OTHER INDUSTRIAL WASTE DISPOSAL CELL SITE CHARACTERIZATION KERR-McGEE CUSHING REFINERY SITE

Cushing, Oklahoma

Prepared by
Steven R. Lower
Regional Hydrologist
Kerr-McGee Hydrology Department

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DISPOSAL CELL SITE CHARACTERIZATION
KERR-McGEE CUSHING REFINERY SITE

Cushing, Oklahoma
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INTRODUCTION

Petroleum wastes resulting from the past operation of the oil refinery formerly located at the Cushing Facility are contained within five large pits and several smaller pits. These wastes include Pit 4 hydrocarbon sludges, tank bottom sediments and sludges, tars, greases, and other petroleum hydrocarbons. Acid hydrocarbon sludges are contained within five pits identified as Pits 1 through 5.

The approved option for the remediation of these acid hydrocarbon sludges is treatment and burial in an engineered waste disposal cell. It is possible that this disposal cell may be used for other non-radioactive refinery wastes. This investigation was conducted to characterize the shallow subsurface in three areas of the Cushing Facility in an effort to find a location suitable for the construction of such an engineered disposal cell.

IDENTIFICATION OF POTENTIAL DISPOSAL CELL LOCATIONS

Limiting factors in the selection of a site for an engineered waste disposal cell are lithology, permeability of substrata, depth to groundwater, and extent of subsurface contamination, if any. This investigation involved the drilling of boreholes and the collection and analysis of soil and bedrock samples in an effort to characterize the bedrock. Wells were installed at selected locations to monitor groundwater levels.

Potential locations were selected based upon information on soils derived from mudstones and clayey shales as described in the Payne County Soil Survey (Henley, Gelnar, and Mayhugh, 1987). Criteria for site evaluation were 1) absence of waste pits; 2) potential for low permeability materials underlying the site; 3) the absence of operating pipeline facilities and storage tanks; and 4) the distance from the 100-year floodplain.

Hydrogeology of the Cushing Facility and Vicinity

The Cushing Facility is immediately underlain by residual soils derived from the weathering of underlying bedrock. Alluvial soils may occur along the major and tributary drainages.

The Cushing Facility is directly underlain by bedrock of the Pennsylvanian-age Vanoss Group and associated soils. The shallow bedrock is dominated by thick beds of reddish-brown mudstone with thin interbeds of siltstone, sandstone, and limestone. Some shale also occurs beneath the site, increasing in proportion to the south.

The Vanoss Group is underlain in turn by the sandstones of the Ada Group and the sandstones and shales of the Vamoosa Formation. The Oklahoma Geological Survey collectively refers to the Ada Group and the Vamoosa Formation as the Vamoosa-Ada Aquifer hydrologic unit. At the site of borehole CC6 in the northwest portion of the Cushing Facility, the top of the Ada Group lies at a depth of 175 feet (elevation 720 feet MSL Mean Sea Level). At the site of borehole CMW32.2 in the southeast part of the Facility, the top of the Ada Group lies at a depth of 120 feet (elevation 729 feet MSL). Borehole CMW32.2 is about one-half mile east (geologically up dip) from borehole CC6.

Water-bearing units are present in both the Vanoss Group and the underlying Ada Group. Groundwater in the Vanoss Group is limited to the thin sandstone and limestone interbeds that occur within the low-permeability mudstones of the Vanoss Group. Water-bearing sandstones in the Ada Group are typically thicker and more productive than those in the overlying Vanoss Group.

Descriptions of the Soils Underlying the Cushing Facility

Soils underlying the Cushing Facility are indicative of the underlying shallow bedrock. The formation of this soil results from the modification of the bedrock by physical, chemical, and biological processes.

Review of existing soils information identified areas underlain by bedrock types potentially suitable for construction of an engineered waste disposal cell. These areas were the focus of this investigation.

A total of five (5) soil series have been identified at the Cushing facility. These soil series, which are shown on Figure 1, are described below. The locations and descriptions of the soils are based upon the Payne County soil survey (Henley, Gelnar, and Mayhugh, 1987).

* Agra Series - Soils of the Agra Series directly underlie the majority of the Cushing Facility north of Deep Rock Road and a small area south of Deep Rock Road (see Figure 1). These soils are formed in material weathered from shales that contain thin layers of interbedded sandstone. Bedrock is generally found at a depth greater than five feet. The soils are typically deep, well drained, and slowly permeable. The soil profile typically supports a perched water table at a depth of about three to four feet below the surface during the period November through June when evapotranspiration is typically low. Areas underlain by the Agra Series soils are under consideration as potential sites for the location of an engineered excavation. However, while the shale underlying the soil is favorable for the construction of a waste disposal cell, the presence of a seasonal, shallow perched water table may make these areas undesirable for such a purpose.

* Coyle Series - Soils of the Coyle Series directly underlie about half of the Cushing Facility south of Deep Rock Road (see Figure 1). These soils are formed in material weathered from sandstone. Bedrock is generally found at a depth from two to four feet. Due to the preponderance of sand, soils of the Coyle Series are typically fine loamy and siliceous. The soils are typically moderately deep, well drained, and moderately permeable.

  The presence of these soils indicate sandstone bedrock. This may make areas underlain by soils of the Coyle Series undesirable as a disposal cell for petroleum wastes.

* Easpur and McClain Series - These soils are found along the floodplains of Skull Creek and its tributaries (see Figure 1). Areas underlain by these soils, which are subject to periodic flooding, are unsuited for a waste disposal cell.

* Steedman Series - Soils of the Steedman Series directly underlie a small portion of the Cushing Facility north of Deep Rock Road and about one-third of the Facility south of Deep Rock Road (see Figure 1). These soils are formed in material weathered from clayey shales. Bedrock is generally found at a depth from two to four feet. The soils are typically moderately deep, well drained, and slowly permeable. The profile typically supports a water table in the soil perched at a very shallow depth of one-half to one foot below the surface. This perched water table would generally be present during the period November through March when evapotranspiration is typically low.

  Areas underlain by the Steedman Series soils are under consideration as potential sites for the location of an engineered excavation. The shale underlying the soil is favorable for the construction of a waste disposal cell. The presence of a very shallow seasonal water table perched in the soil should not make these areas undesirable for such a purpose.

DESCRIPTION OF THE DISPOSAL CELL INVESTIGATION

This investigation utilized auger and rotary wash drilling methodologies to characterize the lithology underlying three study areas. Locations of the study areas are shown on Figure 2.

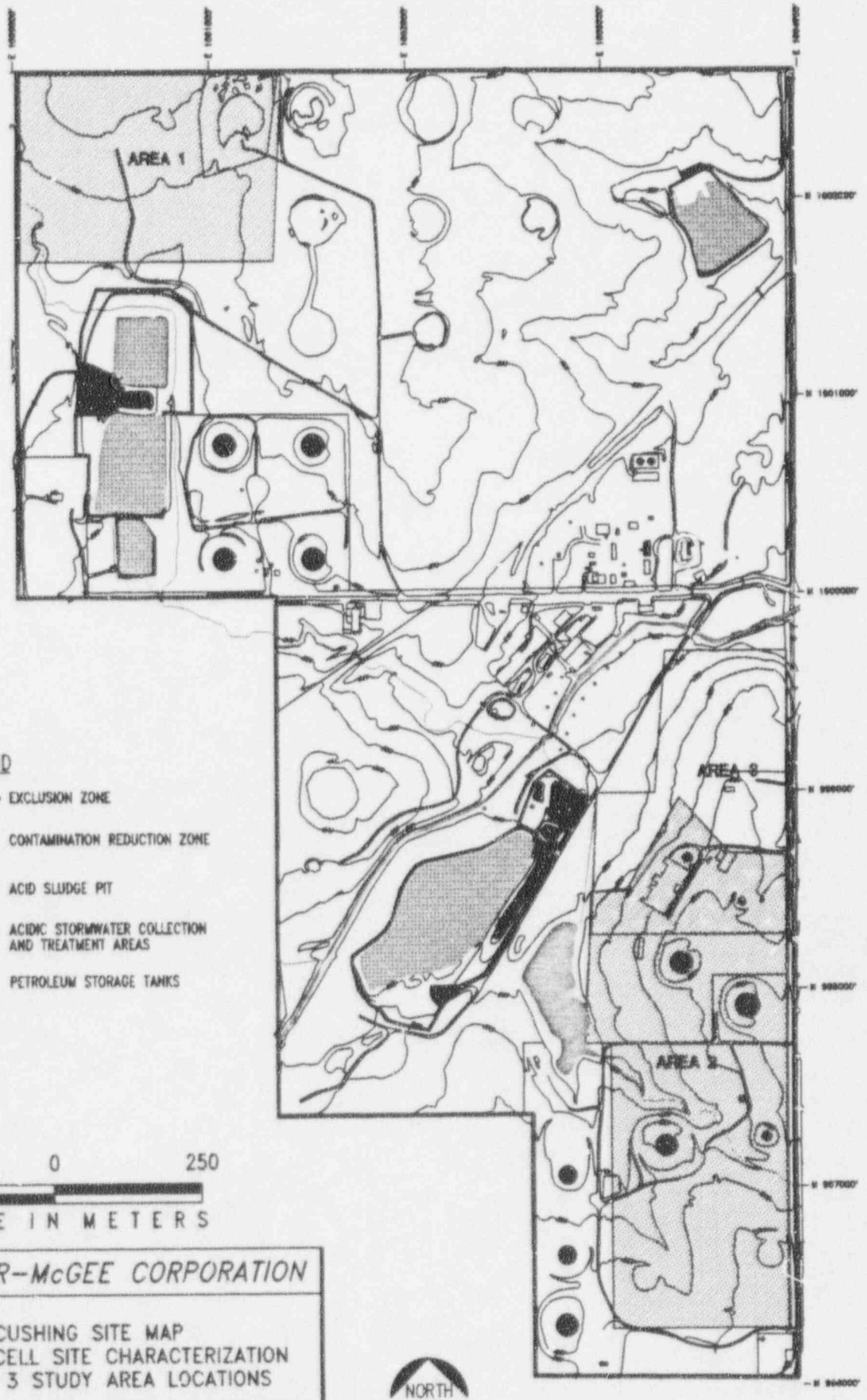
Lithology was logged from cuttings and cores in Area 1 and Area 2. Most boreholes in Area 3 were logged from cuttings; two boreholes were logged from cores. All boreholes in Area 3 were also logged geophysically using transportable down-hole logging equipment.

Samples were monitored during drilling to detect any subsurface contamination that may render the site unsuitable for the disposal of petroleum waste. Monitoring for potential radiological contamination was performed by on-site health physics personnel in accordance with a Special Work Permit (SWP) prepared for this work.

Core segments were collected at selected locations in Areas 1 and 3 for laboratory determinations of permeability. The resulting permeability data aid in determining the suitability of the underlying mudstones and shales for an engineered waste disposal cell.

Water-bearing units were identified and described during drilling. Monitor wells were installed at selected locations in Areas 1 and 3.

FIGURE 2



KERR-McGEE CORPORATION

DOCUMENT TITLE:

CUSHING SITE MAP
DISPOSAL CELL SITE CHARACTERIZATION
SHOWING 3 STUDY AREA LOCATIONS

PREPARED BY: SL	DWN BY: JE
DRAWING NO. BR_AREA0	DATE: 12/14/93

HYDROGEOLOGIC CHARACTERIZATION OF AREA 1

Field activities were conducted in Area 1, located in the northwest corner of the Cushing Facility, in July and November 1991. This area has never been used for refinery operations, and is thus free from potential hydrocarbon contamination.

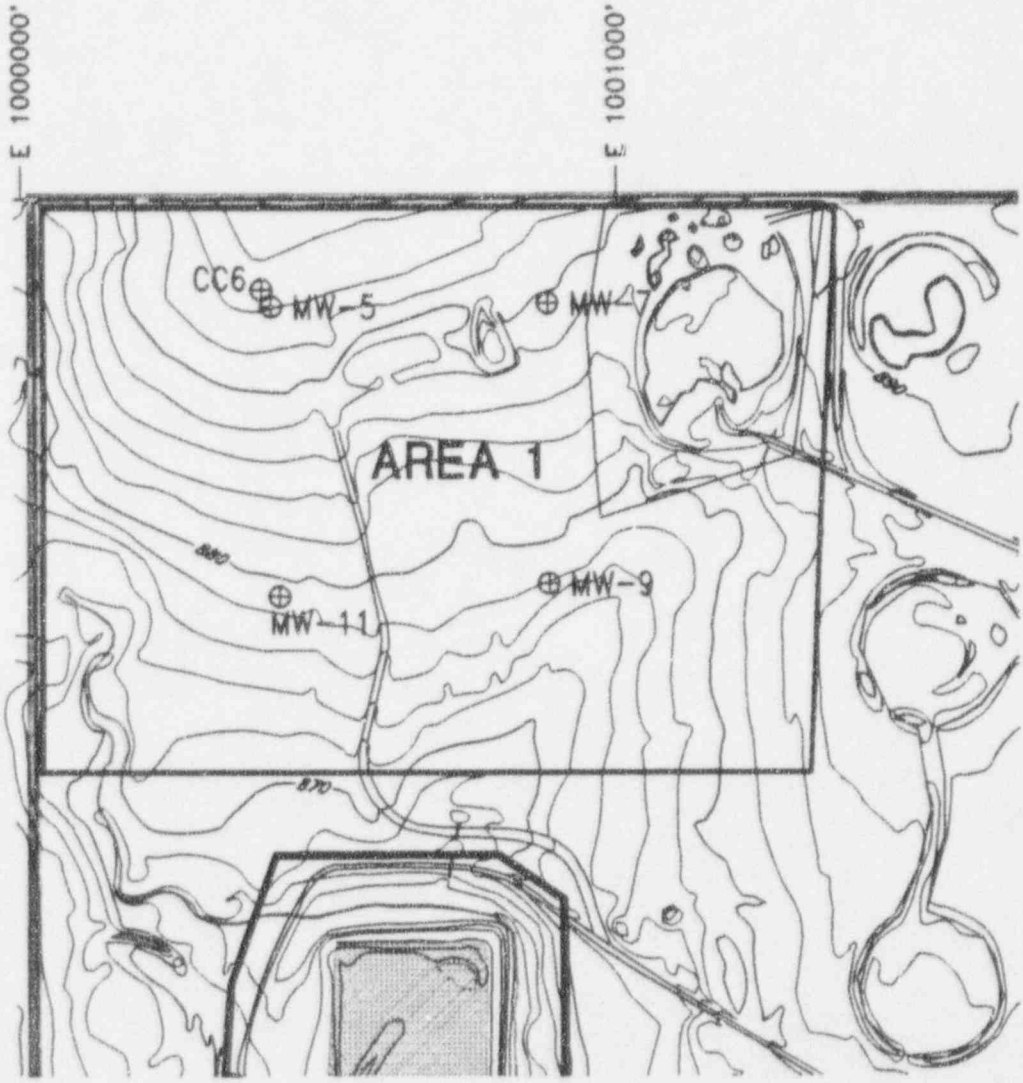
A total of five boreholes were drilled and 12 groundwater monitor wells were installed at four nested locations in Area 1. Four of the boreholes were shallow, ranging in depth from 36 feet (MW-11) to 61 feet (MW-5) in the Vanoss Group. The Ada Group underlying the Vanoss Group was targeted by the fifth borehole (CC6), drilled to a total depth of 255 feet. The top of the Ada Group was encountered at a depth of 175 feet at an elevation of 720 feet MSL. One monitor well was completed in the Vamoosa-Ada Aquifer.

Summary of the Lithology of Area 1

The lithology underlying Area 1 was described from cuttings and cores. Locations of the Area 1 boreholes are shown on Figure 3. Lithologic logs are presented in Appendix A. Lithologic cross sections and isometric diagrams across Area 1 are presented as Plate 1. Selected core intervals from borehole CC6 were tested for permeability.

The lithology underlying Area 1 consists primarily of mudstone and shale with lesser quantities of sandstone, siltstone, and limestone. As shown in the lithologic cross sections and isometric diagrams, shallow sandstone units were encountered at all four of the shallow boring sites. A thin sandstone lens was found at boring site MW-5 at a depth of 11 feet (elevation 882.6 feet MSL). A sandstone unit 15 feet in thickness was found at boring site MW-9 at a depth of 11

FIGURE 3



KERR-McGEE CORPORATION

DOCUMENT TITLE:

CUSHING SITE MAP
BORING LOCATIONS
AREA 1

PREPARED BY: SL	DWN BY: JE
DRAWING NO. BR_AREIA	DATE: 12/14/93

feet (elevation 865.7 feet MSL). Uppermost sandstone units were encountered at a depth of 20 feet (elevation 868.8 feet MSL) and 21 feet (elevation 856.9 feet MSL) at boring sites MW-7 and MW-11, respectively. Review of the cross sections and isometric diagrams show that shallow sandstone units encountered at boring sites MW-7, MW-9, and MW-11 may be continuous over the eastern and southern parts of Area 1. These sandstone units increase in thickness to the east and south.

Area 1 Core Permeabilties

Core samples from intervals at 124 feet, 129 feet, 134 feet, 156 feet, 164 feet, and 166 feet were selected from Area 1 borehole CC6 for determinations of permeability. All samples consisted of shale within the Vanoss Group.

Permeabilities were determined by constant head permeability tests of core samples. Summaries of core interval permeabilities are presented in Table 1. Laboratory report sheets for the Area 1 permeability tests are presented in Appendix B.

Review of Table 1 shows the highest reported permeability to be 2.2×10^{-6} cm/sec from the sample at 166 feet. The lowest permeability was 4.3×10^{-8} cm/sec from the sample at 164 feet.

Area 1 Water Levels

A total of 12 wells have been constructed to monitor groundwater in Area 1. Water level data for Cushing Area 1 Vanoss monitor wells MW-1 through MW-11 and Vamoosa-Ada Aquifer well CMW29.1 are available for the period January 1992 through December 1993. These data

TABLE 1
SUMMARY OF CORE INTERVAL PERMEABILITIES
AREA 1 BOREHOLE CC6

Sample Depth	Core Permeability (cm/sec)	Description
124 feet	5.3×10^{-8}	Reddish-brown weathered shale
129 feet	1.1×10^{-7}	Red-brown and gray marbled weathered shale
134 feet	2.2×10^{-6}	Grayish-brown unweathered shale
156 feet	5.8×10^{-7}	Reddish-brown weathered shale
164 feet	4.3×10^{-8}	Dark brown weathered shale
166 feet	7.1×10^{-6}	Dark gray weathered shale

are included as Appendix C. Monitor well installation diagrams for Area 1 monitor wells are presented in Appendix D. Well locations are shown on Figure 4. A summary of completed lithologies and depths and water level ranges is presented in Table 2.

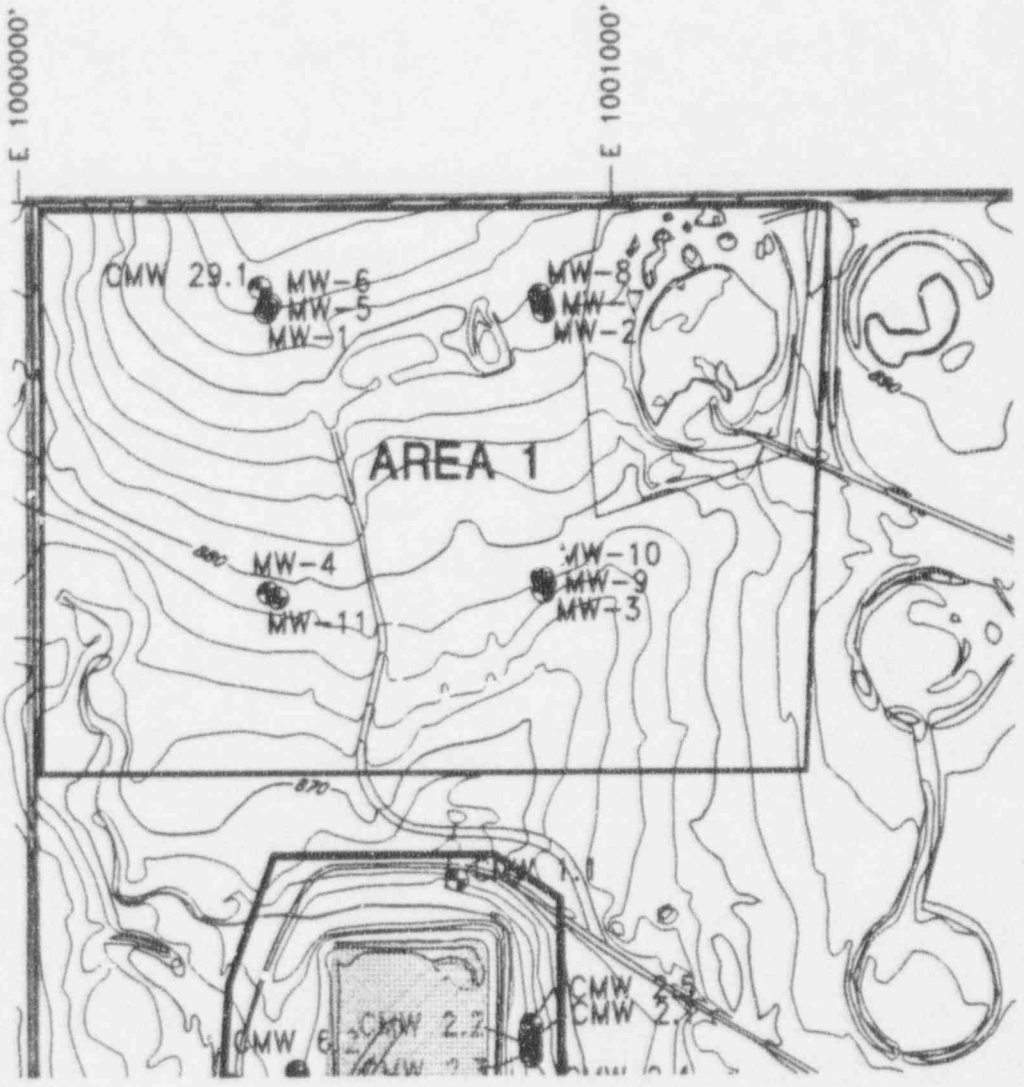
Four wells were constructed to monitor groundwater in the deeper shales and limestones (MW-5, MW-7, and MW-9). Water levels in two of these wells (MW-5 and MW-7) show little change in response to seasonal precipitation. Seasonal water-level changes in deep well MW-9 suggests a good connection with recharge areas.

Four wells were constructed to monitor groundwater in intermediate mudstones and sandstones (MW-8, MW-10, and MW-11) and shale (MW-6). Water levels in two of these wells (MW-8 and MW-10) show definite response to seasonal precipitation. Water levels in well MW-11 show little change in response to seasonal precipitation. With the exception of the December 1993 measurement, water levels in intermediate well MW-6 have shown a continuous slow rise since completion, suggesting isolation from surface recharge sources.

Four wells were constructed to monitor groundwater in shallow shales. Water levels in three of these wells (MW-1, MW-2, and MW-3) show definite response to seasonal precipitation. Water levels in shallow well MW-4 had shown a continuous slow rise until July 1993. Since that time water levels have declined in response to an unusually dry summer and fall 1993.

Well CMW29.1 was constructed to monitor water levels in the Vamoosa-Ada Aquifer. Water levels in this well have shown no significant changes with time.

FIGURE 4



KERR-McGEE CORPORATION

DOCUMENT TITLE:

CUSHING SITE MAP
MONITOR WELL LOCATIONS
AREA 1

PREPARED BY: SL	DRN BY: JE
DRAWING NO. BR_AREA1	DATE: 12/14/93

TABLE 2
SUMMARY OF COMPLETED LITHOLOGIES AND DEPTHS AND WATER LEVEL RANGES CUSHING AREA 1 GROUNDWATER MONITOR WELLS

Well Number	Completed Lithologies	Depth of Completion (feet BGS)	Water-Level Range (feet BGS)	Responds Well To Precip?
MW-1	Shallow Mudstone	1 - 9	Dry - 7.1	Yes
MW-2	Shallow Mudstone	2 - 11	0.7 - 8.6	Yes
MW-3	Shallow Mudstone	2.5 - 10.5	4.9 - 9.6	Yes
MW-4	Shallow Mudstone	3 - 11	7.1 - 10.1	Slow Rise
MW-5	Deep Shale and Limestone	38 - 61	29.9 - 35	No
MW-6	Intermediate Mudstone and Siltstone/Shale	17 - 30	7.8 - 27.8	Slow Rise
MW-7	Deep Shale and Limestone	40.5 - 52.5	19.9 - 23.7	No
MW-8	Intermediate Mudstone and Sandstone	18 - 31	4.8 - 10.7	Yes
MW-9	Deep Mudstone, Sandstone, and Limestone	19 - 36	5.4 - 19.7	Yes
MW-10	Intermediate Mudstone and Sandstone	8 - 26	5.8 - 10	Yes
MW-11	Intermediate Mudstone and Sandstone	8 - 31	9.1 - 12.6	No
CMW29.1	Vamoosa-Ada Sandstone and Shale	168 - 245	98.6-104.4	No

Note: "feet BGS" indicates "Feet Below Ground Surface"
Date of Table: December 21, 1993

HYDROGEOLOGIC CHARACTERIZATION OF AREA 2

Field activities were conducted in Area 2, located in the southeast corner of the Cushing Facility, in March and April 1993. A tank farm located in the southern portion of Area 2 is still in active service. The northern part of Area 2 has previously been used for hydrocarbon storage and refinery operations.

A total of seven boreholes were drilled in Area 2. Three of the boreholes were drilled to depths of 49 and 50 feet in the southern part of Area 2. Four additional boreholes were drilled to a common depth of 50 feet in the northern part of Area 2. No monitor wells were installed.

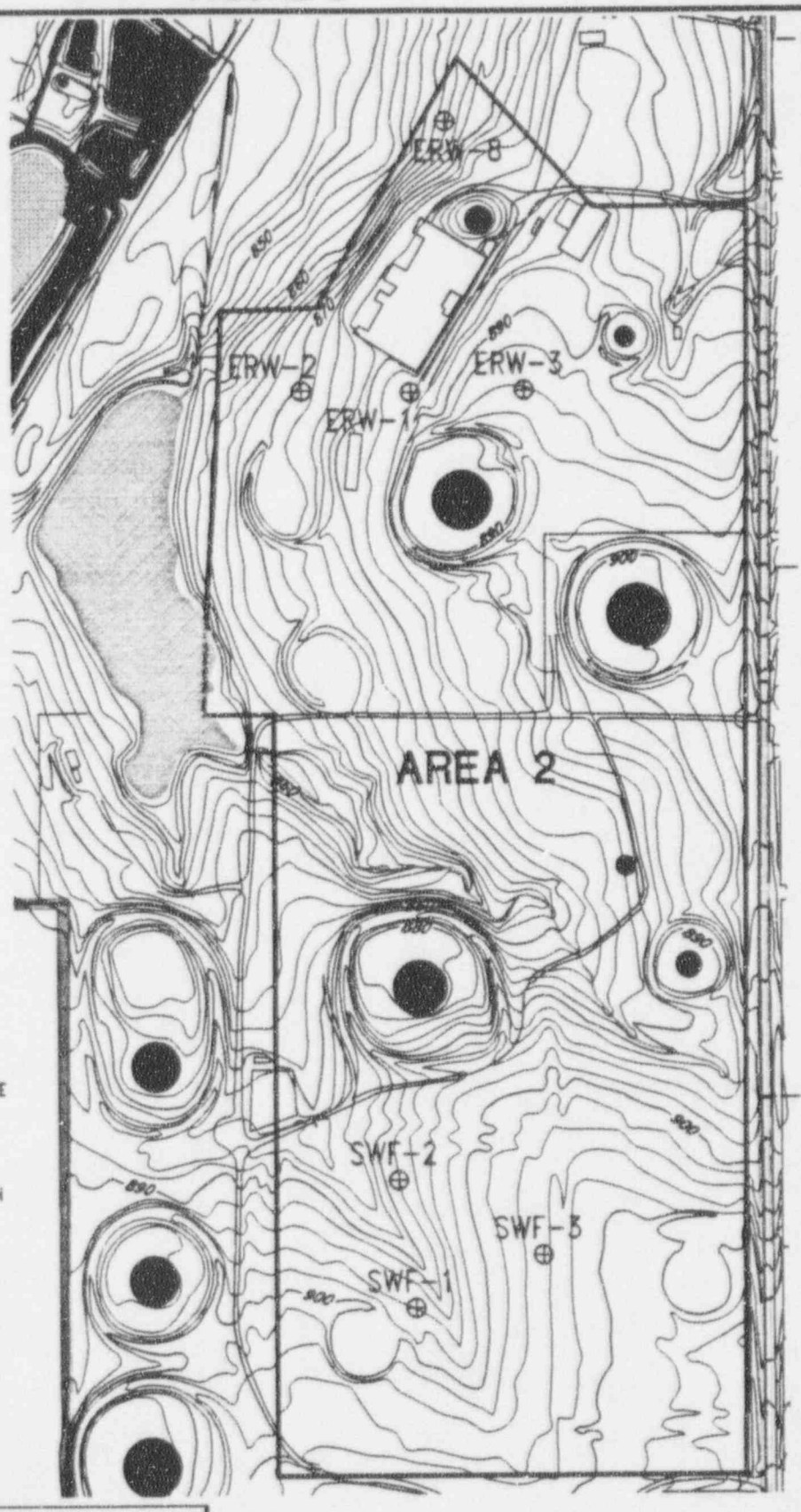
Summary of the Lithology of Area 2

The lithology underlying Area 2 was described from cuttings and cores. Locations of the Area 2 boreholes are shown on Figure 5. Lithologic logs are presented in Appendix E.

The shallow lithology underlying the southern part of Area 2 consists of sandstone from the surface to depths ranging from 12 to 20 feet. This sandstone is underlain by a sequence of interbedded sandstone, siltstone, mudstone, limestone, and shale. The shallow lithology underlying the northern part of Area 2 consists of interbedded mudstone and shale with some thin interbeds of limestone and sandstone.

Due to shallow sandstones in the southern part of Area 2 and the recent reactivation of two petroleum tanks in the northern part, Area 2 has been deleted from consideration as a potential disposal site.

FIGURE 5



KERR-McGEE CORPORATION

DOCUMENT TITLE:

CUSHING SITE MAP
BORING LOCATIONS
AREA 2

PREPARED BY: SL	DWN BY: JE
DRAWING NO. BR_AREA2	DATE: 12/14/93

HYDROGEOLOGIC CHARACTERIZATION OF AREA 3

Field activities were conducted in Area 3, located on the eastern Cushing Facility boundary, in June and July 1993. The southern part of Area 3 overlaps with the northern part of Area 2. Area 3 has been a site of previous refinery operations.

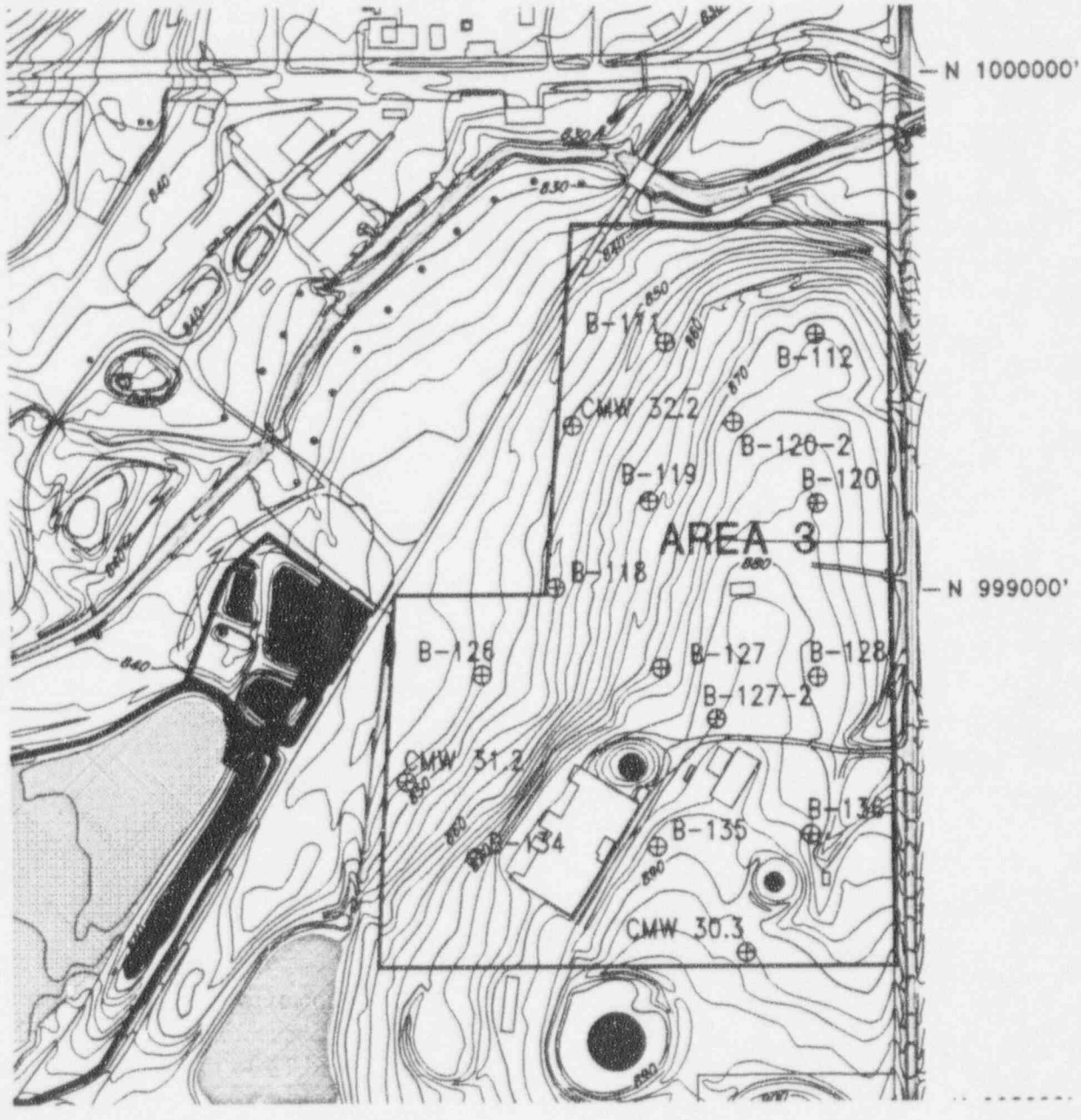
A total of 16 exploratory boreholes were drilled in Area 3. Most of the exploratory boreholes were drilled and logged in the Vanoss Group to depths ranging from 42.5 feet (B-126) to 140 feet (CMW30.3). The Ada Group underlying the Vanoss Group was targeted by exploratory borehole CMW32.2, drilled and logged to a total depth of 200 feet. The top of the Ada Group was encountered at a depth of 120 feet at an elevation of 729 feet MSL. In addition, seven groundwater monitor wells were completed in the Vanoss Group at three nested locations.

Summary of the Lithology of Area 3

The lithology underlying Area 3 was described from cuttings, cores, and geophysical logs. Fourteen of the 16 boreholes were logged by cuttings and geophysically using transportable downhole logging equipment. The two remaining boreholes (B-120-2 and B-127-2) were logged from cores and geophysically. Selected core intervals from boreholes B-120-2 and B-127-2 were tested for permeability.

Locations of the boreholes are shown on Figure 6. Lithologic logs are presented in Appendix F. Geophysical logs are presented in Appendix G. Lithologic cross sections across Area 3 are presented as Plates 2 and 3. Isometric diagrams across Area 3 are presented as Plate 4.

FIGURE 6



KERR-McGEE CORPORATION

DOCUMENT TITLE:

CUSHING SITE MAP
BORING LOCATIONS
AREA 3

PREPARED BY: SL	DWN BY: JE
DRAWING NO. BR_AREA3	DATE: 12/15/93

The shallow lithology underlying Area 3 (less than 30 to 40 feet in depth) consists of a sequence of mudstones and shale with thin interbeds of sandstone, siltstone, and limestone. As shown on the lithologic cross sections and isometric diagrams, most of the shallow sandstone lenses are less than two feet in thickness, and many are less than one foot thick.

Review of cross sections and isometric diagrams show that sandstone units become more prevalent to the south and east with increasing depth. These sandstones may exceed 25 feet in thickness at some locations.

Area 3 Core Permeabilities

Intervals were selected from Area 3 boreholes B-120-2 and B-127-2 for determination of permeability. All samples consisted of sandstone and mudstone within the Vanoss Group.

Permeabilities were determined from flexible wall permeability tests of core samples. Intervals were selected to provide a wide range of lithologies. Summaries of core interval permeabilities are presented in Tables 3 and 4. Laboratory report sheets for the Area 3 permeability tests are presented in Appendix H.

Review of Table 3 shows the highest reported permeability at Area 3 borehole B-120-2 to be 6.1×10^{-7} cm/sec from the interval 43 to 44 feet. The lowest permeability was 1.2×10^{-8} cm/sec from the interval 15 to 16 feet. Review of Table 4 shows that the highest reported permeability at Area 3 borehole B-127-2 was 1.8×10^{-6} cm/sec from the interval 70 to 71 feet. The lowest permeability was 1.9×10^{-8} cm/sec from the interval 47 to 48 feet.

TABLE 3
SUMMARY OF CORE INTERVAL PERMEABILITIES
AREA 3 BOREHOLE B-120-2

Sample Interval	Core Permeability (cm/sec)	Description
15 - 16 feet	1.2×10^{-8}	Dark gray shaly mudstone
35 - 37 feet	7.1×10^{-8}	Red shaly mudstone
43 - 44 feet	6.1×10^{-7}	Red mudstone
58 - 59 feet	1.7×10^{-8}	Variegated red/gray silty mudstone
63 - 65 feet	8.8×10^{-8}	Dark gray shaly mudstone
77 - 78 feet	3.1×10^{-7}	Dark gray mudstone

TABLE 4
SUMMARY OF CORE INTERVAL PERMEABILITIES
AREA 3 BOREHOLE B-127-2

Sample Interval	Core Permeability (cm/sec)	Description
26 - 27 feet	3.2×10^{-7}	Dark gray mudstone
39 - 40 feet	5.8×10^{-8}	Red shaly mudstone
47 - 48 feet	1.9×10^{-8}	Red shaly mudstone
63 - 64 feet	1.6×10^{-7}	Red clayey sandstone
70 - 71 feet	1.8×10^{-6}	Tan clayey sandstone
77 - 78 feet	3.4×10^{-8}	Dark gray shaly mudstone

Area 3 Water Levels: A total of seven wells have been constructed to monitor groundwater in the Vanoss Group at three nested locations in Area 3. Water level data for these Cushing Area 3 monitor wells are available for the period July through December 1993. Two other wells constructed in January 1990 during an earlier investigation are located in the northern part of Area 3.

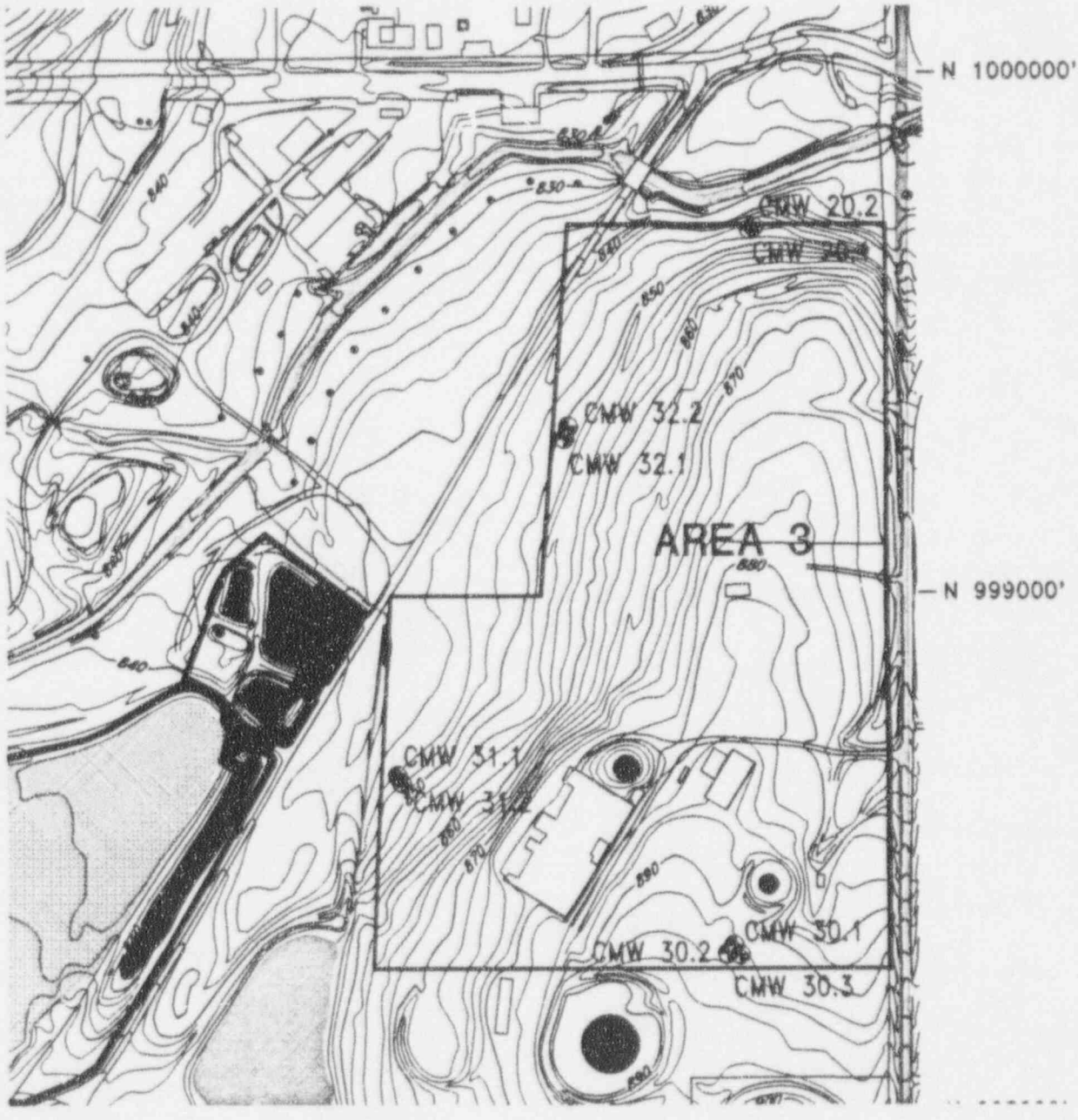
Water level data for the Area 3 wells are included as Appendix I. Monitor well installation diagrams for Area 3 are presented in Appendix J. Well locations are shown on Figure 7. A summary of completed lithologies and depths and water level ranges is presented in Table 5.

Wells at site CMW30 were completed in shallow, intermediate, and deep intervals. CMW30.1 was completed to a depth of 43 feet in a shallow sandstone with thin mudstone stringers. Well CMW30.2 was completed to a depth of 80 feet in a sandstone unit. Well CMW30.3 was completed to a depth of 103 feet in a shale.

Wells at site CMW31 were completed in intermediate and deep intervals. Well CMW31.1 was completed to a depth of 43 feet in a mudstone with thin sandstone stringers. Well CMW31.2 was completed to a depth of 70 feet in a shale with thin sandstone stringers.

Wells at site CMW32 were completed in intermediate and deep intervals. Well CMW32.1 was completed to a depth of 52 feet in a sandstone and siltstone unit. Well CMW32.2 was completed to a depth of 73 feet in a mudstone with thin sandstone stringers.

FIGURE 7



KERR-McGEE CORPORATION

DOCUMENT TITLE:

CUSHING SITE MAP
MONITOR WELL LOCATIONS
AREA 3

PREPARED BY: SL	DWN BY: JE
DRAWING NO. BR_ARE3A	DATE: 12/15/93

TABLE 5
SUMMARY OF COMPLETED LITHOLOGIES AND DEPTHS AND WATER LEVEL RANGES CUSHING AREA 3 GROUNDWATER MONITOR WELLS

Well Number	Completed Lithologies	Depth of Completion (feet BGS)	Water-Level Range (feet BGS)	Responds Well To Precip?
CMW20.1	Intermediate Shale, Siltstone, and Limestone	19 - 42.4	28.9 - 29.4	No
CMW20.2	Deep Shale and Sandstone	61.7 - 87.4	34.5 - 35.3	No
CMW30.1	Shallow Sandstone and Mudstone	5 - 20	7.6 - 10.4	Yes
CMW30.2	Intermediate Sandstone and Mudstone	64.5 - 80	54.9 - 57.4	Yes
CMW30.3	Deep Shale and Mudstone	88 - 103	58.1 - 85.8	Slow Rise
CMW31.1	Intermediate Mudstone and Sandstone	28 - 43	12 - 12.6	No
CMW31.2	Deep Shale	55 - 70	32.7 - 40.7	Slow Rise
CMW32.1	Intermediate Siltstone and Sandstone	37 - 52	22.7 - 25.7	No
CMW32.2	Deep Mudstone	58 - 73	42.3 - 64.2	Slow Rise

Note: "feet BGS" indicates "Feet Below Ground Surface"
Date of Table: December 17, 1993

As of December 1993, water levels in many of the recently constructed wells were still stabilizing following initial development. Water levels in the wells completed in the deep intervals (CMW30.3, CMW31.2, and CMW32.2) were slowly rising towards a point of stabilization. Water levels in two wells completed in the intermediate interval (CMW31.1 and CMW32.1) appear to have reached stabilization. The water level in intermediate well CMW30.2 has shown a decline, apparently in response to an unusually dry summer and fall 1993. The water level in shallow well CMW30.1 has fluctuated slightly since development in response to relative wet and dry periods.

Water levels in all wells completed in intermediate and deep intervals show strong artesian effects reflecting confinement. As might be expected, the water level in shallow well CMW30.1 reflects water-table conditions.

As noted above, two preexisting wells are located in the northern part of Area 3 (see Figure 7). Well CMW20.1 is completed to a depth of 42.4 feet in shale with thin lenses of siltstone and limestone. Since construction in January 1990, water levels in this well have stabilized at an elevation of about 819 feet MSL. Well CMW20.2 is completed to a depth of 87.4 feet in thick shale and sandstone sequences. Since construction in January 1990, water levels in this well have stabilized at an elevation of about 812 feet MSL. The lack of significant water-level fluctuations in these two wells suggest poor communication with surface recharge sources. Lithologic logs for these wells are included in Appendix F. Well construction diagrams are included in Appendix J. Recent water levels are tabulated in Appendix I.

CONCLUSIONS

Three areas of the Cushing Facility have been investigated and characterized for a potential disposal cell. One area (Area 2) has been deleted from consideration due to adverse geology and the presence of active storage tank operations.

The Cushing Facility is underlain by bedrock of the Pennsylvanian-age Vanoss Group and associated soils. The Vanoss Group is dominated by thick beds of mudstone with thin interbeds of siltstone, sandstone, and limestone. Many of the interbeds are lenses, changing in thickness over short distances. The Vanoss Group is underlain at depth by sandstones of the Ada Group and sandstones and shales of the Vamoosa Formation, collectively referred to as the Vamoosa-Ada Aquifer.

The lithology underlying Area 1, located in the northwest corner of the Cushing Facility, is mudstone and shale with lesser quantities of sandstone, siltstone, and limestone. Shallow sandstone in the northwest corner of Area 1 appears to be limited in areal extent and water-bearing capabilities. Shallow sandstones in the eastern and southern parts of Area 1 appears to be more extensive and may contain considerable quantities of groundwater. Permeabilities of Vanoss Group shale core samples range from a high of 2.2×10^{-6} to a low of 4.3×10^{-8}.

A total of 12 wells have been constructed to monitor groundwater in the Vanoss Group and underlying Vamoosa-Ada Aquifer at four nested locations in Area 1. Water levels in the Vamoosa-Ada Aquifer have shown no significant response to precipitation, confirming isolation from the surface. Water levels in all four wells completed in the shallow mudstones of the

Vanoss Group are under water-table conditions. These wells show minimal saturation. Water levels in three of these wells respond to precipitation, while that in the fourth has risen slowly since construction. Water levels in two of four wells completed in intermediate mudstones and sandstones of the Vanoss Group are also under water-table conditions. In the two remaining intermediate wells, also completed in Vanoss Group mudstones and sandstones, water levels are under artesian conditions. Water levels in two of the intermediate wells respond to precipitation, while those in two do not. Water levels in the three wells completed in deep shales, mudstones, limestones, and sandstones of the Vanoss Group are all under artesian conditions. Water levels in two of these deep wells do not respond to precipitation, while those in the third do.

The lithology underlying Area 3, located on the eastern boundary of the Cushing Facility, is mudstone and shale with thin interbeds of sandstone, siltstone, and limestone. Most of the shallow sandstone lenses are less than two feet in thickness, and many are less than one foot thick. A shallow sandstone unit about five feet in thickness is extensive beneath the higher elevations in the eastern and southern parts of Area 3. This sandstone may contain considerable quantities of water. Permeabilities of Vanoss Group core samples range from a high of 1.8×10^{-6} to a low of 1.9×10^{-8}.

A total of seven wells have been constructed to monitor groundwater in the Vanoss Group in three nested areas of Area 3. Two additional wells, constructed during an earlier investigation, are also located in Area 3.

Water levels in the one well completed in shallow mudstones and sandstones of the Vanoss Group are under water-table conditions, and show response to precipitation. This well shows several feet of saturation. Water levels in the three wells completed in intermediate mudstones and sandstones of the Vanoss Group are under artesian conditions, indicating confinement. Water levels in two of the intermediate wells show no significant response to precipitation, while those in the third do. Water levels in the three wells completed in deep shales, mudstones, and sandstones of the Vanoss Group are also under artesian conditions, again indicating confinement. Water levels in these three deep wells have shown a slow rise since construction in July 1993. Water levels in the two preexisting wells located in the northern part of Area 3 also show confinement.

REFERENCES CITED

Henley, J., R. D. Gelnar, and R. E. Mayhugh, 1987, Soil survey of Payne County, Oklahoma: United States Department of Agriculture, Soil Conservation Service, 268p.

APPENDIX A
LITHOLOGIC LOGS
AREA 1

MW-5

SOIL BORING LOG KM-5655-A

MW-5

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY KMC	LOCATION CUSHING, OK	BORING NUMBER CRC-6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
5	CLAY AIR DRILL CUTTINGS		CL			1		11'		START CORING
10	SILTSTONE/SHALE, LIGHT RED BROWN SOFT, DRY		SM							
	SANDSTONE/SHALE CONGLOMERATE (WASH) LAYERED WHITE, LIGHT RED BROWN		SM							
15	CLAY, RED, SOFT, BLACK CARBONACEOUS MOTTLING, SOME SANDSTONE CLASTS		CL			2			7'	10' RUN
20	NO RECOVERY CLAY IN CUTTINGS		CL					21'		NO RECOVERY
	CLAY, RED GREEN MOTTLING		CL			3			1.5'	
25	CLAY, RED SAMPLE FROM CUTTINGS		CL							NO RECOVERY
30								31'		
35	CLAY, RED FROM CUTTINGS		CL			4			2.6'	NO RECOVERY
	SHALE, RED, GREEN MOTTLING		Sh							
40								40		

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- _____
- _____

DATE DRILLED: 11-21-91

PAGE: 1 of 2

DRILLING METHOD: CORE

DRILLED BY: WINNEK

LOGGED BY: R. KRAKOWSKI

EXISTING GRADE ELEVATION (FT AMSL):

LOCATION OR GRID COORDINATES:

MW-5

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY KMC	LOCATION CUSHING, OK	BORING NUMBER CRC-6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
						4		41'		
45	SHALE, RED, GREEN MOTTLING		Sh			5			6.7	NO RECOVERY 10' RUN
50	SHALE, BURGANDY RED GREEN MOTTLING		Sh					51'		NO RECOVERY
55	SHALE, TAN TO LIGHT BROWN PURPLE MOTTLING		Sh			6			9.0	10' RUN
	LIMESTONE, FOSSILIFEROUS LIGHT GRAY, DRY, HARD		Ls							
60	SHALE, LIGHT GRAY/THIN COAL SEAM		Sh					61'		
	TD = 61'									

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- _____
- _____

DATE DRILLED 11-21-91

PAGE 2 of 2

DRILLING METHOD CORE

DRILLED BY WINJEK

LOGGED BY R. KRAKOWSKI

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

MW-7

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY KMC	LOCATION CUSHING, OK	BORING NUMBER MWR-7 CRC-B

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
5	CLAY FROM AIR DRILL CUTTINGS		CL			1		11'		
10										START CORING
	CLAY, RED, HARD									5ft RUN
15	RED CLAY FROM AIR DRILL CUTTINGS		CL			2		16'	1.3	NO RECOVERY
										NO RECOVERY
	RED CLAY WITH ALTERNATING GREEN SILTSTONE AND SANDSTONE					3		21'	4.0	5ft RUN
20 ▽	SANDSTONE LIGHT GREEN TO VERY LIGHT TAN, FINE GRAIN, WET SILTY		SM			4		29'	3.0	3ft. RUN
25	SANDSTONE BY CUTTINGS									
	SANDSTONE, SILTY		SM			5		32'	7.6	8ft. RUN
30	LIMESTONE, FOSSILIFFOUS		LS							
	SHALE BY CUTTINGS		Sh			6		37'	1.6	6ft RUN
35	SHALE, RED, HARD GREEN MOTTLING					7		40		

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- _____
- _____

DATE DRILLED	11-22-91
PAGE	1 of 1
DRILLING METHOD	CORE
DRILLED BY	WINNEK
LOGGED BY	R. KRANOWSKI
EXISTING GRADE ELEVATION (FT AMSL)	
LOCATION OR GRID COORDINATES	NE CORNER

MW-7

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	SUBSIDIARY KMC	LOCATION CUSHING, OK	BORING NUMBER MWR-7 CRC-8

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
	SHALE; RED; GREEN MOTTLING HARD; MOIST		Sh			7		40'	9.1	10 FT. RUN
45	LIMESTONE FOSSILIFEROUS		Ls							
	SHALE, GRAY		Sh			8		52.5'	4.5	4.5 FT RUN
50	TD = 52.5									

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC PEAT
- SANDY CLAY
- CLAYEY SAND
- ☐ _____
- ☐ _____

DATE DRILLED	PAGE
11-22-91	2 of 2
DRILLING METHOD: CORE	
DRILLED BY: WINNEN	
LOGGED BY: R. KRAKOWSKI	
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

MW-9

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY KMC	LOCATION CUSHING, OK	BORING NUMBER MWR-9 CRC-9

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
5	CLAY FROM AIR CUTTINGS		CL			1		11'		START CORE
10	START CORE									
15	SILTY SAND ▼ LIGHT TAN, WET		SM			2		17'	5.7	6 ft RUN
20	SAME AS ABOVE					3		26'	7.0	9 ft RUN
25										
30	CLAY, RED, SOFT		CL			4		31'	3.2	5 ft RUN
35	LIMESTONE FOSSILIFEROUS		Ls			5		41'	7.3	10 ft RUN
40	SHALE GRAY TD = 41'		Sh							

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- _____
- _____

DATE DRILLED	PAGE
11-25-91	1 of 1

DRILLING METHOD: CORE

DRILLED BY: WINNEK

LOGGED BY: R. KRAKOWSKI

EXISTING GRADE ELEVATION (FT AMSL):

LOCATION OR GRID COORDINATES: SE CORNER

MW-11

SOIL BORING LOG KM-5655-A

MWR-11

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY KMC	LOCATION CUSHING, OK	BORING NUMBER CRC-10

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
5	CLAY FROM RETURNS		CL			1				SAMPLES FROM RETURNS
10	START CORE							11'		START CORE
	CLAY, RED, SOFT, MOIST		CL			2		16'	4.3	5ft RUN
15	CLAY, LIGHT GREEN, SOFT, MOIST									
	ALTERNATING SILTSTONE SHALE AND SILTY SANDSTONE		SM Sh			3		21'	4.7	5FT RUN
20	SANDSTONE, LIGHT TAN FINE GRAIN, WET		SM			4		31'	8.6	10 ft RUN
25	SAME AS ABOVE									
30	SHALE, RED, GREEN MOTTLING GREEN STRINGERS		Sh			5		36'	4.4	5 ft RUN
35	SHALE, DARK MAROON, GREEN AND LIGHT BROWN MOTTLING		Sh							

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
  - SPLIT-BARREL
  - AUGER
  - ROCK CORE
  - THIN-WALLED TUBE
  - CONTINUOUS SAMPLER
  - NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- ____
- ____

DATE DRILLED	PAGE
11-26-91	1 of 1

DRILLING METHOD: CORE

DRILLED BY: WINNER

LOGGED BY: R. KRAKOWSKI

EXISTING GRADE ELEVATION (FT AMSL):

LOCATION OR GRID COORDINATES: SW CORNER

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: Refining	LOCATION: Cushing OK	BORING NUMBER: CC6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
0	No RECOVERY								2'	
	lt brn clayey silt									
	red brn silty calc mudstone moist									
5	as above with some yellow streaks and irregular sand beds dk moist								5'	
	as above with white calc laminae									
10	red brn silty calc moist mudstone								2.5'	
	No RECOVERY									
15	red brn sandy silty moist mudstone								5'	
	as above dk brn calc and w/ yellow streaks									
20										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL | AUGER | ROCK CORE | THIN-WALLED TUBE | CONTINUOUS SAMPLER | NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY | SILT | SAND | GRAVEL | SILTY CLAY | CLAYEY SILT | DEBRIS FILL | HIGHLY ORGANIC (PEAT) | SANDY CLAY | CLAYEY SAND | ____ | ____

DATE DRILLED: 7/22/91 | PAGE: 1 of 13
DRILLING METHOD: ROTARY AUGER
DRILLED BY: TERRACON
LOGGED BY: R. E. OPPEL
EXISTING GRADE ELEVATION (FT. AMSL)
LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER CC6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
20	red brn silty sli calcareous mudstone w/ lt gy grn silty dolomitic sandstone beds from 22.5' to 24.5'								5'	
25	as above but softer								5'	
30	NO RECOVERY									
	red brn silty sli calc shale								4	
35	as above								5	
40										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
  - SPLIT-BARREL
  - AUGER
  - ROCK CORE
  - THIN-WALLED TUBE
  - CONTINUOUS SAMPLER
  - NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- ☐ _____
- ☐ _____

DATE DRILLED: 7/22/91

PAGE: 2 of 13

DRILLING METHOD: ROTARY AUGER

DRILLED BY: TERRACON

LOGGED BY: R. E. OPPEL

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: Refining	LOCATION: Cushing, OK	BORING NUMBER: CC6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
40	NO RECOVERY									
	red brn silty sli calcareous shale crumbly @ top								5'	
45	NO RECOVERY BEGAN WIRE LINE CORING AT 45'									
50	red-maroon mudstone slightly fissile at top. Slickensides @ 49.2' and 52.0' limestone nodules from 51.5' to 52.5'								6'	
	maroon-red brn silty mudstone with scat sand streaks									
	lt gy greenish vf-f grnd sandstone									
55	variegated mudstone yellow streaks at base / silt									
	dark grey-black mudstone								10.25'	
	fxln argil brecciated gy ls									
	fxl argil foss ls									
	rubble-like dol argil vfxln-fxln ls with abundant fossil frags vuggy @ base									
60										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL; AUGER; ROCK CORE; THIN-WALLED TUBE; CONTINUOUS SAMPLER; NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY; DEBRIS FILL; SILT; HIGHLY ORGANIC (PEAT); SAND; SANDY CLAY; GRAVEL; CLAYEY SAND; SILTY CLAY; CLAYEY SILT; ______; ______

DATE DRILLED	7/22&23/91
PAGE	3 of 13
DRILLING METHOD	ROTARY AUGER & WIRELINE CORE
DRILLED BY	TERRACON
LOGGED BY	R.E. OPPEL
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY Refining	LOCATION Cushing	BORING NUMBER CC6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
60	vf gnd silty ss lt gray									
	black shale with sand streak @ 61.5								10.25'	
	fine to very fine gnd ss w/ thin black shale laminae lt grey									
65	black shale pyritic fossils? along partings									
	interbedded vf gnd silty sand and black shale. lt grey sd									
	vf gnd silty sand with wavy shale laminae.								6.5'	
70	hard black shale									
	sd as above									
	no recovery core hard; driller suspected limestone									
75	hard black pyritic shale								10'	
80										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID — Photoionization Detection (ppm)
- NO. — Identifies Sample by Number
- TYPE — Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH — Depth Top and Bottom of Sample
- REC. — Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- _____
- _____

DATE DRILLED 7/23/91. PAGE 4 of 13

DRILLING METHOD ROTARY WIRE LINE CORE

DRILLED BY TERRACON

LOGGED BY R. E. OPPEL

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: Refining	LOCATION: Cushing	BORING NUMBER: CC6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
80	hard black pyritic shale									
	fine to v fine grad sub-angular very arenaceous fossiliferous mudstone with occasional sand stroks								10'	
	black hard clayey shale									
85	No Recovery									
	dk gy blk mudstone w/ scatt pebbles, to ½" at base									
	greenish grey & maroon mottled silt w/ pebbles of f grad ss and ls, up to 2" at base								2'	
	greenish gy silty v f grad ss w/ ls pebbles at base									
90	as above w/ maroon mottles									
	gy v f grad silty ss									
	maroon sandy mudstone w/ ⅛" pebbles of ss and ls and irregular stringers and nodules of gy v. argillaceous ss fewer pebbles from 94' to 95'									
95	as above								10'	
100										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. TYPE Identifies Sample by Number / Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- ☐ _____
- ☐ _____

DATE DRILLED: 7/23/91

PAGE: 5 of 13

DRILLING METHOD: ROTARY WIRELINE GJ

DRILLED BY: TERRACON

LOGGED BY: R E OPPEL

EXISTING GRADE ELEVATION (FT. AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM—5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: Refining	LOCATION: Cushing OK	BORING NUMBER: CC6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
100	as above									
	maroon clayey mudstone									
	maroon & yellow mottled silty mudstone w/ scatt stks gy silt									
	gy siltstone w/ scatt maroon silty mudstone								10'	
	silty mudstone with ls, ss & dol pebbles at base									
	gy & grn gy silt in part dolomitic with interbeds of silty mudstone in part contorted									
105	as above									
	gy grn allcalc argil ss & maroon silty mudstone									
	maroon silty mudstone w/ irreg yellow beds								9.8'	
	as above with dol blebs									
	gy silt w/ mix of yellow & maroon mudstone in irregular pattern in part dolomitic									
110	maroon silty mudstone w/ irregular yellow streaks									
	v argil dol ss ls w/ maroon & gy grn argil stks									
	maroon silty mudstone w/ c-ss ls pink purple dense argil limestone									
	No RECOVERY									
	maroon mudstone									
	maroon gy grn silty sandy mudstone with 4 beds of ls pebbles									
	gy grn mott silty & sand sandy mudstone									
115	maroon & gy grn sandy argil silt w/ thin beds maroon mudstone								9.25'	
	maroon & gy grn mudstone									
	gy grn, maroon & yellow silty mudstone with few thin beds gy silt									
	see next page									
120										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY, SILT, SAND, GRAVEL, SILTY CLAY, CLAYEY SILT, DEBRIS FILL, HIGHLY ORGANIC (PEAT), SANDY CLAY, CLAYEY SAND

DATE DRILLED: 7/24 & 25/91

PAGE: 6 of 13

DRILLING METHOD: ROTARY WIRELINE CORE

DRILLED BY: TERRACON

LOGGED BY: R. E. DOPEL

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: Refining	LOCATION: Cushing OK	BORING NUMBER: CC6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
120	maroon argillaceous sandy in part silt								9.25'	
	maroon & gy grn mottled clayey slick mudstone; grn predominant at base. scatt gy silt beds in top 1'									took sample (7") @ 124' for perm analysis →
	No Recovery									
125	Variegated mottled mudstone gy, blk, maroon, yellow in part bedded									
	gy f-vf grnd argil sd w/ w/ scatt gy, grn, maroon & yellow traces of mudstone								10'	#2 perm sample @ 129' →
	as above w/ inc in mudst.									
	variegated bedded mudstone with gy, blk, maroon, grn yellow beds									
130	gy grn silty mudstone w/ 1" brown ?? bands @ top									
	var gil siltstone w/ bands of fossil material									
	multicolor laminated sh blk & yellow predominate plus maroon, gy grn									#3 perm sample @ 134' →
	soft black clayey sh									
135	hard blk shale w/ scattered chert pebbles								9'	
	soft clayey blk shale									
	No RECOVERY									
140	SEE NEXT PAGE									

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY, SILT, SAND, GRAVEL, SILTY CLAY, CLAYEY SILT, DEBRIS FILL, HIGHLY ORGANIC (PEAT), SANDY CLAY, CLAYEY SAND

DATE DRILLED	7/25/91
PAGE	7 of 13
DRILLING METHOD	Rotary Wire Line Core
DRILLED BY	TERRACON
LOGGED BY	R.E. OPPEL
EXISTING GRADE ELEVATION (FT AMSL)	
LOCATION OR GRID COORDINATES	

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY Refining	LOCATION Cushing OK	BORING NUMBER CCG

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
140	gy & maroon silty sandy mudstone w/ few dolomite pebbles @ 144'								9'	
145	red maroon mudstone with dolomite inclusions from 148-149.5 Dolomite is lt gy grn hard fine grained									
150	reddish tan clayey mudstone w/ scatt dolomite pebble plus few chert pebbles more olive brn below 152.75								9.5'	
	to sandy w/ dol cobbles									
	olive brn clayey mudstone w/ dol pebbles									
155	NO RECOVERY									
	maroonish w/ scatt inclusions of pinkish purple argil ls few scatt silt brds from 158'-160'								9.8'	prim smpl @ 156'
160										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- ☐ _____
- ☐ _____

DATE DRILLED 7/25 & 26/91 PAGE 8 of 13

DRILLING METHOD Rotary / Wireline Core

DRILLED BY Terracon

LOGGED BY R. E. OPPEL

EXISTING GRADE ELEVATION (FT. AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY: Refining	LOCATION: Cushing OK	BORING NUMBER: CC6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
160	variegated shale w/ abundant [illegible] beds									
	variegated sh. - gy, gygrn yelow maroon, maroon in top [illegible]								9.8'	
	[illegible] ls									
	variegated shale as above w/o maroon									#5 prim sample @ 164' →
165	black shale									prim smpl @ 166' → #6
	black sandy fossiliferous shale and mudstone most fossils 168'-169.75' non below 170.5' pebbles common from 170.0' - 172.5'								9.8'	
170										
	gy grn dense argills with mottled appearance on side of core									
	as above but maroon									
	gngy vfgnd argil silty sd									
175	as above w/ [illegible] maroon & gy grn mudstone									
	maroon mudstone w/ [illegible] [illegible] at base									
	maroon mudstone with few scattered layers of fossil debris								10'	
	gygrn vf-fgnd [illegible] argillaceous [illegible]									
180										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY, DEBRIS FILL, SILT, HIGHLY ORGANIC (PEAT), SAND, SANDY CLAY, GRAVEL, CLAYEY SAND, SILTY CLAY, CLAYEY SILT

DATE DRILLED	7/26 & 27/91
PAGE	9 of 13
DRILLING METHOD	ROTARY WIRELINE CORE
DRILLED BY	TERRACON
LOGGED BY	R. E. OPPEL
EXISTING GRADE ELEVATION (FT AMSL)	
LOCATION OR GRID COORDINATES	

SOIL BORING LOG KM–5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION	BORING NUMBER CC6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
180	sand as above w/ scatt layers red mudstone and pebbles dolomite & siltstone									
	maroon sandy mudstone w/ sand in worm borings									
	gy grn vf and argil sd								10'	
	gy grn silt argil f gnd sd									
	gy grn vf-f gnd argil sand w/ irregular bedding.									
185	gy grn vf-f gnd argil subrnd to ang sandstone thin streaks [illegible] mudstone at 185.5' 2" [illegible] mudstone at 187.5' [illegible] of [illegible] mudstone 188', 188.75' and 189' - 189.5'								10'	
190										
195	gy grn vf-f gnd argil sandstone w/ thin beds, [illegible] beds, swirls. Sand is angular to subround								10'	
200										

EXPLANATION

▼ Water Table (24 Hour)
▽ Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO. Identifies Sample by Number
TYPE Sample Collection Method

SPLIT-BARREL — AUGER — ROCK CORE — THIN-WALLED TUBE — CONTINUOUS SAMPLER — NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY — DEBRIS FILL — SILT — HIGHLY ORGANIC (PEAT) — SAND — SANDY CLAY — GRAVEL — CLAYEY SAND — SILTY CLAY — CLAYEY SILT

DATE DRILLED: 7/27/91

PAGE: 10 of 13

DRILLING METHOD: Rotary wireline core

DRILLED BY: Terracon

LOGGED BY: R.E. Oppel

EXISTING GRADE ELEVATION (FT AMSL):

LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM—0655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY Refining	LOCATION Cushing OK	BORING NUMBER CC6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
200	sandstone as above								15'	
205	gy grn vf-f grnd angular to sub rond argil sandstone; abundant dark laminae throughout in various orientations								9.8'	
210										
215	sandstone as above 2" gy shot streak at 220'								9.4	7.27.91 8.5.91
220										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY, SILT, SAND, GRAVEL, SILTY CLAY, CLAYEY SILT, DEBRIS FILL, HIGHLY ORGANIC (PEAT), SANDY CLAY, CLAYEY SAND

DATE DRILLED	7/27 & 8/5/91
PAGE	11 of 13
DRILLING METHOD	ROTARY WIRELINE CORE
DRILLED BY	TERRACON
LOGGED BY	K.F. OPPEL
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

KM SUBSIDIARY: Refining

LOCATION: Cushing OK

BORING NUMBER: CC6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
220	as above occassional clay and mudstone inclusions in what appear to be vugs								9.4	
225	sand as above w/ fossil rubble and mudstones									
	gy f-mgnd sub angular sub rnd friable sandstone w/ scatt irregular black mudstone laminae								9.2	
230										
235	sandstone as above								[illegible]	
240										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL / AUGER / ROCK CORE
- THIN-WALLED TUBE / CONTINUOUS SAMPLER / NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND: CLAY, DEBRIS FILL, SILT, HIGHLY ORGANIC (PEAT), SAND, SANDY CLAY, GRAVEL, CLAYEY SAND, SILTY CLAY, CLAYEY SILT

DATE DRILLED: 8-5-91

PAGE: 12 of 13

DRILLING METHOD: ROTARY WIRELINE CORE

DRILLED BY: TERRACON

LOGGED BY: R. E. OPPEL

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION	BORING NUMBER CC 6

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
240	sand as above								10.1	
	as above w/ abundant [illegible] fragments "rubble"									
245'	gy, grn gy to maroon sh									
	maroon calcareous mudstone w/ scatt fossil fragments								9.3'	
	gy grn sh w/ occ scatt thin beds silt & vfgnd sandstone									
250	maroon fossiliferous mudstone grading to brownish maroon @ 252'									
255	TOTAL DEPTH 254.25'									
260										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- ☐ _____
- ☐ _____

DATE DRILLED 8-5-91

PAGE 13 of 13

DRILLING METHOD ROTARY WIRE LINE CORE

DRILLED BY TERRACON

LOGGED BY R. E. OPPEL

EXISTING GRADE ELEVATION (FT. AMSL)

LOCATION OR GRID COORDINATES

APPENDIX B
FORMATION CORE PERMEABILITY DATA
AREA 1

CONSTANT HEAD PERMEABILITY REPORT

PROJECT NAME Karr McCaa Testing PROJECT NO. 91-325T

LOCATION Cushing, OK

BORING # CC6 SAMPLE # 1 DEPTH 124'

SAMPLE TYPE Undisturbed % COMPACTION ---

INITIAL MOISTURE 9.7% INITIAL DRY UNIT WEIGHT 124.2 pcf

INITIAL VOID RATIO .36 INITIAL SATURATION 73.4%

FINAL MOISTURE 12.7% FINAL SATURATION 96.3%

SAMPLE DESCRIPTION Reddish-brown weathered shale

TEST DATA

DATE	TEST NO.	TIME (sec.)	HEAD PRESSURE (cm)	TEMP. °C	Q_3 cm³
9/3/91	1	3600	105.5	27	.25
9/3/91	2	3600	105.5	27	.5
9/3/91	3	3600	105.5	27	.1
9/3/91	4	3600	105.5	27	.1
AVERAGE	4	3600	105.5	27	.24

k = $5.27E^{-8}$ cm/s n/n_{20} = .8502

k_{20} = $4.48E^{-8}$ cm/s

CONSTANT HEAD PERMEABILITY REPORT

PROJECT NAME Kerr McGee Testing PROJECT NO. 91-325T

LOCATION Cushing, OK

BORING # _____ SAMPLE # CC6 #2 DEPTH ± 329'

SAMPLE TYPE Undisturbed % COMPACTION ---

INITIAL MOISTURE 9.6% INITIAL DRY UNIT WEIGHT 135.8 pcf

INITIAL VOID RATIO .29 INITIAL SATURATION 94.1%

FINAL MOISTURE 10.4 FINAL SATURATION 101.5%

SAMPLE DESCRIPTION Red brown & gray marbled weathered shale

TEST DATA

DATE	TEST NO.	TIME (sec.)	HEAD PRESSURE (cm)	TEMP. °C	Q_3 cm^3
9/21/91	1	6000	98.5	27	.1
9/21/91	2	6030	98.5	27	.1
9/21/91	3	6000	98.5	27	.1
9/21/91	4	6000	98.5	27	.05
AVERAGE	4	6007	98.5	27	.08

k_T = 1.06E^{-7} cm/s $\quad n_T/n_{20}$ = .8502

k_{20} = 8.98E^{-8} cm/s

ALPHA-OMEGA GEOTECH

Lux

FAX TRANSMISSION

TODAY'S DATE 9/25/91 TIME 5:20 NO. OF PAGES 6

TO: Jeff Lux
LOCATION: Kerr McGee
FAX NUMBER: 405-270-3010
TELEPHONE NUMBER:
COMMENTS:

FROM: Frank Comer
LOCATION: Alpha-Omega Geotech, Inc.
FAX NUMBER:
TELEPHONE NUMBER: 913-371-0000

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TOP OF DOCUMENT

CONSTANT HEAD PERMEABILITY REPORT

PROJECT NAME Kerr McGee Testing PROJECT NO. 91-325T
LOCATION Cushing, OK
BORING # CC6 SAMPLE # 3 DEPTH 134'
SAMPLE TYPE Undisturbed % COMPACTION ---
INITIAL MOISTURE 11.2% INITIAL DRY UNIT WEIGHT 124.2 pcf
INITIAL VOID RATIO .36 INITIAL SATURATION 84.2%
FINAL MOISTURE 14.1% FINAL SATURATION 96.8%
SAMPLE DESCRIPTION Grayish-brown unweathered shale

TEST DATA

DATE	TEST NO.	TIME (sec.)	HEAD PRESSURE (cm)	TEMP. °C	Q_{in} cm³
9/3/91	1	3600	105.5	27	3.6
9/3/91	2	3600	105.5	27	3.8
9/3/91	3	4500	105.5	27	4.8
9/3/91	4	6000	105.5	27	5.1
AVERAGE	4	4425	105.5	27	4.8

$k = 2.15E^{-6}$ cm/s $n / n_{20} = .8502$

$k_{20} = 1.83E^{-6}$ cm/s

CONSTANT HEAD PERMEABILITY REPORT

PROJECT NAME Kerr McGee PROJECT NO. 91-325T

LOCATION Cushing, OK

BORING # CC6 SAMPLE # 4 DEPTH 156'

SAMPLE TYPE Undisturbed % COMPACTION ------

INITIAL MOISTURE 12.3% INITIAL DRY UNIT WEIGHT 133.6PCF

INITIAL VOID RATIO .35 INITIAL SATURATION 100.4%

FINAL MOISTURE 12.1% FINAL SATURATION 98.8%

SAMPLE DESCRIPTION Ruddish Brown weathered shale

TEST DATA

DATE	TEST NO.	TIME (sec.)	HEAD PRESSURE (cm)	TEMP. °C	Q_3 cm^3
9/14	1	3600	70.34	27	.3
9/14	2	3600	70.34	27	.3
9/14	3	3600	70.34	27	.3
9/14	4	3600	70.34	27	.2
AVERAGE	4	3600	70.34	27	.3

k_T = $5.76E^{-7}$ cm/s n_T/n_{20} = .8502

k_{20} = $4.90E^{-7}$ cm/s

ALPHA-OMEGA GEOTECH

CONSTANT HEAD PERMEABILITY REPORT

PROJECT NAME Kerr McGee Testing PROJECT NO. 91-325T

LOCATION Cushing, OK

BORING # CC6 SAMPLE # 3 DEPTH 164'

SAMPLE TYPE Undisturbed % COMPACTION ---

INITIAL MOISTURE 10.3% INITIAL DRY UNIT WEIGHT 131.1 pcf

INITIAL VOID RATIO .29 INITIAL SATURATION 97.5%

FINAL MOISTURE 9.7% FINAL SATURATION 100%

SAMPLE DESCRIPTION Dark brown weathered shale

TEST DATA

DATE	TEST NO.	TIME (sec.)	HEAD PRESSURE (cm)	TEMP. °C	Q_h cm³
9/9/91	1	3600	133.6	27	.10
9/9/91	2	3600	133.6	27	.10
9/9/91	3	3600	133.6	27	.10
9/9/91	4	7200	133.6	27	.10
AVERAGE	4	4500	133.6	27	.10

$k = 4.29 \times 10^{-8}$ cm/s $n / n_{20} = .8502$

$k_{20} = 3.65 \times 10^{-8}$ cm/s

CONSTANT HEAD PERMEABILITY REPORT

PROJECT NAME Kerr McGee Testing PROJECT NO. 91-325T

LOCATION Cushing, OK

BORING # _____ SAMPLE # CC6 #6 DEPTH 166'

SAMPLE TYPE Undisturbed % COMPACTION ---

INITIAL MOISTURE 9.7% INITIAL DRY UNIT WEIGHT 134.3 pcf

INITIAL VOID RATIO .30 INITIAL SATURATION 89.8%

FINAL MOISTURE 10.6% FINAL SATURATION 98.1%

SAMPLE DESCRIPTION Dark gray weathered SHALE

TEST DATA

DATE	TEST NO.	TIME (sec.)	HEAD PRESSURE (cm)	TEMP. °C	Q_w cm³
9/13/91	1	3600	70.34	27	3.8
9/13/91	2	3600	70.34	27	3.6
9/13/91	3	3600	70.34	27	3.3
9/13/91	4	3600	70.34	27	4.0
AVERAGE					

$k_T = 7.07E^{-6}$ cm/s $\eta_T/\eta_{20} = .8502$

$k_{20} = 6.01E^{-6}$ cm/s

ALPHA-OMEGA GEOTECH

APPENDIX C

WATER LEVEL DATA FOR MONITOR WELLS

AREA 1

Historical Water Levels in Cushing Area 1

	MW-1		MW-2		MW-3		MW-4		MW-5		MW-6	
Date	Depth to Water (ft BTOC)	WL Elev. (ft BTOC)	Depth to Water (ft BTOC)	WL Elev. (ft BTOC)	Depth to Water (ft BTOC)	WL Elev. (ft BTOC)	Depth to Water (ft BTOC)	WL Elev. (ft BTOC)	Depth to Water (ft BTOC)	WL Elev. (ft BTOC)	Depth to Water (ft BTOC)	WL Elev. (ft BTOC)
01/22/92	Dry	Dry	8.18	883.57	13.06	866.49	13.15	868.01	38.42	858.62	31.18	866.05
02/26/92	Dry	Dry	7.98	883.77	12.67	866.88	13.15	868.01	35.27	861.77	29.67	867.56
03/19/92	Dry	Dry	7.49	884.26	12.38	867.17	13.14	868.02	34.82	862.22	28.67	868.56
04/21/92	Dry	Dry	7.40	884.35	12.04	867.51	13.15	868.01	34.43	862.61	27.11	870.12
05/20/92	Dry	Dry	6.01	885.74	11.73	867.82	13.14	868.02	34.40	862.64	25.79	871.44
06/17/92	Dry	Dry	6.03	885.72	11.59	867.96	13.15	868.01	34.11	862.93	24.69	872.54
07/23/92	Dry	Dry	8.28	883.47	11.23	868.32	12.57	868.59	34.10	862.94	22.84	874.39
08/19/92	Dry	Dry	8.67	883.08	11.14	868.41	12.31	868.85	34.02	863.02	20.77	876.46
09/23/92	Dry	Dry	9.36	882.39	10.99	868.56	12.05	869.11	33.96	863.08	18.73	878.50
10/21/92	Dry	Dry	10.13	881.62	10.95	868.60	11.92	869.24	34.07	862.97	17.43	879.80
11/18/92	Dry	Dry	9.93	881.82	10.98	868.57	11.89	869.27	33.98	863.06	16.42	880.81
12/11/92	Dry	Dry	5.17	886.58	10.91	868.64	11.87	869.29	33.99	863.05	15.85	881.38
01/13/93	Dry	Dry	4.35	887.40	10.69	868.86	11.95	869.21	33.93	863.11	15.13	882.10
02/17/93	Dry	Dry	4.01	887.74	10.39	869.16	11.91	869.25	33.90	863.14	14.31	882.92
03/17/93	8.37	887.27	5.49	886.26	10.02	869.53	11.62	869.54	33.83	863.21	13.53	883.70
04/21/93	7.75	887.89	4.93	886.82	9.58	869.97	11.25	869.91	33.71	863.33	12.80	884.43
05/26/93	7.09	888.55	5.72	886.03	8.84	870.71	10.72	870.44	34.17	862.87	12.14	885.09
06/18/93	7.37	888.27	6.72	885.03	8.33	871.22	10.48	870.68	34.14	862.90	11.74	885.49
07/28/93	8.14	887.50	9.39	882.36	8.72	870.83	10.20	870.96	33.82	863.22	11.33	885.90
08/25/93	8.63	887.01	10.72	881.03	9.42	870.13	10.29	870.87	33.33	863.71	11.24	885.99
09/24/93	8.83	886.81	10.70	881.05	9.76	869.79	10.47	870.69	33.60	863.44	11.22	886.01
10/27/93	8.95	886.69	11.54	880.21	10.28	869.27	10.73	870.43	33.72	863.32	11.43	885.80
11/16/93	9.07	886.57	11.69	880.06	10.47	869.08	10.84	870.32	33.46	863.58	11.52	885.71
09/24/93	9.32	886.32	11.94	879.81	10.78	868.77	11.19	869.97	33.47	863.57	11.71	885.52
Mean WL	8.35	887.29	7.99	883.76	10.71	868.84	11.80	869.36	34.19	862.85	17.80	879.43

Note: "ft BTOC" indicates "Feet Below Top of Casing"

Historical Water Levels in Cushing Area 1 (continued)

	MW-7		MW-8		MW-9		MW-10		MW-11		CMW29.1	
Date	Depth to Water (ft BTOC)	WL Elev. (ft BTOC)	Depth to Water (ft BTOC)	WL Elev. (ft BTOC)	Depth to Water (ft BTOC)	WL Elev. (ft BTOC)	Depth to Water (ft BTOC)	WL Elev. (ft BTOC)	Depth to Water (ft BTOC)	WL Elev. (ft BTOC)	Depth to Water (ft BTOC)	WL Elev. (ft BTOC)
01/22/92	26.40	865.08	13.24	879.04	10.32	869.92	10.82	869.82	13.77	867.55	N/A	N/A
02/26/92	24.58	866.90	13.73	878.55	10.39	869.85	10.91	869.73	14.81	866.51	N/A	N/A
03/19/92	24.04	867.44	13.74	878.54	10.42	869.82	10.84	869.80	14.52	866.80	106.60	790.62
04/21/92	23.62	867.86	13.79	878.49	10.32	869.92	10.75	869.89	14.22	867.10	106.80	790.42
05/20/92	23.64	867.84	13.95	878.33	10.68	869.56	11.10	869.54	14.40	866.92	106.15	791.07
06/17/92	23.54	867.94	13.19	879.09	10.17	870.07	10.60	870.04	13.92	867.40	106.75	790.47
07/23/92	23.73	867.75	12.81	879.47	10.66	869.58	11.06	869.58	14.10	867.22	106.34	790.88
08/19/92	23.72	867.76	12.53	879.75	10.58	869.66	10.99	869.65	14.10	867.22	106.68	790.54
09/23/92	23.77	867.71	13.02	879.26	10.94	869.30	11.36	869.28	14.47	866.85	106.73	790.49
10/21/92	23.84	867.64	13.77	878.51	11.59	868.65	12.00	868.64	14.82	866.50	106.64	790.58
11/18/92	23.66	867.82	13.35	878.93	10.60	869.64	11.02	869.62	14.53	866.79	106.69	790.53
12/11/92	23.63	867.85	12.60	879.68	9.94	870.30	10.39	870.25	14.17	867.15	105.96	791.26
01/13/93	23.60	867.88	11.88	880.40	9.66	870.58	10.12	870.52	13.91	867.41	105.60	791.62
02/17/93	23.11	868.37	11.38	880.90	9.50	870.74	9.94	870.70	13.42	867.90	105.15	792.07
03/17/93	22.86	868.62	10.96	881.32	9.42	870.82	9.86	870.78	13.30	868.02	104.68	792.54
04/21/93	22.67	868.81	10.51	881.77	9.17	871.07	9.66	870.98	12.61	868.71	104.94	792.28
05/26/93	22.61	868.87	9.67	882.61	8.94	871.30	9.38	871.26	12.44	868.88	100.96	796.26
06/18/93	22.65	868.83	9.82	882.46	9.28	870.96	9.70	870.94	12.46	868.86	103.51	793.71
07/28/93	22.93	868.55	8.13	884.15	11.21	869.03	11.63	869.01	13.58	867.74	104.20	793.02
08/25/93	23.18	868.30	[illegible]	880.17	12.76	867.48	13.16	867.48	14.93	866.39	104.74	792.48
09/24/93	23.23	868.25	12.42	879.86	12.88	867.36	13.30	867.34	15.38	865.94	104.88	792.34
10/27/93	23.53	867.95	13.28	879.00	13.24	867.00	13.61	867.03	15.93	865.39	105.33	791.89
11/16/93	23.22	868.26	13.42	878.86	13.15	867.09	13.56	867.08	15.79	865.53	105.21	792.01
09/24/93	23.40	868.08	13.02	879.26	11.73	868.51	12.13	868.51	15.30	866.02	106.64	790.58
Mean WL	23.55	867.93	12.35	879.93	10.73	869.51	11.16	869.48	14.20	867.12	105.51	791.71

Note: "ft BTOC" indicates "Feet Below Top of Casing"

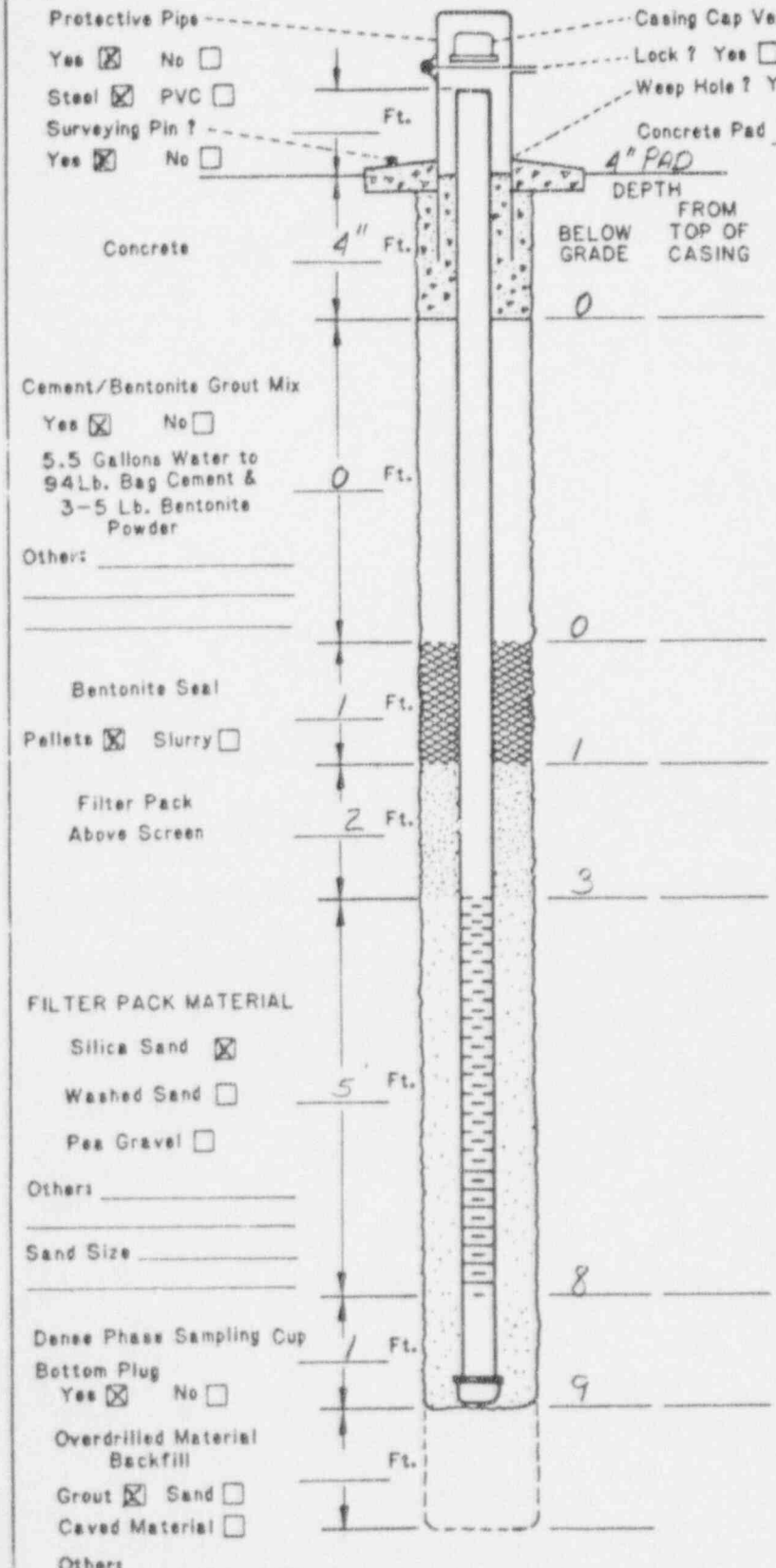
APPENDIX D

WELL COMPLETION DIAGRAMS FOR MONITOR WELLS

AREA 1

MW-1

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 8 1/4 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☒
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw–Couple ☒ Glue–Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 2 Inches, Screen 2 Inches.
5. Slot Size of Screen: .010
6. Type of Screen Perforation: Factory Slotted ☑
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☒ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   _____ / _____ Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☐
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☐
   If Yes , Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling _____ Ft. Date _____
Before Development _____ Ft. Date _____
After Development _____ Ft. Date _____

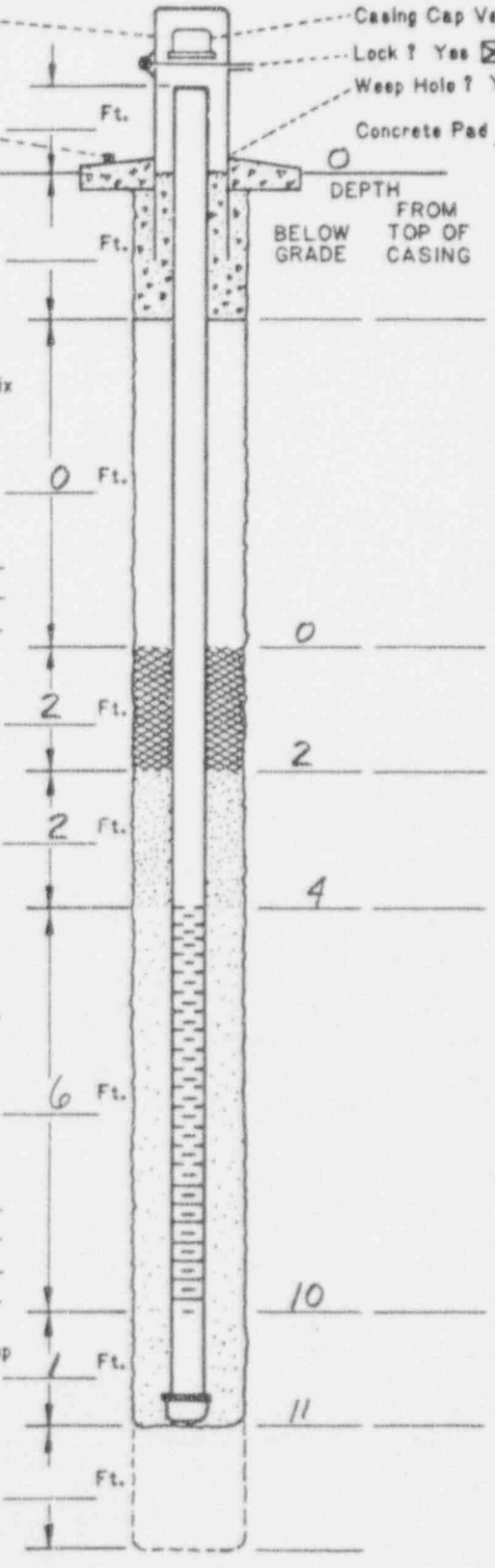
Driller/Firm WINNER Drill Rig Type MOBIL-B-53 Date Installed 11-19-91

Drill Crew _____ Well No. MWR-1 / SBR-1 Kerr-McGee Hydrologist R KRAKOWSKI

START 1:20
FINISH 2:30

MW-2

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Protective Pipe — Yes ☒ No ☐ — Steel ☒ PVC ☐ — Surveying Pin ? Yes ☒ No ☐

Casing Cap Vent ? Yes ☒ No ☐

Lock ? Yes ☒ No ☐

Weep Hole ? Yes ☒ No ☐

Concrete Pad 5 Ft. x 5 Ft. x 4 Inches

Ft.

0 DEPTH FROM TOP OF CASING

Concrete Ft. BELOW GRADE

Cement/Bentonite Grout Mix
Yes ☒ No ☐
5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder
0 Ft.
Other: _____

0

Bentonite Seal
2 Ft.
Pellets ☒ Slurry ☐

2

Filter Pack Above Screen
2 Ft.

4

FILTER PACK MATERIAL
Silica Sand ☒
Washed Sand ☐
Pea Gravel ☐
6 Ft.
Other: _____
Sand Size _____

10

Dense Phase Sampling Cup
1 Ft.
Bottom Plug Yes ☐ No ☐

11

Overdrilled Material Backfill
Ft.
Grout ☒ Sand ☐
Caved Material ☐
Other: _____

DRILLING INFORMATION:

1. Borehole Diameter= 8 1/4 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☒
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 2 Inches, Screen 2 Inches.
5. Slot Size of Screen: .010
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☒ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   _____ / _____ Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☐
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☐
   If Yes , Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling _____ Ft. Date _____

Before Development _____ Ft. Date _____

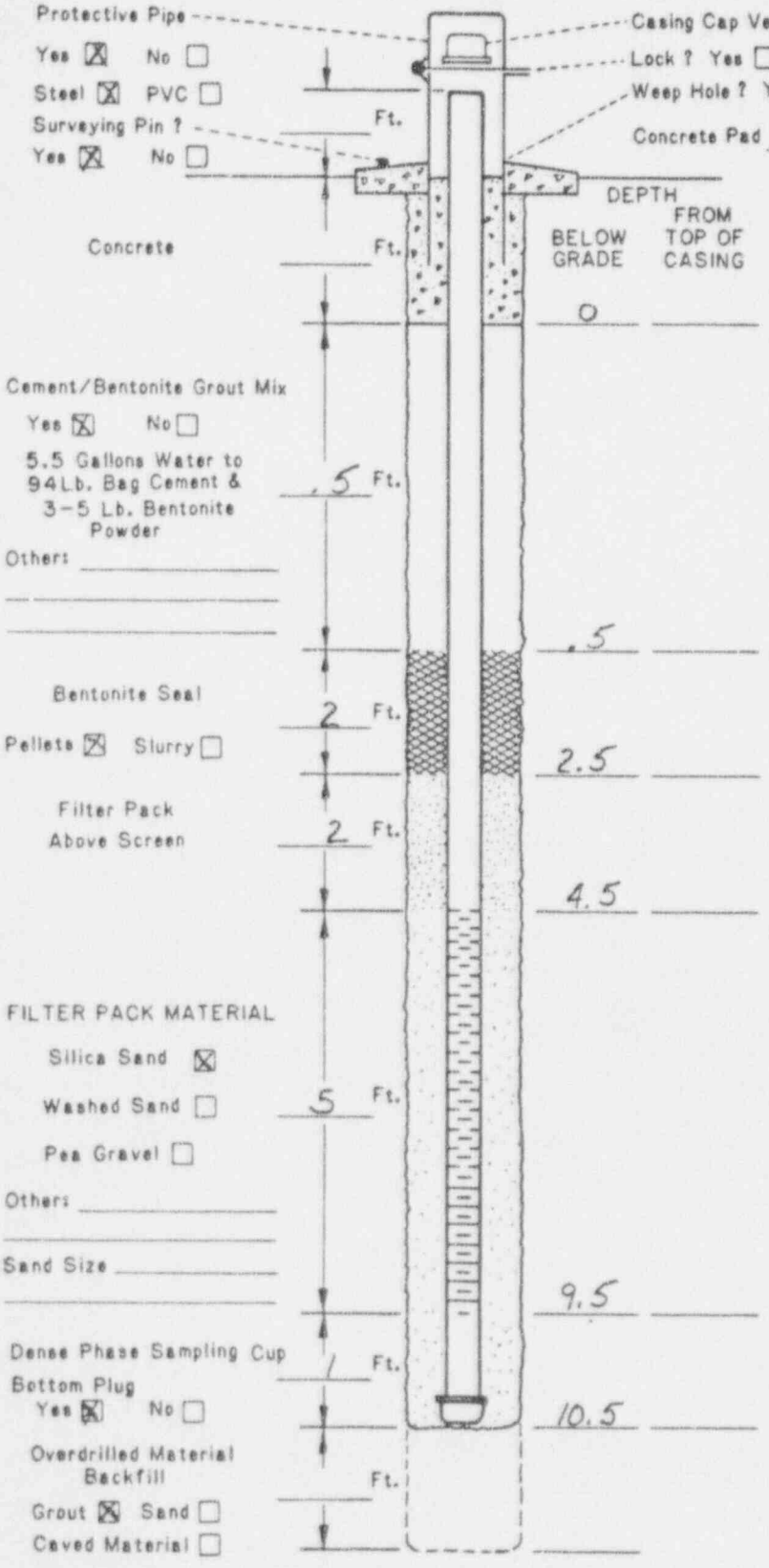
After Development _____ Ft. Date _____

Driller/Firm WINNER — Drill Rig Type _____ — Date Installed 11-19-91

Drill Crew W. VICK — Well No. MWR-2 — Kerr-McGee Hydrologist P. KRAKOWSKI

MW-3

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 8 1/4 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☒
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 2 Inches, Screen 2 Inches.
5. Slot Size of Screen:
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☒ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   _____ / _____ Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☐
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☐
   If Yes , Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

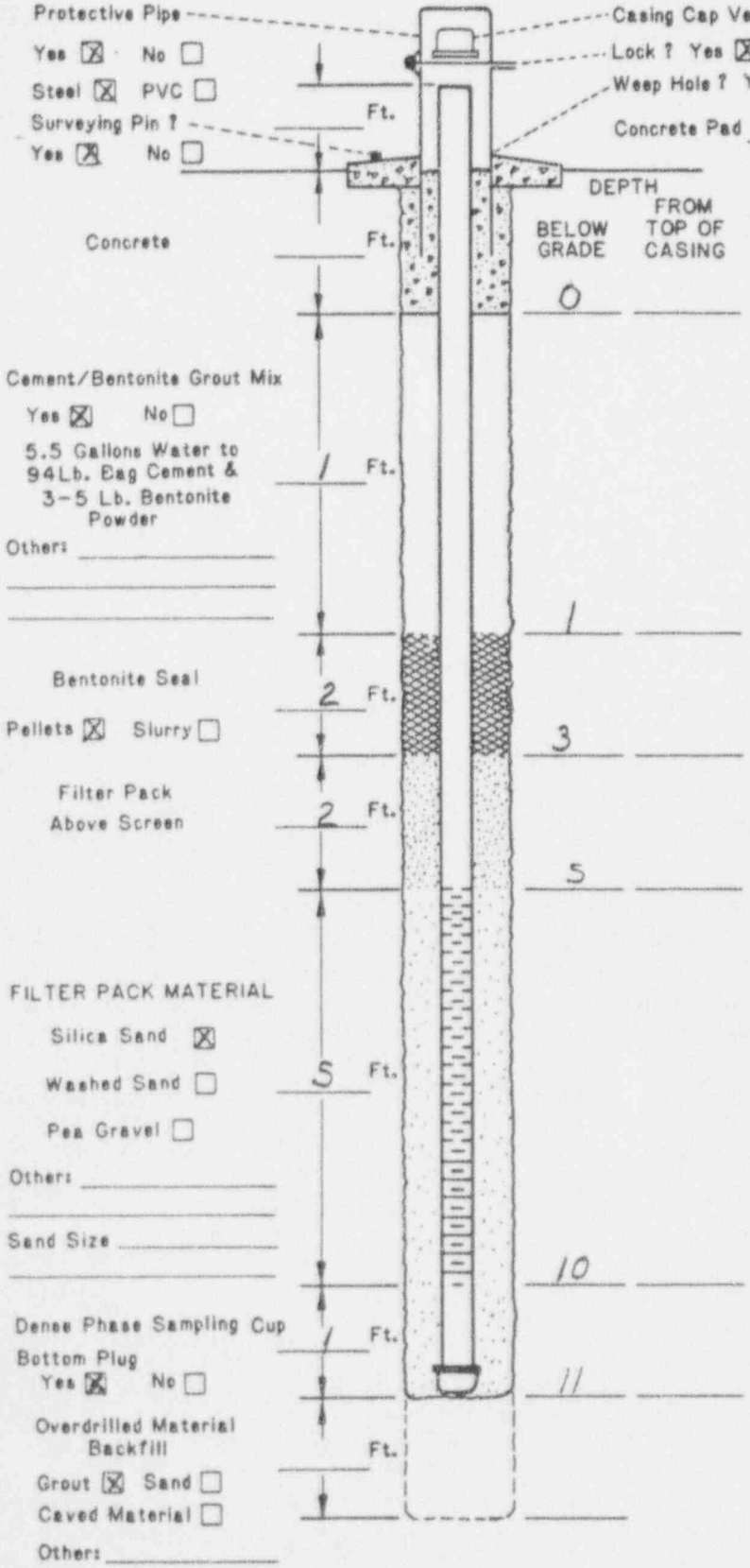
During Drilling _____ Ft. Date _____
Before Development _____ Ft. Date _____
After Development _____ Ft. Date _____

Driller/Firm WINNEK Drill Rig Type _____ Date Installed 11-20-91

Drill Crew W. VICK Well No. MWR-3 SBR-4 Kerr-McGee Hydrologist R. KRAKOWSKI

MW-4

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 8 1/4 inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☒
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 2 inches, Screen 2 inches.
5. Slot Size of Screen: .010
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☒ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   _____ / _____ Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☐
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☐
   If Yes , Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling _____ Ft. Date _____

Before Development _____ Ft. Date _____

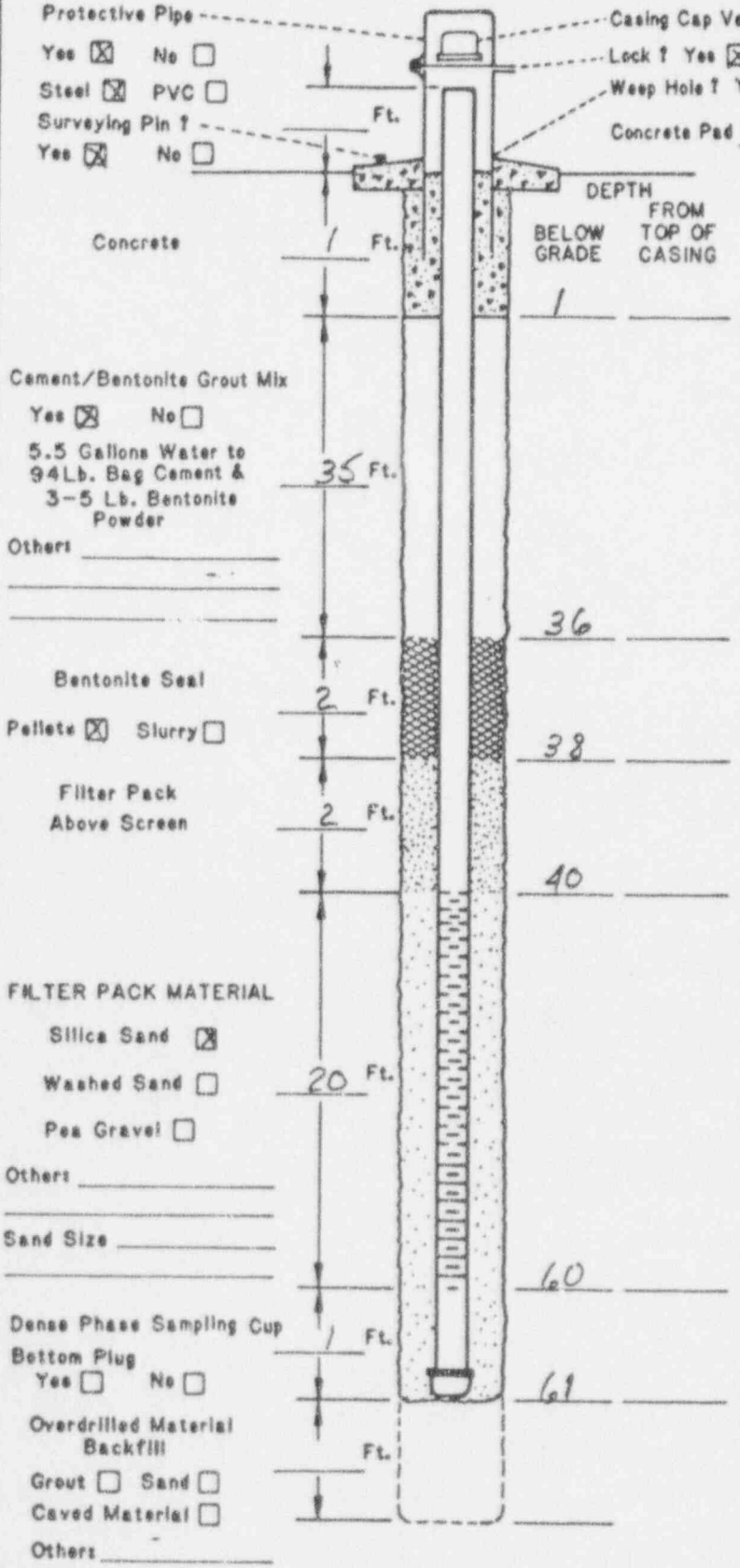
After Development _____ Ft. Date _____

Driller/Firm WINNER Drill Rig Type _____ Date Installed 11-20-91

Drill Crew W. VICK Well No. MWR-4 SBR-5 Kerr-McGee Hydrologist R. KRANOWSKI

MW-5

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Concrete Pad 5 Ft. x 5 Ft. x 4 inches

DRILLING INFORMATION:

1. Borehole Diameter= 8 1/4 inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☒ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 2 Inches, Screen 2 Inches.
5. Slot Size of Screen: .010
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☒ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   _____ / _____ Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☐
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☐
   If Yes, Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling _____ Ft. Date _____

Before Development _____ Ft. Date _____

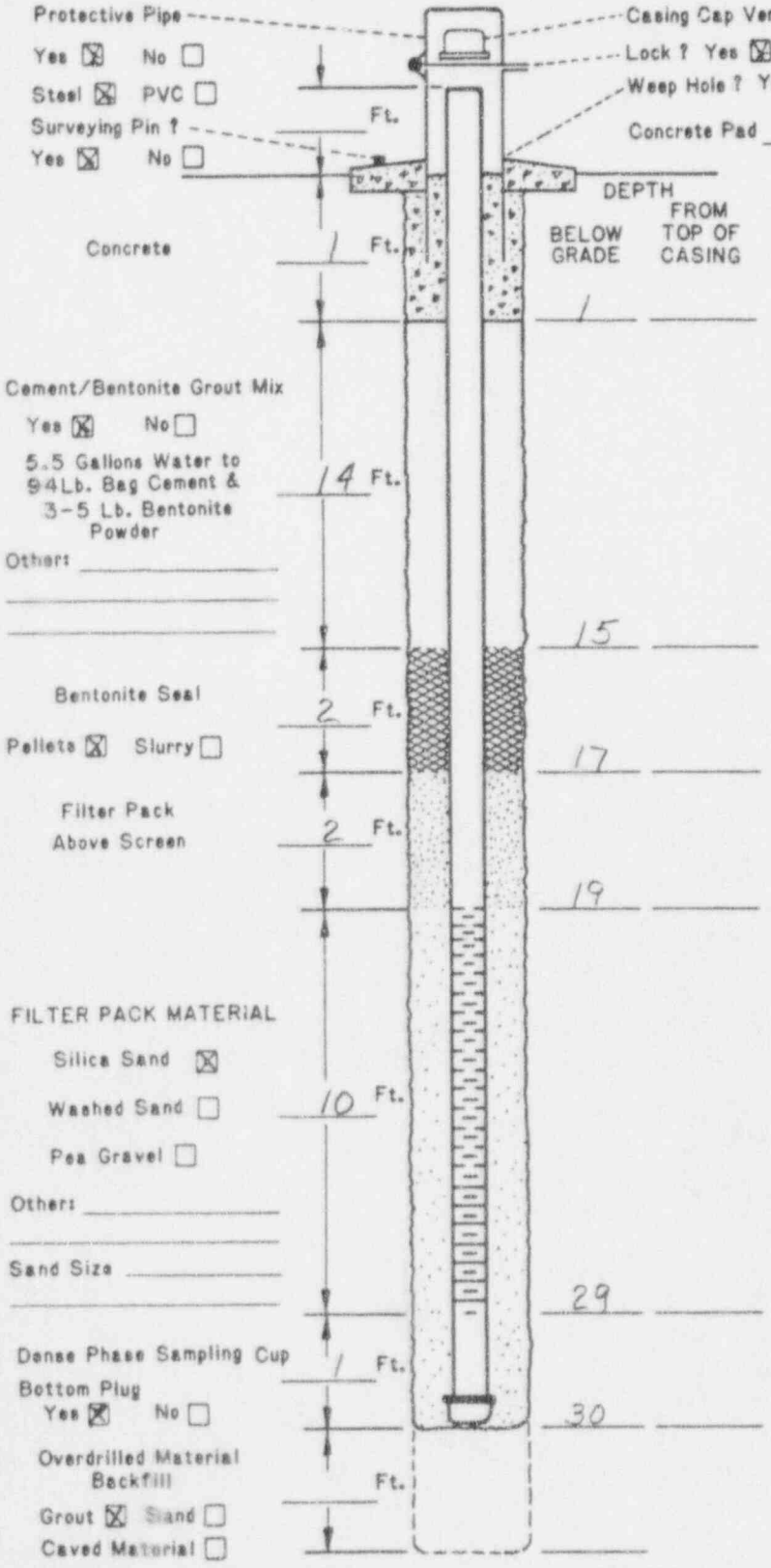
After Development _____ Ft. Date _____

Driller/Firm WINNEK Drill Rig Type FAILING-1250 Date Installed 11-21-91

Drill Crew W. VICK Well No. MWR-5 CRC-6 Kerr-McGee Hydrologist R. KRAKOWSKI

MW-6

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 8 1/4 inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☒ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= ____ to ____ Feet.
4. Borehole Diameter for Outer Casing ____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other ____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other ____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other ____
4. Diameter of Casing and Well Screen:
   Casing 2 Inches, Screen 2 Inches.
5. Slot Size of Screen:
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other ____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☒ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other ____
2. Time Spent on Well Development ?
   ____ / ____ Minutes/Hours
3. Approximate Water Volume Removed ? ____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☐ Opaque ☐
6. Did Water have Oder ? Yes ☐ No ☐
   If Yes, Describe ____
7. Did Water have any Color ? Yes ☐ No ☐
   If Yes , Describe ____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

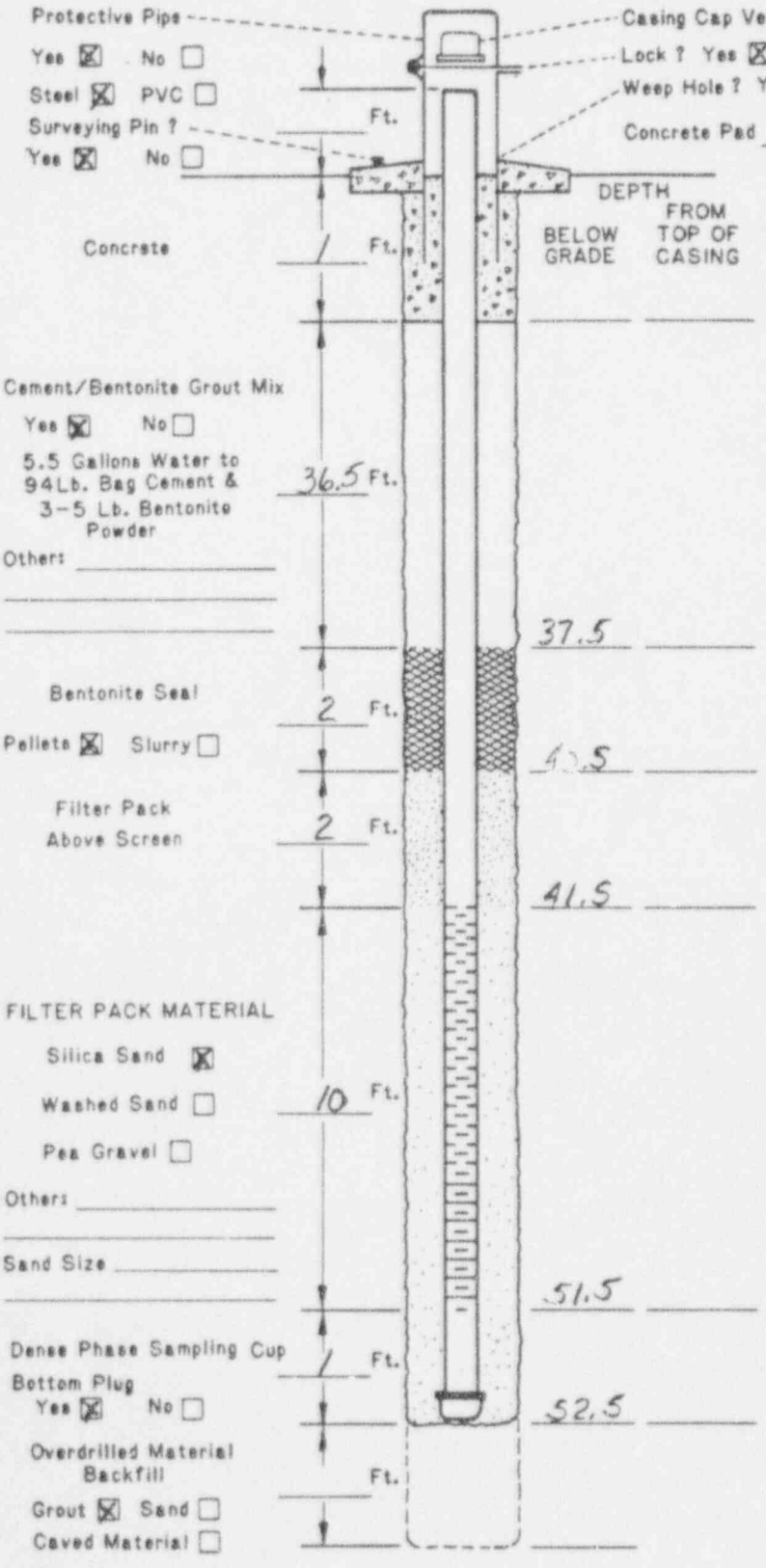
During Drilling ____ Ft. Date ____
Before Development ____ Ft. Date ____
After Development ____ Ft. Date ____

Driller/Firm WINNEK Drill Rig Type FAILING - 1250 Date Installed 11-21-91

Drill Crew W. VICK Well No. MWR-6 CRC-7 Kerr-McGee Hydrologist R. KRAKOWSKI

MW-7

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 8 1/4 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☒
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 2 Inches, Screen 2 Inches.
5. Slot Size of Screen: .010
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☒ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   _____ / _____ Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☐
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☐
   If Yes , Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

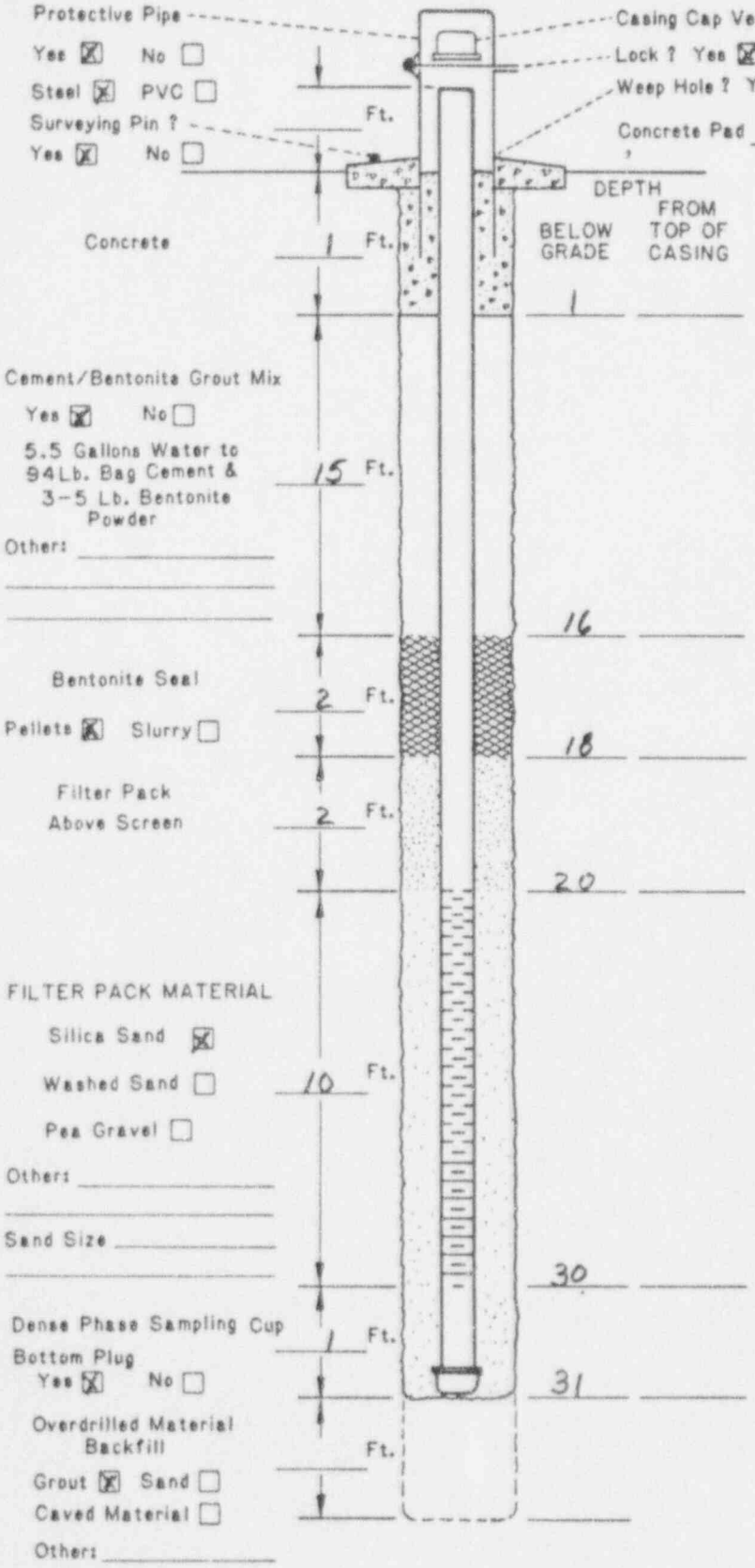
During Drilling _____ Ft. Date _____
Before Development _____ Ft. Date _____
After Development _____ Ft. Date _____

Driller/Firm WINNER Drill Rig Type FOILING-1250 Date Installed 11-22-91

Drill Crew W. VICK Well No. MWR-7 CRC-8 Kerr-McGee Hydrologist R. KRAKOWSKI

MW-8

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 8 1/4 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☒
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 2 Inches, Screen 2 Inches.
5. Slot Size of Screen: .010
6. Type of Screen Perforation: Factory Slotted ☐
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☒ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   _____ / _____ Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☐
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☐
   If Yes , Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

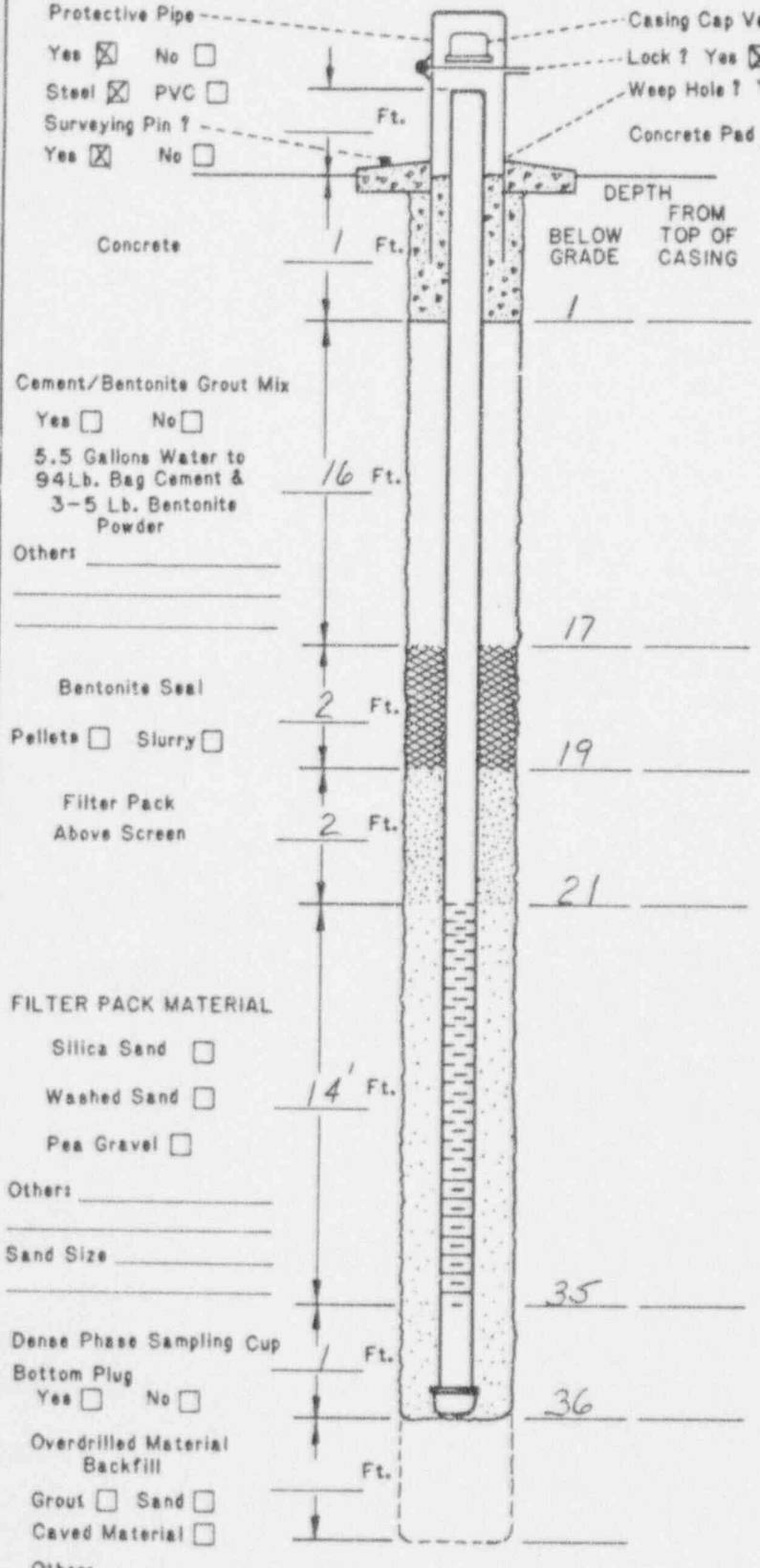
During Drilling _____ Ft. Date _____
Before Development _____ Ft. Date _____
After Development _____ Ft. Date _____

Driller/Firm WINNEK
Drill Rig Type _____
Date Installed 11-25-91
Drill Crew W. VICK
Well No. MWR-8
COMPLETE WELL ID
Kerr-McGee Hydrologist R. KRAKOWSKI

(NO SOIL BORING LOG)

MW-9

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 8 1/4 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☒
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 2 Inches, Screen 2 Inches.
5. Slot Size of Screen: .010
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   _____ / _____ Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☐
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☐
   If Yes, Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

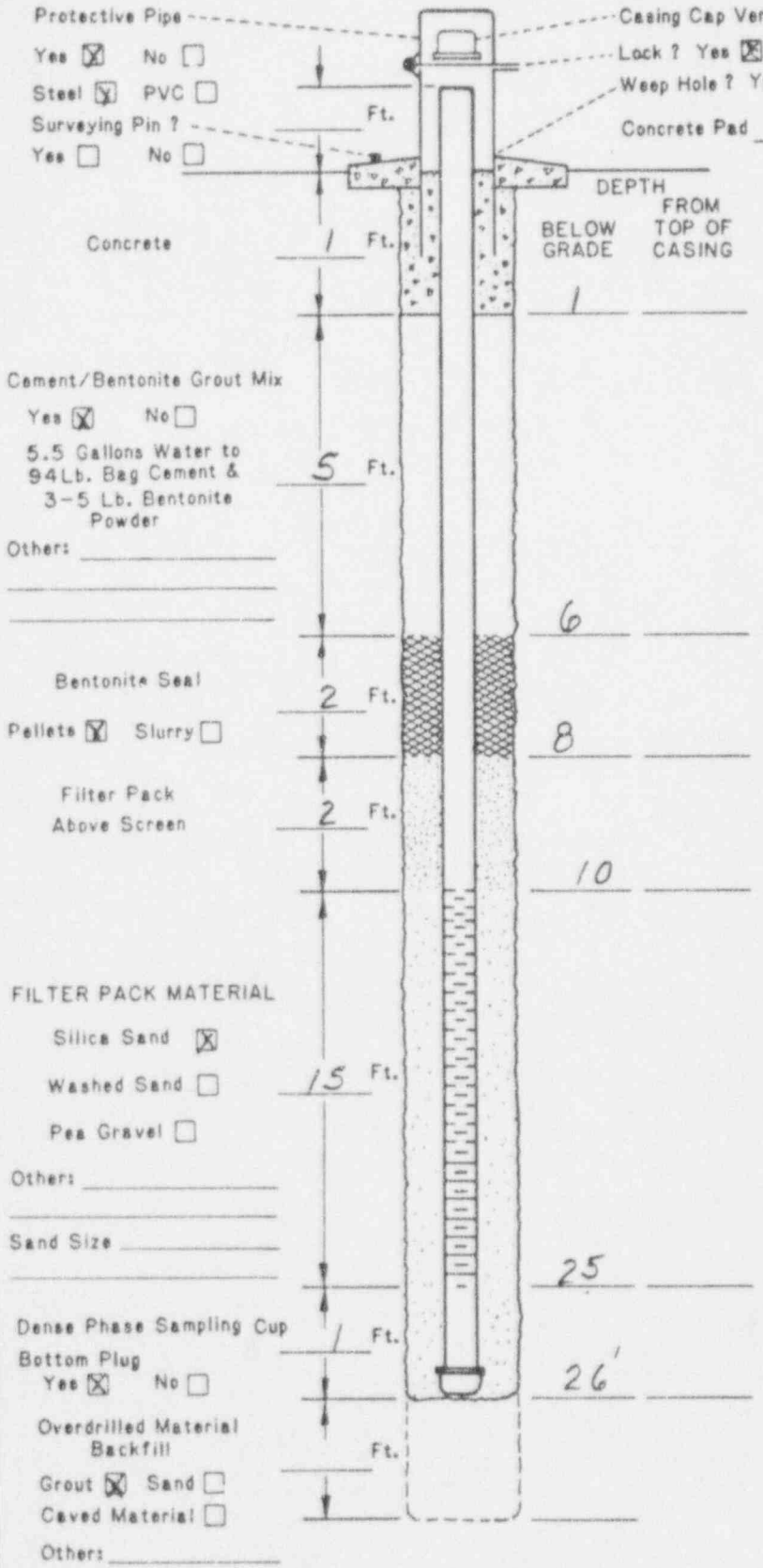
During Drilling _____ Ft. Date _____
Before Development _____ Ft. Date _____
After Development _____ Ft. Date _____

Driller/Firm WINNEK Drill Rig Type FAILING 1250 Date Installed 11-25-91

Drill Crew W. VICK Well No. MWR-9 CRC-9 Kerr-McGee Hydrologist R. MAKOWSKI

MW-10

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 8 1/4 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☒
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 2 Inches, Screen 2 Inches.
5. Slot Size of Screen:
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☒ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   _____ / _____ Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☐
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☐
   If Yes , Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling _____ Ft. Date _____
Before Development _____ Ft. Date _____
After Development _____ Ft. Date _____

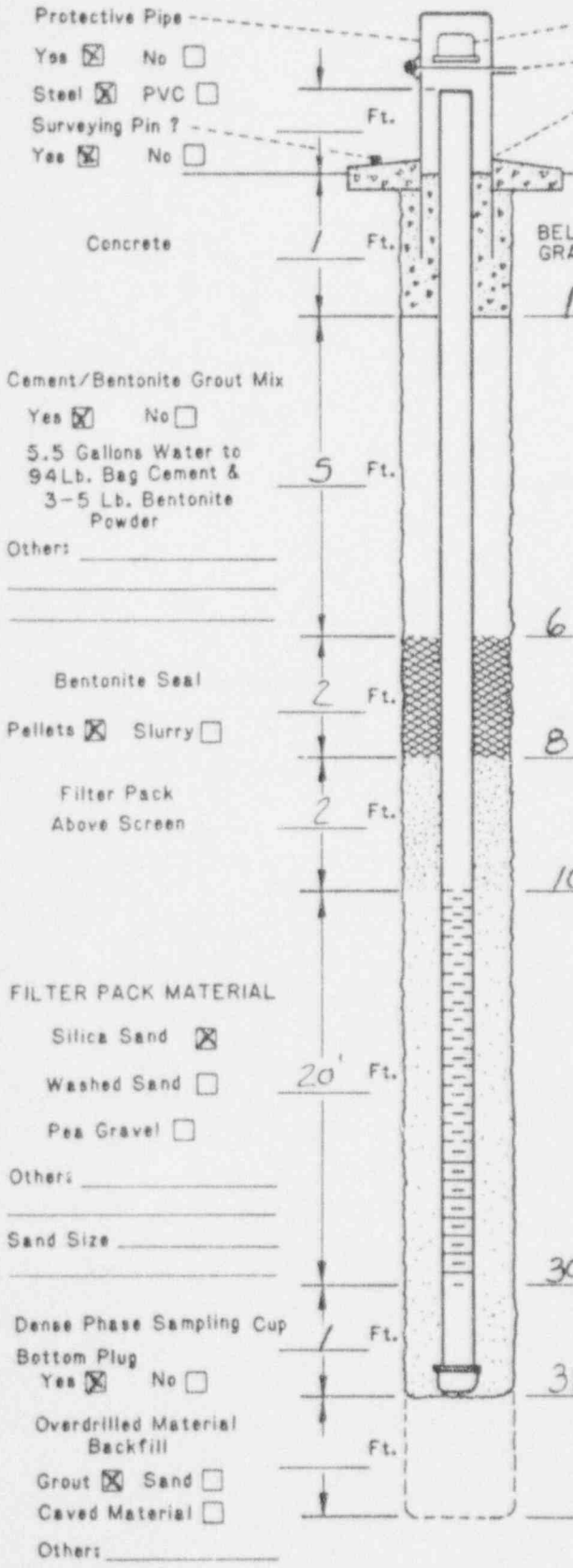
Driller/Firm WINNEK Drill Rig Type _____ Date Installed 11-25-91

Drill Crew W. VICK Well No. MWR-10 Kerr-McGee Hydrologist R. KRAKOWSKI

NOTE:
(NO SOIL BORING LOG)

MW-11

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 8 1/4 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☐
   Solid Auger ☐ Hollow Stem Auger ☒
3. Was Outer Steel Casing Used ? Yes ☐ No ☒
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing _____ Inches, Screen _____ Inches.
5. Slot Size of Screen:
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☒ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   _____ / _____ Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☐ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☐
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☐
   If Yes , Describe _____

WATER LEVEL INFORMATION:

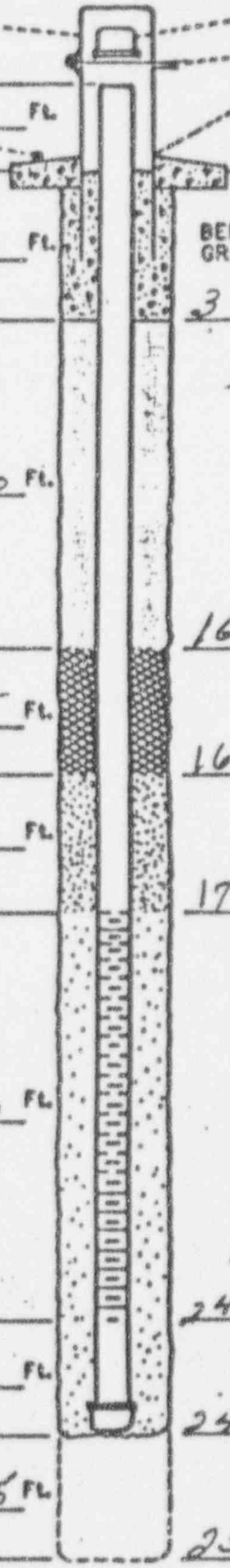
Water Level Summary (From Top of Casing)

During Drilling _____ Ft. Date _____
Before Development _____ Ft. Date _____
After Development _____ Ft. Date _____

Driller/Firm WINNEK Drill Rig Type FAILING 1250 Date Installed 11-26-91

Drill Crew W. VICK Well No. MWR-11 CRC-10 Kerr-McGee Hydrologist R. KRAKOWSKI

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
CMW29.1
MONITORING WELL INSTALLATION DIAGRAM



Protective Pipe
Yes [x] No [ ]
Steel [x] PVC [ ]
3 Ft.
Surveying Pin ?
Yes [x] No [ ]

Casing Cap Vent ? Yes [ ] No [x]
Lock ? Yes [x] No [ ]
Weep Hole ? Yes [ ] No [ ]
Concrete Pad 5 Ft. x 5 Ft. x 4 Inches

	Length	DEPTH BELOW GRADE	DEPTH FROM TOP OF CASING
Concrete	3 Ft.	3	
Cement/Bentonite Grout Mix Yes [x] No [ ] (5.5 Gallons Water to 94Lb. Bag Cement & 3-5 Lb. Bentonite Powder); Others	160 Ft.	163	
Bentonite Seal — Pellets [x] Slurry [ ]	5 Ft.	168	
Filter Pack Above Screen	6 Ft.	174	
Screen	70 Ft.	244	
Dense Phase Sampling Cup; Bottom Plug Yes [x] No [ ]	1 Ft.	245	
Overdrilled Material Backfill — Grout [ ] Sand [x] Caved Material [ ] Others None	9.25 Ft.	254.25	

FILTER PACK MATERIAL
Silica Sand [x]
Washed Sand [ ]
Pea Gravel [ ]
Others
Sand Size 10-20 CSSI

DRILLING INFORMATION:
1. Borehole Diameter= 8 Inches.
2. Were Drilling Additives Used ? Yes [x] No [ ]
   Revert [x] Bentonite [ ] Water [x]
   Solid Auger [ ] Hollow Stem Auger [x]
3. Was Outer Steel Casing Used ? Yes [ ] No [x]
   Depth= ______ to ______ Feet.
4. Borehole Diameter for Outer Casing 8 Inches.

WELL CONSTRUCTION INFORMATION:
1. Type of Casing: PVC [ ] Galvanized [ ] Teflon [ ]
   Stainless [x] Other ______
2. Type of Casing Joints: Screw-Couple [x] Glue-Couple [ ] Other ______
3. Type of Well Screen: PVC [ ] Galvanized [ ]
   Stainless [x] Teflon [ ] Other ______
4. Diameter of Casing and Well Screen
   Casing 4" Inches, Screen 4" Inches.
5. Slot Size of Screen
6. Type of Screen Perforation: Factory Slotted [x]
   Hacksaw [ ] Drilled [ ] Other ______
7. Installed Protector Pipe w/Lock: Yes [ ] No [ ]

WELL DEVELOPMENT INFORMATION:
1. How was Well Developed ? Bailing [ ] Pumping [ ]
   Air Surging (Air or Nitrogen) [x] Other ______
2. Time Spent on Well Development ?
   60min. / Minutes/Hours
3. Approximate Water Volume Removed ? ______ Gallons
4. Water Clarity Before Development ? Clear [ ]
   Turbid [x] Opaque [ ]
5. Water Clarity After Development ? Clear [x]
   Turbid [ ] Opaque [ ]
6. Did Water have Odor ? Yes [ ] No [x]
   If Yes, Describe ______
7. Did Water have any Color ? Yes [ ] No [x]
   If Yes, Describe ______

WATER LEVEL INFORMATION:
Water Level Summary (From Top of Casing)

During Drilling ______ Ft. Date ______
Before Development 105 Ft. Date 8/17
After Development ______ Ft. Date ______

Driller/Firm [illegible] / Terra[illegible]   Drill Rig Type CME rotary   Date installed 8/17/91
Drill Crew ASH / strunn   Well No. CC6   Kerr-McGee Hydrologist OPPEL

APPENDIX E
LITHOLOGIC LOGS
AREA 2

SOIL BORING LOG KM-1 USA

KERR McGEE CORPORATION
Hydrology Dept. Engineering Services

KM SUBSIDIARY: KM Hydrology

LOCATION: Cushing SW Farm

BORING NUMBER: SWF-1

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
0	brown silty SAND					1		0-5		SOIL CUTTINGS NO HC ODOR
5	brown to tan fine SANDSTONE					2			15%	
10	fine brown SANDSTONE - med. brown to dark brown sl. CLAY to SHALE - with some sandstone gravel					3			60%	
15	red brown & gray SHALE; gray LIMESTONE; dark gray CLAY (SHALE)								80%	
	medium gray CLAY (very stiff)					4			20%	dark & gray CL - very stiff, plugging the core bit (drilling discontinued)
20	medium gray SILTSTONE									drilling resumed on 3-16-93
	gray silty SANDSTONE; gray MUDSTONE, organics - black laminae with organic 1/4" of fine SANDSTONE					5			45%	
25	gray silty CLAY to MUDSTONE					6			70%	NO HC ODOR
30	dark gray MUDSTONE to shale					7			65%	
35	some brown SANDSTONE in MUDSTONE									
	dark gray SHALE with gypsum crystals					8		35-39	70%	
40	(see page 2)									

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS, FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED: 3-15 & - 93

PAGE: 1 of 2

DRILLING METHOD: core bit, rot. mud

DRILLED BY: KM - M. Wilkerson

LOGGED BY: Jan Fajgl

EXISTING GRADE ELEVATION (FT AMSL):

LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM-5655A

KERR-McGEE CORPORATION
Hydrology Dept Engineering Services

KM SUBSIDIARY: Kt Hydro Pogy

LOCATION: CUSHING, OK SW FARM

BORING NUMBER: SWF-1

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
40	gray SHALE					9		39-49	30%	NO HC ODOR
45	red brown clayey SHALE with sand									boring terminated
50										
55										
60										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS,FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED: 3-16-93 - 3-17-93

PAGE: 2 of 2

DRILLING METHOD: rotary mud / core bit

DRILLED BY: Mark Wilkerson

LOGGED BY: Jan Fajgl

EXISTING GRADE ELEVATION (FT AMSL):

LOCATION OR GRID COORDS:

SOIL BORING LOG KM-5655A

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

KM SUBSIDIARY: KM Hydrology

LOCATION: CUSHING, OK — SW FARM

BORING NUMBER: SWF-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	TYPE	DEPTH	REC.	REMARKS OR FIELD OBSERVATIONS
0	0-1 top soil; 1'-5' fine gr. SAND (light brown)					1		0-5		0-5 - auger cuttings NO HC ODOR
5	fine gr. SANDSTONE light brown - tan					2		5-10	20%	
10	fine gr. SANDSTONE light brown to tan (with some CLAY)					3		10-15	25%	
15	brown sl. CLAY					4		15-20	90%	
	light gray fine SANDSTONE s. [illegible] well cemented									well cemented sandstone NO HC ODOR
20	gray to red brown clayey SHALE (1'); gray fine silty SANDSTONE (3'); gray silty SHALE (0.5')					5		20-30	45%	
30	gray sl. MUDSTONE to SHALE					6			85%	
	sandy MUDSTONE gray									
40										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT BARREL — AUGER — ROCK CORE — THIN-WALLED TUBE — CONTINUOUS SAMPLER — NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS,FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED: 3-1[illegible]-93 / 3-1[illegible]-93

PAGE 1 of 2

DRILLING METHOD: rotary mud / core bit

DRILLED BY: Mark W.

LOGGED BY: Jon F

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM-5655-A

KERR-McGLE CORPORATION
Hydrology Dept Engineering Services

KM SUBSIDIARY: KM Hydro Pogg

LOCATION: CUSHING, OK SW FARM

BORING NUMBER: SWF-2

LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
40 grey SILTSTONE (1') well cemented grey MUDSTONE & SHALE (1')									NO HC ODOR
45 reddish brown sandy CLAY to SHALE (1.5')					7		40-50	35%	
50									
55									
60									

Water Table (24 Hour)
Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO Identifies Sample by Number
TYPE Sample Collection Method

SPLIT BARREL | AUGER | ROCK CORE
THIN WALLED TUBE | CONTINUOUS SAMPLER | NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS, FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED: 3-17-93 / 3-19-93

PAGE: 2 of 2

DRILLING METHOD: rotary mud / core bit

DRILLED BY: Mark W.

LOGGED BY: Jan F.

EXISTING GRADE ELEVATION (FT AMSL):

LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM-5655A

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

KM SUBSIDIARY: KM Hydro Pogg

LOCATION: CUSHING, OK SW FARM

BORING NUMBER: SWF-3

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
0	br. sl. sl SAND					1		0-5		auger cuttings NO HC ODOR
5	brown to tan fine SANDSTONE hard with dark brown staining					2		5-10	20%	
10	tan silty SANDSTONE with orange and brown staining					3		10-20	85%	
15	= interbedded layer of siltstone ~ 0.5" and 2" thick									
20	gray, fossiliferous LIMESTONE (1')					4		20'-30'	15%	
25	2" of gray fine silty SANDSTONE + pebbles of gravel (SANDSTONE)									
30	0.5' of medium gray fine silty SANDSTONE w/black organic laminas					5		30'-40'	10%	
35	0.5' med. brown silty CLAY									
40										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS, FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED: 3-22-93

PAGE: 1 of 2

DRILLING METHOD: rotary mud / core bit

DRILLED BY: Mark W.

LOGGED BY: Jon F

EXISTING GRADE ELEVATION (FEET AMSL):

LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION
Hydrology Dept Engineering Services

KM SUBSIDIARY: Kit Hydro Pogg

LOCATION: CUSHING, OK SW FARM

BORING NUMBER: SWF-3

DEPTH	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
40	NO RECOLERY					6			0	NO RECOLERY
45	med. gray SHALE, firm, 3" of SILTSTONE w/ fossils					7			75%	NO HC ODOR
	dark gray silty CLAY									
50										
55										
60										

Water Table (24 Hour)
Water Table (Time of Boring)
PID Photoionization Detection (ppm)
NO Identifies Sample by Number
TYPE Sample Collection Method

SPLIT BARREL
AUGER
ROCK CORE
THIN WALLED TUBE
CONTINUOUS SAMPLER
NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND
CLAY/SHALE
SILT/SILTSTONE
SAND/SANDSTONE
DEBRIS,FILL
MUDSTONE
LIMESTONE

DATE DRILLED: 3-23-93
PAGE: 2 of 2
DRILLING METHOD: rotary mud / core bit
DRILLED BY: Mark W.
LOGGED BY: Jan F.
EXISTING GRADE ELEVATION (FT. MSL):
LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM-5655A

KERR-McGEE CORPORATION
Hydrology Dept Engineering Services

KM SUBSIDIARY: KM Hydro Togy

LOCATION: CUSHING, OK ERW property

BORING NUMBER: ERW-1

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
0						1		0'-5'		auger cuttings debris, brick fill, sh. sl. CLAY
5	5' to 7.5' medium brown CLAY, very stiff, moist, (fat CLAY)					2		5'-10'	65%	NO HC ODOR
10	cca 0.5' of fossiliferous limestone					3		10'-20'	20%	CLAY plugged the sampler bottom not allowing for higher sample recovery
15	brown, fine silty SANDSTONE (2')									NO HC ODOR
20	gray with orange stains CLAY, silt (fat CLAY) (6") gray CLAY to SHALE					4		20'-25'	65%	
25	gray clayey SHALE (8")					5		25'-30'	15%	plugged sampler NO HC ODOR
30	gray clayey SHALE to red-brown clayey and silty SHALE (2.5')					6		30'-35'	50%	
35						7		35-38.5'	80%	← Loss of circulation at 38.5
40	see page 2					8		38.5-40'		

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT BARREL | AUGER | ROCK CORE | THIN WALLED TUBE | CONTINUOUS SAMPLER | NO RECOVERY

DEPTH Depth to and Bottom of Sample
REC. Actual length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS, FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED: 3-24-93 & 3-25-93

PAGE: 1 of 2

DRILLING METHOD: rotary mud / core bit

DRILLED BY: Mark W.

LOGGED BY: Jon F

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION
Hydrology Dept Engineering Services

KM SUBSIDIARY: Kit Hydro Pogy

LOCATION: CUSHING, OK — ERW property

BORING NUMBER: ERW-1

LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
40 red-brown and gray silty CLAY to SHALE					8		38.5-'	90%	NO HC ODOR ↓ plugged sample
45 Same as above					9		-50'	10%	NO HC ODOR
50									boring terminated
55									
60									

DESTINATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT BARREL | AUGER | ROCK CORE | THIN WALLED TUBE | CONTINUOUS SAMPLER | NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS, FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED: 3-25-93

PAGE: 2 of 2

DRILLING METHOD: rotary mud / core bit

DRILLED BY: Mark W.

LOGGED BY: Jan F.

EXISTING GRADE ELEVATION (FT AMSL):

LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION
Hydrology Dept Engineering Services

KM SUBSIDIARY

LOCATION: ERW - Property

BORING NUMBER: ERW-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
0	silty and sandy CLAY				200 ppm	1		0-4.5		auger cuttings HC ODOR
5	tan, fine silty SANDSTONE					2		4.5-10	66%	NO HC ODOR
10	med. brown sl. CLAY, stiff + some pebbles of sandstone grag sl. CLAY					3		10-15	50%	no bedrock may be at 12'-12.5' based on drilling velocity
15	dark gray sl. SHALE interbedded with brown sl. CLAY					4		15-20	60%	NO HC ODOR
20	dark gray SHALE, hard, fissile to SILTSTONE at 20-14' 2" of gray, fat CLAY					5		20-25	70%	
25	red-brown and gray SHALE only 6" recovery					6		25-30	10%	only 6" recovery ⇒ a 2' lost core!
30	debris of red-brown and gray SHALE					7		30-35	20%	(lost core from ~30') NO HC ODOR
35	red-brown sl. SHALE, clayey					8		35-40	10%	
40										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS, FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED: 3-26-93

PAGE: 1 of 2

DRILLING METHOD: core bit + rotary mud

DRILLED BY: KM Hydro - Mail

LOGGED BY: Jan F.

EXISTING GRADE ELEVATION (FT. AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept Engineering Services	KM SUBSIDIARY	LOCATION ERW-Property	BORING NUMBER ERW-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
40	red-brown cl. SHALE, crumbly					9			15%	NO HC ODOR
45	4" of red-brown and gray SILTSTONE, hard red brown cl. SHALE - crumbly 3" of red-brown to gray SILTSTONE, hard					10			80%	
50										boring terminated

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS, FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED 3-29-93 PAGE 2 of 2

DRILLING METHOD core bit + mud rotary

DRILLED BY KM Hydro - Mark W.

LOGGED BY Jan F.

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GWL COORDINATES

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

KM SUBSIDIARY

LOCATION: ERW - Property

BORING NUMBER: ERW-3

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
0	sandy sl. CLAY, brown							0-3		soil cuttings
5	light brown SANDSTONE some clay at 10'							3-10	30%	
10	light to medium brown sl. CLAY (3')							10-15	60%	
	light brown LIMESTONE (2')									
15	med. brown sl. SILT (6") fine brown SANDSTONE (18")							15-20	20%	
20	light gray to brown sl. CLAY brown, fine to medium SANDSTONE (3')							20-25	80%	
25	gray sl. CLAY to MUDSTONE (1')							25-30	95%	
	gray sl. SHALE (3') gray sl. CLAY (1.5')									
30	gray sl. SHALE							30-35	75%	
35	gray fossiliferous limestone (1')							35-40	40%	
	gray mudstone									
40										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS, FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED: 4-1-93 to 4-8-93

PAGE: 1 of 2

DRILLING METHOD: ROTARY MUD / COR BIT

DRILLED BY: KMHD - Mark W.

LOGGED BY: Jan F.

EXISTING GRADE ELEVATION (FT AMSL):

LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION
Hydrology Dept Engineering Services

KM SUBSIDIARY

LOCATION ERW - Property

BORING NUMBER ERW-3

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
40	red brown and gray MUDSTONE (to SHALE), crumbly							40-50	80%	
45										
50										Boring Terminated

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS, FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED 4-8-93

PAGE 2 of 2

DRILLING METHOD Rotary mud / tor Bit

DRILLED BY KOILO - Mark W.

LOGGED BY Van F.

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG AM-5655A

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

KM SUBSIDIARY

LOCATION Cushing, OK

BORING NUMBER ERW-8

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
0	medium brown sl. CLAY							0-5		auger cuttings NO ODOR
5								5-10	0%	NO RECOVERY
10	? SANDSTONE ?									based on drilling velocity → SANDSTONE goes to appr. 15'
15	reddish brown and gray CLAY							10-20	30%	NO ODOR
20	red-brown to gray MUDSTONE to crumbly SHALE									
25								20-30	30%	
30	same as above									
35								30-40	5%	
40										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS, FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED 4-13-93

PAGE 2 of 2

DRILLING METHOD Rotary Mud/Cor Bit

DRILLED BY KMHD - Mark W.

LOGGED BY Jan W.

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5653A

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

KM SUBSIDIARY

LOCATION

BORING NUMBER ERW-8

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
40	red brown SHALE, firm									
	red brown and gray fine SANDSTONE							40-50	60%	
45										
50										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS, FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED 4-12-93

PAGE 1 of 2

DRILLING METHOD Rotary Mud / Cor Bit

DRILLED BY KMHD - Mark W.

LOGGED BY Van F.

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

APPENDIX F
LITHOLOGIC LOGS
AREA 3

DRILL REPORT AND LOG

HOLE NO. B-111 RIG NO. 6

CLIENT Kerr McGee

PROJECT Cushing OK

CLIENT'S REP Jan Fajgl

DRILLER Knopf

DATE: STARTED 6-16-93

COMPLETED

METHOD OF DRILLING Mud Rotary

DEPTH From	DEPTH To	FORMATIONS
0	1.5	Bk. Silty Clay
1.5	2.0	Fill
2.0	3.0	Sandstone
3.0	4.0	Tan Clay
4.0	5.0	Sandstone
5.0	17.0	Tan Clay
17.0	34	Red Bed
34	38	Tan Clay w/ Sandstone lenses
38	42	Sandstone w/ Clay lenses
42	47	Red Bed
47	48	Sandstone
48	58	Red Bed
[illegible]	59	Sandstone
59	[illegible]	Gray Shale
[illegible]	70	Sandstone

SAMPLING						
METHOD	FROM	TO		METHOD	FROM	TO

WELL COMPLETION

Hole Diameter ____ In.
Casing Size ____ In.
Screen Slot ____
Yield ____ GPM
Static W.T. ____ ft.

Material	Depth From	Depth To
Cement Seal		
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		

DRILL REPORT AND LOG

HOLE NO. B-112 RIG NO. 6

CLIENT Kerr McGee

PROJECT Cushing OK

CLIENT'S REP Steve Lower

DRILLER Knopf

DATE: STARTED 6-15-93

COMPLETED

METHOD OF DRILLING Air - Mud Rotary

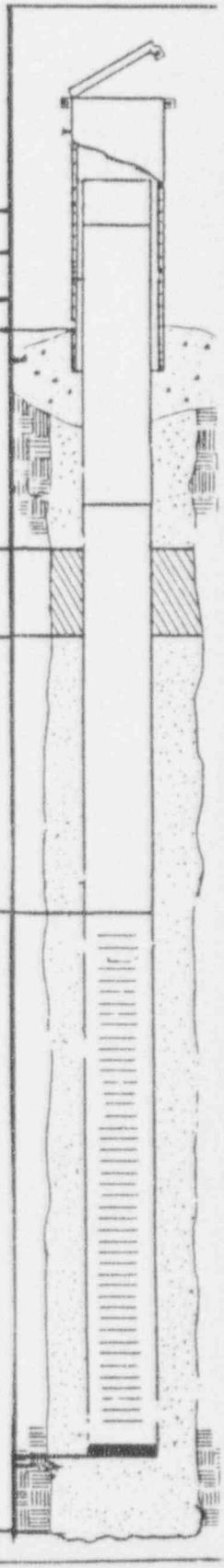
DEPTH From	DEPTH To	FORMATIONS
0	2	Brown S. Clay
2	4.7	Tan Sand Stone
4.7	5.0	Gray Clay Fat
5.0	10.2	Gray Sandy Clay (Slight Petro Oder)
10.2	10.3	Tan Sand Stone
10.3	14.5	Gray Clay (H_2O @ 12'
14.5	18.5	Gray Staley Clay
18.5	19	Tan Sandstone
19	21	Gray Staley Clay w/ Sandstone Lenses
21	22.5	Gray Sandstone
22.5	23.5	Gray Weathered Stale
23.5	24.0	Gray Sandstone
24	27	Gray Staley Clay
27	43	Red Bed
43	45	Gray Shale w/ Sandstone Lenses
45	45.5	Sandstone
45.5	50	Red Bed
50	51	Sandstone

SAMPLING						
METHOD	FROM	TO		METHOD	FROM	TO
		1				

WELL COMPLETION

Hole Diameter ____ In.
Casing Size ____ In.
Screen Slot ____
Yield ____ GPM
Static W.T. ____ ft.

Material	Depth From	Depth To
Cement Seal		
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		



DRILL REPORT AND LOG

HOLE NO. B-112 RIG NO. _____

CLIENT Kerr McGee

PROJECT Cushing

CLIENT'S REP _____

DRILLER _____

DATE: STARTED 5-15-93

COMPLETED _____

METHOD OF DRILLING _____

DEPTH From	DEPTH To	FORMATIONS
51	52	Red Bed
52	53	Sandstone
53	58	Red Bed
58	59	Sandstone
59	71	Red Bed
71	72	Red Bed
72	80	Gray Shale

SAMPLING						
METHOD	FROM	TO		METHOD	FROM	TO

WELL COMPLETION

Hole Diameter ____ In.
Casing Size ____ In.
Screen Slot ____
Yield ____ GPM
Static W.T. ____ ft.

Material	Depth From	Depth To
Cement Seal		
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		

DRILL REPORT AND LOG

HOLE NO. 118-1 RIG NO. 6

CLIENT Kerr McGee

PROJECT Cushing OK

CLIENT'S REP Jan Fajal

DRILLER Koopf

DATE: STARTED 6-21-93

COMPLETED

METHOD OF DRILLING

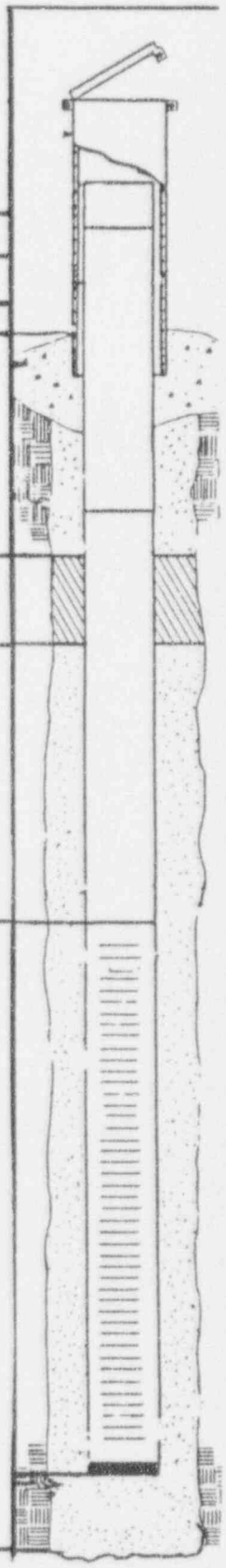
DEPTH From	DEPTH To	FORMATIONS
0	2	Fill
2	3	Tan Clay
3	6	Olive Clay
6	12	Red Clay
12	15	Sandstone
15	21.5	Red Clay
21.5	101	Sandstone
101	110	Gray-Tan Clay

SAMPLING						
METHOD	FROM	TO		METHOD	FROM	TO

WELL COMPLETION

Hole Diameter ____ In.
Casing Size ____ In.
Screen Slot ____
Yield ____ GPM
Static W.T. ____ ft.

Material	Depth From	Depth To
Cement Seal		
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		



DRILL REPORT AND LOG

HOLE NO. B-119 RIG NO. 6

CLIENT Kerr McGee

PROJECT Cushing OK

CLIENT'S REP Jay Fajgl

DRILLER Knopf

DATE: STARTED 6-17-93

COMPLETED

METHOD OF DRILLING Mud Rotary

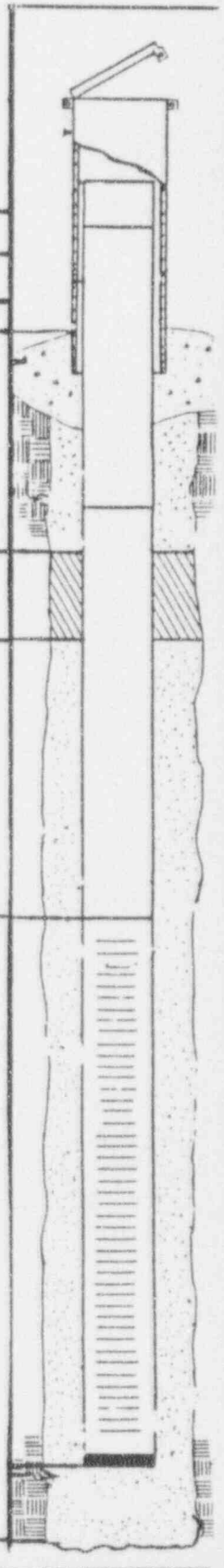
DEPTH From	DEPTH To	FORMATIONS
0	4	Tan Clay
4	18	Olive Clay Broken S.S
18	32	Red Bed
32	34	Sandstone
34	37	Gray Shaley Clay
37	40.5	Red Bed
40.5	41.5	Sandstone
41.5	43	Red Bed
43	64	Sandstone w/ Gray Shale Lenses
64	70	Gray Shale

SAMPLING						
METHOD	FROM	TO		METHOD	FROM	TO

WELL COMPLETION

Hole Diameter ____ In.
Casing Size ____ In.
Screen Slot ____
Yield ____ GPM
Static W.T. ____ ft.

Material	Depth From	Depth To
Cement Seal		
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		



DRILL REPORT AND LOG

HOLE NO. B-120 RIG NO. 6

CLIENT Kerr McGee

PROJECT Cushing OK

CLIENT'S REP Jan Fajgl

DRILLER Knopf

DATE: STARTED 6-16-93

COMPLETED

METHOD OF DRILLING Mud Rotary

DEPTH From	DEPTH To	FORMATIONS
0	1	Br. Silty Clay
1	6	Tan Clay
6	6.5	Sandstone
6.5	7.0	Gray Clay
7.0	9.0	Sandstone (Tar in Pit)
9.0	15.5	Tan Clay
15.5	21	Gray Clay
21	21.5	Sandstone
21.5	22	Gray Clay
22	31	Gray Shaley Clay w/ Sandstone Lenses
31	113.5	Red Bed
113.5	118	Sandstone & Gray Shaley Clay
	52.5	Red Bed
52.5	54.5	Sandstone (Hard)
54.5	55.5	Red Bed
55.5	56	Sandstone
56	60.5	Gray Shaley Clay w/ Sandstone Lenses
60.5	67	Sandstone w/ Gray Shaley Clay
67	69	Red Bed

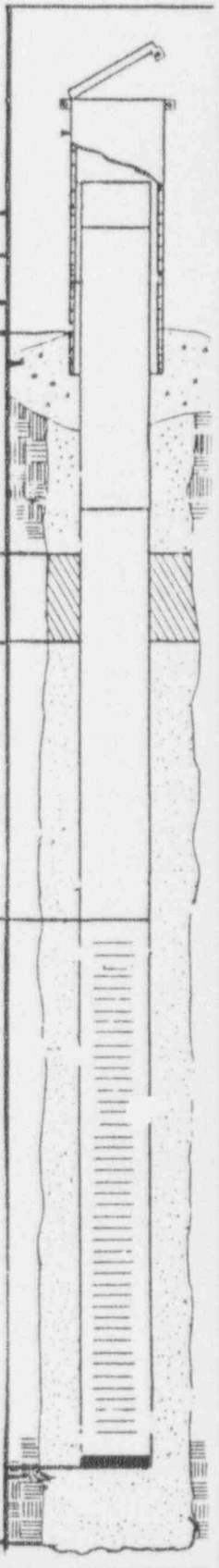
SAMPLING

METHOD	FROM	TO	METHOD	FROM	TO

WELL COMPLETION

Hole Diameter ____ In.
Casing Size ____ In.
Screen Slot ____
Yield ____ GPM
Static W.T. ____ ft.

Material	Depth From	Depth To
Cement Seal	80	0
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		



DRILL REPORT AND LOG

HOLE NO. B-120 RIG NO. 6

CLIENT Kerr McGee

PROJECT Cushing OK

CLIENT'S REP Jan Fajgl

DRILLER Knopf

DATE: STARTED 6-16-93

COMPLETED

METHOD OF DRILLING

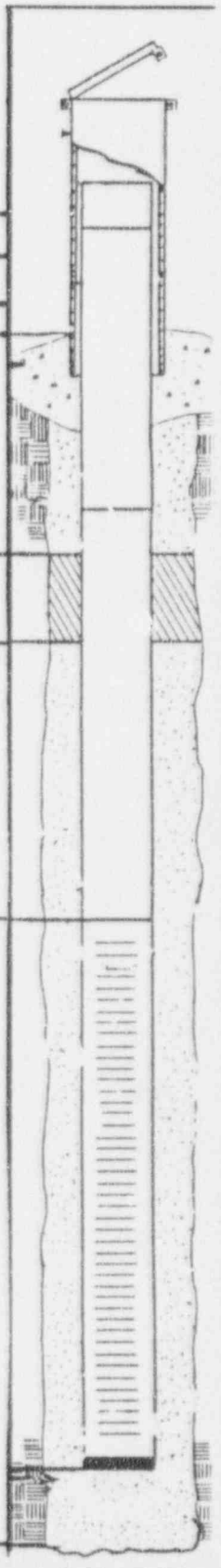
DEPTH From	DEPTH To	FORMATIONS
69	73.5	Gray Shaley Clay w/Sandstone Lenses
73.5	74	Sandstone (Hard)
74	80	Gray Shaley Clay

SAMPLING						
METHOD	FROM	TO		METHOD	FROM	TO

WELL COMPLETION

Hole Diameter ____ In.
Casing Size ____ In.
Screen Slot ____
Yield ____ GPM
Static W.T. ____ ft.

Material	Depth From	Depth To
Cement Seal		
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		



DRILL REPORT AND LOG

HOLE NO. B-126 RIG NO. 6

CLIENT Kerr McGee

PROJECT Cushing OK

CLIENT'S REP Jan Fojal

DRILLER Knopf

DATE: STARTED 6-16-93

COMPLETED

METHOD OF DRILLING Mud Rotary

DEPTH From	DEPTH To	FORMATIONS
0	.5	Brown Silt
.5	3	Sandstone
3	3.5	Tan Clay
3.5	7.0	Sandstone
7.0	18.0	Tan Clay
18.0	26.0	Red Bed
26.0	26.5	Sandstone
26.5	33	Gray Shaley Clay w/ Sandstone Lenses
33	42	Sandstone
42	42.5	Limestone

SAMPLING						
METHOD	FROM	TO		METHOD	FROM	TO

WELL COMPLETION

Hole Diameter ____ In.
Casing Size ____ In.
Screen Slot ____
Yield ____ GPM
Static W.T. ____ ft.

Material	Depth From	Depth To
Cement Seal	12.5	0
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		

DRILL REPORT AND LOG

HOLE NO. B-127 RIG NO. 6

CLIENT Kerr McGee

PROJECT Cushing OK

CLIENT'S REP

DRILLER

DATE: STARTED 6-17-93

COMPLETED

METHOD OF DRILLING Mud Rotary

DEPTH From	DEPTH To	FORMATIONS
0	1.5	Silty Clay
1.5	2.0	Sandstone
2.0	2.5	Gray Clay
2.5	7.0	Sandstone w/ Gray Clay
7.0	9.0	Tan Clay
9.0	11.0	Sandstone (Broken)
11.0	24.5	Gray Clay w/ Sandstone stringers
24.5	35	Red Bed
35	43	Sandstone w/ Gray Clay stringers
43	47.5	Red Bed
47.5	70	Sandstone

SAMPLING						
METHOD	FROM	TO		METHOD	FROM	TO

WELL COMPLETION

Hole Diameter ____ In.
Casing Size ____ In.
Screen Slot ____
Yield ____ GPM
Static W.T. ____ ft.

Material	Depth From	Depth To
Cement Seal		
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		

DRILL REPORT AND LOG

HOLE NO. B-128 RIG NO. 6

CLIENT Kerr McGee

PROJECT Cushing OK

CLIENT'S REP Jan Fajgl

DRILLER Knopf

DATE: STARTED 6-17-93

COMPLETED

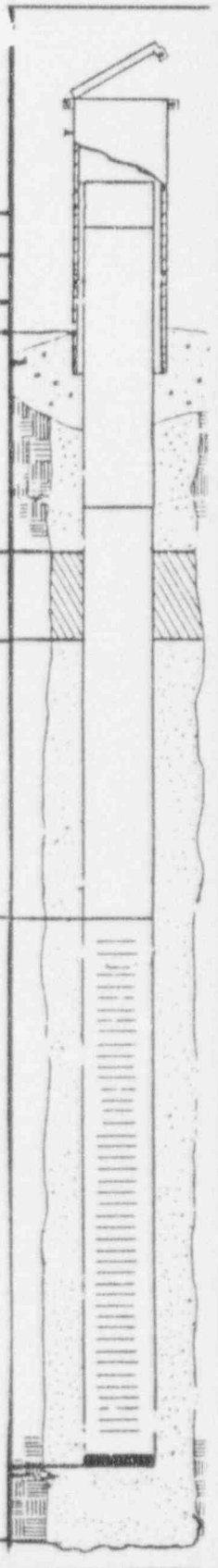
METHOD OF DRILLING Mud Rotary

DEPTH From	DEPTH To	FORMATIONS
0	1	Silt
1	3	Sandstone
3	12	Tan Clay
12	14	Gray Clay
14	15	Sandstone
15	24	Gray Clay
24	32	Red Bed
32	37	Gray Shaley Clay w/Sandstone Stringers
37	38	Red Bed
38	39	Sandstone
39	41	Red Bed
41	46	Sandstone
[redacted]	48	Gray Shaley Clay
48	51	Sandstone
51	60.5	Gray Shaley Clay w/Sandstone Stringers
60.5	60.5	Limestone

WELL COMPLETION

Hole Diameter ____ In.
Casing Size ____ In.
Screen Slot ____
Yield ____ GPM
Static W.T. ____ ft.

Material	Depth From	Depth To
Cement Seal		
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		



SAMPLING

METHOD	FROM	TO		METHOD	FROM	TO
[redacted]						

DRILL REPORT AND LOG

HOLE NO. B134 RIG NO. 6

CLIENT Kerr McGee

PROJECT Cushing OK

CLIENT'S REP Steve Lower-

DRILLER Knopf

DATE: STARTED 6-15-93

COMPLETED

METHOD OF DRILLING Mud Rotary

DEPTH From	DEPTH To	FORMATIONS
0	1.5	Brown S. Clay
1.5	4.5	Tan Sandstone
4.5	16	Gray Clay
16	18	Med. Sandstone
18	39	Red Bed
39	41	Sandstone
41	59	Gray Shaley Clay
59	60	Sandstone
60	60.5	Gray Clay
60.5	61	Sandstone
61	63.5	Gray Clay
63.5	64	Sandstone
		Limestone

SAMPLING						
METHOD	FROM	TO		METHOD	FROM	TO

WELL COMPLETION

Hole Diameter ____ In.
Casing Size ____ In.
Screen Slot ____
Yield ____ GPM
Static W.T. ____ ft.

Material	Depth From	Depth To
Cement Seal		
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		

DRILL REPORT AND LOG

HOLE NO. B-135 RIG NO. 6

CLIENT Kerr McGee

PROJECT Cushing OK

[redacted]NT'S REP Jan Fajgl

DRILLER

DATE: STARTED 6-17-93

COMPLETED

METHOD OF DRILLING Mud Rotary

DEPTH From	DEPTH To	FORMATIONS
0	5.	Fill (Clast Lmc.)
5.0	8.0	Sandstone
8.0	11.0	Red Bed
11.0	13.5	Sandstone
13.5	16.0	Red Bed
16.0	17.0	Sandstone
17.0	32.0	Gray Shaley Clay
32.0	33.0	Sandstone
33.0	35.5	Gray Shaley Clay
35.5	36	Sandstone
36	54.5	Red Bed
54.5	55.5	Sandstone
[redacted]	59	Red Bed
[redacted]	61.5	Sandstone
61.5		Limestone

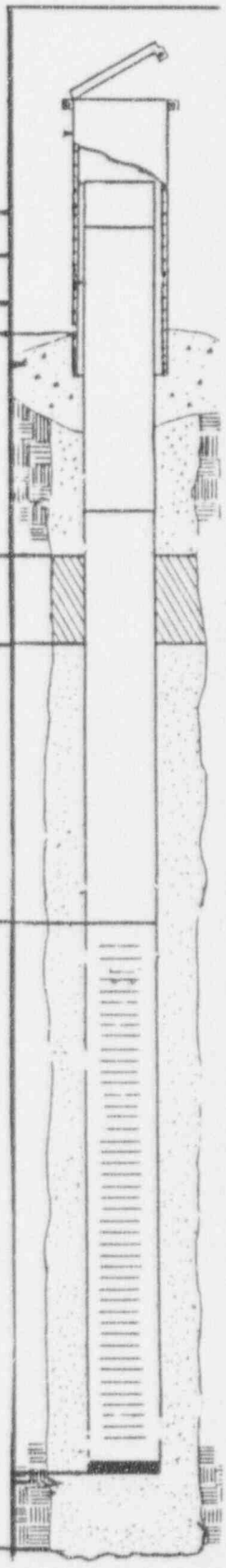
SAMPLING

METHOD	FROM	TO		METHOD	FROM	TO
[redacted]						

WELL COMPLETION

Hole Diameter ____ In.
Casing Size ____ In.
Screen Slot ____
Yield ____ GPM
Static W.T. ____ ft.

Material	Depth From	Depth To
Cement Seal		
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		



DRILL REPORT AND LOG

HOLE NO. B-136 RIG NO. 6

CLIENT Kerr McGee

PROJECT Cushing OK

[redacted]'S REP Jay Fajgl

DRILLER Knopf

DATE: STARTED 6-18-93

COMPLETED

METHOD OF DRILLING Mud Rotary

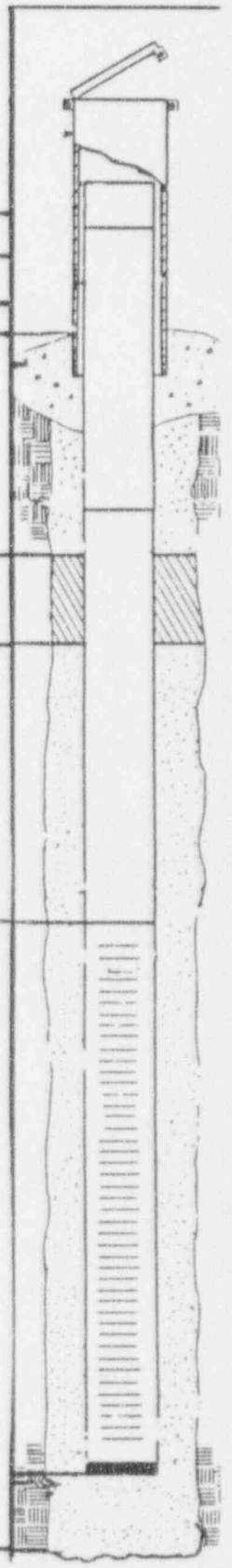
DEPTH From	DEPTH To	FORMATIONS
0	7	Fill
7	8	Red Clay
8	23	Gray Clay S.S. 14-15
23	27	Red Clay
27	30	Sandstone
30	42	Gray Clay
42	43	Sandstone
43	47	Gray Clay w/ Sandstone Stringers
47	69	Sandstone
69	70	Gray Shaley Clay
70	70.5	Sandstone
70.5	75	Gray Clayey Shale

SAMPLING METHOD	FROM	TO		METHOD	FROM	TO

WELL COMPLETION

Hole Diameter 4 In.
Casing Size In.
Screen Slot
Yield GPM
Static W.T. ft.

Material	Depth From	Depth To
Cement Seal		
Bentonite Seal		
Gravel Pack		
Screen		
Total Depth		



SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-120-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
0'	grass brown sl. CLAY damp, plastic		CL		0	1		0-1	100%	Shelby Tube NO ODOR
1'	tan sl., sn. CLAY, plastic lenses of fine, yellow sand damp		CL		0	2		1-2	100%	Shelby Tube NO ODOR
2'	tan sl. sn. CLAY slightly plastic - more sandy damp		CL		0	3		2-3	100%	Shelby Tube NO ODOR
3'	light brown, fine SANDSTONE less cemented				1	4		3-4	35%	Starter Barrel - AIR ROTARY NO ODOR
4'	gray brown cl. SILT to sl. CLAY light gray, fine sl. SANDSTONE		CL		0	5		4-5	40%	NO ODOR
5'	olive gray cl., sl. SAND loose,		SC		0	6		5-6	0%	→ sample lost - no recovery due to moisture
6'	tan and gray sl. cl. SANDSTONE loose				0	7		6-7	0%	Pitcher Barrel NO ODOR
7'	light brown SANDSTONE				0	8		7-9	0%	HYDROCARBON ODOR
8'										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL · AUGER · ROCK CORE · THIN-WALLED TUBE · CONTINUOUS SAMPLER · NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED: 6-22-93	PAGE: 1 of 10
DRILLING METHOD: Rotary Mud Coring	
DRILLED BY: Winnie	
LOGGED BY: J.F.	
EXISTING GRADE ELEVATION (FT AMSL):	
LOCATION OR GRID COORDINATES: □ 120 NW corner	

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-120-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
8'	see page 1				0	8		7'-9'	10%	Pitcher Barrel AIR ROTARY WATER W/ FREE PRODUCT (THIN LAYER) AT 9' 6-22-93
9'	▼ WATER W/ FREE PRODUCT									
10'	light gray and brown sl. sd. CLAY to SILT damp, slightly plastic				0	9		9'-11'	83.7%	6-23-93 Conventional Barrel + Rotary Mud Drilling SLIGHT DIESEL ODOR
11'										
12'	light brown sl. CLAY damp, sl. plastic				0	10		11'-13'	100%	NO ODOR
13'										
14'	same as above				0	11		13'-15'	100%	
	medium gray MUDSTONE									
15'	light brown and gray CLAY, plastic									
16'	light brown and gray CLAY				0	12		15'-17'		
	med. gray MUDSTONE									

* SURFACE CASING INSTALLED FROM 0 TO 9'

* TO PREVENT FREE PRODUCT FROM ENTERING THE HOLE

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED	6-14/23-93
PAGE	2 of 10
DRILLING METHOD	Rotary Mud Coring
DRILLED BY	Winnie
LOGGED BY	J.F.
EXISTING GRADE ELEVATION (FT AMSL)	
LOCATION OR GRID COORDINATES	□ 120 NW corner

SOIL BORING LOG KM-8655-A

KERR McGEE CORPORATION Hydrology Dept Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-120-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
16	light brown gray sl. CLAY, plastic				0	12		15-17	100%	CONVENTIONAL BARREL NO ODOR
17	medium gray MUDSTONE to SHALE									
18	with ca 2" of light brown sl. CLAY interbedded				0	13		17-19	75%	hard drilling at 18'
19										NO ODOR
20	medium to dark gray MUDSTONE to SHALE				0	14		19-21	81%	
21	2.5° of yellow brown LIMESTONE									
22	medium gray silty SHALE w/ LIMESTONE fossils — (Crinoidea ?) hard				0	15		21-23	91.6%	
23	same as above, softer - SHALE & MUDSTONE				0	16		23-25	95%	
24										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL · AUGER · ROCK CORE · THIN-WALLED TUBE · CONTINUOUS SAMPLER · NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED 6-23-93 | PAGE 3 of 10

DRILLING METHOD Rotary Mud Coring

DRILLED BY Winnie

LOGGED BY T.F.

EXISTING GRADE ELEVATION (FT. AMSL)

LOCATION OR GRID COORDINATES □ 120 NW corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-120-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
24	see page 3				0	16		23-25	95%	NO ODOR
25	dark to medium gray MUDSTONE to SHALE - no fossils -				0	17		25-27	100%	NO ODOR
26										
27	light gray + reddish brown MUDSTONE (no SHALE) soft, no limestone				0	18		27-29	100%	NO ODOR
28										
29	medium gray, fine silty and clayey SANDSTONE to SILTSTONE w/some $CaCO_3$ - cemented interbedded with red brown MUDSTONE				0	19		29-31	95%	NO ODOR hard at 31'
30										
31	red brown MUDSTONE dry, with some sand interbedded with gray sm. SILTSTONE				0	20		31-33	100%	NO ODOR
32										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL · AUGER · ROCK CORE · THIN-WALLED TUBE · CONTINUOUS SAMPLER · NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED	PAGE
6-23-93	4 of 10

DRILLING METHOD: Rotary Mud Coring
DRILLED BY: Winnie
LOGGED BY: T.F.
EXISTING GRADE ELEVATION (FT AMSL):
LOCATION OR GRID COORDINATES: □ 120 NW corner

SOIL BORING LOG KM-5653-A

KERR-McGEE CORPORATION Hydrology Dept Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-120-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
32	see page 4				0	20		31-32	100%	NO ODOR
33	red brown and gray MUDSTONE to SILTSTONE hard between 34'-35'				0	21		33-35	100%	hard drilling at 34'-35'
35	red brown and gray silty MUDSTONE				0	22		35-37	100%	
37	red brown and gray silty MUDSTONE				0	23		37-39	100%	
39	red brown MUDSTONE less silty than above				0	24		39-41	100%	
40										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED: 6-23-93

DRILLING METHOD: Rotary Mud Coring

DRILLED BY: Winnie

LOGGED BY: T.F.

EXISTING GRADE ELEVATION (FT. &MSL)

LOCATION OR GRID COORDINATES: ☐ 120 NW corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-120-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
40	see page 5				0	24		39-41	100%	NO ODOR
41	red brown MUDSTONE									
42	loose at 42.5' - 43'				0	25		41-43	87.5%	hard drilling at 42'
43	red brown MUDSTONE									NO ODOR
44	fine, silty SANDSTONE light gray, hard - well cemented w/some $CaCO_3$				0	26		43-45	100%	hard drilling at 44.5 - 45' 6-23-93
45	fine sl. SANDSTONE, interbed. with thin layers (0.5") of sandy SILT - loose									6-24-93 broken core - interbedding SILT mostly washed out during drilling
46	medium gray red brown MUDSTONE				0	27		45-47	82.3%	NO ODOR
47	red brown MUDSTONE, hard				0	28		47-49	91.6%	
48	red brown + gray MUDSTONE less hard									

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL; AUGER; ROCK CORE; THIN-WALLED TUBE; CONTINUOUS SAMPLER; NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED 6-23-93 | PAGE 6 of 10

DRILLING METHOD Rotary Mud Coring

DRILLED BY Winnie

LOGGED BY J.F.

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES ☐ 120 NW corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-120-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
48	red brown and med. gray MUDSTONE (no shale)				V	28			91.6%	NO ODOR
49	red brown and gray MUDSTONE dry, crumbly									broken core
50					0	29		49-51	62.5%	hard drilling at 50-51
51	red brown MUDSTONE, soft, interbedded with 2"-4" layers of LIMESTONE									NO ODOR
52					0	30		51-53	68.7%	
53	light gray, orange and red brown MUDSTONE TO SILTSTONE with lenses (max. thickness 1.5") of LIMESTONE some LIMESTONE broken									it is not clear, whether the limestone was broken prior to drilling
54					0	31		53-55	98%	
55	gray, orange + red brown MUDSTONE, silty									NO ODOR
56					0	32		55-57	91.6%	

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED 6-24-93 | PAGE 7 of 10

DRILLING METHOD Rotary Mud Coring

DRILLED BY Ulmet

LOGGED BY J.F.

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES ☐ 120 NW corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-120-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
56	3/4" of light gray SILTSTONE & soft MUDSTONE				0	32		55-57	91.6%	NO ODOR
57	2" of gray SILTSTONE to LIMESTONE									
	2" of gray SILTSTONE hard, broken, trace of $CaCO_3$									NO ODOR
58	light gray and red brown SILTSTONE - argillaceous				0	33		57-59	79.5%	
59										
	red brown and gray SILTSTONE - argillaceous								100%	NO ODOR
60	more clayey → SILTSTONE TO MUDSTONE				0	34		59-61		broken core
61										
	light gray and red brown silty MUDSTONE				0	35		61-63	87%	NO ODOR
62										
63	2" of red brown LIMESTONE - broken									- broken
	red brown, light gray, and orange MUDSTONE less silty than above				0	36		63-65	100%	NO ODOR
64										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL · AUGER · ROCK CORE · THIN-WALLED TUBE · CONTINUOUS SAMPLER · NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED: 6-24-93
PAGE: 8 of 10
DRILLING METHOD: Rotary Mud Coring
DRILLED BY: Cimmet
LOGGED BY: J.F.
EXISTING GRADE ELEVATION (FT AMSL):
LOCATION OR GRID COORDINATES: □ 120 NW corner

SOIL BORING LOG KM-8855-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-120-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
64	see page 8				0	36		63-65		hard drilling at 64.5 to 65
65	red brown and gray MUDSTONE soft									NO ODOR mixing appx - mist 4" of core
66					0	37		65-67		
67										hard drilling at 67'
	same as above									to 68'
68	} hard				0	38		67-69		
69	} soft, more silty									NO ODOR
	dark gray SHALE trace of LIMESTONE									
70					1	39		69-71		
71										
	dark gray SHALE									
72					0	40		71-73		NO ODOR

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID — Photoionization Detection (ppm)
- NO. — Identifies Sample by Number
- TYPE — Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH — Depth Top and Bottom of Sample
- REC. — Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED	6-24-93
PAGE	9 of 10
DRILLING METHOD	Rotary Mud Coring
DRILLED BY	Kinnet
LOGGED BY	J.F.
EXISTING GRADE ELEVATION (FT AMSL)	
LOCATION OR GRID COORDINATES	□ 120 NW corner

SOIL BORING LOG KM--5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-120-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
72	dark gray SHALE									Hard
	2" of medium to light gray fossiliferous LIMESTONE				0	41		71-73	82.3%	NO ODOR
73	medium gray MUDSTONE soft									broken core
74					1	42		73-75	100%	
75										NO ODOR
	dark gray - brown MUDSTONE medium hard to soft									
76					0	43		75-77	97.1%	
77										NO ODOR
	gray, red brown and orange MUDSTONE, medium hard to hard									
78					0	44		77-80	100%	hard drilling at 78'
79										
80										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL · AUGER · ROCK CORE · THIN-WALLED TUBE · CONTINUOUS SAMPLER · NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED	6-24-93
PAGE	10 of 10
DRILLING METHOD	Rotary Mud Coring
DRILLED BY	Kinnet
LOGGED BY	J.F.
EXISTING GRADE ELEVATION (FT AMSL)	
LOCATION OR GRID COORDINATES	□ 120 NW corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-127-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
0	brown cl SILT + roots									SHELBY TUBE
	light brown cl. sn. SILT									NO ODOR
1	damp				0				100%	
2	light brown - gray cl sn. SILT									
3	damp				0				90%	
4										SLIGHT HC ODOR
	f. gr SANDSTONE hard - well cemented dark gray									AIR ROTARY CORE - start to C
5	→ impacted w. Hydrocarbon wet				5				80%	moisture at 5' HC ODOR
6	light gray - light brown SANDSTONE wet				0				45%	start to C slight HC ODOR
7	light gray fine SANDSTONE				1				75%	start to C
8										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT BARREL · AUGER · ROCK CORE · THIN WALLED TUBE · CONTINUOUS SAMPLER · NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY/SHALE
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS, FILL
- MUDSTONE
- LIMESTONE

DATE DRILLED: 6-22-93 | PAGE: 1 of 10

DRILLING METHOD: Rotary - Air Mud - Coring

DRILLED BY: Winnett

LOGGED BY: J.F.

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES: □ 127 - SE Corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-127-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
8	light gray, fine to medium, sl. SANDSTONE				0			7-8.5	85%	NO ODOR
9	5" cl. SILT - light brown 3" fine-med. SANDSTONE 4" cl. SILT, light brown, moist				0			8.5-10	67%	stainless barrel NO ODOR
10	2" fine-med. SANDSTONE light gray light brown and medium gray MUDSTONE moist				0			10-12	72%	very soft mudstone partly washed out during drilling NO ODOR
12	medium gray - gray brown MUDSTONE soft, moist				0			12-14	87%	NO ODOR
14	medium gray sl. CLAY to MUDSTONE - moist - soft				0			14-16	100%	
15										
16										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID — Photoionization Detection (ppm)
- NO. — Identifies Sample by Number
- TYPE — Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH — Depth Top and Bottom of Sample
- REC. — Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC PEAT
- SANDY CLAY
- CLAYEY SAND

DATE DRILLED	PAGE
6-25-93	2 of 10

DRILLING METHOD: Rotary-Mud-Coring

DRILLED BY: Winnebo

LOGGED BY: J.F.

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES: □ 127 - SE Corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-127-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
16	medium gray MUDSTONE									NO ODOR
17					0			16-18	87%	
18	same as above									
19					0			18-20	98%	harder drilling at 19'
	2" MUDSTONE w/trace of limestone									
20										NO ODOR
	2" MUDSTONE									broken core
	gray SILTSTONE w/ fossils → $CaCO_3$									
21					0			20-22	85%	
22										
	5" of SILTSTONE w/ fossils									NO ODOR
	medium gray MUDSTONE									
23					0			22-24	82%	
	dark gray MUDSTONE to SHALE									
24										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID — Photoionization Detection (ppm)
- NO. — Identifies Sample by Number
- TYPE — Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH — Depth Top and Bottom of Sample
- REC. — Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND

DATE DRILLED	6-25-93
PAGE	3 of 10
DRILLING METHOD	Rotary-mud-Coring
DRILLED BY	Winnebo
LOGGED BY	J.F.
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	☐ 127 - SE Corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-127-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
24	med. gray MUDSTONE silty, soft									NO ODOR
25					0			24-26	100%	
26										
	med. gray - to gray - brown MUDSTONE soft with trace of limestone (angular debris)									NO ODOR
27					0			26-28	100%	
28										
	light gray and red brown MUDSTONE									NO ODOR
29					0			28-30	100%	
30										
	gray and red brown MUDSTONE									NO ODOR broken core → washed out
31					0			30-32	68.7%	
32										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT BARREL | AUGER | ROCK CORE | THIN WALLED TUBE | CONTINUOUS SAMPLER | NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY | SILT | SAND | GRAVEL | SILTY CLAY | CLAYEY SILT | DEBRIS FILL | HIGHLY ORGANIC PEAT | SANDY CLAY | CLAYEY SAND | ____ | ____

DATE DRILLED	PAGE
6-25-93	4 of 10

DRILLING METHOD: Air Rotary - mud - Coring
DRILLED BY: Winnebo
LOGGED BY: J.F.
EXISTING GRADE ELEVATION (FT. AMSL):
LOCATION OR GRID COORDINATES: ☐ 127 - SE Corner

SOIL BORING LOG KM-5655A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-127-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
32	red brown and gray MUDSTONE									NO ODOR
33					0			32-34	82%	
34										
	same as above									NO ODOR
35					0			34-36	100%	
36										
	red brown, gray and orange MUDSTONE									NO ODOR
37					0			36-38	100%	
38										
	red brown, gray and orange MUDSTONE									NO ODOR
39					0			38-40	100%	
40										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID — Photoionization Detection (ppm)
- NO. — Identifies Sample by Number
- TYPE — Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH — Depth Top and Bottom of Sample
- REC. — Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC PEAT
- SANDY CLAY
- CLAYEY SAND
- _____
- _____

DATE DRILLED	PAGE
6-25-93	5 of 10

DRILLING METHOD: Rotary-mud - Coring

DRILLED BY: Winnek

LOGGED BY: J.F.

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES: ☐ 127 - SE Corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-127-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
40	red brown MUDSTONE dry, hard									
41					0			40-42	100%	
42										NO ODOR
	same as above red brown and gray									
43					0			42-44	100%	
44										
	red brown and gray MUDSTONE									
45					0			44-46	100%	harder, drilling at 45'
46	light gray SILTSTONE 2"									NO ODOR
	gray + reddish brown MUDSTONE									
47					1			46-48	95% (23")	
48										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID — Photoionization Detection (ppm)
- NO. — Identifies Sample by Number
- TYPE — Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH — Depth Top and Bottom of Sample
- REC. — Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- _____
- _____

DATE DRILLED	6-25-93
PAGE	6 of 10
DRILLING METHOD	Rotary-Air Hammer-Coring
DRILLED BY	Winnek
LOGGED BY	J.F.
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	B 127 - SE Corner

SOIL BORING LOG KM--5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-127-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
48	red brown + gray MUDSTONE									no odor
49					0			48-50	62.5%	
50										6-25-93
	red brown + gray MUDSTONE to SHALE hard, brittle									6-28-93
51					0			50-52	79.5%	broken core
52										no odor
	red brown MUDSTONE w/ lenses of LIMESTONE ca 15" of yelowish LIMESTONE									harder drilling at 52'
53					0			52-54	100%	
54										no odor
	red brown MUDSTONE w/ LIMESTONE									
55	1" of light gray SILT base 5" of light gray SILTSTONE - broken core no $CaCO_3$				0			54-56	75%	
56										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth To and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC PEAT
- SANDY CLAY
- CLAYEY SAND
- MUDSTONE
- LIMESTONE

DATE DRILLED: 6-25-93 | PAGE: 7 of 10

DRILLING METHOD: Rotary-mud-Coring

DRILLED BY: Winneb

LOGGED BY: J.F.

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES: □ 127 - SE Corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-127-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
56	light gray, fine silty SANDSTONE to SILTSTONE, hard to med. hard broken, no $CaCO_3$				0			56-58	75%	NO ODOR broken core hard drilling at 57.5'
57										
58										
59	light gray, fine silty SANDSTONE very hard, no $CaCO_3$ last 2" → broken core (less cemented)				0			58-60	87.1	↑ hard drilling NO ↓ ODOR
60										
61	light gray very fine SANDSTONE to sandy SILTSTONE broken core no $CaCO_3$				0			60-62	62.5	broken core
62										
63	light to medium gray fine silty SANDSTONE				0			62-64	79.5	
64										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC PEAT
- SANDY CLAY
- CLAYEY SAND
- _____
- _____

DATE DRILLED	6-28-93
PAGE	6 of 10
DRILLING METHOD	Air Rotary - mud - Coring
DRILLED BY	Winnebo
LOGGED BY	J.F.
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	□ 127 - SE Corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-127-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
64	light to medium gray, fine silty SANDSTONE								20"	
65					0			64-66	82.3%	
66										no odor
	light to medium gray, fine silty SANDSTONE								9"	
67					0			66-68	75%	
	thin, whitish laminas of LIMESTONE in last 4"									
68	light to medium gray, fine silty SANDSTONE with thin LIMESTONE laminas								21"	no odor
69					1			68-70	87.1%	
	last 5" - medium gray, orange fine SANDSTONE, no $CaCO_3$									
70	same as above									no odor
										partly broken core
71	↕ 4 inches soft → → less cemented				1			70-72		
72										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID — Photoionization Detection (ppm)
- NO — Identifies Sample by Number
- TYPE — Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH — Depth Top and Bottom of Sample
- REC. — Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- _____
- _____

DATE DRILLED: 6-28-93

PAGE: 9 of 10

DRILLING METHOD: Rotary-Mud-Coring

DRILLED BY: Winnebo

LOGGED BY: J.F

EXISTING GRADE ELEVATION (FT. AMSL):

LOCATION OR GRID COORDINATES: ☐ 127 - SE Corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER B-127-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
72	light gray fine silty SAND-STONE									NO ODOR
73	no $CaCO_3$				0			72-74	75%	
74	3" of silty MUDSTONE gray - orange 4" of gray fine silty SANDSTONE, no $CaCO_3$									NO ODOR hard drilling at 75'
75	14" gray fine silty SANDSTONE w/ $CaCO_3$ (thin laminas of white LIMESTONE)				0			74-76	87.1	bit bit, broken core
76	7" of hard fossiliferous LIMESTONE, white-gray 17" inches of gray MUDSTONE							76-78		NO ODOR
77					0				100%	
78	gray & gray brown MUDSTONE									NO ODOR
79					1			78-80	87.1%	
80										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT BARREL · AUGER · ROCK CORE · THIN-WALLED TUBE · CONTINUOUS SAMPLER · NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY · SILT · SAND · GRAVEL · SILTY CLAY · CLAYEY SILT · DEBRIS FILL · HIGHLY ORGANIC PEAT · SANDY CLAY · CLAYEY SAND

DATE DRILLED	6-28-93
PAGE	10 of 10
DRILLING METHOD	Rotary-mud - Coring
DRILLED BY	Winnek
LOGGED BY	J.F.
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	□ 127 - SE Corner

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER CMW-30.3

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
0	orange and red brown sl., sm. CLAY							0-5		CUTTINGS WERE EXAMINED 0'-20' → 8" dia surface casing pvc
5	hards at 7'							5-10		reds, had using 4 3/4"
10	fine SANDSTONE at 11' to 17'							10-15		
15	red brown + gray CLAY							15-20		
20	light brown fine SANDSTONE + medium gray MUDSTONE							20-25		
25	25-28 some SANDSTONE brown + med. gray clay (fat clay)							25-30		
30	brown sl. CLAY							20-35		
35	red-brown MUDSTONE							35-41		
40										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID — Photoionization Detection (ppm)
- NO. — Identifies Sample by Number
- TYPE — Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH — Depth Top and Bottom of Sample
- REC. — Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED	7-12-93
PAGE	1 of 4
DRILLING METHOD	Rotary Mud
DRILLED BY	Winnek
LOGGED BY	J.F.
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER CMW-30.3

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
40	red brown MUDSTONE / lt. CLAY ?							40-45		CUTTINGS WERE EXAMINED
45	red brown and light gray MUDSTONE							45-50		
50	same as above (harder drilling at 55')							50-55		
55	some fine SANDSTONE * red brown and orange MUDSTONE w/ hard silty laminas							55-60		
60	red brown MUDSTONE light brown SANDSTONE - fine							60-65		
65	light brown fine SANDSTONE + medium to dark brown MUDSTONE							65-70		
70	light brown - calcitic fine SANDSTONE w/ LIMESTONE + + brown MUDSTONE							70-75		
75	brown, orange brown fine to medium SANDSTONE + SILTSTONE + brown MUDSTONE							75-80		hard drilling ↑ ↓
80										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL · AUGER · ROCK CORE · THIN-WALLED TUBE · CONTINUOUS SAMPLER · NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED	7-13-93
PAGE	2 of 4
DRILLING METHOD	Rotary Mud
DRILLED BY	Winnek
LOGGED BY	J.F.
EXISTING GRADE ELEVATION (FT AMSL)	
LOCATION OR GRID COORDINATES	

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER CMW-30.3

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
80	fine SANDSTONE to SILTSTONE light gray - brown							80-85		CUTTINGS WERE EXAMINED ↓ hard drilling
85	red brown and med. gray MUDSTONE							85-90		
90	same as above trace of SAND							90-95		
95	red brown + med. gray MUDSTONE							95-100		
100	red brown + some gray MUDSTONE/SHALE trace of sand							100-105		
105	LIMESTONE red brown + dark gray SHALE							105-110		hard drilling
110	same as above more red brown than gray + less LIMESTONE							110-115		
115	red brown + some gray MUDSTONE/SHALE							115-120		
120										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL · AUGER · ROCK CORE · THIN-WALLED TUBE · CONTINUOUS SAMPLER · NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED: 7-13-93 | PAGE: 3 of 4

DRILLING METHOD: Rotary Mud

DRILLED BY: Winnek

LOGGED BY: J. F.

EXISTING GRADE ELEVATION (FT. AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-56554

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER CMW-30.3

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
120	red brown + gray SHALE + some LIMESTONE							120 - 125		CUTTINGS WERE EXAMINED Hard at 123'
125	same as above							125 - 130		Hard at 126'
130	same as above							130 - 135		Hard at 133'
135	same as above							135 - 140		
140	TERMINATED AT 140'									Boring terminated at 140'; grouted to 95'; reamed with a 7 7/8" bit to 105'; completed as a monitor well; specs are attached

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL | AUGER | ROCK CORE | THIN-WALLED TUBE | CONTINUOUS SAMPLER | NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED 7-13-93 | PAGE 4 of 4

DRILLING METHOD Rotary Mud

DRILLED BY Winnes

LOGGED BY J.F.

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

KM SUBSIDIARY

LOCATION: Cushing, OK

BORING NUMBER: CMW-31.2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
0	red brown + gray silty CLAY							0-5		8" surface casing set from 0' to 20'
5	red brown + gray silt CLAY							5-10		SOIL CUTTINGS WERE EXAMINED
10	same as above							10-15		
15	fine SANDSTONE							15-20		
20	red brown sl. CLAY + gray cl. SILT							21-25		
25	26' stringer of SAND: red brown and gray sl. CLAY							25-30		
30	same as above							30-35		
35	red brown sl. CLAY some SANDSTONE at 37' to 38 - fine grained							35-40		
40										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED: 7-9-93

PAGE: 1 of 4

DRILLING METHOD: Rotary Mud

DRILLED BY: Kinney

LOGGED BY: J.F.

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER CMW-31.2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
40	fine gray SANDSTONE + red brown SI. CLAY							40-45		hard at 43' CUTTINGS WERE EXAMINED
45	mostly fine gray SANDSTONE							45-50		
50	gray and red brown MUDSTONE (silty)							50-55		
55	mostly medium gray + some red brown MUDSTONE							55-60		
60	red brown + gray MUDSTONE + gray SILT (SILTSTONE)							60-65		
65	red brown + gray MUDSTONE 69-69.5 SILTSTONE							65-70		hard at 69
70	red brown SI. CLAY-MUDSTONE hard at 75' -SILTSTONE							70-75		hard at 73-75
75	red brown and gray MUDSTONE							75-80		
80										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED 7-9-93

PAGE 2 of 4

DRILLING METHOD Rotary Mud

DRILLED BY Winnel

LOGGED BY J.F.

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION
Hydrology Dept Engineering Services

KM SUBSIDIARY

LOCATION: Cushing, OK

BORING NUMBER: CMW-31.2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
80	red brown and gray MUDSTONE harder at 82'-85' SILTSTONE FROM 82'							80-85		CUTTINGS WERE EXAMINED
85	SILTSTONE LIMESTONE AT 87 + some red brown MUDSTONE							85-90		
90	same as above							90-95		
95	red brown MUDSTONE from 95.5 (no SANDSTONE)							95-100		
	red brown MUDSTONE + some medium gray MUDSTONE							100-105		
105	dark gray SHALE from 106'							105-110		
110	dark gray SHALE							110 115		
115	dark gray SHALE + some brown SHALE + LIMESTONE at 116'							115-120		hard at 116'
120										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
  - SPLIT-BARREL
  - AUGER
  - ROCK CORE
  - THIN-WALLED TUBE
  - CONTINUOUS SAMPLER
  - NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED: 7-9-93

DRILLING METHOD: Rotary Mud

DRILLED BY: Cimmet

LOGGED BY: J. F.

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER MW-SI. 2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
120	dark gray SHALE						■	120-121		
	Boring terminated at 121'									Boring completed as a monitor water well; attached spec.
125										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED	PAGE
7-9-93	4 of 4
DRILLING METHOD: Rotary Mud	
DRILLED BY: Cimmes	
LOGGED BY: J. F.	
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER CWM 32.2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
0	brown and gray sl. CLAY – fin fine SANDSTONE							0-5		CUTTINGS WERE EXAMINED 8' SURFACE
5	tar, bricks – fill brown CLAY from 8.5'							5-10		CASING SET TO 15' DRILLED TO 200' USING A
10	brown sl. CLAY							10-15		4 1/4" BIT THAN REAMED USING A 7 7/8" BIT AND COMPLETED
15	brown sl. CLAY							15-20		AS A 4" MONITOR WELL – SEE ATTACHED SPECS
20	brown sl. CLAY some grey SILT some LIMESTONE							20-25		
25	red brown sl. CLAY some LIMESTONE AT 29'							25-30		
30	red brown CLAY – MUDSTONE fine SANDSTONE from 32'							30-35		
35	red brown SHALE/CLAY + light grey SILT							35-40		
40										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL · AUGER · ROCK CORE · THIN-WALLED TUBE · CONTINUOUS SAMPLER · NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED	7-14-93
PAGE	1 of 5
DRILLING METHOD	Rotary Mud
DRILLED BY	Uinne[illegible]
LOGGED BY	J.F.
EXISTING GRADE ELEVATION (FT. AMSL)	
LOCATION OR GRID COORDINATES	

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER CUM – 32.2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC	REMARKS OR FIELD OBSERVATIONS
40	light gray fine SANDSTONE ± some MUDSTONE							40-45		CUTTINGS WERE EXAMINED
45	same as above							45-50		
50	light gray fine SANDSTONE med. gray SHALE at 54'							50-55		HARD DRILLING AT 53' HARD AT 54'
55	red brown and med. gray MUDSTONE to SHALE							55-60		
60	same as above							60-65		
65	same as above							65 70		
70	red brown MUDSTONE SHALE, fine SANDSTONE w/ $CaCO_3$							70-75		HARDER AT 71' HARD AT 75
75	light gray fine SANDSTONE, white LIMESTONE red brown MUDSTONE/SHALE –							75-80		HARDER ↕ VERY HARD
80										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL | AUGER | ROCK CORE | THIN-WALLED TUBE | CONTINUOUS SAMPLER | NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED	PAGE
7-14-93	2 of 5

DRILLING METHOD: Rotary Mud
DRILLED BY: Winnek
LOGGED BY: J.F.
EXISTING GRADE ELEVATION (FT AMSL):
LOCATION OR GRID COORDINATES:

SOIL BORING LOG KM-3655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER CMW-32-2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
80	brown + red brown sl. MUDSTONE							80-85		CUTTINGS WERE EXAMINED
85	brown + red brown MUDSTONE some dark gray SHALE							85-90		
90	red brown MUDSTONE/ SHALE + white and gray LIMESTONE							90-95		
95	med. brown MUDSTONE/ /SHALE with thin layers of LIMESTONE							95-100		
100	dark reg MUDSTONE/ /SHALE, trace of LIME- STONE							100-105		
105	dark red-brown and medium gray SHALE							105-110		
110	medium gray SHALE, hard							110-115		
115	medium gray SHALE hard, with some LIMESTONE							115-120		
120										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT-BARREL | AUGER | ROCK CORE | THIN-WALLED TUBE | CONTINUOUS SAMPLER | NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED	PAGE
7-14-93	3 of 5
DRILLING METHOD: Rotary Mud	
DRILLED BY: Clinnes	
LOGGED BY: Jay F.	
EXISTING GRADE ELEVATION (FT AMSL):	
LOCATION OR GRID COORDINATES:	

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER CMW-32.2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
120	med. gray hard SHALE + some LIMESTONE							120-125		CUTTINGS WERE EXAMINED
125	hard red brown and med. gray SHALE + LIMESTONE							125-130		
130	gray silty MUDSTONE ? + ? fine SANDSTONE							130-135		
135	fine SANDSTONE w/ $CaCO_3$, light gray brown; + some medium gray SHALE							135-140		
140	medium to dark gray SHALE/MUDSTONE							140-145		hard at 145'
145	fine to medium SANDSTONE - light gray to tan w/ little $CaCO_3$							145-150		harder drilling
150	hard, fine silty SANDSTONE + little gray SHALE							150-155		
155	medium gray + some brown SHALE							155-160		
160										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED	PAGE
7-14-93	4 of 5
DRILLING METHOD: Rotary Mud	
DRILLED BY: Winnez	
LOGGED BY: J.F.	
EXISTING GRADE ELEVATION (FT AMSL):	
LOCATION OR GRID COORDINATES:	

SOIL BORING LOG KM-5655-A

KERR-McGEE CORPORATION Hydrology Dept. Engineering Services	KM SUBSIDIARY	LOCATION Cushing, OK	BORING NUMBER CMW-32.2

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
160	med. - gray SHALE, hard							160 - 165		CUTTINGS WERE EXAMINED ↓ hard
165	med. gray + red brown SHALE, + SILTSTONE?							165 - 170		
170	red brown SHALE, hard							170 - 175		
175	fine silty SANDSTONE, light gray w/ $CaCO_3$							175 - 180		
180	fine silty SANDSTONE light gray w/ $CaCO_3$ - fossiliferous - Crinoidea							180 - 185		
185	red brown SHALE hard + some SANDSTONE							185 - 190		
190	red brown SHALE/MUDSTONE + trace of LIMESTONE							190 - 195		
195	same as above							195 - 200		
200										

EXPLANATION

- ▼ Water Table (24 Hour)
- ▽ Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT/SILTSTONE
- SAND/SANDSTONE
- DEBRIS/FILL
- MUDSTONE/SHALE
- LIMESTONE

DATE DRILLED	PAGE
7-14-93	5 of 5
DRILLING METHOD: Rotary Mud	
DRILLED BY: Ainus	
LOGGED BY: J.F	
EXISTING GRADE ELEVATION (FT AMSL)	
LOCATION OR GRID COORDINATES	

SOIL BORING LOG KM-86584

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

RUN SUBSEQUENT

LOCATION CUSHING, OK

BORING NUMBER CMW 20.1 (CUA 35)

REPINGTON

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
0	Red-brown clayey silt, sl. sdy., moist									
	Clay, yellow-brown, silty, moist to dry, with streaks of red-brown clay, firm									
5										
	as above with red-brown and lt. gray streaks									
10										
	Shale, brown to red-brown, somewhat fissile, small amount of gray streaks, clayey silty, dry									
15										
	Siltstone, lt. gray hard, tight, dry									rig chatter
20										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- _____
- _____

DATE DRILLED: 1-11-90

PAGE: 1 of 3

DRILLING METHOD: rotary

DRILLED BY: Jim WinnekDrilling

LOGGED BY: Tim Bent

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-84564

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

KN SUBSIDIARY

LOCATION REPINING, CUSHING, OK

BORING NUMBER CMW 20.1 (CUA 33)

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
20	Shale, red-brown, soft, silty, dry clayey									
	Shale, lt. gray to tan, slightly waxy on partings, clayey dry									
	to red-brown									
25	Shale, lt. gray, soft, fissile, silty clayey, dry									
	Siltstone, lt. gray, dense, hard, tight									
	Shale, as above									
	Siltstone, lt. gray, dense, hard, tight, dry									
30	Shale, red-brown, silty, fissile									
	to lt. brown									
35	Limestone, wht.-lt. tan, vy. finely crystalline, dense hard, dry									
	Shale, lt. red-brown and gray, soft, somewhat fissile, dry becomes more red-brown									

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID — Photoionization Detection (ppm)
- NO. — Identifies Sample by Number
- TYPE — Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH — Depth Top and Bottom of Sample
- REC. — Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND

DATE DRILLED 1-11-90

PAGE 2 of 3

DRILLING METHOD Rotary

DRILLED BY Jim Winnek Drilling

LOGGED BY Tim Bent

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-5656-A

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

RUN SUBSECTION

LOCATION: Returning, Cushing, OK

BORING NUMBER (MW) 20.1 (CUA 35)

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
40	Shale, interbedded red-brown and lt. gray, soft, silty									
45	Shale, red-brown alt. with gray, soft, dry Siltstone, lt. gray-tan, hard, dry Shale, med. gray, silty, soft, dry									
50										Let hole sit at 51 ft.
55										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID — Photoionization Detection (ppm)
- NO. — Identifies Sample by Number
- TYPE — Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH — Depth Top and Bottom of Sample
- REC. — Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- MARSH ORGANIC PEAT
- SANDY CLAY
- CLAYEY SAND
- _____
- _____

DATE DRILLED: 1-11-90

PAGE: 3 of 3

DRILLING METHOD: rotary

DRILLER: ~~Dinnek~~-Tulsa

LOGGED BY: Tim Bent

EXISTING GRADE ELEVATION (FT AMSL):

LOCATION OR GRID COORDINATES:

SOIL BORING LOG K36-8458-A

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

KM SUBSIDIARY

LOCATION REFINING, CUSHING, OK

BORING NUMBER CMW 20.2 (CUA 3D)

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
40	Shale, dk. red-brown, some gray fissile, clayey									
45	Sandstone? Shale, med. to dk. gray, fine-textured, silty, firm, well consolidated, fissile, with red-brown mudstone, soft slightly sandy, clayey									rig chatter,
50										
55	Shale, med.-dk. gray, with some dk. brown, slightly silty									
60										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID — Photoionization Detection (ppm)
- NO. — Identifies Sample by Number
- TYPE — Sample Collection Method
- SPLIT-BARREL
- AUGER
- ROCK CORE
- THIN-WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH — Depth Top and Bottom of Sample
- REC. — Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC (PEAT)
- SANDY CLAY
- CLAYEY SAND
- _____
- _____

DATE DRILLED 1-10-90

PAGE 3 of 5

DRILLING METHOD rotary

DRILLED BY Winnek-Tulsa

LOGGED BY Tim Bent

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-54564

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

RM SUBDIVISION

LOCATION REFINING CUSHING OK

BORING NUMBER CMW 20.2 (CUA 3D)

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
60	as above Shale, med.-dk. gray, and red-brown, slight amount of sand, some fissility, clayey									chatter
65										
	Sandstone, lt. gray, dk. gray shale lamina fine-grained, tight									harder, chatter
70	Sandstone, lt. gray-green and gray laminations, fine to medium grained, fairly well-sorted, moderately well cemented, subround to subangular.									heavey chatter, change to tricone bit at 70.8 better samples
75	Shale, dk. gray, fine textured, fissile, slightly silty, clayey									
80										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO Identifies Sample by Number
- TYPE Sample Collection Method
- SPLIT BARREL
- AUGER
- ROCK CORE
- THIN WALLED TUBE
- CONTINUOUS SAMPLER
- NO RECOVERY
- DEPTH Depth Top and Bottom of Sample
- REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

- CLAY
- SILT
- SAND
- GRAVEL
- SILTY CLAY
- CLAYEY SILT
- DEBRIS FILL
- HIGHLY ORGANIC PEAT
- SANDY CLAY
- CLAYEY SAND

DATE DRILLED 1-10-90

PAGE 4 of 5

DRILLING METHOD rotary

DRILLED BY Winnek, Tulsa

LOGGED BY Tim Bent

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

SOIL BORING LOG KM-34538-A

KERR-McGEE CORPORATION
Hydrology Dept. Engineering Services

RM SUBSIDIARY

LOCATION

BORING NUMBER CMW 20.2 (COA 30)

REPINING CUSHING, OK

DEPTH IN FEET	LITHOLOGIC DESCRIPTION	GRAPHIC LOG	UNIFIED SOIL FIELD CLASS.	BLOWS PER FOOT	PID (ppm)	SOIL SAMPLE NO.	SOIL SAMPLE TYPE	SOIL SAMPLE DEPTH	SOIL SAMPLE REC.	REMARKS OR FIELD OBSERVATIONS
80	as above									
85	Sandstone, lt. gray, v. fine-grained, silty, tight, well-sorted, well cmtd.									rig chatter
	Silt, dk. gray, fissile, clayey									
90	T.D. 90.5									
95										

EXPLANATION

- Water Table (24 Hour)
- Water Table (Time of Boring)
- PID Photoionization Detection (ppm)
- NO. Identifies Sample by Number
- TYPE Sample Collection Method

SPLIT BARREL | AUGER | ROCK CORE | THIN WALLED TUBE | CONTINUOUS SAMPLER | NO RECOVERY

DEPTH Depth Top and Bottom of Sample
REC. Actual Length of Recovered Sample in Feet

GRAPHIC LOG LEGEND

CLAY | DEBRIS FILL | SILT | HIGHLY ORGANIC (PEAT) | SAND | SANDY CLAY | GRAVEL | CLAYEY SAND | SILTY CLAY | _____ | CLAYEY SILT | _____

DATE DRILLED 1-10-90

PAGE 5 of 5

DRILLING METHOD rotary

DRILLED BY Winnek, Tulsa

LOGGED BY Tim Bent

EXISTING GRADE ELEVATION (FT AMSL)

LOCATION OR GRID COORDINATES

APPENDIX G
GEOPHYSICAL LOGS
AREA 3

BOREHOLE B-111; ELEVATION 854.0 FT MSL

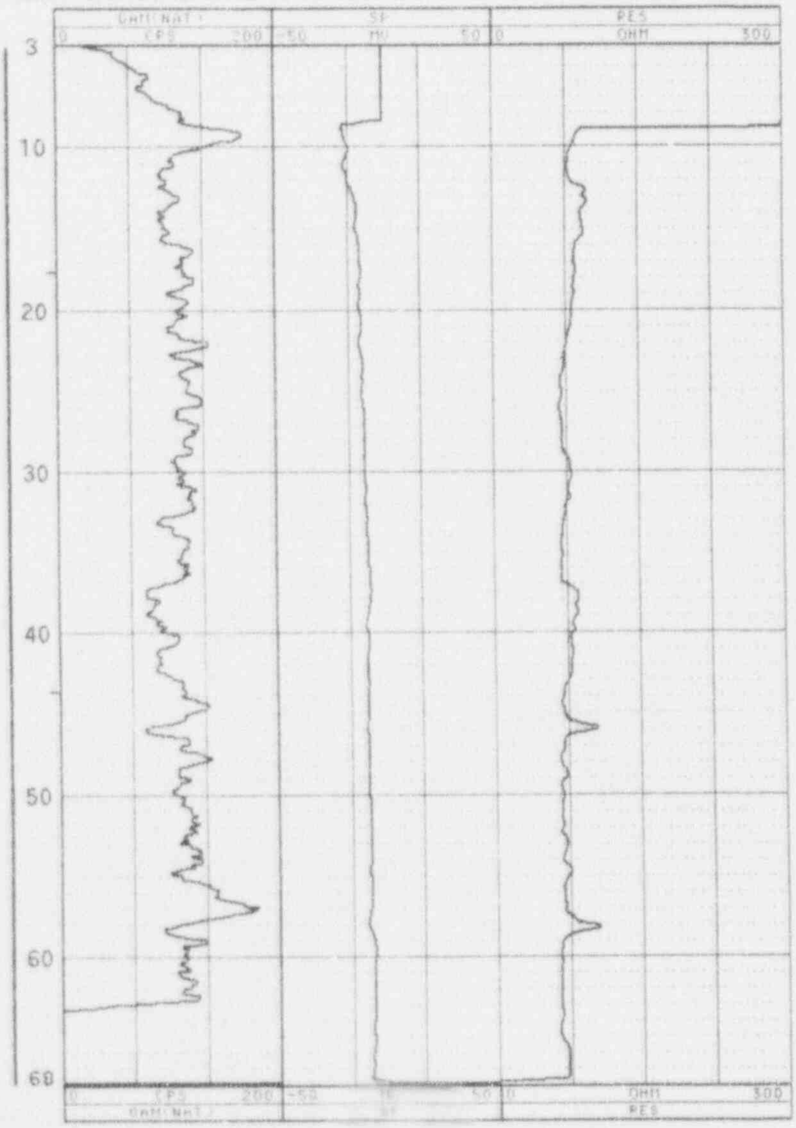
Century GEOPHYSICAL CORP.

B-111-1

COORDINATE
B-111 E 70 $50

COMPANY	: KERR MCGEE			OTHER SERVICES:	
WELL	: B-111-1 E 70 450				
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 06/17/93	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: 65 70	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 68.20	LOG MEASURED FROM	: GS	DF	:
LOG TOP	: 3.90	DRL MEASURED FROM	: GS	GL	:
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE	: ORIGI
MAGNETIC DECL.	:	RM	:	TYPE	: 9055C
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG	: 4
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT	: 9055C
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH	: 0
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



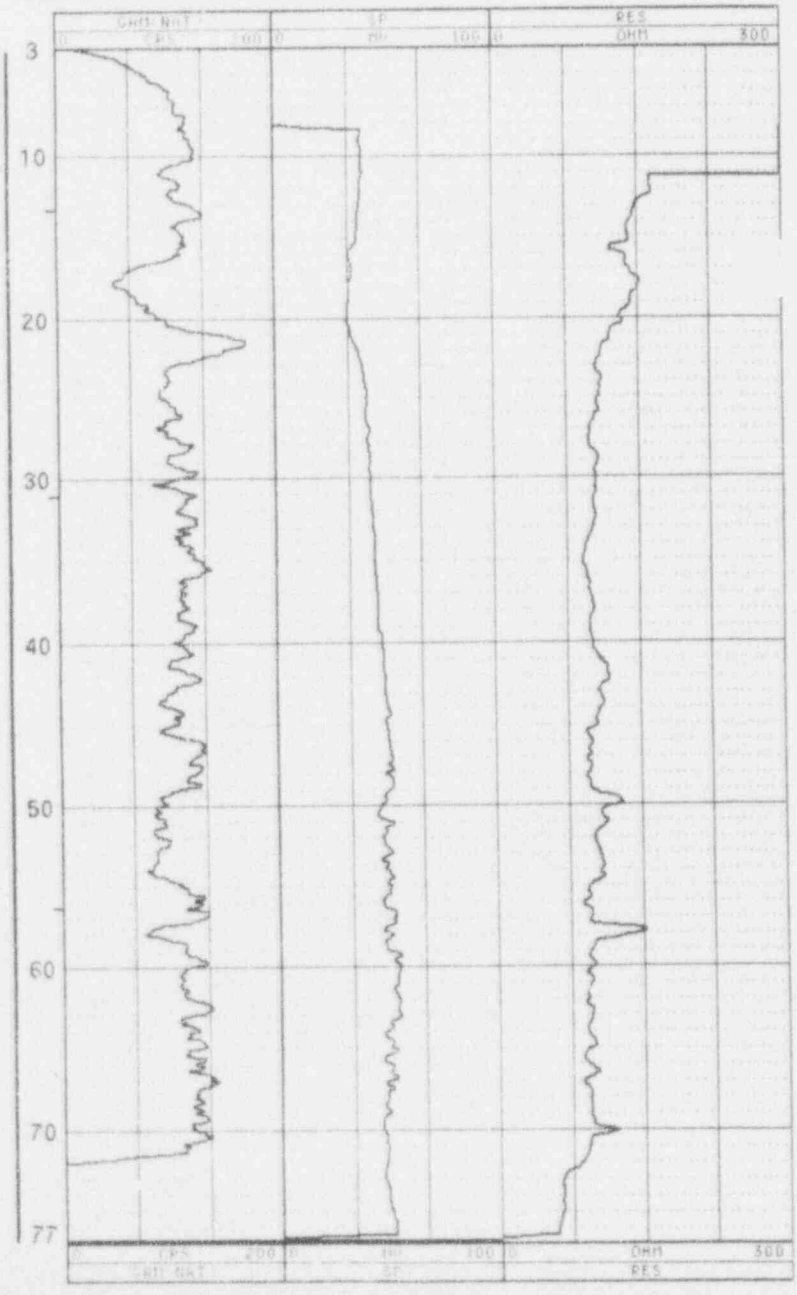
BOREHOLE B-112; ELEVATION 871.3 FT MSL

Century GEOPHYSICAL CORP.

B-112-1

COMPANY	: KERR MCGEE			OTHER SERVICES:	
WELL	: B-112-1 650 FSL				
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 06/16/93	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: 80	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 76.90	LOG MEASURED FROM	: GS	DF	:
LOG TOP	: 3.60	DRL MEASURED FROM	: GS	GL	:
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE	: ORIGI
MAGNETIC DECL.	:	RM	:	TYPE	: 9055C
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG	: 1
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT	: 9055C
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH	: 0
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



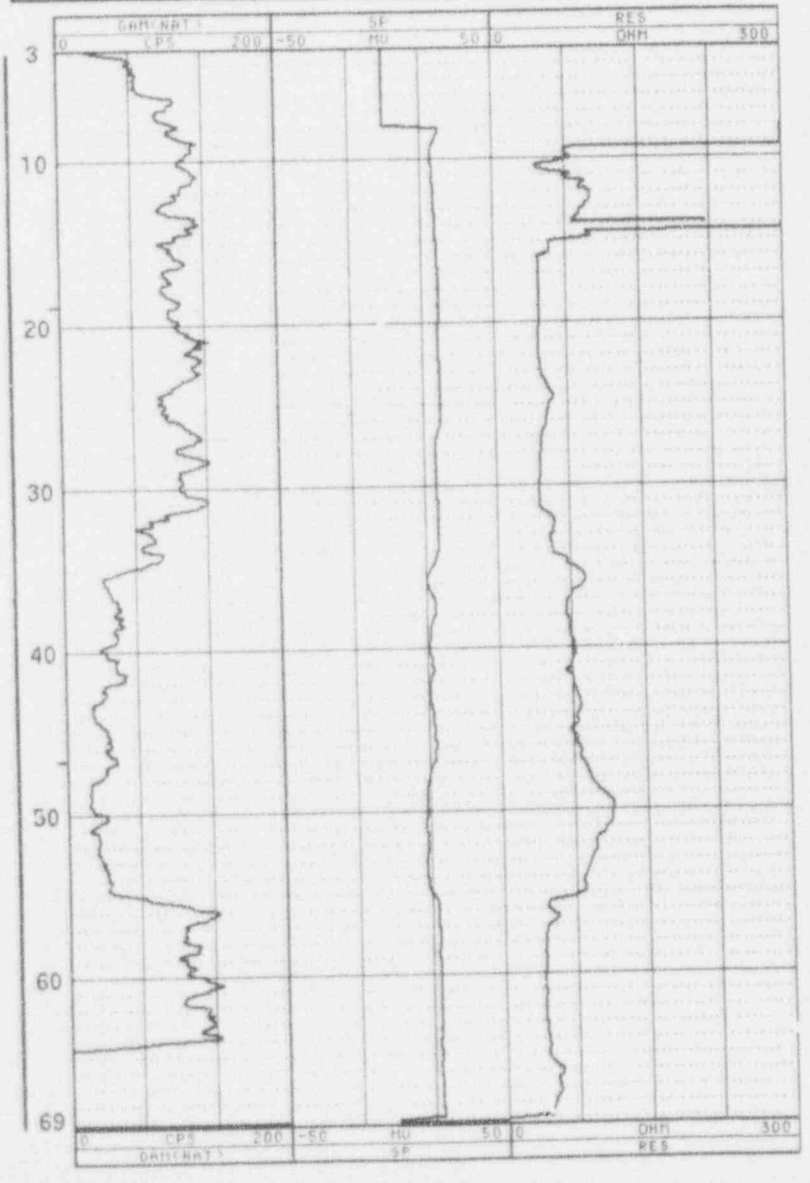
BOREHOLE B-118; ELEVATION 853.0 FT MSL

Century GEOPHYSICAL CORP.

B-118-1

COMPANY	: KERR MCGEE			OTHER SERVICES:	
WELL	: B-118-1 F90 S30				
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 06/21/93	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: 69.9+	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 69.48	LOG MEASURED FROM	: GS	DF	:
LOG TOP	: 3.08	DRL MEASURED FROM	: GS	GL	:
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE	: ORIGI
MAGNETIC DECL.	:	RM	:	TYPE	: 9055C
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG	: 4
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT	: 9055C
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH	: 0
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



B-118-1

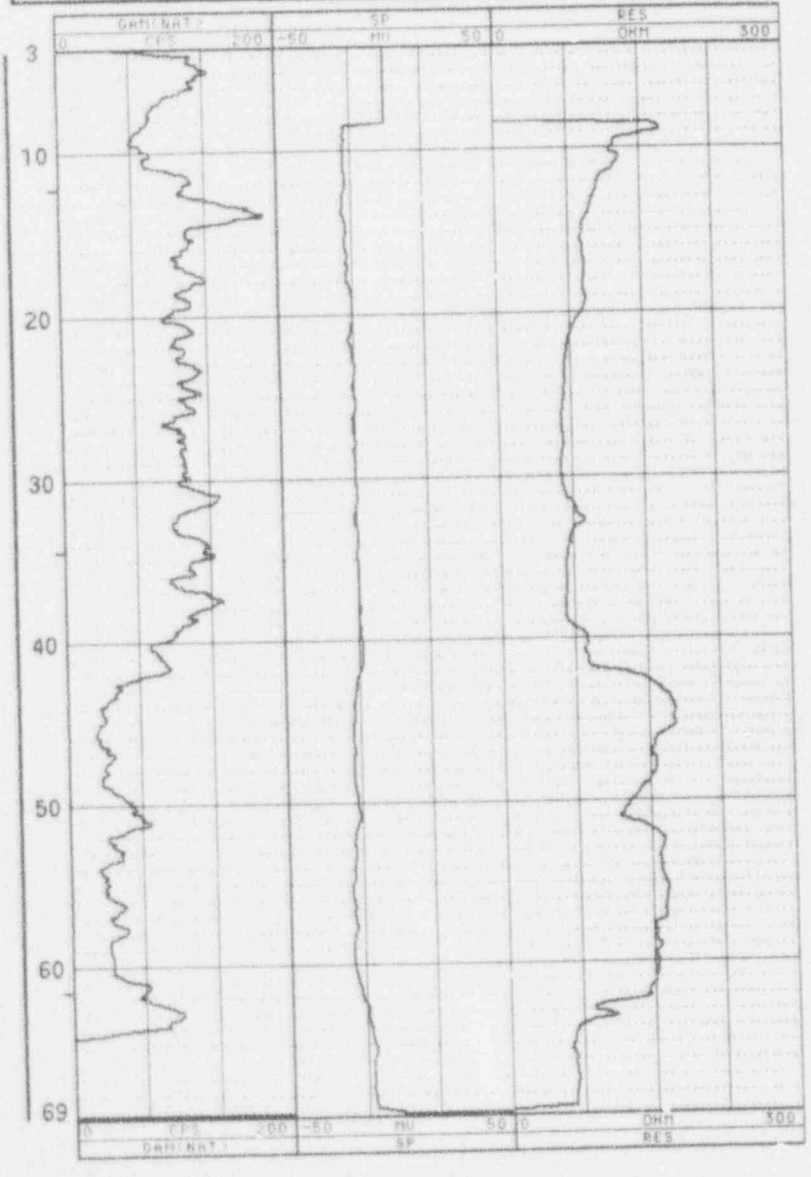
BOREHOLE B-119; ELEVATION 864.3 FT MSL

Century GEOPHYSICAL CORP.

B-119-1

COMPANY	: KERR MCGEE			OTHER SERVICES:	
WELL	: B-119-1 650 350				
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE :	
				ELEVATIONS	
DATE	: 06/17/93	PERMANENT DATUM	:	KB :	
DEPTH DRILLER	: ~~66~~ 70	ELEV. PERM. DATUM	:	DF :	
LOG BOTTOM	: 69.38	LOG MEASURED FROM	: GS	GL :	
LOG TOP	: 3.70	DRL MEASURED FROM	: GS		
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE : ORIGI	
MAGNETIC DECL.	:	RM	:	TYPE : 9055C	
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG : 5	
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT : 9055C	
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH: 0	
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



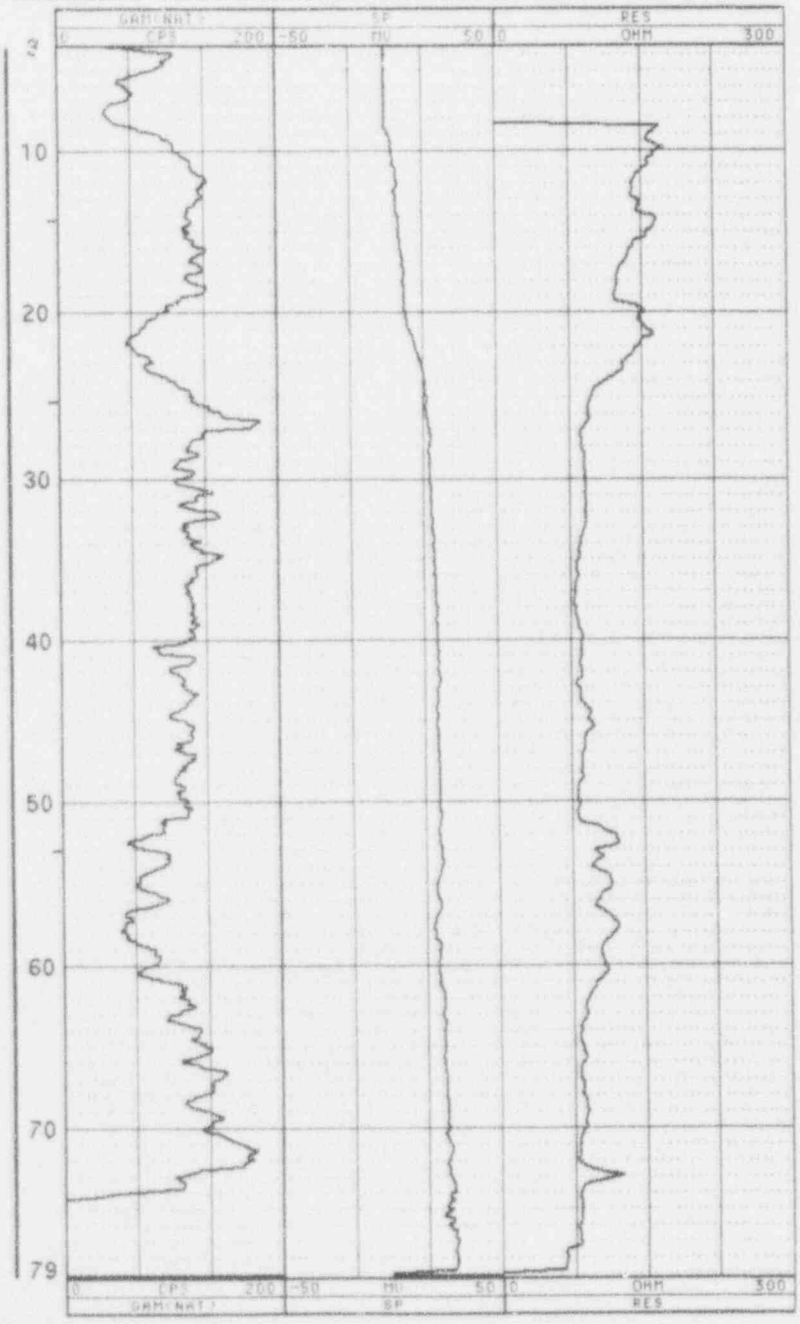
B-119-1

BOREHOLE B-120; ELEVATION 877.5 FT MSL

B-120-1

COMPANY	: KERR MCGEE			OTHER SERVICES:	
WELL	: B-120-1 ~~E 50 S 50~~				
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 06/17/93	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: ~~65 ft~~	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 79.30	LOG MEASURED FROM	: GS	DF	:
LOG TOP	: 3.70	DRL MEASURED FROM	: GS	GL	:
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE	: ORIGI
MAGNETIC DECL.	:	RM	:	TYPE	: 9055C
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG	: 0
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT	: 9055C
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH	: 0
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



B-120-1

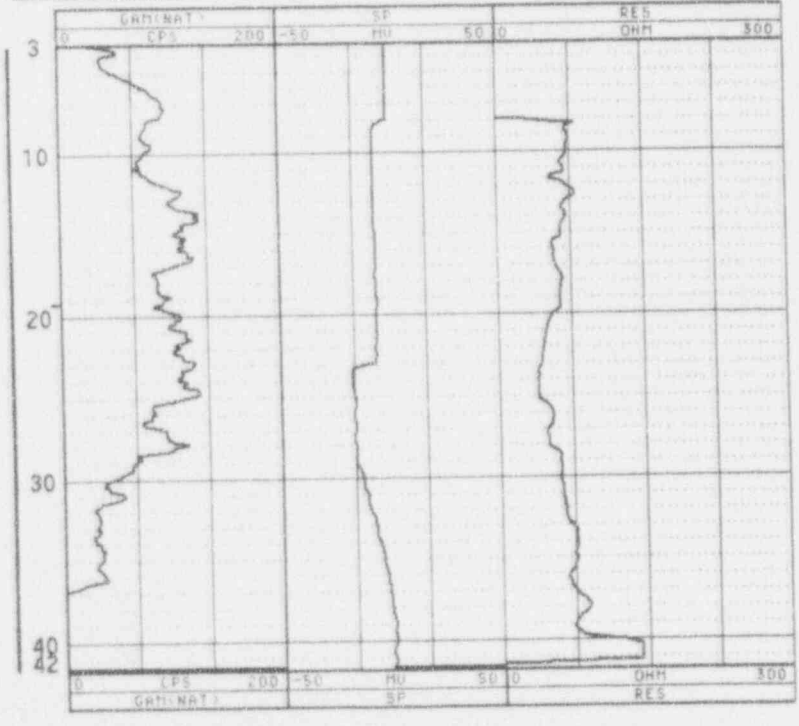
BOREHOLE B-126; ELEVATION 847.2 FT MSL

Century GEOPHYSICAL CORP.

B-126-1

COMPANY	: KERR MCGEE			OTHER SERVICES:	
WELL	: B-126-1	855 452			
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE :	
DATE	: 06/17/93	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: ~~65~~ 42	ELEV. PERM. DATUM	:	KB :	
LOG BOTTOM	: 41.70	LOG MEASURED FROM	: GS	DF :	
LOG TOP	: 3.40	DRL MEASURED FROM	: GS	GL :	
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE	: ORIG1
MAGNETIC DECL.	:	RM	:	TYPE	: 9855C
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG	: 2
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT	: 9855C
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH	: 0
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



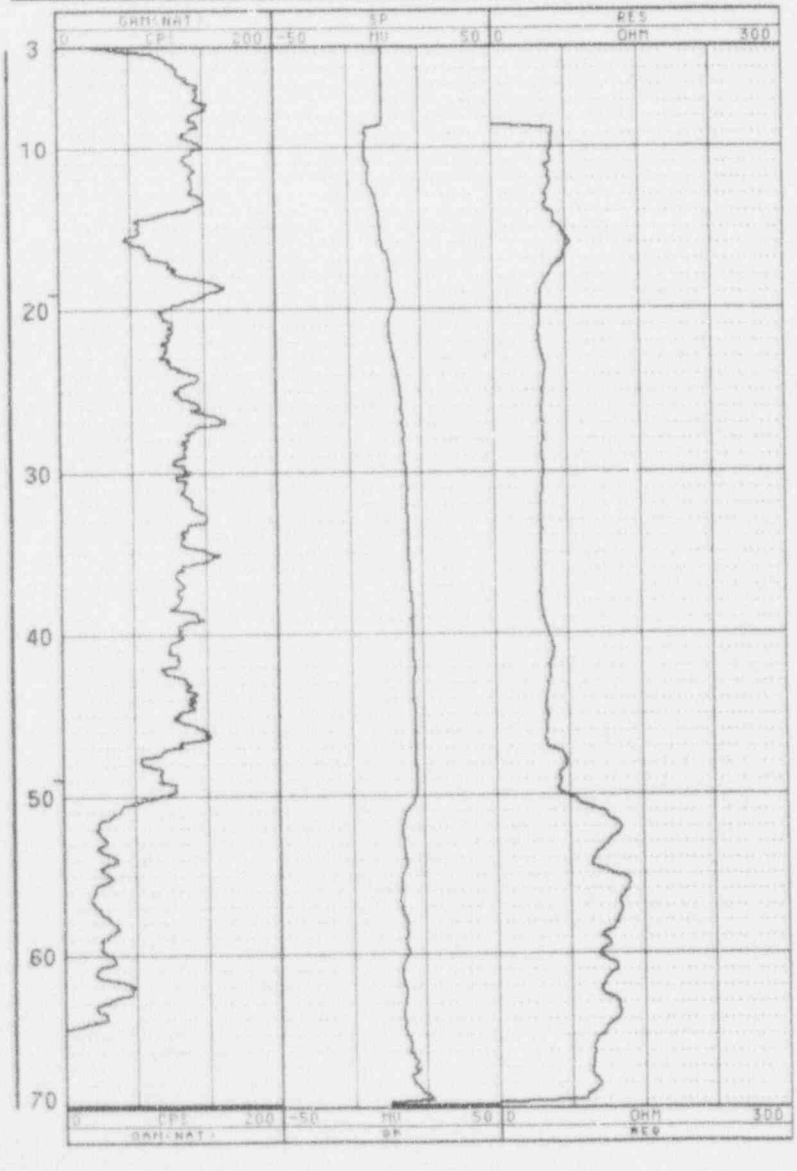
BOREHOLE B-127; ELEVATION 873.9 FT MSL

Century GEOPHYSICAL CORP.

B-127-1

COMPANY	: KERR MCGEE			OTHER SERVICES:	
WELL	: B-127-1 E50 S50				
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 06/18/93	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: 66.90	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 69.50	LOG MEASURED FROM	: GS	DF	:
LOG TOP	: 3.90	DRL MEASURED FROM	: GS	GL	:
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE	: ORIG1
MAGNETIC DECL.	:	RM	:	TYPE	: 9855C
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG	: B
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT	: 9855C
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH	: 0
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



B-127-1

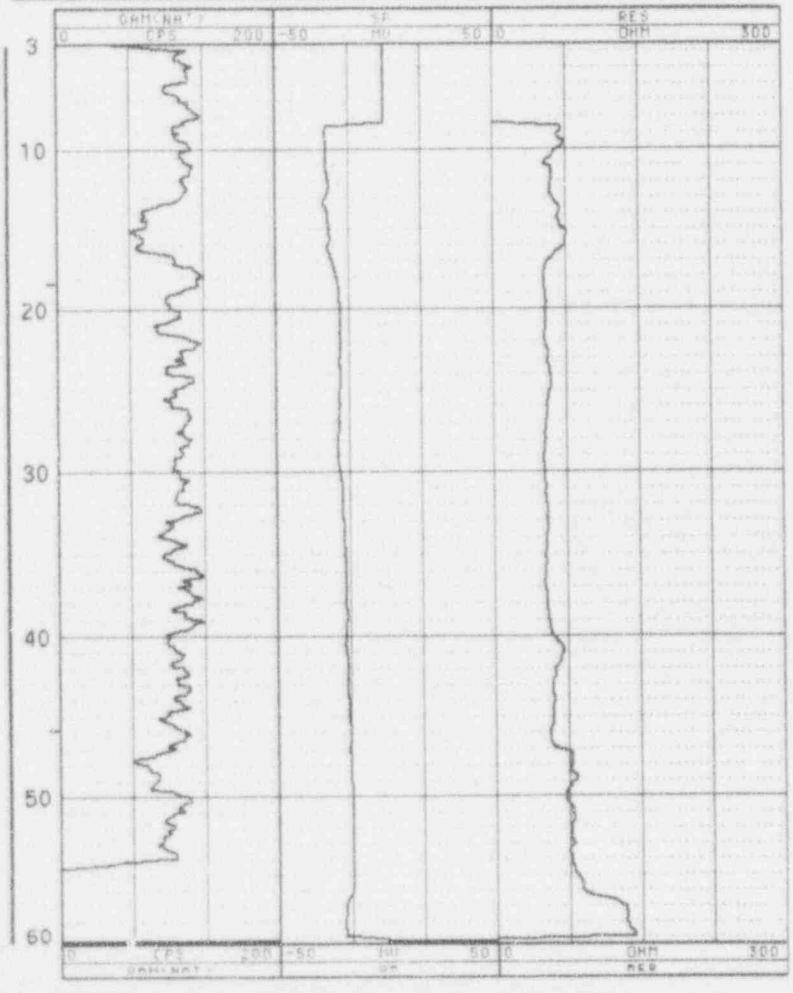
BOREHOLE B-128; ELEVATION 878.9 FT MSL

Century GEOPHYSICAL CORP.

B-128-1

COMPANY	: KERR MCGEE			OTHER SERVICES:	
WELL	: B-128-1 #50 #50				
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 06/18/93	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: ~~66~~ 60	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 59.50	LOG MEASURED FROM	: GS	DF	:
LOG TOP	: 3.00	DRL MEASURED FROM	: GS	GL	:
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE	: ORIGI
MAGNETIC DECL.	:	RM	:	TYPE	: 9855C
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG	: 6
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT	: 9855C
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH	: 0
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



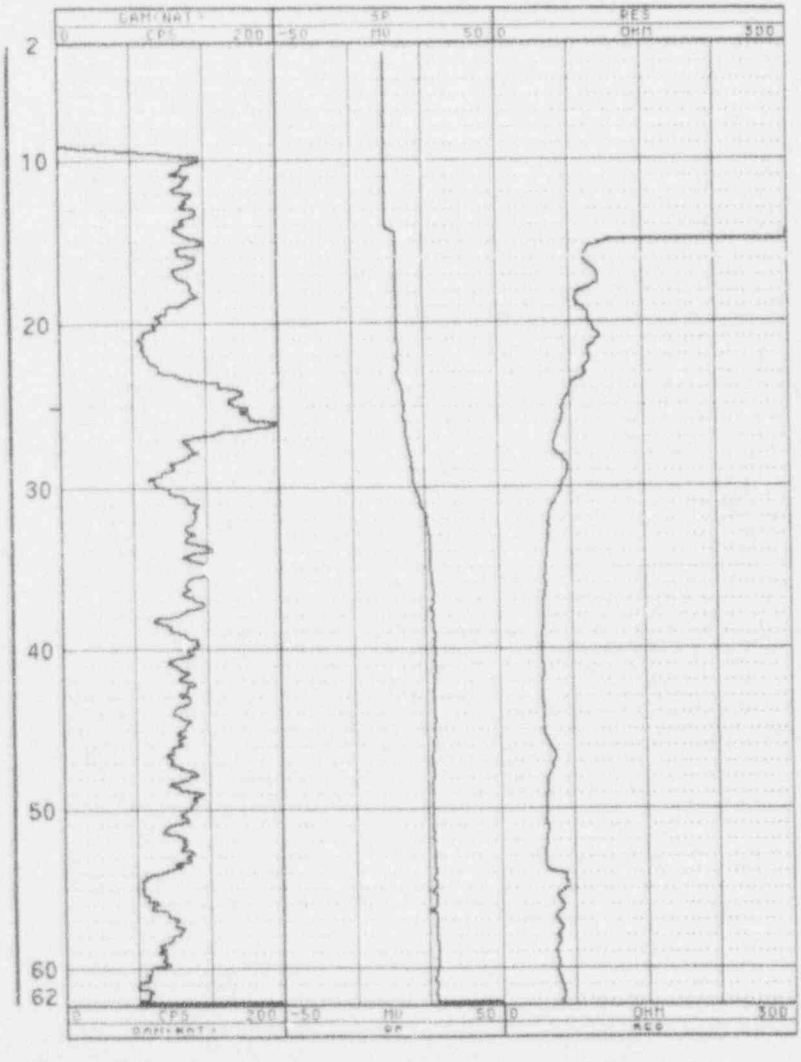
BOREHOLE B-134; ELEVATION 869.9 FT MSL

Century GEOPHYSICAL CORP.

B-134-1

COMPANY	: KERR MCGEE			OTHER SERVICES:	
WELL	: B-134-1				
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 06/16/93	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: 65	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 62.30	LOG MEASURED FROM	: GS	DF	:
LOG TOP	: 3.00	DRL MEASURED FROM	: GS	GL	:
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE	: ORIGI
MAGNETIC DECL.	:	RM	:	TYPE	: 9055C
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG	: 3
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT	: 9055C
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH	: 0
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



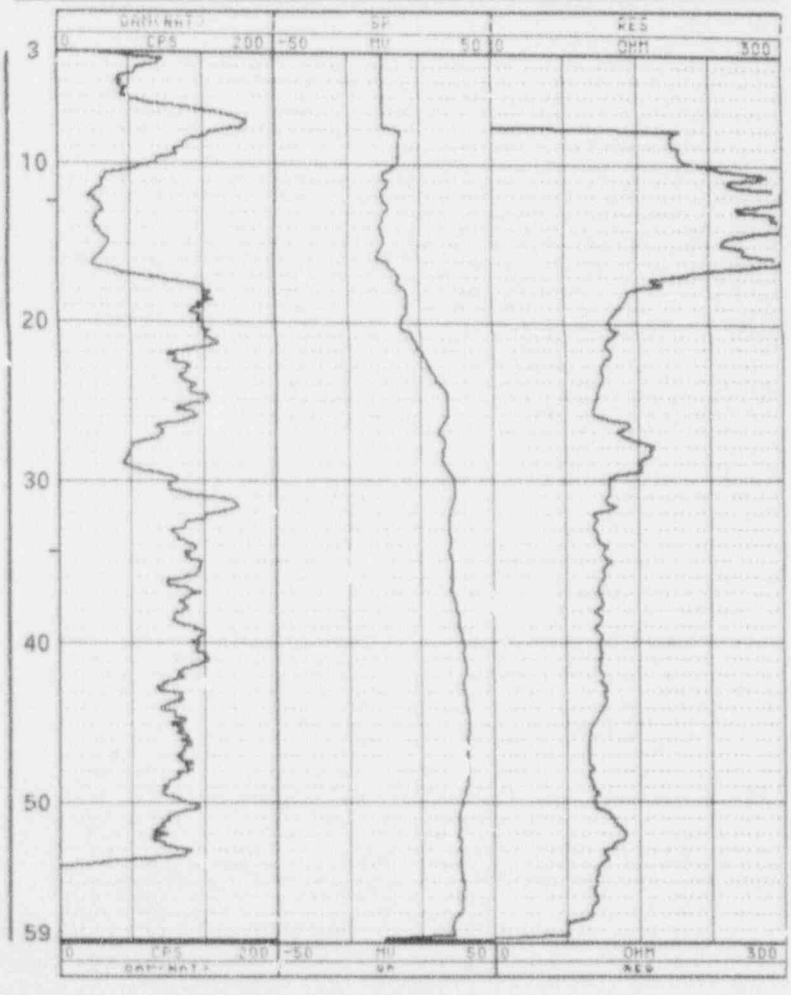
BOREHOLE B-135; ELEVATION 888.4 FT MSL

Century GEOPHYSICAL CORP.

B-135-1

COMPANY	: KERR MCGEE			OTHER SERVICES:	
WELL	: B-135-1				
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 06/10/93	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: 6060	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 58.90	LOG MEASURED FROM	: GS	DF	:
LOG TOP	: 3.30	DRL MEASURED FROM	: GS	GL	:
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE	: ORIGI
MAGNETIC DECL.	:	RM	:	TYPE	: 9055C
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG	: 1
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT	: 9055C
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH	: 0
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



B-135-1

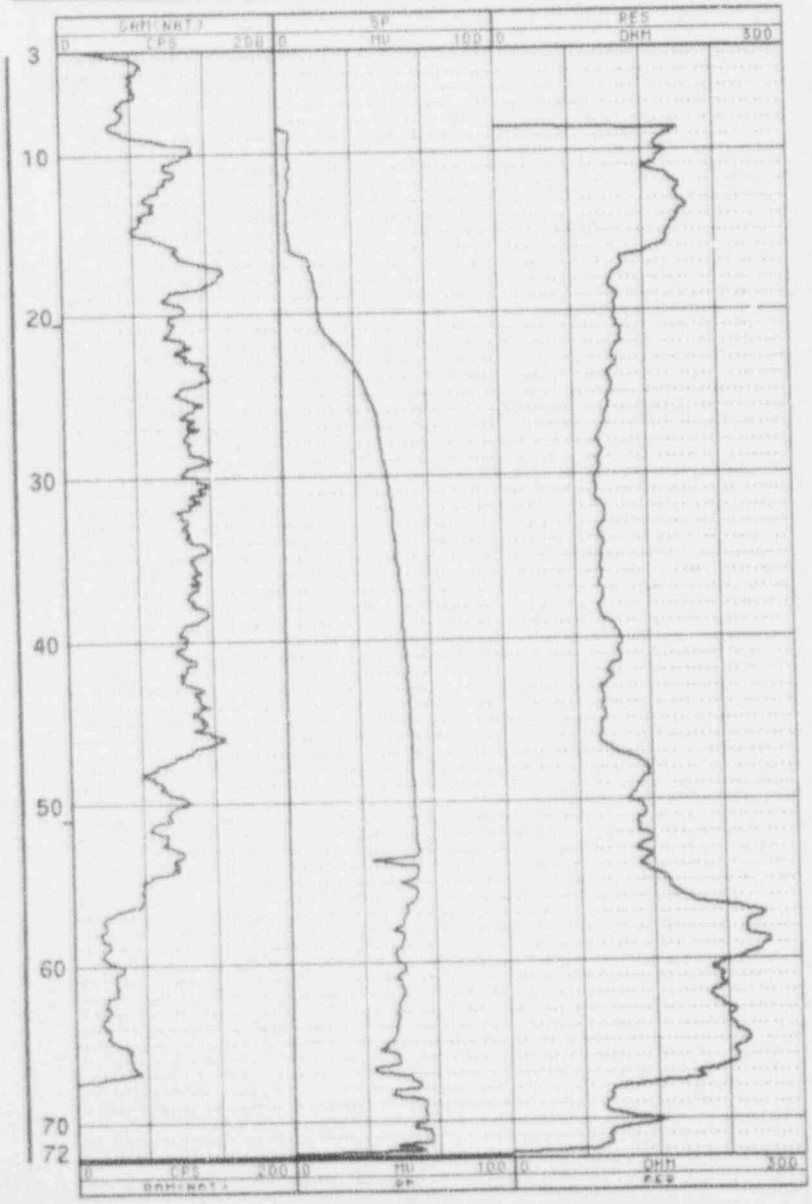
BOREHOLE B-136; ELEVATION 881.5 FT MSL

Century GEOPHYSICAL CORP.

B-136-1

COMPANY	: KERR MCGEE			OTHER SERVICES:	
WELL	: B-136-1				
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE	:
				ELEVATIONS	
DATE	: 06/19/93	PERMANENT DATUM	:	KB	:
DEPTH DRILLER	: 69' 5"	ELEV. PERM. DATUM	:	DF	:
LOG BOTTOM	: 72.46	LOG MEASURED FROM	: GS	GL	:
LOG TOP	: 3.00	DRL MEASURED FROM	: GS		
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE	: ORIGI
MAGNETIC DECL.	:	RM	:	TYPE	: 9055C
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG	: 2
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT	: 9055C
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH	: 0
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS



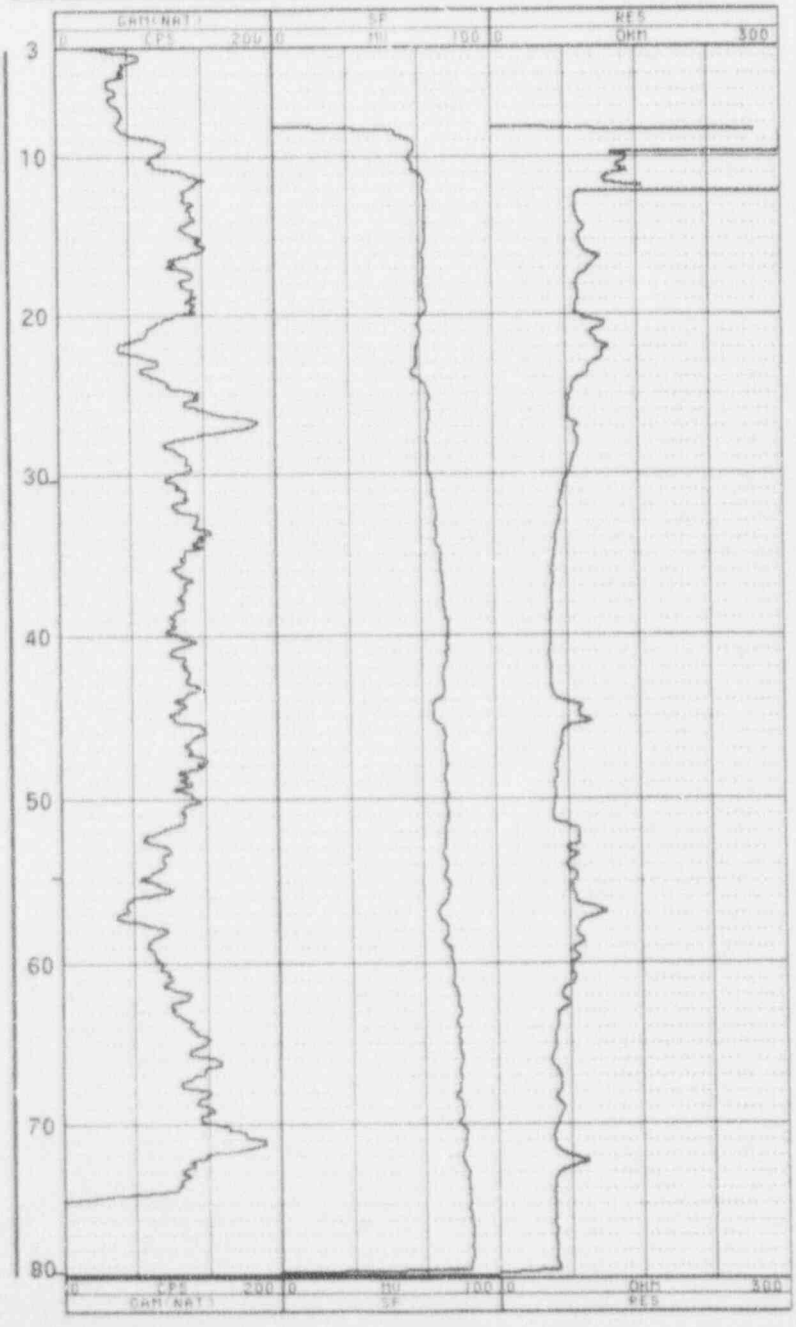
R-136-1

COREHOLE B-120-2; ELEVATION 873.0 FT MSL

B-120-2

COMPANY	: KERR MCGEE			OTHER SERVICES:	
WELL	: B-120-2				
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 06/24/93	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: 69.00	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 79.70	LOG MEASURED FROM	: GS	DF	:
LOG TOP	: 3.60	DRL MEASURED FROM	: GS	GL	:
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE	: ORIGI
MAGNETIC DECL.	:	RM	:	TYPE	: 9055C
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG	: 9
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT	: 9055C
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH	: 0
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

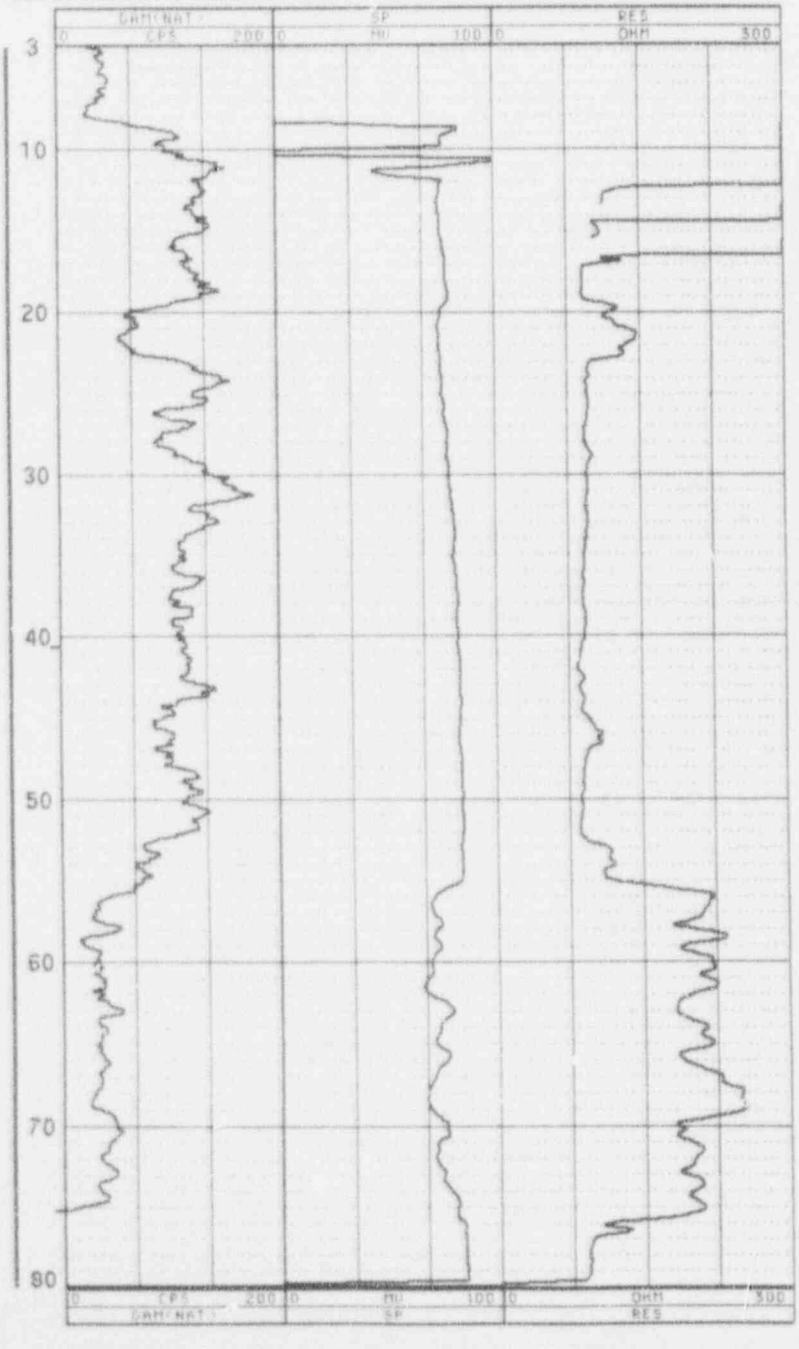


COREHOLE B-127-2; ELEVATION 881.8 FT MSL

B-127-2

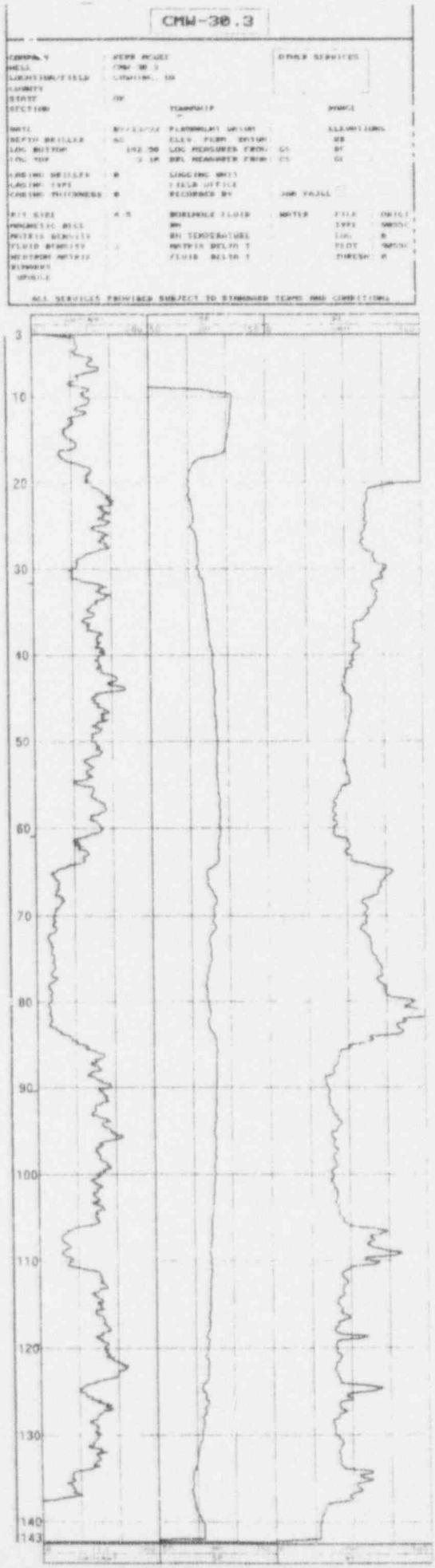
COMPANY	: KERR-McGEE			OTHER SERVICES:	
WELL	: B-127-2 E 05 J05				
LOCATION/FIELD	: CUSHING, OK				
COUNTY	:				
STATE	: OK				
SECTION	:	TOWNSHIP	:	RANGE	:
DATE	: 06/28/93	PERMANENT DATUM	:	ELEVATIONS	
DEPTH DRILLER	: 80' ∅	ELEV. PERM. DATUM	:	KB	:
LOG BOTTOM	: 80.10	LOG MEASURED FROM	: GS	DF	:
LOG TOP	: 3.00	DRL MEASURED FROM	: GS	GL	:
CASING DRILLER	: 0	LOGGING UNIT	:		
CASING TYPE	:	FIELD OFFICE	:		
CASING THICKNESS	: 0	RECORDED BY	: JAN FAJGL		
BIT SIZE	: 4.5	BOREHOLE FLUID	: WATER	FILE	: ORIGI
MAGNETIC DECL.	:	RM	:	TYPE	: 9855C
MATRIX DENSITY	:	RM TEMPERATURE	:	LOG	: 5
FLUID DENSITY	: 1	MATRIX DELTA T	:	PLOT	: 9855C
NEUTRON MATRIX	:	FLUID DELTA T	:	THRESH	: 0
REMARKS	:				
UPHOLE					

ALL SERVICES PROVIDED SUBJECT TO STANDARD TERMS AND CONDITIONS

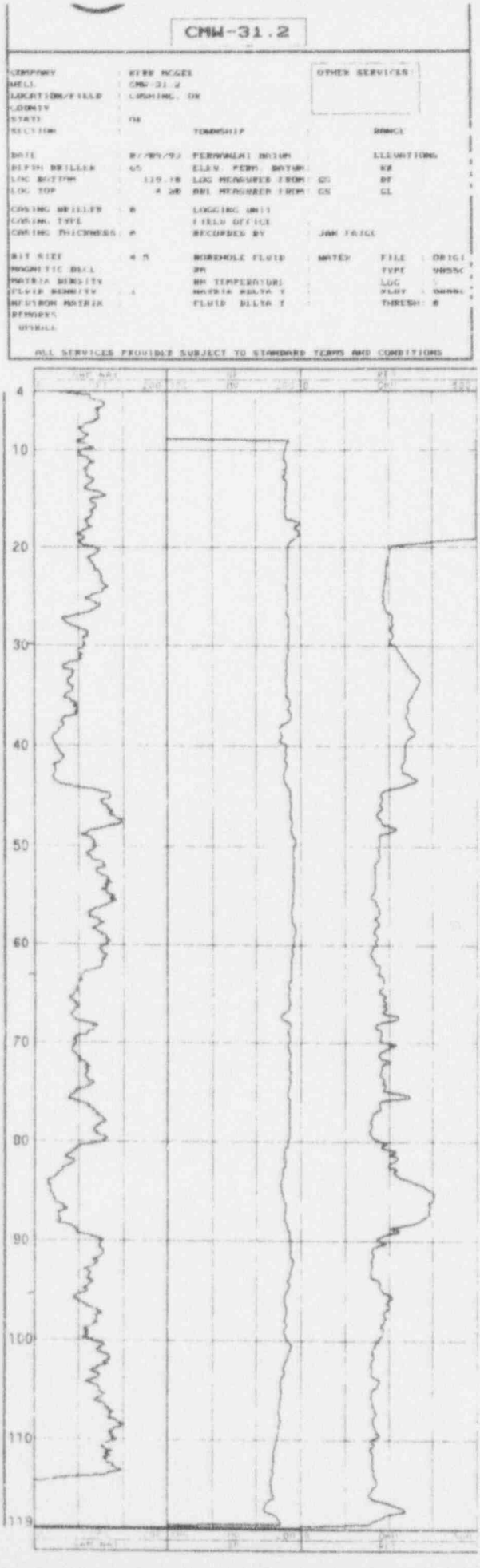


B-127-2

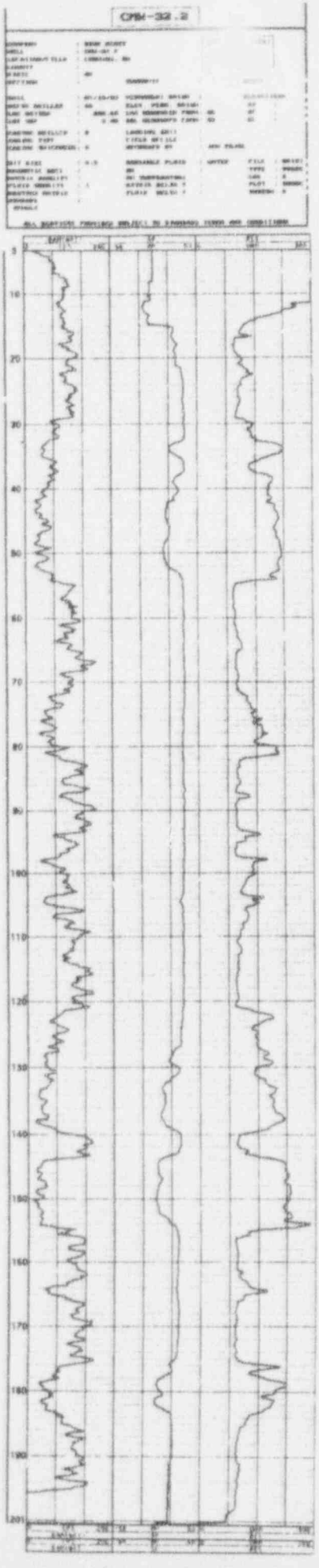
BOREHOLE CMW30.3; ELEVATION 892.1 FT MSL



BOREHOLE CMW31.2; ELEVATION 847.7 FT MSL



BOREHOLE CMW32.2; ELEVATION 850.6 FT MSL



APPENDIX H
FORMATION CORE PERMEABILITY DATA
AREA 3

Table. FLEXIBLE WALL PERMEABILITY TEST RESULTS

Cores from the Cushing Kerr-McGee Facility

Core	B-120-2	B-120-2	B-120-2	B-120-2	B-120-2	B-120-2	B-127-2
Interval	15'-16'	35'-37'	43'-44'	58'-59'	63'-65'	77'-78'	26'-27'
Dry Density (pcf)	126.4	131.7	114.2	133.0	125.3	111.1	114.4
Moisture, %	17.0	11.4	15.0	8.7	11.5	14.0	14.7
k, cm/sec.	1.2×10^{-8}	7.1×10^{-8}	6.1×10^{-7}	1.7×10^{-8}	8.8×10^{-8}	3.1×10^{-7}	3.2×10^{-7}

pcf = pounds per cubic foot
k = coefficient of permeability

Table. FLEXIBLE WALL PERMEABILITY TEST RESULTS

Cores from the Cushing Kerr-McGee Facility

Core	B-127-2	B-127-2	B-127-2	B-127-2	B-127-2
Interval	39'-40'	47'-48'	63'-64'	70'-71'	77'-78'
Dry Density (pcf)	134.3	134.0	124.7	123.5	125.9
Moisture, %	9.3	8.7	11.1	11.5	12.0
k, cm/sec.	5.8×10^{-8}	1.9×10^{-8}	1.6×10^{-7}	1.8×10^{-6}	3.4×10^{-8}

pcf = pounds per cubic foot
k = coefficient of permeability

APPENDIX I

WATER LEVEL DATA FOR MONITOR WELLS

AREA 3

Historical Water Levels in Cushing Area 3

Date	CMW30.1 Depth to Water (ft BTOC)	CMW30.1 WL Elev. (ft BTOC)	CMW30.2 Depth to Water (ft BTOC)	CMW30.2 WL Elev. (ft BTOC)	CMW30.3 Depth to Water (ft BTOC)	CMW30.3 WL Elev. (ft BTOC)	CMW31.1 Depth to Water (ft BTOC)	CMW31.1 WL Elev. (ft BTOC)	CMW31.2 Depth to Water (ft BTOC)	CMW31.2 WL Elev. (ft BTOC)
07/22/93	11.97	880.86	56.95	837.27	87.90	806.27	16.50	831.79	42.59	806.93
07/28/93	10.94	881.89	56.82	837.40	78.13	816.04	15.86	832.43	38.65	810.87
08/25/93	9.21	883.62	58.06	836.16	67.18	826.99	16.47	831.82	35.64	813.88
09/24/93	9.98	882.85	58.16	836.06	63.35	830.82	16.09	832.20	35.17	814.35
10/27/93	10.91	881.92	58.78	835.44	61.34	832.83	16.38	831.91	34.71	814.81
11/16/93	11.57	881.26	57.98	836.24	60.64	833.53	16.29	832.00	34.58	814.94
12/09/93	12.05	880.78	59.31	834.91	60.20	833.97	16.20	832.09	34.78	814.74
Mean WL	10.74	882.09	58.46	835.76	62.54	831.63	16.29	832.00	34.98	814.54

Note: "ft BTOC" indicates "Feet Below Top of Casing"

Historical Water Levels in Cushing Area 3 (continued)

	CMW32.1		CMW32.2		CMW20.1		CMW20.2	
	Depth to Water	WL Elev.	Depth to Water	WL Elev.	Depth to Water	WL Elev.	Depth to Water	WL Elev.
Date	(ft BTOC)	(ft BTOC)	(ft BTOC)	(ft BTOC)	(ft BTOC)	(ft BTOC)	(ft BTOC)	(ft BTOC)
07/22/93	27.90	825.40	66.58	786.42				
07/28/93	26.82	826.48	64.35	788.65	28.92	819.08	34.84	812.42
08/25/93	25.16	828.14	55.51	797.49	29.31	818.69	35.25	812.01
09/24/93	24.93	828.37	50.18	802.82	29.42	818.58	34.96	812.30
10/27/93	25.44	827.86	46.90	806.10	29.18	818.82	35.0[illegible]	812.21
11/16/93	25.48	827.82	45.66	807.34	28.89	819.11	34.51	812.75
12/09/93	25.37	827.93	44.68	808.32	29.30	818.70	34.62	812.64
Mean WL	25.28	828.02	48.59	804.41	29.22	818.78	34.88	812.38

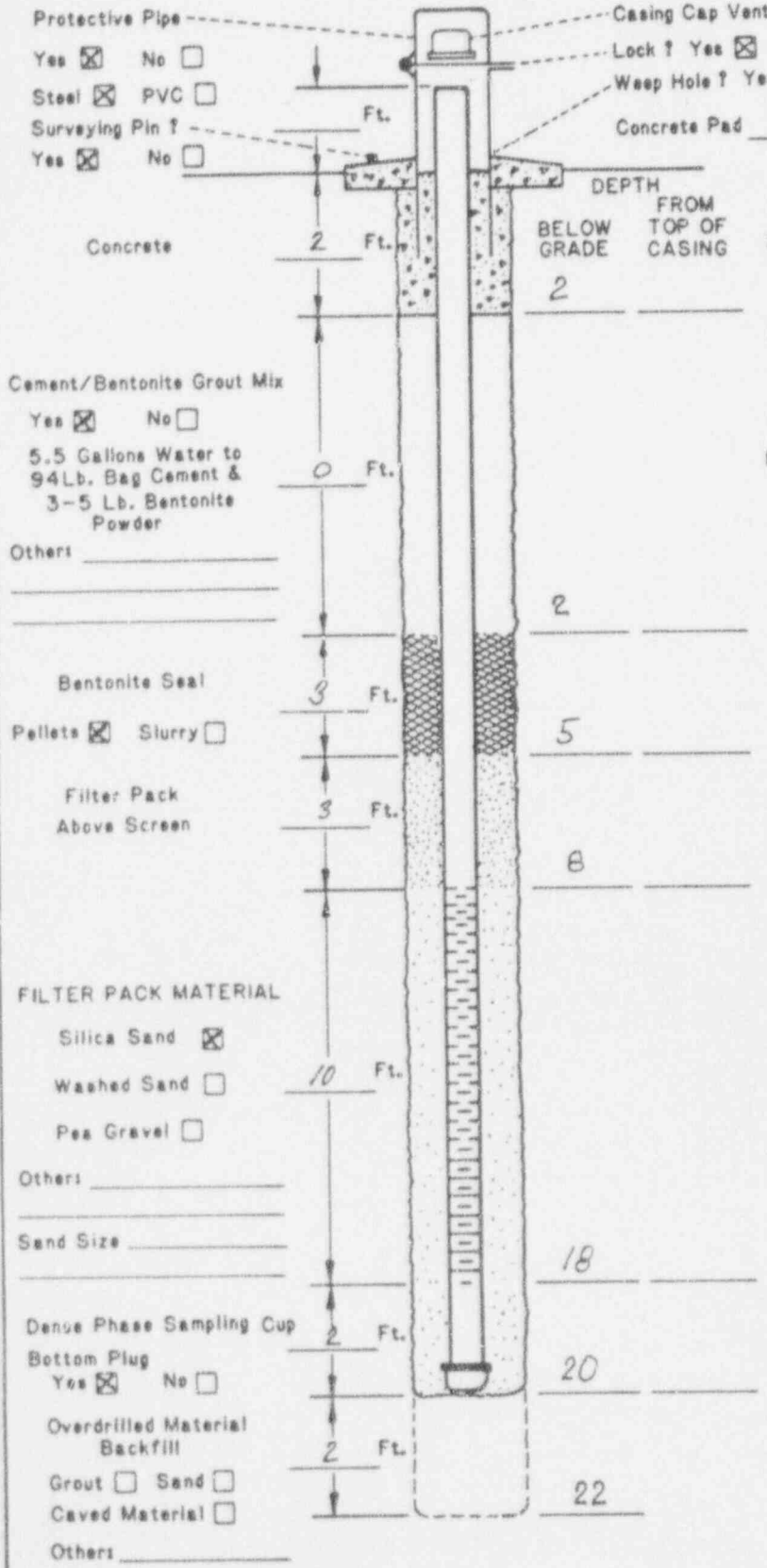
Note: "ft BTOC" indicates "Feet Below Top of Casing"

APPENDIX J

WELL COMPLETION DIAGRAMS FOR MONITOR WELLS
AREA 3

CMW30.1

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 7 7/8 inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☒
   Solid Auger ☒ Hollow Stem Auger ☐
3. Was Outer PVC Casing Used ? Yes ☒ No ☐
   Depth= 0 to 6 Feet.
4. Borehole Diameter for Outer Casing 10 Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 4 Inches, Screen 4 Inches.
5. Slot Size of Screen: 0.01"
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   _____ / 4 Hrs 5 Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe _____

WATER LEVEL INFORMATION:

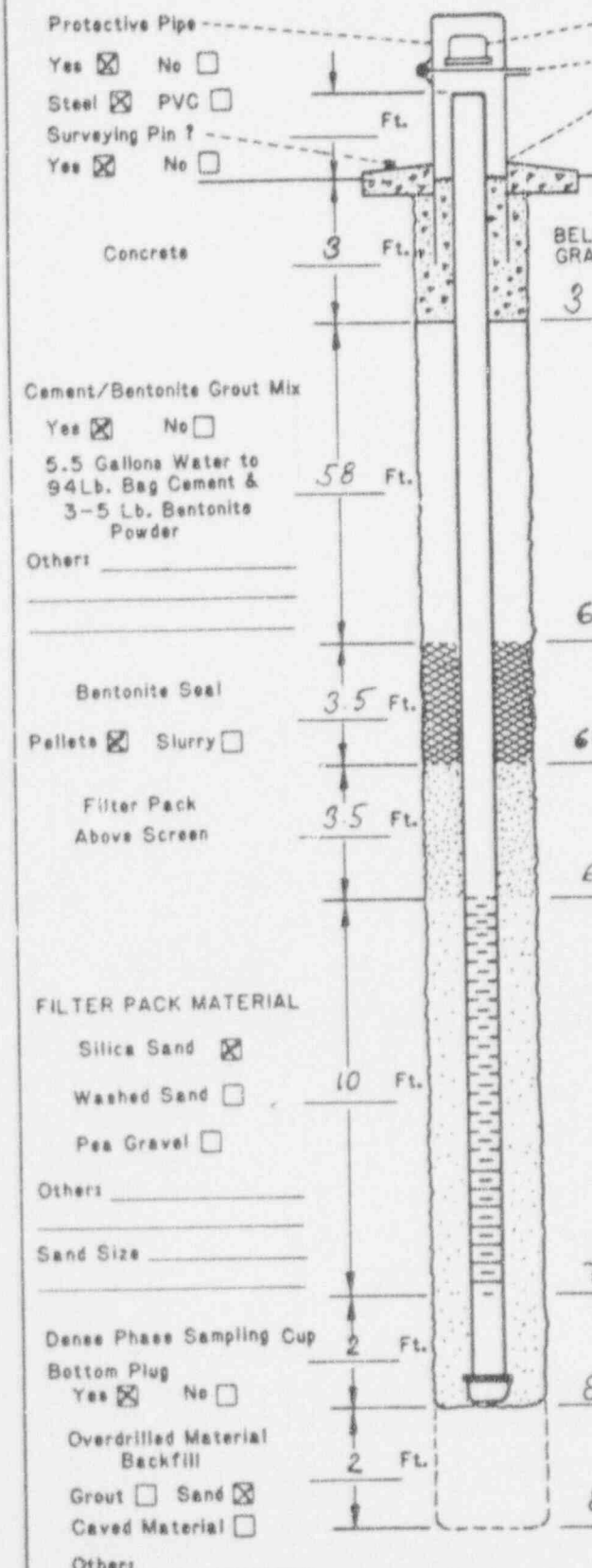
Water Level Summary (From Top of Casing)

During Drilling _____ Ft. Date _____
Before Development _____ Ft. Date _____
After Development _____ Ft. Date _____

Driller/Firm Wimmek
Drill Rig Type _____
Date Installed 7-20-93
Drill Crew B. Knopf
Well No. CMW 30.1
Kerr-McGee Hydrologist J. Fogle / S.R. Lower

CMW30.2

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 7 7/8 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☒
   Solid Auger ☒ Hollow Stem Auger ☐
3. Was Outer PVC Casing Used ? Yes ☒ No ☐
   Depth= 0 to 20 Feet.
4. Borehole Diameter for Outer Casing 12 Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 4 Inches, Screen 4 Inches.
5. Slot Size of Screen: 0.01"
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   _____ / 4 Hrs Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

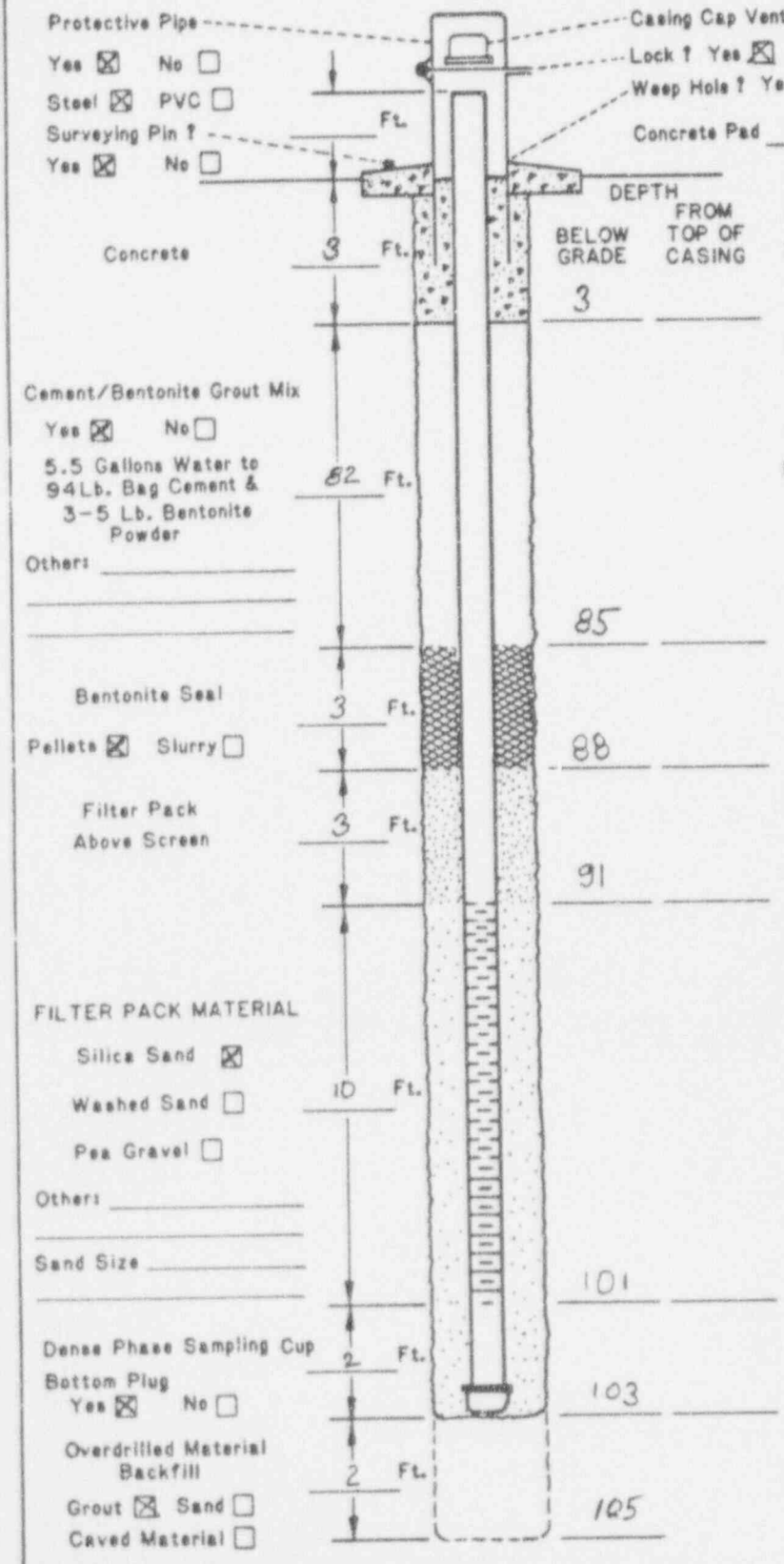
During Drilling _____ Ft. Date _____
Before Development _____ Ft. Date _____
After Development _____ Ft. Date _____

Driller/Firm Winnek Drill Rig Type _____ Date Installed 7-20-93

Drill Crew B. Knopf Well No. CMW 30.2 Kerr-McGee Hydrologist J. Fajc / S.R. Lower

CMW30.3

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 7 7/8 inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☒
   Solid Auger ☒ Hollow Stem Auger ☐
3. Was Outer PVC Casing Used ? Yes ☒ No ☐
   Depth= 0 to 20 Feet.
4. Borehole Diameter for Outer Casing 12 inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other
4. Diameter of Casing and Well Screen:
   Casing 4 inches, Screen 4 inches.
5. Slot Size of Screen: 0.01"
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☐ Other
2. Time Spent on Well Development ?
   / 4 Hrs Minutes/Hours
3. Approximate Water Volume Removed ? Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe

WATER LEVEL INFORMATION:

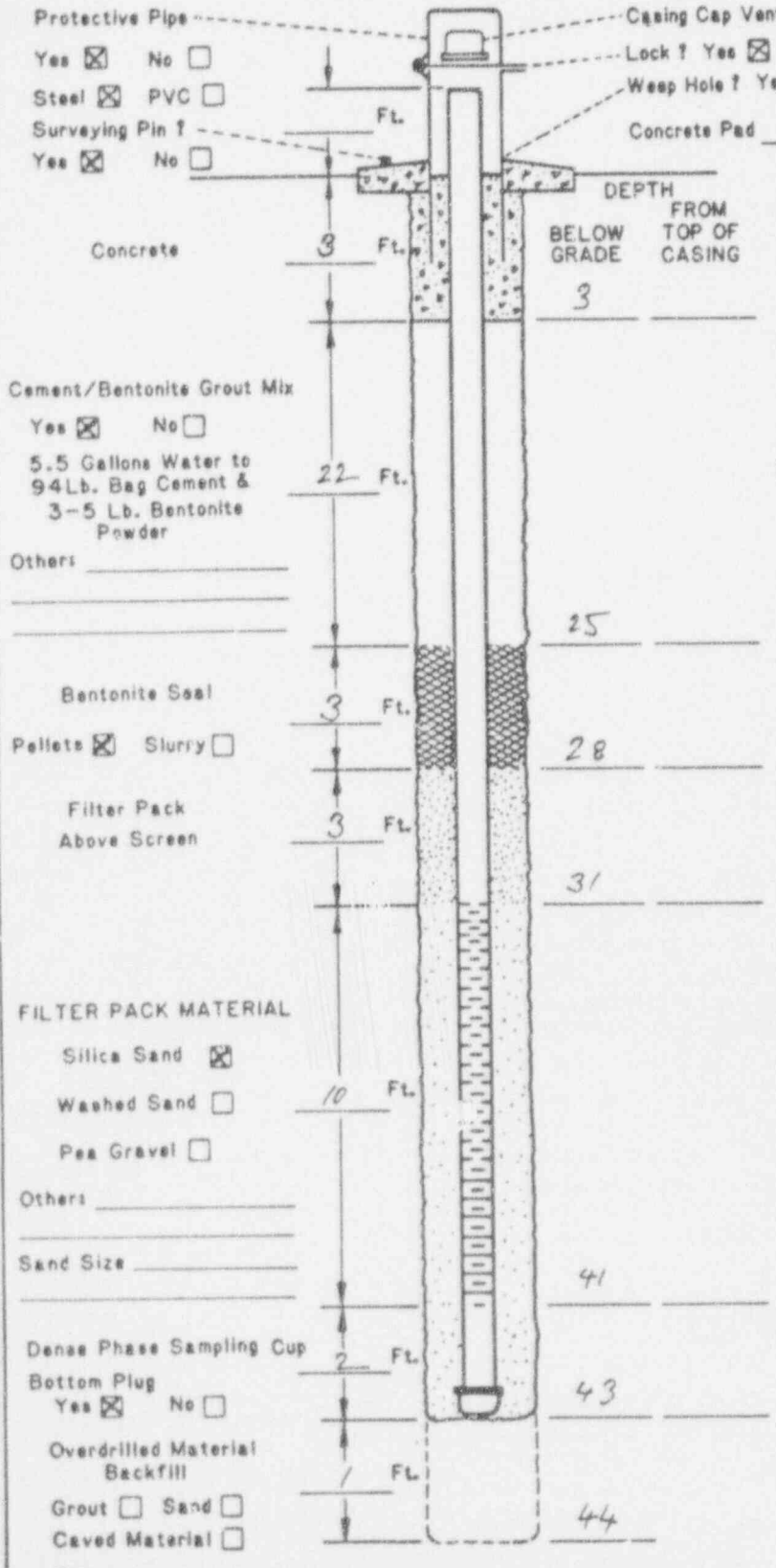
Water Level Summary (From Top of Casing)

During Drilling Ft. Date
Before Development Ft. Date
After Development Ft. Date

Driller/Firm Wimmek
Drill Rig Type
Date Installed 7-15-93
Drill Crew B. Knopf
Well No. CMW 30.3
Kerr-McGee Hydrologist J. Fogle / S.R. Lower

CMW31.1

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Concrete Pad 2 Ft. x 2 Ft. x 4 Inches

DRILLING INFORMATION:

1. Borehole Diameter= 7 7/8 inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☒
   Solid Auger ☒ Hollow Stem Auger ☐
3. Was Outer Casing Used ? Yes ☒ No ☐
   Depth= 0 to 20 Feet.
4. Borehole Diameter for Outer Casing 12 Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other
4. Diameter of Casing and Well Screen:
   Casing 4 Inches, Screen 4 Inches.
5. Slot Size of Screen: 0.01"
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☐ Other
2. Time Spent on Well Development ?
   / 4 Hrs Minutes/Hours
3. Approximate Water Volume Removed ? Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe

WATER LEVEL INFORMATION:

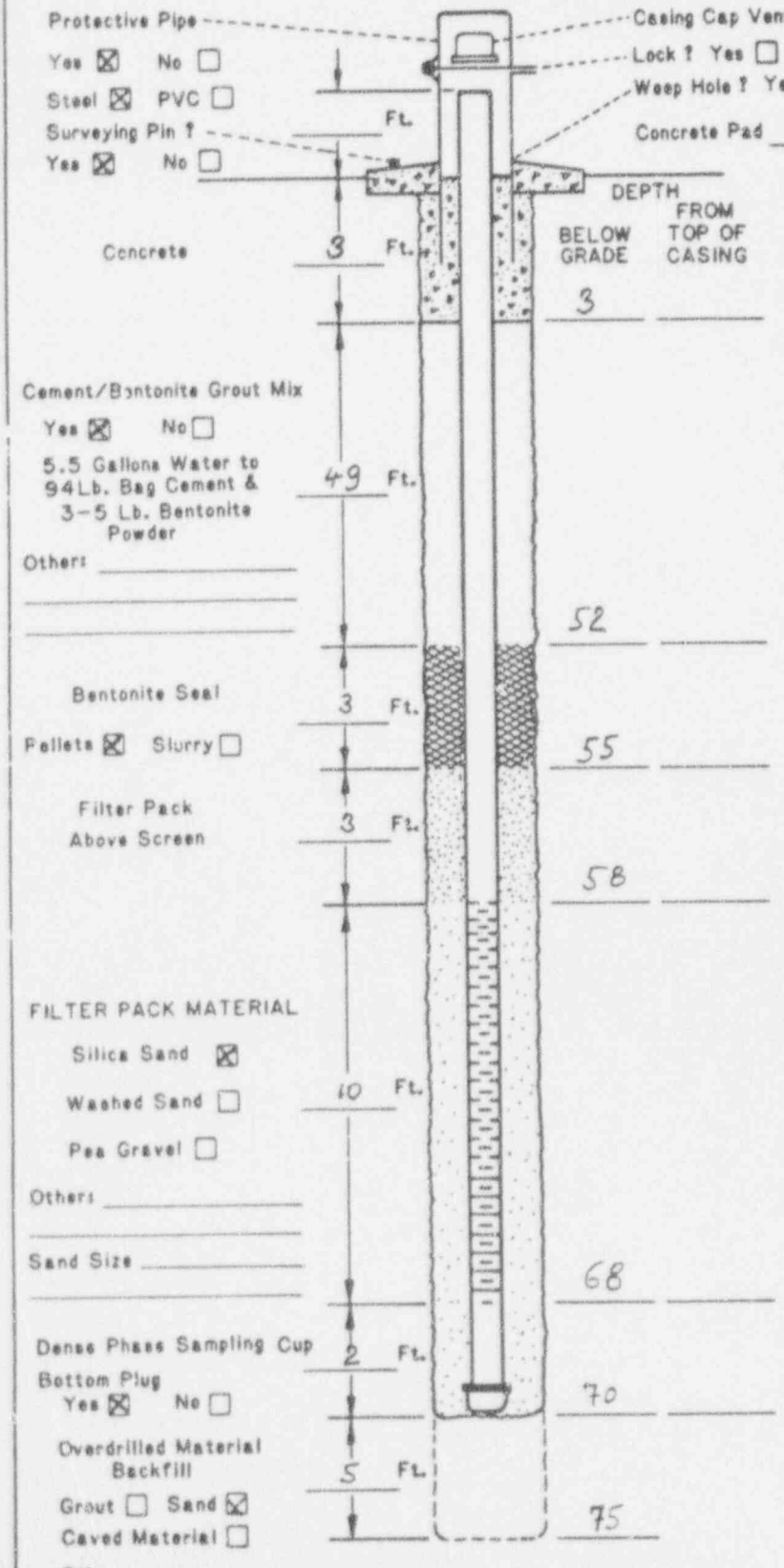
Water Level Summary (From Top of Casing)

During Drilling Ft. Date
Before Development Ft. Date
After Development Ft. Date

Driller/Firm Winnek
Drill Rig Type
Date Installed 7-20-93
Drill Crew Bob Knopf
Well No. CMW 31.1
Kerr-McGee Hydrologist J. Fuge / S.R. Lower

CMW31.2

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter= 7 3/8" inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☒
   Solid Auger ☒ Hollow Stem Auger ☐
3. Was Outer Casing Used ? Yes ☒ No ☐
   Depth= 0 to 20 Feet.
4. Borehole Diameter for Outer Casing 12 inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other
4. Diameter of Casing and Well Screen:
   Casing 4 inches, Screen 4 inches.
5. Slot Size of Screen: 0.01"
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☐ Other
2. Time Spent on Well Development ?
   / 4Hrs Minutes/Hours
3. Approximate Water Volume Removed ? Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes , Describe

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

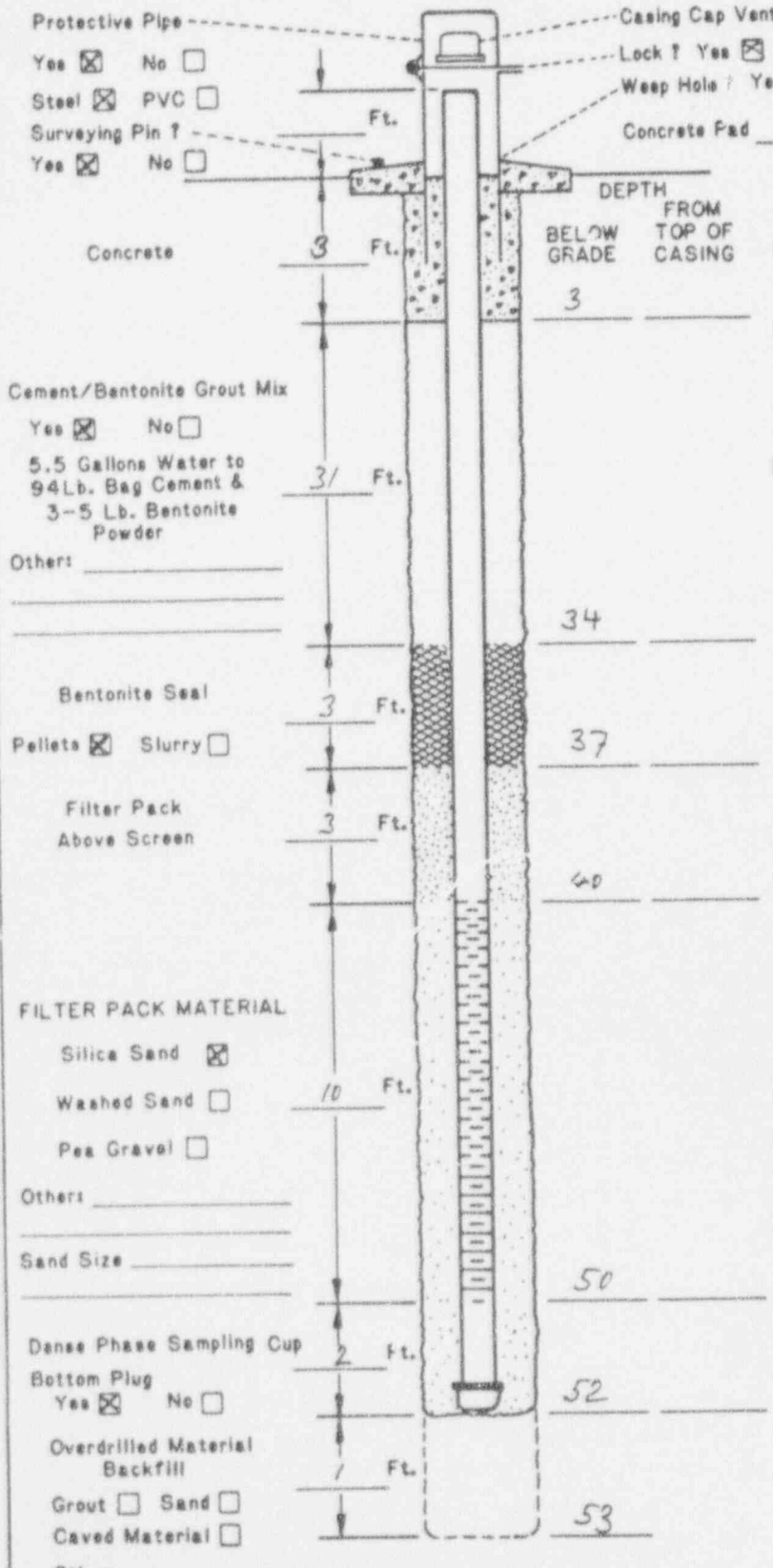
During Drilling Ft. Date
Before Development Ft. Date
After Development Ft. Date

Driller/Firm Winnek Drill Rig Type Date Installed 7-15-93

Drill Crew B. Knopf Well No. CMW31.2 Kerr-McGee Hydrologist J. Fuge / S.R. Lower

CMW32.1

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter: 7 7/8 inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☒
   Solid Auger ☒ Hollow Stem Auger ☐
3. Was Outer Casing Used ? Yes ☒ No ☐
   Depth: 0 to 15 Feet.
4. Borehole Diameter for Outer Casing _____ inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 4 inches, Screen 4 inches.
5. Slot Size of Screen: 0.01"
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   ____ / 4hrs Minutes/Hours
3. Approximate Water Volume Removed ? ____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe _____

WATER LEVEL INFORMATION:

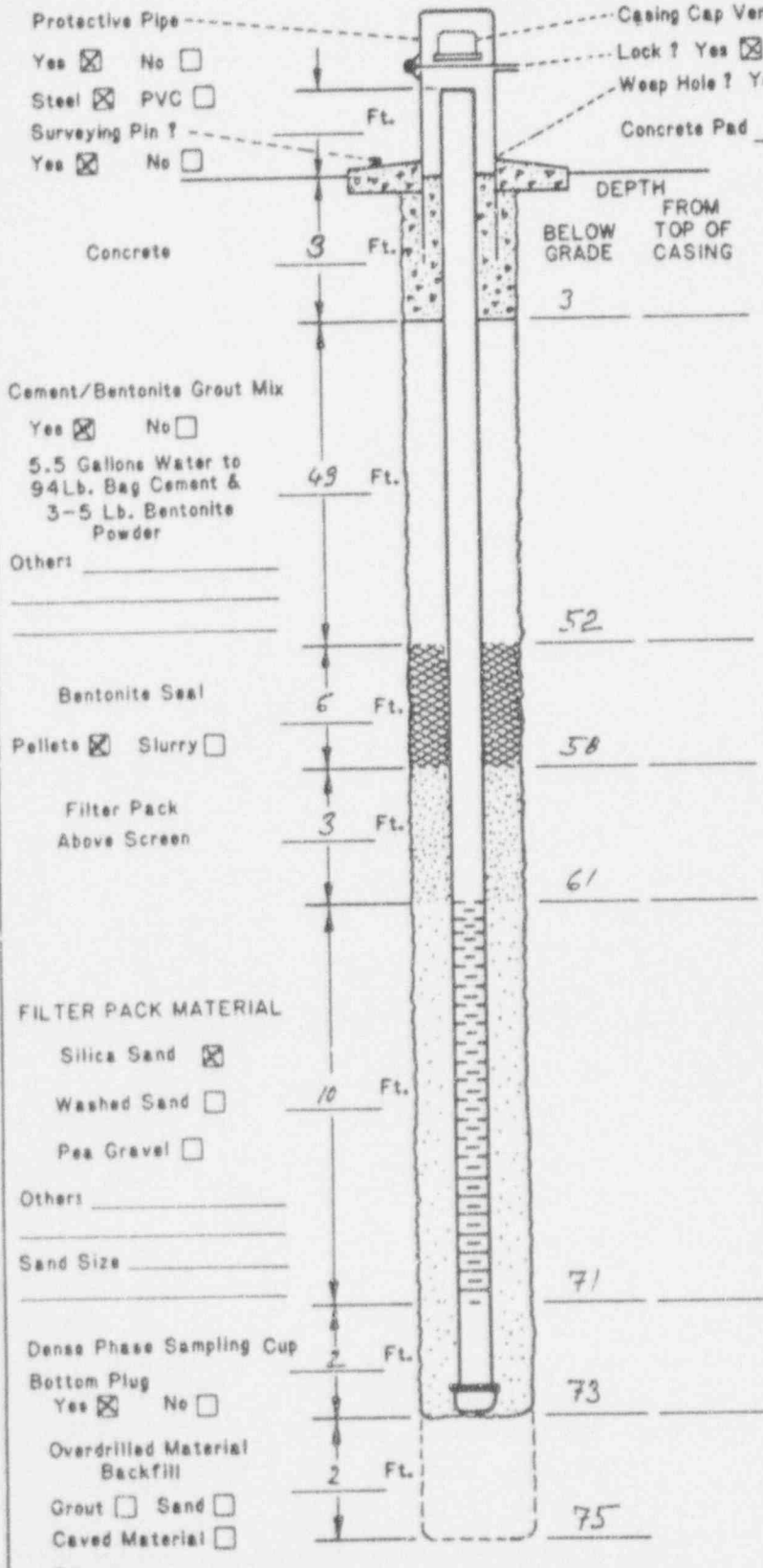
Water Level Summary (From Top of Casing)

During Drilling _____ Ft. Date _____
Before Development _____ Ft. Date _____
After Development _____ Ft. Date _____

Driller/Firm: Wimmek
Drill Rig Type: _____
Date Installed: 7-16-93
Drill Crew: Bob Knopf
Well No.: CMW 32.1
Kerr-McGee Hydrologist: J. Feige / S.R. Lower

CMW32.2

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



Concrete Pad 2 Ft. x 2 Ft. x 4 inches

DRILLING INFORMATION:

1. Borehole Diameter= 7 7/8 inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☒
   Solid Auger ☒ Hollow Stem Auger ☐
3. Was Outer PVC Casing Used ? Yes ☒ No ☐
   Depth= 0 to 15 Feet.
4. Borehole Diameter for Outer Casing 12 inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☒ Galvanized ☐ Teflon ☐
   Stainless ☐ Other
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other
3. Type of Well Screen: PVC ☒ Galvanized ☐
   Stainless ☐ Teflon ☐ Other
4. Diameter of Casing and Well Screen:
   Casing 4 inches, Screen 4 inches.
5. Slot Size of Screen: 0.01"
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☐ Other
2. Time Spent on Well Development ?
   / 4 hrs Minutes/Hours
3. Approximate Water Volume Removed ? Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☒
   Turbid ☐ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe

WATER LEVEL INFORMATION:

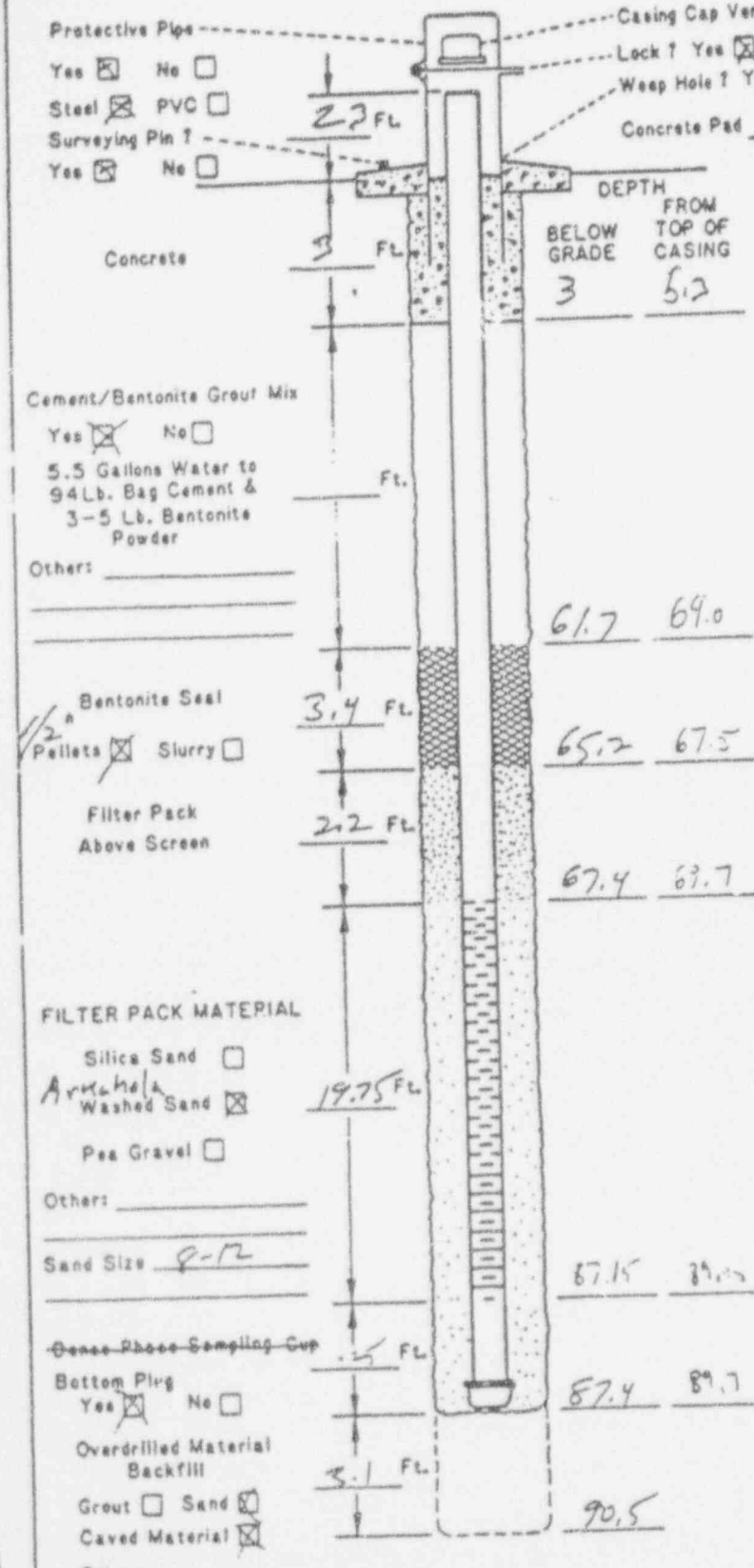
Water Level Summary (From Top of Casing)

During Drilling Ft. Date
Before Development Ft. Date
After Development Ft. Date

Driller/Firm Winnek Drill Rig Type Date Installed 7-17-93

Drill Crew 306 Knopf Well No. CMW 32.2 Kerr-McGee Hydrologist J. Fuge / S.R. Lower

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter: 6.25 Inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☒
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☐
   Depth= _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☐ Galvanized ☐ Teflon ☐
   Stainless ☒ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☐ Galvanized ☐
   Stainless ☒ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 2 Inches, Screen 2 Inches.
5. Slot Size of Screen: .020
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☐ Pumping ☒
   Air Surging (Air or Nitrogen) ☐ Other ☒ Air Lift.
2. Time Spent on Well Development ?
   _____ / _____ Minutes/Hours
3. Approximate Water Volume Removed ? _____ Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☒ Opaque ☐ Clearing
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe _____

WATER LEVEL INFORMATION:

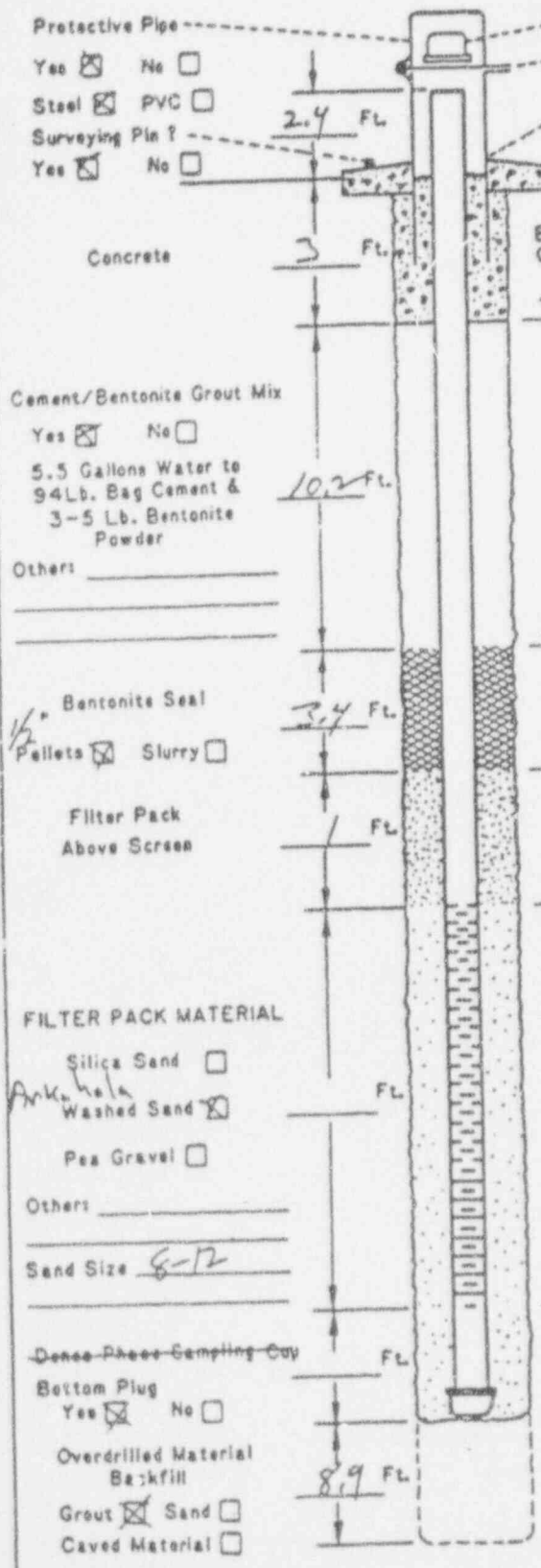
Water Level Summary (From Top of Casing)

During Drilling _____ Ft. Date _____
Before Development 23.9 Ft. Date 1-16-90
After Development _____ Ft. Date _____

Driller/Firm Robert J Kingsley / Winnek Drill Rig Type Rotary Date Installed 1-11-90
Drill Crew Nathan E. Williams Well No. (CUA-3-D) Kerr-McGee Hydrologist Tim Bent

(MW) 20.2

KERR-McGEE CORPORATION
HYDROLOGY DEPARTMENT
MONITORING WELL INSTALLATION DIAGRAM



DRILLING INFORMATION:

1. Borehole Diameter 6.25 inches.
2. Were Drilling Additives Used ? Yes ☐ No ☒
   Revert ☐ Bentonite ☐ Water ☒
   Solid Auger ☐ Hollow Stem Auger ☐
3. Was Outer Steel Casing Used ? Yes ☐ No ☐
   Depth _____ to _____ Feet.
4. Borehole Diameter for Outer Casing _____ Inches.

WELL CONSTRUCTION INFORMATION:

1. Type of Casing: PVC ☐ Galvanized ☐ Teflon ☐
   Stainless ☒ Other _____
2. Type of Casing Joints: Screw-Couple ☒ Glue-Couple ☐ Other _____
3. Type of Well Screen: PVC ☐ Galvanized ☐
   Stainless ☒ Teflon ☐ Other _____
4. Diameter of Casing and Well Screen:
   Casing 2 inches, Screen 2 inches.
5. Slot Size of Screen: .020
6. Type of Screen Perforation: Factory Slotted ☒
   Hacksaw ☐ Drilled ☐ Other _____
7. Installed Protector Pipe w/Lock: Yes ☒ No ☐

WELL DEVELOPMENT INFORMATION:

1. How was Well Developed ? Bailing ☒ Pumping ☐
   Air Surging (Air or Nitrogen) ☐ Other _____
2. Time Spent on Well Development ?
   20 / _____ Minutes/Hours
3. Approximate Water Volume Removed ? 1 Gallons
4. Water Clarity Before Development ? Clear ☐
   Turbid ☒ Opaque ☐
5. Water Clarity After Development ? Clear ☐
   Turbid ☒ Opaque ☐
6. Did Water have Odor ? Yes ☐ No ☒
   If Yes, Describe _____
7. Did Water have any Color ? Yes ☐ No ☒
   If Yes, Describe _____

WATER LEVEL INFORMATION:

Water Level Summary (From Top of Casing)

During Drilling Dry Ft. Date _____
Before Development _____ Ft. Date _____
After Development _____ Ft. Date _____

Driller/Firm Robert J. Kingsley / Winnsboro Drill Rig Type Rotary Date Installed 1-12-90

Drill Crew Nathan E. Williams Well No. (CUA-3-5) Kerr-McGee Hydrologist Tim Best

CMW20.1