Ground-Water Resources of the

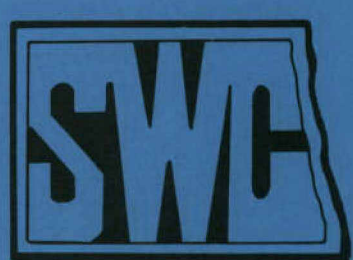
Rugby-Pleasant Lake Area

by David P. Ripley and Allen E. Comeskey

North Dakota Ground Water Studies

Number - 89

North Dakota State Water Commission



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NORTH DAKOTA GROUND-WATER STUDIES
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CONTENTS

INTRODUCTION

The city of Rugby requested that the State Water Commission conduct a study to locate a supplemental water supply because its well field had experienced a serious decline of water levels and water quality. The goals of the study were: 1) to define areas within the Pleasant Lake aquifer which possess a potential to provide additional water to the city, 2) assess chemical quality, 3) determine long term capacity for production wells within the Pleasant Lake aquifer, 4) determine the long term capacity for the Rugby aquifer.

Because of water quality changes that occurred in the well field completed in

Rugby aquifer, the city of Rugby lost interest in the utilization of the old well field except at times of high demand. As a result, objective 4 was not studied with a digital model. Objective 3 has been addressed twice, once in 1976, and then in 1982, when the city of Leeds applied for a water permit from the Pleasant Lake aquifer.

The study was accomplished by means of: 1) test drilling, which includes the recording of lithologic logs and bore hole geophysical logs, and observation well construction, 2) water sample collection and analysis, 3) water level monitoring, 4) a three day aquifer test to determine the hydrologic properties of the aquifer, and 5) development of a digital computer model to simulate aquifer characteristics to help in the evaluation of various scenarios for development.

The test drilling was conducted from July 14, 1975 to August 20, 1975. Fifty-eight test holes were drilled totaling 7,160 feet. A map showing the location of these holes is found on Plate 1. Twenty

of the test holes were completed as observation wells. The pump test was conducted from September 29, 1975 to October 7, 1975 in a selected portion of the Pleasant Lake aquifer. The initial modeling procedure began in December 1975 and was completed in September of 1976. Additional work was done in 1982.

The test drilling was accomplished by the forward rotary-mud method generally using a 4 3/4 inch bit. Lithologic logs are written records of the materials encountered by the drill and are based on samples obtained from the drilling mud. These are compiled by the geologist. Geophysical logs are graphs of the electrical properties of the materials penetrated by the bore hole. The lithologic and geophysical logs have been included in the appendix. Observation wells provide access to the water contained in the aquifer by means of 1¼ inch pvc plastic pipe completed with 1¼ inch stainless steel sand points of various slot sizes. Water samples were obtained by blowing the water from the wells with air provided by compressors. These samples are sent to the State Laboratory for analysis. Results of the analysis are found in Table 1 (page 22). The significance of these results are found in Table 2 in the appendix. Water levels are obtained by inserting a steel tape into the well and measuring depth to water. The water level data has also been included in the appendix.

The aquifer test was accomplished by completing a high capacity production well and a series of observation wells in the aquifer and observing the drawdown effects as the production well was pumped.

The digital computer model was accomplished by developing a mathematical representation of the aquifer to which stresses could be applied and their corresponding effects observed.

Location

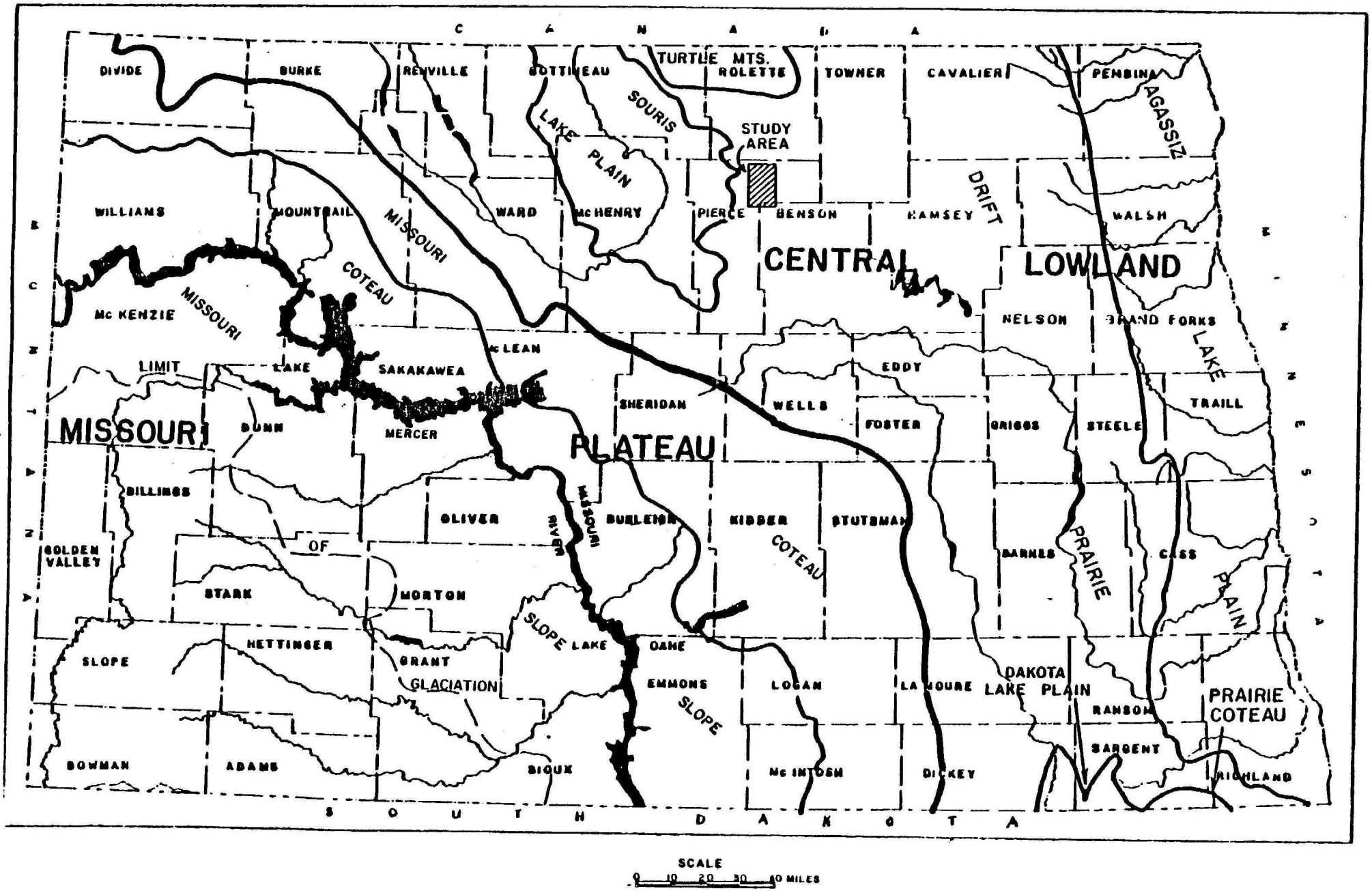
The city of Rugby is located in the north-central portion of Pierce County (Fig. 1). The Pleasant Lake aquifer is located between 5 and 9 miles east of Rugby and is oriented north-south passing beneath the community of Pleasant Lake. Test drilling was conducted in portions of Township 156 North, Ranges 71 and 72 West; Township 157 North, Ranges 71 and 72 West; and Township 158 North, Ranges 71 and 72 West in Benson and Pierce Counties. Both Benson and Pierce Counties are located in the Drift Prairie section of the Central Lowland physiographic province. This area is characterized by ground and end moraine deposits, lake and beach deposits, and glacial outwash deposits.

Previous Investigations

A general overview of the water resources of North Dakota is presented by Simpson (1929). Benson County is discussed on pages 71-76 and Pierce County is discussed on pages 187-188.

Lemke (1960) extended the eastern boundary of his study to the western edge of Pierce County. Though Benson and Pierce Counties are not included in the discussion, the surficial geology is included in Plate 15.

The North Dakota State Department of Health (1964) included analyses of water from the Rugby city supply in its study of municipal water supplies in North Dakota.



SCALE
0 10 20 30 40 MILES

FIG I STUDY AREA LOCATION

Froelich (1965) was the first to study the area in detail when conducting a study to locate a municipal supply for the city of Rugby. He described the general geology of, and availability and quality of water from the glacial deposits in the Rugby aquifer.

Randich (1971) lists test holes, water quality, and water levels for the Pleasant Lake aquifer that were accumulated for the Benson-Pierce Ground Water Study (Part II). A preliminary aquifer map was presented in the Hydrologic Investigations Atlas for Benson and Pierce Counties (Randich 1972). Pages 56-60 of the Benson-Pierce Ground-Water Study deals with the Pleasant Lake aquifer (Randich 1977) (Part III).

Well Numbering Systems

The system for denoting the location of a test hole or observation well is based on the federal system of rectangular surveys of public land. The first and second numbers indicate Township North and Range West of the 5th Principal Meridian and base line (Fig. 2). The third number indicates the Section. The letters A, B, C, and D designate respectively the northeast, northwest, southwest, and southeast quarter Section (160 acre tract), quarter-quarter Section (40 acre tract) and quarter-quarter-quarter Section (10 acre tract). Therefore a well denoted by 157-072-25AAA would be located in NE¼NE¼NE¼ of Section 25, Township 157 North, Range 72 West. Consecutive terminal numbers are added if more than one well is located in a 10 acre tract, i.e., 157-072-25AAA_1 and 157-072-25AAA_2.

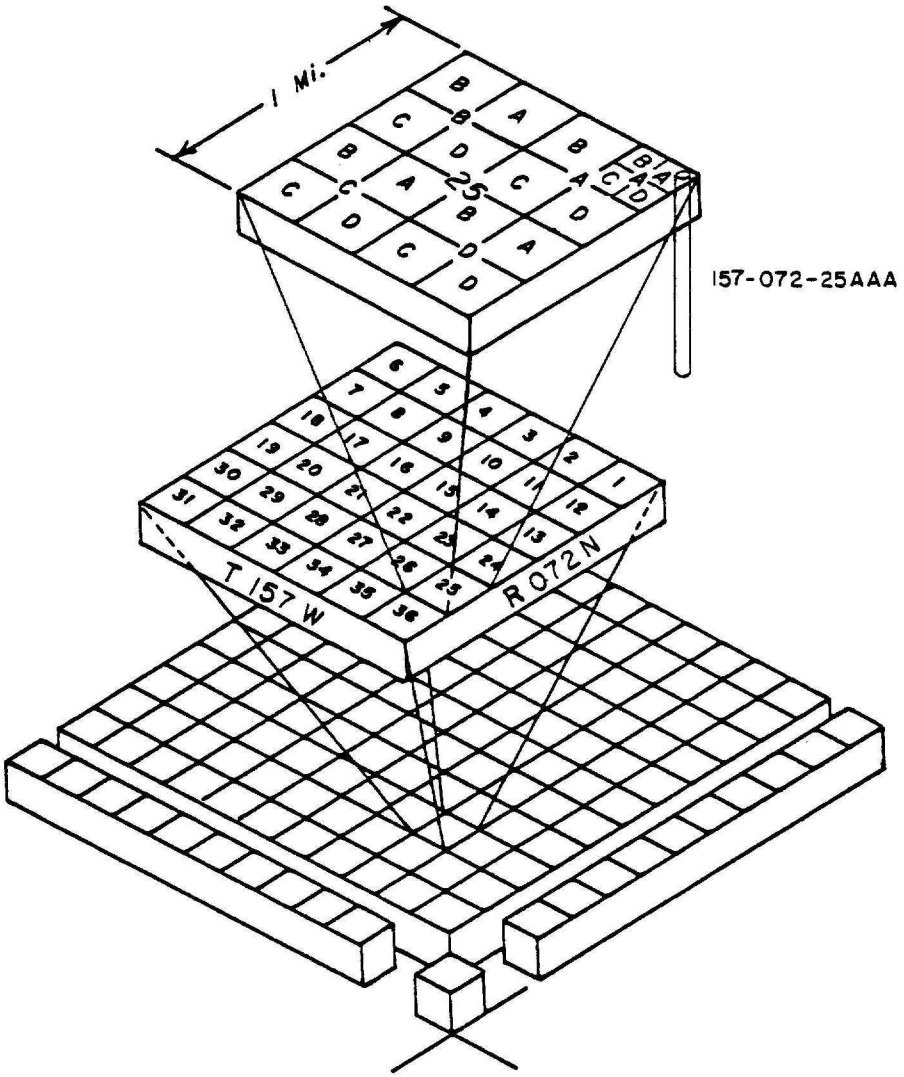


FIG. 2 WELL NUMBERING SYSTEM

Water Supply (1975)

In 1975, the city of Rugby's well field was located 3½ miles east of town. This well field, which consists of two wells, is still utilized in 1983. City well #1 is located at 157-072-36ADDD. It is 135 feet deep, cased with 12" casing to 102 feet and screened from 102'-135'. Annual withdrawal is not allowed to exceed 525 acre-feet at 420 gallons/minute. City well #2 is located at 157-072-36ADDA. It is 127 feet deep, cased with 12" casing to 94 feet and screened from 94 to 127 feet. Annual withdrawal is not allowed to exceed 525 acre-feet at 420 gallons/minute. The complete system is permitted to withdraw up to 1050 acre-feet/year at 840 gallons/minute.

The water levels in the well field had experienced a continuous decline since its utilization began in 1966 until 1976. An observation well at 157-072-36AAD provides a record of the water levels from 1967 to 1982 (Figure 3). Water level monitoring did not start until 1967 so the initial rapid water level decline is not recorded on the hydrograph. The hydrograph for this well displays the effects of pumping until 1976 and the effects of greatly reduced pumping since 1976. Annual use in acre-feet is noted along the bottom of the hydrograph.

Withdrawals average 269.8 acre-feet/year from 1967 to 1971. An increase in the rate of decline is evident from the latter part of 1971. Withdrawal averaged 280.96 acre-feet per year from 1972-1976. The increase in the rate of decline observed in 1971-72 cannot be accounted for by the slight increase in withdrawal. Most probably it is the result of the cone of depression produced by the production wells reaching a physical boundary such as the edge of the aquifer.

157-072-36AAD

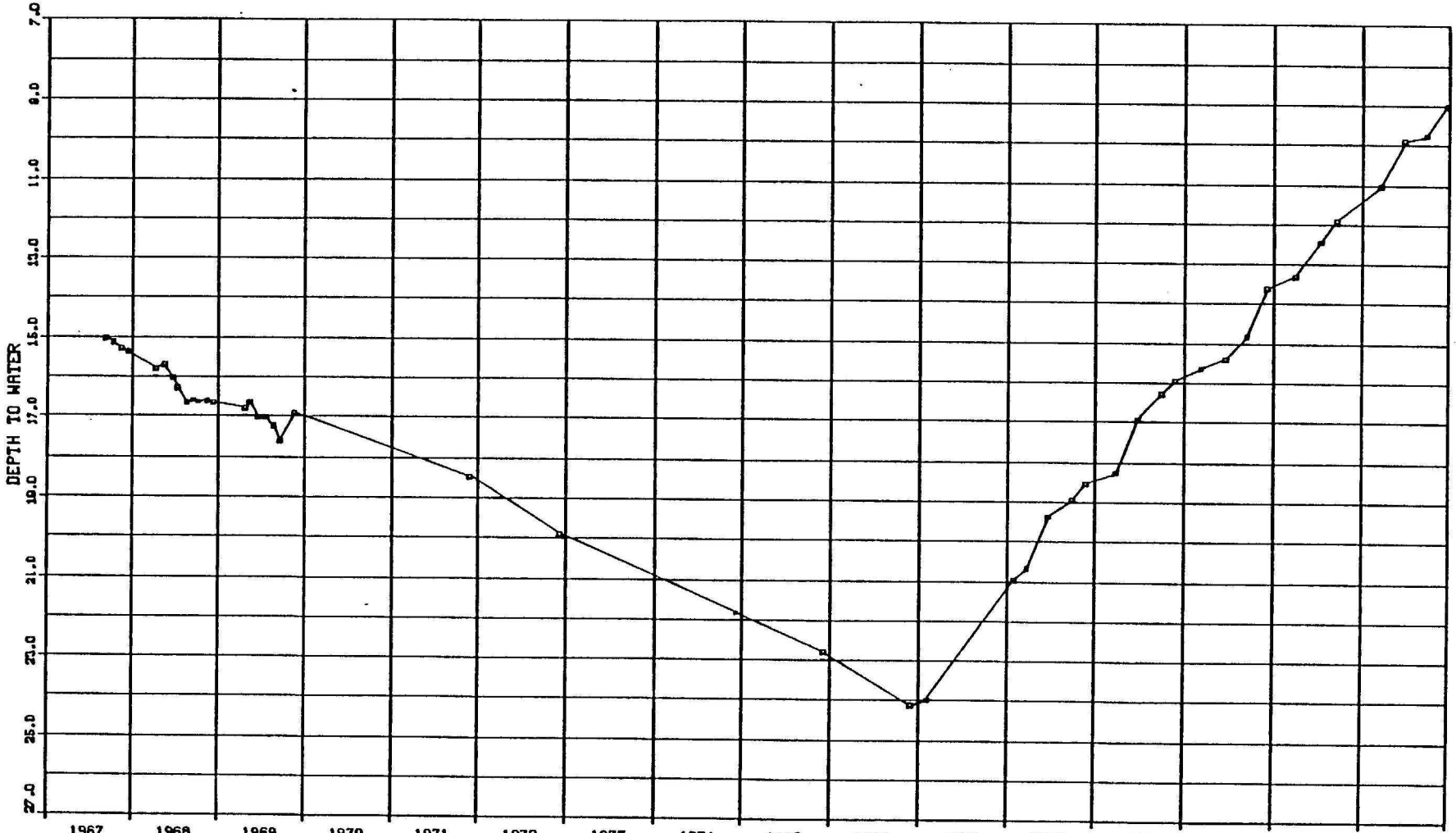


FIG. 3

The chemical quality of the water has also deteriorated since the well field was utilized. Virgil Hoium of the Rugby water treatment plant provided values for the change in hardness since 1966. City wells #1 and #2 averaged 268 ppm hardness from May 1966 to December 1974. Since 1974 city well #1 has experienced the most drastic change in hardness with occasional values as high as 800 ppm. Mr. Hoium also indicated that the manganese concentration had increased, though he could not provide specific values for the changes. Because of well construction, sampling at the well sites cannot be accomplished. As a result, the water quality change has to be evaluated on the basis of treatment at the water plant.

HYDROLOGY

Rugby Aquifer

The old Rugby well field is located in the Rugby aquifer in portions of Township 156 North, Range 72 West, Section 13; Township 157 North, Range 71 West, Sections 19, 30, and 31; and Township 157 North, Range 72 West, Sections 24, 25, 26, 35, and 36. The aquifer underlies an area of approximately three square miles. Thickness ranges from 0 to 122 feet and is a very inconsistent sequence of fluvial clays, silts, and sands. Depth to the aquifer ranges from 0 to 128 feet.

Physical Characteristics

Composition of the sand sequence is variable. Grain size ranges from very fine sand to gravel with a slight predominance of fine and

medium sand. Grain shape ranges from subangular to rounded with a slight predominance of subrounded grains. The sand was composed predominantly of quartz. Gravel is predominantly carbonates with minor amounts being igneous material. Sand and gravel sequences also contained much interbedded fluvial silt and clay.

The thickness and areal extent of the aquifer is shown in the north-south cross section (Fig. 4) and the isopach map (Fig. 5). City well(s) #1 and #2 are completed in the thickest part of the section in the vicinity of 157-071-31CBB. The sand rapidly thins to the south. The sand persists to the north but eventually is cut up by clay and is truncated by a bedrock high. As seen in Fig. 5, there is a divide present in the southern portion of the aquifer. The hydrologic connection around the north end of the divide between the well field and the western extreme of the aquifer is restricted by interbedded silts and clays in the sand section in the vicinity of 157-072-25DCC. The well field is effectively limited to a narrow trench about 1600 feet wide and 4200 feet long.

Flow System

Water levels in this aquifer reached their lowest levels at the end of 1976 (Fig. 3). Potentiometric surface map #1 (Fig. 6) is based on water levels measured in November of 1976. The cone of depression in the potentiometric surface around the production wells is clearly seen. The gradient of the potentiometric surface is quite steep to the north of the production wells and only slightly less steep to the south. The water level elevation was about 1488 feet above msl near

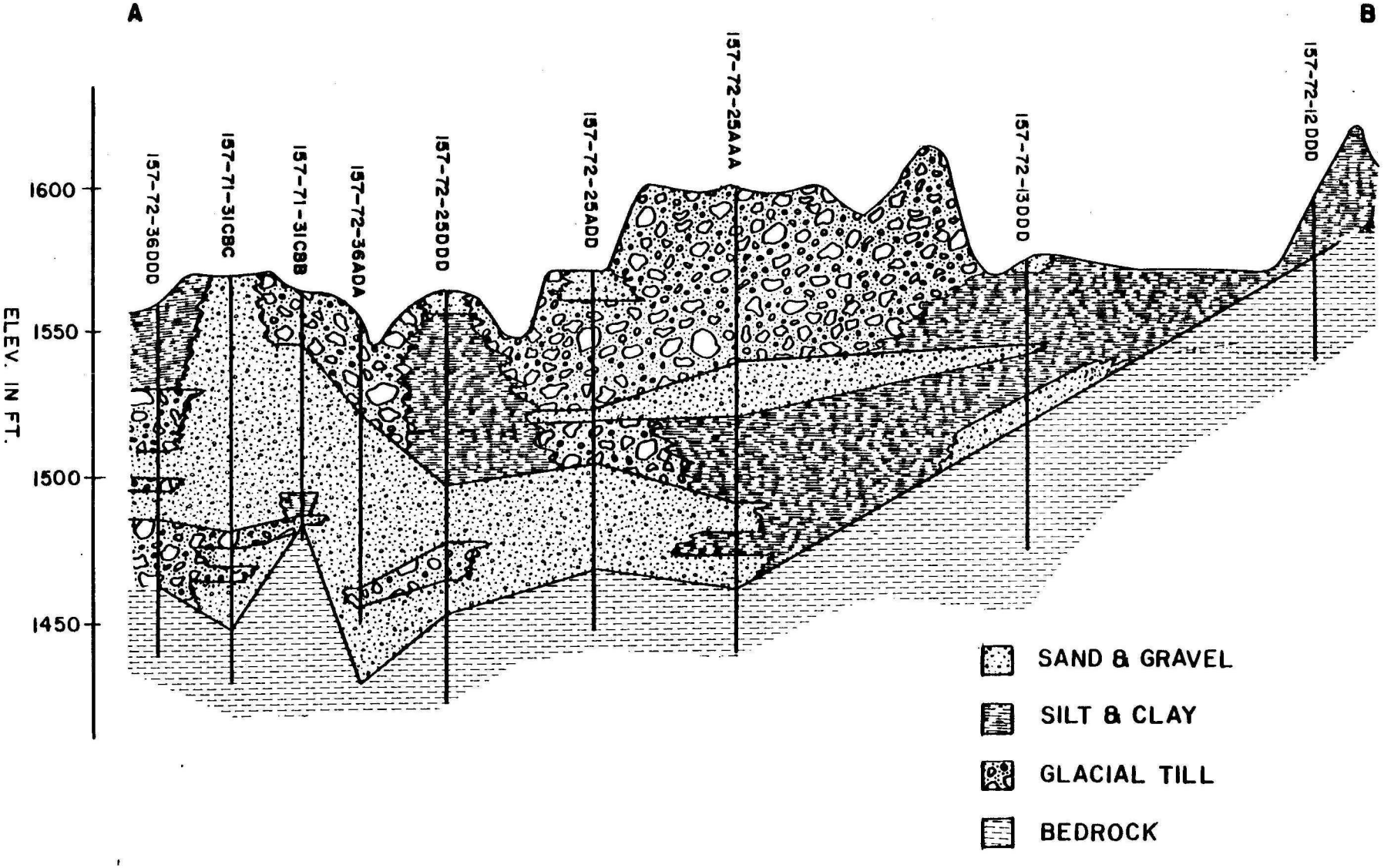

A
B
157-72-36DDD
157-71-31CBC
157-71-31CBB
157-72-36ADA
157-72-25DDD
157-72-25ADD
157-72-25AAA
157-72-13DDD
157-72-12DDD
1600
1550
1500
1450
ELEV. IN FT.
SAND & GRAVEL
SILT & CLAY
GLACIAL TILL
BEDROCK

FIG. 4

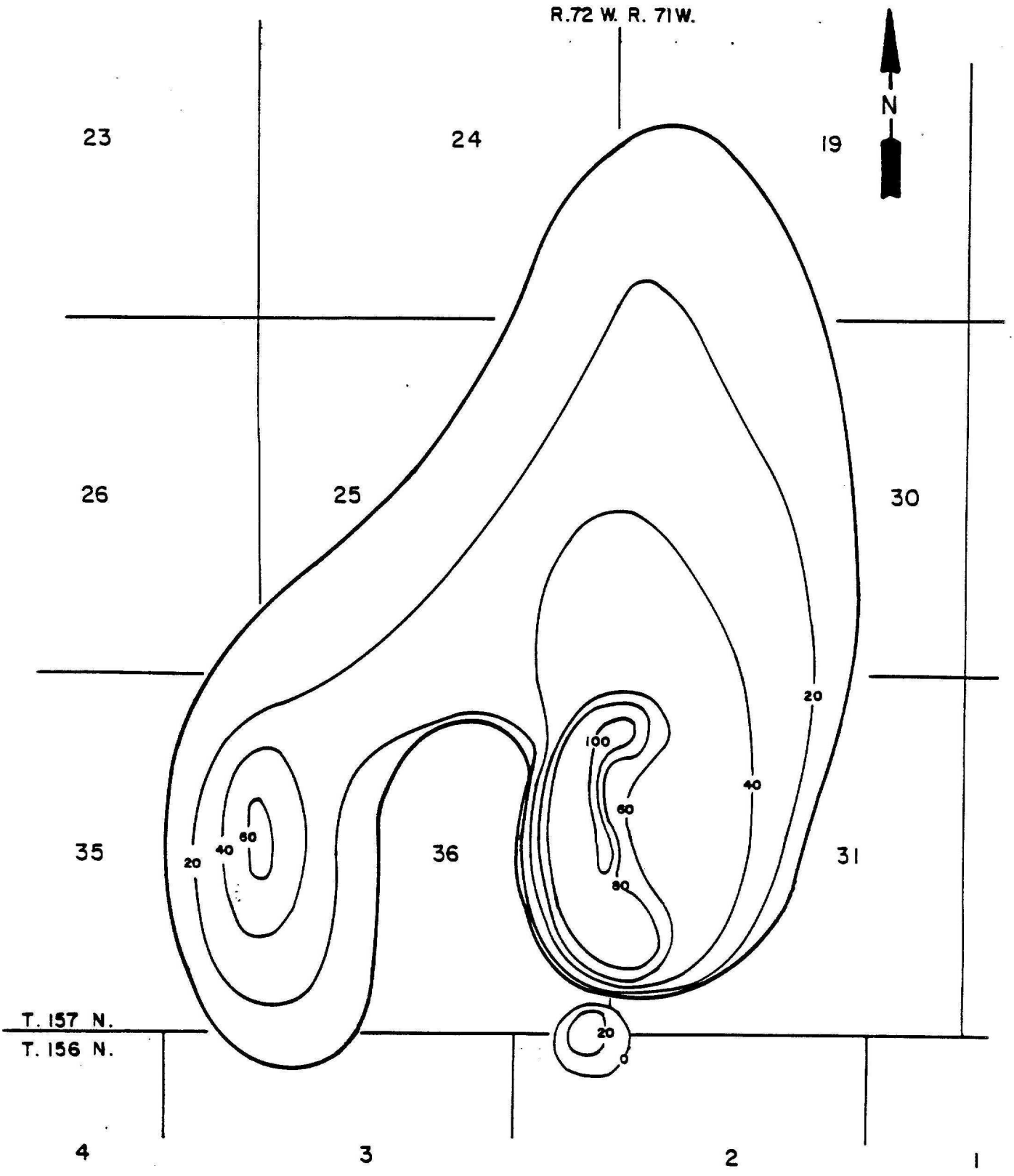


FIG. 5 ISOPACH MAP OF RUGBY AQUIFER

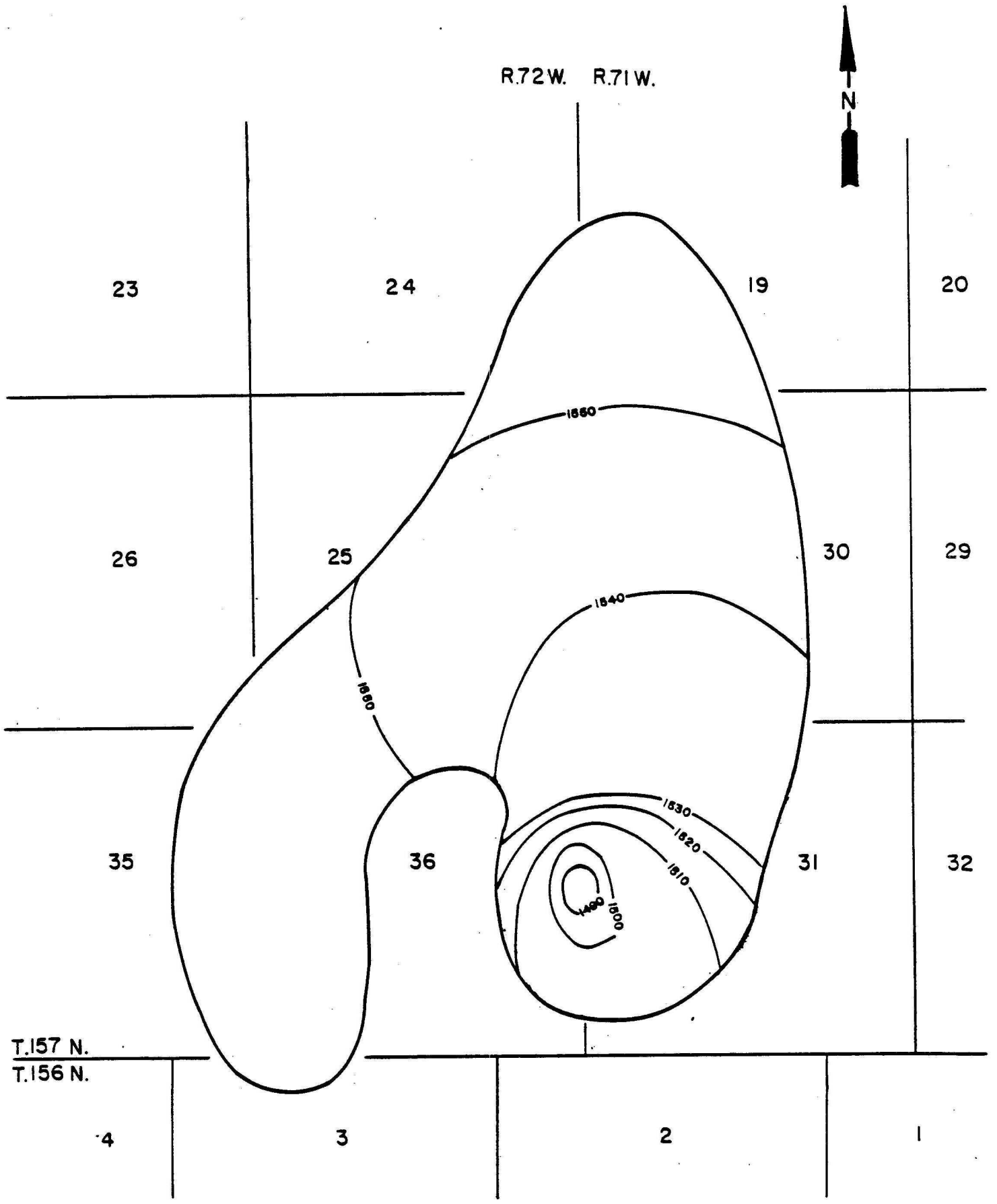


FIG. 6 RUGBY AQUIFER POTENTIOMETRIC SURFACE MAP, NOV. 30, 1976

the production wells in observation well 157-072-36ADD$_3$. About 1300 feet to the north the water level was about 1539 feet above msl in observation well 157-072-36AAD. The change in elevation was about 51 feet and the gradient was about 200 feet/mile. About 1.5 miles north of the production wells the water level was about 1552 feet above msl in observation well 157-072-25AAA. The change from 157-072-36AAD to 157-072-25AAA is about 13 feet. The gradient between these observation wells was about 10 feet/mile. South of the production wells at observation well 157-071-31CBC, the water level was about 1506 feet above msl. The elevation change was about 18 feet in about .25 mile with a gradient of about 72 feet/mile between 36ADD$_3$ and 31CBC.

At the end of 1976 Rugby began utilizing a new well field in the Pleasant Lake aquifer and thereby greatly reduced the withdrawal from the Rugby aquifer well field. The reduction of withdrawal allowed the water levels to rise as is seen in the hydrograph for 157-072-36AAD (see Fig. 3). Potentiometric surface map #2 (Fig. 7) is based on the water levels in December of 1982. The cone of depression is still evident although the overall water levels had risen about 36 feet and the gradients had lessened considerably.

All of the aquifer units in the study area experienced a rise in water levels during this time period. Separate aquifer units were distinguished by different patterns of rise. Compare the hydrographs for wells 157-72-25AAA and 157-71-19AAA$_2$ (Figs. 8 and 9). The pumping rate was reduced at the end of 1976 and the water levels began to rise at the end of 1977. The water level stabilized in 1981 at well 157-71-19AAA$_2$

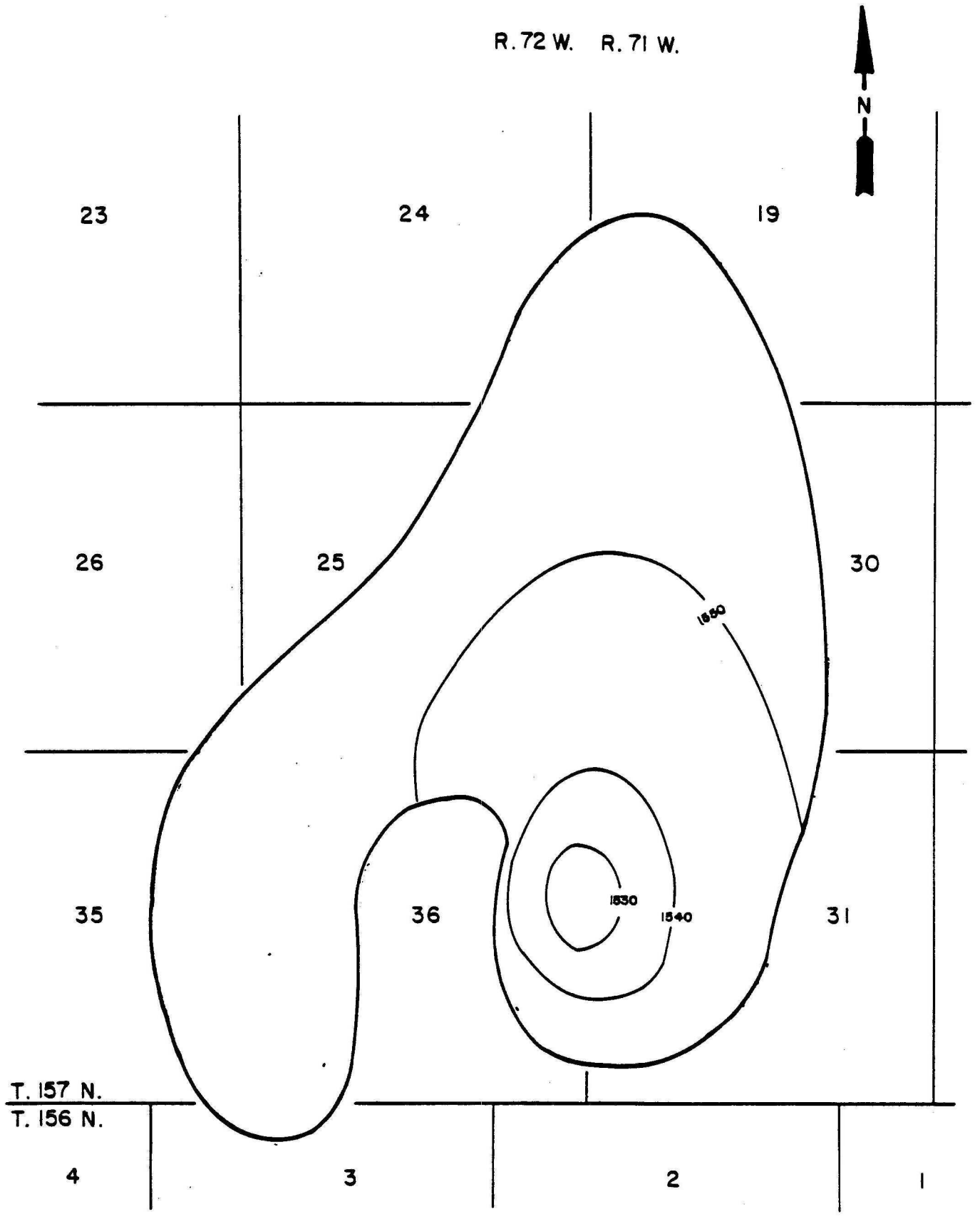
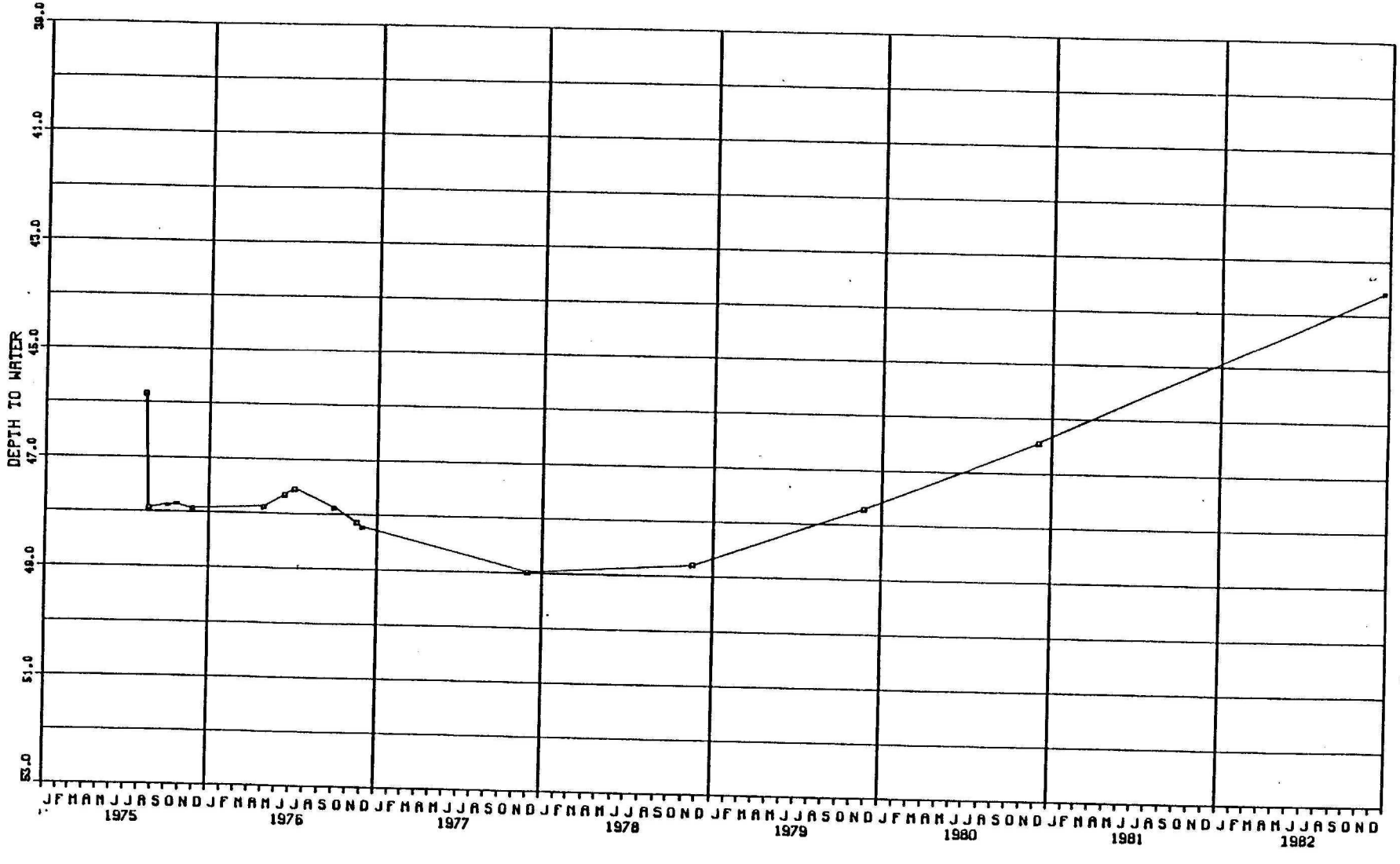
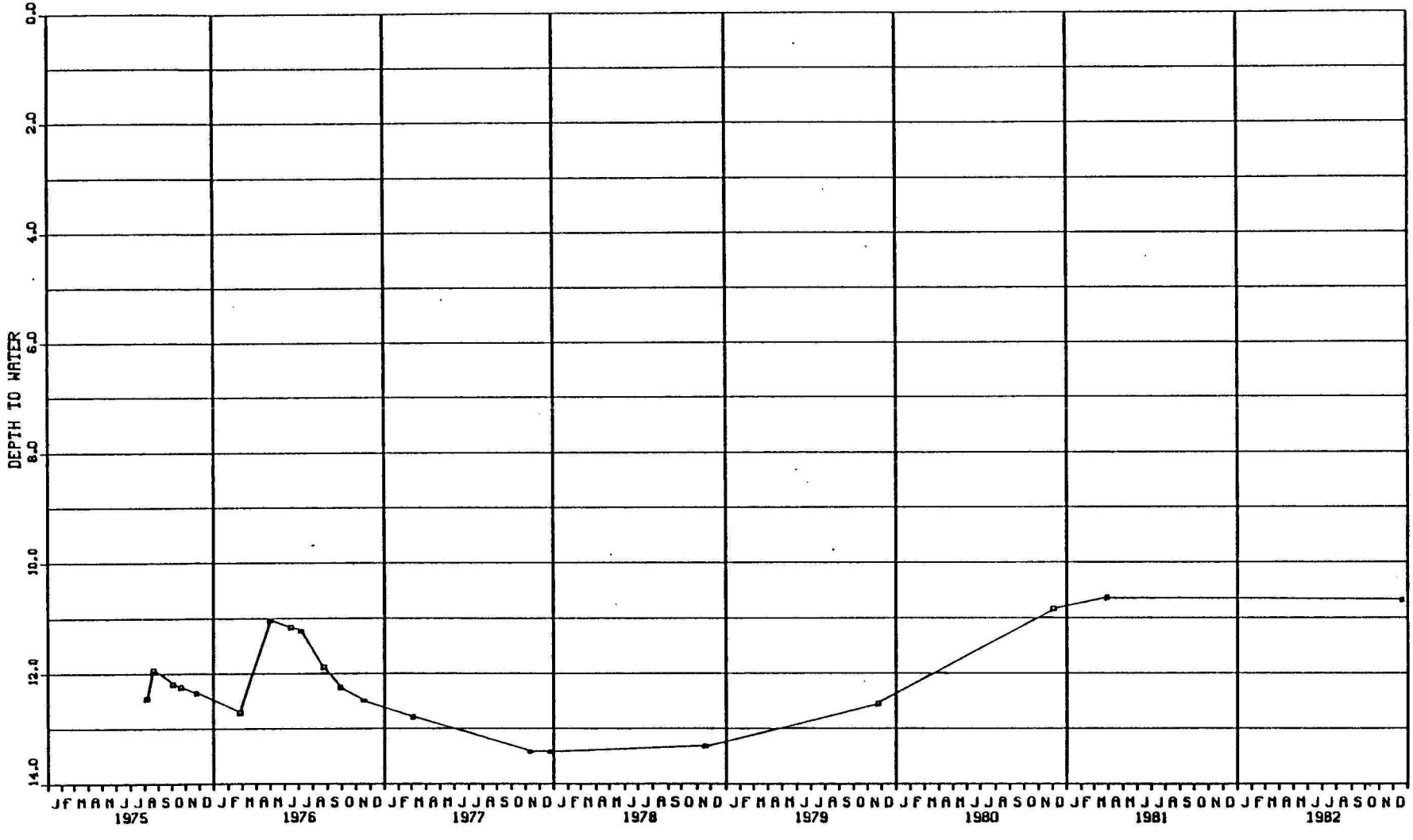


FIG. 7 RUGBY AQUIFER POTENTIOMETRIC SURFACE MAP, DEC. 18, 1982

157-072-25AAA



157-071-19AAA2



17

FIG. 9

even though precipitation was above normal from 1980-1982 (Fig. 10), inferring that the aquifer unit in that area had reached a state of near saturation. The water level in well 157-072-25AAA had continued to rise through 1982, a pattern similar to that found in well 157-072-36AAD (Fig. 3). It can be inferred that well 157-072-25AAA is completed in the same unit as the production wells which had experienced considerable depletion and is still in a state of recovery, whereas $19AAA_2$ is not. Wells $157\text{-}071\text{-}11CCC_1$, $157\text{-}071\text{-}19AAA_2$, and 157-071-32DAA were segregated from the Rugby aquifer on the basis of historical water levels. Wells $157\text{-}071\text{-}31CBC_1$. 157-072-25AAA, and 157-072-25DCC, 157-072-25DDD, and 157-072-36AAD were included in the Rugby aquifer on the basis of their continued recovery.

A well located at 157-072-36DDD appears to be completed in a separate unit with a very limited connection to the Rugby aquifer. The water levels exhibited extreme seasonal fluctuations not evident in the old well field (Fig. 11). The unit has also experienced an overall rise in water levels through 1982 similar to that occurring in the old well field.

A steep water level gradient existed between the unit in which 157-072-36DDD is completed and the old Rugby well field. A difference of about 35 feet existed between water levels found in 157-072-36DDD and 157-071-31CBC in November of 1976, resulting in a gradient of about 140 feet/mile. Leakage would occur from the separate unit, located in 157-072-36DDD, to the old well field under these circumstances even with a very limited connection.

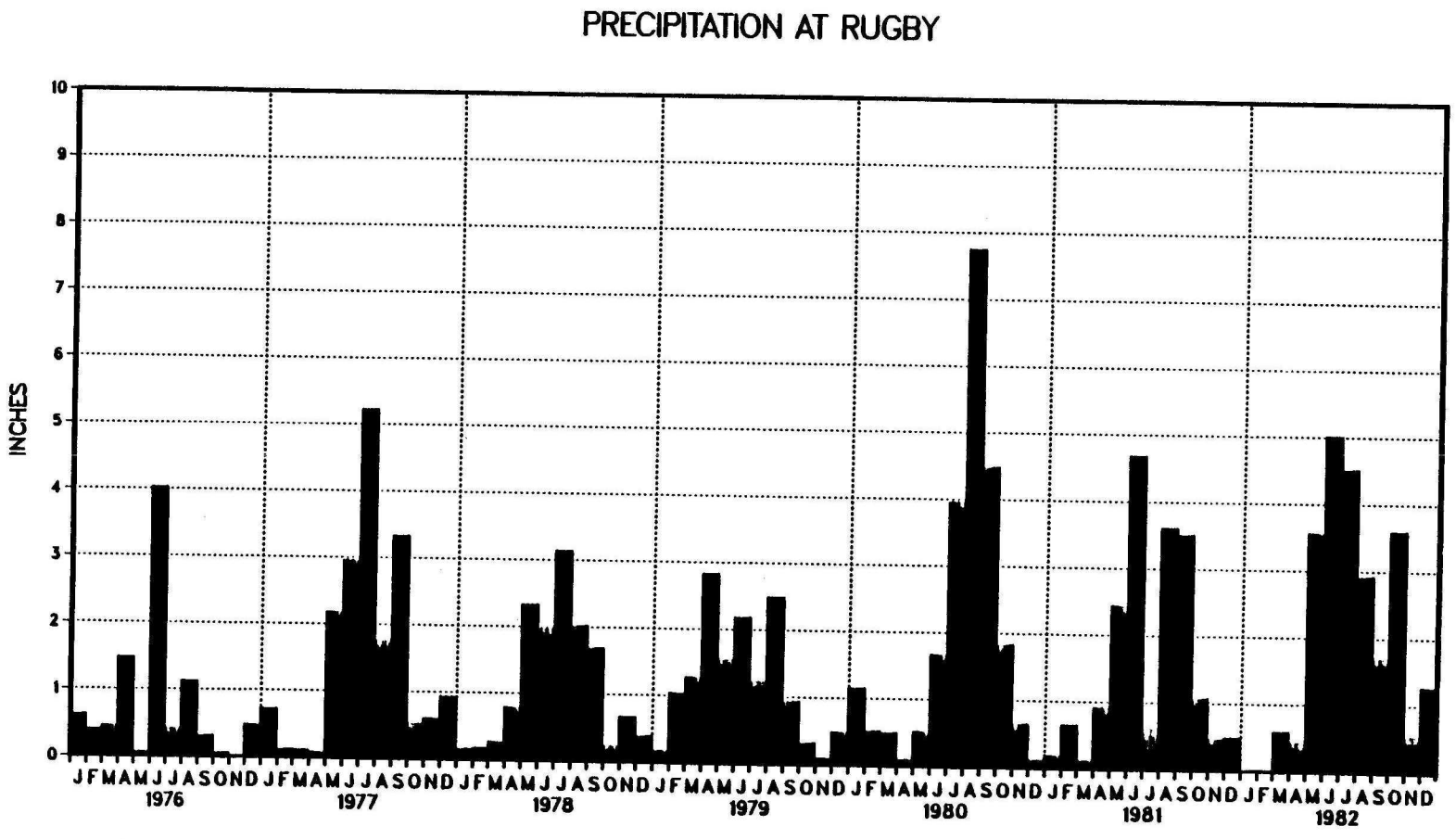

PRECIPITATION AT RUGBY
INCHES
0
1
2
3
4
5
6
7
8
9
10
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1976
1977
1978
1979
1980
1981
1982

FIG. 10

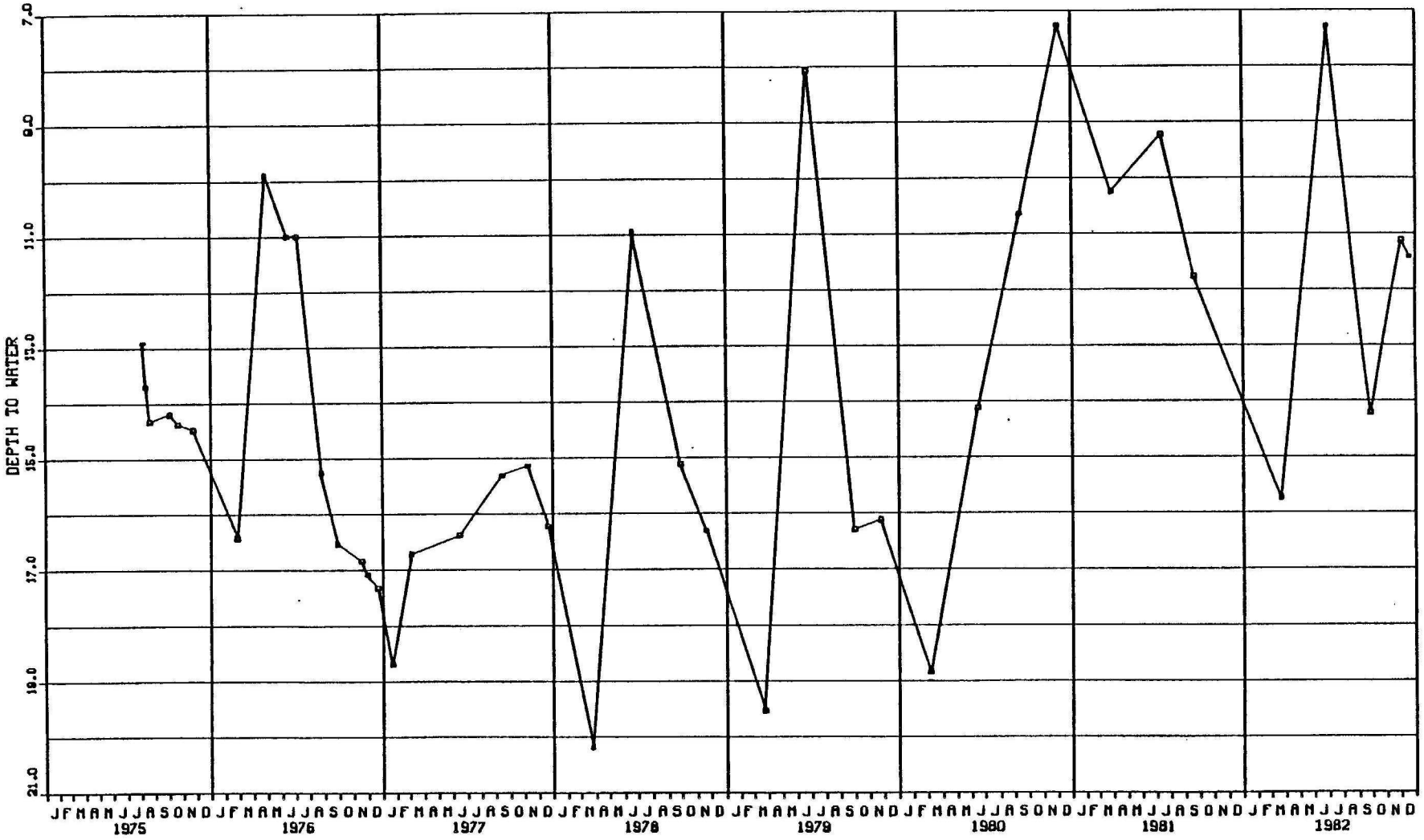

157-072-36DDD
DEPTH TO WATER
7.0
9.0
11.0
13.0
15.0
17.0
19.0
21.0
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1975
1976
1977
1978
1979
1980
1981
1982

FIG. 11

Water Quality

Analysis of water samples from the Rugby aquifer can be found in Table 1. The water is generally a calcium bicarbonate type. Total dissolved solids ranged from 389 mg/l to 508 mg/l. Hardness ranged from 140 mg/l to 340 mg/l. Iron ranged from 15 mg/l to 18 mg/l. Generally, better quality water was found in the northern part of the aquifer and became poorer to the south.

Water quality near the city production wells had deteriorated with time. Samples from 157-071-31CBC$_2$ were taken in 1975 and 1979. Total dissolved solids increased from 479 mg/l to 772 mg/l. Hardness increased from 340 mg/l to 530 mg/l. Iron increased from 15 mg/l to 26 mg/l.

Water quality was another parameter which could be used to help distinguish separate aquifers. A sample obtained from 157-072-36DDD was a calcium sulfate type water. Total dissolved solids concentration was 1800 mg/l. Other constituents were also much higher than found in the Rugby aquifer. On this basis, 157-072-36DDD was considered to be completed in a separate unit. However, the changes in quality in the Rugby aquifer may suggest leakage of highly mineralized water like that found in the vicinity of 157-072-36DDD into the aquifer by some limited connection.

Pleasant Lake Aquifer

The part of the Pleasant Lake aquifer that was under consideration as a water supply is located in portions of Township 156 North, Range 71 West, Sections 4 and 5; and Township 157 North, Range 71 West, Sections

TABLE 1 -- CHEMICAL ANALYSES

(Analytical results are in milligrams per liter except where indicated)

AQUIFERS Owner or Designation	Location	Depth of Well (feet)	Temp(°F)	Date of Collection	(SiO_2)	(Fe)	(Mn)	(Ca)	(Mg)	(Na)	(K)	(HCO_3)	(CO_3)	(SO_4)	(Cl)	(F)	(NO_3)	(B)	Total Dissolved Solids	Total Hardness as $CaCO_3$	Total Hardness Noncarbonate	Percent Sodium	SAR	Specific Conductance	pH
SNC #9361	156-071-04ABA$_1$	160		75/07/29	19	.04	.15	30	11	100	6.1	398	0	23	1.7	.3	.4	.24	395	120	0	63	4.0	624	8.1
SNC #9361A	156-071-04ABA$_2$	100		75/07/30	16	.02	.34	51	18	7.1	3.0	238	0	13	.4	.2	0	.04	219	200	5	7	.2	326	8.0
SNC #9361A	156-071-04ABA$_2$	100		81/07/29	25	.32	.32	55	15	21	4.5	293	0	14	0	.2	1.0	.09	243	200	0	18	.6	420	8.1
SNC #5086	156-071-04BBA	58		74/07/17	25	0	.38	57	17	5.5	2.3	240	0	19	.9	.5	0	0	253	210	14	5	.2	395	8.0
SNC #5086	156-071-04BBA			81/07/16	22	.02	.22	54	16	7.5	1.4	241	0	18	.8	.2	1	.41	246	200	3	8	.2	378	7.7
SNC #9406	156-071-04DCD	76		76/05/05	21	.54	.32	53	14	52	4.1	288	0	21	2.4	.2	0	.04	282	190	0	26	1.0	475	7.8
SNC #9359	156-071-05AAA	57		75/07/30	17	.02	.32	52	15	25	5.4	285	0	16	1.4	.2	0	.24	274	190	0	22	.8	479	7.9
SNC #9359	156-071-05AAA	57		81/07/29	26	.35	.45	77	19	41	7.0	415	0	16	2.0	.2	1	.05	372	270	0	24	1.1	603	8.1
SNC #9363	156-071-17CDA	100		75/07/31	18	.06	.10	46	11	260	7.0	648	0	180	15	.2	0	.35	827	160	0	77	8.1	1320	8.2
SNC #9363	156-071-17CDA	100		81/07/29	27	.02	.17	35	13	280	9.0	721	0	160	13	.2	1	.32	847	140	0	80	10.0	1290	8.3
SNC #9355	156-072-03ABB	81		75/07/25	16	0	.17	130	69	810	13	740	0	1700	60	.1	.8	.47	3080	610	3	74	14.0	3980	7.6
SNC #5088	157-071-02CCC	35		75/07/22	16	.71	.30	69	24	21	4.0	312	0	65	3.7	.2	0	.04	353	270	14	14	.6	604	7.9
SNC #9332	157-071-08CCC	106		75/07/15	18	.52	.14	26	12	110	4.8	352	0	47	9.4	.2	0	.28	411	110	0	67	4.6	655	8.1
SNC #9344	157-071-11CCC	51		75/07/22	17	.04	.32	60	20	51	4.0	307	0	51	3.3	.1	0	.08	351	230	0	22	.9	559	7.9
SNC #9342	157-071-14CDC	61		75/07/24	16	.04	.3	41	14	43	3.0	272	0	30	2.0	.1	0	.08	281	160	0	36	1.5	460	8.0
SNC #9409	157-071-15CCC			79/07/12	26	1.3	.16	49	16	24	3.1	271	0	20	2.9	.1	1	.03	303	190	0	21	.8	449	8.2
SNC #9343	157-071-15DDD	71		75/07/22	19	.87	.28	51	13	100	5.8	395	0	79	9.6	.2	0	.2	466	180	0	54	3.2	766	7.9
SNC #9333	157-071-19AAA	51		75/07/22	14	.42	.29	78	26	28	4.1	356	0	68	54	.2	0	.04	396	300	8	17	.7	649	8.1
SNC #9419	157-71-23CBB	61		76/05/05	20	.42	.32	85	26	30	4.7	389	0	60	8.1	.1	1	.04	418	320	1	17	.7	694	7.9
SNC #9418	157-071-26BBA	55		76/05/05	18	.06	.34	75	22	40	4.5	363	0	66	6.9	.2	1	0	412	280	0	23	1.0	680	7.9
SNC #9418	157-071-26BBA	55		79/07/11	26	.12	.32	78	35	44	3.8	397	0	100	7.6	.2	1	.03	522	340	14	22	1.0	775	7.9
SNC #9416	157-071-26BCB	81		76/05/05	20	.40	.26	79	22	63	5.8	413	0	91	6.9	.1	1	.24	486	290	0	32	1.6	789	7.9
SNC #9421	157-071-26BCC$_5$	71		75/10/01	16	1.8	.40	110	30	60	7.2	490	0	120	7.6	.2	.2	.2	619	400	0	24	1.3	955	7.4
SNC #9420	157-071-26CCC	101		76/05/05	21	1.2	.32	87	25	47	5.5	417	0	71	5.3	.2	1	.08	461	320	0	24	1.1	756	7.8
SNC #9420	157-071-26CCC	101		79/07/11	29	.2	.28	71	40	52	4.9	434	0	86	8.0	.2	1	.43	524	340	0	25	1.2	803	7.9
SNC #9420	157-071-26CCC	101		81/07/09	27	1.3	.32	91	27	73	8.1	498	0	90	6.2	.2	1	.23	542	340	0	31	1.7	872	7.9
SNC #9352	157-071-31CBC$_1$	116		75/07/25	18	.08	.40	78	30	68	6.2	403	0	120	3.8	.2	0	0	508	320	0	31	1.7	801	7.8
SNC #9352A	157-071-31CBC$_2$	81		75/07/24	15	.06	.25	84	32	51	5.6	426	0	93	2.6	.2	0	0	479	340	0	24	1.2	630	8.0
SNC #9352A	157-071-31CBC$_2$	81		79/07/10	26	.04	.40	140	44	68	6.7	498	0	230	8.8	.1	1	0	772	530	120	22	1.3	1120	7.7
SNC #9352B	157-071-31CBC$_3$	91		75/07/29	17	.17	.36	73	29	69	6.2	380	0	120	4.2	.2	0	.12	479	300	0	33	1.7	785	7.9
SNC #49	157-071-32DAA	98		75/07/22	20	2.2	.08	58	23	66	6.8	410	0	51	5.9	.2	0	.12	437	240	0	37	1.9	713	7.8
Rugby Well #3	157-071-34AAA	113		76/07/08	31	1.5	.32	79	20	44	4.9	384	0	71	3.8	.3	1	.15	425	280	0	25	1.1	707	7.5
Rugby Well #3	157-071-34AAA	113		81/07/09	25	1.0	.29	74	18	35	4.9	352	0	51	5.6	.2	1	.03	372	260	0	22	.9	619	7.7
Rugby Well #4	157-071-34AAB			76/05/05	20	1.5	.26	75	20	43	5.2	375	0	57	5.9	.2	1	.08	424	270	0	25	1.1	680	7.7
SNC #9360	157-071-34DAA	57		75/07/29	18	.04	.40	75	25	13	5.3	347	0	25	1.3	.2	0	.12	338	290	5	9	.3	550	8.0
SNC #9341	157-071-35ABB	101		75/07/22	19	1.9	.44	100	32	27	4.8	441	0	76	4.3	.2	0	.08	511	380	18	13	.6	787	7.5
SNC #9351	157-072-25DCC	111		75/07/29	17	.08	.17	34	13	93	5.6	356	0	41	10	.2	0	.24	389	140	0	58	3.4	628	8.2
SNC #9353	157-072-36DDD	71		75/07/25	16	0	.64	220	92	240	12	455	0	970	22	.1	.5	.47	1800	930	560	36	3.4	2240	7.5
SNC #9353	157-072-36DDD	71		79/07/10	21	1.2	.48	230	67	240	12	483	0	940	23	.1	1	0	1850	850	450	38	3.6	2300	7.7
SNC #9346	158-071-30DAA	51		75/07/29	17	.08	.38	63	23	11	3.9	297	0	26	3.9	.1	0	.12	288	250	7	9	.3	489	7.8
SNC #9347	158-072-23DDC	121		75/07/29	19	.12	.12	46	16	190	6.3	496	0	160	20	.2	.3	.28	692	180	0	69	6.2	1080	7.9

3, 4, 5, 8, 9, 10, 11, 14, 15, 16, 21, 22, 23, 25, 26, 27, 28, 35, and 36. It underlies an area of about 14 square miles. The aquifer ranges in thickness from 0 to 115 feet. Depth to the aquifer ranges from 0 to 56 feet. It is composed predominantly of sand with minor amounts of gravel, silt, and clay.

Physical Characteristics

Sand size ranges from very fine to coarse. It is moderately well sorted with the medium grain size range predominating. Grain shape ranges from angular to subrounded with a predominance of subrounded. Grain composition averages about 75% quartz with minor amounts of carbonates and lignite. All logged sand sections were very clean. There is very little interstitial silt and clay. Sand sections are very homogeneous containing little interbedded silt and clay. Gravel size ranges from fine to medium. Shape ranges from angular to rounded. Composition is predominantly carbonates with minor amounts of granitics and shale.

The thickness and areal extent can be seen in the isopach map (Fig. 12). The aquifer ranges from 1.5 to 2.2 miles wide. Within the study area the aquifer is oriented north-south. Immediately north of the study area the aquifer curves to the northwest. To the south the aquifer is truncated at Broken Bone Lake. It is bounded on the east by a ridge of low hills and on the west by a bedrock high covered with a thin veneer of till.

The thickest section is about 1 mile wide and 3 miles long. It occupies portions of Sections 26, 27, 34, and 35 of Township 157 North, Range 71 West and Section 4 of Township 156 North, Range 71 West. It thins rapidly in sections 4 and 5 and is truncated completely in Section 9.

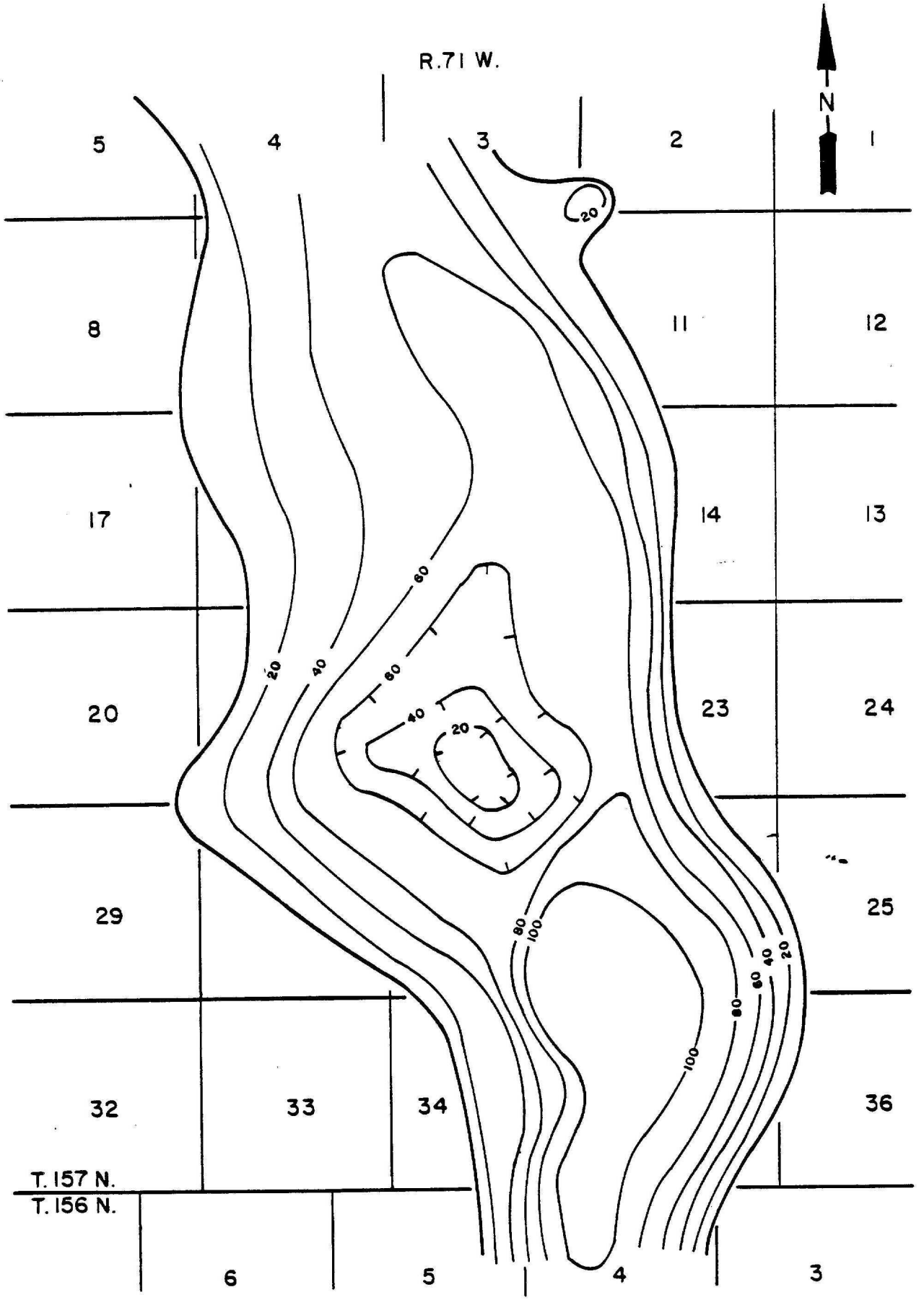


FIG. 12 ISOPACH MAP OF PLEASANT LAKE AQUIFER

There is evidence of two different environments being responsible for the deposits comprising the Pleasant Lake aquifer. Older deposits are found in a fluvial channel incised into the bedrock and till. This channel is most prominant in the northern portion of the study area in the vicinity of test holes 157-071-08CCC and 157-071-19AAA (Fig. 13). Further south this channel becomes less prominant or nonexistent (Fig. 14). To the north this channel may connect to the main Pleasant Lake aquifer, but in the main study area this channel is separate from the main Pleasant Lake aquifer.

Overlying the channel deposits are interbedded fluvial silt and clay and glacial till. Above these have been deposited the sands which comprise the majority of the Pleasant lake aquifer. These sands are exposed at the surface in places. They extend to the east and probably begin to thin and pinch out where they overlap the rising bedrock and till hills.

Flow System

The highest water levels in November, 1976 were found along the eastern edge of the aquifer in the vicinity of test holes 157-071-14CDC and 157-071-35BAA (Fig. 15). The lowest water levels were encountered along the western boundary of the aquifer and in the vicinity of 156-071-05AAA. Ground water movement was both to the west and to the south. The western flow component was evident in the vicinity of 157-071-14CDC where movement was toward the lower water levels in the vicinity of 157-071-15CCC. The southern flow component was evident in the vicinity of 157-071-35BAA

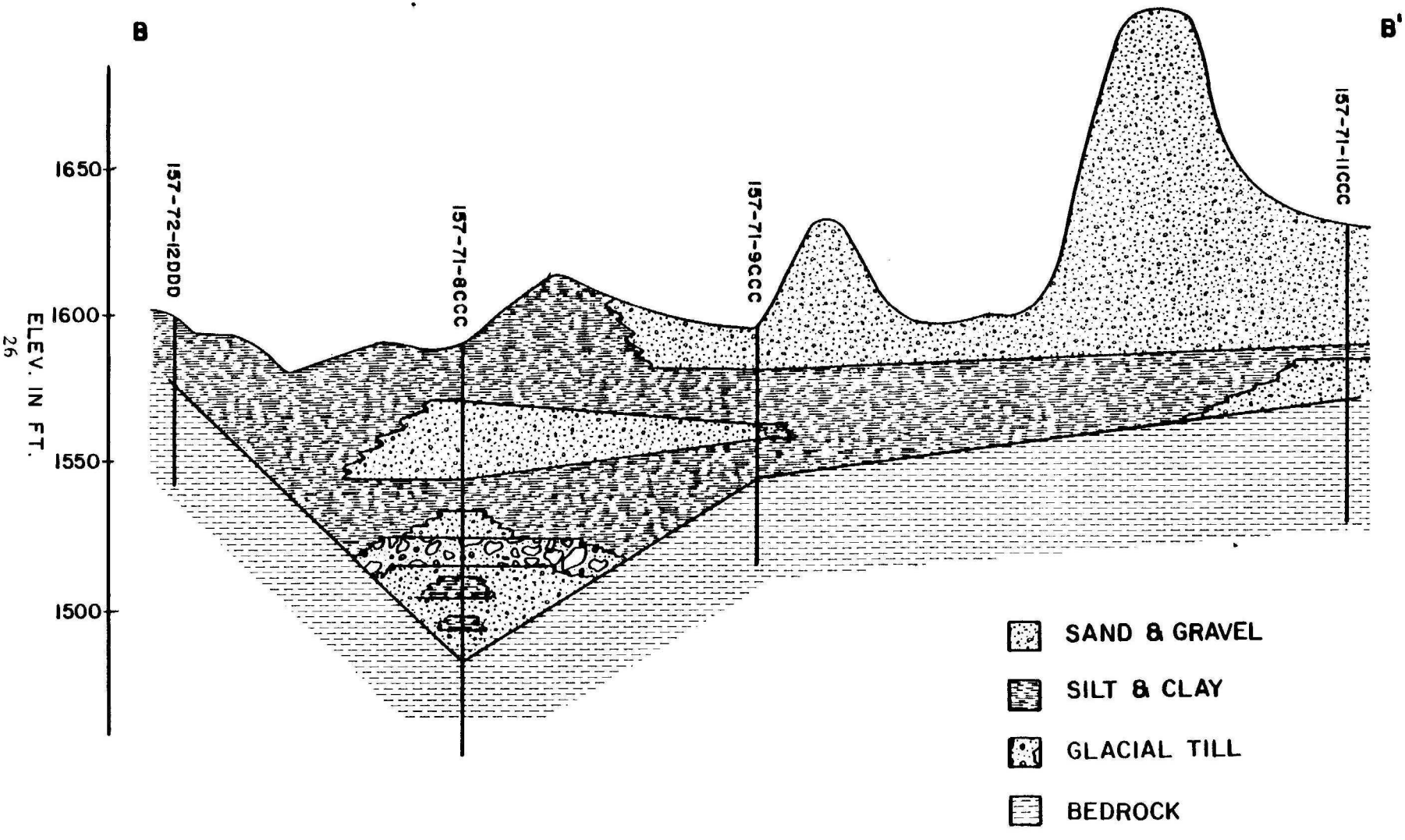

B
B'
157-72-12DDD
157-71-8CCC
157-71-9CCC
157-71-11CCC
1650
1600
1550
1500
ELEV. IN FT.
SAND & GRAVEL
SILT & CLAY
GLACIAL TILL
BEDROCK

FIG. 13

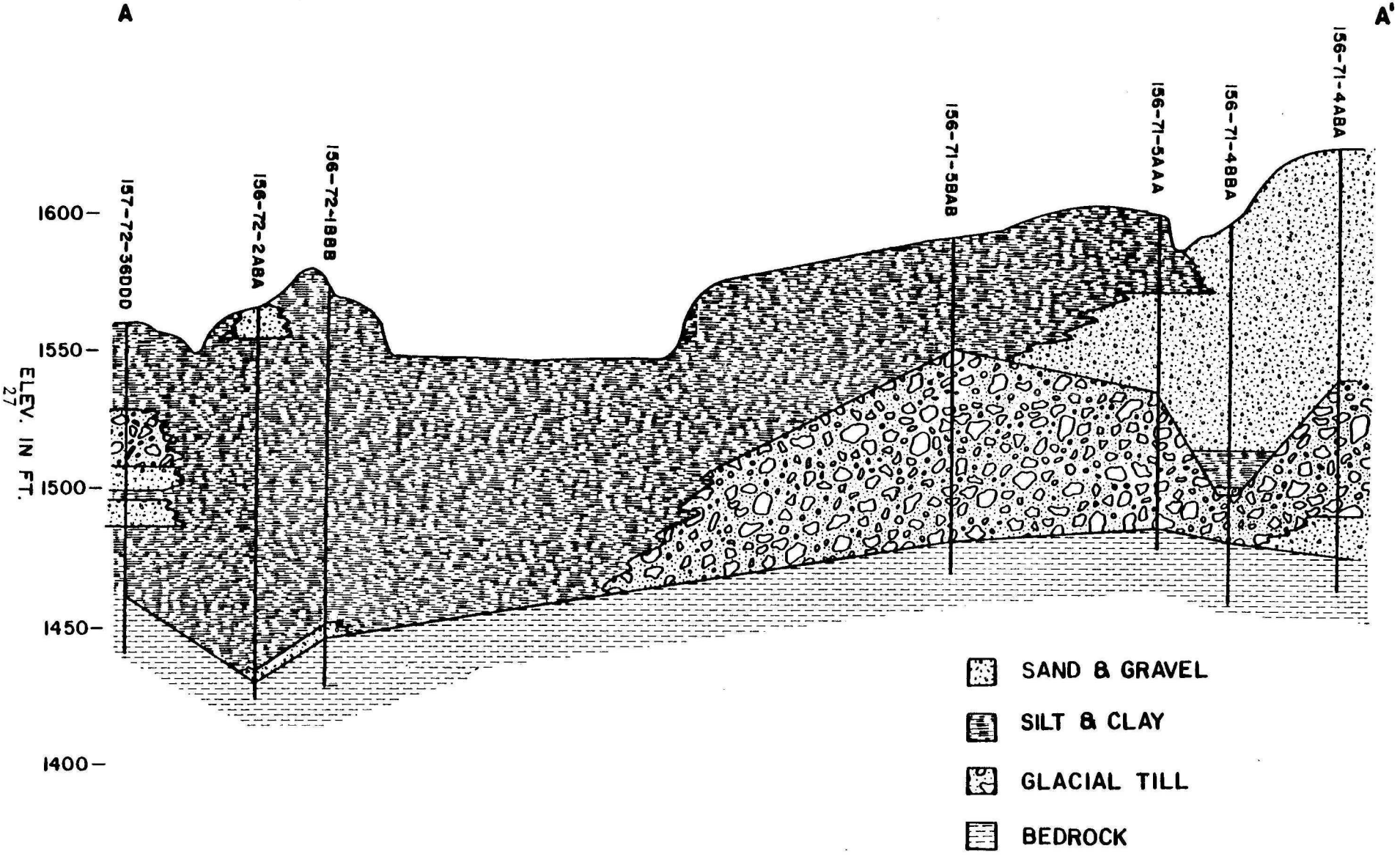

A
A'
157-72-36DDD
156-72-2ABA
156-72-18BB
156-71-5BAB
156-71-5AAA
156-71-4BBA
156-71-4ABA
1600
1550
1500
1450
1400
ELEV. IN FT.
SAND & GRAVEL
SILT & CLAY
GLACIAL TILL
BEDROCK

FIG. 14

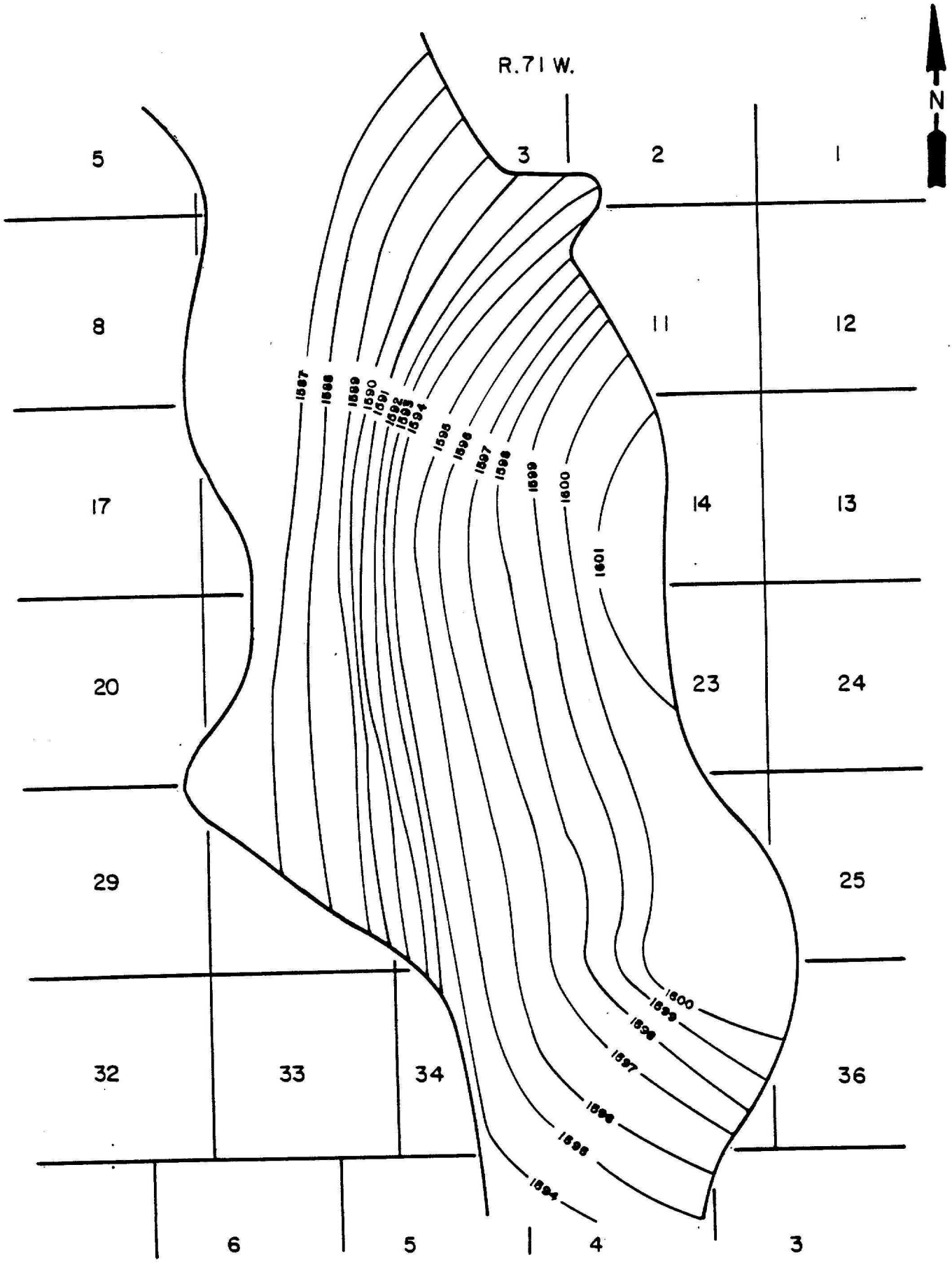


FIG. 15 PLEASANT LAKE AQUIFER POTENTIOMETRIC SURFACE MAP, NOV. 30, 1976

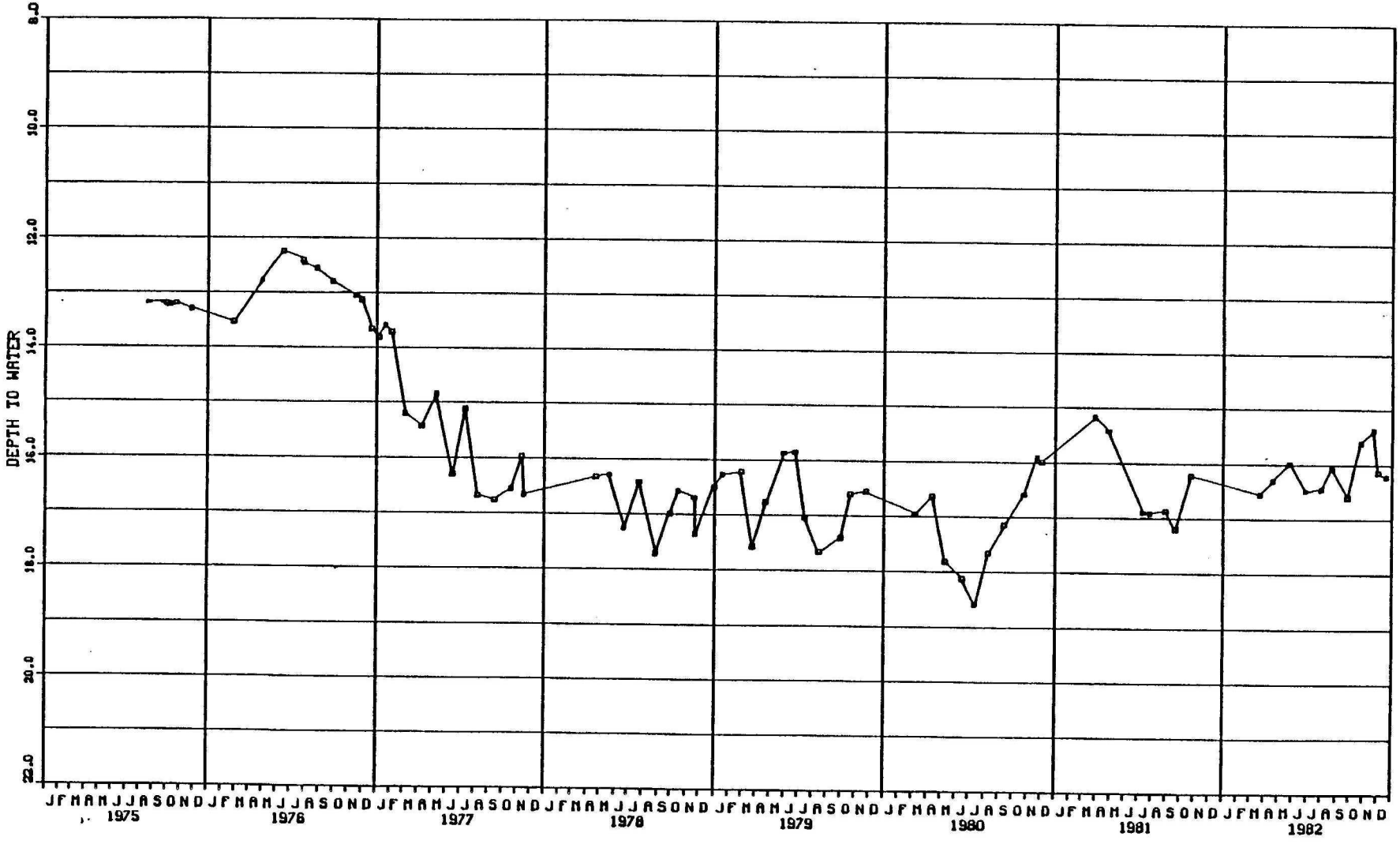
where movement was toward 156-071-04ABA. The two flow components combined to produce a southwestern flow in the vicinity of 157-071-34DAA.

Gradients were low in the Pleasant lake aquifer. The difference in water levels between 157-071-14CDC and 157-071-15CCC was 7.6 feet in 1.2 miles. The gradient was 6.4 feet/mile. The difference between 157-071-35BAA and 156-071-04ABA is 6.1 feet with a gradient of 4.9 feet/mile.

Based on water levels the areas of recharge were estimated to be along a line southward from 157-071-14CDC to 157-071-35BAA. Areas of discharge were located along the western boundary of the aquifer and in the vicinity of Pleasant Lake. Water is discharged through evapotranspiration from the lakes and sloughs in the western part of the aquifer and is discharged through springs near Pleasant Lake in the hills north of Broken Bone Lake.

Water levels were slightly different six years after the utilization of the new well field. Water levels in an observation well completed at 157-071-26CCC experience about a 4 foot decline. This is shown by the hydrograph in Fig. 16. Annual use in acre-feet is noted along the bottom of the hydrograph. After the initial decline over the year 1977 the water levels stabilized until 1980. Water levels then experience a small rise, probably due to the increase in precipitation from 1980-1982. This same pattern of decline, stabilization, and slight recovery can be seen in observation wells 156-071-04ABA$_2$, 157-071-26BBA, 157-071-34DAA, and 157-071-35BAA$_1$.

157-071-26CCC



ACRE FT. USED	76.0	323.0	372.0	297.3	295.6	218.9

FIG. 16

The cone of depression around the production wells is represented in the potentiometric surface map for December 1982 (Fig. 17). The cone is elongate, oriented to the southwest, and affects an area of about one square mile. The elongation to the southwest results from the drawdown effects being more pronounced downgradient. Areas outside the cone of depression experienced a rise in water levels since 1976.

Water Quality

Analysis of water from the Pleasant Lake aquifer can be found in Table 1. The water is generally acalcium bicarbonate type. The total dissolved solids (TDS) concentration ranged from 246 mg/1 to 619 mg/1. Samples from city wells #3 and #4 possessed TDS concentrations of about 425 mg/1. Overall hardness concentrations ranged from 120 mg/1 to 400 mg/1. Samples from city well #3 and #4 possessed hardness concentrations of about 275 mg/1. Overall iron concentrations ranged from .02 mg/1 to 1.8 mg/1. Samples from city wells #3 and #4 possessed iron concentrations of about 1.5 mg/1.

The best water quality was encountered in the eastern portion of the aquifer adjacent to the hills. Very small streams and valleys are incised into the hills and drain into the area of the aquifer. Sand and gravel deposited in these valleys act as tributaries to the aquifer. This can account for the influx of fresh water from the east. Water quality deteriorates downgradient to the south and particularly to the west. Water is being discharged through numerous lakes in the west and springs in the south. The poorest quality water encountered in the area was at 157-07-26BCC$_5$. This poor quality is anomalous considering

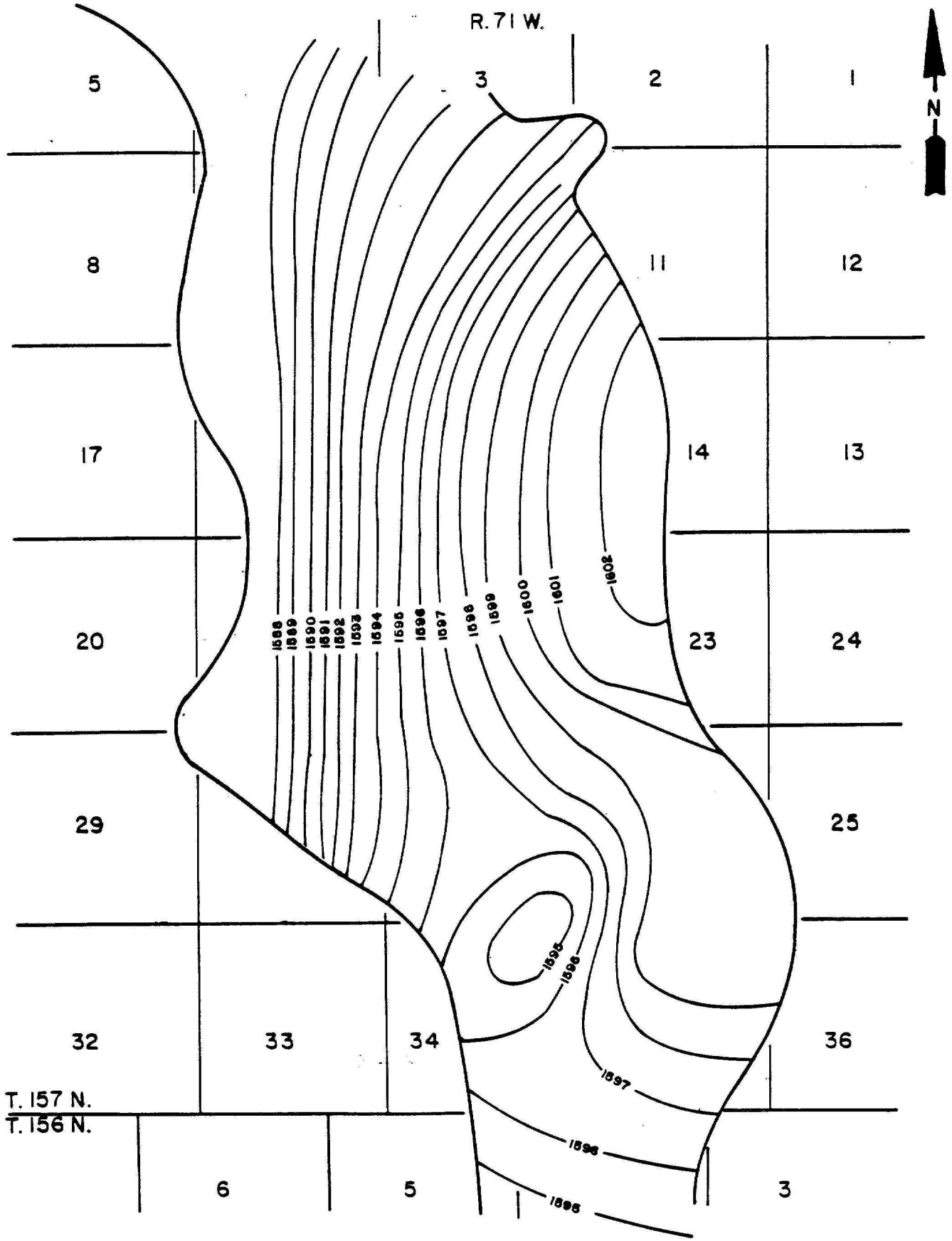


FIG. 17 PLEASANT LAKE AQUIFER POTENTIOMETRIC SURFACE MAP, DEC. 18, 1982

the proximity to the eastern boundary of the aquifer. It is possible the lake immediately east of 157-071-26BCC is intercepting water moving west from the hills. Once captured by the lake the water would evaporate out of the system. This would create a zone of stagnant, mineralized water directly west of the lake.

PLEASANT LAKE MODEL

Theory

A mathematical model of the Pleasant Lake aquifer was used to determine the effects of development on the aquifer. A nonsteady-state model was selected for this study in order to simulate the transient response of the aquifer after various pumping periods and rates of actual and planned wells.

The head changes that will occur in the Rugby aquifer after various periods of pumping may be calculated by solution of the following partial differential equation for nonsteady flow in a nonhomogeneous porous medium:

$$\frac{\delta}{\delta x}\left[bK_x \frac{\delta h}{\delta x}\right] + \frac{\delta}{\delta y}\left[bK_y \frac{\delta h}{\delta y}\right] = S_{x,y} \frac{\delta h}{\delta t} + W(x,y,t) \qquad (1)$$

where:

b is the saturated thickness;

h is the hydraulic head;

k is the hydraulic conductivity;

S is the storage coefficient of specific yield;

t is time; and

W(x,y,t) is the volume flux per unit area.

Equation 1 may be approximated by a finite-difference equation by applying Taylor's theorem (Pinder and Bredehoeft, 1968). The finite-difference equation is solved at each node of a rectangular grid on a digital computer using an iterative alternating direction implicit technique. For this study, the flow equation was solved on a digital computer using a program developed by Pinder, Trescott, and Larson (Trescott, 1976), and modified for this study.

Analysis of a complex nonhomogeneous aquifer system is accomplished by subdividing the system into a large number of relatively small rectangular cells, which constitute the finite-difference grid. The finite-difference grid used in this study consisted of 17 rows and 32 columns with constant cell dimensions of 1,320 feet. For each cell, values of hydraulic conductivity, specific yield, bottom of aquifer, land elevation, recharge, and discharge were supplied.

The accuracy of the solution of the finite-difference equations when applied to a problem in ground-water hydrology depends upon a number of variables. Errors are introduced when the continuous time and space factors of a natural system are represented by discrete elements in a mathematical model. The errors, however, may be lessened by the proper selection of input parameters (Pinder and Bredehoeft, 1968; Bedinger, Reed, and Griffin, 1973).

Calibration

Calibration of the digital model was obtained by comparing the output from various simulations with the measured ground-water levels

for a given time. Recharge to the model system was adjusted so that the calculated water levels from the simulation were in reasonable agreement with the measured water levels. Through this process it was clear that recharge to the nodes on the east side had to be much greater than on the west side. A true calibration would take a period of time in which the aquifer were being stressed and attempt to duplicate measured water levels with model simulated water levels. The 1976 model could not be calibrated in 1976 because no substantial stress (major pumping) had yet occurred. Such a calibration did occur in 1982, and this will be discussed in the following "Results" section.

Results

Utilization of the ground-water model allowed for a better understanding of the flow system. While initial data clearly showed a general flow system from east to west, and in the southern portion of the study area from north to south, the magnitudes of flow were not known. The model, however, allowed for an approximate quantification of these flows. Average recharge to the area was estimated originally to be in the range of 1 to 5 inches per year. This wide range of values for recharge results from having little understanding of the recharge process as well was inadequate historical data and inadequate spatial distribution of data. The model was investigated utilizing a range of recharge values. The higher rate of recharge resulted in more evaporation and transpiration as well as more flow out the lakes, springs and west margin of the aquifer.

In 1976 the model simulation utilized constant values for specific yield, recharge rate, grid size spacing and the ET function. The values varied from node to node for the water levels, hydraulic conductivity, bottom of aquifer, land elevation, and constant flux. Because the recharge rate could not be varied from node to node in the 1976 model, the constant flux was used for varying recharge input into different nodes. This had to be done because repeated efforts to use a constant recharge rate always resulted in the "modeled" water levels being lower than measured water levels along the east margin of the model, and especially so in the southeast part of the modeled area in Sections 26, 35, 3 and 4 (see Fig. 18). The use of variable constant fluxes of appropriate magnitudes and locations allowed for much better reproduction of measured water levels. This is not inconsistent with data gathered from the easternmost observation wells where higher than expected spring peaks occur in the measured water levels. The potentiometric surface shown in Figure 15 shows that the hills to the east are a major source of recharge to the modeled area.

Some examples of the possible variations in the 1976 model are shown on lines 1, 2, and 3 of Table 3. The model that was used to simulate the aquifer system in 1976 is shown on line 3. This model utilizes an average of about 2¼ inches of recharge per year. This rate was approximately doubled (line 2) for a "wet" model and halved (line 1) for a "dry" model. In both instances the aquifer properties remained basically the same, only the volumes of water passing through the aquifer changed. Table 3 shows the variations. Columns 1 (model

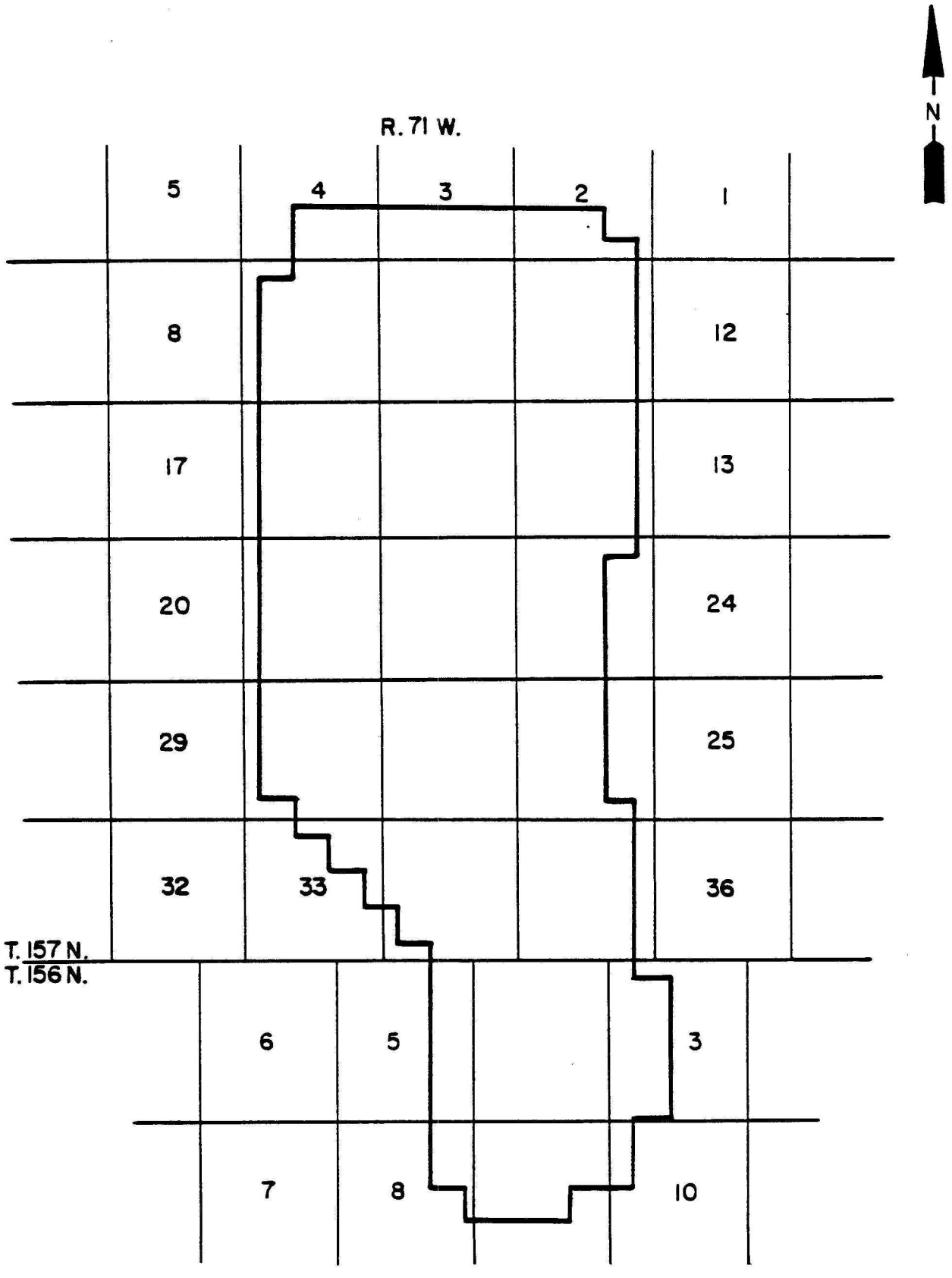


FIG. 18 MAP OF MODELED AREA

TABLE 3

	STEADY STATE CALIBRATION	INFLOW (ac.ft/yr) QRE Recharge	Constant Flux Recharge	Storage Decrease	OUTFLOW (ac.ft/yr) -Pumping Wells	-Pumping Springs	Constant Head Springs	Evapotranspiration ET and Springs
1	1976 Model ("dry" version)	407	520	0	0	533	0	394
2	1976 model ("wet" version)	3258	269	0	0	1394	0	2133
3	1976 Model	1343	598	0	0	991	0	950
4	1976 model (slightly adjusted)	1387	598	0	0	778	0	1205
5	1982 model (altered)	2626	0	0	0	0	862	1764
	1976-1980 VERIFICATION							
6	1976 (adjusted)	1387	598	300	514	778	0	993
7	1982 (altered)	2624	0	239	301	0	824	1738
	1981-2000 SIMULATION (at steady state)							
8	1982 model city of Rugby	2624	0	0	275	0	814	1534
9	1982 model cities of Rugby & Leeds	2624	0	0	425	0	798	1400
10	1982 model cities of Rugby & Leeds and nearby irrigation	2624	0	0	537	0	764	1322

recharge) and 2 (model constant flux) should be combined as recharge to the aquifer. Note that an approximate doubling of recharge from the "dry" (927 acre-feet/year) model to the "medium" (1941 acre-feet/year) model resulted in slightly less than doubling (column 5) the outflow through springs and more than doubling (column 7) outflow through evapotranspiration (ET). However a doubling of recharge from the "medium" model to the "wet" (3527 acre-feet/year) model results in a smaller increase in spring flow, and a much larger increase in ET. In essence the modeled system fills up and ET becomes a much more dominant factor.

This model was used to give examples of impacts based on different assumptions. Very little was known about the recharge process, and the magnitudes of the variables described within those processes. The situation was made all the more difficult because there had been no major pumping on the system, thus there was no way the model could be reasonably verified. A conservative estimate (2.24"/yr) was made of the recharge to the aquifer and the potential impacts were assessed on a somewhat "worst case" basis.

In 1982, the model was "dusted off" and used to simulate the 1976 to 1980 water use on the part of Rugby. The model was able to duplicate reasonably well the measured water levels both spatially and in magnitude. The 1976 model predicted slightly more drawdown than actually observed, however, particularly in the vicinity of the production wells. The 1976 model was reevaluated and some changes were made.

The new model (1982) increased the actual ET rate to a more reasonable 16"/year from 7"/year. All slough nodes where discharge was simulated

with pumping nodes were discontinued. The recharge in the 1982 model was increased to 3.03"/year which is larger than the 2.24"/year of the 1976 model (see Table 3, line 5). The springs on the south side were modeled as constant head nodes. As constant head nodes in the 1982 model, they put out 13% less water than they did as discharge nodes in the 1976 model. The springs in the 1982 model represented a smaller percentage of the overall flow system than they did in the 1976 model.

The refined 1982 model duplicated measured water levels of the 1976 to 1980 time period better than the 1976 model. The 1982 model should still be considered a crude model, however, and only used for rough estimates. More data is needed on recharge, and the ET function which is subject to substantial variations depending on water levels. Lines 6 and 7 on Table 3 give a comparison of the 1976-1980 verification run between the slightly adjusted 1976 model and the altered 1982 model. Line 4 shows the steady state simulation of the slightly altered 1976 model used for verification on line 6. Note that less water is taken out of storage (column 3 lines 6 and 7) in the 1982 model. This is reflective of the lesser drawdown (better matching field measured values) in the 1982 model as compared with the 1976 model.

SUMMARY

In 1982 the 1976 Pleasant lake aquifer model was reinvestigated for the purpose of investigating potential impacts due to proposed diversion from the Pleasant Lake aquifer by the city of Leeds. Lines 8, 9, and 10 of Table 3 show the variations in the flow system depending

on different levels of development. These can be compared with line 5 which shows the 1982 model with no development. At any of the three levels of development, most of the change in flow magnitude occurs in evapotranspiration losses. This would be reflected predominantly by a slight lowering (fraction of a foot) of water levels around the slough areas at the west edge of the study area. The springs to the south would be affected somewhere in the range of 40 to 100 acre-feet/year. This would be about 5 to 10% of the total spring flow calculated. The effects would be a little less in wet periods and a little more in dry periods.

The development of a computer model of the aquifer has shown a flow system consisting of more than 2500 acre-feet/year of recharge to the Pleasant Lake aquifer in the outlined study area. Discharge has been approximated to be more than 800 acre-feet/year flowing out the southern springs, and more than 1700 acre-feet/year being evaporated and transpired from lakes and sloughs.

The simulation of the development of three water permits involving two municipalities and one irrigation supply totalling over 500 acre-feet/year show only moderate and acceptable impacts to the springs to the south (5 to 10% decrease). The aquifer system appears stable and capable of handling present demands without unreasonable adverse effects.

APPENDIX

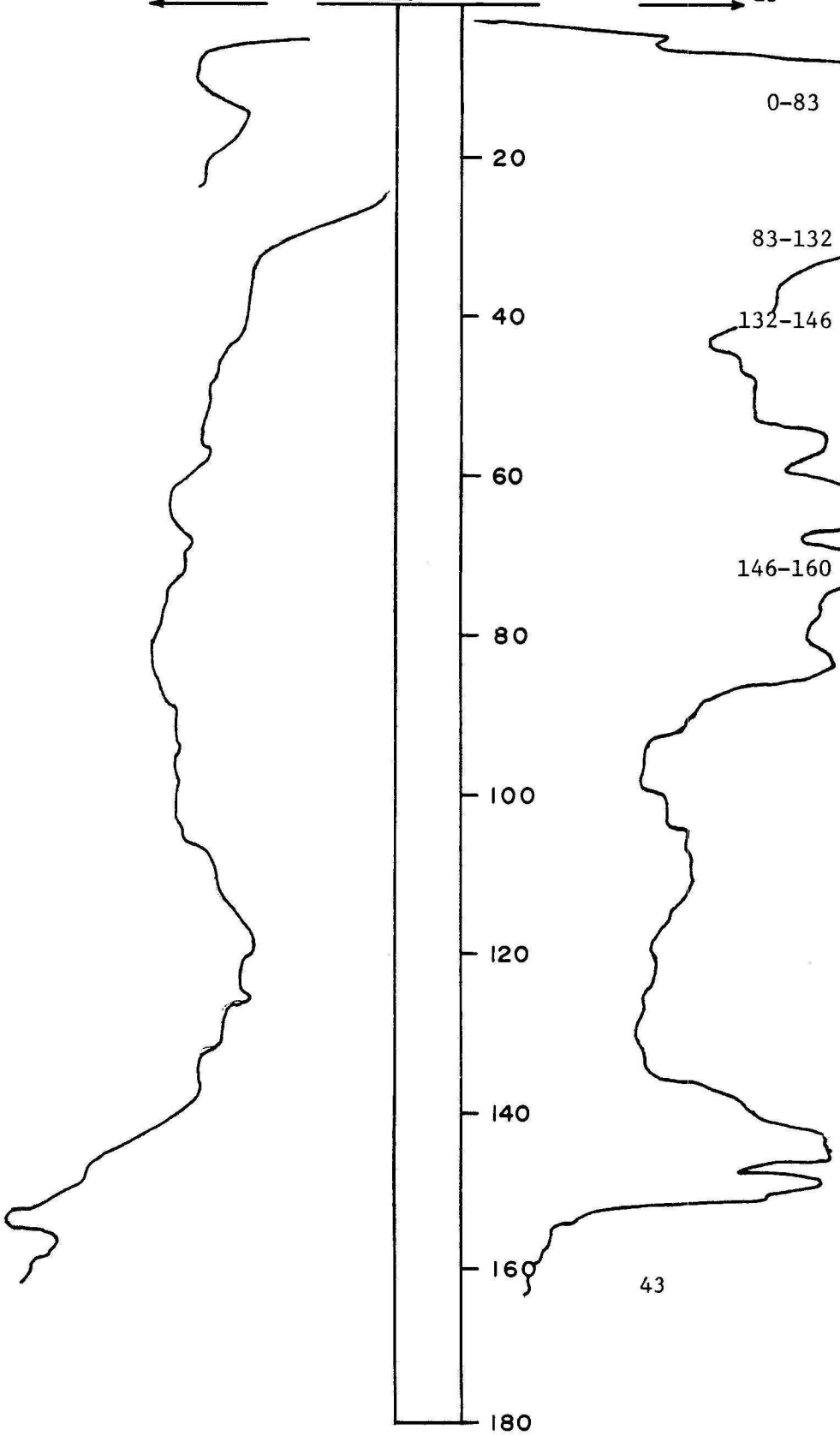
TEST HOLE 9361

LOCATION: 156-71-4 ABA

DATE DRILLED: 7-23-75

ELEVATION: 1625
(FT, MSL)

DEPTH: 160
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-83 Sand, fine-to medium-grained, subrounded to rounded, slightly lignitic, well-sorted.

83-132 Clay, Sandy, silty, olive gray, soft, plastic.

132-146 Sand, fine-to very coarse, angular to subrounded, gravelly, slightly clayey, poorly-sorted.

Fox Hills Formation

146-160 Clay, silty, sandy, medium light gray, moderately soft, with some well indurated layers.

Observation Well (9361)

Depth: 141 feet
S.I. : 138-141 feet

Observation Well (9361-A)

Depth: 81 feet
S. I.: 78-81 feet

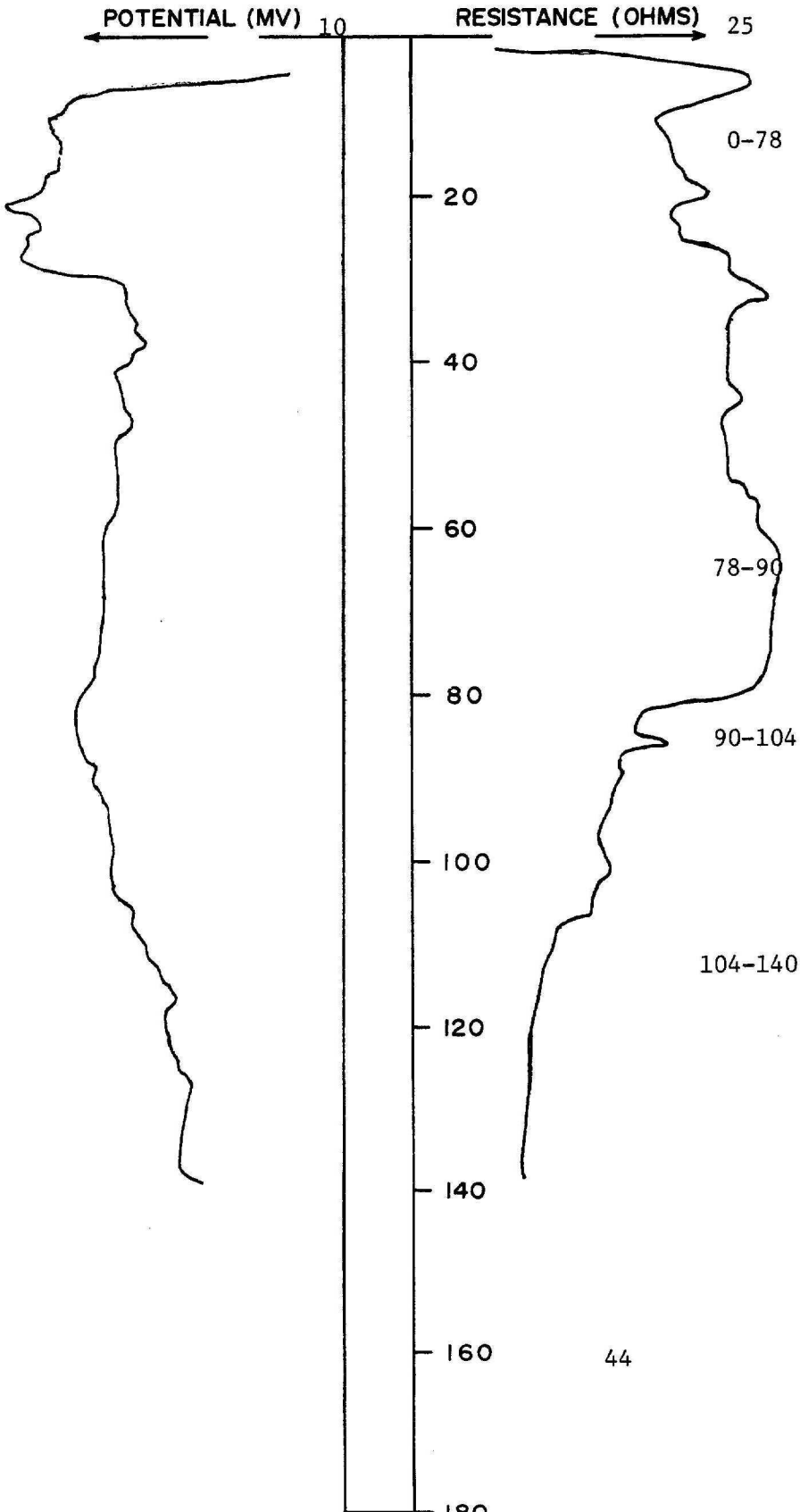
TEST HOLE 9406

LOCATION: 156-71-4DCD

DATE DRILLED: 8-13-75

ELEVATION: 1571
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-78 Sand, very fine-to coarse-grained predominantly medium, subangular to subrounded, slightly lignitic oxidized to 40 feet, well-sorted.

78-90 Clay, very sandy, silty, medium dark gray, soft, poor sample return.

90-104 Clay, sandy, silty, pebbly, gravelly, olive gray, cohesive very slightly plastic (till).

Fox Hills Formation

104-140 Clay, sandy, silty, medium gray to medium dark gray, tight, friable.

Observation Well

Depth: 76 feet
S. I.: 73-76 feet

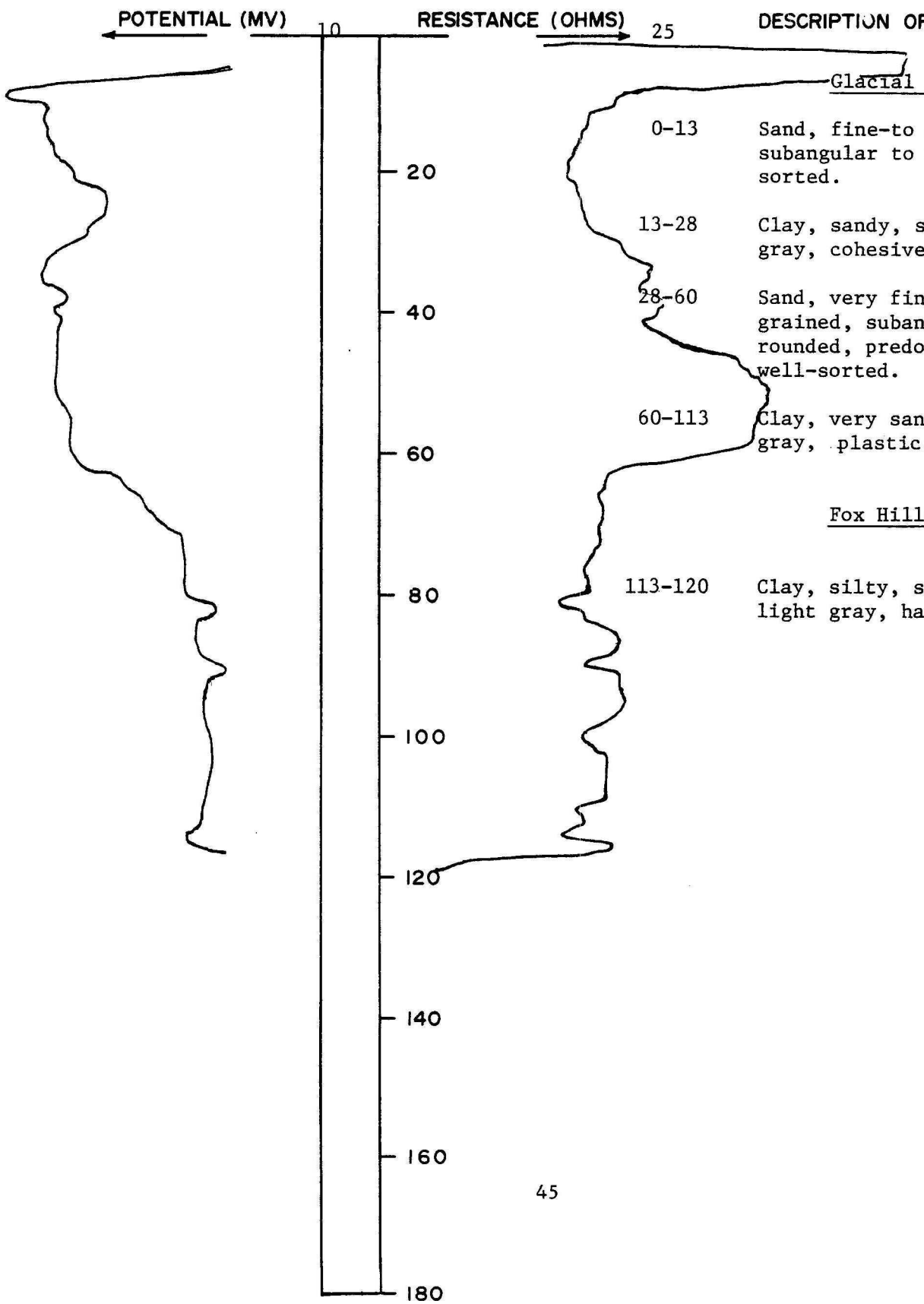
TEST HOLE 9359

LOCATION: 156-71-5AAA

DATE DRILLED: 7-23-75

ELEVATION: 1598
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-13 Sand, fine-to coarse-grained, subangular to rounded, well-sorted.

13-28 Clay, sandy, silty, olive gray, cohesive.

28-60 Sand, very fine-to medium grained, subangular to rounded, predominantly quartz, well-sorted.

60-113 Clay, very sandy, silty, olive gray, plastic.

Fox Hills Formation

113-120 Clay, silty, sandy, medium light gray, hard, friable.

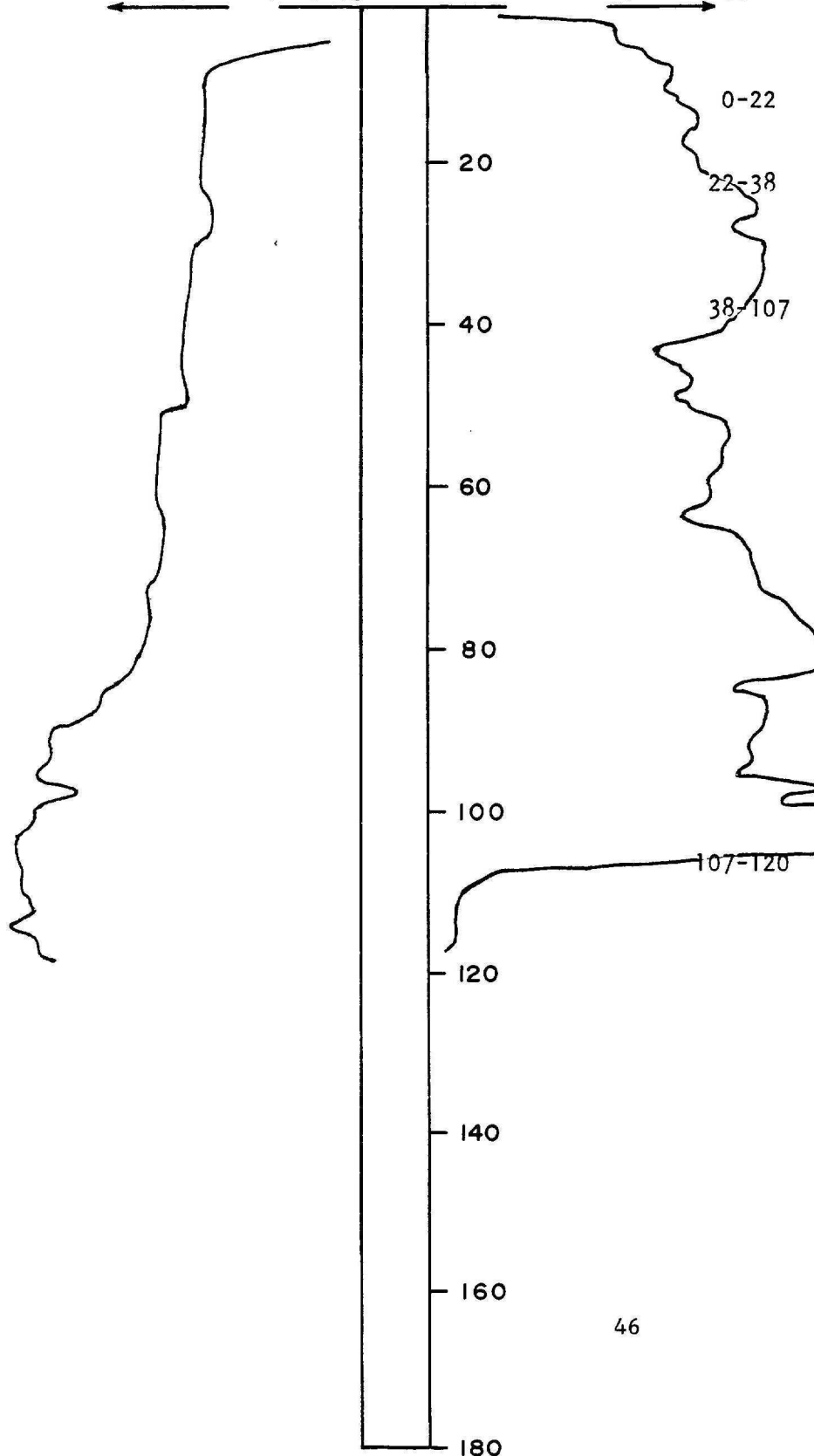
TEST HOLE 9358

LOCATION: 156-71-5BAB

DATE DRILLED: 7-23-75

ELEVATION: 1590
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-22 Clay, silty, sandy, moderate yellowish brown, plastic, oxidized.

22-38 Clay, as above, olive gray.

38-107 Clay, very sandy, silty, pebbly, olive gray, cohesive, slightly plastic (till).

Fox Hills Formation

107-120 Clay, sandy, silty, medium gray, tight, hard.

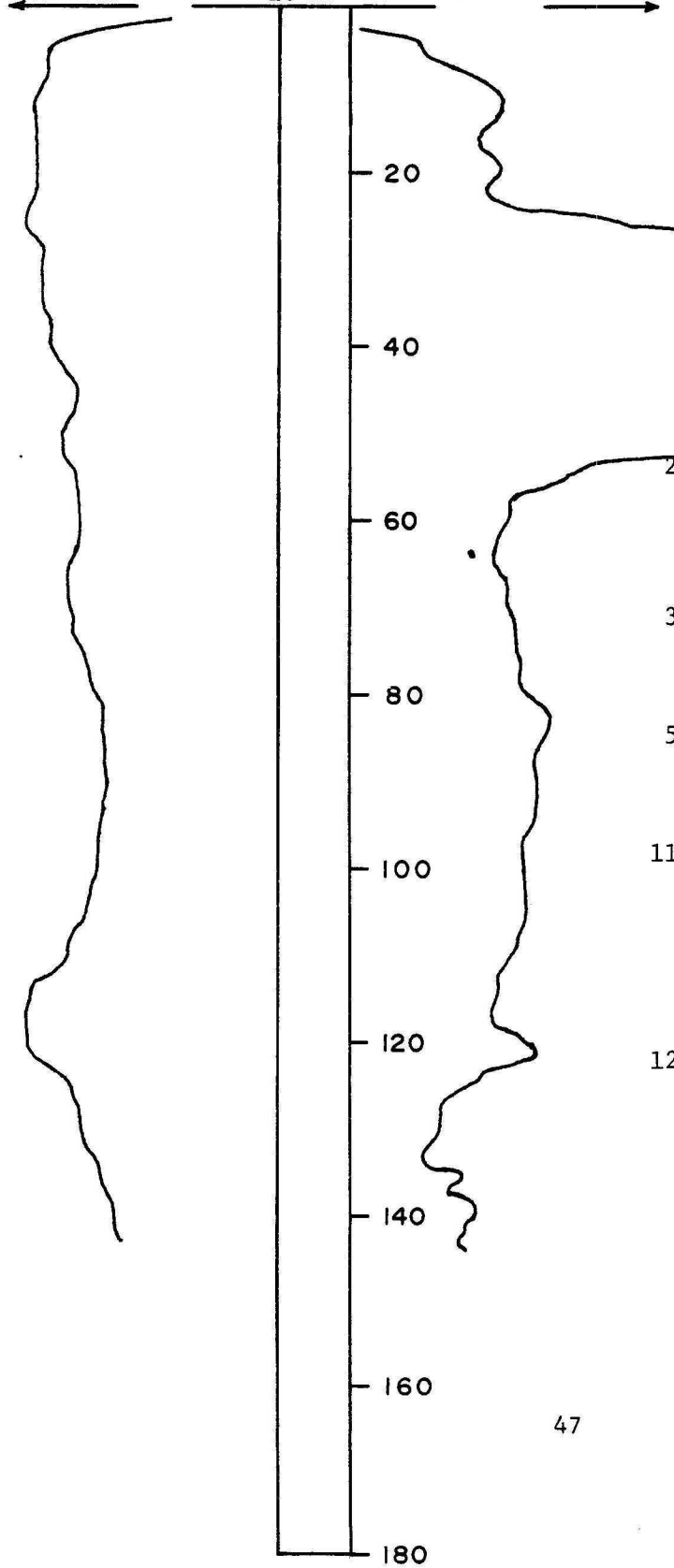
TEST HOLE 9408

LOCATION: 156-71-9DCD

DATE DRILLED: 8-13-75

ELEVATION: 1600
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-9 Clay, silty, sandy, moderate yellowish brown, soft, slightly plastic, oxidized (lacustrine).

9-24 Clay, sandy, silty, pebbly, gravelly, moderate yellowish brown, tight, cohesive, very slightly plastic, oxidized to 21 feet (till).

24-36 Sand, fine-to coarse-grained, subangular to subrounded, predominantly quartz, clayey, moderately well-sorted.

36-50 Clay, very sandy, silty, pebbly olive gray, tight cohesive, slightly plastic (till).

50-116 Clay, silty, sandy, medium gray, smooth, cohesive slightly plastic (lacustrine).

116-120 Clay, sandy, silty, pebbly, olive gray, cohesive, very slightly plastic (till).

Fox Hills Formation

120-140 Siltstone, clayey, sandy, medium dark gray to bluish gray, tight, brittle.

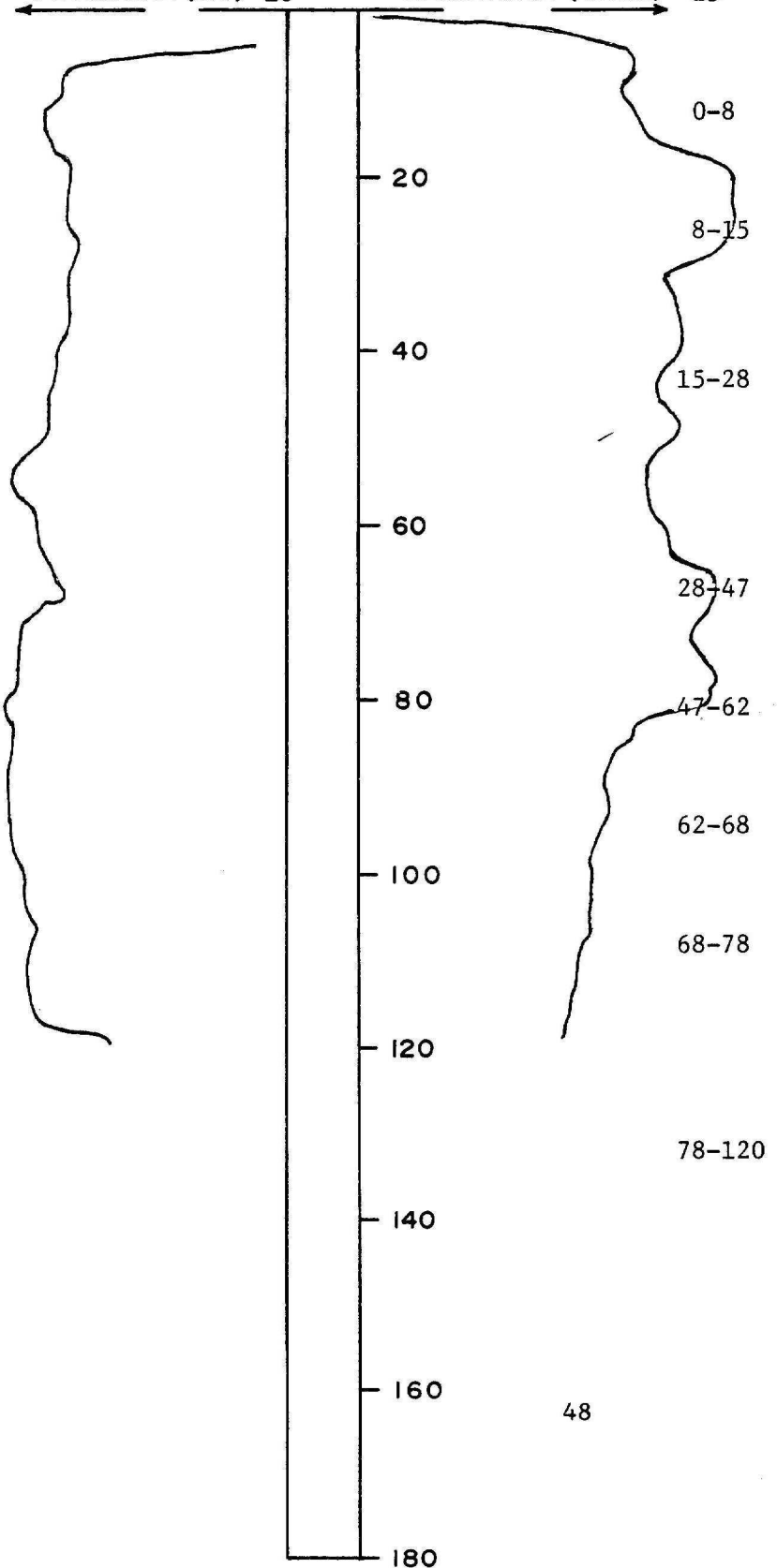
TEST HOLE 9407

LOCATION: 156-71-10CBB

DATE DRILLED: 8-13-75

ELEVATION: 1580
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-8 Sand, very fine-to fine-grained subrounded to rounded, predominantly quartz, oxidized.

8-15 Clay, silty, sandy, pebbly moderate yellowish brown, tight, cohesive, very slightly plastic (till).

15-28 Sand, fine to very coarse-grained, predominantly coarse, angular to subrounded, (about 40 percent fine to coarse gravel), poorly-sorted, taking some water.

28-47 Clay, very silty, sandy, medium gray, smooth, cohesive (lacustrine).

47-62 Clay, sandy, silty, pebbly, olive gray, cohesive,very slightly plastic (till).

62-68 Sand, very fine-to coarse-grained, subangular to subrounded, well-sorted.

68-78 Clay, sandy, silty, pebbly, gravelly, olive gray, tight cohesive (till).

Fox Hills Formation

78-120 Clay, sandy, silty, medium gray, hard friable.

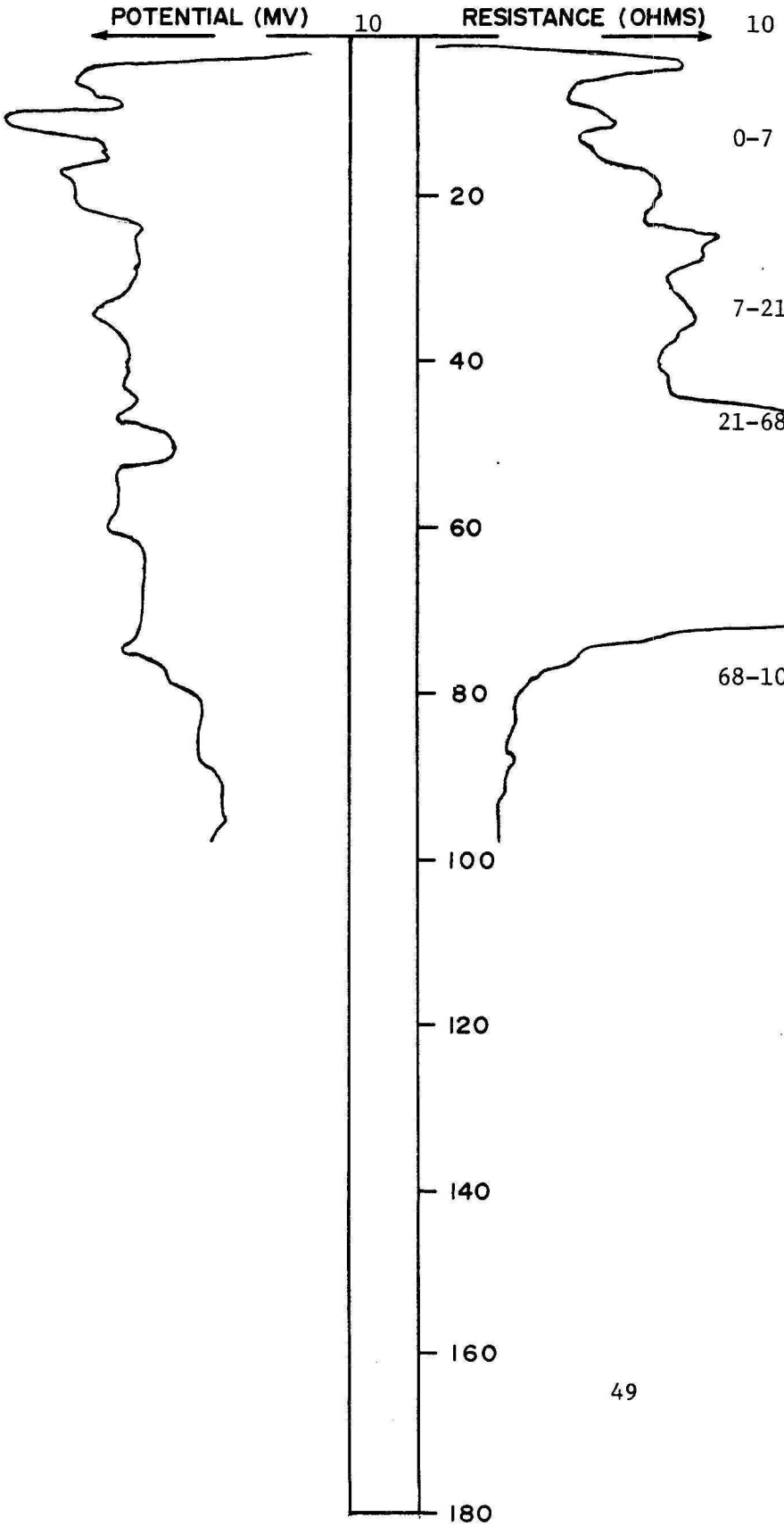
TEST HOLE 9405

LOCATION: 156-71-16BBA

DATE DRILLED: 8-13-75

ELEVATION: 1540
(FT, MSL)

DEPTH: 100
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-7 Clay, very silty, sandy, moderate yellowish brown, moderately cohesive, very slightly plastic (lacustrine).

7-21 Clay, as above, medium dark gray (lacustrine).

21-68 Clay, sandy, silty, Pebbly, olive gray, tight, cohesive, very slightly plastic (till).

Fox Hills Formation

68-100 Shale, silty, sandy, dark gray to brownish black, tight, brittle.

Observation Well

Depth: 56 feet
S.I. : 53-56 feet

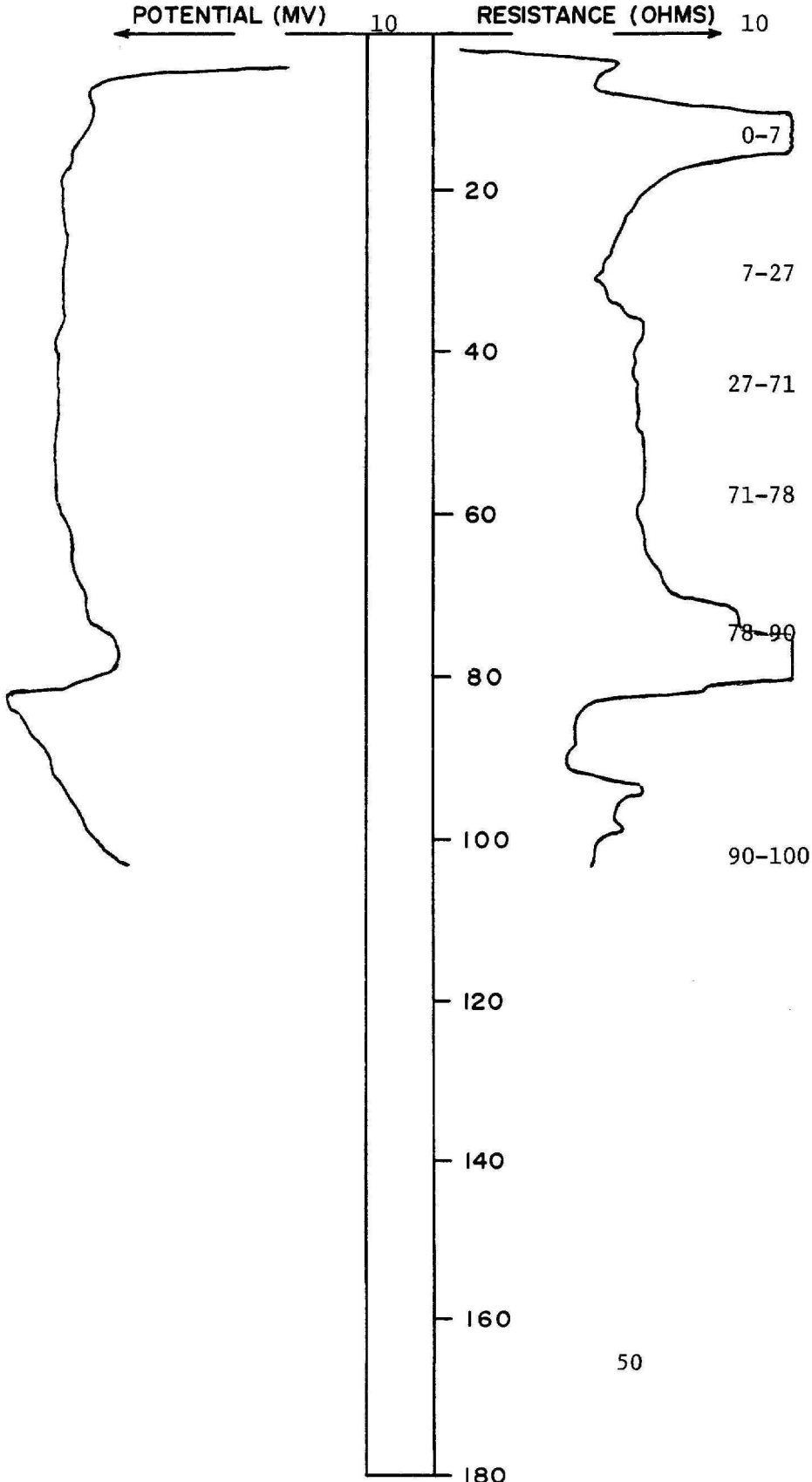
TEST HOLE 9363

LOCATION: 156-71-17CDA

DATE DRILLED: 7-24-75

ELEVATION: 1570
(FT, MSL)

DEPTH: 100
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-7 Sand, very fine-to medium grained, clayey, silty, poorly-sorted.

7-27 Clay, silty, moderate yellowish brown, soft, slightly plastic.

27-71 Clay, silty, sandy, olive gray soft, cohesive, slightly plastic.

71-78 Sand, fine to coarse-grained angular to subrounded, clayey, poorly-sorted, crock at 77 feet.

78-90 Clay, sandy, silty, pebbly, gravelly, olive gray, soft slightly plastic.

Fox Hills Formation

90-100 Clay, silty, sandy, medium gray, moderately soft.

Observation Well

Depth: 76 feet
S. I.: 73-76 feet

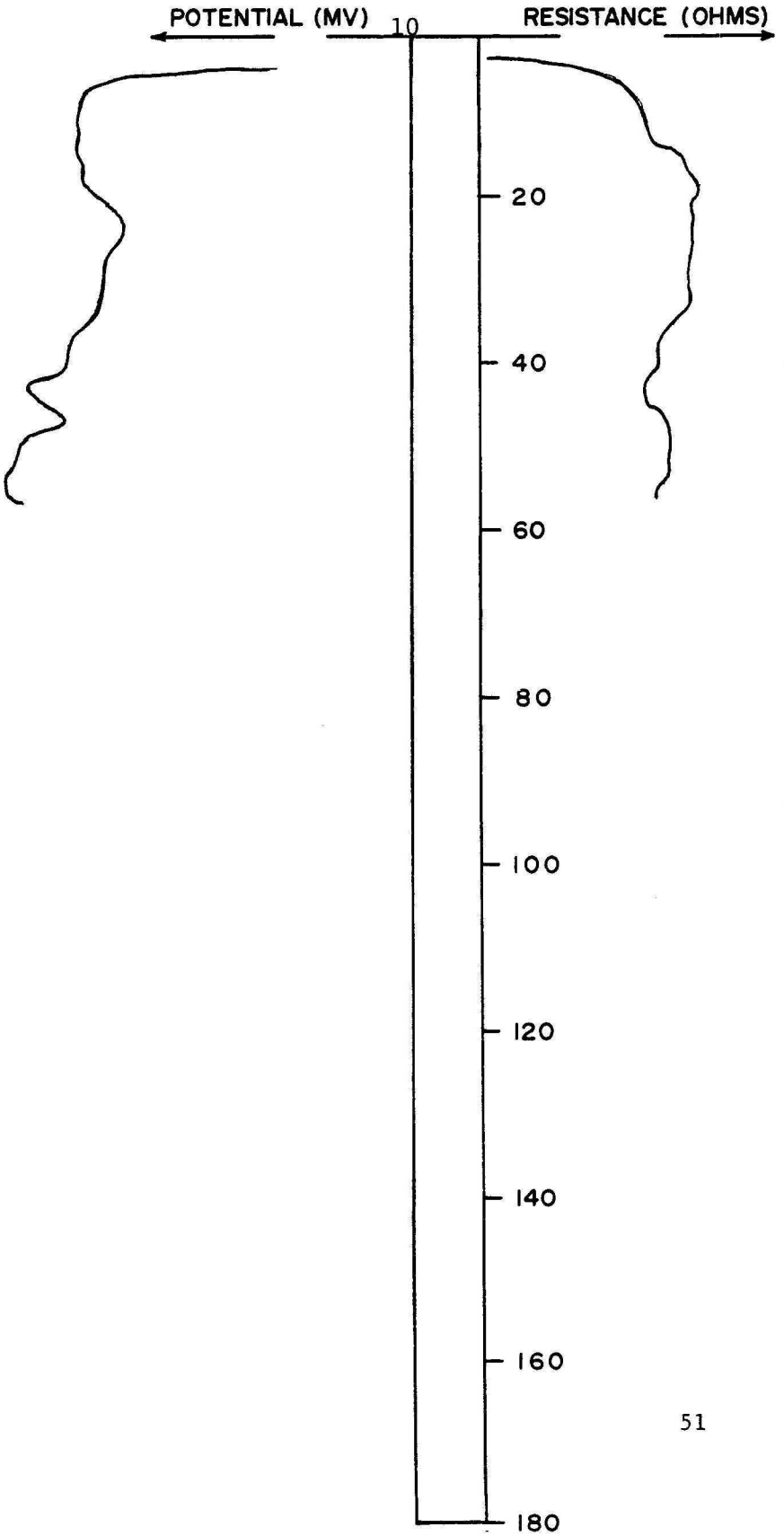
TEST HOLE 9364

LOCATION: 156-71-20ACA

DATE DRILLED: 7-24-75

ELEVATION: 1550
(FT, MSL)

DEPTH: 60
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-5	Sand, fine-to medium-grained, clayey, well-sorted, oxidized.
5-14	Clay, silty, moderate yellowish brown, very soft, slightly plastic, oxidized
14-20	Clay, sandy, silty, pebbly, olive gray, slightly plastic (till).
20-38	Gravel, sandy, medium to very coarse, subangular to rounded
38-52	Clay, sandy, silty, pebbly, gravelly, olive gray, slightly plastic (till).

Fox Hills Formation

52-60	Clay, silty, sandy, medium gray, with some hard sand layers.

Observation Well

Depth: 36 feet
S. I.: 33-36 feet

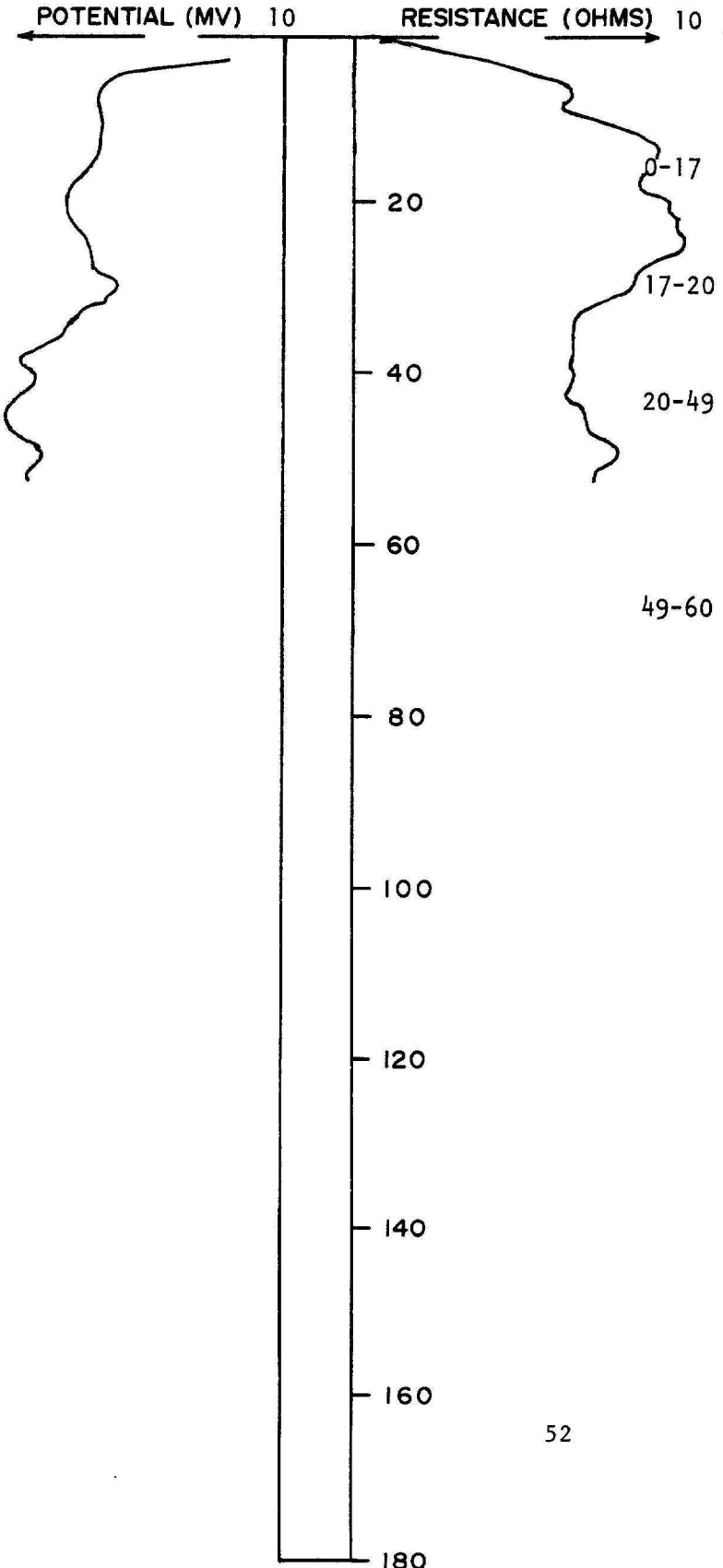
TEST HOLE 9362

LOCATION: 156-71-20CDC

DATE DRILLED: 7-24-75

ELEVATION: 1535
(FT, MSL)

DEPTH: 60
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-17 Clay, sandy silty, light gray to greenish gray, plastic.

17-20 Clay, silty, sandy, pebbly, olive gray, very slightly plastic (till).

20-49 Sand, fine to very coarse graine angular to subrounded, silty, clayey, very gravelly after 29 feet.

Fox Hills Formation

49-60 Siltstone, sandy, medium gray to olive gray, hard , brittle.

Observation Well

Depth: 46 feet
S. I.: 43-46 feet

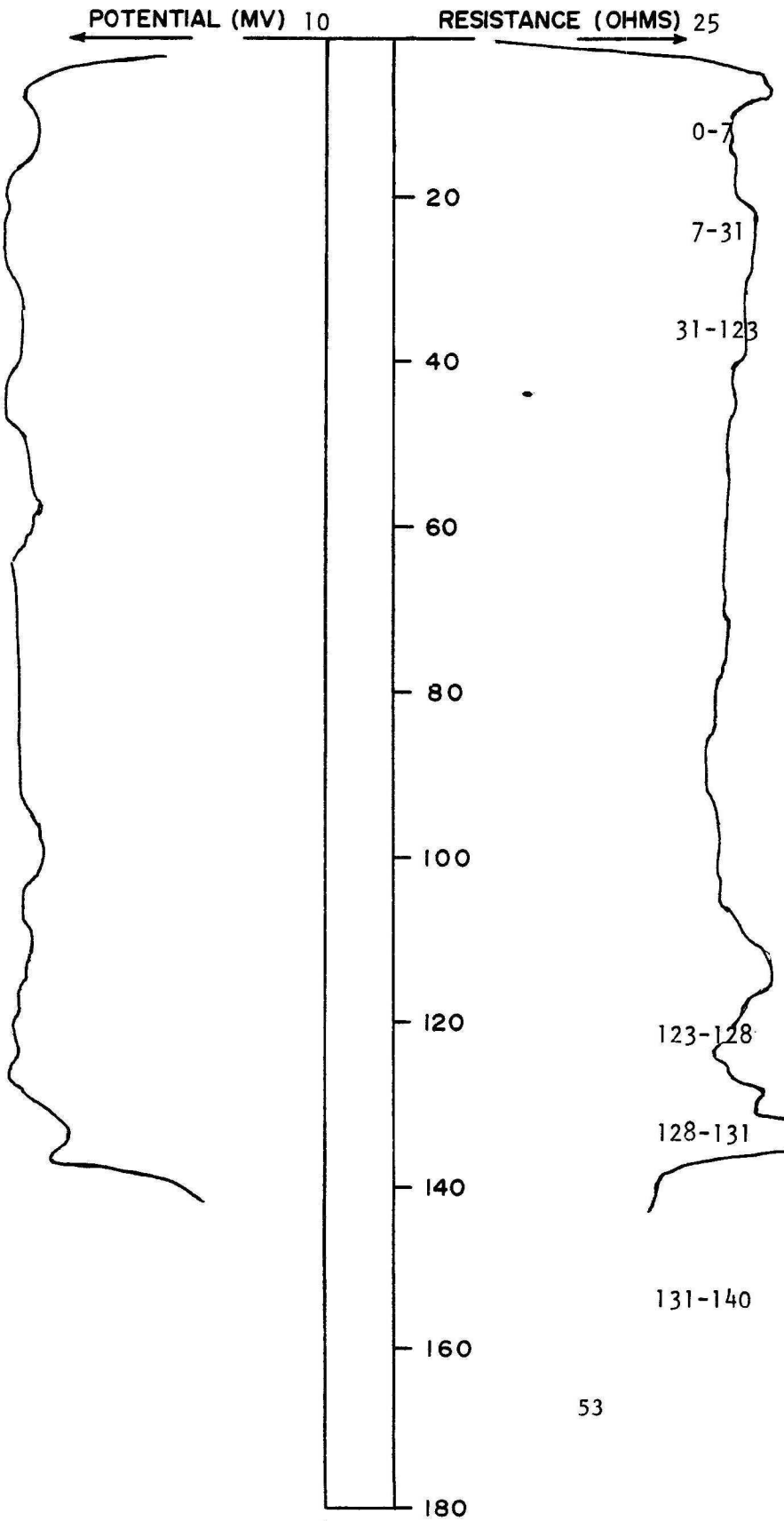
TEST HOLE 9354

LOCATION: 156-72-2ABA

DATE DRILLED: 7-22-75

ELEVATION: 1568
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-7 Sand, very fine- to fine-grained, subrounded to rounded, slightly lignitic, well-sorted, oxidized.

7-31 Silt, very clayey, sandy, moderate yellowish brown, soft, slightly plastic, oxidized

31-123 Silt, as above, medium dark gray, tight after 100 feet.

123-128 Clay, silty, sandy, pebbly, olive gray, cohesive, slightly plastic (till).

128-131 Gravel, shaley, medium to coarse, angular to subrounded, poorly-sorted.

Fox Hills Formation

131-140 Clay, sandy, silty, shaley, medium light gray to greenish gray, hard, friable.

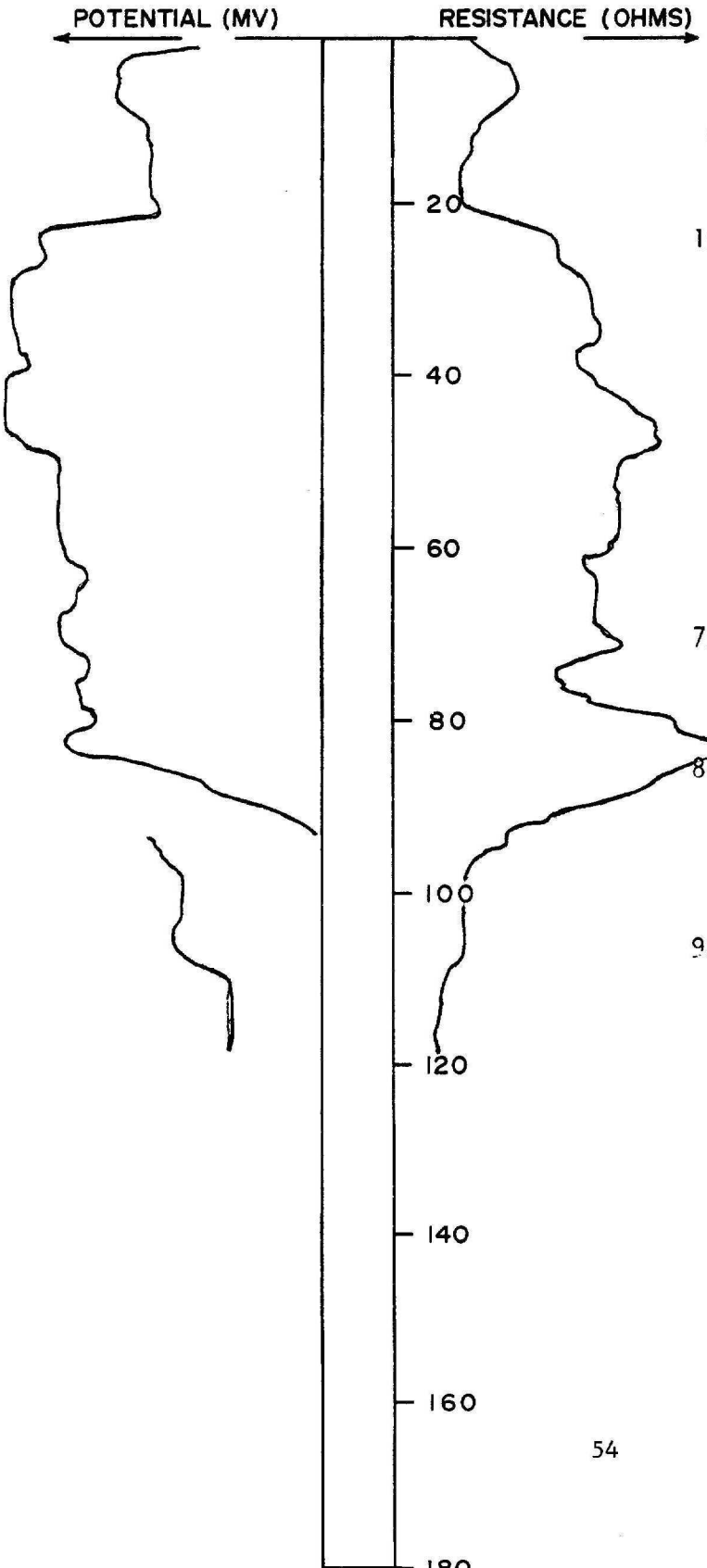
TEST HOLE 9355

LOCATION: 156-72-3ABB

DATE DRILLED: 7-22-75

ELEVATION: 1553
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-15 Clay, silty, sandy, moderate yellowish brown, cohesive, very slightly plastic, oxidized.

15-75 Clay, as above, medium gray, sand layers 60-70 feet.

75-84 Sand, fine- to very coarse-grained, gravelly, angular to subrounded, slightly lignitic, poorly sorted.

84-92 Clay, sandy, silty, pebbly, olive gray, tight, very slightly plastic (till).

Fox Hills Formation

92-120 Clay, sandy, silty, shaley, medium to greenish gray, hard, friable.

Observation Well

Depth 81 feet
Screened interval 78-81 feet

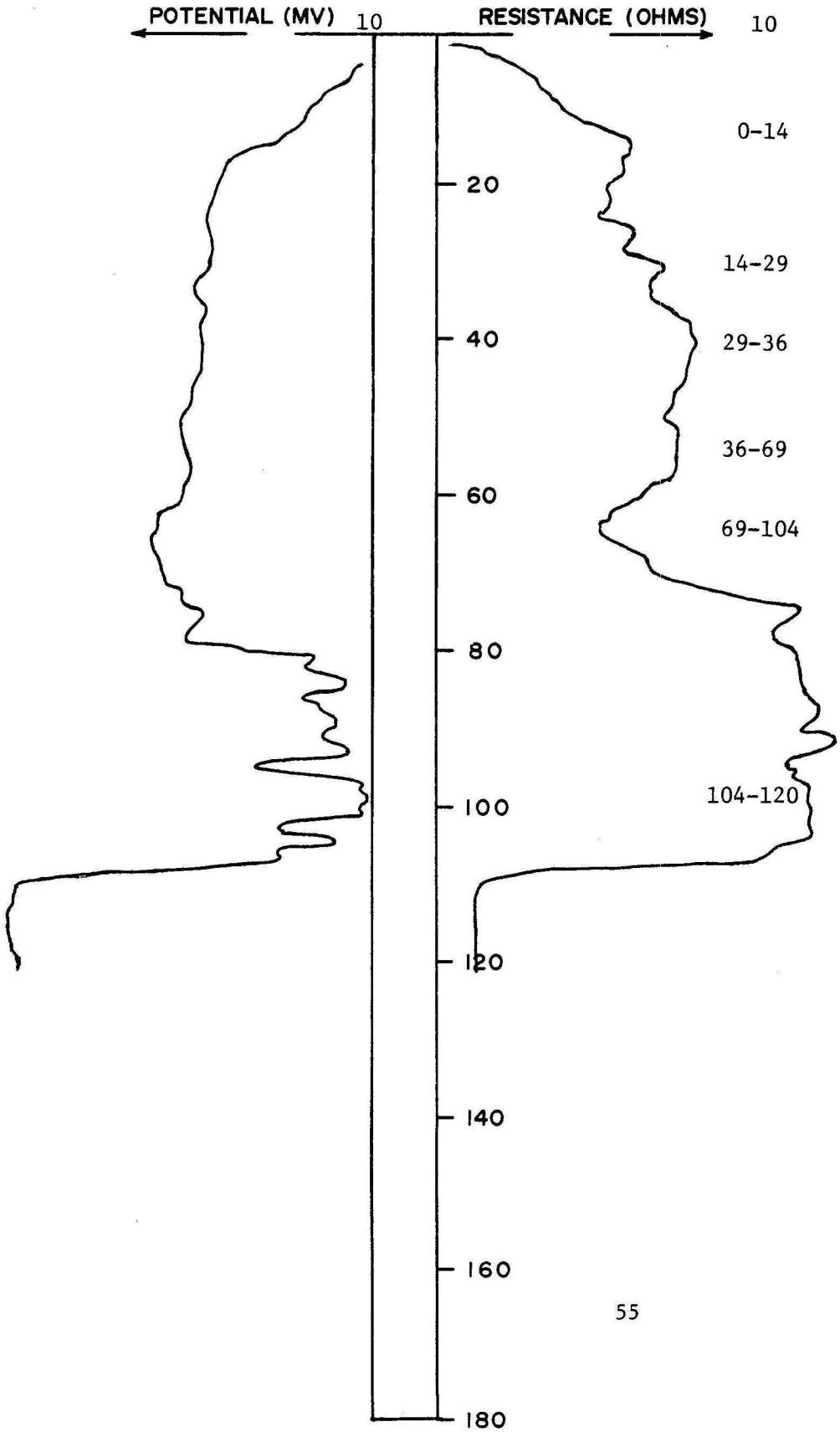
TEST HOLE 9399

LOCATION: 156-72-9CDC

DATE DRILLED: 8-12-75

ELEVATION: 1570
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-14 Clay, very silty, sandy, moderate yellowish brown, cohesive, sticky, slightly plastic, oxidized (lacustrine).

14-29 Clay, as above, medium dark gray (lacustrine).

29-36 Clay, sandy, silty, pebbly, olive gray, tight very slightly plastic (till).

36-69 Clay, very silty, sandy, medium gray, tight, brittle (lacustrine)

69-104 Sand, fine-to very coarse-grained, predominantly coarse, angular to sub-rounded, (about 20 percent fine to coarse gravel), moderately well-sorted.

Fox Hills Formation

104-120 Shale, silty, sandy, medium dark gray, hard, brittle.

Observation Well

Depth: 101 feet
S. I.: 98 - 101 feet

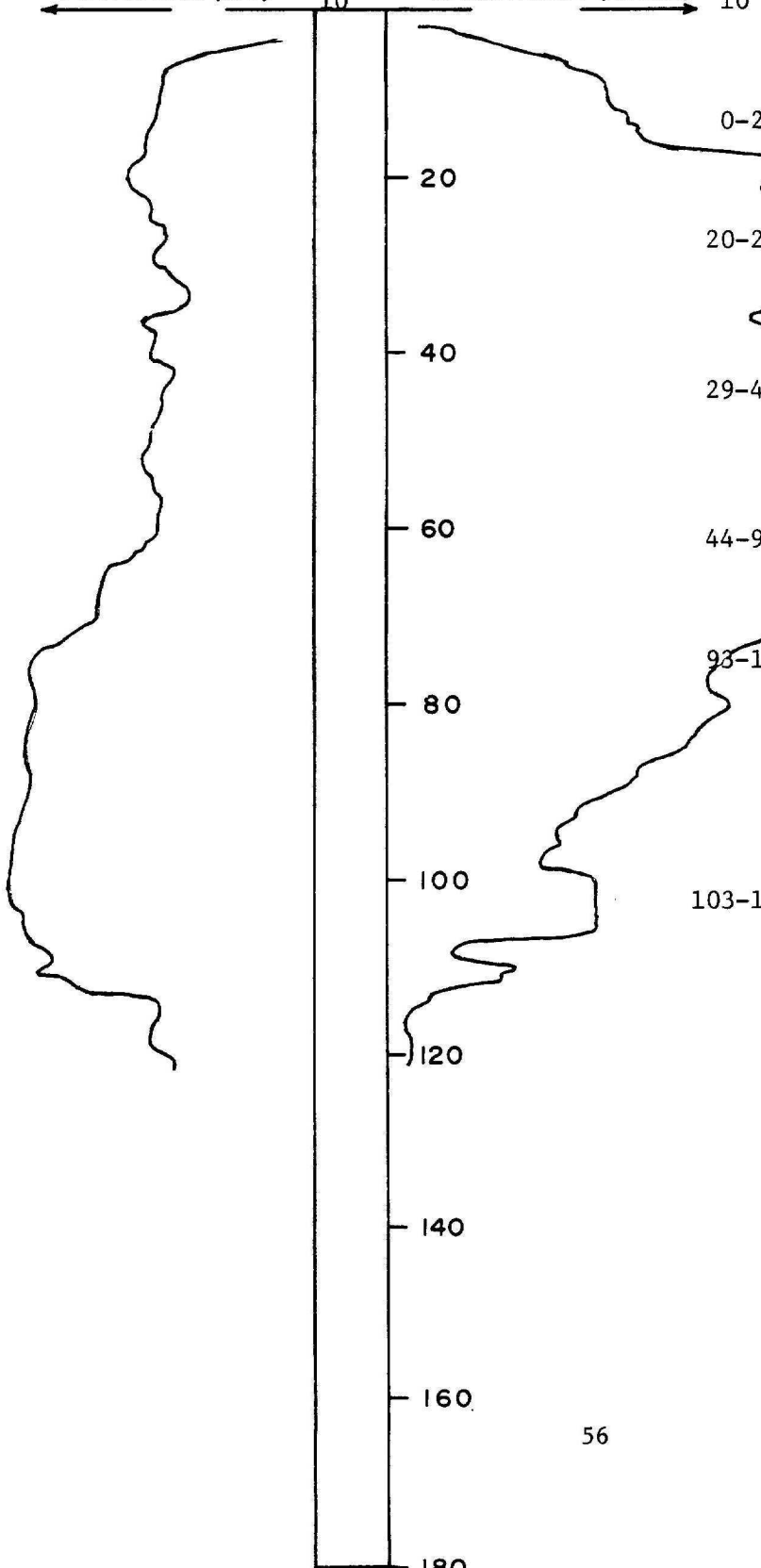
TEST HOLE 9400

LOCATION: 156-72-16AAA

DATE DRILLED: 8-12-75

ELEVATION: 1572
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-20 Clay, silty, slightly sandy, moderate yellowish brown, soft, cohesive, oxidized (lacustrine).

20-29 Clay, sandy, silty, pebbly, olive gray, with a fine to very coarse sand layer 23-27 feet (till).

29-44 Sand, very fine-to medium grained, subrounded to rounded numerous interbedded clay layers.

44-93 Clay, very silty, sandy, medium gray, tight after 65 feet (lacustrine).

93-103 Clay, sandy, silty, pebbly, olive gray, cohesive, tight (till).

Fox Hills Formation

103-120 Shale, silty, sandy, medium to medium dark gray, tight, brittle.

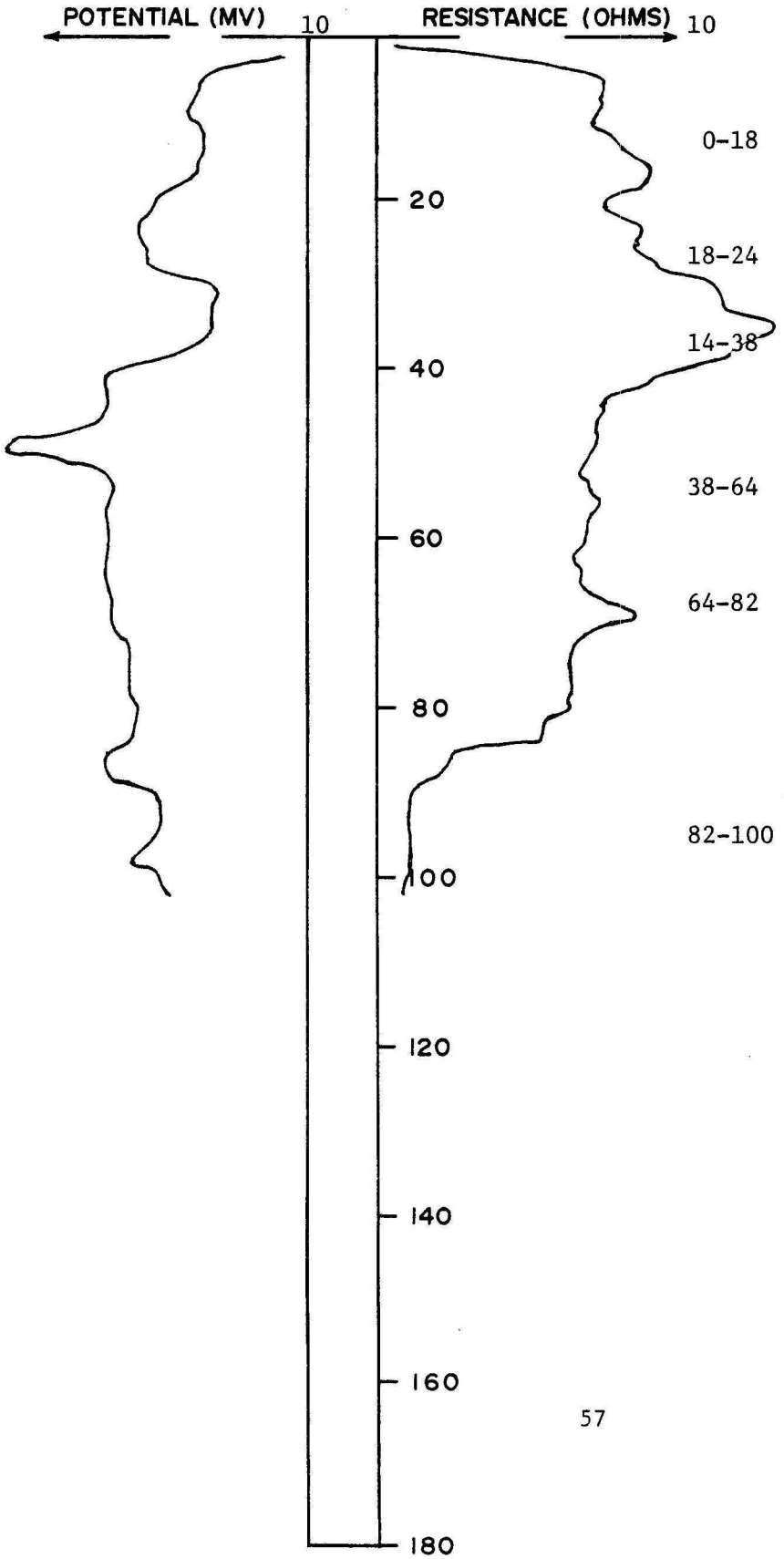
TEST HOLE 9398

LOCATION: 156-72-18AAA

DATE DRILLED: 8-12-75

ELEVATION: 1555
(FT, MSL)

DEPTH: 100
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-18 Silt, sandy clayey, moderate yellowish brown, soft, slightly plastic, oxidized.

18-24 Silt, as above, medium dark gray.

14-38 Sand, very fine- to fine-grained, subrounded to rounded, clayey, moderately well-sorted.

38-64 Clay, sandy, silty, medium to olive gray, very tight, cohesive.

64-82 Clay, sandy, silty, pebbly, olive gray, tight, very slightly plastic (till).

Fox Hills Formation

82-100 Clay, sandy, silty, brownish to medium gray, hard, tight friable.

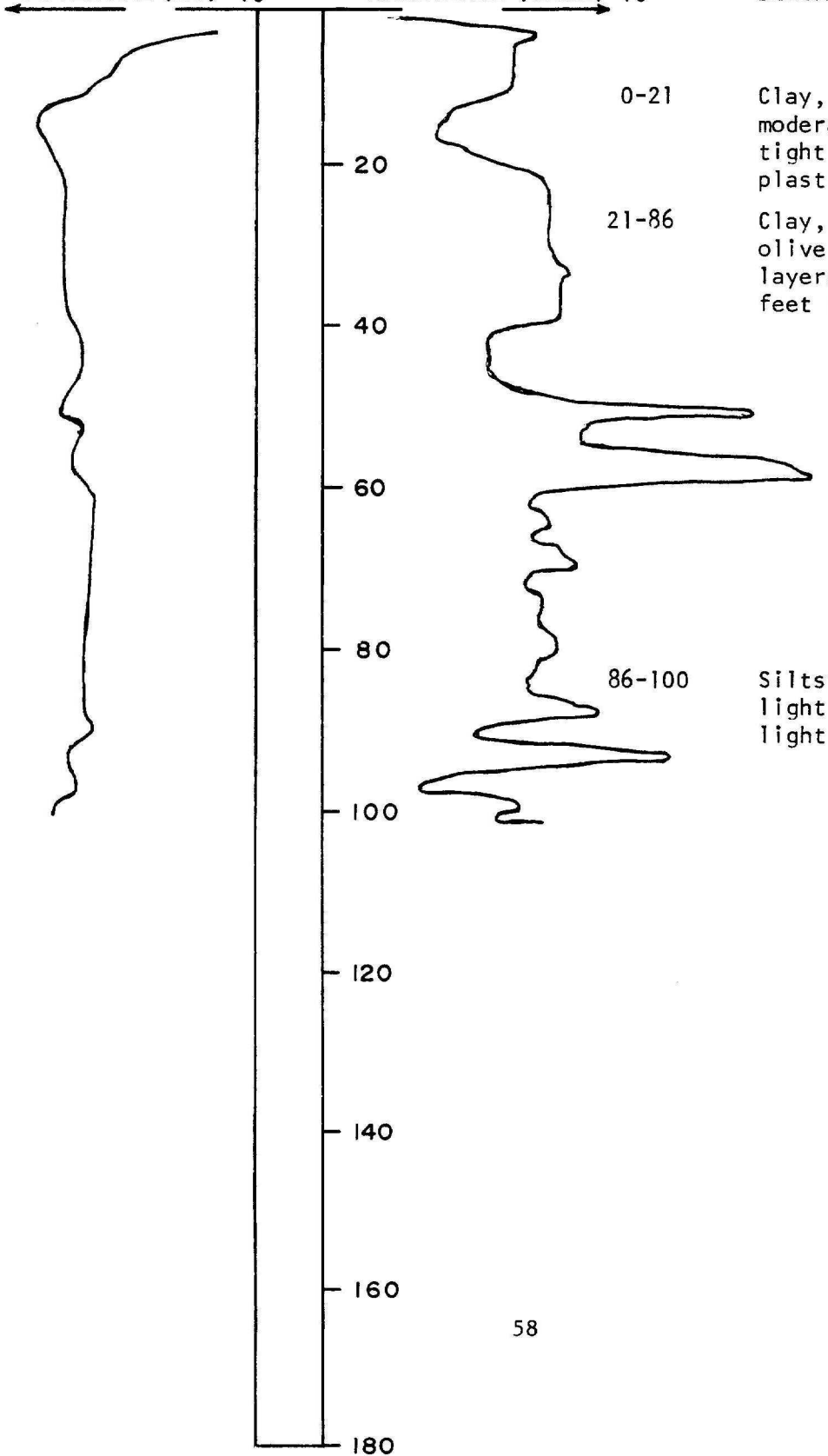
TEST HOLE 9345

LOCATION: 157-71-2DCB

DATE DRILLED: 7-17-75

ELEVATION: 1620
(FT, MSL)

DEPTH: 100
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-21 Clay, sandy, silty, pebbly, moderate yellowish brown, tight, cohesive, slightly plastic (till).

21-86 Clay, sandy, silty, pebbly, olive gray, tight, with gravel layers 48-50 feet and 54-56 feet (till).

Fox Hills Formation

86-100 Siltstone, clayey, sandy, light bluish gray to medium light gray, hard brittle.

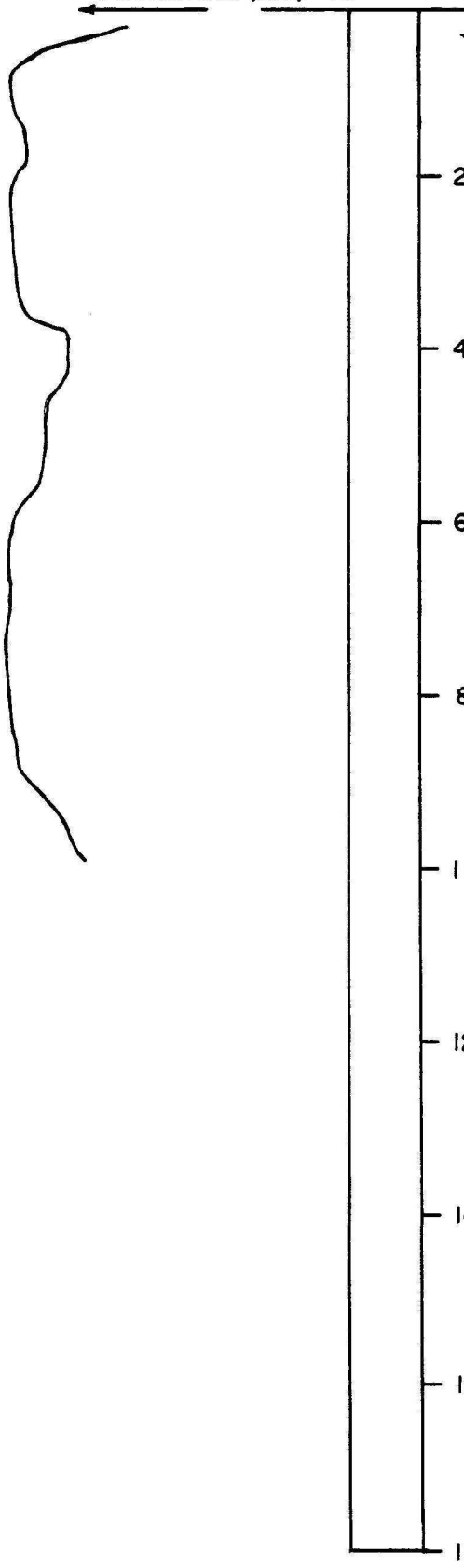
TEST HOLE 9349

LOCATION: 157-71-3CCD

DATE DRILLED: 7-21-75

ELEVATION: 1612
(FT, MSL)

DEPTH: 100
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-3	Sand, very fine- to coarse-grained, angular to subrounded, well-sorted, oxidized.
3-8	Clay, silty, slightly sandy, moderate yellowish brown, slightly plastic, oxidized.
8-25	Sand, very fine- to coarse-grained, gravelly, angular to subrounded, well-sorted, oxidized.
25-31	Clay, silty, slightly sandy, moderate yellowish brown, moderately cohesive, oxidized.
31-36	Clay, as above, medium dark gray.
36-57	Sand, fine- to coarse-grained, predominantly medium, angular to rounded, well-sorted.
57-74	Clay, silty, sandy, medium dark to light gray, tight.

Fox Hills Formation

74-100	Siltstone, clay, sandy, medium gray to pale blue, hard, friable.

Observation Well

Depth 56 feet
Screened interval 53-56 feet

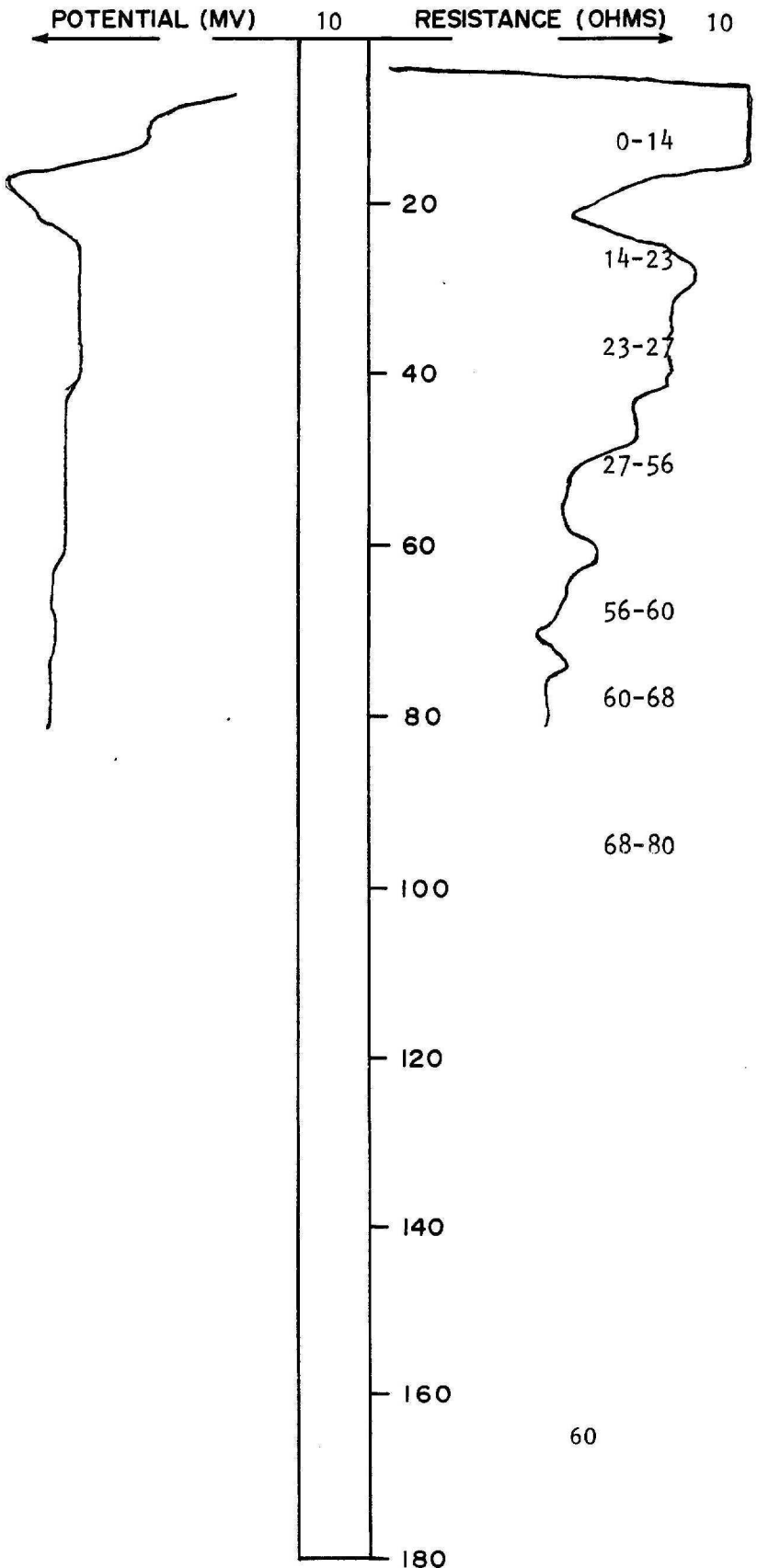
TEST HOLE 9348

LOCATION: 157-71-3DCD

DATE DRILLED: 7-21-75

ELEVATION: 1606
(FT, MSL)

DEPTH: 80
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-14 Sand, very fine-to medium-grained subrounded to rounded, mostly quartz, well-sorted, oxidized.

14-23 Clay, silty, sandy, dark gray, cohesive, very slightly plastic.

23-27 Sand, very fine-to medium-grained angular to rounded, moderately lignitic, well-sorted.

27-56 Clay, sandy, silty, pebbly, gravelly, olive gray, (with a ver fine-to medium-grained sand layer 36-41 feet) cohesive (till).

56-60 Sand, fine-to medium-grained, subrounded to rounded, well-sorte

60-68 Clay, silty, moderately sandy, medium dark gray, soft, cohesive.

Fox Hills Formation

68-80 Siltstone, clayey, sandy, medium light gray to pale blue, hard, friable.

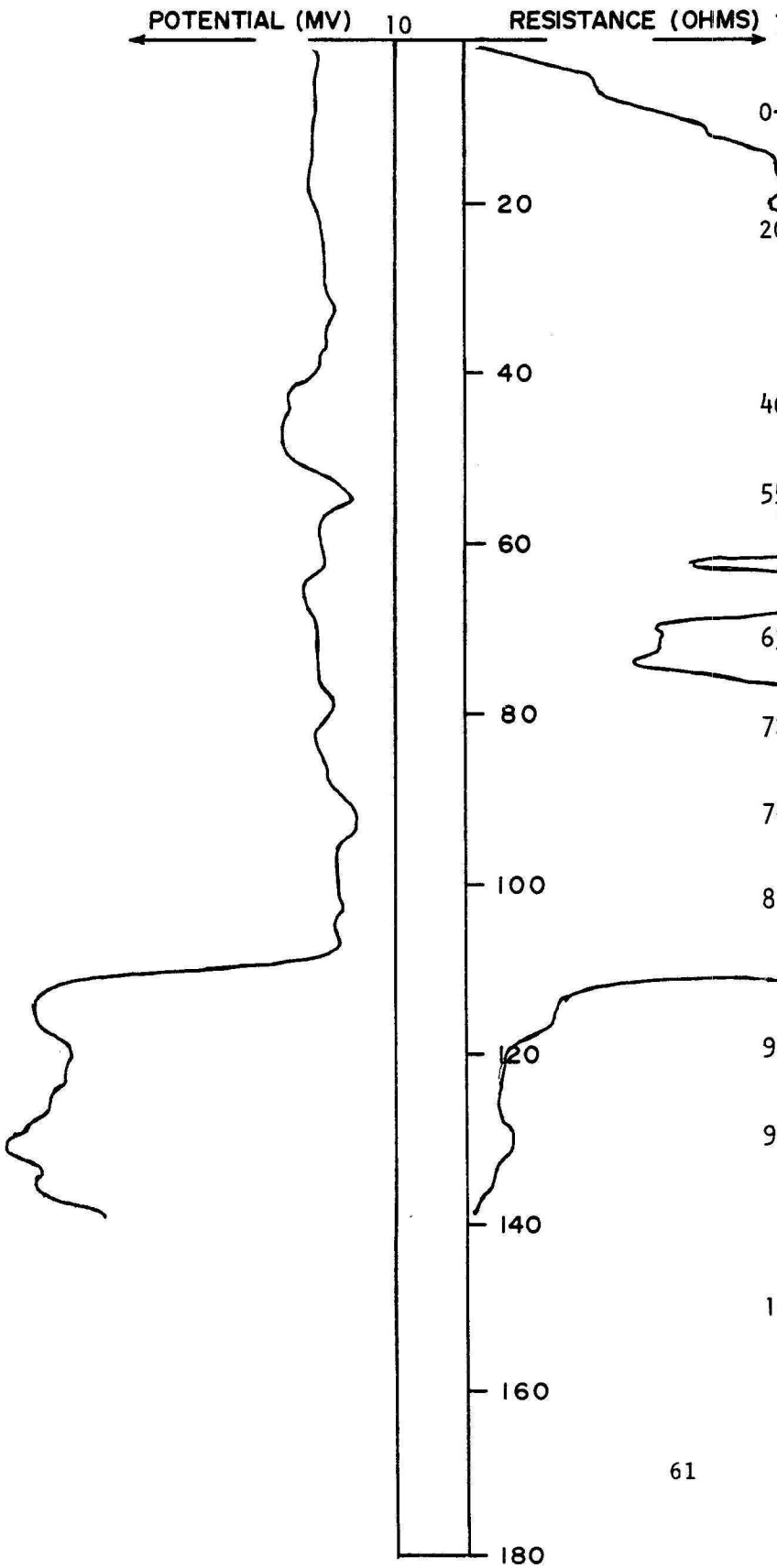
TEST HOLE 9332

LOCATION: 157-71-8CCC

DATE DRILLED: 7-14-75

ELEVATION: (FT, MSL) 1588

DEPTH: (FT) 140



DESCRIPTION OF DEPOSITS

Glacial Drift

0-20 Clay, Silty, sandy, moderate yellowish brown, soft, very slightly plastic, oxidized.

20-46 Sand, very fine to medium, rounded lignitic, clayey to 32 feet.

46-55 Clay, silty, slightly sandy, dark gray, cohesive.

55-63 Sand, very fine to very coarse, angular to subrounded, (about 30-% fine to coarse gravel) lignitic.

63-72 Clay, silty, sandy, pebbly, olive gray, very slighty plastic (till).

72-78 Sand, very fine to coarse, sub-round to rounded, lignitic.

78-87 Silt, very clayey, sandy, medium dark gray slightly plastic.

87-92 Sand, very fine to very coarse, angular to subrounded, predoninantly quartz, lignitic, moderately well-sorted.

92-98 Silt, very clayey, sandy, medium dark gray, slightly plastic.

98-107 Sand, very fine to very coarse, angular to subrounded, lignitic, moderately well-sorted.

Fox Hills Formation

107-140 Clay, very silty, sandy, medium gray, hard, brittle.

Observation Well

Depth: 106 feet
S. I.: 103-106 feet

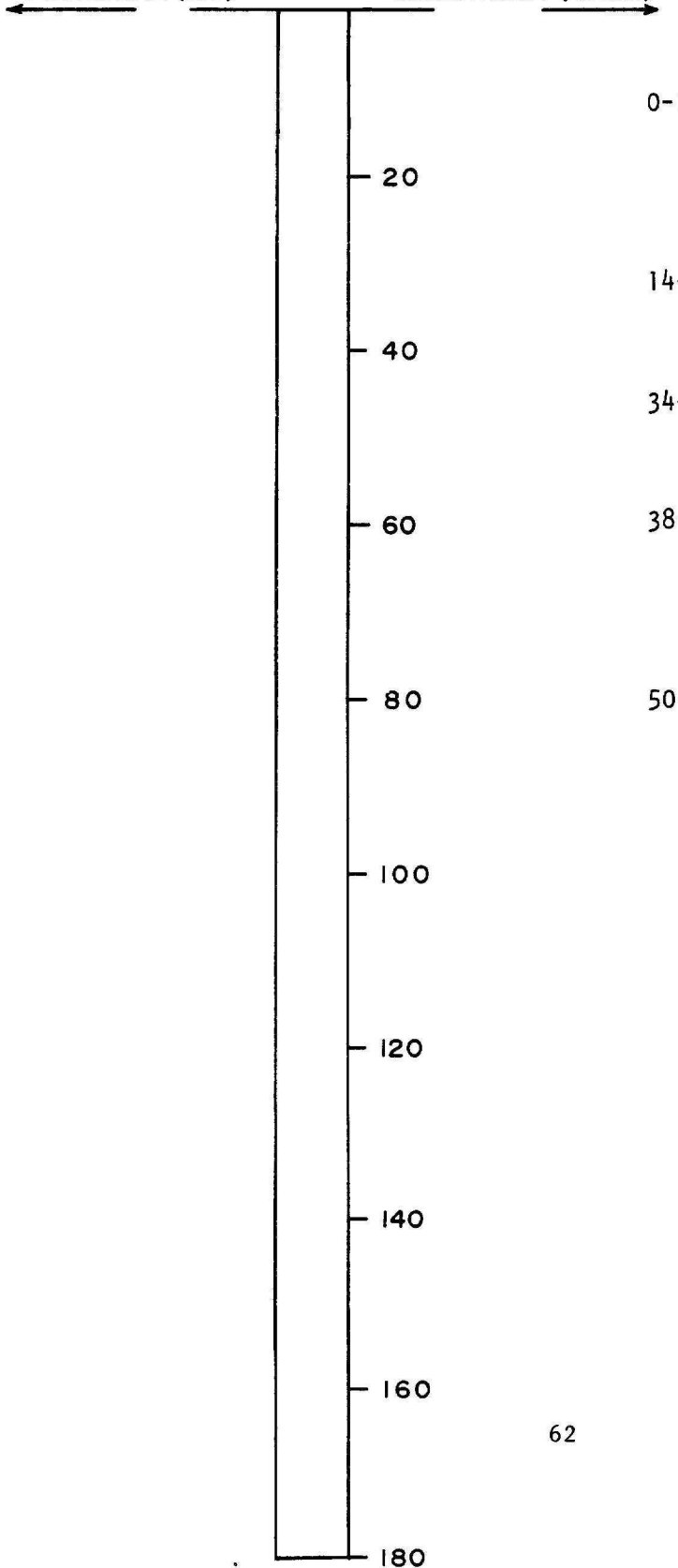
TEST HOLE 9336

LOCATION: 157-71-9CCC

DATE DRILLED: 7-16-75

ELEVATION: (FT, MSL) 1589

DEPTH: (FT) 80



DESCRIPTION OF DEPOSITS

Glacial Drift

0-14 Sand, fine to coarse, predominantly medium, angular to subrounded, mostly quartz, slightly lignitic, oxidized, well-sorted.

14-34 Clay, very sandy, silty, medium gray to dark gray, soft, very slightly plastic (lacustrine).

34-38 Sand, fine to very coarse, angula to subrounded, predominantly. quartz, moderately well-sorted.

38-50 Clay, very silty, slightly sandy, medium dark gray, very slightly plastic.

Fox Hills Formation

50-80 Clay, very sandy, medium light gray to medium gray, hard, friable, silty.

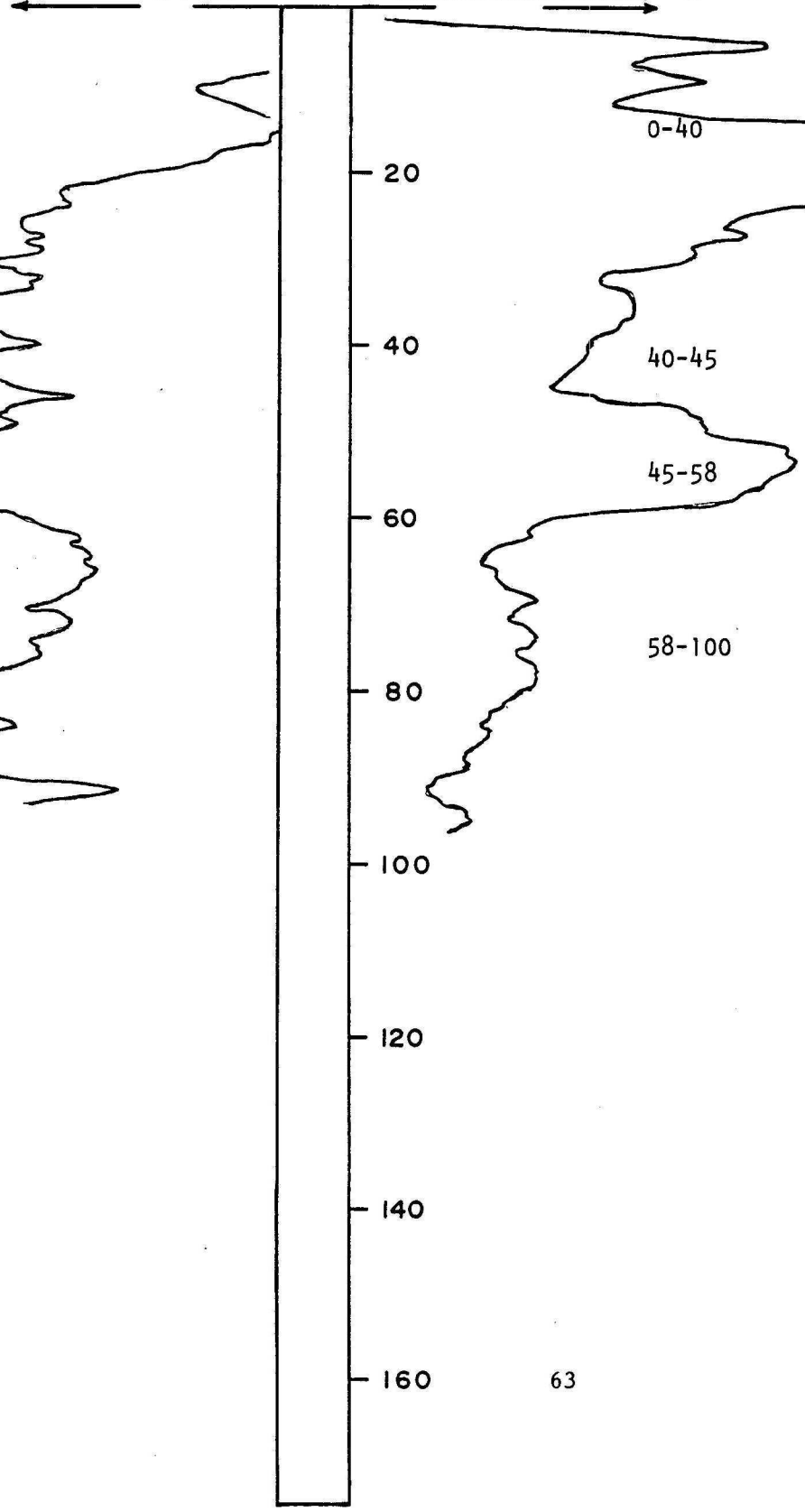
TEST HOLE 9344

LOCATION: 157-71-11CCC

DATE DRILLED: 7-17-75

ELEVATION: (FT, MSL) 1622

DEPTH: (FT) 100



DESCRIPTION OF DEPOSITS

Glacial Drift

0-40 Sand, ~~very fine to very~~ coarse grained, angular to subrounded, (about 10 percent ~~fine~~ to coarse gravel) slightly lignitic, moderately well-sorted, oxidized to 36 feet.

40-45 Clay, silty sandy, medium dark gray, soft, cohesive, very slightly plastic.

45-58 Gravel, medium to coarse, angular to subrounded, (about 40% very fine to very coarse sand).

Fox Hills Formation

58-100 Siltstone, clayey, sandy, medium light gray to pale blue, hard, friable.

Observation Well

Depth: 51 feet
S. I.: 48-51 feet

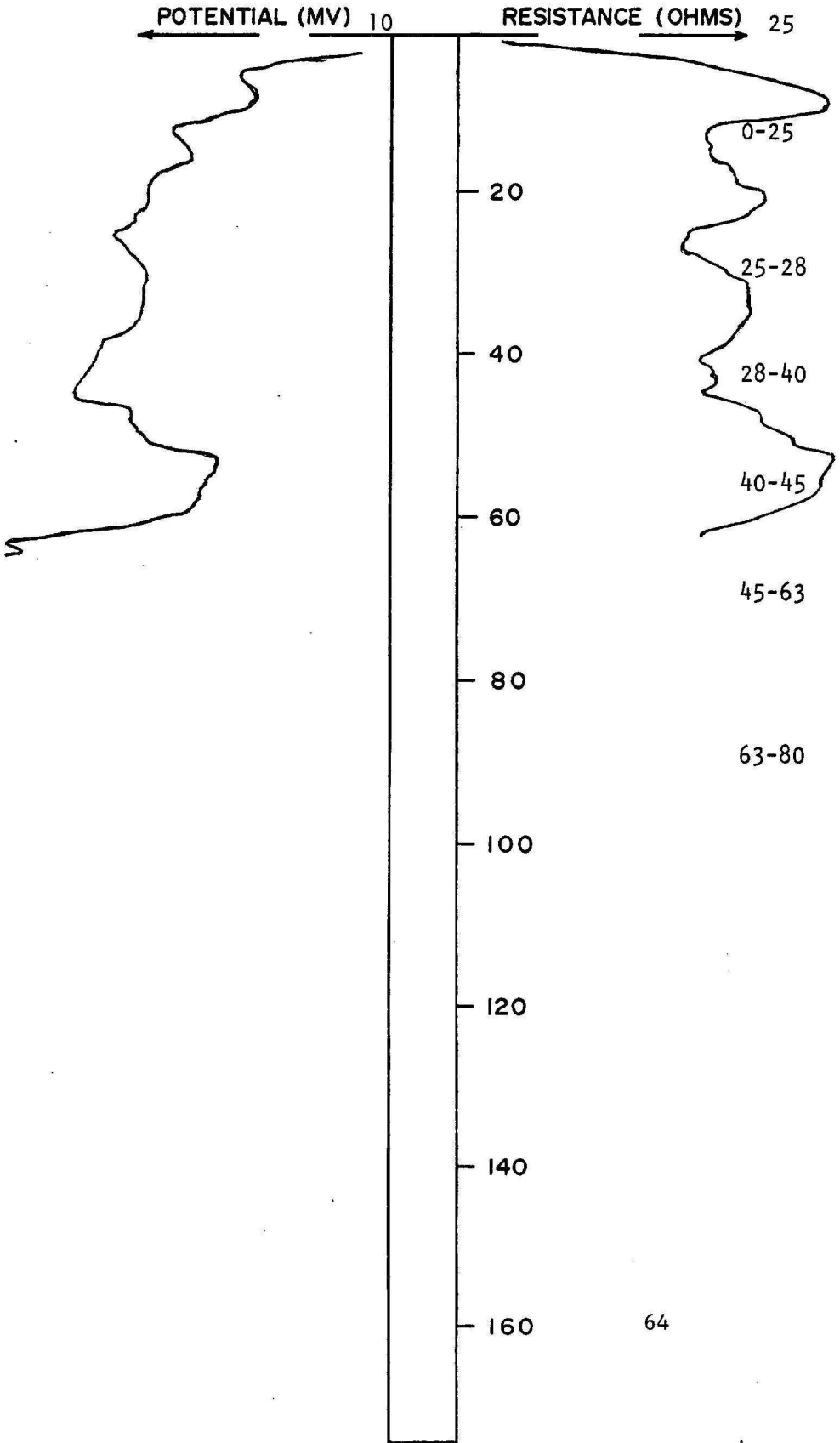
TEST HOLE 9342

LOCATION: 157-71-14CDC

DATE DRILLED: 7-17-75

ELEVATION: 1608
(FT, MSL)

DEPTH: 80
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-25 Sand, fine to very coarse grained, angular to subrounded, slightly lignitic, moderatley well-sorted, oxidized to 21 fee

25-28 Clay, sandy, silty, pebbly, olive gray, ver slightly plastic (till).

28-40 Sand, very fine to coarse grained, angular to rounded, mostly quartx, slightly ligniti

40-45 Clay, silty, sandy, medium dark gray, soft, very slightly plastic.

45-63 Sand, very fine to coarse grained, angular to rounded, mostly quartz, slightly ligniti

Fox Hills Formation

63-80 Siltstone, clayey, sandy, mediu light to medium dark gray, hard, friable.

Observation Well

Depth: 61 feet
S. I.: 58-61 feet

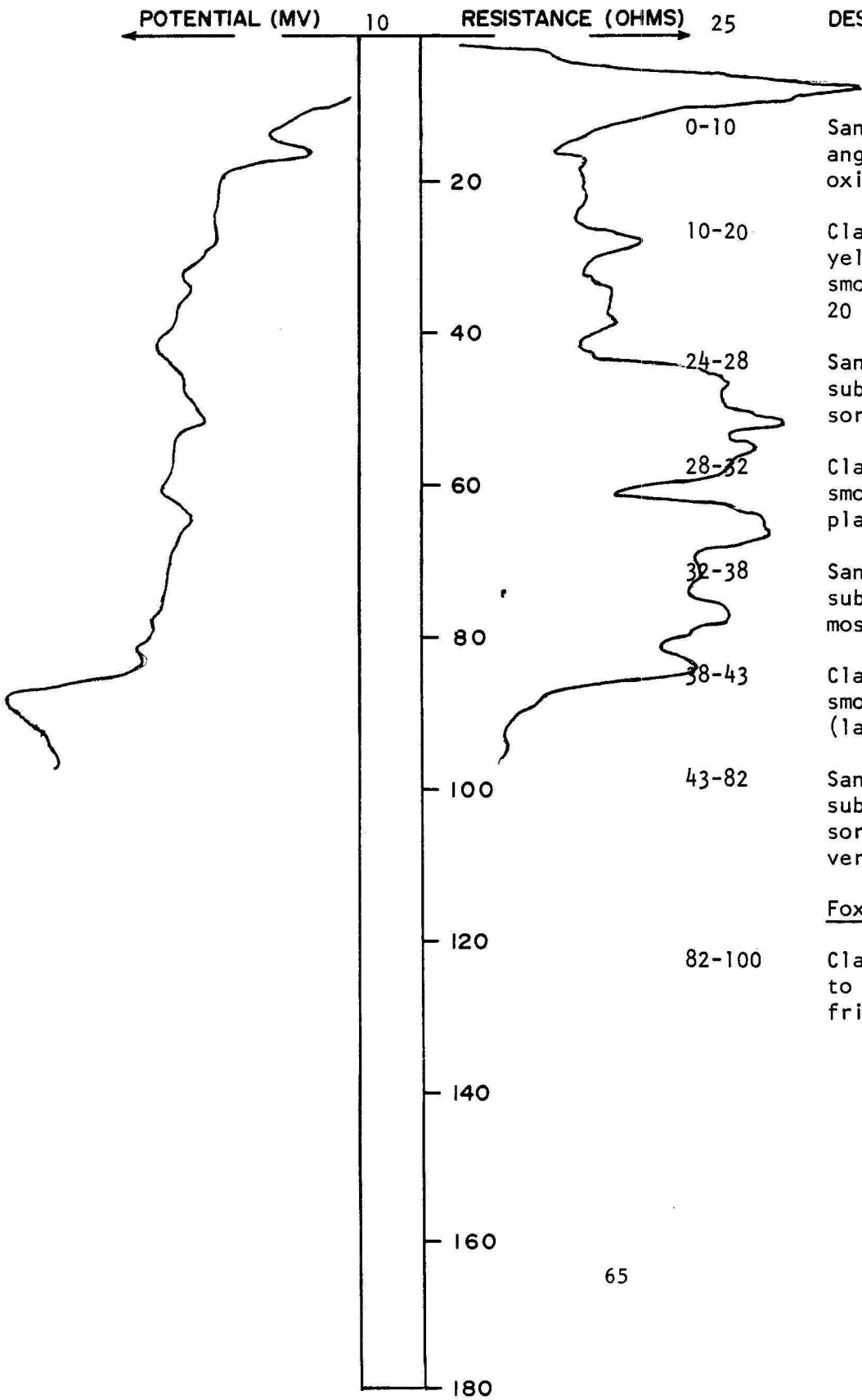
TEST HOLE 9409

LOCATION: 157-71-15CCC

DATE DRILLED: 8-14-75

ELEVATION: (FT, MSL) 1612

DEPTH: (FT) 100



DESCRIPTION OF DEPOSITS

Glacial Drift

0-10 Sand, fine to very coarse grained angular to subrounded, well-sorted oxidized, taking water.

10-20 Clay, silty, sandy, moderate yellowish brown to medium gray smooth, cohesive, oxidized to 20 feet (lacustrine).

24-28 Sand, fine to coarse grained, subangular to subrounded, well-sorted.

28-32 Clay, silty, sandy, medium gray, smooth, cohesive, slightly plastic (lacustrine).

32-38 Sand, fine to coarse grained, subangular to subrounded, mostly quartz.

38-43 Clay, silty, sandy, medium gray, smooth, slightly plastic (lacustrine).

43-82 Sand, fine to very coarse grained, subangular to subrounded, well-sorted, with clay layer 57-59 feet very gravelly 76-82 feet.

Fox Hills Formation

82-100 Clay, sandy, silty, medium gray to light bluish gray, tight, friable.

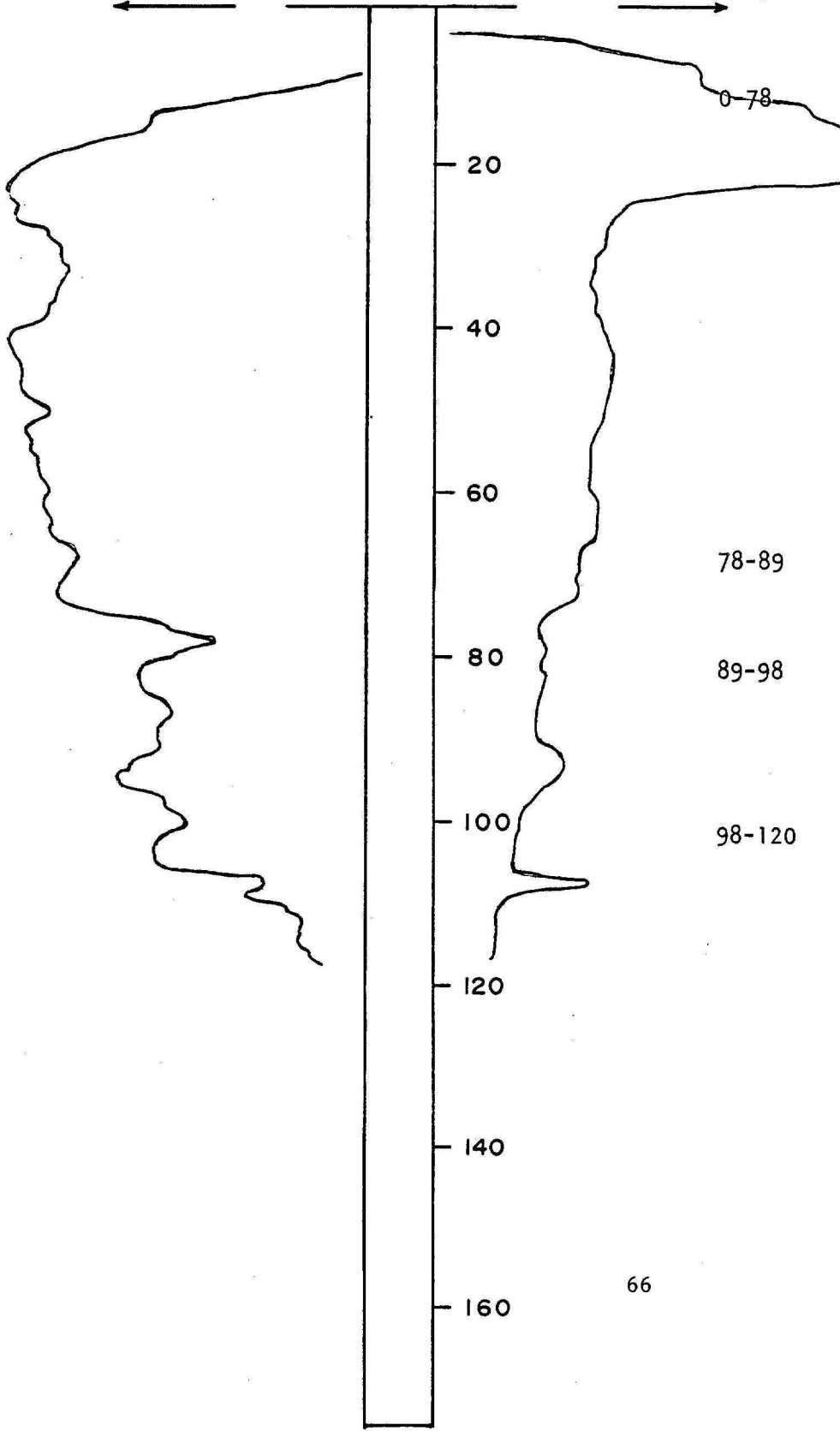
TEST HOLE 9343

LOCATION: 157-71-15DDD

DATE DRILLED: 7-17-75

ELEVATION: 1625
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-78 Sand, very fine to very coarse grained, angular to subrounded, (about 10 percent medium to coarse gravel), moderately well-sorted, mixed 2 bags of mud, oxidized to 40 feet.

78-89 Clay, very silty, sandy, medium dark gray, moderately cohesive.

89-98 Clay, sandy, silty, pebbly, gravelly, olive gray (till).

Fox Hills Formation

98-120 Siltstone, clayey, sandy, medium light to medium dark gray, with an indurated sandstone from 106 to 108 feet.

Observation Well

Depth: 71 feet
S. I.: 68-71 feet

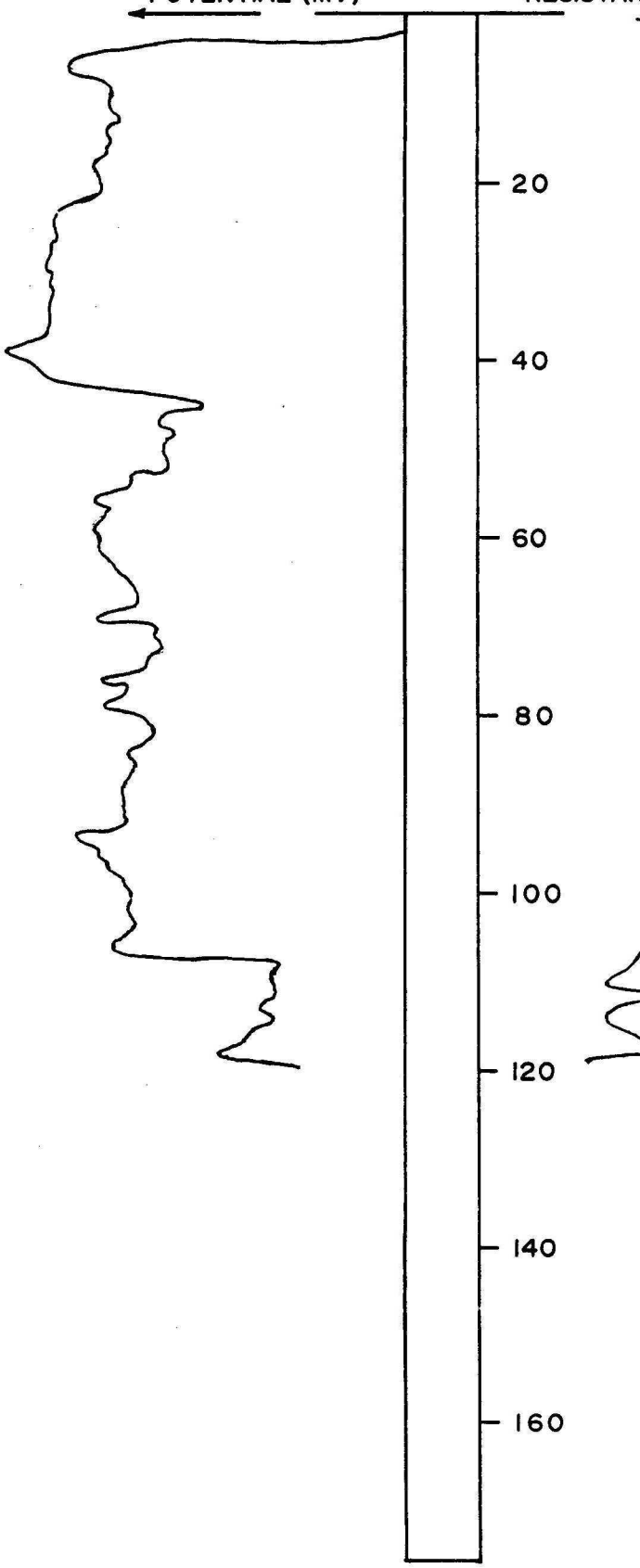
TEST HOLE 9337

LOCATION: 157-71-16CCC

DATE DRILLED: 7-16-75

ELEVATION: (FT, MSL) 1593

DEPTH: (FT) 120



DESCRIPTION OF DEPOSITS

Glacial Drift

0-9 Sand, very fine to coarse predominantly medium, angular to rounded, slightly lignitic, moderately well-sorted, oxidized.

9-69 Silt, very clayey, sandy, medium dark gray, slightly plastic.

69-106 Clay, sandy, silty, pebbly, olive gray, tight, very slightly plastic (till).

Fox Hills Formation

106-120 Sandstone, clayey, silty, medium light to medium dark gray, hard, friable.

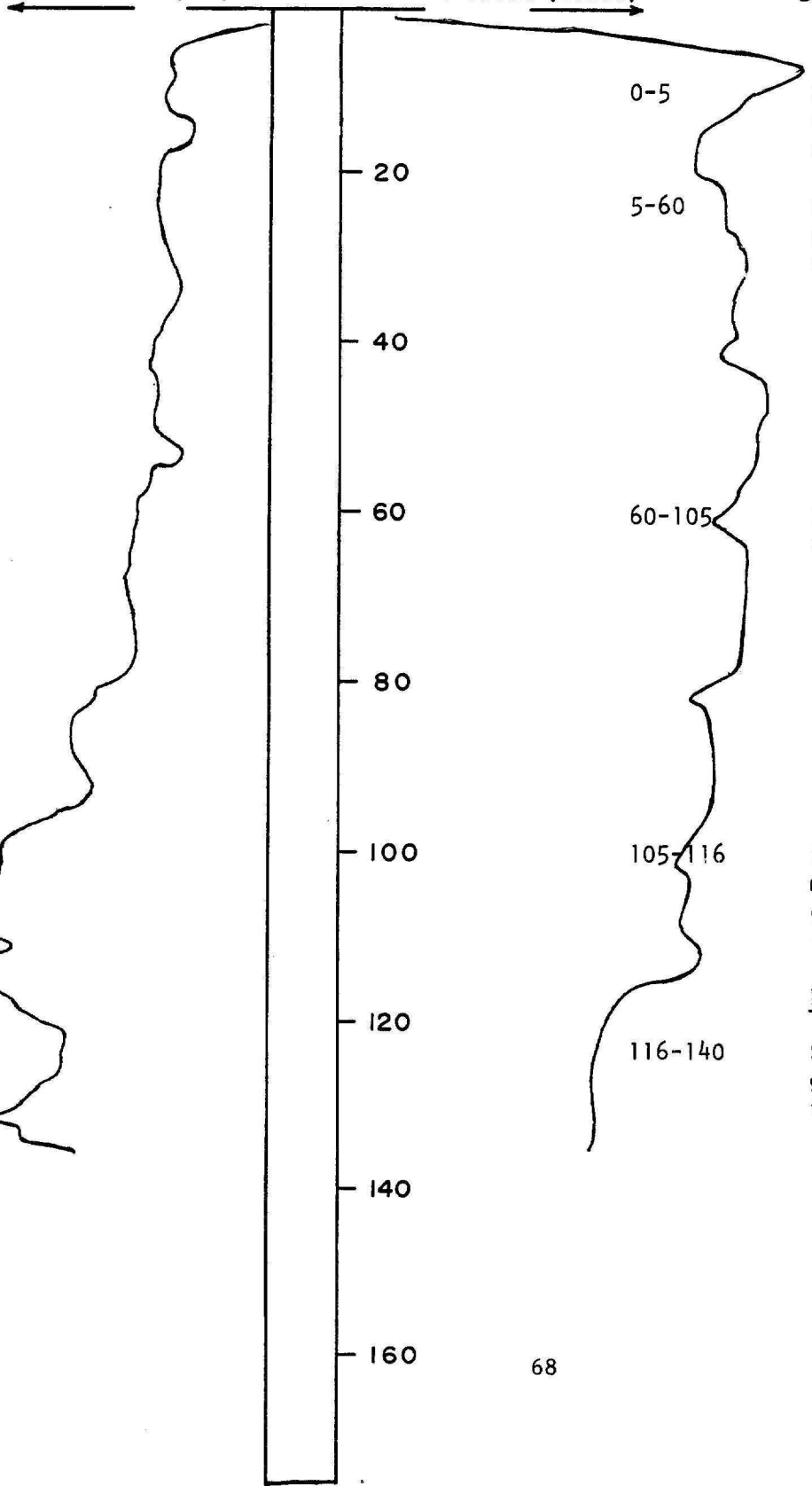
TEST HOLE 9333

LOCATION: 157-71-19AAA

DATE DRILLED: 7-15-75

ELEVATION: 1590
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-5 Clay, very sandy, silty, dark yellowish brown, soft, oxidized.

5-60 Sand, very fine to medium grained, rounded, well-sorted oxidized to 20 feet.

60-105 Clay, very sandy, silty, dark gray, slightly plastic.

105-116 Clay, silty, sandy, pebbly, medium dark gray to olive gray, very slightly plastic (till).

Fox Hills Formation

116-140 Siltstone, light to medium gray, clayey, sandy, hard, friable.

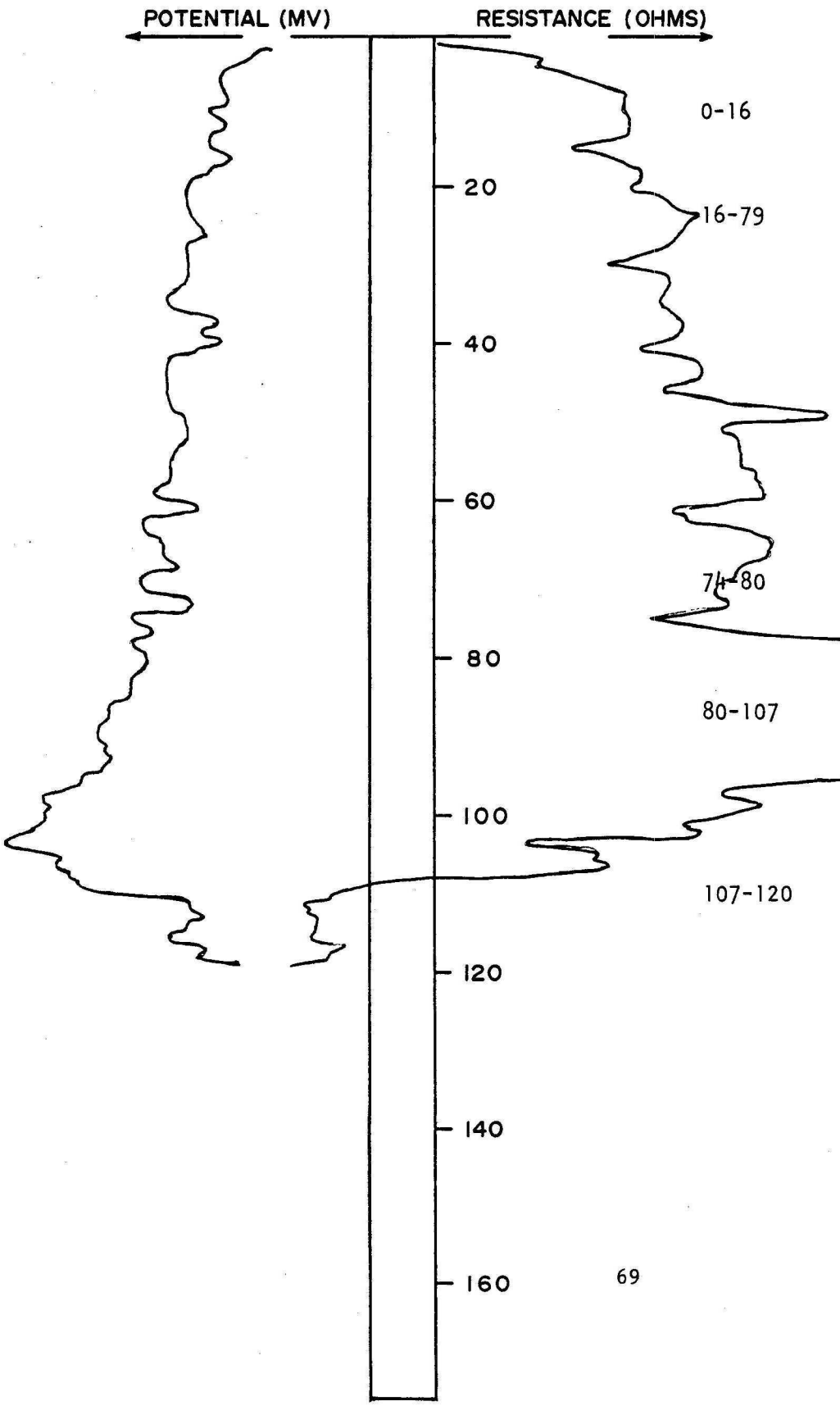
TEST HOLE 9338

LOCATION: 157-71-20DDD

DATE DRILLED: 7-17-75

ELEVATION: 1587
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-16 Clay, very silty, sandy, moderate yellowish brown, soft, very slightly plastic, oxidized.

16-79 Clay, very silty, slightly sandy, medium dark gray, soft, poor sample return.

79-80 Sand, fine to very coarse, angular to subrounded, slightly lignitic, moderately well-sorted.

80-107 Clay, silty, sandy, pebbly, with interbedded gravel layers, medium dark to olive gray, very slightly plastic (till).

Fox Hills Formation

107-120 Siltstone, clayey, sandy, medium light to medium dark gray, hard, friable.

No Observation Well

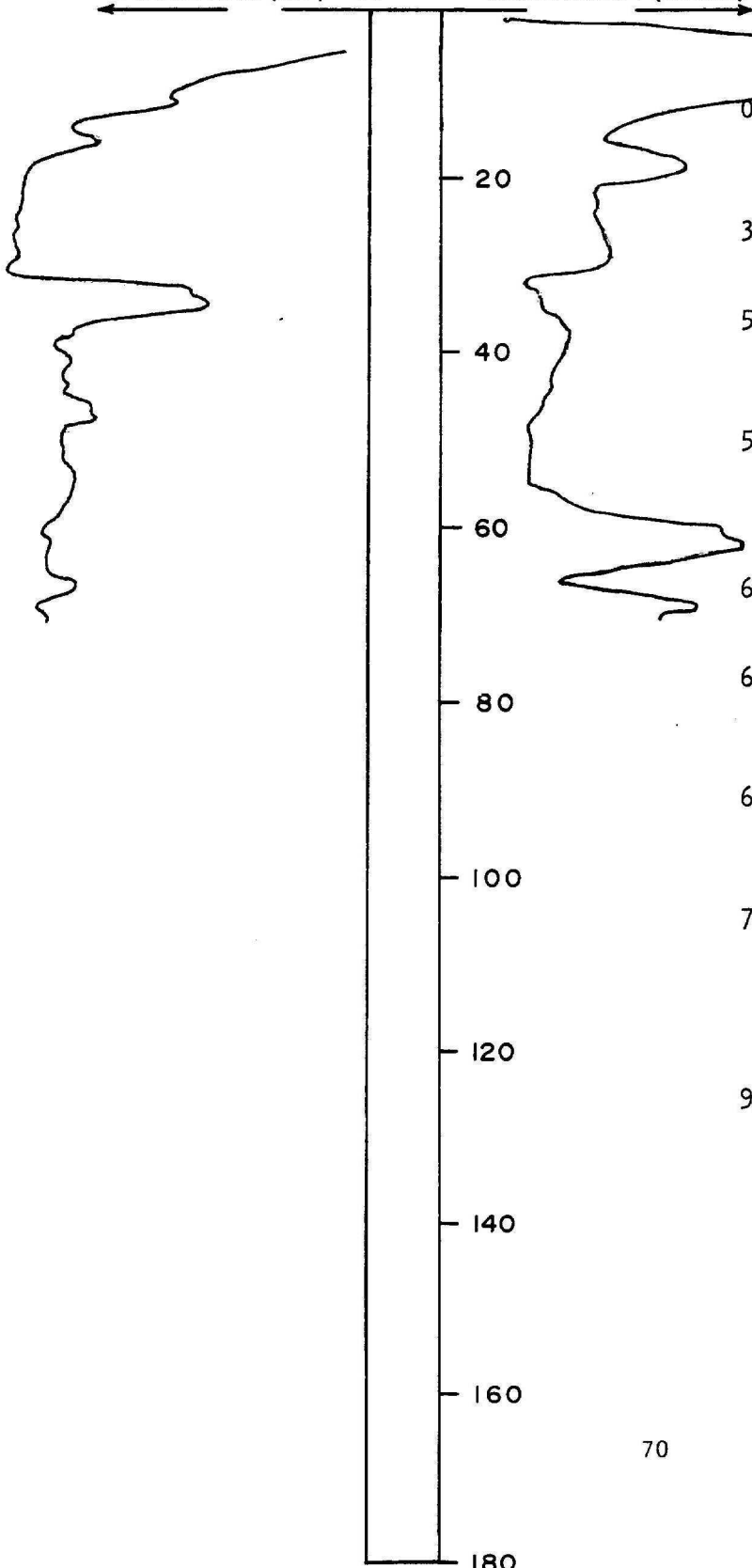
TEST HOLE 9410

LOCATION: 157-71-21ADD

DATE DRILLED: 8-14-75

ELEVATION: 1604
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-32	Sand, fine to coarse grained, subangular to subrounded, oxidized to 20 feet, well-sorted.
32-51	Clay, very silty, sandy, medium gray, smooth, soft (lacustrine).
51-56	Clay, sandy, silty, pebbly, olive gray, tight, cohesive very slightly plastic (till).
56-64	Gravel, fine to coarse, angular to subrounded, (about 30% fine to very coarse grained sand), shaley.
64-66	Clay, silty, sandy, medium gray, tight, slightly plastic.
66-69	Sand, fine to very coarse grained subangular to subrounded, prodominantly quartz, well-sorted
69-75	Clay, sandy, silty,pebbly, olive gray, tight, very slightly plastic (till).
75-93	Clay, very silty, sandy, medium gray, tight, slightly plastic smooth (lacustrine)

Fox Hills Formation

93-120	Sandstone, clayey, silty, light gray to light bluish gray, tight, friable.

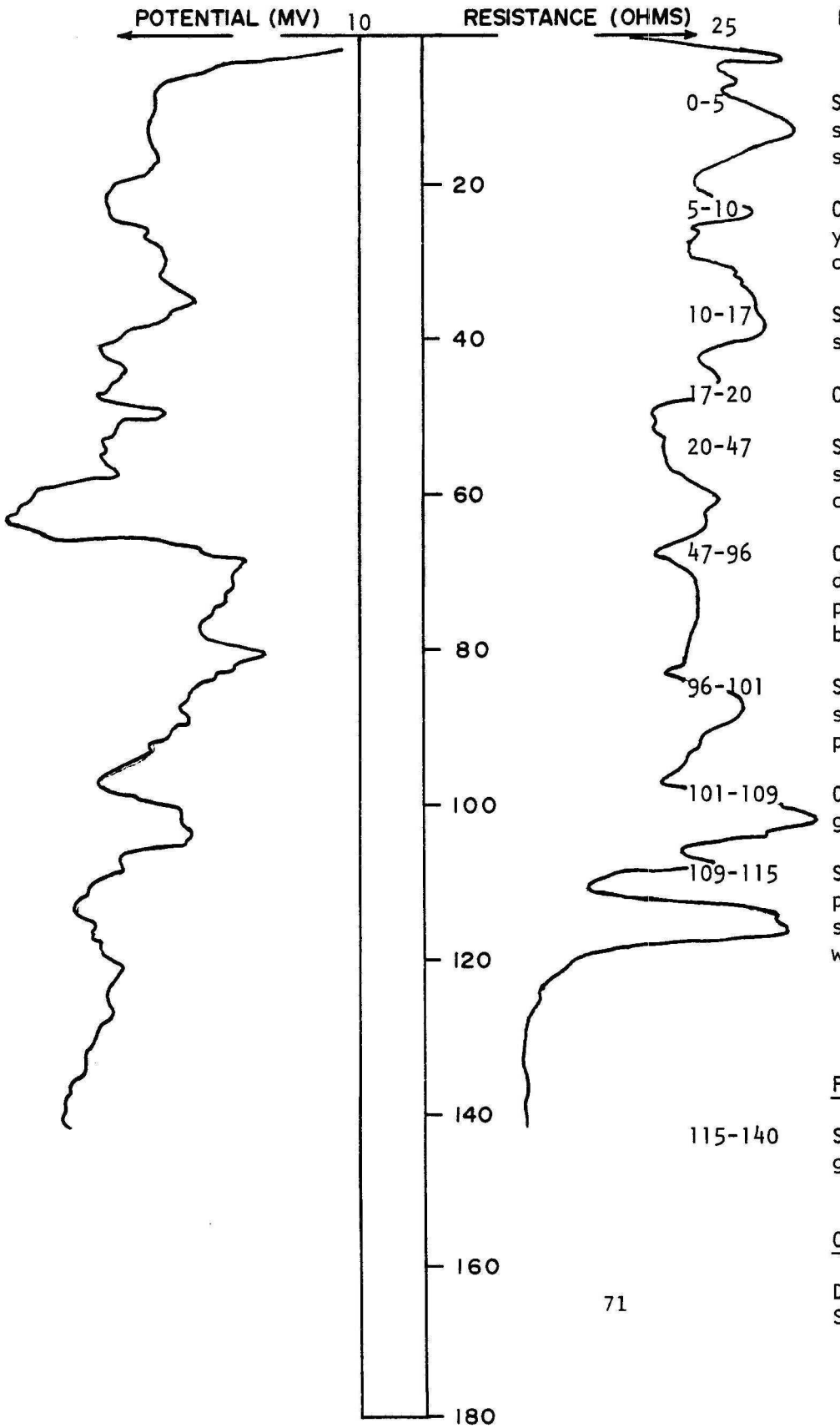
TEST HOLE 9411

LOCATION: 157-71-21DCC

DATE DRILLED: 8-18-75

ELEVATION: (FT, MSL) 1596

DEPTH: (FT) 140



DESCRIPTION OF DEPOSITS

Glacial Drift

0-5 Sand, very fine to fine grained, subangular to rounded, well-sorted, oxidized.

5-10 Clay, very silty, sandy, moderate yellowish brown, soft, smooth, cohesive, oxidized.

10-17 Sand, very fine to medium grained subangular to rounded, lignitic.

17-20 Clay, as above, medium dark gray.

20-47 Sand, very fine to medium grained subangular to rounded, with a clay layer 37-39 feet.

47-96 Clay very silty, sandy, medium dark gray, soft smooth, slightly plastic, with several small interbedded sand layers (lacustrine).

96-101 Sand, very fine to medium grained, subangular to subrounded, predoninantly quartz, well-sorted.

101-109 Clay, very silty, sandy, medium gray, soft, slightly cohesive.

109-115 Sand, fine to very coarse grained predomina ly coarse, angular to subrounded. lignitic, moderately well-sorted.

Fox Hills Formation

115-140 Shale, sandy, silty, medium gray, hard, tight, brittle.

Observation Well

Depth: 115 feet
S. I.: 112-115 feet

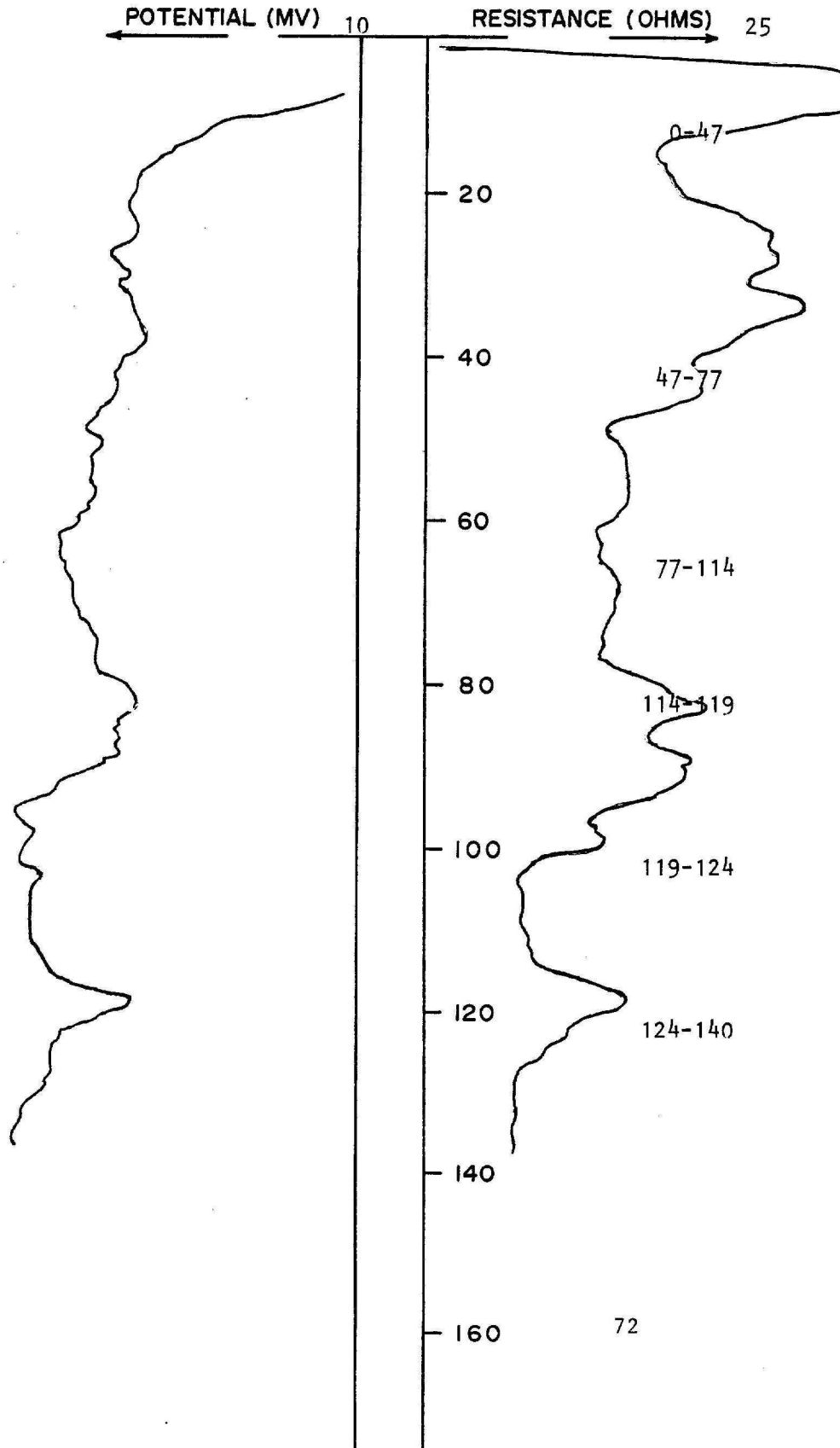
TEST HOLE 9414

LOCATION: 157-71-22ABB

DATE DRILLED: 8-19-75

ELEVATION: 1612
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-47 Sand, fine-to very coarse-grained, predominantly coarse, angular to subrounded, moderatel well-sorted, oxidized to 10 feet

47-77 Silty, sandy, clayey, medium gray, soft, smooth (lacustrine).

77-114 Clay, sandy, silty, pebbly, oliv gray, tight, slightly plastic (till) - possible reworked Fox Hills 104-114 feet.

114-119 Gravel, fine to coarse, angular to subrounded, (about 40 percent fine to very coarse sand).

119-124 Clay, sandy, silty, pebbly, oliv gray, tight, very slightly plastic (till).

Fox Hills Formation

124-140 Siltstone, clayey, sandy, medium gray to brownish gray, hard, tight, friable.

Observation Well

Depth: 46 feet
S. I.: 43-46 feet

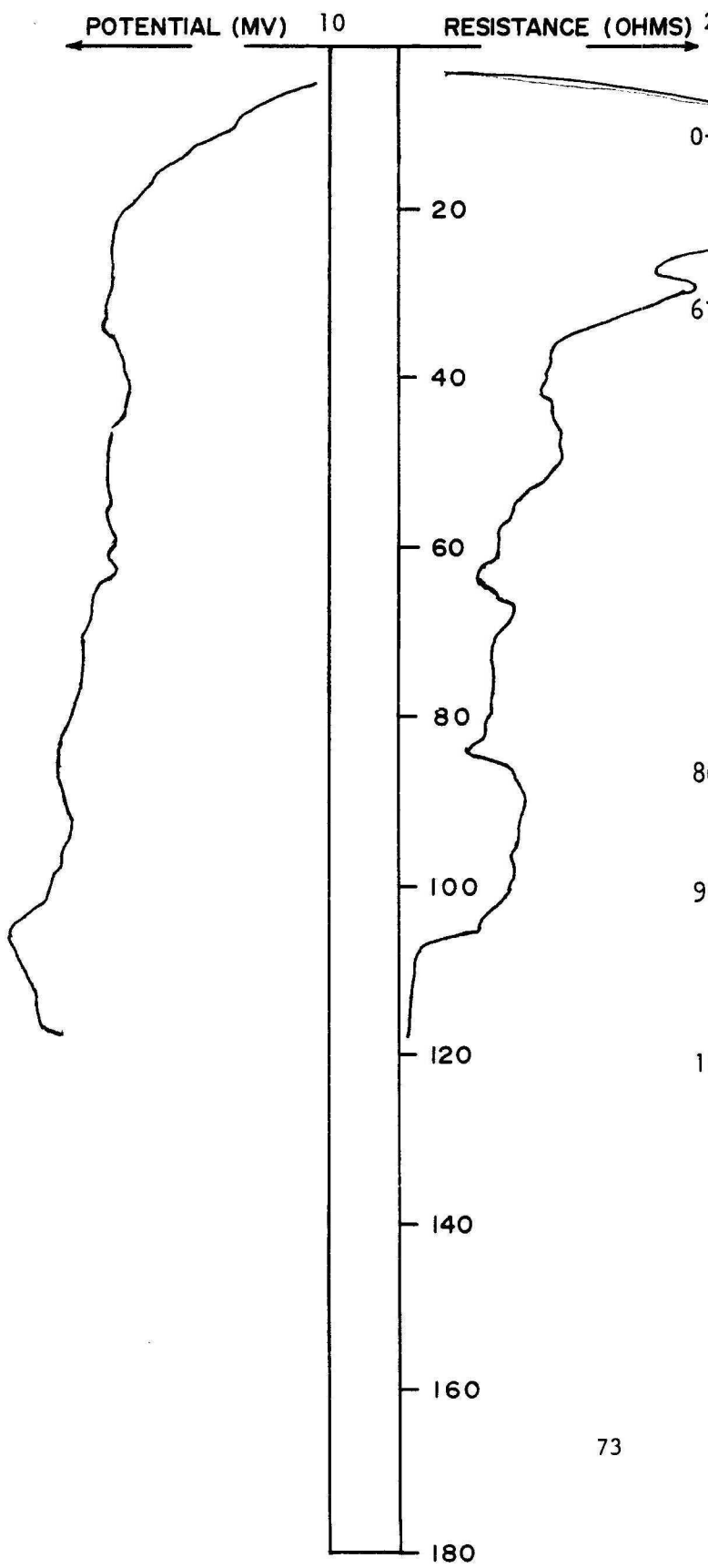
TEST HOLE 9412

LOCATION: 157-71-22CCB

DATE DRILLED: 8-18-75

ELEVATION: 1614
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-67 Sand, fine to very coarse grained predoninantly medium to coarse, angular to subrounded, mostly quartz, lignitic, moderately well-sorted, oxidized to 35 feet.

67-80 Clay, very silty, sandy, medium gray, soft, with several interbedded sand layers.

80-98 Sand, fine to coarse grained subangular to subrounded, slightly lignitic, well-sorted.

98-103 Clay, sandy, silty, pebbly, olive gray, very slightly plastic (till).

Fox Hills Formation

103-120 Sandstone, fine grained, clayey silty, medium gray, to medium bluish gray, hard, tight, brittle.

Observation Well

Depth: 96 feet
S. I.: 93-96 feet.

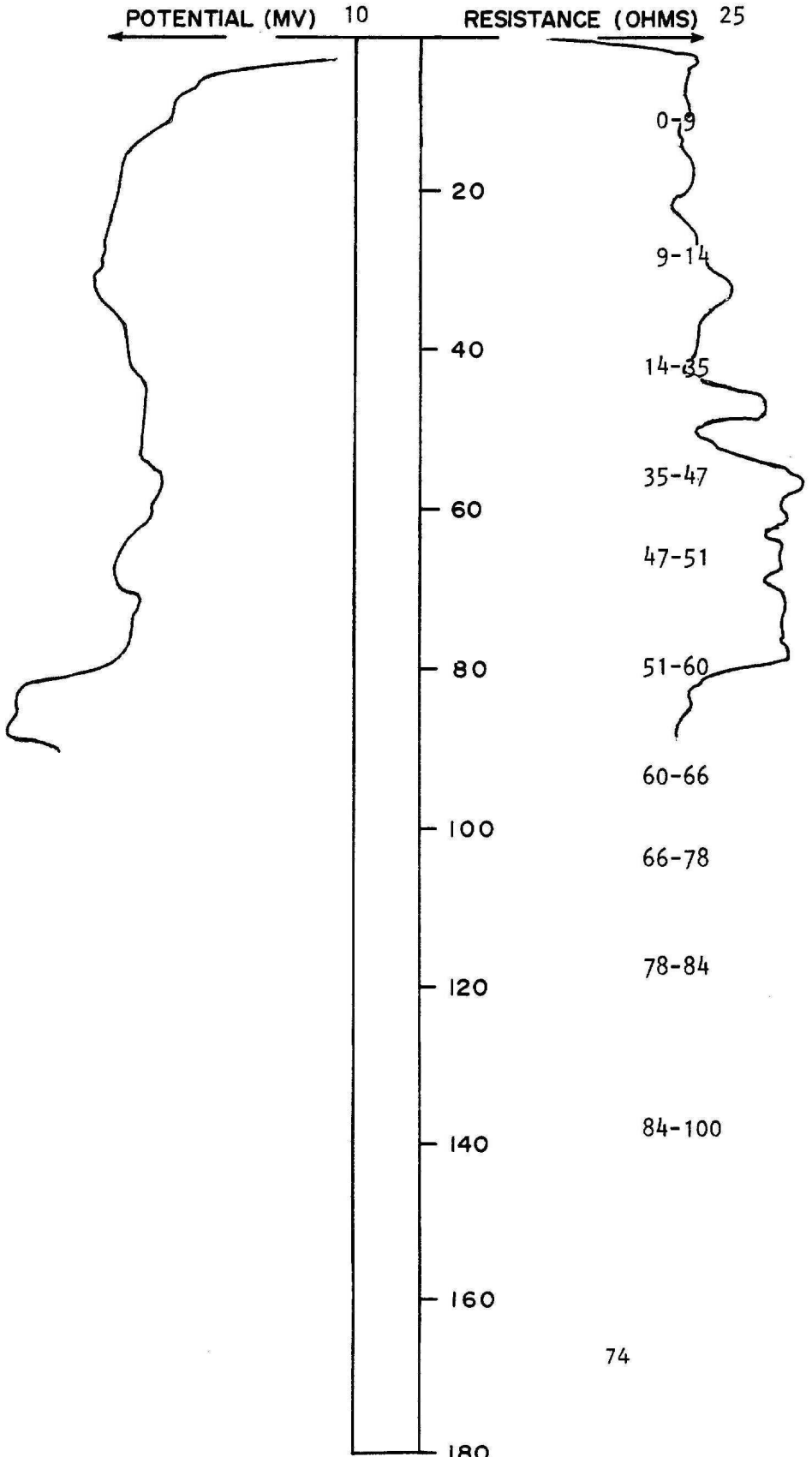
TEST HOLE 9413

LOCATION: 157-71-22CDD

DATE DRILLED: 8-18-75

ELEVATION: 1599
(FT, MSL)

DEPTH: 100
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-9 Sand, fine-to very coarse-grained subangular to subrounded, predominantly quartz, well-sorted oxidized.

9-14 Clay, silty, sandy, pebbly, olive gray, cohesive, slightly plastic (till).

14-35 Sand, fine-to very coarse-grained angular to subrounded moderately well-sorted, slightly lignitic.

35-47 Silt, sandy, clayey, medium gray soft.

47-51 Clay, sandy, silty, pebbly, olive gray, cohesive very slightly plastic (till).

51-60 Sand, fine-to coarse-grained, subangular to subrounded, predominantly quartz, well-sorted.

60-66 Clay, sandy, silty, pebbly, olive gray (till).

66-78 Sand, fine-to very coarse-grained predominantly coarse, gravelly, moderately well-sorted.

78-84 Clay, sandy, silty, pebbly, olive gray, tight, very slightly plastic (till).

Fox Hills Formation

84-100 Shale, sandy, silty, medium to brownish gray, hard, tight, friable.

Observation Well

Depth: 73 feet
S. I.: 70-73 feet

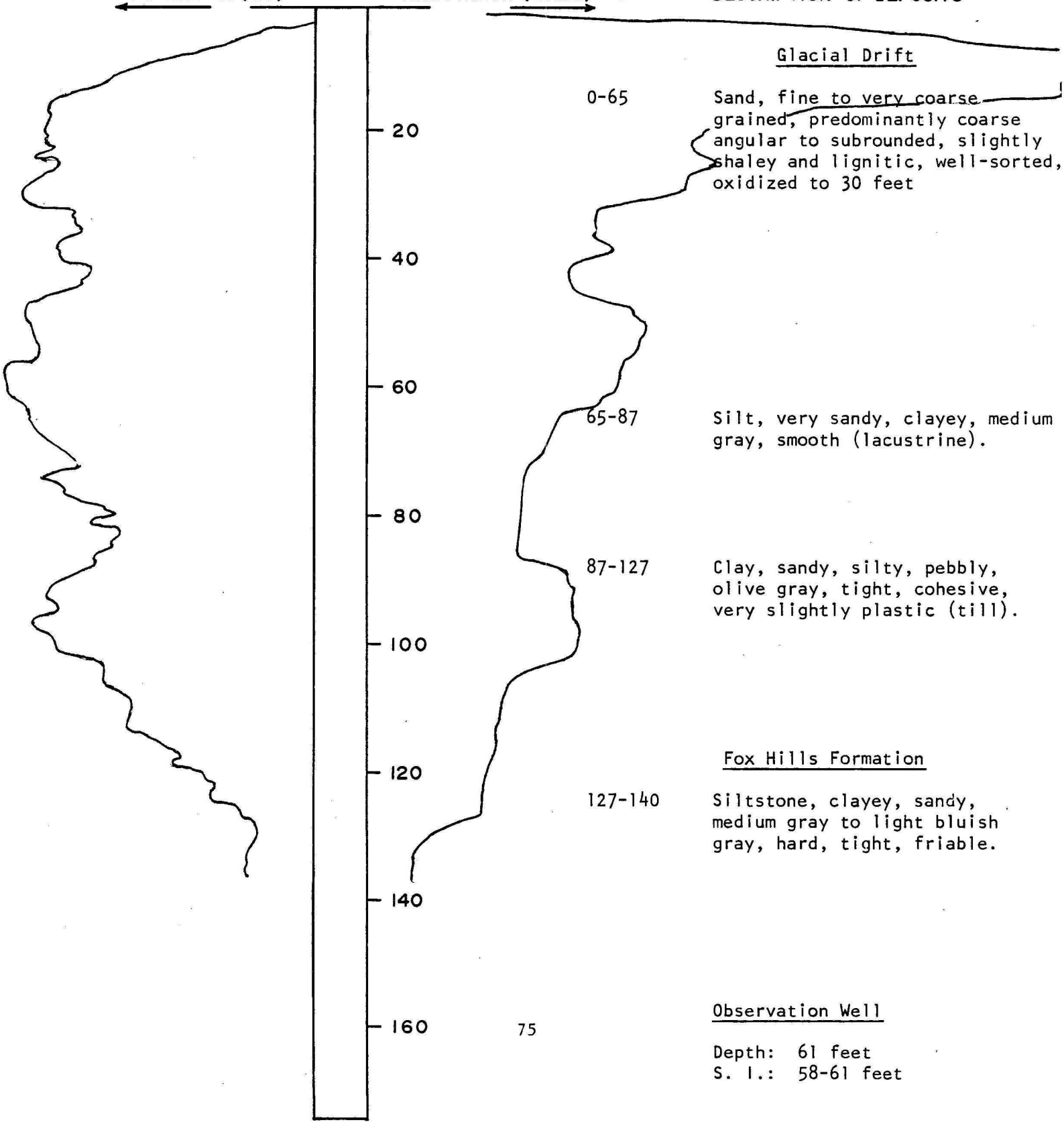
TEST HOLE 9419

LOCATION: 157-71-23CBB

DATE DRILLED: 8-20-75

ELEVATION: (FT, MSL) 1617

DEPTH: (FT) 1617



DESCRIPTION OF DEPOSITS

Glacial Drift

0-65 Sand, fine to very coarse grained, predominantly coarse angular to subrounded, slightly shaley and lignitic, well-sorted, oxidized to 30 feet

65-87 Silt, very sandy, clayey, medium gray, smooth (lacustrine).

87-127 Clay, sandy, silty, pebbly, olive gray, tight, cohesive, very slightly plastic (till).

Fox Hills Formation

127-140 Siltstone, clayey, sandy, medium gray to light bluish gray, hard, tight, friable.

Observation Well

Depth: 61 feet
S. I.: 58-61 feet

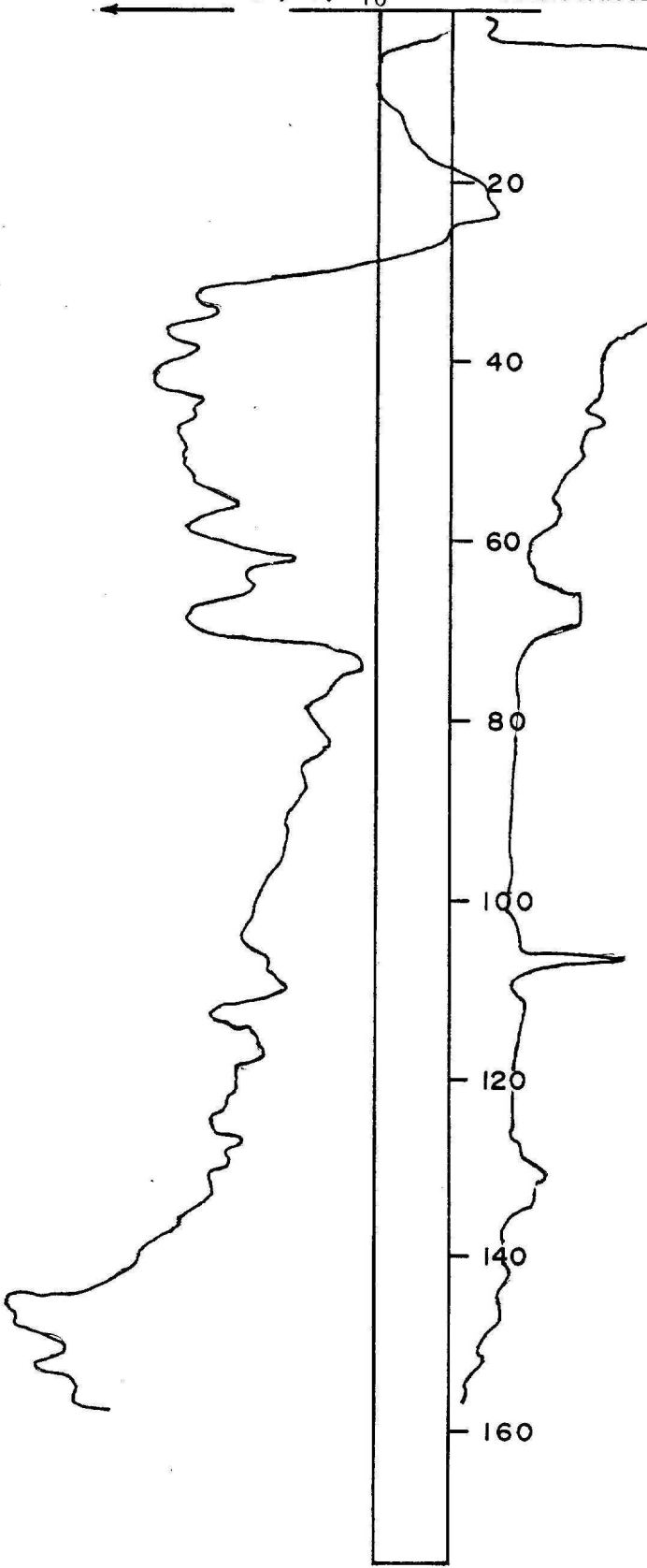
TEST HOLE 9417

LOCATION: 157-71-26BAA

DATE DRILLED: 8-19-75

ELEVATION: 1633
(FT, MSL)

DEPTH: 160
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-6 Clay, silty, sandy, dark yellowish orange, soft, cohesive oxidized (lacustrine).

6-59 Sand, fine-to very coarse-grained, predominantly coarse, angular to subrounded, oxidized to 40 feet.

59-70 Silt, very sandy, clayey, medium-gray, cohesive, very slightly plastic (lacustrine).

70-145 Clay, sandy, silty, pebbly, oliv gray, tight, cohesive, very slightly plastic (till).

Fox Hills Formation

145-160 Siltstone, clayey, sandy, medium gray to brownish gray, hard, tight, friable, with indurated sandstone layers.

Observation Well

Depth: 56 feet
S. I.: 53-56 feet

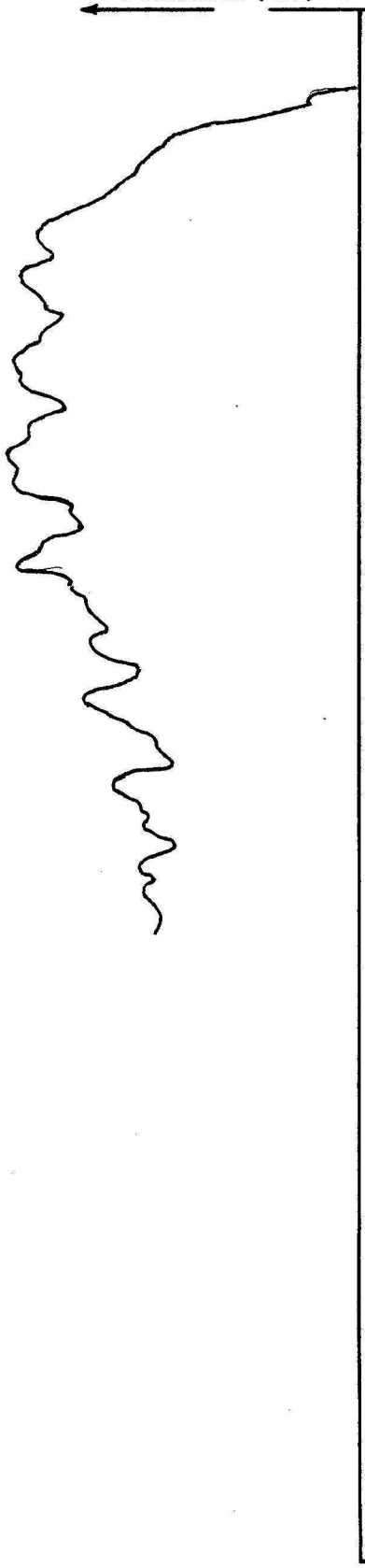
TEST HOLE 9418

LOCATION: 157-71-26BBA

DATE DRILLED: 8-20-75

ELEVATION: 1626
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-57 Sand, fine-to very coarse grained, predominantly coarse, angular to subrounded, gravelly, moderately to well-sorted, oxidized to 40 feet.

57-59 Clay, sandy, silty, medium gray, slightly cohesive.

59-64 Sand, very fine-to coarse-grained, subangular to sub-rounded, predominantly quartz, well-sorted.

64-120 Clay, very sandy, silty, medium dark gray to olive gray, tight, cohesive, very slightly plastic, numerous interbedded layers of sand and gravel-terminated hole at 120 feet due to a granite boulder.

Observation Well

Depth: 55 feet
S. I.: 52-55 feet

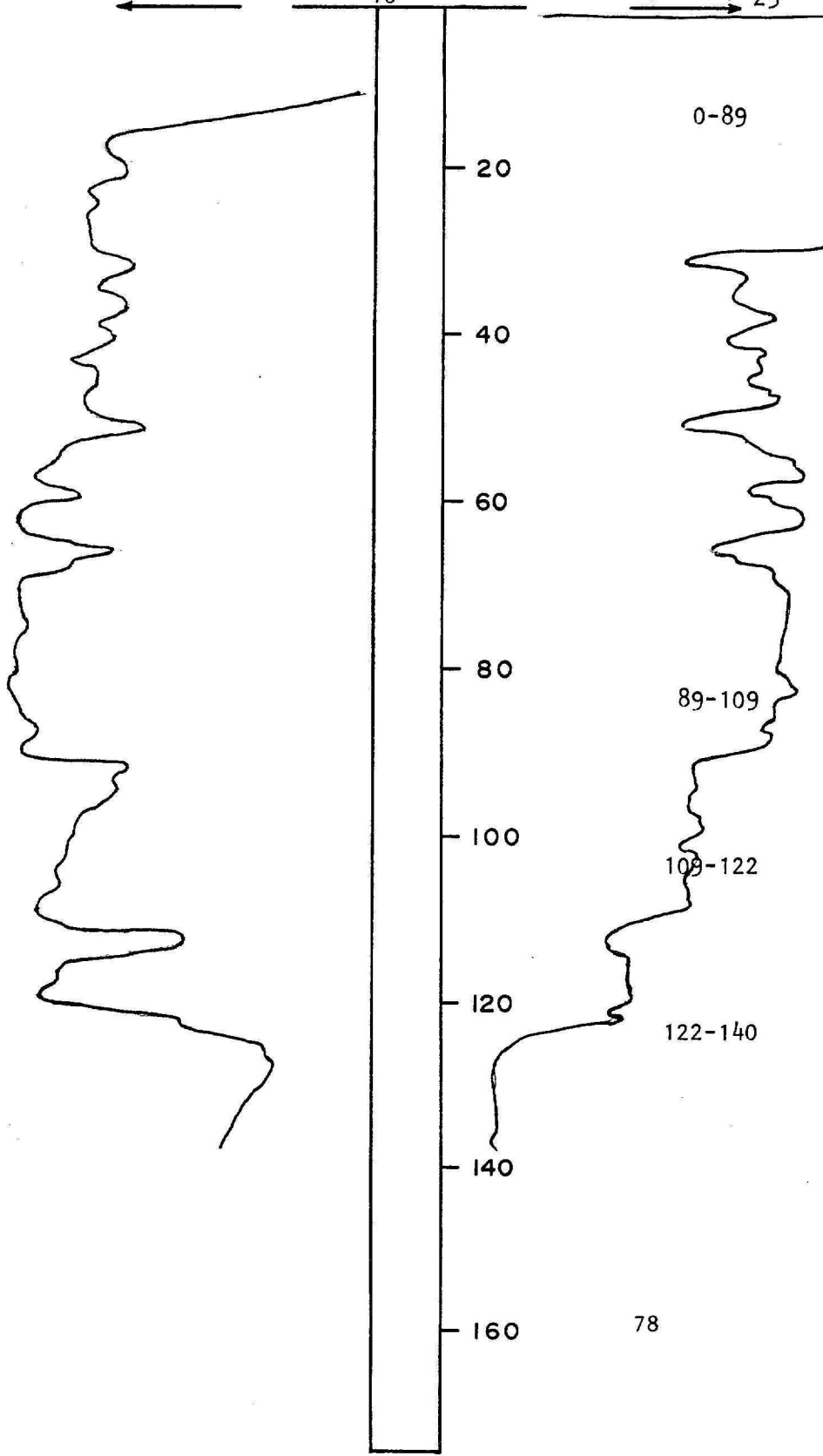
TEST HOLE 9416

LOCATION: 157-71-26BCB

DATE DRILLED: 8-19-75

ELEVATION: 1614
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-89 Sand, fine-to very coarse-grained, predominantly coarse, angular to subrounded, (about 15 percent fine to coarse gravel) lignitic, well-sorted.

89-109 Silt, very sandy, clayey, medium gray, soft, slightly cohesive (lacustrine).

109-122 Clay, sandy, silty, pebbly, Olive gray, tight, very slightly plastic (till).

Fox Hills Formation

122-140 Siltstone, clayey, sandy, medium gray, to medium bluish gray, hard, tight, friable.

Observation Well

Depth: 81 feet
S. I.: 78-81 feet

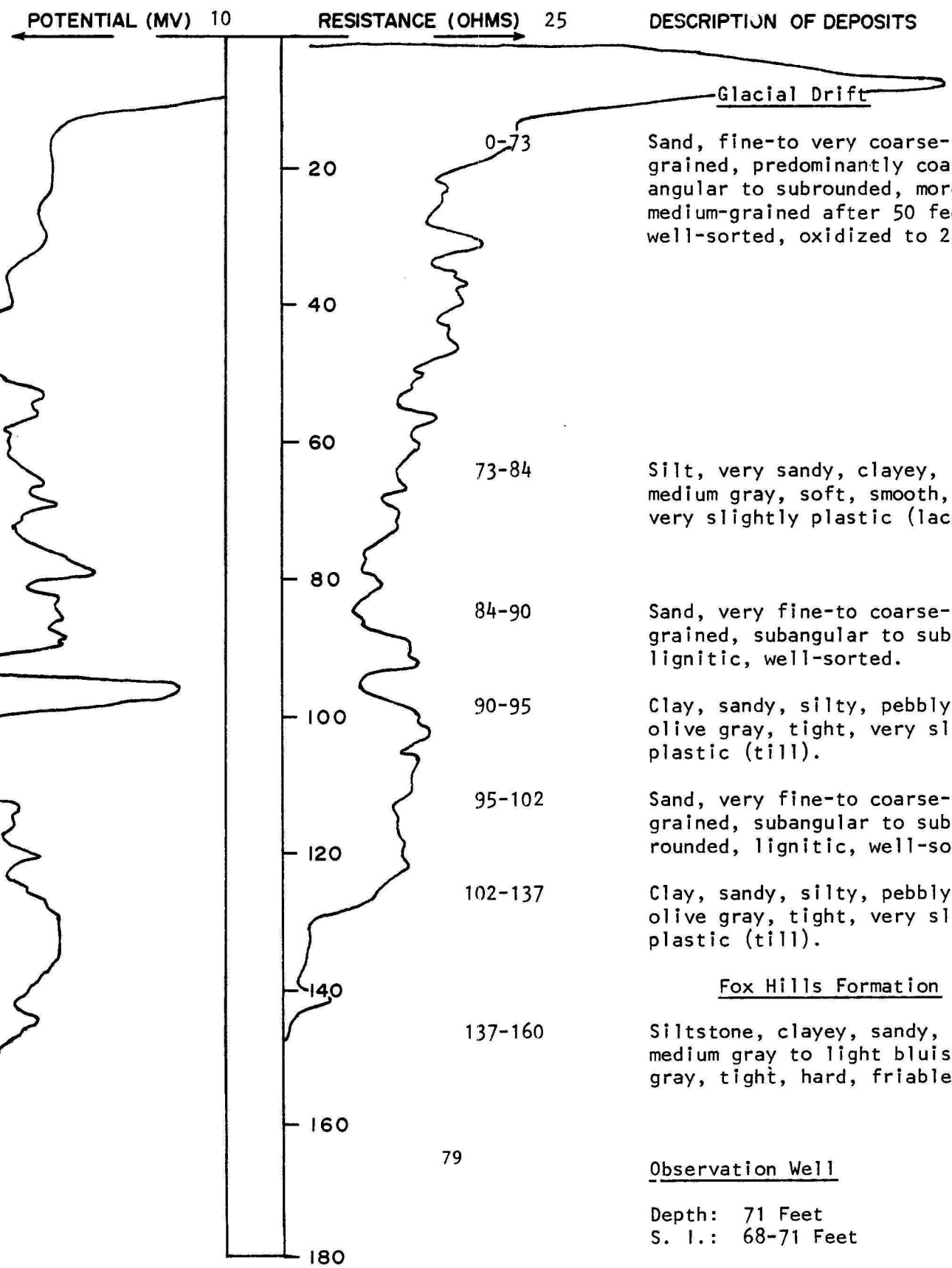
TEST HOLE 9421

LOCATION: 157-71-26BCC

DATE DRILLED: 8-20-75

ELEVATION: 1611
(FT, MSL)

DEPTH: 160
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-73 Sand, fine-to very coarse-grained, predominantly coarse, angular to subrounded, more medium-grained after 50 feet, well-sorted, oxidized to 25 feet.

73-84 Silt, very sandy, clayey, medium gray, soft, smooth, very slightly plastic (lacustrine)

84-90 Sand, very fine-to coarse-grained, subangular to subrounded, lignitic, well-sorted.

90-95 Clay, sandy, silty, pebbly, olive gray, tight, very slightly plastic (till).

95-102 Sand, very fine-to coarse-grained, subangular to sub-rounded, lignitic, well-sorted.

102-137 Clay, sandy, silty, pebbly, olive gray, tight, very slightly plastic (till).

Fox Hills Formation

137-160 Siltstone, clayey, sandy, medium gray to light bluish gray, tight, hard, friable.

Observation Well

Depth: 71 Feet
S. I.: 68-71 Feet

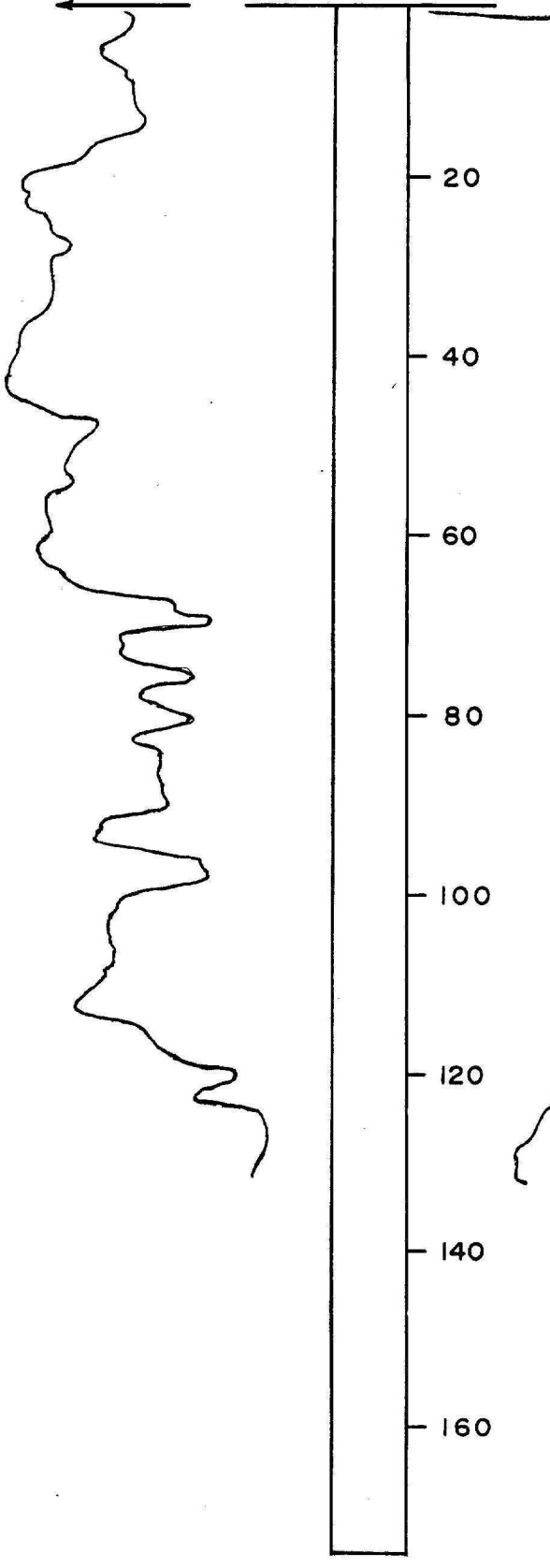
TEST HOLE 9422

LOCATION: 157-71-26BCD

DATE DRILLED: 8-20-75

ELEVATION: 1619
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial ~~Drift~~

0-67 Sand, fine to very coarse grain predoninantly coarse, angular t ~~subrounded, mostly quartz~~, slightly lignitic, well-sorted oxidized to 30 feet.

67-94 Clay, very sandy, silty, medium gray, soft, slightly cohesive (lacustrine).

94-122 Clay, very sandy, silty, pebbl olive gray, moderately tight, very slightly plastic (till).

Fox Hills Formation

122-140 Siltstone, clayey, sandy, light bluish to brownish gray, hard, tight, friable.

Observation Well

Depth: 64 feet
S. I.: 58-64 feet

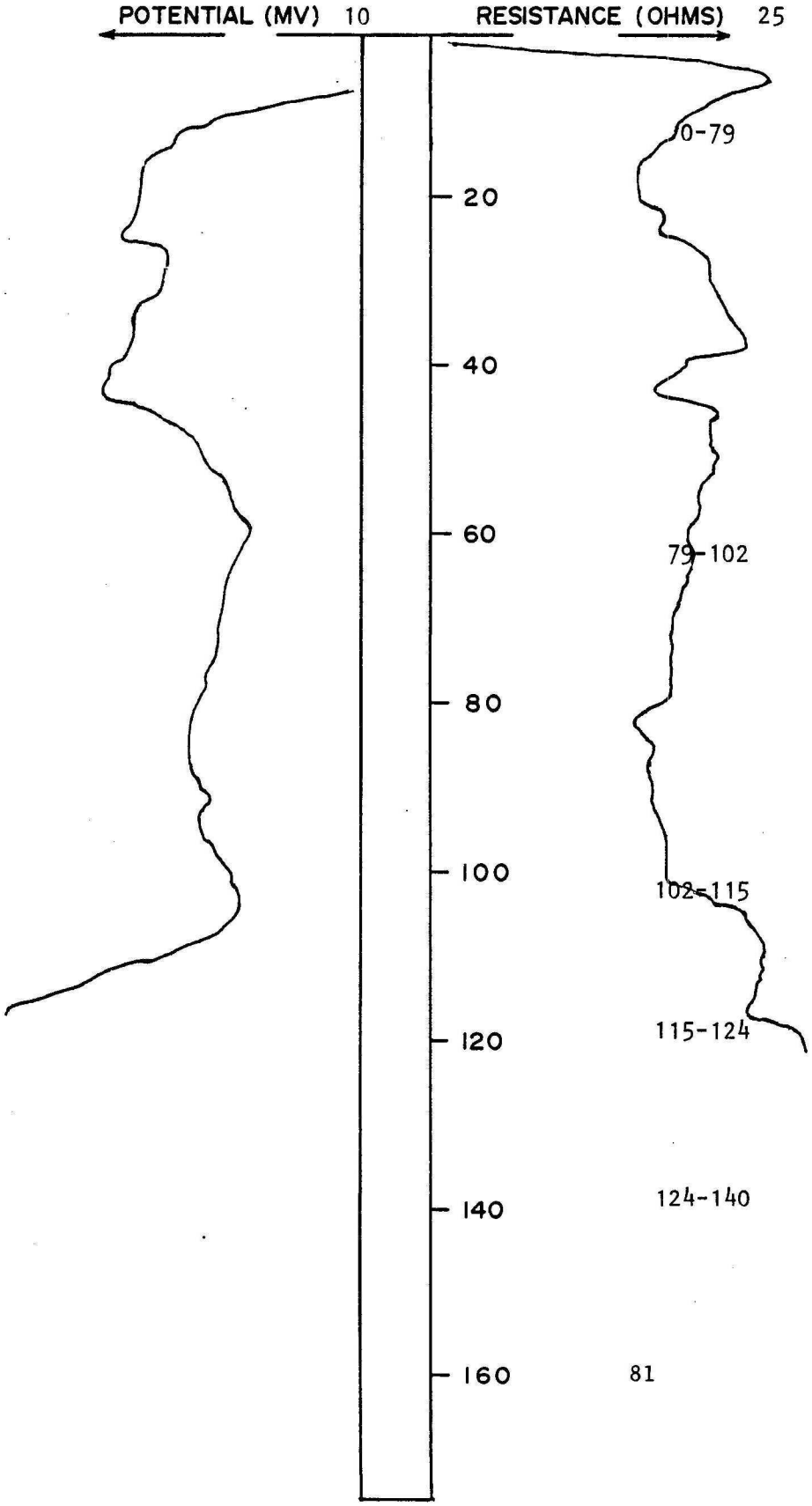
TEST HOLE 9415

LOCATION: 157-71-26CBB

DATE DRILLED: 8-19-75

ELEVATION: 1607
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-79 Sand, fine-to very coarse-grained, predominantly coarse angular to subrounded, lignitic, well-sorted, oxidized to 15 feet.

79-102 Silty, very sandy, clayey, medium-gray, soft, slightly cohesive (lacustrine).

102-115 Gravel, fine to coarse, angular to subrounded, (about 40 percent fine to very coarse sand) poorly-sorted.

115-124 Clay, sandy, silty, pebbly, olive gray, very slightly plastic (till).

Fox Hills Formation

124-140 Siltstone, clayey, sandy, medium bluish gray, to brownish gray, hard, tight, friable.

Observation Well

Depth: 77 feet
S. I.: 74-77 feet

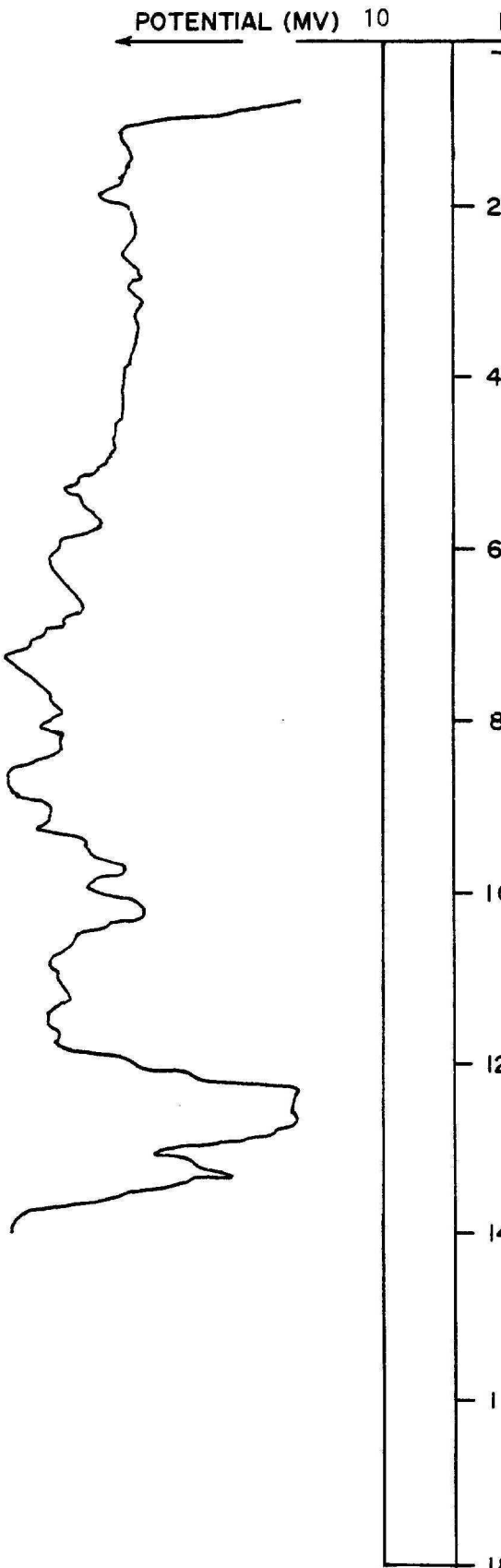
TEST HOLE 9420

LOCATION: 157-71-26CCC

DATE DRILLED: 8-20-75

ELEVATION: 1611
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-84 Sand, fine-to very coarse-grained, predominantly coarse to 60 feet medium after 60 feet, well-sorted, oxidized to 30 feet.

84-88 Silt, very sandy, clayey, medium gray, soft, smooth.

88-108 Gravel, fine-to coarse-grained, angular to subrounded, poorly-sorted.

108-117 Clay, sandy, silty, pebbly, olive gray, tight, cohesive (till).

Fox Hills Formation

117-140 Siltstone, clayey, sandy, medium gray to light bluish gray, hard, tight, friable.

Observation Well

Depth: 101 feet
S. I.: 98-101 feet

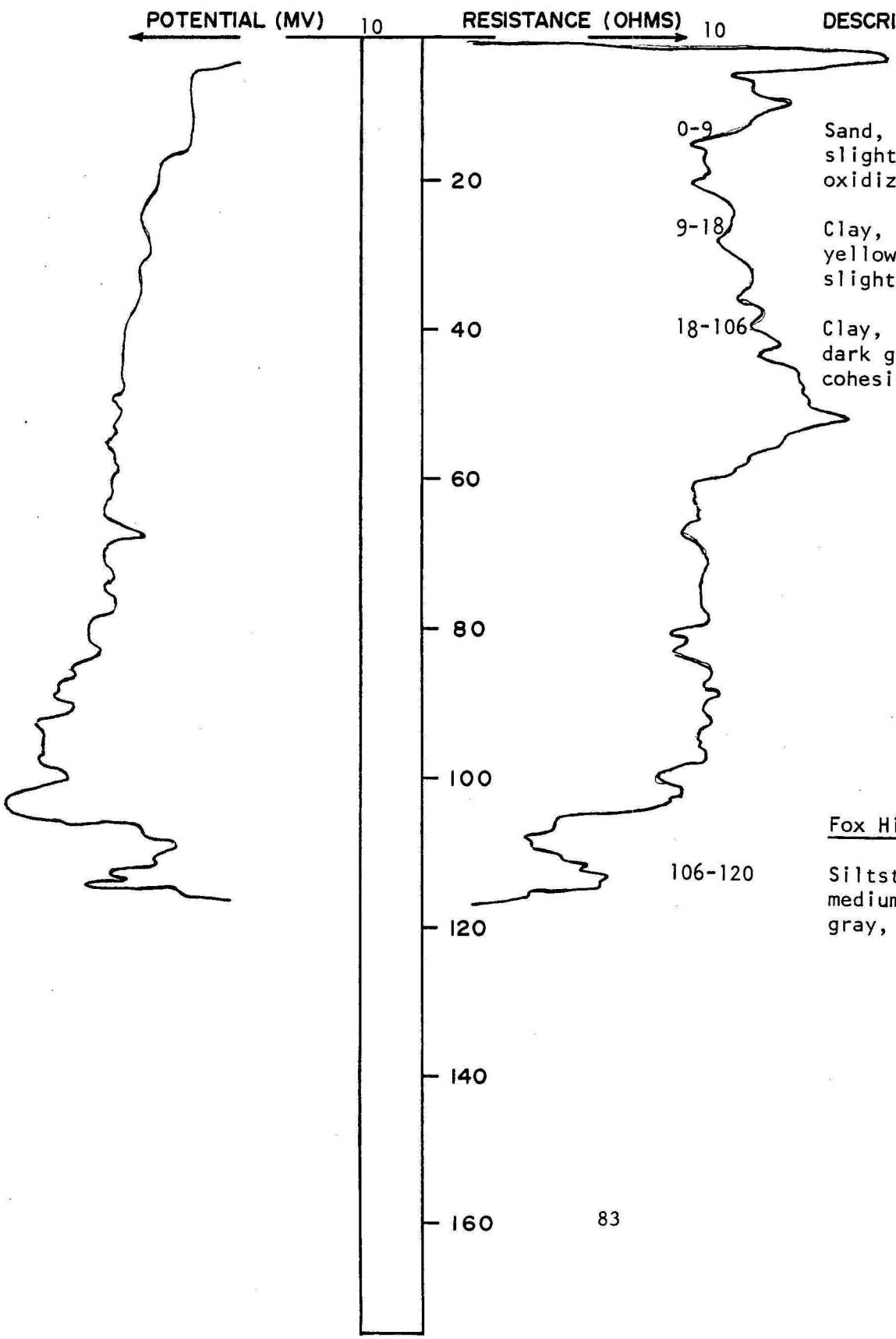
TEST HOLE 9339

LOCATION: 157-71-28CCC

DATE DRILLED: 7-17-75

ELEVATION: (FT, MSL) 1593

DEPTH: (FT) 120



DESCRIPTION OF DEPOSITS

Glacial Drift

0-9 Sand, very fine to fine grained, slightly lignitic, well-sorted, oxidized.

9-18 Clay, very silty, sandy, moderate yellowish brown, soft, very slightly plastic.

18-106 Clay, sandy, silty, medium dark gray, soft, moderately cohesive.

Fox Hills Formation

106-120 Siltstone, clayey, sandy, medium light to medium dark gray, hard, friable.

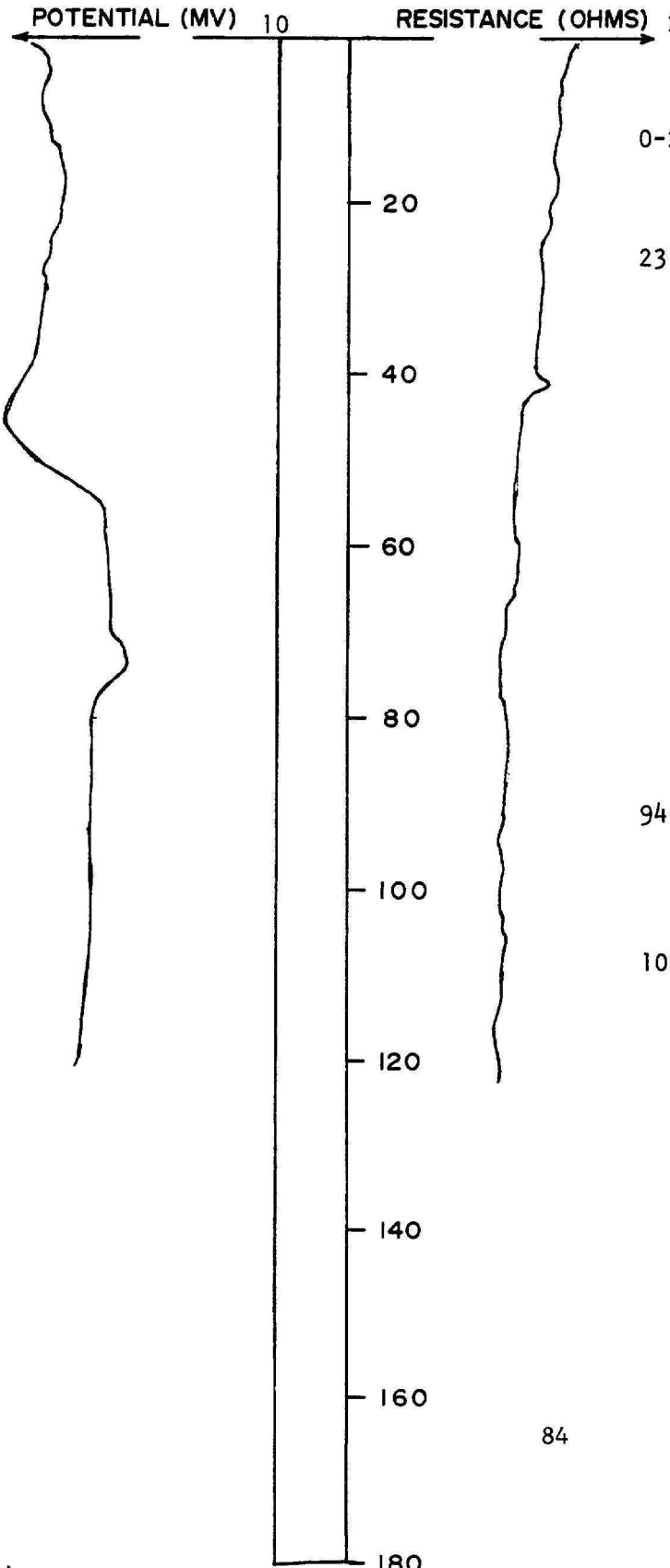
TEST HOLE 9335

LOCATION: 157-71-29CCC

DATE DRILLED: 7-15-75

ELEVATION: 1580
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-23 Clay, very silty, slightly sandy, moderate yellowish brown, soft, oxidized (lacustrine).

23-94 Clay, very sandy, silty, medium dark gray, soft, sticky (lacustrine).

94-100 Clay, sandy, silty, pebbly, olive gray, tight (till).

Fox Hills Formation

100-120 Clay, very sandy, silty, medium gray to dark gray, hard, friable

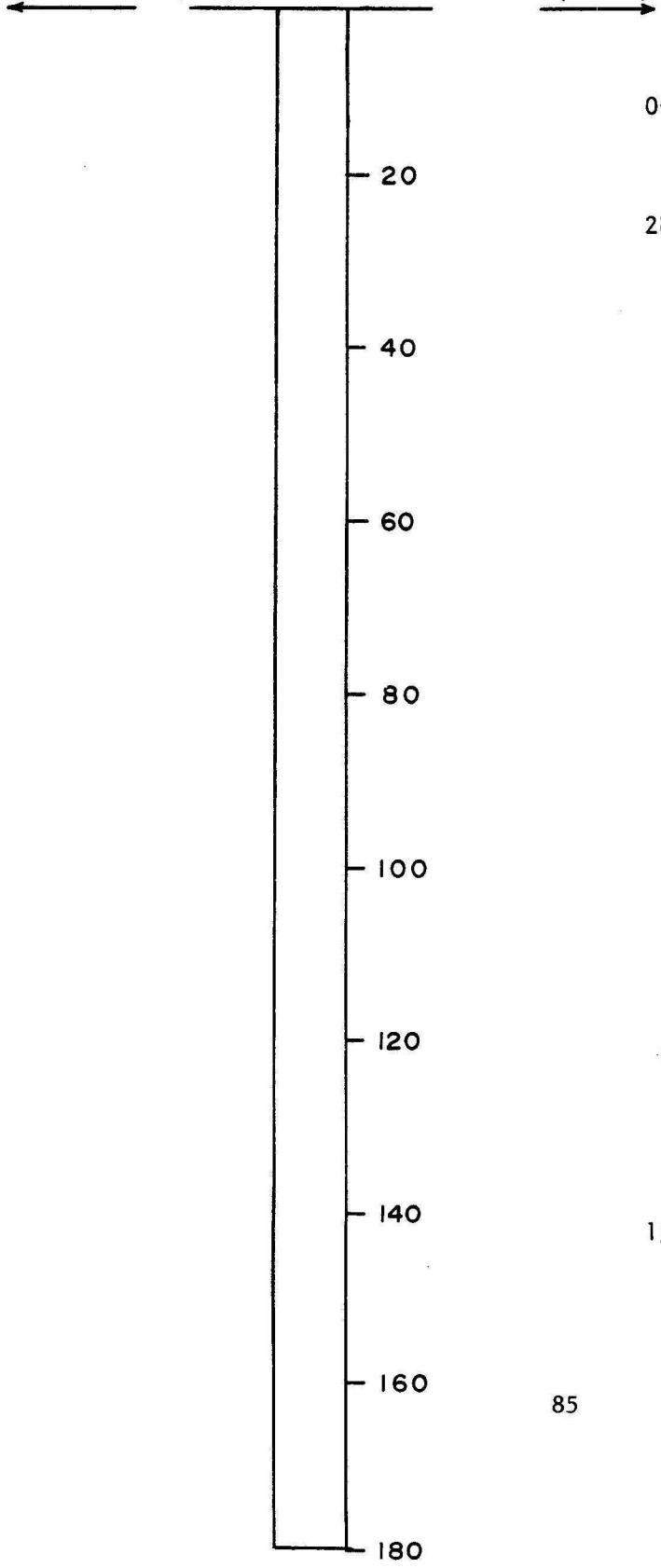
TEST HOLE 9334

LOCATION: 157-71-30AAA

DATE DRILLED: 7-15-75

ELEVATION: (FT, MSL) 1592

DEPTH: (FT) 140



DESCRIPTION OF DEPOSITS

Glacial Drift

0-28 Sand, very fine to fine, rounded, moderate yellowish brown, clayey, oxidized.

28-124 Silty, very clayey, sandy, medium dark gray, soft (lacustrine)

124-131 Clay, silty, sandy, pebbly, olive gray, very slightly plastic (till).

Fox Hills Formation

131-140 Clay, silty, moderately sandy, medium gray, hard, tight, brittle.

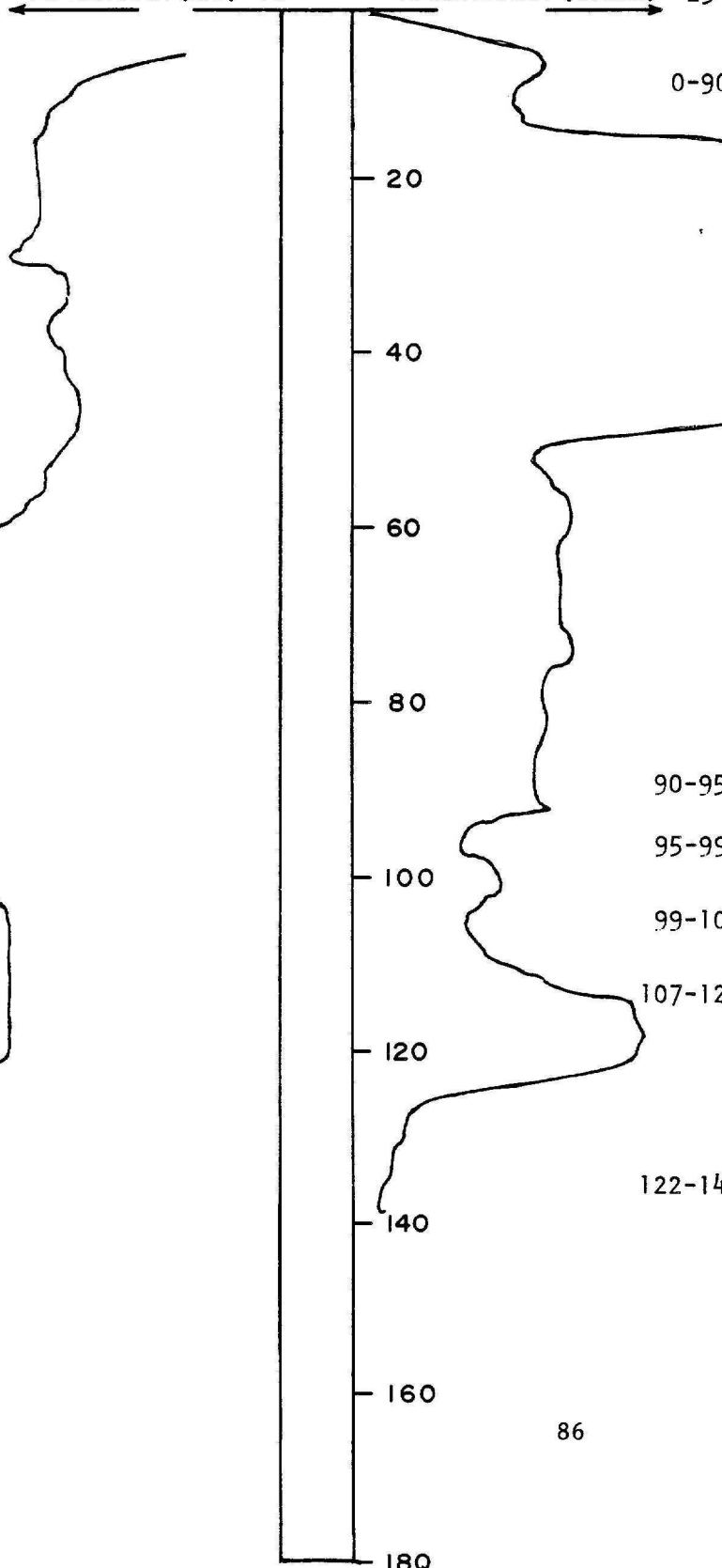
TEST HOLE 9352

LOCATION: 157-71-31CBC

DATE DRILLED: 7-22-75

ELEVATION: 1561
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-90 Sand, fine- to very coarse-grained, predominantly coarse, angular to subrounded, moderately well-sorted, taking some water, oxidized to 28 feet.

90-95 Clay, sandy, silty, pebbly, olive gray (till).

95-99 Gravel, coarse, angular to subrounded, predominantly quartz.

99-107 Clay, sandy, silty, pebbly, gravelly, olive gray (till).

107-122 Gravel, fine to very coarse, angular to subrounded, rough drilling.

Fox Hills Formation

122-140 Siltstone, clayey, sandy, medium light to greenish gray, hard, brittle.

Observation Well (9352)

Depth 116 feet
Screened interval 113-116 feet

Observation Well (9352-A)

Depth 81 feet

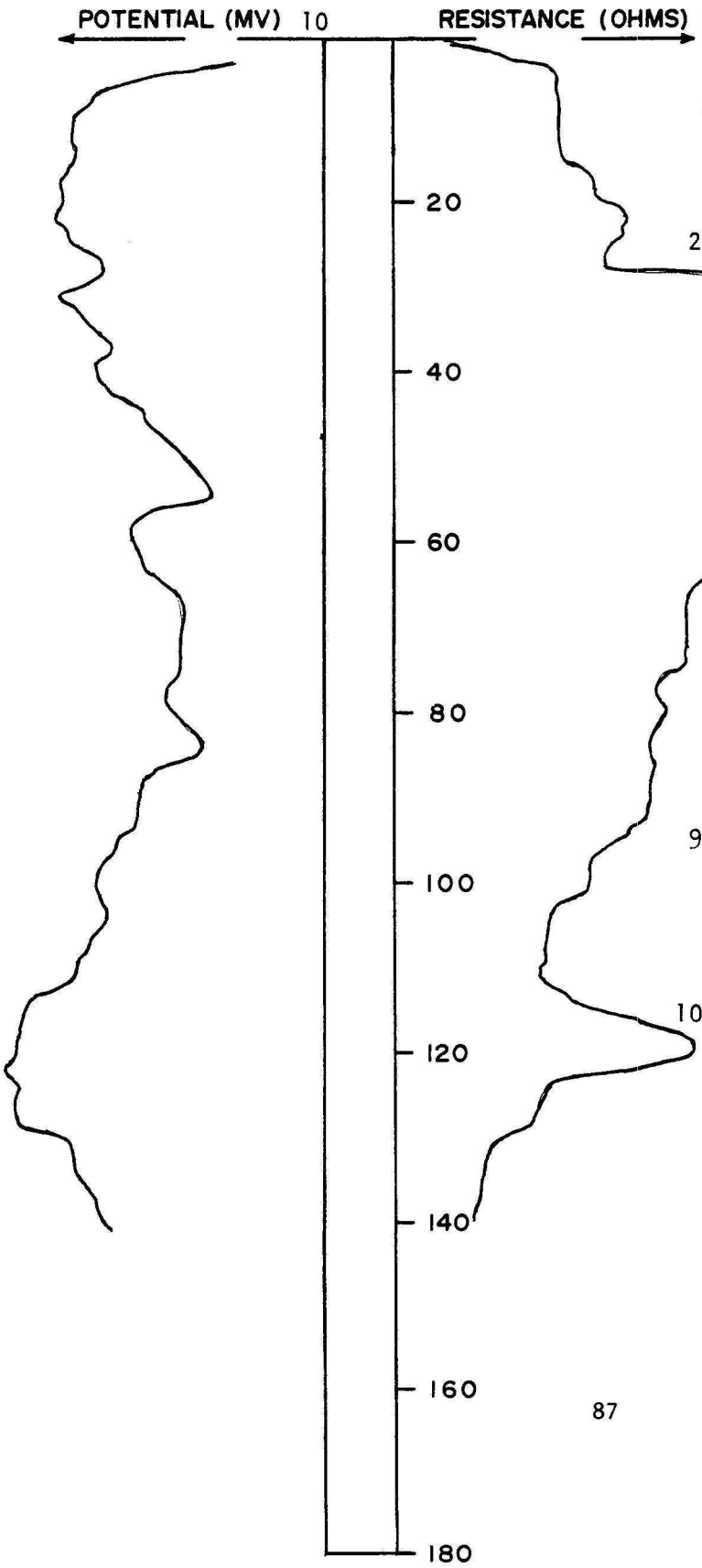
TEST HOLE 9352B

LOCATION: 157-71-31CBC$_3$

DATE DRILLED: 7-22-75

ELEVATION: 1567
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-28 Clay, silty, sandy, pebbly, moderate yellowish brown, cohesive very slightly plastic, oxidized (till).

28-97 Sand, fine-to very coarse-grained, predominantly coarse, angular to subrounded (about 30 percent medium to coarse gravel after 60 feet), poorly-sorted, taking water, mixed 1 bag of mud.

97-109 Clay, sandy, silty, pebbly, olive gray, tight, moderately cohesive (till).

Fox Hills Formation

109-140 Siltstone, clayey, sandy, shaley, medium bluish gray to greenish gray (indurated sandstone layers 110-120 feet), hard, friable

Observation Well

Depth 91 feet
Screened interval 88-91 feet

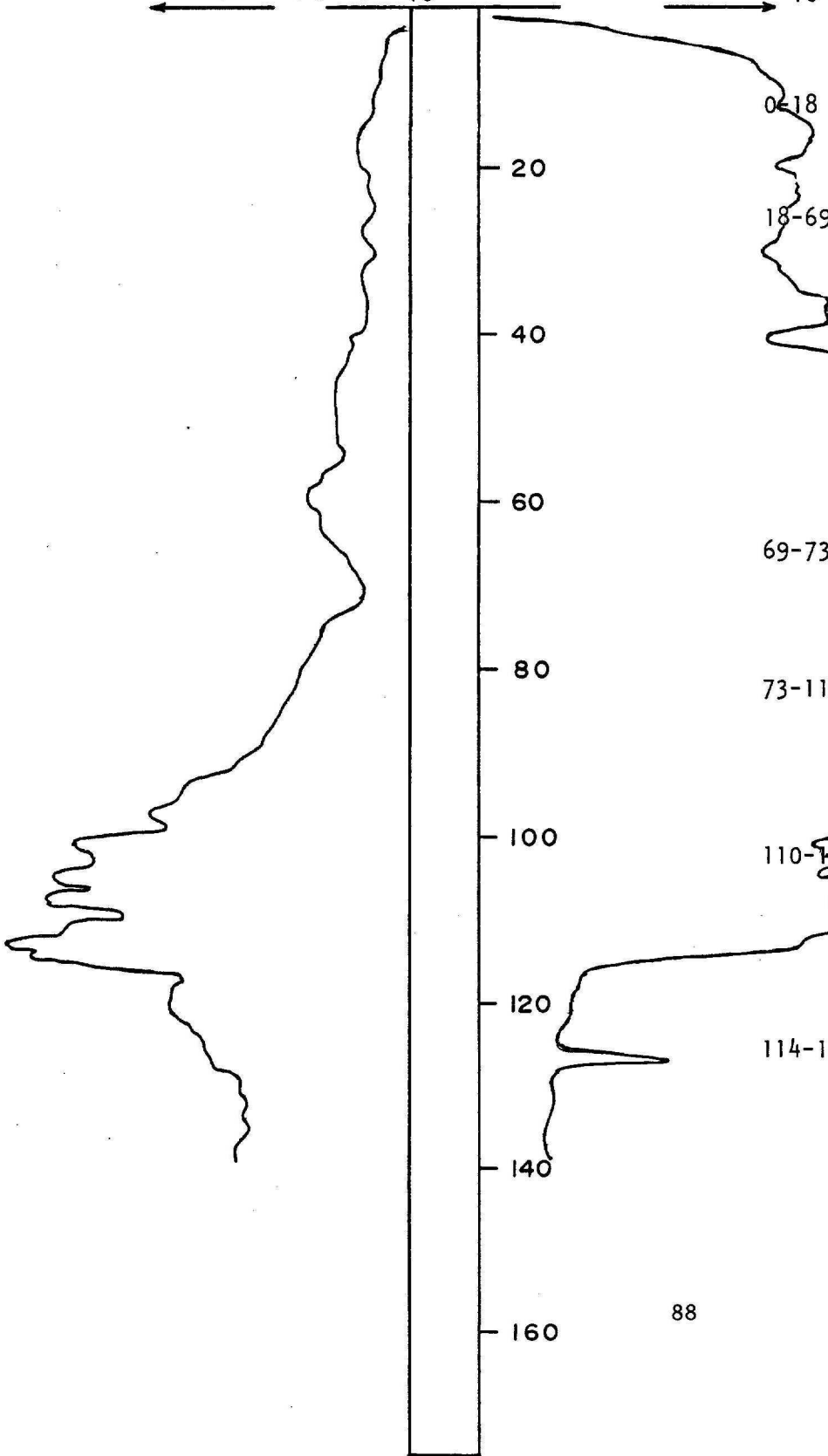
TEST HOLE 9340

LOCATION: 157-71-34CBB

DATE DRILLED: 7-17-75

ELEVATION: 1593
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-18 Clay, very silty, sandy, moderate yellowish brown, soft, very slightly plastic, oxidized

18-69 Clay, very silty, sandy, medium dark gray, moderately cohesive, slightly plastic.

69-73 Sand, very fine to fine grained subrounded to rounded, slightly lignitic, well-sorted.

73-110 Clay, very sandy, very silty, medium dark gray, moderately cohesive, soft.

110-114 Clay, sandy, silty, pebbly, olive gray, moderately cohesive very slightly plastic (till).

Fox Hills Formation

114-140 Siltstone, clayey, sandy, mediu light to medium dark gray, hard friable.

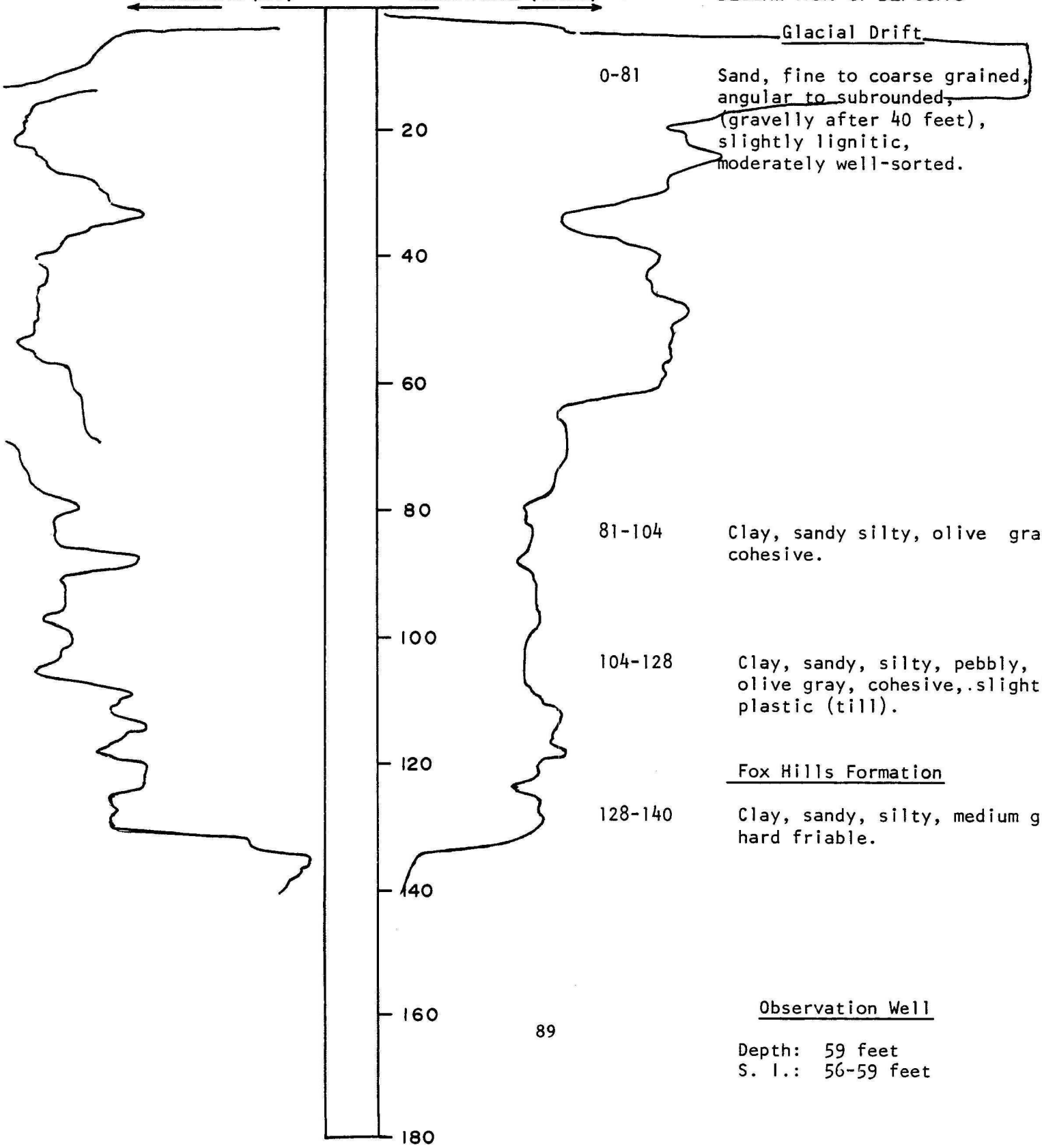
TEST HOLE 9360

LOCATION: 157-71-34DAA

DATE DRILLED: 7-23-75

ELEVATION: 1612
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-81 Sand, fine to coarse grained, angular to subrounded, (gravelly after 40 feet), slightly lignitic, moderately well-sorted.

81-104 Clay, sandy silty, olive gray, cohesive.

104-128 Clay, sandy, silty, pebbly, olive gray, cohesive,.slightly plastic (till).

Fox Hills Formation

128-140 Clay, sandy, silty, medium gray, hard friable.

Observation Well

Depth: 59 feet
S. I.: 56-59 feet

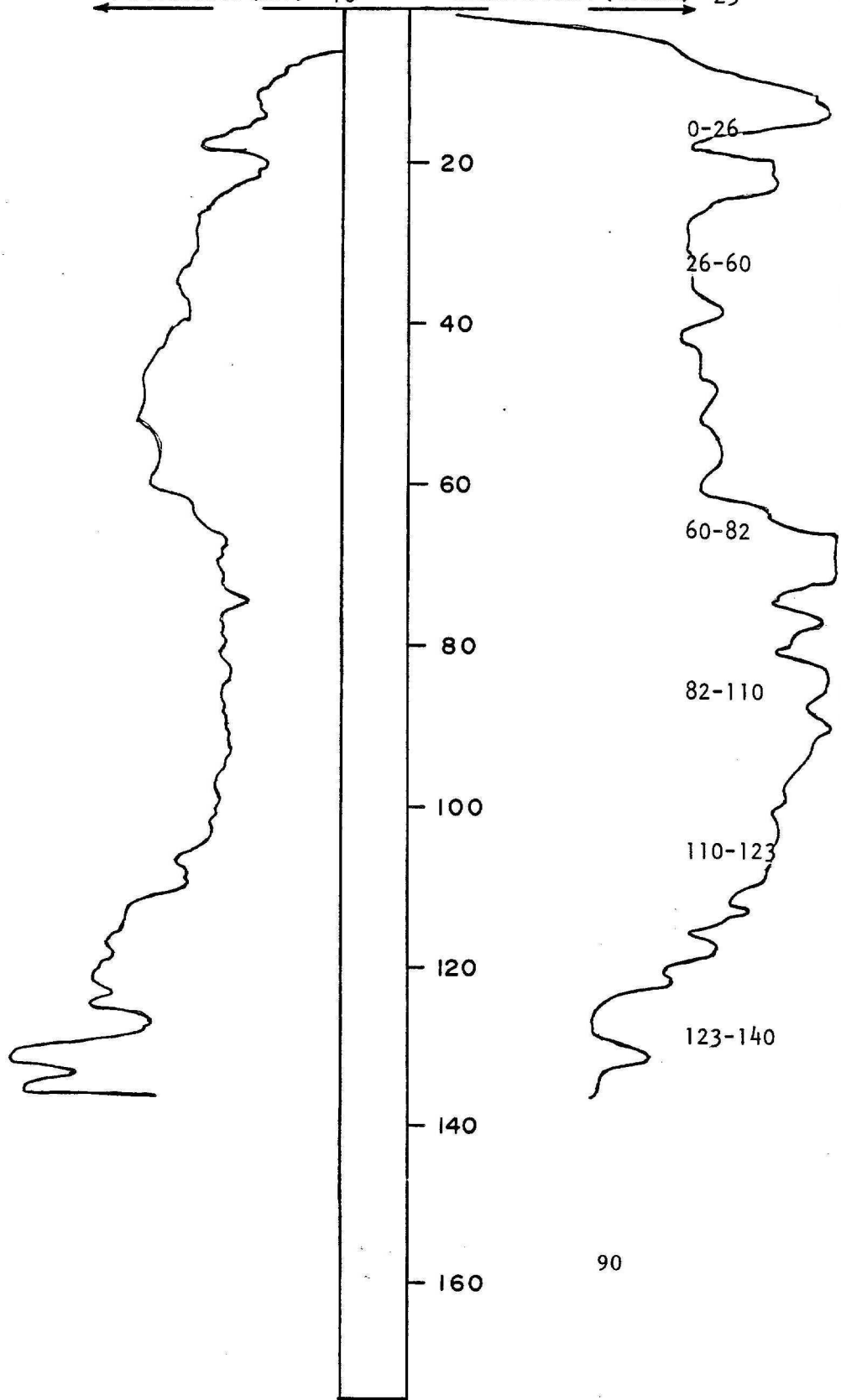
TEST HOLE 9341

LOCATION: 157-71-35BAA

DATE DRILLED: 7-17-75

ELEVATION: (FT, MSL) 1611

DEPTH: (FT) 140



DESCRIPTION OF DEPOSITS

Glacial Drift

0-26 Sand, Fine to very coarse grained, slightly clayey, slightly lignitic, moderately well-sorted, oxidized to 19 ft.

26-60 Clay, very silty, sandy, medium dark gray, soft, moderately cohesive.

60-82 Sand, very fine to medium grain predominantly fine, subrounded to rounded, slightly lignitic.

82-110 Sand, fine to very coarse grained, angular to subrounded.

110-123 Clay, very sandy, silty, pebbly, gravelly, medium dark to olive gray (till).

Fox Hills Formation

123-140 Siltstone, clayey, sandy, medium light to medium dark gray, hard, friable.

Observation Well

Depth: 101 feet
S. I.: 98-101 feet

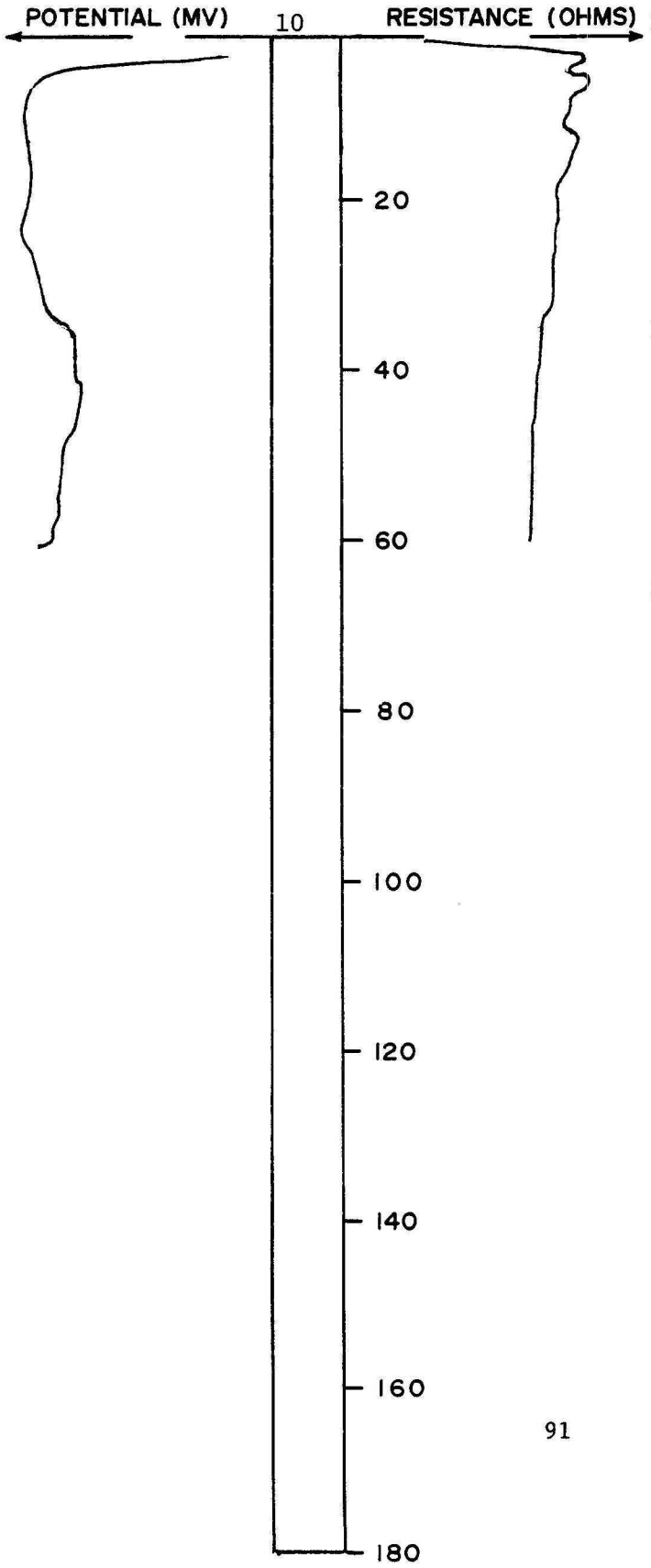
TEST HOLE 9403

LOCATION: 157-72-12DDD

DATE DRILLED: 8-13-75

ELEVATION: 1600
(FT, MSL)

DEPTH: 60
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-18 Clay, silty, sandy, moderate yellowish brown, cohesive, very slightly plastic (lacustrine).

18-25 Clay, as above, medium dark gray (lacustrine).

Fox Hills Formation

25-60 Clay, sandy, silty, medium gray to light bluish gray tight, friable.

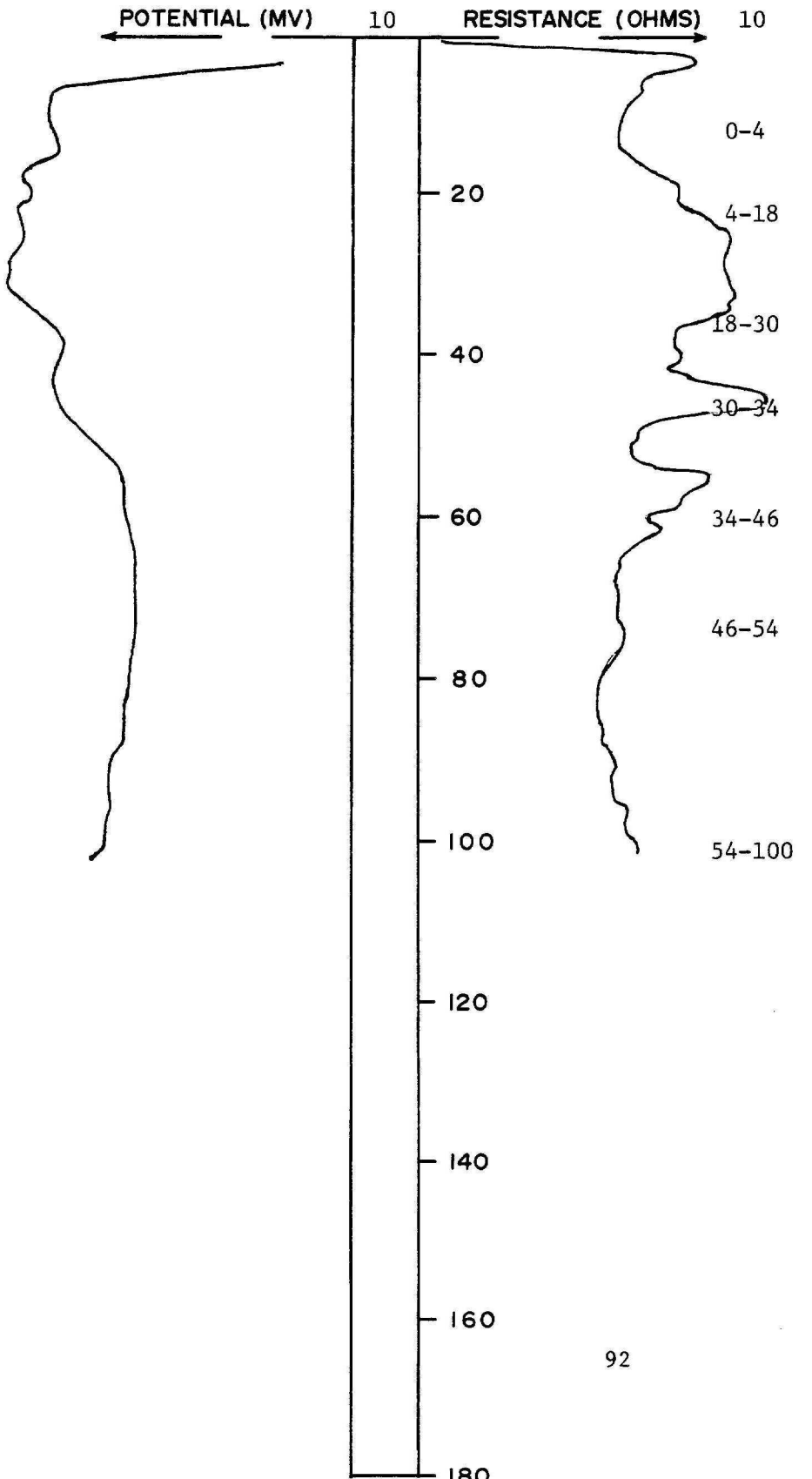
TEST HOLE 9402

LOCATION: 157-72-13DDD

DATE DRILLED: 8-13-75

ELEVATION: 1575
(FT, MSL)

DEPTH: 100
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-4 Sand, very fine-to fine-grained well-rounded, oxidized.

4-18 Clay, silty, sandy, moderate yellowish brown, sticky, slightly plastic, oxidized (lacustrine).

18-30 Clay, as above, medium dark gray (lacustrine).

30-34 Sand, very fine- to fine-grained, well-rounded, silty.

34-46 Clay, silty, sandy, medium dark gray, sticky, slightly plastic (lacustrine).

46-54 Clay, sandy, silty, pebbly, olive gray, very slightly plastic (till).

Fox Hills Formation

54-100 Siltstone, clayey, Sandy, medium gray to light bluish gray, tight, friable

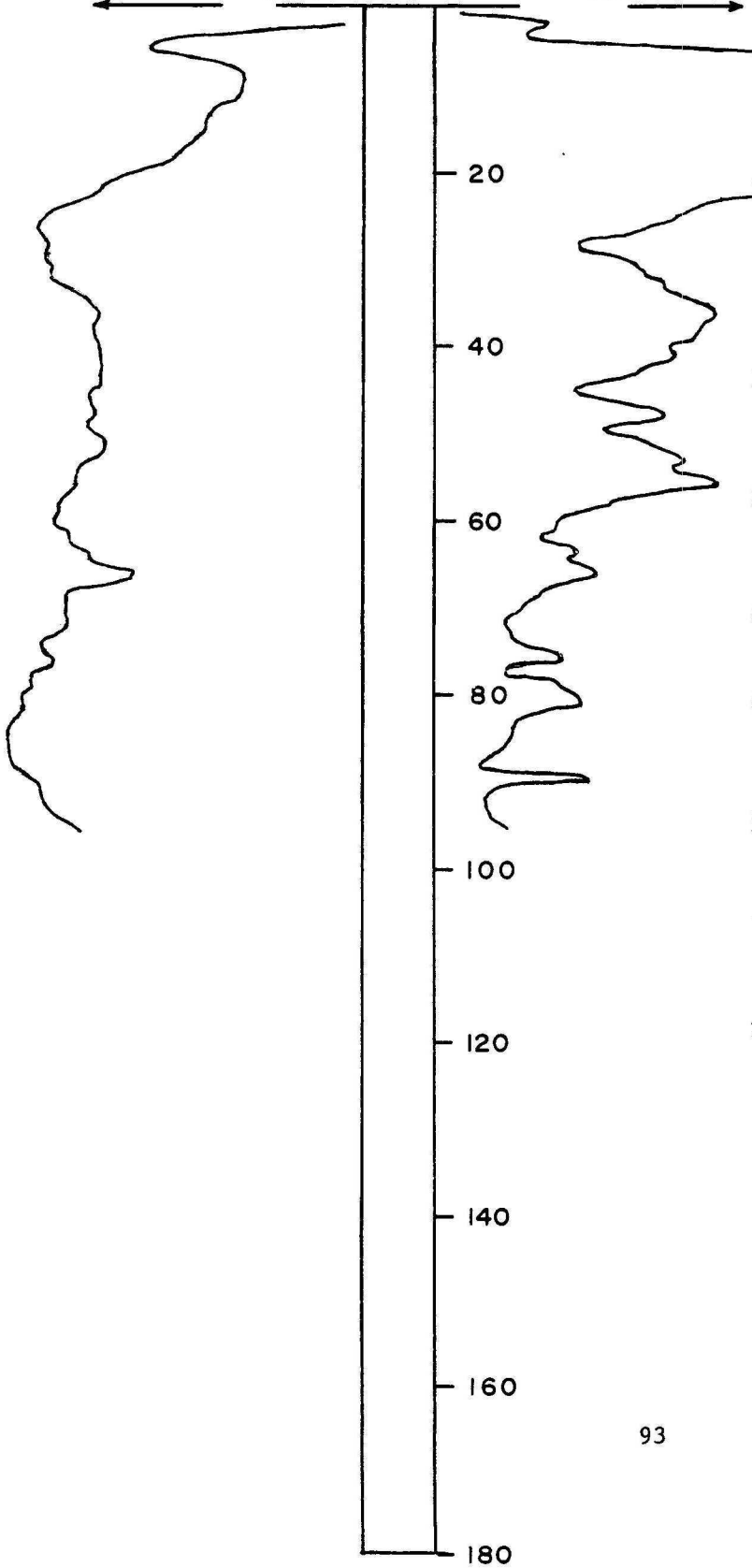
TEST HOLE 9404

LOCATION: 157-72-15CCB

DATE DRILLED: 8-13-75

ELEVATION: 1570
(FT, MSL)

DEPTH: 100
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-4	Clay, silty, sandy, moderate yellowish-brown, cohesive, slightly plastic (lacustrine).
4-18	Sand, fine-to very coarse-grained Predominantly coarse, angular to subrounded, slightly lignitic, well-sorted.
18-28	Clay, silty, sandy, medium dark gray, cohesive, very slightly plastic.
28-43	Sand, fine-to coarse-grained, subangular to subrounded, lignitic, well-sorted.
43-46	Clay, silty, sandy, medium dark gray, tight, cohesive.
46-56	Sand, fine-to coarse-grained subangular to subrounded, lignitic, well-sorted.
56-74	Clay, very sandy, silty, medium dark gray, soft, cohesive.

Fox Hills Formation

74-100	Clay, sandy, silty, medium gray to bluish gray, tight, friable (bentonitic 85-100 feet).

Observation Well

Depth: 54 feet
S. I. : 51-54 feet

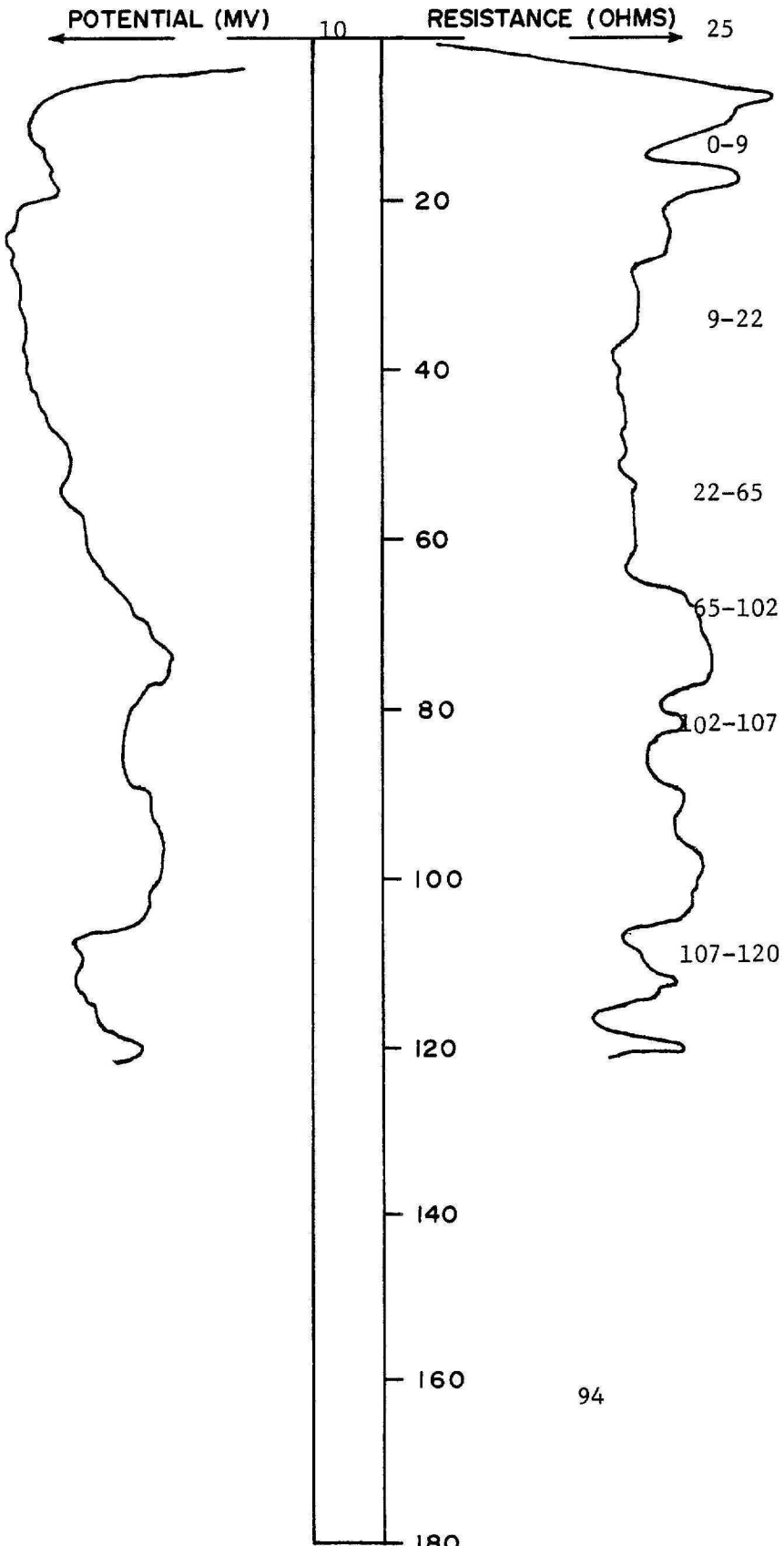
TEST HOLE 9401

LOCATION: 157-72-25ADD

DATE DRILLED: 8-12-75

ELEVATION: 1570
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-9 Sand, fine-to very coarse grained, predominantly coarse, angular to sub-rounded, moderately well-sorted, oxidized.

9-22 Clay, sandy, silty, pebbly, moderate yellowish brown, slightly cohesive, very slightly plastic, oxidized (till).

22-65 Clay, as above, olive gray, (fine to very coarse gravel 48-50 feet), tight (till).

65-102 Sand, fine to very coarse, angular to subrounded, clayey, mostly quartz.

102-107 Clay, sandy, silty, pebbly, olive gray, tight (till).

Fox Hills Formation

107-120 Shale, clayey, sandy, silty, medium to medium dark gray, tight, friable, with layers of indurated sandstone

Observation Well

Depth: 97 feet
S. I.: 94-97 feet

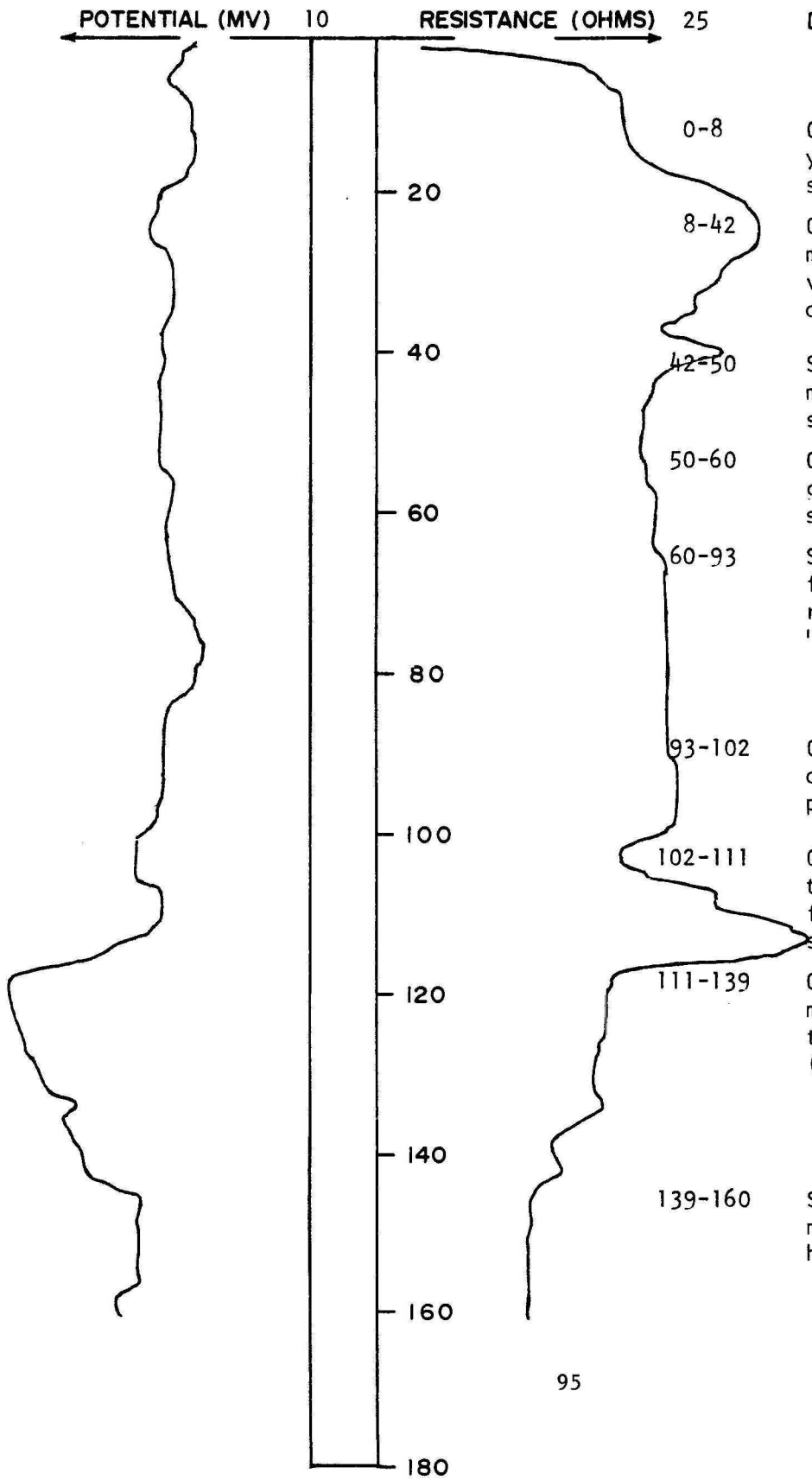
TEST HOLE 9351

LOCATION: 157-72-25DCC

DATE DRILLED: 7-22-75

ELEVATION: 1590
(FT, MSL)

DEPTH: 160
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-8 Clay, very sandy, silty, dark yellowish brown, soft, very slightly plastic, oxidized.

8-42 Clay, sandy, silty, pebbly, moderate yellowish brown, very slightly plastic, oxidized (till).

42-50 Sand, clayey, very fine- to medium-grained, angular to subrounded.

50-60 Clay, sandy, silty, pebbly, gravelly, olive gray, very slightly plastic (till).

60-93 Sand, clayey, very fine- to fine-grained, subrounded to rounded, slightly lignitic, "dirty".

93-102 Clay, silty, sandy, pebbly, olive gray, very slightly plastic (till).

102-111 Gravel, fine to coarse, angular to subrounded, (about 40 percent fine- to very coarse-grained sand), poorly sorted.

111-139 Clay, sandy, silty, pebbly, medium dark to olive gray, tight, moderately cohesive (till).

Fox Hills Formation

139-160 Siltstone, clayey, sandy, medium light to greenish gray, hard friable.

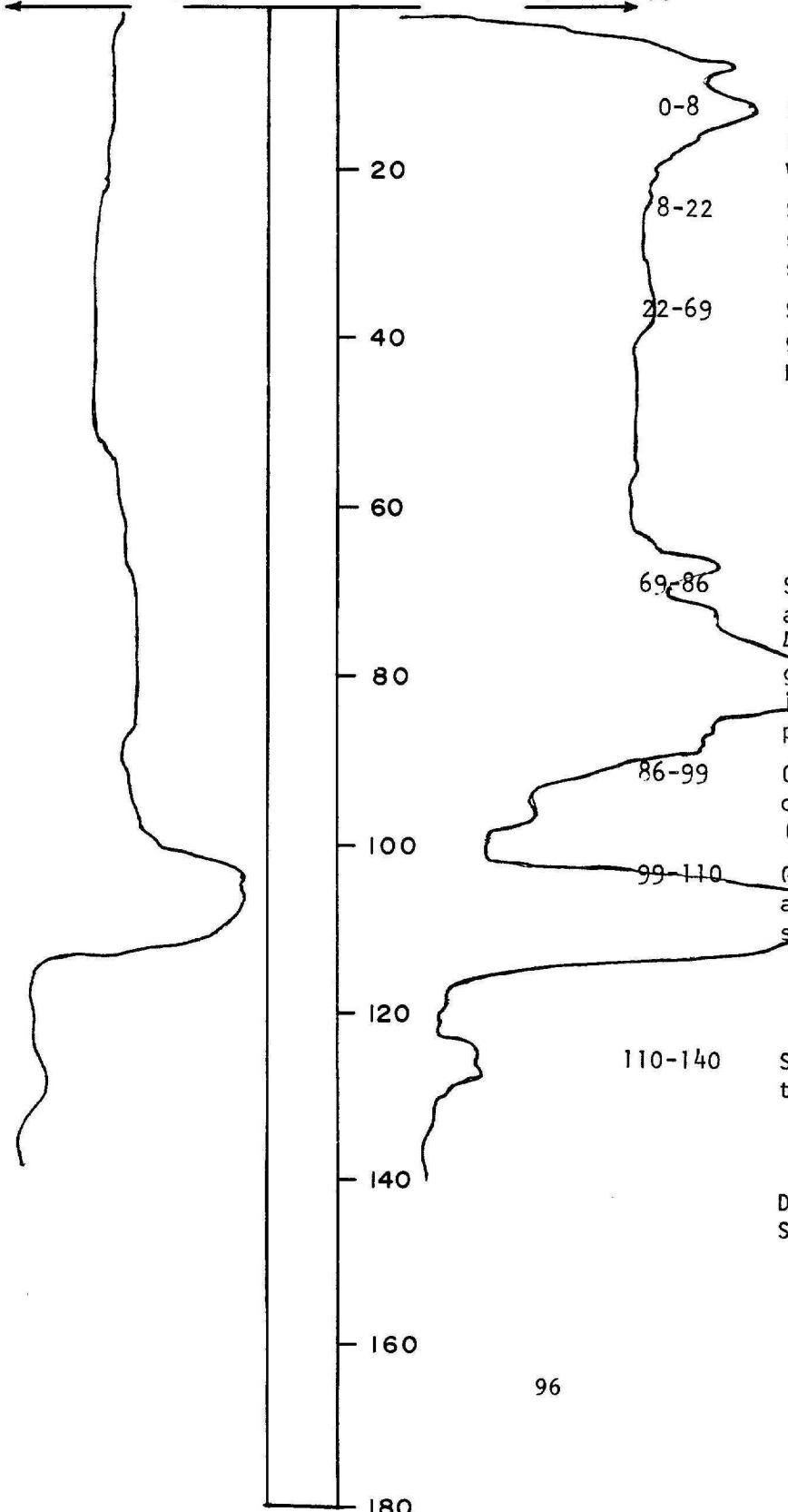
TEST HOLE 9350

LOCATION: 157-72-25DDD

DATE DRILLED: 7-21-75

ELEVATION: 1565
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-8 Sand, very fine- to medium-grained, subrounded to rounded, well-sorted, oxidized.

8-22 Silt, very clayey, slightly sandy, dark yellowish brown, soft, oxidized.

22-69 Silt, as above, medium dark gray, tight, very slightly plastic.

69-86 Sand, fine- to very coarse, angular to subrounded, (about 40 percent fine- to coarse-grained gravel), with small interbedded layers of clay, poorly sorted.

86-99 Clay, silty, sandy, pebbly, olive gray, tight, cohesive (till)

99-110 Gravel, medium- to coarse-grained angular to subrounded, poorly-sorted, clean.

Fox Hills Formation

110-140 Shale, silty, sandy, medium gray to greenish gray, hard, brittle.

Observation Well

Depth 109 feet
Screened interval 106-109 feet

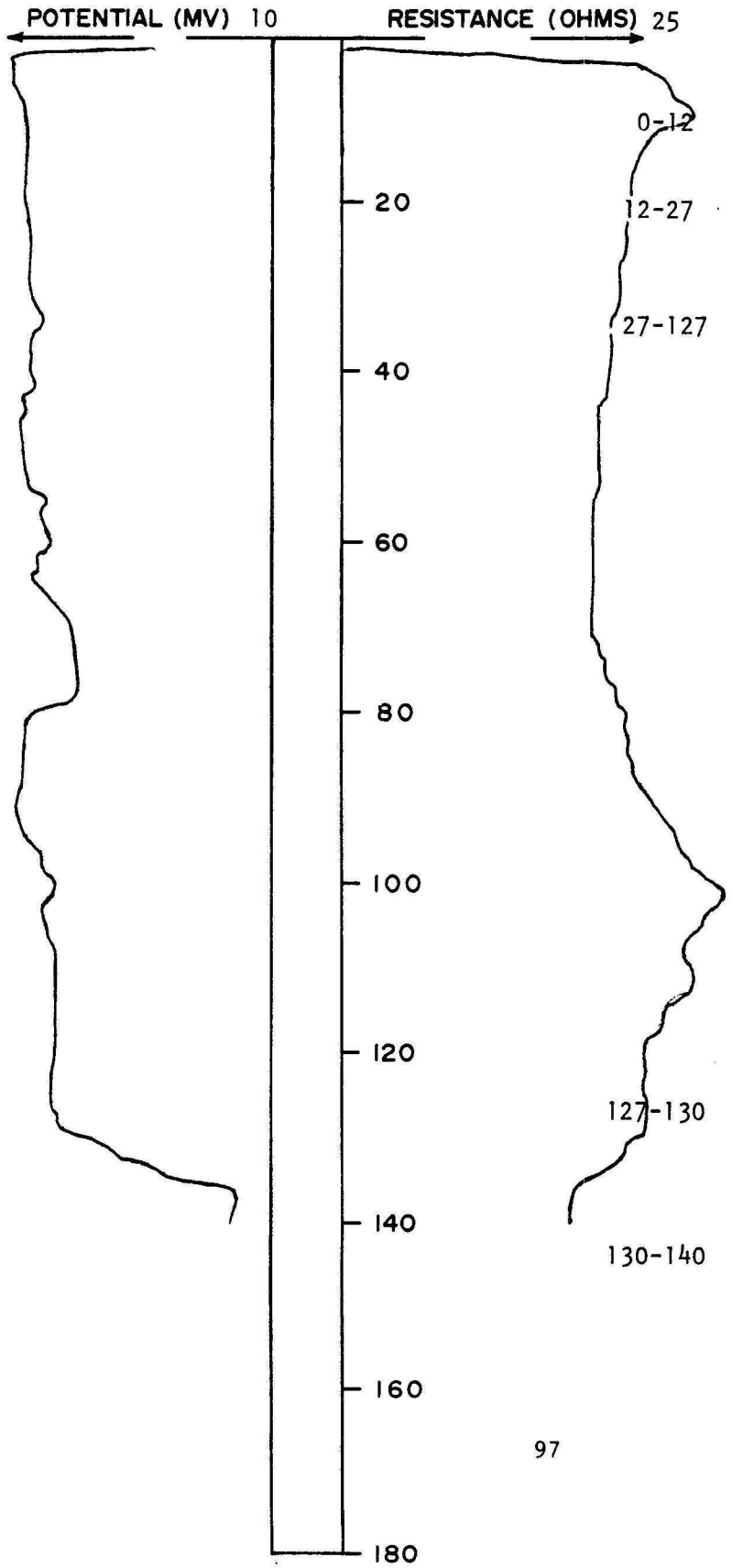
TEST HOLE 9356

LOCATION: 157-72-35DDA

DATE DRILLED: 7-22-75

ELEVATION: 1550
(FT, MSL)

DEPTH: 140
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-12 Sand, very fine- to fine-grained, subrounded to rounded, well-sorted, oxidized.

12-27 Clay, silty, sandy, moderate yellowish brown, soft, cohesive, slightly plastic, oxidized (lacustrine).

27-127 Clay, as above, medium gray, slightly tighter (lacustrine).

127-130 Clay, silty, sandy, pebbly, olive gray, tight, cohesive (till).

Fox Hills Formation

130-140 Clay, sandy, silty, shaley, medium gray to greenish gray, hard, friable.

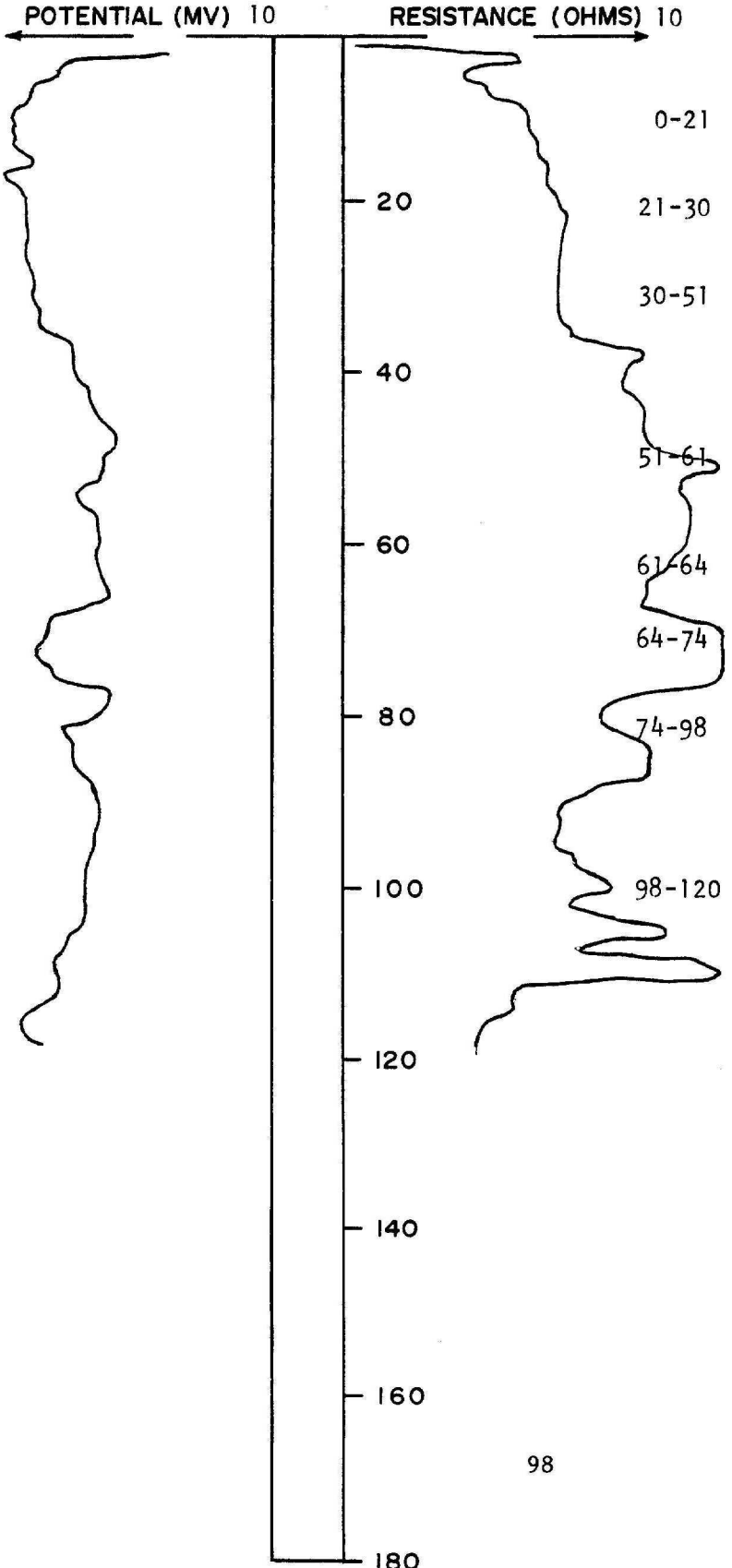
TEST HOLE 9353

LOCATION: 157-72-36DDD

DATE DRILLED: 7-22-75

ELEVATION: 1558
(FT, MSL)

DEPTH: 120
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

Silt, very clayey, sandy, dark yellowish brown, soft, cohesive, very slightly plastic, oxidized.

Silt, as above, medium gray.

Clay, silty, sandy, pebbly, olive gray, tight, very slightly plastic (till).

Sand, very fine- to medium-grain subrounded to rounded, mostly quartz, well-sorted.

Clay, silty, sandy, medium dark gray, soft, cohesive.

Sand, fine- to coarse-grained, predominantly medium, angular to subrounded, slightly lignitic.

Clay, silty, moderately sandy, medium gray, tight, cohesive, slightly plastic.

Fox Hills Formation

Siltstone, clayey, sandy, medium light gray to greenish gray, tight, hard, friable.

Observation Well

Depth 71 feet
Screened interval 68-71 feet

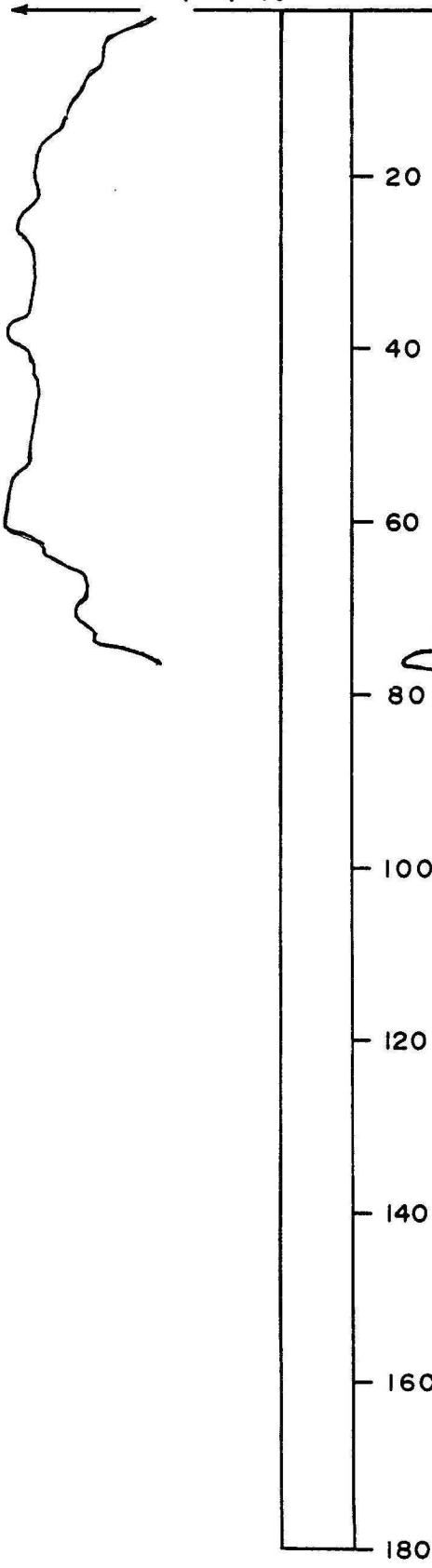
TEST HOLE 9346

LOCATION: 158-71-30DAA

DATE DRILLED: 7-18-75

ELEVATION: (FT, MSL) 1594

DEPTH: (FT) 80



DESCRIPTION OF DEPOSITS

Glacial Drift

0-61 Sand, very fine to very coarse grained, angular to subrounded, (about 40% fine to coarse gravel), interbedded clay layers 20-40 feet, moderately well-sorted, oxidized to 20 feet. More rounded and well-sorted after 40 feet, sl. lignitic.

61-69 Clay, sandy, silty, pebbly, olive gray, cohesive, very slightly plastic (till).

Fox Hills Formation

69-80 Siltstone, clayey, sandy, medium, light gray, to light bluish gray, hard, friable.

Observation Well

Depth: 51 feet
S. I.: 48-51 feet

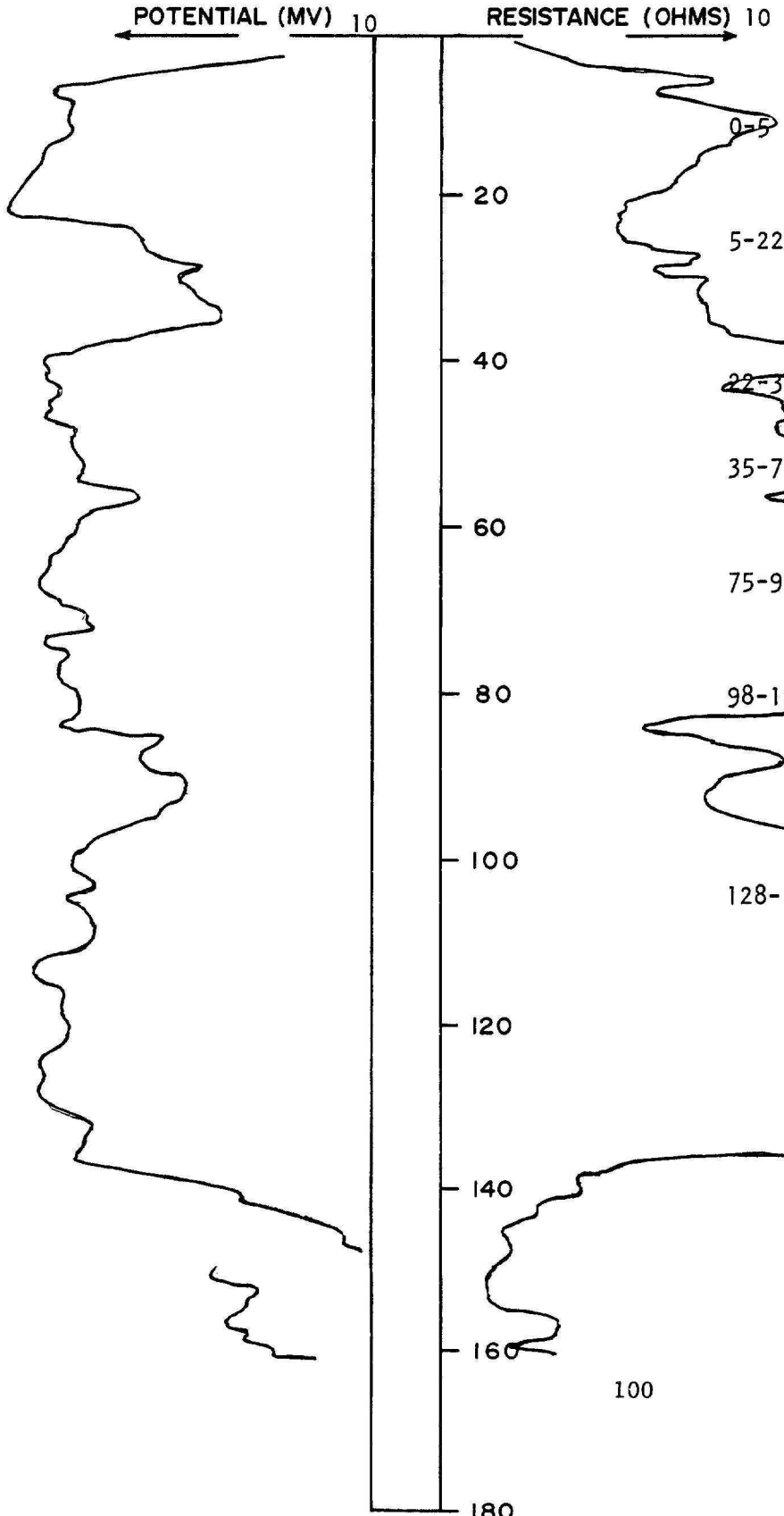
TEST HOLE 9347

LOCATION: 158-72-23DDC

DATE DRILLED: 7-18-75

ELEVATION: 1578
(FT, MSL)

DEPTH: 160
(FT)



DESCRIPTION OF DEPOSITS

Glacial Drift

0-5 Clay, silty, moderately sandy, moderate yellowish brown, cohesive, oxidized.

5-22 Sand, fine to very coarse grained predominantly coarse, angular to rounded, well-sorted, oxidized to 8 feet.

22-35 Silty, clayey, sandy, medium, dark gray, soft (lacustrine).

35-75 Sand, very fine to medium grained, subrounded to rounded, well-sorted, slightly lignitic.

75-98 Silt, very sandy, clayey, medium dark gray, soft, cohesive (lacustrine).

98-128 Sand, very fine to medium grained predominantly medium, subrounded to rounded, well-sorted, slightly lignitic.

Fox Hills Formation

128-160 Siltstone, clayey, sandy, medium light gray to light bluish gray, hard, friable.

Observation Well

Depth: 121 feet
S. I.: 118-121 feet

WATER LEVELS FOR BENSON COUNTY, ND

WELL 156-071-04ABA1 SITE NUMBER 482212099472001

HIGHEST WATER LEVEL 29.57 FEET BELOW LAND SURFACE DATUM MAR 14, 1978.

LOWEST WATER LEVEL 31.55 FEET BELOW LAND SURFACE DATUM SEP 13, 1977.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
JUL 30, 1975	30.76	JUN 15, 1976	30.41	MAR 14, 1978	29.57	JUL 02, 1981	30.52
AUG 05	30.83	JUL 08	30.39	JUN 06	31.28	29	30.61
12	30.85	29	30.52	SEP 13	31.33	OCT 20	30.78
21	30.89	AUG 25	30.68	NOV 21	31.55	DEC 02	30.81
SEP 30	30.95	SEP 29	30.73	JUN 06, 1979	30.43	MAR 02, 1982	31.24
OCT 06	30.93	NOV 18	30.86	SEP 20	30.97	MAY 27	30.59
07	30.91	JAN 20, 1977	31.11	NOV 27	31.16	JUL 16	30.72
21	30.96	MAR 04	31.12	MAR 04, 1980	31.50	OCT 14	30.31
NOV 25	31.08	JUN 14	31.3	JUN 11	31.50		
FEB 26, 1976	31.34	SEP 13	31.55	OCT 01	31.29		
APR 29	30.55	NOV 15	31.53	DEC 05	30.90		

WATER LEVELS FOR BENSON COUNTY, ND

WELL 156-071-04ABA2 SITE NUMBER 482212099472002

HIGHEST WATER LEVEL 29.21 FEET BELOW LAND SURFACE DATUM NOV 18, 1976.

LOWEST WATER LEVEL 31.74 FEET BELOW LAND SURFACE DATUM MAR 14, 1978.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
JUL 30, 1975	30.03	JUN 15, 1976	29.86	NOV 15, 1977	31.14	DEC 05, 1980	31.20
AUG 05	30.08	JUL 08	29.65	MAR 14, 1978	31.74	JUL 02, 1981	30.38
12	30.11	29	29.72	JUN 06	31.1	29	30.42
21	30.16	AUG 25	29.85	SEP 13	31.03	OCT 20	30.62
SEP 30	30.27	SEP 29	29.96	NOV 21	31.31	DEC 02	30.62
OCT 06	30.23	NOV 18	29.21	JUN 06, 1979	31.10	MAR 02, 1982	31.02
07	30.21	30	30.16	SEP 20	30.63	MAY 27	30.09
21	30.28	JAN 20, 1977	30.38	NOV 27	30.91	JUL 16	30.27
NOV 25	30.42	MAR 04	30.57	MAR 04, 1980	31.22	OCT 14	30.19
FEB 26, 1976	30.69	JUN 14	30.78	JUN 11	31.31		
APR 29	29.72	SEP 13	31.07	OCT 01	31.20		

WATER LEVELS FOR BENSON COUNTY, ND

WELL 156-071-04B8A SITE NUMBER 482212099475801

HIGHEST WATER LEVEL 8.10 FEET BELOW LAND SURFACE DATUM MAY 16, 1979.

LOWEST WATER LEVEL 11.01 FEET BELOW LAND SURFACE DATUM FEB 04, 1971.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
DEC 01, 1970	10.83	MAR 22, 1974	10.70	AUG 02, 1976	9.38	MAR 13, 1979	10.70
JAN 18, 1971	10.99	APR 22	9.46	11	9.47	APR 04	10.70
FEB 04	11.01	MAY 21	8.72	26	9.55	MAY 16	8.10
MAR 04	11.01	AUG 06	9.51	SEP 14	9.70	JUN 06	9.06
APR 13	9.05	SEP 03	9.71	29	9.68	18	10.60
MAY 11	9.70	OCT 01	9.81	OCT 13	9.73	JUL 17	9.51
JUN 09	9.74	21	9.78	NOV 04	9.78	AUG 22	9.72
JUL 02	9.97	DEC 04	9.92	06	9.54	SEP 20	9.90
27	10.16	JAN 07, 1975	9.95	18	9.75	OCT 16	9.99
SEP 09	10.33	28	10.04	30	9.83	NOV 27	10.09
OCT 05	10.25	MAR 21	9.92	JAN 06, 1977	9.85	MAR 04, 1980	10.50
NOV 03	10.23	APR 20	9.27	20	10.00	APR 09	9.75
DEC 01	10.20	MAY 09	8.83	FEB 02	9.96	MAY 13	9.84
JAN 04, 1972	10.42	JUN 12	8.81	MAR 04	10.00	JUN 11	10.25
FEB 08	10.62	JUL 09	9.27	APR 07	9.83	JUL 15	10.54
MAR 09	10.66	30	9.44	MAY 10	9.66	AUG 13	10.48
APR 05	9.81	AUG 05	9.44	JUN 14	10.07	OCT 01	9.40
MAY 02	9.54	12	9.53	JUL 12	9.90	21	9.34
JUN 05	9.66	14	9.57	AUG 09	10.22	DEC 05	9.45
28	9.80	21	9.60	SEP 13	10.33	JAN 28, 1981	9.70
AUG 04	10.12	SEP 11	9.47	OCT 19	10.30	MAR 06	9.21
31	10.27	30	9.54	NOV 11	10.42	APR 08	8.88
OCT 05	10.09	OCT 06	9.56	16	10.38	MAY 21	9.20
DEC 06	10.31	07	9.58	DEC 21	10.48	JUL 02	9.08
FEB 28, 1973	10.47	21	9.49	JAN 18, 1978	10.62	27	9.47
MAY 01	10.05	NOV 06	9.54	FEB 14	10.69	OCT 20	9.60
31	10.20	DEC 02	9.58	MAR 14	10.75	DEC 02	9.64
JUL 03	10.06	FEB 04, 1976	9.82	APR 13	9.83	MAR 02, 1982	9.98
27	10.37	26	9.82	MAY 16	9.67	APR 22	9.11
SEP 05	10.30	MAR 08	9.77	JUN 06	9.61	MAY 27	8.78
OCT 08	10.54	APR 29	8.57	JUL 11	9.59	JUL 15	8.80
NOV 01	10.52	JUN 09	9.00	AUG 22	10.26	OCT 14	8.85
DEC 06	10.59	15	8.64	SEP 13	10.11	DEC 01	9.02
JAN 11, 1974	10.74	JUL 06	10.36	OCT 12	10.33		
FEB 06	10.77	08	9.03	NOV 21	10.38		
MAR 04	10.74	29	9.34	FEB 20, 1979	10.70		

WATER LEVELS FOR BENSON COUNTY, ND

WELL 156-071-04DCD SITE NUMBER 482125099472001

HIGHEST WATER LEVEL 8.40 FEET BELOW LAND SURFACE DATUM APR 29, 1976.

LOWEST WATER LEVEL 12.7 FEET BELOW LAND SURFACE DATUM DEC 21, 1977.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 21, 1975	9.59	APR 29, 1976	8.40	NOV 18, 1976	10.22	NOV 27, 1979	11.30
OCT 02	10.22	JUN 15	9.16	30	10.88	DEC 05, 1980	10.63
07	10.18	JUL 08	9.64	JAN 20, 1977	9.99	JUL 29, 1981	11.45
21	10.01	09	9.68	NOV 14	10.29	DEC 02	11.11
NOV 25	9.85	AUG 23	9.67	DEC 21	12.7	DEC 01, 1982	10.76
FEB 26, 1976	9.52	SEP 29	10.75	NOV 21, 1978	11.68		

WATER LEVELS FOR BENSON COUNTY, ND

WELL 156-071-05AAA SITE NUMBER 482212099481701

HIGHEST WATER LEVEL 6.81 FEET BELOW LAND SURFACE DATUM OCT 14, 1982.

LOWEST WATER LEVEL 10.57 FEET BELOW LAND SURFACE DATUM MAR 14, 1978.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
JUL 30, 1975	8.45	JUN 15, 1976	7.16	SEP 13, 1978	9.	MAR 06, 1981	8.33
AUG 05	8.53	JUL 08	7.71	NOV 21	9.32	JUL 02	7.13
12	8.7	AUG 24	8.91	MAR 13, 1979	10.08	29	8.23
20	8.77	SEP 29	9.08	JUN 06	9.59	OCT 20	8.35
OCT 02	8.32	NOV 18	8.59	SEP 20	8.62	DEC 02	8.27
07	8.37	MAR 04, 1977	9.18	NOV 27	8.85	MAR 02, 1982	9.13
21	8.27	JUN 04	9.15	MAR 04, 1980	9.85	MAY 27	6.96
NOV 25	8.38	SEP 13	9.48	JUN 11	9.02	OCT 14	6.81
FEB 26, 1976	9.05	MAR 14, 1978	10.57	OCT 01	7.26		
APR 29	7.13	JUN 06	7.83	DEC 05	7.27		

WATER LEVELS FOR BENSON COUNTY, ND

WELL 156-071-1688A SITE NUMBER 482025099475801

HIGHEST WATER LEVEL 0.04 FEET BELOW LAND SURFACE DATUM SEP 29, 1976.

LOWEST WATER LEVEL 7.19 FEET BELOW LAND SURFACE DATUM DEC 02, 1981.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 05, 1975	0.77	APR 29, 1976	1.50	FEB 02, 1977	1.	DEC 05, 1980	6.14
12	0.60	JUN 15	1.10	NOV 14	2.12	JUL 29, 1981	6.19
21	0.47	JUL 09	0.88	DEC 21	4.36	DEC 02	7.19
OCT 02	0.58	AUG 26	0.18	NOV 20, 1978	5.27	MAR 02, 1982	7.19
21	0.58	SEP 29	0.04	NOV 27, 1979	5.90	DEC 01	6.52

WATER LEVELS FOR BENSON COUNTY, ND

WELL 156-071-17CDA SITE NUMBER 481945099485601

HIGHEST WATER LEVEL 26.50 FEET BELOW LAND SURFACE DATUM JUL 29, 1981.

LOWEST WATER LEVEL 32.14 FEET BELOW LAND SURFACE DATUM NOV 14, 1977.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 05, 1975	30.19	FEB 26, 1976	31.45	NOV 18, 1976	31.22	DEC 05, 1980	27.22
12	30.2	APR 29	30.52	30	31.34	JUL 29, 1981	26.50
21	30.36	JUN 15	30.24	NOV 14, 1977	32.14	DEC 02	28.27
OCT 02	30.73	JUL 09	30.24	DEC 21	31.3	DEC 01, 1982	27.55
21	30.76	AUG 26	30.7	NOV 20, 1978	31.6		
NOV 25	31.08	SEP 29	30.98	NOV 27, 1979	29.53		

WATER LEVELS FOR BENSON COUNTY, ND

WELL 156-071-20CDC SITE NUMBER 481845099490601

HIGHEST WATER LEVEL 0.88 FEET ABOVE LAND SURFACE DATUM NOV 30, 1976.

LOWEST WATER LEVEL 2.82 FEET BELOW LAND SURFACE DATUM NOV 20, 1978.

WATER LEVELS IN FEET ABOVE OR BELOW(-) LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
NOV 30, 1976	0.88	NOV 20, 1978	-2.82	DEC 05, 1980	-0.51	DEC 02, 1981	-1.62
DEC 21, 1977	-2.26	NOV 27, 1979	-2.75	JUL 29, 1981	-2.78	DEC 01, 1982	-1.42

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 156-072-09CDC SITE NUMBER 482033099553501

HIGHEST WATER LEVEL 6.35 FEET BELOW LAND SURFACE DATUM DEC 05, 1981.

LOWEST WATER LEVEL 17.39 FEET BELOW LAND SURFACE DATUM DEC 21, 1977.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 21, 1975	12.73	AUG 24, 1976	13.03	DEC 21, 1977	17.39	DEC 16, 1981	6.53
OCT 02	13.32	SEP 29	14.63	NOV 20, 1978	14.00	DEC 18, 1982	9.67
21	9.52	NOV 18	15.61	NOV 25, 1979	14.73		
FEB 26, 1976	13.75	MAR 04, 1977	15.70	DEC 04, 1980	10.02		
JUN 15	10.91	NOV 09	17.27	DEC 05, 1981	6.35		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-02CCC SITE NUMBER 482639099474301

HIGHEST WATER LEVEL 3.71 FEET BELOW LAND SURFACE DATUM MAR 29, 1981.

LOWEST WATER LEVEL 8.15 FEET BELOW LAND SURFACE DATUM AUG 07, 1968.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 07, 1968	8.15	MAY 13, 1969	6.19	NOV 29, 1971	5.47	NOV 24, 1979	5.60
19	7.73	JUN 18	6.50	DEC 06, 1972	6.11	DEC 04, 1980	4.32
SEP 09	7.45	JUL 16	6.17	DEC 06, 1973	6.33	MAR 29, 1981	3.71
16	7.52	AUG 20	6.40	DEC 04, 1974	5.87	DEC 05	4.56
OCT 07	7.63	SEP 17	6.76	DEC 03, 1975	5.70	16	4.70
NOV 12	7.64	NOV 18	6.78	NOV 19, 1976	6.00	DEC 18, 1982	4.16
DEC 11	7.68	JAN 22, 1970	7.01	MAR 04, 1977	6.25		
JAN 15, 1969	8.00	MAR 24	7.11	DEC 22	6.16		
APR 24	6.46	DEC 01	6.43	NOV 21, 1978	6.12		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-03CCD SITE NUMBER 482640099485101

HIGHEST WATER LEVEL 19.95 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 25.15 FEET BELOW LAND SURFACE DATUM MAR 04, 1977.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
NOV 19, 1976	23.65	DEC 22, 1977	22.35	DEC 04, 1980	20.86	DEC 16, 1981	20.65
MAR 04, 1977	25.15	NOV 21, 1978	22.29	MAR 29, 1981	20.63	DEC 18, 1982	19.95
NOV 15	24.31	NOV 24, 1979	21.51	DEC 05	20.53		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-11CCC SITE NUMBER 482547099474301

HIGHEST WATER LEVEL 21.86 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 23.90 FEET BELOW LAND SURFACE DATUM DEC 22, 1977.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
JUL 30, 1975	22.85	OCT 20, 1975	23.14	AUG 26, 1976	22.90	NOV 21, 1978	23.74
AUG 05	22.82	NOV 25	23.25	SEP 29	23.13	NOV 24, 1979	23.11
12	23.16	FEB 26, 1976	23.36	NOV 18	23.45	DEC 04, 1980	22.19
20	23.22	APR 30	22.42	MAR 04, 1977	23.59	MAR 29, 1981	21.95
SEP 30	23.18	JUN 15	22.58	NOV 16	23.80	DEC 18, 1982	21.86
OCT 06	23.17	JUL 08	22.57	DEC 22	23.90		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-14CDC SITE NUMBER 482455099472301

HIGHEST WATER LEVEL 5.48 FEET BELOW LAND SURFACE DATUM APR 30, 1983; MAY 29, 1983.

LOWEST WATER LEVEL 7.92 FEET BELOW LAND SURFACE DATUM JAN 28, 1978.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
NOV 18, 1976	7.30	JUN 21, 1978	7.11	MAR 08, 1980	7.14	APR 18, 1982	6.23
JAN 20, 1977	7.48	JUL 23	7.08	APR 13	7.05	MAY 23	5.98
MAR 04	7.43	AUG 27	7.38	MAY 11	6.85	JUN 27	5.88
APR 07	7.54	SEP 27	7.37	JUN 15	7.15	JUL 31	5.77
MAY 10	7.43	OCT 15	7.58	JUL 12	7.29	AUG 22	5.75
JUN 14	7.47	NOV 19	7.70	AUG 10	7.31	SEP 26	5.89
JUL 12	7.50	21	7.44	SEP 13	7.06	OCT 24	5.82
AUG 09	7.55	DEC 31	7.57	OCT 25	6.48	NOV 21	5.87
SEP 13	7.67	JAN 18, 1979	7.53	NOV 23	6.38	DEC 01	5.78
OCT 19	7.65	FEB 27	7.66	DEC 04	6.19	18	5.75
NOV 15	7.55	MAR 24	7.60	MAR 29, 1981	5.92	MAR 28, 1983	5.64
16	7.60	APR 22	7.54	APR 26	5.96	APR 30	5.48
DEC 21	7.60	MAY 30	6.47	JUL 13	6.09	MAY 29	5.48
JAN 28, 1978	7.92	JUN 24	6.37	26	6.09	JUN 25	5.63
FEB 11	7.87	JUL 15	6.53	AUG 29	6.25	JUL 31	5.85
MAR 21	7.88	AUG 14	6.69	SEP 20	6.30	AUG 21	6.02
APR 23	7.28	OCT 21	6.98	OCT 24	6.37	SEP 24	6.10
MAY 21	7.08	NOV 24	6.94	MAR 21, 1982	6.57		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-15CCC SITE NUMBER 482455099490101

HIGHEST WATER LEVEL 17.57 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 23.10 FEET BELOW LAND SURFACE DATUM JUN 15, 1976.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 20, 1975	18.65	APR 29, 1976	17.92	NOV 18, 1976	17.94	JUL 12, 1979	18.15
SEP 30	18.65	JUN 15	23.10	MAR 04, 1977	19.76	NOV 24	18.56
OCT 06	18.65	JUL 08	18.05	NOV 15	19.05	DEC 04, 1980	17.90
NOV 25	18.67	AUG 25	20.51	DEC 21	19.07	DEC 18, 1982	17.57
FEB 26, 1976	18.69	SEP 29	18.68	NOV 21, 1978	18.03		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-15DDD SITE NUMBER 482455099475301

HIGHEST WATER LEVEL 23.33 FEET BELOW LAND SURFACE DATUM MAR 28, 1983.

LOWEST WATER LEVEL 25.74 FEET BELOW LAND SURFACE DATUM MAR 21, 1978.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
JUL 30, 1975	24.77	AUG 26, 1976	24.61	SEP 27, 1978	25.41	JUL 14, 1981	23.88
AUG 05	24.85	SEP 29	24.82	NOV 21	25.38	SEP 20	24.15
12	24.76	NOV 18	25.04	MAR 24, 1979	25.43	MAR 21, 1982	24.36
20	24.79	JAN 20, 1977	25.18	JUN 24	24.25	JUN 27	23.65
SEP 30	24.91	MAR 04	25.26	SEP 29	24.69	SEP 26	23.74
OCT 06	24.90	JUN 14	25.17	NOV 24	24.80	DEC 01	23.61
20	24.88	SEP 13	24.39	MAR 08, 1980	24.95	18	23.61
NOV 25	25.01	NOV 15	25.43	JUN 15	23.94	MAR 28, 1983	23.33
FEB 26, 1976	25.06	DEC 21	25.51	SEP 13	24.73	JUN 25	23.46
APR 29	24.17	MAR 21, 1978	25.74	DEC 04	24.10	SEP 24	23.96
JUL 08	24.34	JUN 21	25.06	MAR 29, 1981	23.63		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-19AAA2 SITE NUMBER 482449099514802

HIGHEST WATER LEVEL 10.62 FEET BELOW LAND SURFACE DATUM MAR 29, 1981.

LOWEST WATER LEVEL 13.40 FEET BELOW LAND SURFACE DATUM NOV 10, 1977.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 05, 1975	12.44	FEB 26, 1976	12.69	SEP 29, 1976	12.24	NOV 20, 1978	13.30
20	11.92	APR 30	11.04	NOV 18	12.48	NOV 24, 1979	12.54
OCT 02	12.18	JUN 15	11.15	MAR 04, 1977	12.78	DEC 04, 1980	10.83
21	12.24	JUL 08	11.22	NOV 10	13.40	MAR 29, 1981	10.62
NOV 25	12.34	AUG 25	11.68	DEC 22	13.40	DEC 18, 1982	10.67

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-21ADD SITE NUMBER 482429099491101

HIGHEST WATER LEVEL 12.85 FEET BELOW LAND SURFACE DATUM APR 29, 1976.

LOWEST WATER LEVEL 16.80 FEET BELOW LAND SURFACE DATUM MAR 04, 1977.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 20, 1975	14.20	NOV 25, 1975	13.96	AUG 25, 1976	14.12	NOV 10, 1977	14.42
SEP 30	14.19	APR 29, 1976	12.85	SEP 29	14.25		
OCT 06	14.23	JUN 15	13.16	NOV 18	14.38		
21	13.93	JUL 08	13.27	MAR 04, 1977	16.80		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-21DCC SITE NUMBER 482403099494001

HIGHEST WATER LEVEL 7.83 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 10.50 FEET BELOW LAND SURFACE DATUM AUG 20, 1975.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 20, 1975	10.50	FEB 26, 1976	10.15	SEP 29, 1976	9.15	NOV 21, 1978	10.06
SEP 30	9.95	APR 29	9.13	NOV 18	9.30	NOV 24, 1979	9.38
OCT 06	9.94	JUN 15	8.98	MAR 04, 1977	9.68	DEC 04, 1980	9.05
21	9.87	JUL 08	8.88	NOV 15	9.90	MAR 29, 1981	8.72
NOV 25	9.93	AUG 25	9.04	DEC 21	10.11	DEC 18, 1982	7.83

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-22ABB SITE NUMBER 482449099482201

HIGHEST WATER LEVEL 13.47 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 15.24 FEET BELOW LAND SURFACE DATUM DEC 22, 1977.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 20, 1975	14.25	APR 29, 1976	14.03	JAN 20, 1977	14.90	MAR 29, 1981	13.61
SEP 30	14.63	JUN 15	14.01	MAR 04	15.05	DEC 01, 1982	13.56
OCT 06	14.63	JUL 08	14.04	DEC 22	15.24	18	13.47
20	14.61	AUG 25	14.29	NOV 21, 1978	15.10		
NOV 25	14.79	SEP 29	14.48	NOV 24, 1979	14.50		
FEB 26, 1976	14.81	NOV 18	14.70	DEC 04, 1980	13.96		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-23C8B SITE NUMBER 482422099474301

HIGHEST WATER LEVEL 15.70 FEET BELOW LAND SURFACE DATUM MAR 28, 1983.

LOWEST WATER LEVEL 17.78 FEET BELOW LAND SURFACE DATUM NOV 19, 1978.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 21, 1975	15.77	SEP 13, 1977	17.63	MAR 24, 1979	17.43	APR 26, 1981	16.04
SEP 30	17.29	OCT 19	17.63	APR 22	17.20	JUL 14	16.40
OCT 02	17.33	NOV 11	17.73	MAY 30	16.57	26	16.45
06	17.39	16	17.69	JUN 24	16.62	AUG 29	16.64
07	17.40	DEC 21	17.75	JUL 15	16.75	SEP 20	16.68
20	17.42	JAN 28, 1978	17.67	AUG 14	16.95	OCT 24	16.70
NOV 25	17.59	FEB 11	17.65	SEP 29	17.12	MAR 21, 1982	16.57
FEB 26, 1976	17.43	MAR 21	17.60	OCT 21	17.25	APR 18	16.06
JUN 15	16.95	APR 23	17.18	NOV 24	17.21	MAY 23	16.05
JUL 29	16.98	MAY 21	17.18	MAR 08, 1980	17.14	JUN 27	16.05
AUG 26	17.33	JUN 21	17.28	APR 13	16.88	JUL 31	16.04
SEP 29	17.57	JUL 23	17.27	MAY 11	16.98	AUG 22	16.11
NOV 18	17.42	AUG 27	17.54	JUN 15	17.33	SEP 26	16.26
JAN 20, 1977	17.40	SEP 27	17.65	JUL 12	17.47	OCT 24	16.13
MAR 04	17.31	OCT 15	17.71	AUG 10	17.49	NOV 21	16.12
APR 07	17.37	NOV 19	17.78	SEP 13	17.23	DEC 18	16.00
MAY 10	17.17	21	17.63	OCT 25	16.84	MAR 28, 1983	15.70
JUN 14	17.43	DEC 31	17.60	NOV 23	16.70	JUN 25	15.83
JUL 12	17.46	JAN 18, 1979	17.53	DEC 04	16.63	SEP 24	16.41
AUG 09	17.54	FEB 27	17.50	MAR 29, 1981	16.10		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-26BBA SITE NUMBER 482356099473301

HIGHEST WATER LEVEL 25.87 FEET BELOW LAND SURFACE DATUM APR 30, 1983.

LOWEST WATER LEVEL 27.70 FEET BELOW LAND SURFACE DATUM MAR 04, 1977.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
NOV 18, 1976	26.39	APR 23, 1978	27.03	AUG 14, 1979	26.66	AUG 29, 1981	25.95
DEC 01	26.38	MAY 21	26.98	SEP 29	26.84	SEP 20	26.52
JAN 06, 1977	26.45	JUN 21	26.94	OCT 21	26.91	OCT 24	26.58
20	26.56	JUL 23	26.96	NOV 24	26.96	MAR 21, 1982	26.80
FEB 02	26.56	AUG 27	27.09	MAR 08, 1980	27.23	MAY 23	26.17
MAR 04	27.70	SEP 27	27.22	APR 13	27.21	JUN 27	26.15
APR 07	26.72	OCT 15	27.28	MAY 11	27.04	JUL 31	26.13
MAY 10	26.69	NOV 19	27.38	JUN 15	27.22	AUG 22	26.10
JUN 14	26.73	21	27.21	JUL 12	27.33	OCT 24	26.18
JUL 12	26.79	DEC 31	27.33	AUG 10	27.40	NOV 21	26.18
AUG 09	26.82	JAN 18, 1979	27.32	SEP 13	27.25	DEC 18	26.13
SEP 13	26.90	FEB 27	27.40	OCT 25	26.73	MAR 28, 1983	25.97
OCT 19	26.92	MAR 24	27.44	NOV 23	26.38	APR 30	25.87
NOV 11	27.04	APR 22	27.45	DEC 04	26.16	MAY 29	25.89
16	27.01	MAY 30	26.66	MAR 29, 1981	26.23	JUN 25	25.99
JAN 28, 1978	27.47	JUN 24	26.56	APR 26	26.19	JUL 31	26.14
FEB 11	27.48	JUL 11	26.50	JUL 14	26.33	AUG 21	26.22
MAR 21	27.07	15	26.56	26	26.34	SEP 24	26.35

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-26BCB SITE NUMBER 482343099474301

HIGHEST WATER LEVEL 14.87 FEET BELOW LAND SURFACE DATUM JUL 08, 1976.

LOWEST WATER LEVEL 16.98 FEET BELOW LAND SURFACE DATUM AUG 10, 1980.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 21, 1975	15.60	JUL 12, 1977	16.10	FEB 27, 1979	16.90	APR 26, 1981	15.69
SEP 22	15.56	AUG 09	16.19	MAR 24	16.94	JUL 14	15.84
OCT 06	15.62	SEP 13	16.32	APR 22	16.88	26	15.89
07	15.60	OCT 19	16.37	MAY 30	16.06	AUG 29	16.02
NOV 25	15.74	NOV 11	16.49	JUN 24	15.90	SEP 20	16.10
FEB 26, 1976	15.84	16	16.48	JUL 15	15.89	OCT 24	16.02
APR 29	14.98	DEC 21	16.50	AUG 14	16.03	DEC 16	16.32
JUN 15	14.99	JAN 28, 1978	16.78	SEP 29	16.25	MAR 21, 1982	16.46
JUL 08	14.87	FEB 11	16.80	OCT 21	16.35	APR 18	15.89
09	15.05	MAR 21	16.84	NOV 24	16.44	MAY 23	15.78
AUG 26	15.24	APR 23	16.38	MAR 08, 1980	16.80	JUN 27	15.69
SEP 29	15.44	MAY 21	16.30	APR 13	16.65	JUL 31	15.64
NOV 18	15.63	JUN 21	16.30	MAY 11	16.56	AUG 22	15.60
DEC 01	15.70	JUL 23	16.30	JUN 15	16.76	SEP 26	15.70
JAN 06, 1977	16.28	AUG 27	16.50	JUL 12	16.91	OCT 24	15.70
20	15.83	SEP 27	16.65	AUG 10	16.98	NOV 21	15.72
FEB 02	15.80	OCT 15	16.70	SEP 13	16.88	DEC 01	15.79
MAR 04	15.85	NOV 19	16.92	OCT 25	16.37	18	15.70
APR 07	15.54	21	16.67	NOV 23	16.23	MAR 28, 1983	15.73
MAY 10	16.04	DEC 31	16.77	DEC 04	16.07	JUN 25	15.73
JUN 14	16.09	JAN 18, 1979	16.80	MAR 29, 1981	15.72	SEP 24	16.24

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-26CBB SITE NUMBER 482330099474301

HIGHEST WATER LEVEL 8.16 FEET BELOW LAND SURFACE DATUM OCT 20, 1975.

LOWEST WATER LEVEL 11.67 FEET BELOW LAND SURFACE DATUM AUG 10, 1980.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 21, 1975	9.09	MAY 10, 1977	10.05	JAN 18, 1979	11.14	JUL 13, 1981	10.06
SEP 22	9.11	JUN 14	10.03	FEB 27	10.50	26	10.15
OCT 01	8.22	JUL 12	10.14	APR 22	11.17	AUG 29	10.42
20	8.16	AUG 09	10.23	MAY 30	10.00	SEP 20	10.54
NOV 25	9.38	SEP 13	10.38	JUN 24	9.91	OCT 24	10.58
FEB 26, 1976	9.58	OCT 19	10.52	JUL 15	9.95	MAR 21, 1982	11.00
APR 29	8.49	NOV 11	10.67	AUG 14	10.28	APR 18	10.49
JUN 15	8.46	16	10.68	SEP 29	10.61	MAY 23	10.36
JUL 08	8.44	DEC 21	10.50	OCT 21	10.75	JUN 27	9.96
09	8.45	JAN 28, 1978	10.94	NOV 24	10.92	JUL 31	9.83
29	8.68	FEB 11	11.08	MAR 08, 1980	11.31	AUG 22	9.87
30	8.26	MAR 21	11.21	APR 13	11.16	SEP 26	10.06
AUG 26	8.78	APR 23	10.68	MAY 11	11.10	OCT 24	10.07
SEP 29	9.04	MAY 21	10.47	JUN 15	11.32	NOV 21	10.10
NOV 18	9.33	JUN 21	10.37	JUL 12	11.43	DEC 01	10.24
DEC 01	9.35	JUL 23	10.40	AUG 10	11.67	18	10.17
21	9.38	AUG 27	10.73	SEP 13	11.21	MAR 28, 1983	10.73
JAN 06, 1977	9.46	SEP 27	10.93	OCT 25	10.59	JUN 25	10.56
20	9.58	OCT 15	11.03	NOV 23	10.35	SEP 24	11.21
FEB 02	9.45	NOV 19	11.21	DEC 04	10.42		
MAR 04	9.73	21	11.03	MAR 29, 1981	9.96		
APR 07	9.94	DEC 31	11.08	APR 26	10.10		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-26CCC SITE NUMBER 482311099474301

HIGHEST WATER LEVEL 12.24 FEET BELOW LAND SURFACE DATUM JUN 15, 1976.

LOWEST WATER LEVEL 18.58 FEET BELOW LAND SURFACE DATUM JUL 12, 1980.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 21, 1975	13.17	MAY 10, 1977	14.83	MAY 30, 1979	15.86	SEP 20, 1981	17.19
SEP 22	13.17	JUN 14	16.29	JUN 24	15.84	OCT 24	16.21
30	13.18	JUL 12	15.11	JUL 15	17.04	MAR 21, 1982	16.55
OCT 06	13.21	AUG 09	16.67	AUG 14	17.65	APR 18	16.28
07	13.21	SEP 13	16.75	SEP 29	17.38	MAY 23	15.97
21	13.19	OCT 19	16.54	OCT 21	16.60	JUN 27	16.48
NOV 25	13.29	NOV 11	15.95	NOV 24	16.55	JUL 31	16.43
FEB 26, 1976	13.51	16	16.64	MAR 08, 1980	16.94	AUG 22	16.04
APR 29	12.76	APR 23, 1978	16.31	APR 13	16.62	SEP 26	16.59
JUN 15	12.24	MAY 21	16.27	MAY 11	17.80	OCT 24	15.60
JUL 29	12.38	JUN 21	17.25	JUN 15	18.11	NOV 21	15.36
30	12.45	JUL 23	16.40	JUL 12	18.58	DEC 01	16.14
AUG 26	12.55	AUG 27	17.69	AUG 10	17.64	18	16.21
SEP 29	12.77	SEP 27	16.97	SEP 13	17.14	MAR 28, 1983	15.50
NOV 18	13.04	OCT 15	16.57	OCT 25	16.58	APR 30	15.40
DEC 01	13.10	NOV 19	16.68	NOV 23	15.90	MAY 29	15.50
21	13.64	21	17.34	DEC 04	15.98	JUN 25	16.76
JAN 06, 1977	13.79	DEC 31	16.49	MAR 29, 1981	15.15	JUL 31	17.26
20	13.57	JAN 18, 1979	16.26	APR 26	15.40	AUG 21	17.77
FEB 02	13.70	FEB 27	16.20	JUL 13	16.89	SEP 24	17.36
MAR 04	15.18	MAR 24	17.56	26	16.91		
APR 07	15.41	APR 22	16.75	AUG 29	16.85		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-31CBC1 SITE NUMBER 482232099525601

HIGHEST WATER LEVEL 20.17 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 54.92 FEET BELOW LAND SURFACE DATUM NOV 18, 1976.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
NOV 18, 1976	54.92	DEC 21, 1977	42.77	JUN 24, 1979	33.29	APR 26, 1981	27.44
DEC 21	54.78	JAN 28, 1978	41.37	JUL 15	32.74	JUL 13	25.69
27	54.74	FEB 11	41.02	AUG 14	32.10	26	25.47
JAN 06, 1977	53.96	MAR 24	39.89	SEP 29	31.17	AUG 29	24.86
21	53.41	APR 23	39.03	OCT 21	30.92	SEP 20	24.62
FEB 02	52.90	MAY 21	38.49	NOV 24	30.42	OCT 24	24.26
MAR 04	51.05	JUN 21	38.18	MAR 08, 1980	30.28	MAR 21, 1982	23.30
APR 01	49.48	JUL 23	37.61	APR 13	30.17	APR 18	22.34
07	49.48	AUG 27	37.31	MAY 11	29.80	MAY 23	21.87
MAY 10	48.68	SEP 27	36.48	JUN 15	30.96	JUN 27	21.47
JUN 14	47.43	NOV 21	35.25	JUL 12	30.43	JUL 31	21.14
JUL 12	47.32	DEC 31	35.20	AUG 10	29.99	AUG 22	21.02
AUG 09	46.12	JAN 18, 1979	35.16	SEP 13	27.40	SEP 26	20.82
SEP 13	45.08	FEB 18	35.30	OCT 25	28.58	OCT 24	20.68
OCT 19	43.85	MAR 24	34.89	NOV 23	28.05	NOV 21	20.63
NOV 09	43.37	APR 29	34.69	DEC 04	27.55	DEC 01	21.30
16	43.10	MAY 30	33.76	MAR 29, 1981	27.84	18	20.17

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-31C8C2 SITE NUMBER 482232099525602

HIGHEST WATER LEVEL 20.53 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 54.49 FEET BELOW LAND SURFACE DATUM SEP 29, 1976.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
JUL 23, 1975	51.04	MAY 10, 1977	49.00	DEC 31, 1978	35.73	DEC 04, 1980	27.96
AUG 05	50.75	JUN 14	48.06	JAN 18, 1979	35.46	MAR 29, 1981	28.61
12	50.96	JUL 12	47.61	FEB 18	35.64	APR 26	27.77
20	51.16	AUG 09	46.83	MAR 24	35.40	JUL 13	26.07
OCT 02	51.48	SEP 13	46.85	APR 29	35.13	26	25.86
21	51.48	OCT 19	44.67	MAY 30	34.26	AUG 29	25.30
NOV 25	51.45	NOV 09	44.10	JUN 24	33.58	SEP 20	25.02
FEB 26, 1976	51.63	16	43.86	JUL 15	33.19	OCT 24	24.64
APR 29	51.90	DEC 21	42.87	AUG 14	32.60	MAR 21, 1982	23.70
JUN 15	52.88	JAN 28, 1978	42.09	SEP 29	31.66	APR 18	22.74
JUL 08	53.43	FEB 11	41.65	OCT 21	31.40	MAY 23	22.28
AUG 26	54.23	MAR 24	40.50	NOV 24	31.54	JUN 27	21.89
SEP 29	54.49	APR 23	39.66	MAR 08, 1980	30.65	JUL 31	21.52
NOV 18	54.19	MAY 21	39.10	APR 13	30.61	AUG 22	21.43
DEC 21	54.44	JUN 21	38.68	MAY 11	29.30	SEP 26	21.24
27	54.44	JUL 23	38.11	JUN 15	31.20	OCT 24	21.08
JAN 06, 1977	53.87	AUG 27	37.78	JUL 12	30.83	NOV 21	20.98
21	53.56	SEP 27	37.06	AUG 10	30.40	DEC 01	20.66
FEB 02	53.02	OCT 15	36.88	SEP 13	29.82	18	20.53
MAR 04	51.69	NOV 19	36.22	OCT 25	29.03		
APR 07	50.16	21	35.72	NOV 23	28.46		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-32DAA SITE NUMBER 482239099502901

HIGHEST WATER LEVEL 7.63 FEET BELOW LAND SURFACE DATUM DEC 04, 1980.

LOWEST WATER LEVEL 16.09 FEET BELOW LAND SURFACE DATUM FEB 21, 1968.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
NOV 13, 1967	15.65	SEP 09, 1968	15.14	AUG 20, 1969	11.72	DEC 01, 1976	11.57
DEC 12	15.63	16	15.00	SEP 17	12.62	JAN 20, 1977	11.77
JAN 15, 1968	15.82	OCT 07	14.78	NOV 18	12.77	DEC 21	12.10
FEB 21	16.09	NOV 12	14.53	DEC 01, 1970	11.13	NOV 21, 1978	11.77
MAR 12	15.76	DEC 11	14.41	NOV 29, 1971	9.89	NOV 21, 1979	11.77
APR 12	14.92	JAN 15, 1969	14.68	DEC 06, 1972	11.56	DEC 04, 1980	7.63
MAY 14	14.59	APR 24	12.45	DEC 06, 1973	12.16	MAR 29, 1981	7.90
JUN 20	14.61	MAY 13	11.80	DEC 04, 1974	10.42	DEC 01, 1982	7.79
JUL 11	15.06	JUN 18	11.73	DEC 03, 1975	10.43	18	7.93
AUG 19	15.67	JUL 16	11.58	NOV 18, 1976	11.09		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-340AA SITE NUMBER 482238099475301

HIGHEST WATER LEVEL 15.45 FEET BELOW LAND SURFACE DATUM DEC 01, 1976.

LOWEST WATER LEVEL 18.40 FEET BELOW LAND SURFACE DATUM AUG 10, 1980.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
DEC 01, 1976	15.45	APR 23, 1978	16.65	AUG 14, 1979	17.53	JUL 26, 1981	16.00
JAN 06, 1977	15.68	MAY 21	16.46	SEP 29	17.11	AUG 29	17.22
FEB 02	15.67	JUN 21	16.46	OCT 21	17.07	SEP 20	16.76
MAR 04	15.67	JUL 23	16.59	NOV 24	17.00	OCT 24	16.60
APR 07	15.95	AUG 27	16.88	APR 13, 1980	17.08	MAR 21, 1982	16.97
MAY 10	15.94	SEP 27	17.16	MAY 11	17.15	APR 18	16.47
JUN 14	16.12	OCT 15	17.15	JUN 15	18.08	MAY 23	16.21
JUL 12	16.07	NOV 19	17.28	JUL 12	18.30	JUN 27	15.83
AUG 09	16.18	21	17.14	AUG 10	18.40	JUL 31	16.08
SEP 13	16.45	DEC 31	17.20	SEP 13	17.54	AUG 22	16.27
OCT 19	16.51	JAN 18, 1979	17.24	OCT 25	16.52	SEP 26	16.02
NOV 16	16.58	FEB 27	17.35	NOV 23	16.49	OCT 24	15.88
DEC 21	16.70	APR 22	17.20	DEC 04	17.06	NOV 21	15.72
JAN 28, 1978	16.99	MAY 30	16.00	MAR 29, 1981	16.17	DEC 01	16.73
FEB 11	17.05	JUN 24	16.41	APR 26	16.09	18	15.74
MAR 21	17.21	JUL 15	16.51	JUL 13	15.47		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-071-358AA SITE NUMBER 482304099471301

HIGHEST WATER LEVEL 9.95 FEET BELOW LAND SURFACE DATUM JUN 15, 1976.

LOWEST WATER LEVEL 13.64 FEET BELOW LAND SURFACE DATUM JAN 18, 1979.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
JUL 30, 1975	10.43	MAR 04, 1977	10.99	NOV 21, 1978	12.64	DEC 04, 1980	12.35
AUG 05	10.48	APR 07	11.26	DEC 31	12.68	MAR 28, 1981	11.94
12	10.52	MAY 10	11.32	JAN 18, 1979	13.64	APR 26	11.89
21	10.54	JUN 14	11.56	FEB 27	12.73	JUL 13	11.90
SEP 30	10.62	JUL 12	11.58	MAR 24	12.87	26	11.92
OCT 06	10.57	AUG 09	11.74	APR 22	12.86	AUG 29	12.10
07	10.55	SEP 13	11.82	MAY 30	12.25	SEP 20	12.12
21	10.57	OCT 19	12.00	JUN 24	12.10	OCT 24	12.12
NOV 25	10.72	NOV 11	11.87	JUL 15	12.19	MAR 21, 1982	12.41
FEB 26, 1976	10.96	16	12.09	AUG 14	12.31	APR 18	12.27
APR 29	10.30	DEC 21	12.17	SEP 29	12.47	MAY 23	12.05
JUN 15	9.95	JAN 28, 1978	12.57	OCT 21	12.57	JUN 27	11.86
JUL 08	10.07	FEB 11	12.60	NOV 24	12.45	JUL 31	11.73
09	10.11	MAR 21	12.74	MAR 08, 1980	12.74	AUG 22	11.68
29	10.18	APR 23	12.59	APR 13	12.76	SEP 26	11.74
30	10.15	MAY 21	12.48	MAY 11	12.80	OCT 24	11.65
AUG 24	10.22	JUN 21	12.44	JUN 15	12.97	NOV 21	11.62
SEP 29	10.32	JUL 23	12.43	JUL 12	13.14	DEC 01	11.60
NOV 18	10.50	AUG 27	12.66	AUG 10	13.20	18	11.59
DEC 21	10.53	SEP 27	11.95	SEP 13	13.05		
JAN 06, 1977	10.64	OCT 15	12.79	OCT 25	12.63		
FEB 02	11.42	NOV 19	12.89	NOV 23	12.45		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-072-15CC8 SITE NUMBER 482503099565101

HIGHEST WATER LEVEL 3.02 FEET BELOW LAND SURFACE DATUM DEC 04, 1980.

LOWEST WATER LEVEL 5.62 FEET BELOW LAND SURFACE DATUM FEB 26, 1976.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 21, 1975	5.36	JUN 15, 1976	4.05	NOV 30, 1976	4.91	NOV 24, 1979	4.95
OCT 02	5.04	JUL 04	4.21	DEC 01	4.91	DEC 04, 1980	3.02
NOV 25	5.17	AUG 25	4.75	NOV 16, 1977	5.37	DEC 18, 1982	3.35
FEB 26, 1976	5.62	SEP 29	4.93	DEC 01	5.43		
APR 30	3.36	NOV 19	5.21	NOV 20, 1978	5.52		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-072-25AAA SITE NUMBER 482358099530601

HIGHEST WATER LEVEL 43.58 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 48.98 FEET BELOW LAND SURFACE DATUM NOV 10, 1977.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 12, 1975	45.83	APR 30, 1976	47.87	NOV 18, 1976	48.14	DEC 04, 1980	46.43
20	47.93	JUN 15	47.64	30	48.22	DEC 18, 1982	43.58
OCT 02	47.86	JUL 08	47.54	NOV 10, 1977	48.98		
21	47.84	AUG 25	47.70	NOV 20, 1978	48.77		
NOV 25	47.92	SEP 29	47.87	NOV 24, 1979	47.70		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-072-25DCC SITE NUMBER 482312099533501

HIGHEST WATER LEVEL 39.90 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 46.60 FEET BELOW LAND SURFACE DATUM JUL 10, 1979.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
JUL 23, 1975	44.20	NOV 25, 1975	44.29	NOV 18, 1976	44.81	JAN 29, 1978	46.20
AUG 05	44.25	APR 29, 1976	44.12	30	44.84	NOV 21	45.60
12	44.10	JUN 15	43.93	MAR 04, 1977	44.85	JUL 10, 1979	46.60
20	43.99	JUL 08	43.79	JUN 14	45.62	NOV 24	44.30
OCT 02	44.07	AUG 26	44.01	SEP 13	45.90	DEC 04, 1980	43.22
21	44.20	SEP 29	44.35	NOV 09	45.98	DEC 18, 1982	39.90

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-072-25DDD1 SITE NUMBER 482312099530601

HIGHEST WATER LEVEL 18.36 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 28.90 FEET BELOW LAND SURFACE DATUM JAN 20, 1977.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 05, 1975	27.37	AUG 26, 1976	28.35	JAN 29, 1978	28.14	JUN 15, 1980	23.90
12	27.49	SEP 29	28.58	MAR 24	28.05	SEP 13	23.38
20	27.51	NOV 18	28.68	JUN 21	26.94	DEC 04	22.41
OCT 02	27.50	30	28.69	SEP 27	26.91	MAR 29, 1981	21.96
21	27.54	DEC 21	28.40	NOV 21	26.45	MAR 21, 1982	20.30
NOV 25	27.59	JAN 20, 1977	28.90	MAR 24, 1979	26.24	JUN 27	19.18
FEB 26, 1976	28.10	MAR 04	28.85	JUN 24	25.00	SEP 26	18.97
APR 29	27.34	JUN 14	28.56	SEP 29	24.78	DEC 18	18.36
JUN 15	27.55	SEP 13	25.25	NOV 24	24.52		
JUL 08	27.68	NOV 10	28.09	MAR 08, 1980	24.36		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-072-36AAD SITE NUMBER 482259099530601

HIGHEST WATER LEVEL 9.02 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 24.12 FEET BELOW LAND SURFACE DATUM NOV 30, 1976.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
SEP 07, 1967	15.03	DEC 11, 1968	16.65	NOV 30, 1976	24.12	JUN 15, 1980	15.38
OCT 12	15.13	APR 24, 1969	16.79	FEB 02, 1977	23.98	SEP 13	14.80
NOV 13	15.27	MAY 13	16.62	JAN 29, 1978	20.94	DEC 04	13.61
DEC 12	15.36	JUN 18	17.00	MAR 24	20.67	MAR 29, 1981	13.30
APR 11, 1968	15.79	JUL 16	17.01	JUN 21	19.37	JUL 13	12.44
MAY 14	15.68	AUG 20	17.22	SEP 27	18.95	SEP 20	11.92
JUN 20	16.02	SEP 17	17.61	NOV 21	18.53	MAR 21, 1982	11.04
JUL 11	16.26	NOV 18	16.90	MAR 24, 1979	18.27	JUN 27	9.91
AUG 19	16.64	NOV 29, 1971	18.46	JUN 24	16.91	SEP 26	9.77
SEP 16	16.58	DEC 06, 1972	19.90	SEP 29	16.28	DEC 18	9.02
OCT 07	16.62	DEC 04, 1974	21.82	NOV 24	15.93		
NOV 12	16.59	DEC 03, 1975	22.79	MAR 08, 1980	15.63		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-072-36ADD3 SITE NUMBER 482246099530603

HIGHEST WATER LEVEL 55.78 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 92.50 FEET BELOW LAND SURFACE DATUM NOV 30, 1976.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
NOV 30, 1976	92.50	JUN 21, 1978	74.85	SEP 29, 1979	66.81	JUL 26, 1981	61.16
FEB 02, 1977	90.20	JUL 23	74.27	OCT 21	66.51	AUG 29	60.52
APR 07	86.37	AUG 27	73.90	NOV 24	67.05	SEP 20	60.35
MAY 10	86.04	SEP 27	73.03	MAR 08, 1980	65.93	OCT 24	59.92
JUN 14	84.45	OCT 15	73.00	APR 13	65.78	MAR 21, 1982	58.40
JUL 12	83.87	NOV 19	72.20	MAY 11	65.40	APR 18	58.01
AUG 09	83.06	21	70.82	JUN 15	66.80	MAY 23	57.52
SEP 13	81.92	DEC 31	71.97	JUL 12	66.04	JUN 27	57.12
OCT 19	80.80	JAN 18, 1979	72.27	AUG 10	65.69	JUL 31	56.78
NOV 16	80.02	FEB 18	70.82	SEP 13	65.05	AUG 22	56.64
DEC 21	79.39	MAR 24	70.52	OCT 25	64.36	SEP 26	56.44
JAN 28, 1978	77.94	APR 29	70.29	NOV 23	63.73	OCT 24	58.11
FEB 11	77.58	MAY 30	69.37	DEC 04	63.19	NOV 21	56.26
MAR 24	76.35	JUN 24	68.70	MAR 29, 1981	64.02	DEC 01	56.70
APR 23	75.60	JUL 15	68.38	APR 26	63.14	18	55.78
MAY 21	75.07	AUG 14	67.70	JUL 13	61.26		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-072-36ADD4 SITE NUMBER 482246099530604

HIGHEST WATER LEVEL 39.61 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 78.19 FEET BELOW LAND SURFACE DATUM NOV 17, 1976.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
NOV 17, 1976	78.19	DEC 21, 1977	62.79	MAR 24, 1979	55.32	DEC 04, 1980	45.51
18	76.19	JAN 28, 1978	61.68	APR 29	55.11	MAR 29, 1981	48.38
DEC 21	75.95	FEB 11	61.29	MAY 30	54.30	APR 26	47.44
JAN 06, 1977	75.15	MAR 24	60.10	JUN 24	55.10	JUL 26	43.45
21	74.24	APR 23	59.37	JUL 15	52.65	AUG 29	42.86
FEB 02	73.69	MAY 21	59.17	AUG 14	52.05	SEP 20	44.13
MAR 04	71.46	JUN 21	58.68	SEP 29	53.17	OCT 24	43.66
APR 07	69.83	JUL 23	58.11	OCT 21	52.91	APR 18, 1982	41.75
MAY 10	69.46	AUG 27	57.63	NOV 24	51.24	MAY 23	41.26
JUN 14	67.95	SEP 27	56.82	MAR 08, 1980	50.33	JUN 27	40.86
JUL 12	68.44	OCT 15	56.53	APR 13	48.10	JUL 31	40.55
AUG 09	66.57	NOV 19	55.00	JUN 15	48.85	AUG 22	40.38
SEP 13	65.32	21	55.66	JUL 12	48.41	SEP 26	40.25
OCT 19	64.27	DEC 31	55.67	SEP 13	46.84	OCT 24	40.06
NOV 10	63.71	JAN 18, 1979	55.54	OCT 25	48.70	DEC 18	39.61
16	63.52	FEB 27	55.82	NOV 23	48.04		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 157-072-36DDD SITE NUMBER 482220099530601

HIGHEST WATER LEVEL 7.25 FEET BELOW LAND SURFACE DATUM DEC 04, 1980.

LOWEST WATER LEVEL 20.17 FEET BELOW LAND SURFACE DATUM MAR 24, 1978.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 05, 1975	12.89	SEP 29, 1976	16.52	JUN 21, 1978	10.93	MAR 29, 1981	10.24
12	13.68	NOV 18	16.83	SEP 27	15.11	JUL 13	9.21
20	14.32	30	17.07	NOV 21	16.30	SEP 20	11.75
OCT 02	14.19	DEC 21	17.31	MAR 24, 1979	19.51	MAR 21, 1982	15.73
21	14.37	JAN 21, 1977	18.68	JUN 24	8.05	JUN 27	7.27
NOV 24	14.46	MAR 04	16.70	SEP 29	16.29	SEP 26	14.20
FEB 26, 1976	16.41	JUN 14	16.37	NOV 24	16.10	DEC 01	11.10
APR 29	9.87	SEP 13	15.30	MAR 08, 1980	18.84	18	11.40
JUN 15	10.98	NOV 09	15.12	JUN 15	14.10		
JUL 08	10.97	DEC 21	16.20	SEP 13	10.63		
AUG 26	15.24	MAR 24, 1978	20.17	DEC 04	7.25		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 158-071-30DAA SITE NUMBER 482843099514901

HIGHEST WATER LEVEL 10.56 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 12.25 FEET BELOW LAND SURFACE DATUM NOV 20, 1978.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
AUG 05, 1975	11.71	APR 30, 1976	10.85	NOV 19, 1976	12.08	NOV 25, 1979	11.78
20	11.83	JUN 15	11.72	DEC 01	12.19	DEC 04, 1980	10.82
OCT 02	11.70	JUL 09	11.42	NOV 16, 1977	12.05	DEC 18, 1982	10.56
NOV 25	11.77	AUG 25	11.86	DEC 22	12.12		
FEB 26, 1976	12.06	SEP 29	12.00	NOV 20, 1978	12.25		

WATER LEVELS FOR PIERCE COUNTY, ND

WELL 158-072-23DDC SITE NUMBER 482916099543501

HIGHEST WATER LEVEL 1.54 FEET BELOW LAND SURFACE DATUM DEC 18, 1982.

LOWEST WATER LEVEL 4.31 FEET BELOW LAND SURFACE DATUM MAR 29, 1981.

WATER LEVELS IN FEET BELOW LAND SURFACE DATUM.

DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL	DATE	WATER LEVEL
NOV 19, 1976	3.64	DEC 22, 1977	3.02	NOV 25, 1979	2.98	MAR 29, 1981	4.31
DEC 01	3.35	NOV 20, 1978	3.63	DEC 04, 1980	1.66	DEC 18, 1982	1.54
NOV 16, 1977	3.03						

Table 2 -- Dissolved chemical constituents in water -- their effects upon usability and recommended concentration limits for domestic and municipal water supplies in North Dakota.

Constituent or Parameter	Effects of dissolved constituents on water use	Suggested limits for drinking water in North Dakota[1]	U.S. Public Health Service recommended limits for drinking water[2]
Silica (SiO_2)	No physiological significance		
Iron (Fe)	Concentrations over 0.1 mg/l will cause staining of fixtures. Over 0.5 mg/l may impart taste and colors to food and drink.		0.3 mg/l
Manganese (Mn)	Produces black staining when present in amounts exceeding 0.05 mg/l		0.05 mg/l
Calcium(Ca) and Magnesium (Mg)	Calcium and magnesium are the primary causes of hardness. High concentrations may have a laxative effect on persons not accustomed to this type of water.		
Sodium (Na)	No physiological significance except for people on salt-free diets. Does have an effect on the irrigation usage of water.		
Potassium (K)	Small amounts of potassium are essential to plant and animal nutrition.		
Bicarbonate (HCO_3) and Carbonate (CO_3)	No definite significance, but high bicarbonate content will impart a flat taste to water.		
Sulfate (SO_4)	Combines with Calcium to form scale. More than 500 mg/l tastes bitter and may be a laxative	0-300 mg/l - low 300-700 mg/l - high over-700 mg/l - very high	250 mg/l
Percent Sodium and Sodium Adsorption Ratio (SAR)	Indicate the sodium hazard of irrigation water.		
Chloride (cl)	Over 250 mg/l may impart a salty taste, greatly excessive concentrations may be physiologically harmful. Humans and animals may adapt to higher concentrations.		250 mg/l
Flouride (F)	Flouride helps prevent tooth decay within specified limits. Higher concentrations cause mottled teeth.	Limits of 0.9 mg/l to 1.5 mg/l	Recommended limits depend on average of daily temperatures. Limits range from 0.6 mg/l at 32°C. to 1.7 mg/l at 10°C.
Nitrate (NO_3)	Over 45 mg/l can be toxic to infants. Larger Concentrations can be tolerated by adults. More than 200 mg/l may have a deleterious effect on livestock health		45 mg/l
Boron (B)	No physiological significance. Greater than 2.0 mg/l may be detrimental to many plants		
Total dissolved solids	Persons may become accustomed to water containing 2,000 mg/l or more dissolved solids.	0-500 mg/l - low 500-1400 mg/l average 1400-2500 mg/l high over 2500 mg/l very high	500 mg/l
Hardness (as $CaCo_3$)	Increases soap consumption, but can be removed by a water-softening system.	0-200 mg/l - low 200-300 mg/l average 300-450 mg/l high over 450 mg/l very high	
pH	Should be between 6.0 and 9.0 for domestic consumption		
Specific Conductance	An electrical indication of total dissolved solids measured in micromhos per Centimeter at 25°C. Used primarily for irrigation analyses.		

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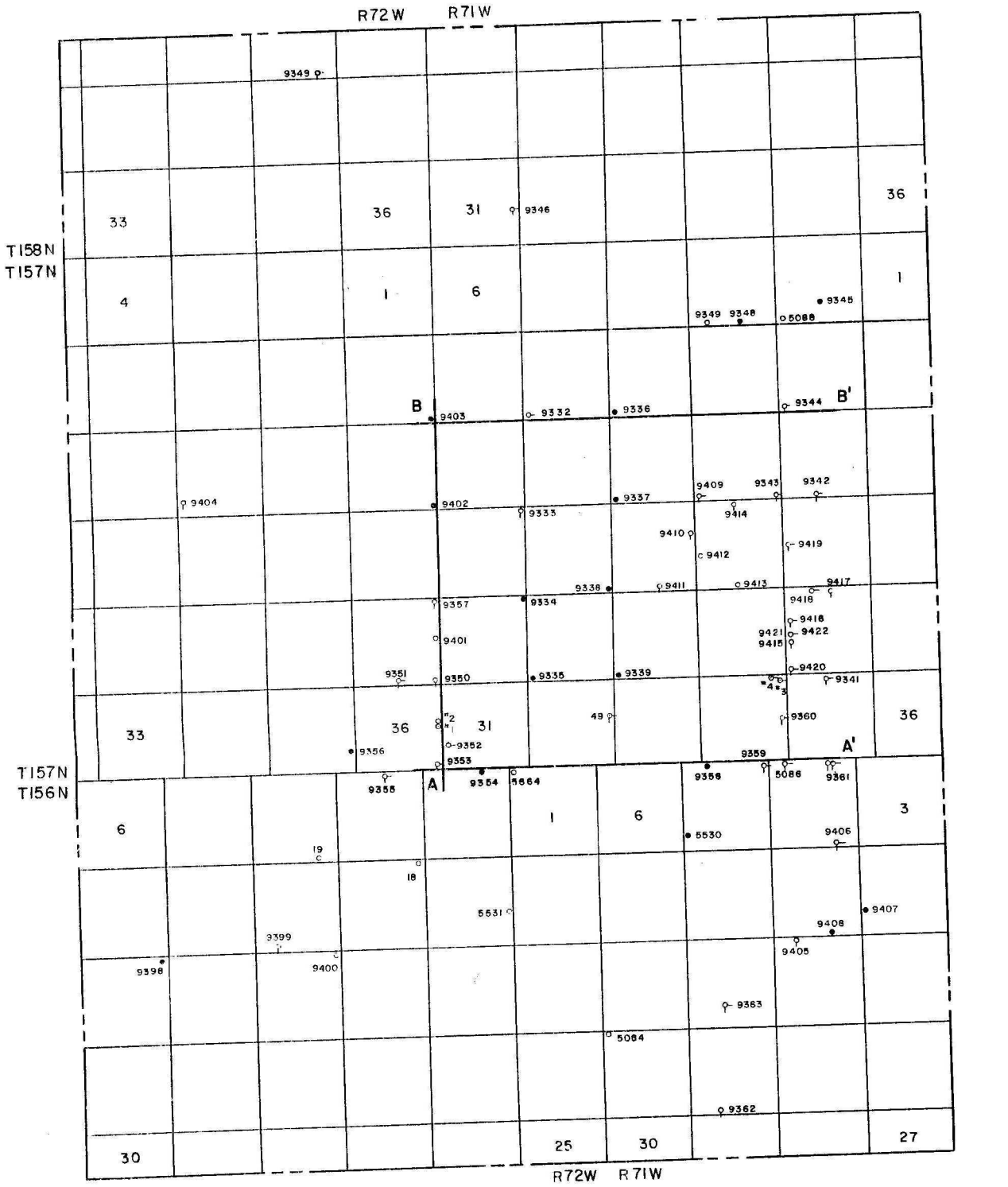

EXPLANATION

- Test hole
- Observation well
- Water quality data available
- Water level available
- Municipal well
- A _____ A' Geologic cross-section

PLATE 1