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DATA COLLECTION FOR ENGINEERING FOR URANIUM
TAILINGS SITE AND PERIPHERICAL PROPS 9/86

Monticello Remedial Action Project

DATA COLLECTION FOR ENGINEERING FOR THE URANIUM MILL TAILINGS SITE AND ADJACENT PERIPHERAL PROPERTIES, MONTICELLO, UTAH

September 1986

Bendix Field Engineering Corporation
Grand Junction, Colorado

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GJ-51

Monticello Remedial Action Project

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1.0 INTRODUCTION

This geotechnical and radiologic characterization of the mill area, mill tailings areas, and peripheral properties surrounding the inactive uranium millsite at Monticello, Utah, was conducted by Bendix Field Engineering Corporation (Bendix) for the U.S. Department of Energy (DOE) under the Surplus Facilities Management Program (SFMP). The data presented in this report are supplementary to other characterization studies performed and are in support of engineering design for remedial activities.

A Quality Assurance Field Readiness Review was conducted by Bendix Field Engineering Corporation on 27 August 1985 at the DOE Grand Junction Projects Office. Fieldwork was conducted at the Monticello, Utah, site from 3 to 13 September 1985 and from 4 to 15 November 1985.

2.0 BACKGROUND

For a detailed description of the Monticello millsite, including location, history, and current geologic and hydrologic conditions, refer to the Monticello Remedial Action Project Site Analysis Report (Abramiuk and others, 1984). For additional information related to the properties surrounding the millsite, refer to the Radiologic Characterization of the Peripheral Properties Adjacent to the Monticello, Utah, Millsite (Marutzky and others, 1985). For additional information related to moisture and mineral content of the tailings refer to the Monticello, Utah, Mill Tailings Drilling and Sampling Project Survey Analysis, Internal Document (Bendix Field Engineering Corporation, 1980).

2.1 LOCATION

The 78-acre Monticello millsite (see Figure 1) is located just southeast of the City of Monticello in San Juan County, Utah. It lies in Section 36, Township 33 South, Range 23 East, and Section 31, Township 33 South, Range 24 East (Salt Lake Meridian). Millsite elevations range from 6990 feet at the northwest corner to 6820 feet at the southeast corner.

The mill area covers approximately 11 acres and the tailings-impoundment area covers the remaining 67 acres. An estimated 182,000 cubic yards (yd^3) of contaminated material have been identified in the former area, and 1,428,000 cubic yards (yd^3) of tailings and contaminated soil in the tailings-impoundment area. The tailings are contained in four piles: the Carbonate Tailings Pile covers 7.7 acres, the Vanadium Tailings Pile covers 3.7 acres, the East Tailings Pile covers 16.6 acres, and the Acid Tailings Pile covers 9.2 acres. All of the piles currently have a vegetative cover consisting of alfalfa and mixed native grasses.

During the period of mill operation, land to the north, west, and south of the tailings area was leased for the stockpiling of ore. These ore-stockpile areas remain contaminated, and contain the majority of the estimated 293,000 yd^3 of peripheral property material that will be excavated as part of this project.

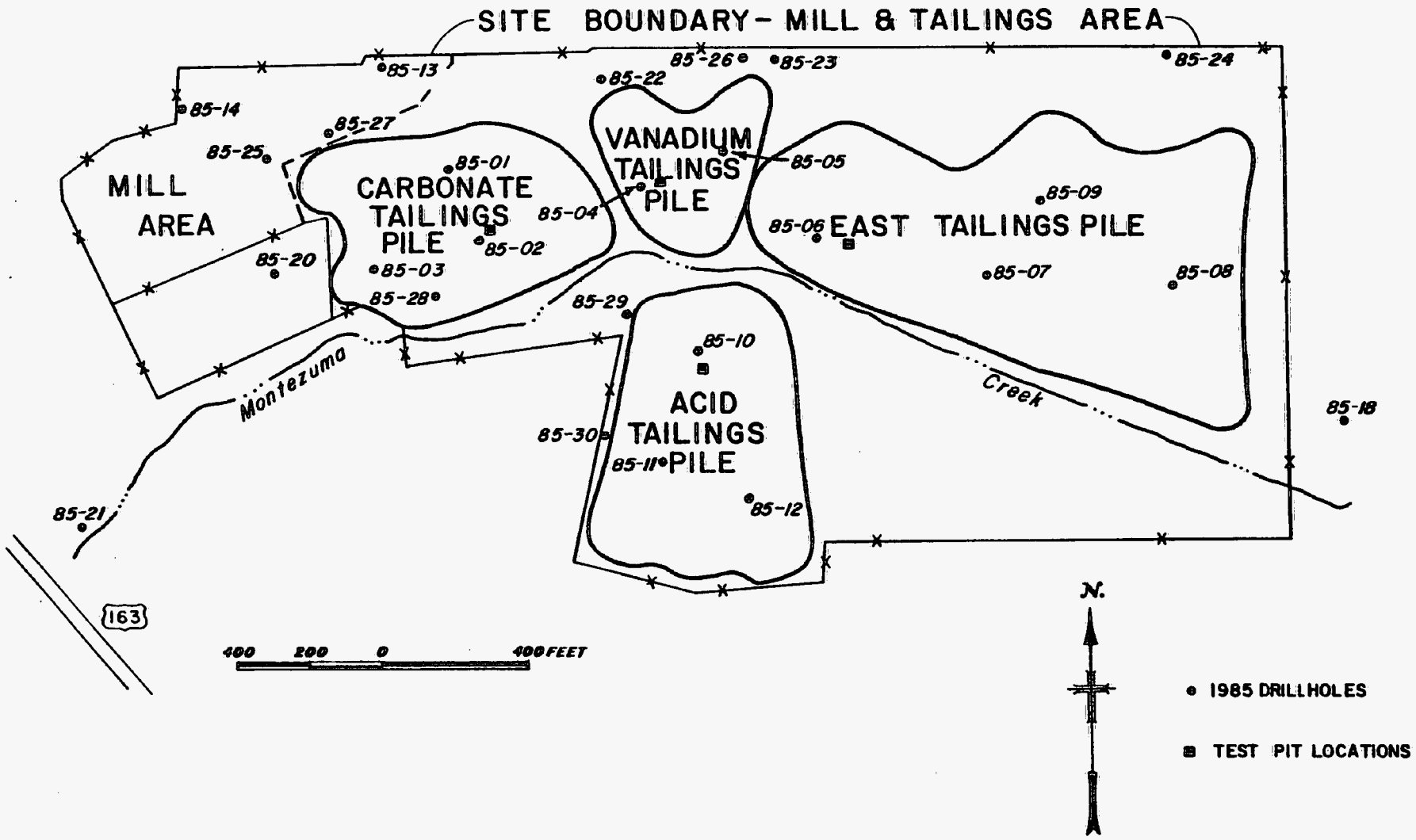


Figure 1. Borehole and Tailings Pile Locations at the Monticello, Utah, Millsite

The total area of the Monticello peripheral properties encompasses approximately 1 square mile surrounding the millsite and tailings piles, excluding the residential properties to the northwest. Peripheral area elevations range from 6700 to 7000 feet above sea level. An estimated 293,000 yd^3 of contaminated material has been identified on the peripheral properties.

The peripheral property areas north and east of the millsite are used mainly for agricultural purposes (i.e., grazing, stockponds, and alfalfa fields) and include some residences.

West of the millsite, thick oak brush and wild roses cover most of the area from Highway 163 to the west fence, except for the ore-storage and ore-buying area in the northwest and the former housing area to the southwest.

The area south of the millsite is used for grazing, and is otherwise undisturbed. The dominant vegetation comprises cedar and pine trees and oak brush, except in the south ore-storage area where the original topsoil was removed some years ago; vegetation in this latter area consists of smaller plants such as sagebrush.

A potential borrow area for obtaining cover material for the tailings piles was included as part of this study, and is located approximately 1 mile east of the millsite.

2.2 PROCEDURES

The geotechnical and radiologic characterization of the site was performed in accord with protocols established in the UMTRA (Uranium Mill Tailings Remedial Action) Program Site Characterization Radiologic Field Measurements Procedures Manual, (Bendix Field Enginering Corporation, 1985b), specifically the following procedures:

- Section 4.1, 'Spectral Gamma (KUT) Borehole Logging,' Rev. No. 03, dated 14 June 1985.
- Section 4.3, 'Portable Total-Count Logging of Augered Holes,' Rev. No. 02, dated 14 June 1985.
- Section 5.2, 'Split-Barrel Sampling,' Rev. No. 03, dated 14 June 1985.
- Section 5.3, 'Soil Identification and Classification,' Rev. No. 02, dated 14 June 1985.
- Section 5.4, 'Test-Pit Sampling,' Rev. No. 02, dated 14 June 1985.
- Section 5.6, 'Shelby Thin-Wall Tube Sampling,' Rev. No. 01, dated 14 June 1985.

2.3 GENERAL

A total of 22 auger boreholes (85-1 through 85-22) were drilled: 12 boreholes were drilled in the tailings piles, 3 boreholes in the mill area, 2 boreholes in the borrow area, and 5 boreholes in the peripheral properties. Borehole locations are presented in Table 1 and are shown in Figure 1.

All boreholes were drilled and downhole logged for determination of radium-226 concentration. If downhole logging indicated the presence of Ra-226 contami-

Table 1. Borehole Locations at the Monticello Millsite

Borehole Number	Grid Coordinates North	Grid Coordinates East	Surface Elevation (ft)
85-01	11060.0	21250.0	6897.2
85-02	10880.0	21300.0	6898.5
85-03	10882.0	21011.0	6871.5
85-04	11090.0	21740.0	6875.9
85-05	11150.0	21900.0	6874.6
85-06	10840.0	22250.0	6850.9
85-07	10750.0	22660.0	6848.6
85-08	10750.0	23140.0	6849.9
85-09	11001.0	22850.0	6850.3
85-10	10430.0	21890.0	6896.8
85-11	10180.0	21800.0	6896.1
85-12	10090.0	22001.0	6897.4
85-13	11326.5	21025.5	6934.7
85-14	11270.0	20400.0	6982.4
85-15	10115.0	28534.5	6841.5
85-16	9798.0	29447.0	6820.0
85-17	10035.0	25005.0	6782.2
85-18	10365.0	23605.0	6803.8
85-19	9360.0	21405.0	6937.2
85-20	10760.0	20705.0	6871.3
85-21	10160.0	20205.0	6884.8
85-22	11285.5	21720.5	6880.0
85-23	11294.0	22143.5	6877.9
85-24	11276.5	23107.5	6868.4
85-25	11106.5	20691.0	6912.1
85-26	11301.5	21967.5	6880.5
85-27	11165.5	20934.5	6905.6
85-28	10795.0	21085.0	6876.2
85-29	10603.5	21652.0	6866.0
85-30	10175.0	21550.0	6888.0

nation in excess of 15 picocuries per gram (pCi/g) at the bottom of the hole, drilling and logging continued at 5-foot increments until a 15 pCi(Ra-226)/g limit was reached.

At least five 3-inch oversize-barrel samples were collected from each borehole in the tailings piles, mill area, and borrow area. One 3-inch outside diameter (OD) Shelby tube sample, sealed and capped, was also collected from each borehole in the tailings piles. Lithologic logs of borehole split-barrel samples were completed using methods and procedures of the Unified Soil Classification System and American Society for Testing Materials (ASTM) standard penetration tests.

Hydrogeologic information was obtained by coring eight additional boreholes (85-23 through 85-30). These boreholes were drilled along the boundary of the

millsite and continuous NX* core samples were obtained in the bedrock. In-situ permeability tests were performed in five of the boreholes. Figure 1 shows the location of boreholes on the millsite property. Plate 1 shows the location of all the boreholes drilled during the geotechnical and radiologic characterization.

Test pits were dug at each borehole location in the peripheral property area. Two 5-gallon soil samples were obtained from each test pit. One test pit was also dug with a backhoe in each of the four tailings piles to a maximum depth of 15 feet. Four bulk samples were collected from each test pit: one surface (2-foot depth) sample, one sand tailings sample, one slime sample, and one sand/slime mix sample.

Sediment samples from the streambed of Montezuma Creek, downstream from the site, were collected from six locations in 5-gallon buckets. Locations of the streambed samples are listed in Table 2.

Table 2. Location of Test Pits in the Montezuma Creek Streambed

Station	Grid Coordinates	
	North	East
ZERO	9261.5	27443.0
+1000	8823.5	28668.0
+2000	8602.5	29624.0
+3500	8150.0	30876.0
+5000	7714.0	32575.5
+6500	7781.0	34011.0

2.4 ANALYSIS OF SAMPLES

The following analyses were performed on the collected soil samples:

- Dry-Bulk Density
- Radon Emanation
- Radium-226 Concentration in Soil
- Moisture Content
- American Society for Testing Materials (ASTM) D422 Particle Size
- ASTM D698-78 Moisture-Density Relations (Proctor)
- ASTM D854-83 Specific Gravity of Soils
- ASTM D2325-68 or 3152-72 Capillary-Moisture Relationships
- ASTM D2434-68 Constant-Head Permeability
- ASTM D2435-80 One-Dimensional Consolidation
- ASTM D2487-83 Classification of Soils
- ASTM D4318-83 Atterberg Limits (liquid limit, plastic limit, and plasticity index)

*NX = outside diameter 3-1/2 inches, inside diameter 3-3/16 inches.

A total of 83 split-barrel, 12 Shelby tube, and 16 test-pit samples were collected in the tailings piles. Ten split-barrel samples were collected in the mill area, and 11 split-barrel and 10 test-pit samples were collected from the peripheral properties. A total of 10 samples were collected at the potential borrow site: 7 split-barrel, 2 test-pit, and 1 Shelby tube. Six test-pit samples were collected from the streambed of Montezuma Creek, downstream from the millsite, and 10 continuous core samples in bedrock were collected along the northern boundary of the millsite.

At the millsite, three 5-gallon test-pit samples of tailings were collected at each tailings pile: one sample each of slime, sand, and sand/slime mix. These 12 samples were analyzed for bulk-diffusion coefficient at three moisture contents at 90 percent of standard Proctor density. Sixty split-barrel samples of tailings, collected at random depths, were analyzed for radon-emanation fraction, radium-226 concentration, and moisture content. Four test-pit samples, collected from the surface cover of each tailings pile, were analyzed for gradation and moisture-density relations (Proctor) for soil classification purposes. Twelve Shelby tube samples of tailings were tested for one-dimensional consolidation, dry-bulk density, Atterberg Limits, capillary-moisture relationships, and specific gravity.

Test-pit samples collected at five locations in the peripheral property areas were analyzed for bulk-diffusion coefficient, one-dimensional consolidation, dry-bulk density, Atterberg Limits, and capillary-moisture relationships. Specific gravity, gradation, Proctor, and radon-emanation fraction were analyzed from split-barrel samples collected at each of the five peripheral property locations. Five-gallon samples taken at six locations in the streambed of Montezuma Creek were analyzed for gradation.

Eight split-barrel samples taken from two boreholes in the potential borrow area were analyzed for bulk-diffusion coefficient. One Shelby tube sample from the borrow area was tested for one-dimensional consolidation, dry-bulk density, Atterberg Limits, capillary-moisture relationships, specific gravity, and gradation classification of soils. Drill-hole cuttings from the two borrow area sample locations were tested for moisture-density relations (Proctor).

3.0 RADIOLOGIC ASSESSMENT

3.1 SAMPLING PROCEDURES

The measurement techniques and procedures used for the Monticello Remedial Action Project engineering characterization were based primarily on procedures developed by the DOE Division of Remedial Action Projects (DRAP) Technical Measurements Center (TMC) and on field-implementation experience gained from the radiologic characterization of the Monticello peripheral properties (Marutzky and others, 1985) and the Grand Junction Tailings Pile (Rush and Bonner, 1984).

3.1.1 Drilling and Sampling

Borehole drilling was accomplished using standard geotechnical techniques with a truck-mounted CME-55 auger rig. Hollow-stem augers [7-1/4 inch outside diameter (OD) by 3-1/4 inch inside diameter (ID)] were used to drill to total depth in each hole. Augers were left in place in the hole during radiologic logging operations to prevent hole collapse and to minimize smearing of any downhole contamination. The retrievable center bit used during drilling prevented contamination within the auger itself. The center bit was removed for radiologic logging.

The boreholes were drive sampled using split-barrel samplers (3-inch OD by 24-inch length and 2-inch OD by 24-inch length) and Shelby tube samplers (as presented in Section 4.1.2). The split-barrel sampler was attached to the drill rods and lowered through the hollow stem. A 140-pound drop weight was attached to the drill rods and used to drive the sampler into undisturbed soil. After the sampler was raised to the surface, the split barrel was opened, and approximately 3 inches of the top of the sample was discarded. The sample was cut longitudinally, lithologically logged, and placed in a sample bag labeled with the borehole number, sample number, sample depth, and sample ticket number. The top of the sample bag was folded twice and stapled shut to retain moisture.

The boreholes were drilled and sampled to the estimated depth. Once the borehole was advanced to this depth, a geophysical logging tool was lowered to the bottom of the hole. The hole was deepened if the resulting measurement indicated a Ra-226 concentration in excess of 15 pCi/g above background [the Environmental Protection Agency (EPA) standard for subsurface contamination in any 15-centimeter thick layer]. Additional drilling was performed and measurements were made until the Ra-226 concentration at the bottom of the hole was less than 15 pCi/g above background or refusal. The augers were left in place for geophysical logging.

Once geophysical operations were completed, hole abandonment for all boreholes was accomplished by filling the hole with auger cuttings. Those boreholes encountering subsurface water were plugged with bentonite to the fluid level, and subsequently filled with auger cuttings.

The American Society for Testing Materials (ASTM) standard penetration test was conducted during drive sampling. Modifications involved using a split-barrel sampler with a 3-inch OD to ensure that enough sample volume was obtained for radium analysis. The sampler was driven with blows delivered by dropping a 140-pound weight a vertical distance of 30 inches. The number of blows required to drive the sampler through each 6-inch increment was recorded on the lithologic logs (see Appendix A).

3.1.2 Radiologic and Moisture Analysis

Following transport to the DOE Grand Junction Projects Office, selected soil samples to be analyzed by the Bendix Analytical Laboratory for radium-226 were weighed, dried, reweighed, crushed and ground to -28 mesh, blended, and sealed in sample cans. The difference in weight after drying, loss-on-drying (LOD) in percent, was recorded for the samples. The samples were stored for at least 21 days to allow the radon and radon daughters to reach equilibrium with

any radium present. The samples were analyzed for radium-226, thorium-232, and potassium using high-resolution germanium gamma-ray-spectroscopy systems (Dechant and Donivan, 1984).

3.1.3 Disequilibrium

The amount of disequilibrium between radium and its radon daughters was determined from laboratory analysis of borehole samples. The samples were processed 'as is', without crushing or drying, and sealed in cans. Equivalent-radium concentrations were measured at 2 to 12 hours after canning, and again after 6 days. Estimates of the radon-disequilibrium ratio were made by calculating the radium concentration at disequilibrium and at equilibrium, using the standard equations for ingrowth and decay of the various isotopes involved (Marutzky and others, 1985; Evans, 1980; Scott and Dodd, 1960). Following disequilibrium measurements, the samples were processed for gamma-ray-spectroscopic determination of radium-226, thorium-232, and potassium (see Section 3.1.2). The average disequilibrium between radium and its radon daughters in the analyzed samples is 36 percent, which is consistent with results found in Marutzky and others (1985).

3.1.4 Lithologic Borehole-Logging Procedures

A lithologic log was prepared for each borehole from which the split-barrel or Shelby tube samples were taken. The lithologic logs are presented in Appendix A. Standard penetration tests are also noted on the lithologic logs. The subsurface materials are classified in accord with the Unified Soil Classification System (U.S. Bureau of Reclamation, 1974).

3.1.5 Geophysical Borehole-Logging Procedures

Boreholes accessible by two-wheel-drive truck were logged using a Bendix computer-based geophysical logging (Compulogger) system. The probe, which contains a 2-inch diameter by 6-inch length sodium iodide detector, was raised from the bottom to the top of the borehole at an approximate rate of 1.5 feet per minute. Data were recorded at each 0.5-foot interval. Repeat logs were made of the entire borehole to confirm the measurements obtained during the main logging phase.

The gamma-ray detection system was operated in a linear (energy-proportional) mode. Uphole electronics provided system-gain stabilization by monitoring the 835-keV gamma-ray peak from a manganese-54 source contained in the probe. Pulse-height data were collected from three single-channel-analyzer (SCA) windows corresponding to the principal energy peaks from the decays of potassium, radium, and thorium. Data from a fourth SCA window, the total-count window (1050 to 3000 keV), were collected to provide statistically improved radium concentrations. The collected data were manually entered into the data base of a Zenith Z-100 portable computer and manually verified in accord with approved quality assurance procedures.

To determine radium concentrations from the total-count channel, the count rates were first corrected for attenuation due to formation moisture content (Marutzky and others, 1985), borehole fluid (if present), and auger casing and

auger joint effects (see Appendix B). A correction was also applied for contributions from potassium and thorium concentrations. The data were then spatially deconvolved (George and Price, 1982).

In areas not accessible by two-wheel-drive truck, logging was performed using a portable gross-count system. The system consists of an Eberline Model PRS-1 field survey meter (RASCAL) connected by 20 feet of cable to a waterproof Eberline Model SPA-3, 2-inch-by-2-inch sodium iodide detector. The system operates on a counting plateau in a gross-count mode, which counts all gamma rays with energies exceeding approximately 30 keV.

The detector was manually lowered to the bottom of the borehole in 0.5-foot increments, with 30-second measurements recorded at each stop. The detector was subsequently raised to the top of the borehole in 0.5-foot intervals as the repeat log. The data were manually entered into the data base of a Zenith Z-100 portable computer and manually verified in accord with approved quality assurance procedures. The entered and verified data were corrected (as described for the truck-mounted logging system) for average moisture content, potassium and thorium concentrations, and auger casing and auger joint effects, and the data were spatially deconvolved (see Appendix B).

To determine the radium concentration from the corrected count-rate data measured in the formation, the computer program LOGCALC (Showalter, 1986) was utilized. The LOGCALC program uses the calibration coefficients determined in the models maintained by the DOE Grand Junction Projects Office (George and Knight, 1982).

Both logging systems were calibrated at the DOE Grand Junction Projects Office calibration facilities once every 6 months. Instrument response field checks were made before use each day, and the results were monitored for compliance with quality-control limits established on the statistical basis of previous response checks.

3.2 RESULTS

The borehole numbers, coordinates, elevations, log depths, and fluid levels of the 22 auger holes drilled are presented in Table 3. The boreholes were logged with a Compulogger System 1815, unless noted otherwise. A total of 554.5 feet of soil was drilled, of which 274 feet were sampled. Sixty-six samples were analyzed for radium-226, thorium-232, potassium, disequilibrium, and moisture content (LOD) (see Tables 4 and 5). Cross sections depicting the composition and subsurface contamination of each of the tailings piles are shown in Plate 2. A summary of borehole contamination is presented in Table 6.

3.2.1 Acid Tailings Pile

The sand cover of the Acid Tailings Pile ranges in thickness from 2.0 feet to 2.5 feet in Boreholes 85-10, 85-11, and 85-12 (refer to Cross Section A-A on Plate 2). Clay (slime) tailings, with some interbedded sand layers, are predominant in Boreholes 85-11 and 85-12. The slimes vary in color (red, black, purple, and yellow), which may be the result of the type of ore processed. Borehole 85-10 contains layers of primarily sand tailings, which are underlain by alluvial clay and gravel. Depth to interface of the tailings and

Table 3. Summary of Borehole Data for the Monticello Millsite

Borehole Number	Elevation (ft)	Log Depth (ft)	Fluid Level (ft)
85-01	6897.2	49.0	36.5
85-02	6898.5	42.0	11.5
85-03[a]	6871.5	14.4	-
85-04	6875.9	28.5	-
85-05	6874.6	18.5	-
85-06	6850.9	32.5	27.8
85-07	6848.6	37.0	34.0
85-08	6849.9	48.5	48.5
85-09	6850.3	35.5	-
85-10	6896.8	46.5	-
85-11	6896.1	37.0	-
85-12	6897.4	25.5	-
85-13[b]	6934.7	8.6	-
85-14[c]	6982.4	9.5	-
85-15	6841.5	35.5	-
85-16	6820.0	16.0	10.8
85-17[c]	6782.2	13.0	-
85-18	6803.8	8.9	7.8
85-19[c]	6937.2	4.4	-
85-20[c]	6871.3	4.5	-
85-21[c]	6884.8	12.8	-
85-22	6880.0	Not Logged	-
85-23	6877.9	29.0	10.0
85-24	6868.4	51.5	12.6
85-25[b]	6912.1	5.6	-

[a]Logged with Compulogger 1815 and RASCAL C-3958S.
[b]Logged with RASCAL C-3572S.
[c]Logged with RASCAL C-3958S.

the original surface is shown on the lithologic logs (see Appendix A); the interface is also indicated on the geophysical logs (see Appendix B), and for most boreholes these two types of logs agree. The radiologic logs indicate that the clay (slime) layers contain higher concentrations of radium than the sand layers. The radium concentrations of the slimes range from 700 to 1100 pCi (Ra-226)/g, with a moisture content range of 29.0 to 44.6 percent. The radium concentrations of the sand tailings range from 400 to 600 pCi(Ra-226)/g, with an average moisture content of 13.0 percent (see Table 5). The depth of the subsurface contamination, >16 pCi(eRa-226)/g* above background as determined from the geophysical logs, is presented in Table 6 and Appendix B. Contamination extends below the tailings interface to a total depth of 16.0 feet in Borehole 85-12, 32.0 feet in Borehole 85-10, and 33.0 feet in Borehole 85-11.

*For purposes of this study, radiometric measurements made indirectly by measurement of radiation from sources other than the decay of the nuclide of interest are reported as 'equivalent' concentrations, denoted by an 'e' prefix, i.e., pCi(eRa-226)/g.

3.2.2 East Tailings Pile

Boreholes 85-06, 85-07, 85-08, and 85-09 were drilled in the East Tailings Pile (refer to Cross Section E-E on Plate 2). Thickness of the clay cover varies from 1.5 feet in Borehole 85-07 to 7.0 feet in Borehole 85-08, where materials from the vicinity properties were disposed. Lithologic logs show interbedded sand tailings and clays (slimes) in Boreholes 85-08 and 85-09,

Table 4. Gamma-Ray-Spectroscopy Data for Soil Samples

Borehole Number	Grid Coordinates North	Grid Coordinates East	Depth (ft)	Sample (MKB No.)	Concentration[a] Ra-226 (pCi/g)	Concentration[a] Thorium (ppm)	Concentration[a] Potassium (%)
85-01	11060	21250	8-10	653	517 ± 40	< 124	< 2.5
			10-12	654	1308 ± 101	< 237	< 5.1
			19-21	656	597 ± 46	< 133	< 2.6
			29-31	658	398 ± 31	< 78	< 1.5
			34-36	659	3 ± 1	< 4	2.4 ± 0.9
85-02	10880	21300	4- 6	662	1421 ± 110	< 1	< 5.2
			14-16	664	766 ± 59	< 154	< 3.1
			24-26	666	1796 ± 139	< 454	< 8.9
			34-36	668	425 ± 33	< 94	< 2.0
			44-46	670	408 ± 32	< 97	< 1.9
85-25	11107	20691	0- 2	672	399 ± 31	< 81	< 1.6
			2- 4	673	53 ± 4	< 14	1.8 ± 1.0
85-05	11150	21900	2- 4	676	28 ± 2	< 10	1.3 ± 1.0
			4- 6	677	1007 ± 78	< 251	5.0
			8-10	679	5 ± 1	< 3	2.0 ± 1.1
			10-12	680	5 ± 1	< 6	1.3 ± 1.1
85-04	11090	21740	8-10	683	772 ± 60	< 211	< 3.8
			10-12	684	225 ± 17	< 28	< 1.0
85-13	11327	21026	2- 4	686	14 ± 1	< 4	2.0 ± 1.0
			0- 2	687	5 ± 1	< 3	2.4 ± 0.9
			4- 6	688	15 ± 1	< 8	1.4 ± 0.9
85-06	10840	22250	4- 6	690	415 ± 32	< 101	< 2.0
			6- 8	691	340 ± 25	< 68	< 1.4
			10-12	693	381 ± 27	< 59	< 1.3
			14-16	695	224 ± 16	< 42	< 0.9
85-07	10750	22660	4- 6	698	480 ± 35	< 70	< 1.5
			14-16	700	1443 ± 105	< 320	< 6.1
			24-26	702	643 ± 47	< 127	< 2.6
			29-31	704	5 ± 1	< 2	3.4 ± 0.3
85-09	11001	22850	6- 8	707	74 ± 5	< 13	2.7 ± 0.4
			8-10	708	1243 ± 90	< 105	< 4.5
			10-12	709	25 ± 2	< 6	2.9 ± 0.3
			12-14	710	14 ± 1	< 2	3.0 ± 0.3

[a]A less-than sign (<) indicates that the minimum detection limit based on Compton background was reached.

Table 4 (continued). Gamma-Ray-Spectroscopy Data for Soil Samples

Borehole Number	Grid Coordinates North	Grid Coordinates East	Depth (ft)	Sample (MKB No.)	Concentration[a] Ra-226 (pCi/g)	Concentration[a] Thorium (ppm)	Concentration[a] Potassium (%)
85-08	10750	23140	10-12	713	291 ± 21	< 60	< 1.1
			14-16	715	1759 ± 128	< 276	< 5.9
			16-18	716	1451 ± 105	< 287	< 5.1
			18-20	717	1527 ± 111	< 306	< 6.6
			20-22	718	1646 ± 120	< 304	< 7.8
85-10	10430	21890	9-11	724	434 ± 31	< 69	< 1.5
			14-16	725	1224 ± 89	< 235	< 5.0
			19-21	726	964 ± 70	< 168	< 3.5
			24-26	727	1553 ± 120	< 266	< 5.3
			31-33	729	213 ± 17	< 53	< 1.0
85-12	10090	22001	6- 8	733	1178 ± 91	< 316	< 6.3
			8-10	734	1211 ± 110	< 277	< 5.1
			10-12	735	1470 ± 134	< 325	< 6.0
			12-14	736	962 ± 87	< 422	< 7.8
			16-18	738	61 ± 6	< 9	< 0.2
85-11	10180	21800	6- 8	742	1460 ± 132	< 492	< 9.1
			8-10	743	1573 ± 143	< 362	< 6.7
			10-12	744	1521 ± 139	< 578	< 10.7
			12-14	745	1398 ± 127	< 487	< 9.0
			14-16	746	1483 ± 134	< 570	< 10.5
			16-18	747	1637 ± 149	< 522	< 9.6
85-03	10882	21011	4- 6	750	6 ± 1	< 5	2.2 ± 0.5
85-20	10760	20705	2- 4	754	3 ± 1	< 4	2.8 ± 0.5
85-21	10160	20205	2- 4	757	79 ± 7	< 19	< 0.4
			5- 7	758	9 ± 1	< 6	2.1 ± 0.5
85-19	9360	21405	2- 4	760	2 ± 1	< 4	< 0.1
85-14	11270	20400	0- 2	761	3 ± 1	< 5	< 0.1
			2- 4	762	2 ± 1	< 12	< 0.2
			4- 6	763	4 ± 1	< 16	0.8 ± 0.4
			6- 8	764	2 ± 1	< 0	< 0
			8-10	765	3 ± 1	< 0	2.2 ± 0.5
85-17	10035	25005	2- 4	767	2 ± 1	< 0	2.5 ± 0.5
86-18	10365	23605	2- 4	769	78 ± 7	< 25	< 0.5

[a]A less-than sign (<) indicates that the minimum detection limit based on Compton background was reached.

Table 5. Results of Measurements of Disequilibrium Between Radium and Its Gamma-Emitting Radon Daughters and Moisture Content

Borehole Number	Grid Coordinates North	Grid Coordinates East	Depth (ft)	Sample (MKB No.)	Ra-226 (pCi/g)	Disequilibrium (%)	Moisture LOD (%)
85-01	11060.0	21250.0	8-10	653	517	50.1	7.0
			10-12	654	1308	53.3	20.8
			19-21	656	597	46.9	16.0
			29-31	658	398	36.2	11.1
85-02	10880.0	21300.0	4- 6	662	1421	34.1	29.2
			14-16	664	766	46.5	9.5
			24-26	666	1796	22.9	30.4
			34-36	668	425	27.5	8.4
			44-46	670	408	26.3	19.7
85-25	1106.5	20691.0	0- 2	672	399	8.6	7.8
			2- 4	673	53	13.9	8.2
85-05	11150.0	21900.0	2- 4	676	28	44.9	16.2
			4- 6	677	1007	60.4	20.8
			8-10	679	5	51.6	22.0
			10-12	680	5	68.9	18.6
85-04	11090.0	21740.0	8-10	683	772	33.4	24.4
			10-12	684	225	51.5	23.3
85-13	11326.5	21025.5	2- 4	686	14	42.1	11.2
			0- 2	687	5	44.9	5.4
			4- 6	688	15	38.5	10.4
85-06	10840.0	22250.0	4- 6	690	415	19.4	12.6
			6- 8	691	340	21.3	11.3
			10-12	693	381	25.1	11.0
			14-16	695	224	24.5	20.6
85-07	10750.0	22660.0	4- 6	698	480	45.7	16.2
			14-16	700	1443	14.2	39.1
			24-26	702	652	41.0	27.5
85-09	11001.0	22850.0	6- 8	707	74	31.5	21.0
			8-10	708	1243	19.7	21.5
			12-14	710	14	39.5	21.9
85-08	10750.0	23140.0	10-12	713	291	11.9	17.5
			14-16	715	1759	24.7	37.7
			16-18	716	1451	22.6	37.6
			18-20	717	1527	11.7	37.2
			20-22	718	1646	18.7	37.4
85-10	10430.0	21890.0	9-11	724	434	20.2	13.0
			14-16	725	1224	36.5	33.3
			19-21	726	964	28.4	29.0
			24-26	727	1553	30.1	34.5
			31-33	729	214	64.2	18.3
85-12	10090.0	22001.0	6- 8	733	1178	32.2	32.7
			8-10	734	1211	21.9	33.7
			10-12	735	1470	17.5	41.0
			12-14	736	962	49.2	35.4
			16-18	738	61	37.7	19.3

Table 5 (continued). Results of Measurements of Disequilibrium Between Radium and Its Gamma-Emitting Radon Daughters and Moisture Content

Borehole Number	Grid Coordinates North	Grid Coordinates East	Depth (ft)	Sample (MKB No.)	Ra-226 (pCi/g)	Disequilibrium (%)	Moisture LOD (%)
85-11	10180.0	21800.0	6- 8	742	1460	22.2	35.0
			8-10	743	1573	26.1	38.1
			10-12	744	1521	21.6	39.2
			12-14	745	1398	20.6	37.3
			14-16	746	1483	12.8	42.0
			16-18	747	1637	19.2	44.6
85-03	10882.0	21011.0	4- 6	750	6	29.6	19.2
85-20	10760.0	20750.0	2- 4	754	3	41.2	17.8
85-21	10160.0	20205.0	2- 4	757	79	43.2	8.0
			5- 7	758	9	32.6	7.1
85-19	9360.0	21405.0	2- 4	760	2	38.9	9.6
85-14	11270.0	20400.0	0- 2	761	3	41.1	8.8
			2- 4	762	2	43.7	17.7
			4- 6	763	4	44.8	11.0
			6- 8	764	2	7.1	17.9
			8-10	765	3	40.9	17.8
85-17	10365.0	23605.0	2- 4	767	2	36.0	10.8
85-18	10035.0	25005.0	2- 4	769	78	46.6	11.9

predominantly sand in Borehole 85-06, and clay (slime) tailings in Borehole 85-07. Based on the lithologic logs, interface between the tailings and original surface is a unique layer, or marker bed, containing abundant organic-clay material. This organic layer is present in all four boreholes drilled in the East Tailings Pile and is underlain by clay, which is, in turn, underlain by gravel. The radium concentrations of the slimes range from 500 to 1100 pCi(Ra-226)/g, with moisture content ranging from 21.1 to 39.1 percent, depending on the quantity of sand. The radium concentrations of the sand tailings range from 200 to 600 pCi(Ra-226)/g, with moisture content ranging from 11.0 to 17.5 percent (see Table 5). Moisture content of the clay substrate material ranges from 15.9 percent in Borehole 85-07 to 21.9 percent in Borehole 85-09. Geophysical logging results of all the boreholes indicate contamination of the organic layer and of the alluvium clay below the organic layer (refer to Table 6). The deepest contamination occurs in Borehole 85-08 at a depth of 33.5 feet (see Table 6), or 5.0 feet below the tailings subsurface.

3.2.3 Vanadium Tailings Pile

Boreholes 85-04 and 85-05 were drilled in the Vanadium Tailings Pile (see Cross Section V-V on Plate 2). The clay cover ranges in thickness from 1.5 feet in Borehole 85-04 to 5.7 feet in Borehole 85-05. Lithologic logs indicate shallow depths of tailings; the tailings consist predominantly of clay (slime), with some sand found in Borehole 85-04. Lithologic logs indicate an organic layer at the interface of the tailings and substrate material, similar

Table 6. Borehole Contamination Summary

Borehole Number	Location	Tailings/Subsurface Interface (ft)	Depth (ft) of Contamination [>16pCi(Ra-226)/g]	Contaminated Subsurface (difference in ft)
85-01	Carbonate Tailings Pile	34.0	>34.0[a]	----
85-02	Carbonate Tailings Pile	51.0	52.0	1.0
85-03	Carbonate Tailings Pile	4.0	4.5	0.5
85-04	Vanadium Tailings Pile	10.5	13.0	2.5
85-05	Vanadium Tailings Pile	7.5	8.5	1.0
85-06	East Tailings Pile	16.0	17.0	1.0
85-07	East Tailings Pile	26.0	29.0	3.0
85-08	East Tailings Pile	28.5	33.5	5.0
85-09	East Tailings Pile	10.0	12.5	2.5
85-10	Acid Tailings Pile	31.5	32.0	0.5
85-11	Acid Tailings Pile	22.5	33.0	10.5
85-12	Acid Tailings Pile	14.5	16.0	1.5
85-13	Mill Area	NT[b]	6.0	----
85-14	Mill Area	NC[c]	----	----
85-15	Borrow Area	NC[c]	----	----
85-16	Borrow Area	NC[c]	----	----
85-17	Peripheral Property	NC[c]	----	----
85-18	Peripheral Property	NT[b]	4.0	----
85-19	Peripheral Property	NC[c]	----	----
85-20	Peripheral Property	NC[c]	----	----
85-21	Peripheral Property	5.0	7.0	2.0
85-22	North Millsite Boundary	NC[c]	----	----
85-23	North Millsite Boundary	NC[c]	----	----
85-24	North Millsite Boundary	NC[c]	----	----
85-25	Mill Area	1.0	3.5	2.5
			AVERAGE	2.5

[a]Depth of contamination undetermined.
[b]NT = No Tailings.
[c]NC = No Contamination.

to that found under the East Tailings Pile. This organic layer is, in turn, underlain by an alluvial clay layer, with moisture content ranging from 18.6 to 22.0 percent. The radium concentrations of the slimes range from 400 to 980 pCi(Ra-226)/g, with moisture content ranging from 20.8 to 24.4 percent. The radium concentrations of the sand tailings range from 200 to 300 pCi(Ra-226)/g (see Table 5). The geophysical logging results indicate contamination extends 1.0 foot below the interface of tailings and natural substrate in Borehole 85-05, and 2.5 feet below this interface in Borehole 85-04 (see Table 6). Geophysical logs also indicate that the drilling augers may have been contaminated in Borehole 85-04.

3.2.4 Carbonate Tailings Pile

Boreholes 85-01 and 85-02 are located in the Carbonate Tailings Pile (see Cross Section C-C on Plate 2). Lithologic logs indicate a clay cover 2.0 feet thick, evenly distributed over the pile. Borehole 85-03, located on the west slope of the tailings pile near the bottom of an erosional gully, has a sand covering 3.0 feet thick and is underlain by 1.5 feet of sand tailings, which correlates with geophysical logging (see Appendices A and B). Boreholes 85-01 and 85-02 were drilled in sand tailings, some clay (slime) layers, and thin interbedded layers of sand/slime mixed. The clay (slime) and sand tailings layers vary in color (red, brown, and purple). In Borehole 85-02, a distinct organic clay layer interfaces with the tailings and clay substrate below, while in Borehole 85-01 a trace of organics (roots) was found at the interface. Both boreholes were drilled until refusal. Radium concentrations of the sand tailings range from 400 to 600 pCi(Ra-226)/g, with moisture content ranging from 7.0 to 11.1 percent. The radium concentrations of the slimes range from 700 to 1800 pCi(Ra-226)/g, with moisture content ranging from 16.0 to 30.4 percent (see Table 5). Geophysical logging was not completed to the total depth drilled because material flowed into the hollow-stem auger after the center stem and bit were removed. Contamination in Borehole 85-02 was found to the total depth drilled (52 feet). The depth of contamination in Borehole 85-01 is questionable due to possible auger-stem contamination from the tailings flowing down the outside of the auger (see Appendix B).

3.2.5 Mill Area

Lithologic logs of Boreholes 85-13, 85-14, and 85-25 indicate primarily clay (slime) with some sand (see Appendix A). Geophysical logging results indicate Borehole 85-14 is uncontaminated, but that Boreholes 85-25 and 85-13 are contaminated to 3.5 feet and 6.0 feet, respectively.

3.2.6 Peripheral Properties

Five boreholes are located on properties adjacent to the millsite area. Lithologic logs indicate sand, clay, and gravel in the boreholes (see Appendix A). Borehole 85-18 is located in a pond area and contains a distinct layer of organic clay, which may represent the original pond surface. Contamination was found in Borehole 85-21 to a depth of 7.0 feet and in Borehole 85-18 to a depth of 4.0 feet (see Appendix B).

3.2.7 Borrow Area

Boreholes 85-15 and 85-16 were drilled in the borrow area east of the mill-site. Lithologic logs indicate sand and clay layers (see Appendix A). Geophysical borehole logs indicate no contamination [<5 pCi(eRa-226)/g] in both boreholes (see Appendix B).

3.3 SUMMARY

Based upon results of the lithologic and radiologic data, each tailings-material type bears a distinct relationship to the substrate material, formation moisture, and Ra-226 lab analysis.

The tailings consist of interbedded sand and clay (slime) layers. Most of the boreholes drilled in the tailings piles are underlain by clay (alluvium) and gravel. A distinct organic clay layer, probably the original ground surface, underlies the tailings beneath all the tailings piles north of Montezuma Creek. This organic clay layer is, in turn, underlain by clay (alluvium) or bedrock (Dakota Sandstone). The organic layer was not present under the Acid Tailings Pile south of Montezuma Creek.

Geophysical logs of boreholes drilled in the four tailings piles indicate contamination above 16 pCi(Ra-226)/g extends below the tailings/substrate interface an average of 2.5 feet, with a maximum of 10.5 feet (Borehole 85-11). Results of geophysical logging and Ra-226 laboratory analysis of samples agree, except in boreholes containing slimes with high Ra-226 values. Laboratory analysis shows that the Ra-226 concentration of some slimes exceeds approximately 1700 pCi(Ra-226)/g. Some analytical results are not consistent with the geophysical logging results, due to deadtime problems in the tool at high-radium concentration values.

In the peripheral properties and mill area, contamination is shallow and present in four of the five boreholes drilled. The material in the borrow area is mostly clay with sands, and geophysical logs indicate it is uncontaminated.

4.0 GEOTECHNICAL ASSESSMENT

4.1 SAMPLING PROCEDURES

4.1.2 Shelby Thin-Wall Tube Sampling

Boreholes were drilled on the millsite and peripheral properties as described in Section 3.1. In addition to drive sampling, each borehole drilled in the tailings piles and Borehole 85-16 in the borrow area was sampled using a 3-inch OD by 30-inch length Shelby thin-wall tube sampler. Once the auger advanced the hole to the desired sample depth, the center bit was removed. The Shelby thin-walled tube sampler was attached to drill rods and lowered through the hollow stem to sample the soil at the bottom of the hole. A drive head was attached to the top of the drill rods holding the sampler, the sampler was hydraulically pushed into the undisturbed soil, and the drill rod

was rotated one-quarter turn to shear off the sample. After the sample was removed from the hole, 1 inch of material was removed from the bottom and top of the sample and melted paraffin was poured into each end to prevent moisture loss. Plastic caps were placed on each end of the tube and taped in place. Each sample was labeled with the pertinent data and stored upright in special containers to prevent compaction.

4.1.3. Test-Pit and Bulk Samples

One test pit was dug using a backhoe in each of the four tailings piles. Lithologic logs of the drilled boreholes were used to locate the test pits to minimize sample depths. A trench was excavated, exposing a vertical surface which was lithologically logged (see Appendix A). Four individual soil-stratum bulk samples were collected from each tailings area: one surface-cover sample, one sand sample, one slime sample, and one sand/slime mix sample. Each test pit was reclaimed with the tailings material and original cover material.

Sediment samples collected from the Montezuma Creek area were obtained by manually digging a shallow test pit at six locations. The bulk samples were placed inside a 5-gallon bucket and the bucket was capped with a rubber-sealed lid to prevent moisture loss. Containers were marked with pertinent test-pit information.

Two 5-gallon test-pit samples were obtained at each borehole location in the peripheral properties. Cover-material borrow area samples were obtained by collecting auger cuttings as the boreholes were drilled. Each sample was placed in a plastic bag inside a 5-gallon bucket, and sealed as previously described.

4.2 RESULTS

Thirteen Shelby tube samples were collected: 12 tailings pile samples and 1 sample from borrow area material. Five split-barrel samples were collected from the peripheral property surface materials.

The Shelby tube samples were analyzed for one-dimensional consolidation, Atterberg limits, capillary-moisture relationships, specific gravity, dry-bulk density, and moisture content. The peripheral property split-barrel samples were analyzed for one-dimensional consolidation, Atterberg limits, capillary-moisture relationships, specific gravity, dry-bulk density, moisture content, constant- or falling-head permeability, and classification of soils.

The four test-pit samples of the tailings piles and the five samples of the peripheral property surface materials were analyzed for moisture-density relations and classification of soils. The two test-pit samples collected from the borrow area were analyzed for moisture-density relations only. The six samples collected from the streambed of Montezuma Creek, downstream from the millsite, were analyzed for particle size.

A summary of the laboratory results from the analyses listed in Table 7 are shown in Table 8, and described in more detail in Appendix C. Radon diffusion tests were performed on test-pit samples of the tailings, peripheral property

Table 7. Type of Geotechnical Analysis Performed on Monticello Soil Samples

Sampling Method and Location/ Geotechnical Analysis for All Samples	Sample	Borehole Number	Depth (ft)
Shelby Tube Samples of Tailings Piles			
One-Dimensional Consolidation	MKB-652	85-01	6- 8
(ASTM D2435)	MKB-661	85-02	2- 4
Atterberg Limits (ASTM D4318-83)	MKB-678	85-05	6- 8
Capillary-Moisture Relationships	MKB-682	85-04	4- 6
(ASTM D2325-68)	MKB-689	85-06	2- 4
Specific Gravity of Soils	MKB-697	85-07	2- 4
(ASTM D854-83)	MKB-706	85-09	4- 6
Dry-Bulk Density	MKB-714	85-08	12-14
Moisture Content	MKB-723	85-10	4- 6
	MKB-732	85-12	4- 6
	MKB-741	85-11	4- 6
	MKB-749	85-03	2- 4
Split-Barrel Samples of Peripheral Property			
One-Dimensional Consolidation	MKB-753	85-20	0- 2
(ASTM D2435)	MKB-756	85-21	0- 2
Atterberg Limits (ASTM D4318-83)	MKB-759	85-19	0- 2
Capillary-Moisture Relationships	MKB-766	85-17	0- 2
(ASTM D2325-68)	MKB-768	85-18	0- 2
Specific Gravity (ASTM D854-83)			
Dry-Bulk Density			
Moisture Content			
Classification of Soils			
(ASTM D2487)			
Constant- or Falling-Head Permeability			
(ASTM D2434-68)			
Shelby Tube Samples of Borrow Area			
One-Dimensional Consolidation	MKB-776	85-16	9-10
(ASTM D2435)			
Atterberg Limits (ASTM D4318-83)			
Capillary-Moisture Relationships			
(ASTM D2325-68)			
Specific Gravity (ASTM D854-83)			
Dry-Bulk Density			
Moisture Content			
Test-Pit Samples of Tailings Piles			
Moisture-Density Relations	MKB-779	85-06	~1
(ASTM D698-78)	MKB-783	85-04	~1
Classification of Soils	MKB-787	85-02	~1
(ASTM D2487-83)	MKB-791	85-10	~1

Table 7 (continued). Type of Geotechnical Analysis Performed on Monticello Soil Samples

Sampling Method and Location/ Geotechnical Analysis for All Samples	Sample	Borehole Number	Depth (ft)
Test-Pit Samples of Peripheral Property			
Moisture-Density Relations	MKB-830	85-17	0- 5
(ASTM D698-78)	MKB-833	85-18	0- 5
Classification of Soils	MKB-828	85-19	0- 5
(ASTM D2487-83)	MKB-836	85-20	0- 3
Test-Pit Samples of Downstream Creekbed			
Particle Size (ASTM D422)	MKB-841	ZERO	0- 2
	MKB-842	+1000	0- 2
	MKB-843	+2000	0- 2
	MKB-840	+3500	0- 1.5
	MKB-839	+5000	0- 2
	MKB-838	+6500	0- 1.5
Bulk Samples of Borrow Area			
Moisture-Density Relations	MKB-834	85-15	2-37
(ASTM D698-78)	MKB-835	85-16	5.5-12

soils, and cover materials. The results of the tests are listed in Appendix E. One borehole in each of the tailings piles was temporarily cased with aluminum after drilling, and a neutron moisture probe was used to obtain relative moisture data for depths up to 19 feet. The results from these in-situ tests are presented in Appendix D. Previous to the 1985 fieldwork, some preliminary drilling was done on the potential-cover borrow area. Chemical and engineering analyses results from this study are presented in Tables 9 and 10.

4.3 SUMMARY

The tailings materials range in composition from silty sands to silty clay, with specific gravity ranging from 2.57 to 2.76. Moisture-density relationships (Proctor) were measured for the existing cover material and tailings samples down to a maximum of 14 feet. Maximum density/optimum moisture was 114.7 pounds per cubic foot (lb/ft^3)/14.5 percent for the Carbonate Tailings Pile cover, 114.3 lb/ft^3/13.7 percent for the Vanadium Tailings Pile cover, 111.2 lb/ft^3/14.1 percent for the East Tailings Pile cover, and 111.8 lb/ft^3/16.9 percent for the Acid Tailings Pile cover. For each tailings area, the Proctor test results were reported for a sample of sand tailings and slimes. Natural dry density averaged 96.4 lb/ft^3 for the carbonate tailings, 78.4 lb/ft^3 for the vanadium tailings, 101.1 lb/ft^3 for the east tailings, and 72.43 lb/ft^3 for the acid tailings.

Samples of the peripheral property surface soils range in composition from silty sands to organic silts, with specific gravities averaging 2.60. A wide

Table 8. Geotechnical Test Results of Monticello Millsite Soil Samples

GOODSON & ASSOCIATES, INC.
11949 West Colfax Avenue
Lakewood, Colorado 80215

December 20, 1985

G&AI PROJECT NO: 6411.01

MKB No.	Location	Depth (Feet)	Nat. Moist. (%)	Nat. Dry Density (PCF)	Gravel (%)	Sand (%)	Fines (%)	Atterberg Limits LL (%)	Atterberg Limits PI (%)	ASTM D-698 Density/ Moisture	Specific Gravity	Soil Description/ USCS
652	85-01	6-8'	4.6	89.6			3		NP		2.57	silty clay (CL-ML)
661	85-02	2-4'	4.0	107.5			49		NP		2.60	very silty sand (SM)
787	85-02	1'					66			114.7/14.5		sandy silt (ML)
749	85-03	2-4'	27.4	92.1			84	20	4		2.67	slightly clayey silt (ML)
682	85-04	4-6'	39.8	80.7			44	27	10		2.62	sandy clay (CL)
783	85-04	1'					71			114.3/13.7		sandy silt (SM)
678	85-05	6-8'	41.7	76.1			94	21	5		2.63	clayey silt (CL-ML)
689	85-06	2-4'	5.2	96.4			42		NP		2.67	very silty sand (SM)
779	85-06	1'					52			111.2/14.1		sandy silt (ML)
697	85-07	2-4'	9.9	94.0			19		NP		2.61	silty sand (SM)
714	85-08	12-14'	34.4	108.6			81	41	22		2.70	sandy clay (CL)
706	85-09	4-6'	21.4	100.7			88	42	13		2.63	sandy clay (CL)
723	85-10	4-6'	43.5	66.1			78	29	11		2.63	sandy clay (CL)
791	85-10	1'					49			111.8/16.9		silty sand (SM)
741	85-11	4-6'	39.8	74.8			72	44	20		2.69	sandy clay (CL)
732	85-12	4-6'	40.5	76.4			87	47	10		2.68	slightly sandy silt (ML)

Table 8 (continued). Geotechnical Test Results of Monticello Millsite Soil Samples

GOODSON & ASSOCIATES, INC.
11949 West Colfax Avenue
Lakewood, Colorado 80215

December 20, 1985

G&AI PROJECT NO: 6411.01

MKB No.	Location	Depth (Feet)	Nat. Moist. (%)	Nat. Dry Density (PCF)	Gravel (%)	Sand (%)	Fines (%)	Atterberg Limits LL (%)	Atterberg Limits PI (%)	ASTM D-698 Density/ Moisture	Specific Gravity	Soil Description/ USCS
834	85-15	2-37'	6.9				82			102.5/19.7		slightly sandy, clayey silt (ML)
835	85-16	5.5-12'	13.2				82			113.7/14.9	2.65	gravelly silt (ML)
776	85-16	9-10'	11.8	121.0			79	36	14		2.61	sandy clay (CL)
766	85-17	0-2'	48.2				31	33	10		2.63	clayey sand (SC)
830	85-17	0-5'			13	6	81			108.3/17.0		gravelly silt (ML)
768	85-18	0-2'	14.3				65	32	14		2.55	sandy clay (CL)
833	85-18	0-5'					80			103.3/19.0		sandy silt (ML)
759	85-19	0-2'	5.8				70	26	6		2.61	sandy clayey silt (CL-ML)
828	85-19	0-5'					73			109.8/15.8		sandy silt, organics (ML-OL)
753	85-20	0-2'	10.8				80	41	7		2.62	sandy silt, organics (OL)
836	85-20	0-3'					71			101.9/18.9		gravelly silt, (topsoil, OL)
756	85-21	0-2'	7.5					30	10		2.60	silty sand, (topsoil, OL)
826	85-21	0-3'					43			115.2/13.6		silty sand (SM)
841	+0	0-2'			19	52	29				2.54	gravelly, silty sand, organics (SM)

Table 8 (continued). Geotechnical Test Results of Monticello Millsite Soil Samples

GOODSON & ASSOCIATES, INC.
11949 West Colfax Avenue
Lakewood, Colorado 80215

December 20, 1985

G&AI PROJECT NO: 6411.01

MKB No.	Location	Depth (Feet)	Nat. Moist. (%)	Nat. Dry Density (PCF)	Gravel (%)	Sand (%)	Fines (%)	Atterberg Limits LL (%)	Atterberg Limits PI (%)	ASTM D-698 Density/ Moisture	Specific Gravity	Soil Description USCS
842	+1000	0-2'			56	40	4				2.65	sandy gravel (GP) organics
843	+2000	0-2'			0	39	61				2.61	very silty sand (SM) organics
840	+3500	0-1.5'			2	39	59				2.66	sandy silt (ML) organics
839	+5000	0-2'			10	40	50				2.58	gravelly sandy silt (ML) organics
838	+6500	0-1.5'			15	38	47				2.65	gravelly, sandy silt (ML) organics

Table 9. Chemical Analysis of Potential Borrow Material

Drill Hole	Depth (ft)	Sample (MMK No.)	LOD (%)	Ra-226 (pCi/g)	Th (ppm)	K (%)	Grain Density (g/cm³)
GP	0-20	117	9.71	0.8	13.9	1.4	2.71
	20-40	120	4.58	1.0	8.8	0.9	2.69
	40-50	123	5.51	0.4	3.7	0.4	2.66
	at 50 ft hit bottom clays						
GPN	0-20	121	11.79	1.1	14.5	1.4	2.70
	20-40	125	9.73	0.8	7.6	0.8	2.69
	40-60	122	28.87	1.9	17.4	1.3	2.69
	60-80	115	21.64	2.7	21.7	1.3	2.78
	at 80 ft still in clays						
GPSE	0-20	124	5.60	1.1	10.1	1.3	2.70
	20-40	116	7.57	1.9	19.4	1.0	2.73
	40-50	119	3.71	1.4	4.1	2.1	2.66
	at 47 ft hit sandstone						

range of density-moisture relationships was analyzed. Natural moisture of the 2-foot depth of surface soil ranged from 5.8 to 48.2 percent.

The proposed borrow area soil ranges from clayey silt to sandy clay, with specific gravity averaging 2.63. The material contains approximately 80 percent fines, and natural dry density for the material is 121.0 lb/ft³. Due to testing of two large samples of drill cuttings representing depths from 2 to 37 feet and 6 to 12 feet, a wide range of density/moisture values was measured.

5.0 GEOLOGY

5.1 SAMPLING PROCEDURES

A total of eight holes were augered/drilled in order to conduct permeability tests (presented in Section 6), to obtain soil/bedrock profiles along proposed cutoff-wall locations, and to ascertain geotechnical characteristics of the materials drilled.

Unconsolidated material was penetrated with a 6 7/8-inch diameter hollow-stem auger using a truck-mounted Central Mine Equipment (CME) 45B drill rig. Soil samples from most holes were collected every 5 feet, using a 2-inch diameter split-barrel sampler driven 18 inches with a 140-pound hammer falling 30 inches. The number of blows for each 6 inches of penetration was observed and recorded. Soil samples were logged and classified by inspection, in accord with the Unified Soil Classification System. Relative densities of the materials encountered were estimated using the standard penetration test conversions given in Lambe and Whitman (1969), p. 77.

Table 10. Engineering Analysis of Potential Borrow Material

Drill Hole	Depth (ft)	Soil Classification	Silt (%)	Clay (%)	Proctor (lb/ft³)	Proctor H_2O(%)	Permeability[a] Settlement (%)	Permeability[a] K (ft/yr)	Dry Density[b] (lb/ft³)
GP	0–20	Yellow-Brown Clay	19.6	16.0	113.6	15.7	0.1	0.36	107.9
GP	20–40	Gray Clayey Sand	20.6	8.0	125.7	11.7	0.65	1.39	119.4
GPN	0–20	Yellow-Brown Clay	35.8	28.2	110.8	18.3	0.02	0.027	105.3
GPN	20–40	Silty Sand	23.5	7	120.5	12.6	0.5	0.115	114.5
GPN	40–60	Gray Shaley Clay	32.2	18.0	116.3	14.0	+0.03	0.021	110.5
GPN	60–80	Gray Shaley Clay	31.4	23.9	113.7	14.0	1.2	0.259	108.0
GPSE	0–20	Silty, Clayey Sand	31.6	9	118.4	11.0	0.8	0.53	112.5
GPSE	20–40	Gray Clay	29.3	24.5	118.2	14.4	0.0	0.084	112.3

[a]Data corresponds to an applied load of 114 lb/ft².
[b]Measured at 95 percent of maximum compaction, standard ASTM D698-78.

The auger was seated in the first several inches of weathered bedrock, in preparation for rock coring. The hollow-stem auger remained in the hole and was used as surface casing through which coring was performed. The coring was conducted using an NX core barrel to make 5-foot core runs. The core was classified, labeled, and placed in core boxes on retrieval from the core barrel.

The rock core was classified according to its engineering/structural and geologic properties. The properties used to classify the core include fracture intensity (see Table 11), rock strength (see Table 12), percent recovery, and rock quality designation (RQD). A site plan showing the locations of the boreholes and corresponding cross sections is shown in Figure 2. The geophysical logs of the borings and drill holes are presented in Figures 3 through 10. Two cross sections were constructed using the logs and are presented as Plates 3 and 4. It should be emphasized that connections drawn between the drill holes are based on geologic interpretations; actual subsurface features may differ from those shown on the cross sections.

Table 11. Fracture Intensity

Fracture Frequency (measured parallel to core length)	Classification
-5 microns to 0.05 ft (contains clay)	Crushed
0.05 ft to 0.1 ft (contains no clay)	Intensely Fractured
0.1 ft to 0.5 ft	Closely Fractured
0.5 ft to 1 ft	Moderately Fractured
1 ft to 3 ft	Little Fractured
4 ft and larger	Massive

5.2 RESULTS

The rock formations encountered during coring operations were the Dakota Sandstone and the overlying Mancos Shale. These rocks dip gently (from less than 1 to 1.4 degrees) to the east-northeast; the bedrock dip slope is visible as the Dakota/Mancos contact in Plate 3.

The Dakota Sandstone can be divided into three general units: a lower conglomerate/sandstone unit; a middle unit consisting of interbedded sandstone, shale, siltstone, claystone, and low-grade coal; and an upper sandstone unit. Only parts of the middle unit were penetrated during this study. The middle Dakota Sandstone unit consists of friable (crumbles in hand) to moderately strong rock (will withstand a few firm hammer blows before breaking) that is predominantly little fractured. The upper sandstone unit of the Dakota consists of moderately strong rock that is predominantly little fractured to massive. Rocks of the Dakota Sandstone are present in the subsurface everywhere under the mill-tailings site; however, the Dakota crops out along the man-made channel of Montezuma Creek south of the East Tailings Pile. The upper sandstone unit of the Dakota has probably been removed along at least part of the former channel of Montezuma Creek, as evidenced by previously

Table 12. Rock Structural Classification

Structural Classification	Typical Geologic Classification	Common Identification Characteristics	Coring Characteristics (percent)			
			NX[a] or Larger		BX[b] or Smaller	
			Recovery	Rock Quality Designation	Recovery	Rock Quality Designation
Class 1 - Hard Sound Rock Slightly Jointed Unweathered	Crystalline Igneous or Metamorphic Rocks Highly Siliceous Sedimentary Rocks	Rings when struck with bar. Does not disintegrate upon exposure nor slake in water. Joints or fractures generally unweathered, less than 1/8 in. wide, and no closer than 3 ft apart in exposure. Sharp, hard fracture surface when broken.	95 or More	85 or More	85 or More	75 or More
Class 2 - Medium-Hard Rock Moderately Sound Moderately Jointed Slightly Weathered	Same as Class 1 Moderately Siliceous Sedimentary Rocks Certain Calcareous Rocks	Characteristics same as Class 1 except joints or fractures may be 1/4 in. wide and slightly weathered, generally no closer than 2 ft apart in exposure. Piece can be broken off with hammer and the fracture surface iron-stained.	70	50 to 85	50	40
Class 3 - Intermediate Rock Moderately to Highly Jointed Moderately Weathered	Same as Class 2 Most Sedimentary Rocks Other Than Compaction Shales Most Calcareous Rocks Are Not Porous	Gives dull sound when struck with bar. Does not disintegrate upon exposure. Unweathered pieces do not slake in water. Joints or fractures may be up to 1 in. wide. Contains weathered material, spaced as close as 8 ft in exposure. Piece can be broken off with hammer on weathered surface.	50	35 to 50	35	25
Class 4 - Soft Rock Highly Jointed Extensively Weathered Porous	Weathered Rocks of Class 3 Compaction Sedimentaries Calcareous Rocks with Soil-Filled Cavities	May soften upon exposure. May slake in water. May include thoroughly weathered zones up to 3 in. wide with stiff soil. Weathered zones or soil-filled cavities exhibit standard penetration resistance exceeding 50 blows per foot.	Less Than 50	Less Than 35	Less Than 35	Less Than 25

[a]NX = outside diameter 3-1/2 in., inside diameter 3-3/16 in.
[b]BX = outside diameter 2-7/8 in., inside diameter 2-9/16 in.

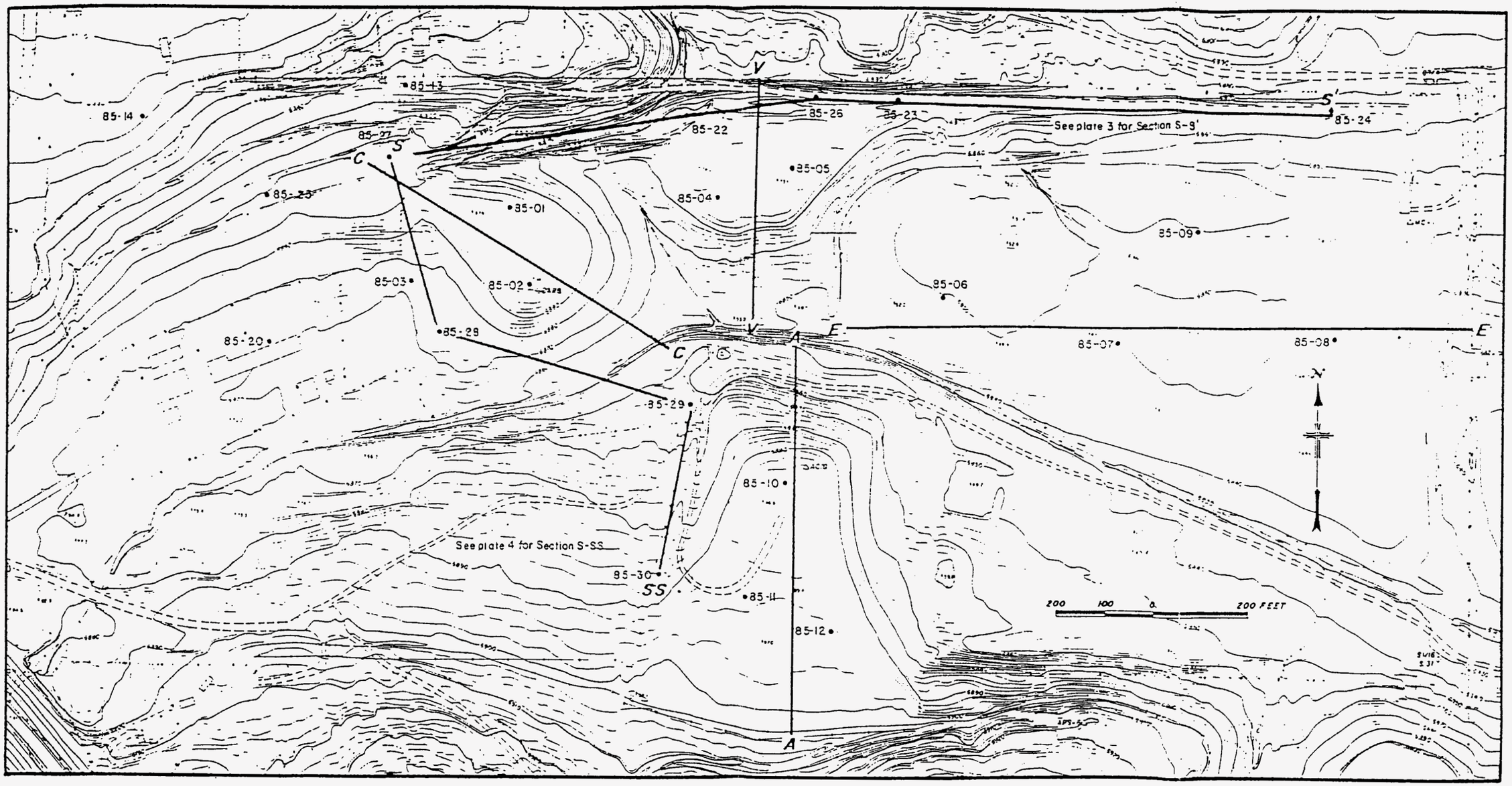


Figure 2. Locations of Geologic and Tailings Pile Cross Sections at the Monticello Millsite

Depth (feet)	Blows/ 6" or Core-box no.	Sample Interval or Core Runs	RQD/ Recovery (percent)	Permeability (cm/s)	Graphic Log	Description
						UNCONSOLIDATED DEPOSITS
5						Silty, fine-grained sand (SM) brown; loose to medium; scattered pebbles and cobbles of diorite-porphry, sandstone, and shale.
10						Clayey silt (ML); brownish olive.
						Thin gravel zone (GM); pebbles and cobbles of diorite-poyphyry, sandstone, and shale.
15						
20						Clayey silt (ML) grades downward to silty clay (CL); only traces of shale and sandstone fragments; very stiff.
25						**MANCOS SHALE**
						Brown to gray shale with minor stringers of sandsand near contact with Dakota Sandstone; little fractured.
30		Run 1	0/100			**DAKOTA SANDSTONE**
35	Box * 1	2	33/100			Light-to dark-gray medium-grained quartzose sandstone; scattered mollusks from 32 to 33 feet, and from 38 to 39 feet (closely fractured); fracture zone (closely fractured) from 36 to 37 feet; fractures filled with gray clay from 39 to 39.5 feet (crushed); very carbonaceous; abundant pyrite.
40		3	70/100			Little fractured to massive.
45	2	4	70/100			Thin gray claystone from 46.3 to 46.7 feet marks boundary between Upper Dakota Sandstone and more variable Middle Dakota Sandstone.
50						White to light-gray medium-grained sandstone from 46.7 to T.D. of 47.9 feet.
55						
60						

Figure 3. Geotechnical Log of Borehole 85-22

Depth (feet)	Blows/6" or Core-box no.	Sample interval or Core Runs	RQD/Recovery (percent)	Permeability (cm/s)	Graphic Log	Description
5						**UNCONSOLIDATED DEPOSITS** Clayey silt (ML); brown; scattered pebbles of diorite porphyry.
						Silty clay, very stiff (CL); brown; scattered angular fragments of Mancos Shale and sandstone.
10	Box # 1	1	0/100			**MANCOS SHALE**
15		2	0/100			Upper 3 feet highly weathered and grades upwards into residual soil; appears more fissile with depth; fossils (mostly gryphae newberryi, mollusks of Cretaceous age) are abundant from a depth of 14.5 to 18 feet; abundant fractures with iron-oxide and calcareous infilling from a depth of 15 to 25 feet (intensely fractured to crushed); color is brown above 25 feet, and grades to gray and dark-gray below 25 feet; numerous horizontal fractures are present near the contact with Dakota Sandstone (closely fractured).
20		3	0/100			
	2	4	0/100	2.0×10^{-4}		
25		5	0/80			
				5.0×10^{-4}		
30		6	0/20	$+3.0 \times 10^{-4}$	LOST	
						Closely fractured.
35	3	7	20/100			**DAKOTA SANDSTONE**
40		8	68/100			Light-to-dark-gray, medium-grained quartzose sandstone; scattered mollusks (pelecy pods) from a depth of 35 to 37 feet; nearly vertical fractures (closely fractured) from 36 to 36.5 feet, from 40.5 to 41 feet, and from 42 to 44.5 feet (little fractured); white clay layer, approximately .25 inches thick near a depth of 46 feet; very carbonaceous; abundant soft-sediment deformation features; abundant pyrite.
45	4	9	67/100			
50						
55						
60						

Figure 4. Geotechnical Log of Borehole 85-23

Depth (feet)	Blows/ 6" or Core-box no.	Sample interval or Core Runs	RQD/ Recovery (percent)	Permeability (cm/s)	Graphic Log	Description
5						**UNCONSOLIDATE DEPOSITS** Light brown clayey silt (ML) grading downwards into very stiff residual soil of silty clay (CL); minor scattered fragments of diorite, sandstone and shale
						MANCOS SHALE Dark gray marine shale; fissile.
10						
15						Vertical fracture with iron-oxide staining and some calcareous infill is present throughout most of the range from 14 to 24 feet.
	Box # 1	Run 1	0/90	5.3×10^{-4} $\pm 4.1 \times 10^{-4}$		
20		2	27/95			Dark gray shale, less fissile than above.
25		3	53/95	1.3×10^{-4}		Fossil zone is present at a depth of 24 to 26 feet. Little fratured.
30	2	4	8/100	1.0×10^{-3} $\pm 3.1 \times 10^{-4}$		Dark gray, very fissile marine shale.
35		5	0/100	5.0×10^{-7}		Little fractured.
40	3	6	0/100	1.0×10^{-6} 5.0×10^{-7}		Light gray to white clay at a depth of 38' 10" to 39' 1"; A similar clay layer from 40' 1/2" to 40' 1".
						DAKOTA SANDSTONE Light- to dark-gray, medium-grained sandstone; very carbonaceous; abundant soft-sediment deformation features; abundant pyrite.
45		7	58/100			Little fractured to massive.
50	4	8	83/100			
55						
60						

Figure 5. Geotechnical Log of Borehole 85-24

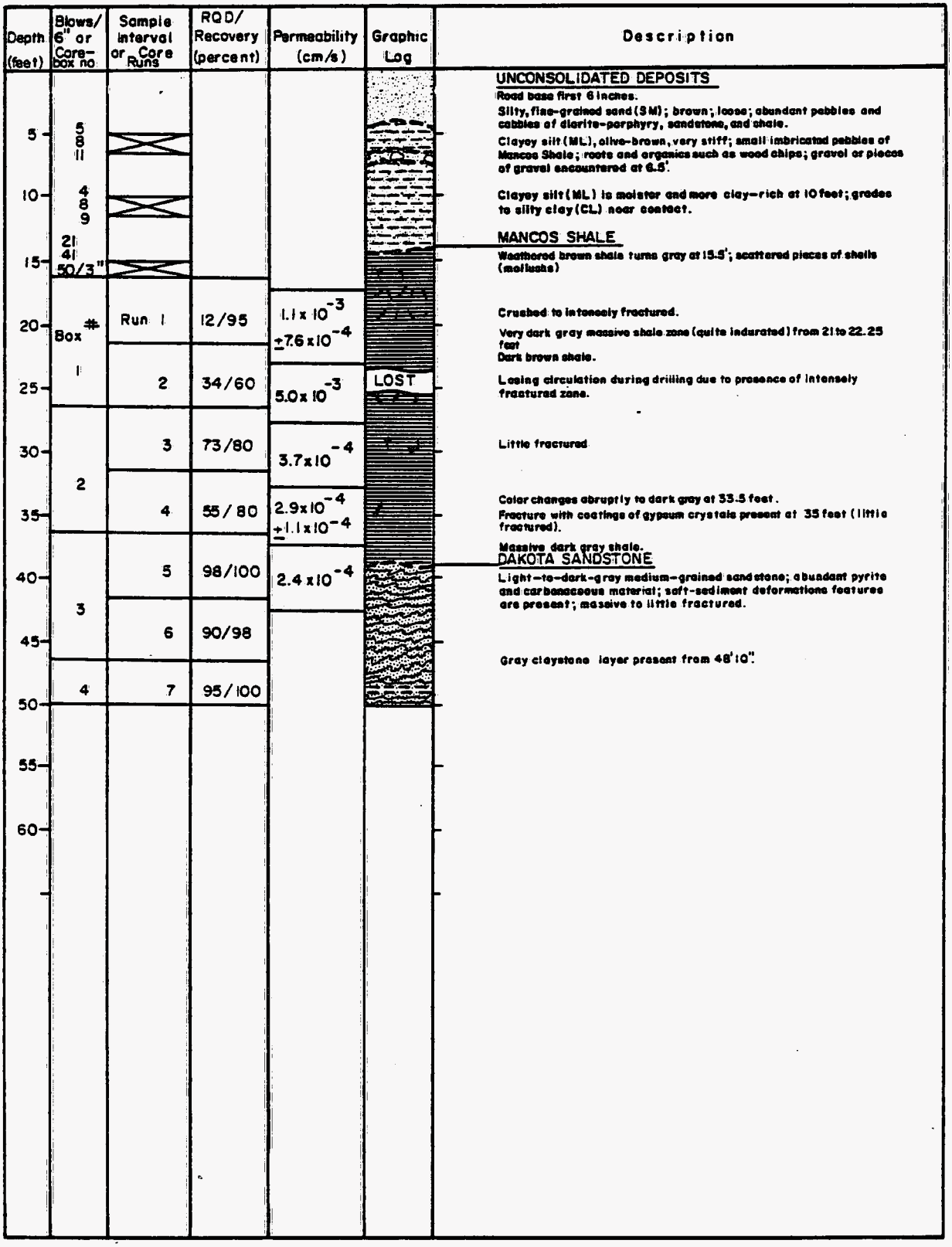


Figure 6. Geotechnical Log of Borehole 85-26

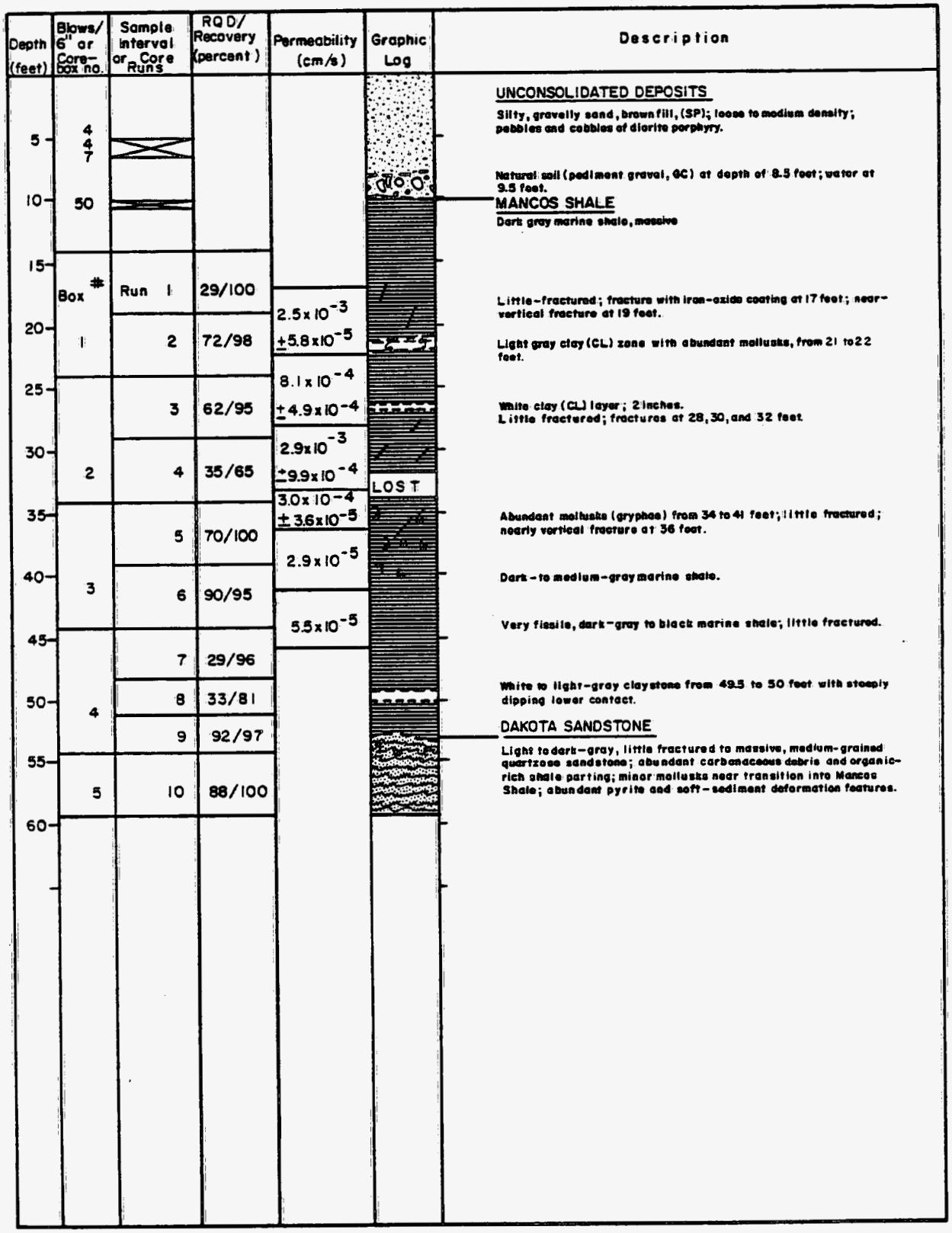


Figure 7. Geotechnical Log of Borehole 85-27

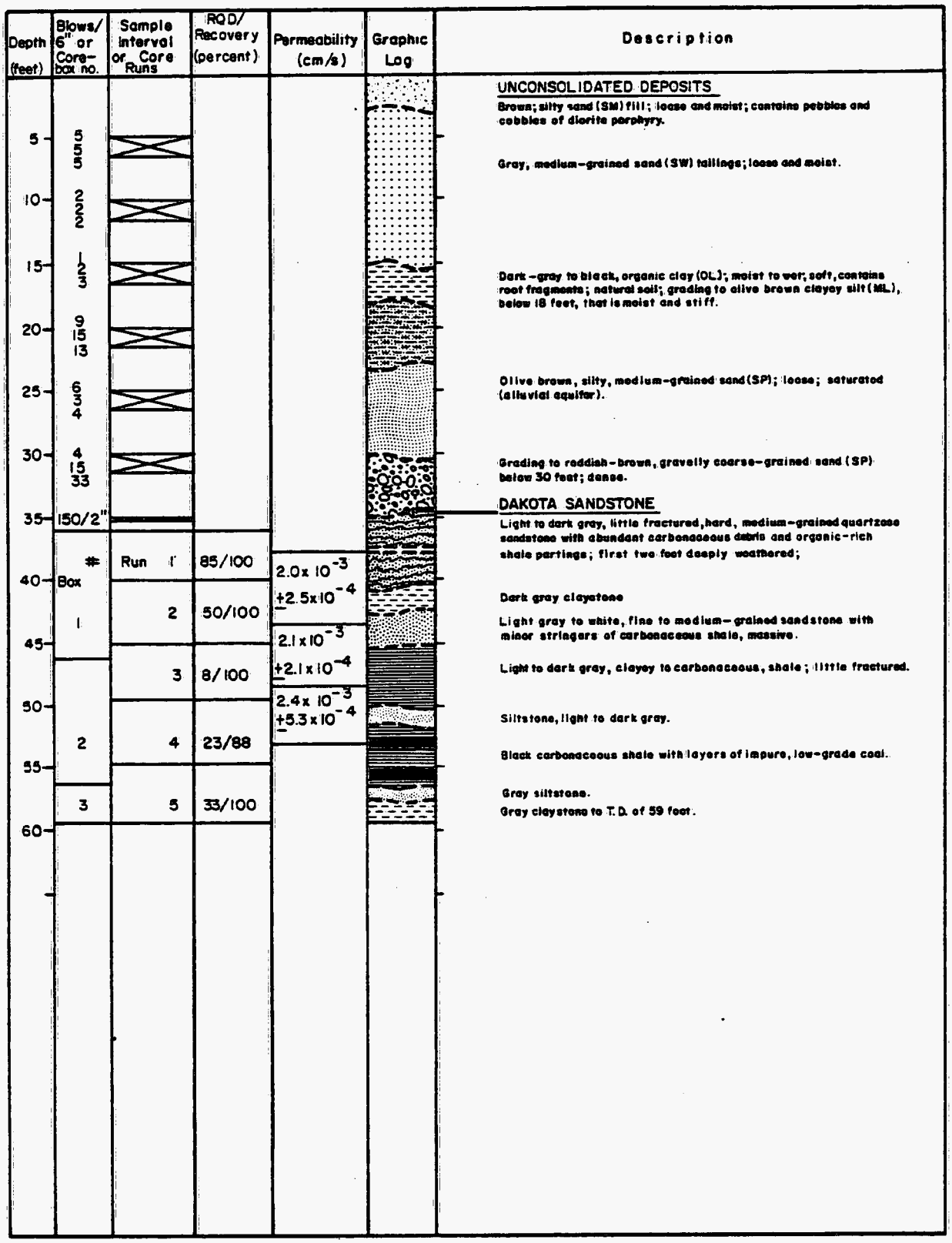


Figure 8. Geotechnical Log of Borehole 85-28

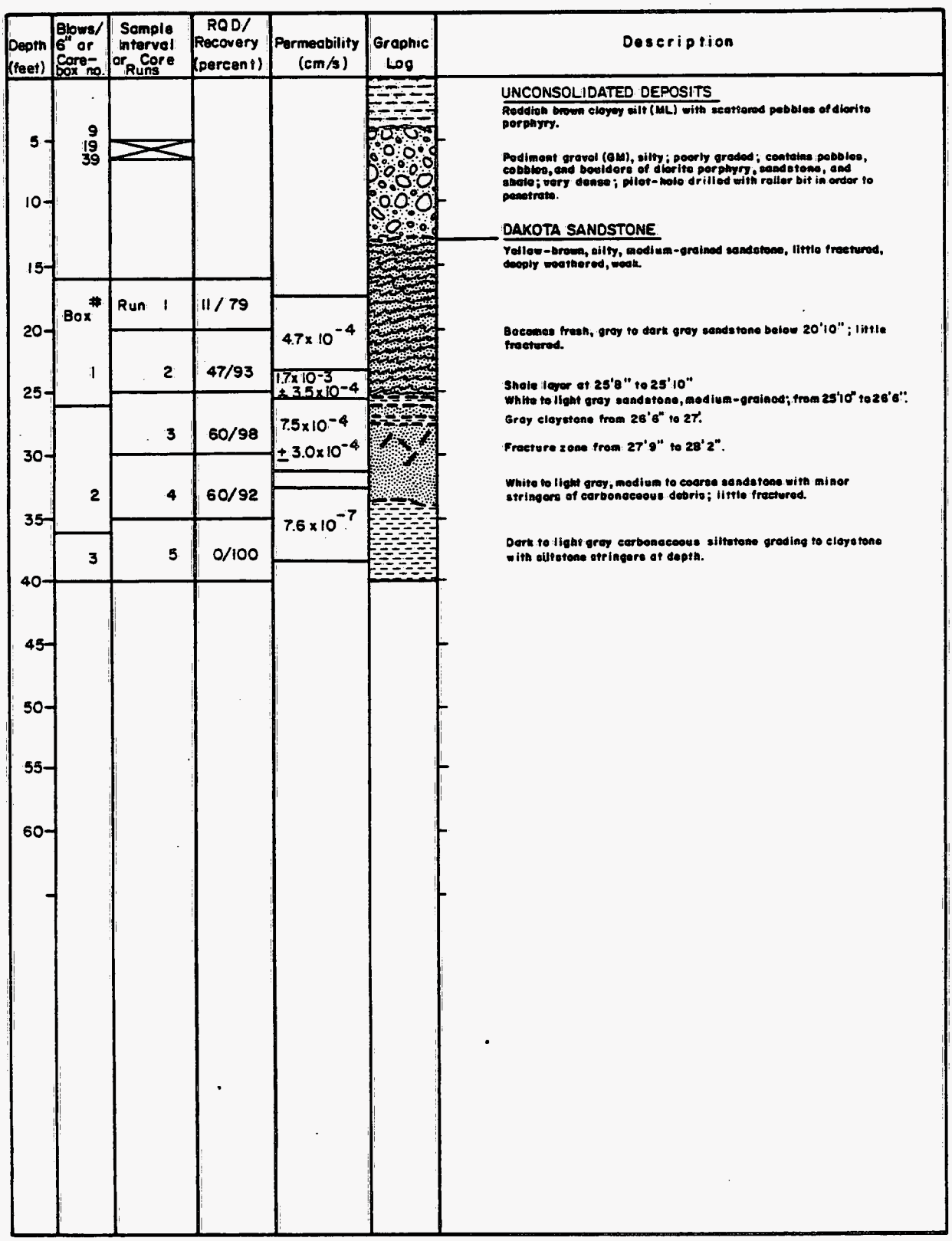


Figure 9. Geotechnical Log of Borehole 85-29

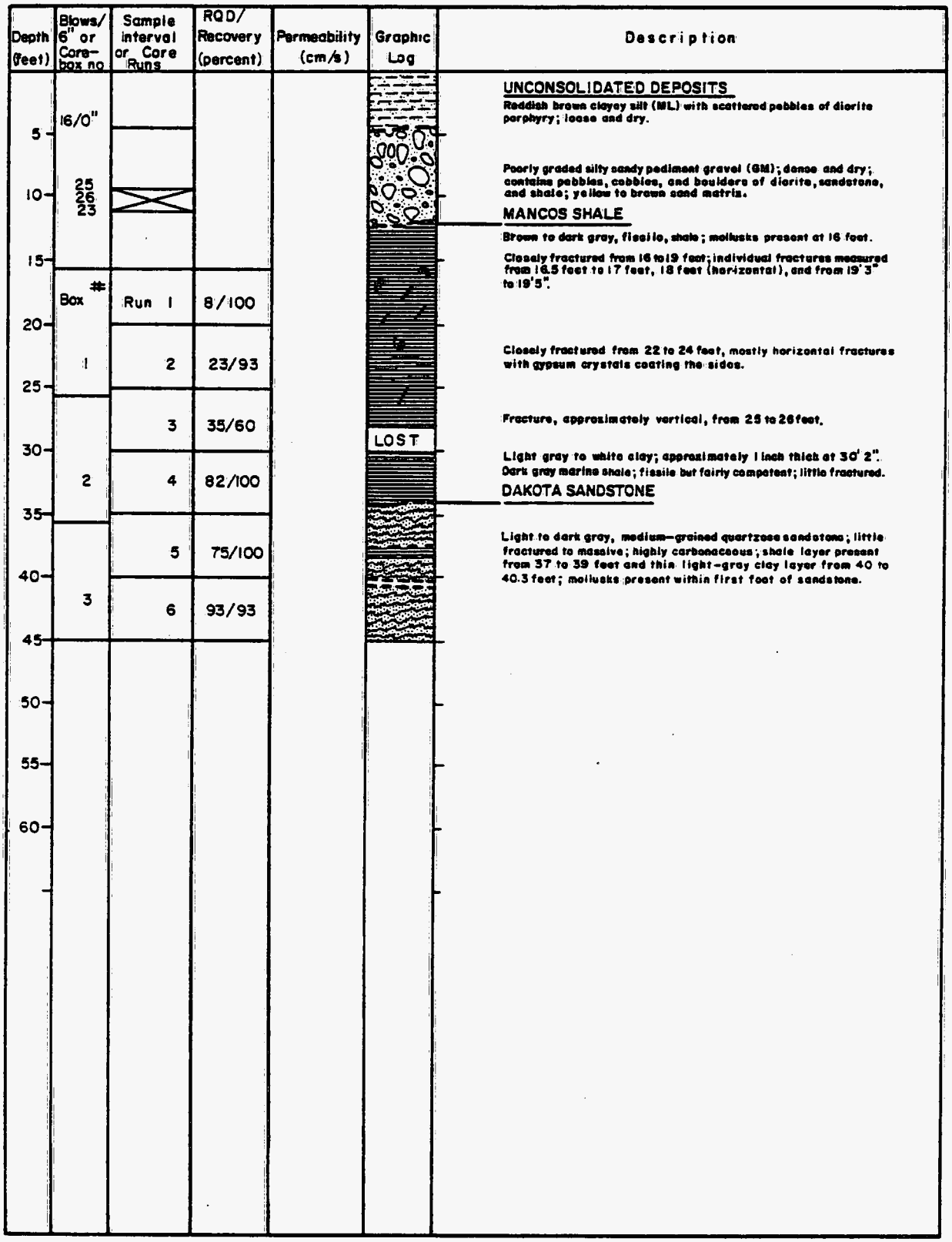


Figure 10. Geotechnical Log of Borehole 85-30

collected rock-core data. The absence of this unit is also suggested by the presence of only the lower 1 foot of Dakota Sandstone shown between Boreholes 85-28 and 85-29 (see Plate 4) on the western side of the tailings areas.

The Mancos consists of friable (crumbles in hand) to weak (crumbles under light hammer blows), brown to gray marine shale. The shale is predominantly little fractured, but thin zones of crushed to intensely fractured Mancos are common. The Mancos does not entirely underlie the tailings piles, and has been eroded from much of the study area, as was reported in the Environmental Assessment of Remedial Action at the Monticello Uranium Mill Tailings Site, Monticello, Utah, (Abramiuk and others, 1985). Evidence of this erosion can also be seen on Cross Section S-SS (see Plate 4). As presented in Cross Section S-SS, the west side of the Carbonate Tailings Pile lies directly on the former Montezuma Creek floodplain, which lies on the upper sandstone unit of the Dakota. Mancos shale has also been deeply eroded on the north side of the site, as well. Cross Section S-S' (see Plate 3) portrays a tributary of Montezuma Creek; only about 5 feet of Mancos remains in the center of this tributary. To the south of the cross-section line, this tributary channel has been covered by tailings piles.

Unconsolidated deposits encountered during this study range in thickness from 7 to 34 feet. The deposits include gravel, sand, and soils deposited by Montezuma Creek; wind-blown loess overlying pediment gravel on the south side of the Montezuma Creek channel; pediment gravels, residual soils, and tributary alluvium on the north side of the Montezuma Creek channel; and fill/tailings materials.

Plate 3 depicts an interpretation of Cross Section S-S', which extends from east to west, along the north side of the millsite. On the east side of the cross section, clayey-silt soil with scattered pebbles of lag gravel grades downward to a silty-clay residual soil developed on top of the Mancos Shale. The middle of the cross section crosses the previously described tributary to Montezuma Creek. The bottom of this channel consists of a clayey-silt unit, with scattered fragments of locally derived sandstone and shale, which grades to a silty-clay residual soil near the contact with Mancos Shale. A thin zone of gravel is present within the clayey-silt unit; the gravel consists of pebbles and cobbles of igneous lithologies (probably derived from upland pediment gravels and ultimately from the igneous intrusive rocks of the Abajo Mountains) and locally derived sandstone and shale. The uppermost unit consists of loose to medium-dense silty sand with abundant cobbles and pebbles of diorite porphyry, sandstone, and shale. The hill to the west of the tributary is Mancos Shale capped with a thin veneer of pediment gravel.

An interpretation of Cross Section S-SS, which extends from northwest to southeast, near the western side of the millsite, is depicted in Plate 4. Borehole 85-27 penetrates 8.5 feet of contaminated silty gravelly sand fill, which rests on 1 foot of uncontaminated, natural pediment gravel. The north side of the former Montezuma Creek floodplain occurs between Boreholes 85-27 and 85-28, but is concealed at the surface by tailings/fill. The cross section drawn between these two holes is partly based on old data pertaining to the thickness of tailings in an adjacent area, but the actual cross-sectional shape of the alluvial valley is unknown. Borehole 85-28 penetrates a complete section of Montezuma Creek alluvium. This alluvium was deposited by a meandering river system. Sediments represented in Borehole 85-28 include

backswamp or floodplain deposits (represented by the black organic clay and clayey silt), point-bar or channel-fill deposits (represented by the saturated sand), and channel-lag deposits (represented by the lower sands/gravels). These sediments were deposited during early or middle glacial stages when the climate was much wetter than at present. Depending on the longevity and complexity of the meandering river system, variations in lateral continuity of the different deposits can be expected. Therefore, the cross section (see Plate 4) has great modification potential, and should be regarded as tentative. The saturated sands and gravels represent the alluvial aquifer that is present under most of the tailings, except the Acid Tailings Pile on the south side of the creek. The Acid Tailings Pile rests on wind-blown loess (loose, brown clayey silt of Boreholes 85-29 and 85-30) overlying pediment gravel; these sediments are dry but probably interfinger with deposits of the alluvial aquifer, as presented in Plate 4. However, the exact nature and extent of this interfingering, as well as the bedrock profile of the alluvial valley at the point of interfingering, is unknown. The present-day Montezuma Creek is entrenched in its own alluvium, and is depositing fine-grained sediments in the channel bed.

5.3 SUMMARY

Distribution of both unconsolidated materials and bedrock along the north side of the millsite is well documented, as shown in Cross Section S-S' (see Plate 3). However, interpolation was greatest between Boreholes 85-27, 85-28, and 85-29 which encompass the northern and southern boundaries of the alluvial aquifer. This alluvium was deposited by a meandering river when the climate was much wetter than at present; the current Montezuma Creek is an entrenched meander system that is depositing fine-grained sediment on the channel floor. Boundaries of the alluvial aquifer and the lateral extent of its sediments are poorly understood, and additional borings are recommended prior to construction of any slurry walls.

6.0 HYDROLOGY

6.1 PURPOSE AND SCOPE

The hydrologic portion of the characterization consisted of drilling boreholes along the proposed groundwater cutoff-wall locations and testing the subsurface rock permeabilities using water injection tests. The scope of the investigation included:

- Determine permeabilities at the proposed cutoff-wall locations.
- Assess the hydrologic conditions along the northern peripheries of the tailings area.
- Make recommendations regarding future work efforts in regard to the cutoff-wall design.

6.2 WATER INJECTION TESTS

6.2.1 Procedure

Water injection, or 'packer' tests were used to estimate horizontal formation permeabilities within discrete horizons. The tests were performed in accord with methods recommended at the University of Missouri-Rolla Seminar for Drillers and Exploration Managers (1981), U.S. Bureau of Reclamation (1974), and summarized in the Environmental Sciences Procedure Manual: Second Edition (Bendix Field Engineering Corporation, 1985a), Procedure 3.3.

The packer test is performed by pumping water into the formation through a conductor pipe, which transmits water to the formation through a 5-foot length of perforated pipe. The perforated pipe is terminated on both ends with inflatable packers, which seal off the test interval of the formation. A pressure gauge and a flow meter are used at the surface to monitor the pressure created in the packed-off interval and to measure the flow rate entering the formation in the isolated zone, respectively.

The rate at which the formation accepts a steady flow of water ($dh/dt = 0$) is measured at various pressures. For the purpose of this study, the first tests were run at low-gauge pressures [usually <10 pounds per square inch (psi)], while the second tests were run at higher gauge pressures (up to 50 psi), and the third tests were usually run at lower gauge pressures (<10 psi). The duration of each test was approximately 6 minutes; however, longer tests were conducted which required up to 16 minutes of pumping for steady flow to occur. The permeability was then computed using the following equation:

$$K = \frac{Q}{2\pi Lh} \ln\left(\frac{L}{r}\right) \qquad (1)$$

where Q is the volumetric flow rate (cubic foot per minute), L is the test length (feet), h is the hydraulic head (feet), and r is the borehole radius (feet) (U.S. Bureau of Reclamation, 1974). The use of this equation implies that the test interval is at least 10 times the borehole radius.

6.2.2 Results and Discussion

Results of the water injection tests are presented in the boring logs (see Figures 3 through 10) adjacent to the horizons tested. The test results indicate that most of the subsurface horizontal permeabilities are in the range 10^{-3} to 10^{-5} centimeter per second (cm/s). Portions of both the Mancos Shale and the Dakota Sandstone are in this permeability range.

Of the six boreholes subjected to water injection tests, the lowest permeabilities were encountered in Boreholes 85-24 and 85-29, which had permeabilities of 10^{-6} to 10^{-7} cm/s. These low-permeability zones were found in the basal Mancos Shale (Borehole 85-24) and in the middle Dakota (Borehole 85-29). In both these low-permeability intervals, the rock was predominantly a shale or claystone at a depth of 35 to 40 feet below the surface.

Two additional points of interest were noted during this investigation. First, Borehole 85-23, a 48-foot-deep hole located along the northern margin

of the site, was dry at the time of packer testing. Since this hole had been left open for about 1 month prior to packer testing and had contained water used during coring operations, it is apparent that the water dissipated through unsaturated fractures. Groundwater seeps, however, emanate from the Mancos Shale in certain locations along the northern boundary of the site. The groundwater is apparently transmitted through shallow fractures within the Mancos Shale. These fractures probably obtain recharge from irrigation-ditch leakage and infiltration of groundwater from pediment gravels north of the site. In areas where the fractured Mancos Shale is dry, there is no hydraulic communication between the fractures and these sources of recharge.

A second observation worth noting is that Boreholes 85-29 and 85-30, drilled south of Montezuma Creek and west of the Acid Tailings Pile, encountered dry pediment gravels overlying the Dakota Sandstone. The initial motive behind planning a cutoff wall in this area was to divert water from the alluvial aquifer system around the Acid Tailings Pile. The current investigation seems to indicate that no saturated alluvial gravels are present west of the Acid Tailings Pile. Consequently, a groundwater cutoff wall may be unnecessary in this area.

6.3 RECOMMENDATIONS

Additional borings should be drilled across the alluvial aquifer prior to cutoff-wall design to determine the aquifer's cross-sectional dimensions, to assess the permeability of the underlying Dakota Sandstone, and to collect samples for laboratory testing. The borings should be drilled along the proposed cutoff-wall alignment, west of the Carbonate Tailings Pile.

An additional suite of borings should be drilled along an east-west alignment to the north of, and parallel to, Montezuma Creek. This group of borings is necessary to characterize the longitudinal-subsurface profile of the alluvial-gravel system, to determine the permeability of the underlying bedrock, and to collect samples for laboratory testing. It is critical that subsurface information be obtained for this longitudinal alignment, since the diverted groundwater from the upgradient side must remain in the creek channel and not be permitted to seep back into the alluvial system.

If, as suspected, water seepage into the northern periphery of the site is primarily due to leakage from the adjacent irrigation ditch, a water balance must be performed on the drainage ditch to confirm and estimate the volume of that leakage. Corrective measures can then be taken to repair the ditch system, which would preempt the far more expensive cutoff-wall design and construction.

7.0 BIBLIOGRAPHY

Abramiuk, I. N., L. A. Blanchfield, E. T. Cotter, H. L. Fleischhauer, C. S. Goodknight, V. G. Johnson, K. E. Karp, P. M. Kearl, N. E. Korte, C. A. Ridolfi, R. R. Roquemore, D. W. Schaer, and J. M. Sewell, 1984. Monticello Remedial Action Project Site Analysis Report, GJ-10(84), U.S. Department of Energy, Grand Junction Area Office, Grand Junction, Colorado.

Abramiuk, I. N., and others, 1985. Environmental Assessment of Remedial Action at the Monticello Uranium Mill Tailings Site, Monticello, Utah (Draft), DOE/EA--, prepared for the Surplus Facilities Management Program, Richland, Washington, by Bendix Field Engineering Corporation, Grand Junction Operations, Grand Junction, Colorado.

Bendix Field Engineering Corporation, 1980. Monticello, Utah, Mill Tailings Drilling and Sampling Project Survey Analysis, Internal Document, Grand Junction Operations, Grand Junction, Colorado.

_____1985a. Environmental Sciences Procedure Manual: Second Edition (Draft), Internal Document, Environmental Programs Division, Grand Junction Operations, Grand Junction, Colorado.

_____1985b. UMTRA Program Site Characterization Radiologic Field Measurements Procedure Manual, GJ-09, prepared for the U.S. Department of Energy, Surplus Facilities Management Program, Richland, Washington by Bendix Field Engineering Corporation, Grand Junction Operations.

Dechant, G. L., and S. Donivan, 1984. Calibration and Performance of a High-Resolution Gamma-Spectroscopy System, GJBX-4(84), U.S. Department of Energy, Grand Junction Area Office, Grand Junction, Colorado.

Evans, R. D., 1980. 'Engineers Guide to the Elementary Behavior of Radon Daughters,' Health Physics, Vol. 38, No. 6, pp. 1173-1197.

George, D. C., and L. Knight, 1982. Field Calibration Facilities for Environmental Measurement of Radium, Thorium, and Potassium, GJ/TMC-01(82), U.S. Department of Energy, Technical Measurements Center, Grand Junction, Colorado.

George, D. C., and R. K. Price, 1982. Abbreviated Total-Count Logging Procedures for Use in Remedial Action, GJ/TMC-03(82), U.S. Department of Energy, Technical Measurements Center Report, Grand Junction, Colorado.

Lambe, T. W., and R. V. Whitman, 1969. Soil Mechanics, John Wiley and Sons, New York, New York.

Marutzky, S. J., Callie Ridolfi, David Traub, Susan Knutson, and Bruce W. Walker, 1985. Radiologic Characterization of the Peripheral Properties Adjacent to the Monticello, Utah, Millsite, GJ-26, U.S. Department of Energy, Grand Junction Projects Office, Grand Junction, Colorado.

Rush, S. M., and P. Bonner, 1984. Radiologic Characterization of the Grand Junction, Colorado, Uranium Mill Tailings Remedial Action Site, GJ-28, U.S. Department of Energy, Grand Junction Projects Office, Grand Junction, Colorado.

Scott, J. H., and P. H. Dodd, 1960. Gamma-Only Assaying for Disequilibrium Corrections, Open-File Report RME-135, U.S. Atomic Energy Commission, Grand Junction Operations Office, Grand Junction, Colorado.

Showalter, R. A., 1986. UMTRA Site Characterization Data Entry and Reduction Procedures, Internal Document, Bendix Field Engineering Corporation, Grand Junction Operations, Grand Junction, Colorado.

U.S. Bureau of Reclamation, 1974. Earth Manual: A Guide to the Use of Soils as Foundation and as Construction Materials for Hydraulic Structures, Denver, Colorado.

University of Missouri at Rolla, Seminar for Drillers and Exploration Managers, Orlando, Florida, 25 February 1981.

Appendix A

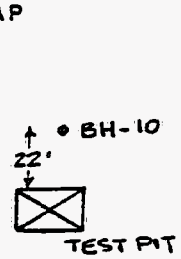
BOREHOLE AND TEST-PIT LITHOLOGIC LOGS

Lithologic logs were prepared for split-barrel or Shelby tube samples from each test pit and boreholes (85-01 through 85-21, and 85-25) from which samples were taken. The subsurface materials were classified using the Unified Soil Classification System (U.S. Bureau of Reclamation, 1974).

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION

TEST PIT LOG

LOCATION MAP



SITE: ACID LOCATION: near BH85-10
APPROX. SITE COORDINATES (ft.):
N 10408 E 21890
GROUND ELEVATION (ft. MSL)
DATE EXCAVATED: 9/10/85
BACKHOE TYPE: John Deere 690-B 24" wide shovel
CONTRACTOR: Crowley Construction
FIELD REP.: J. Krabacher & C. Ridolfi
REHAB. DATE: 9/10

GROUNDWATER LEVELS			
DATE	TIME	DEPTH(ft)	EST. FLOW (gpm)
		N/A	

LOCATION DESCRIPTION ACID pile 22' S of BH85-10
SITE DESCRIPTION level - scattered grass

DEPTH (ft.)	SAMPLE INT.	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
1		D	MKB 791	CL	dk. brown topsoil, ≈1' thick, clay w/sand [sample @ 1': cover]
					lt. brown w/cobbles & gravel, alm. yellowish
2				SP	Tailings, lt. brown-tan sand [sample @ 3 = sand]
3		D	792		
4					
5				ML	Slimes, brown, some thin darker beds 1', some thick gray beds ≈1' wet, clay, sl. plastic
6					
7					
8		D	793	CL	[sample @ 8' = slimes] sandier slimes med. plastic, wet liquidey
9					
10					
11		D	794		mix of sands & slimes [sample @ 11' = mix]

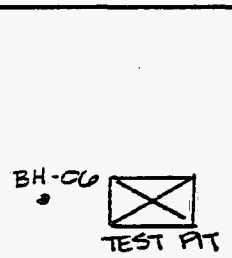
COMMENTS Stopped @ 12'. collected the 4 required samples.

SAMPLE TYPE
B — UNDISTURBED BLOCK SAMPLE
D — DISTURBED BULK SAMPLE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION

TEST PIT LOG

LOCATION MAP



SITE: MRAP EAST PILE LOCATION: Drill hole 85-06
APPROX. SITE COORDINATES (ft.): N 10,8409 E 2225?.?
N E
GROUND ELEVATION (ft. MSL)
DATE EXCAVATED: 9/10/85
BACKHOE TYPE: John Deere 690B
CONTRACTOR: Crowley Construction
FIELD REP.: Riddell & J. Krabacher
REHAB. DATE: 9/10/85

GROUNDWATER LEVELS			
DATE	TIME	DEPTH(ft)	EST. FLOW (gpm)
		N/A	

LOCATION DESCRIPTION East Pile E. of BH85-06
SITE DESCRIPTION level, grass & weed cover

DEPTH (ft.)	SAMPLE INT.	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
0			MKB		
1		D	779	CL	Topsoil, brown, rocky to depth of 1½-2'
2					
3		D	780		Tailings, gray, silty, damp
4					
5					
6		D	781	SM	Sand/Slime Mix, fine-grained, lt. gray, damp, orange/rust slimes, interbedding
7					
8					Sands, Lt. Gray and tan, damp
9					
10					
11					
12					Slimes, dk . gray, sand w/fines
13					
14					
15		D	782	SP	

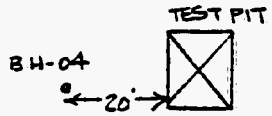
COMMENTS: stopped @ 15.0 ft after collecting the 4 required samples

SAMPLE TYPE
B — UNDISTURBED BLOCK SAMPLE
D — DISTURBED BULK SAMPLE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION

TEST PIT LOG

LOCATION MAP



SITE: Vanadium Pile LOCATION: 85-04
APPROX. SITE COORDINATES (ft.):
N 11090 E 21760
GROUND ELEVATION (ft. MSL)
DATE EXCAVATED: 9/10/85
BACKHOE TYPE: Deere 690B 24" wide shovel
CONTRACTOR: Crowley Construction
FIELD REP.: J. Krabacher & C. Ridolfi
REHAB. DATE: 9/10

GROUNDWATER LEVELS			
DATE	TIME	DEPTH(ft.)	EST. FLOW (gpm)
		N/A	

LOCATION DESCRIPTION Vanadium Pile ~20' E of BH85-04

SITE DESCRIPTION level, scattered grass & weeds

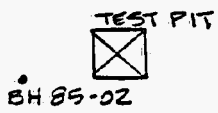
DEPTH (ft.)	SAMPLE INT.	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
		D	MKB 783	CL	Cover, dk. brown, cobbles to ~1', clay w/sand
1					
2		D	784	SP	Tailings, sandy, tan color
3					
4					
5		D	785	SC	Slimes/sands mix, plastic
6					
7		D	786	ML	Wet slimes, almost liquid consistency, brown color

COMMENTS ~~stopped 7.0' - collected 4 required samples~~

SAMPLE TYPE
B — UNDISTURBED BLOCK SAMPLE
D — DISTURBED BULK SAMPLE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
TEST PIT LOG

LOCATION MAP



SITE: Carbonate LOCATION: near BH-85-02
APPROX. SITE COORDINATES (ft.):
N 10893 E 21305
GROUND ELEVATION (ft. MSL)
DATE EXCAVATED: 9/10/85
BACKHOE TYPE: Deere, 690-B 24" shovel
CONTRACTOR: Crowley Construction
FIELD REP.: J. Krabacher & C. Ridolfi
REHAB. DATE: 9/10

GROUNDWATER LEVELS			
DATE	TIME	DEPTH(ft.)	EST. FLOW (gpm)
		N/A	

LOCATION DESCRIPTION CARBONATE PILE ~21' N-NE of BH85-02
SITE DESCRIPTION level, scattered grass

DEPTH (ft.)	SAMPLE INT.	SAMPLE TYPE	SAMPLE ID	UNIFIED SOIL CLASS.	VISUAL CLASS.: DENSITY, COLOR, STRENGTH, PLASTICITY, CONDITION, ETC.
1		D	MKB 787	CL	cover, dk. brown, clay w/sand, a few cobbles 1'-2' some cobbles & small boulders
2					
3		D	MKB 788	SP	Tailings, lt. brown, sand [sample @ 3'= sand]
4		D	MKB 789	SC	Slimes, [sample @ 4'= sand] clay, plastic
5					
6		D	MKB 790		intermixed-thin beds, some reddish, dark (almost black), brown, tan [sample @ 6'=slime]
7					
8					
9					
10					

COMMENTS: stopped @ 7-0' - collected all 4 required samples.

SAMPLE TYPE
B — UNDISTURBED BLOCK SAMPLE
D — DISTURBED BULK SAMPLE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-01
APPROX. SITE COORDINATES (ft.):
N 11,060 N E 21,250
GROUND ELEVATION (ft. MSL) 6893.2
DRILLING METHOD: 7¼" HSA, 3" & 2½" Split Barrel, 3" Shelby
DRILLER: Lincoln Drilling
DATE STARTED: 9/3/85
DATE COMPLETED: 9/3/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
9/3/85	1600	51.0'

LOCATION DESCRIPTION Carbonate Pile
SITE DESCRIPTION scattered grass cover

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0				A				CL	silty clay, lo-med pl., brn., minor roots (COVER)
2									(tailings)
4								SP	sand, fine, lt. gray/tan
	X	X	X	U	MKB 651	5,8,6,6 (2.0")			
6	X	X	X	T	MKB 652				
8	X	X	X	U	MKB 653	8,14,16,14 (3.0")			8.0' — 1" layer slime (ML) silt, brn/purple
10	X	X	X	U	MKB 654	5,8,8,18 (3.0")			11.0' — 4" layer slime (ML) silt, brn/purple
12				A					11.5' — interbedded layers of sand and slimes approx. 1/8" thickness
14	X	X	X	U	MKB 655	3,5,5,6 (2.0")			14-16' — interbedded layers of sand and slimes approx. 1/8" layers
16				A					
18									19.0' interbedded layers of sand and slimes approx. 1/16-1/8", dk gray, moist
20	X	X	X	U	MKB 656	4,8,11,12 (3.0")			20.0' sand, fine, red, moist
22				A					

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-01
APPROX. SITE COORDINATES (ft.):
N 11,060 E 21,250
GROUND ELEVATION (ft. MSL) 6897.2
DRILLING METHOD: 3¼" HSA, 3" & 2½" Split Barrel, 3" Shelby
DRILLER: Lincoln Dollard
DATE STARTED: 9/3/85
DATE COMPLETED: 9/3/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
9/3/85	1600	51.0'

LOCATION DESCRIPTION Carbonate Pile
SITE DESCRIPTION scattered grass cover

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
22				A				SP	sand, fine, lt. gray/brn
24	X	X	X	U	MKB 657	3,5,6,8 (2.0")			24-26'- interbedded layers of sand and slimes, approx 1/16", moist (ML) silt, brn/purple, sand, fine, lt. brn
26				A					26' – red, sand, fine
28									29-29.5' sand, fine, red, interbedded slimes 1/16"-1/4", minor pieces of wood
30	X	X	X	U	MKB 658	6,12,15,13 (3.0")			29.5'-31' sand, fine, green/brn
32				A					34' – sand, fine, brn, moist
34	X	X	X	U	MKB 659	5,9,17,20 (3.0")			34'2" interface
36				A				CL	clay, med pl., dk brn., major roots ≈ 1/8" dia. moist
38									
40									
50									52.0
60									TD = 52.0' refusal Dakota Sandstone?

COMMENTS:

SAMPLE TYPE
A – AUGER CUTTINGS
B – 2" O.D. 1.38" I.D. DRIVE SAMPLE
U – 3" O.D. 2.42" I.D. TUBE SAMPLE
T – 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MEAP-85-02
APPROX. SITE COORDINATES (ft.):
N 10,880 E 21,300
GROUND ELEVATION (ft. MSL): 6892.5
DRILLING METHOD: 7¼" HSA, 2 & 3" Split Barrel, 3" Shelby
DRILLER: Lincoln Delong
DATE STARTED: 9/3/85
DATE COMPLETED: 9/3/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: Carbonate Pile
SITE DESCRIPTION: scattered glass cover

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U	MKB 660	4,10,15,50/4" (2.0')		CL	silty clay, med pl, brn trace roots (cover)
2	X	X	X	T	MKB 661	Shelby			2.0'
4	X	X	X	U	MKB 662	3,3,3,3 (3")		SP	sand, fine, lt. brn/gray (tailings)
6				A				ML/CL	clayey silt, brn, moist
8									
10	X	X	X	U	MKB 663	3,3,4,2 (2")		SP	sand, fine, lt. brn/gray thin beds of sand/silt ≈ 1/16"
12				A					
14	X	X	X	U	MKB 664	5,7,13,16 (3")			14.5 – 2" layer (CL) layer, purple/brn
16				A					
18	X	X	X	U	MKB 665	4,8,7,8 (2.0')			18'-21' – interbedded silts and sand ≈ 1/16"
20				A					
22									

COMMENTS:

SAMPLE TYPE
A – AUGER CUTTINGS
B – 2" O.D. 1.38" I.D. DRIVE SAMPLE
U – 3" O.D. 2.42" I.D. TUBE SAMPLE
T – 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-02
APPROX. SITE COORDINATES (ft.):
N 10,880.0 E 21,300.0
GROUND ELEVATION (ft. MSL) 6696.5
DRILLING METHOD: 7 1/4" HSA, 2" & 3" Split Barrel, 3" Shelby
DRILLER: Lincoln Drilling
DATE STARTED: 9/3/85
DATE COMPLETED: 9/3/85
FIELD REP.: Jonson Tinutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Carbonate Pile
SITE DESCRIPTION Scattered grass cover

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
24	X	X	X	U	MKB	4,4,4,4		CL/ML	clayey silt, low pl, red/gray
26				↓	666	(3")			
				A					
28				↓					
									29-31' interbedded sands and silts ~ 1/16"
30	X	X	X	B		4,7,7,6			
				↓	667	(2")		SP	sand, fine, gray
32				A					
				↓					
34									
	X	X	X	U	MKB	9,14,15,19			
36				↓	668	(3")			
				A					
38				↓					39' - sand very wet
40	X	X	X	B	MKB	3,5,6,8			
				↓	669	(2")			
42				A					
				↓					
44	X	X	X	U	MKB	5,12,16,15			
46				↓	670	(3")			
48									

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-8502
APPROX. SITE COORDINATES (ft.):
N 10,890.0 E 21,300.0
GROUND ELEVATION (ft. MSL) 6898.5
DRILLING METHOD: 7 1/4" HSA 2 + 3" Split Barrel
DRILLER: Lincoln Drury
DATE STARTED: 9/3/85
DATE COMPLETED: 9/3/85
FIELD REP.: Susan Knitter

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Carbonate Pile
SITE DESCRIPTION Scattered grass

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
~~49~~				A				SP	Sand, fine, gray (tailings)
50	X	X	X	U	MKB 671	2,3,4,5 (2")			
				↓					50.7' interface
~~52~~				A				OL	silty clay, med pl, blk, dk brn, wood c
									TD = 52.0' refusal

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-03
APPROX. SITE COORDINATES (ft.):
N 10882.0 E 21011.0
GROUND ELEVATION (ft. MSL) 6571.5
DRILLING METHOD: 7¼" HSA, 2 & 3" Split Barrel, 3" Shelby
DRILLER: Lincoln DeVore
DATE STARTED: 9/5/85
DATE COMPLETED: 9/5/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: Carbonate Pile.
SITE DESCRIPTION: Scattered grass, large cobbles

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X			U		12,22,18,15 (2")		SP	silty sand, fine, brn trace gravel, roots clay (cover)
2	X			↓					3.0' interface
	X	X	X	T	mkB			SP	sand, fine, brn (tailings)
4	X	X	X	↓	749				4.0' interface
	X	X	X	U	mkB	8,16,30,30 (3")			
	X	X	X	↓	750			CL	silty clay, med pl., dk brn. trace gravel, carbonaceous material, roots
6	X	X	X	U	mkB	3,8,10,15 (2")			
	X	X	X	↓	751				
8	X	X	X	U	mkB	4,9,13,20 (2").			
	X	X	X	↓	752				
10				A					
12				↓					
14									
16									TD=15.0'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRFP-85-04
APPROX. SITE COORDINATES (ft.):
N 11890 E 21,740
GROUND ELEVATION (ft. MSL) 6875.9
DRILLING METHOD: 3 1/4" HSA, 2 1/2" Split Barrel, 3" Shelby
DRILLER: Lincoln DeYoung
DATE STARTED: 9/4/85
DATE COMPLETED: 9/4/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Vanadium Pile
SITE DESCRIPTION Scattered grass cover

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X			U		5/4"		Sm	silty sand, fine, reddish brn, trace clay
									1.5' interface
2	X	X	X	U	MKB 681	5,6,5,4 (2")		SP	sand, fine, brn, moist (tailings)
4	X	X	X	T	MKB 682				
6				A				CL/ML	clayey silt, brn moist
8	X	X	X	U	MKB 683	2,2,2,2 (3")			8-10' silt interbedded w/sand 1/8"-2"
10	X	X	X	U	MKB 684	3,4,8,16 (3")			10.5' interface
								OL	silty 11.0 clay, blk, wood, roots
12	X	X	X	U	MKB 685	5,9,12,15 (2")		CL	12-14' - clay, red ft., green/gray
14				A					
16									21' = pieces of sandstone, shale
29									TD = 29.0'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

N

SITE: Monticello LOCATION: MRAP - 85-05
APPROX. SITE COORDINATES (ft.):
N 11150.0 E 21906.0
GROUND ELEVATION (ft. MSL) 6574.6
DRILLING METHOD: 7 1/4" HSA, 2 & 3" Split Barrel, 3" Shelby
DRILLER: Lincoln Nevada
DATE STARTED: 9/4/85
DATE COMPLETED: 9/4/85
FIELD REP.: Susan Kimson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Vanadium Pile
SITE DESCRIPTION scattered grass cover

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U	MKB	7,17,11,9		CL	silty clay, med pl, red/brn minor roots
2	X	X	X	↓	675	(2")			
	X	X	X	U	MKB				
4	X	X	X	↓	676				
	X	X	X	U	MKB	7,8,11,12			
6	X	X	X	↓	677	(3")			5.7'
	X	X	X	T	MKB			CL	silty clay, med pl, brn. moist (tailings)
8	X	X	X	↓	678				8.0' interface
	X	X	X	U	MKB	4,6,11,18		OL	silty clay, med pl, blk
10	X	X	X		679	(3")			9.6
	X	X	X		MKB			CL	10.8' - 2" layer organic, blk clay
12	X	X	X	↓	680	8,15,13,20 (3")			clay, med pl, brn minor roots minor carbonaceous material
				A					
14									trace shale frag.
									(mancos)
16									
18									
				↓					
20									TD = 19.0'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-06
APPROX. SITE COORDINATES (ft.):
N 10870.0 E 222 50.0
GROUND ELEVATION (ft. MSL) 6856.9
DRILLING METHOD: 3½" HSA, 2 + 3" Split Barrel, 3" Shelby
DRILLER: Lincoln DeLore
DATE STARTED: 9/5/85
DATE COMPLETED: 9/5/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION East Tailings Pile
SITE DESCRIPTION Scattered grass cover

DEPTH (ft.)	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X			U		14,14,13,13 (2")		CL	clay, med pl, brn, minor roots, trace rock frag - porphyry (cover)
2	X			T	MKB 689				2.0' interface
4	X	X	X	U	MKB 690	6,7,8,9 (3")		SP	(tailings) sand, fine, lt. brn
6	X	X	X		MKB 691	5,5,5,5 (3")			2-3.5' - interbedded silts and sand silt, lt brn / reddish brn 2 1/8"
8	X	X	X	U	MKB 692	1,2,2,3 (2")			
10	X	X	X	U	MKB 693	4,4,5,6 (3")			13' - silts, reddish brn, 1" thick 14' - silts, reddish, brn 1" thick
12	X	X	X	U	MKB 694	2,3,2,3 (2")			14.6' - coarse sand, wet
14	X	X	X	U	MKB 695	3,5,7,7 (3")			14.9' interface
16	X	X	X	U	MKB 696	2,4,4,4 (2")		OL	silty clay, med pl, blk, roots 16.0'
18	X	X	X	A				CL	clay, med pl, brn
20									
34									29.0'
								GP	gravel
									TD = 34.0'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-07
APPROX. SITE COORDINATES (ft.): N 70750.0 E 22680.0
GROUND ELEVATION (ft. MSL) 6848.6
DRILLING METHOD: 7 1/4" HSA, 2" 3" Split Barrel, 3" Shelby
DRILLER: Lincoln Novak
DATE STARTED: 9/5/85
DATE COMPLETED: 9/5/85
FIELD REP.: Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION East Tailings Pile
SITE DESCRIPTION Scattered vegetation

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X			U		8,12,14,12 (2")		CL	sandy clay, med pl, brn (cover)
2	X			↓					1.5' interface
	X	X	X	T	mkB			SP	sand, fine # brn/gray (tailings)
4	X	X	X	↓	697				
	X	X	X	U	mkB	3,3,3,3 (6")			4.8' - iron staining
	X	X	X	↓	698				
6				A					
8									
				↓					
10	X	X	X	U	mkB	2/24" (2")			
	X	X	X	↓	699				
12				A					
								CL/ML	clayey silt, brn, very moist
14				↓					
	X	X	X	U	mkB	9,1,1,2 (3")			
16	X	X	X	↓	700				
				A					
18									
				↓					
20	X	X	X	U	mkB	1,1,1,1 (2")			19-21. - brn/green color
	X	X	X	↓	701				
22				A					
24				↓					

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-07
APPROX. SITE COORDINATES (ft.):
N 10750.0 E 22660.0
GROUND ELEVATION (ft. MSL) 6548.6
DRILLING METHOD: 7 1/2 HSA, 2 1/2 Split Barrel
DRILLER: Lincoln Service
DATE STARTED: 9/5/85
DATE COMPLETED: 9/5/85
FIELD REP.: Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION East Tailings Pile
SITE DESCRIPTION Scattered grass cover

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
24	X	X	X	U	MKB 702	1,5,6,7 (3")		ML/CL	silty clay, med pl, brn/green
									24.75 interface
26	X	X	X	U	MKB 703	1,2,1,4 (2")		OL	26.0 silty clay, blk, roots
								~~ML~~	~~silts, blk~~
									26.5'
28				A				CL	clay, med, pl, dk brn. trace organics
30	X	X	X	U	MKB 704	4,10,9,9 (3")			30.0'
32				A				GP/CL	gravel/clay mixture gravel to 3" size
34									
36									
38									TD = 37.0'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

N

SITE: Monticello LOCATION: MRAP - 85-08
APPROX. SITE COORDINATES (ft.):
N 10,750.0 E 23140.0
GROUND ELEVATION (ft. MSL) 6849.9
DRILLING METHOD: 7 1/4" HSA, 2-3" split barrel 3" Shelby
DRILLER: Lincoln DeVore
DATE STARTED: 9/6/85
DATE COMPLETED: 9/6/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION East Tailings Pile
SITE DESCRIPTION scraped surface, UP material dump area

DEPTH Ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U		8,10,7,6 (2")			
2	X	X	X		MKB 711	4,5,4,4 (2")		SP	silty sand, fine, brn trace clay, roots
4	X	X	X			13,13,6,8 (2")			4-6' - clay increase red/brn shale pieces (cover) interface
6	X	X	X	U	MKB 712	6,7,11,10 (2")			7.0'
8				A				SP	sand, fine, brn, moist (tailings)
10	X	X	X	U	MKB 713	3,1,2,3 (3")			
12	X	X	X	T	MKB 714				
14	X	X	X	U	MKB 715	1,1,1,2 (3")		ML/GL	clayey silt, brn/gray 15' - white calcareous layer = 1/16"
16	X	X	X		MKB 716	1,2,2,7 (3")			
18	X	X	X		MKB 717	1,2,2,3 (3")			19.5'
20	X	X	X		MKB 718	3,2,2,2 (3")		SP	sand, fine, brn 20.5'
22	X	X	X	U	MKB 719	2,1,1,1 (2")		CL/ML	clayey silt, brn/reddish brn 23.0'
24	X	X	X					SP	sand, fine, brn

COMMENTS: 8-10' Shelby sample lost

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-08
APPROX. SITE COORDINATES (ft.):
N 6758.0 E 8346.0
GROUND ELEVATION (ft. MSL) 6849.9
DRILLING METHOD: 7 1/4" HSA, 2 & 3 Split Barrel, 3" Shelby
DRILLER: Lincoln Drilling
DATE STARTED: 9/6/85
DATE COMPLETED: 9/6/85
FIELD REP.: Susan Pinsky

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION East Tailings Pile
SITE DESCRIPTION Scraped Surface - VP material dump area

DEPTH ft	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
24	X	X	X	U	mKB 720	1,1,1,1 (2")		CL/ML	clayey silt, reddish brn
26				A					interface
28								OL	silty clay to clayey silt, blk, major organic
30	X	X	X	U	mKB 721	6,8,11,15			29.5'
32				A					
34								CL/ML	silty clay to clayey silt, brn/green
36									
38									
40									
									46'
50								GP	gravel
									TD = 50.0'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-09
APPROX. SITE COORDINATES (ft.):
N 11001.0 E 22850.0
GROUND ELEVATION (ft. MSL) 6558.3
DRILLING METHOD: 7¼" HSA 2 & 3" Split barrel 3" Shelby
DRILLER: Lincoln DeVore
DATE STARTED: 9/5/85
DATE COMPLETED: 9/5/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION East Tailings Pile
SITE DESCRIPTION scattered grass

DEPTH ft	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X			U		13,15,18,30 (2")		CL	sandy clay, med pl, brn. Some roots, gravel. with frag. (cover)
2	X								2.0' interface
	X	X	X		MKB 705	5,3,2,1 (2")		SP	sand, fine, brn (tailings)
4	X	X	X	↓					4.8'
	X	X	X	T	MKB 706			CL/ML	Silty clay, med pl. brn
6	X	X	X	↓					6.0'
	X	X	X	U	MKB 707	2,4,9,5 (3")		SP/CL	clay + sand layers thinly interbedded
8	X	X	X						8.0'
	X	X	X		MKB 708	1,2,2,3 (3")		CL/ML	clayey silt brn.
10	X	X	X						10.0' interface
	X	X	X		MKB 709	23,5,10 (3")		OL	silty clay, med pl., blk. major organics roots
12	X	X	X						11.5'
	X	X	X		MKB 710	4,14,20,30 (3")		CL	silty clay, med pl. brn
14				↓					
				A					
16									
18									
↓				↓					
36'									TD = 36.0'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

N

SITE: Monticello LOCATION: MRAP-85-10
APPROX. SITE COORDINATES (ft.):
N 10430.0 E 21790.0
GROUND ELEVATION (ft. MSL) 689.8
DRILLING METHOD: 7¼" HSA, 2-3" split barrel, 3" shelby
DRILLER: Lincoln Davis
DATE STARTED: 9/6/85
DATE COMPLETED: 9/6/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION: Acid Pile
SITE DESCRIPTION: scattered vegetation

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X			U		3,23,18,11 (2")		SP	silty sand, fine, brn, trace roots (cover) trace gravel - volc. porphyry
2	X			↓					2.5' interface
	X	X	X		MKB	3,9,2,3 (2")		SP	sand, fine, lt. brn (tailings)
4	X	X	X	↓	722				3.7'
	X	X	X	T	MKB			CL/ML	clayey silt to silty clay, brn.
6	X	X	X	↓	723				
				A					
8				↓					
10	X	X	X	U	MKB	9,6,4,6 (3")		SP	sand, fine, brn
	X	X	X	↓	724				
12				A					
				↓					
14									
	X	X	X	U	MKB	1,1,2,2 (3")		CL/ML	clayey silt to silty clay, brn
16	X	X	X	↓	725				
				A					
18				↓					
									Note: thin interbedded layers of sand 2 1/16"
20	X	X	X	U	MKB	1,2,2,2 (3")			
	X	X	X	↓	726				
22				A					
				↓					
24									

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-10
APPROX. SITE COORDINATES (ft.):
N 10430.0 E 21840.0
GROUND ELEVATION (ft. MSL) 6846.8
DRILLING METHOD: 7¼ HSA 2+3 Split Barrel 3" Shelby
DRILLER: Lincoln Divine
DATE STARTED: 9/6/85
DATE COMPLETED: 9/6/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Acid Pile
SITE DESCRIPTION Scattered vegetation

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
A. 24	X	X	X	U	MKB 727	1,2,2,2 (3")		CL/ML	clay silt, to silty clay, med pl., brn
26				A					Note: 24-26' thin interbedded layers of sand and silt. ≈ 1/16"
28									
30	X	X	X	U	MKB 728	1,1,3,6 (2")			30.2'
								CL	30.2-30.4 silty clay, med pl, white/purple non calcareous interface
32	X	X	X	U	MKB 729	5,8,10,14 (3")		SC	31.0' clayey sand, fine, brn
34				A				CL	32.0' silty clay, med pl, brn trace gravel 1/16" to 2" trace, organic, roots, carbonaceous material
36									
38									
40	X	X	X	U	MKB 730	10,33,43,33 (2")			41.0'
42				A				GP	gravel 42.0
44								CL	clay, med pl, brn
46									
									TD = 47.0

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

N

SITE: Monticello LOCATION: MRAP - 85-11
APPROX. SITE COORDINATES (ft.):
N 10180.0 E 21880.0
GROUND ELEVATION (ft. MSL) 6896.1
DRILLING METHOD: 7 1/4" HSA 2 & 3 Split Barrel, 3" Shelby
DRILLER: Lincoln Lefevre
DATE STARTED: 9/7/85
DATE COMPLETED: 9/7/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Acid Pile
SITE DESCRIPTION scattered grass cover

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0				U		9,16,35,16 (2")		SP	silty sand, fine, brn major roots trace gravel - volc porphery (cover)
2					MKB 740	7,8,9,10 (2")			2.5' interface
4				T	MKB 741			CL/ML	silty clay to clayey silt (tailings) reddish brn trace carbonaceous material interbedded with sand, fine, brn
6				U	MKB 742	1,1,1,2 (3")			8-9' - interbedded silt layers red, blk, yellow
8					MKB 743	2,1,1,1 (3")			10.5' - 1/16" carbonaceous layer
10					MKB 744	1,2,1,2 (3")			
12					MKB 745	1,1,2,3 (3")			
14					MKB 746	1,1,2,2 (3")			
16				U	MKB 747	1,2,2,3 (3")			
18				A					
20				U		1,2,1,2 (2")			
22				A					22.0' interface
24								GP	gravel

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-11
APPROX. SITE COORDINATES (ft.):
N 10190.0 E 21500.0
GROUND ELEVATION (ft. MSL) 6896.1
DRILLING METHOD: 7¼ HSA, 2-3 Spoon Barrel, 3" Shelby
DRILLER: Lincoln DeVore
DATE STARTED: 9/7/85
DATE COMPLETED: 9/7/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Acid Pits
SITE DESCRIPTION scattered grass cover

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
24				A				GP	gravel
									25.5
26								CL/ML	silty clay to clayey silt. dk brn/gray
28									
				↓					
30	X	X	X	U	MRB 748				
				↓					
32				A					
34									
36									
38									TD = 37.5'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T - 3" OD. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

N

SITE: Monticello LOCATION: MRAP - BS-12
APPROX. SITE COORDINATES (ft.):
N 6098.0 E 22001.0
GROUND ELEVATION (ft. MSL) 6897.4
DRILLING METHOD: 7 1/4 HSA, 2 1/2 Split Barrel, 3" Shelby
DRILLER: Lincoln Nelson
DATE STARTED: 9/7/85
DATE COMPLETED: 9/7/85
FIELD REP.: Susan Krutsen

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Acid Pile
SITE DESCRIPTION scattered vegetation

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X			U		5,22,20,8 (2")		SP	silty sand, fine, brn, trace roots (cover)
									2.0 interface
2	X								top 4" (SP) sand, fine, brn (tailings)
	X					5,2,2,3 (2")			
4	X			↓					
	X	X	X	T	MKB 732			CL/ML	silty clay to clayey silt, brn/purple/red
6	X	X	X	↓					
	X	X	X	U	MKB 733	2,2,2,2 (3")			
8	X	X	X						
	X	X	X		MKB 734	1,1,1,2 (3")			
10	X	X	X						
	X	X	X		MKB 735	2,1,1,2 (3")			10.5' - 3" sand layer (SP)
12	X	X	X						
	X	X	X	↓	MKB 736	1,1,3,9 (3")			interface
14									13.6
				U	MKB 737	3,5,5,5 (2")		CL	silty clay, med pl, dk brn
16				↓					16-18' intermixed dk brn clay and clayey silt (tailings?)
				U	MKB 738	3,3,5,6 (3")			
18				↓					
				A					
20									
									23.0'
								GP	gravel
27				↓					
									TD = 26.0'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T - 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

Page 1 of 1.

LOCATION MAP

N

SITE: Monticello LOCATION: MRAP-85-13
APPROX. SITE COORDINATES (ft.):
N 11326.5 E 21025.5
GROUND ELEVATION (ft. MSL) 6934.7
DRILLING METHOD: 7 1/4" HSA, 2 + 3 Split Barrel
DRILLER: Lincoln DeVora
DATE STARTED: 9/4/85
DATE COMPLETED: 9/4/85
FIELD REP.: Olson Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Mill Yard Area north slope next to fence line
SITE DESCRIPTION grass covered

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U	MKB 687	30, 50/5" (3")		CL	Sandy, silty clay, med pl. lt. brn minor roots trace gravel - porphery
2	X	X	X		MKB 686	15, 13, 13, 13 (3")		CL	2.0' silty clay, med pl., brn trace roots trace gravel - porphery trace shale pieces
4	X	X	X		MKB 688	9, 16, 22, 50 (3") 1"			
6				A		50 - refusal			TD = 9.0' refusal cobble?
8									
10									

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T - 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-14
APPROX. SITE COORDINATES (ft.):
N 11270.8 E 90400.0
GROUND ELEVATION (ft. MSL) 6482.4
DRILLING METHOD: 3 1/4" HSA, 2" Split Barrel
DRILLER: Lincoln DeVore
DATE STARTED: 9/8/85
DATE COMPLETED: 9/8/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Mill Area - NNW north of BLM compound
SITE DESCRIPTION Scattered grass cover

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U	MCB 761	11,20,20,17 (3")		SP	(OL) top 3" silty clay, blk; silty sand, fine, lt. brn, trace gravel-periphery
									1.0'
2	X	X	X		MCB 762	10,17,20,26 (3")		CL	silty clay, med pl, lt. brn, trace gravel, trace calcareous coating
4	X	X	X		MCB 763	11,15,20,24 (3")			6-8' clay becoming gray
6	X	X	X		MCB 764	12,19,18,24 (3")			
8	X	X	X		MCB 765	8,18,21,24 (3")			8-10' becomes less gray
10									TD = 10.0'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP - 85-15
APPROX. SITE COORDINATES (ft.):
N 10,113.0 E 28,534.5
GROUND ELEVATION (ft. MSL) 1064.3
DRILLING METHOD: 7½" HSA 3" Split Barrel
DRILLER: Lincoln Drilling
DATE STARTED: 6/9/85
DATE COMPLETED: 6/9/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Borrow Area - Sunderland Property
SITE DESCRIPTION scattered grass

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U	MKB			SP/GP	Sand, fine, lt. brn / gravel - porphyry
2	X	X	X	↓	770				2'
				A		25, 35/50/3" (3")			
4								CL	silty clay, med pl., lt. brn / gray
6									
8									9.5 - 9.75' fracture, iron oxide stains major roots
				↓					
10	X	X	X	U	MKB	29, 45, 50/3" (3")			
	X	X	X	↓	771				
12				A					
14				↓					
	X	X	X	U	MKB	27, 37, 33, 50/5" (3")			14-16' major roots
16	X	X	X	↓	772				17' - drilling got harder
				A					
18									
20									
22									
24				↓					

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

N

SITE: Monticello LOCATION: MRAP - 85-15
APPROX. SITE COORDINATES (ft.):
N 10115.0 E 28534.5
GROUND ELEVATION (ft. MSL) 6841.5
DRILLING METHOD: 4 1/4" HSA 2 & 3" split Barrel
DRILLER: Lincoln DeVore
DATE STARTED: 9/9/85
DATE COMPLETED: 9/9/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Borrow Area - Sunderland property
SITE DESCRIPTION scattered grass

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
24				U	MKB 773	50/3" (2")		CL	silty clay, med pl, lt brn/gray - mottled
26				A					
28									28' - drilling easier
30				U A	MKB 774	30, 50/3" (2")			29' - silty clay, med pl, dk brn, blk sandstone pieces
32									
34				U A	MKB 775	50/3" (2")			34 - trace carbonaceous material
36									35.5' TD = 35.5' refusal - sandstone

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

SITE: Monticello LOCATION: MRAP-85-16
APPROX. SITE COORDINATES (ft.):
N 9798.0 E 29447.0
GROUND ELEVATION (ft. MSL) 1020.0
DRILLING METHOD: 7¼" HSA 3" Split Barrel, 3" Shelby
DRILLER: Lincoln Devore
DATE STARTED: 9/9/85
DATE COMPLETED: 9/9/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Borrow Area - Sunderland Property
SITE DESCRIPTION Scattered grass cover

DEPTH	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0				A					
2				↓				SP	silty, clayey sand, fine, brn trace gravel - porphyry
	X			U		50/5.5" (3")			
4	X			↓					
				A					
6				↓					5.5'
								CL	silty clay, med pl, gray
8									
				↓					9-11' - mottled yellow/gray color
10	X	X	X	T	mkB				
	X	X	X	↓	776				
12				A					12.0'
				↓				SC	clayey sand, fine, gray/yellow
14									13.0' top 3" gray clay
	X	X	X	U	mkB	30, 50/2" (3")		CL	silty clay, med pl, gray/yellow mottled
16	X	X	X	↓	777				
				A					
18				↓					
20									TD = 19.0' - refusal sandstone

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

Page 1 of 1

LOCATION MAP

N

SITE: Monticello LOCATION: MRAP-85-17
APPROX. SITE COORDINATES (ft.):
N 10035.0 E 25005
GROUND ELEVATION (ft. MSL) 1675.2
DRILLING METHOD: 7 1/4" HSA 3" Split Barrel
DRILLER: Lincoln Devore
DATE STARTED: 9/8/85
DATE COMPLETED: 9/8/85
FIELD REP.: Susan Fenton

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Peripheral Property - Sommerville 200'N of creek
SITE DESCRIPTION tall grass cover

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U	MKB	25, 50/6"		CL	0.5' silty clay, med pl, dk brn, trace sand, roots
2	X	X	X		766	(3")		CL	silty clay, med pl, brn. trace gravel - poor ss, trace roots, sand
	X	X	X		MKB	11,15,12,16			2-4' increase of brn to gray color w/depth
4	X	X	X		767	(3")			
				A					
6									
8									
10									
12									
14									TD = 13.5'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

N

SITE: Monticello LOCATION: MRAP-ES-18
APPROX. SITE COORDINATES (ft.):
N 10365.8 E 23695.6
GROUND ELEVATION (ft. MSL) 6603.8
DRILLING METHOD: 3 1/4" HSA 3" Split Barrel
DRILLER: Lincoln Drilling
DATE STARTED: 9/8/85
DATE COMPLETED: 9/8/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)
9/8/85	1800	8.0'

LOCATION DESCRIPTION Peripheral Property - Pond Area Sommerville property
SITE DESCRIPTION no cover

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U	MKB 768	4,7,7 (3")		SP	1.6', silty sand, fine, brn some clay, roots
2	X	X	X	↓				OL	2.8', silty clay, med pl, blk, lg roots, wood
	X	X	X		MKB 769	15,10,15,22 (3")		SP	4.0', sand, fine, brn trace gravel - pebbles to 2" size
4	X	X	X	↓					
				A					
6				↓				GP	gravel
8				↓					
10									TD = 9.0'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

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LOCATION MAP

N

SITE: Monticello LOCATION: MRAP - 85-19
APPROX. SITE COORDINATES (ft.):
N 9360.0 E 21405.0
GROUND ELEVATION (ft. MSL) 6937.2
DRILLING METHOD: 7¼" HSA, 3" Split Barrel
DRILLER: Lincoln DeVore
DATE STARTED: 9/8/85
DATE COMPLETED: 9/8/85
FIELD REP.: Susa Kruter

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Peripheral Property - Christensen property
SITE DESCRIPTION grass cover, gully drainage

DEPTH Ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U	MKB	4, 8, 11, 11 (3")			
2	X	X	X		759			SC	clayey sand, fine, brn trace silt trace gravel
	X	X	X		MKB	9, 18, 27, 36 (3")			
4	X	X	X	V	760				2-3 dk brn
				A					
6									TD = 5.0'

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

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LOCATION MAP

N

SITE: Monticello LOCATION: MRAP-85-20
APPROX. SITE COORDINATES (ft.):
N 10760.0 E 20705.0
GROUND ELEVATION (ft. MSL) 6871.3
DRILLING METHOD: 7¼" HSA 3" Split Barrel
DRILLER: Lincoln DeVore
DATE STARTED: 9/8/85
DATE COMPLETED: 9/8/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Peripheral Property - BLM compound
SITE DESCRIPTION Scattered grass

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U	MKB	2,10,15,20 (3")		CL	silty clay, med pl, dk brn trace sand, gravel roots, carbonaceous material
2	X	X	X		753				
	X	X	X		MKB	9,16,20,23 (3")			
4	X	X	X		754				
				A					
6									TD=5.0'

OMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

LOCATION MAP

N

SITE: Monticello LOCATION: MRAP-85-21
APPROX. SITE COORDINATES (ft.):
N 10166.0 E 40205.0
GROUND ELEVATION (ft. MSL) 1684.8
DRILLING METHOD: 3 1/4" HSA 3" Split Barrel
DRILLER: Lincoln DeLong
DATE STARTED: 9/5/85
DATE COMPLETED: 9/5/85
FIELD REP.: Susan Knutsen

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Peripheral Properties - west of BLM compound - roadside
SITE DESCRIPTION grass cover, west embankment of dirt road

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U	MKB 756	6,13,13,15		SP	0.5' clayey sand, fine, brn, roots
2	X	X	X	↓				CL	2.0' silty clay, med pl, gray/brn, trace gravel, shale pieces
4	X	X	X	↓	MKB 757	14,25,8,11		SP	Sand, fine, reddish brn (tailings)
				A					
6	X	X	X	U	MKB 758	6,6,7,8			
8				A				CL	clay, brn
10				↓					10.0'
12				↓				GP	gravel
14									TD = 13.0' refusal

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

ALLIED BENDIX AEROSPACE
BENDIX FIELD ENGINEERING CORPORATION
BOREHOLE LOG (SOIL)

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LOCATION MAP

N

SITE: Monticello LOCATION: MRAP-85-25
APPROX. SITE COORDINATES (ft.):
N 11106.5 E 20691.0
GROUND ELEVATION (ft. MSL) 6912.1
DRILLING METHOD: 7¼" HSA, 3" Split Barrel
DRILLER: Lincoln Tevora
DATE STARTED: 9/4/85
DATE COMPLETED: 9/4/85
FIELD REP.: Susan Knutson

GROUNDWATER LEVELS		
DATE	TIME	DEPTH (ft.)

LOCATION DESCRIPTION Mill Area
SITE DESCRIPTION scattered grass, cement

DEPTH ft.	SAMPLE INTERVAL	SAMPLE RECOVERY	SAMPLE RETAINED	TYPE	ID	BLOWS Per 6"	N VALUE	USCS	VISUAL CLASSIFICATION
0	X	X	X	U	MKB	5,13,18,25			0-0.5' sandy clay, med pc, brn
2	X	X	X		672	(3")		CL	0.5 → silty clay, med pc, brn. minor roots ss pieces
	X	X	X		MKB	12,31,50/4			
4	X				673	(3")			2' - wood pieces
	X								
6	X					50/4"			TD = 6.0' refusal cobble?
	X					50/0 refusal			
8	X			↓					

COMMENTS:

SAMPLE TYPE
A — AUGER CUTTINGS
B — 2" O.D. 1.38" I.D. DRIVE SAMPLE
U — 3" O.D. 2.42" I.D. TUBE SAMPLE
T — 3" O.D. THIN-WALLED SHELBY TUBE

Appendix B

BOREHOLE GEOPHYSICAL LOGS AND DATA

Three logging systems were used at the Monticello, Utah, site—two total-count tools (PRS-1 RASCAL) and a spectral tool (Compulogger). Only the main log is presented in this appendix, since the main and repeat logs agree. Borehole data with each system, in cased boreholes, are presented below. Equipment characteristics and calibration information are included to document the parameters used in data reduction.

Uncertainties for the total-count system were calculated at a 95 percent confidence level (2σ). Water was not encountered in several boreholes as indicated by the fluid-level depth of 99.0 feet, a default value, shown in the tables and on the geophysical logs. The auger height shown on each log indicates the distance measured from the top of the auger to the ground surface.

LOGGING EQUIPMENT DATA

INSTRUMENT	COMPULOGGER	CASING FACTOR*	1.33 ± 0.01	
GJO NUMBER	C-1815S	FLUID FACTOR†	1.10 ± 0.07	
SERIAL NUMBER	230-01	MOISTURE FACTOR‡	1.10 ± 0.01	
DETECTOR	NaI(Tl)	K FACTOR (Ra-226)§	7.61 ± 0.22	g-cps/pCi (Ra-226)
DETECTOR SIZE	2 in. x 6 in.	BACKGROUND COUNT RATE	30.05 ± 12.25	cps
PROBE DIAMETER	2.65 in.	ALPHA FACTOR	3.20 ± 0.32	ft^{-1}
CALIBRATION DATE	23 August 1985			
INSTRUMENT	PRS-1/SPA-3	CASING FACTOR*	1.73 ± 0.02	
GJO NUMBER	C-3572S	FLUID FACTOR†	1.04 ± 0.07	
SERIAL NUMBER	753	MOISTURE FACTOR‡	1.10 ± 0.01	
DETECTOR	NaI(Tl)	K FACTOR (Ra-226)§	79.87 ± 1.36	g-cps/pCi (Ra-226)
DETECTOR SIZE	2 in. x 2 in.	BACKGROUND COUNT RATE	195.23 ± 76.61	cps
PROBE DIAMETER	2.5 in.	ALPHA FACTOR	3.20 ± 0.32	ft^{-1}
CALIBRATION DATE	23 August 1985			
INSTRUMENT	PRS-1/SPA-3	CASING FACTOR*	1.69 ± 0.02	
GJO NUMBER	C-3958S	FLUID FACTOR†	1.05 ± 0.03	
SERIAL NUMBER	813	MOISTURE FACTOR‡	1.10 ± 0.01	
DETECTOR	NaI(Tl)	K FACTOR (Ra-226)§	76.72 ± 0.89	g-cps/pCi (Ra-226)
DETECTOR SIZE	2 in. x 2 in.	BACKGROUND COUNT RATE	194.31 ± 53.89	cps
PROBE DIAMETER	2.5 in.	ALPHA FACTOR	3.20 ± 0.32	ft^{-1}
CALIBRATION DATE	22 August 1985			

*Based on casing thickness of 0.25 in.

†Based on hole diameter of 4.5 in.

‡Based on average subsurface moisture content of 9.1 ± 4.2 percent.

§Based on average Th-232 concentration of 10.0 ppm and average K concentration of 2.0 percent.

APPARENT RADIUM-226 CONCENTRATION MRP-001

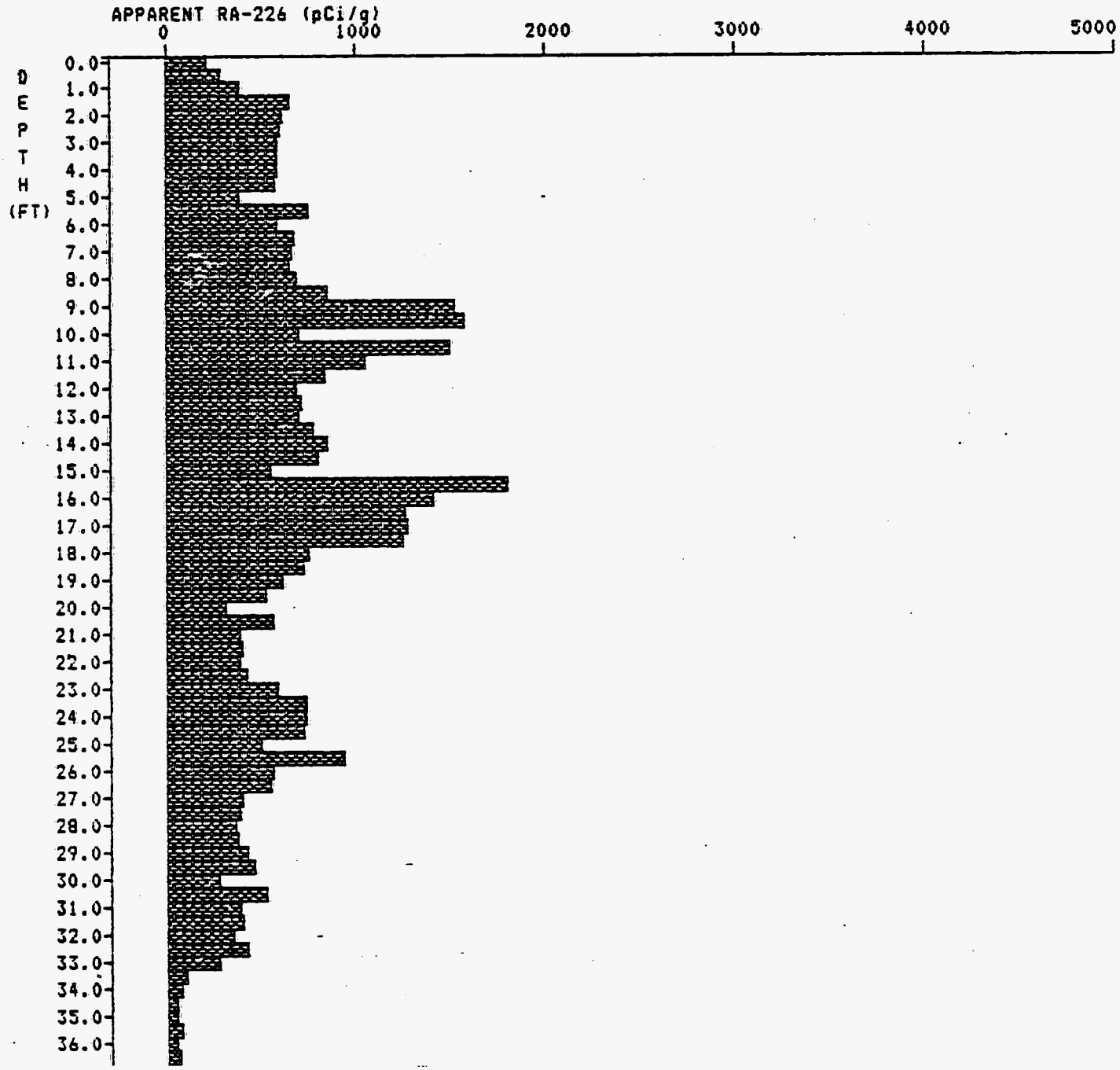
PROJECT: M R A P

START DATE: 850903

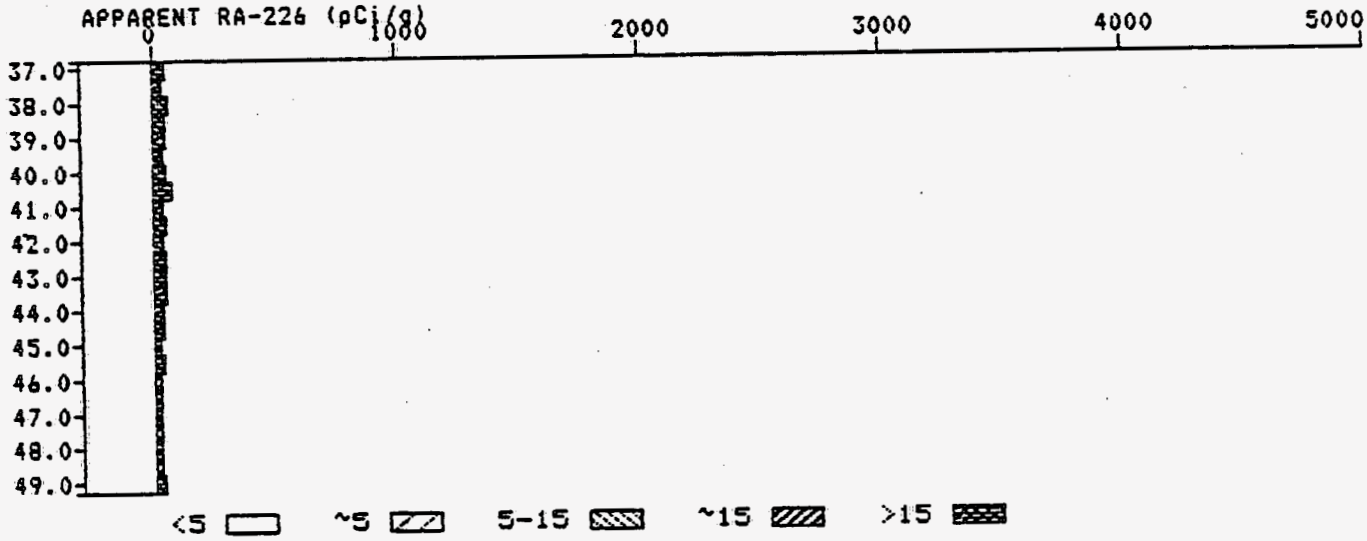
HOLE NUMBER: 001
LOCATION: 11060.0N 21250.0E
FLUID LEVEL: 36.5 FT.
PHASE: 1

DATE DRILLED: 850903
ELEVATION: 6897.2 FT.
AUGER HEIGHT: 54.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-001



APPARENT RADIUM-226 CONCENTRATION MRP-001

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1193.5	208.6	14.5
0.5	1399.7	> 283.6	22.8
1.0	2351.2	> 385.2	28.5
1.5	3501.3	> 647.7	51.6
2.0	3693.1	> 608.9	39.7
2.5	3584.8	> 596.4	37.0
3.0	3513.2	> 581.8	35.9
3.5	3483.6	> 580.7	35.8
4.0	3452.7	> 579.7	35.8
4.5	3330.1	> 574.7	37.2
5.0	2703.0	> 376.4	63.0
5.5	3019.6	> 744.3	77.6
6.0	3642.6	> 582.2	52.0
6.5	3872.9	> 663.1	44.1
7.0	3978.3	> 661.2	41.1
7.5	3994.6	> 643.7	41.1
8.0	4346.3	> 679.5	47.6
8.5	5507.0	> 841.7	64.8
9.0	8107.1	> 1522.6	125.2
9.5	8580.7	> 1569.1	120.8
10.0	5657.3	> 694.7	174.1
10.5	5791.8	> 1487.7	177.6
11.0	6336.5	> 1047.4	94.4
11.5	5118.1	> 830.1	58.7
12.0	4328.5	> 686.6	47.1
12.5	4204.5	> 703.0	43.8
13.0	4245.2	> 687.6	43.4
13.5	4568.4	> 768.1	47.0
14.0	4904.5	> 841.2	52.4
14.5	4834.7	> 795.7	50.0
15.0	4517.3	> 549.5	139.4
15.5	6821.5	> 1792.6	217.9
16.0	8425.3	> 1408.4	120.1
16.5	7700.0	> 1257.6	83.9
17.0	7421.6	> 1262.7	78.0
17.5	6952.7	> 1243.1	85.6
18.0	5083.5	> 749.5	69.5
18.5	4221.6	> 720.3	49.2
19.0	3684.5	> 612.0	38.7
19.5	3060.9	> 516.4	32.8
20.0	2202.9	> 304.4	52.1
20.5	2251.7	> 562.1	61.8
21.0	2456.4	> 385.2	38.5
21.5	2339.0	> 387.7	27.2
22.0	2364.1	> 375.3	25.8
22.5	2646.6	> 413.1	29.5
23.0	3430.5	> 583.6	36.9
23.5	4173.4	> 726.8	47.2
24.0	4354.8	> 735.7	45.6
24.5	4186.5	> 719.5	45.9
25.0	3422.4	> 497.2	72.2
25.5	3631.6	> 930.0	106.3
26.0	3630.8	> 556.0	63.2
26.5	3108.5	> 538.4	40.7
27.0	2552.0	> 393.9	30.6
27.5	2318.8	> 386.4	25.4
28.0	2232.7	> 362.3	23.6
28.5	2253.0	> 364.1	23.7
29.0	2461.6	> 420.0	27.0
29.5	2545.0	> 452.6	32.3
30.0	1983.5	> 273.9	47.2
30.5	2081.9	> 514.9	55.4
31.0	2379.4	> 382.2	34.6
31.5	2300.6	> 389.5	26.7
32.0	2179.5	> 345.8	23.8
32.5	2245.5	> 421.4	36.3
33.0	1651.5	> 270.2	20.3
33.5	801.3	99.2	18.1
34.0	441.1	65.8	8.9
34.5	329.8	47.7	5.8
35.0	281.2	40.9	6.1
35.5	290.1	67.7	8.3
36.0	305.9	42.3	6.8
36.5	289.6	53.5	8.6

APPARENT RADIUM-226 CONCENTRATION MRP-001

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
37.0	269.1	45.0	8.0
37.5	232.4	33.0	7.7
38.0	278.4	52.5	8.8
38.5	281.8	47.3	8.2
39.0	264.3	45.4	7.7
39.5	238.5	36.8	7.2
40.0	236.9	38.8	7.9
40.5	260.3	69.0	11.5
41.0	249.5	35.0	9.1
41.5	244.8	44.0	7.6
42.0	237.1	37.1	7.0
42.5	248.8	43.0	7.2
43.0	257.6	45.3	7.4
43.5	233.4	37.9	6.8
44.0	213.1	36.8	6.4
44.5	176.1	26.5	5.6
45.0	148.9	24.1	5.3
45.5	129.9	30.0	5.7
46.0	121.7	15.2	4.9
46.5	126.0	20.7	4.4
47.0	127.4	19.4	4.2
47.5	121.7	17.8	4.1
48.0	124.6	19.6	4.2
48.5	121.2	13.0	5.0
49.0	188.0	30.6	4.0

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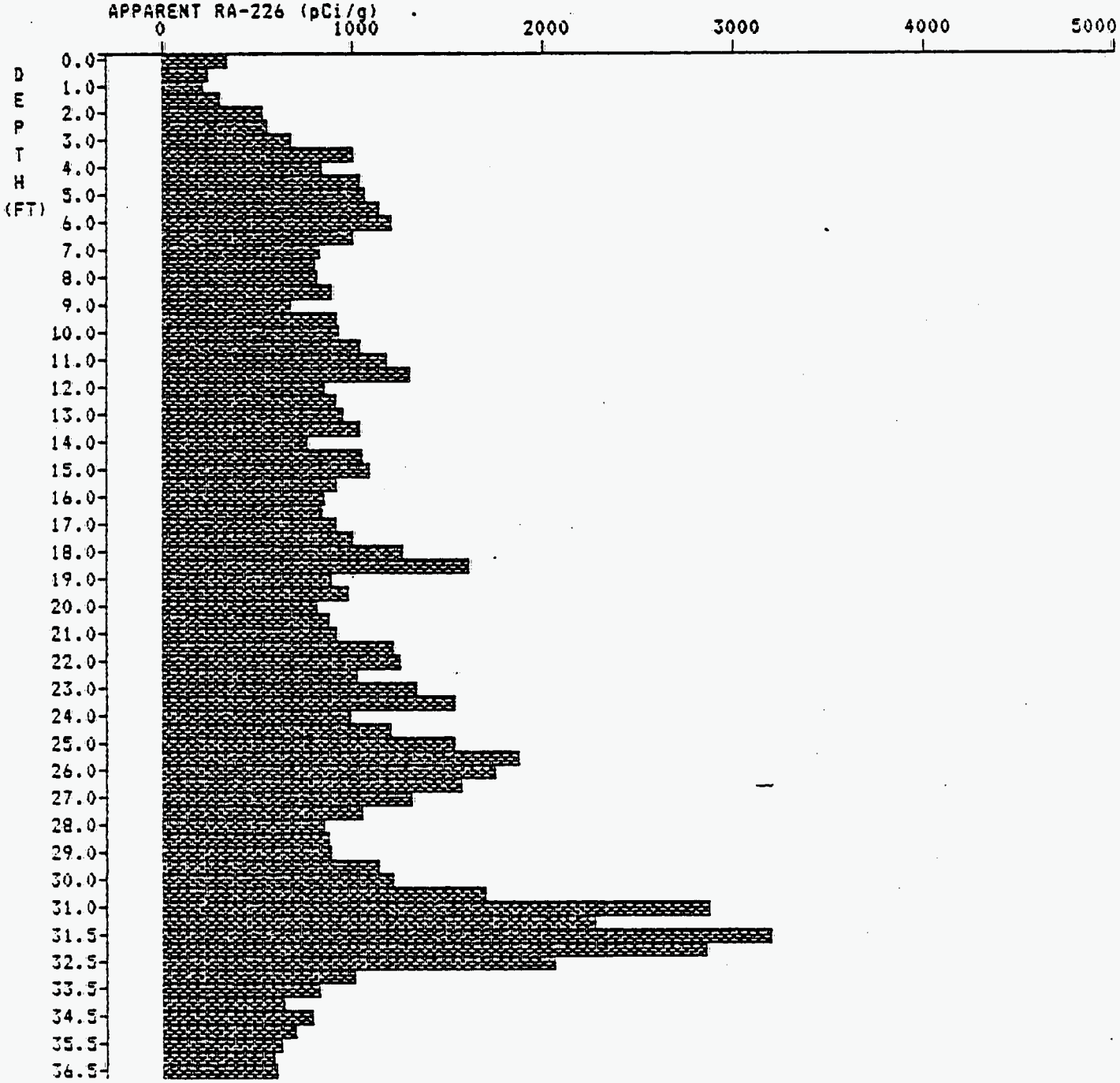
APPARENT RADIUM-226 CONCENTRATION MRP-002

PROJECT: M R A P
START DATE: 850903

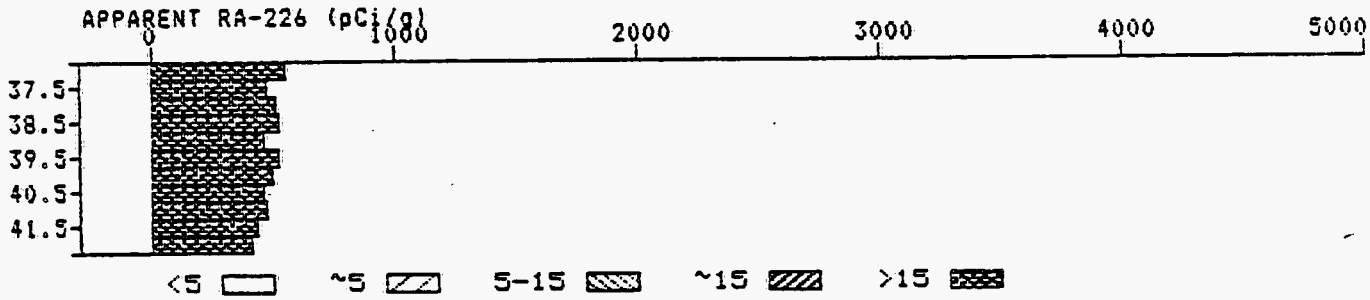
HOLE NUMBER: 002
LOCATION: 10880.0N 21300.0E
FLUID LEVEL: 11.5 FT.
PHASE: 1

DATE DRILLED: 850904
ELEVATION: 6898.5 FT.
AUGER HEIGHT: 16.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-002



APPARENT RADIUM-226 CONCENTRATION MRP-002

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	2021.6	> 334.7	20.2
0.5	1532.5	228.3	19.2
1.0	1418.0	204.8	20.4
1.5	1890.1	> 288.0	22.8
2.0	2911.0	> 524.5	38.3
2.5	3454.1	> 547.3	37.2
3.0	4098.1	> 673.5	45.4
3.5	4341.8	> 988.5	85.9
4.0	4838.6	> 825.5	85.6
4.5	5946.1	> 1033.2	70.1
5.0	6384.5	> 1059.3	64.6
5.5	6673.7	> 1125.1	67.5
6.0	6829.9	> 1198.0	77.1
6.5	6034.4	> 991.3	60.9
7.0	5131.4	> 821.3	52.6
7.5	4843.9	> 799.8	48.9
8.0	4792.9	> 811.4	51.8
8.5	4029.7	> 875.5	69.1
9.0	4062.9	> 664.6	77.5
9.5	5145.2	> 905.1	64.1
10.0	5641.1	> 919.8	57.6
10.5	6179.4	> 1032.0	61.9
11.0	6831.5	> 1164.1	76.0
11.5	6486.4	> 1289.2	162.7
12.0	5204.9	> 841.9	143.0
12.5	4910.8	> 904.9	127.1
13.0	5038.2	> 937.7	130.3
13.5	4299.1	> 1035.0	145.2
14.0	4274.2	> 762.0	142.7
14.5	5359.0	> 1046.9	142.2
15.0	5693.7	> 1082.4	144.6
15.5	5110.9	> 908.5	129.9
16.0	4681.8	> 838.6	119.1
16.5	4644.9	> 827.8	117.3
17.0	5008.3	> 907.0	125.1
17.5	5620.1	> 998.3	140.2
18.0	6589.8	> 1251.4	168.9
18.5	6174.0	> 1604.3	227.4
19.0	5158.0	> 885.2	185.5
19.5	5032.4	> 965.4	139.7
20.0	4664.8	> 802.6	121.9
20.5	4760.2	> 867.0	120.3
21.0	5183.0	> 904.0	130.6
21.5	6245.8	> 1210.2	159.3
22.0	6624.6	> 1249.2	166.5
22.5	6140.4	> 1016.6	163.0
23.0	6840.8	> 1329.4	179.8
23.5	6157.5	> 1526.9	212.9
24.0	5661.4	> 984.9	196.1
24.5	6615.2	> 1189.3	173.1
25.0	8239.8	> 1535.0	205.0
25.5	9641.1	> 1872.8	245.4
26.0	9441.9	> 1745.0	237.0
26.5	8475.4	> 1573.7	215.2
27.0	7150.0	> 1300.6	182.9
27.5	5842.2	> 1046.9	150.9
28.0	4817.3	> 846.9	129.8
28.5	3869.0	> 871.8	129.3
29.0	4572.0	> 883.4	141.6
29.5	6066.0	> 1125.4	153.0
30.0	7172.0	> 1208.2	184.2
30.5	9672.0	> 1693.8	241.6
31.0	13855.0	> 2873.3	382.9
31.0	13855.0	> 2274.8	371.6
31.5	15774.0	> 3191.6	427.6
32.0	15009.0	> 2861.4	386.0
32.5	11130.0	> 2051.3	291.5
33.0	6418.0	> 1007.3	205.2
33.5	3656.0	> 815.4	136.5
34.0	3409.0	> 631.8	113.5
34.5	3980.0	> 779.5	106.8
35.0	3823.0	> 694.5	97.0
35.5	3439.0	> 617.8	87.5
36.0	3218.0	> 579.5	81.6
36.5	3162.0	> 589.9	80.2

APPARENT RADIUM-226 CONCENTRATION MRP-002

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
37.0	2970.0	> 542.3	75.1
37.5	2701.0	> 471.5	69.2
38.0	2673.0	> 502.1	69.7
38.5	2238.0	> 518.7	74.4
39.0	2376.0	> 459.4	74.1
39.5	2756.0	> 524.0	71.5
40.0	2724.0	> 498.8	68.8
40.5	2545.0	> 451.3	64.6
41.0	2526.7	> 473.7	64.3
41.5	2389.2	> 429.1	60.4
42.0	2262.6	> .411.8	35.6

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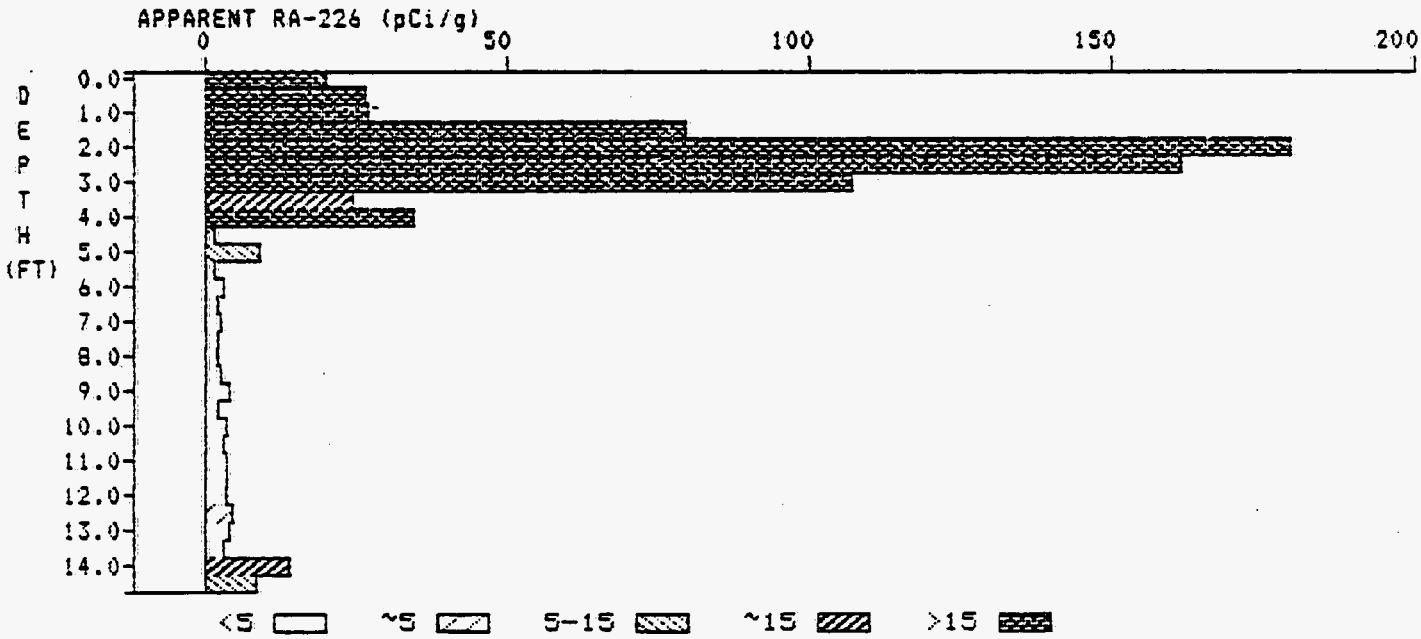
APPARENT RADIUM-226 CONCENTRATION MRP-003

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 003
LOCATION: 10882.0N 21011.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850908
ELEVATION: 6873.7 FT.
AUGER HEIGHT: 12.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 813 GJO NO.: C-3958S



APPARENT RADIUM-226 CONCENTRATION MRP-003

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1071.6	19.8	1.4
0.5	1438.9	26.0	1.9
1.0	1990.2	27.0	6.4
1.5	4095.1	79.3	5.6
2.0	7305.9	179.2	17.1
2.5	7368.9	161.4	11.3
3.0	5088.5	106.7	6.7
3.5	2144.2	24.3	9.5
4.0	932.5	34.0	6.2
4.5	396.0	< 1.0	5.7
5.0	366.5	8.8	3.1
5.5	280.5	1.2	1.7
6.0	237.1	2.6	1.0
6.5	232.0	1.9	0.8
7.0	230.6	2.1	0.8
7.5	229.0	1.9	0.8
8.0	230.4	2.0	0.8
8.5	241.3	2.1	0.8
9.0	197.8	3.9	1.0
9.5	213.9	1.5	1.2
10.0	265.4	3.2	0.9
10.5	276.5	2.8	0.8
11.0	288.5	3.4	0.8
11.5	293.7	3.3	0.8
12.0	301.1	3.4	0.8
12.5	322.2	4.2	0.8
13.0	323.6	3.7	0.8
13.5	345.0	2.6	1.2
14.0	418.4	13.6	2.4
14.4	398.7	8.1	1.3

This data generated by LOGCALC.BAS Version 2.2 S/N 008

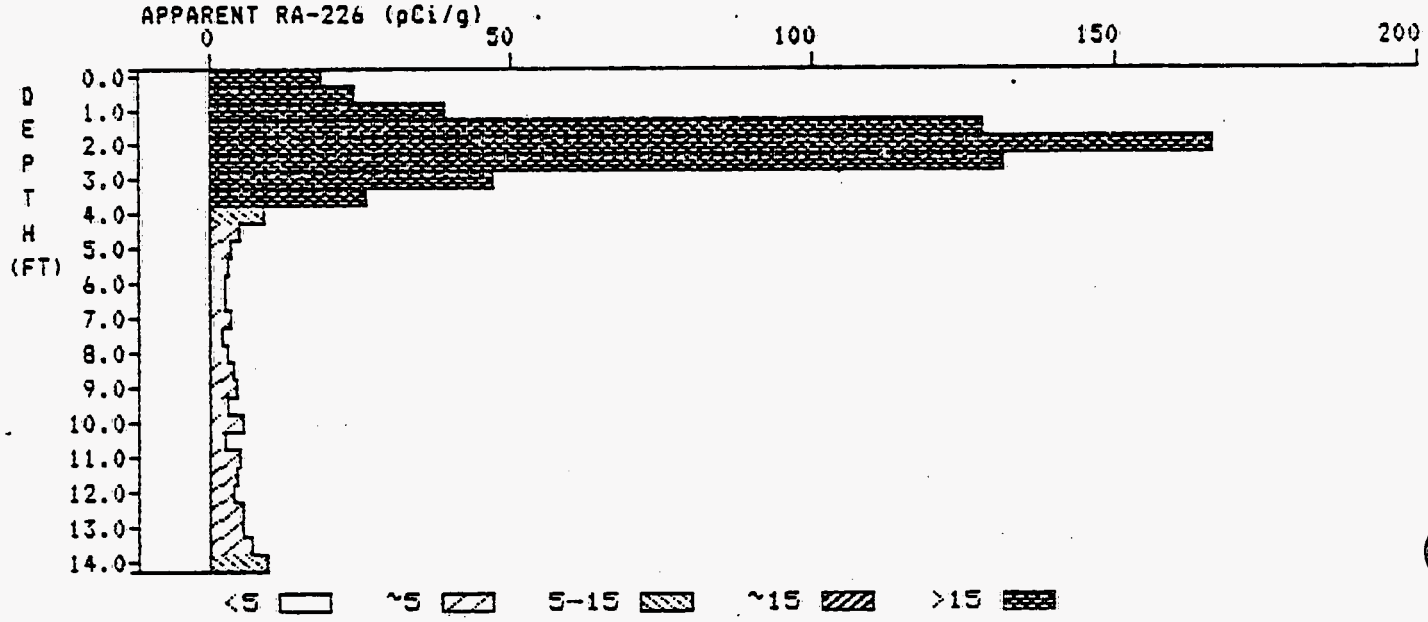
APPARENT RADIUM-226 CONCENTRATION MRP-003

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 003
LOCATION: 10882.0N 21011.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850908
ELEVATION: 6873.7 FT.
AUGER HEIGHT: 13.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	133.4	18.4	2.3
0.5	194.4	23.6	4.1
1.0	331.2	38.5	7.9
1.5	696.7	127.9	12.1
2.0	907.6	165.6	14.6
2.5	759.9	131.2	10.7
3.0	387.4	46.9	8.9
3.5	169.4	25.8	5.2
4.0	74.8	8.7	3.5
4.5	54.2	4.7	2.4
5.0	44.4	3.3	2.1
5.5	40.4	2.8	2.0
6.0	37.8	2.2	2.0
6.5	38.4	2.4	2.0
7.0	41.2	3.4	2.0
7.5	37.0	1.6	2.0
8.0	39.7	2.8	2.0
8.5	41.2	3.8	2.1
9.0	38.4	4.5	2.2
9.5	43.0	2.7	2.1
10.0	49.0	5.3	2.1
10.5	43.4	2.2	2.1
11.0	48.5	4.8	2.1
11.5	50.5	4.5	2.0
12.0	49.2	3.9	2.0
12.5	54.2	5.4	2.1
13.0	57.4	5.3	2.1
13.5	58.7	6.6	2.4
14.0	61.2	9.1	2.2

This data generated by LOGCALC.BAS Version 2.2 S/N 008

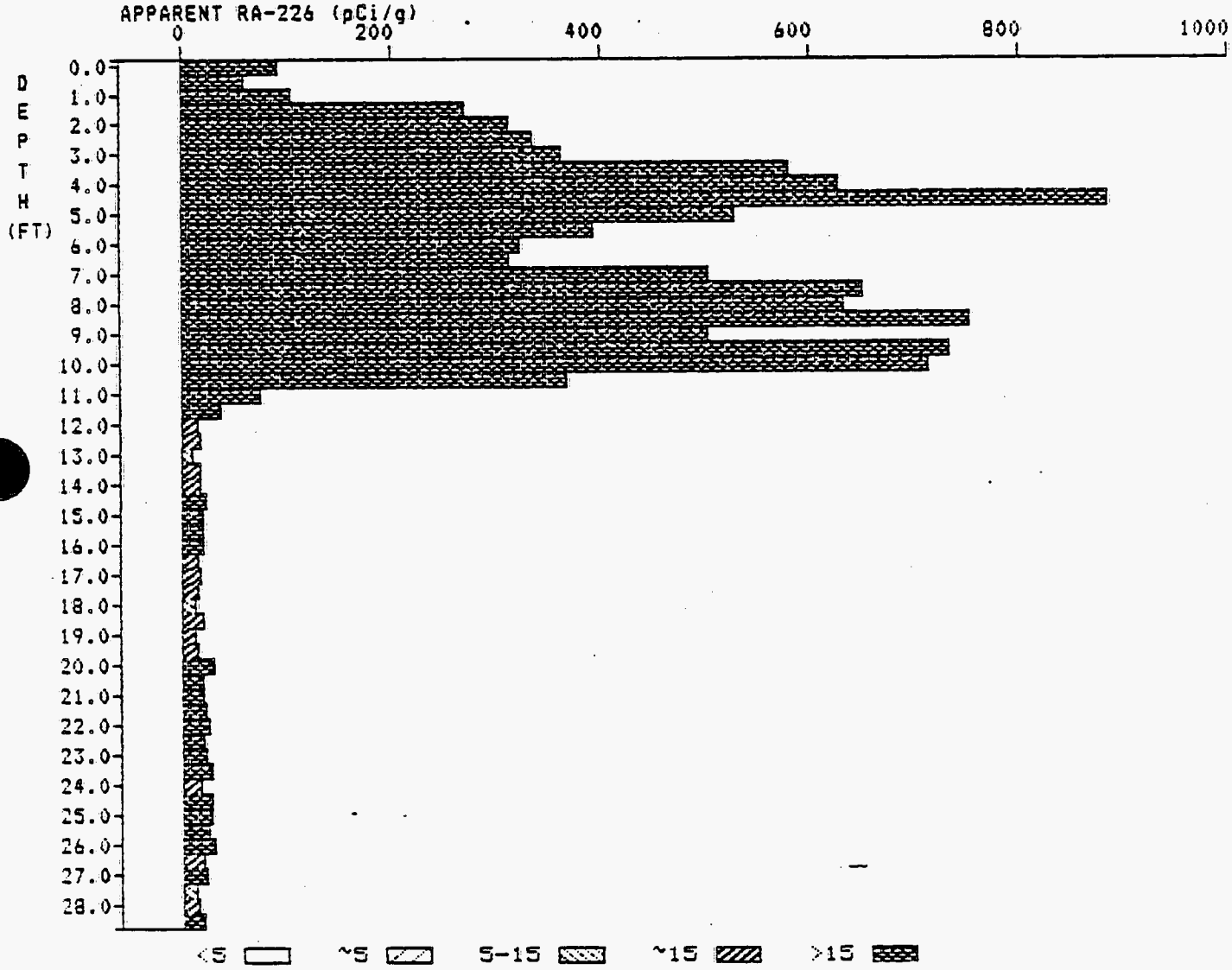
APPARENT RADIUM-226 CONCENTRATION MRP-004

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 004
LOCATION: 11090.0N 21740.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850904
ELEVATION: 6875.9 FT.
AUGER HEIGHT: 15.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-004

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	561.8	90.2	6.1
0.5	501.0	58.6	12.1
1.0	766.2	104.6	13.6
1.5	1461.3	> 267.6	22.3
2.0	1864.6	> 311.3	20.8
2.5	2062.8	> 332.6	21.9
3.0	2360.4	> 360.8	30.4
3.5	2736.1	> 578.8	56.3
4.0	3337.8	> 626.6	66.5
4.5	4541.0	> 884.2	84.6
5.0	3483.5	> 526.6	49.5
5.5	2475.6	> 392.1	30.4
6.0	2069.5	> 320.1	24.6
6.5	2121.3	> 311.3	29.1
7.0	2920.6	> 502.1	33.3
7.5	3701.8	> 648.3	43.1
8.0	3856.3	> 631.9	42.0
8.5	3451.7	> 750.4	73.9
9.0	3055.8	> 500.5	75.6
9.5	3952.9	> 731.2	62.6
10.0	3876.8	> 711.6	57.3
10.5	2354.7	> 366.2	30.2
11.0	808.8	74.9	30.4
11.5	272.4	37.2	12.6
12.0	141.6	14.8	6.1
12.5	113.9	16.5	3.5
13.0	94.3	9.1	3.1
13.5	93.7	16.2	3.3
14.0	109.2	17.0	3.4
14.5	137.1	20.1	3.1
15.0	136.4	18.6	3.0
15.5	134.4	18.7	2.9
16.0	133.2	19.4	3.0
16.5	116.3	14.4	2.8
17.0	111.2	15.3	2.8
17.5	102.9	12.9	2.6
18.0	95.0	10.5	2.7
18.5	96.2	17.7	3.4
19.0	93.3	12.1	3.3
19.5	118.4	14.6	3.0
20.0	163.9	27.7	3.9
20.5	152.9	19.9	3.3
21.0	144.3	19.6	3.0
21.5	155.4	22.5	3.1
22.0	163.6	24.8	3.3
22.5	148.6	19.3	3.1
23.0	149.2	21.3	3.1
23.5	134.8	25.1	4.0
24.0	122.9	16.6	4.0
24.5	162.0	25.1	3.5
25.0	176.1	26.1	3.4
25.5	170.9	23.6	3.3
26.0	178.8	29.0	3.7
26.5	146.6	18.2	3.3
27.0	133.7	20.3	3.1
27.5	107.5	11.5	2.9
28.0	108.7	13.7	2.7
28.5	112.5	19.1	2.3

This data generated by LOGCALC.BAS Version 2.2 S/N 008

APPARENT RADIUM-226 CONCENTRATION MRP-005

PROJECT: M R A P

START DATE: 850903

HOLE NUMBER: 005

DATE DRILLED: 850904

LOCATION: 11150.0N 21900.0E

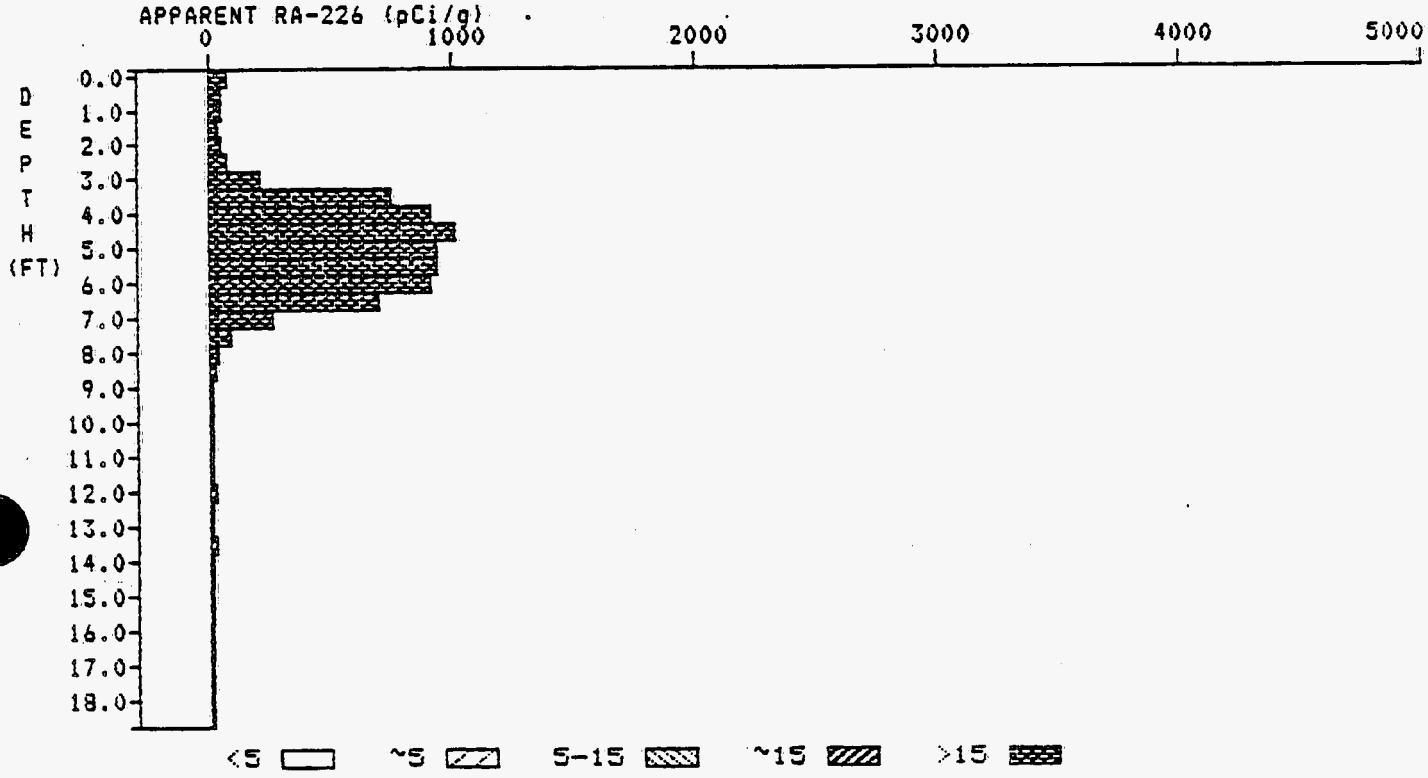
ELEVATION: 6874.6 FT.

FLUID LEVEL: 99.0 FT.

AUGER HEIGHT: 18.0 IN.

PHASE: 1

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-005

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	455.1	72.3	5.0
0.5	322.8	44.6	5.0
1.0	274.4	41.6	4.1
1.5	264.5	34.6	4.7
2.0	344.9	40.2	8.1
2.5	667.7	69.0	21.0
3.0	1570.3	208.8	40.9
3.5	3089.8	> 739.0	68.8
4.0	5072.6	> 903.1	61.8
4.5	5790.8	> 1001.9	63.5
5.0	5634.8	> 926.7	56.5
5.5	5466.9	> 928.4	56.4
6.0	5124.0	> 901.9	59.2
6.5	3955.1	> 694.9	46.7
7.0	1946.3	> 260.0	36.5
7.5	668.0	76.8	21.3
8.0	225.6	27.9	9.9
8.5	98.9	15.0	4.8
9.0	90.4	11.7	2.8
9.5	77.5	8.9	2.3
10.0	63.9	5.4	2.2
10.5	71.0	7.7	2.1
11.0	90.4	12.3	2.4
11.5	94.3	11.2	2.3
12.0	102.0	15.3	2.6
12.5	80.8	7.5	2.5
13.0	74.3	8.6	2.4
13.5	78.5	15.2	2.9
14.0	84.1	9.5	2.4
14.5	79.1	8.9	2.2
15.0	84.9	11.5	2.3
15.5	74.3	8.3	2.2
16.0	58.7	5.4	2.2
16.5	51.2	4.0	2.0
17.0	55.9	5.9	1.9
17.5	57.4	5.7	2.0
18.0	53.0	5.4	2.2
18.5	44.2	5.5	1.8

This data generated by LOGCALC.BAS Version 2.2 S/N 008

APPARENT RADIUM-226 CONCENTRATION MRP-006

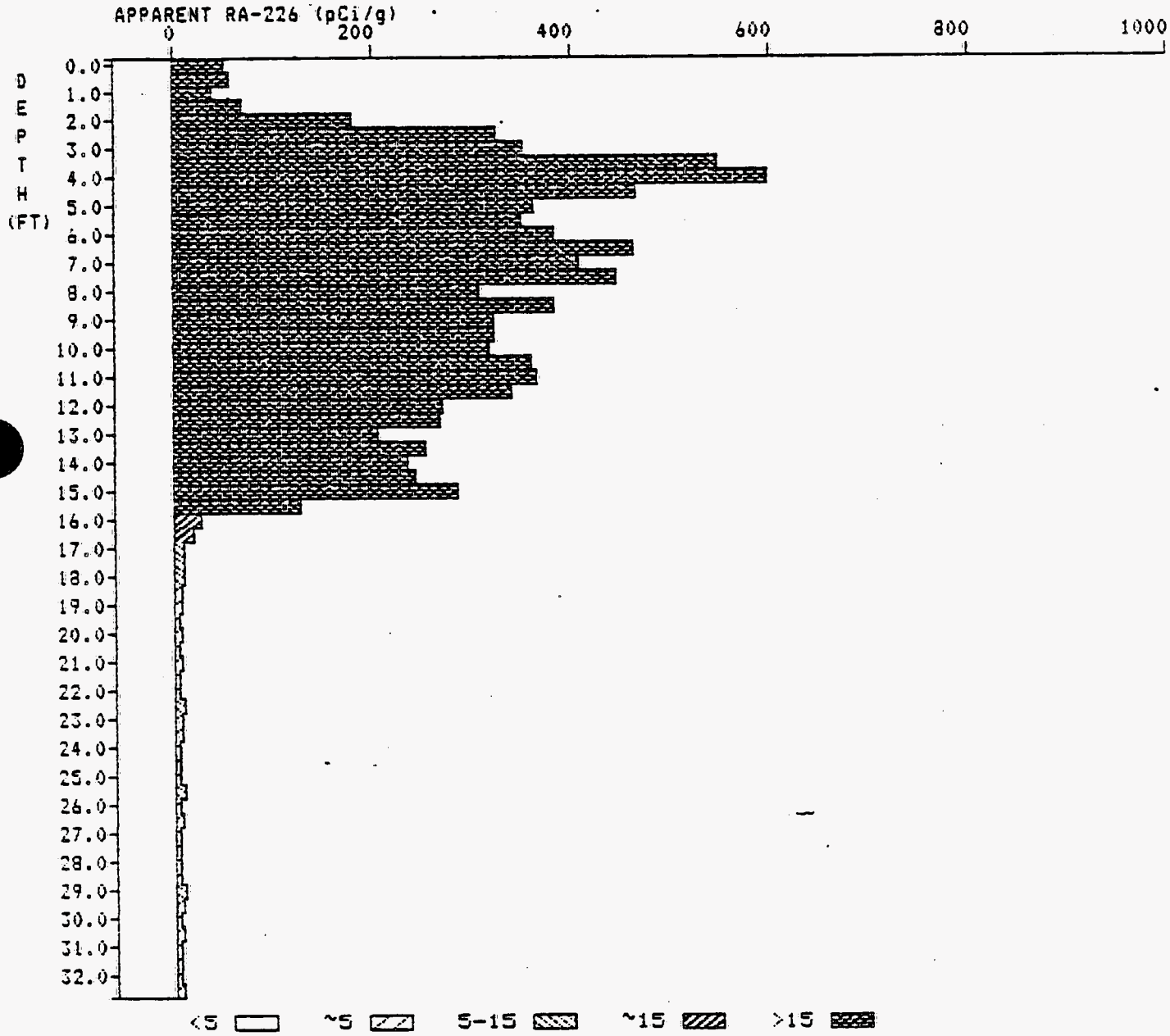
PROJECT: M R A P

START DATE: 850903

HOLE NUMBER: 006
LOCATION: 10840.0N 22250.0E
FLUID LEVEL: 27.8 FT.
PHASE: 1

DATE DRILLED: 850905
ELEVATION: 6850.9 FT.
AUGER HEIGHT: 27.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-006

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	324.0	50.3	3.8
0.5	349.1	56.4	4.8
1.0	346.2	39.9	8.3
1.5	548.8	69.7	11.3
2.0	1105.9	179.7	13.6
2.5	1538.2	> 324.9	32.0
3.0	1970.9	> 351.4	40.9
3.5	3029.8	> 546.6	41.2
4.0	3356.8	> 595.7	41.9
4.5	2856.6	> 463.2	30.3
5.0	2306.8	> 360.1	25.6
5.5	2166.9	> 348.3	23.0
6.0	2325.1	> 380.9	24.0
6.5	2617.6	> 461.4	31.4
7.0	2504.5	> 405.3	27.7
7.5	2080.5	> 443.4	43.1
8.0	1803.7	> 306.6	41.4
8.5	2125.3	> 380.5	30.7
9.0	2015.0	> 320.1	22.7
9.5	1940.9	> 320.2	20.6
10.0	1962.6	> 317.3	20.4
10.5	2104.7	> 358.3	22.9
11.0	2142.8	> 362.7	23.0
11.5	2004.1	> 339.3	21.7
12.0	1689.5	> 268.4	19.2
12.5	1305.6	> 267.1	25.9
13.0	1179.8	204.4	26.0
13.5	1439.9	> 251.5	19.4
14.0	1453.5	234.8	16.0
14.5	1454.2	240.1	15.7
15.0	1476.6	> 284.1	27.2
15.5	874.8	125.2	14.9
16.0	296.0	25.2	11.9
16.5	133.3	18.6	5.3
17.0	88.1	8.8	3.1
17.5	63.6	9.2	2.6
18.0	60.4	7.8	2.5
18.5	62.2	6.1	2.2
19.0	61.4	6.8	2.1
19.5	56.1	4.8	2.1
20.0	58.7	6.8	2.1
20.5	51.9	3.7	2.1
21.0	55.6	6.1	2.1
21.5	54.8	5.0	2.0
22.0	53.1	4.2	2.1
22.5	55.1	8.3	2.4
23.0	56.7	7.3	2.4
23.5	55.7	5.1	2.1
24.0	50.7	4.4	2.0
24.5	49.3	4.3	2.0
25.0	48.4	3.2	2.0
25.5	61.6	8.3	2.3
26.0	51.1	3.2	2.1
26.5	50.7	5.4	2.1
27.0	45.9	3.4	2.0
27.5	35.6	3.1	2.1
28.0	33.5	2.9	2.2
28.5	43.7	3.7	2.3
29.0	57.4	7.8	2.5
29.5	57.1	6.5	2.5
30.0	51.2	5.0	2.4
30.5	52.5	6.4	2.4
31.0	46.1	3.8	2.3
31.5	45.4	4.5	2.3
32.0	46.9	4.5	2.3
32.5	43.0	5.7	1.9

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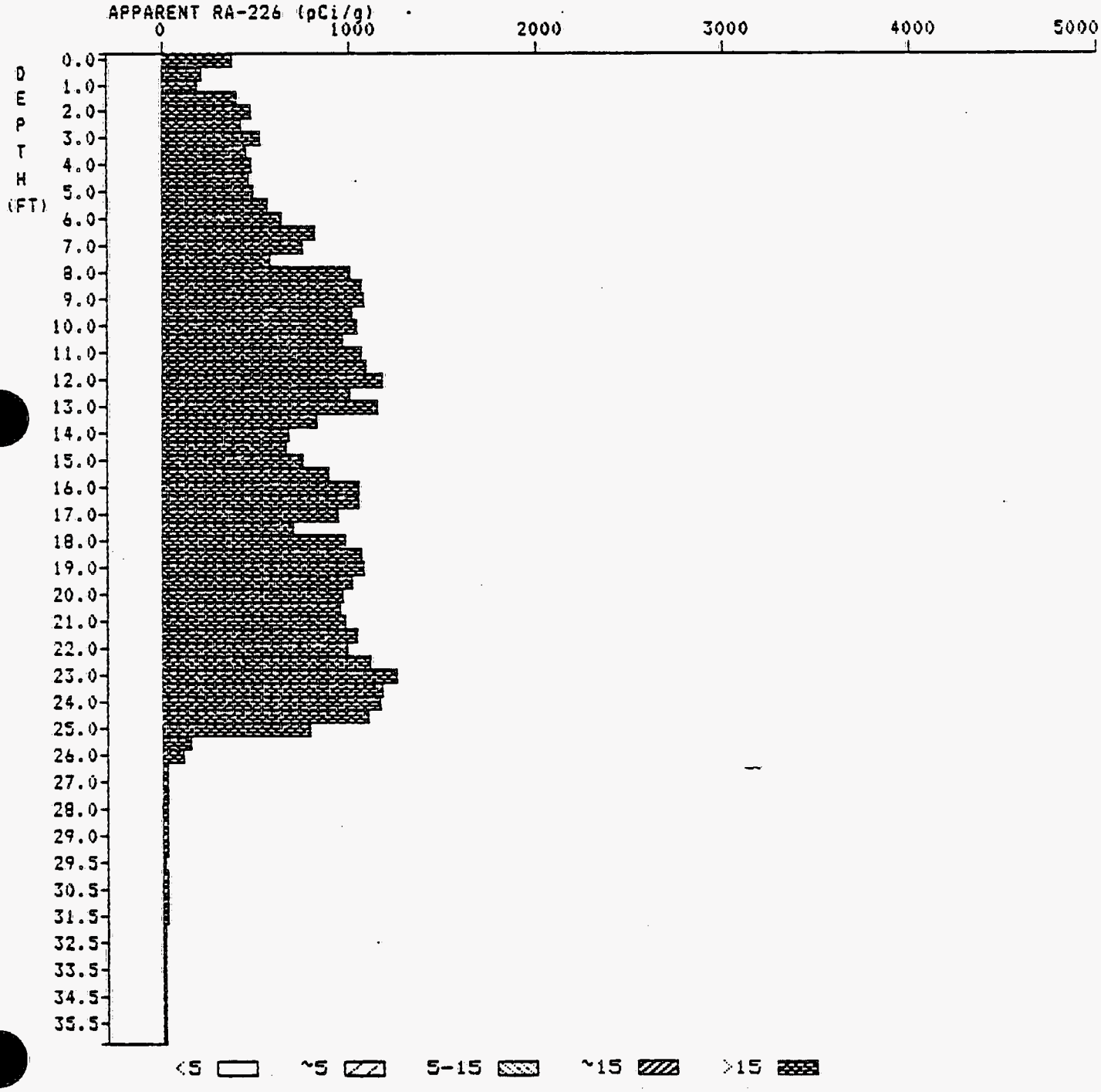
APPARENT RADIUM-226 CONCENTRATION MRP-007

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 007
DATE DRILLED: 850905
LOCATION: 10750.0N 22660.0E
ELEVATION: 6848.6 FT.
FLUID LEVEL: 34.0 FT.
AUGER HEIGHT: 35.0 IN.
PHASE: 1

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-007

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	2194.2	> 363.6	21.8
0.5	1474.7	202.0	24.6
1.0	1381.9	185.4	26.2
1.5	2106.6	> 395.5	33.6
2.0	2140.3	> 474.7	35.2
2.5	2495.2	> 417.2	34.7
3.0	2899.3	> 516.4	37.0
3.5	2771.4	> 439.3	30.1
4.0	2757.2	> 462.7	29.0
4.5	2794.2	> 453.6	28.6
5.0	2962.5	> 482.2	30.2
5.5	3347.0	> 553.4	33.9
6.0	3840.7	> 630.3	39.0
6.5	4347.2	> 801.4	60.5
7.0	3499.8	> 739.0	51.2
7.5	3801.2	> 565.7	72.2
8.0	5432.9	> 989.2	76.2
8.5	6227.4	> 1051.7	65.9
9.0	6335.2	> 1071.7	64.9
9.5	6147.2	> 1012.0	61.1
10.0	6082.5	> 1025.1	61.6
10.5	5944.2	> 958.4	60.0
11.0	6252.3	> 1060.0	64.7
11.5	6294.8	> 1086.1	75.2
12.0	5298.7	> 1166.7	80.8
12.5	5821.0	> 989.3	77.6
13.0	6278.7	> 1144.5	85.7
13.5	5186.1	> 816.8	58.5
14.0	4249.5	> 674.6	45.9
14.5	4108.3	> 659.8	42.6
15.0	4538.8	> 746.7	45.7
15.5	5262.2	> 878.7	52.8
16.0	6022.7	> 1048.2	66.6
16.5	5916.9	> 1048.8	73.6
17.0	4397.0	> 936.5	63.6
17.5	4446.5	> 688.6	75.2
18.0	5529.1	> 970.5	67.3
18.5	6217.2	> 1056.8	65.3
19.0	6321.3	> 1070.9	64.8
19.5	6064.9	> 1007.0	60.5
20.0	5789.1	> 955.8	57.5
20.5	5696.3	> 940.6	56.7
21.0	5807.8	> 963.3	58.3
21.5	5866.0	> 1031.2	71.5
22.0	4818.7	> 984.1	69.3
22.5	6140.9	> 1103.3	79.3
23.0	7188.2	> 1249.3	80.0
23.5	7056.6	> 1167.7	70.8
24.0	6791.1	> 1159.4	70.6
24.5	6194.1	> 1099.0	73.6
25.0	4443.6	> 781.7	53.1
25.5	1671.0	146.2	67.0
26.0	634.4	108.9	27.3
26.5	264.6	23.8	14.3
27.0	120.3	20.4	6.3
27.5	147.9	23.8	3.9
28.0	154.1	22.9	3.1
28.5	128.3	16.7	2.7
29.0	109.3	13.6	2.5
29.0	107.5	14.8	2.5
29.5	99.6	10.7	2.6
30.0	118.4	17.5	2.8
30.5	125.0	15.7	2.7
31.0	141.6	21.8	3.0
31.5	130.6	20.1	3.0
32.0	75.4	11.1	2.6
32.5	57.8	4.8	2.4
33.0	59.5	6.4	2.2
33.5	60.9	5.5	2.3
34.0	65.1	9.8	2.9
34.5	54.3	4.1	2.8
35.0	60.4	8.6	2.9
35.5	55.9	5.8	2.7
36.0	47.3	5.4	1.9

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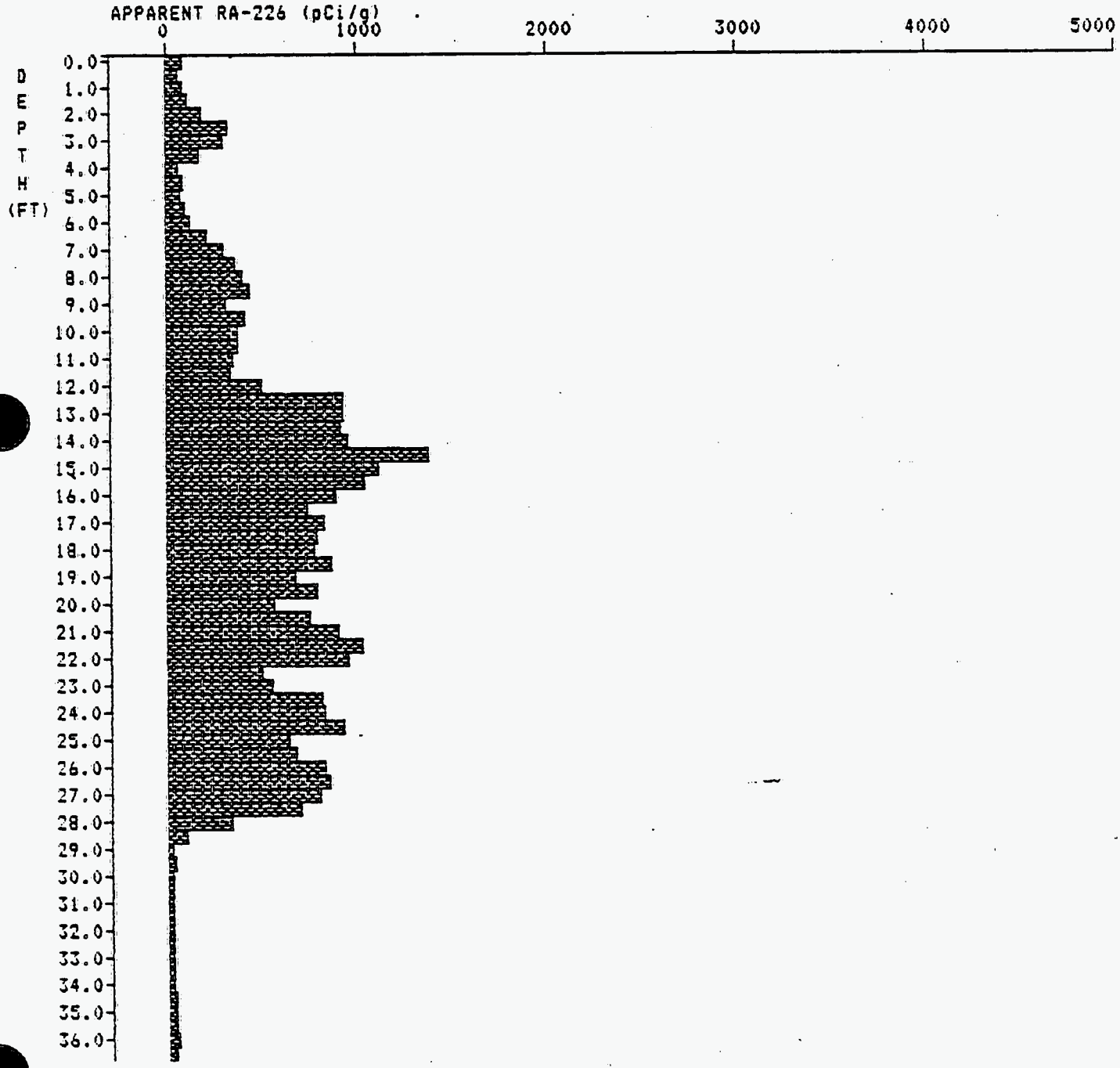
APPARENT RADIUM-226 CONCENTRATION MRP-008

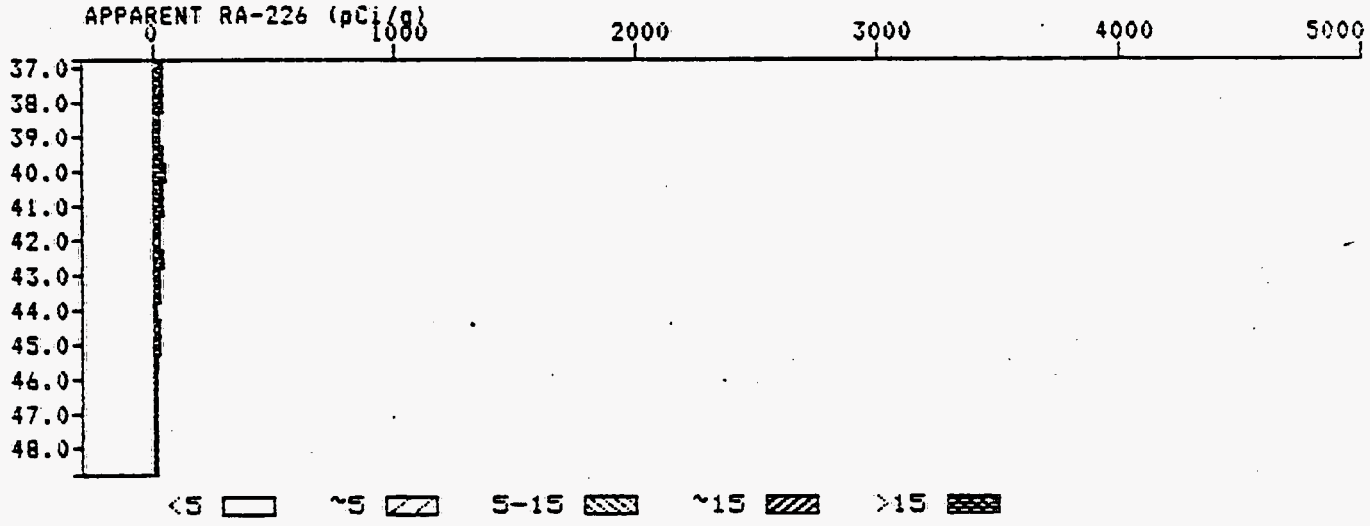
PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 008
DATE DRILLED: 850906
LOCATION: 10750.0N 23140.0E
ELEVATION: 6849.9 FT.
FLUID LEVEL: 48.5 FT.
AUGER HEIGHT: 17.0 IN.
PHASE: 1

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-008



APPARENT RADIUM-226 CONCENTRATION MRP-008

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	510.2	81.5	5.6
0.5	433.1	56.6	8.0
1.0	539.0	85.6	7.3
1.5	728.4	104.1	10.8
2.0	1135.9	182.4	13.0
2.5	1686.5	> 319.1	28.8
3.0	1587.9	> 290.6	24.5
3.5	843.9	165.8	15.1
4.0	492.0	56.3	16.2
4.5	470.3	80.8	9.3
5.0	491.8	69.1	8.1
5.5	619.4	98.0	7.9
6.0	829.3	121.7	11.4
6.5	1253.0	207.2	14.2
7.0	1737.2	> 294.2	19.4
7.5	2102.9	> 355.6	23.1
8.0	2239.5	> 388.0	28.1
8.5	1925.3	> 433.9	33.4
9.0	1960.0	> 304.3	33.5
9.5	2253.6	> 401.9	30.8
10.0	2246.2	> 362.9	24.6
10.5	2213.2	> 372.2	24.0
11.0	2152.9	> 343.4	23.1
11.5	2262.8	> 325.4	32.9
12.0	3211.6	> 499.9	36.9
12.5	4975.8	> 924.0	73.8
13.0	5321.7	> 914.3	66.6
13.5	4385.8	> 905.5	63.5
14.0	5577.1	> 943.3	74.9
14.5	7346.3	> 1371.5	110.8
15.0	6866.1	> 1109.4	75.2
15.5	6082.8	> 1026.4	63.6
16.0	5343.7	> 883.1	54.0
16.5	4659.4	> 729.0	50.7
17.0	4750.0	> 817.1	52.0
17.5	4734.8	> 781.8	48.5
18.0	4529.5	> 770.8	54.6
18.5	3834.2	> 858.8	62.6
19.0	4066.9	> 674.6	57.9
19.5	4353.2	> 778.1	56.2
20.0	3872.9	> 558.4	57.0
20.5	4398.0	> 744.7	49.0
21.0	5256.6	> 895.1	55.4
21.5	5761.3	> 1016.7	67.4
22.0	5305.3	> 939.5	64.0
22.5	3678.2	> 499.2	66.3
23.0	3339.2	> 537.6	49.1
23.5	3541.5	> 800.9	60.9
24.0	4613.0	> 823.4	60.8
24.5	5093.1	> 917.8	66.3
25.0	4228.2	> 626.7	56.9
25.5	4140.4	> 674.4	45.1
26.0	4748.1	> 824.4	53.1
26.5	4941.5	> 843.3	52.5
27.0	4639.9	> 795.2	49.7
27.5	3884.8	> 698.2	50.0
28.0	2145.1	> 332.5	32.6
28.5	631.8	88.4	24.9
29.0	219.6	19.2	13.0
29.5	168.3	26.7	6.1
30.0	161.8	22.4	3.8
30.5	152.7	21.8	3.2
31.0	144.8	19.3	3.1
31.5	151.7	21.4	3.1
32.0	165.3	24.7	3.3
32.5	163.8	24.1	3.2
33.0	142.8	20.6	3.2
33.5	103.7	15.9	3.3
34.0	139.3	20.6	3.3
34.5	186.4	27.1	3.4
35.0	229.3	37.3	4.1
35.5	230.5	32.1	4.0
36.0	254.3	43.1	4.8
36.5	224.7	30.4	4.1

APPARENT RADIUM-226 CONCENTRATION MRP-008

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
37.0	219.2	33.5	3.8
37.5	222.8	34.2	3.8
38.0	203.1	32.4	3.9
38.5	138.9	23.2	3.8
39.0	160.2	22.4	3.7
39.5	217.9	34.3	3.9
40.0	252.6	42.8	4.8
40.5	208.6	28.3	3.9
41.0	179.0	27.0	3.5
41.5	150.1	19.8	3.1
42.0	136.2	16.4	3.1
42.5	168.4	27.7	3.8
43.0	157.6	23.6	3.4
43.5	105.6	18.8	3.2
44.0	91.4	9.5	3.1
44.5	104.5	14.2	3.7
45.0	118.8	18.4	3.0
45.5	92.1	9.8	2.6
46.0	76.2	8.6	2.4
46.5	73.5	8.2	2.3
47.0	74.9	8.8	2.3
47.5	74.6	8.7	2.3
48.0	68.3	7.5	2.4
48.5	54.0	8.6	2.0

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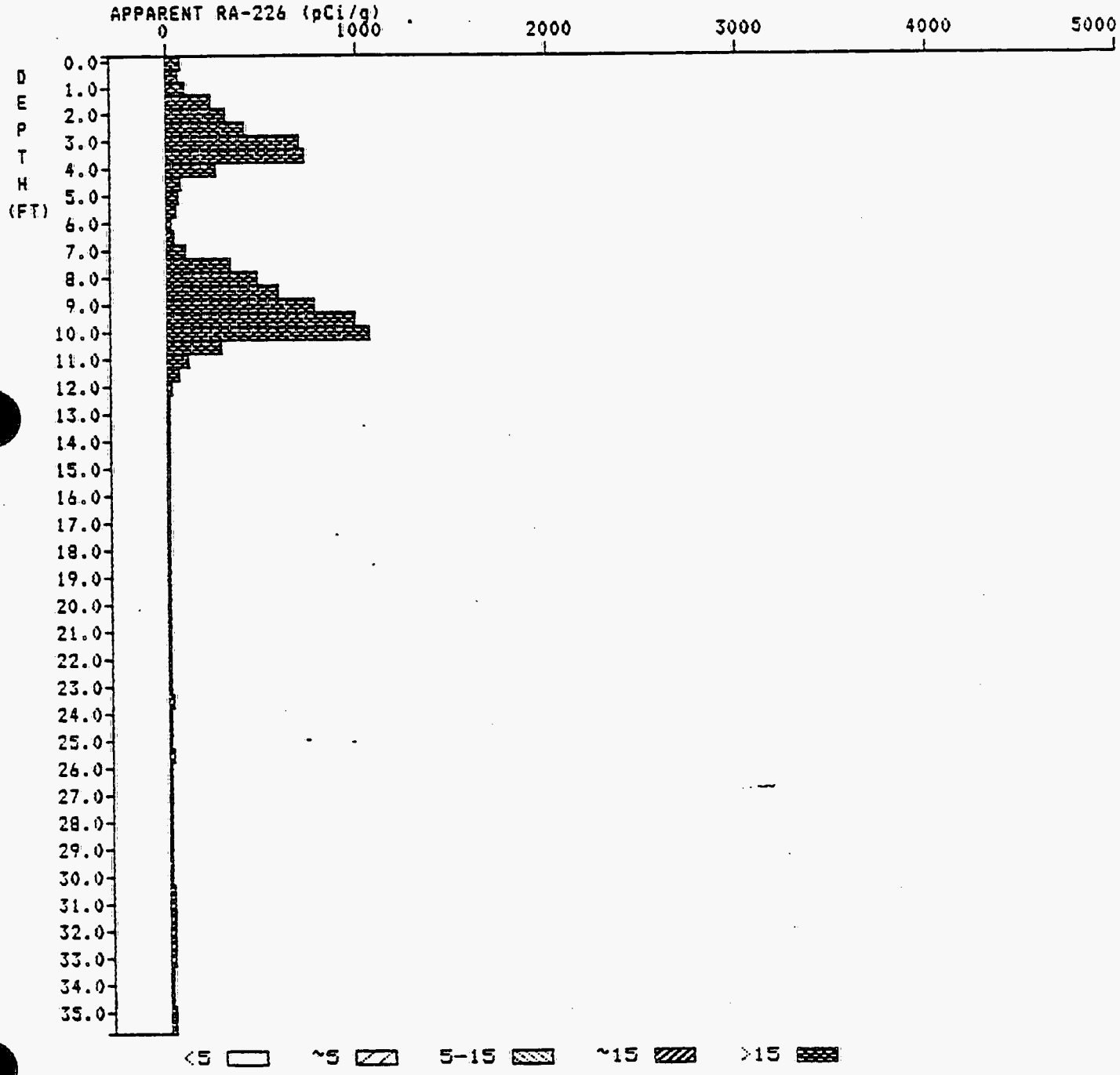
APPARENT RADIUM-226 CONCENTRATION MRP-009

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 009
LOCATION: 11001.0N 22850.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850905
ELEVATION: 6850.3 FT.
AUGER HEIGHT: 54.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-009

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	391.7	65.8	5.3
0.5	345.6	53.3	10.4
1.0	683.6	97.3	12.8
1.5	1357.5	236.9	17.4
2.0	1909.2	> 302.8	21.0
2.5	2580.2	> 403.1	28.7
3.0	3713.2	> 696.9	58.3
3.5	3791.1	> 724.0	66.1
4.0	1978.2	> 258.7	43.4
4.5	660.4	68.8	25.6
5.0	314.5	50.7	11.4
5.5	200.3	37.7	6.2
6.0	190.4	18.7	6.6
6.5	309.7	28.5	10.9
7.0	781.8	94.0	18.8
7.5	1873.9	> 334.1	25.4
8.0	2793.8	> 464.2	29.5
8.5	3567.6	> 580.2	36.5
9.0	4545.5	> 766.1	46.9
9.5	5465.7	> 976.0	67.9
10.0	5057.0	> 1051.6	113.2
10.5	1996.3	> 285.2	81.9
11.0	815.3	111.7	35.2
11.5	378.2	52.8	14.7
12.0	167.5	18.0	7.0
12.5	89.0	10.1	3.6
13.0	60.2	5.2	2.5
13.5	50.5	4.2	2.2
14.0	50.3	4.4	2.2
14.5	52.9	5.1	2.2
15.0	50.5	5.0	2.3
15.5	42.9	5.4	2.3
16.0	51.0	4.9	2.2
16.5	51.0	4.4	2.1
17.0	52.0	4.5	2.1
17.5	57.5	6.3	2.2
18.0	55.5	5.2	2.2
18.5	52.9	4.5	2.2
19.0	57.2	5.5	2.2
19.5	64.9	8.1	2.4
20.0	51.8	2.9	2.6
20.5	58.7	11.3	3.0
21.0	63.6	5.5	2.5
21.5	66.3	7.8	2.4
22.0	65.6	7.0	2.3
22.5	61.7	5.8	2.3
23.0	67.1	6.4	2.3
23.5	88.7	12.5	2.7
24.0	90.7	11.2	2.6
24.5	83.3	9.1	2.5
25.0	85.2	10.6	2.7
25.5	88.6	17.9	3.4
26.0	88.7	10.7	2.7
26.5	67.1	6.0	2.4
27.0	66.0	7.5	2.3
27.5	66.9	7.4	2.3
28.0	63.9	6.0	2.3
28.5	71.5	9.1	2.4
29.0	67.1	6.2	2.4
29.5	72.7	7.6	2.4
30.0	88.8	11.5	2.8
30.5	99.3	19.8	3.5
31.0	115.9	15.2	3.0
31.5	115.7	15.2	2.8
32.0	120.1	16.3	2.8
32.5	124.2	17.9	2.9
33.0	112.0	14.8	2.7
33.5	94.3	12.1	2.6
34.0	73.3	7.5	2.4
34.5	64.3	2.8	3.0
35.0	115.5	18.8	3.4
35.5	133.6	24.8	2.5

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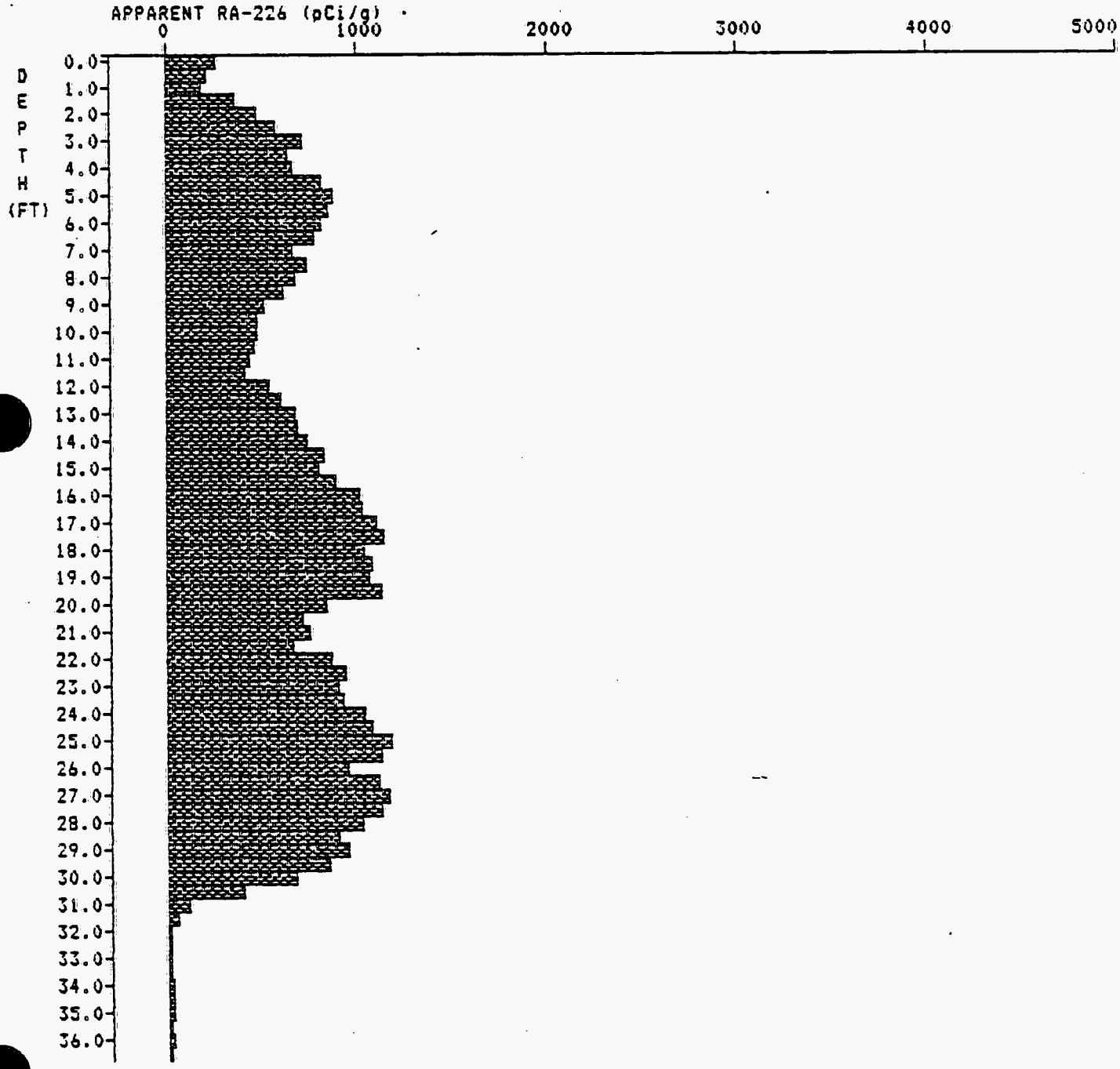
APPARENT RADIUM-226 CONCENTRATION MRP-010

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 010
LOCATION: 10430.0N 21890.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850906
ELEVATION: 6896.8 FT.
AUGER HEIGHT: 41.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-010

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1557.0	> 256.9	15.5
0.5	1348.0	207.5	15.3
1.0	1314.0	185.0	24.7
1.5	1621.0	> 353.0	26.2
2.0	2602.0	> 464.8	33.9
2.5	3419.0	> 572.7	35.4
3.0	3999.0	> 706.7	47.2
3.5	3933.0	> 626.4	41.3
4.0	4059.0	> 654.8	41.4
4.5	4678.0	> 800.6	49.3
5.0	5103.0	> 874.7	53.8
5.5	5036.0	> 839.9	50.9
6.0	4667.0	> 809.8	56.1
6.5	3602.0	> 769.8	52.1
7.0	3866.0	> 656.5	51.4
7.5	4180.0	> 725.2	47.5
8.0	3999.0	> 667.1	40.9
8.5	3628.0	> 609.8	37.0
9.0	3158.0	> 510.9	31.9
9.5	2868.0	> 467.1	29.1
10.0	2806.0	> 470.0	28.8
10.5	2739.0	> 455.3	28.0
11.0	2557.0	> 434.5	30.8
11.5	2078.0	> 408.7	32.2
12.0	2884.0	> 525.5	38.7
12.5	3538.0	> 588.1	36.6
13.0	3945.0	> 671.0	41.1
13.5	4140.0	> 677.8	41.4
14.0	4430.0	> 737.5	44.3
14.5	4800.0	> 816.9	49.6
15.0	4917.0	> 796.3	49.3
15.5	5288.0	> 875.4	53.2
16.0	5705.0	> 1012.4	70.6
16.5	4860.0	> 1013.4	68.8
17.0	6050.0	> 1098.0	78.7
17.5	6650.0	> 1136.7	70.9
18.0	6352.0	> 1032.1	63.7
18.5	6323.0	> 1064.5	63.9
19.0	6319.0	> 1052.9	62.8
19.5	6284.0	> 1114.9	74.2
20.0	5246.0	> 833.4	55.7
20.5	4443.0	> 708.4	47.0
21.0	4233.0	> 745.0	52.4
21.5	3386.0	> 661.3	53.4
22.0	4609.0	> 853.3	63.3
22.5	5450.0	> 933.0	58.7
23.0	5446.0	> 887.5	54.6
23.5	5616.0	> 923.6	55.8
24.0	6111.0	> 1034.6	62.2
24.5	6457.0	> 1072.0	64.0
25.0	6800.0	> 1172.0	72.1
25.5	6610.0	> 1114.9	67.4
26.0	5829.0	> 938.0	74.8
26.5	5091.0	> 1110.1	76.8
27.0	6332.0	> 1153.0	83.0
27.5	6611.0	> 1120.6	69.6
28.0	6092.0	> 1013.8	61.0
28.5	5512.0	> 888.6	55.5
29.0	5418.0	> 941.3	59.6
29.5	4931.0	> 842.5	52.0
30.0	3906.0	> 671.8	42.2
30.5	2429.6	> 394.6	25.2
31.0	926.4	105.4	27.8
31.5	256.0	43.0	12.0
32.0	101.8	5.8	6.6
32.5	67.6	8.5	3.3
33.0	60.5	3.6	2.6
33.5	86.5	9.5	2.3
34.0	143.8	23.6	3.3
34.5	153.7	22.6	2.9
35.0	130.2	17.9	2.6
35.5	101.4	10.6	2.6
36.0	106.3	16.5	2.8
36.5	81.3	12.4	2.5

APPARENT RADIUM-226 CONCENTRATION MRP-010

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
37.0	92.3	11.9	2.5
37.5	112.1	14.2	2.4
38.0	139.4	20.5	2.7
38.5	153.1	24.6	3.2
39.0	116.1	11.7	3.1
39.5	120.3	18.5	2.9
40.0	111.8	13.8	2.5
40.5	104.8	13.0	2.4
41.0	109.5	14.4	2.5
41.5	106.6	23.0	3.6
42.0	88.7	7.9	3.2
42.5	92.0	12.3	2.4
43.0	101.3	14.5	2.4
43.5	83.6	9.9	2.2
44.0	59.4	4.5	2.1
44.5	59.1	5.0	2.0
45.0	82.4	11.5	2.3
45.5	86.1	10.1	2.2
46.0	82.4	7.6	2.6
46.5	101.1	17.5	2.5

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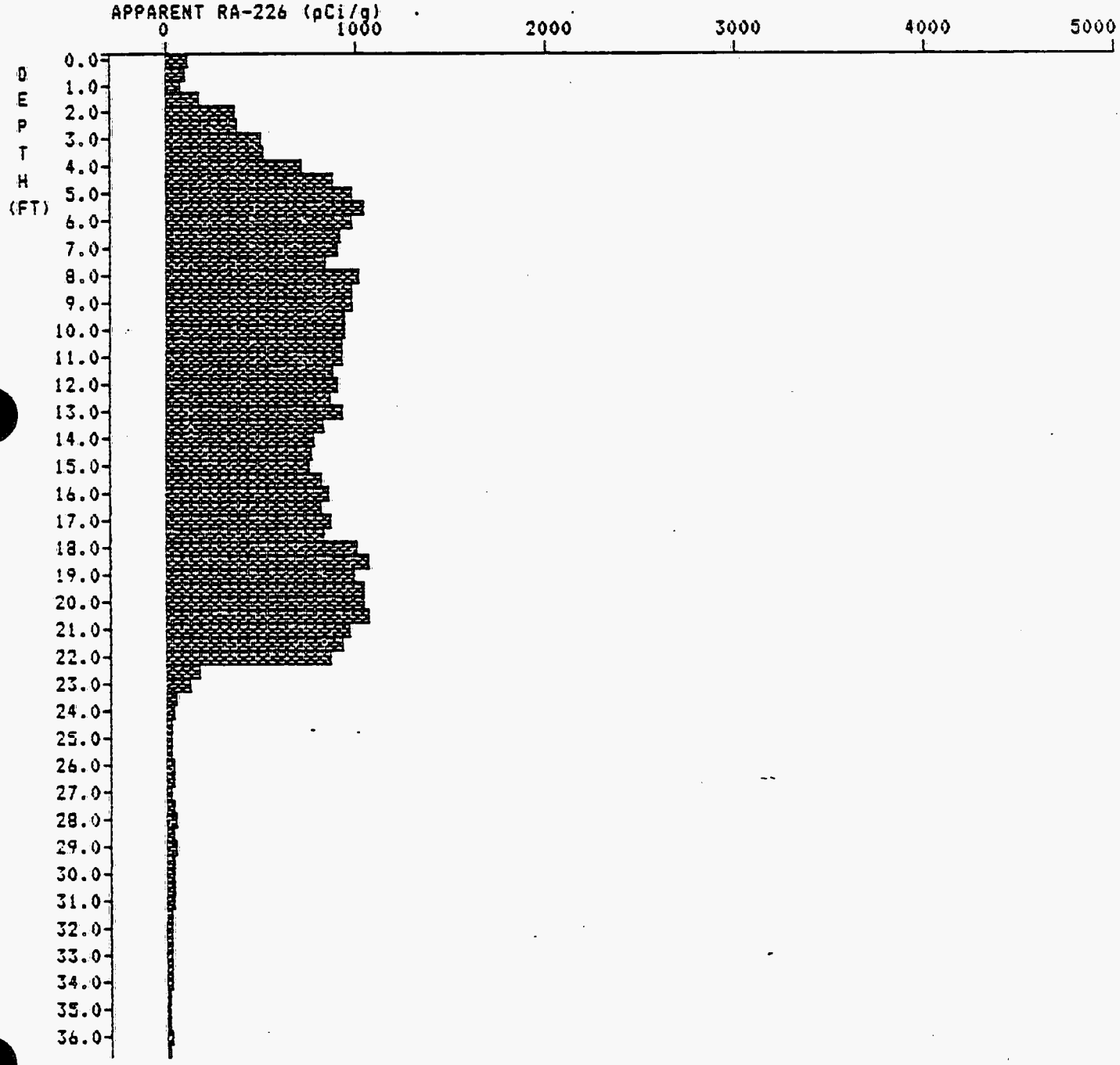
APPARENT RADIUM-226 CONCENTRATION MRP-011

PROJECT: M R A P
START DATE: 850903

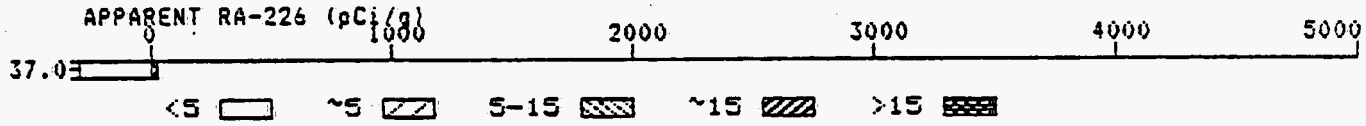
HOLE NUMBER: 011
LOCATION: 10180.0N 21800.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850907
ELEVATION: 6896.1 FT.
AUGER HEIGHT: 33.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-011



APPARENT RADIUM-226 CONCENTRATION MRP-011

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	644.2	104.0	6.8
0.5	582.1	88.1	7.3
1.0	603.0	69.2	15.4
1.5	1072.9	163.2	15.3
2.0	1623.7	> 357.8	37.3
2.5	2025.1	> 368.5	41.6
3.0	2860.1	> 493.8	34.3
3.5	3282.5	> 509.4	37.0
4.0	4152.7	> 700.3	43.4
4.5	5109.3	> 870.4	53.3
5.0	5731.4	> 969.9	58.8
5.5	6032.5	> 1035.5	63.8
6.0	5808.8	> 965.4	58.4
6.5	5421.0	> 900.0	57.0
7.0	4462.4	> 895.8	83.7
7.5	4522.3	> 834.6	91.0
8.0	5737.2	> 1007.6	71.0
8.5	5839.1	> 966.8	60.1
9.0	5752.7	> 964.0	58.3
9.5	5644.2	> 937.2	56.5
10.0	5575.5	> 931.5	56.1
10.5	5508.7	> 917.6	55.3
11.0	5449.7	> 917.2	55.4
11.5	5224.2	> 863.5	55.0
12.0	4412.1	> 893.8	83.3
12.5	4498.9	> 856.5	89.3
13.0	5293.3	> 921.9	64.7
13.5	4983.2	> 815.4	51.6
14.0	4676.0	> 772.8	47.3
14.5	4560.9	> 755.2	45.9
15.0	4558.1	> 747.0	45.7
15.5	4775.7	> 802.0	48.6
16.0	4976.5	> 843.9	51.4
16.5	4880.6	> 804.3	51.6
17.0	4212.1	> 851.8	79.5
17.5	4414.4	> 815.2	88.6
18.0	5724.7	> 988.4	67.4
18.5	6191.8	> 1059.7	66.0
19.0	6057.0	> 986.3	60.9
19.5	6135.8	> 1035.5	62.6
20.0	6181.1	> 1031.5	61.9
20.5	6155.5	> 1050.8	64.0
21.0	5766.9	> 954.6	57.7
21.5	5303.4	> 923.5	59.3
22.0	3765.1	> 858.5	91.3
22.5	1609.6	171.2	80.4
23.0	697.2	114.4	32.2
23.5	342.8	38.1	15.0
24.0	214.8	32.7	6.7
24.5	168.7	22.3	3.9
25.0	150.1	20.2	3.1
25.5	158.5	21.7	3.0
26.0	186.2	28.2	3.3
26.5	203.3	33.4	3.8
27.0	144.8	20.8	4.4
27.5	163.8	26.6	4.4
28.0	252.0	43.2	4.8
28.5	252.7	36.9	4.0
29.0	247.4	39.0	4.0
29.5	228.4	33.9	3.6
30.0	206.9	29.4	3.4
30.5	207.4	31.6	3.5
31.0	202.7	31.4	3.5
31.5	169.5	23.4	3.2
32.0	126.1	21.3	3.8
32.5	121.6	20.4	4.0
33.0	120.4	15.3	3.2
33.5	112.2	15.0	3.0
34.0	106.7	14.1	2.9
34.5	96.9	11.8	2.8
35.0	93.1	11.8	2.8
35.5	89.6	9.5	2.8
36.0	108.8	16.6	3.1
36.5	100.8	10.5	3.0

APPARENT RADIUM-226 CONCENTRATION MRP-011

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
37.0	99.5	16.3	2.4

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APPARENT RADIUM-226 CONCENTRATION MRP-012

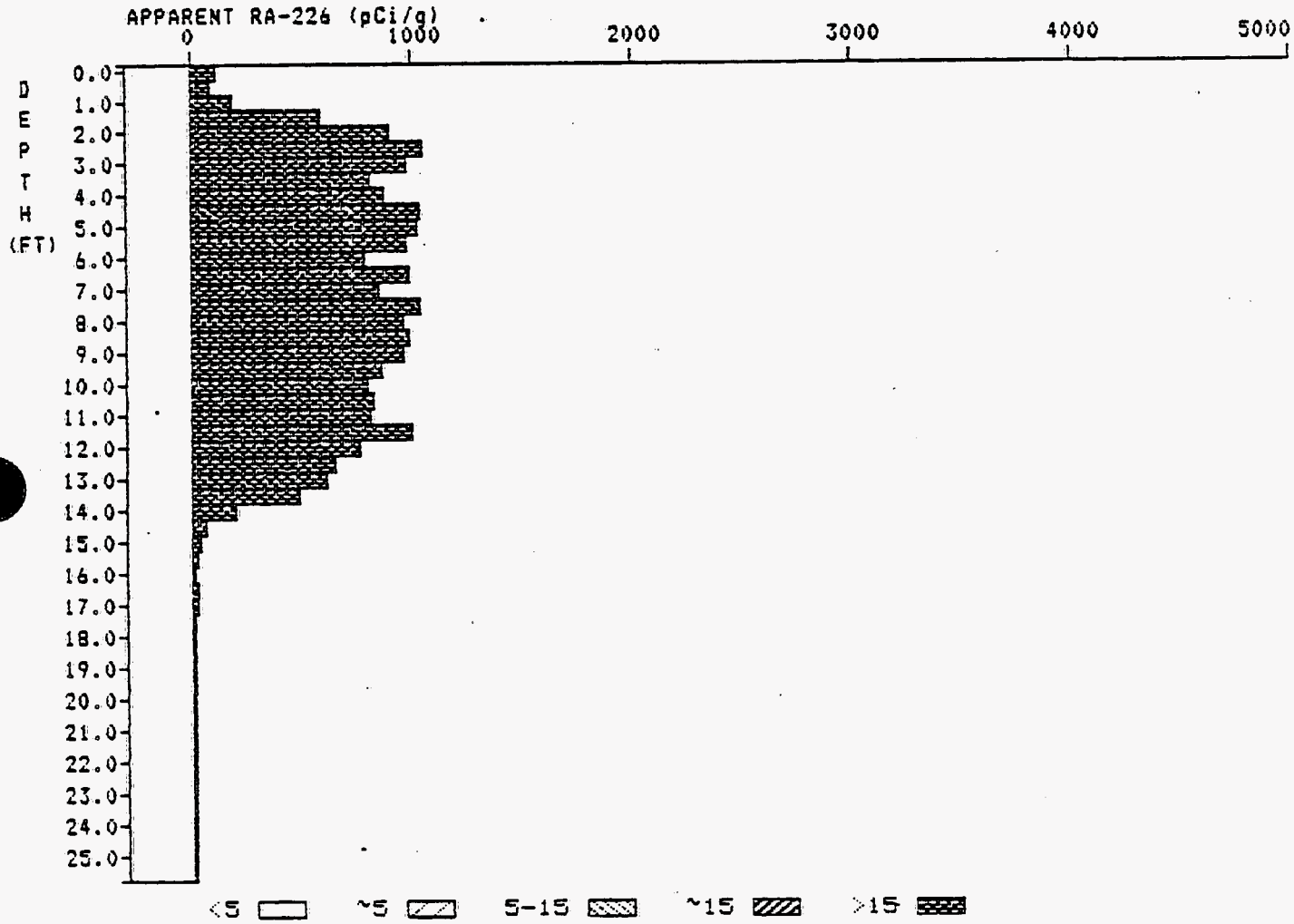
PROJECT: M R A P

START DATE: 850903

HOLE NUMBER: 012
LOCATION: 10090.0N 22001.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850907
ELEVATION: 6897.4 FT.
AUGER HEIGHT: 52.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-012

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	642.2	105.6	7.0
0.5	595.0	79.4	22.6
1.0	1296.5	178.2	36.7
1.5	3291.0	> 576.7	40.3
2.0	5085.2	> 896.9	59.9
2.5	5955.7	> 1043.8	68.3
3.0	5767.3	> 969.8	59.6
3.5	5162.2	> 810.1	55.6
4.0	5285.1	> 866.5	53.9
4.5	5935.2	> 1031.5	65.7
5.0	5938.8	> 1021.2	65.8
5.5	4620.3	> 972.9	75.1
6.0	4605.7	> 783.1	81.1
6.5	5507.3	> 981.4	71.2
7.0	5422.4	> 845.8	61.2
7.5	5857.6	> 1030.8	68.8
8.0	5824.0	> 950.7	59.5
8.5	5791.0	> 982.3	60.1
9.0	5635.0	> 951.0	57.8
9.5	5212.0	> 858.8	52.5
10.0	4796.0	> 796.8	52.2
10.5	3938.0	> 818.0	63.6
11.0	4464.0	> 801.6	72.7
11.5	5430.0	> 996.3	77.5
12.0	4731.0	> 759.8	52.1
12.5	3931.0	> 643.0	40.9
13.0	3479.0	> 601.8	38.9
13.5	2745.0	> 485.5	34.0
14.0	1421.0	195.2	24.6
14.5	514.0	56.1	16.5
15.0	233.0	34.1	7.3
15.5	114.0	16.3	4.4
16.0	98.0	12.0	3.4
16.5	133.0	21.3	3.4
17.0	127.0	18.9	3.0
17.5	79.0	7.1	2.6
18.0	55.0	4.2	2.3
18.5	61.0	7.2	2.3
19.0	59.0	5.1	2.2
19.5	63.9	8.0	2.3
20.0	53.4	3.0	2.4
20.5	57.3	11.3	3.0
21.0	45.2	2.4	2.5
21.5	41.5	3.2	2.1
22.0	42.4	1.9	2.1
22.5	60.6	6.6	2.2
23.0	80.4	12.1	2.7
23.5	58.6	4.0	2.4
24.0	50.5	4.5	2.1
24.5	53.7	4.0	2.2
25.0	71.4	10.5	2.7
25.5	50.5	6.6	1.9

This data generated by LOGCALC.BAS Version 2.2 S/N 008

APPARENT RADIUM-226 CONCENTRATION MRP-013

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 013
LOCATION: 11326.5N 21025.5E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850904
ELEVATION: 6934.7 FT.
AUGER HEIGHT: 20.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S

Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	858.6	14.9	1.4
0.5	553.6	5.5	1.9
1.0	629.6	12.3	1.8
1.5	593.7	7.9	1.5
2.0	645.9	10.7	1.3
2.5	755.1	13.3	1.4
3.0	762.7	13.1	1.8
3.5	597.0	15.0	1.6
4.0	1117.5	23.9	2.5
4.5	1057.2	18.6	1.7
5.0	878.8	14.0	1.6
5.5	883.4	16.1	1.5
6.0	869.7	15.7	1.5
6.5	759.1	13.1	1.3
7.0	600.4	9.0	1.2
7.5	501.3	5.9	1.4
8.0	601.4	12.1	1.8
8.5	407.5	9.0	1.4
8.6	419.0	9.8	1.3

This data generated by LOGCALC.BAS Version 2.2 S/N 008

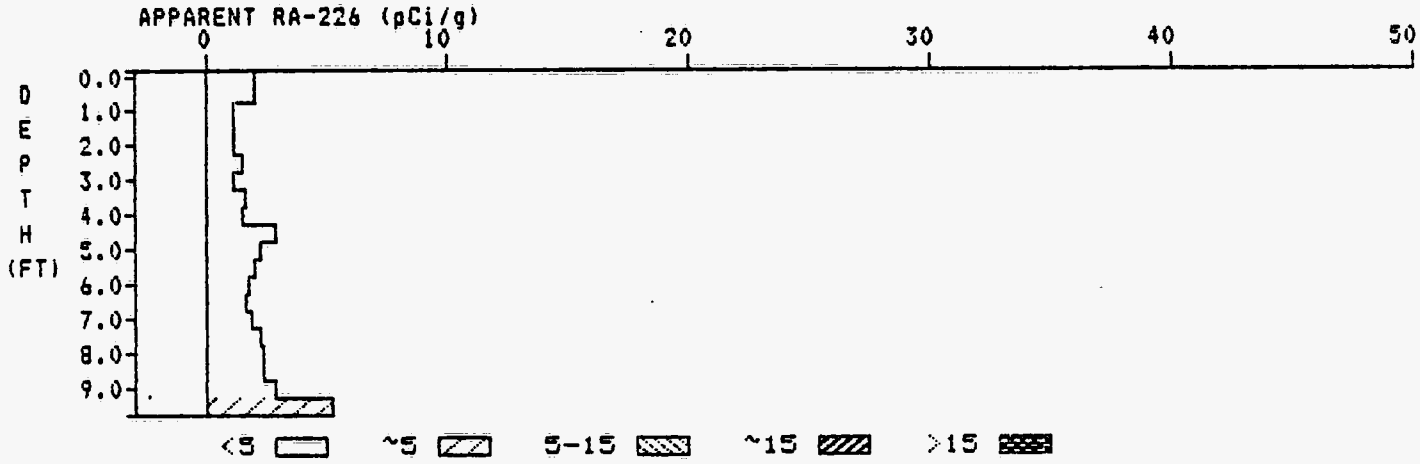
APPARENT RADIUM-226 CONCENTRATION MRP-014

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 014
LOCATION: 11270.0N 20400.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850908
ELEVATION: 6982.4 FT.
AUGER HEIGHT: 8.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 813 GJO NO.: C-3958S



Depth (ft)	Observed Count Rate (cps)		Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	226.6		1.9	0.7
0.5	218.8		1.9	0.8
1.0	193.0		1.1	0.8
1.5	182.1	<	1.0	0.8
2.0	183.5	<	1.0	0.8
2.5	193.2		1.4	0.8
3.0	188.3	<	1.0	0.9
3.5	202.7		1.6	0.8
4.0	202.5		1.4	0.8
4.5	167.5		2.8	0.8
5.0	235.6		2.2	0.8
5.5	225.4		1.9	0.8
6.0	216.0		1.7	0.8
6.5	211.8		1.5	0.8
7.0	220.0		1.8	0.8
7.5	234.3		2.1	0.8
8.0	245.5		2.4	0.8
8.5	253.5		2.3	0.8
9.0	275.3		2.8	0.9
9.5	257.5		5.2	0.8

This data generated by LOGCALC.BAS Version 2.2 S/N 008

APPARENT RADIUM-226 CONCENTRATION MRP-015

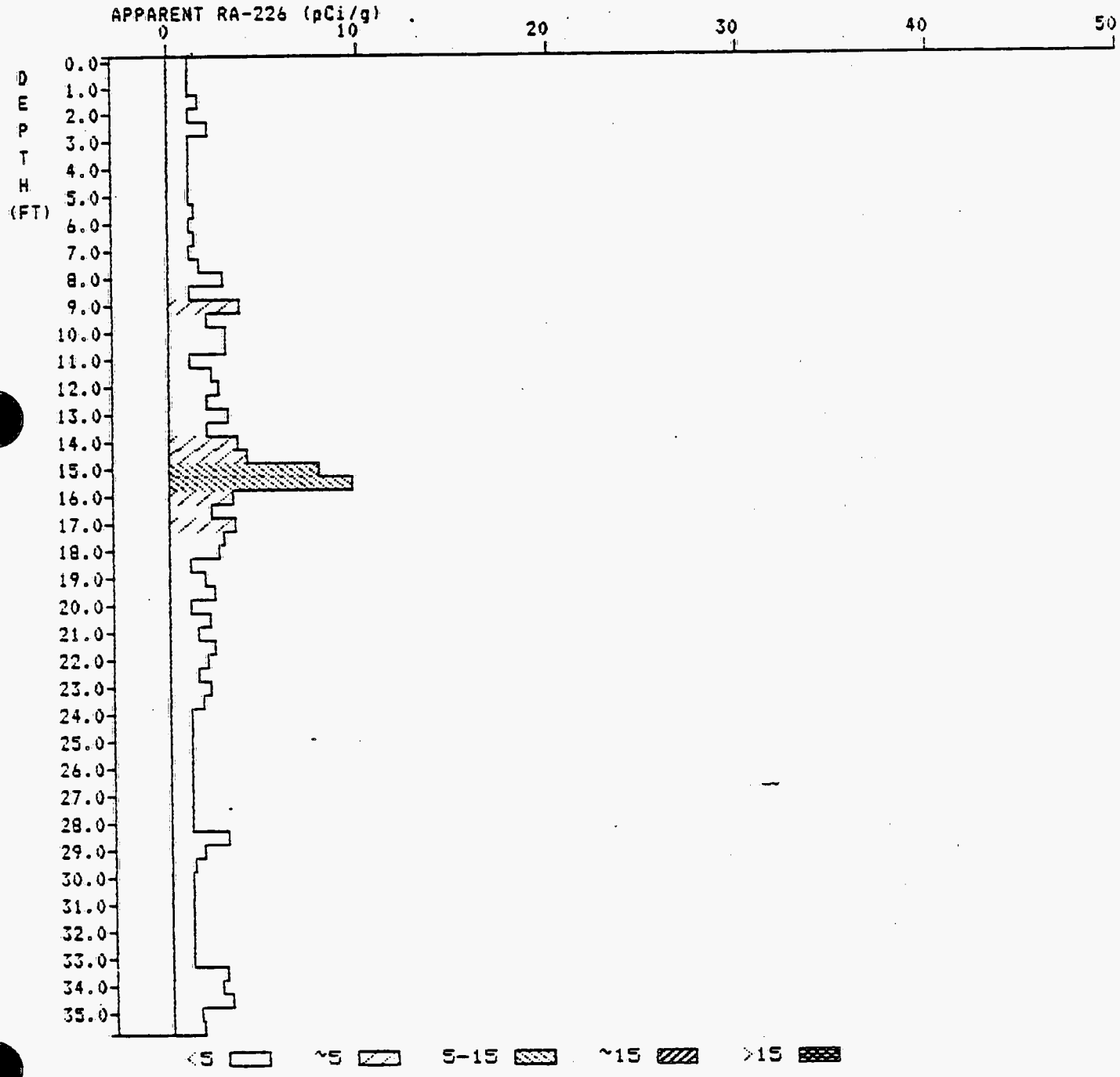
PROJECT: M R A P

START DATE: 850903

HOLE NUMBER: 015
LOCATION: 10115.0N 28534.5E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850909
ELEVATION: 6841.5 FT.
AUGER HEIGHT: 52.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-015

Depth (ft)	Observed Count Rate (cps)		Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	24.7	<	1.0	1.7
0.5	22.4	<	1.0	1.9
1.0	24.8	<	1.0	1.9
1.5	30.6		1.6	1.9
2.0	29.3	<	1.0	1.9
2.5	31.9		2.0	1.9
3.0	27.6	<	1.0	1.8
3.5	25.8	<	1.0	1.8
4.0	25.9	<	1.0	1.8
4.5	25.7	<	1.0	1.8
5.0	25.7	<	1.0	1.8
5.5	23.3		1.4	1.9
6.0	23.0	<	1.0	1.9
6.5	28.9		1.3	1.9
7.0	29.8	<	1.0	1.8
7.5	33.0		1.6	1.9
8.0	37.3		2.8	1.9
8.5	34.5		1.1	1.9
9.0	40.4		3.6	2.0
9.5	38.3		2.0	1.9
10.0	38.5		2.9	1.9
10.5	31.6		3.0	2.0
11.0	29.3	<	1.0	2.0
11.5	35.2		2.2	1.9
12.0	38.2		2.6	1.9
12.5	37.0		1.9	1.9
13.0	39.5		3.0	1.9
13.5	38.7		2.0	1.9
14.0	44.2		3.6	1.9
14.5	51.2		4.1	2.0
15.0	64.4		7.8	2.2
15.5	57.9		9.6	2.5
16.0	45.4		3.3	2.2
16.5	39.1		2.2	2.0
17.0	41.8		3.5	1.9
17.5	40.7		2.8	1.9
18.0	37.7		2.6	1.9
18.5	31.4	<	1.0	1.9
19.0	33.1		1.8	1.9
19.5	35.5		2.3	1.9
20.0	31.3	<	1.0	1.9
20.5	27.4		2.1	1.9
21.0	30.4		1.5	1.9
21.5	35.6		2.3	1.9
22.0	35.2		1.9	1.9
22.5	33.4		1.5	1.9
23.0	34.5		2.0	1.9
23.5	33.4		1.7	1.9
24.0	29.8		1.1	1.8
24.5	25.4	<	1.0	1.8
25.0	20.8	<	1.0	1.8
25.5	18.3	<	1.0	1.8
26.0	19.8	<	1.0	1.8
26.5	20.5	<	1.0	1.8
27.0	19.9	<	1.0	1.7
27.5	18.5	<	1.0	1.8
28.0	27.6	<	1.0	1.8
28.5	37.2		3.0	1.9
29.0	34.7		1.7	1.9
29.5	29.9		1.2	1.8
30.0	23.7	<	1.0	1.8
30.5	18.0	<	1.0	1.8
31.0	19.4	<	1.0	1.8
31.5	17.5	<	1.0	1.7
32.0	20.5	<	1.0	1.8
32.5	20.0	<	1.0	1.8
33.0	27.6	<	1.0	1.8
33.5	37.6		2.8	1.9
34.0	39.4		2.6	1.9
34.5	39.7		3.1	1.9
35.0	33.9		1.5	1.8
35.5	26.2		1.5	1.7

This data generated by LOGCALC.BAS Version 2.2 S/N 008

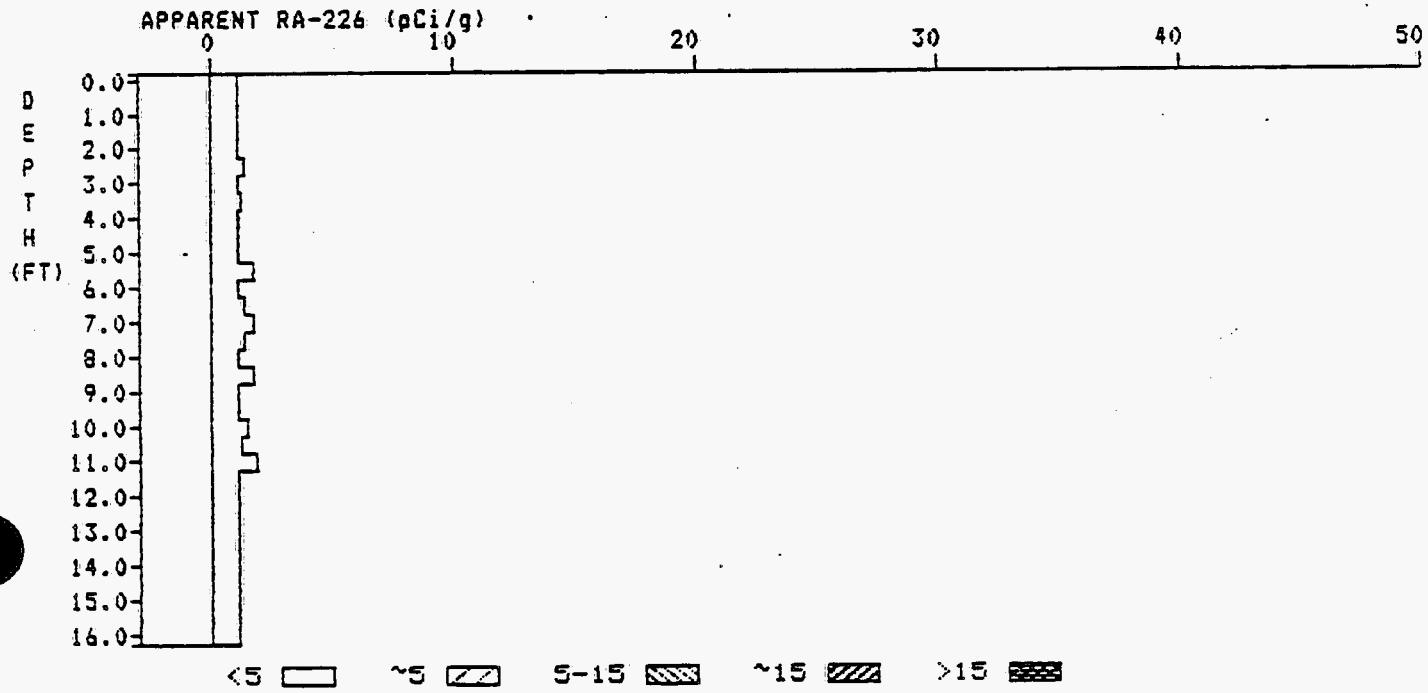
APPARENT RADIUM-226 CONCENTRATION MRP-016

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 016
LOCATION: 9798.0N 29447.0E
FLUID LEVEL: 10.8 FT.
PHASE: 1

DATE DRILLED: 850909
ELEVATION: 6820.0 FT.
AUGER HEIGHT: 19.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-016

Depth (ft)	Observed Count Rate (cps)		Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	24.8	<	1.0	1.7
0.5	25.4	<	1.0	1.8
1.0	26.7	<	1.0	1.8
1.5	26.9	<	1.0	1.8
2.0	24.8	<	1.0	1.8
2.5	28.7		1.3	1.8
3.0	26.2	<	1.0	1.8
3.5	22.8		1.2	1.9
4.0	22.5	<	1.0	1.8
4.5	23.2	<	1.0	1.8
5.0	26.2	<	1.0	1.8
5.5	30.6		1.6	1.8
6.0	28.4	<	1.0	1.8
6.5	30.3		1.3	1.8
7.0	32.6		1.7	1.8
7.5	31.2		1.3	1.8
8.0	25.8	<	1.0	1.8
8.5	24.9		1.7	1.9
9.0	29.1	<	1.0	1.8
9.5	28.2	<	1.0	1.8
10.0	30.8		1.5	1.8
10.5	30.9		1.1	1.8
11.0	28.3		1.9	1.9
11.5	20.5	<	1.0	1.8
12.0	18.1	<	1.0	1.8
12.5	19.2	<	1.0	1.8
13.0	18.5	<	1.0	1.8
13.5	14.7	<	1.0	1.8
14.0	19.1	<	1.0	1.8
14.5	20.2	<	1.0	1.8
15.0	18.3	<	1.0	1.8
15.5	18.2	<	1.0	1.8
16.0	21.6	<	1.0	1.7

This data generated by LOGCALC.BAS Version 2.2 S/N 008

APPARENT RADIUM-226 CONCENTRATION MRP-017

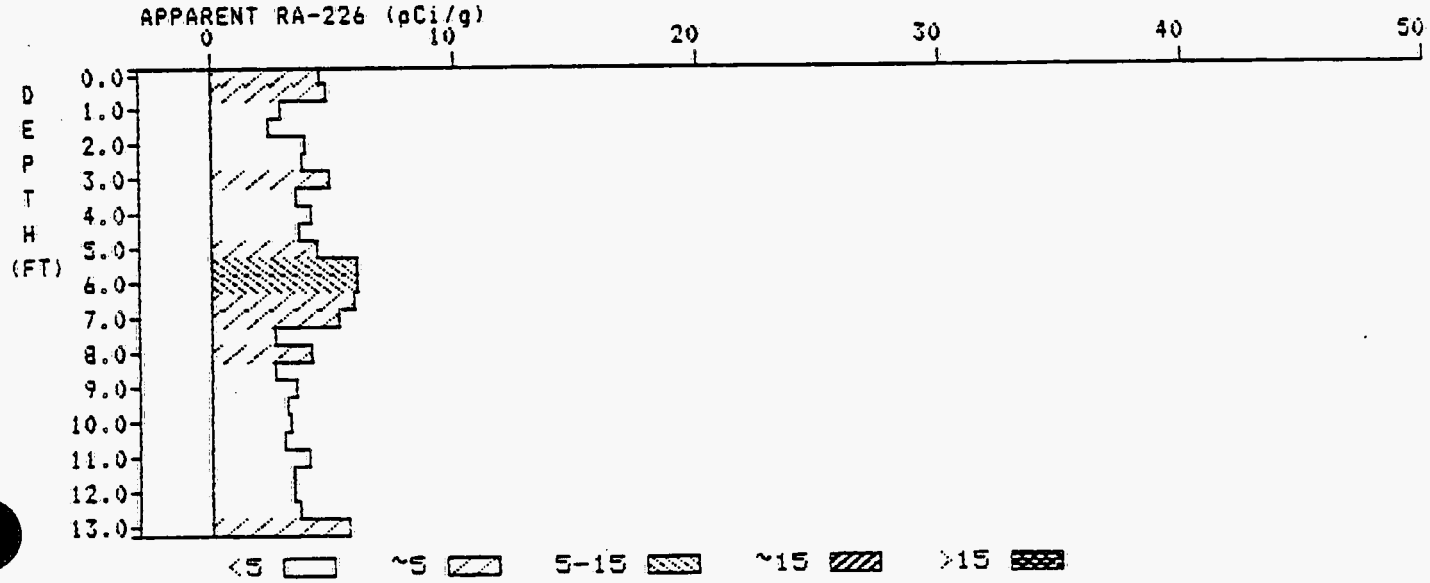
PROJECT: M R A P

START DATE: 850903

HOLE NUMBER: 017
LOCATION: 10035.0N 25005.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850908
ELEVATION: 6782.2 FT.
AUGER HEIGHT: 27.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 813 GJO NO.: C-3958S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	343.5	4.4	0.8
0.5	338.1	4.7	0.9
1.0	284.5	2.8	0.8
1.5	262.2	2.4	0.8
2.0	301.4	3.9	0.9
2.5	283.8	3.7	1.2
3.0	233.5	4.8	1.0
3.5	313.4	3.4	0.9
4.0	319.6	4.1	0.8
4.5	319.0	3.6	0.8
5.0	345.2	4.4	0.8
5.5	397.6	5.9	0.9
6.0	412.7	6.0	0.9
6.5	402.2	5.8	0.9
7.0	366.4	5.1	0.9
7.5	263.5	4.6	1.2
8.0	208.6	4.1	1.0
8.5	275.3	4.5	0.9
9.0	285.4	3.5	0.8
9.5	284.8	3.1	0.8
10.0	284.4	3.2	0.8
10.5	284.0	3.0	0.8
11.0	305.4	3.9	0.8
11.5	299.2	3.3	0.8
12.0	296.6	3.2	0.8
12.5	289.2	3.6	1.2
13.0	274.8	5.6	0.9

This data generated by LOGCALC.BAS Version 2.2 S/N 008

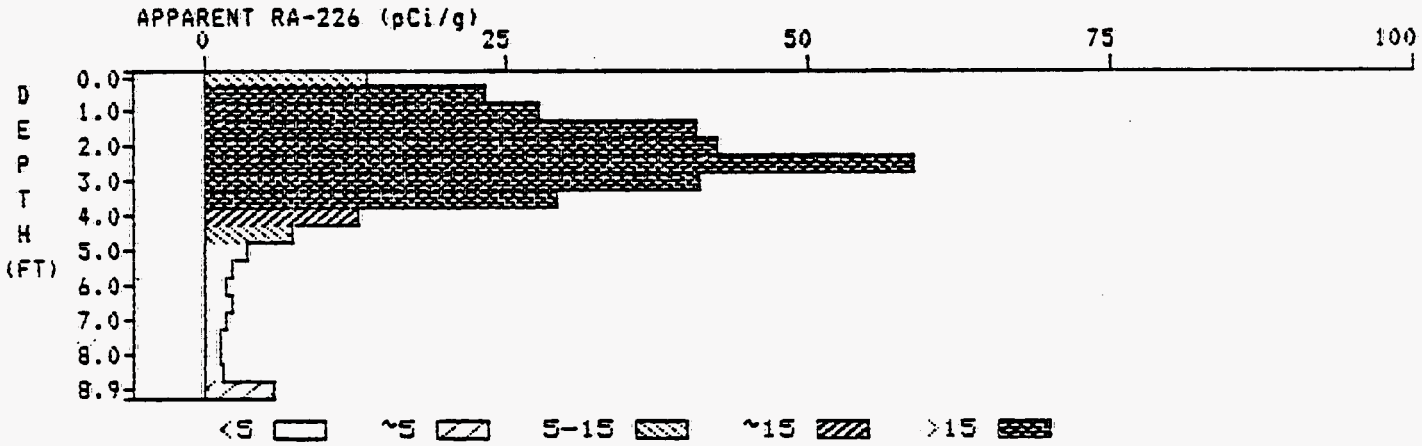
APPARENT RADIUM-226 CONCENTRATION MRP-018

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 018
LOCATION: 10365.0N 23605.0E
FLUID LEVEL: 7.8 FT.
PHASE: 1

DATE DRILLED: 850908
ELEVATION: 6803.8 FT.
AUGER HEIGHT: 17.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 813 GJO NO.: C-3958S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	770.5	13.4	1.1
0.5	1185.1	23.0	1.7
1.0	1503.0	27.5	2.0
1.5	1954.4	40.6	2.7
2.0	2216.6	42.4	2.8
2.5	2570.0	58.7	5.0
3.0	2121.6	40.9	3.1
3.5	1082.7	29.1	4.5
4.0	665.5	12.5	3.8
4.5	496.0	7.2	1.7
5.0	319.9	3.3	1.0
5.5	244.7	2.2	0.8
6.0	218.2	1.6	0.8
6.5	221.5	2.0	0.8
7.0	210.6	1.6	0.8
7.5	187.3	< 1.0	0.8
8.0	186.2	1.1	0.8
8.5	169.1	1.3	1.1
8.9	271.6	5.6	1.0

This data generated by LOGCALC.BAS Version 2.2 S/N 008

APPARENT RADIUM-226 CONCENTRATION MRP-019

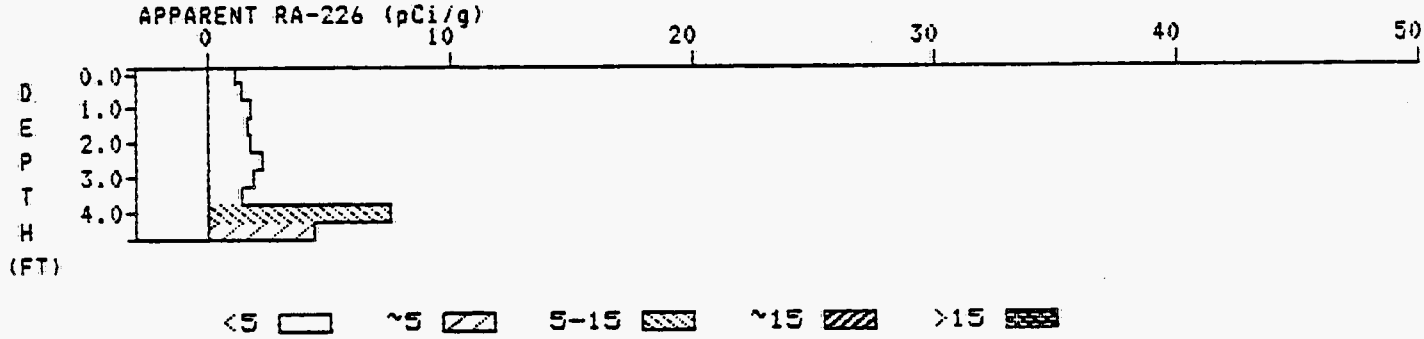
PROJECT: M R A P

START DATE: 850903

HOLE NUMBER: 019
LOCATION: 9360.0N 21405.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850908
ELEVATION: 6937.2 FT.
AUGER HEIGHT: 11.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 813 GJO NO.: C-3958S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	175.8	< 1.0	0.7
0.5	195.2	1.3	0.8
1.0	210.4	1.7	0.8
1.5	212.8	1.6	0.8
2.0	218.3	1.7	0.8
2.5	231.9	2.2	0.8
3.0	230.0	1.8	0.8
3.5	243.7	1.3	0.9
4.0	286.2	7.4	1.7
4.4	241.8	4.3	0.9

This data generated by LOGCALC.BAS Version 2.2 S/N 008

APPARENT RADIUM-226 CONCENTRATION MRP-020

PROJECT: M R A P

START DATE: 850903

HOLE NUMBER: 020

DATE DRILLED: 850908

LOCATION: 10760.0N 20705.0E

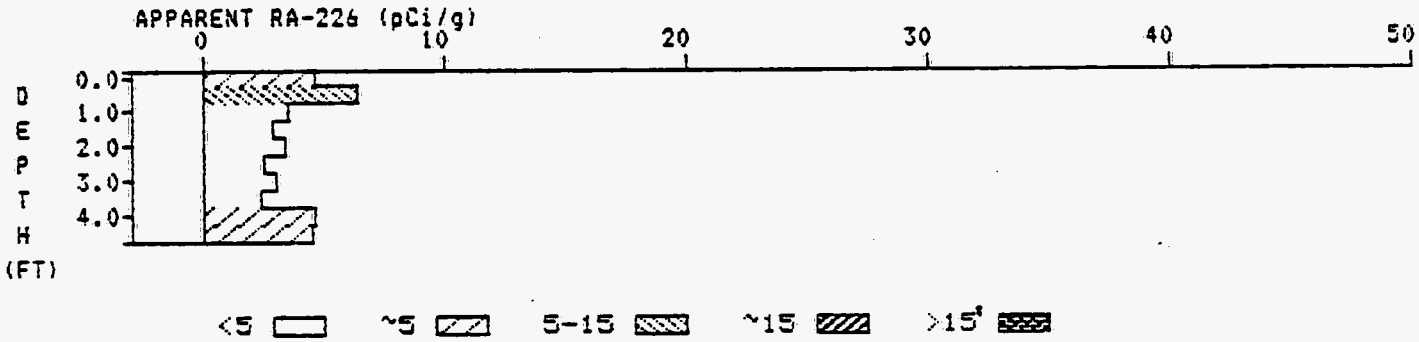
ELEVATION: 6871.3 FT.

FLUID LEVEL: 99.0 FT.

AUGER HEIGHT: 9.0 IN.

PHASE: 1

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 813 GJO NO.: C-3958S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	352.4	4.6	0.8
0.5	390.5	6.3	1.0
1.0	321.5	3.4	0.9
1.5	274.6	2.8	0.8
2.0	277.9	3.3	0.8
2.5	263.3	2.5	0.8
3.0	265.9	2.9	0.8
3.5	267.4	2.3	0.8
4.0	291.9	4.5	1.3
4.5	239.4	4.5	0.8

This data generated by LOGCALC.BAS Version 2.2 S/N 008

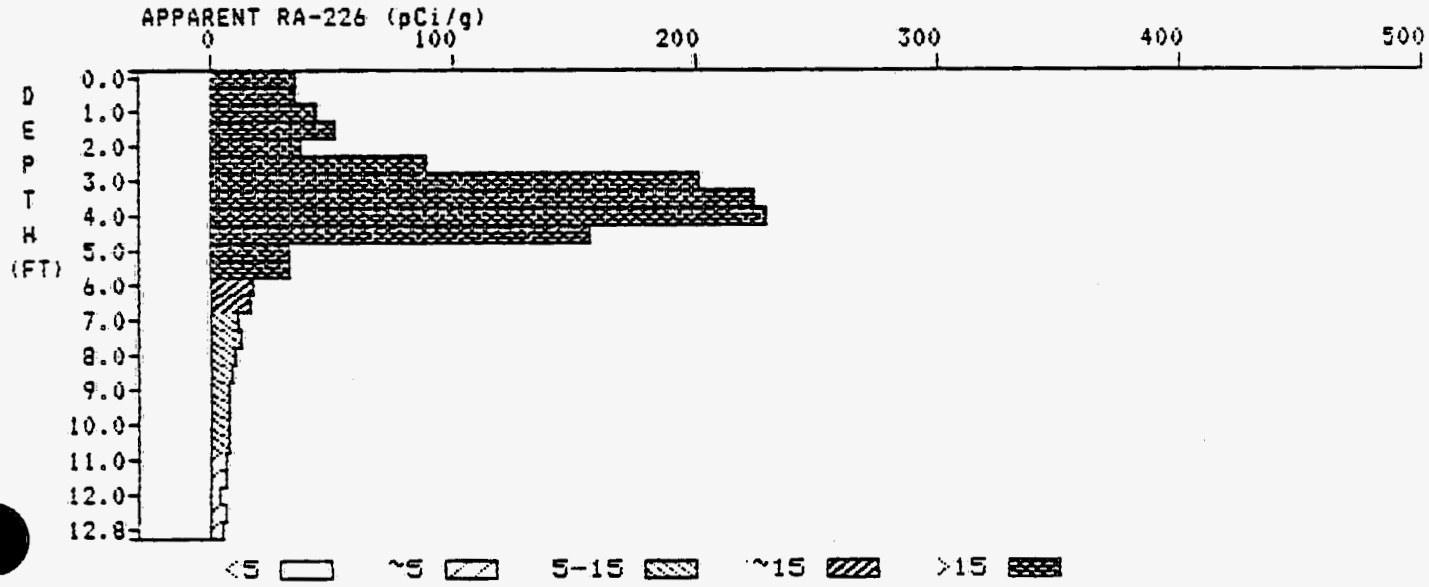
APPARENT RADIUM-226 CONCENTRATION MRP-021

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 021
LOCATION: 10160.0N 20205.0E
FLUID LEVEL: 99.0 FT.
PHASE: 2

DATE DRILLED: 850908
ELEVATION: 6884.8 FT.
AUGER HEIGHT: 31.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 813 GJO NO.: C-3958S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	1767.5	34.5	2.1
0.5	1852.3	34.5	2.4
1.0	2157.8	43.5	2.7
1.5	2464.9	50.0	3.0
2.0	2597.3	36.9	8.6
2.5	3148.5	88.7	8.5
3.0	8117.2	200.7	21.8
3.5	10332.0	223.5	14.8
4.0	10062.4	227.8	15.8
4.5	7224.3	155.1	9.7
5.0	2890.5	31.7	13.6
5.5	1517.9	32.1	5.8
6.0	1056.0	16.3	3.0
6.5	845.5	15.7	1.7
7.0	687.8	10.9	1.3
7.5	434.8	11.3	1.2
8.0	552.7	9.4	1.5
8.5	517.7	8.0	1.0
9.0	469.1	7.0	0.9
9.5	440.8	6.4	0.9
10.0	432.7	6.3	0.9
10.5	430.0	6.4	0.9
11.0	403.1	5.7	0.9
11.5	369.1	5.2	0.9
12.0	307.4	2.7	1.0
12.5	253.4	6.1	1.1
12.8	275.8	4.8	1.0

This data generated by LOGCALC.BAS Version 2.2 S/N 008

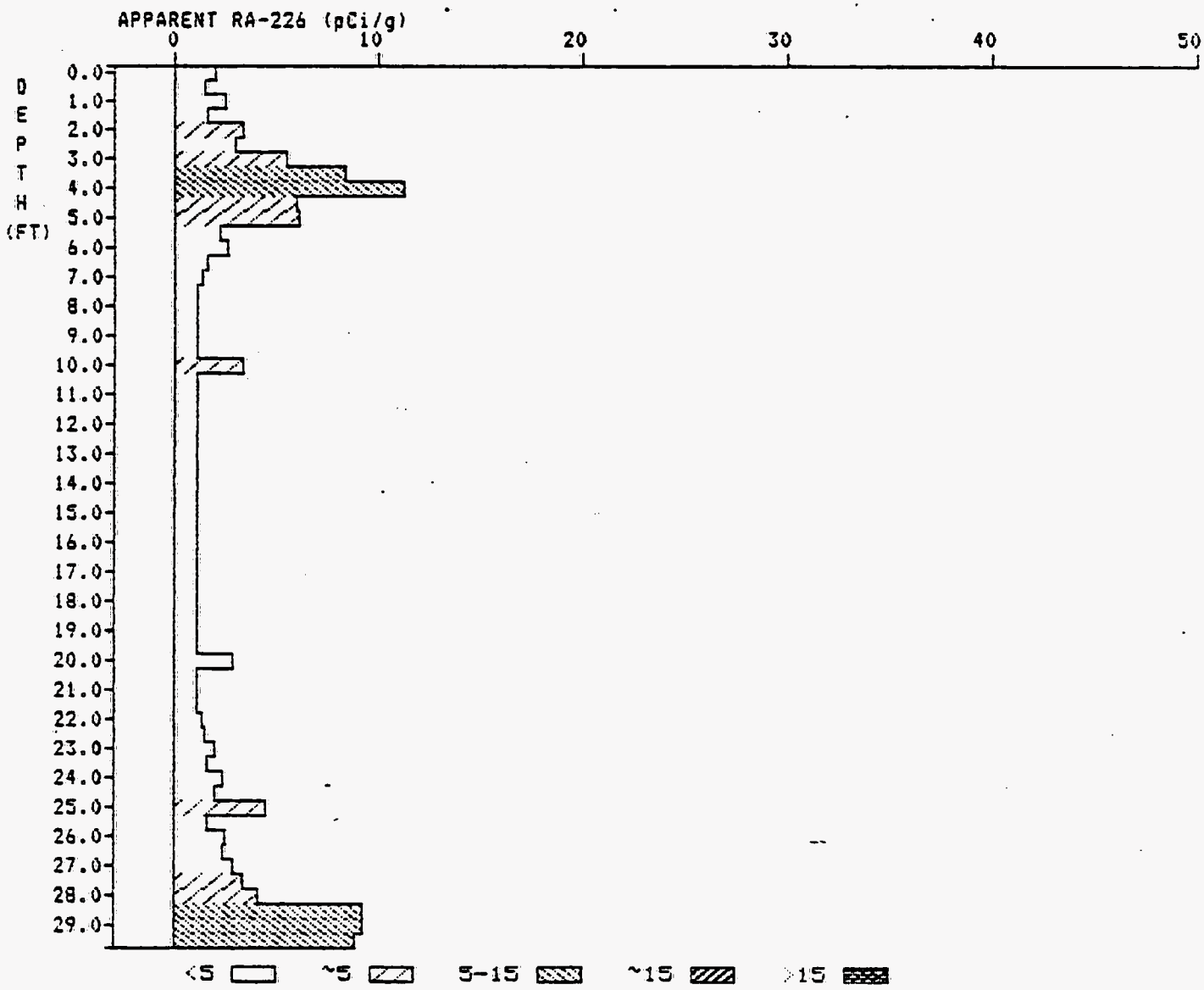
APPARENT RADIUM-226 CONCENTRATION MRP-023

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 023
LOCATION: 11294.0N 22143.5E
FLUID LEVEL: 10.0 FT.
PHASE: 1

DATE DRILLED: 850911
ELEVATION: 6877.9 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-023

Depth (ft)	Observed Count Rate (cps)		Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	35.1		1.9	1.7
0.5	42.4		1.5	1.8
1.0	48.4		2.4	1.8
1.5	47.7		1.5	1.8
2.0	55.3		3.4	1.9
2.5	59.8		2.9	1.9
3.0	74.4		5.4	2.0
3.5	94.6		8.3	2.1
4.0	107.6		11.1	2.3
4.5	81.7		6.0	2.2
5.0	58.3		6.0	2.1
5.5	53.5		2.2	2.0
6.0	49.7		2.6	1.9
6.5	45.0		1.5	1.8
7.0	41.5		1.3	1.8
7.5	38.9	<	1.0	1.8
8.0	36.0	<	1.0	1.8
8.5	36.6	<	1.0	1.8
9.0	33.5	<	1.0	1.8
9.5	31.3	<	1.0	1.8
10.0	33.0		3.3	2.2
10.5	28.6	<	1.0	2.0
11.0	31.3	<	1.0	1.9
11.5	31.0	<	1.0	1.9
12.0	31.0	<	1.0	1.9
12.5	32.0	<	1.0	1.9
13.0	31.0	<	1.0	1.9
13.5	29.9	<	1.0	1.8
14.0	26.2	<	1.0	1.8
14.5	26.5	<	1.0	1.9
15.0	25.3		1.0	1.9
15.5	24.5	<	1.0	1.8
16.0	26.5	<	1.0	1.8
16.5	26.6	<	1.0	1.8
17.0	29.1	<	1.0	1.8
17.5	31.5	<	1.0	1.9
18.0	30.1	<	1.0	1.9
18.5	32.2	<	1.0	1.9
19.0	32.7	<	1.0	1.9
19.5	32.4	<	1.0	1.9
20.0	33.8		2.9	2.1
20.5	36.1	<	1.0	2.0
21.0	34.8		1.0	1.9
21.5	32.1	<	1.0	1.9
22.0	36.4		1.3	1.9
22.5	39.6		1.5	1.9
23.0	41.9		2.0	2.0
23.5	41.5		1.5	2.0
24.0	44.4		2.4	2.0
24.5	43.1		2.0	2.1
25.0	41.9		4.4	2.2
25.5	43.5		1.5	2.1
26.0	45.0		2.5	2.0
26.5	46.5		2.3	2.0
27.0	49.3		2.8	2.1
27.5	54.1		3.3	2.1
28.0	63.2		4.1	2.2
28.5	87.1		9.2	2.6
29.0	94.3		9.1	2.5
29.5	89.7		8.8	2.0

This data generated by LOGCALC.BAS Version 2.2 S/N 008

APPARENT RADIUM-226 CONCENTRATION MRP-024

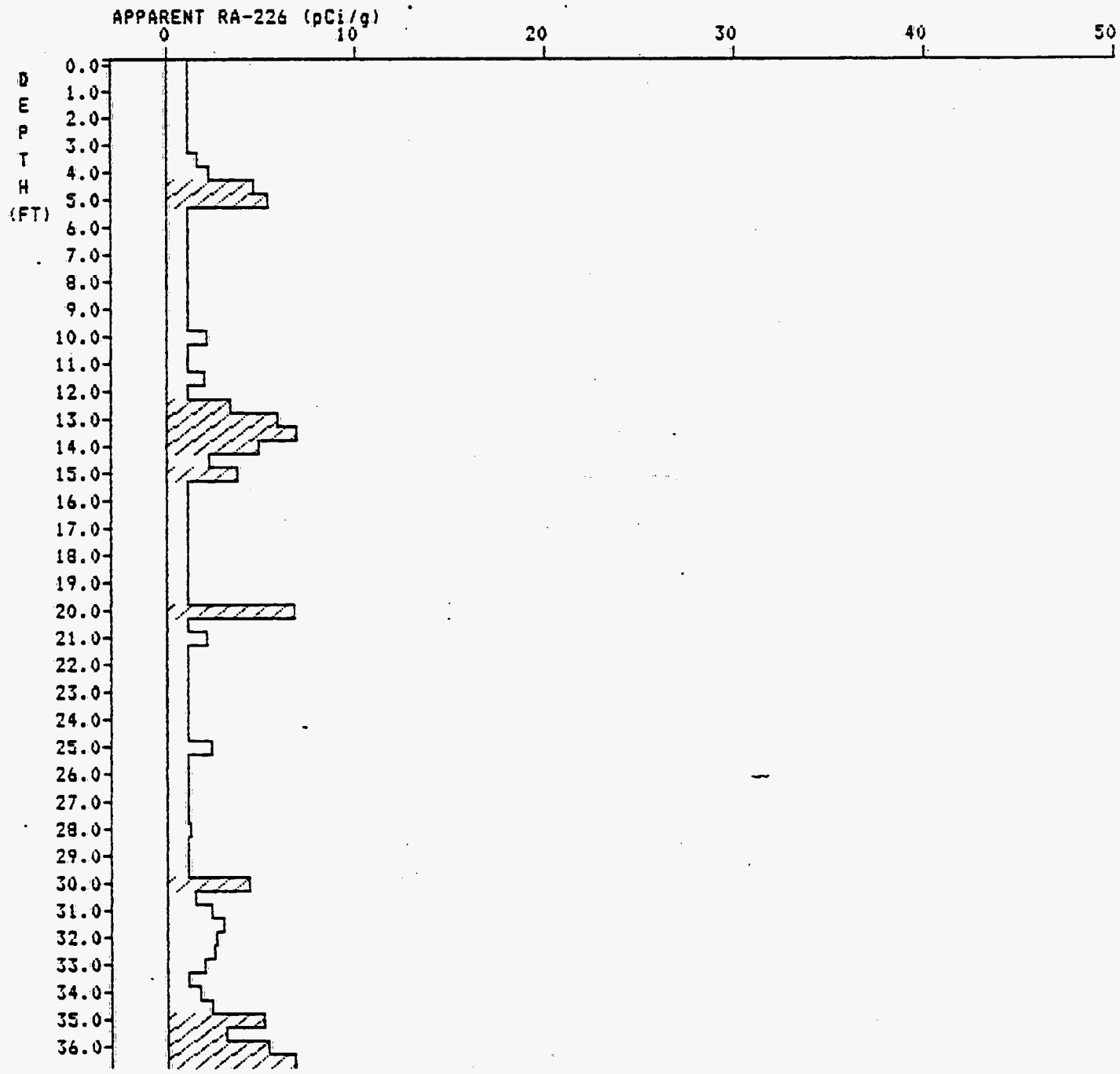
PROJECT: M R A P

START DATE: 850903

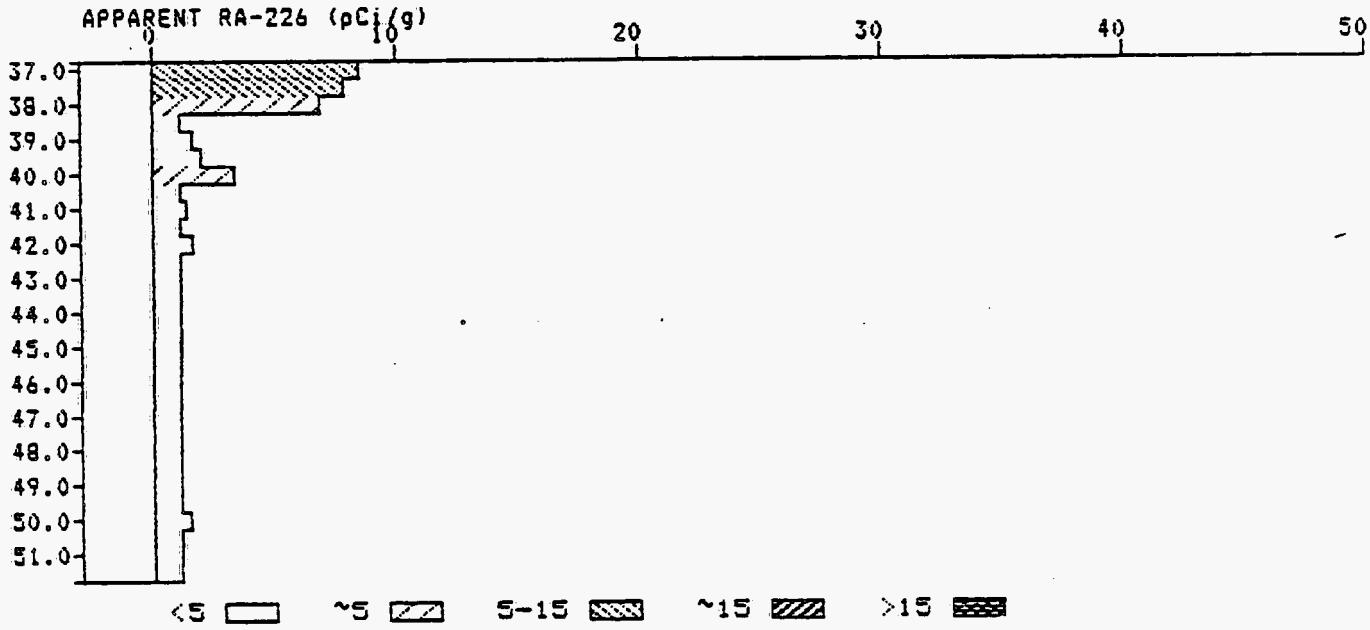
HOLE NUMBER: 024
LOCATION: 11276.5N 23107.5E
FLUID LEVEL: 12.6 FT.
PHASE: 1

DATE DRILLED: 850910
ELEVATION: 6868.4 FT.
AUGER HEIGHT: 0.0 IN.

INSTRUMENT TYPE: COMPULOGGER SERIAL NO. 230-01 GJO NO.: C-1815S



APPARENT RADIUM-226 CONCENTRATION MRP-024



APPARENT RADIUM-226 CONCENTRATION MRP-024

Depth (ft)	Observed Count Rate (cps)		Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	27.1	<	1.0	1.7
0.5	23.5	<	1.0	1.7
1.0	22.9	<	1.0	1.7
1.5	20.1	<	1.0	1.7
2.0	25.0	<	1.0	1.7
2.5	27.4	<	1.0	1.8
3.0	32.1	<	1.0	1.8
3.5	42.6		1.6	1.8
4.0	50.7		2.2	1.9
4.5	59.2		4.6	2.0
5.0	51.3		5.3	2.1
5.5	41.0	<	1.0	1.9
6.0	29.8	<	1.0	1.8
6.5	26.7	<	1.0	1.8
7.0	28.0	<	1.0	1.8
7.5	25.8	<	1.0	1.7
8.0	24.2	<	1.0	1.7
8.5	25.8	<	1.0	1.7
9.0	26.0	<	1.0	1.7
9.5	27.8	<	1.0	1.8
10.0	31.7		2.1	1.9
10.5	31.9	<	1.0	1.9
11.0	34.8	<	1.0	1.8
11.5	43.7		1.9	1.8
12.0	45.3		1.1	1.9
12.5	57.4		3.3	1.9
13.0	67.1		5.8	2.3
13.5	73.2		6.8	2.4
14.0	63.4		4.8	2.3
14.5	46.6		2.2	2.2
15.0	37.9		3.7	2.2
15.5	32.0	<	1.0	2.0
16.0	29.4	<	1.0	1.9
16.5	34.0		1.1	1.9
17.0	32.5	<	1.0	1.9
17.5	34.0	<	1.0	1.9
18.0	35.2	<	1.0	1.9
18.5	34.6	<	1.0	1.9
19.0	32.9	<	1.0	1.9
19.5	35.2	<	1.0	2.0
20.0	47.5		6.7	2.6
20.5	43.9		1.0	2.2
21.0	38.4		2.1	2.0
21.5	27.0	<	1.0	1.9
22.0	26.2	<	1.0	1.8
22.5	25.9	<	1.0	1.8
23.0	27.5	<	1.0	1.8
23.5	26.6	<	1.0	1.8
24.0	26.8	<	1.0	1.8
24.5	25.9	<	1.0	1.9
25.0	29.6		2.3	2.0
25.5	31.1	<	1.0	1.9
26.0	31.3	<	1.0	1.9
26.5	28.8	<	1.0	1.9
27.0	29.8	<	1.0	1.9
27.5	25.7	<	1.0	1.9
28.0	32.6		1.2	1.9
28.5	33.2	<	1.0	1.9
29.0	32.5	<	1.0	1.9
29.5	31.7	<	1.0	2.0
30.0	39.1		4.4	2.3
30.5	43.1		1.4	2.1
31.0	44.7		2.3	2.0
31.5	48.3		2.9	2.1
32.0	47.5		2.6	2.1
32.5	45.4		2.4	2.0
33.0	42.3		1.9	2.0
33.5	38.0	<	1.0	2.0
34.0	41.2		1.7	2.0
34.5	44.7		2.3	2.1
35.0	46.6		5.1	2.3
35.5	55.1		3.1	2.2
36.0	65.5		5.3	2.3
36.5	76.5		6.7	2.4

APPARENT RADIUM-226 CONCENTRATION MRP-024

Depth (ft)	Observed Count Rate (cps)		Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
37.0	85.2		8.4	2.6
37.5	83.1		7.8	2.5
38.0	72.3		6.8	2.4
38.5	45.3	<	1.0	2.2
39.0	39.6		1.6	2.0
39.5	40.7		2.0	2.0
40.0	37.2		3.3	2.1
40.5	36.4	<	1.0	2.0
41.0	36.5		1.4	1.9
41.5	35.3	<	1.0	1.9
42.0	35.9		1.6	1.9
42.5	27.1	<	1.0	1.8
43.0	19.9	<	1.0	1.8
43.5	17.7	<	1.0	1.7
44.0	20.7	<	1.0	1.8
44.5	25.9	<	1.0	1.9
45.0	15.6	<	1.0	1.8
45.5	14.3	<	1.0	1.7
46.0	16.5	<	1.0	1.7
46.5	21.3	<	1.0	1.8
47.0	26.3	<	1.0	1.8
47.5	25.2	<	1.0	1.8
48.0	21.0	<	1.0	1.8
48.5	19.2	<	1.0	1.8
49.0	21.2	<	1.0	1.8
49.5	23.0	<	1.0	1.8
50.0	25.6		1.4	2.0
50.5	25.7	<	1.0	1.9
51.0	25.6	<	1.0	1.9
51.5	32.5	<	1.0	1.7

This data generated by LOGCALC.BAS Version 2.2 S/N 008

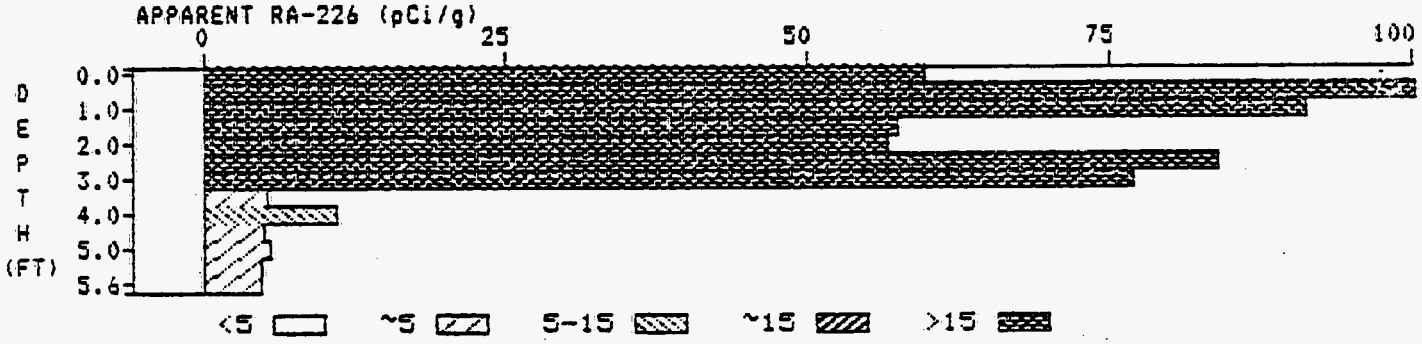
APPARENT RADIUM-226 CONCENTRATION MRP-025

PROJECT: M R A P
START DATE: 850903

HOLE NUMBER: 025
LOCATION: 11106.5N 20691.0E
FLUID LEVEL: 99.0 FT.
PHASE: 1

DATE DRILLED: 850904
ELEVATION: 6912.1 FT.
AUGER HEIGHT: 56.0 IN.

INSTRUMENT TYPE: PRS-1 RASCAL SERIAL NO. 753 GJO NO.: C-3572S



Depth (ft)	Observed Count Rate (cps)	Apparent Radium-226 (pCi/g)	2-Sigma Uncertainty (pCi/g)
0.0	2869.5	59.6	4.3
0.5	2886.9	100.2	8.6
1.0	4258.6	91.2	7.0
1.5	3302.0	57.5	5.7
2.0	3062.5	56.6	4.4
2.5	3709.6	83.9	7.1
3.0	3332.4	76.8	7.3
3.5	1175.8	5.0	8.7
4.0	549.4	10.8	3.8
4.5	437.5	4.8	1.9
5.0	369.7	5.5	1.4
5.5	248.0	4.6	1.1
5.6	248.5	4.6	1.1

This data generated by LOGCALC.BAS Version 2.2 S/N 008

Appendix C

BOREHOLE AND TEST-PIT GEOTECHNICAL DATA

Geotechnical analyses were performed on selected borehole and test-pit samples by Goodson and Associates, Inc., of Lakewood, Colorado. Proctor tests and specific gravity for tailings and borrow soils were performed by Rogers and Associates Engineering Corporation, Salt Lake City, Utah.

GOODSON & ASSOCIATES, INC.
11949 West Colfax Avenue
Lakewood, Colorado 80215

December 20, 1985

G&AI PROJECT NO: 6411.01

SUMMARY OF LABORATORY TEST RESULTS

MKB No.	Location	Depth (Feet)	Nat. Moist. (%)	Nat. Dry Density (PCF)	Gravel (%)	Sand (%)	Fines (%)	Atterberg Limits LL (%)	Atterberg Limits PI (%)	ASTM D-698 Density/ Moisture	Specific Gravity	Soil Description/ USCS
652	85-01	6-8'	4.6	89.6			3		NP		2.57	silty clay (CL-ML)
661	85-02	2-4'	4.0	107.5			49		NP		2.60	very silty sand (SM)
787	85-02	1'					66			114.7/14.5		sandy silt (ML)
749	85-03	2-4'	27.4	92.1			84	20	4		2.67	slightly clayey silt (ML)
682	85-04	4-6'	39.8	80.7			44	27	10		2.62	sandy clay (CL)
783	85-04	1'					71			114.3/13.7		sandy silt (SM)
678	85-05	6-8'	41.7	76.1			94	21	5		2.63	clayey silt (CL-ML)
689	85-06	2-4'	5.2	96.4			42		NP		2.67	very silty sand (SM)
779	85-06	1'					52			111.2/14.1		sandy silt (ML)
697	85-07	2-4'	9.9	94.0			19		NP		2.61	silty sand (SM)
714	85-08	12-14'	34.4	108.6			81	41	22		2.70	sandy clay (CL)
706	85-09	4-6'	21.4	100.7			88	42	13		2.63	sandy clay (CL)
723	85-10	4-6'	43.5	66.1			78	29	11		2.63	sandy clay (CL)
791	85-10	1'					49			111.8/16.9		silty sand (SM)
741	85-11	4-6'	39.8	74.8			72	44	20		2.69	sandy clay (CL)
732	85-12	4-6'	40.5	76.4			87	47	10		2.68	slightly sandy silt (ML)

GOODSON & ASSOCIATES, INC.
11949 West Colfax Avenue
Lakewood, Colorado 80215

December 20, 1985

G&AI PROJECT NO: 6411.01

SUMMARY OF LABORATORY TEST RESULTS

MKB No.	Location	Depth (Feet)	Nat. Moist. (%)	Nat. Dry Density (PCF)	Gravel (%)	Sand (%)	Fines (%)	Atterberg Limits LL (%)	Atterberg Limits PI (%)	ASTM D-698 Density/ Moisture	Specific Gravity	Soil Description/ USCS
834	85-15	2-37'	6.9				82			102.5/19.7		slightly sandy, clayey silt (ML)
835	85-16	5.5-12'	13.2				82			113.7/14.9	2.65	gravelly silt (ML)
776	85-16	9-10'	11.8	121.0			79	36	14		2.61	sandy clay (CL)
766	85-17	0-2'	48.2				31	33	10		2.63	clayey sand (SC)
830	85-17	0-5'			13	6	81			108.3/17.0		gravelly silt (ML)
768	85-18	0-2'	14.3				65	32	14		2.55	sandy clay (CL)
833	85-18	0-5'					80			103.3/19.0		sandy silt (ML)
759	85-19	0-2'	5.8				70	26	6		2.61	sandy clayey silt (CL-ML)
828	85-19	0-5'					73			109.8/15.8		sandy silt, organics (ML-OL)
753	85-20	0-2'	10.8				80	41	7		2.62	sandy silt, organics (OL)
836	85-20	0-3'					71			101.9/18.9		gravelly silt, (topsoil, OL)
756	85-21	0-2'	7.5					30	10		2.60	silty sand, (topsoil, OL)
826	85-21	0-3'					43			115.2/13.6		silty sand (SM)
841	+0	0-2'			19	52	29				2.54	gravelly, silty sand, organics (SM)

GOODSON & ASSOCIATES, INC.
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G&AI PROJECT NO: 6411.01

SUMMARY OF LABORATORY TEST RESULTS

MKB No.	Location	Depth (Feet)	Nat. Moist. (%)	Nat. Dry Density (PCF)	Gravel (%)	Sand (%)	Fines (%)	Atterberg Limits LL (%)	Atterberg Limits PI (%)	ASTM D-698 Density/ Moisture	Specific Gravity	Soil Description USCS
842	+1000	0-2'			56	40	4				2.65	sandy gravel (GP) organics
843	+2000	0-2'			0	39	61				2.61	very silty sand (SM) organics
840	+3500	0-1.5'			2	39	59				2.66	sandy silt (ML) organics
839	+5000	0-2'			10	40	50				2.58	gravelly sandy silt (ML) organics
838	+6500	0-1.5'			15	38	47				2.65	gravelly, sandy silt (ML) organics

SUMMARY OF PERMEABILITY TEST RESULTS

SAMPLE NO.	TYPE OF TEST	USCS	INITIAL/FINAL VOID RATIO	MAXIMUM DRY DENSITY (PCF)	MINIMUM DRY DENSITY (PCF)	PERMEABILITY (FT/YEAR)	PERMEABILITY (CM/SEC)
MKB-753	FALLING HEAD	CL	0.71/0.79	97.3	93.7	0.225	2.2 X 10-7
MKB-756	CONSTANT HEAD	CL/ML	0.71/0.67	95.9	95.4	351.8	3.4 X 10-4
MKB-756	FALLING HEAD	CL/ML	0.71/0.71	96.9	96.2	1237.6	1.2 X 10-3
MKB-759	FALLING HEAD	CL	0.74/0.68	95.1	94.0	2.07	2.0 X 10-6
MKB-766	FALLING HEAD	CL	0.77/0.75	96.0	93.2	0.062	6.1 X 10-8
MKB-768	CONSTANT HEAD	SM/SC	0.68/0.62	95.8	95.4	20.7	2.0 X 10-5
MKB-768	FALLING HEAD	SM/SC	0.64/0.58	98.0	97.8	238.5	2.3 X 10-4

NOTE: Samples were remolded to approximately 90% of an average maximum density determined from MKB-830, 833, 828, 836, and 826, which was 107.8 pcf with an optimum moisture content of 16.9%.

SUMMARY OF PERMEABILITIES
DETERMINED FROM CONSOLIDATION DATA

Sample No. (MKB No.)	USCS	Initial/Final Void Ratio	Load PSF	Permeability (ft/year)	Permeability (cm/sec)
652	CL-ML	1.046/1.043	800	0.185	1.8×10^{-7}
		1.027/1.021	1,600	0.232	2.2×10^{-7}
		1.008/0.998	3,200	0.170	1.7×10^{-7}
		0.978/0.973	6,400	0.010	9.3×10^{-9}
		0.951/0.946	12,800	0.010	9.2×10^{-9}
		0.917/0.906	25,600	0.016	1.5×10^{-8}
661	ML	0.847/0.844	800	0.030	2.9×10^{-8}
		0.834/0.830	1,600	0.032	3.1×10^{-8}
		0.816/0.813	3,200	0.008	8.1×10^{-9}
		0.804/0.793	6,400	0.104	1.0×10^{-7}
		0.771/0.768	12,800	0.007	6.4×10^{-9}
		0.741/0.735	25,600	0.007	7.2×10^{-9}
749	ML	0.928/0.921	1,600	0.020	2.0×10^{-8}
		0.908/0.900	3,200	0.008	7.6×10^{-9}
		0.885/0.860	6,400	0.007	6.4×10^{-9}
		0.854/0.815	12,800	0.004	3.7×10^{-9}
682	CL	0.635/0.629	800	0.010	9.7×10^{-9}
		0.623/0.618	1,600	0.028	2.7×10^{-8}
		0.607/0.604	3,200	0.013	1.2×10^{-8}
		0.595/0.590	6,400	0.041	3.9×10^{-8}
		0.571/0.558	12,800	0.006	5.5×10^{-9}
		0.538/0.521	25,600	0.007	7.2×10^{-9}
678	CL-ML	1.008/0.968	1,600	0.029	2.8×10^{-8}
		0.956/0.919	3,200	0.037	3.6×10^{-8}
		0.908/0.879	6,400	0.029	2.8×10^{-8}
		0.856/0.814	12,800	0.009	8.9×10^{-9}
		0.798/0.750	25,600	0.058	4.7×10^{-9}
689	SM	0.947/0.945	800	0.218	2.1×10^{-7}
		0.939/0.936	1,600	0.199	1.9×10^{-7}
		0.923/0.915	3,200	0.220	2.1×10^{-7}
		0.892/0.885	6,400	0.060	5.9×10^{-8}
		0.858/0.848	12,800	0.043	4.1×10^{-8}
697	SM	0.920/0.918	1,600	0.202	1.9×10^{-7}
		0.902/0.898	3,200	0.017	1.6×10^{-8}
		0.874/0.869	6,400	0.011	1.0×10^{-8}
		0.839/0.834	12,800	0.005	5.1×10^{-9}
714	CL	1.007/0.977	3,200	0.023	2.2×10^{-8}
		0.951/0.909	6,400	0.008	8.0×10^{-9}
		0.888/0.827	12,800	0.007	6.8×10^{-9}

SUMMARY OF PERMEABILITIES
DETERMINED FROM CONSOLIDATION DATA

Sample No. (MKB No.)	USCS	Initial/Final Void Ratio	Load PSF	Permeability (ft/year)	Permeability (cm/sec)
706	CL	0.757/0.756	800	0.087	8.5×10^{-8}
		0.750/0.734	1,600	0.044	4.2×10^{-8}
		0.671/0.662	12,800	0.061	5.9×10^{-8}
791	SM	1.077/1.074	800	0.185	1.8×10^{-7}
		0.998/0.981	6,400	0.154	1.5×10^{-7}
		0.955/0.947	12,800	0.037	3.6×10^{-8}
741	CL	1.677/1.675	800	0.113	1.1×10^{-7}
		1.654/1.647	1,600	0.223	5.1×10^{-7}
		1.405/1.326	12,800	0.161	1.6×10^{-7}
732	ML	1.468/1.465	400	0.361	3.5×10^{-7}
		1.456/1.448	800	0.221	2.1×10^{-7}
		1.434/1.425	1,600	0.173	1.7×10^{-7}
		1.401/1.351	3,200	0.361	3.5×10^{-7}
		1.290/1.208	6,400	0.184	1.8×10^{-7}
		1.134/1.031	12,800	0.090	8.9×10^{-8}
768	CL	0.688/0.686	1,600	0.069	6.8×10^{-8}
776	CL	0.405/0.403	3,200	0.215	2.1×10^{-7}

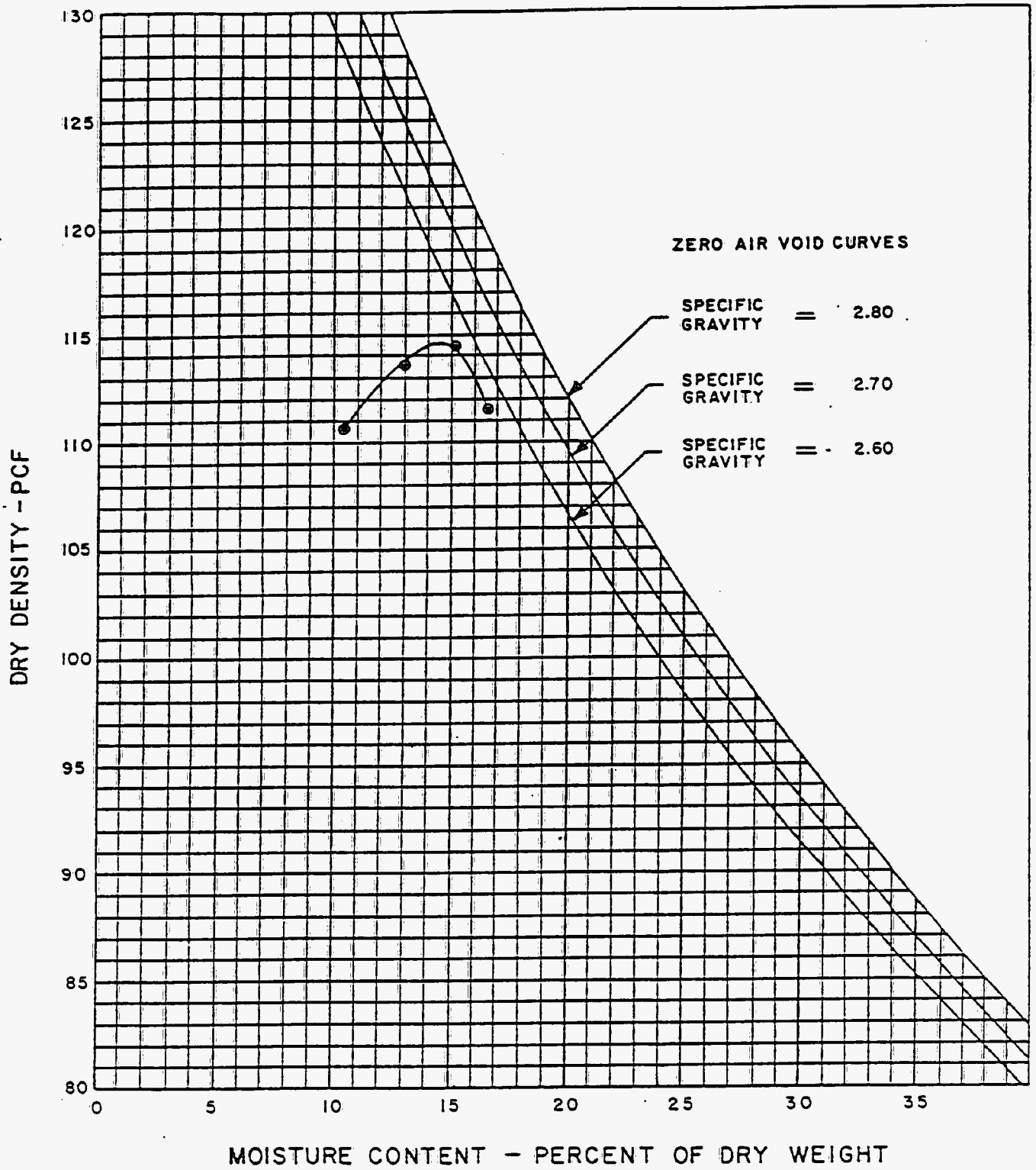
Note: Initial and Final Void Ratios are based on d_0 and d_{100} readings from Taylor plot.

GOODSON & ASSOCIATES, INC.
11949 WEST COLFAX AVENUE
LAKEWOOD, COLORADO 80215

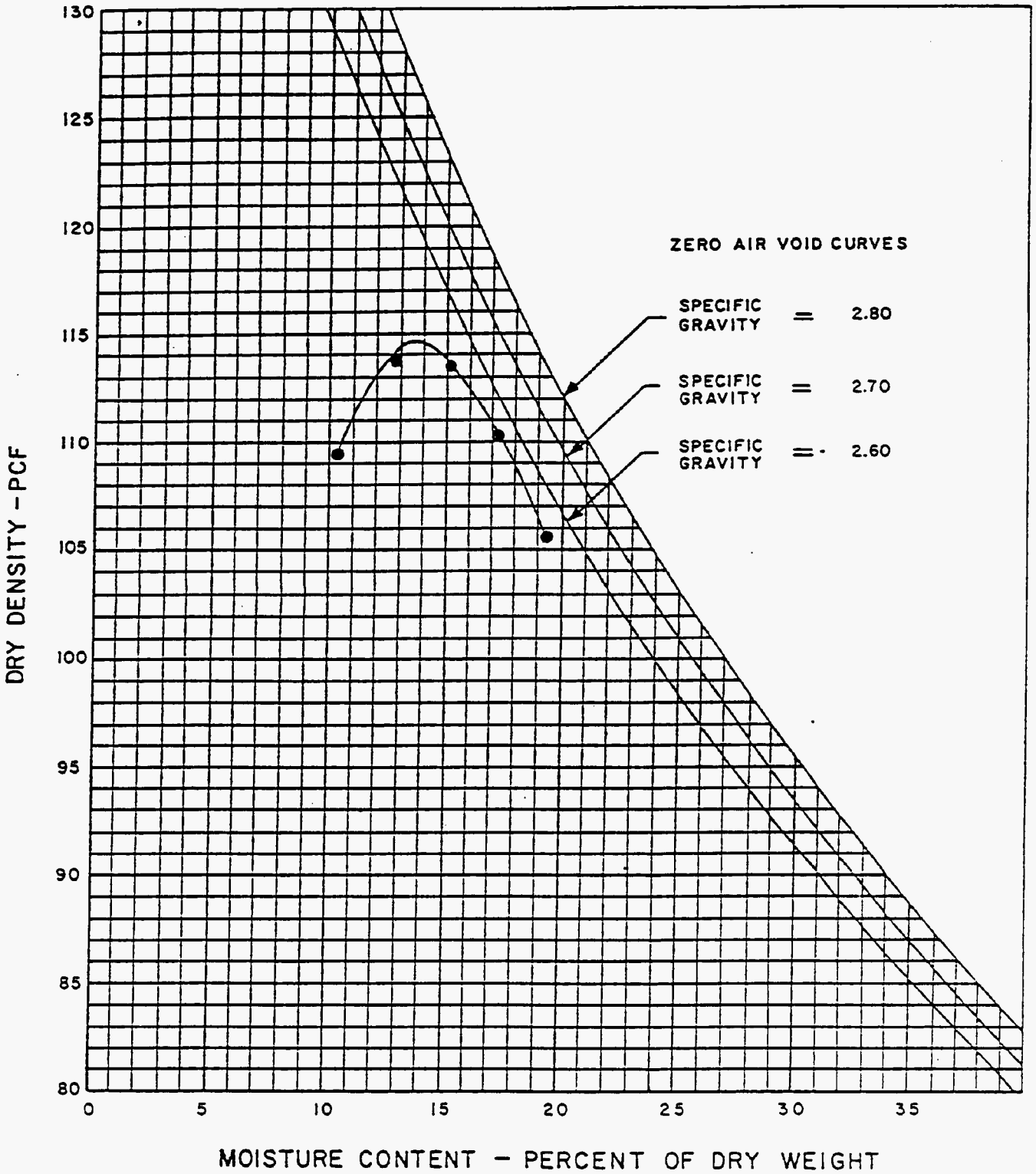
CAPILLARY WATER TEST RESULTS

Percent Capillary Water at 15 Bars tension (ASTM D2325 - 68/81)

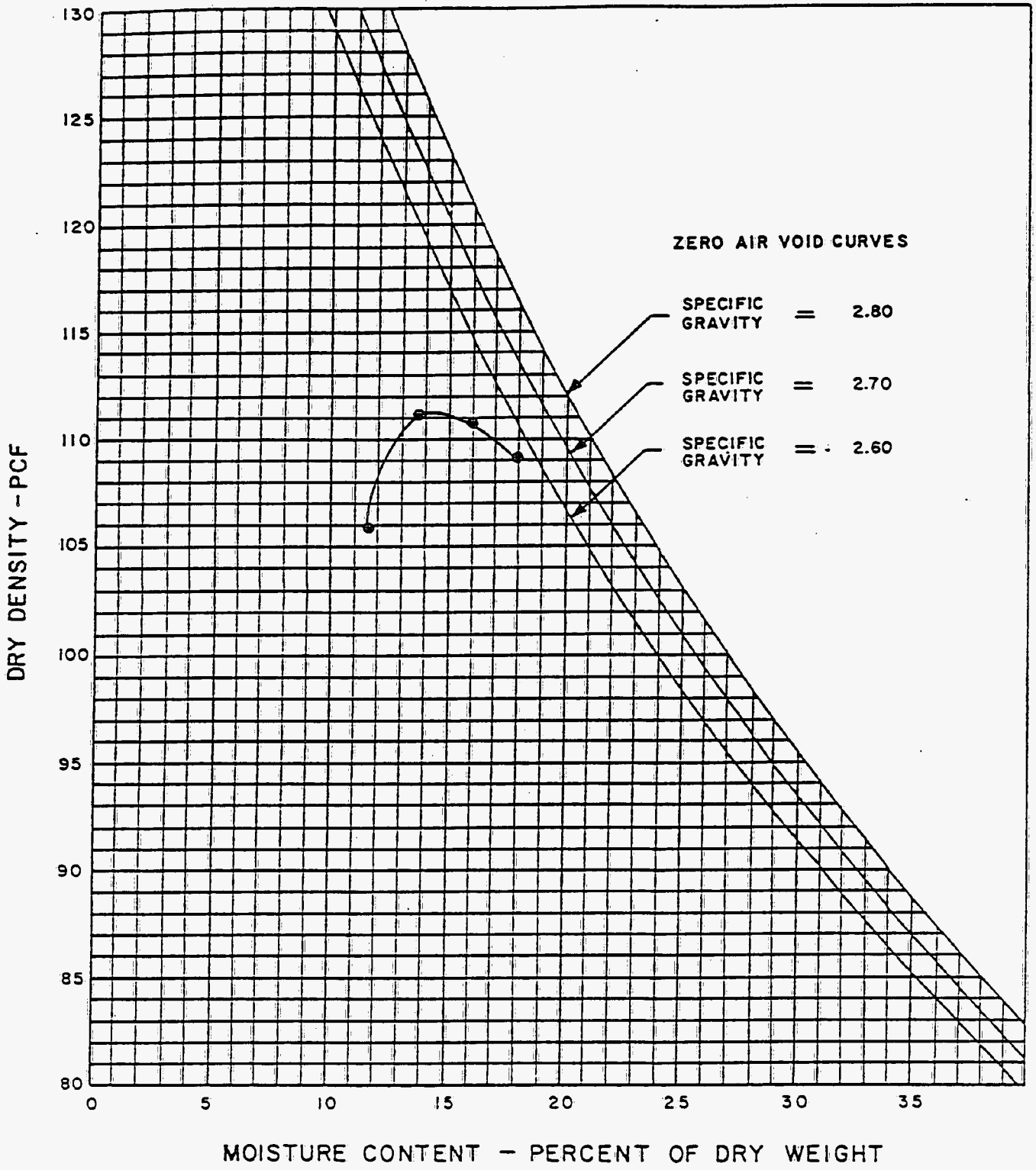
MKB NO.	LOCATION	DEPTH	(by weight) % WATER
652	85-01	6-8	4.2
661	85-02	2-4	28.9
678	85-05	6-8	34.4
689	85-06	2-4	12.5
697	85-07	2-4	7.6
714	85-08	12-14	23.5
723	85-10	4-6	33.1
732	85-12	4-6	37.5
741	85-11	4-6	7.4
749	85-03	2-4	17.9
753	85-20	0-2	14.2
756	85-21	0-2	8.4
759	85-19	0-2	9.6
766	85-17	0-2	7.0
768	85-18	0-2	12.1
706	85-09	4-6	26.4
776	85-16	9-10	11.1
682	85-04	4-6	5.3



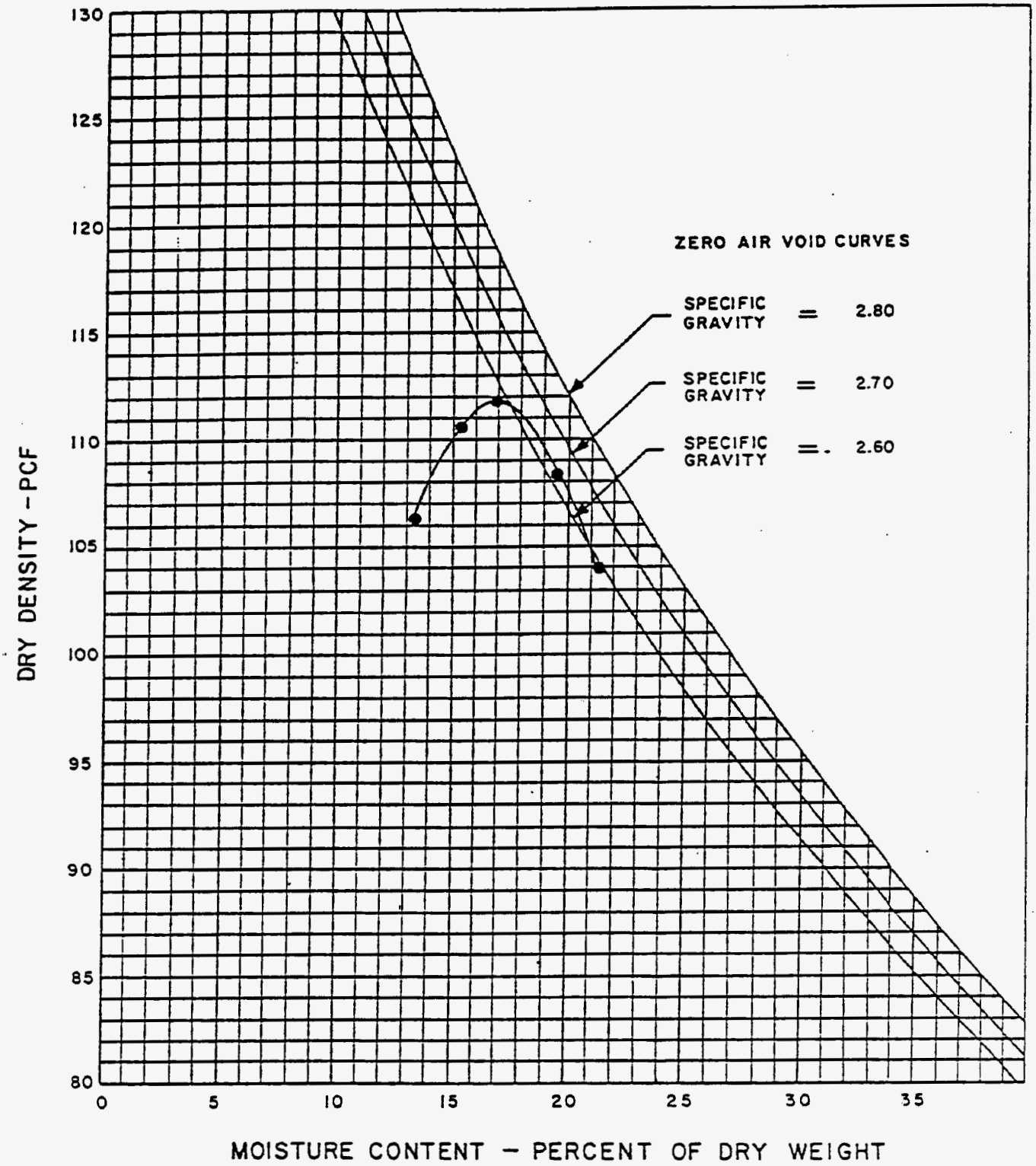
LOCATION:	MOISTURE-DENSITY RELATIONSHIPS	
HOLE NO.: 85-02 DEPTH: 1' SAMPLE NO.: MKB-787		
SOIL DESCRIPTION: sandy silt (ML)	GOODSON & ASSOC. INC.	
X. DRY DENSITY: 114.7 PCF OPT. MOIST. CONTENT: 14.5 %	PROCEDURE: ASTM D-698 Method A	
QUID LIMIT: _____ PLASTICITY INDEX: _____	JOB NO.: 6411.01	FIG. NO.
GRAVEL: ____ % SAND: 7.0 % SILT AND CLAY (-200): ____ %	DATE: 09-16-85	



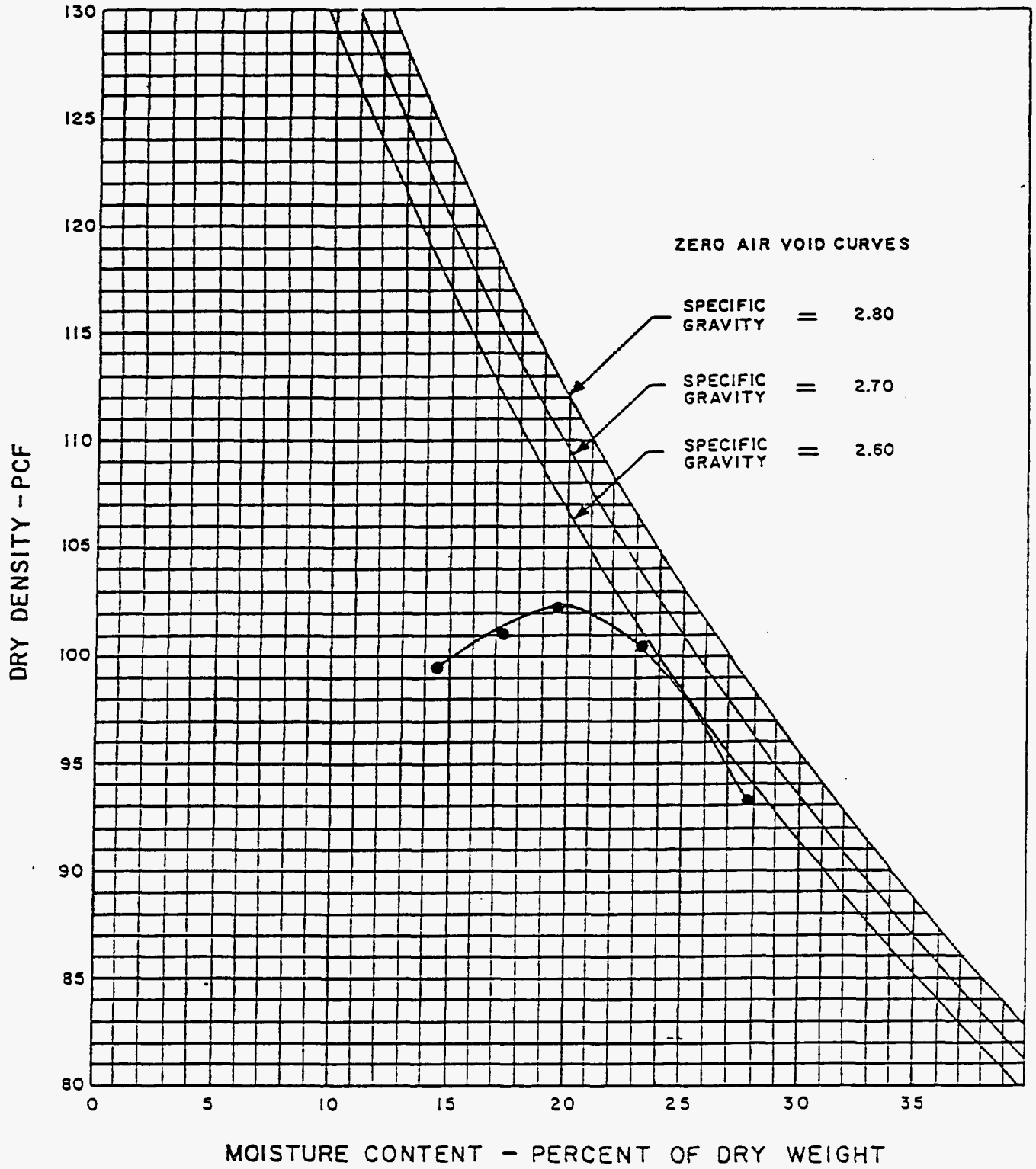
LOCATION:	MOISTURE-DENSITY RELATIONSHIPS	
HOLE NO.: 85-04 DEPTH: 1' SAMPLE NO.: MKB-783		
SOIL DESCRIPTION: sandy silt (SM)	GOODSON & ASSOC. INC.	
MAX. DRY DENSITY: 114.3 PCF OPT. MOIST. CONTENT: 13.7 %	PROCEDURE: ASTM D-698 Method A	
LIQUID LIMIT: ____ PLASTICITY INDEX: ____	JOB NO.: 6411.01	FIG. NO.
GRAVEL: ____ % SAND: ____ % SILT AND CLAY (-200) 71 %	DATE: 09-16-85	



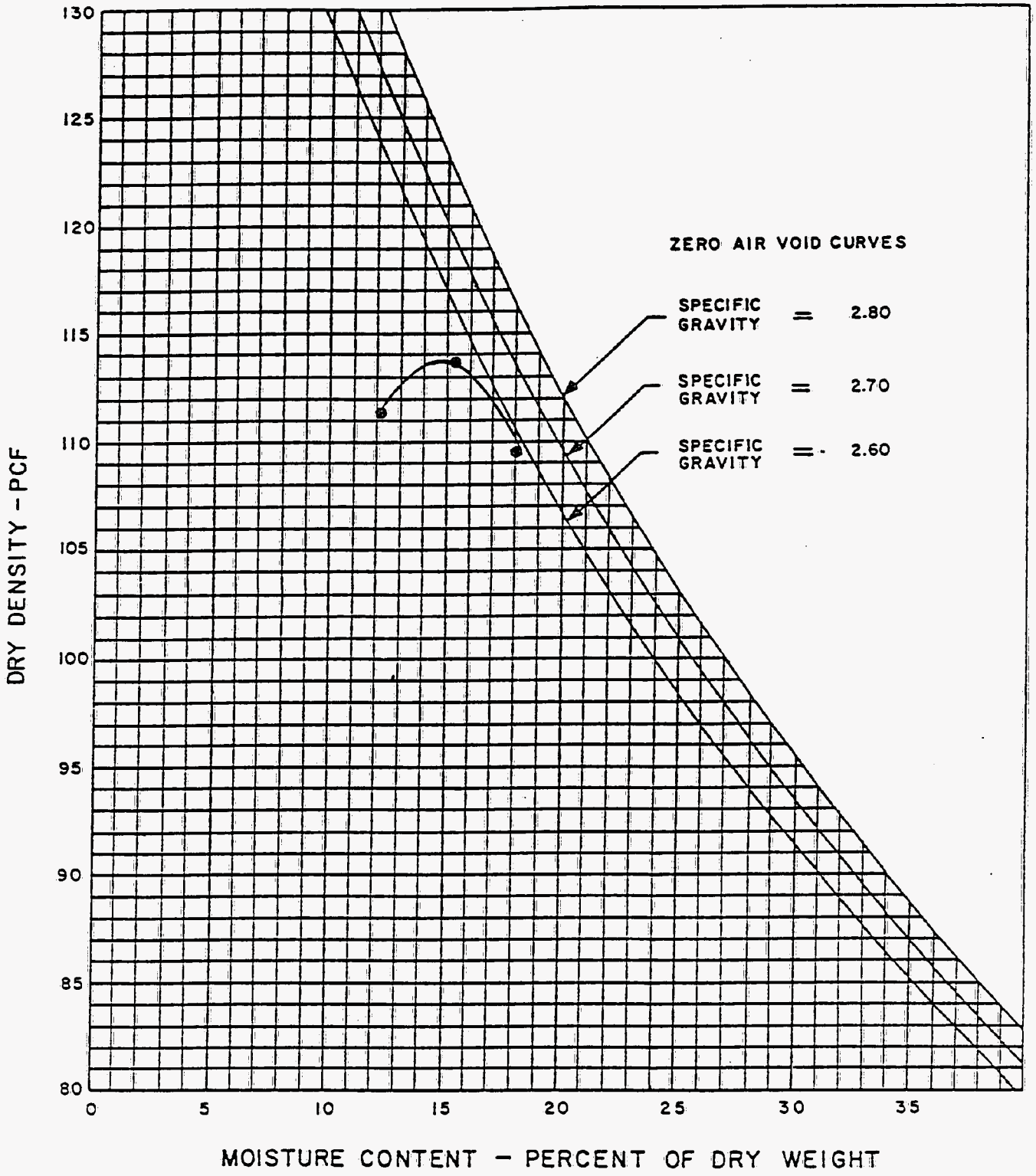
LOCATION:		MOISTURE-DENSITY RELATIONSHIPS
HOLE NO.: 85-06 DEPTH: 1.0' SAMPLE NO.: MKB-779		
SOIL DESCRIPTION: sandy silt (ML)		GOODSON & ASSOC. INC.
. DRY DENSITY: 111.2 PCF OPT. MOIST. CONTENT: 14.1 %		PROCEDURE: ASTM D-698 Method A
JID LIMIT: PLASTICITY INDEX:		JOB NO.: 6411.01 FIG. NO.
GRAVEL: % SAND: % SILT AND CLAY (-200): 52 %		DATE: 09-16-85



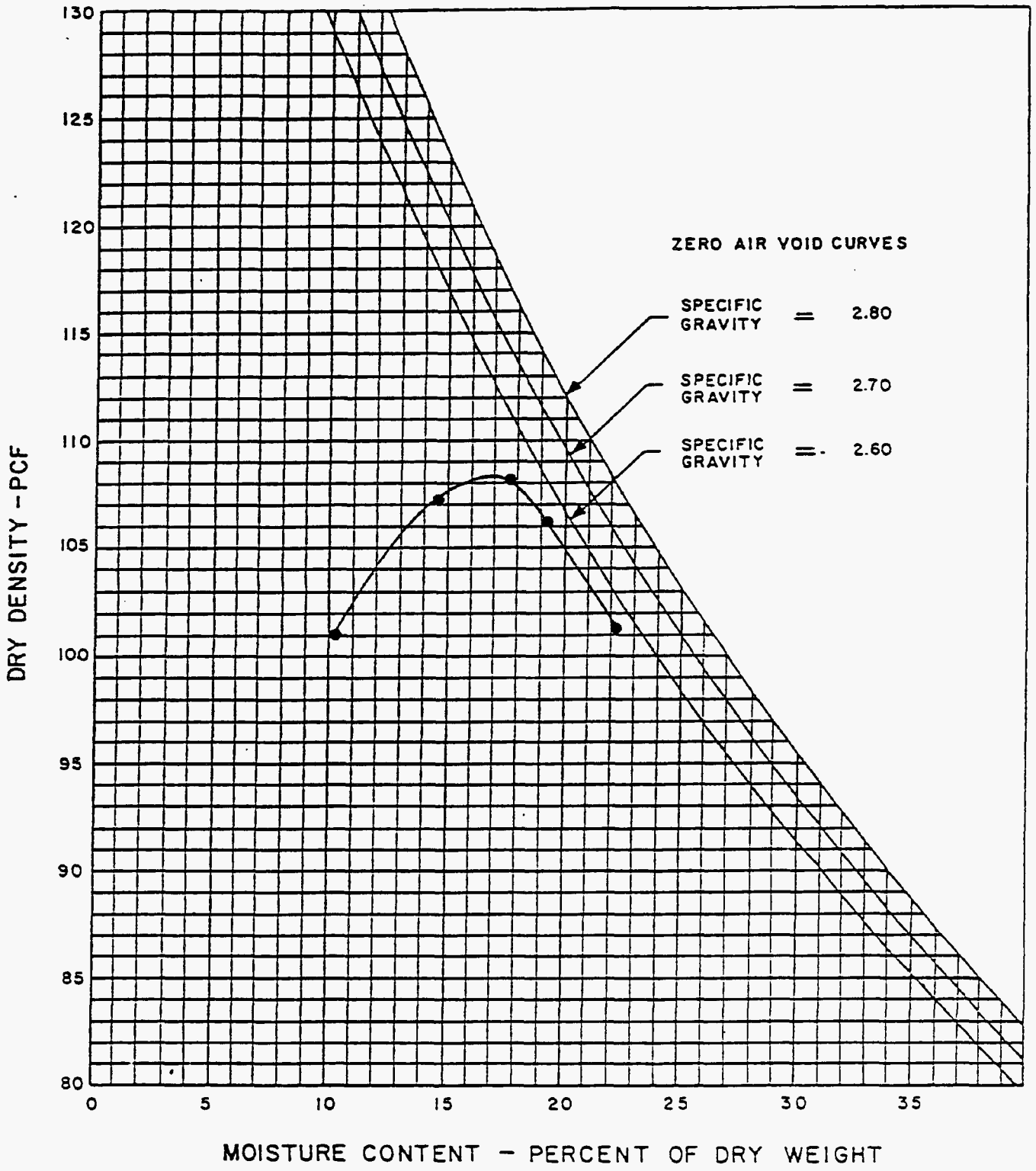
LOCATION:		MOISTURE-DENSITY RELATIONSHIPS
HOLE NO.: 85-10 DEPTH: 1' SAMPLE NO.: MKB-791		
SOIL DESCRIPTION: silty sand (SC)		GOODSON & ASSOC. INC.
MAX. DRY DENSITY: 111.8 PCF OPT. MOIST. CONTENT: 16.9 %		PROCEDURE: ASTM D-698 Method A
LIQUID LIMIT: ____ PLASTICITY INDEX: ____	JOB NO.: 6411.01	FIG NO.
GRAVEL: ____ % SAND: ____ % SILT AND CLAY (-200): 49 %	DATE: 09-16-85	



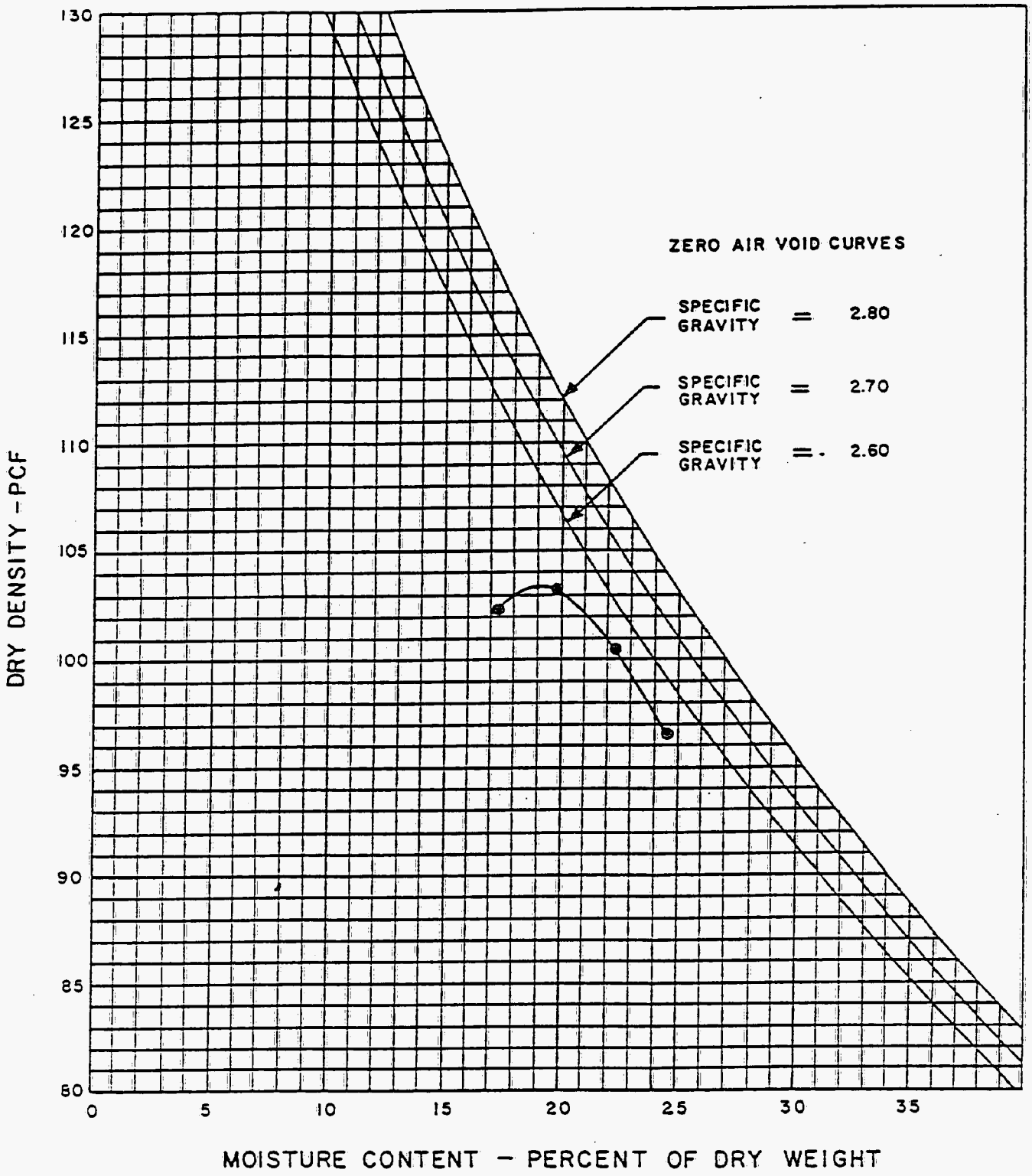
LOCATION:		MOISTURE-DENSITY RELATIONSHIPS
HOLE NO.: 85-15	DEPTH: 2-37'	SAMPLE NO.: MKB-834
SOIL DESCRIPTION: clayey silt (ML)		GOODSON & ASSOC. INC.
MAX. DRY DENSITY: 102.5 PCF	OPT. MOIST. CONTENT: 19.7 %	PROCEDURE: ASTM D-698 Method A
LIQUID LIMIT:	PLASTICITY INDEX:	JOB NO.: 6411.01 — FIG. NO.
GRAVEL: %	SAND: %	SILT AND CLAY (-200): 82 % — DATE: 09-16-85



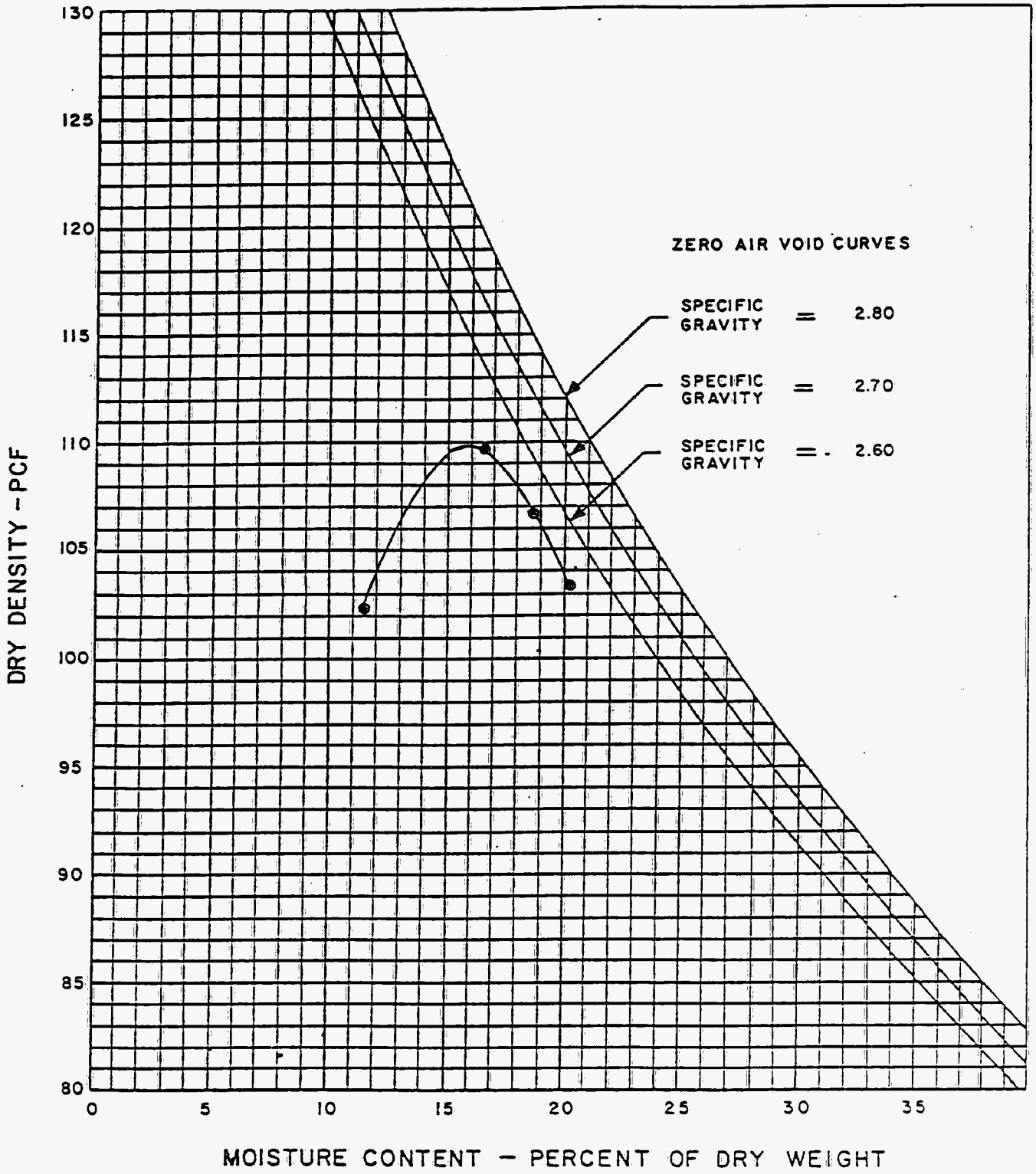
LOCATION:	MOISTURE-DENSITY RELATIONSHIPS	
HOLE NO.: 85-16 DEPTH: 5.5-12' SAMPLE NO.: MKB-835		
SOIL DESCRIPTION: slightly gravely silt	GOODSON & ASSOC. INC.	
MAX. DRY DENSITY: 113.7 PCF OPT. MOIST. CONTENT: 14.9 %	PROCEDURE: ASTM D-698 Method A	
LIQUID LIMIT: _____ PLASTICITY INDEX: _____	JOB NO.: 6411.01	FIG. NO.
GRAVEL: ____ % SAND: ____ % SILT AND CLAY (-200): 82 %	DATE: 09-16-85	



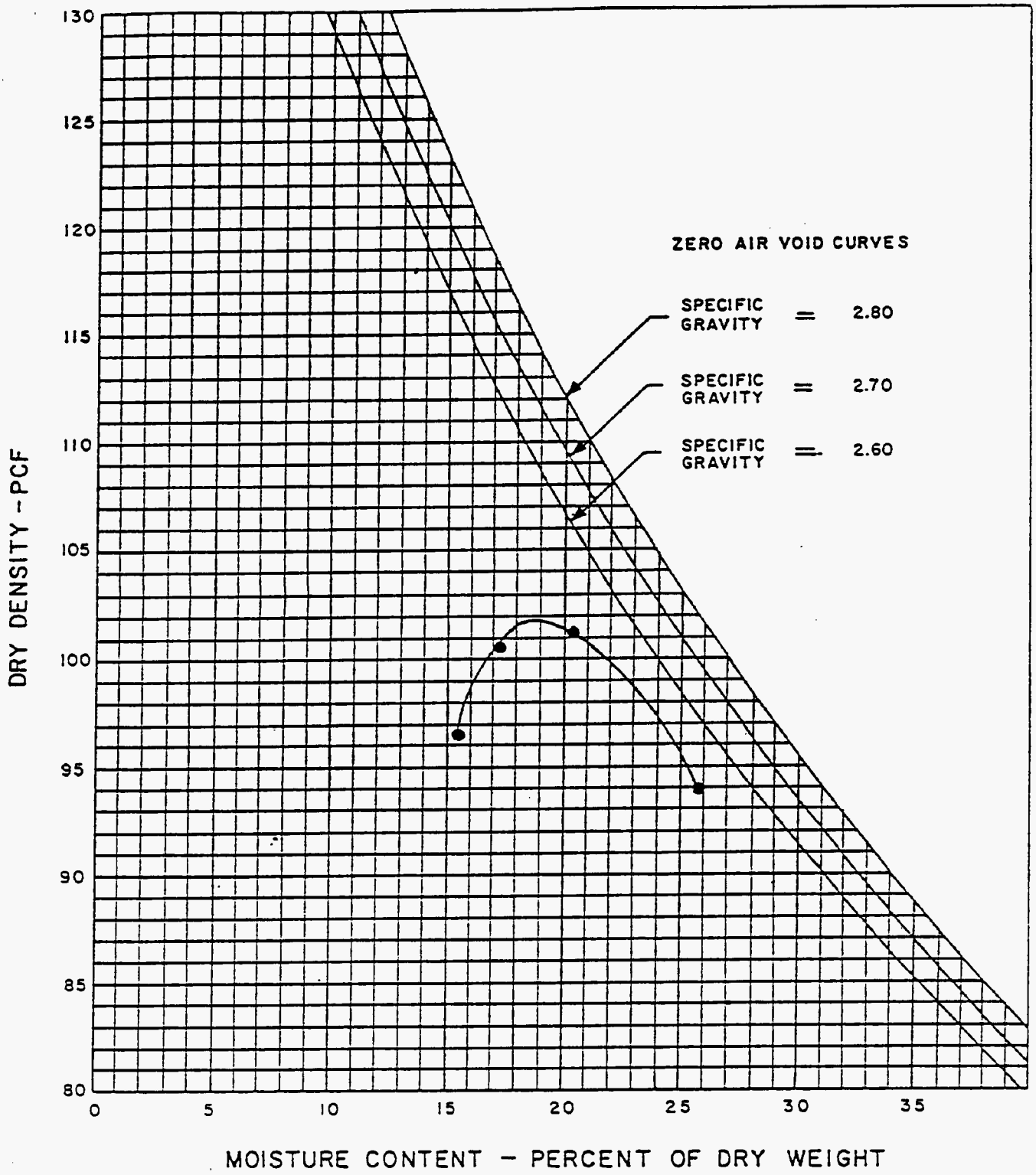
LOCATION:		MOISTURE-DENSITY RELATIONSHIPS
HOLE NO.: 85-17 DEPTH: 0-5' SAMPLE NO.: MKB-830		
SOIL DESCRIPTION: gravelly silt (ML)		GOODSON & ASSOC. INC.
MAX. DRY DENSITY: 108.3 PCF OPT. MOIST. CONTENT: 17.0 %	PROCEDURE: ASTM D-698 Method A	
LIQUID LIMIT: PLASTICITY INDEX:	JOB NO.: 6411.01	FIG. NO.
GRAVEL: 13 % SAND: 6 % SILT AND CLAY (-200): 81 %	DATE: 09-16-85	



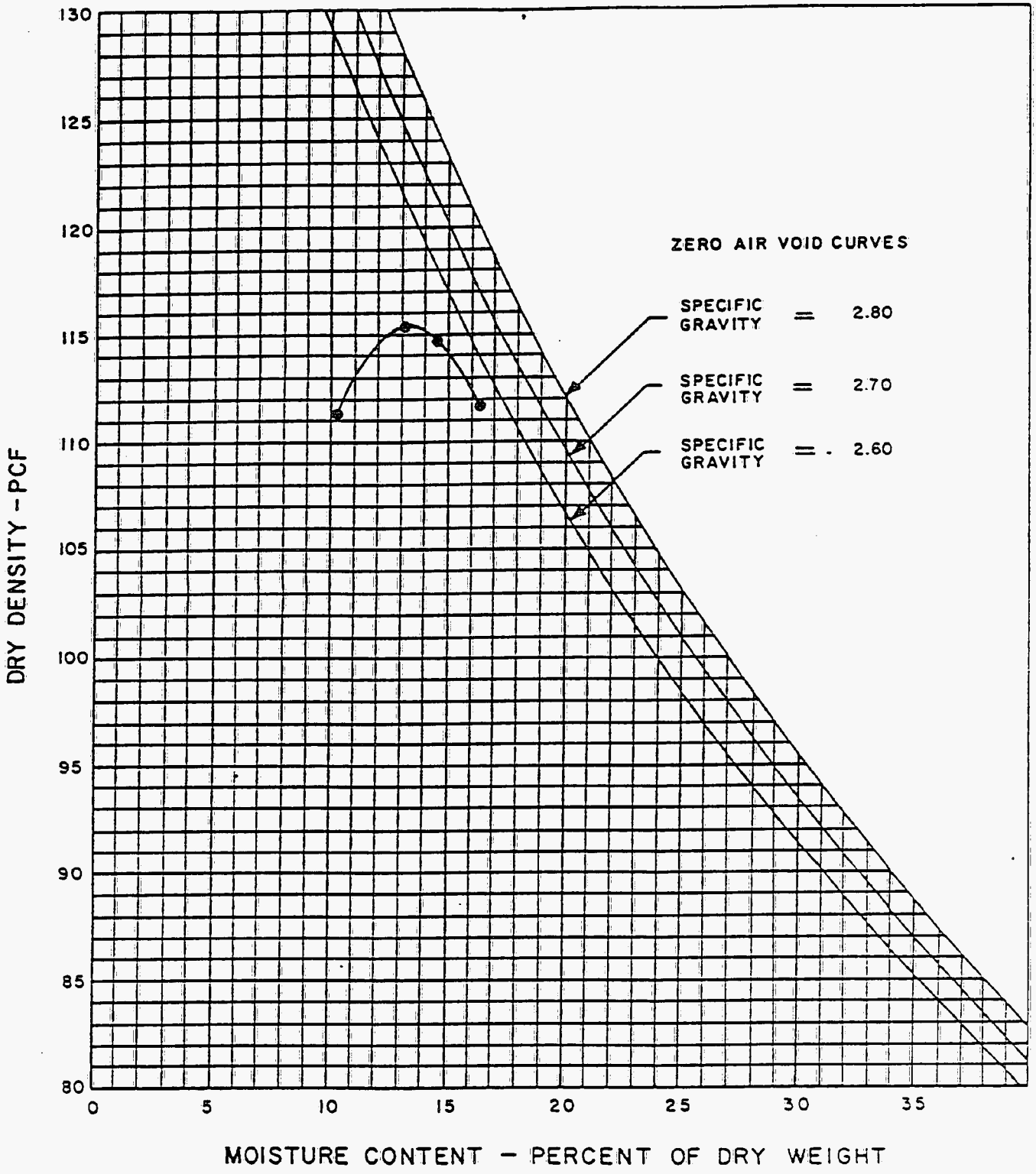
LOCATION:		MOISTURE-DENSITY RELATIONSHIPS
HOLE NO.: 85-18 DEPTH: 0-5' SAMPLE NO.: MKB-833		
SOIL DESCRIPTION: sandy silt (ML)		GOODSON & ASSOC. INC.
MAX. DRY DENSITY: 103.3 PCF OPT. MOIST. CONTENT: 19.0 %		PROCEDURE: ASTM D-698 Method A
LIQUID LIMIT: ____ PLASTICITY INDEX: ____		JOB NO.: 6411.01 FIG. NO.
GRAVEL ____ % SAND: ____ % SILT AND CLAY (-200): 80 %		DATE: 09-16-85



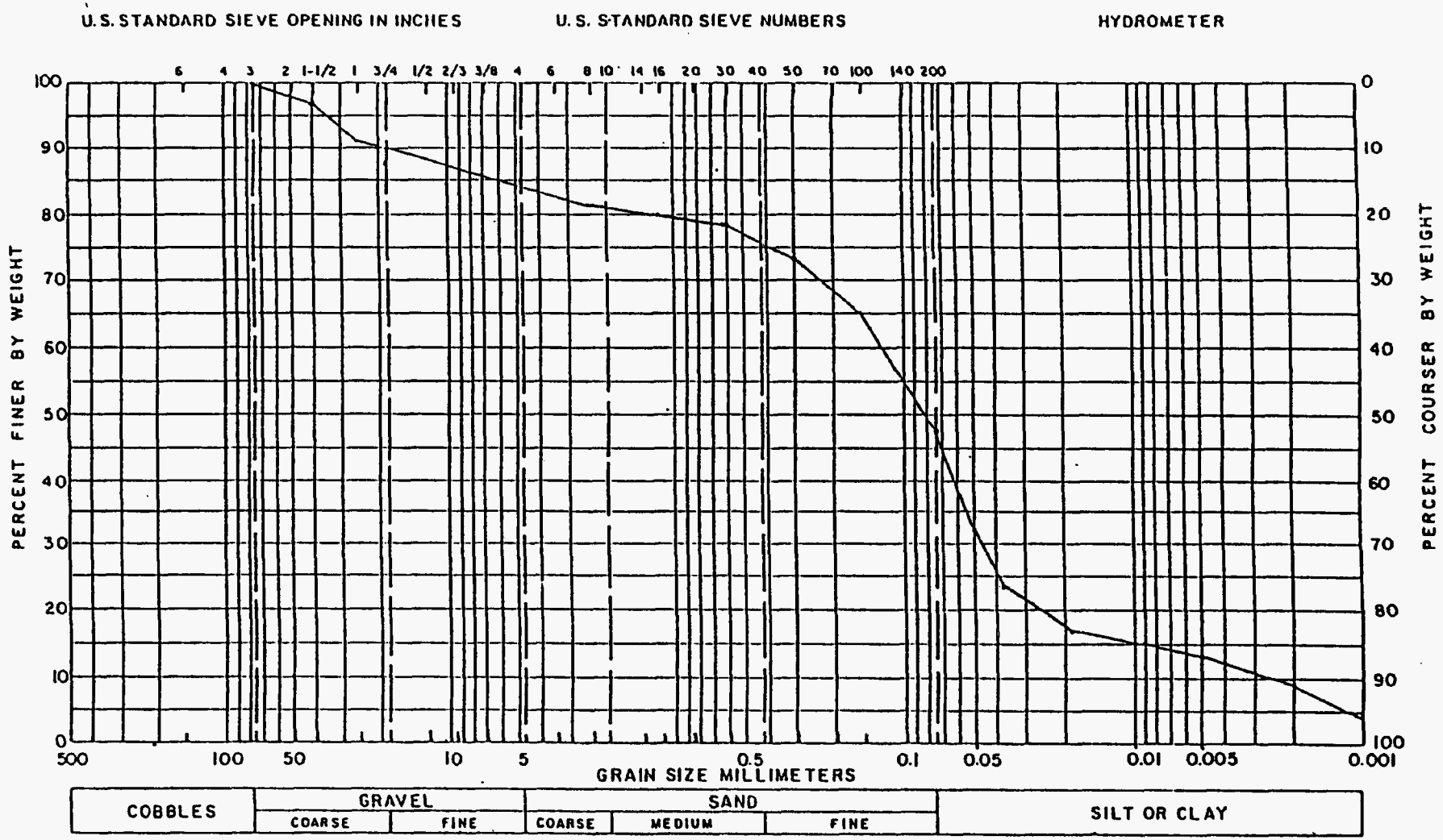
LOCATION:		MOISTURE-DENSITY RELATIONSHIPS
HOLE NO.: 85-19 DEPTH: 0-5' SAMPLE NO.: MKB-828		
SOIL DESCRIPTION: Sandy silt (organics, ML-OL)		GOODSON & ASSOC. INC.
MAX. DRY DENSITY: 109.8PCF OPT. MOIST. CONTENT: 15.8 %		PROCEDURE: ASTM D-698 Method A
LIQUID LIMIT: ____ PLASTICITY INDEX: ____		JOB NO.: 6411.01 FIG. NO.
GRAVEL: ____ % SAND: ____ % SILT AND CLAY (-200): 73 %		DATE: 09-16-85



LOCATION:		MOISTURE-DENSITY RELATIONSHIPS
HOLE NO.: 85-20 DEPTH: 0-3' SAMPLE NO.: MKB-836		
SOIL DESCRIPTION: gravelly silt (topsoil, OL)		GOODSON & ASSOC. INC.
MAX. DRY DENSITY: 101.9 PCF OPT. MOIST. CONTENT: 18.9 %		PROCEDURE: ASTM D-698 Method A
LIQUID LIMIT: ____ PLASTICITY INDEX: ____		JOB NO.: 6411.01 FIG. NO.
GRAVEL: ____ % SAND: ____ % SILT AND CLAY (-200): 71 %		DATE: 09-16-85



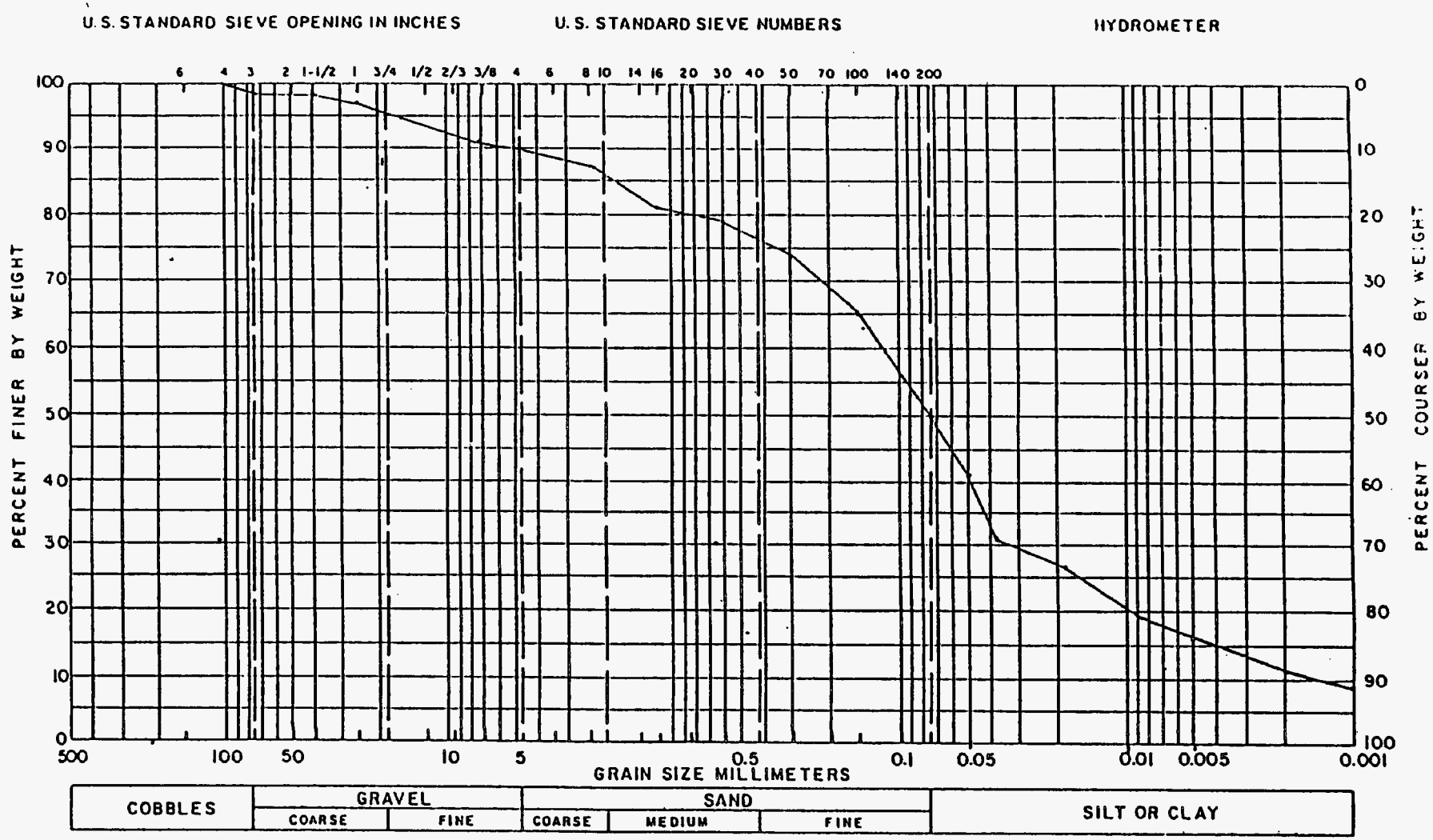
LOCATION:		MOISTURE-DENSITY RELATIONSHIPS
HOLE NO.: 85-21	DEPTH: 0-3'	SAMPLE NO.: MKB-826
SOIL DESCRIPTION: Silty sand (SM)		GOODSON & ASSOC. INC.
MAX. DRY DENSITY: 115.2 PCF	OPT. MOIST. CONTENT: 13.6 %	PROCEDURE: ASTM D-698 Method A
LIQUID LIMIT:	PLASTICITY INDEX:	JOB NO.: 6411.01 FIG NO.
GRAVEL: % SAND: %	SILT AND CLAY(-200): 43 %	DATE: 09-16-85



BORING NO.	LEGEND	EL. or DEPTH	CLASSIFICATION	w_n	w_L	w_p	PI
+6500	MKB-838	0-1.5'	sandy, gravely, silt				
Drawn by:							
Engr.			PROJECT NO. 6411.01	DWG. NO.			
Approved:			GRADATION CURVES				

Bendix Corporation

GOODSON & ASSOCIATES, INC
CONSULTING ENGINEERS

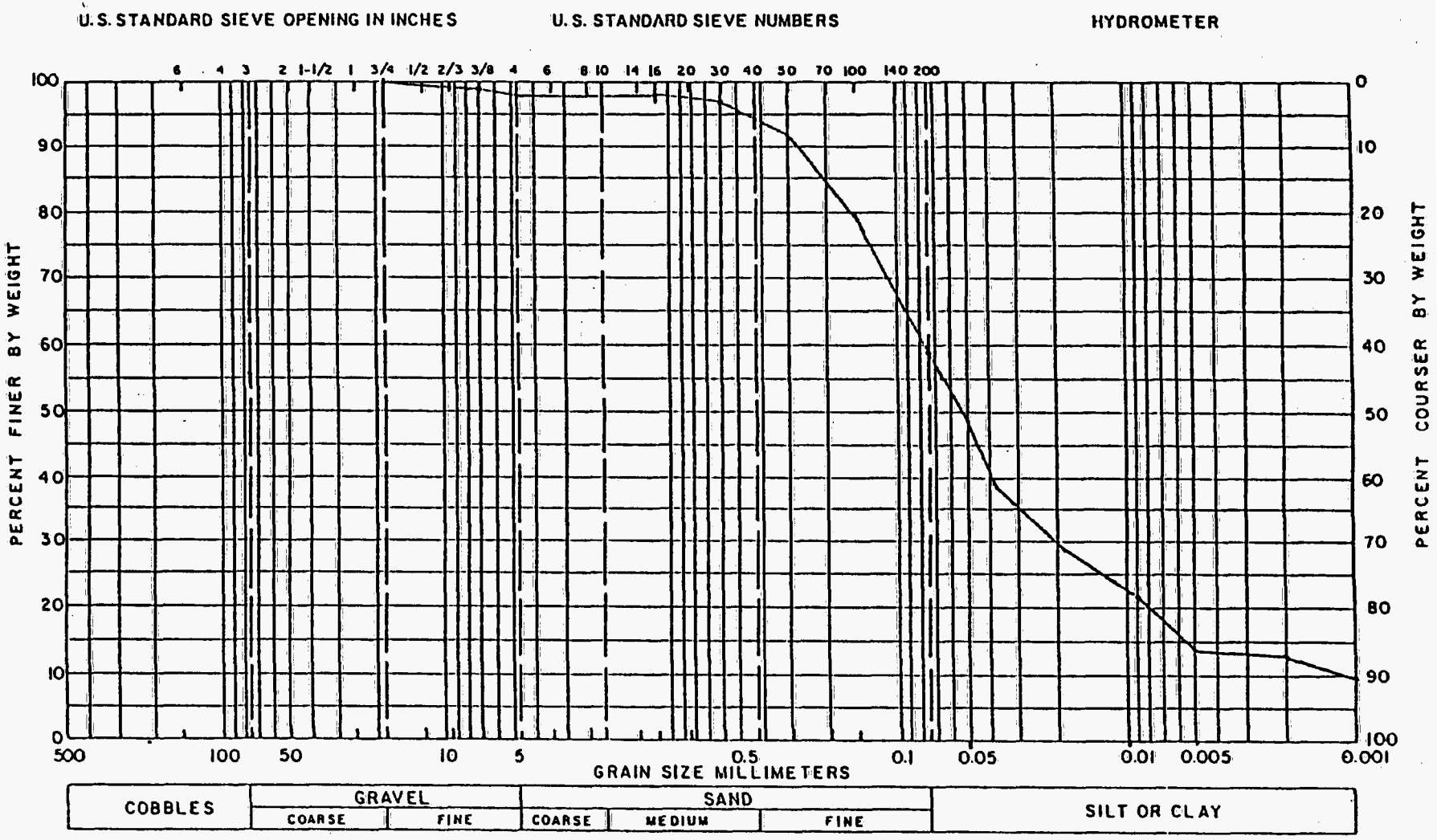


BORING NO.	LEGEND	EL. or DEPTH	CLASSIFICATION	w_n	w_L	w_p	PI
+5000	MKB-839	0-2'	sandy, gravely silt				

Bendix Corporation

Drawn by:			
Engr.		PROJECT NO. 6411.01	DWG. NO.
Revised:		GRADATION CURVES	

GOODSON & ASSOCIATES, INC
CONSULTING ENGINEERS



BORING NO.	LEGEND	EL. or DEPTH	CLASSIFICATION	w_n	w_L	w_p	PI
+3500	MKB-840	0-1.5'	sandy, slightly gravely silt				

Bendix Corporation

Drawn by:

Engr.

Revised:

PROJECT NO. 6411.01

DWG. NO.

GRADATION CURVES

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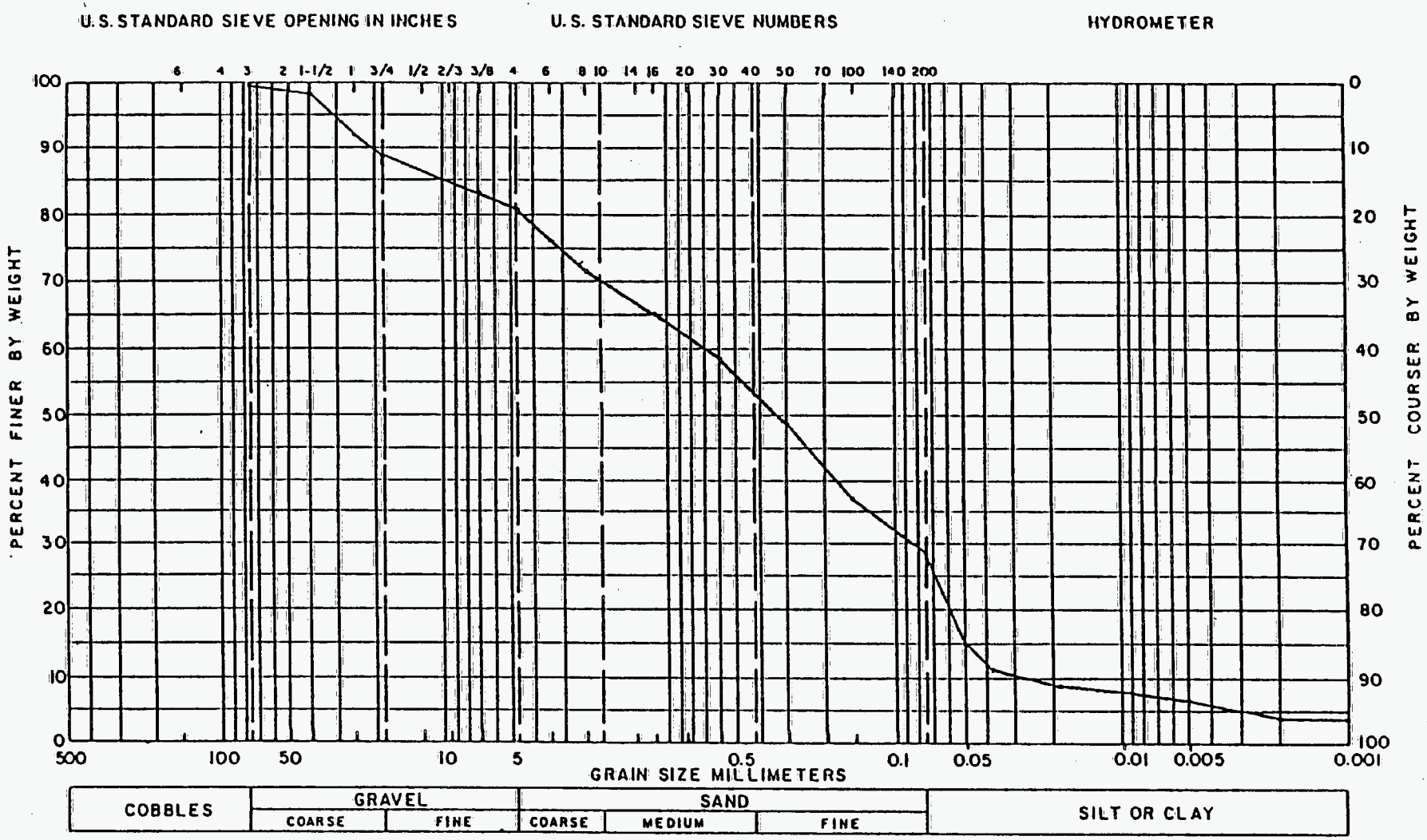

BORING NO.	LEGEND	EL. or DEPTH	CLASSIFICATION	w_n	w_L	w_p	PI
+0	MKB-841	0-2'	silty, gravely, sand				

Bendix Corporation

Drawn by:				
Engr.			PROJECT NO. 6411.01	DWG. NO.
Revised:			GRADATION CURVES	

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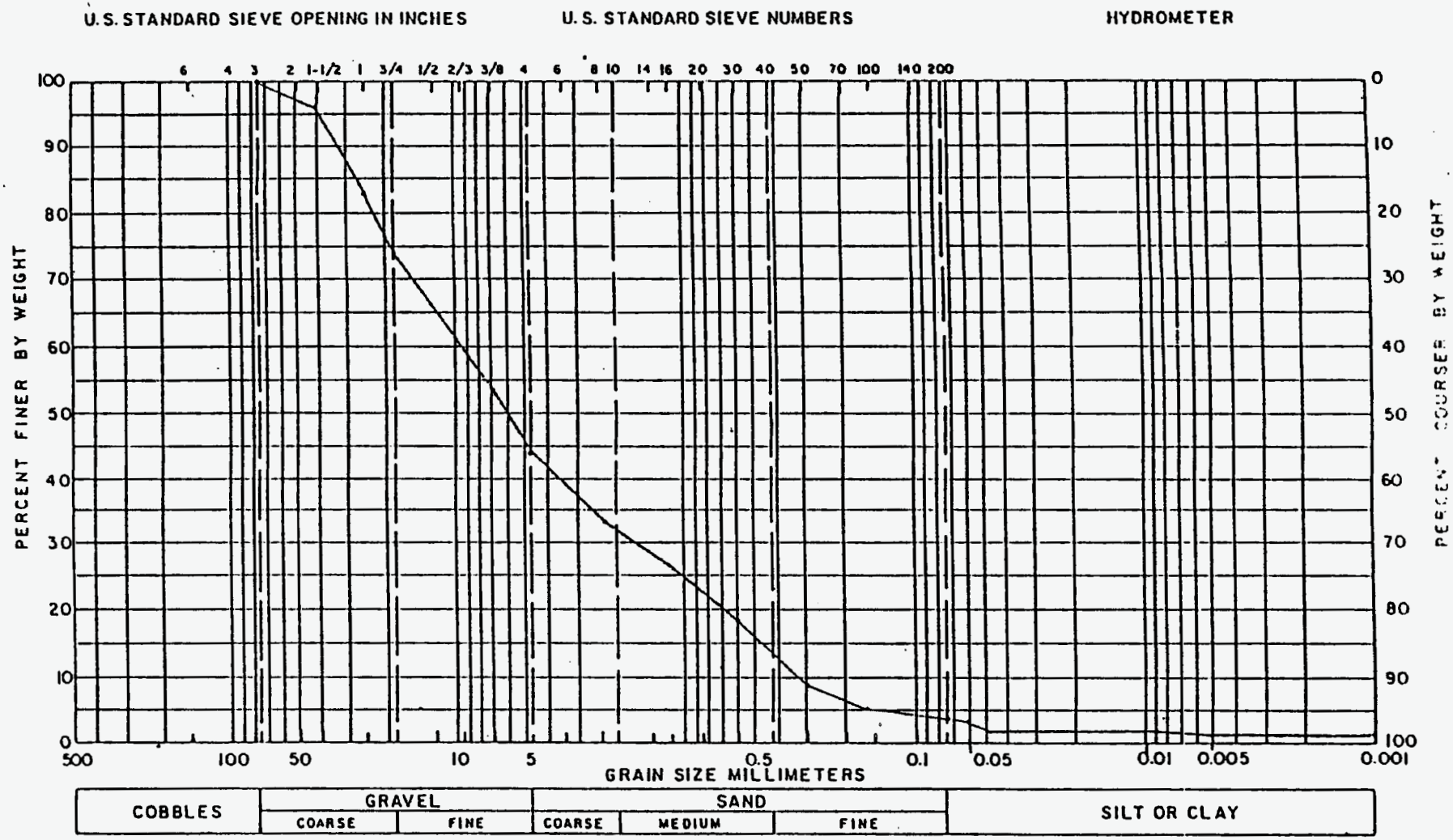

BORING NO.	LEGEND	EL. or DEPTH	CLASSIFICATION	w_n	w_L	w_p	PI
+1000	MKB-842	0-2'	sandy, slightly				
			silty, gravel				

Bendix Corporation

Drawn by:

Engr.

Reviewed:

PROJECT NO. 6411.01

DWG. NO.

GRADATION CURVES

GOODSON & ASSOCIATES, INC
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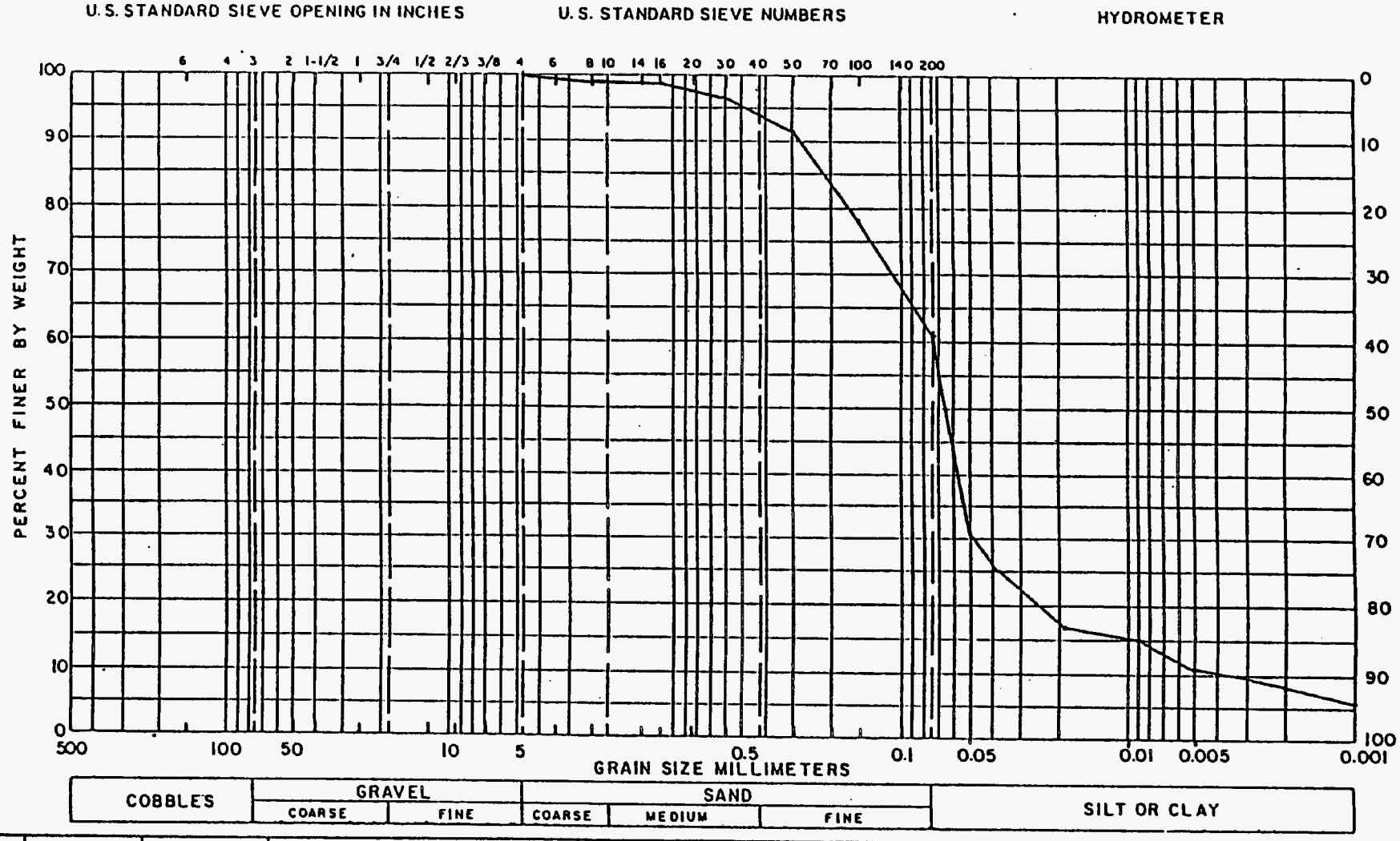

BORING NO.	LEGEND	EL. or DEPTH	CLASSIFICATION	w_n	w_L	w_p	PI
+2000	MKB-843	0-2'	silty, slightly gravely, sand				

Bendix Corporation

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Engr.

Revised:

PROJECT NO. 6411.01 DWG. NO.

GRADATION CURVES

GOODSON & ASSOCIATES, INC
CONSULTING ENGINEERS

ROGERS AND ASSOCIATES ENGINEERING CORP.

May 7, 1986

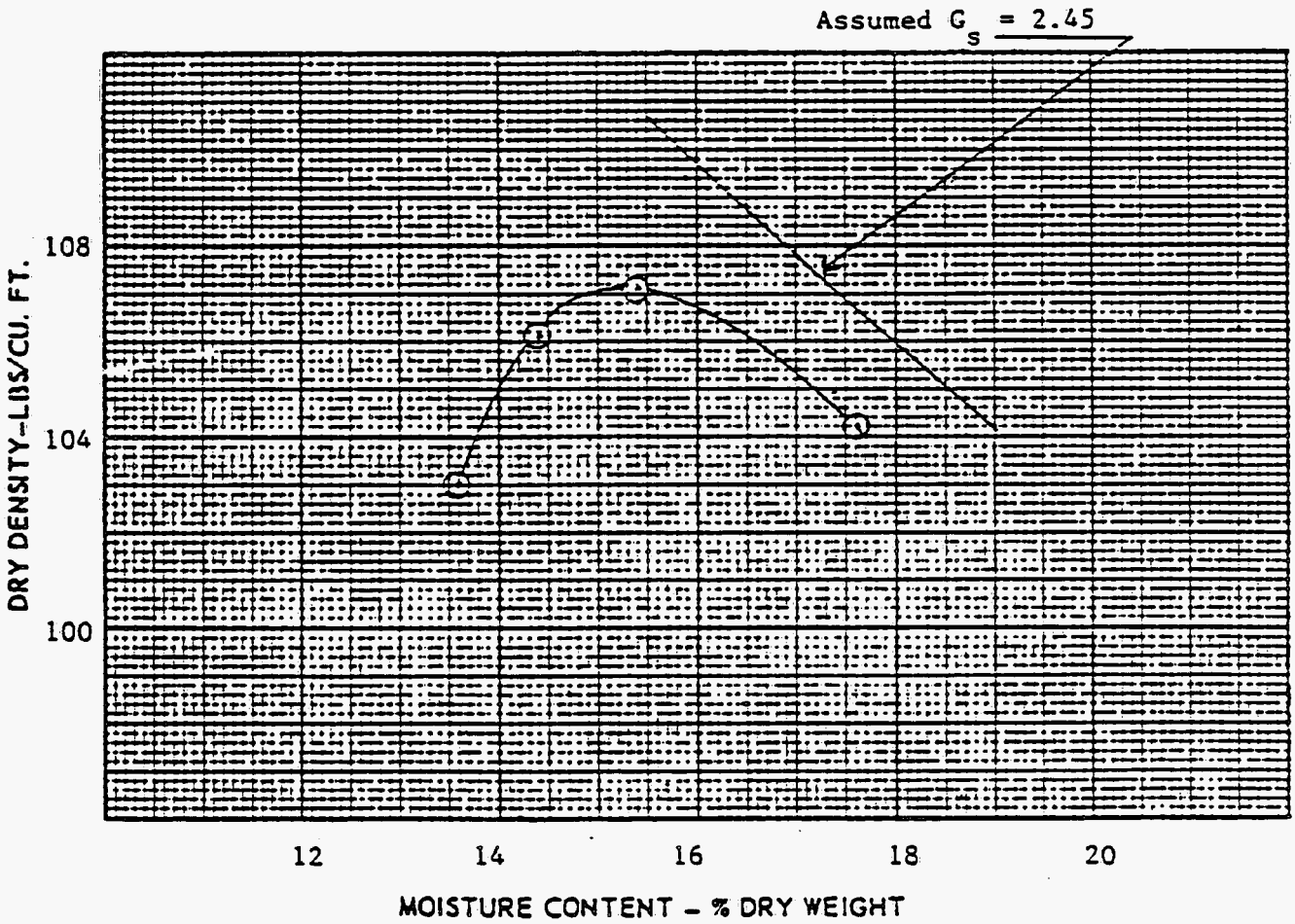
SUMMARY OF GEOTECHNICAL TEST RESULTS

on BFEC Uranium Mill Tailings and Borrow Soil Samples

Sample	Standard Proctor Test (ASTM-D698)		Specific Gravity (ASTM-D854) (g/cm^3)
	Optimum Moisture	Max. Dry Density	
MKB-780	15.3	107.1	--
MKB.782	15.5	103.6	2.70
MKB-784	13.2	107.6	2.67
MKB-786	15.3	113.8	2.60
MKB-788	13.0	102.9	--
MKB-790	28.3	94.6	2.70
MKB-792	12.4	110.4	--
MKB-793	26.3	94.5	2.76
MKB-834	--	---	2.66

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Uranium Tailings Monticello, Utah Site **JOB NO.** T86-2511



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
1	MKB - 780	15.3	107.1	ASTM D-698	A	2511-1

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,906
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,906
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,906

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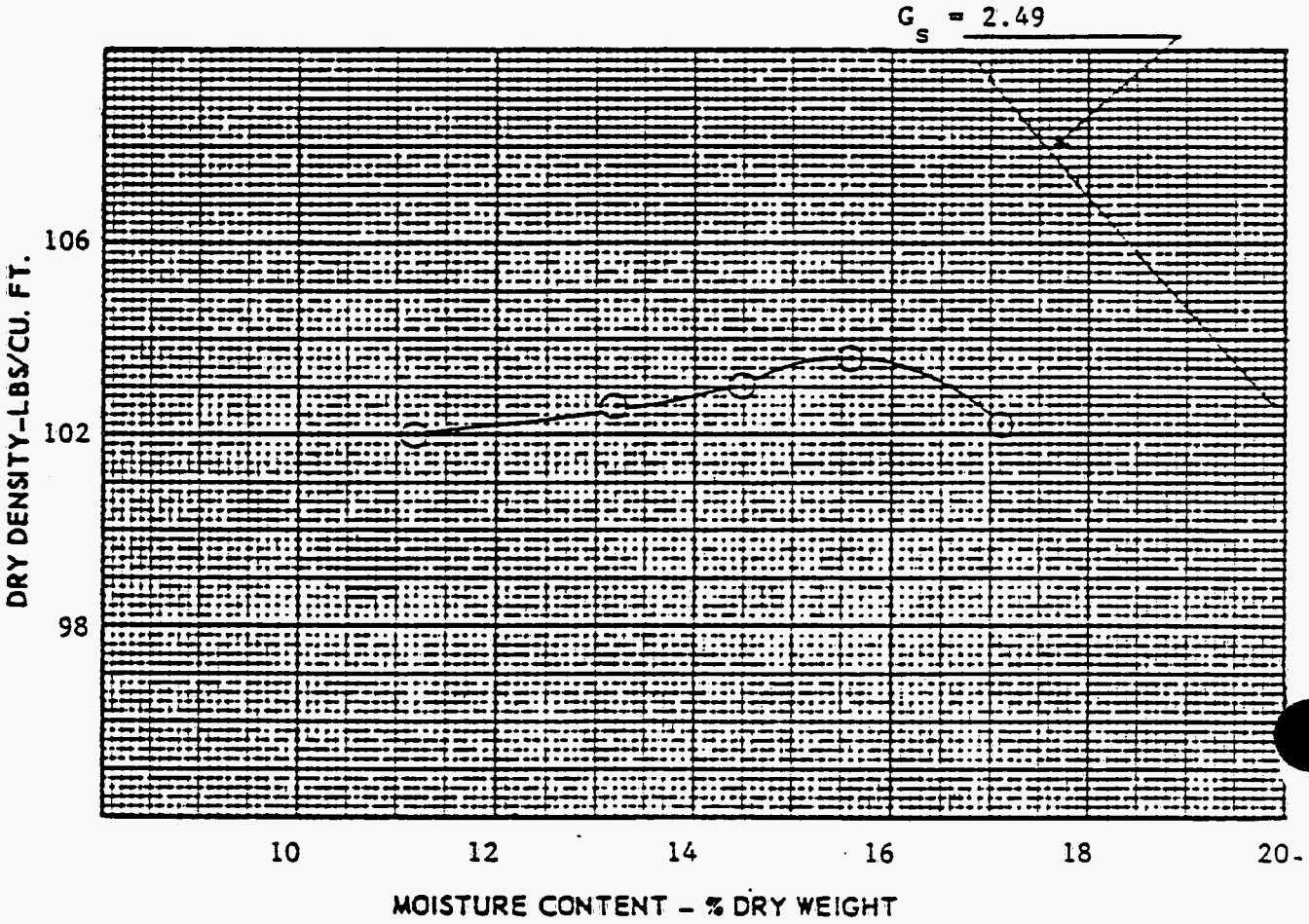
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Uranium Tailings Monticello, Utah Site **JOB NO.** T86-2511



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
2	MKB - 782	15.5	103.6	ASTM D-698	A	2511-2

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,860
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,860
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,860

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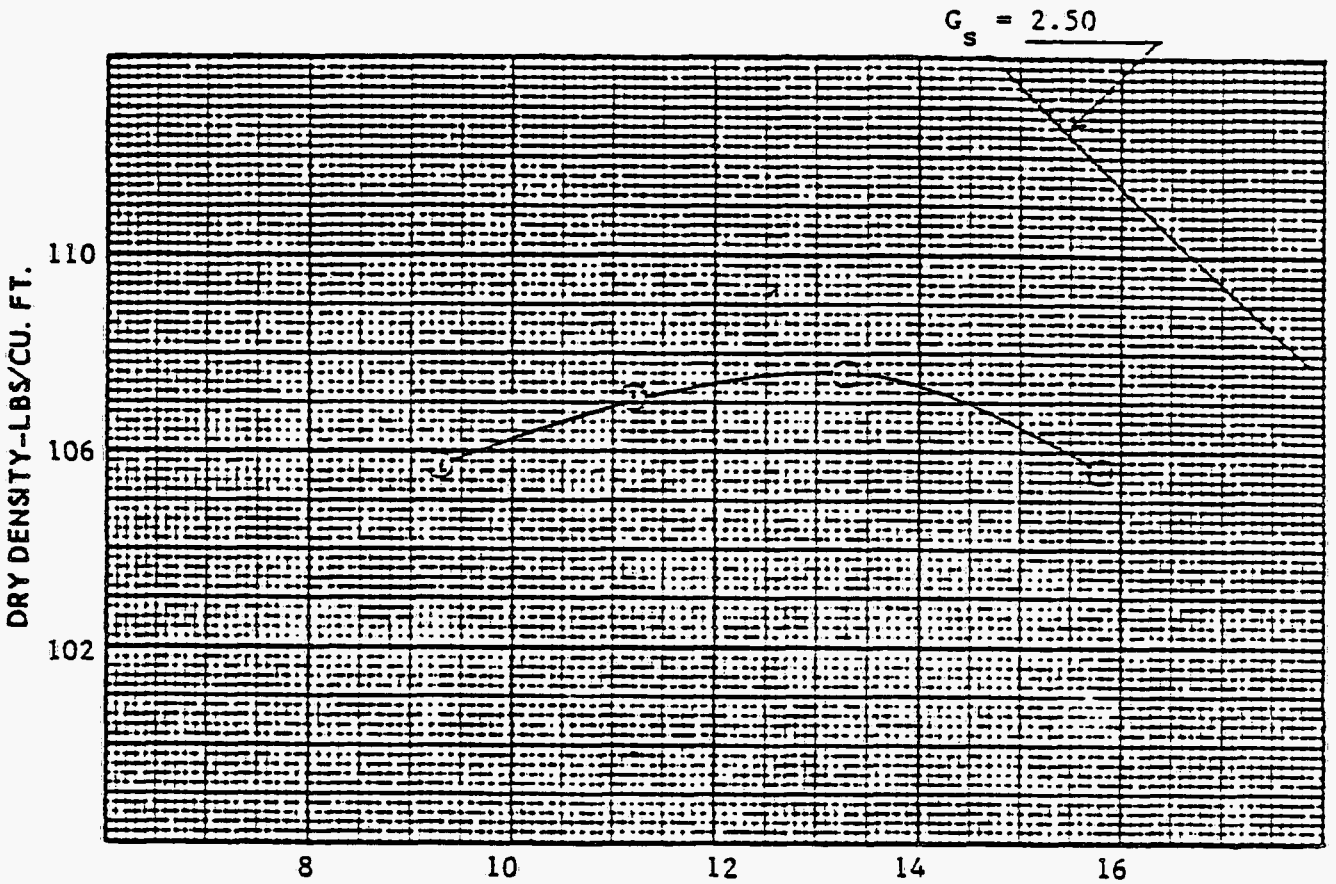
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Uranium Tailings Monticello, Utah Site JOB NO. T86-2511



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
3	MKB - 784	13.2	107.6	ASTM D-698	A	2511-3

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,906
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,906
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,906

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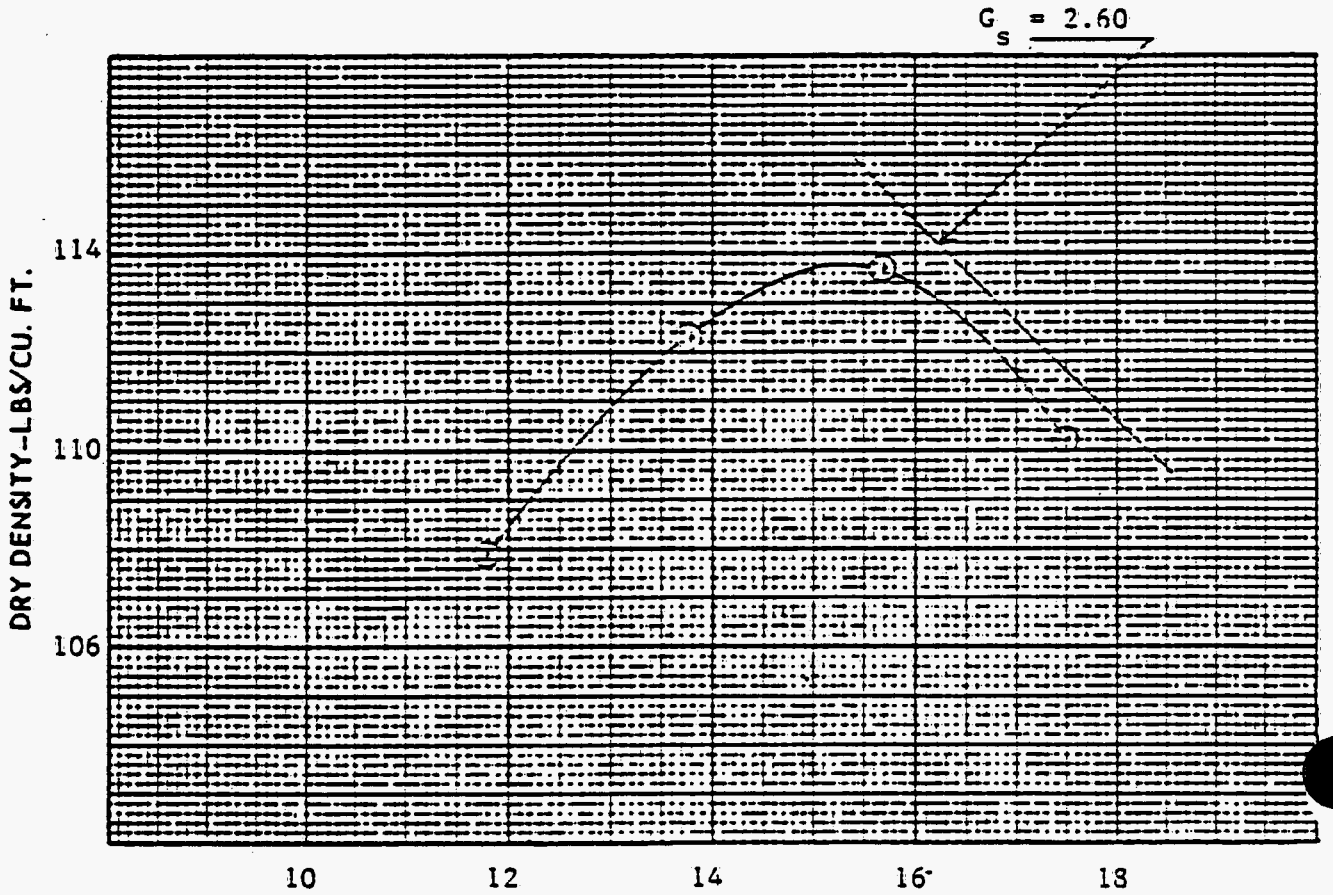
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Uranium Tailings Monticello, Utah Site **JOB NO.** T86-2511



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
4	MKB - 786	15.3	113.8	ASTM D-698	A	2511-4

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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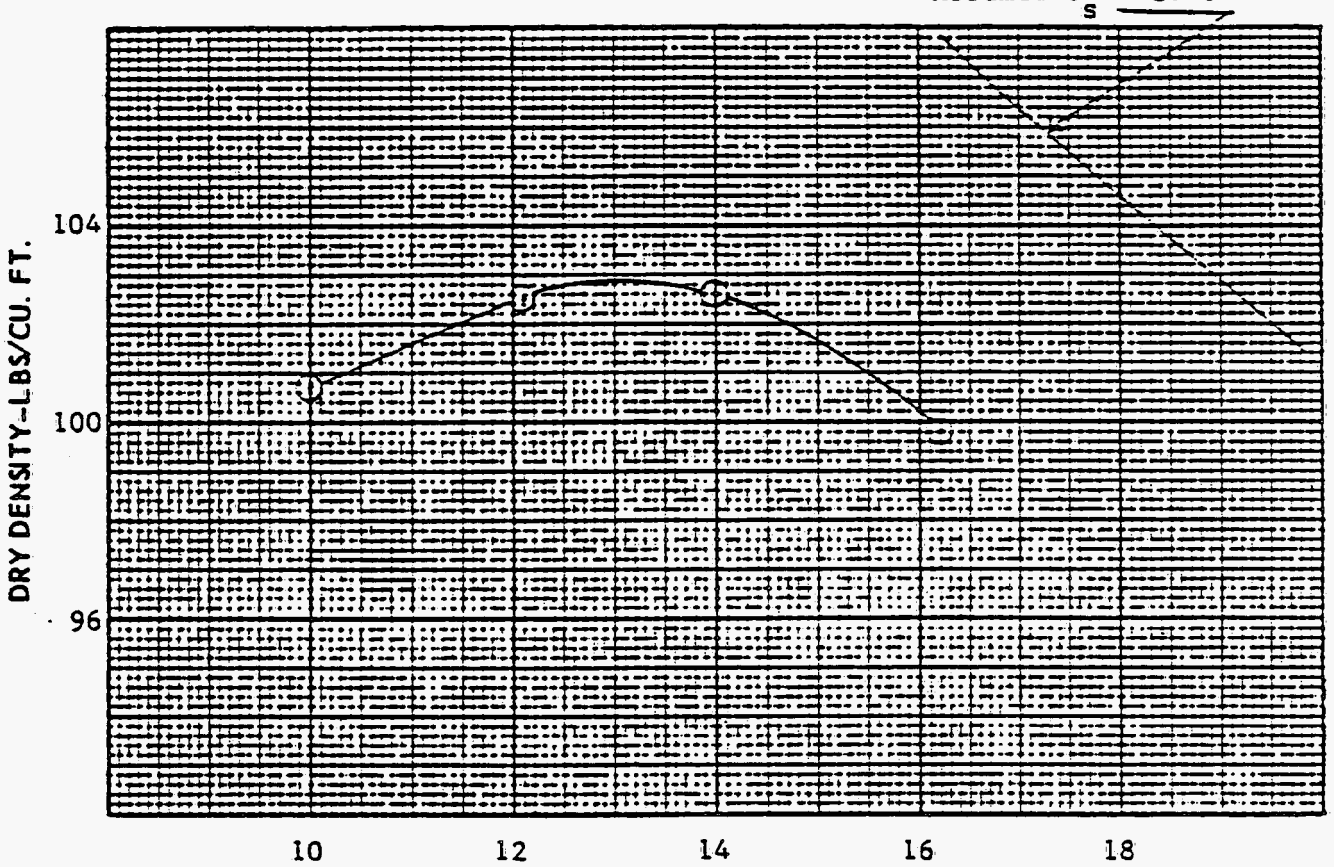
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Uranium Tailings Monticello, Utah Site JOB NO. T86-2511

Assumed G_s = 2.40



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
5	MKB - 788	13.0	102.9	ASTM D-698	A	2511-5

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,906
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,906
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,906

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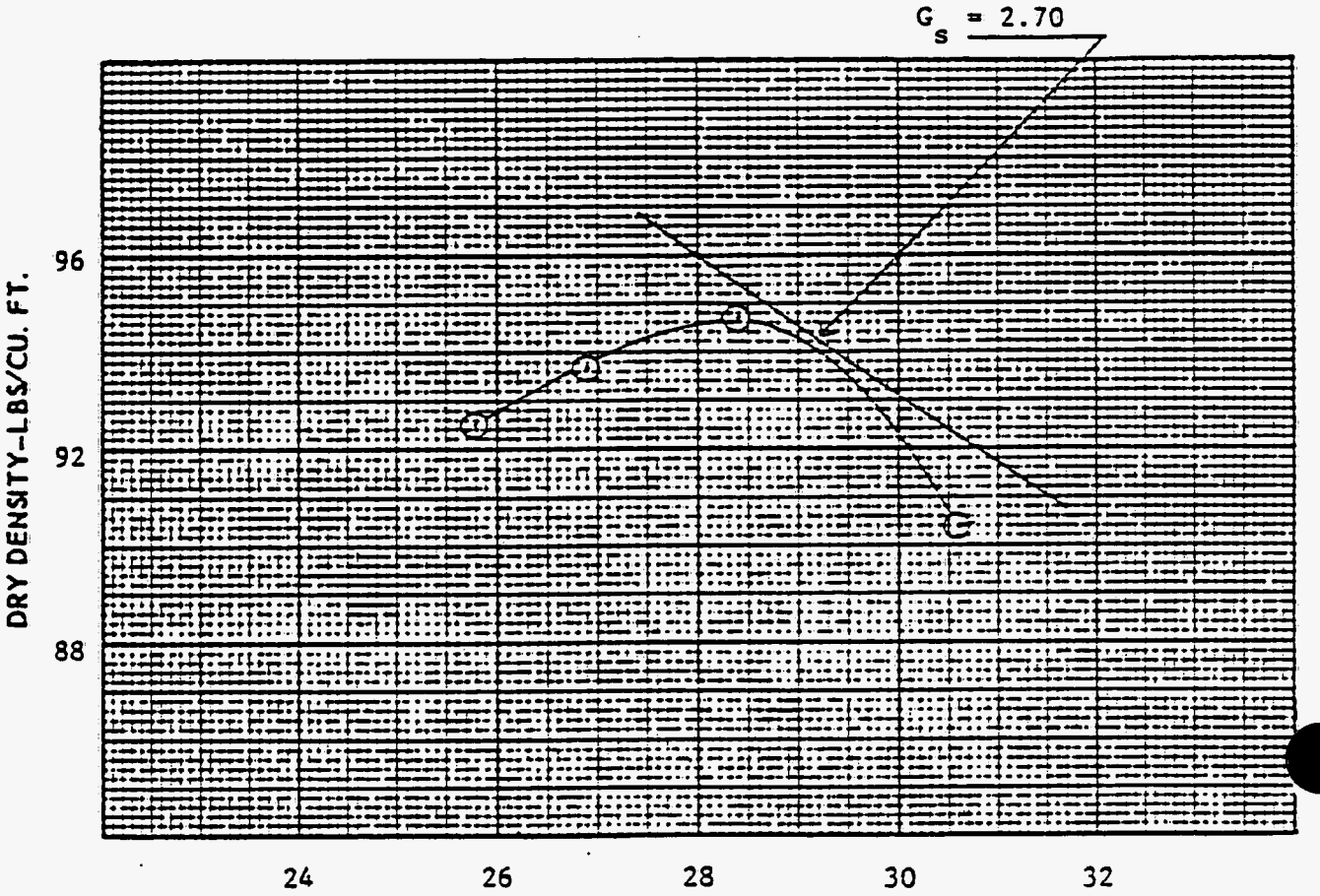
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Uranium Tailings Monticello, Utah Site JOB NO. T86-2511



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
6	MKB - 790	28.3	94.6	ASTM D-698	A	2511-6

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

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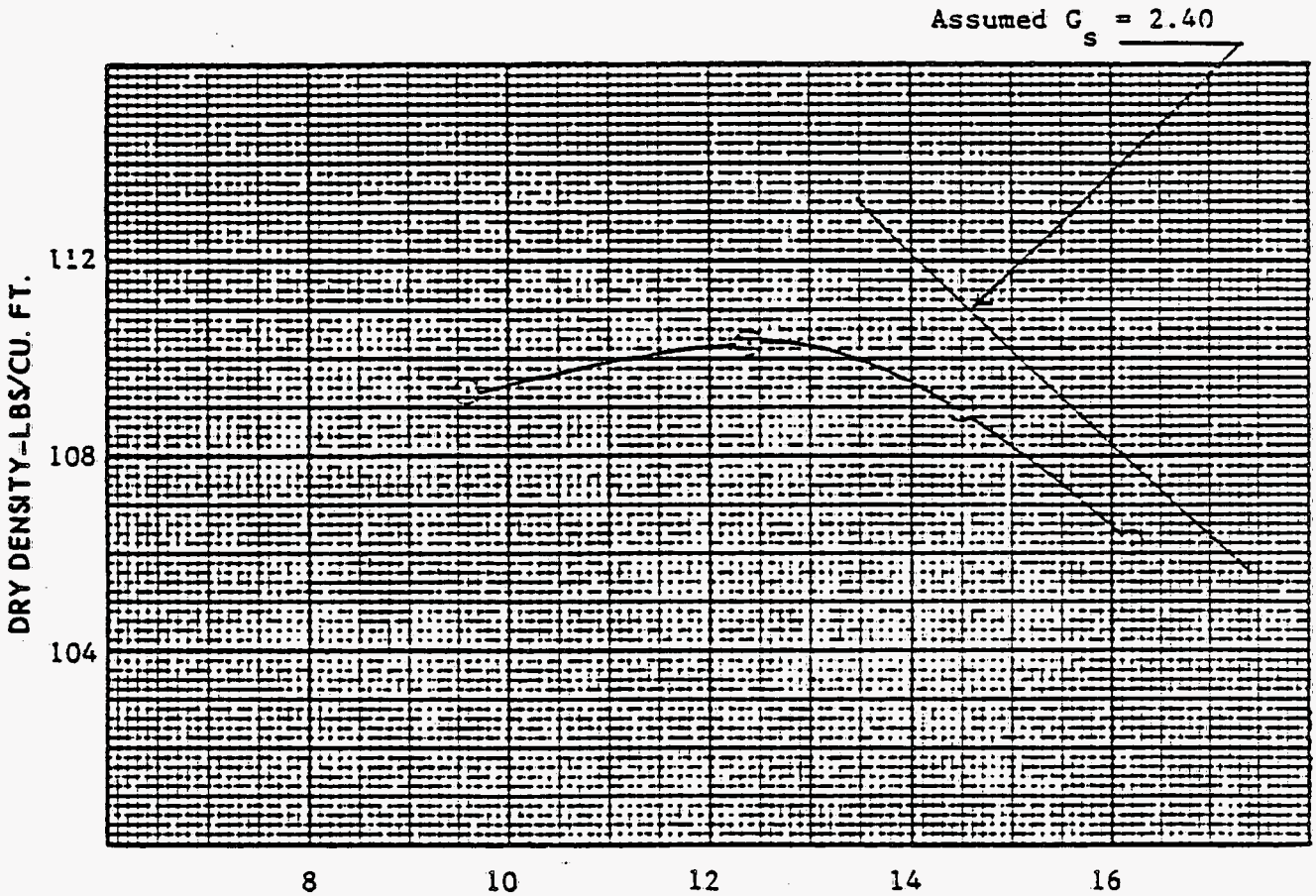
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Uranium Tailings Monticello, Utah Site **JOB NO.** T86-2511



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
7	MKB – 792	12.4	110.4	ASTM D-698	A	2511-7

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,966
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,966
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,966

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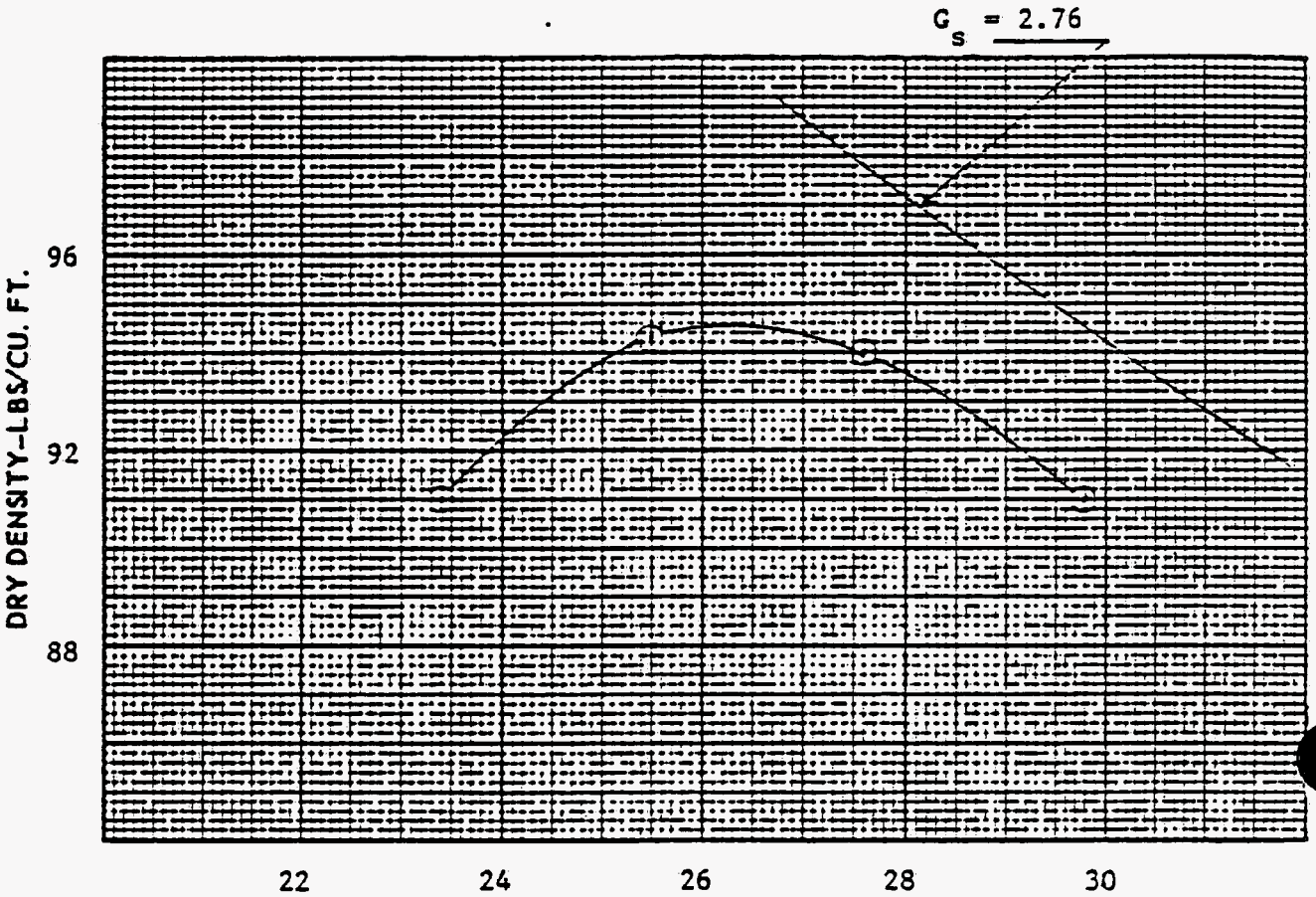
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT Uranium Tailings Monticello, Utah Site JOB NO. T86-2511



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
8	MKB - 793	26.3	94.5	ASTM D-698	A	2511-8

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,056
C	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,056
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,056

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Appendix D

IN-SITU NEUTRON MOISTURE PROBE DATA

Table D-1. In-Situ Neutron Moisture Probe Data

Location	Depth From Surface (ft)	Moisture (% volume)
East Tailings Pile		
Borehole 85-07	2	8.4
(total depth = 19'0")	3	7.3
	4	8.6
	5	26.1
	6	7.6
	7	54.3
	8	44.7
	9	52.0
	10	50.9
	11	55.2
	12	50.8
	13	51.3
	14	50.8
	15	48.4
	16	40.9
	17	42.6
Acid Tailings Pile		
Borehole 85-10	2	9.4
(total depth = 17'4")	3	8.4
	4	13.4
	5	21.3
	6	19.2
	7	14.9
	8	11.2
	9	9.9
	10	11.8
	11	11.6
	12	11.9
	13	31.1
	14	40.5
	15	25.8
	16	19.8

Table D-1 (continued). In-Situ Neutron Moisture Probe Data

Location	Depth From Surface (ft)	Moisture (% volume)
Carbonate Tailings Pile		
Borehole 85-02	2	9.5
(total depth = 18'11")	3	7.8
	4	12.5
	5	15.1
	6	15.6
	7	9.5
	8	6.7
	9	6.3
	10	7.2
	11	9.7
	12	8.5
	13	6.2
	14	5.9
	15	6.9
	16	6.7
	17	5.5
Vanadium Tailings Pile		
Borehole 85-04	2	8.9
(total depth = 19'0")	3	17.3
	4	24.8
	5	17.8
	6	11.2
	7	42.5
	8	50.0
	9	50.2
	10	51.3
	11	51.7
	12	51.8
	13	52.8
	14	52.8
	15	47.7
	16	47.0
	17	49.3

Appendix E

RADON DIFFUSION TEST DATA

Radon diffusion tests were performed on test-pit samples of the tailings, peripheral property soils, and borrow materials by Rogers and Associates Engineering Corporation, Salt Lake City, Utah. The testing was performed in accord with U.S. Nuclear Regulatory Commision, NUREG/CR-2875.

R
A
E

Rogers & Associates Engineering Corporation

Post Office Box 330
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May 7, 1986

Bendix Field Engineering Corp. C8613
ATTN: Receiving Dept. (P.O. 24357)
P.O. Box 1569
Grand Junction, CO 81502-1569

Gentlemen:

Enclosed are the results of the 48 radon diffusion tests on uranium tailings; 18 radon diffusion tests on peripheral soils, 16 radon diffusion tests on borrow materials; 8 proctor compaction tests; and six specific gravity measurements that you requested. In addition, we have performed an additional 12 radon diffusion measurements on the peripheral soil samples in lieu of compositing this set of samples to three. There will be no charge for these extra 12 diffusion tests; their results are also enclosed.

As noted on some of the data sheets, the specified moistures exceeded drainage limits, and visible moisture heterogeneity was noted. This may have affected measurement accuracy in these cases.

These deliverables complete our work under your P.O. #24357 and its addendum. Please call me if there are any questions on any of these results.

Sincerely yours,

Kirk K. Nielson

Kirk K. Nielson
Vice President

KKN/b

Rogers & Associates Engineering Corporation

REPORT OF RADON DIFFUSION COEFFICIENT MEASUREMENTS (TIME-DEPENDENT DIFFUSION TEST METHOD RAE-SQAP-3.6)

REPORT DATE May 7, 1986

CONTRACT C-8613

BY RYB

SAMPLE IDENTIFICATION Uranium Tailings MKB-780

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-780	5.7	1.54	2.6 E-2	0.21	
MKB-780	6.1	1.54	3.1 E-2	.22	
MKB-780	13.4	1.54	2.5 E-3	.49	
MKB-780	13.2	1.55	1.2 E-2	.49	
MKB-780	21.9	1.54	2.4 E-6	.80	Moisture Drainage
MKB-780	22.0	1.55	2.4 E-6	.81	Moisture Drainage

[a]BASED ON A SPECIFIC GRAVITY OF 2.67 g/cm^3.

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REPORT DATE May 7, 1986

CONTRACT C-8613

BY RYB

SAMPLE IDENTIFICATION Uranium Tailings MKB-782

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-782	5.2	1.51	3.0 E-2	0.19	
MKB-782	5.5	1.50	2.4 E-2	.19	
MKB-782	14.8	1.49	1.1 E-2	.49	
MKB-782	14.8	1.50	7.7 E-3	.50	
MKB-782	23.0	1.52	4.1 E-6	.79	Moisture Drainage
MKB-782	23.2	1.52	2.3 E-6	.81	Moisture Drainage

[a] BASED ON A SPECIFIC GRAVITY OF 2.70 g/cm^3.

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REPORT DATE May 7, 1986

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BY RYB

SAMPLE IDENTIFICATION Uranium Tailings MKB-784

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-784	4.1	1.56	1.9 E-2	0.15	
MKB-784	4.6	1.56	2.5 E-2	.17	
MKB-784	12.2	1.55	1.7 E-2	.45	
MKB-784	12.2	1.56	1.7 E-2	.46	
MKB-784	18.9	1.56	1.8 E-4	.71	Moisture Drainage
MKB-784	19.4	1.57	2.4 E-5	.74	Moisture Drainage

[a] BASED ON A SPECIFIC GRAVITY OF 2.67 g/cm^3.

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REPORT DATE May 7, 1986

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SAMPLE IDENTIFICATION Uranium Tailings MKB-786

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-786	4.2	1.65	2.7 E-2	0.19	
MKB-786	4.4	1.65	2.6 E-2	.20	
MKB-786	10.5	1.65	2.1 E-2	.47	
MKB-786	17.0	1.65	1.2 E-3	.77	
MKB-786	18.0	1.64	1.6 E-3	.80	
MKB-786	10.6	1.65	1.8 E-2	.48	

[a]BASED ON A SPECIFIC GRAVITY OF 2.60 g/cm^3.

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REPORT DATE May 7, 1986

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BY RYB

SAMPLE IDENTIFICATION Uranium Tailings MKB-788

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-788	5.4	1.49	2.3 E-2	0.19	
MKB-788	5.8	1.48	2.5 E-2	.20	
MKB-788	13.2	1.50	3.9 E-3	.47	
MKB-788	13.8	1.49	6.0 E-3	.48	
MKB-788	21.7	1.50	1.0 E-5	.77	Moisture Drainage
MKB-788	23.3	1.48	3.2 E-6	.80	Moisture Drainage

[a] BASED ON A SPECIFIC GRAVITY OF 2.60 g/cm^3.

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REPORT DATE May 7, 1986

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BY RYB

SAMPLE IDENTIFICATION Uranium Tailings MKB-790

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] (Mp/P)	COMMENTS
MKB-790	5.9	1.38	1.6 E-2	0.17	
MKB-790	8.5	1.35	1.4 E-2	.23	
MKB-790	17.3	1.37	1.5 E-2	.48	
MKB-790	18.6	1.36	1.1 E-2	.51	
MKB-790	28.3	1.37	8.4 E-3	.78	
MKB-790	32.0	1.34	1.3 E-5	.85	Moisture Drainage

[a]BASED ON A SPECIFIC GRAVITY OF 2.70 g/cm^3.

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REPORT DATE May 7, 1986

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BY RYB

SAMPLE IDENTIFICATION Uranium Tailings MKB-792

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-792	3.9	1.61	2.8 E-2	0.16	
MKB-792	4.9	1.59	2.8 E-2	.20	
MKB-792	12.2	1.59	1.2 E-2	.49	
MKB-792	11.6	1.60	7.2 E-3	.48	
MKB-792	19.6	1.61	2.0 E-5	.82	Moisture Drainage
MKB-792	19.0	1.59	9.6 E-5	.77	Moisture Drainage

[a] BASED ON A SPECIFIC GRAVITY OF 2.63 g/cm^3.

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REPORT DATE May 7, 1986

CONTRACT C-8613

BY RYB

SAMPLE IDENTIFICATION Uranium Tailings MKB-793

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-793	6.2	1.38	2.1 E-2	0.17	
MKB-793	6.5	1.37	2.8 E-2	.18	
MKB-793	16.7	1.38	1.2 E-2	.46	
MKB-793	18.0	1.37	9.7 E-3	.49	
MKB-793	28.8	1.37	2.0 E-3	.78	
MKB-793	31.0	1.35	6.2 E-3	.82	

[a]BASED ON A SPECIFIC GRAVITY OF 2.76 g/cm^3.

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BY RYB

SAMPLE IDENTIFICATION Peripheral Soil MKB-827

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-827	3.9	1.67	4.0 E-2	0.18	
MKB-827	5.8	1.64	1.8 E-2	0.26	
MKB-827	9.7	1.68	9.5 E-3	.46	
MKB-827	11.0	1.66	6.0 E-3	.51	
MKB-827	16.6	1.67	2.8 E-4	.77	Moisture Drainage
MKB-827	17.4	1.66	5.3 E-3	.80	Moisture Drainage

[a]BASED ON A SPECIFIC GRAVITY OF 2.60 g/cm^3.

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REPORT DATE May 7, 1986

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BY RYB

SAMPLE IDENTIFICATION Peripheral Soil MKB-829

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] (Mp/P)	COMMENTS
MKB-829	5.4	1.58	1.9 E-2	0.22	
MKB-829	6.0	1.57	2.5 E-2	.24	
MKB-829	11.1	1.60	9.2 E-3	.46	
MKB-829	12.2	1.59	1.2 E-2	.49	
MKB-829	17.8	1.61	1.2 E-3	.75	
MKB-829	16.1	1.60	3.9 E-3	.67	

[a] BASED ON A SPECIFIC GRAVITY OF 2.61 g/cm^3.

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REPORT DATE May 7, 1986

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BY RYB

SAMPLE IDENTIFICATION Peripheral Soil MKB-831

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-831	5.5	1.56	2.5 E-2	0.21	
MKB-831	6.4	1.55	2.4 E-2	.24	
MKB-831	12.1	1.57	1.5 E-2	.48	
MKB-831	12.2	1.57	1.2 E-2	.48	
MKB-831	19.2	1.58	2.8 E-3	.76	
MKB-831	19.8	1.59	7.9 E-4	.79	

[a]BASED ON A SPECIFIC GRAVITY OF 2.63 g/cm^3.

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REPORT DATE May 7, 1986

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BY RYB

SAMPLE IDENTIFICATION Peripheral Soil MKB-832

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-832	5.4	1.50	2.7 E-2	.20	
MKB-832	6.2	1.48	2.1 E-2	.23	
MKB-832	14.4	1.48	5.3 E-3	.51	
MKB-832	14.6	1.48	9.5 E-3	.52	
MKB-832	21.4	1.50	2.4 E-3	.78	
MKB-832	21.9	1.50	9.2 E-4	.79	

[a] BASED ON A SPECIFIC GRAVITY OF 2.55 g/cm^3.

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REPORT DATE May 7, 1986

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BY RYB

SAMPLE IDENTIFICATION Peripheral Soil MKB-837

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-837	6.2	1.46	2.3 E-2	0.21	
MKB-837	5.4	1.48	2.6 E-2	.21	
MKB-837	14.9	1.47	1.7 E-2	.50	
MKB-837	15.6	1.46	1.4 E-2	.52	
MKB-837	23.0	1.48	1.7 E-4	.78	
MKB-837	22.3	1.49	3.7 E-3	.77	

[a]BASED ON A SPECIFIC GRAVITY OF 2.62 g/cm^3.

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REPORT DATE May 7, 1986

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BY RYB

SAMPLE IDENTIFICATION Borrow Material MKB-834

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-834	5.7	1.56	2.3 E-2	0.21	
MKB-834	6.5	1.54	2.3 E-2	.24	
MKB-834	11.1	1.55	1.8 E-2	.41	
MKB-834	10.0	1.57	1.9 E-2	.38	
MKB-834	15.6	1.56	5.1 E-3	.59	
MKB-834	14.7	1.57	1.2 E-2	.56	
MKB-834	20.5	1.57	4.1 E-4	.78	
MKB-834	21.2	1.56	8.2 E-4	.80	

[a] BASED ON A SPECIFIC GRAVITY OF 2.66 g/cm^3.

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REPORT DATE May 7, 1986

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BY RYB

SAMPLE IDENTIFICATION Borrow Material MKB-835

SUBMITTED BY Bendix Field Engineering Corporation DATE RECEIVED 10-Mar-86

SAMPLE NUMBER	MOISTURE (DRY WT.%)	DENSITY (g/cm^3)	RADON DIFFUSION COEFF. (cm^2/s)	SATURATION[a] ($M\rho/P$)	COMMENTS
MKB-835	4.3	1.72	2.8 E-2	0.22	
MKB-835	4.9	1.71	3.0 E-2	.24	
MKB-835	5.8	1.76	1.8 E-2	.32	
MKB-835	8.0	1.74	1.9 E-2	.42	
MKB-835	10.9	1.74	1.4 E-2	.57	
MKB-835	13.6	1.70	1.0 E-2	.67	
MKB-835	14.1	1.75	5.1 E-3	.75	
MKB-835	14.3	1.75	6.9 E-3	.76	
MKB-835	15.3	1.72	4.6 E-3	.77	

[a] BASED ON A SPECIFIC GRAVITY OF 2.61 g/cm^3.

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