY, GRAY, SANDY
21.0	-	31.0	GRAVEL, MEDIUM PEBBLE
31.0	-	79.0	CLAY, GRAY; INTERBEDDED WITH SAND
79.0	-	88.0	SAND, MEDIUM TO COARSE
88.0	-	102.0	CLAY, GRAY; INTERBEDDED WITH SAND
102.0	-	107.0	SAND, MEDIUM TO COARSE
107.0	-	117.0	CLAY, GRAY, SANDY
117.0	-	122.0	SAND, MEDIUM TO COARSE
122.0	-	134.0	CLAY, GRAY, VERY SANDY
134.0	-	141.0	CLAY, GRAY, SANDY
141.0	-	144.0	SAND, MEDIUM TO COARSE
144.0	-	175.0	CLAY, GRAY, SANDY, PEBBLY (TILL)

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COUNTY: DEUEL	LOCATION: 115N-48W-06DDDD 2
MAP LOCATION: 9	
LEGAL LOCATION: SE SE SE SE SEC. 06, T. 115 N., R. 48 W.	
LATITUDE: 44.4726	LONGITUDE: 96.3720
LAND OWNER:	
PROJECT: BROOKINGS-DEUEL RWS	
DRILLING COMPANY: SDGS	
DRILLER: D. JACOBSON	DRILLER'S LOG:
GEOLOGIST: P. DAWSON	GEOLOGIST'S LOG: X
DATE DRILLED: 06-04-1987	DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1761.00 T	
TOTAL DRILL HOLE DEPTH: 62.0	TEST HOLE NUMBER: CO-87-15
WATER RIGHTS WELL:	SDGS WELL NAME: CO-87-15
OTHER WELL NAME:	
BASIN: MINNESOTA/WHETSTONE	AQUIFER: PRAIRIE COTEAU
MANAGEMENT UNIT:	
SCREEN TYPE: PVC, MFG.	SCREEN LENGTH: 10.0
CASING TYPE: PVC	CASING DIAMETER: 2.0
CASING TOP ELEVATION:	
CASING STICK-UP: 3.00	TOTAL CASING AND SCREEN: 54.0
WELL MAINTENANCE DATE:	
USGS HYDROLOGICAL UNIT CODE: 07020003	
ELECTRIC LOG INFORMATION:	
SPONTANEOUS POTENTIAL:	SINGLE POINT RESISTIVITY:
NATURAL GAMMA:	EXTRA:
SAMPLES:	

0	-	10.0	CLAY, YELLOW, SILTY
10.0	-	30.0	SAND, MEDIUM TO COARSE; OXIDIZED
30.0	-	43.0	CLAY, GRAY; GRAVEL STRINGERS, MEDIUM TO COARSE PEBBLE GRAVEL IN STRINGERS
43.0	-	52.0	GRAVEL, MEDIUM TO COARSE PEBBLE

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COUNTY: DEUEL LOCATION: 115N-48W-07ADAA 1
MAP LOCATION: 10
LEGAL LOCATION: NE NE SE NE SEC. 07, T. 115 N., R. 48 W.
LATITUDE: 44.4712 LONGITUDE: 96.3721
LAND OWNER:
PROJECT: BROOKINGS-DEUEL RWS
DRILLING COMPANY: SDGS
DRILLER: T. MCCUE/L. SCHULZ DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 08-06-1987 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1787.00 T
TOTAL DRILL HOLE DEPTH: 195.0 TEST HOLE NUMBER: R2-87-51
USGS HYDROLOGICAL UNIT CODE: 07020003
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY: X
NATURAL GAMMA: X EXTRA:
SAMPLES:

0	-	2.0	TOPSOIL, BLACK
2.0	-	7.0	CLAY, YELLOW-BROWN, SILTY, SANDY; CONTAINS DRY, FINE SAND, OXIDIZED
7.0	-	11.0	SAND, RED-BROWN, MEDIUM TO COARSE; OXIDIZED
11.0	-	13.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
13.0	-	17.0	SAND, MEDIUM TO COARSE
17.0	-	23.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
23.0	-	29.0	GRAVEL, MEDIUM TO COARSE PEBBLE
29.0	-	68.0	CLAY, GRAY, SILTY, SANDY; INTERBEDDED GRAVELS (TILL)
68.0	-	74.0	SAND, MEDIUM
74.0	-	81.0	CLAY, GRAY; INTERBEDDED WITH SAND
81.0	-	94.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
94.0	-	112.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
112.0	-	139.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
139.0	-	162.0	CLAY, GRAY; INTERBEDDED WITH SAND
162.0	-	177.0	CLAY, SILTY, SANDY, PEBBLY (TILL)
177.0	-	195.0	CLAY, DARK-GRAY, SILTY, SANDY, PEBBLY (TILL)

* * * *

COUNTY: DEUEL LOCATION: 115N-48W-07DCCD 1
MAP LOCATION: 11
LEGAL LOCATION: SE SW SW SE SEC. 07, T. 115 N., R. 48 W.
LATITUDE: 44.4633 LONGITUDE: 96.3721
LAND OWNER:
PROJECT: BROOKINGS-DEUEL RWS
DRILLING COMPANY: SDGS
DRILLER: D. JACOBSON DRILLER'S LOG:
GEOLOGIST: P. DAWSON GEOLOGIST'S LOG: X
DATE DRILLED: 05-26-1987 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1779.00 T

TOTAL DRILL HOLE DEPTH: 176.0 TEST HOLE NUMBER: CO-87-05
USGS HYDROLOGICAL UNIT CODE: 10170202

ELECTRIC LOG INFORMATION:

SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY: X
NATURAL GAMMA: X EXTRA:
SAMPLES:

0	-	30.0	GRAVEL, FINE TO COARSE PEBBLE
30.0	-	50.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
50.0	-	119.0	CLAY AND SAND; INTERBEDDED; HIT ROCKS AT 83 AND 93 FEET
119.0	-	127.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
127.0	-	129.0	GRAVEL AND SAND
129.0	-	130.0	ROCK
130.0	-	142.0	CLAY, DARK-GRAY, PEBBLY, SILTY; SOME GRAVEL STRINGERS (TILL)
142.0	-	176.0	CLAY, DARK-GRAY, SANDY, PEBBLY; SOME GRAVEL STRINGERS, HIT ROCK AT 176 FEET AND ABANDONED HOLE (TILL)

STRINGERS (6 INCHES TO 2 FEET) OF SAND AND GRAVEL
FOUND THROUGHOUT 140 TO 176 FEET.

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COUNTY: DEUEL LOCATION: 115N-48W-07DCCD 2
MAP LOCATION: 12
LEGAL LOCATION: SE SW SW SE SEC. 07, T. 115 N., R. 48 W.
LATITUDE: 44.4633 LONGITUDE: 96.3721
LAND OWNER:

PROJECT: BROOKINGS-DEUEL RWS

DRILLING COMPANY: SDGS

DRILLER: D. JACOBSON

DRILLER'S LOG:

GEOLOGIST: P. DAWSON

GEOLOGIST'S LOG: X

DATE DRILLED: 08-28-1987

DRILLING METHOD: ROTARY

GROUND SURFACE ELEVATION: 1779.00 T

TOTAL DRILL HOLE DEPTH: 63.0

TEST HOLE NUMBER: CO-87-08

WATER RIGHTS WELL:

SDGS WELL NAME: CO-87-08

OTHER WELL NAME:

BASIN: BIG SIOUX

AQUIFER: PRAIRIE COTEAU

MANAGEMENT UNIT:

SCREEN TYPE: PVC, MFG.

SCREEN LENGTH: 10.0

CASING TYPE: PVC

CASING DIAMETER: 2.0

CASING TOP ELEVATION:

CASING STICK-UP: 3.00

TOTAL CASING AND SCREEN: 63.0

WELL MAINTENANCE DATE:

USGS HYDROLOGICAL UNIT CODE: 10170202

ELECTRIC LOG INFORMATION:

SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:

NATURAL GAMMA: EXTRA:

SAMPLES:

SCREEN BETWEEN 50 AND 60 FEET, 3-FOOT BLANK
BELOW SCREEN.

0	-	30.0	GRAVEL, MEDIUM TO COARSE PEBBLE; OXIDIZED
30.0	-	45.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
45.0	-	47.0	GRAVEL, MEDIUM TO COARSE PEBBLE; OXIDIZED
47.0	-	50.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
50.0	-	54.0	GRAVEL, COARSE PEBBLE; OXIDIZED
54.0	-	57.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
57.0	-	60.0	GRAVEL, COARSE PEBBLE; OXIDIZED
60.0	-	63.0	CLAY, GRAY, SANDY, PEBBLY (TILL)

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COUNTY: DEUEL	LOCATION: 115N-48W-08CBAA 1
MAP LOCATION: 13	
LEGAL LOCATION: NE NE NW SW SEC. 08, T. 115 N., R. 48 W.	
LATITUDE: 44.4656	LONGITUDE: 96.3704
LAND OWNER: W. RUSSOW	
PROJECT: BROOKINGS-DEUEL RWS	
DRILLING COMPANY: SDGS	
DRILLER: T. MCCUE/L. SCHULZ	DRILLER'S LOG:
GEOLOGIST: P. DAWSON	GEOLOGIST'S LOG: X
DATE DRILLED: 08-10-1987	DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1808.00 T	
TOTAL DRILL HOLE DEPTH: 178.0	TEST HOLE NUMBER: R2-87-52
WATER RIGHTS WELL:	SDGS WELL NAME: R2-87-52
OTHER WELL NAME:	
BASIN: BIG SIOUX	AQUIFER: PRAIRIE COTEAU
MANAGEMENT UNIT:	
SCREEN TYPE: PVC, MFG.	SCREEN LENGTH: 10.0
CASING TYPE: PVC	CASING DIAMETER: 2.0
CASING TOP ELEVATION:	
CASING STICK-UP: 2.00	TOTAL CASING AND SCREEN: 180.0
WELL MAINTENANCE DATE:	
USGS HYDROLOGICAL UNIT CODE: 10170202	
ELECTRIC LOG INFORMATION:	
SPONTANEOUS POTENTIAL:	SINGLE POINT RESISTIVITY: X
NATURAL GAMMA: X	EXTRA:
SAMPLES:	

SCREEN BETWEEN 160 AND 170 FEET, 8-FOOT BLANK
BELOW SCREEN. WELL INSTALLED IN STRINGERS.

0	-	1.0	TOPSOIL
1.0	-	8.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL; OXIDIZED
8.0	-	11.0	CLAY, TAN-BROWN, SILTY, PEBBLY (TILL)
11.0	-	20.0	SAND AND GRAVEL, MEDIUM SAND TO COARSE PEBBLE GRAVEL; INCREASING CLAY CONTENT NEAR BOTTOM PORTION OF INTERVAL
20.0	-	25.0	CLAY, SILTY, PEBBLY (TILL)
25.0	-	31.0	SAND AND GRAVEL, MEDIUM SAND TO COARSE PEBBLE GRAVEL
31.0	-	39.0	CLAY, GRAY, SILTY
39.0	-	54.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL; INTERBEDDED CLAY

54.0 -	59.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
59.0 -	61.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
61.0 -	67.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
67.0 -	74.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
74.0 -	79.0	CLAY, GRAY, SILTY, PEBBLY; WITH INTERBEDDED SAND (TILL)
79.0 -	133.0	GRAVEL, FINE TO COARSE PEBBLE; WITH SOME INTERBEDDED CLAY
133.0 -	143.0	CLAY, GRAY, SILTY, SANDY, PEBBLY, VERY SANDY AND GRAVELLY FROM 136 TO 139 FEET (TILL)
143.0 -	178.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL; WITH SOME INTERBEDDED CLAY

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COUNTY: DEUEL	LOCATION: 115N-48W-08CBAA 2
MAP LOCATION: 14	
LEGAL LOCATION: NE NE NW SW SEC. 08, T. 115 N., R. 48 W.	
LATITUDE: 44.4656	LONGITUDE: 96.3704
LAND OWNER: W. RUSSOW	
PROJECT: BROOKINGS-DEUEL RWS	
DRILLING COMPANY: SDGS	
DRILLER: L. SCHULZ/T. MCCUE	DRILLER'S LOG:
GEOLOGIST: P. DAWSON	GEOLOGIST'S LOG: X
DATE DRILLED: 08-11-1987	DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1809.00 T	
TOTAL DRILL HOLE DEPTH: 112.0	TEST HOLE NUMBER: R2-87-53
WATER RIGHTS WELL:	SDGS WELL NAME: R2-87-53
OTHER WELL NAME:	
BASIN: BIG SIOUX	AQUIFER: PRAIRIE COTEAU
MANAGEMENT UNIT:	
SCREEN TYPE: PVC, MFG.	SCREEN LENGTH: 10.0
CASING TYPE: PVC	CASING DIAMETER: 2.0
CASING TOP ELEVATION:	
CASING STICK-UP: 2.00	TOTAL CASING AND SCREEN: 112.0
WELL MAINTENANCE DATE:	
USGS HYDROLOGICAL UNIT CODE: 10170202	
ELECTRIC LOG INFORMATION:	
SPONTANEOUS POTENTIAL:	SINGLE POINT RESISTIVITY:
NATURAL GAMMA:	EXTRA:
SAMPLES:	

0 -	4.0	TOPSOIL
4.0 -	19.0	GRAVEL, COARSE PEBBLE; OXIDIZED
19.0 -	22.0	CLAY, YELLOW-BROWN; CONTAINS FINE, DRY SAND
22.0 -	32.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL; OXIDIZED
32.0 -	38.0	CLAY, YELLOW-BROWN, SANDY, SILTY
38.0 -	46.0	SAND AND GRAVEL, COARSE SAND TO COARSE

46.0 - 88.0 PEBBLE GRAVEL
 CLAY, GRAY, SILTY; WITH INTERBEDDED
 GRAVEL (TILL)
 88.0 - 112.0 SAND AND GRAVEL, COARSE SAND TO COARSE
 PEBBLE GRAVEL

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COUNTY: DEUEL LOCATION: 115N-48W-08CCBB 1
 MAP LOCATION: 15
 LEGAL LOCATION: NW NW SW SW SEC. 08, T. 115 N., R. 48 W.
 LATITUDE: 44.4645 LONGITUDE: 96.3718
 LAND OWNER: W. RUSSOW
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: D. JACOBSON DRILLER'S LOG:
 GEOLOGIST: P. DAWSON GEOLOGIST'S LOG: X
 DATE DRILLED: 06-02-1987 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1798.00 T
 TOTAL DRILL HOLE DEPTH: 90.0 TEST HOLE NUMBER: CO-87-12
 WATER RIGHTS WELL: SDGS WELL NAME: CO-87-12
 OTHER WELL NAME:
 BASIN: BIG SIOUX AQUIFER: PRAIRIE COTEAU
 MANAGEMENT UNIT:
 SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
 CASING TYPE: PVC CASING DIAMETER: 2.0
 CASING TOP ELEVATION:
 CASING STICK-UP: 3.00 TOTAL CASING AND SCREEN: 87.0
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 10170202
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
 NATURAL GAMMA: X EXTRA:
 SAMPLES:

0 - 4.0 TOPSOIL
 4.0 - 10.0 GRAVEL, FINE TO COARSE PEBBLE; OXIDIZED
 10.0 - 15.0 CLAY, BROWN, SILTY
 15.0 - 54.0 CLAY, GRAY, SILTY
 54.0 - 90.0 GRAVEL, FINE TO COARSE PEBBLE; OXIDIZED;
 HIT ROCK AT 90 FEET AND COULD NOT
 PENETRATE

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COUNTY: DEUEL LOCATION: 115N-48W-08CCBC 1
 MAP LOCATION: 16
 LEGAL LOCATION: SW NW SW SW SEC. 08, T. 115 N., R. 48 W.
 LATITUDE: 44.4641 LONGITUDE: 96.3720
 LAND OWNER:
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: L. SCHULZ/T. MCCUE DRILLER'S LOG:
 GEOLOGIST: D. ILES GEOLOGIST'S LOG: X

DATE DRILLED: 08-04-1987 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1789.00 T
TOTAL DRILL HOLE DEPTH: 190.0 TEST HOLE NUMBER: R2-87-46
USGS HYDROLOGICAL UNIT CODE: 10170202
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES:

0	-	1.0	TOPSOIL
1.0	-	17.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
17.0	-	34.0	CLAY, YELLOW-BROWN, SILTY, SANDY, PEBBLY (TILL)
34.0	-	47.0	SAND, FINE TO MEDIUM
47.0	-	60.0	CLAY, GRAY, SILTY, SANDY, PEBBLY; FINE SAND (TILL)
60.0	-	90.0	CLAY, LIGHT-GRAY, SANDY, PEBBLY (TILL)
90.0	-	117.0	CLAY, GRAY, SANDY; INTERBEDDED GRAVEL, MEDIUM GRAVEL (TILL)
117.0	-	139.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
139.0	-	169.0	CLAY, DARK-GRAY, SANDY, PEBBLY (TILL)
169.0	-	190.0	CLAY, GRAY, SANDY

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COUNTY: DEUEL LOCATION: 115N-48W-08CDBB 1
MAP LOCATION: 17
LEGAL LOCATION: NW NW SE SW SEC. 08, T. 115 N., R. 48 W.
LATITUDE: 44.4646 LONGITUDE: 96.3658
LAND OWNER:
PROJECT: BROOKINGS-DEUEL RWS
DRILLING COMPANY: SDGS
DRILLER: D. JACOBSON DRILLER'S LOG:
GEOLOGIST: P. DAWSON GEOLOGIST'S LOG: X
DATE DRILLED: 06-03-1987 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1817.00 T
TOTAL DRILL HOLE DEPTH: 150.0 TEST HOLE NUMBER: CO-87-13
WATER RIGHTS WELL: SDGS WELL NAME: CO-87-13
OTHER WELL NAME:
BASIN: BIG SIOUX AQUIFER: PRAIRIE COTEAU
MANAGEMENT UNIT:
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
CASING TYPE: PVC CASING DIAMETER: 2.0
CASING TOP ELEVATION:
CASING STICK-UP: 3.00 TOTAL CASING AND SCREEN: 122.0
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170202
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: X EXTRA:
SAMPLES:

0	-	2.0	TOPSOIL, BLACK
2.0	-	12.0	CLAY, BROWN, SILTY
12.0	-	20.0	SAND, MEDIUM TO COARSE; OXIDIZED
20.0	-	24.0	CLAY, BROWN, SILTY
24.0	-	28.0	SAND, MEDIUM TO COARSE
28.0	-	34.0	CLAY, BROWN, SILTY
34.0	-	53.0	GRAVEL, MEDIUM TO COARSE PEBBLE
53.0	-	58.0	CLAY, GRAY, SILTY
58.0	-	61.0	GRAVEL, MEDIUM TO COARSE PEBBLE
61.0	-	70.0	CLAY, GRAY, SILTY
70.0	-	78.0	GRAVEL, FINE TO COARSE PEBBLE
78.0	-	98.0	CLAY, GRAY, SILTY
98.0	-	150.0	GRAVEL, FINE TO COARSE PEBBLE; WITH SOME INTERBEDDED CLAY

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COUNTY: DEUEL	LOCATION: 115N-48W-08CDBB 2
MAP LOCATION: 18	
LEGAL LOCATION: NW NW SE SW SEC. 08, T. 115 N., R. 48 W.	
LATITUDE: 44.4646	LONGITUDE: 96.3658
LAND OWNER: W. RUSSOW	
PROJECT: BROOKINGS-DEUEL RWS	
DRILLING COMPANY: SDGS	
DRILLER: D. JACOBSON	DRILLER'S LOG:
GEOLOGIST: P. DAWSON	GEOLOGIST'S LOG: X
DATE DRILLED: 05-03-1987	DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1817.00 T	
TOTAL DRILL HOLE DEPTH: 57.0	TEST HOLE NUMBER: CO-87-14
WATER RIGHTS WELL:	SDGS WELL NAME: CO-87-14
OTHER WELL NAME:	
BASIN: BIG SIOUX	AQUIFER: PRAIRIE COTEAU
MANAGEMENT UNIT:	
SCREEN TYPE: PVC, MFG.	SCREEN LENGTH: 10.0
CASING TYPE: PVC	CASING DIAMETER: 2.0
CASING TOP ELEVATION:	
CASING STICK-UP: 3.00	TOTAL CASING AND SCREEN: 60.0
WELL MAINTENANCE DATE:	
USGS HYDROLOGICAL UNIT CODE: 10170202	
ELECTRIC LOG INFORMATION:	
SPONTANEOUS POTENTIAL:	SINGLE POINT RESISTIVITY:
NATURAL GAMMA:	EXTRA:
SAMPLES:	

0	-	2.0	TOPSOIL
2.0	-	6.0	CLAY, LIGHT-BROWN, SILTY
6.0	-	10.0	SAND, MEDIUM TO COARSE; OXIDIZED
10.0	-	32.0	CLAY, GRAY, SILTY
32.0	-	55.0	GRAVEL, MEDIUM TO COARSE PEBBLE
55.0	-	57.0	CLAY, GRAY, SILTY

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COUNTY: DEUEL	LOCATION: 115N-48W-08CDCC 1
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MAP LOCATION: 19
 LEGAL LOCATION: SW SW SE SW SEC. 08, T. 115 N., R. 48 W.
 LATITUDE: 44.4633 LONGITUDE: 96.3700
 LAND OWNER:
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: T. MCCUE/L. SCHULZ DRILLER'S LOG:
 GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
 DATE DRILLED: 08-05-1987 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1827.00 T
 TOTAL DRILL HOLE DEPTH: 215.0 TEST HOLE NUMBER: R2-87-47
 USGS HYDROLOGICAL UNIT CODE: 10170202
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
 NATURAL GAMMA: EXTRA:
 SAMPLES:

0	-	2.0	TOPSOIL
2.0	-	5.0	CLAY, BROWN, SANDY
5.0	-	28.0	SAND, YELLOW-BROWN, VERY FINE; OXIDIZED
28.0	-	32.0	CLAY, GRAY; VERY FINE SILT
32.0	-	60.0	CLAY, GRAY, SILTY
60.0	-	117.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
117.0	-	127.0	CLAY, GRAY, SANDY, GRAVELLY (TILL)
127.0	-	138.0	CLAY, YELLOW-BROWN, SANDY
138.0	-	215.0	CLAY, GRAY, SANDY, PEBBLY (TILL)

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COUNTY: DEUEL LOCATION: 115N-48W-08CDCC 2
 MAP LOCATION: 20
 LEGAL LOCATION: SW SW SE SW SEC. 08, T. 115 N., R. 48 W.
 LATITUDE: 44.4633 LONGITUDE: 96.3700
 LAND OWNER:
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: L. SCHULZ/T. MCCUE DRILLER'S LOG:
 GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
 DATE DRILLED: 08-04-1987 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1827.00 T
 TOTAL DRILL HOLE DEPTH: 110.0 TEST HOLE NUMBER: R2-87-48
 WATER RIGHTS WELL: SDGS WELL NAME: R2-87-48
 OTHER WELL NAME:
 BASIN: BIG SIOUX AQUIFER: PRAIRIE COTEAU
 MANAGEMENT UNIT:
 SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
 CASING TYPE: PVC CASING DIAMETER: 2.0
 CASING TOP ELEVATION:
 CASING STICK-UP: 3.00 TOTAL CASING AND SCREEN: 110.0
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 10170202
 ELECTRIC LOG INFORMATION:

SPONTANEOUS POTENTIAL:
NATURAL GAMMA:
SAMPLES:

SINGLE POINT RESISTIVITY:
EXTRA:

0	-	29.0	CLAY, YELLOW-BROWN, SILTY, VERY SANDY, PEBBLY (TILL)
29.0	-	47.0	CLAY, GRAY, VERY SILTY
47.0	-	51.0	SAND, MEDIUM TO COARSE
51.0	-	71.0	CLAY, GRAY, VERY SILTY
71.0	-	110.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL

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COUNTY: DEUEL
MAP LOCATION: 21
LEGAL LOCATION: NW NW SW SE SEC. 08, T. 115 N., R. 48 W.
LATITUDE: 44.4644
LAND OWNER: J. COROTHERS
PROJECT: BROOKINGS-DEUEL RWS
DRILLING COMPANY: SDGS
DRILLER: T. MCCUE/L. SCHULZ
GEOLOGIST: P. DAWSON
DATE DRILLED: 08-11-1987
GROUND SURFACE ELEVATION: 1854.00 T
TOTAL DRILL HOLE DEPTH: 205.0
WATER RIGHTS WELL:
OTHER WELL NAME:
BASIN: BIG SIOUX
MANAGEMENT UNIT:
SCREEN TYPE: PVC, MFG.
CASING TYPE: PVC
CASING TOP ELEVATION:
CASING STICK-UP: 2.00
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170202
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL:
NATURAL GAMMA: X
SAMPLES:

LOCATION: 115N-48W-08DCBB 1
LONGITUDE: 96.3653
DRILLER'S LOG:
GEOLOGIST'S LOG: X
DRILLING METHOD: ROTARY
TEST HOLE NUMBER: R2-87-54
SDGS WELL NAME: R2-87-54
AQUIFER: PRAIRIE COTEAU
SCREEN LENGTH: 10.0
CASING DIAMETER: 2.0
TOTAL CASING AND SCREEN: 202.0
SINGLE POINT RESISTIVITY: X
EXTRA:

SCREEN BETWEEN 170 AND 180 FEET, 20-FOOT BLANK
BELOW SCREEN.

0	-	3.0	TOPSOIL, BLACK
3.0	-	31.0	GRAVEL, COARSE PEBBLE
31.0	-	40.0	CLAY, GRAY, SILTY; WITH INTERBEDDED SAND
40.0	-	45.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
45.0	-	50.0	CLAY, GRAY, SILTY
50.0	-	54.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
54.0	-	58.0	CLAY, GRAY, SILTY, GRAVELLY (TILL)

58.0 -	65.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
65.0 -	70.0	CLAY, GRAY, SILTY, GRAVELLY (TILL)
70.0 -	80.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
80.0 -	99.0	CLAY, DARK-GRAY, SILTY, SANDY
99.0 -	104.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL; WITH INTERBEDDED CLAY
104.0 -	106.0	CLAY, GRAY, SILTY, SANDY
106.0 -	113.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL; WITH SOME CLAY LAYERS
113.0 -	169.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL; WITH THIN CLAY LAYERS THROUGHOUT
169.0 -	175.0	CLAY, GRAY, SILTY, SANDY
175.0 -	200.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL; WITH INTERBEDDED CLAY
200.0 -	205.0	CLAY, GRAY, SILTY, SANDY, GRAVELLY (TILL)

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COUNTY: DEUEL	LOCATION: 115N-48W-08DCBB 2
MAP LOCATION: 22	
LEGAL LOCATION: NW NW SW SE SEC. 08, T. 115 N., R. 48 W.	
LATITUDE: 44.4644	LONGITUDE: 96.3653
LAND OWNER: J. COROTHERS	
PROJECT: BROOKINGS-DEUEL RWS	
DRILLING COMPANY: SDGS	
DRILLER: L. SCHULZ/T. MCCUE	DRILLER'S LOG:
GEOLOGIST: P. DAWSON	GEOLOGIST'S LOG: X
DATE DRILLED: 08-21-1987	DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1855.00 T	
TOTAL DRILL HOLE DEPTH: 137.0	TEST HOLE NUMBER: R2-87-55
WATER RIGHTS WELL:	SDGS WELL NAME: R2-87-55
OTHER WELL NAME:	
BASIN: BIG SIOUX	AQUIFER: PRAIRIE COTEAU
MANAGEMENT UNIT:	
SCREEN TYPE: PVC, MFG.	SCREEN LENGTH: 10.0
CASING TYPE: PVC	CASING DIAMETER: 2.0
CASING TOP ELEVATION:	
CASING STICK-UP: 2.00	TOTAL CASING AND SCREEN: 138.0
WELL MAINTENANCE DATE:	
USGS HYDROLOGICAL UNIT CODE: 10170202	
ELECTRIC LOG INFORMATION:	
SPONTANEOUS POTENTIAL:	SINGLE POINT RESISTIVITY:
NATURAL GAMMA:	EXTRA:
SAMPLES:	

0 -	2.0	TOPSOIL
2.0 -	29.0	GRAVEL, COARSE PEBBLE
29.0 -	41.0	CLAY, YELLOW-BROWN, VERY SILTY; SAND STRINGERS
41.0 -	49.0	CLAY, GRAY, VERY SILTY, SANDY
49.0 -	52.0	GRAVEL, COARSE PEBBLE

52.0 - 64.0 CLAY, YELLOW-BROWN, VERY SILTY
 64.0 - 111.0 CLAY, GRAY, VERY SILTY; GRAVEL STRINGERS
 111.0 - 137.0 GRAVEL, MEDIUM TO COARSE PEBBLE

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COUNTY: DEUEL LOCATION: 115N-48W-08DCCC 1
 MAP LOCATION: 23
 LEGAL LOCATION: SW SW SW SE SEC. 08, T. 115 N., R. 48 W.
 LATITUDE: 44.4634 LONGITUDE: 96.3643
 LAND OWNER:
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: D. JACOBSON DRILLER'S LOG:
 GEOLOGIST: P. DAWSON GEOLOGIST'S LOG: X
 DATE DRILLED: 05-27-1987 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1836.00 T
 TOTAL DRILL HOLE DEPTH: 188.0 TEST HOLE NUMBER: CO-87-06
 WATER RIGHTS WELL: SDGS WELL NAME: CO-87-06
 OTHER WELL NAME:
 BASIN: BIG SIOUX AQUIFER: PRAIRIE COTEAU
 MANAGEMENT UNIT:
 SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
 CASING TYPE: PVC CASING DIAMETER: 2.0
 CASING TOP ELEVATION:
 CASING STICK-UP: 3.00 TOTAL CASING AND SCREEN: 185.0
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 10170202
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
 NATURAL GAMMA: EXTRA:
 SAMPLES:

0 - 10.0 SAND, FINE TO MEDIUM; VERY CLEAN,
 OXIDIZED
 10.0 - 43.0 CLAY, SANDY, PEBBLY (TILL)
 43.0 - 51.0 SAND, FINE TO MEDIUM
 51.0 - 61.0 CLAY, GRAY, SANDY, PEBBLY (TILL)
 61.0 - 70.0 SAND AND GRAVEL, FINE SAND TO COARSE
 PEBBLE GRAVEL
 70.0 - 120.0 CLAY, GRAY, SILTY, SANDY; SOME PEBBLES
 120.0 - 188.0 GRAVEL, FINE TO COARSE PEBBLE; OXIDIZED,
 HIT ROCK AT 188 FEET

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COUNTY: DEUEL LOCATION: 115N-48W-08DCCC 2
 MAP LOCATION: 24
 LEGAL LOCATION: SW SW SW SE SEC. 08, T. 115 N., R. 48 W.
 LATITUDE: 44.4634 LONGITUDE: 96.3643
 LAND OWNER:
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: D. JACOBSON DRILLER'S LOG:

GEOLOGIST: P. DAWSON
 DATE DRILLED: 05-28-1987
 GROUND SURFACE ELEVATION: 1837.00 T
 TOTAL DRILL HOLE DEPTH: 97.0
 WATER RIGHTS WELL:
 OTHER WELL NAME:
 BASIN: BIG SIOUX
 MANAGEMENT UNIT:
 SCREEN TYPE: PVC, MFG.
 CASING TYPE: PVC
 CASING TOP ELEVATION:
 CASING STICK-UP: 3.00
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 10170202
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL:
 NATURAL GAMMA: X
 SAMPLES:

GEOLOGIST'S LOG: X
 DRILLING METHOD: ROTARY
 TEST HOLE NUMBER: CO-87-07
 SDGS WELL NAME: CO-87-07

AQUIFER: PRAIRIE COTEAU

SCREEN LENGTH: 10.0
 CASING DIAMETER: 2.0

TOTAL CASING AND SCREEN: 100.0

SINGLE POINT RESISTIVITY: X
 EXTRA:

SCREEN BETWEEN 67 AND 77 FEET, 20-FOOT BLANK
 BELOW SCREEN.

0	-	13.0	SAND AND GRAVEL, FINE SAND TO COARSE PEBBLE GRAVEL; OXIDIZED
13.0	-	16.0	CLAY, BROWN TO RED, SILTY, SANDY, PEBBLY (TILL)
16.0	-	18.0	SAND AND GRAVEL, FINE SAND TO COARSE PEBBLE GRAVEL
18.0	-	22.0	CLAY, BROWN TO RED, SILTY, SANDY, PEBBLY (TILL)
22.0	-	27.0	SAND AND GRAVEL, FINE SAND TO COARSE PEBBLE GRAVEL
27.0	-	36.0	CLAY, GRAY, SILTY, SANDY
36.0	-	41.0	SAND AND GRAVEL, FINE SAND TO COARSE PEBBLE GRAVEL
41.0	-	46.0	CLAY, GRAY, SILTY, SANDY
46.0	-	54.0	SAND, FINE TO MEDIUM
54.0	-	55.0	CLAY, GRAY, SILTY
55.0	-	64.0	CLAY, BROWN, SILTY
64.0	-	74.0	SAND AND GRAVEL, FINE SAND TO COARSE PEBBLE GRAVEL
74.0	-	97.0	CLAY, GRAY, SILTY TO VERY SILTY

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COUNTY: DEUEL
 MAP LOCATION: 25
 LEGAL LOCATION: SW NW SW SW SEC. 09, T. 115 N., R. 48 W.
 LATITUDE: 44.4634
 LAND OWNER:
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: G. JENSEN/L. HELSETH
 GEOLOGIST: D. ILES

LOCATION: 115N-48W-09CCBC 1
 LONGITUDE: 96.3607

DRILLER'S LOG:
 GEOLOGIST'S LOG: X

DATE DRILLED: 09-30-1987 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1837.00 T
 TOTAL DRILL HOLE DEPTH: 245.0 TEST HOLE NUMBER: R1-87-75
 WATER RIGHTS WELL: SDGS WELL NAME: R1-87-75
 OTHER WELL NAME:
 BASIN: MINNESOTA/WHETSTONE AQUIFER: PRAIRIE COTEAU
 MANAGEMENT UNIT:
 SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
 CASING TYPE: PVC CASING DIAMETER: 2.0
 CASING TOP ELEVATION:
 CASING STICK-UP: 3.00 TOTAL CASING AND SCREEN: 218.0
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 07020003
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY: X
 NATURAL GAMMA: X EXTRA:
 SAMPLES:

0	-	2.0	TOPSOIL, BLACK
2.0	-	18.0	GRAVEL, FINE TO COARSE PEBBLE; WITH SOME MEDIUM TO VERY COARSE SAND, OXIDIZED, WITH INTERBEDDED CLAY
18.0	-	49.0	GRAVEL AND SAND, FINE SAND TO COARSE PEBBLE GRAVEL, OXIDIZED, WITH INTERBEDDED CLAY
49.0	-	57.0	GRAVEL, VERY FINE TO COARSE PEBBLE; WITH SOME MEDIUM TO VERY COARSE SAND, OXIDIZED
57.0	-	71.0	CLAY, GRAY, SILTY; WITH INTERBEDDED SAND
71.0	-	113.0	CLAY, SAND AND SILT, FINE TO VERY COARSE SAND; INTERBEDDED, PRIMARILY UNOXIDIZED, FINER GRAINED SEDIMENTS ARE PREDOMINANT IN THIS INTERVAL
113.0	-	120.0	CLAY, GRAY, SILTY; WITH INTERBEDDED SAND
120.0	-	220.0	GRAVEL, VERY FINE TO COARSE PEBBLE; WITH FINE TO VERY COARSE SAND, OXIDIZED
220.0	-	224.0	SAND, FINE TO VERY COARSE
224.0	-	235.0	GRAVEL, VERY FINE TO COARSE PEBBLE; WITH FINE TO VERY COARSE SAND
235.0	-	245.0	CLAY, GRAY, SILTY

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COUNTY: DEUEL LOCATION: 115N-48W-09CCCC 1
 MAP LOCATION: 26
 LEGAL LOCATION: SW SW SW SW SEC. 09, T. 115 N., R. 48 W.
 LATITUDE: 44.4634 LONGITUDE: 96.3606
 LAND OWNER:
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: G. JENSEN DRILLER'S LOG:
 GEOLOGIST: P. DAWSON GEOLOGIST'S LOG: X

DATE DRILLED: 09-25-1987 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1865.00 T
 TOTAL DRILL HOLE DEPTH: 245.0 TEST HOLE NUMBER: R1-87-73
 WATER RIGHTS WELL: SDGS WELL NAME: R1-87-73
 OTHER WELL NAME:
 BASIN: MINNESOTA/WHETSTONE AQUIFER: PRAIRIE COTEAU
 MANAGEMENT UNIT:
 SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
 CASING TYPE: PVC CASING DIAMETER: 2.0
 CASING TOP ELEVATION:
 CASING STICK-UP: 2.00 TOTAL CASING AND SCREEN: 232.0
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 07020003
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY: X
 NATURAL GAMMA: X EXTRA:
 SAMPLES:

0	-	2.0	TOPSOIL, BLACK
2.0	-	18.0	SAND, BROWN, FINE TO COARSE; SOME VERY FINE PEBBLE GRAVEL
18.0	-	22.0	CLAY, SANDY, SILTY, PEBBLY (TILL)
22.0	-	30.0	SAND, BROWN, FINE TO COARSE; SOME VERY FINE PEBBLE GRAVEL
30.0	-	65.0	CLAY, GRAY, SANDY, SILTY, VERY PEBBLY; INTERBEDDED WITH GRAVEL, INCREASING CLAY CONTENT DOWNWARD (TILL)
65.0	-	70.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
70.0	-	82.0	CLAY, GRAY, SANDY, SILTY, VERY PEBBLY; INTERBEDDED WITH GRAVEL (TILL)
82.0	-	90.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
90.0	-	97.0	CLAY, GRAY, SANDY, SILTY, VERY PEBBLY (TILL)
97.0	-	117.0	CLAY, GRAY, SANDY, SILTY, VERY PEBBLY; INTERBEDDED WITH GRAVEL, INCREASING CLAY CONTENT DOWNWARD (TILL)
117.0	-	128.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
128.0	-	130.0	CLAY
130.0	-	188.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
188.0	-	190.0	CLAY
190.0	-	238.0	GRAVEL, VERY FINE TO COARSE PEBBLE
238.0	-	245.0	CLAY, GRAY, SANDY, PEBBLY (TILL)

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COUNTY: DEUEL LOCATION: 115N-48W-17ABAA 1
 MAP LOCATION: 27
 LEGAL LOCATION: NE NE NW NE SEC. 17, T. 115 N., R. 48 W.
 LATITUDE: 44.4633 LONGITUDE: 96.3627
 LAND OWNER:

PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: L. SCHULZ/T. MCCUE
 GEOLOGIST: D. ILES
 DATE DRILLED: 08-05-1987
 GROUND SURFACE ELEVATION: 1860.00 T
 TOTAL DRILL HOLE DEPTH: 215.0
 WATER RIGHTS WELL:
 OTHER WELL NAME:
 BASIN: BIG SIOUX
 MANAGEMENT UNIT:
 SCREEN TYPE: PVC, MFG.
 CASING TYPE: PVC
 CASING TOP ELEVATION:
 CASING STICK-UP: 3.00
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 10170202
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL:
 NATURAL GAMMA: X
 SAMPLES:

DRILLER'S LOG:
 GEOLOGIST'S LOG: X
 DRILLING METHOD: ROTARY
 TEST HOLE NUMBER: R2-87-49
 SDGS WELL NAME: R2-87-49
 AQUIFER: PRAIRIE COTEAU
 SCREEN LENGTH: 10.0
 CASING DIAMETER: 2.0
 TOTAL CASING AND SCREEN: 218.0
 SINGLE POINT RESISTIVITY: X
 EXTRA:

SCREEN BETWEEN 190 AND 200 FEET, 15-FOOT
 BLANK BELOW SCREEN.

0	-	2.0	TOPSOIL, BLACK
2.0	-	32.0	SAND AND GRAVEL, FINE SAND TO COARSE PEBBLE GRAVEL
32.0	-	35.0	CLAY, YELLOW-BROWN, VERY SILTY
35.0	-	48.0	CLAY, GRAY, VERY SILTY
48.0	-	52.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
52.0	-	55.0	CLAY, GRAY, VERY SILTY
55.0	-	76.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
76.0	-	102.0	CLAY, GRAY, VERY SILTY
102.0	-	114.0	CLAY, GRAY, VERY SILTY; INTERBEDDED WITH GRAVEL (TILL)
114.0	-	178.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
178.0	-	183.0	CLAY, GRAY, VERY SANDY
183.0	-	209.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL
209.0	-	215.0	CLAY, GRAY, SANDY, PEBBLY (TILL)

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COUNTY: DEUEL
 MAP LOCATION: 28
 LEGAL LOCATION: NE NE NW NE SEC. 17, T. 115 N., R. 48 W.
 LATITUDE: 44.4633
 LAND OWNER:
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS

LOCATION: 115N-48W-17ABAA 2
 LONGITUDE: 96.3627

DRILLER: L. SCHULZ/T. MCCUE
 GEOLOGIST: D. ILES
 DATE DRILLED: 08-05-1987
 GROUND SURFACE ELEVATION: 1860.00 T
 TOTAL DRILL HOLE DEPTH: 135.0
 WATER RIGHTS WELL:
 OTHER WELL NAME:
 BASIN: BIG SIOUX
 MANAGEMENT UNIT:
 SCREEN TYPE: PVC, MFG.
 CASING TYPE: PVC
 CASING TOP ELEVATION:
 CASING STICK-UP: 2.00
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 10170202
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL:
 NATURAL GAMMA: X
 SAMPLES:

DRILLER'S LOG:
 GEOLOGIST'S LOG: X
 DRILLING METHOD: ROTARY
 TEST HOLE NUMBER: R2-87-50
 SDGS WELL NAME: R2-87-50
 AQUIFER: PRAIRIE COTEAU
 SCREEN LENGTH: 10.0
 CASING DIAMETER: 2.0
 TOTAL CASING AND SCREEN: 127.0
 SINGLE POINT RESISTIVITY:
 EXTRA:

0	-	1.0	TOPSOIL
1.0	-	33.0	SAND AND GRAVEL, MEDIUM SAND TO COARSE PEBBLE GRAVEL
33.0	-	38.0	CLAY, YELLOW-BROWN, VERY SILTY
38.0	-	46.0	CLAY, GRAY, VERY SILTY, SLIGHTLY PEBBLY
46.0	-	51.0	GRAVEL, FINE TO COARSE PEBBLE
51.0	-	54.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
54.0	-	72.0	GRAVEL, FINE TO COARSE PEBBLE
72.0	-	82.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
82.0	-	91.0	GRAVEL, VERY FINE TO COARSE PEBBLE
91.0	-	110.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
110.0	-	135.0	GRAVEL, VERY FINE TO COARSE PEBBLE

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COUNTY: DEUEL
 MAP LOCATION: 29
 LEGAL LOCATION: NW SW NW NE SEC. 17, T. 115 N., R. 48 W.
 LATITUDE: 44.4626
 LAND OWNER: J. COROTHERS
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: T. MCCUE/L. SCHULZ
 GEOLOGIST: P. DAWSON
 DATE DRILLED: 08-12-1987
 GROUND SURFACE ELEVATION: 1841.00 T
 TOTAL DRILL HOLE DEPTH: 265.0
 USGS HYDROLOGICAL UNIT CODE: 10170202
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL:
 NATURAL GAMMA: X
 SAMPLES:

LOCATION: 115N-48W-17ABCB 1
 LONGITUDE: 96.3643
 DRILLER'S LOG:
 GEOLOGIST'S LOG: X
 DRILLING METHOD: ROTARY
 TEST HOLE NUMBER: R2-87-56
 SINGLE POINT RESISTIVITY: X
 EXTRA:

0	-	3.0	TOPSOIL, BLACK
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3.0 -	5.0	CLAY, BROWN, SILTY
5.0 -	8.0	CLAY, YELLOW-BROWN, SILTY
8.0 -	25.0	CLAY, YELLOW-BROWN, SILTY, SANDY
25.0 -	37.0	SILT, GRAY, SANDY
37.0 -	54.0	SAND, MEDIUM
54.0 -	72.0	SILT, GRAY, SANDY
72.0 -	110.0	GRAVEL, FINE TO COARSE PEBBLE
110.0 -	151.0	GRAVEL, FINE TO COARSE PEBBLY; SOME INTERBEDDED CLAY
151.0 -	153.0	CLAY, GRAY, SANDY, SILTY, VERY PEBBLY (TILL)
153.0 -	166.0	GRAVEL, COARSE PEBBLE
166.0 -	202.0	CLAY, GRAY, SILTY, SANDY, PEBBLY; WITH INTERBEDDED SAND (TILL)
202.0 -	207.0	CLAY, YELLOW-BROWN, SILTY, SANDY
207.0 -	230.0	CLAY, GRAY, SILTY, SANDY, VERY PEBBLY (TILL)
230.0 -	240.0	GRAVEL, COARSE PEBBLE
240.0 -	256.0	CLAY, GRAY, VERY SILTY, SANDY; WITH SOME INTERBEDDED GRAVEL (TILL)
256.0 -	258.0	GRAVEL, COARSE PEBBLE
258.0 -	265.0	CLAY, YELLOW-BROWN, VERY SILTY

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COUNTY: DEUEL	LOCATION: 115N-48W-17ABCB 2
MAP LOCATION: 30	
LEGAL LOCATION: NW SW NW NE SEC. 17, T. 115 N., R. 48 W.	
LATITUDE: 44.4626	LONGITUDE: 96.3643
LAND OWNER: J. COROTHERS	
PROJECT: BROOKINGS-DEUEL RWS	
DRILLING COMPANY: SDGS	
DRILLER: L. SCHULZ/T. MCCUE	DRILLER'S LOG:
GEOLOGIST: P. DAWSON	GEOLOGIST'S LOG: X
DATE DRILLED: 08-12-1987	DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1841.00 T	
TOTAL DRILL HOLE DEPTH: 155.0	TEST HOLE NUMBER: R2-87-57
WATER RIGHTS WELL:	SDGS WELL NAME: R2-87-57
OTHER WELL NAME:	
BASIN: BIG SIOUX	AQUIFER: PRAIRIE COTEAU
MANAGEMENT UNIT:	
SCREEN TYPE: PVC, MFG.	SCREEN LENGTH: 10.0
CASING TYPE: PVC	CASING DIAMETER: 2.0
CASING TOP ELEVATION:	
CASING STICK-UP: 2.00	TOTAL CASING AND SCREEN: 149.0
WELL MAINTENANCE DATE:	
USGS HYDROLOGICAL UNIT CODE: 10170202	
ELECTRIC LOG INFORMATION:	
SPONTANEOUS POTENTIAL:	SINGLE POINT RESISTIVITY:
NATURAL GAMMA:	EXTRA:
SAMPLES:	

0 -	2.0	TOPSOIL
2.0 -	16.0	CLAY, YELLOW-BROWN, SILTY, SANDY

16.0 - 18.0 SAND, MEDIUM TO COARSE
 18.0 - 29.0 CLAY, YELLOW-BROWN, SILTY, SANDY
 29.0 - 38.0 SILT, GRAY, VERY FINE
 38.0 - 53.0 SAND, FINE TO MEDIUM
 53.0 - 76.0 SILT, GRAY, FINE
 76.0 - 155.0 SAND AND GRAVEL, COARSE SAND TO COARSE
 PEBBLE GRAVEL

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COUNTY: DEUEL LOCATION: 115N-48W-17ABCB 3
 MAP LOCATION: 31
 LEGAL LOCATION: NW SW NW NE SEC. 17, T. 115 N., R. 48 W.
 LATITUDE: 44.4626 LONGITUDE: 96.3643
 LAND OWNER: J. COROTHERS
 PROJECT: BROOKINGS-DEUEL RWS
 DRILLING COMPANY: SDGS
 DRILLER: T. MCCUE/L. SCHULZ DRILLER'S LOG:
 GEOLOGIST: P. DAWSON GEOLOGIST'S LOG: X
 DATE DRILLED: 08-13-1987 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1841.00 T
 TOTAL DRILL HOLE DEPTH: 165.0 TEST HOLE NUMBER: R2-87-58
 WATER RIGHTS WELL: SDGS WELL NAME: R2-87-58
 OTHER WELL NAME:
 BASIN: BIG SIOUX AQUIFER: PRAIRIE COTEAU
 MANAGEMENT UNIT:
 SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
 CASING TYPE: PVC CASING DIAMETER: 2.0
 CASING TOP ELEVATION:
 CASING STICK-UP: 3.00 TOTAL CASING AND SCREEN: 166.0
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 10170202
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
 NATURAL GAMMA: EXTRA:
 SAMPLES:

SCREEN BETWEEN 138 AND 148 FEET, 15-FOOT
 BLANK BELOW SCREEN.

0 - 3.0 TOPSOIL
 3.0 - 5.0 SAND, RED-BROWN, FINE TO MEDIUM
 5.0 - 9.0 CLAY, RED-BROWN, SANDY
 9.0 - 15.0 GRAVEL, COARSE PEBBLE
 15.0 - 29.0 CLAY, YELLOW-BROWN, SILTY; INTERBEDDED
 GRAVEL, WELL-ROUNDED
 29.0 - 38.0 SILT, GRAY; SAND, VERY FINE
 38.0 - 50.0 SAND AND GRAVEL, FINE SAND TO COARSE
 PEBBLE GRAVEL
 50.0 - 72.0 SILT, GRAY, SANDY; INCREASING CLAY
 CONTENT NEAR BOTTOM PORTION OF
 INTERVAL
 72.0 - 148.0 SAND AND GRAVEL, COARSE SAND TO COARSE
 PEBBLE GRAVEL

148.0 - 150.0 CLAY, GRAY, SANDY, PEBBLY; SAND LENSES
(TILL)
150.0 - 162.0 SAND AND GRAVEL, COARSE SAND TO COARSE
PEBBLE GRAVEL
162.0 - 165.0 CLAY, GRAY, SILTY, SANDY, PEBBLY (TILL)

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COUNTY: DEUEL LOCATION: 115N-48W-17ADDA 1
MAP LOCATION: 32
LEGAL LOCATION: NE SE SE NE SEC. 17, T. 115 N., R. 48 W.
LATITUDE: 44.4613 LONGITUDE: 96.3608
LAND OWNER:
PROJECT: BROOKINGS-DEUEL RWS
DRILLING COMPANY: SDGS
DRILLER: G. JENSEN/L. HELSETH DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 09-29-1987 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1850.00 T
TOTAL DRILL HOLE DEPTH: 260.0 TEST HOLE NUMBER: R1-87-74
WATER RIGHTS WELL: SDGS WELL NAME: R1-87-74
OTHER WELL NAME:
BASIN: BIG SIOUX AQUIFER: PRAIRIE COTEAU
MANAGEMENT UNIT:
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
CASING TYPE: PVC CASING DIAMETER: 2.0
CASING TOP ELEVATION:
CASING STICK-UP: 3.00 TOTAL CASING AND SCREEN: 261.0
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170202
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY: X
NATURAL GAMMA: X EXTRA:
SAMPLES:

SCREEN BETWEEN 228 AND 238 FEET, 20-FOOT BLANK
BELOW SCREEN.

0 - 2.0 TOPSOIL, BLACK
2.0 - 8.0 SAND, FINE TO COARSE
8.0 - 26.0 GRAVEL, VERY FINE TO COARSE PEBBLE
26.0 - 32.0 CLAY, GRAY, SILTY
32.0 - 48.0 SILT, BROWN, CLAYEY
48.0 - 64.0 SILT, GRAY, CLAYEY
64.0 - 86.0 CLAY, GRAY, SILTY
86.0 - 162.0 GRAVEL, VERY FINE TO COARSE PEBBLE; WITH
SOME MEDIUM TO COARSE SAND
162.0 - 174.0 CLAY, GRAY, SILTY, SANDY; SOME PEBBLES
174.0 - 188.0 GRAVEL, VERY FINE TO COARSE PEBBLE; WITH
SOME MEDIUM TO COARSE SAND
188.0 - 189.0 ROCK; GRANITE
189.0 - 242.0 GRAVEL, VERY FINE TO COARSE PEBBLE; WITH
SOME MEDIUM TO COARSE SAND
242.0 - 260.0 CLAY, GRAY, SANDY, SILTY (TILL)

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COUNTY: DEUEL LOCATION: 115N-48W-17ADDA 2
MAP LOCATION: 33
LEGAL LOCATION: NE SE SE NE SEC. 17, T. 115 N., R. 48 W.
LATITUDE: 44.4613 LONGITUDE: 96.3608
LAND OWNER:
PROJECT: BROOKINGS-DEUEL RWS
DRILLING COMPANY: SDGS
DRILLER: G. JENSEN/L. HELSETH DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 09-30-1987 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1850.00 T
TOTAL DRILL HOLE DEPTH: 130.0 TEST HOLE NUMBER: R1-87-76
WATER RIGHTS WELL: SDGS WELL NAME: R1-87-76
OTHER WELL NAME:
BASIN: BIG SIOUX AQUIFER: PRAIRIE COTEAU
MANAGEMENT UNIT:
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
CASING TYPE: PVC CASING DIAMETER: 2.0
CASING TOP ELEVATION:
CASING STICK-UP: 3.00 TOTAL CASING AND SCREEN: 128.0
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170202
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: X EXTRA:
SAMPLES:

0	-	2.0	TOPSOIL, BLACK
2.0	-	26.0	GRAVEL, FINE TO COARSE PEBBLE; OXIDIZED
26.0	-	34.0	CLAY, BROWN, SILTY
34.0	-	38.0	GRAVEL, VERY FINE TO MEDIUM PEBBLE; OXIDIZED
38.0	-	48.0	SILT, BROWN, CLAYEY
48.0	-	65.0	SILT, GRAY, PEBBLY
65.0	-	72.0	CLAY, GRAY, SILTY, SANDY
72.0	-	78.0	SAND AND GRAVEL, FINE SAND TO VERY FINE PEBBLE GRAVEL
78.0	-	90.0	CLAY, GRAY, SILTY, SANDY, PEBBLY (TILL)
90.0	-	104.0	SAND, FINE TO MEDIUM, CLAYEY
104.0	-	130.0	GRAVEL, VERY FINE TO COARSE PEBBLE

* * * *

COUNTY: DEUEL LOCATION: 115N-48W-17DDDD 1
MAP LOCATION: 34
LEGAL LOCATION: SE SE SE SE SEC. 17, T. 115 N., R. 48 W.
LATITUDE: 44.4541 LONGITUDE: 96.3603
LAND OWNER:
PROJECT: BROOKINGS-DEUEL RWS
DRILLING COMPANY: SDGS
DRILLER: G. JENSEN/ L. HELSETH DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X

DATE DRILLED: 10-05-1987 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1827.00 T
TOTAL DRILL HOLE DEPTH: 245.0 TEST HOLE NUMBER: R1-87-77
USGS HYDROLOGICAL UNIT CODE: 10170202
ELECTRIC LOG INFORMATION:

SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY: X
NATURAL GAMMA: X EXTRA:
SAMPLES:

0	-	2.0	TOPSOIL, BLACK
2.0	-	18.0	GRAVEL, FINE TO COARSE PEBBLE; OXIDIZED
18.0	-	34.0	SAND AND GRAVEL, FINE SAND TO COARSE PEBBLE GRAVEL
34.0	-	54.0	CLAY, BROWN TO GRAY, SILTY, SANDY
54.0	-	56.0	SAND, FINE TO COARSE
56.0	-	58.0	CLAY, SILTY, SANDY
58.0	-	60.0	SAND, FINE TO COARSE
60.0	-	70.0	CLAY, SILTY, SANDY; WITH SOME SAND AND GRAVEL
70.0	-	139.0	SAND AND GRAVEL, FINE SAND TO COARSE PEBBLE GRAVEL; OXIDIZED
139.0	-	144.0	CLAY, GRAY, SANDY, SILTY
144.0	-	162.0	GRAVEL, VERY FINE TO COARSE PEBBLE; OXIDIZED
162.0	-	174.0	CLAY, BROWN TO GRAY, PEBBLY (TILL)
174.0	-	181.0	SAND AND GRAVEL
181.0	-	187.0	ROCKS; GRANITE
187.0	-	236.0	CLAY, GRAY, PEBBLY, SILTY; WITH INTERBEDDED FINE BROWN SAND (TILL)
236.0	-	245.0	CLAY, GRAY, VERY SILTY; SOME PEBBLES (TILL)

* * * *

COUNTY: DEUEL LOCATION: 115N-48W-20BBBB 1
MAP LOCATION: 35
LEGAL LOCATION: NW NW NW NW SEC. 20, T. 115 N., R. 48 W.
LATITUDE: 44.4538 LONGITUDE: 96.3720
LAND OWNER:

PROJECT: BROOKINGS-DEUEL RWS
DRILLING COMPANY: SDGS

DRILLER: D. JACOBSON

DRILLER'S LOG:

GEOLOGIST: P. DAWSON

GEOLOGIST'S LOG: X

DATE DRILLED: 05-29-1987

DRILLING METHOD: ROTARY

GROUND SURFACE ELEVATION: 1783.00 T

TOTAL DRILL HOLE DEPTH: 98.0

TEST HOLE NUMBER: CO-87-09

WATER RIGHTS WELL:

SDGS WELL NAME: CO-87-09

OTHER WELL NAME:

BASIN: BIG SIOUX

AQUIFER: PRAIRIE COTEAU

MANAGEMENT UNIT:

SCREEN TYPE: PVC, MFG.

SCREEN LENGTH: 10.0

CASING TYPE: PVC

CASING DIAMETER: 2.0

CASING TOP ELEVATION:

CASING STICK-UP: 3.00

TOTAL CASING AND SCREEN: 100.0

WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170202
ELECTRIC LOG INFORMATION:

SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES:

SCREEN BETWEEN 44 AND 54 FEET, 43-FOOT
BLANK BELOW SCREEN.

0	-	10.0	GRAVEL, FINE PEBBLE; OXIDIZED
10.0	-	40.0	CLAY, BROWN, SILTY
40.0	-	55.0	GRAVEL, MEDIUM TO COARSE PEBBLE; OXIDIZED
55.0	-	80.0	CLAY, GRAY, PEBBLY, SILTY (TILL)
80.0	-	82.0	GRAVEL, MEDIUM TO COARSE PEBBLE; UNOXIDIZED
82.0	-	90.0	CLAY, GRAY, PEBBLY, SILTY (TILL)
90.0	-	93.0	GRAVEL, MEDIUM TO COARSE PEBBLE; OXIDIZED
93.0	-	98.0	CLAY, GRAY, PEBBLY, SILTY; HIT ROCK AT 98 FEET (TILL)

* * * *

COUNTY: DEUEL LOCATION: 115N-48W-20BBBB 2
MAP LOCATION: 36
LEGAL LOCATION: NW NW NW SEC. 20, T. 115 N., R. 48 W.
LATITUDE: 44.4538 LONGITUDE: 96.3720
LAND OWNER:

PROJECT: BROOKINGS-DEUEL RWS
DRILLING COMPANY: SDGS
DRILLER: D. JACOBSON

DRILLER'S LOG:
GEOLOGIST'S LOG: X

DATE DRILLED: 06-01-1987 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1783.00 T
TOTAL DRILL HOLE DEPTH: 90.0 TEST HOLE NUMBER: CO-87-10
USGS HYDROLOGICAL UNIT CODE: 10170202

ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES:

0	-	10.0	GRAVEL, MEDIUM TO COARSE PEBBLE; OXIDIZED
10.0	-	20.0	CLAY, BROWN, SANDY, SILTY
20.0	-	45.0	CLAY, GRAY, SANDY, SILTY
45.0	-	57.0	GRAVEL, MEDIUM TO COARSE PEBBLE; OXIDIZED
57.0	-	90.0	CLAY, GRAY, SILTY; HIT ROCK AT 90 FEET, ABANDONED HOLE (TILL)

* * * *

COUNTY: DEUEL LOCATION: 115N-48W-20BBBB 3
MAP LOCATION: 37
LEGAL LOCATION: NW NW NW NW SEC. 20, T. 115 N., R. 48 W.
LATITUDE: 44.4538 LONGITUDE: 96.3720
LAND OWNER:
PROJECT: BROOKINGS-DEUEL RWS
DRILLING COMPANY: SDGS
DRILLER: D. JACOBSON DRILLER'S LOG:
GEOLOGIST: P. DAWSON GEOLOGIST'S LOG: X
DATE DRILLED: 06-02-1987 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1783.00 T
TOTAL DRILL HOLE DEPTH: 167.0 TEST HOLE NUMBER: CO-87-11
WATER RIGHTS WELL: SDGS WELL NAME: CO-87-11
OTHER WELL NAME:
BASIN: BIG SIOUX AQUIFER: PRAIRIE COTEAU
MANAGEMENT UNIT:
SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
CASING TYPE: PVC CASING DIAMETER: 2.0
CASING TOP ELEVATION:
CASING STICK-UP: 3.00 TOTAL CASING AND SCREEN: 169.0
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170202
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: X EXTRA:
SAMPLES:

0	-	10.0	GRAVEL, FINE TO COARSE PEBBLE; OXIDIZED
10.0	-	30.0	CLAY, BROWN, SILTY, PEBBLY (TILL)
30.0	-	36.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
36.0	-	57.0	GRAVEL, FINE TO COARSE PEBBLE; OXIDIZED
57.0	-	90.0	CLAY, GRAY, SILTY
90.0	-	147.0	CLAY, GRAY, SILTY, SANDY, PEBBLY (TILL)
147.0	-	154.0	CLAY, GRAY, VERY SANDY; SAND STRINGERS
154.0	-	161.0	SAND, FINE TO MEDIUM; CEMENTED
161.0	-	167.0	CLAY, GRAY, SANDY, VERY GRAVELLY (TILL)

* * * *

APPENDIX C

Results of a water-quality analysis performed by the South Dakota Department of Health

Well sampled: R2-87-49

Date sampled: October 1, 1987

Parameter	Units *	Maximum Limit	Suggested Limit	Results
Arsenic (As)	ug/L	50	--	1.8
Barium (Ba)	ug/L	1000	--	136
Cadmium (Cd)	ug/L	10	--	<1.0
Chromium (Cr)	ug/L	50	--	<1.0
Lead (Pb)	ug/L	50	--	<1.0
Mercury (Hg)	ug/L	2	--	<0.2
Nitrate (NO ₃) as (N)	mg/L	10	--	<0.1
Selenium (Se)	ug/L	10	--	<1.0
Silver (Ag)	ug/L	50	--	<1.0
Fluoride (F)	mg/L	2.4	--	0.21
Gross radium	pci/L	--	--	0.4 ± 0.3
Chloride (Cl)	mg/L	--	250	7.4
Iron (Fe)	mg/L	--	0.3	<0.01
Manganese (Mn)	mg/L	--	0.05	0.72
Sulfate (SO ₄)	mg/L	--	250	75
Total dissolved solids	mg/L	--	500	394
pH	----	--	6.5 - 8.5	7.48
Alkalinity-M (CaCO ₃)	mg/L	--	--	249
Alkalinity-P (CaCO ₃)	mg/L	--	--	0
Bicarbonate (HCO ₃)	mg/L	--	--	304
Carbonate (CO ₃)	mg/L	--	--	0
Specific conductance at 25°	umhos	--	--	606
Calcium (Ca)	mg/L	--	--	83.7
Magnesium (Mg)	mg/L	--	--	27.9
Hardness (CaCO ₃)	mg/L	--	--	324
Langelier Index	----	--	--	0.01
Sodium (Na)	mg/L	--	--	4.3
Potassium (K)	mg/L	--	--	2.5

* mg/L = milligrams per liter; ug/L = micrograms per liter; pci/L = picocuries per liter; umhos/cm = micromhos per centimeter.

Chemical data are from the South Dakota State Health Laboratory.

APPENDIX D

Results of water analyses for tritium content

Sample	Location	Date of Sample Collection	TU *	eTU *
Brookings-Deuel Rural Water System production well 4	NW 1/4 NW 1/4 SW 1/4 SW 1/4 sec. 8, T. 115 N., R. 48 W.	06-18-87	35.0	1.1
Spring	NE 1/4 NW 1/4 NW 1/4 NE 1/4 sec. 6, T. 115 N., R. 48 W.	06-18-87	-0.01	0.09
Well R2-87-49	NE 1/4 NE 1/4 NW 1/4 NE 1/4 sec. 17, T. 115 N., R. 48 W.	10-01-87	6.67	0.23

Chemical data and the explanation below are from the University of Miami Tritium Laboratory.

* The tritium concentrations are expressed in TU, where 1 TU indicates a T/H ratio of 10^{-18} . The values refer to the old, internationally-adopted scale of U.S. National Bureau of Standards (NBS), which is based on their tritium water standard #4926 as measured on 1961/09/03, and age-corrected with the old half-life of 12.26 years, i.e., = 5.65% year⁻¹. In this scale, 1 TU is 7.186 dpm/kg H₂O, or 3.237 pCi/kg H₂O. TU values are calculated for date of sample collection. The stated errors, eTU, are one standard deviation (1 sigma) including all conceivable contributions.

APPENDIX E. Water levels in South Dakota Geological Survey monitoring wells

Map Location (1)	Location (2)	Well	Relative casing top elevation (3)	Depths to water on various dates (4)															
				05-29 1987	06-01 1987	06-02 1987	06-03 1987	06-04 1987	06-08 1987	06-10 1987	06-24 1987	06-25 1987	07-07 1987	08-11 1987	08-12 1987	08-17 1987	09-08 1987	09-10 1987	10-07 1987
5	115N-48W-05 CCCC 4	R1-87-39	967.04	--	--	--	--	--	32.92	32.08	30.80	30.86	--	31.50	--	30.76	30.42		
6	115N-48W-05 CCCC 5	R1-87-40	966.67	--	--	--	--	--	26.76	23.51	23.37	23.10	--	23.36	--	22.40	22.31		
7	115N-48W-06 DDAD 1	R2-87-45	----	flowing well															
9	115N-48W-06 DDDD 2	CO-87-15	966.04	--	--	17.08	17.04	17.24	17.22	17.31	17.33	--	17.47	--	17.42	17.45			
12	115N-48W-07 DCCD 2	CO-87-08	983.71	25.61	31.78	31.94	32.10	32.23	32.47	--	57.46	49.57	40.99	--	40.36	--	40.19	38.99	
13	115N-48W-08 CBAA 1	R2-87-52	1012.14	--	--	--	--	--	--	--	61.12	--	73.34	--	72.57	72.43			
14	115N-48W-08 CBAA 2	R2-87-53	1014.68	--	--	--	--	--	--	--	72.38	--	72.69	--	72.50	72.49			
15	115N-48W-08 CCB8 1	CO-87-12	1003.24	--	--	60.44	63.49	60.45	60.23	61.05	61.12	61.12	--	61.29	--	61.18	61.40		
17	115N-48W-08 CDB8 1	CO-87-13	1021.59	--	--	22.44	76.65	79.62	79.49	79.44	79.54	79.41	--	79.86	--	79.59	79.75		
18	115N-48W-08 CDB8 2	CO-87-14	1021.42	--	--	34.10	41.63	41.92	41.91	42.01	42.12	--	42.24	--	42.37	42.46			
20	115N-48W-08 CDCC 2	R2-87-48	1032.02	--	--	--	--	--	--	--	89.75	--	90.17	90.00	89.90	90.21			
21	115N-48W-08 DCBB 1	R2-87-54	1058.14	--	--	--	--	--	--	--	116.51	116.66	116.46	116.31	116.62				
22	115N-48W-08 DCBB 2	R2-87-55	1059.21	--	--	--	--	--	--	--	108.32	117.64	117.45	117.32	117.63				
23	115N-48W-08 DCCC 1	CO-87-06	1040.73	98.25	98.05	98.26	98.54	98.56	98.61	98.36	98.90	98.84	98.89	98.73	--	99.19	98.98	98.88	99.15
24	115N-48W-08 DCCC 2	CO-87-07	1041.53	55.74	56.23	56.44	56.58	56.52	56.56	56.37	56.80	56.73	56.73	56.59	--	56.94	56.88	56.82	57.19
25	115N-48W-09 CCBC 1	R1-87-75	1041.41	--	--	--	--	--	--	--	--	--	--	--	--	100.21			
26	115N-48W-09 CCCC 1	R1-87-73	1068.79	--	--	--	--	--	--	--	--	--	--	--	--	127.95			
27	115N-48W-17 ABAA 1	R2-87-49	1064.54	--	--	--	--	--	--	--	170.50	--	123.13	--	122.86	123.16			
28	115N-48W-17 ABAA 2	R2-87-50	1064.10	--	--	--	--	--	--	--	170.50	--	122.51	--	122.24	122.55			
30	115N-48W-17 ABCC 2	R2-87-57	1044.89	--	--	--	--	--	--	--	--	--	103.19	--	102.95	103.25			
31	115N-48W-17 ABCC 3	R2-87-58	1046.11	--	--	--	--	--	--	--	--	--	104.38	104.24	104.14	104.46			
32	115N-48W-17 ADDA 1	R1-87-74	1054.61	--	--	--	--	--	--	--	--	--	--	--	--	113.95			
33	115N-48W-17 ADDA 2	R1-87-76	1054.39	--	--	--	--	--	--	--	--	--	--	--	--	112.57			
35	115N-48W-20 BBBBB 1	CO-87-09	----	45.60	45.82	46.05	45.93	45.96	45.53	46.13	46.04	46.12	47.68	--	46.43	--	46.39	46.75	
37	115N-48W-20 BBBBB 3	CO-87-11	----	--	--	40.78	40.58	42.32	44.50	46.82	48.19	46.47	44.01	--	45.44	--	42.31	41.07	

(1) Map Location - corresponds to number on figure 1 and in appendix B.

(2) See appendix B for explanation of location format.

(3) The datum used for surveying was the south side of the top of a 4-inch diameter polyvinyl chloride well casing located at 115N-48W-CCBB. This well was installed by the Brookings-Deuel Rural Water System and is approximately 163 feet deep. The elevation assumed for the casing top was 1000.00 feet.

(4) All water levels are presented in feet below top of well casing.

APPENDIX F. Water elevations in South Dakota Geological Survey monitoring wells

Map Location (1)	Location (2)	Well	Relative casing top elevation (3)	Relative water elevations on various dates															
				05-29 1987	06-01 1987	06-02 1987	06-03 1987	06-04 1987	06-08 1987	06-10 1987	06-24 1987	06-25 1987	07-07 1987	08-11 1987	08-12 1987	08-17 1987	09-08 1987	09-10 1987	10-07 1987
5	115N-48W-05 CCCC 4	R1-87-39	967.04	---	---	---	---	---	934.12	934.96	936.24	936.18	---	935.54	---	936.28	936.62		
6	115N-48W-05 CCCC 5	R1-87-40	966.67	---	---	---	---	---	939.91	943.16	943.30	943.57	---	943.31	---	944.27	944.36		
7	115N-48W-06 DDDD 1	R2-87-45	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
9	115N-48W-06 DDDD 2	CO-87-15	966.04	---	---	---	---	948.96	949.00	948.80	948.73	948.71	---	948.57	---	948.62	948.59		
12	115N-48W-07 DCCC 2	CO-87-08	983.71	958.10	951.93	951.77	951.61	951.48	951.24	---	926.25	934.14	942.72	---	943.35	---	943.52		
13	115N-48W-08 CAAA 1	R2-87-52	1012.14	---	---	---	---	---	---	---	---	951.02	---	938.80	---	939.57	939.71		
14	115N-48W-08 CAAA 2	R2-87-53	1014.68	---	---	---	---	---	---	---	---	942.30	---	941.99	---	942.18	942.19		
15	115N-48W-08 CBBB 1	CO-87-12	1003.24	---	---	---	942.80	939.75	942.79	943.01	942.19	942.23	942.12	942.12	---	942.06	941.84		
17	115N-48W-08 CBBB 1	CO-87-13	1021.59	---	---	---	---	999.15	944.94	941.97	942.10	942.15	942.05	942.18	---	942.00	941.84		
18	115N-48W-08 CBBB 2	CO-87-14	1021.42	---	---	---	---	---	987.32	979.79	979.50	979.51	979.41	979.30	---	979.05	978.96		
20	115N-48W-08 CCCC 2	R2-87-48	1032.02	---	---	---	---	---	---	---	---	---	942.27	---	942.12	942.12	941.81		
21	115N-48W-08 CBBB 1	R2-87-54	1058.14	---	---	---	---	---	---	---	---	---	---	941.63	941.48	941.83	941.52		
22	115N-48W-08 CBBB 2	R2-87-55	1059.21	---	---	---	---	---	---	---	---	---	---	950.89	941.57	941.89	941.58		
23	115N-48W-08 DCCC 1	CO-87-06	1040.73	942.48	942.68	942.47	942.19	942.17	942.12	942.37	941.83	941.89	941.84	942.00	---	941.85	941.58		
24	115N-48W-08 DCCC 2	CO-87-07	1041.53	985.79	985.30	985.09	984.95	985.01	984.73	984.73	984.80	984.80	984.94	---	984.65	984.71	984.34		
25	115N-48W-09 CCBC 1	R1-87-75	1041.41	---	---	---	---	---	---	---	---	---	---	---	---	---	941.20		
26	115N-48W-09 CCCC 1	R1-87-73	1068.79	---	---	---	---	---	---	---	---	---	---	---	---	---	940.84		
27	115N-48W-17 ABAA 1	R2-87-49	1064.54	---	---	---	---	---	---	---	---	---	---	---	941.41	---	941.38		
28	115N-48W-17 ABAA 2	R2-87-50	1064.10	---	---	---	---	---	---	---	---	---	---	---	941.59	---	941.55		
30	115N-48W-17 ABCB 2	R2-87-57	1044.89	---	---	---	---	---	---	---	---	---	---	---	941.70	---	941.64		
31	115N-48W-17 ABCB 3	R2-87-58	1046.11	---	---	---	---	---	---	---	---	---	---	---	941.73	941.87	941.65		
32	115N-48W-17 ADDA 1	R1-87-74	1054.61	---	---	---	---	---	---	---	---	---	---	---	---	---	940.66		
33	115N-48W-17 ADDA 2	R1-87-76	1054.39	---	---	---	---	---	---	---	---	---	---	---	---	---	941.82		
35	115N-48W-20 B88B 1	CO-87-09	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
37	115N-48W-20 B88B 3	CO-87-11	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		

(1) Map Location - corresponds to number on figure 1 and in appendix B.

(2) See appendix B for explanation of location format.

(3) The datum used for surveying was the south side of the top of a 4-inch diameter polyvinyl chloride well casing located at 115N-48W-CCBB. This well was installed by the Brookings-Deuel Rural Water System and is approximately 163 feet deep. The elevation assumed for the casing top was 1000.00 feet.

APPENDIX G

Aquifer test data: Production well 4

This aquifer test was conducted in September, 1987, with pumping beginning on September 8 and recovery measurements terminating on September 10.

The test utilized Brookings-Deuel Rural Water System production well 4 as the pumping well.

Two wells were monitored in addition to the pumping well. These were:

1. well CO-87-12, a 2-inch diameter well installed by the South Dakota Geological Survey, and
2. a 4-inch diameter well installed by the Rural Water System as a test well prior to the involvement of the Geological Survey.

The 4-inch diameter well is completed in an outwash deeper than that in which the production well and well CO-87-12 are completed.

DRAWDOWN DATA

WELL: Brookings-Deuel Rural Water System production well 4

DATE PUMPING STARTED: 09-08-87

TIME PUMPING STARTED: 1500 hours (3:00 p.m.)

DATE PUMPING CEASED: 09-09-87

TIME PUMPING CEASED: 1335 hours (1:30 p.m.)

PUMPING RATE: 50 gallons per minute

STATIC WATER LEVEL: 60.50 feet

DAY	HOUR	MINUTE	SECOND	Depth to water from casing top (feet)	Draw- down (feet)	DAY	HOUR	MINUTE	SECOND	Depth to water from casing top (feet)	Draw- down (feet)
8	14	0	0	60.50	0.00	8	15	35	0	64.07	3.57
8	14	59	0	60.50	0.00	8	15	40	0	64.07	3.57
8	15	1	18	64.32	3.82	8	15	50	0	64.08	3.58
8	15	2	0	64.34	3.84	8	16	0	0	64.09	3.59
8	15	2	30	64.32	3.82	8	16	10	0	64.09	3.59
8	15	3	0	64.30	3.80	8	16	20	0	64.09	3.59
8	15	3	30	64.28	3.78	8	16	30	0	64.09	3.59
8	15	4	0	64.28	3.78	8	16	40	0	64.09	3.59
8	15	4	30	64.23	3.73	8	16	50	0	64.09	3.59
8	15	5	0	64.23	3.73	8	17	14	0	64.09	3.59
8	15	5	30	64.19	3.69	8	18	4	0	64.11	3.61
8	15	6	0	64.19	3.69	8	19	38	0	64.15	3.65
8	15	6	30	64.15	3.65	8	20	15	0	64.16	3.66
8	15	7	0	64.11	3.61	8	21	6	0	64.18	3.68
8	15	7	30	64.11	3.61	8	22	12	0	64.24	3.74
8	15	8	0	64.11	3.61	8	23	10	0	64.23	3.73
8	15	8	30	64.09	3.59	9	0	9	0	64.26	3.76
8	15	9	0	64.09	3.59	9	1	8	0	64.26	3.76
8	15	9	30	64.09	3.59	9	2	8	0	64.26	3.76
8	15	10	0	64.09	3.59	9	3	8	0	64.18	3.68
8	15	11	0	64.07	3.57	9	5	5	0	64.15	3.65
8	15	12	0	64.07	3.57	9	6	58	0	64.16	3.66
8	15	13	0	64.07	3.57	9	7	58	0	64.16	3.66
8	15	14	0	64.07	3.57	9	8	58	0	64.17	3.67
8	15	16	0	64.07	3.57	9	9	58	0	64.16	3.66
8	15	18	0	64.07	3.57	9	11	11	0	64.16	3.66
8	15	20	0	64.07	3.57	9	12	12	0	64.17	3.67
8	15	25	0	64.07	3.57	9	13	30	0	64.14	3.64
8	15	30	0	64.07	3.57	9	13	35	0	64.14	3.64

RECOVERY DATA

WELL: Brookings-Deuel Rural Water System production well 4

DATE PUMPING CEASED: 09-09-87

TIME PUMPING CEASED: 1335 hours (1:30 p.m.)

STATIC WATER LEVEL: 60.50 feet

DAY	HOUR	MINUTE	SECOND	Depth		DAY	HOUR	MINUTE	SECOND	Depth	
				to water from casing top (feet)	Residual draw down (feet)					to water from casing top (feet)	Residual draw down (feet)
9	13	35	0	64.14	3.64	9	13	50	0	60.74	0.24
9	13	35	30	60.84	0.34	9	13	51	0	60.74	0.24
9	13	38	0	60.81	0.31	9	13	52	0	60.74	0.24
9	13	38	30	60.81	0.31	9	13	53	0	60.74	0.24
9	13	39	0	60.81	0.31	9	13	54	0	60.74	0.24
9	13	39	30	60.80	0.30	9	13	55	0	60.74	0.24
9	13	40	0	60.80	0.30	9	14	0	0	60.74	0.24
9	13	41	0	60.79	0.29	9	14	6	0	60.71	0.21
9	13	42	0	60.78	0.28	9	14	10	0	60.71	0.21
9	13	42	30	60.78	0.28	9	14	15	0	60.70	0.20
9	13	43	0	60.78	0.28	9	14	20	0	60.70	0.20
9	13	43	30	60.77	0.27	9	14	33	0	60.69	0.19
9	13	44	0	60.77	0.27	9	14	40	0	60.67	0.17
9	13	44	30	60.77	0.27	9	14	58	0	60.66	0.16
9	13	45	0	60.76	0.26	9	15	10	0	60.64	0.14
9	13	45	30	60.76	0.26	9	15	25	0	60.62	0.12
9	13	46	0	60.76	0.26	9	15	40	0	60.62	0.12
9	13	46	30	60.76	0.26	9	15	55	0	60.61	0.11
9	13	47	0	60.76	0.26	9	16	27	0	60.60	0.10
9	13	47	30	60.76	0.26	9	17	11	0	60.58	0.08
9	13	48	0	60.76	0.26	9	19	20	0	60.56	0.06
9	13	49	0	60.74	0.24	10	8	0	0	60.50	0.00

DRAWDOWN DATA

WELL: Monitoring well CO-87-12

DATE PUMPING STARTED: 09-08-87

TIME PUMPING STARTED: 1500 hours (3:00 p.m.)

DATE PUMPING CEASED: 09-09-87

TIME PUMPING CEASED: 1335 hours (1:30 p.m.)

STATIC WATER LEVEL: 61.18 feet

DAY	HOUR	MINUTE	SECOND	Depth to water from casing top (feet)	Draw- down (feet)	DAY	HOUR	MINUTE	SECOND	Depth to water from casing top (feet)	Draw- down (feet)
8	13	58	0	61.20	--	8	15	21	0	61.21	0.03
8	14	58	45	61.18	--	8	15	22	0	61.21	0.03
8	15	0	0	61.18	0.00	8	15	25	0	61.21	0.03
8	15	0	30	61.18	0.00	8	15	30	0	61.21	0.03
8	15	1	0	61.18	0.00	8	15	35	0	61.21	0.03
8	15	1	30	61.18	0.00	8	15	40	0	61.21	0.03
8	15	2	0	61.18	0.00	8	15	50	0	61.21	0.03
8	15	2	30	61.19	0.01	8	16	0	0	61.22	0.04
8	15	3	0	61.19	0.01	8	16	10	0	61.22	0.04
8	15	3	30	61.19	0.01	8	16	20	0	61.22	0.04
8	15	4	0	61.19	0.01	8	16	30	0	61.22	0.04
8	15	4	30	61.19	0.01	8	16	40	0	61.22	0.04
8	15	5	0	61.19	0.01	8	16	50	0	61.23	0.05
8	15	5	30	61.19	0.01	8	17	14	30	61.23	0.05
8	15	6	0	61.19	0.01	8	18	4	0	61.25	0.07
8	15	6	30	61.19	0.01	8	19	33	0	61.27	0.09
8	15	7	0	61.20	0.02	8	20	15	40	61.28	0.10
8	15	7	30	61.20	0.02	8	21	4	30	61.30	0.12
8	15	8	0	61.20	0.02	8	22	7	0	61.31	0.13
8	15	8	30	61.20	0.02	8	23	2	0	61.32	0.14
8	15	9	0	61.20	0.02	9	0	2	0	61.33	0.15
8	15	9	30	61.20	0.02	9	1	2	0	61.33	0.15
8	15	10	0	61.20	0.02	9	2	2	0	61.33	0.15
8	15	11	0	61.20	0.02	9	3	2	0	61.31	0.13
8	15	12	0	61.20	0.02	9	5	14	0	61.35	0.17
8	15	13	0	61.20	0.02	9	6	10	0	61.35	0.17
8	15	14	0	61.20	0.02	9	7	3	0	61.34	0.16
8	15	15	0	61.20	0.02	9	8	2	0	61.34	0.16
8	15	16	0	61.21	0.03	9	9	1	0	61.34	0.16
8	15	17	0	61.21	0.03	9	10	1	0	61.34	0.16
8	15	18	0	61.21	0.03	9	11	11	0	61.33	0.15
8	15	19	0	61.21	0.03	9	12	15	0	61.34	0.16
8	15	20	0	61.21	0.03	9	13	30	0	61.33	0.15
						9	13	34	0	61.33	0.15

RECOVERY DATA

WELL: Monitoring well CO-87-12

DATE PUMPING CEASED: 09-09-87

TIME PUMPING CEASED: 1335 hours (1:30 p.m.)

STATIC WATER LEVEL: 61.18 feet

DAY	HOUR	MINUTE	SECOND	Depth		DAY	HOUR	MINUTE	SECOND	Depth	
				to water from casing top (feet)	Residual draw down (feet)					to water from casing top (feet)	Residual draw down (feet)
9	13	35	0	61.33	0.15	9	13	47	30	61.29	0.11
9	13	35	30	61.33	0.15	9	13	48	0	61.29	0.11
9	13	36	0	61.32	0.14	9	13	49	0	61.29	0.11
9	13	36	30	61.32	0.14	9	13	50	0	61.29	0.11
9	13	37	0	61.32	0.14	9	13	51	0	61.29	0.11
9	13	37	30	61.32	0.14	9	13	55	0	61.29	0.11
9	13	38	0	61.31	0.13	9	14	0	0	61.28	0.10
9	13	38	30	61.31	0.13	9	14	5	0	61.27	0.09
9	13	39	0	61.31	0.13	9	14	10	0	61.27	0.09
9	13	39	30	61.31	0.13	9	14	15	0	61.27	0.09
9	13	40	0	61.31	0.13	9	14	20	0	61.26	0.08
9	13	40	30	61.31	0.13	9	14	30	0	61.25	0.07
9	13	41	0	61.31	0.13	9	14	40	0	61.25	0.07
9	13	41	30	61.30	0.12	9	14	50	0	61.24	0.06
9	13	42	0	61.30	0.12	9	15	0	0	61.24	0.06
9	13	42	30	61.30	0.12	9	15	10	0	61.23	0.05
9	13	43	0	61.30	0.12	9	15	20	0	61.22	0.04
9	13	43	30	61.30	0.12	9	15	30	0	61.22	0.04
9	13	44	0	61.30	0.12	9	15	45	0	61.21	0.03
9	13	44	30	61.30	0.12	9	16	0	0	61.21	0.03
9	13	45	0	61.30	0.12	9	16	30	0	61.20	0.02
9	13	45	30	61.29	0.11	9	17	12	0	61.20	0.02
9	13	46	0	61.29	0.11	9	19	23	0	61.18	0.00
9	13	46	30	61.29	0.11	10	8	14	0	61.18	0.00
9	13	47	0	61.29	0.11						

DRAWDOWN and RECOVERY DATA

WELL: Monitoring well - Brookings-Deuel Rural Water System deep observation well near production well 4

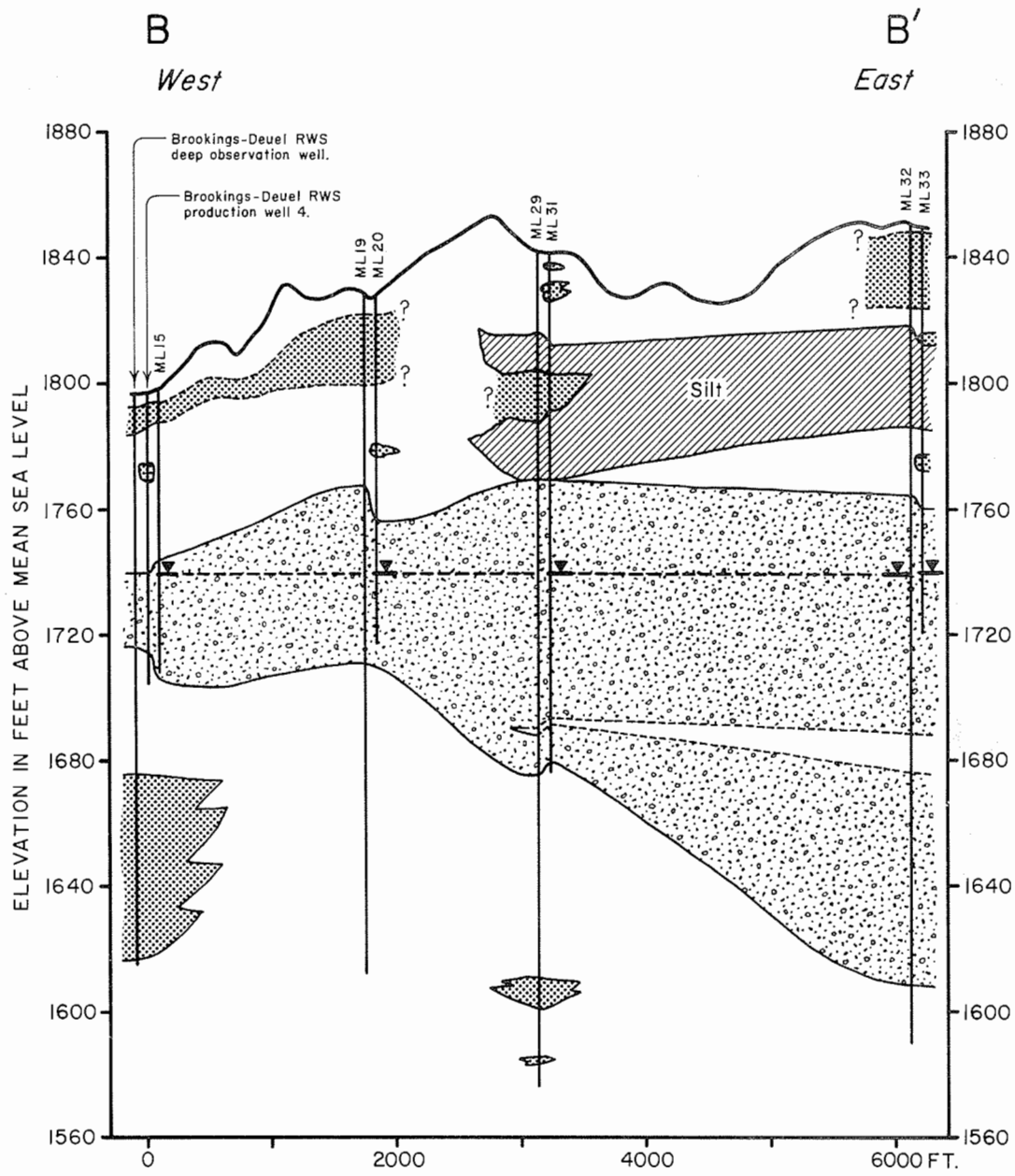
DATE PUMPING CEASED: 09-09-87

TIME PUMPING CEASED: sometime between 2:00 and 3:00 a.m.

OTHER INFORMATION: This well was being affected by the pumping of a nearby irrigation well and not Brookings-Deuel Rural Water System production well 4. The static water level in this well is not known because the irrigation well was pumping when water level measurements began.

Depth to water from casing top					Depth to water from casing top				
DAY	HOUR	MINUTE	SECOND	(feet)	DAY	HOUR	MINUTE	SECOND	(feet)
8	14	40	0	61.61	8	15	30	0	61.85
8	15	0	0	61.64	8	15	35	0	61.88
8	15	1	0	61.64	8	15	40	0	61.91
8	15	1	30	61.66	8	15	50	0	61.97
8	15	2	0	61.66	8	16	0	0	62.03
8	15	3	0	61.67	8	16	10	0	62.08
8	15	3	30	61.67	8	16	20	0	62.13
8	15	4	0	61.67	8	16	30	0	62.18
8	15	4	30	61.67	8	16	40	0	62.22
8	15	5	0	61.67	8	16	50	0	62.26
8	15	5	30	61.67	8	17	14	0	62.36
8	15	6	0	61.68	8	18	6	0	62.54
8	15	6	30	61.68	8	19	35	0	62.75
8	15	7	0	61.70	8	20	17	0	62.83
8	15	7	30	61.70	8	21	4	0	62.91
8	15	8	0	61.72	8	22	8	0	63.01
8	15	8	30	61.70	8	23	4	0	63.07
8	15	9	0	61.71	9	0	4	0	63.15
8	15	9	30	61.71	9	1	5	0	63.23
8	15	10	0	61.71	9	2	4	0	63.24
8	15	11	0	61.72	9	3	5	0	63.24
8	15	12	0	61.73	9	5	12	0	62.17
8	15	13	0	61.73	9	6	6	0	61.87
8	15	14	0	61.73	9	7	1	0	61.67
8	15	16	0	61.76	9	8	0	0	61.49
8	15	17	0	61.77	9	8	59	0	61.34
8	15	18	0	61.77	9	10	0	0	61.24
8	15	19	0	61.78	9	11	13	0	61.13
8	15	20	0	61.78	9	12	14	0	61.05
8	15	21	0	61.80	9	13	32	0	60.97
8	15	22	0	61.80	9	14	7	0	60.94
8	15	23	0	61.80	9	14	22	0	60.93
8	15	24	0	61.81	9	14	42	0	60.91
8	15	25	0	61.82	9	15	56	0	60.85
8	15	26	0	61.82	9	16	29	0	60.82
8	15	27	0	61.83	9	17	12	0	60.79
8	15	28	0	61.84	9	19	21	0	60.73
8	15	29	0	61.84	10	8	11	0	60.46

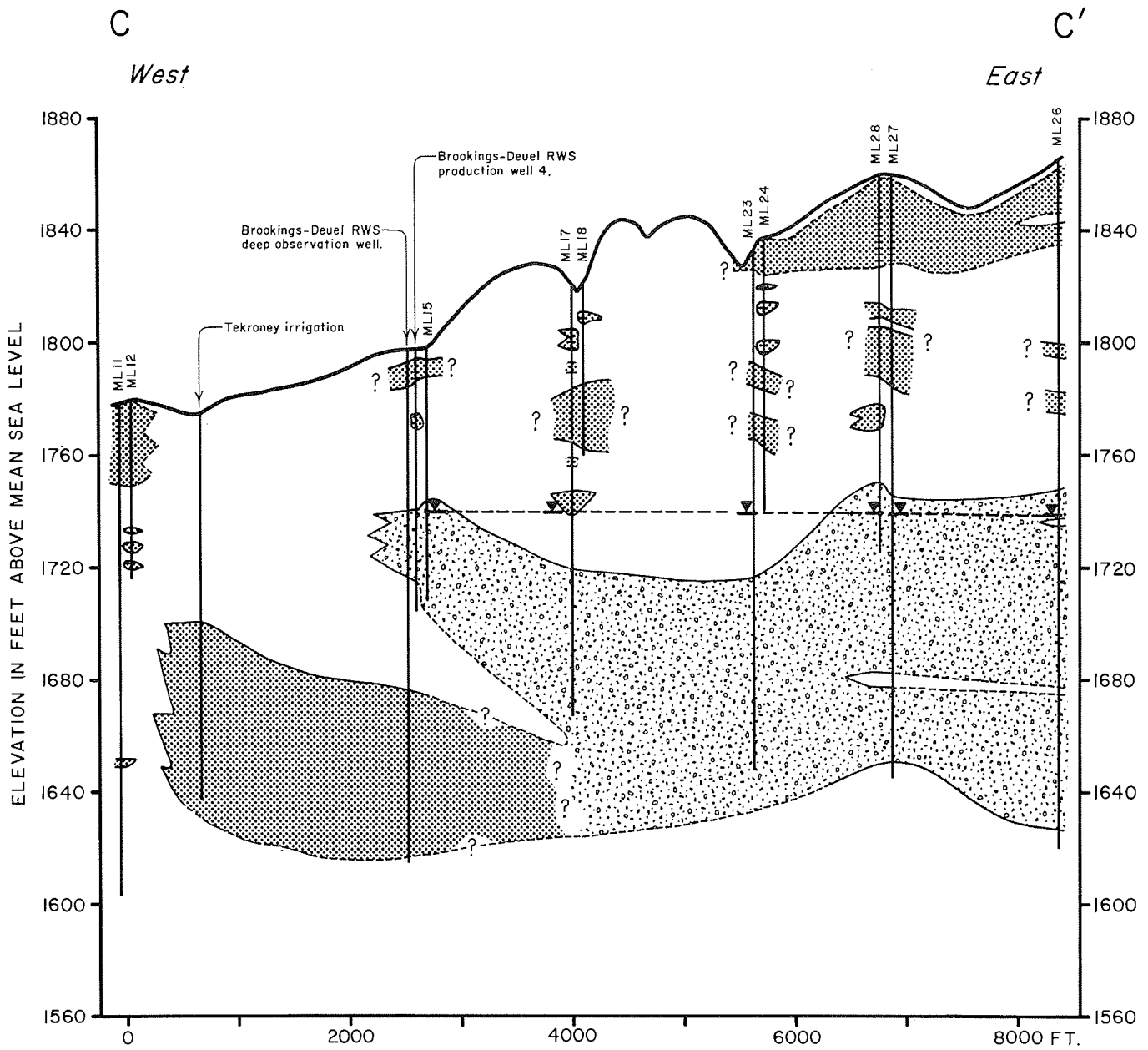
APPENDIX H
Cross Sections



EXPLANATION

- See map on page 69 for cross section location.
- Outwash, undifferentiated
- Outwash, Clear Lake aquifer
- Unpatterned portions represent non-aquifer sediment which is primarily till, unless otherwise noted.
- Approximate water level in well on 10-7-87.
- Approximate water level in the Clear Lake aquifer on 10-7-87.
- Lithologic contact. Dashed where approximate. A "?" is used where lateral extent is very uncertain.
- Vertical exaggeration = 25

Appendix H. Cross section B-B'

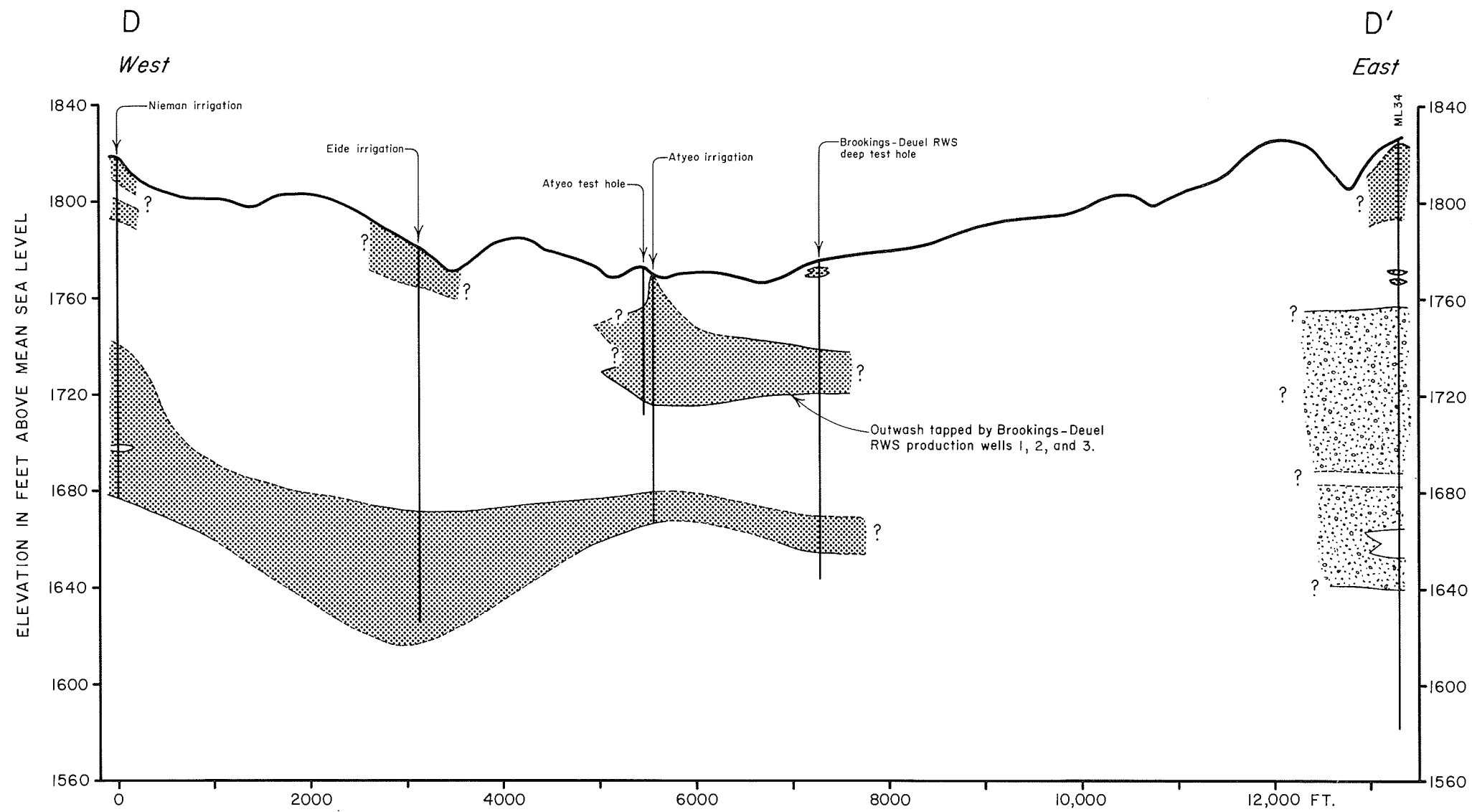


EXPLANATION

- | | |
|---|---|
| <p>See map on page 69 for cross section location.</p> <p> Outwash, undifferentiated</p> <p> Outwash, Clear Lake aquifer</p> <p>Unpatterned portions represent non-aquifer sediment which is primarily fill, unless otherwise noted.</p> | <p> Approximate water level in well on 10-7-87.</p> <p> Approximate water level in the Clear Lake aquifer on 10-7-87.</p> <p> Lithologic contact. Dashed where approximate. A "?" is used where lateral extent is very uncertain.</p> |
|---|---|

Vertical exaggeration = 25

Appendix H. Cross section C-C'



See map on page 69 for cross section location.

Outwash, undifferentiated

EXPLANATION

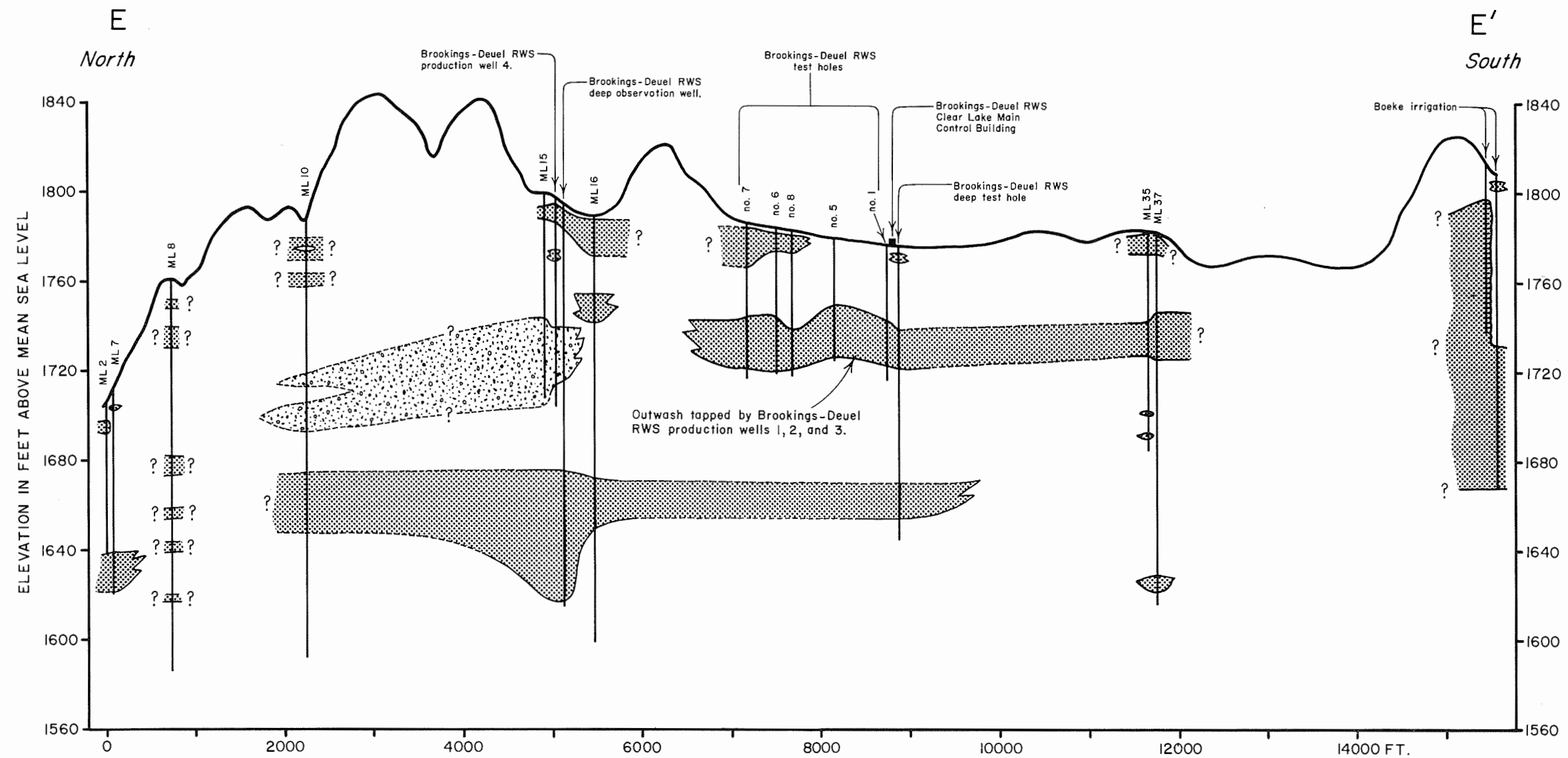
Outwash, Clear Lake aquifer

Unpatterned portions represent non-aquifer sediment which is primarily till, unless otherwise noted.


Lithologic contact. Dashed where approximate. A "?" is used where lateral extent is very uncertain.

Vertical exaggeration = 25


Appendix H.- Cross section D-D'



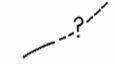
See map on page 69 for cross section location.

 Outwash, undifferentiated

EXPLANATION

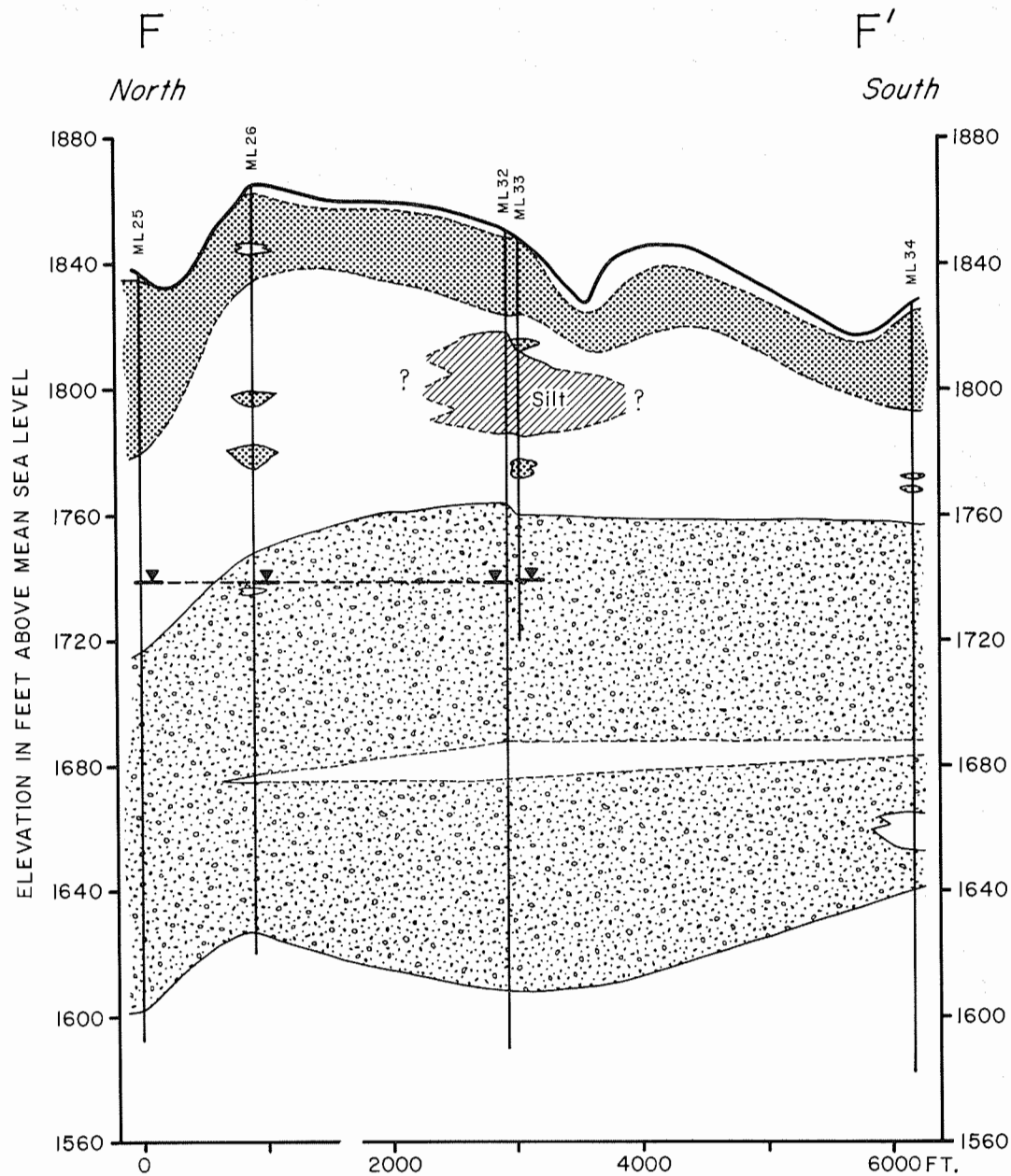
 Outwash, Clear Lake aquifer

Unpatterned portions represent non-aquifer sediment which is primarily till, unless otherwise noted.

 Lithologic contact. Dashed where approximate. A "?" is used where lateral extent is very uncertain.

Vertical exaggeration = 25

Appendix H. Cross section E - E'



EXPLANATION

- See map on page 69 for cross section location.
 - Outwash, undifferentiated
 - Outwash, Clear Lake aquifer
 - Unpatterned portions represent non-aquifer sediment which is primarily till, unless otherwise noted.
 - Approximate water level in well on 10-7-87.
 - Approximate water level in the Clear Lake aquifer on 10-7-87.
 - Lithologic contact. Dashed where approximate. A "?" is used where lateral extent is very uncertain.
- Vertical exaggeration = 25

Appendix H. Cross section F-F'

APPENDIX I

**Logs of wells and test holes, drilled by private companies,
which were used to construct cross sections
for this report**

Information in this appendix is on file at the Division of Water Rights, Department of Water and Natural Resources, Pierre, South Dakota, and the Brookings-Deuel Rural Water System, Toronto, South Dakota.

Locations are presented in the order of quarter section, section, township, and range.

=====

LOCATION: SE SE SW SE sec. 7, T. 115 N., R. 48 W.
WELL: Tekroney irrigation
ESTIMATED GROUND ELEVATION (FT): 1775

DEPTH	LITHOLOGY
0 - 2	Topsoil
2 - 38	Yellow clay
38 - 75	Gray till
75 - 85	Gravel
85 - 95	Sand
95 - 138	Sand and gravel

=====

LOCATION: NW NW SW SW sec. 8, T. 115 N., R. 48 W.
WELL: Brookings-Deuel Rural Water System production well 4
ESTIMATED GROUND ELEVATION (FT): 1798
DRILLER: LTP Enterprises, Inc.
DATE DRILLED: June 27, 1986

DEPTH	LITHOLOGY
0 - 1	Topsoil, black
1 - 2	Silty clay, brown
2 - 3.5	Rock, white
3.5- 11	Sand and silty clay, brown
11 - 23	Clay, sandy, brown
23 - 29	Sand, dirty, brown
29 - 58	Clay, silty, with lenses(?), blue
58 - 67	Sand, clean, takes water, brown
67 - 84	Sand, coarse, gravel, colored
84 - 94	Sandy clay, soft, blue

=====

=====

LOCATION: NW NW SW SW sec. 8, T. 115 N., R. 48 W.
 WELL: Brookings-Deuel Rural Water System deep observation well
 ESTIMATED GROUND ELEVATION (FT): 1797
 DRILLER: LTP Enterprises, Inc.
 DATE DRILLED: July 2, 1986

DEPTH	LITHOLOGY
0 - 1	Topsoil, black
1 - 4	Silty clay, brown
4 - 13	Sand, brown
13 - 21	Clay, brown
21 - 34	Clay, silty, with layers of sand, blue
34 - 57	Clay, sandy, blue
57 - 64	Sand, colored
64 - 81	Gravel and sand, colored
81 - 121	Clay, sandy, blue
121 - 125	Sand, dirty, gray
125 - 126	Sand, clay, rocks, blue
126 - 141	Sand, colored; clean, takes water
141 - 158	Sand, colored, coarser
158 - 166	Sand, colored, finer; 12-15 slot
166 - 167	Rock, red
167 - 180	Gravel, sand, rocks, clay, colored
180 - 182	Clay, blue

=====

LOCATION: NW NW SW NW sec. 17, T. 115 N., R. 48 W.
 WELL: Brookings-Deuel Rural Water System test hole 8
 ESTIMATED GROUND ELEVATION (FT): 1783
 DRILLER: Empire Irrigation Drill Company, Inc.
 DATE DRILLED: June 8, 1976

DEPTH	LITHOLOGY
0 - 2	Topsoil
2 - 10	Sand
10 - 20	Yellow clay
20 - 44	Silt
44 - 62	Gravel
62 - 65	Clay

=====

=====

LOCATION: SE SE NE NE sec. 18, T. 115 N., R. 48 W.
WELL: Brookings-Deuel Rural Water System test hole 6
ESTIMATED GROUND ELEVATION (FT): 1784
DRILLER: Empire Irrigation Drill Company, Inc.
DATE DRILLED: June 8, 1976

DEPTH	LITHOLOGY
0 - 2	Topsoil
2 - 10	Sand
10 - 40	Clay and sand
40 - 64	Sand and gravel
64 - 65	Clay

=====

LOCATION: NE SE NE NE sec. 18, T. 115 N., R. 48 W.
WELL: Brookings-Deuel Rural Water System test hole 7
ESTIMATED GROUND ELEVATION (FT): 1787
DRILLER: Empire Irrigation Drill Company, Inc.
DATE DRILLED: June 8, 1976

DEPTH	LITHOLOGY
0 - 2	Topsoil
2 - 20	Sand
20 - 42	Silt and sand
42 - 65	Sand and gravel
65 - 70	Clay

=====

LOCATION: NE NE SW NE sec. 18, T. 115 N., R. 48 W.
WELL: Atyeo test hole
ESTIMATED GROUND ELEVATION (FT): 1772
DRILLER: Empire Irrigation Drill Company, Inc.
DATE DRILLED: March 12, 1975

DEPTH	LITHOLOGY
0 - 2	Topsoil
2 - 8	Sandy clay
8 - 15	Clay
15 - 25	Sand and clay
25 - 54	Sand and gravel
54 - 60	Clay

=====

=====

LOCATION: NE NE SW NE sec. 18, T. 115 N., R. 48 W.
WELL: Atyeo irrigation
ESTIMATED GROUND ELEVATION (FT): 1772
DRILLER: Empire Irrigation Drill Company, Inc.
DATE DRILLED: July 26, 1976

DEPTH	LITHOLOGY
0 - 2	Topsoil
2 - 56	Sand and gravel
56 - 92	Gray till
92 - 105	Gravel
105	Gray till

=====

LOCATION: SE NE SE NE sec. 18, T. 115 N., R. 48 W.
WELL: Brookings-Deuel Rural Water System test hole 5
ESTIMATED GROUND ELEVATION (FT): 1780
DRILLER: Empire Irrigation Drill Company, Inc.
DATE DRILLED: June 8, 1976

DEPTH	LITHOLOGY
0 - 2	Topsoil
2 - 30	Sandy clay
30 - 35	Sand and clay
35 - 53	Sand, medium
53 - 55	Clay

=====

LOCATION: SE SE SE NE sec. 18, T. 115 N., R. 48 W.
WELL: Brookings-Deuel Rural Water System test hole 1
ESTIMATED GROUND ELEVATION (FT): 1776
DRILLER: Empire Irrigation Drill Company, Inc.
DATE DRILLED: March 10, 1976

DEPTH	LITHOLOGY
0 - 2	Topsoil
2 - 17	Yellow clay
17 - 33	Silt and yellow clay
33 - 45	Gravel
45 - 46	Clay
46 - 53	Sand and gravel
53 - 60	Gray till

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LOCATION: SE SE SE NE sec. 18, T. 115 N., R. 48 W.
WELL: Brookings-Deuel Rural Water System deep test hole
ESTIMATED GROUND ELEVATION (FT): 1776
DRILLER: LTP Enterprises, Inc.
DATE DRILLED: June 26, 1986

DEPTH	LITHOLOGY
0 - 3	Silt and sand, brown
3 - 7	Sand, brown
7 - 11	Clay, brown, silty; with layers of sand
11 - 16	Clay, brown, silty
16 - 27	Silt, blue
27 - 37	Clay, blue; with lenses
37 - 55	Gravel, colored
55 - 69	Clay, blue; with lenses, soft
69 - 74	Clay, blue; rocks
74 - 105	Clay, blue, sandy; hard
105 - 106	Clay, blue; with lenses
106 - 121	Sand, colored
121 - 122	Rock, white
122 - 132	Clay, blue, sandy

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LOCATION: NW SW SE NW sec. 18, T. 115 N., R. 48 W.
WELL: Eide irrigation
ESTIMATED GROUND ELEVATION (FT): 1782
DRILLER: Empire Irrigation Drill Company, Inc.
DATE DRILLED: July, 1976

DEPTH	LITHOLOGY
0 - 2	Topsoil
2 - 17	Gravel
17 - 46	Yellow clay - sand
46 - 110	Gray till
110 - 156	Sand and gravel

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LOCATION: SW sec. 20, T. 115 N., R. 48 W.
WELL: Boeke irrigation - deep
ESTIMATED GROUND ELEVATION (FT): 1810

DEPTH	LITHOLOGY
0 - 1	Topsoil
1 - 4	Yellow clay
4 - 9	Gravel
9 - 29	Sandy yellow clay
29 - 78	Blue clay
78 - 142	Gravel and sand
142	Blue clay

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LOCATION: SE NE NE SW sec. 20, T. 115 N., R. 48 W.
WELL: Boeke irrigation - shallow
ESTIMATED GROUND ELEVATION (FT): 1810
DATE DRILLED: September 12, 1977

DEPTH	LITHOLOGY
0 - 3	Topsoil
3 - 12	Sandy clay
12 - 72	Sand and gravel

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LOCATION: NW NW NE NE sec. 13, T. 115 N., R. 49 W.
WELL: Nieman irrigation
ESTIMATED GROUND ELEVATION (FT): 1820
DRILLER: Empire Irrigation Drill Company, Inc.
DATE DRILLED: August 25, 1981

DEPTH	LITHOLOGY
0 - 2	Topsoil
2 - 12	Fine sand
12 - 19	Silty blue clay
19 - 28	Coarse sand
28 - 32	Clay, yellow
32 - 35	Coarse sand and yellow clay
35 - 54	Clay, yellow; with rocks
54 - 56	Silty blue clay
56 - 63	Yellow clay
63 - 79	Blue clay
79 - 83	Sand, rocks
83 - 116	Sand, blue clay, rocks
116 - 121	Pepper sand
121 - 124	Blue clay and rocks
124 - 130	Medium to coarse sand, some clay layers
130 - 143	Medium to coarse sand
143	Clay

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