

**KANSAS GEOLOGICAL SURVEY  
OPEN-FILE REPORT 97-39**

**GROUNDWATER MONITORING NETWORK FOR THE EQUUS BEDS  
AQUIFER MINERAL INTRUSION STUDY:  
DESCRIPTION AND INITIAL MONITORING RESULTS**

by

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# Kansas Geological Survey

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Prepared by the Kansas Geological Survey in cooperation with the Equus Beds Groundwater Management District No. 2 and the Kansas Water Office

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D. P. Young, D. O. Whittemore, and R. W. Buddemeier

EQUUS BEDS GROUNDWATER MANAGEMENT DISTRICT NO. 2  
D. R. Koci and M. T. Dealy

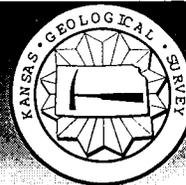
KANSAS WATER OFFICE  
G. D. Hargadine

Kansas Geological Survey Open-File Report 97-39

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*GEOHYDROLOGY*

MINERAL INTRUSION PROJECT



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# **Groundwater Monitoring Network for the Equus Beds Aquifer Mineral Intrusion Study: Description and Initial Monitoring Results**

## **Introduction**

The Equus Beds Aquifer Mineral Intrusion (EBMI) project is a joint effort of the U.S. Bureau of Reclamation, Equus Beds Groundwater Management No. 2 (GMD2), Kansas Geological Survey (KGS), U.S. Geological Survey (USGS), and the Kansas Water Office. The background and purpose are discussed in detail by Whittemore and Sophocleous (1995) in an appraisal investigation for the study.

The study is focused on interactions between the Arkansas River and its tributaries, the underlying Equus Beds alluvial aquifer, and Permian-age bedrock beneath the aquifer. Both surface waters and bedrock of Permian age may be sources of saline water to the aquifer. The main study area lies between Nickerson and Hutchinson in the extended western portion of GMD2 in north-central Reno County (Figure 1). The general study area encompasses the sixteen townships shown in Figure 1. Fresh water is present in the aquifer north of the Arkansas River while saline ground water occurs along and south of the river. The cities of Hutchinson and Nickerson obtain their water supplies from the fresh ground water.

Intrusion of saline water is both natural and human-induced in the Great Bend Prairie and Equus Beds alluvial aquifers in south-central Kansas. Buddemeier et al. (1995) provided an overview of the issue and identified areas with known or suspected saltwater contamination (see Figure 2). The recent Big Bend Aquifer Mineral Intrusion study researched the saltwater intrusion problem in the Great Bend Prairie aquifer in the eastern portion of Groundwater Management District No. 5 (GMD5), which is just upgradient (west) of the present study area (Figure 2). Another study concerning hydrologic and chemical interactions between the Arkansas River and the Equus Beds aquifer was recently conducted downgradient between Hutchinson and Wichita (see Myers et al., 1996).

Whittemore and Sophocleous (1995) identified specific needs and purposes for investigating the salinity problem in the Equus Beds aquifer in the western part of GMD2. Their report also identified information gaps that need to be filled and additional interpretations necessary for determination of saltwater movement in the aquifer. One recommendation of the appraisal investigation was the establishment of a data-collection network, including a set of observation wells screened at different depths in the Arkansas River alluvial valley, to fill gaps in geologic, hydrologic, and water-quality data. This report describes the recently-installed groundwater monitoring network and presents initial monitoring results.

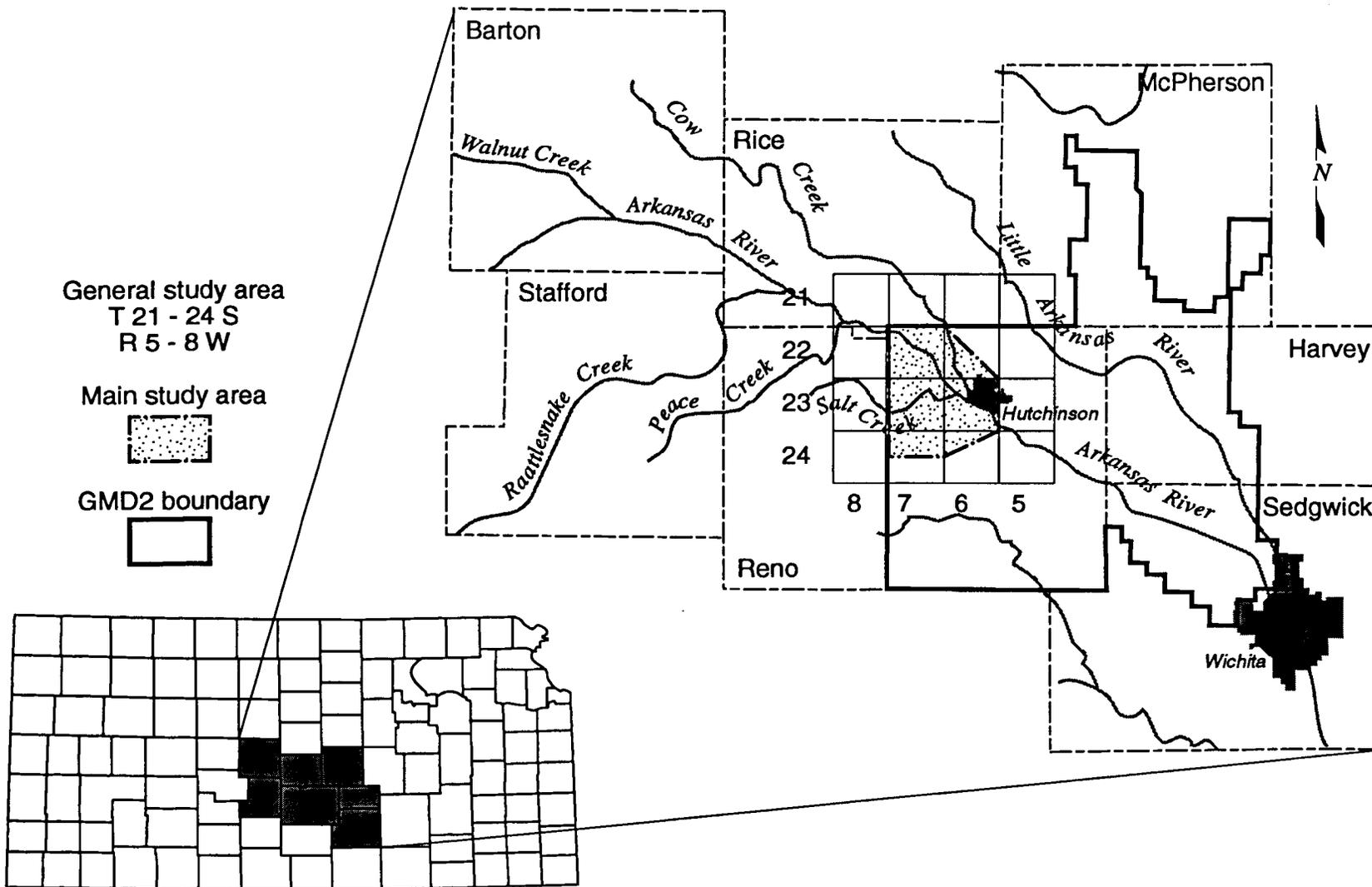


Figure 1. Location of main study area (stippled) within general study area (township-range grid) and study region (7 county area).

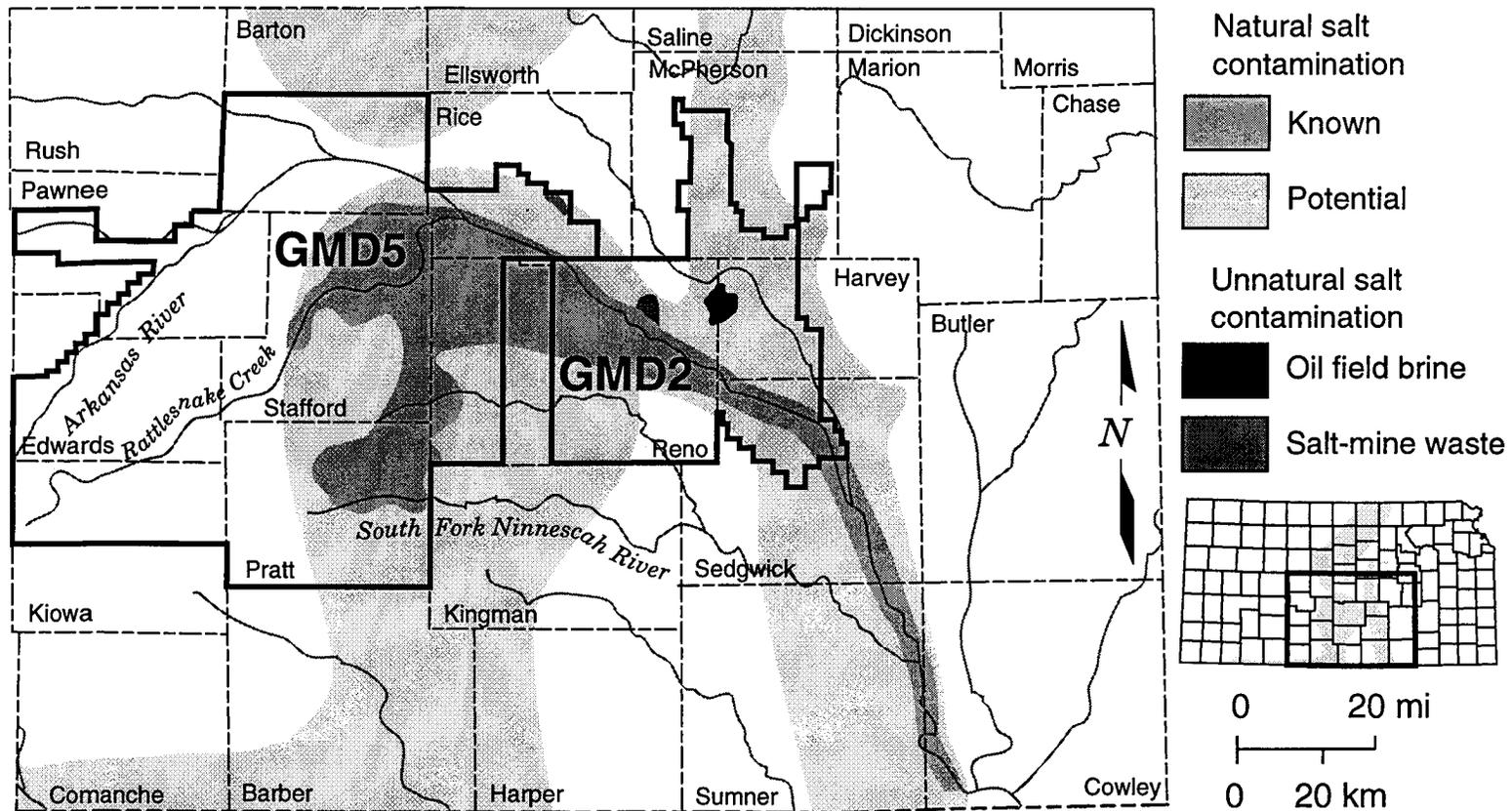


Figure 2. Areas with known or potential saltwater contamination in south-central Kansas. Areas identified as "known" natural salt contamination have saltwater within the freshwater aquifer. In the areas labeled "potential" natural salt contamination, subsurface bedrock formations containing salt or saltwater are in contact with the overlying freshwater aquifers (from Buddemeier et al., 1995).

## Site and Well Information

A network of 41 monitoring wells at 21 sites was installed for groundwater data collection. The wells are used primarily for monitoring water levels and water quality at different depths in the Equus Beds aquifer. In addition, logs of the wells provide information on the sediments that comprise the aquifer, the salinity distribution at the different locations, and the depth to bedrock.

Drilling began in late September 1996 and was completed in January 1997. Each site has at least one well screened in the Equus Beds aquifer. Most sites consist of two or more wells completed at different depths in the aquifer. Nearly all the sites have a deep well, the "C" well, completed directly above bedrock. Some sites have a well of intermediate depth in the aquifer, the "B" well. Most sites have at least one well of shallow to intermediate depth, the "A" well. And one site has four wells; the shallowest well has the designation "AA". See Table 1 for a listing of sites and wells.

The monitoring sites were situated to form transects across the Arkansas River. An effort was made to complete some wells in alluvial materials deposited in deep bedrock channels, which may be significant pathways for saltwater transport. Figure 3 shows locations of new (EB250-EB270) and existing groundwater monitoring sites in the general study area. Table 1 summarizes basic well and site information, including groundwater monitoring site and well ID, legal location, estimated land surface elevation, depth to bedrock, estimated bedrock surface elevation, and screen and gravel pack intervals. Elevation estimates were obtained from 7.5-minute series topographic maps. The U.S. Bureau of Reclamation is scheduled to survey the well sites; when that is completed the well data base will be updated with the measured elevations.

## Geologic and Hydrologic Information

### Well logs

Information on sediments that comprise the Equus Beds aquifer is important for characterizing the high-permeability sand and gravel zones and low-permeability clays. Such information is available from both lithologic and geophysical logs of the monitoring wells. Lithologic logs based on cuttings collected during drilling by the site geologist are included in Appendix A. Also included on these forms is information on depth to water, thickness of the alluvial materials, and well construction and materials.

Geophysical logs of the monitoring wells are reproduced in Appendix B. The natural gamma log responds primarily to fine-grained sediments such as clays. The electromagnetic (EM) or conductivity log responds primarily to salt concentration and secondarily to clays (see Garneau, 1995). (The EM log also responds quite strongly to metal; the conductivity spikes in the top 10 feet of the logs are caused by steel surface

Table 1. Well and site information from the EBMI groundwater monitoring network.

ID	LOCATION				EST LAND ELEV (ft)	DEPTH TO BEDROCK (ft)	EST BEDROCK ELEV (ft)	SCREEN DEPTH (ft)	GRAVEL PACK (ft)
	SUBD	SEC	TWP	RGE					
EB250C EB250A	NENENW	19	23	04W	1497	67	1430	57-67 38-48	57-71 34-48
EB251C EB251A	SESESE	14	22	06W	1628	65	1563	52-62 20-30	52-70 20-32
EB252C EB252A	NENENE	27	22	06W	1553	66	1487	56-66 37-47	52-71 33-49
EB253C	SESW	27	22	06W	1553	61	1492	49.5-59.5	46-62.5
EB254C	NENENE	5	23	06W	1555	46	1509	36-46	31-50.5
EB255C EB255A	SWSWNE	5	23	06W	1555	75	1480	63-73 20-30	58-73 18-30
EB256C EB256B EB256A	NESENE	12	23	07W	1560	85	1475	74-84 51-61 12-22	72-90 48-62 11-22
EB257C EB257B EB257A	NWNENE	23	23	07W	1600	186	1414	176-186 140-150 84-94	171-189 135-150 79-94
EB258B EB258A	NENENE	33	23	07W	1616	127	1489	96-106 64-74	92-108 57-75
EB259B EB259A	SESESE	33	21	06W	1695	106	1589	75-85 10-20	70-89 10-20
EB260C	NENENE	18	22	06W	1575	73	1502	63-73	58-77
EB261C EB261A*	SESESE	23	22	07W	1580	120	1460	112-122 20-76	105-122 10-76
EB262C	NENENE	19	21	06W	1650	2	1648	55-65	50-69.5
EB263C	NENENE	35	21	07W	1590	67	1523	56-66	51-71
EB264C EB264A*	NENENE	3	22	07W	1593	55	1538	45-55 20-51	40-55 10-51

(continued)

Table 1. Well and site information from the EBMI groundwater monitoring network (continued).

ID	LOCATION				LAND ELEV (ft)	DEPTH TO BEDROCK (ft)	BEDROCK ELEV (ft)	SCREEN DEPTH (ft)	GRAVEL PACK (ft)
	SUBD	SEC	TWP	RGE					
EB265C	SESESE	4	22	07W	1595	55	1540	44.5-54.5	39.5-60
EB266B EB266A	SESWSE	8	22	07W	1595	108	1487	85-95 37-47	80-95 33-49
EB267C EB267B EB267A	SWSWSW	17	22	07W	1633	206	1427	196-206 105-115 63-73	191-206 100-115 59-73
EB268C EB268B EB268A	SWSWNW	30	22	07W	1637	152	1485	141.5-151.5 88-98 33-43	137-155  28-46
EB269C EB269B EB269A	SWSWSW	31	22	07W	1634	187	1447	177-187 101-111 35-45	173-191.5 97-114 31-47
EB270C EB270B EB270A EB270AA	NWNWNW	18	23	07W	1627	170	1457	160-170 127-137 82-92 40-50	160-174 123-138 77-95 35-54

\* Wells identified here as EB261A and EB264A refer to City of Hutchinson wells T1 and T5, respectively.

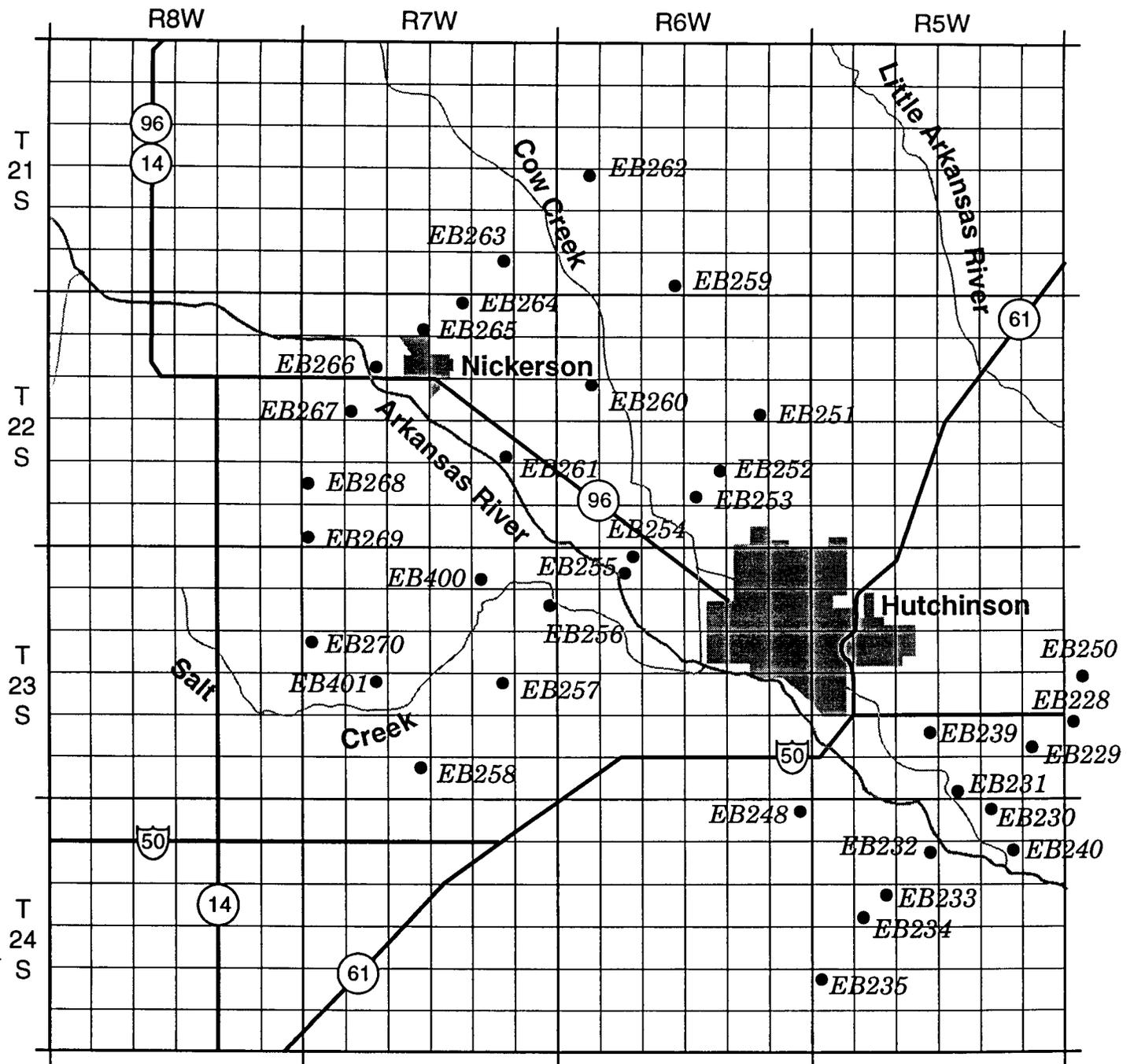


Figure 3. Locations of groundwater monitoring sites and other physical features in the EBMI general study area.

casing.) In general, higher conductivities on the EM logs indicate higher groundwater salinities; preliminary analysis of the EM logs confirms that higher groundwater salinities occur along and south of the Arkansas River. Future work will involve correlations between the conductivity measurements from the EM logs and actual groundwater salinities.

The aquifer is composed primarily of unconsolidated Quaternary deposits of sand and gravel interbedded with layers or lenses of silt and clay; the thickness and character of the materials is variable. Generally the aquifer overlies bedrock of Permian age, however bedrock of Cretaceous age may be found in the northern part of the general study area. The heterogeneity of the aquifer is evident in hydrogeologic cross sections (Plates 1-3), which are based on well logs from the new monitoring sites. In the Arkansas River valley, the deposits consist of fairly extensive sand and gravel beds, separated by clays in places. A near-surface clay layer is common. The sediments generally are thicker south of the Arkansas River. Notice the bedrock lows at site EB257 in the Willow Brook-Partridge section and at site EB267 in the Nickerson section (Plates 1-2). These sites are located where the ancestral Arkansas River eroded a channel into the Permian bedrock. Plate 3 includes a map showing transect locations.

A map showing the configuration of the bedrock surface under the study area accompanies this report (see OFR 97-28). A reduced version is shown as Figure 4. The bedrock map was produced from information from the new monitoring sites combined with existing measurements, interpretation of gamma logs from oil and gas boreholes, lithologic logs from selected water well records (WWC-5 forms), and records from the Kansas Department of Transportation. A major feature of the bedrock surface is an ancestral channel trending roughly parallel to the present Arkansas River.

Maps showing surface geology, soil classifications, water levels, water rights, and land cover are also included in OFR 97-28. Some of these maps cover the general study area and some span the entire Great Bend Prairie/Equus Beds region.

### Water levels

Water levels were measured during the first round of geophysical logging and approximately monthly beginning in January 1997. Both depth-to-water measurements and estimated water-level elevations are listed in Table 2. Approximate water levels measured during drilling are shown on the lithologic logs in Appendix A. Well-screen intervals and the approximate water-table elevation are shown in the hydrogeologic cross sections in Plates 1-3. Screened intervals are also listed in Table 1.

Depth-to-water measurements ranged from less than 10 feet to about 40 feet below land surface (Table 2). The deeper measurements were encountered at the southernmost sites, EB257 and EB258. In well EB262C at the northernmost site, artesian conditions cause the water level to rise to within 2-3 feet of land surface. At site EB262,

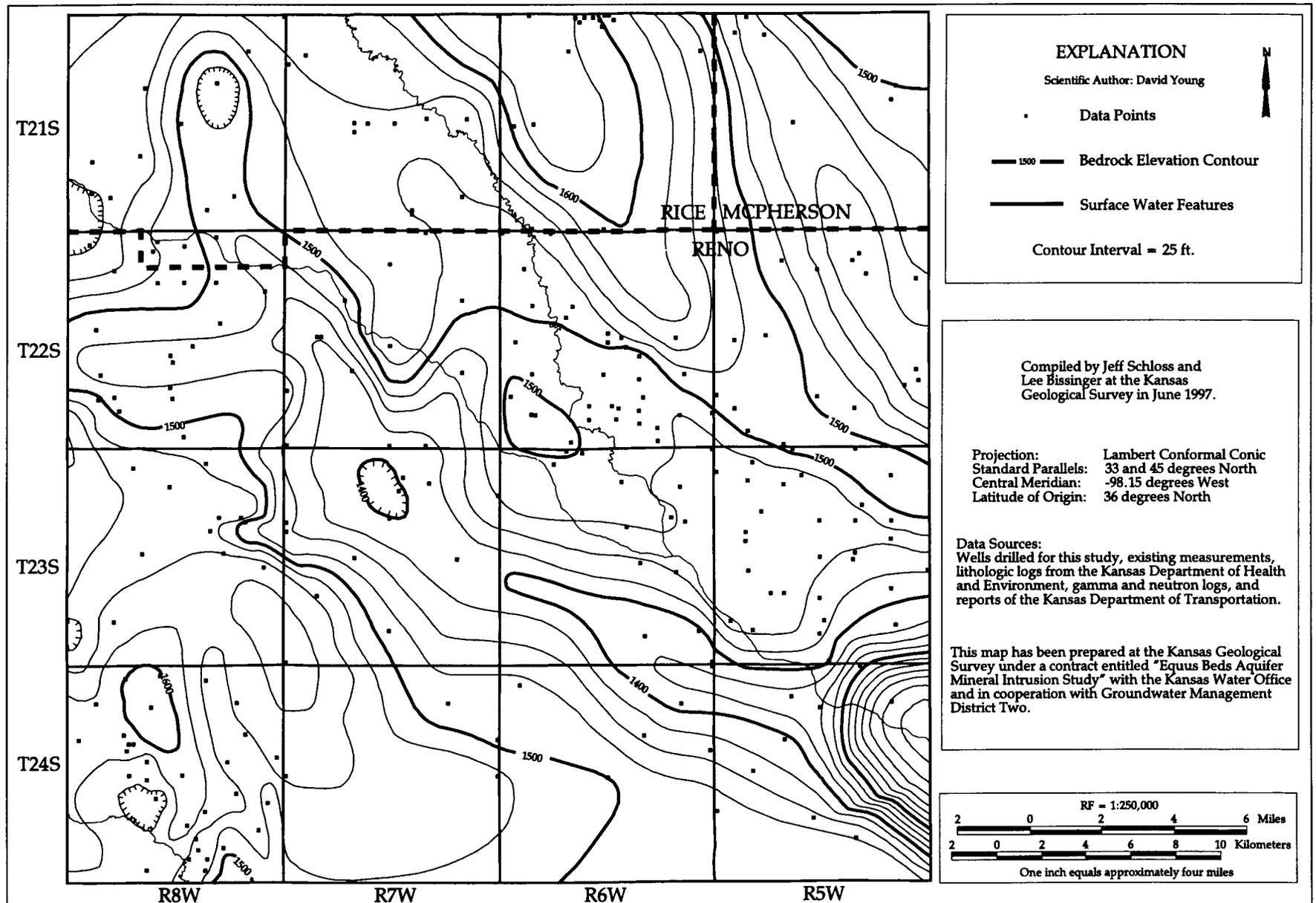


Figure 4. Bedrock elevation isolines in the south-central Kansas study area

Table 2. Water-level measurements in EBMI monitoring wells.

SITE/ DATE	DEPTH TO WATER (feet below land surface)			ESTIMATED WATER-LEVEL ELEVATION (feet above mean sea level)		
	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
EB250	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
10/1/96	9.12		9.11	1487.88		1487.89
1/22/97	8.79		8.78	1488.21		1488.22
2/25/97	7.94		7.93	1489.06		1489.07
3/18/97	7.76		7.74	1489.24		1489.26
EB251	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
10/1/96	16.88		16.95	1611.12		1611.05
1/22/97	15.33		15.39	1612.67		1612.61
2/25/97	14.75		14.81	1613.25		1613.19
3/18/97	14.60		14.66	1613.40		1613.34
EB252	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
10/1/96	14.44		14.41	1538.56		1538.59
1/22/97	14.63		14.62	1538.37		1538.38
2/25/97	14.74		14.73	1538.26		1538.27
3/18/97	14.85		14.83	1538.15		1538.17
EB253	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
10/1/96	12.75			1540.25		
1/22/97	13.24			1539.76		
2/25/97	13.31			1539.69		
3/25/97	14.36			1538.64		
EB254	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
10/1/96	8.71			1546.29		
1/22/97	8.72			1546.28		
2/25/97	8.82			1546.18		
3/24/97	8.67			1546.33		
EB255	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
10/24/96	8.12		8.29	1546.88		1546.71
1/22/97	8.44		8.58	1546.56		1546.42
2/25/97	8.38		8.55	1546.62		1546.45
3/24/97	8.49		8.67	1546.51		1546.33
EB256	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
9/30/96	11.05			1548.95		
1/23/97	11.15	10.68	11.36	1548.85	1549.32	1548.64
2/25/97	11.20	10.73	11.26	1548.80	1549.27	1548.74
3/25/97	11.21	10.77	11.42	1548.79	1549.23	1548.58

(continued)

Table 2. Water-level measurements in EBM! monitoring wells (continued).

SITE/ DATE	DEPTH TO WATER (feet below land surface)			ESTIMATED WATER-LEVEL ELEVATION (feet above mean sea level)		
	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
EB257	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
1/22/97	41.65	41.63	41.55	1558.35	1558.37	1558.45
1/23/97	41.61	41.59	41.48	1558.39	1558.41	1558.52
2/25/97	41.62	41.60	41.53	1558.38	1558.40	1558.47
3/26/97	41.67	41.66	41.58	1558.33	1558.34	1558.42
EB258	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
1/23/97		37.27	35.40		1578.73	1580.60
2/25/97		37.34	35.50		1578.66	1580.50
3/26/97		37.45	35.60		1578.55	1580.40
EB259	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
11/22/96		8.45	7.66		1686.55	1687.34
1/24/97		8.45	7.43		1686.55	1687.57
2/25/97		8.25	7.02		1686.75	1687.98
3/25/97		8.10	6.73		1686.90	1688.27
EB260	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
11/7/96	8.50			1566.50		
1/24/97	8.39			1566.61		
2/25/97	8.21			1566.79		
3/24/97	8.23			1566.77		
EB261	WELL C	WELL B	WELL A*	WELL C	WELL B	WELL A
1/21/97	11.36			1568.64		
1/24/97	11.40		11.57	1568.60		1568.43
2/25/97	11.44		11.61	1568.56		1568.39
3/24/97	11.52		11.60	1568.48		1568.40
EB262	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
11/22/96	2.75			1647.25		
1/24/97	2.59			1647.41		
2/25/97	1.80			1648.20		
3/21/97	1.90			1648.10		
EB263	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A
1/21/97	7.85			1582.15		
1/24/97	7.98			1582.02		
2/25/97	7.70			1582.30		
3/21/97	7.52			1582.48		

(continued)

Table 2. Water-level measurements in EBMI monitoring wells (continued).

SITE/ DATE	DEPTH TO WATER (feet below land surface)			ESTIMATED WATER-LEVEL ELEVATION (feet above mean sea level)				
	WELL C	WELL B	WELL A*	WELL C	WELL B	WELL A		
EB264	WELL C	WELL B	WELL A*	WELL C	WELL B	WELL A		
11/22/96	9.06			1583.94				
1/24/97	8.80		8.64	1584.20		1584.36		
2/25/97	8.57		8.43	1584.43		1584.57		
3/21/97	8.34		8.20	1584.66		1584.80		
EB265	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A		
11/22/96	5.72			1589.28				
1/24/97	5.68			1589.32				
2/25/97	5.50			1589.50				
3/21/97	5.42			1589.58				
EB266	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A		
11/22/96			2.15			1592.85		
1/22/97		6.35	8.67		1588.65	1586.33		
1/23/97		6.24	8.68		1588.76	1586.32		
2/25/97		6.19	8.54		1588.81	1586.46		
3/21/97		6.26	8.78		1588.74	1586.22		
EB267	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A		
1/23/97	34.32	35.88	36.34	1598.68	1597.12	1596.66		
2/25/97	34.39	35.92	36.37	1598.61	1597.08	1596.63		
3/21/97	34.34	35.84	36.26	1598.66	1597.16	1596.74		
EB268	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A		
1/23/97	31.70	29.05	29.19	1605.30	1607.95	1607.81		
2/25/97	31.93	29.26	29.40	1605.07	1607.74	1607.60		
3/20/97	31.98	29.32	29.46	1605.02	1607.68	1607.54		
EB269	WELL C	WELL B	WELL A	WELL C	WELL B	WELL A		
1/23/97	26.03	24.77	24.82	1607.97	1609.23	1609.18		
2/25/97	26.31	25.04	25.14	1607.69	1608.96	1608.86		
3/20/97	26.30	25.04	25.17	1607.70	1608.96	1608.83		
EB270	WELL C	WELL B	WELL A	WELL AA	WELL C	WELL B	WELL A	WELL AA
1/22/97	14.73	13.92	15.89	15.59	1612.27	1613.08	1611.11	1611.41
1/23/97	14.75	13.96	15.86	15.59	1612.25	1613.04	1611.14	1611.41
2/25/97	15.03	14.31	16.14	15.82	1611.97	1612.69	1610.86	1611.18
3/19/97	14.97	14.26	15.95	15.67	1612.03	1612.74	1611.05	1611.33

\* Wells identified here as EB261A and EB264A refer to City of Hutchinson wells T1 and T5, respectively.

the Dakota Formation was encountered at about 2 feet below land surface. Well EB262C is screened in the Cheyenne Sandstone.

Well EB266A, adjacent to the Arkansas River, has shown the most variability in water level, ranging from about 2 feet to about 9 feet below land surface. However, the 2 foot measurement was taken during wet conditions on November 22 when the river was out of its banks. Not all wells were measured during this wet period. It is interesting that the specific conductance of Arkansas River water at site EB266 measured 490  $\mu\text{mho/cm}$  during high flows on November 22, and 2,650  $\mu\text{mho/cm}$  during moderate flows on January 22, 1997.

Higher water levels in the deeper (B and/or C) wells compared with the shallow wells at sites EB255, EB256, EB261, EB266, EB267, and EB270 probably indicate semiconfined conditions at depth, and the potential for upward flow exists at these sites. This could also be a reflection of the high Permian head at these sites. Boreholes were generally drilled a few feet into bedrock for freeboard to ensure that screens could be placed as close to the bedrock contact as possible. Most of these sites are located near major surface water features. Sites EB255, EB261, and EB266 are located near the Arkansas River; EB256 is located near Salt Creek.

## Water Quality

The new monitoring wells drilled for this study were developed and water samples were collected in March and early April 1997. Two existing monitoring wells within the study area (EB400C and EB401C) were also sampled, as well as the monitoring wells just east of Hutchinson comprising part of the earlier Hutchinson to Wichita salinity study. Sampling information, including field specific conductance, are included in Appendix C. Compressed air was used to obtain the samples, except for waters bailed as indicated in Appendix C. Waters were also collected from 3 sites on the Arkansas River, two sites on Cow Creek, and one site on Salt Creek. Samples were shipped to the Kansas Geological Survey for analysis. The KGS lab and project numbers are listed in Appendix D for record keeping purposes. Three of the well sample and two of the stream sample bottles were broken during shipment; these sites were resampled.

All of the samples were filtered before analysis. All samples from the new well network between Nickerson and Hutchinson, wells EB400C and EB401C, and the stream sites were analyzed in the laboratory for the chemical properties specific conductance and pH, and for the dissolved concentrations of the following major, minor, and selected trace inorganic constituents: silica ( $\text{SiO}_2$ ), calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), strontium (Sr), carbonate ( $\text{CO}_3$ ), bicarbonate ( $\text{HCO}_3$ ), sulfate ( $\text{SO}_4$ ), chloride (Cl), nitrate ( $\text{NO}_3$ ), fluoride (F), bromide (Br), and iodide (I). Dissolved iodate ( $\text{IO}_3$ ) was determined in two of the stream waters. The total dissolved solids concentration (TDS) was computed as the sum of constituents. Bicarbonate and carbonate were multiplied by 0.4917 for use in the TDS to represent the amount of

carbonate remaining after evaporating to dryness. The lab conductance was used to select which of the samples from the monitoring wells just east of Hutchinson were to be analyzed for the complete list of constituents above. The conductance values were compared with the previous data for these wells determined by the KGS for the Hutchinson to Wichita salinity study. Samples with conductances that had changed by more than about 10% were chosen for complete analysis; samples with conductances that had changed by less than 10% were analyzed only for sulfate, chloride, nitrate, bromide, and iodide. The results for the analyses are listed in Appendix E. Nitrate is reported as nitrate-nitrogen (NO<sub>3</sub>-N).

The ground waters from the new network wells range from very fresh (TDS concentration of 147 mg/L and 118 mg/L in EB259A and EB259B, respectively) to highly saline (TDS content of 10,750 mg/L in the deep well EB257C). Chloride concentrations ranged from 2.2 mg/L in EB259B to 5,740 mg/L in EB257C. Where saline waters occur, the TDS increases with depth as indicated by sites with wells completed at multiple levels. Some sites contain freshwaters of similar TDS concentration at different depths. The waters with the highest TDS contents occur south of the Arkansas River, confirming that ground-water salinities are greater in that region. The most saline water is from a well screened in a bedrock channel in the southern part of the study area. The freshest waters are from the most northeastern sites in the three transects of wells (EB262, EB259, and EB251). These sites indicate the effect of fresh ground-water recharge. One of these sites, EB262, is screened in Cretaceous sandstone.

A preliminary examination of the chemical data indicates that there is a wide range in the chemical character of the ground and surface waters. For example, sulfate/chloride ratios differ substantially for some of the saline ground waters. The Arkansas River water is different in chemical type from the Cow Creek and Salt Creek waters. Nitrate-nitrogen concentrations range from undetectable to over the maximum contaminant limit of 10 mg/L for water from wells EB254C, EB255A, EB258A, EB268A, and EB270AA in the new network. In general, nitrate concentrations decreased with depth for sites with multiple level wells. The chemistry of water from site EB263C indicates that oil-field brine could contribute a major portion of the chloride concentration of 454 mg/L. Part of the chloride content of 545 mg/L in the Cow Creek No. 2 site also appears to be have a chloride contribution from oil brine. The chemical data will be examined to a greater extent and interpreted relative to geology, hydrology, and land use in a later report.

## References

- Buddemeier, R. W., Sawin, R. S., Whittemore, D. O., and Young, D. P., 1995. Salt contamination of ground water in south-central Kansas. Kansas Geological Survey Public Information Circular 2, 4 p.
- Garneau, G. W., 1995. Detection and characterization of the distribution of mineral intrusion in the Great Bend Prairie aquifer, south-central Kansas. Kansas Geological Survey Open-File Report 95-35, 102 p. plus appendices.
- Meyers, N. C., Hargadine, G. D., and Gillespie, J. B., 1996. Hydrologic and chemical interaction of the Arkansas River and the Equus Beds aquifer between Hutchinson and Wichita, south-central Kansas. U. S. Geological Survey Water-Resources Investigations Report 95-4191, 100 p.
- Schloss, J., Whittemore, D., Sleezer, R., Young, D., and Buddemeier, R., 1997. Equus Beds Aquifer Mineral Intrusion Study: map products. Kansas Geological Survey Open-File Report 97-28, 12 p. and 8 map plates.
- Whittemore, D. O., and Sophocleous, M. A., 1995. Hydrologic and chemical interaction of the Arkansas River and the Equus Beds aquifer between Hutchinson and Nickerson, north-central Reno County, Kansas: Appraisal Investigation prepared for the U. S. Bureau of Reclamation and the Equus Beds Groundwater Management District No. 2, Kansas Geological Survey Open-File Report 95-70, 73 p. plus appendices.

## Acknowledgments

Appreciation is expressed to Mark Schoneweis for graphics and to Melany Miller for assistance in the preparation of this report. Funding for the study is provided through the Kansas Water Office.

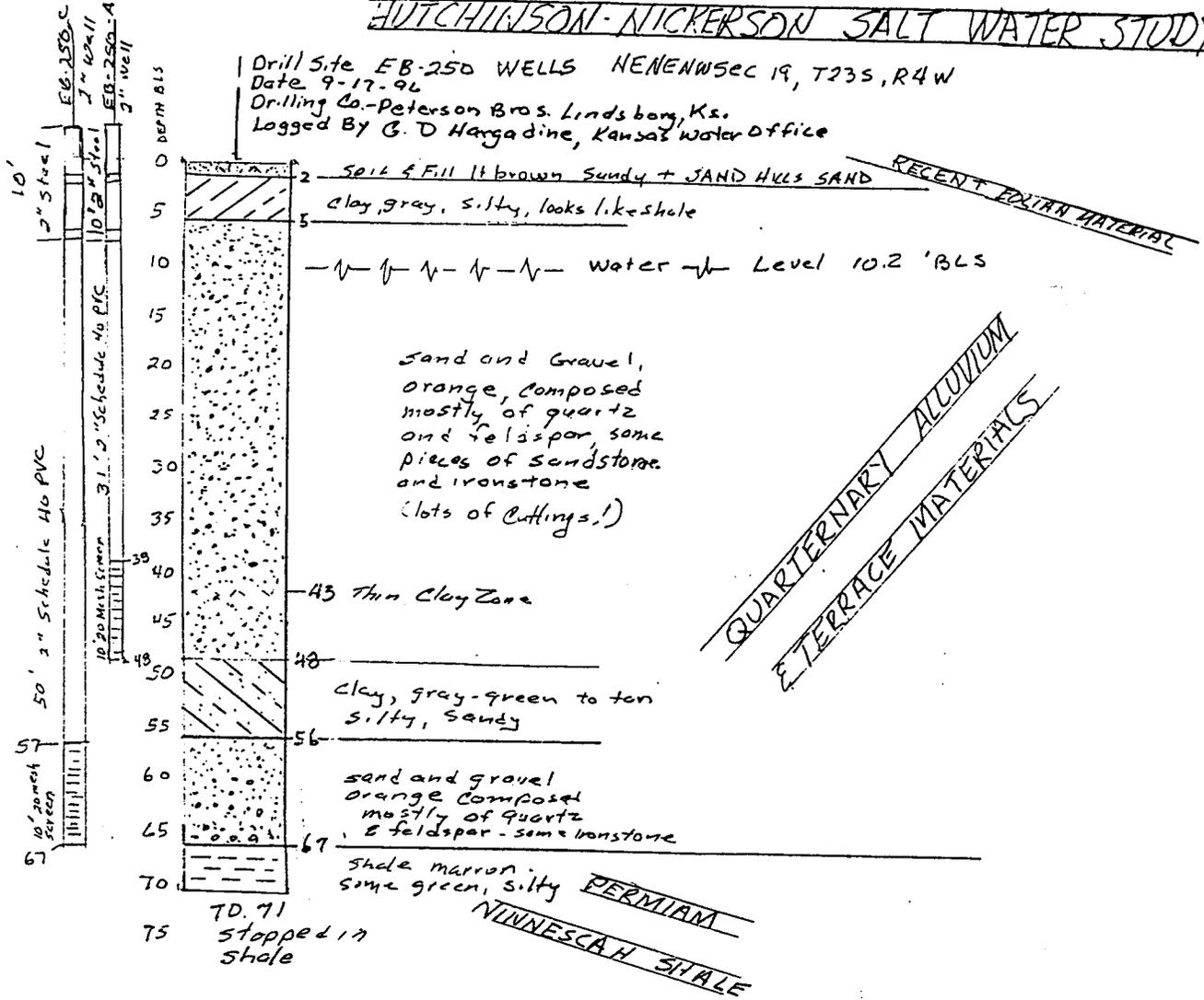
## **Appendix A**

### **Lithologic (Drilling) Logs**

These are photocopies of the original field logs kept by the site geologist, who is identified near the top of each log sheet. Originals are on file at GMD2.

# HUTCHINSON-NICKERSON SALT WATER STUDY

Drill Site EB-250 WELLS NENENWSEC 19, T23S, R4W  
 Date 9-17-96  
 Drilling Co. - Peterson Bros. Lindsborg, Ks.  
 Logged By G. D. Hargadine, Kansas Water Office



**WELL DEVELOPMENT**  
 EB-250 C 9-18-96 good  
 EB-250 A 9-18-96 good

**Water Levels 9-18-96**  
 EB 250 C = 12.80' below Top of Pipe  
 10.15' below Land Surface  
 EB 250 A = 12.80' below Top of pipe  
 10.30' below Land Surface  
 EB-250 A located 7' East of EB-250-C (Lithologic log similar)

**Well Construction - Materials Used**  
 EB-250 C 10' 2" Steel Pipe at Top  
 9-17-96 (7' Below Ground & 3' Above Ground)  
 50' 2" Schedule 40 Pipe  
 10' of 2" Schedule 40 20 mesh screen

**Well Construction Materials Used**  
 EB-250 A 9-18-96 @ 10:45 AM  
 10' 2" steel Pipe at Top  
 (7' Below ground & 3' above ground)

**Materials Used**  
 EB-250-A  
 8 Bags Portland Cement  
 1 Bag Bentonite  
 31' 2" PVC Schedule 40 PVC  
 10' 2" Schedule 40 20 mesh screen

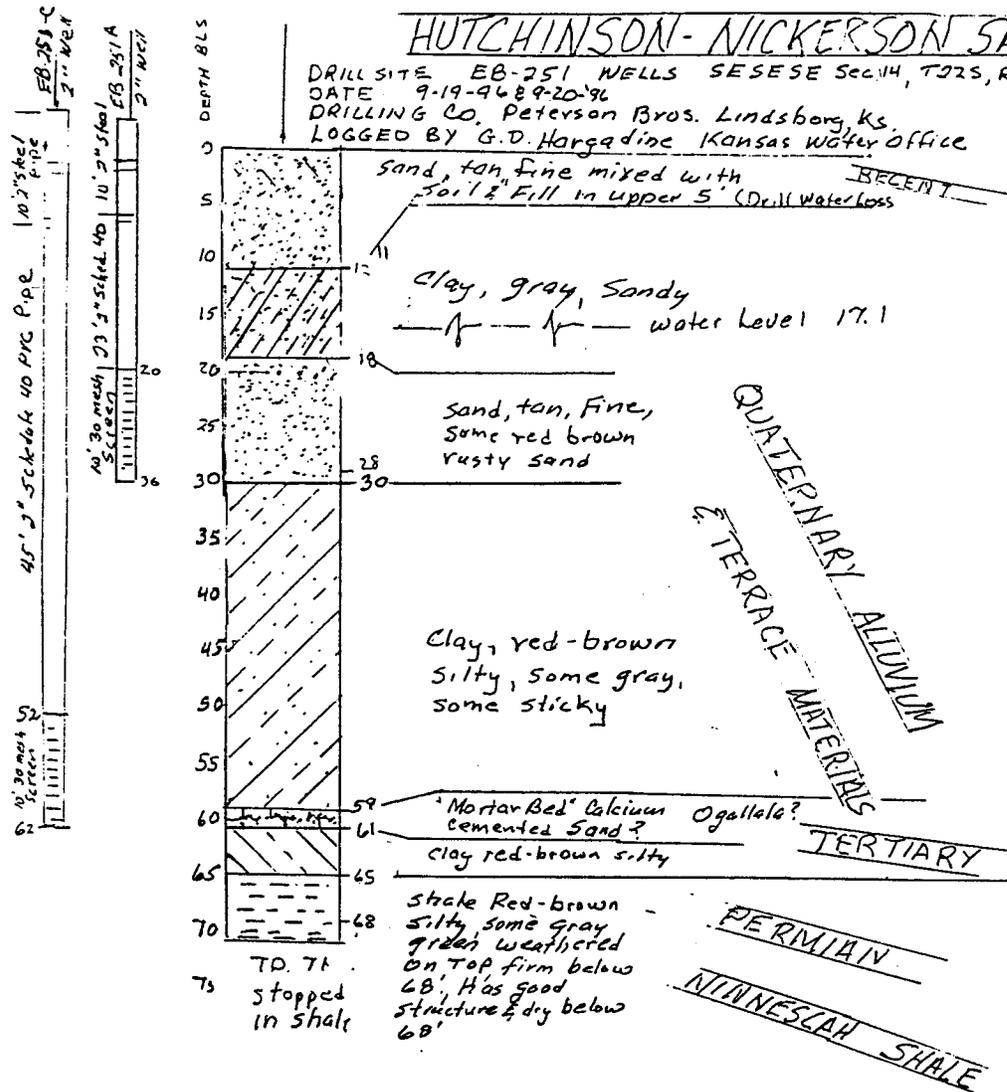
**Annular Space**  
 EB-250 C  
 71-57 Gravel Pack  
 57-4 Neat Cement  
 4-0 Hole Plug

**Annular Space EB-250 A**  
 48-34 Gravel Pack  
 34-4 Neat Cement  
 4-0 Bentonite

**Material Used**  
 EB 250-C  
 18 Bags Portland Cement  
 1 Bag Hole Plug

# HUTCHINSON-NICKERSON SALT WATER STUDY

DRILL SITE EB-251 WELLS SESESE Sec 14, T22S, R6W  
 DATE 9-19-96 89-20-96  
 DRILLING CO. Peterson Bros. Lindsborg, Ks.  
 LOGGED BY G.D. Hargadine Kansas Water Office



## Well Development

- 251A 9-21-96 fair not a lot of water & little cloudy. little fine sand
- 251C 9-21-96 pretty good clear & pretty good quantity

## Water Levels

- EB 251 A 19.59' BTC 9-21-96 17.12' BGL @ 1010
- EB 251 C 21.33' BTC 9-21-96 18.63' BGL @ 1000

## Well Construction Material Used

- EB 251 C: 10' 2" steel, 45' 2" Schedule 40 PVC, 10' 2" 30 mesh screen
- EB 251 A: 10' 2" steel, 13' 2" Schedule 40 PVC, 10' 2" 30 mesh screen

## Annular Space

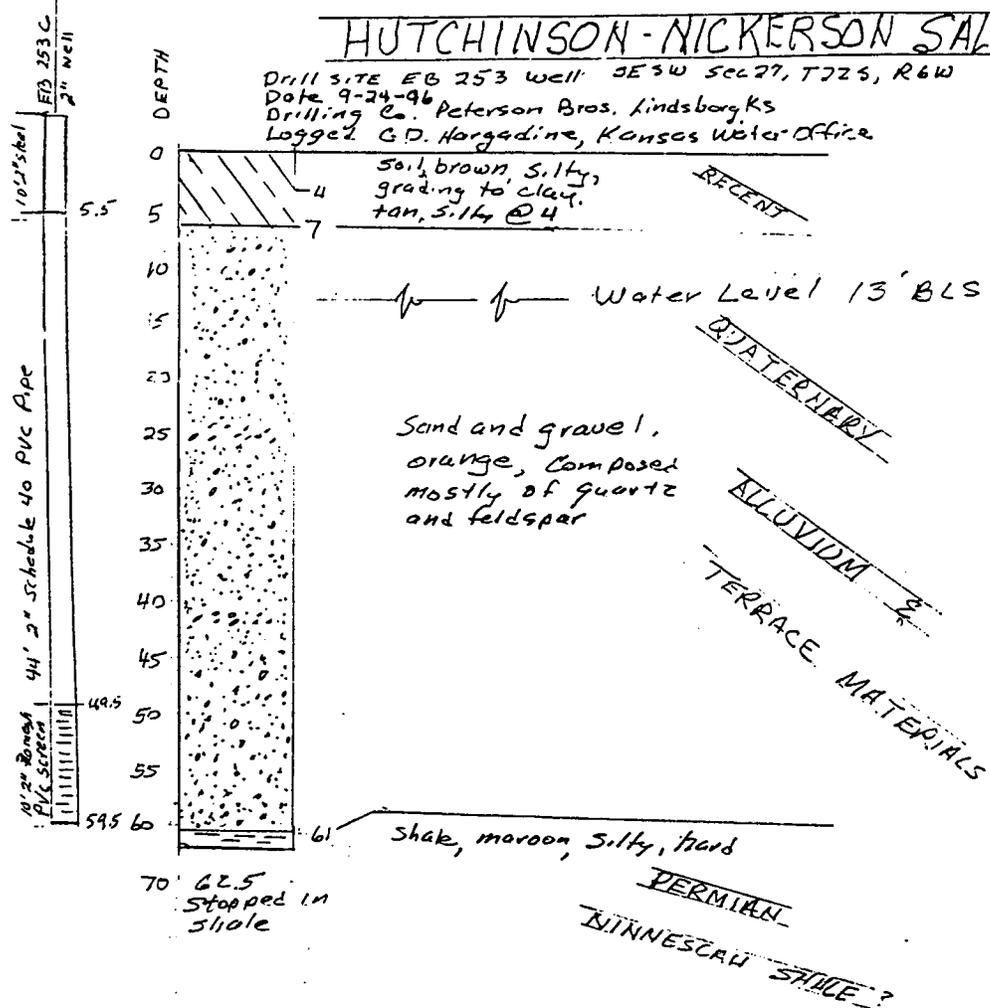
- EB-251 C: 70-57 gravel pack, 52-4 neat cement - 4 Bags, 4-0 Hole Plug Bentonite 1 Bag
- EB 251 A: 32-20 gravel pack, 20-4 neat cement - 2 Bags, 4-0 Bentonite - 3 Bags



# HUTCHINSON-NICKERSON SALT WATER

Drill SITE EB 253 Well SE3W Sec 27, T22S, R6W  
 Date 9-24-96  
 Drilling Co. Peterson Bros. Lindsborg, KS  
 Logger G.D. Hargadine, Kansas Water Office

## STUDY



**Well Development**  
 EB-253 C  
 Good Development  
 Clear WPA  
 Produced a lot of water

**Well Construction**  
 EB-253 C  
 10' 2" steel  
 44' 2" schedule 40 PVC  
 10' 2" 50 mesh Screen

**Water Level**  
 EB-253 C  
 17.66' BTC 9-25-96  
 13.01' BGL 0957

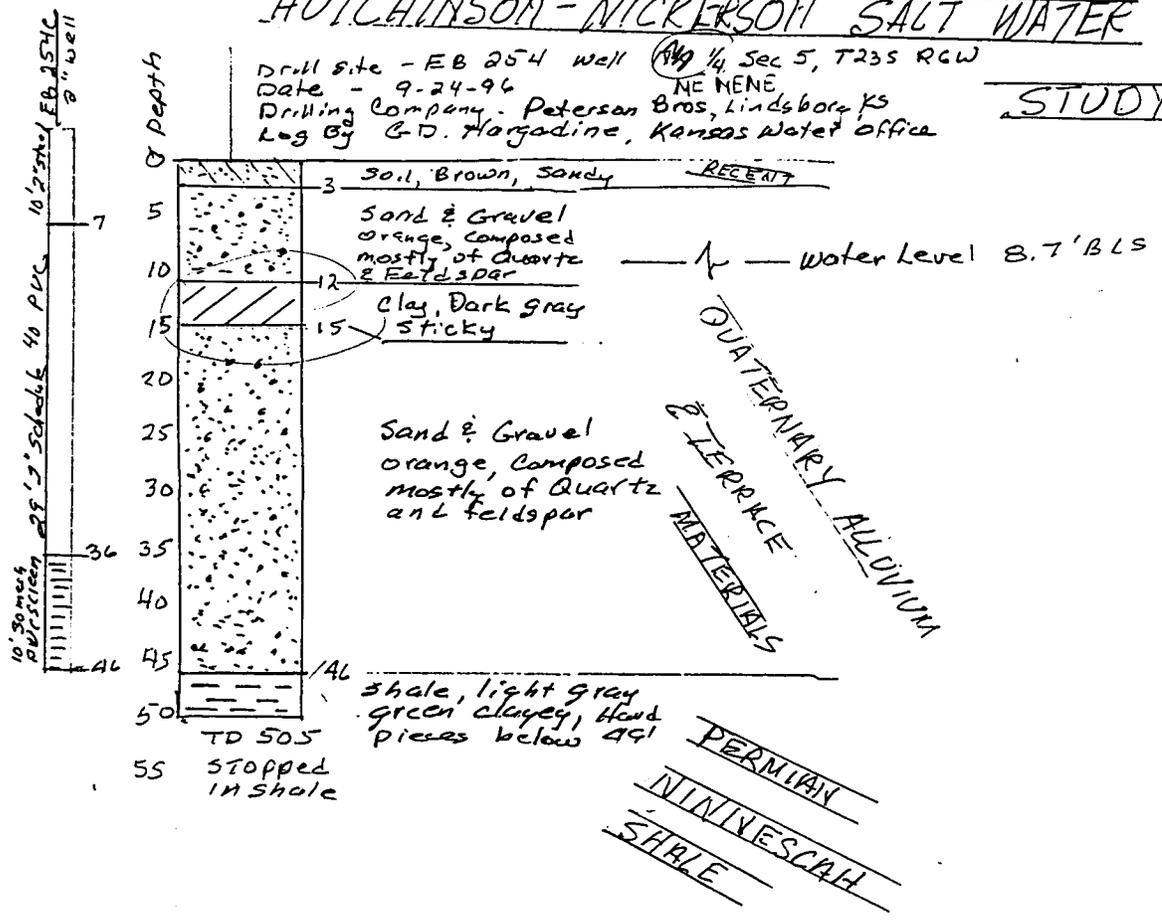
**Annular Space**  
 EB-253 C  
 62.5 - 46 Gravel Pack  
 46 - 4. Nat Cement - 10 Sacks  
 A - 0 Bentonite chips 3 1/2 Sack

**Note**  
 Could not get casing  
 to 61 as planned,  
 Hole filled in to 59.5

# HUTCHINSON-NICKERSON SALT WATER

Drill site - EB 254 well (NE 1/4, Sec 5, T23S R6W)  
 Date - 9-24-96  
 Drilling Company - Peterson Bros, Lindsborg, KS  
 Log by G.D. Hargadine, Kansas Water office

STUDY



Well Development  
 EB-254C  
 Developed well,  
 cleaned up well  
 & produced a  
 lot of water

Well Construction Materials Used  
 EB 254C  
 10' 2" steel  
 29' 2" schedule 40 PVC  
 10' 2" schedule 40 30 mesh screen

Water Level  
 EB 254C 11.33' BTC  
 9-25-96 8.68' BLS  
 @ 0925

Annular Space  
 50.5 - 31 Gravel Pack  
 31 - 4 Neat Cement 7 Bags  
 4 - 0 Hole Plug Bentonite - 2 Bags

# Hutchinson - Nickerson Saltwater Study

Site: EB 255 SW-SW-NE S-23-6W

Date: 10/2/96 Driller: Ken Bankston, Peterson Drilling

Logged by: Don Koci, Equus Beds GMD2

EB255C	0	Topsoil, dark brown, fine sandy loam
10' 2" Steel Pipe	5	Clay, tan to light brown
	6.5	Water Level 7.94'
	10	
	15	Sand, tan, fine to medium, (coarse sand may not be brought up by drill fluid, added bentonite powder at 15 feet to thicken fluid)
	20	Sand mostly quartz w/some feldspar, subangular. Drilled through black organic material at 15'.
10' .030 Slot Screen	25	
	30	Sand was coarser with depth or more coarse sand brought up with higher viscosity fluid. Added more bentonite powder at 33'.
	35	Coarser sand and gravel was primarily feldspar, fine to medium was quartz. (Estimated quartz 60% feldspar 40%).
	40	Feldspar was subangular to angular.
	45	Added more bentonite at 47' to thicken fluid.
	50	After thickening fluid sand brought up was mostly coarse.
	55	Some shale fragments found in sand from 55-60' (reddish shale fragments probably transported in during deposition of alluvium).
	60	
10' .030 Slot Screen	65	
	70	
	75	
75' Projected 73' Actual	80	Shale, reddish brown and green, very hard, platy and brittle. Drilled very hard, Good Structure

## Well Construction

EB 255C (2' of hole lost, construction readjusted)

10' - steel (2") 0-5'

Gravel Pack 73'-58'

58' - PVC (2") 5-63'

Neat Cement 58-4' (11 bags)

10' - PVC Screen (2") 63-73'

Bentonite Hole Plug 4-0' (2 bags)

## EB 255A

10' - steel (2") 0-7'

Gravel Pack 30-18' (ran out of gravel)

13' - PVC (2") 7-20'

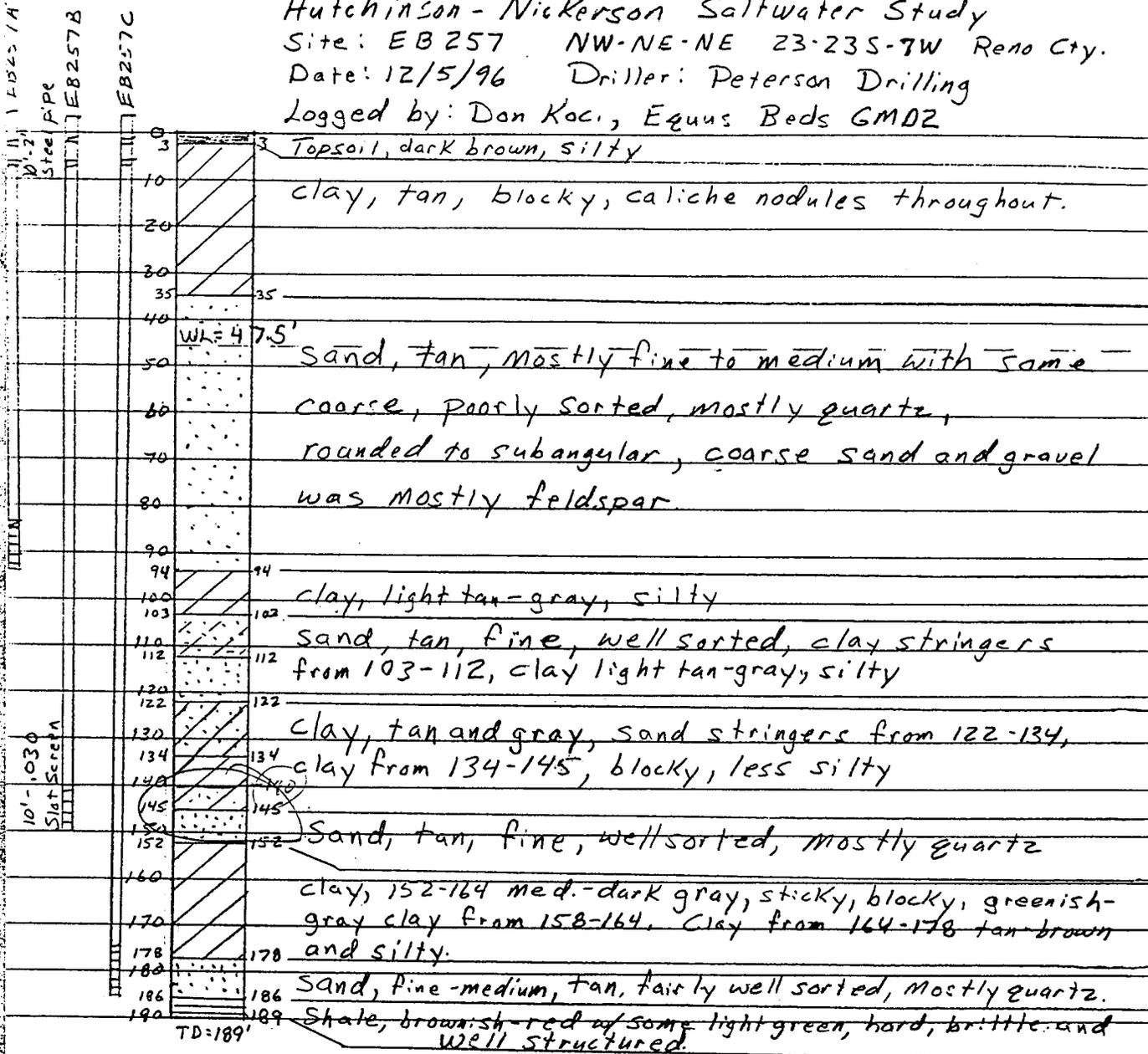
Neat Cement 18-4' (4 bags)

10' - PVC Screen (2") 20-30'

Bentonite Hole Plug 4-0' (1 bag)



Hutchinson - Nickerson Saltwater Study  
 Site: EB257 NW-NE-NE 23-23S-7W Reno Cty.  
 Date: 12/5/96 Driller: Peterson Drilling  
 Logged by: Don Koci, Equus Beds GMDZ



Well Construction

EB257C	EB257B	EB257A
10'(2") Steel 7'-0'	10'(2") steel 7'-0'	10'(2") steel 7'-0'
171'(2") PVC 176'-7'	134'(2") PVC 140'-7'	78'(2") PVC 84'-7'
10'(2") Screen 186'-176'	10'(2") Screen 150'-140'	10'(2") Screen 94'-84'
Gravel 189'-171'	Gravel 150'-135'	Gravel 94'-79'
Neat Cement 171'-4' (18 bags)	Neat Cement 135'-4' (15 bags)	Neat Cement 79'-4'
Bentonite Hole plug 4'-0'	Bentonite Hole plug 4'-0'	Bentonite Hole plug 4'-0'



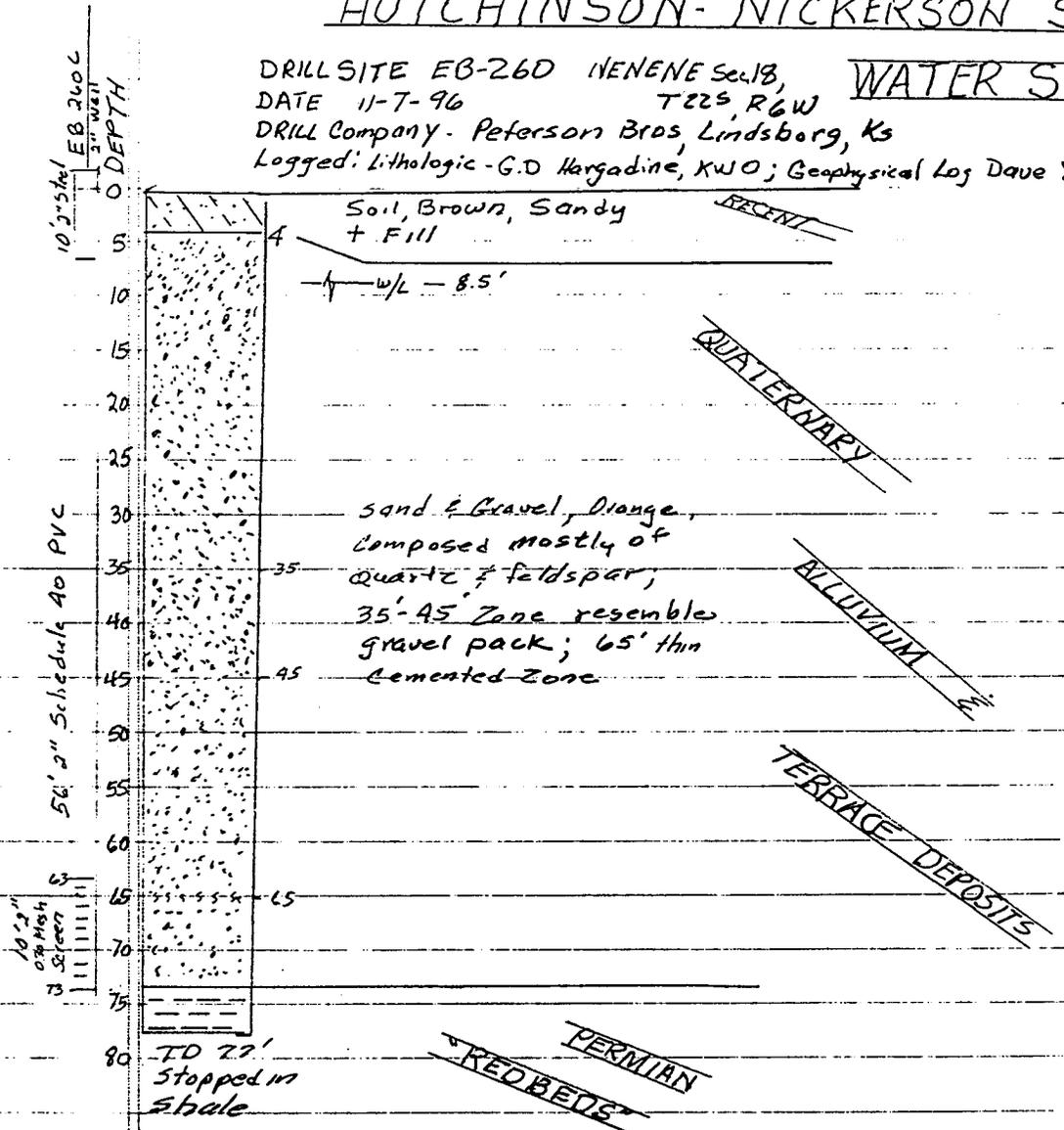
**EQUUS BEDS GROUNDWATER MANAGEMENT DISTRICT NO. 2**  
**Drilling Log and Well Completion Record for EB 259 B**

<b>1 LOCATION OF WATER WELL:</b> County: RICE	Fraction SE 1/4 SE 1/4 SE 1/4	Section Number 33	Township Number T 21 S	Range Number R 6W EW	
Distance and direction from nearest town or city street address of well if located within city? 5 Miles north and 2 west of Hutchinson, Kansas					
<b>2 WATER WELL OWNER:</b> Equus Beds Groundwater Management District No. 2 RR#, St. Address, Box #: 313 Spruce Street City, State, ZIP Code: Halstead, Kansas 67058-1925					
Board of Agriculture, Division of Water Resources Application Number: N/A					
<b>3 LOCATE WELL'S LOCATION WITH AN "X" IN SECTION BOX:</b>	<b>4 DEPTH OF COMPLETED WELL:</b> . . . 85 . . . . . ft. <b>ELEVATION:</b> . . . . .				
	Depth Groundwater Encountered 1. . . 10 . . . . . ft. 2. . . . . ft. 3. . . . . ft. WELL'S STATIC WATER LEVEL . . . 10 . . . . . ft. below land surface measured on mo/day/yr Estimated. . . Pump test data: Well water was . . . . . ft. after . . . . . hrs pumping. . . . . gpm Est. Yield. . . . . gpm: Well water was . . . . . ft. after . . . . . hrs pumping. . . . . gpm Bore Hole Diameter. . 8 . . . . . in. to . . 111. . . . . ft. and . . . . . in. to . . . . . ft. <b>WELL WATER TO BE USED AS:</b> 5 Public water supply 8 Air conditioning 11 Injection well 1 Domestic 3 Feedlot 6 Oil field water supply 9 Dewatering 12 Other (specify) 2 Irrigation 4 Industrial 7 Lawn and garden only 10 <u>Monitoring well</u> Was a chemical/bacteriological sample submitted to Department? <u>Yes</u> . . . . . No . . . . . ; if yes, when mo/day/yr sample was submitted Water Well Disinfected? <u>Yes</u> <u>No</u>				
<b>5 TYPE OF BLANK CASING USED:</b>					
1 Steel 3 RMP (SR) 5 Wrought iron 8 Concrete tile CASING JOINTS: <u>Glued</u> . . . . . Clamped. . . . . 2 PVC 4 ABS 6 Asbestos-Cement 9 Other (specify below) <u>Welded</u> . . . . . Blank casing diameter. . 2 . Steel . . . in. to . 7 . . . ft., Dia. 2 PVC. . . . . in. to . 75 . . . ft., Dia. . . . . in. to . . . ft. Casing height above land surface. . 30 . . . . . in., weight. . . . . lbs./ft. Wall thickness or gauge No. PVC sch 40 . . . . . <b>TYPE OF SCREEN OR PERFORATION MATERIAL:</b> 7 PVC 10 Asbestos-cement 1 Steel 3 Stainless steel 5 Fiberglass 8 RMP (SR) 11 Other (specify). . . . . 2 Brass 4 Galvanized steel 6 Concrete tile 9 ABS 12 None used (open hole) <b>SCREEN OR PERFORATION OPENINGS ARE:</b> 5 Gauzed Wrapped 8 Saw Cut 11 None (open hole) 1 Continuous Slot 3 <u>Mill Slot</u> 6 Wire Wrapped 9 Drilled holes 2 Louvered shutter 4 Key Punched 7 Torch cut 10 Other (specify) . . . . . <b>SCREEN-PERFORATED INTERVALS:</b> From . 75 . . . . . ft. to . . 85 . . . . . ft., From . . . . . ft. to . . . . . ft. From . . . . . ft. to . . . . . ft., From . . . . . ft. to . . . . . ft. <b>GRAVEL PACK INTERVALS:</b> From . 70 . . . . . ft. to . . 89 . . . . . ft., From . . . . . ft. to . . . . . ft. From . . . . . ft. to . . . . . ft., From . . . . . ft. to . . . . . ft.					
<b>6 GROUT MATERIAL:</b> 1 <u>Neat cement</u> 2 Cement grout 3 <u>Bentonite</u> 4 Other . . . . .					
Grout intervals: (3) From . 58 . . . . . ft. to . 70 . . . . . ft., (1) From . 58 . . . . . ft. to . 6 . . . . . ft., (3) From . 5 . . . . . ft. to . 0 . . . . . ft.					
What is the nearest source of possible contamination: None observed 10 Livestock pens 14 Abandoned water well					
1 Septic tank 4 Lateral lines 7 Pit privy 11 Fuel storage 15 Oil well/Gas well					
2 Sewer lines 5 Cess pool 8 Sewage lagoon 12 Fertilizer storage 16 Other (specify below)					
3 Watertight sewer lines 6 Seepage pit 9 Feedyard 13 Insecticide storage					
Direction from well? How many feet?					
<b>FROM</b>	<b>TO</b>	<b>LITHOLOGIC LOG</b>	<b>FROM</b>	<b>TO</b>	<b>LITHOLOGIC LOG</b>
0	3	Soil, clay, sandy, brown, plant debris	69	85	Sand, very fine, tan, fluid loss
3	4	Silt, clayey, light gray	85	92	Clay, tan
4	6	Clay, silty, tan	92	95	Clay, redish tan
6	10	Sand, fine, clayey, tan, mixed	95	106	Clay, redish tan, caliche nodule
10	17	Sand, very fine, tan	106	111	Shale, red, hard
17	23	Clay, sandy, light tan			
23	25	Clay, tan			
25	36	Clay to sandy clay, tan to gray			
36	40	Silt, clayey, gray			
40	49	Clay, gray, firm, iron staining			
49	55	Clay, tan, firm to sandy clay			
55	69	Clay, gray			
<b>7 SITE GEOLOGIST INFORMATION:</b> This water well was constructed and completed on (mo/day/year) <u>November 19, 1996</u>					
Site Geologist Name: <u>Michael T. Dealy</u> Agency: <u>Equus Beds Groundwater Management District No. 2</u>					
This Water Well Record was completed on (mo/day/year) <u>December 18, 1996</u>					
by (signature)					

# HUTCHINSON-NICKERSON SALT

**DRILLSITE EB-260 NENENE Sec. 18, T22S R6W**  
**DATE 11-7-96**  
**DRILL Company - Peterson Bros, Lindsborg, Ks**  
**Logged: Lithologic - G.D Hargadine, KWO; Geophysical Log Dave Young KGS**

## WATER STUDY



**WELL DEVELOPMENT**  
 EB 260C DEVELOPED  
 well & Cleaned up  
 well & produced a  
 lot of water

**WELL CONSTRUCTION MATERIAL USED**  
 10 1/2" STEEL  
 56 1/2" Schedule 40 PVC  
 10 1/2" Schedule 40 30 mesh  
 PVC SCREEN

**WATER LEVEL**  
 EB 260C  
 11.80 BTC  
 8.50 BGL  
 11-8-96 @ 0848

**ANNULAR SPACE**  
 77-58 Gravel Pack  
 58-4 Neat Cement 14 Eggs Portland  
 4-0 Hole Plug Bentonite 2 Bogs  
 Note: Lost 1 1/4" Tremie in hole

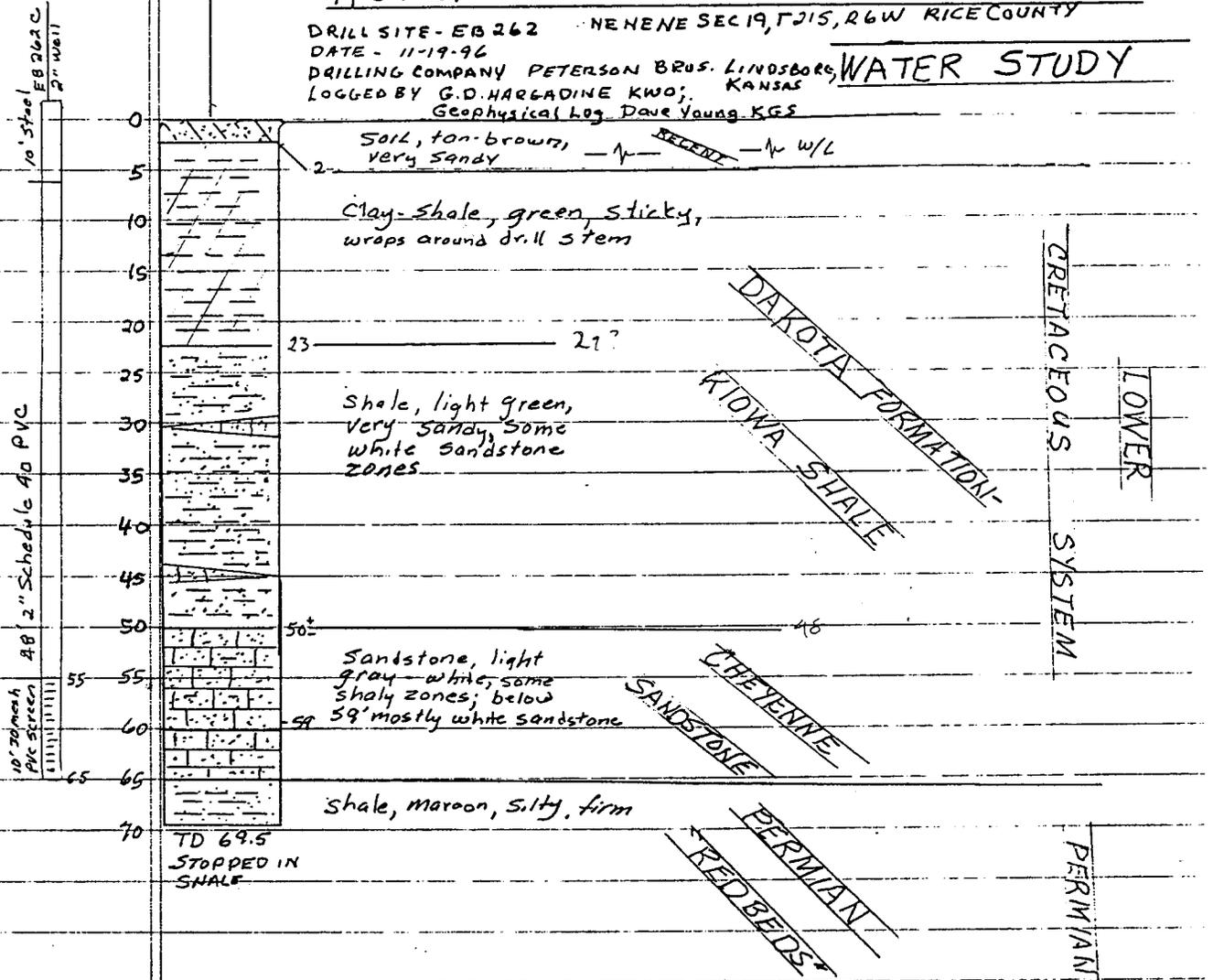
**EQUUS BEDS GROUNDWATER MANAGEMENT DISTRICT NO. 2**  
**Drilling Log and Well Completion Record for EB 261 C**

<b>1 LOCATION OF WATER WELL:</b> County: RENO	Fraction SE 1/4 SE 1/4 SE 1/4	Section Number 23	Township Number T 22 S	Range Number R 7 E/W	
Distance and direction from nearest town or city street address of well if located within city? 1.25 miles east and 1.75 miles south of Nickerson, Kansas.					
<b>2 WATER WELL OWNER:</b> Equus Beds Groundwater Management District No. 2 RR#, St. Address, Box #: 313 Spruce Street City, State, ZIP Code: Halstead, Kansas 67056-1925			Board of Agriculture, Division of Water Resources Application Number: N/A		
<b>3 LOCATE WELL'S LOCATION WITH AN "X" IN SECTION BOX:</b>		<b>4 DEPTH OF COMPLETED WELL:</b> . . . 122 . . . . . ft. <b>ELEVATION:</b> . . . . .			
		Depth Groundwater Encountered 1. .10 . . . . . ft. 2. . . . . ft. 3. . . . . ft. WELL'S STATIC WATER LEVEL . . . 10 . . . . . ft. below land surface measured on mo/day/yr Estimated. . . Pump test data: Well water was. . . . . ft. after. . . . . hrs pumping. . . . . gpm Est. Yield. . . . . gpm: Well water was. . . . . ft. after. . . . . hrs pumping. . . . . gpm Bore Hole Diameter. .5 . . . . . in. to. .125. . . . . ft. and. . . . . in. to. . . . . ft. WELL WATER TO BE USED AS: 5 Public water supply 8 Air conditioning 11 Injection well 1 Domestic 3 Feedlot 6 Oil field water supply 9 Dewatering 12 Other (specify) 2 Irrigation 4 Industrial 7 Lawn and garden only <u>10 Monitoring well</u> Was a chemical/bacteriological sample submitted to Department? -Yes. . . . . No. . . . . ; If yes, when mo/day/yr sample was submitted Water Well Disinfected? Yes <u>No</u>			
<b>5 TYPE OF BLANK CASING USED:</b>					
1 Steel 3 RMP (SR) 2 PVC 4 ABS		5 Wrought iron 6 Asbestos-Cement 7 Fiberglass		8 Concrete tile 9 Other (specify below) CASING JOINTS: <u>Glued</u> (pvc) Clamped. . . . . Welded. . . . . Threaded (steel) . . . . .	
Blank casing diameter. . 2 Steel . . in. to. 7 . . . ft., Dia. 2 PVC. . . . . in. to. .75 . . . ft., Dia. . . . . in. to. . . . . ft. Casing height above land surface. . 30 . . . . . in., weight. . . . . lbs/ft Wall thickness or gauge No. PVC sch 40 . . . . .					
<b>TYPE OF SCREEN OR PERFORATION MATERIAL:</b>					
1 Steel 3 Stainless steel 5 Fiberglass 2 Brass 4 Galvanized steel 6 Concrete tile		7 PVC 8 RMP (SR) 10 Asbestos-cement 9 ABS 11 Other (specify) 12 None used (open hole)			
<b>SCREEN OR PERFORATION OPENINGS ARE:</b>					
1 Continuous Slot 3 Mill Slot 2 Louvered shutter 4 Key Punched		5 Gauzed Wrapped 6 Wire Wrapped 8 Saw Cut 7 Torch cut 9 Drilled holes 10 Other (specify) 11 None (open hole)			
<b>SCREEN-PERFORATED INTERVALS:</b>					
From. .112 . . . . . ft. to. .122 . . . . . ft., From. . . . . ft. to. . . . . ft.					
From. . . . . ft. to. . . . . ft., From. . . . . ft. to. . . . . ft.					
<b>GRAVEL PACK INTERVALS:</b>					
From. .105 . . . . . ft. to. .122 . . . . . ft., From. . . . . ft. to. . . . . ft.					
From. . . . . ft. to. . . . . ft., From. . . . . ft. to. . . . . ft.					
<b>6 GROUT MATERIAL:</b> 1 Neat cement 2 Cement grout 3 Bentonite 4 Other. . . . .					
Grout intervals: (3) From. 80 . . . . . ft. to. 105 . . . . . ft., (1) From. . 20 . . . . . ft. to. . 5 . . . . . ft., (3) From. 5 . . . . . ft. to. . 0 . . . . . ft.					
What is the nearest source of possible contamination: None observed 10 Livestock pens 14 Abandoned water well					
1 Septic tank 4 Lateral lines 7 Pit privy 11 Fuel storage 15 Oil well/Gas well					
2 Sewer lines 5 Cess pool 8 Sewage lagoon 12 Fertilizer storage 16 Other (specify below)					
3 Watertight sewer lines 6 Seepage pit 9 Feedyard 13 Insecticide storage					
Direction from well? How many feet?					
<b>FROM</b>	<b>TO</b>	<b>LITHOLOGIC LOG</b>	<b>FROM</b>	<b>TO</b>	<b>LITHOLOGIC LOG</b>
0	3	Soil, sandy, brown			
3	8	Sand, fine, tan			
8	83	Sand, coarse, gravel			
83	87	Clay, gray			
87	92	Sand, fine			
92	100	Clay, with sand stringers			
100	115	Clay, sandy, brown			
115	120	Sand, fine with fossil fragments			
120	125	Shale, red with gray streaks			
<b>7 SITE GEOLOGIST INFORMATION:</b> This water well was constructed and completed on (mo/day/year) <u>November 11, 1996</u>					
Site Geologist Name: <u>Michael T. Dealy</u> Agency: <u>Equus Beds Groundwater Management District No. 2</u>					
This Water Well Record was completed on (mo/day/year) <u>December 18, 1996</u>					
by (signature)					

# HUTCHINSON - NICKERSON SALT

DRILL SITE - EB 262 NENE SEC 19, T21S, R6W RICE COUNTY  
 DATE - 11-19-96  
 DRILLING COMPANY PETERSON BRUS. LINDSBORG, KANSAS  
 LOGGED BY G.D. HARGADINE KWO,  
 Geophysical Log Dave Young KGS

## WATER STUDY



### WELL DEVELOPMENT

Developed rapidly  
 & produced a lot of  
 water (Artisian)

### WELL CONSTRUCTION MATERIALS USED

EB 262.C  
 10' 2 1/2" steel  
 48' 2" schedule 40 PVC  
 10' 2" schedule 40, 30 mesh screen

### WATER LEVEL

7.0 BTC 3.9' BLS  
 11-20-96 @ 1350

### ANNULAR SPACE

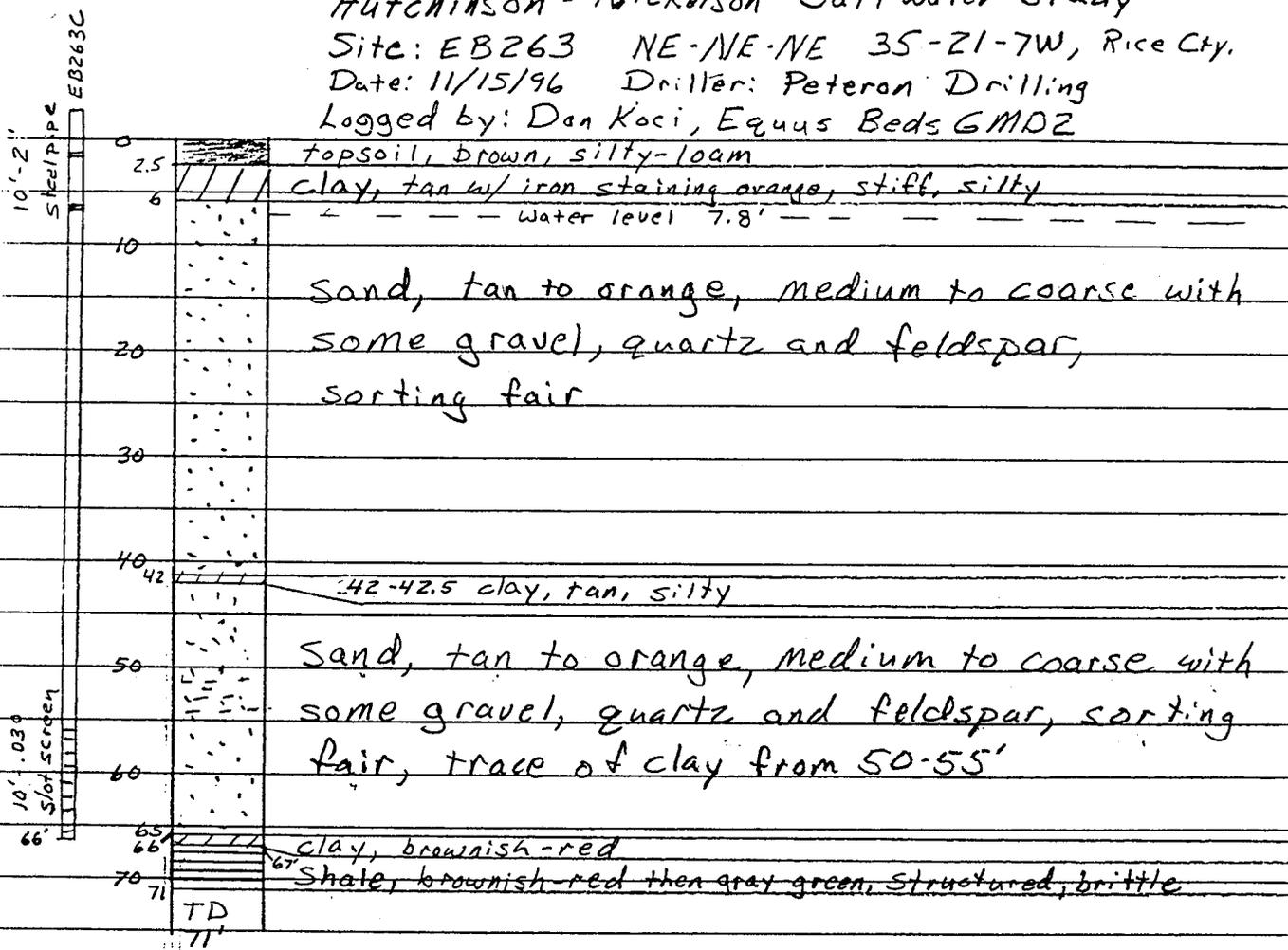
69.5 - 50 gravel pack  
 50 - 5 - Neat Cement - 4 Bags  
 35 - 0 Hole Plug Bentonite - 10.

Hutchinson - Nickerson Saltwater Study

Site: EB263 NE-NE-NE 35-21-7W, Rice Cty.

Date: 11/15/96 Driller: Peteron Drilling

Logged by: Dan Koci, Equus Beds GMD2

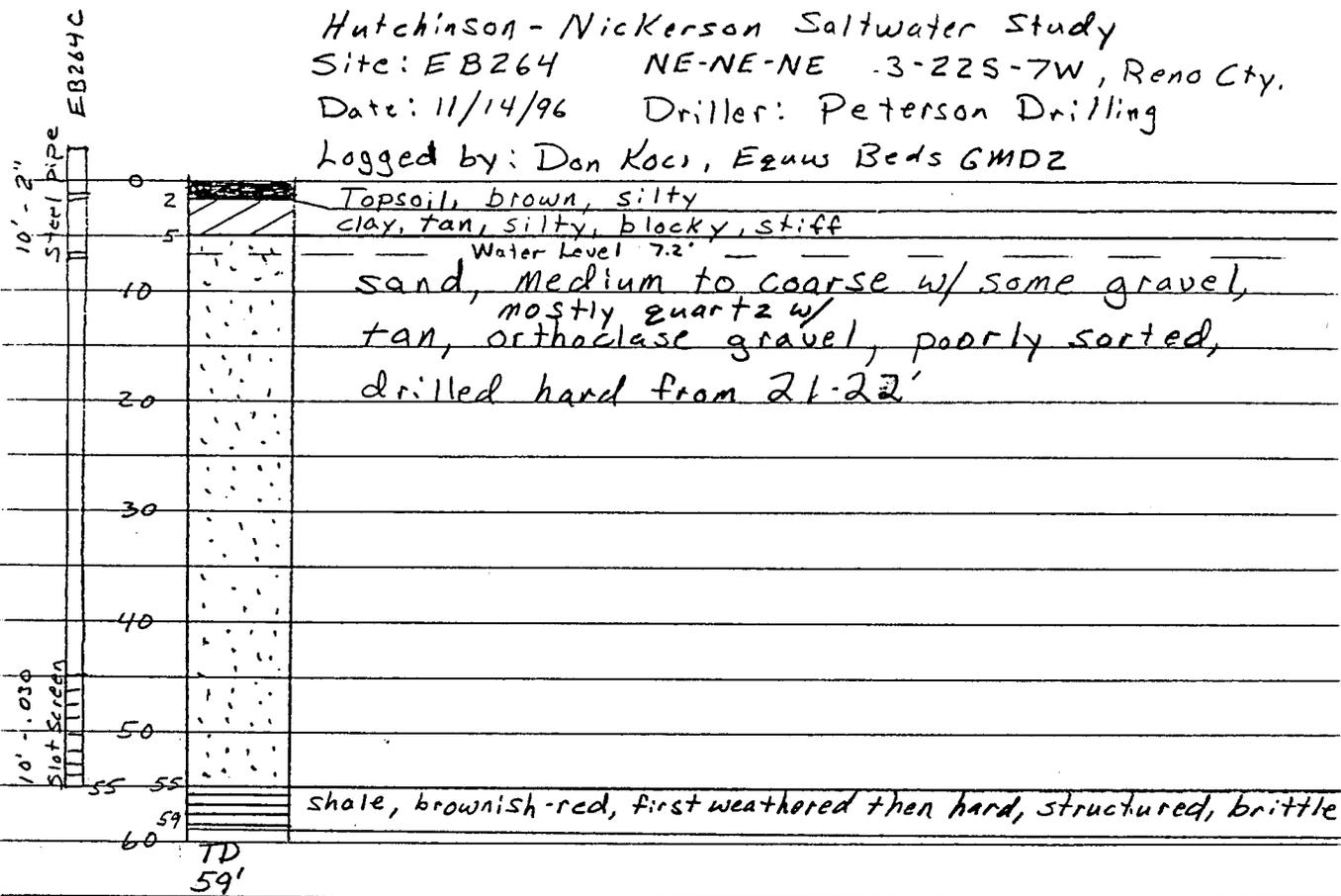


Well Construction

EB263C

10'-steel (2") 0'-7'	Gravel Pack	51'-71'
49'-PVC (2") 7'-56'	Neat Cement	4'-51' (14 bags)
10'-PVC Screen (2") 56'-66'	Bentonite Holeplug	0-4' (2 bags)

Hutchinson - Nickerson Saltwater Study  
 Site: EB264 NE-NE-NE 3-22S-7W, Reno Cty.  
 Date: 11/14/96 Driller: Peterson Drilling  
 Logged by: Don Koci, Equus Beds GMDZ



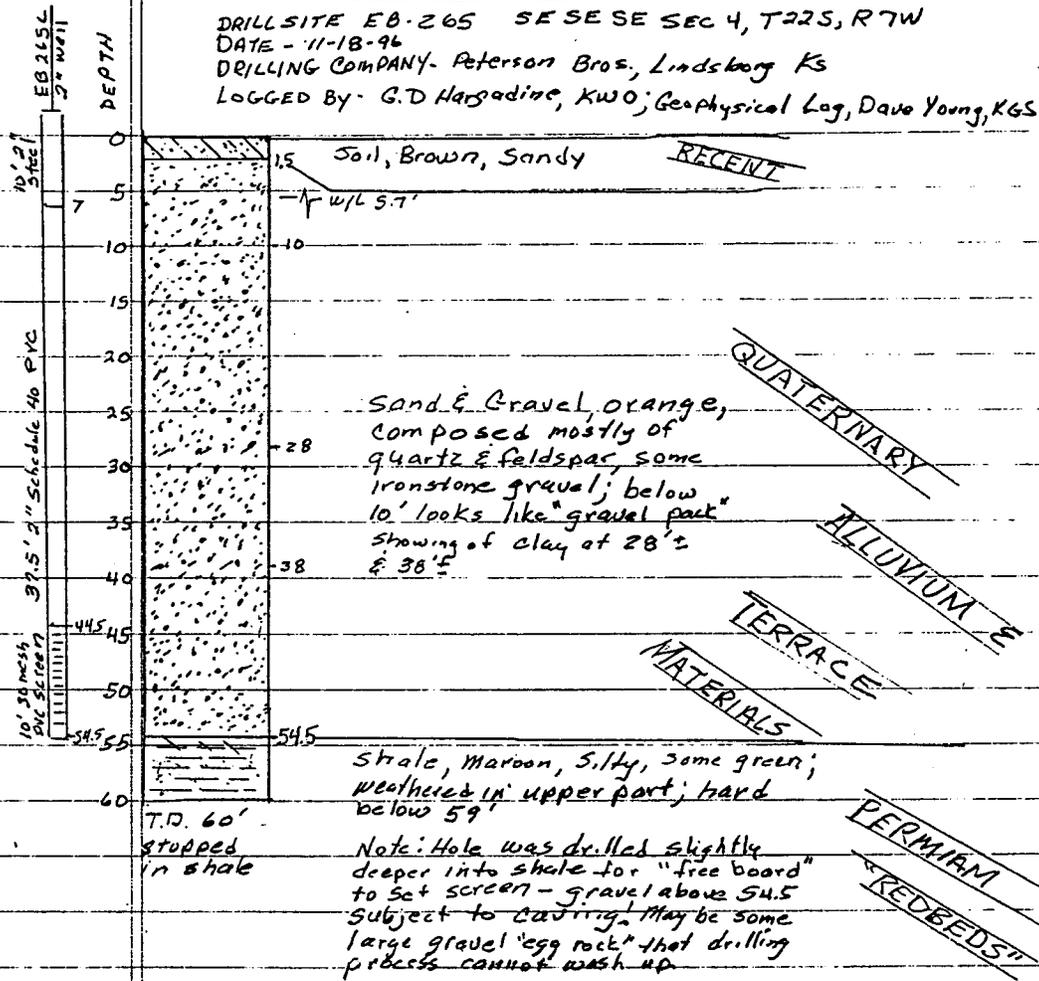
Well Construction - EB264C

10' - (2") steel	0-7'	Gravel Pack	35'-40'
38' - (2") PVC	7'-45'	Neat Cement	40'-4' (11 bags)
10' - (2") PVC screen	45-55'	Bentonite Holeplug	4' - 0' (2 bags)

# HUTCHINSON-NICKERSON SALT WATER

DRILL SITE EB-265 SE SE SE SEC 4, T22S, R7W  
 DATE - 11-18-96  
 DRILLING COMPANY - Peterson Bros, Lindsborg Ks  
 LOGGED BY - G.D Hargadine, KWO; Geophysical Log, Dave Young, KGS

STUDY



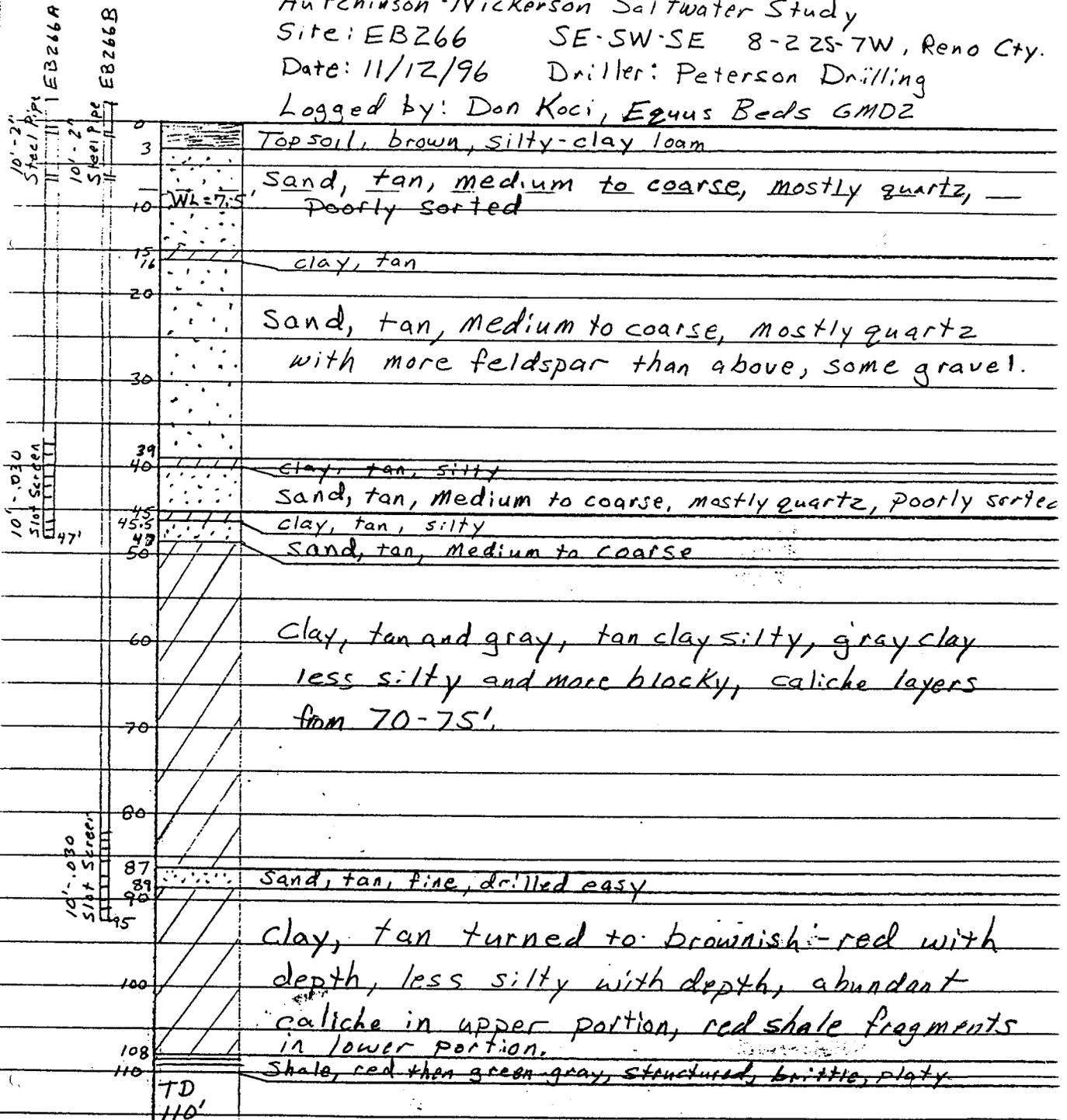
**WELL DEVELOPMENT**  
 EB 265C DEVELOPED WELL  
 Cleaned up well &  
 produced a lot of water

**WELL CONSTRUCTION - Materials Used**  
 EB 265C  
 10' 2" Steel  
 37.5' 2" Schedule 40 PVC  
 10' 2" Schedule 40 20 mesh PVC Screen

**WATER LEVEL**  
 EB 265C 8.50 BTC  
 5.70 OLS 11-19-96 @  
 0930

**ANNULAR SPACE**  
 60 - 39.5 Gravel Pack  
 39.5 - 5.8 Neat Cement - 10 Bags Portland  
 5.8 - 0 Hole Plug Bentonite  
 2 Bags

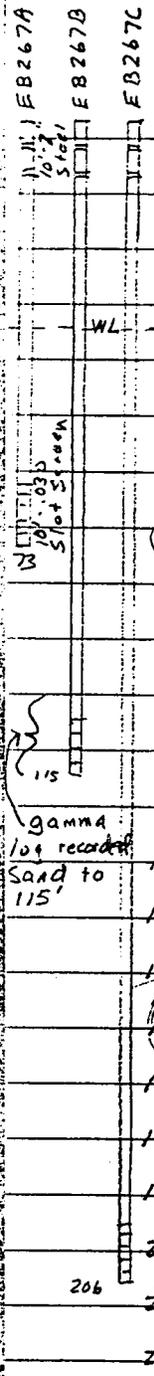
Hutchinson-Nickerson Saltwater Study  
 Site: EB266 SE-SW-SE 8-22S-7W, Reno Cty.  
 Date: 11/12/96 Driller: Peterson Drilling  
 Logged by: Don Koci, Equus Beds GMD2



Well Construction -

EB266B (73-50' collapse zone)		EB266A	
10' (2") steel 0-7'	Gravel Pack 105-73	10' (2") steel 0-7'	Gravel 49-33'
78' (2") PVC 7-85'	Neat Cement 50-4 (8 bags)	30' (2") PVC 7-37'	Neat (8 bags) Cement 33-4'
10' (2") screen 85-95'	Holeplug 4-0 (2 bags)	10' (2") Screen 37-47'	Holeplug 4-0 (3 bags)

Hutchinson-Nickerson Saltwater Study  
 Site: EB267 SW-SW-SW 17-22-7W  
 Date: 10/28/96 Driller: Peterson Drilling  
 Logged by: Don Koci, Equis Beds GMD2



0	Topsoil, dark brown, silty-loam
2.5	
10	clay, tan, very silty, not blocky, caliche layer at 10', thin caliche layers throughout 15-26'. Caliche drilled very hard.
20	
26	
30	sand, tan to orange, fine, well sorted
35	caliche 30-30.5', white, large fragments
40	clay, tan to orange, very silty
44	35-39' sand, fine, tan-orange, well sorted, arkosic
50	clay and caliche, clay tan-orange, silty, drilled very hard
60	Sand, tan to orange, arkosic, fine, some clay stringers. Sand coarser with depth, quartz and feldspar, sub-rounded to sub-angular. Coarse sand and gravel may not all be circulating to top. Drilled harder at 64' like clay.
70	
75	
80	clay, tan-gray, less silty than above, blocky
84	
90	sand, tan-orange, fine, arkosic, well sorted, drilled easy.
100	
105	clay, tan, silty
110	105-107 sand, tan, fine, well sorted
116	clay, tan, very silty, some fine sand stringers.
120	clay, medium gray, blocky
130	clay, dark gray, blocky, drilled softer 131 to 142'
140	
142	
150	sand, tan, fine, well sorted
155	
160	clay, gray, soft-sticky, not blocky
163	
170	sand, gray-tan, fine, well sorted
175	166-167, clay, gray
180	sand, tan, fine, well sorted
190	175-178 clay, dark gray, blocky
200	sand, fine to coarse, gray, poorly sorted, subangular, shell fragments abundant, several thin clay layers throughout difficult to pick out when drilling.
206	
210	shale, red and gray-lt green, well structured, brittle, drilled very hard
212	TD

Well Construction

Water Level = 34.5' BLS	EB267C	EB267B	EB267A
	10' (2") Steel 7'-0'	10' (2") steel 7'-0'	10' (2") steel 7'-0'
	189' (2") PVC 196'-7'	98' (2") PVC 105'-7'	56' (2") PVC 63'-7'
	10' (2") PVC Screen 206'-196'	10' (2") PVC Screen 115-105	10' (2") PVC Screen 73'-63'
	Gravel Pack 206'-191'	Gravel 115-100	Gravel 73'-59'
	Neat Cement 191'-4' (.16 bags)	Cement 100'-4' (9 bags)	Cement 59'-4' (7 bags)
	Bentonite Holeplug (1 bag)	Holeplug 4'-0' (2 bags)	Holeplug 4'-0' (1 bag)

# HUTCHINSON-NICKERSON SALT WATER

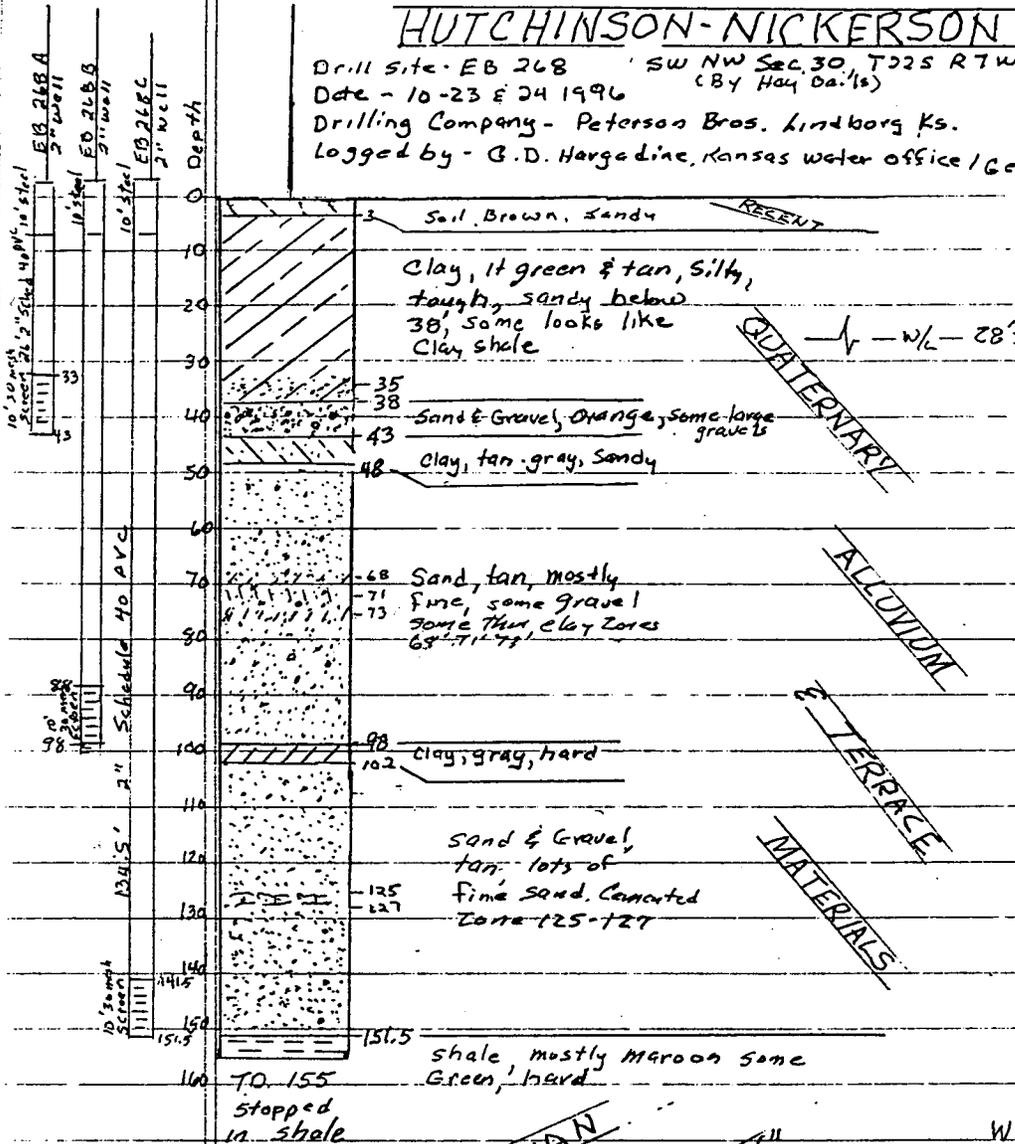
Drill Site - EB 268 SW NW Sec. 30, T22S RTW  
(By Hwy 0a.1's)

Date - 10-23 & 24 1996

Drilling Company - Peterson Bros. Lindborg Ks.

Logged by - G.D. Hargadine, Kansas water office / Geophysical Log Dave Young  
Kansas Geological Survey

## STUDY



### Well Development

All wells Developed & cleaned up Well

### Annular Space

EB 268 C: 155-137 Gravel Pack, 137-4 Neat Cement 2 bags, 10' 2" Schedule 40 30 mesh Screen, 4-0 Hole Plug 1 bag

EB 268 B: 65x 10' 2" Steel, Gravel Pack 2x 26' 3" Schedule 40 PVC, Neat Cement 8 bags 2x 10' 2" Schedule 40 PVC Screen, Hole Plug Bentonite 4 bags

EB 268 A: MORED 268 A & Plugged original EB 268 A & Redbed: 46-30 Gravel Pack, 30-4 Neat Cement 5 bags, 46-28 Gravel Pack, 28-4 Neat Cement 4 bags, 4-0 Bentonite (Hole Plug) 1 bag

### Water Levels

EB 268 C  
28' ± 10-24-96  
@ 1000

PERMIAN

REDBEDS

### Well Construction Materials Used

EB 268 C: 10' 2" Steel, 134.5' 2" Schedule 40 PVC, 10' 2" Schedule 40 30 mesh Screen

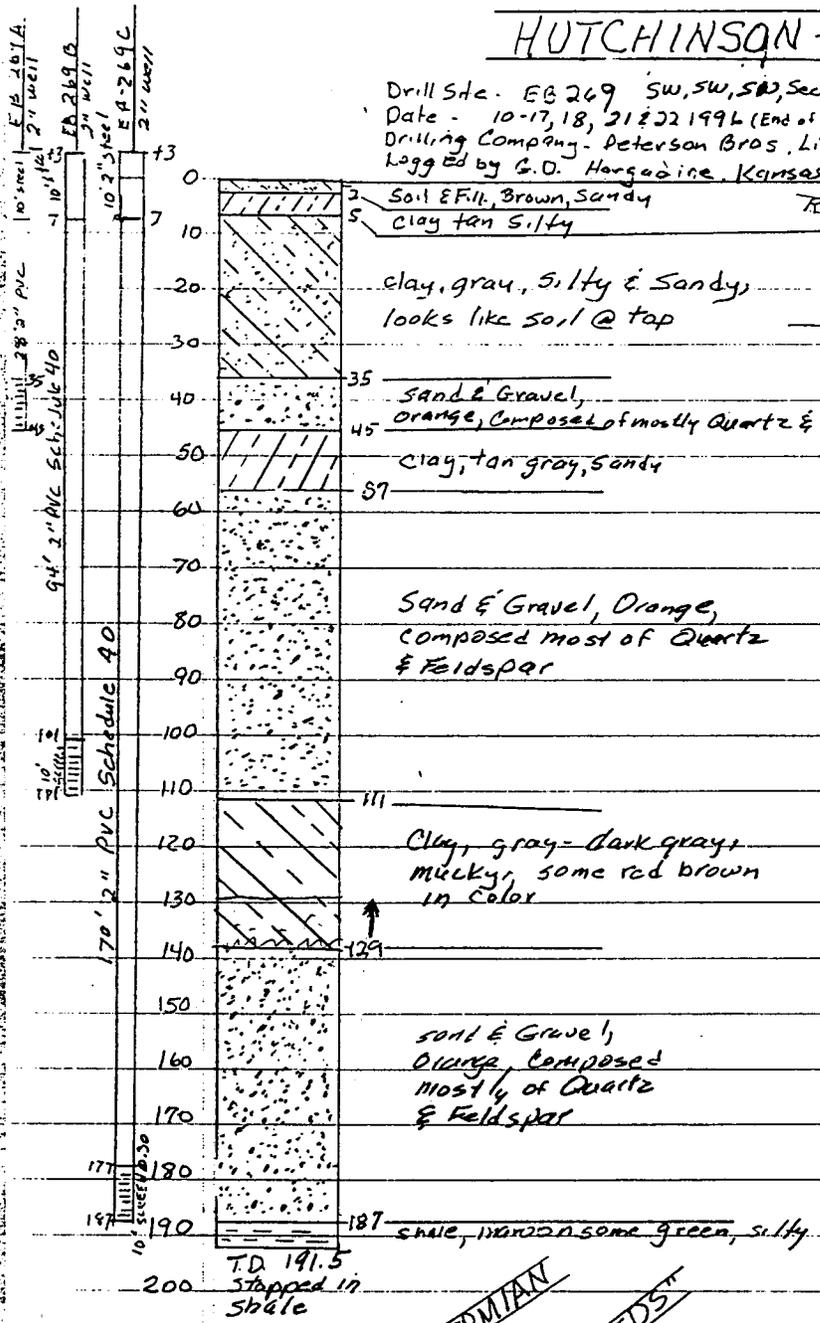
EB 268 B: 10' 2" Steel

EB 268 A: 65x 10' 2" Steel, Gravel Pack 2x 26' 3" Schedule 40 PVC, Neat Cement 8 bags 2x 10' 2" Schedule 40 PVC Screen, Hole Plug Bentonite 4 bags

# HUTCHINSON-NICKERSON SALT

## WATER STUDY

Drill Site - EB 269 SW, SW, S8, Sec. 31, T22S  
 Date - 10-17, 18, 21 & 22 1996 (End of EW Dodge Run)  
 Drilling Company - Peterson Bros. Lindsborg KS  
 Logged by G.D. Hargrave, Kansas Water Office; Geophysical Logs Date Young KG



QUATERNARY

TERRACE MATERIALS

Amount used	Annular Space
	EB-269 C
27 Bags	Gravel Pack 191.5 - 173
	Neat Cement 173 - 4
1 Bag	Hole Plug 4 - 0
	EB 269 B
17 Bag	Gravel Pack 114 - 97
	Neat Cement 97 - 4
2 Bags	Hole Plug 4 - 0
	EB-269 A
4 Bags	Gravel Pack 47 - 31
	Neat Cement 31 - 3
1 bag	Hole Plug 3 - 0

PERMIAN

RED BEDS

**Well Development**  
 EB 269 C, B & A were developed 10-23-90. all produced abundant water

**Water Levels**  
 EB 269 C 29.68' BTC 26.18' BLS 10-23-96 @ 1313

**Well Construction Materials Used**

EB-269 C  
 10' 2" steel  
 170' 2" Schedule 40 PVC  
 10' 2" Schedule 40 30 mesh Screen

EB 269 B  
 10' 2" steel  
 94' 2" Schedule 40 PVC  
 10' 2" Schedule 40 30 mesh Screen

EB 269 A  
 10' 2" steel  
 28' 2" Schedule 40 PVC  
 10' 2" Schedule 40 30 mesh Screen

# HUTCHINSON-NICKERSON SALT WATER

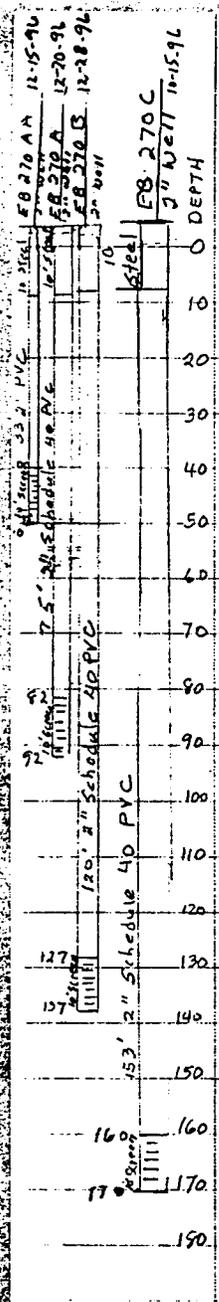
Drill site - EB 270C NW NW NW Sec. 18, T23S, R9W  
 Date - 10-15-90 (4th street + E Salem Road)  
 Drill Company - Peterson Bros Lindsborg, KS  
 Logged by - L. Holgric Log, G.D. Hargadine, Kansas Water Office; Geophysical Log  
 Dave Young - KGS

**STUDY**

**RECEIVED**

JAN 8 1997

Equus Beds Groundwater Management District No.



3.5 Soil, Tan-brown, Silty & Sandy  
 10 Clay, tan, silty w/ Caliche  
 Sandy zone 16-18 w/L 14.5' OLS  
 23  
 40 Sand & Gravel, Orange, Composed mostly of Quartz and Feldspar.  
 92 Clay, Gray-Tan, Sandy & Silty  
 99 Sand, tan, fine?  
 103  
 107 SILT, BLACK, MUCKY clay, tan, silty  
 119  
 127 Sand, fine-medium, orange, composed mostly of Quartz and feldspar, few pieces of maroon shale float  
 137  
 150 Clay, tan, silty and sandy.  
 164 Sand, lots of fine orange, some gravel  
 170 shale, maroon, silty Some green in color  
 190 T.O. = 174 Stopped in Shale

QUATERNARY ALLUVIUM  
 TERTIARY MATERIALS

PERMIAN "REDBEDS"

## Well Development

EB-270C Developed well  
 Cleaned up well produced a lot of water. Assume EB-270B EB 270 A & EB 270 HA were similar

## Water Level

EB 270C  
 16.65' Below Top of Casing  
 14.45' Below land Surface  
 on 10-19-96 @ 1134 AM

## Well Construction - Materials Used

EB-270B	EB-270C	EB 270A
10' 2" steel	10' 2" steel	10' 2" steel
120' 2" sch. 40 PVC	153' 2" Schedule 40 PVC	75' 2" sch. 40 PVC
10' 2" sch. 40 30 mesh screen	10' 2" sch. 40 30 mesh screen	10' 2" sch. 40 30 mesh screen

## Annular Space

EB 270 B	EB 270 C	EB-270 A
Gravel pack 138-128	Gravel Pack 174-160	Gravel Pack 54-55
Neat Cement 128-63	Neat Cement 160-45 - 23 Bags Portland Cem	Neat Cement 35-41
16 Bags	Hole Plug 4" - 0 - 2 Bags Hole Plug	1 1/2" Plug 4-0
Hole Plug 6" - 0 2 Bags		

# EQUUS BEDS GROUNDWATER MANAGEMENT DISTRICT NO. 2

EB 261

DRILLER'S LOG AND WELL RECORD FIELD SHEET

APRIL 5 1996

1 LOCATION OF WATER WELL: County: <b>RENO</b>		Fraction <b>SE 1/4 SE 1/4 SE 1/4</b>	Section Number <b>23</b>	Township Number <b>T 22 S</b>	Range Number <b>R 7 E</b>		
Distance and direction from nearest town or city street address of well if located within city? <b>1.25 MILE EAST + 1.75 MILE SOUTH OF NICKERSON, KS</b>							
2 WATER WELL OWNER: <b>EQUUS BEDS GROUNDWATER MANAGEMENT DISTRICT</b>							
RR#, St. Address, Box #: <b>313 SPIRUE</b>			Board of Agriculture, Division of Water Resources				
City, State, ZIP Code: <b>HAZLEDEAN KS 67256</b>			Application Number: <b>N/A</b>				
3 LOCATE WELL'S LOCATION WITH AN "X" IN SECTION BOX:		4 DEPTH OF COMPLETED WELL: <b>122</b> ft. ELEVATION:					
		Depth(s) Groundwater Encountered 1. .... ft. 2. .... ft. 3. .... ft.					
		WELL'S STATIC WATER LEVEL ..... ft. below land surface measured on mo/day/yr					
		Pump test data: Well water was ..... ft. after ..... hours pumping ..... gpm					
		Est. Yield ..... gpm: Well water was ..... ft. after ..... hours pumping ..... gpm					
		Bore Hole Diameter: <b>5</b> in. to <b>122</b> ft., and ..... in. to ..... in.					
		WELL WATER TO BE USED AS:					
		5 Public water supply      8 Air conditioning      11 Injection well 1 Domestic      3 Feedlot      6 Oil field water supply      9 Dewatering      12 Other (Specify below) 2 Irrigation      4 Industrial      7 Lawn and garden only <b>10 Observation well</b>					
		Was a chemical/bacteriological sample submitted to Department? Yes.....No..... <b>X</b> ; If yes, mo/day/yr sample was submitted					
5 TYPE OF BLANK CASING USED:		CASING JOINTS: Glued <input checked="" type="checkbox"/> Clamped <input type="checkbox"/>					
1 Steel      3 RMP (SR) 2 PVC      4 ABS		5 Wrought iron      8 Concrete tile 6 Asbestos-Cement      9 Other (specify below)					
Blank casing diameter <b>2" PVC</b> in. to <b>7</b> ft., Dia <b>7" STEEL</b> in. to <b>0</b> ft., Dia ..... in. to ..... in.		Casing height above land surface <b>36</b> in., weight ..... lbs./ft. Wall thickness of casing <b>40</b>					
TYPE OF SCREEN OR PERFORATION MATERIAL:		1 Steel      3 Stainless steel      5 Fiberglass      8 RMP (SR)      11 Other (specify) ..... 2 Brass      4 Galvanized steel      6 Concrete tile      9 ABS      12 None used (open hole)					
SCREEN OR PERFORATION OPENINGS ARE:		5 Gauzed wrapped      8 Saw cut      11 None (open hole) 1 Continuous slot      2 Mill slot      6 Wire wrapped      9 Drilled holes 2 Louvered shutter      4 Key punched      7 Torch cut      10 Other (specify) .....					
SCREEN-PERFORATED INTERVALS:		From <b>122</b> ft. to <b>112</b> ft., From ..... ft. to ..... ft.					
GRAVEL PACK INTERVALS:		From <b>122</b> ft. to <b>109</b> ft., From ..... ft. to ..... ft.					
6 GROUT MATERIAL:		1 Neat cement      2 Cement grout      3 Bentonite      4 Other ..... Grout intervals: From <b>109</b> ft. to <b>79</b> ft., From <b>61</b> to <b>79</b> ft. to <b>5'</b> ft., From <b>53</b> to <b>5</b> ft. to <b>0</b> ft.					
What is the nearest source of possible contamination:		1 Septic tank      4 Lateral lines      7 Pit privy      10 Livestock pens      14 Abandoned water well 2 Sewer lines      5 Cess pool      8 Sewage lagoon      11 Fuel storage      15 Oil well/Gas well 3 Watertight sewer lines      6 Seepage pit      9 Feedyard      12 Fertilizer storage      16 Other (specify below) 13 Insecticide storage					
Direction from well?		How many feet?					
FROM	TO	LITHOLOGIC LOG		FROM	TO	LITHOLOGIC LOG	
83	87	CLAY, GRAY					
87	92	SAND, FINE					
92	100	CLAY W/ SAND STRINGERS					
100	115	CLAY, BROWN, SANDY					
115	120	SAND, FINE, BROWN, FINE					
120	125	SAND, FINE, BROWN, FINE					

7 COMPLETION:  
Date Well Completed: **11/11/96**  
Site Geologist: **M. DEALY**

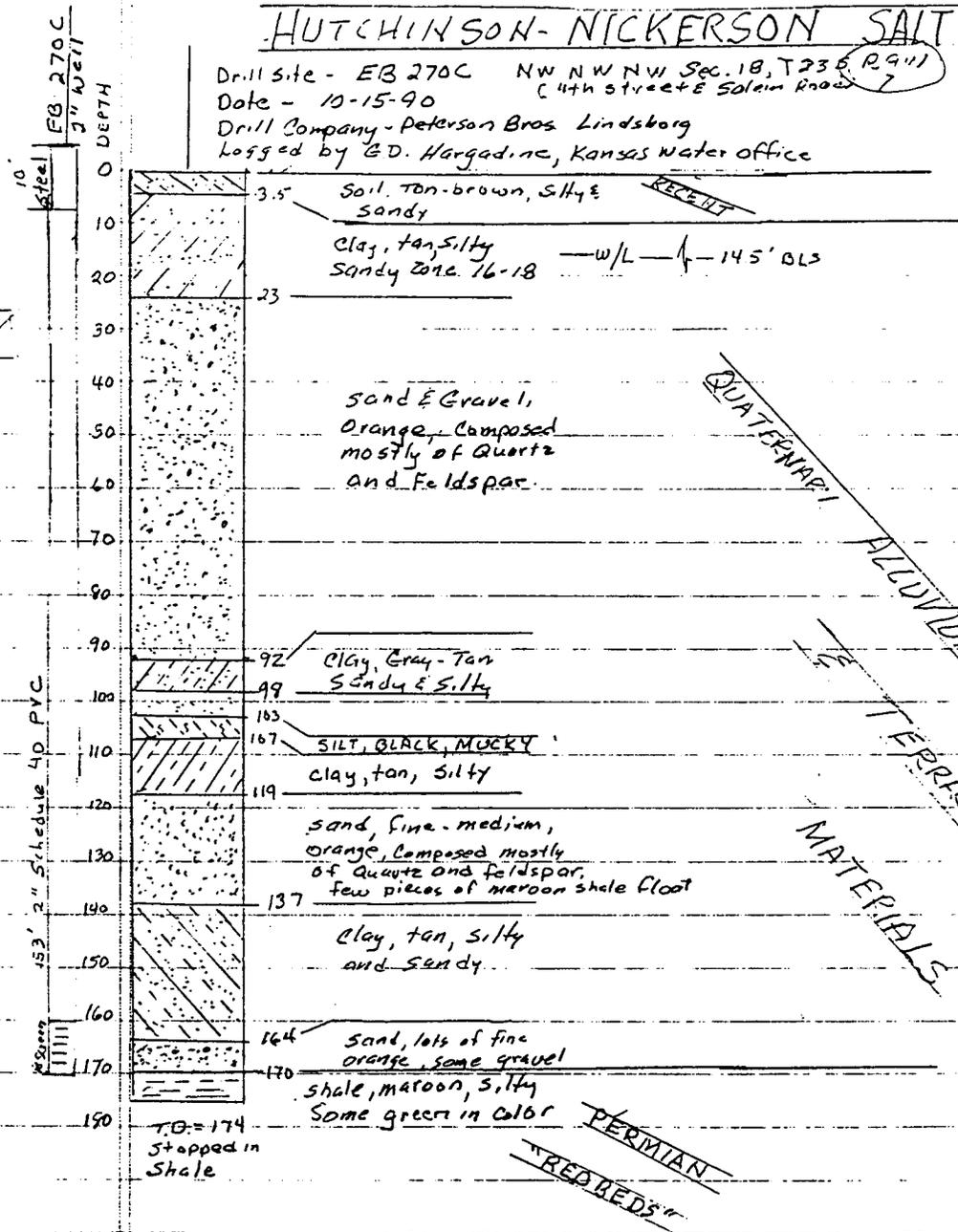
Signature: *[Handwritten Signature]*

# HUTCHINSON-NICKERSON SALT WATER

Drill site - EB 270C NW NW NW Sec. 18, T23E, R9W  
 Date - 10-15-90 C 4th Street + E Salem Road

STUDY

Drill Company - Peterson Bros Lindsborg  
 Logged by G.D. Hargadine, Kansas Water Office



## Well Development

Developed well  
 Cleaned up well  
 produced a lot of water.

## Well Construction - Materials Used

EB-270C  
 10" 2" steel  
 153' 2" schedule 40 PVC  
 10" 2" steel pipe

## Water Level

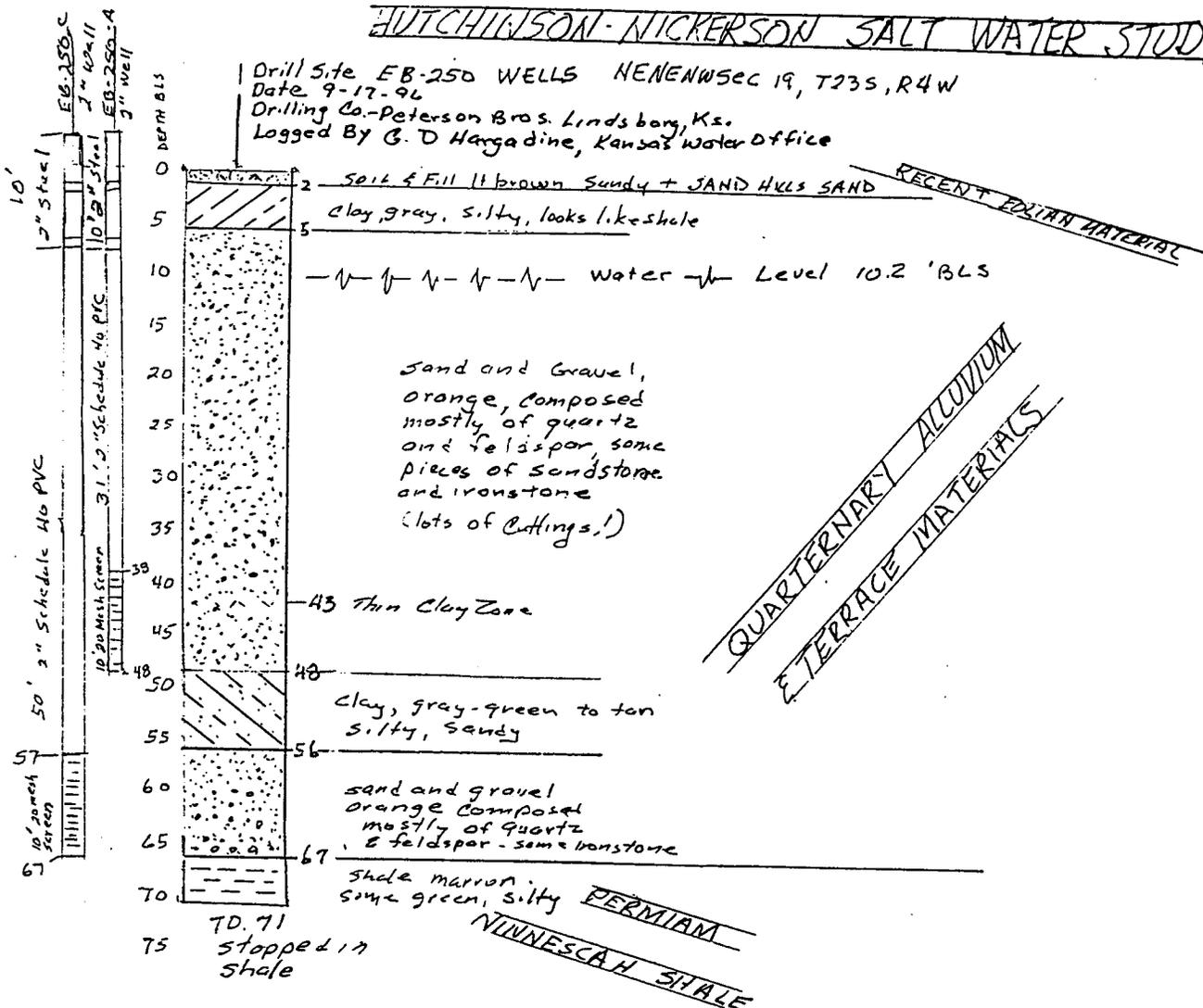
EB 270C  
 16.65' Below Top of Casing  
 14.45' Below land Surface  
 on 10-19-96 @ 11:34 AM

## Annular Space

EB-270C  
 Gravel Pack 174-160  
 Neat Cement 160-42 = 23 Bags Portland Cement  
 Hole Plug 42-0 = 2 Bags Hole Plug

# HUTCHINSON-NICKERSON SALT WATER STUDY

Drill Site EB-250 WELLS NENENW5EC 19, T23S, R4W  
 Date 9-17-96  
 Drilling Co. - Peterson Bros. Lindsborg, Ks.  
 Logged By G. D. Hargadine, Kansas Water Office



**WELL DEVELOPMENT**  
 EB-250 C 9-18-96 good  
 EB-250 A 9-18-96 good

**Water Levels 9-18-96**

EB 250 C = 12.80' below Top of Pipe  
 10.15' below Land Surface  
 EB 250 A = 12.90' below Top of Pipe  
 10.30' below Land Surface  
 EB-250 A located 7' East of EB-250-C (lithologic log similar)

**Well Construction - Materials Used**  
 EB-250 C 9-17-96 10' 2" steel Pipe at Top  
 (7' Below Ground & 3' Above Ground)  
 30' 2" Schedule 40 Pipe  
 EB-250 A located 7' East of EB-250-C (lithologic log similar) 10' of 2" Schedule 40  
 20 mesh screen

**Well Construction Materials Used**

EB-250 A 9-18-96 @ 10:45 AM  
 10' 2" steel Pipe at Top  
 (7' Below ground & 3' above ground)  
 31' 2" PVC Schedule 40  
 40 PVC  
 10' 2" Schedule 40  
 20 mesh screen

**Materials Used**

EB-250-A  
 8 Bags Portland Cement  
 1 Bag Bentonite

Annular Space EB-250 A  
 48-34 Gravel Pack  
 34-4 Neat Cement  
 4-0 Bentonite

Annular Space

EB-250 C T1-57 Gravel Pack  
 57-4 Neat Cement  
 4-0 Hole Plug

**Material Used**

EB 250-C 18 Bags Portland Cement  
 1 Bag Hole Plug

## **Appendix B**

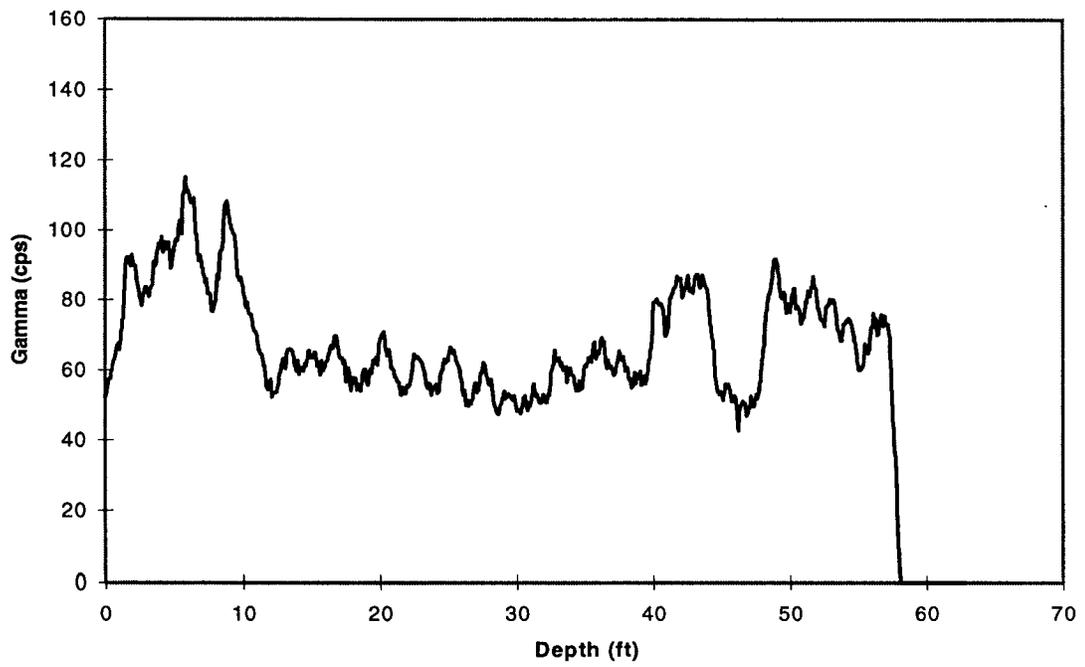
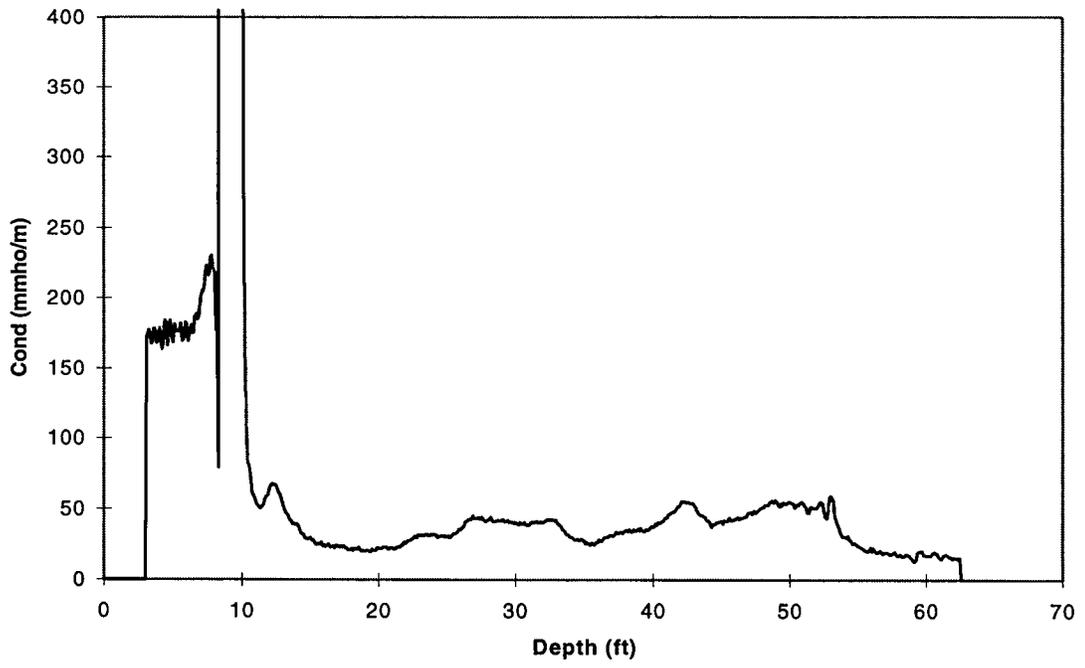
### **Geophysical (Natural Gamma and EM) Logs**

The attached logs were taken with a Century Geophysics UL-1000 data logger, portable drawworks, and a model 9511 combination natural gamma and focused induction logging probe.

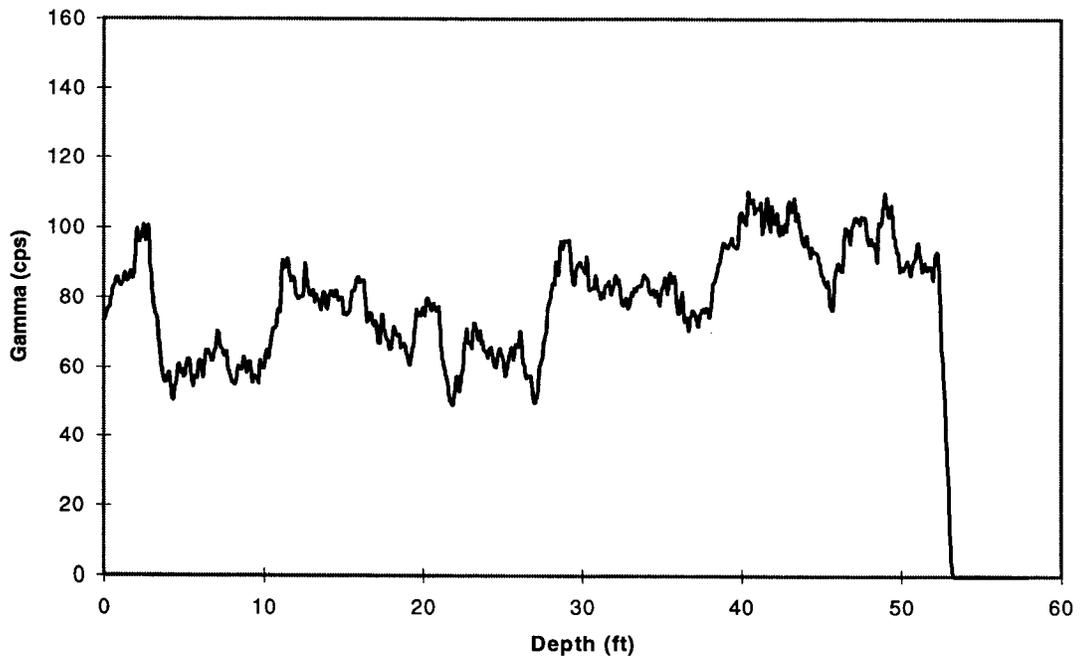
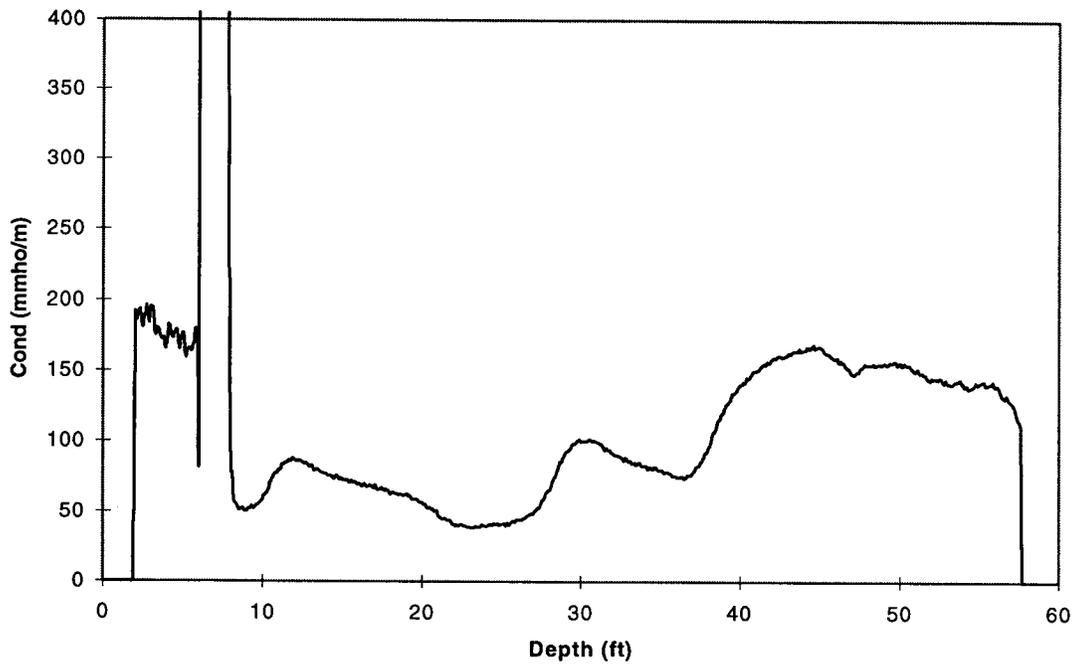
Natural gamma log: in general, higher values suggest greater clay concentrations in the alluvial aquifer, while low counts reflect cleaner sands and gravels.

Electromagnetic induction (EM) logs: these reflect the electromagnetic characteristics of the surrounding materials; higher readings indicate greater electrical conductivity. The extreme high readings at shallow depths are the result of metal surface casing, and do not indicate anything about water or sediment. EM readings increase moderately with clay content (see gamma log), and strongly with salinity. In general, values above about 100 mmho/m indicate brackish or saline water.

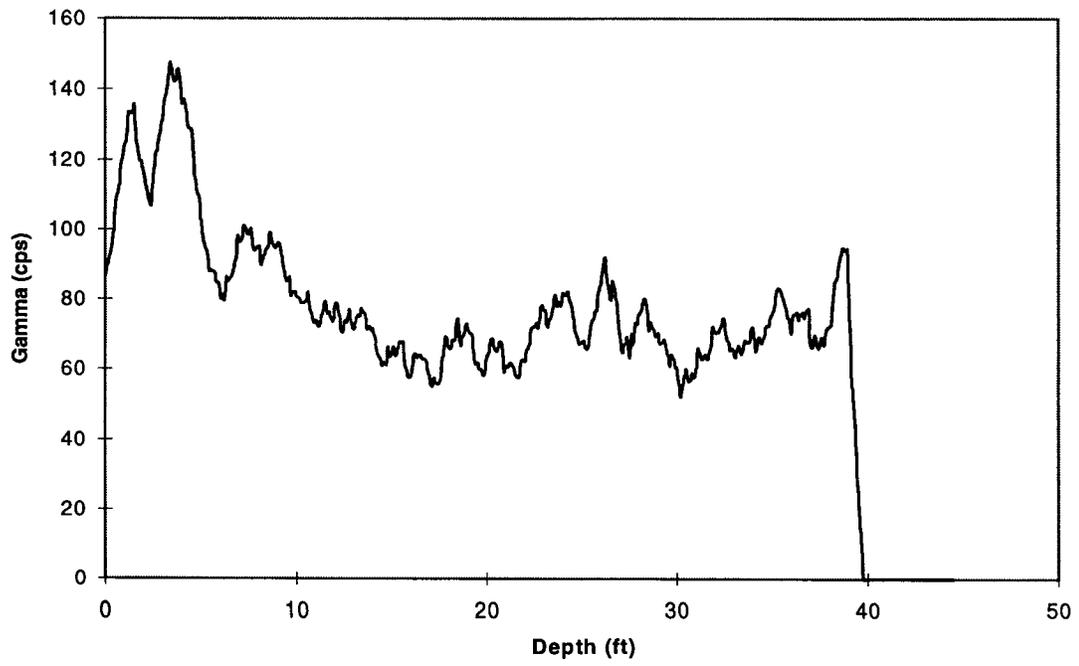
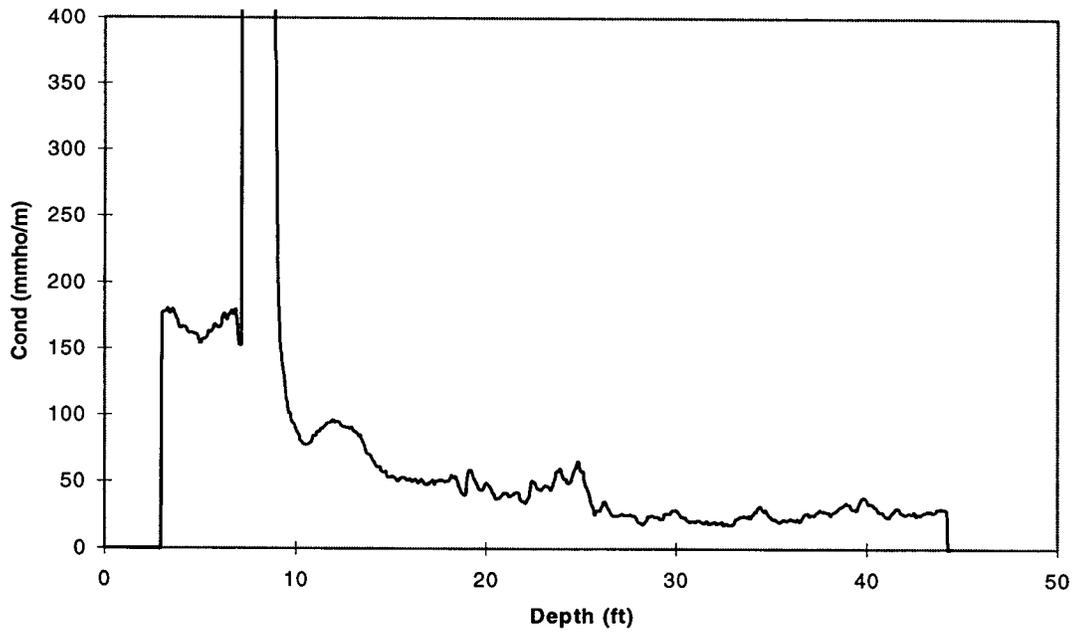
# EB250C



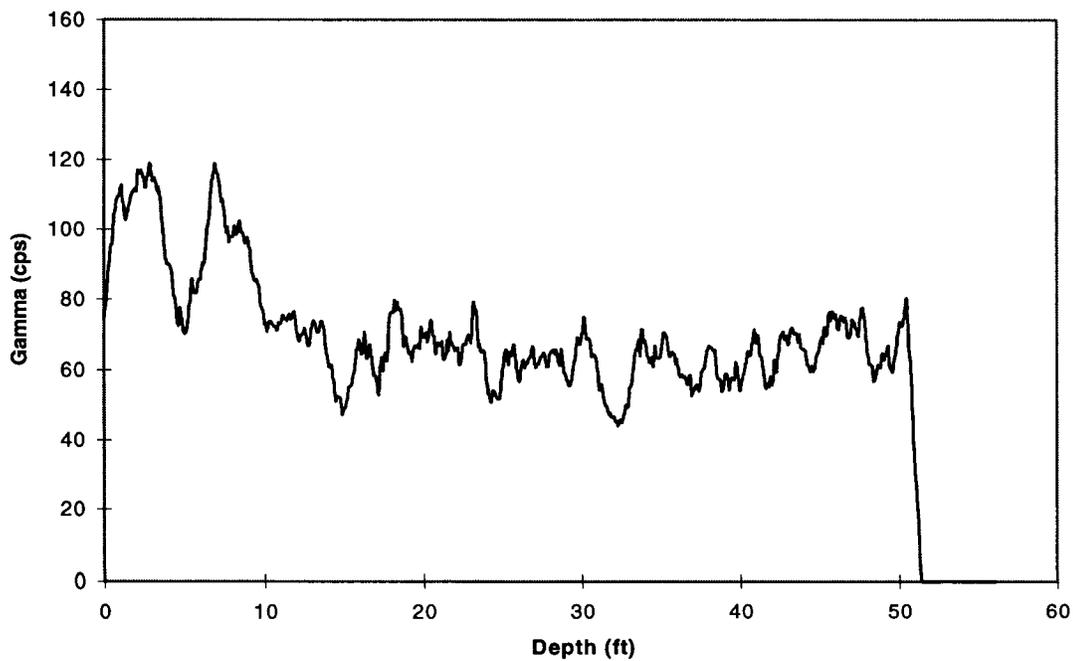
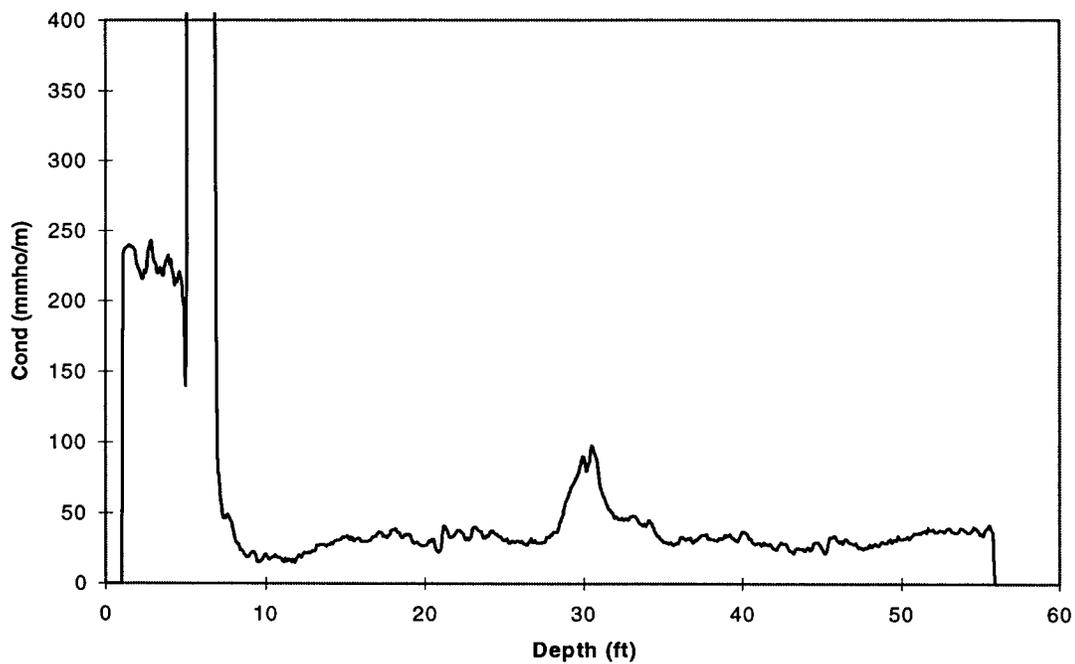
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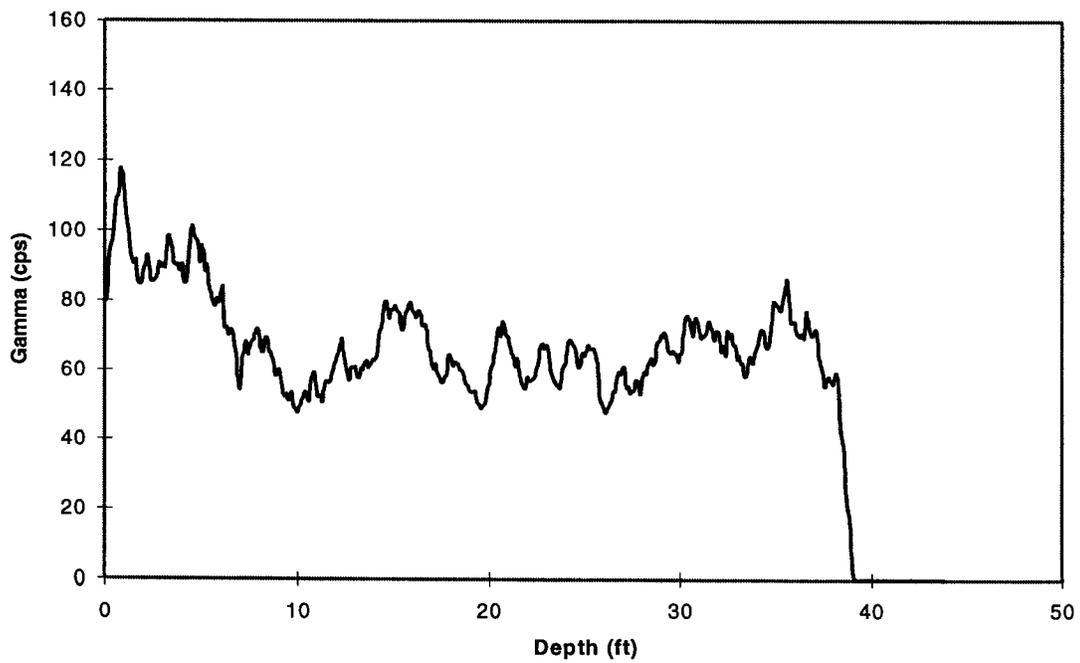
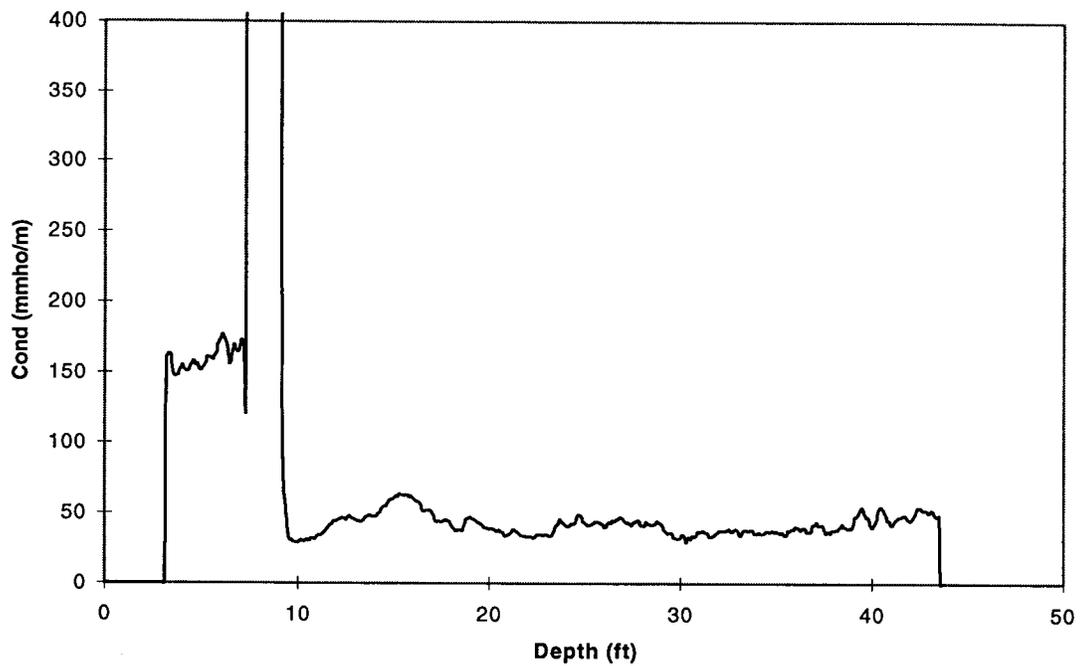
EB252A



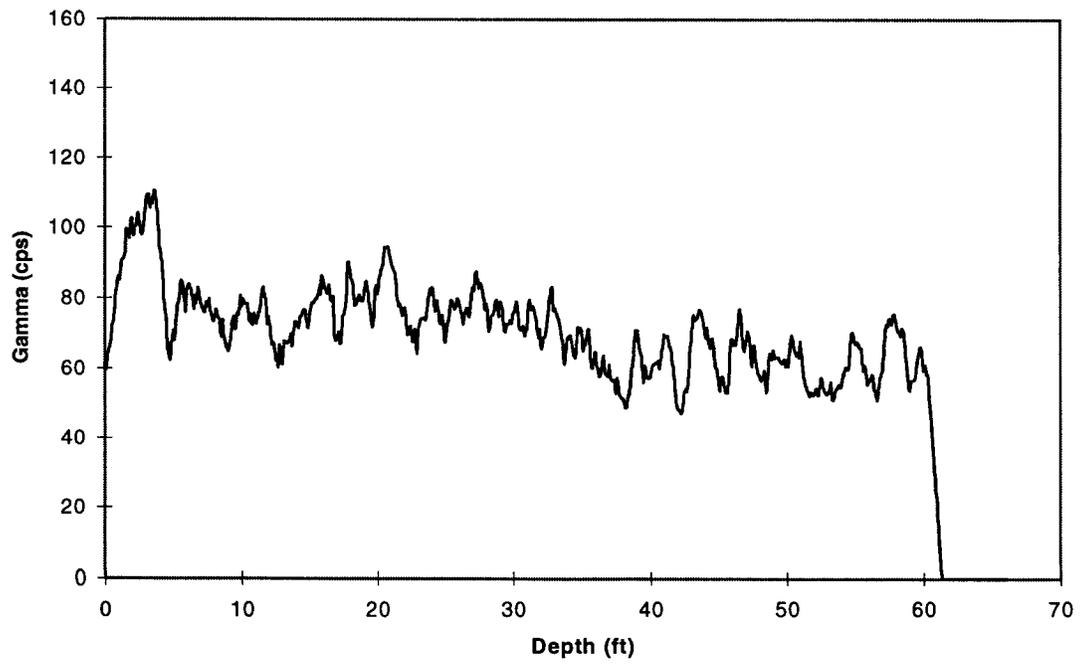
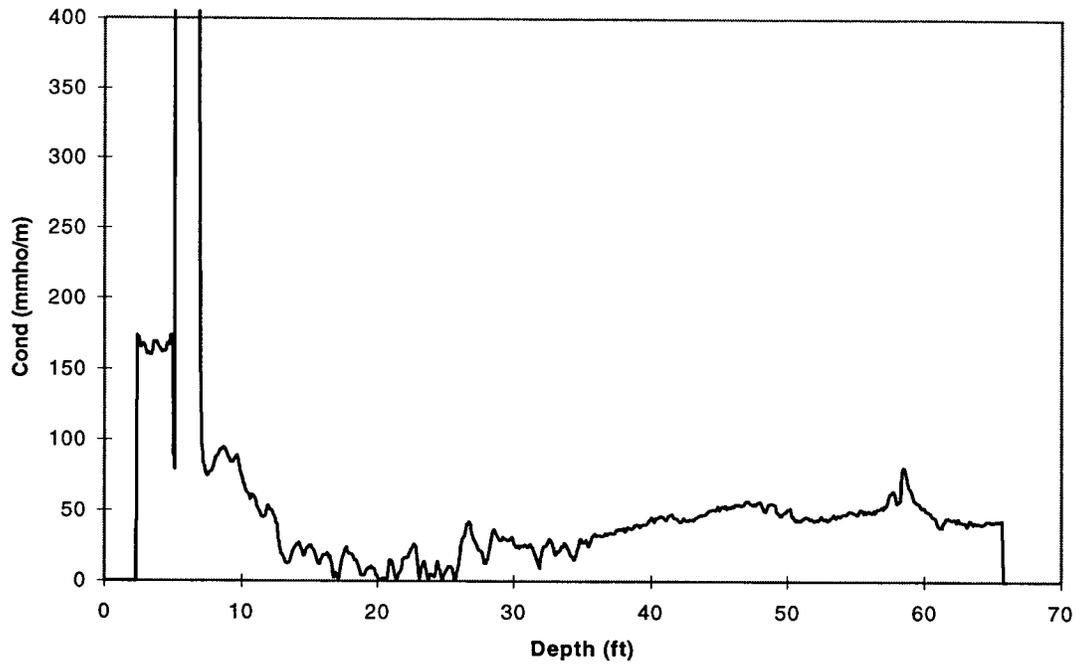
EB253C



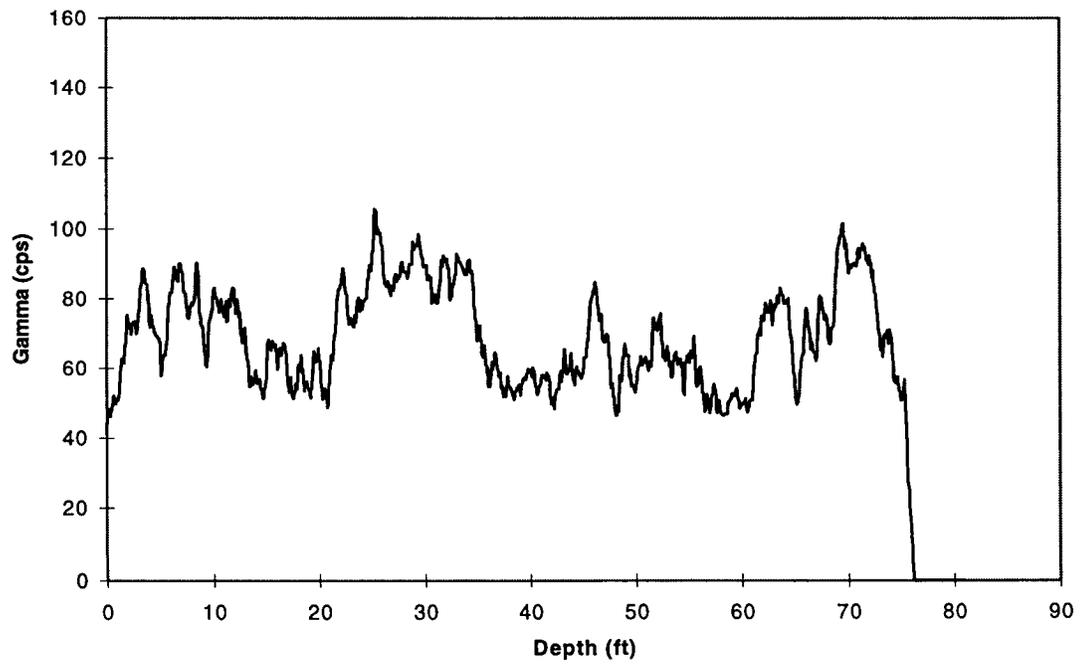
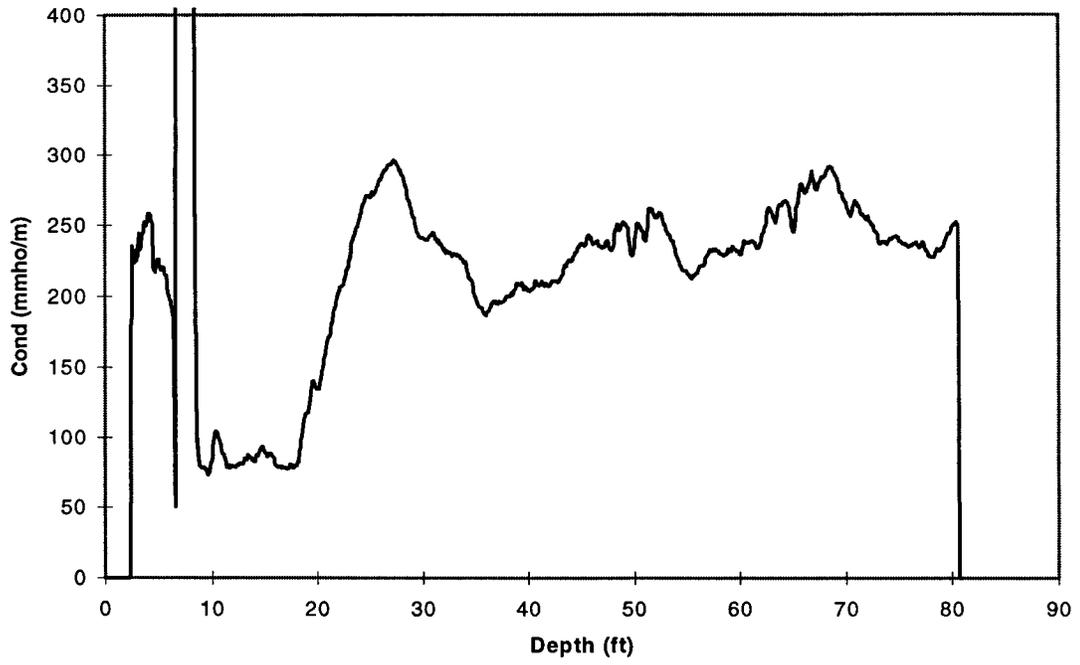
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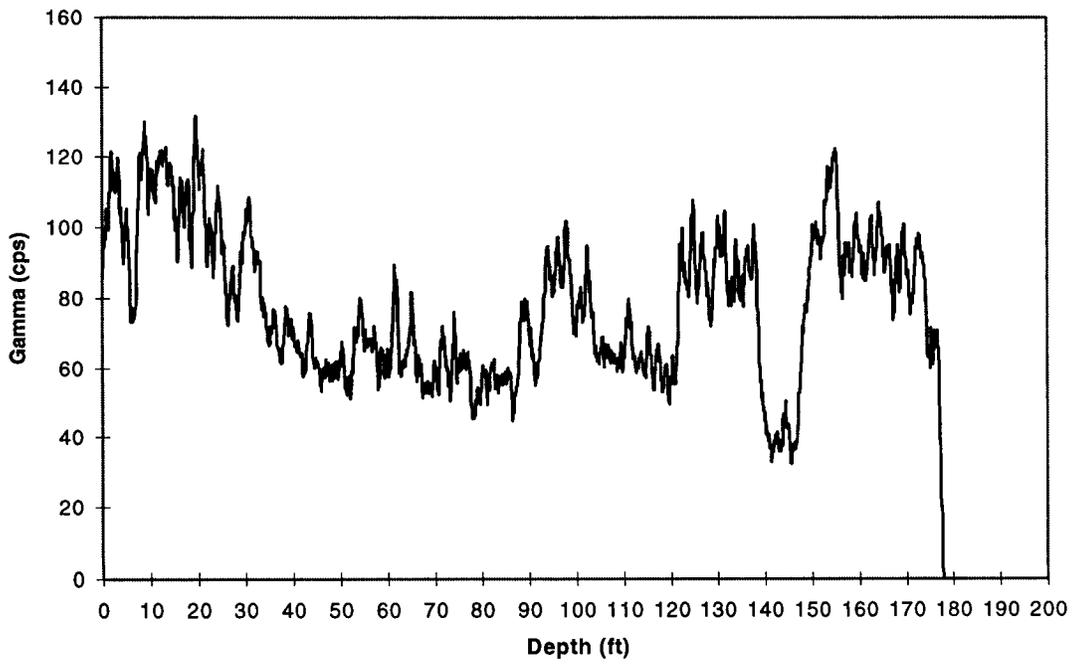
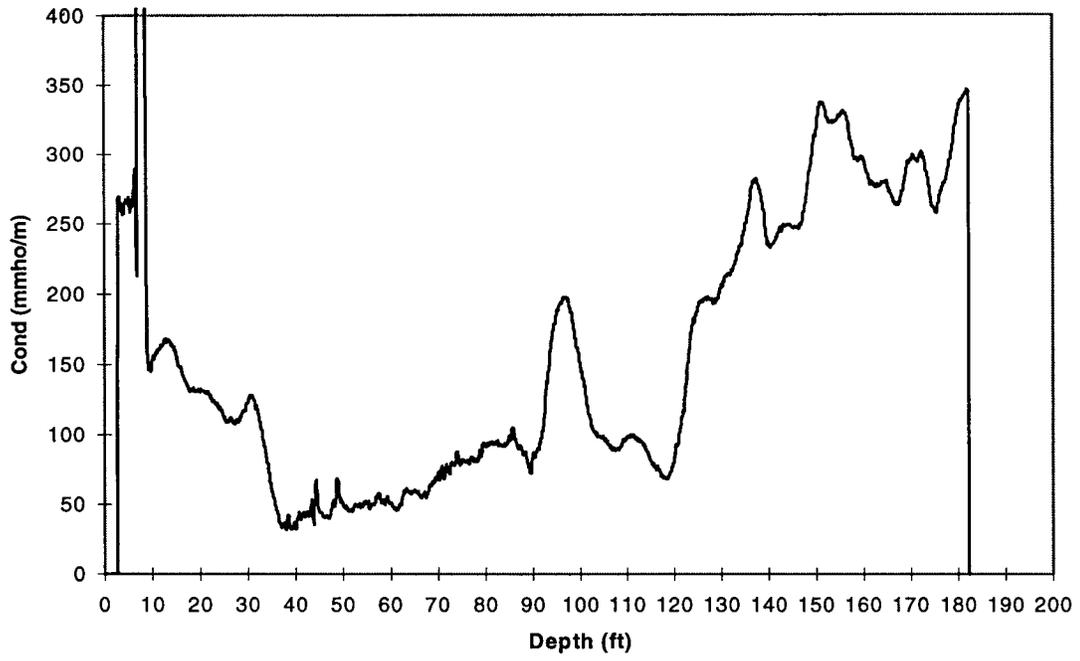
### EB255C



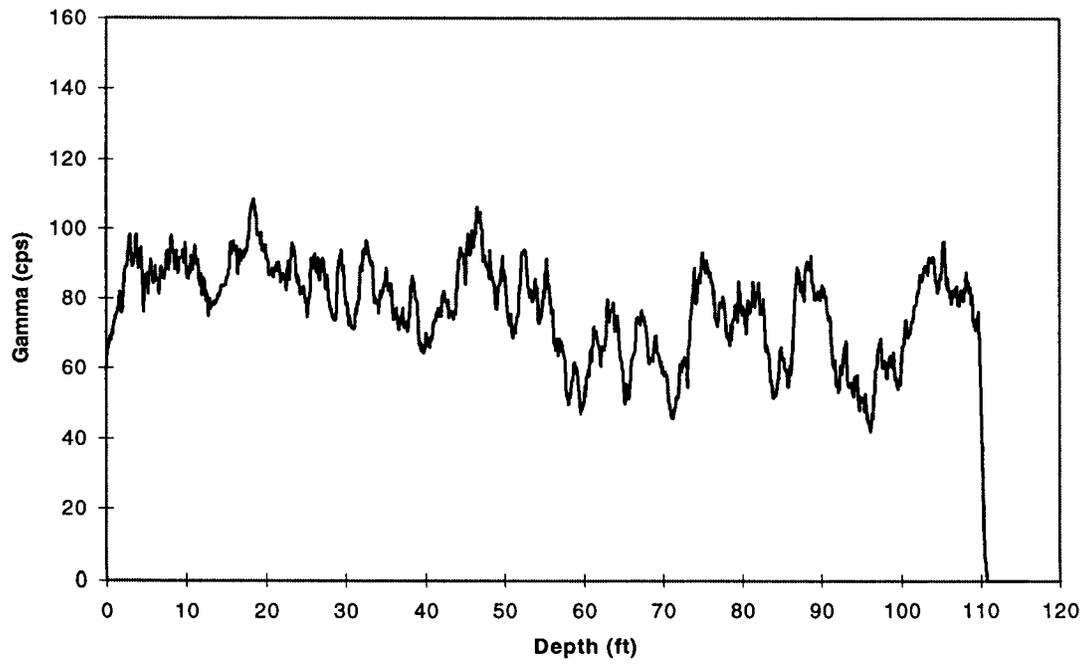
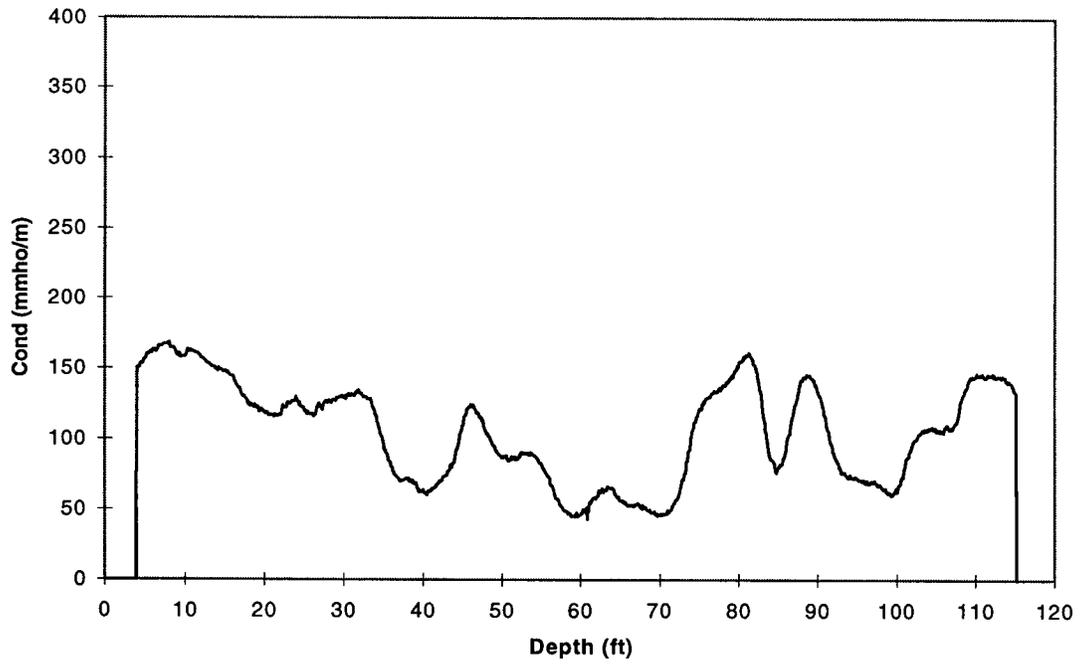
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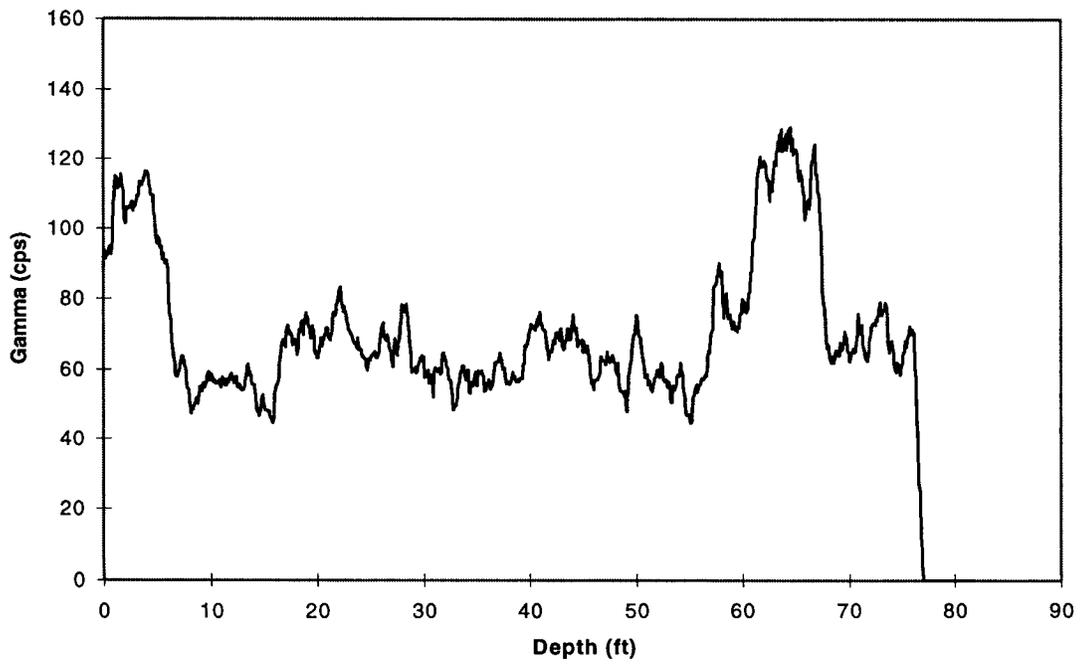
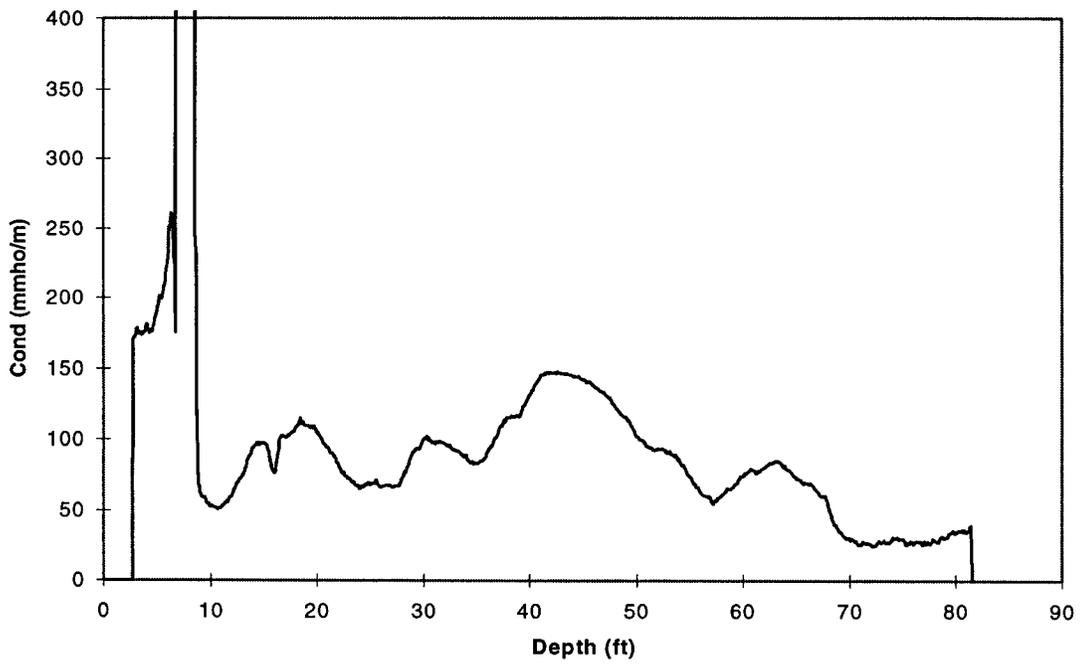
EB257C



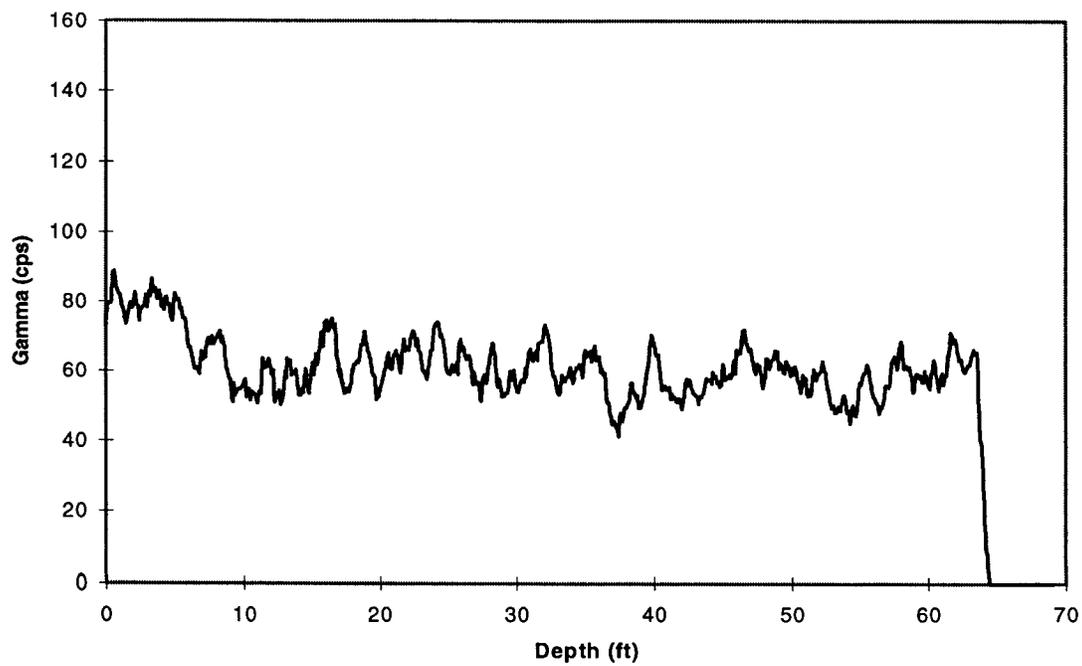
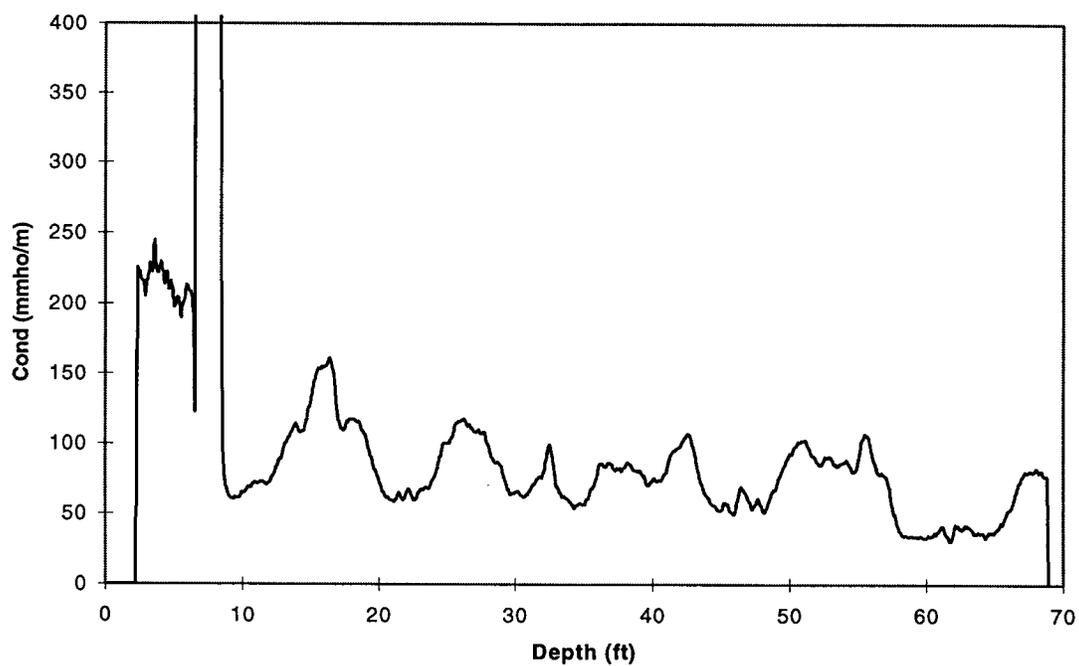
**EB258B**



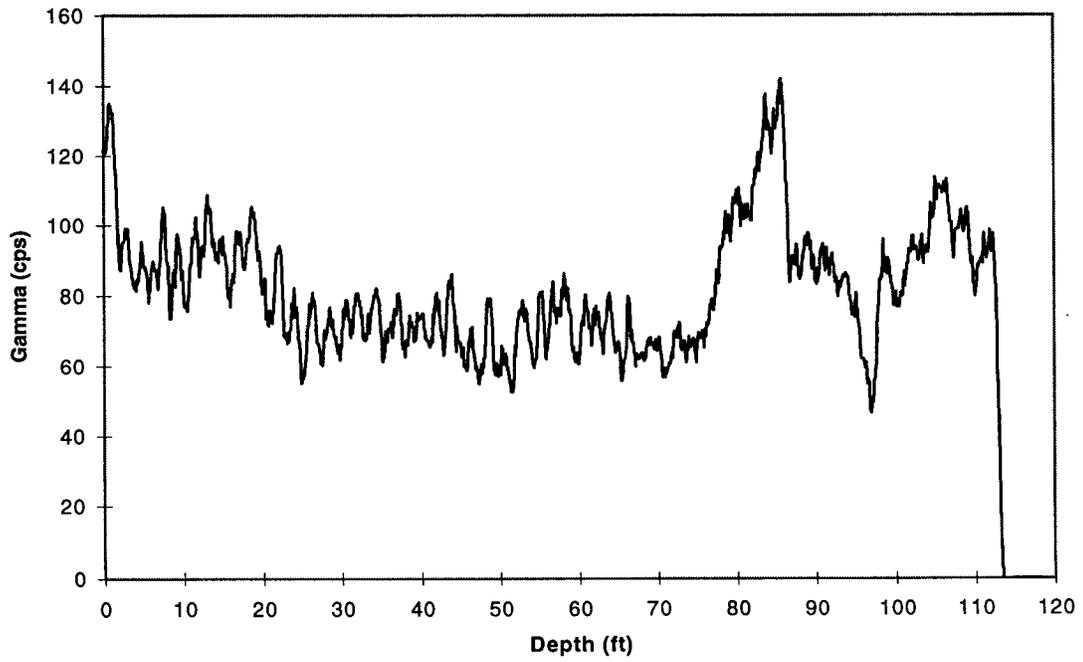
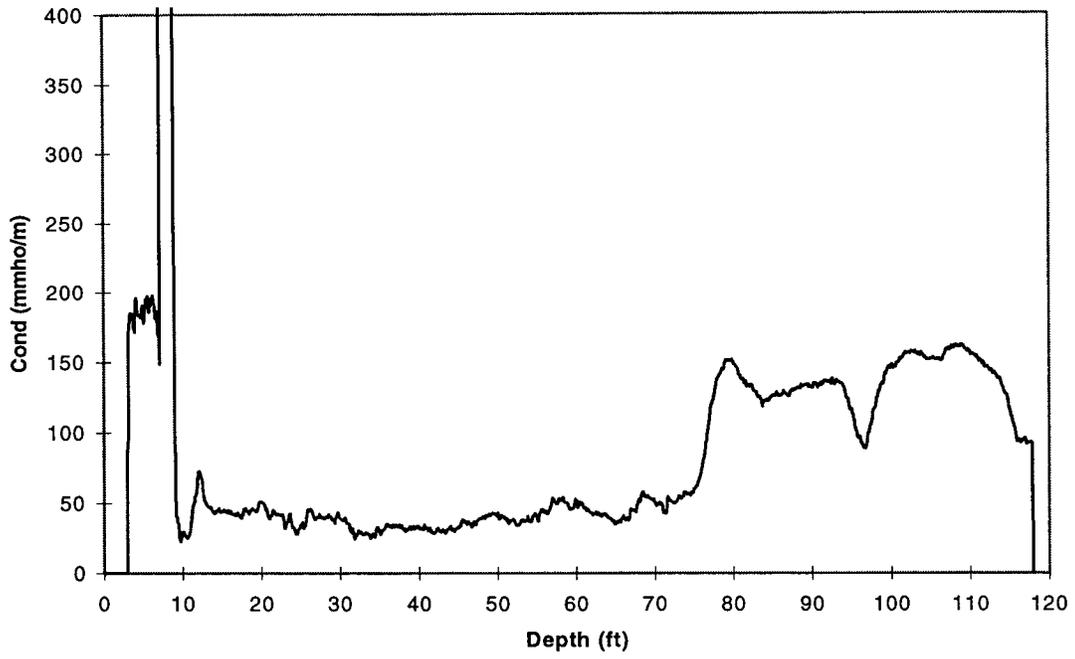
**EB259B**



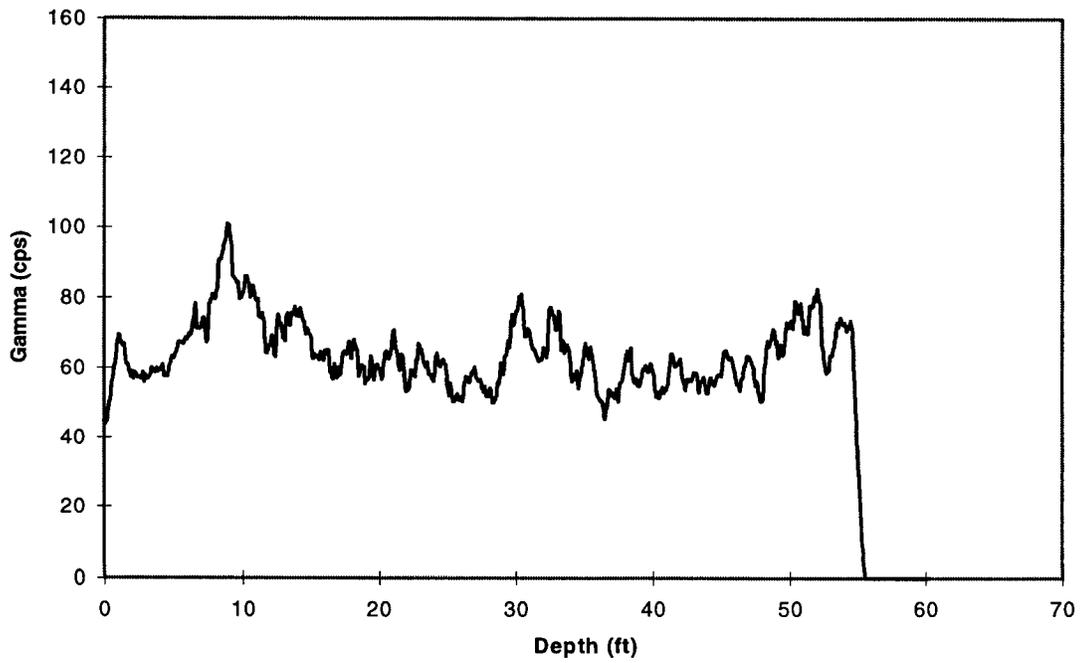
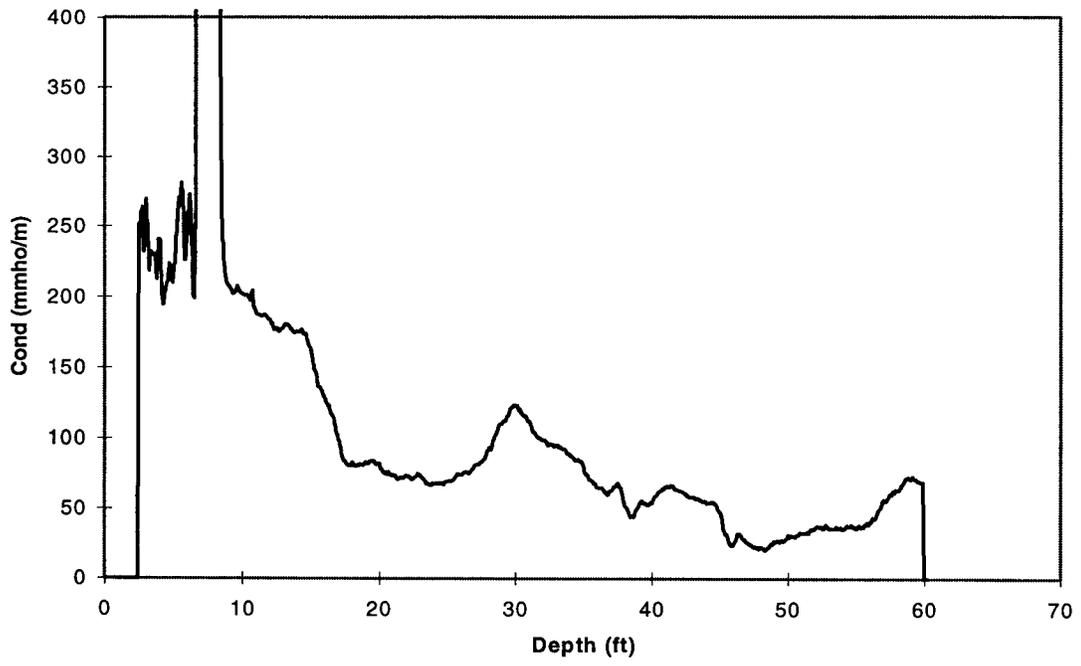
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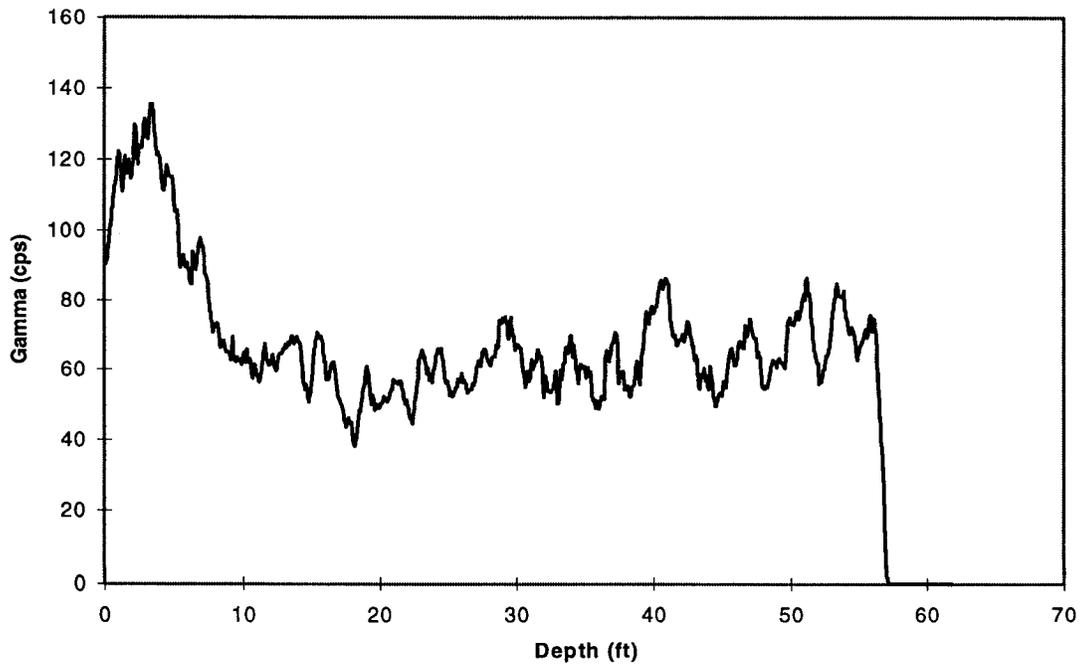
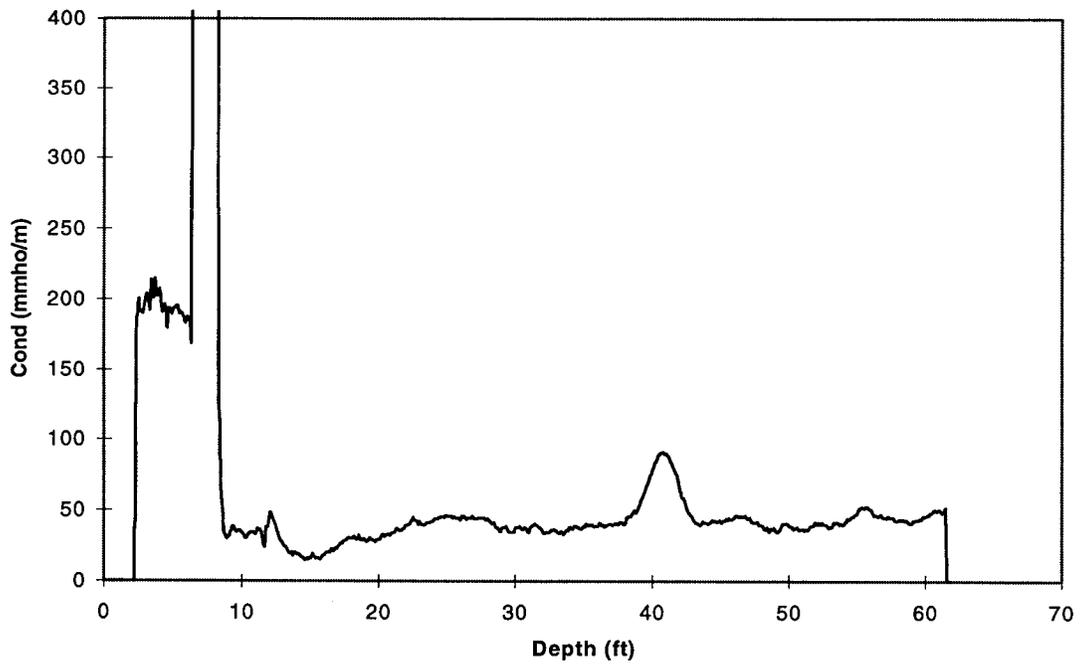
# EB261C



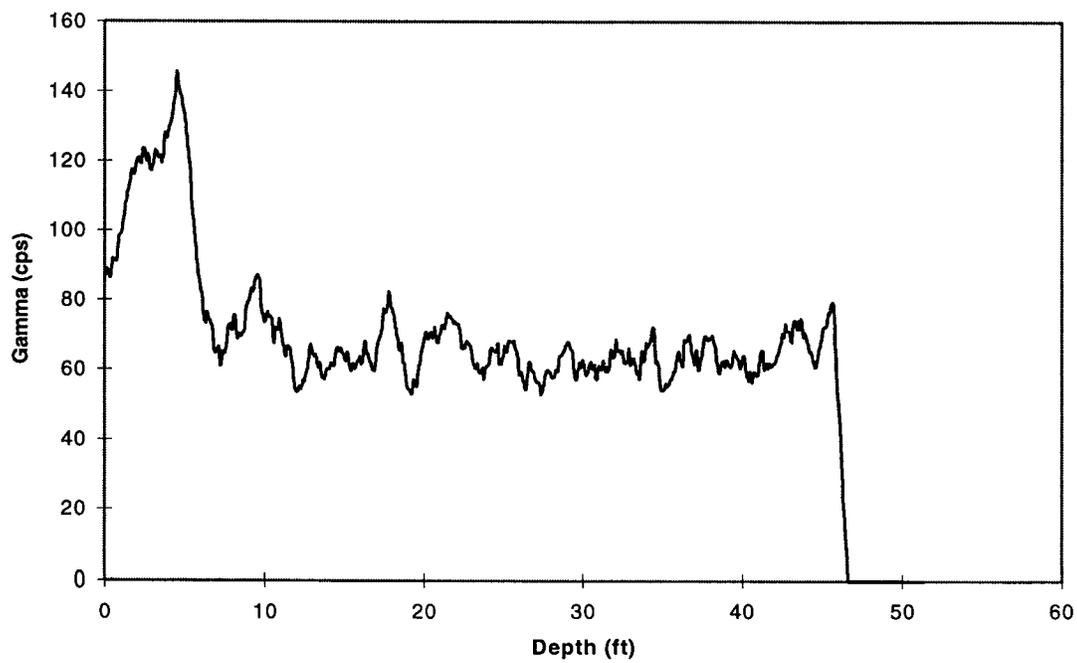
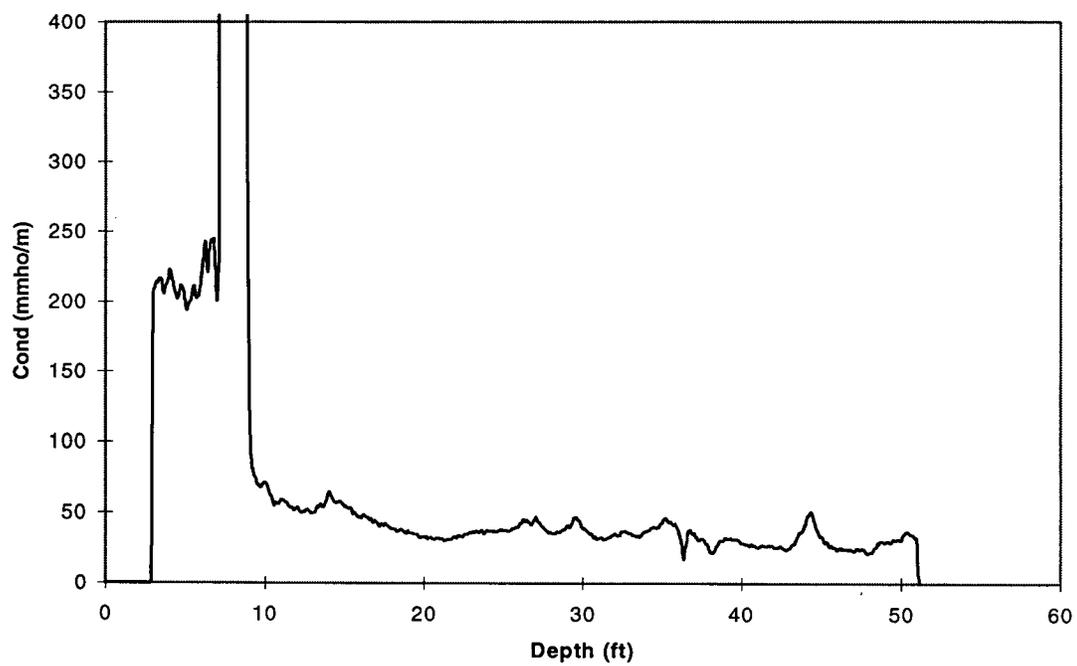
EB262C



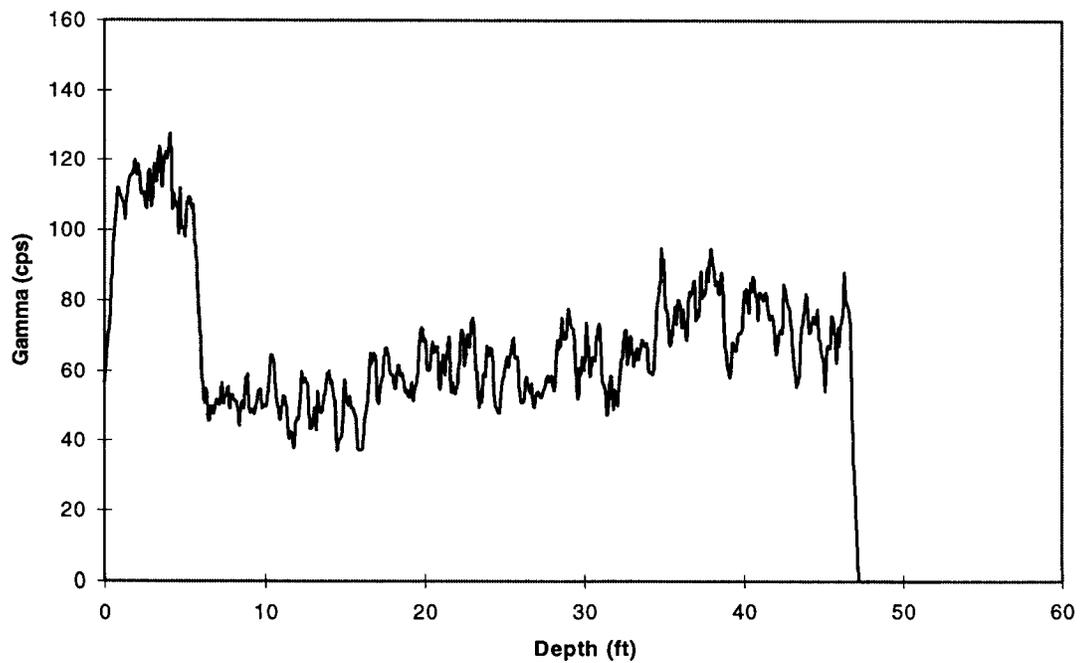
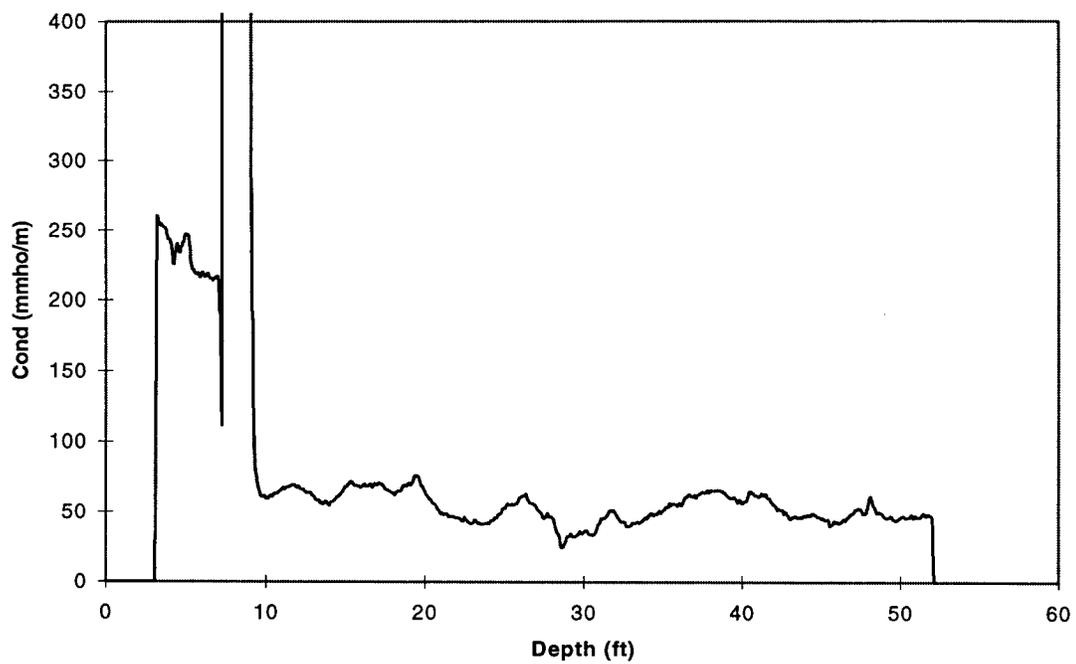
### EB263C



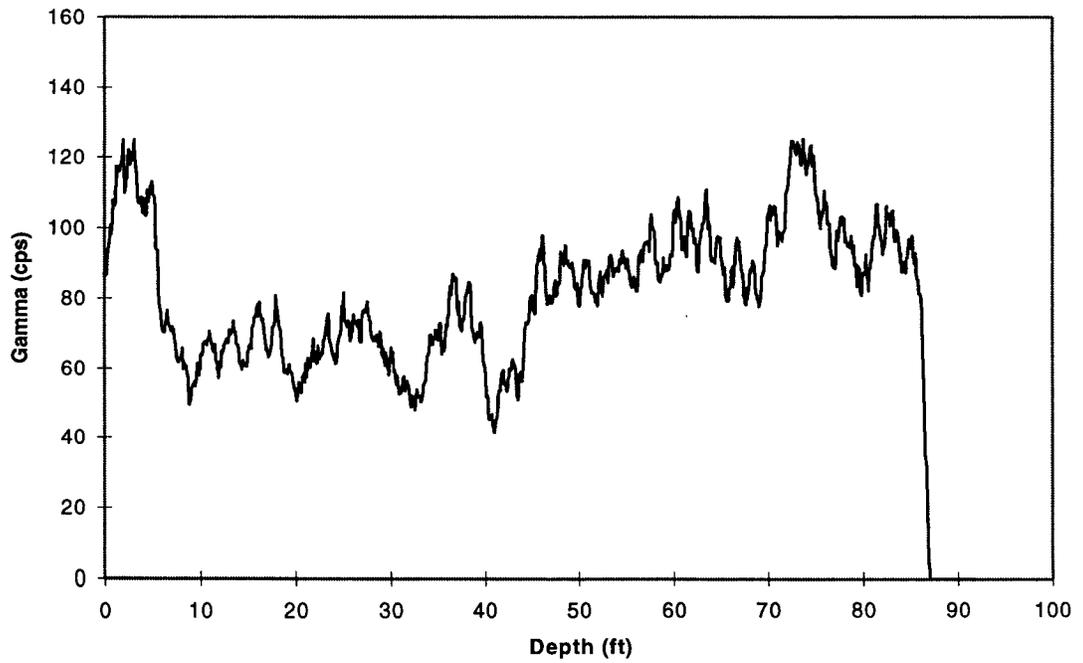
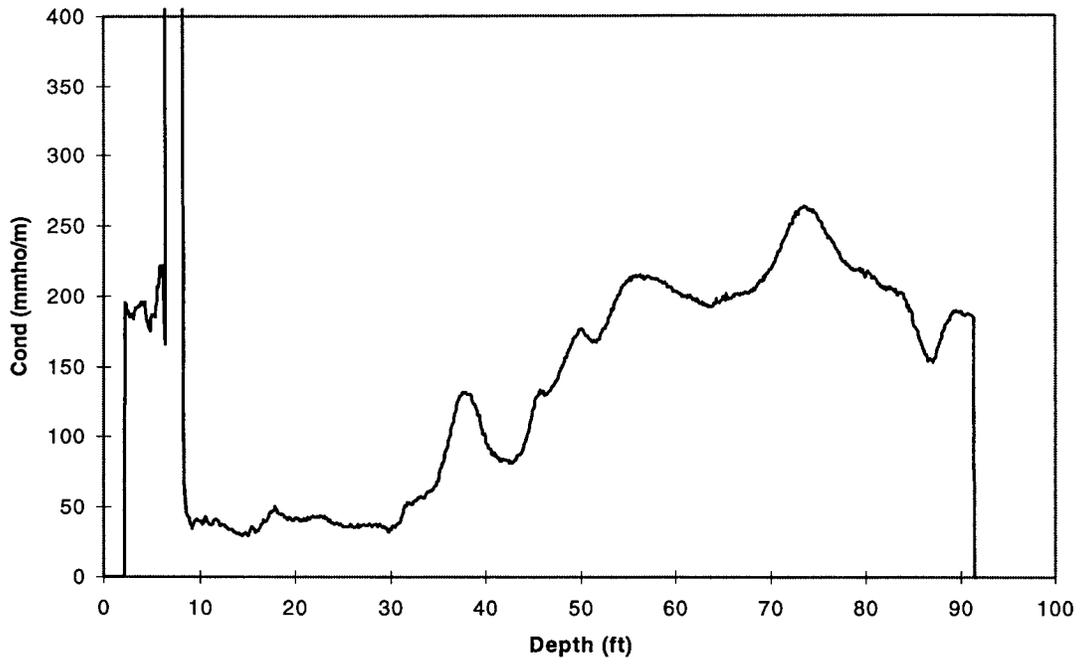
### EB264C



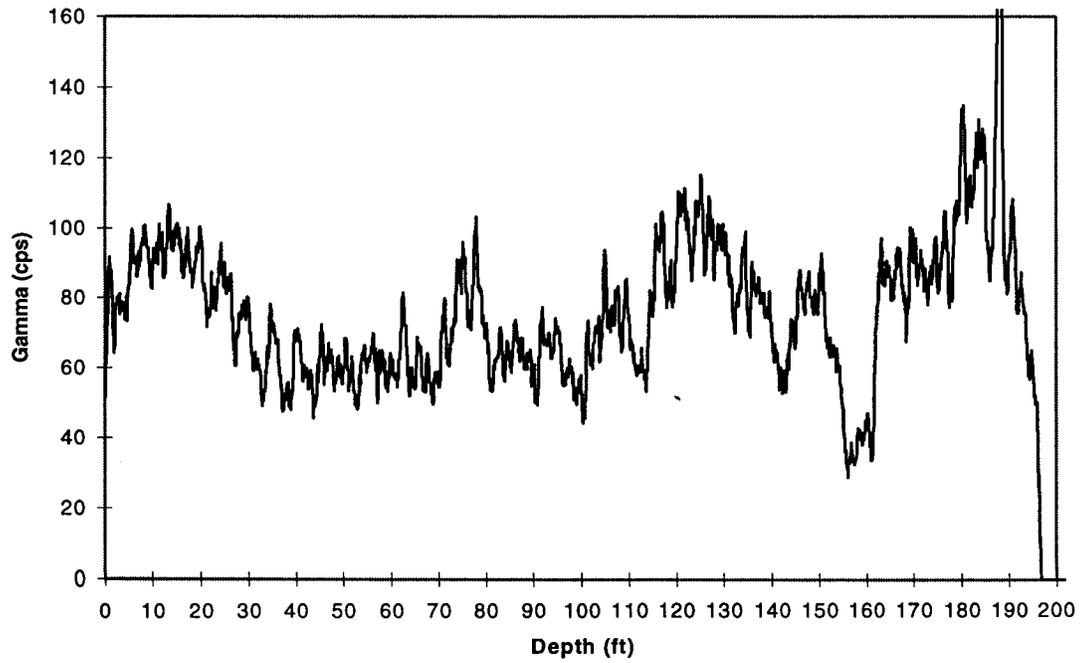
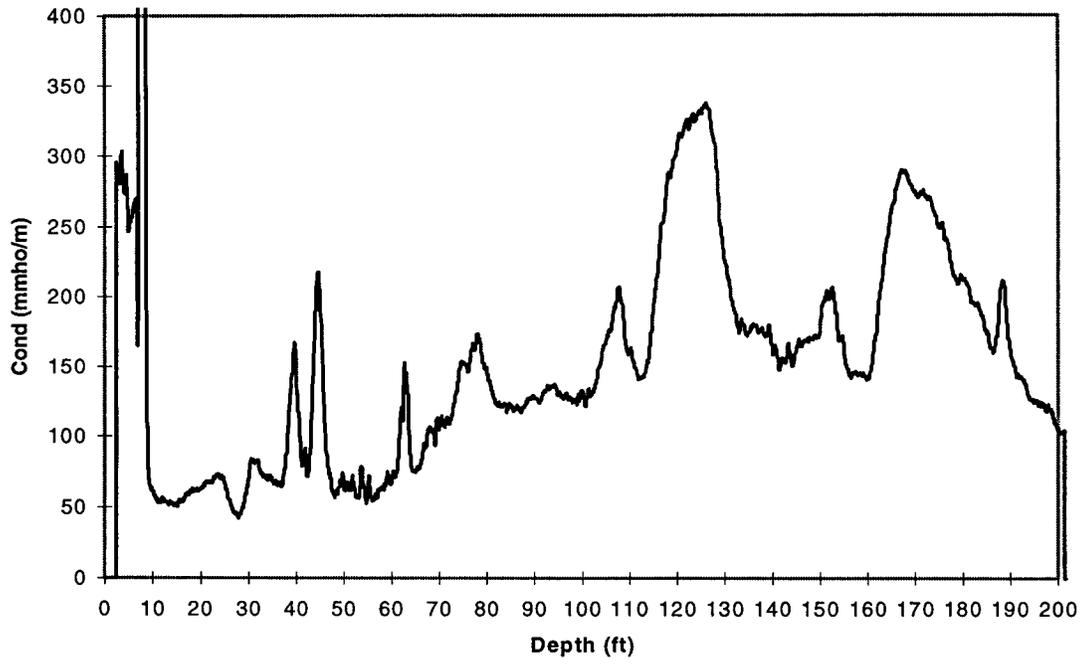
### EB265C



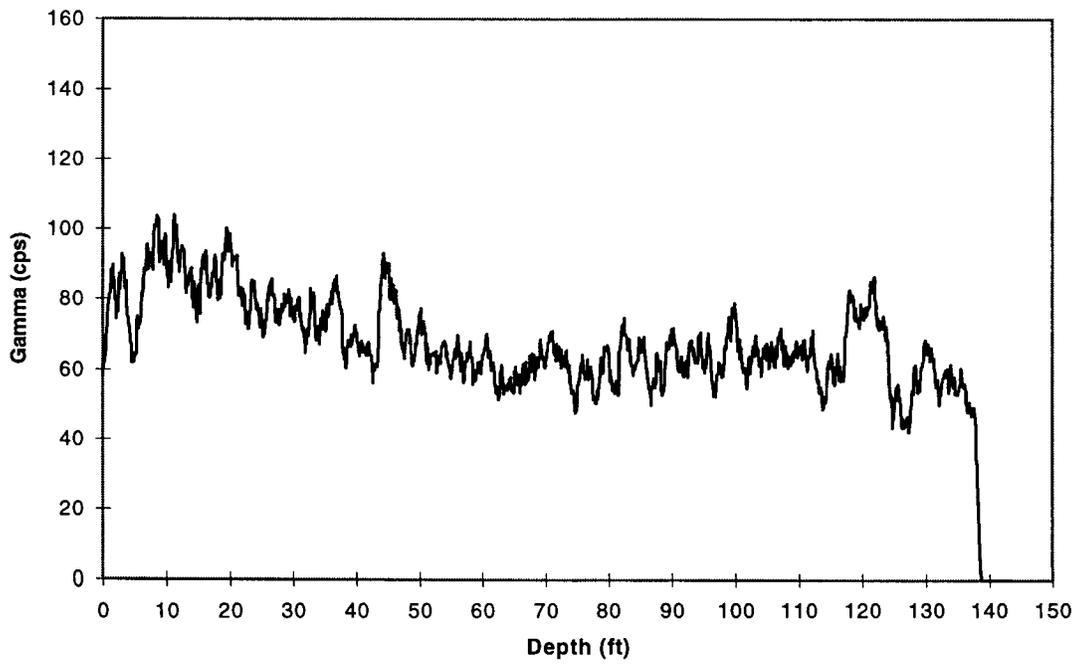
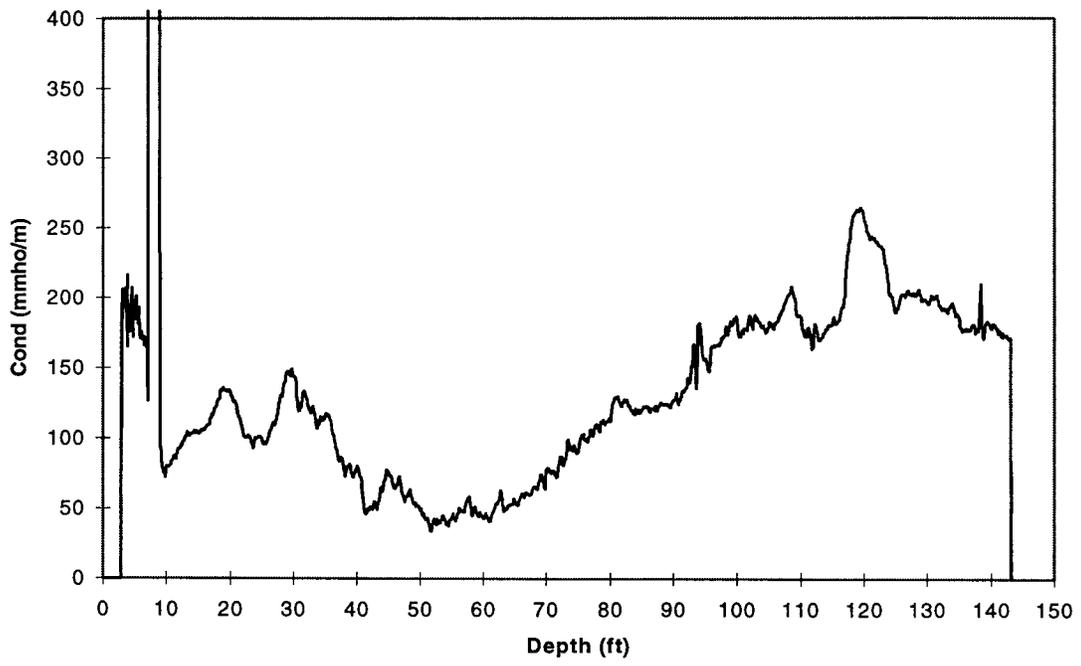
EB266B



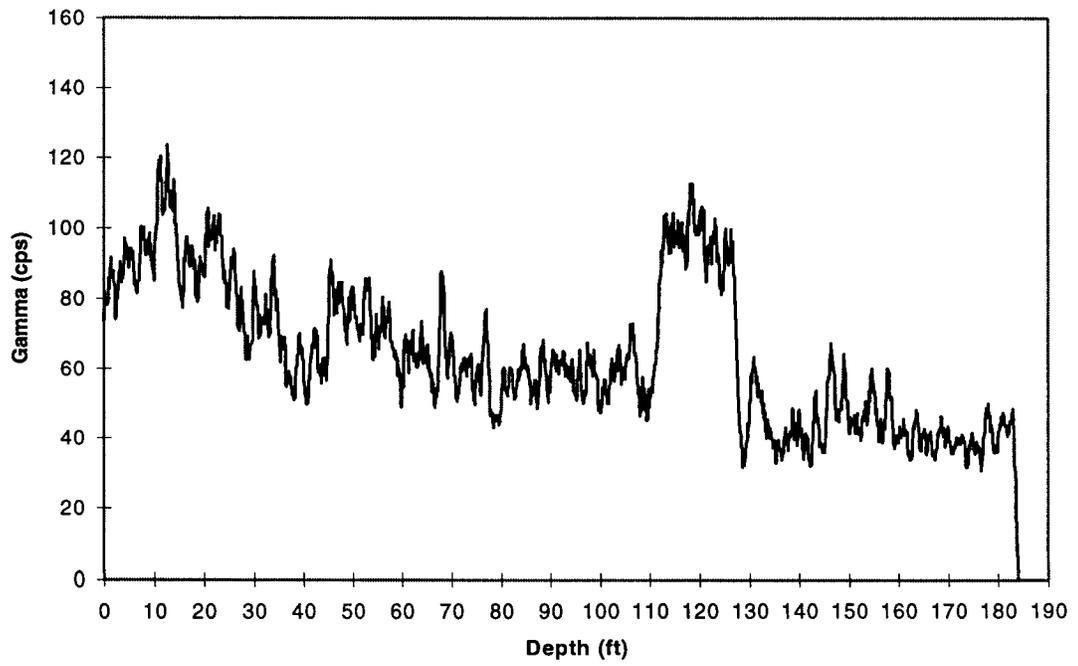
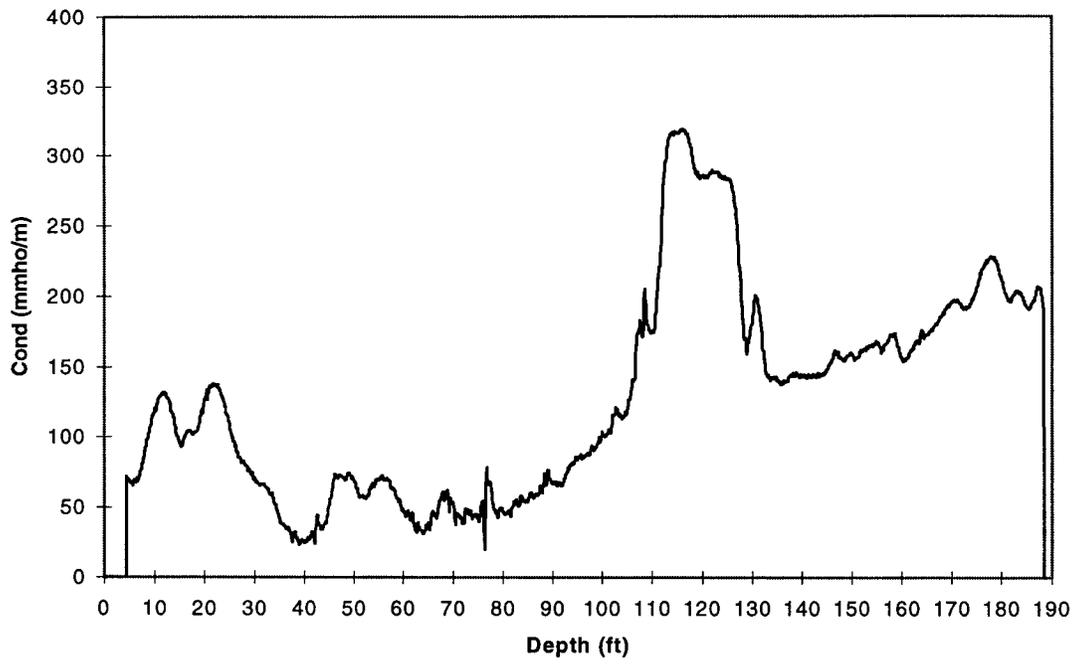
EB267C



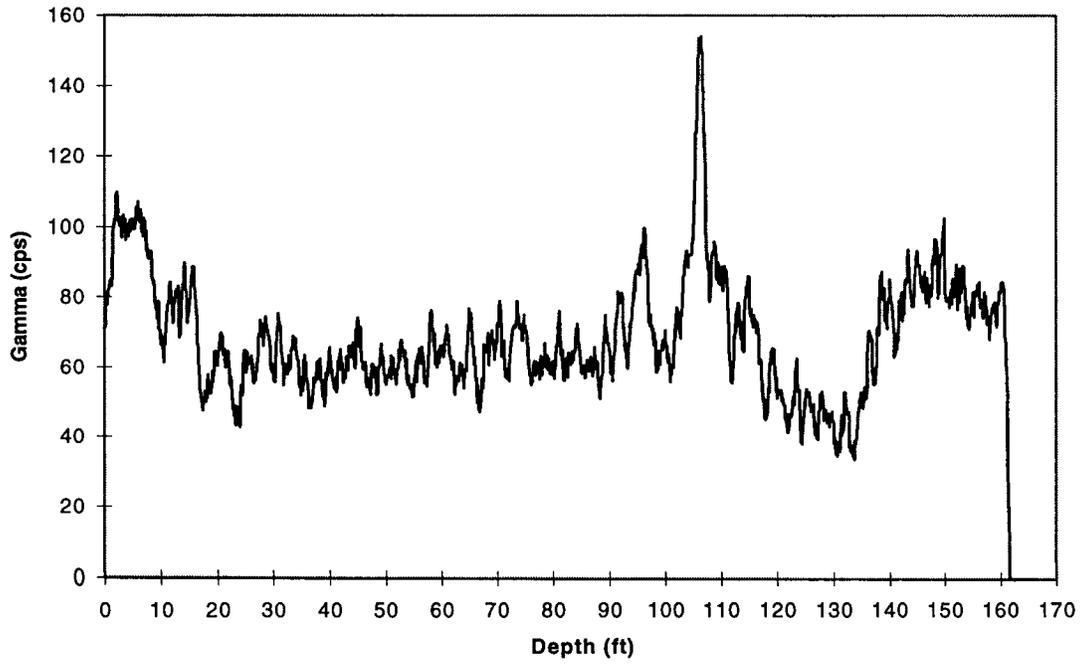
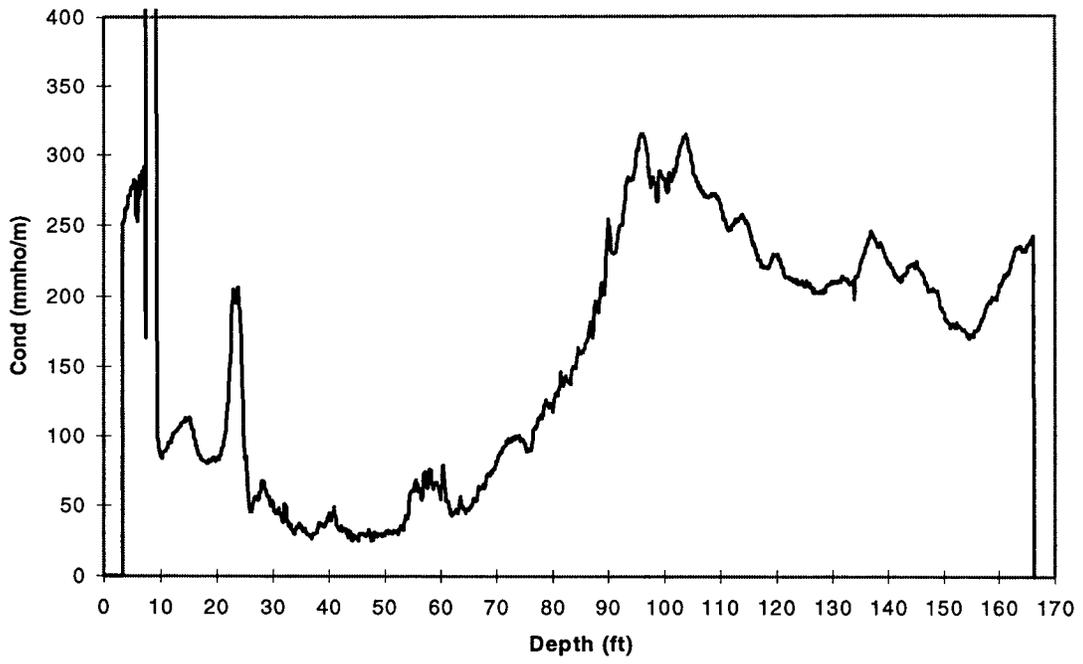
# EB268C



### EB269C



EB270C



## **Appendix C**

**Summary of Field Data for Water Samples Collected from Monitoring Wells and Stream Sites.**

Summary of Field Data for Water Samples Collected from Monitoring Wells and Stream Sites for the Equus Beds Aquifer Mineral Intrusion Study. Samples were collected by Equus Beds Groundwater Management District No. 2

Site #	Sample Collection Date	Sample Collection Time	Name(s) of Sampler	Temperature		Conductivity		Pumping Rate, gpm	Minutes Pumped
				Begin	End	Begin	End		
				Degrees F		Micromhos/cm			
EB250A	3-18-97	1256	BOESE & DEALY			400	400	20	16
EB250C	3-18-97	1317	BOESE & DEALY			520	480	20	16
EB251A	3-18-97	1420	BOESE & DEALY			370	310	2	22
EB251C	3-18-97	1439	BOESE & DEALY			310	280	3	15
EB252A	3-18-97	1509	BOESE & DEALY			760	760	25	15
EB252C	3-18-97	1523	BOESE & DEALY			760	740	30	11
EB270AA	3-19-97	1334	BOESE	58	58	850	830	20	15
EB270A	3-19-97	1409	BOESE	59	59	9650	9250	34	17
EB270B	3-20-97	1150	BOESE & KOCI	60	60	10840	10800	34	13
EB270C	3-20-97	1212	BOESE & KOCI	60	60	12140	13220	30	14
EB269A	3-20-97	1311	BOESE & KOCI	60	59	500	590	2	21
EB269B	3-20-97	1330	BOESE & KOCI	59	59	6400	7650	27	14
EB269C	3-20-97	1350	BOESE & KOCI	60	60	12000	13350	32	14
EB268A	3-20-97	1432	BOESE & KOCI	60	59	510	550	2	22
EB268B	3-20-97	1450	BOESE & KOCI	59	60	7480	8360	18	14
EB268C	3-20-97	1510	BOESE & KOCI	59	60	8190	9890	22	15
EB254C	3-24-97	1117	BOESE	60	60	1670	1690	27	16
EB255A	3-24-97	1204	BOESE	58	58	1040	1080	15	17
EB255C	3-24-97	1228	BOESE	58	58	2360	2370	27	15
EB261A	3-24-97	1340	BOESE	59	59	1720	1710	12	20
EB261C	3-24-97	1408	BOESE	60	60	2680	3590	8	22
EB260C	3-24-97	1444	BOESE	58	58	1260	1280	34	14
EB253C	3-25-97	1402	BOESE & KOCI	58	58	1250	1260	24	15
EB259A	3-26-97	1030	BOESE & KOCI	54	52	150	190	.25	54 SAMPLE BAILED 54 DEG.F
EB259B	2-25-97	1310	BOESE & KOCI	56	57	160	140	30	16
EB252A	3-25-97	1333	BOESE & KOCI	58	58	720	740	25	10 RE-SAMPLE
EB256A	3-25-97	1449	BOESE & KOCI	53	54	6700	7010	3	21
EB256B	3-25-97	1505	BOESE & KOCI	58	58	11480	12460	30	13

Summary of Field Data for Water Samples Collected from Monitoring Wells and Stream Sites for the Equus Beds Aquifer Mineral Intrusion Study (continued).

Site #	Sample Collection Date	Sample Collection Time	Name(s) of Sampler	Temperature		Conductivity		Pumping Rate, gpm	Minutes Pumped
				Begin	End	Begin	End		
				Degrees F		Micromhos/cm			
EB256C	3-25-97	1523	BOESE & KOCI	58	59	12050	11900	30	14
EB257A	3-26-97	1057	BOESE	58	58	3400	3580	11	19
EB257B	3-26-97	1131	BOESE	58	59	10250	10700	27	16
EB257C	3-26-97	1158	BOESE	58	60	16960	16750	27	18
EB258A	3-26-97	1302	BOESE	58	59	460	530	6	25
EB258B	3-26-97	1330	BOESE	58	58	1440	2730	5	24
EB401C	3-26-97	1420	BOESE	58	58	5500	5600	3	24
EB400C	3-26-97	1527	BOESE	58	59	11350	11350	4	27
EB262C	3-21-97	1621	DEALY	58	58	370	370	15	10
EB263C	3-21-97	1545	DEALY	58	58	1830	2210	30	10
EB264A	3-21-97	1456	DEALY	59	59	950	930	12	10
EB264C	3-21-97	1510	DEALY	58	58	870	930	30	10
EB265C	3-21-97	1407	DEALY	60	60	1930	1930	30	19
EB266A	3-21-97	1327	DEALY	60	60	3300	3050	25	10
EB266B	3-21-97	1310	DEALY	59	58	6350	6430	1	54
EB267C	3-21-97	1129	DEALY	60	60	6380	7140	30	10
EB267B	3-21-97	1110	DEALY	60	60	5300	6500	6	20
EB267A	3-21-97	1044	DEALY	60	60	2600	4580	10	15
ARK 1	3-21-97	1249	DEALY		60		3060		
COW 1	3-24-97	1458	BOESE		58		1630		
SALT 1	3-25-97	1432	KOCI		60		4590		
ARK 2	3-25-97	1540	KOCI		60		3010		
EB235A	3-28-97	1009	BOESE	57	57	850	720	12	14
EB235C	3-28-97	1038	BOESE	56	57	490	500	5	23
EB234A	3-28-97	1110	BOESE	57	58	550	610	8	16
EB234C	3-28-97	1130	BOESE	58	58	460	560	14	16
EB233A	3-28-97	1211	BOESE	57	57	530	550	4	21
EB233B	3-28-97	1233	BOESE	56	57	560	570	10	17
EB233C	3-28-97	1255	BOESE	57	58	400	390	20	15
EB240AA	3-28-97	1333	BOESE	56	58	1230	1310	6	15
EB240A	3-28-97	1351	BOESE	58	59	2970	3020	36	11
EB240B	3-28-97	1412	BOESE	58	59	4090	4080	37	12
EB240C	3-28-97	1433	BOESE	59	60	6590	10080	37	14

Summary of Field Data for Water Samples Collected from Monitoring Wells and Stream Sites for the Equus Beds Aquifer Mineral Intrusion Study (continued).

Site #	Sample Collection Date	Sample Collection Time	Name(s) of Sampler	Temperature		Conductivity		Pumping Rate, gpm	Minutes Pumped
				Begin	End	Begin	End		
				Degrees F		Micromhos/cm			
EB230AA	3-28-97	1510	BOESE	58	58	2640	2320	20	11
EB230A	3-28-97	1528	BOESE	58	58	2480	2500	28	12
EB230B	3-28-97	1547	BOESE	58	58	2500	3200	32	12
EB230C	3-28-97	1610	BOESE	58	59	2160	2450	14	17
EB232C	3-31-97	1058	BOESE	59	59	3180	3270	35	15
EB231A	3-31-97	1145	BOESE	54	56	2130	1690	15	14
EB231B	3-31-97	1202	BOESE	57	58	1900	2210	22	12
EB231C	3-31-97	1220	BOESE	58	58	3260	3440	25	12
EB239A	3-31-97	1258	BOESE	59	59	2510	3670	11	13
EB239C	3-31-97	1317	BOESE	58	58	3630	4030	17	13
EB248A	3-31-97	1420	BOESE	58	58	450	440	23	20
EB248B	3-31-97	1439	BOESE	58	59	480	1110	31	11
EB248C	3-31-97	1458	BOESE	58	59	11060	19240	26	13
EB229A	3-31-97	1540	BOESE	57	58	2220	2150	20	11
EB229B	3-31-97	1556	BOESE	58	58	4120	4300	35	12
EB229C	3-31-97	1613	BOESE	58	59	5710	9120	12	38
EB228A	3-31-97	1644	BOESE	55	56	2410	520	7	14
EB228B	3-31-97	1700	BOESE	58	58	340	320	30	11
EB228C	3-31-97	1716	BOESE	58	58	270	270	30	12
EB232A RE-SAMPLED	4-02-97	1308	BOESE	58	59	270	290	26	11
EB232B RE-SAMPLED	4-02-97	1327	BOESE	58	59	1690	1740	31	12
ARK 3 RE-SAMPLED	4-02-97	1342	BOESE		59		2410		
COW 2 RE-SAMPLED	4-02-97	1358	BOESE		62		1970		

## **Appendix D**

**Kansas Geological Survey Lab and Project Numbers for Samples Collected in March and April, 1997 from EB Monitoring Wells and Stream Sites.**

<b>KGS Lab number</b>	<b>Project number</b>	<b>Sample ID</b>	<b>KGS Lab number</b>	<b>Project number</b>	<b>Sample ID</b>
970050	EBMI-001	EB250A	970092	EBMI-043	EB267C
970051	EBMI-002	EB250C	970093	EBMI-044	EB267B
970052	EBMI-003	EB251A	970094	EBMI-045	EB267A
970053	EBMI-004	EB251C	970095	EBMI-046	ARK 1
970054	EBMI-005	EB252C	970096	EBMI-047	COW 1
970055	EBMI-006	EB270AA	970097	EBMI-048	SALT 1
970056	EBMI-007	EB270A	970098	EBMI-049	ARK 2
970057	EBMI-008	EB270B	970100	EBMI-050	EB235A
970058	EBMI-009	EB270C	970101	EBMI-051	EB235C
970059	EBMI-010	EB269A	970102	EBMI-052	EB234A
970060	EBMI-011	EB269B	970103	EBMI-053	EB234C
970061	EBMI-012	EB269C	970104	EBMI-054	EB233A
970062	EBMI-013	EB268A	970105	EBMI-055	EB233B
970063	EBMI-014	EB268B	970106	EBMI-056	EB233C
970064	EBMI-015	EB268C	970107	EBMI-057	EB240AA
970065	EBMI-016	EB254C	970108	EBMI-058	EB240A
970066	EBMI-017	EB255A	970109	EBMI-059	EB240B
970067	EBMI-018	EB255C	970110	EBMI-060	EB240C
970068	EBMI-019	EB261A	970111	EBMI-061	EB230AA
970069	EBMI-020	EB261C	970112	EBMI-062	EB230A
970070	EBMI-021	EB260C	970113	EBMI-063	EB230B
970071	EBMI-022	EB253C	970114	EBMI-064	EB230C
970072	EBMI-023	EB259A	970115	EBMI-065	EB232C
970073	EBMI-024	EB259B	970116	EBMI-066	EB231A
970074	EBMI-025	EB252A	970117	EBMI-067	EB231B
970075	EBMI-026	EB256A	970118	EBMI-068	EB231C
970076	EBMI-027	EB256B	970119	EBMI-069	EB239A
970077	EBMI-028	EB256C	970120	EBMI-070	EB239C
970078	EBMI-029	EB257A	970121	EBMI-071	EB248A
970079	EBMI-030	EB257B	970122	EBMI-072	EB248B
970080	EBMI-031	EB257C	970123	EBMI-073	EB248C
970081	EBMI-032	EB258A	970124	EBMI-074	EB229A
970082	EBMI-033	EB258B	970125	EBMI-075	EB229B
970083	EBMI-034	EB401C	970126	EBMI-076	EB229C
970084	EBMI-035	EB400C	970127	EBMI-077	EB228A
970085	EBMI-036	EB262C	970128	EBMI-078	EB228B
970086	EBMI-037	EB263C	970129	EBMI-079	EB228C
970087	EBMI-038	EB264A	970130	EBMI-080	EB232A
970088	EBMI-039	EB264C	970131	EBMI-081	EB232B
970089	EBMI-040	EB265C	970132	EBMI-082	ARK3
970090	EBMI-041	EB266A	970133	EBMI-083	COW2
970091	EBMI-042	EB266B			

## **Appendix E**

**Chemical Data for Water Samples Collected in March and April, 1997 from EB  
Monitoring Wells and Stream Sites.**

Location, Sample Collection, and Major Constituent Concentrations for Equus Beds Monitoring Wells

Well ID	CO	Location	Sample date	Sample time	Lab Sp.C.	T.D.S. mg/L	Lab pH	SiO2 mg/L	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	HCO3 mg/L	SO4 mg/L	Cl mg/L	NO3-N mg/L
Wells within the Equus Beds Aquifer Mineral Intrusion Study area																
EB250A	RN	23-04W-19BAA	3/18/97	1256	362	236	7.10	29.9	32.9	8.18	25.4	1.56	108	40.9	24.2	4.43
EB250C	RN	23-04W-19BAA	3/18/97	1317	448	286	7.05	30.1	42.0	10.3	28.8	1.71	113	56.8	33.7	6.01
EB251A	RN	22-06W-14DDD	3/18/97	1420	278	196	7.20	36.2	32.7	4.73	12.4	1.73	73.4	33.8	14.7	5.38
EB251C	RN	22-06W-14DDD	3/18/97	1439	255	179	7.95	33.6	37.1	4.31	8.86	1.24	123	13.8	5.4	3.14
EB252A	RN	22-06W-27AAA	3/25/97	1333	725	443	7.80	18.8	66.4	14.5	66.6	2.16	293	90.2	34.0	1.13
EB252C	RN	22-06W-27AAA	3/18/97	1523	705	429	7.85	18.0	59.2	13.2	71.6	2.35	284	83.0	36.0	0.95
EB253C	RN	22-06W-27CD	3/25/97	1402	1230	719	8.05	18.6	100	18.6	123	3.48	267	125	184	2.94
EB254C	RN	23-06W-05AAA	3/24/97	1117	1670	1051	8.00	17.1	119	22.6	214	3.98	310	205	223	20.92
EB255A	RN	23-06W-05ACC	3/24/97	1204	1065	668	8.05	17.1	105	24.7	86.5	4.16	332	134	82.2	11.07
EB255C	RN	23-06W-05ACC	3/24/97	1228	2350	1370	8.05	16.5	149	30.7	291	4.99	255	250	489	2.48
EB256A	RN	23-07W-12ADA	3/25/97	1449	7065	3987	8.00	22.0	181	38.1	1261	4.89	352	253	2046	1.22
EB256B	RN	23-07W-12ADA	3/25/97	1505	11940	6957	7.80	20.3	230	58.6	2290	7.19	274	430	3782	<0.02
EB256C	RN	23-07W-12ADA	3/25/97	1523	11980	6938	7.95	21.0	237	62.7	2287	7.50	272	433	3752	<0.02
EB257A	RN	23-07W-23AAB	3/26/97	1057	3700	2025	8.10	25.7	93.7	16.8	639	3.90	313	127	953	2.46
EB257B	RN	23-07W-23AAB	3/26/97	1131	11150	6448	7.80	26.9	298	77.5	1983	12.7	258	422	3495	0.23
EB257C	RN	23-07W-23AAB	3/26/97	1158	17720	10746	7.85	19.7	330	97.0	3710	9.07	266	701	5742	0.11
EB258A	RN	23-07W-33AAA	3/26/97	1302	609	398	8.20	28.1	89.7	7.51	33.7	1.83	308	22.3	6.4	12.65
EB258B	RN	23-07W-33AAA	3/26/97	1330	2760	1572	8.20	28.2	99.2	16.4	466	3.76	374	100	668	1.08
EB259A	RC	21-06W-33DDD	3/26/97	1030	227	147	6.60	25.9	19.5	4.51	14.3	0.53	64.5	32.0	17.6	0.07
EB259B	RC	21-06W-33DDD	2/25/97	1310	144	118	7.00	36.2	14.5	1.97	10.5	1.29	69.5	2.0	2.2	3.28
EB260C	RN	22-06W-18AAA	3/24/97	1444	1260	759	8.10	19.0	104	23.4	131	3.69	338	136	157	3.82
EB261A	RN	22-07W-26AAA	3/24/97	1340	1680	1044	8.10	17.8	122	24.3	203	4.56	331	254	223	7.00
EB261C	RN	22-07W-23DDD	3/24/97	1408	3500	2018	8.05	18.9	164	53.3	484	4.67	173	312	892	<0.02
EB262C	RC	21-06W-19AAA	3/21/97	1621	355	232	8.10	32.4	45.8	6.00	21.8	1.72	224	4.1	3.7	1.20
EB263C	RC	21-07W-35AAA	3/21/97	1545	2150	1234	7.85	21.3	151	32.6	234	5.04	270	182	454	4.00

Well ID	CO	Location	Sample date	Sample time	Lab Sp.C.	T.D.S. mg/L	Lab pH	SiO2 mg/L	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	HCO3 mg/L	SO4 mg/L	Cl mg/L	NO3-N mg/L
EB264A	RN	22-07W-03AAA	3/21/97	1456	918	560	8.00	18.3	90.3	21.1	74.9	2.81	352	97.2	63.9	3.68
EB264C	RN	22-07W-03AAA	3/21/97	1510	940	582	8.10	18.3	96.4	21.9	76.9	2.54	359	103	63.6	4.65
EB265C	RN	22-07W-04DDD	3/21/97	1407	1860	1061	8.00	16.8	113	25.4	232	3.78	317	139	359	3.07
EB266A	RN	22-07W-08DCD	3/21/97	1327	2950	1672	8.00	16.9	128	24.1	452	3.99	265	174	727	3.07
EB266B	RN	22-07W-08DCD	3/21/97	1310	6286	4205	8.10	23.4	238	63.2	1112	6.30	163	1479	1197	0.02
EB267A	RN	22-07W-17CCC	3/21/97	1044	4625	2593	8.00	26.9	193	27.5	735	2.48	293	177	1276	2.01
EB267B	RN	22-07W-17CCC	3/21/97	1110	6463	3657	8.00	30.9	314	61.1	948	3.95	238	276	1900	0.43
EB267C	RN	22-07W-17CCC	3/21/97	1129	7117	4483	8.05	28.9	251	74.4	1244	4.37	192	1046	1733	<0.02
EB268A	RN	22-07W-30BCC	3/20/97	1432	521	338	8.15	25.1	62.9	6.42	31.7	3.74	196	21.2	14.6	17.08
EB268B	RN	22-07W-30BCC	3/20/97	1450	8255	4593	7.95	16.6	140	27.0	1551	5.17	275	261	2455	0.02
EB268C	RN	22-07W-30BCC	3/20/97	1510	9715	5476	7.95	18.3	187	37.1	1836	5.94	270	331	2925	0.07
EB269A	RN	22-07W-31CCC	3/20/97	1311	578	368	8.25	27.6	62.5	5.98	53.1	1.93	280	17.0	22.1	8.88
EB269B	RN	22-07W-31CCC	3/20/97	1330	7725	4297	7.95	22.6	102	23.8	1499	4.85	288	238	2255	1.76
EB269C	RN	22-07W-31CCC	3/20/97	1350	13240	7652	7.95	22.0	197	58.6	2633	6.93	277	475	4117	0.45
EB270AA	RN	23-07W-18BBB	3/19/97	1334	867	525	8.20	24.3	59.4	6.11	111	8.02	313	23.2	79.4	13.37
EB270A	RN	23-07W-18BBB	3/19/97	1409	9325	5270	7.95	25.8	160	42.0	1810	6.75	293	312	2765	0.36
EB270B	RN	23-07W-18BBB	3/20/97	1150	10650	6185	8.00	26.9	214	53.1	2098	5.98	277	386	3258	0.72
EB270C	RN	23-07W-18BBB	3/20/97	1212	13710	7615	7.95	25.8	273	71.4	2527	7.37	265	491	4082	0.72
EB400C	RN	23-07W-02CCCC	3/26/97	1527	11050	6398	8.20	22.8	198	50.8	2154	6.84	272	384	3442	0.47
EB401C	RN	23-07W-20AAAA	3/26/97	1420	5595	3155	8.15	25.9	172	36.4	951	2.93	303	206	1604	1.13
Wells to the east of the Equus Beds Aquifer Mineral Intrusion Study area (western part of the Hutchinson to Wichita network along the Arkansas River valley)																
EB228A	RN	23-04W-30BBBB	3/31/97		810									91.2	47.2	10.41
EB228B	RN	23-04W-30BBBB	3/31/97		523									74.6	37.1	0.09
EB228C	RN	23-04W-30BBBB	3/31/97		447									66.0	14.2	0.05
EB229A	RN	23-05W-25CCC	3/31/97		2490									119	591	6.10
EB229B	RN	23-05W-25CCC	3/31/97		4289									155	1213	1.45
EB229C	RN	23-05W-25CCC	3/31/97		7078	3894	7.60	19.3	558	103	711	5.29	245	154	2213	0.59

Well ID	CO	Location	Sample date	Sample time	Lab Sp.C.	T.D.S. mg/L	Lab pH	SiO2 mg/L	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	HCO3 mg/L	SO4 mg/L	Cl mg/L	NO3-N mg/L
EB230AA	RN	24-05W-2BBBB	3/28/97		2380	1334	7.95	18.2	90.0	14.4	383	3.64	303	121	552	0.11
EB230A	RN	24-05W-2BBBB	3/28/97		2530	1426	7.95	18.6	78.5	12.7	435	3.05	308	136	588	0.18
EB230B	RN	24-05W-2BBBB	3/28/97		3300	1851	7.85	19.0	147	23.8	502	4.09	279	163	852	0.09
EB230C	RN	24-05W-2BBBB	3/28/97		2550	1428	7.85	22.2	95.7	25.6	389	3.26	221	140	642	0.02
EB231A	RN	23-05W-34CCDA	3/31/97		2010	1118	8.05	11.1	116	15.9	269	4.75	287	144	414	<0.02
EB231B	RN	23-05W-34CCDA	3/31/97		2460	1402	8.00	15.5	98.1	17.4	393	3.52	273	177	561	0.09
EB231C	RN	23-05W-34CCDA	3/31/97		3710	2097	7.95	17.7	199	37.9	514	3.99	250	216	982	0.18
EB232A	RN	24-05W-9AAAD	4/2/97		530									16.3	25.4	3.70
EB232B	RN	24-05W-9AAAD	4/2/97		2090									91.7	441	0.70
EB232C	RN	24-05W-9AAAD	3/31/97		3580									171	891	0.56
EB233A	RN	24-05W-17AAAA	3/28/97		638									27.6	25.6	9.17
EB233B	RN	24-05W-17AAAA	3/28/97		640									27.4	25.1	9.06
EB233C	RN	24-05W-17AAAA	3/28/97		468									12.5	11.8	1.90
EB234A	RN	24-05W-17CCCC	3/28/97		652									14.0	24.4	2.62
EB234C	RN	24-05W-17CCCC	3/28/97		620									2.0	17.4	0.09
EB235A	RN	24-05W30BBBB	3/28/97		808									22.6	28.4	13.55
EB235C	RN	24-05W30BBBB	3/28/97		568									15.3	13.5	2.71
EB239A	RN	23-05W-28AADA	3/31/97		3800									168	1036	0.56
EB239C	RN	23-05W-28AADA	3/31/97		4039									241	1071	0.09
EB240AA	RN	24-05W-11AAAA	3/28/97		1555									84.4	328	0.02
EB240A	RN	24-05W-11AAAA	3/28/97		3130									249	788	0.29
EB240B	RN	24-05W-11AAAA	3/28/97		4128									275	1094	0.32
EB240C	RN	24-05W-11AAAA	3/28/97		9579	5439	7.85	20.6	258	70.1	1688	4.70	215	379	2908	0.29
EB248A	RN	24-06W-1AAAA	3/31/97		671									33.0	27.4	10.30
EB248B	RN	24-06W-1AAAA	3/31/97		1430									54.6	253	5.74
EB248C	RN	24-06W-1AAAA	3/31/97		12090									487	3729	0.52

Location, Sample Collection, and Minor and Selected Trace Constituent Concentrations for Equus Beds Monitoring Wells. The chloride concentration is included for reference.

Well ID	CO	Location	Sample date	Sample time	Cl mg/L	Sr mg/L	F mg/L	Br mg/L	I mg/L	B mg/L
Wells within the Equus Beds Aquifer Mineral Intrusion Study area										
EB250A	RN	23-04W-19BAA	3/18/97	1256	24.2	0.25	0.23	0.055	0.0044	0.028
EB250C	RN	23-04W-19BAA	3/18/97	1317	33.7	0.32	0.19	0.073	0.0057	0.024
EB251A	RN	22-06W-14DDD	3/18/97	1420	14.7	0.15	0.17	0.015	0.0024	<0.015
EB251C	RN	22-06W-14DDD	3/18/97	1439	5.4	0.18	0.13	0.007	0.0036	<0.015
EB252A	RN	22-06W-27AAA	3/25/97	1333	34.0	0.64	0.93	0.127	0.0043	0.063
EB252C	RN	22-06W-27AAA	3/18/97	1523	36.0	0.57	0.93	0.118	0.0062	0.048
EB253C	RN	22-06W-27CD	3/25/97	1402	184	0.85	0.69	0.234	0.0117	0.065
EB254C	RN	23-06W-05AAA	3/24/97	1117	223	0.90	0.62	0.187	0.0057	0.066
EB255A	RN	23-06W-05ACC	3/24/97	1204	82.2	0.94	0.74	0.083	0.0037	0.049
EB255C	RN	23-06W-05ACC	3/24/97	1228	489	1.24	0.48	0.206	0.0094	0.087
EB256A	RN	23-07W-12ADA	3/25/97	1449	2046	1.64	0.33	0.367	0.0075	0.127
EB256B	RN	23-07W-12ADA	3/25/97	1505	3782	2.59	0.37	0.632	0.0129	0.265
EB256C	RN	23-07W-12ADA	3/25/97	1523	3752	2.69	0.36	0.625	0.0143	0.252
EB257A	RN	23-07W-23AAB	3/26/97	1057	953	0.73	0.49	0.195	0.0071	0.085
EB257B	RN	23-07W-23AAB	3/26/97	1131	3495	3.60	0.26	0.547	0.0123	0.189
EB257C	RN	23-07W-23AAB	3/26/97	1158	5742	4.50	0.37	0.877	0.0270	0.375
EB258A	RN	23-07W-33AAA	3/26/97	1302	6.4	0.31	0.17	0.071	0.0046	<0.015
EB258B	RN	23-07W-33AAA	3/26/97	1330	668	0.68	0.32	0.186	0.0060	0.073
EB259A	RC	21-06W-33DDD	3/26/97	1030	17.6	0.15	0	0.027	0.0092	<0.015
EB259B	RC	21-06W-33DDD	2/25/97	1310	2.2	0.08	0.19	0.013	0.0021	0.022
EB260C	RN	22-06W-18AAA	3/24/97	1444	157	0.97	0.81	0.134	0.0050	0.074
EB261A	RN	22-07W-26AAA	3/24/97	1340	223	0.97	0.58	0.189	0.0044	0.134
EB261C	RN	22-07W-23DDD	3/24/97	1408	892	2.35	0.91	0.210	0.0305	0.302
EB262C	RC	21-06W-19AAA	3/21/97	1621	3.7	0.50	0.17	0.017	0.0076	0.015
EB263C	RC	21-07W-35AAA	3/21/97	1545	454	1.56	0.51	1.446	0.0122	0.051
EB264A	RN	22-07W-03AAA	3/21/97	1456	63.9	0.97	1.14	0.114	0.0031	0.045
EB264C	RN	22-07W-03AAA	3/21/97	1510	63.6	1.01	1.19	0.117	0.0034	0.047
EB265C	RN	22-07W-04DDD	3/21/97	1407	359	1.07	0.71	0.291	0.0033	0.074
EB266A	RN	22-07W-08DCD	3/21/97	1327	727	1.13	0.59	0.165	0.0049	0.091
EB266B	RN	22-07W-08DCD	3/21/97	1310	1197	4.47	0.98	0.346	0.0395	0.356
EB267A	RN	22-07W-17CCC	3/21/97	1044	1276	1.30	0.24	0.240	0.0076	0.097
EB267B	RN	22-07W-17CCC	3/21/97	1110	1900	3.38	0.24	0.342	0.0108	0.116
EB267C	RN	22-07W-17CCC	3/21/97	1129	1733	4.98	0.74	0.397	0.0579	0.626
EB268A	RN	22-07W-30BCC	3/20/97	1432	14.6	0.20	0.25	0.070	0.0080	0.020
EB268B	RN	22-07W-30BCC	3/20/97	1450	2455	1.22	0.36	0.374	0.0102	0.176
EB268C	RN	22-07W-30BCC	3/20/97	1510	2925	1.77	0.35	0.400	0.0181	0.221

Well ID	CO	Location	Sample date	Sample time	Cl mg/L	Sr mg/L	F mg/L	Br mg/L	I mg/L	B mg/L
EB269A	RN	22-07W-31CCC	3/20/97	1311	22.1	0.22	0.30	0.048	0.0024	0.033
EB269B	RN	22-07W-31CCC	3/20/97	1330	2255	1.10	0.43	0.376	0.0082	0.213
EB269C	RN	22-07W-31CCC	3/20/97	1350	4117	2.49	0.40	0.672	0.0139	0.310
EB270AA	RN	23-07W-18BBB	3/19/97	1334	79.4	0.27	0.36	0.041	0.0050	0.059
EB270A	RN	23-07W-18BBB	3/19/97	1409	2765	1.91	0.44	0.478	0.0097	0.206
EB270B	RN	23-07W-18BBB	3/20/97	1150	3258	2.50	0.37	0.546	0.0055	0.172
EB270C	RN	23-07W-18BBB	3/20/97	1212	4082	3.29	0.35	0.448	0.0108	0.248
EB400C	RN	23-07W-02CCCC	3/26/97	1527	3442	2.29	0.37	0.560	0.0102	0.275
EB401C	RN	23-07W-20AAAA	3/26/97	1420	1604	1.68	0.43	0.281	0.0070	0.112
Wells to the east of the Equus Beds Aquifer Mineral Intrusion Study area										
EB228A	RN	23-04W-30BBBB	3/31/97		47.2			0.096	0.0050	
EB228B	RN	23-04W-30BBBB	3/31/97		37.1			0.080	0.0141	
EB228C	RN	23-04W-30BBBB	3/31/97		14.2			0.061	0.0183	
EB229A	RN	23-05W-25CCC	3/31/97		591			0.469	0.0053	
EB229B	RN	23-05W-25CCC	3/31/97		1213			0.980	0.0057	
EB229C	RN	23-05W-25CCC	3/31/97		2213	4.60	0.45	1.902	0.0100	0.038
EB230AA	RN	24-05W-2BBBB	3/28/97		552	0.64	0.57	0.520	0.0243	0.082
EB230A	RN	24-05W-2BBBB	3/28/97		588	0.57	0.70	0.531	0.0226	0.098
EB230B	RN	24-05W-2BBBB	3/28/97		852	1.10	0.59	0.681	0.0218	0.109
EB230C	RN	24-05W-2BBBB	3/28/97		642	0.93	0.39	0.302	0.0098	0.075
EB231A	RN	23-05W-34CCDA	3/31/97		414	0.86	0.80	0.422	0.0111	0.077
EB231B	RN	23-05W-34CCDA	3/31/97		561	0.77	0.73	0.445	0.0138	0.090
EB231C	RN	23-05W-34CCDA	3/31/97		982	1.61	0.53	0.676	0.0167	0.051
EB232A	RN	24-05W-9AAAD	4/2/97		25.4			0.026	0.0030	
EB232B	RN	24-05W-9AAAD	4/2/97		441			0.083	0.0134	
EB232C	RN	24-05W-9AAAD	3/31/97		891			0.176	0.0145	
EB233A	RN	24-05W-17AAAA	3/28/97		25.6			0.073	0.0027	
EB233B	RN	24-05W-17AAAA	3/28/97		25.1			0.071	0.0034	
EB233C	RN	24-05W-17AAAA	3/28/97		11.8			0.026	0.0028	
EB234A	RN	24-05W-17CCCC	3/28/97		24.4			0.089	0.0136	
EB234C	RN	24-05W-17CCCC	3/28/97		17.4			0.033	0.0603	
EB235A	RN	24-05W30BBBB	3/28/97		28.4			0.124	0.0032	
EB235C	RN	24-05W30BBBB	3/28/97		13.5			0.049	0.0017	
EB239A	RN	23-05W-28AADA	3/31/97		1036			0.848	0.0190	
EB239C	RN	23-05W-28AADA	3/31/97		1071			0.819	0.0233	
EB240AA	RN	24-05W-11AAAA	3/28/97		328			0.126	0.0135	
EB240A	RN	24-05W-11AAAA	3/28/97		788			0.301	0.0051	
EB240B	RN	24-05W-11AAAA	3/28/97		1094			0.387	0.0070	

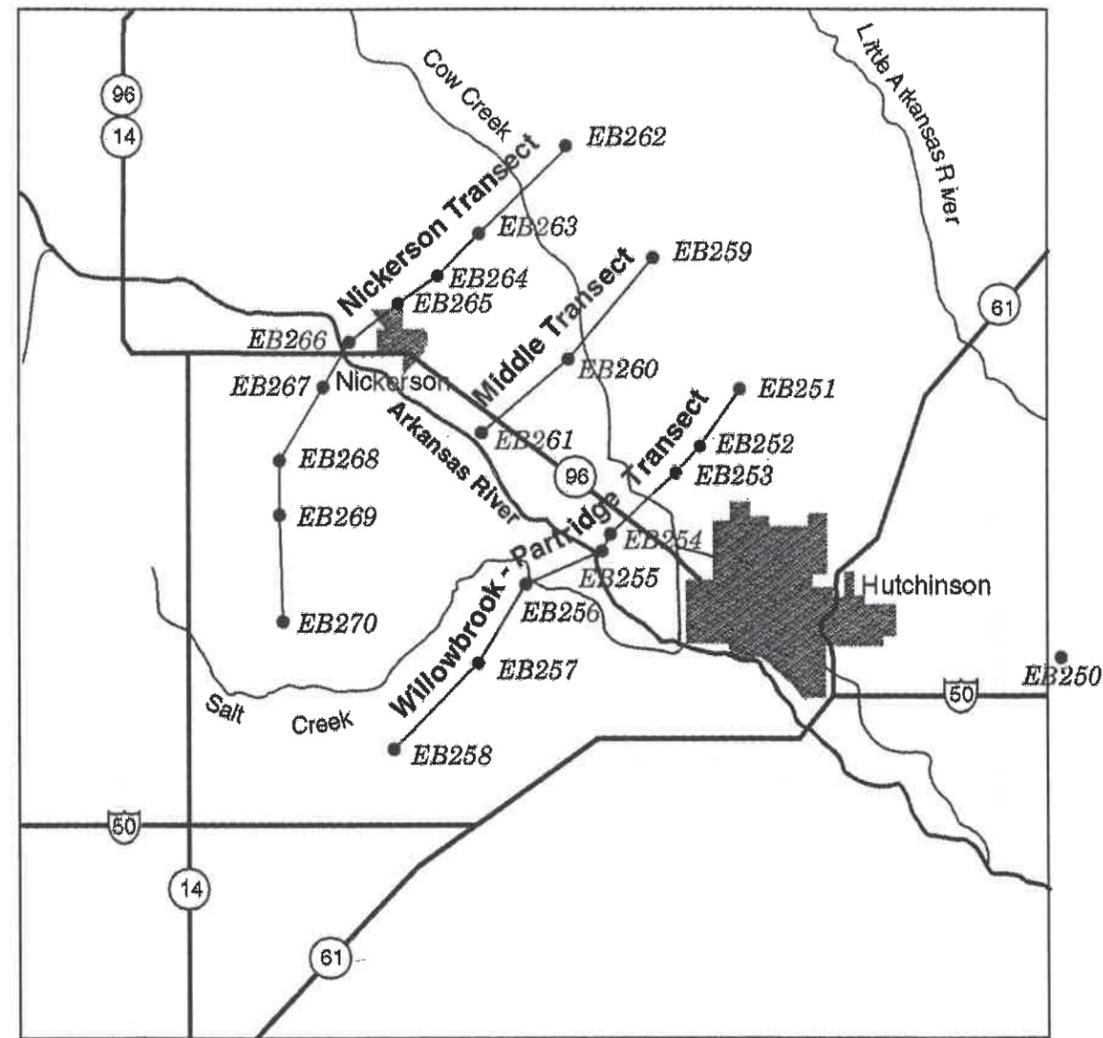
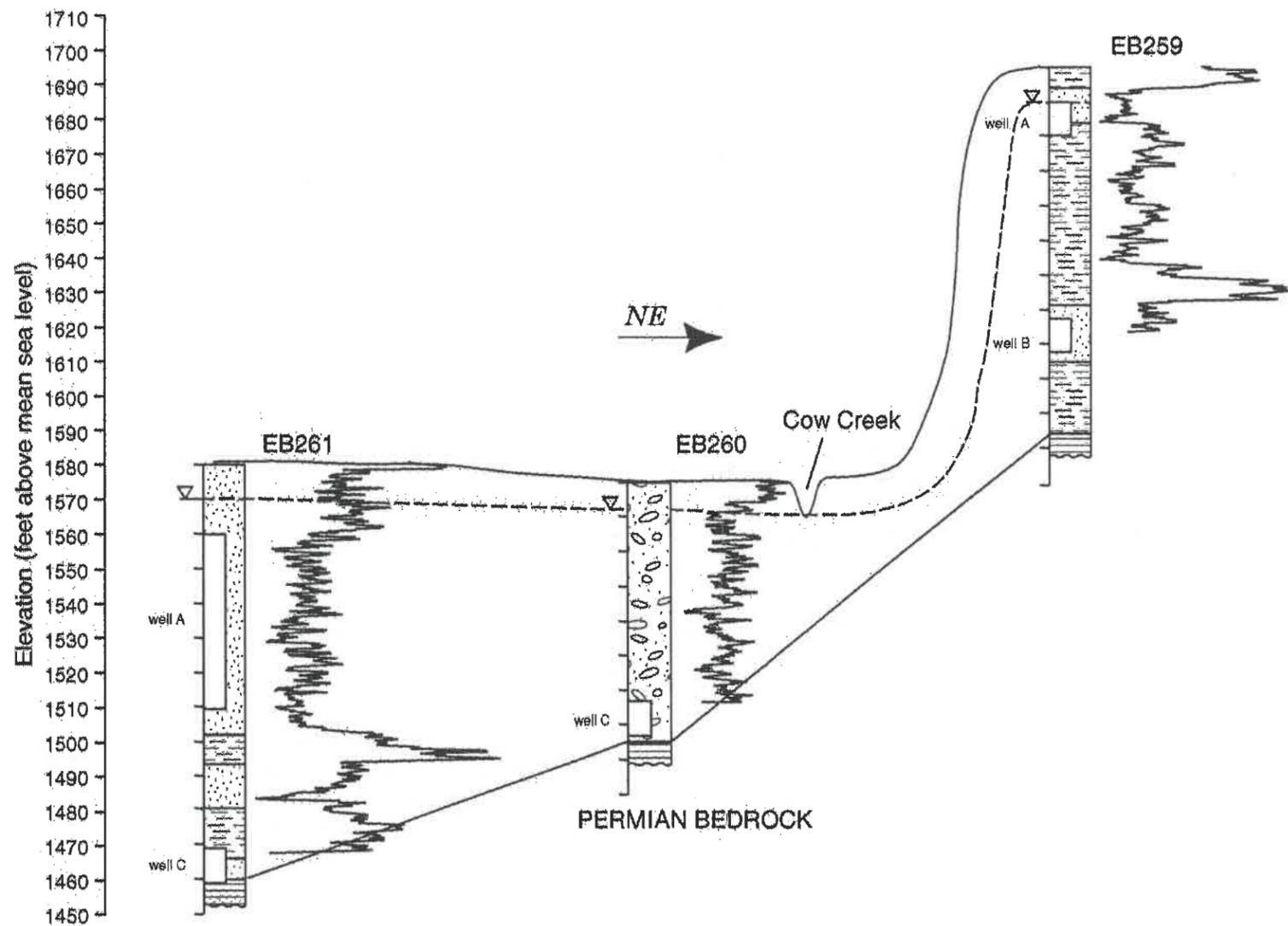
Well ID	CO	Location	Sample date	Sample time	Cl mg/L	Sr mg/L	F mg/L	Br mg/L	I mg/L	B mg/L
EB240C	RN	24-05W-11AAAA	3/28/97		2908	2.85	0.36	0.575	0.0131	0.127
EB248A	RN	24-06W-1AAAA	3/31/97		27.4			0.086	0.0037	
EB248B	RN	24-06W-1AAAA	3/31/97		253			0.117	0.0072	
EB248C	RN	24-06W-1AAAA	3/31/97		3729			0.652	0.0118	

Location, Sample Collection, and Major Constituent Concentrations for Stream Sample Sites in the Study Area.

Well ID	CO	Location	Sample date	Sample time	Lab Sp.C.	T.D.S. mg/L	Lab pH	SiO2 mg/L	Ca mg/L	Mg mg/L	Na mg/L	K mg/L	HCO3 mg/L	SO4 mg/L	Cl mg/L	NO3-N mg/L
ARK 1	RN	99-09W-99XXX	3/21/97	1249	2970	1836	8.40	7.7	134	49.1	440	6.26	252	514	549	1.72
ARK 2	RN		3/25/97	1540	2930	1810	8.45	6.8	131	49.3	431	6.54	234	519	542	1.04
ARK3			4/2/97	1342	2870	1762	8.25	7.5	129	45.9	421	6.71	257	468	549	1.24
COW 1	RN		3/24/97	1458	1615	889	8.35	9.1	120	22.1	172	3.91	277	96.0	325	0.36
COW2			4/2/97	1358	2375	1346	8.25	12.1	93.1	23.0	369	5.03	243	170	545	1.69
SALT 1	RN		3/25/97	1432	4619	2562	8.40	4.6	94.5	22.7	856	4.49	261	161	1287	0.18

Location, Sample Collection, and Minor and Selected Trace Constituent Concentrations for Stream Sample Sites in the Study Area.

Well ID	CO	Location	Sample date	Sample time	Sr mg/L	CO3 mg/L	F mg/L	Br mg/L	I mg/L	IO3-I mg/L	B mg/L
ARK 1	RN		3/21/97	1249	1.72	2.4	0.68	0.285	0.0175		0.183
ARK 2	RN		3/25/97	1540	1.70	4.4	0.70	0.285	0.0179		0.173
ARK3			4/2/97	1342	1.61		0.67	0.301	0.0157	0.026	0.184
COW 1	RN		3/24/97	1458	0.92	2.4	0.40	0.570	0.0176		0.052
COW2			4/2/97	1358	0.90		0.63	0.372	0.0077	0.013	0.130
SALT 1	RN		3/25/97	1432	0.96	2.7	0.40	0.219	0.0100		0.113



Transect Locations



Approximate Water Table  $\nabla$ ---      Gamma Ray Log

Plate 3. Hydrogeologic section through Middle transect.

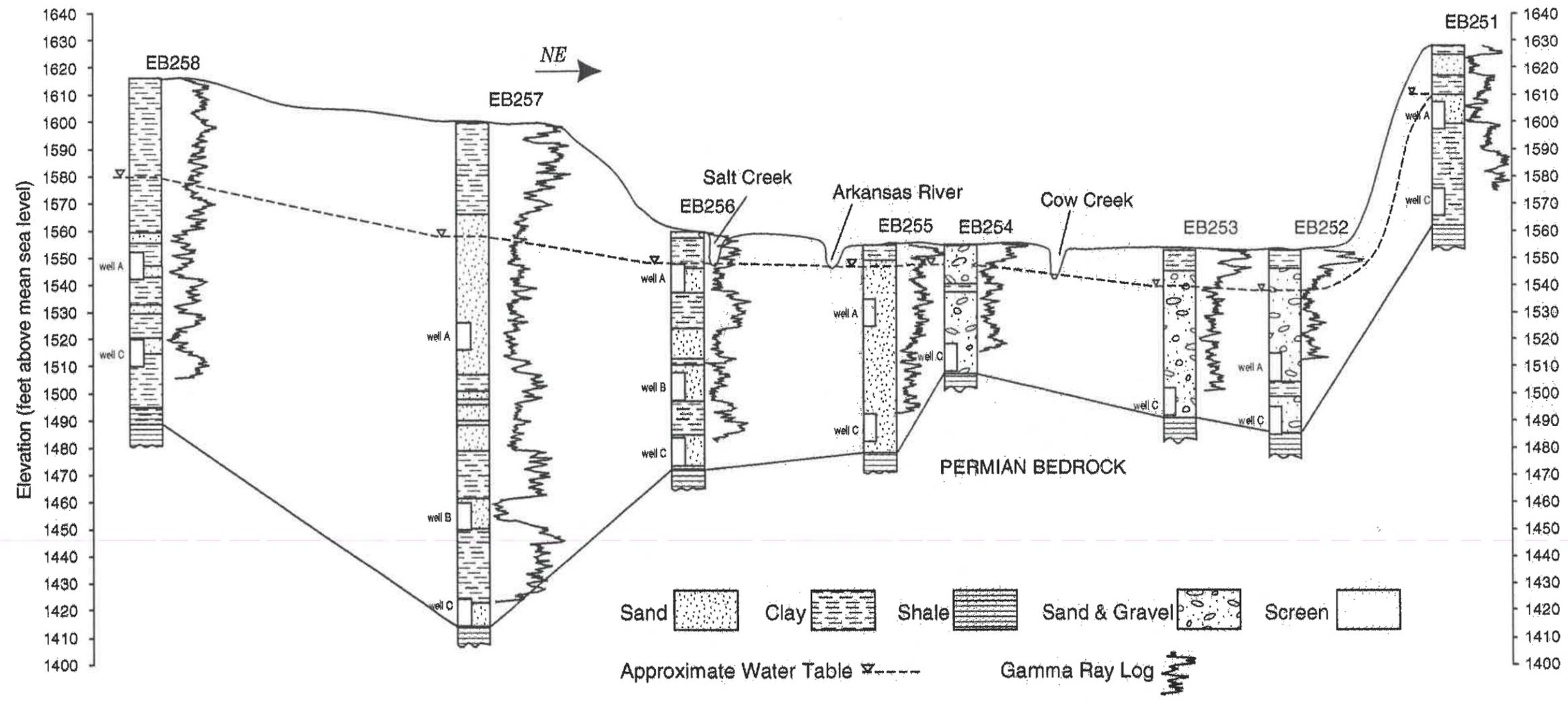


Plate 1. Hydrogeologic section through Willowbrook-Partridge transect.

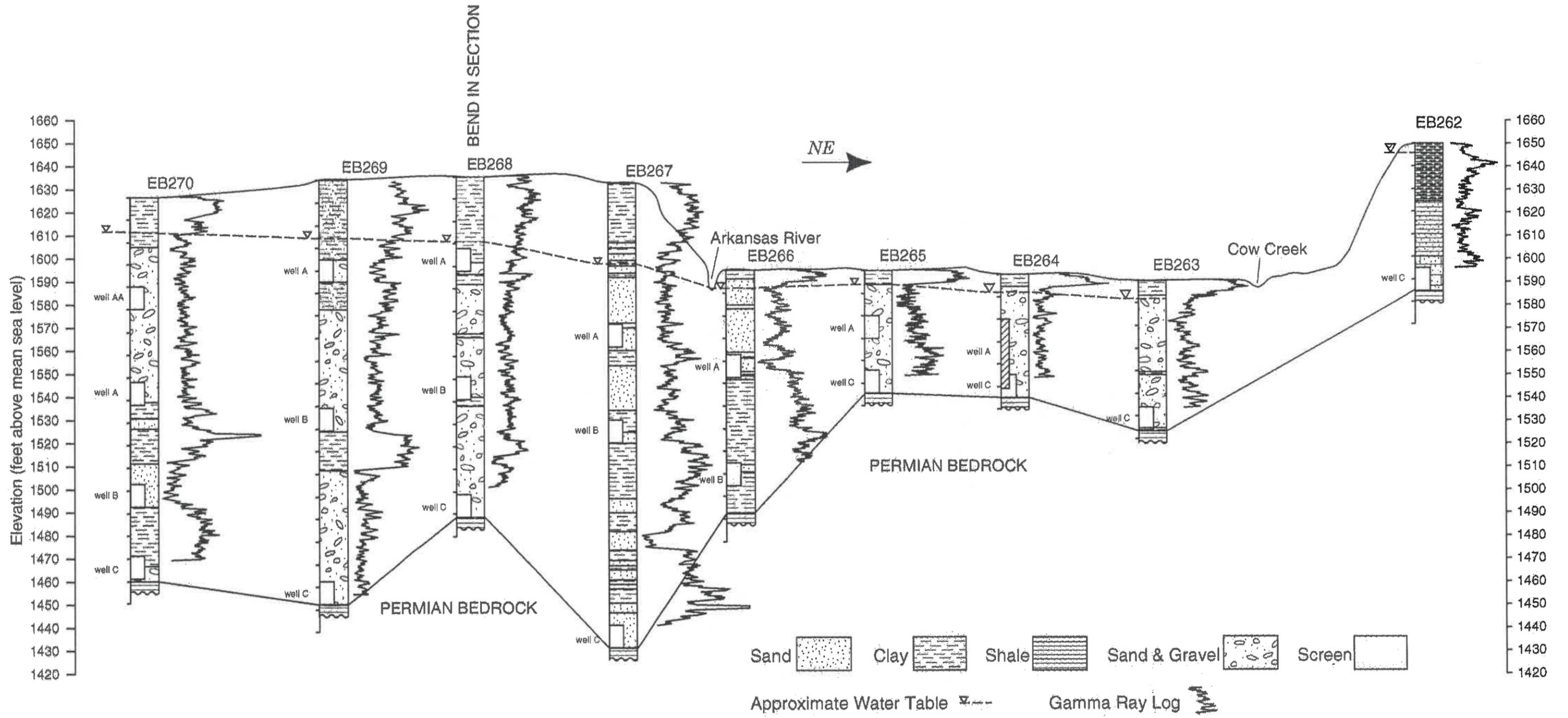


Plate 2. Hydrogeologic section through Nickerson transect.