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Basic Data Report for Drillhole WIPP 21 (Waste Isolation Pilot Plant - WIPP)

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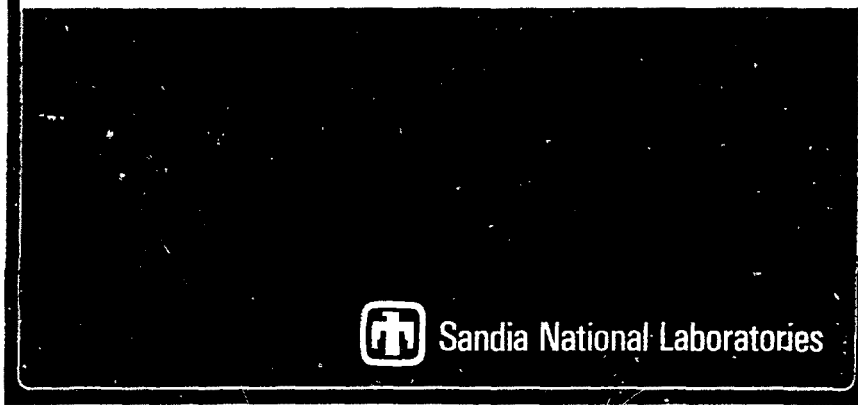

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1.0 ABSTRACT

WIPP 21 is an exploratory borehole whose objective is to determine the nature of the near-surface formations after seismic information indicated a possible fault. The borehole is located in section 20, T.22S., R.31E., in eastern Eddy County, New Mexico, and was drilled between May 24 and 26, 1978. The hole was drilled to a depth of 1046 feet and encountered, from top to bottom, surficial Holocene deposits (6', including artificial fill for drill pad), the Mescalero caliche (6'), the Santa Rosa Sandstone (34'), the Dewey Lake Red Beds (487'), the Rustler Formation (308'), and the upper portion of the Salado Formation (178'). Cuttings were collected at 10-foot intervals. A suite of geophysical logs was run to measure acoustic velocities, density, and radioactivity. On the basis of comparison with other geologic sections drilled in the area, the WIPP 21 section is a normal stratigraphic sequence and it does not show structural disruption.

The WIPP is to demonstrate (through limited operations) disposal technology for transuranic defense wastes. The WIPP will also provide facilities to research interactions between high-level waste and salt.

2.0 INTRODUCTION

The introduction describes background information on the Waste Isolation Pilot Plant (WIPP) and the investigations at WIPP 18, 19, 21, and 22.

2.1 The Purpose of WIPP

The purpose of the WIPP is distinct from that of several other projects for the disposal of radioactive waste. The WIPP is planned to demonstrate disposal technology for the transuranic (TRU) waste resulting from this nation's defense programs of over 30 years. After a period (5-10 years) of limited (pilot) operation, during which the waste is readily retrievable, it is anticipated that the WIPP will be converted to a full-scale repository for permanent disposal of defense TRU waste. The WIPP plans also include a research facility to examine, on a large scale, the interactions between bedded salt and high-level radioactive waste resulting from thermal and radiation fluxes. There is no plan at this time to dispose of high-level waste or spent fuel in the WIPP. DOE had expressed an intent to request licensing of the WIPP by the Nuclear Regulatory Commission (NRC). This licensing policy was not acceptable to the congressional committees responsible for WIPP and DOE has agreed to proceed without licensing.

Additional information on the WIPP and characterization of the WIPP site may be found in Powers, et. al. (1978).

2.2 The Purpose of WIPP Boreholes 18, 19, 21, 22

Seismic reflection data (see X series in Hern et al., 1978) over the mile immediately north of ERDA 9 was acquired in late 1977. Early in 1978, preliminary interpretation of the data from line X-2 (Figure 1) indicated faulting of the upper Castile Formation. The fault line, as interpreted in the Castile, was extrapolated upward into poorly defined reflectors in the Rustler Formation (Figure 2). The possibility of a fault in the Rustler was investigated because of potential hydrologic connections into or through the evaporites.

In addition, anomalously low resistivity was measured (Elliot, 1977) in the area where WIPP 19 was drilled. The anomaly, though of lesser areal size and intensity than those previously measured over known "breccia pipes," has a pattern similar to the resistivity anomalies associated in these "breccia pipes." These coincident features required further investigation.

Boreholes WIPP 18, 19, 21, and 22 (WIPP 20 was unnecessary and was never drilled) were positioned to test the most probable location of the inferred fault and to bracket that location for added certainty (Figure 2). WIPP 18 was located north of the inferred fault. WIPP 19 was to intersect the fault in the lower Rustler or upper Salado. WIPP 22 was drilled so that the inferred fault might be intersected in the upper Rustler or Dewey Lake Redbeds. WIPP 21 was located farther south, between ERDA 9 and WIPP 22, to test for southward dip of the Rustler interpreted from the seismic reflection records.

For this evaluation, the displacement was to be identified primarily from comparison of stratigraphic thickness and position of marker beds identified on borehole geophysical logs. WIPP 19 was cored from surface to total depth as the borehole which might intercept the fault if it existed in the Rustler Formation.

Basic geologic data in this report may be used for many purposes. The geologic interpretation of borehole data relating to the inferred fault and resistivity anomaly will be a separate document.

Additional details regarding the background and justification for WIPP 18, 19, 21, and 22 are in Appendix A.

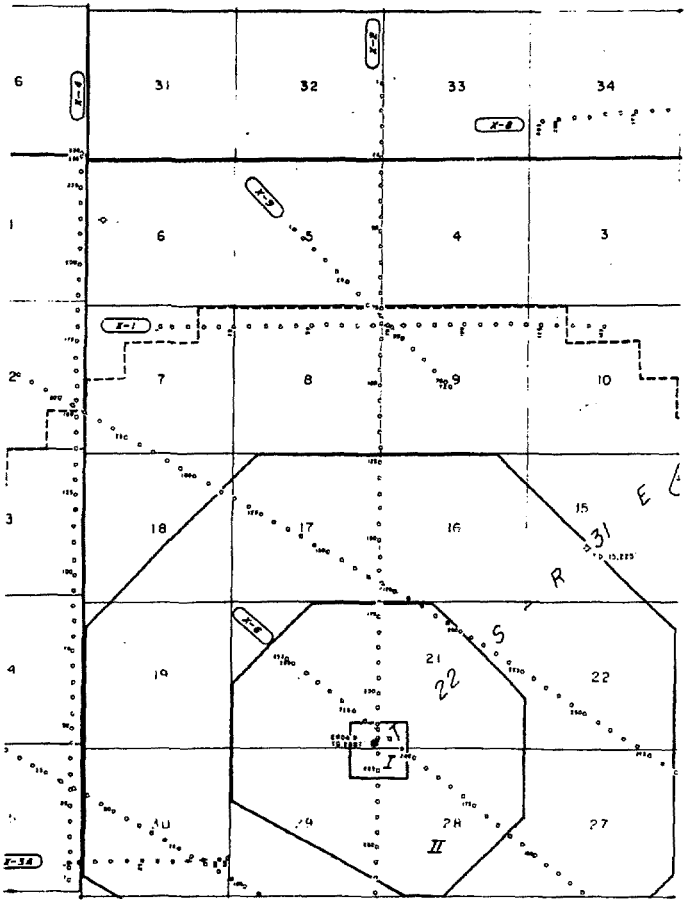

Figure 1. Shot point map of line X-2 north of ERDA 9.

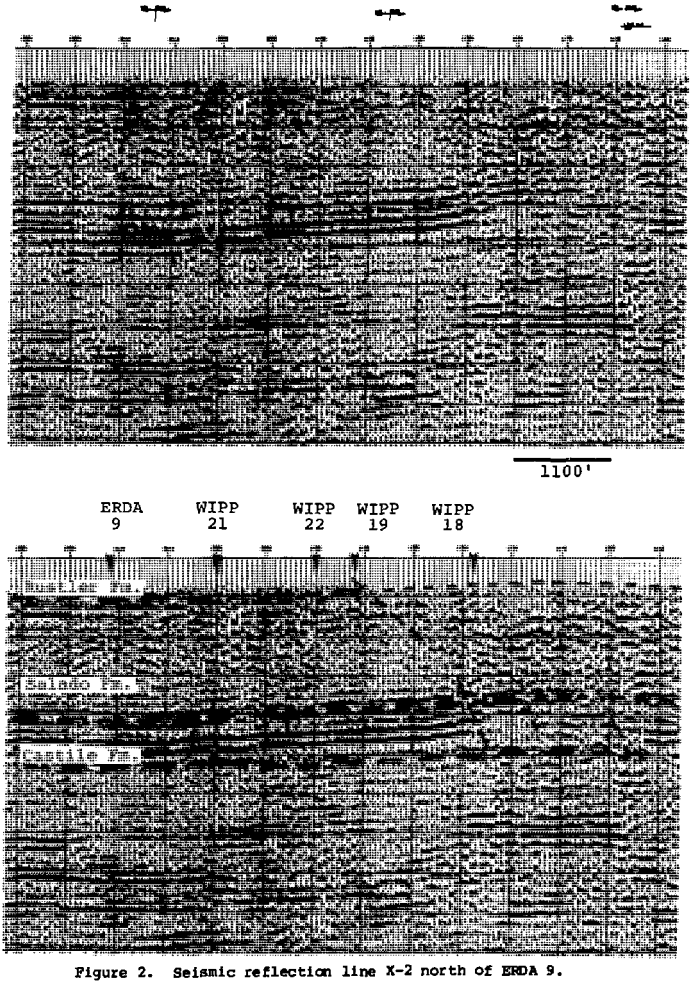

Figure 2. Seismic reflection line X-2 north of ERDA 9. Top: Uninterpreted. Bottom: Preliminary interpretation displaying features investigated by WIPP 18, 19, 21, 22.

3.0 GEOLOGICAL DATA FOR BOREHOLE WIPP 21

By

C. L. Jones[1] and J. L. Gonzales[2]

3.1 Abstract

Borehole WIPP 21 is a stratigraphic test hole drilled in eastern Eddy County, New Mexico, to explore for a possible fault indicated by seismic testing in near-surface formations. The formations penetrated include (1) the Mescalero caliche and Gatuna Formation of Pleistocene age, (2) the Santa Rosa Sandstone of Triassic age, and (3) the Dewey Lake Red Beds, the Rustler Formation, and the upper part of the Salado Formation, all of Permian age. Correlated geologic and geophysical logs of WIPP 21 give stratigraphic, lithologic, and physical details of the near-surface formations and establish a normal stratigraphic section, WIPP 21, unbroken by faulting.

3.2 Introduction

Borehole WIPP 21 is one of a series of stratigraphic tests drilled near the center of the proposed site for a Waste Isolation Pilot Plant (WIPP) in eastern Eddy County, New Mexico (Figure 3) on behalf of the WIPP project office of the U.S. Department of Energy (DOE). The drilling was done to determine the structure of near-surface formations along part of a seismic reflection survey line. On the basis of seismic records, faulting of the near-surface formations with a possible minimum of 100-150 feet of stratigraphic displacement had been inferred.

Geologic details of the section penetrated by WIPP 21 are tabulated herein. The tabulation includes detals of the location and the drilling of WIPP 21; stratigraphic details of the geologic section and lithologic features of the rocks. The lithology is interpreted and correlated with selected geophysical logs on Figure 3. Results of the other drilling will be reported elsehwere.

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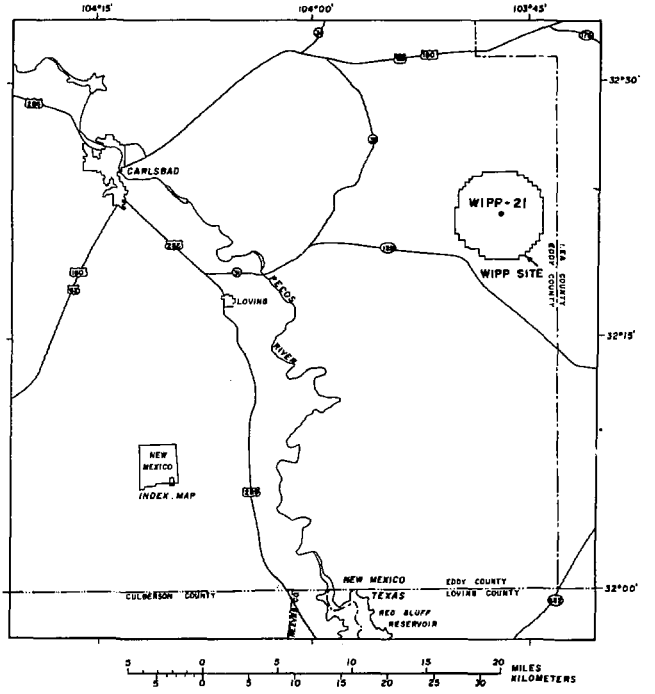


Figure 3: Index map showing location of borehole WIPP 21.

All measurements related to WIPP 21 are reported in the inch-pound system. The system is used to facilitate the comparison of original measurements and observations by surveyors in establishing the geographic coordinates of the hole, by drillers in reporting sample depths, and by geophysical loggers in recording inhole variations in rock properties with depth. If metric equivalents of the inch-pound system are desired, the following conversion factors are provided:

Multiply English unit	By	To obtain metric unit
foot (ft)	0.3048	meter (m)
inch (in)	25.4	millimeter (mm)
inch (in)	2.54	centimeter (cm)

3.3 Description of WIPP 21

Borehole WIPP 21 is located in eastern Eddy County, New Mexico, in the SE 1/4 Section 20, T.22S., R.31E. The hole was drilled between May 24 and 26, 1978, to a depth of 1046 feet measured from a land-surface altitude of 3417 feet above MSL (mean sea level). Table 1 gives further details concerning the drilling of WIPP 21.

Conventional rotary drilling procedures were used to drill WIPP 21. Cuttings were collected at 10-foot intervals by the driller, and all were washed to remove a coating of drilling fluid, and then examined at the drill site. The examination was made with a binocular microscope, and a descriptive lithologic log was prepared by J. L. Gonzales.

On completion of drilling, a suite of wireline geophysical logs was run the full depth of WIPP 21 under open-hole, fluid-filled conditions. The logging was done to facilitate the recognition and correlation of rock units, to assure identification of major lithologies (dolomite, anhydrite, polyhalite, and other evaporites), and to provide depth determinations independent of that indicated by drill-pipe measurements. The geophysical logs included (1) a gamma-ray curve recording variations in distribution of potassium and other radioactive elements, (2) a neutron-porosity curve recording essentially variations in the distribution of hydrogen, and (3) a density-porosity curve recording essentially variations in rock density (Figure 4).

3.4 Geologic Data

The geologic section in WIPP 21 includes continental sediments of Quaternary and Triassic age, and marine red beds and evaporites of Permian age. The Quaternary, Triassic, and Permian parts of the section are listed in Table 2, and are briefly described in descending order.

The Quaternary sediments consist of unnamed deposits of Holocene age, and the Mescalero caliché and Gatuna Formation, both of Pleistocene age. The Holocene deposits areeeunconsolidated sands, the Mescalero caliche is a well-lithified calcareous soil, and the Gatuna is weakly cemented, very fine grained sandstone. The three units from the upper 39 feet of section in WIPP 21.

The Triassic Santa Rosa Sandstone, 39-73 feet below the land surface, is represented by reddish-brown mudstone, siltstone, and sandstone.

The Permian rocks include the Dewey Lake Red Beds (73-560 feet below land surface), the Rustler Formation (560-868 feet below land surface), and the upper part of the Salado Formation (868-1046 feet below land surface), all of Permian age. The Dewey Lake is 487 feet of mostly siltstone with subordinate mudstone and sandstone. The rock is dominantly reddish-brown peppered with greenish-gray reduction spots; much of it carries veins of fibrous selenite. The underlying Rustler Formation is 308 feet of anhydrite and subordinate siltstone, dolomite, and clayey halite; it includes a thick upper interval from which halite and other water-soluble materials have been leached by groundwater, and a thinner lower, halite-bearing interval that has escaped dissolution by groundwater. The underlying upper part of the Salado Formation is 178 feet of chiefly halite with thin interbeds of siltstone, polyhalite, argillaceous halite, and anhydrite.

The geologic section in WIPP 21 is similar lithologically, stratigraphically, and structurally to that reported from other exploratory wells at the WIPP site (Jones, 1978). The section is not disrupted by faulting, and there are no anomalous structural features, thinning of section, or missing rock units. The drilling results very clearly do not confirm the interpretation from seismic records of faulting of near-surface formations at WIPP 21.

Table 1.--*Abridged history of borehole WIPP-21*

LOCATION: sec. 20, T. 22 S., R. 31 E.
1,451.08 feet from south line
11.74 feet from east line

ALTITUDE: LS (land surface) 3,417.00 feet. Datum for depth measurements.

LITHOLOGIC LOG OF CUTTINGS PREPARED BY: J. L. Gonzales

DRILLING CONTRACTOR: Boyles Bros. Drilling Co.

DRILLING RECORD: Commenced drilling on May 24, 1978, and completed on May 26, 1978, at 1,045 feet below land surface.

Drilled 8 3/4-inch hole to 15 feet. Set 7-inch outside-diameter casing at at 15 feet, and packed annulus with dirt.

Drilled 6 1/8-inch hole from 15 to 1,045 feet.

On completion of drilling and logging, borehole was filled with mud and capped pending decision on further work.

Table 2.--*Geologic section in borehole WIPP-21*

Rock unit	Thickness Feet	Depth interval[1] Feet
Quaternary rocks		
Holocene deposits[2]	6	0- 6
Mescalero caliche	6	6- 12
Gatuna Formation		12- 39
Triassic rocks		
Santa Rosa Sandstone	34	39- 73
Permian rocks		
Dewey Lake Red Beds	487	73- 560
Rustler Formation	308	560- 868
Dissolution residue	13	588- 601
Magenta Dolomite Member	24	618- 642
Dissolution residue	9	706- 715
Culebra Dolomite Member	24	729- 753
Dissolution residue	4	755- 759
Salt-bearing interval	98	770- 868
Salado Formation	178	868-1,046
Upper member	178	868-1,046
[3]MB 101	3	986- 989
[3]MB 102	1	1,025-1,026
[3]MB 103	7+	[4]1,039
Maximum depth recorded----------		1,046

[1]Depth recorded on Compensated Neutron-Formation Density Log.
[2]Includes artificial fill for drill pad.
[3]Marker bed.
[4]Top of unit.

Table 3.--*Lithologic log of borehole WIPP-21*
[Color designation from Rock-Color Chart (Goddard and others, 1948)]

Lithologic description	Depth interval Feet
Dune sand, moderate-reddish-brown (10R 4/6), unconsolidated (includes fill for drill pad)----------	0- 6
Caliche, very pale orange (10YR 8/2); sandy----------	6- 12
Sandstone, moderate-reddish-brown (10R 4/6), with grayish-purple (5P 4/2) tint, very fine grained----------	12- 20
Sandstone, moderate-reddish-brown (10R 4/6), very fine grained; grading to silt----------	20- 30
Mudstone (50 percent), moderate-reddish-brown (10R 4/6); moderate-reddish-brown (10R 4/6) siltstone (50 percent), speckled with gray-yellowish-green (5GY 7/2) reduction spots----------	30- 40
Mudstone (90 percent), dark-reddish-brown (10R 3/4), with grayish-purple (5P 4/2) tint; moderate-reddish-brown (10R 4/6) siltstone (10 percent)----------	40- 50
Sandstone (40 percent), dark-reddish-brown (10R 3/4), very fine grained; mudstone (60 percent), same as above----------	50- 60
Sandstone (90 percent), dark-reddish-brown (10R 3/4), very fine grained, with some gray-yellowish-green (5GY 7/2) sandstone; dark-reddish-brown (10R 3/4) siltstone (10 percent)----------	60- 70
Mudstone (70 percent), moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4); moderate-reddish-brown (10R 4/6) siltstone (30 percent)----------	70- 90
Mudstone (90 percent), moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4); moderate-reddish-brown (10R 4/6) siltstone (10 percent)----------	90-100
Mudstone (80 percent) same as above; siltstone (20 percent), same as above----------	100-110
Mudstone, moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4)----------	110-120
Siltstone (70 percent), dark-reddish-brown (10R 3/4); mudstone (30 percent), same as above----------	120-130
Mudstone (60 percent), moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4); dark-reddish-brown (10R 3/4) siltstone (40 percent)------	130-140
Mudstone (70 percent), same as above; siltstone (30 percent), same as above; trace of very pale green (10G 8/2) mudstone----------	140-150
Siltstone (90 percent), dark-reddish-brown (10R 3/4); mudstone (10 percent), same as above; trace of very pale green (10G 8/2) siltstone----------	150-160
Mudstone, moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4), trace of dark-reddish-brown (10R 3/4) siltstone----------	160-170
Mudstone, dark-reddish-brown (10R 3/4), peppered with gray-yellowish-green (5GY7/2) reduction spots----------	170-

Table 3.--*Lithologic log of borehole WIPP-21*--Continued

Lithologic description	Depth interval Feet
Siltstone (70 percent), moderate-brown (5*YR* 4/4), hard; mudstone (30 percent), same as above----------	180-190
Mudstone (70 percent), same as above; siltstone (30 percent), same as above, trace of gray-orange (10*YR* 7/4) siltstone----------	190-200
Mudstone (90 percent), same as above; siltstone (10 percent), same as above----	200-210
Siltstone, dark-reddish-brown (10*R* 3/4); trace of white (*N*9) selenite----------	210-220
Siltstone, same as above, with gray-yellowish-green (5*GY* 7/2) reduction spots, trace of dark-reddish-brown (10*R* 3/4) mudstone----------	220-230
Siltstone, same as above; trace of mudstone, same as above; white (*N*9) selenite----------	230-240
Siltstone, same as above, but reduction spots more numerous----------	240-250
Siltstone (80 percent), dark-reddish-brown (10*R* 3/4); dark-reddish-brown (10*R* 3/4) mudstone; trace of white (*N*9) selenite----------	250-260
Siltstone, same as above, trace mudstone, same as above; white (*N*9) selenite----------	260-270
Siltstone, moderate-reddish-brown (10*R* 4/6); pale-olive (10*Y* 6/2) reduction spots; trace of white (*N*9) vein selenite, and dark-reddish-brown (10*R* 3/4) mudstone----------	270-280
Siltstone, moderate-reddish-brown (10*R* 4/6); trace of white (*N*9) selenite and dark-reddish-brown (10*R* 3/4) mudstone peppered with gray-yellowish-green (5*GY* 7/2) reduction spots----------	280-290
Siltstone, same as above; trace of white (*N*9) selenite (as much as 3 mm thick)----------	290-300
Siltstone, same as above, with few reduction spots; trace of vein selenite-----	300-310
Siltstone, same as above, with reduction spots; vein selenite----------	310-340
Siltstone, same as above; trace of dark-reddish-brown (10*R* 3/4) mudstone with grayish-yellowish-green (5*GY* 7/2) reduction spots----------	340-350
Siltstone, same as above; trace of dark-reddish-brown (10*R* 3/4) mudstone and grayish-olive-green (5*GY* 3/2) siltstone and white (*N*9) selenite----------	350-360
Siltstone, same as above, with reduction spots; grayish-olive-green (5*GY* 3/2) siltstone and white (*N*9) selenite----------	360-370
Siltstone, moderate-reddish-brown (10*R* 4/6) to dark-reddish-brown (10*R* 3/4); trace of dark-reddish-brown (10*R* 3/4) mudstone and vein selenite----------	370-380
Siltstone, moderate-reddish-brown (10*R* 4/6), with grayish-green (5*G* 5/2) reduction spots; some white (*N*9) selenite and trace of biotite----------	380-420
Siltstone, moderate-reddish-brown (10*R* 4/6), speckled with grayish-green (5*G* 5/2) reduction spots, slightly coarser than above; trace of white (*N*9) selenite----------	420-430

Table 3.--*Lithologic log of borehole WIPP-21*--Continued

Lithologic description	Depth interval Feet
Siltstone, moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4) with white (N9) selenite, grayish-green (5G 5/2) reduction spots and biotite; trace of grayish-orange-pink (10R 8/2) and moderate-reddish-orange (10R 6/6) sandstone, very fine grained, slightly friable----------	430-440
Siltstone, same as above; trace of very fine grained sandstone, same as above, and white (N9) selenite----------	440-450
Siltstone, same as above, with vein selenite and reduction spots; trace of moderate-reddish-orange (10R 6/6), fine- to medium-grained, subrounded to rounded sandstone----------	450-460
Siltstone, same as above; trace of white (N9) selenite----------	460-480
Siltstone, same as above; trace of vein selenite----------	480-490
Siltstone, dark-reddish-brown (10R 3/4), with grayish-green (5G 5/2) reduction spots; white (N9) selenite----------	490-500
Siltstone, same as above; trace of very fine grained sandstone, same as above----------	500-510
Siltstone, same as above with white (N9) selenite----------	510-520
Siltstone, same as above with white (N9) selenite----------	520-530
Siltstone, same as above with white (N9) selenite and biotite----------	530-540
Siltstone, same as above with white (N9) selenite----------	540-550
Siltstone, same as above with white (N9) selenite----------	550-560
Anhydrite (60 percent), pale-yellowish-brown (10YR 6/2), very finely crystalline; dark-reddish-brown (10R 3/4) siltstone (40 percent), with trace of white (N9) gypsum----------	560-570
Anhydrite (70 percent), same as above; siltstone (30 percent), same as above----------	570-590
Siltstone (70 percent), dark-reddish-brown (10R 3/4); pale-yellowish-brown (10YR 6/2) and some moderate-yellowish-brown (5YR 5/4), very finely crystalline anhydrite (30 percent)----------	590-600
Anhydrite, light-gray (N7) to medium-light-gray (N6), with light-bluish-gray (5B 7/1) tint, very finely crystalline; trace of white (N9) gypsum----------	600-610
Anhydrite (90 percent), same as above; white (N9) gypsum(10 percent)----------	610-620
Dolomite (90 percent), light-olive-gray (5Y 6/1), silty texture; anhydrite (10 percent), same as above----------	620-630
Dolomite, olive-gray (5Y 4/1), silty----------	630-640
Dolomite (70 percent), same as above; anhydrite (20 percent), same as above; white (N9) gypsum (10 percent)----------	640-650
Anhydrite (80 percent), same as above; dolomite (10 percent), same as above; gypsum (10 percent), same as above with trace of dark-reddish-brown (10R 3/4) siltstone and some selenite----------	650-660

Table 3.--*Lithologic log of borehole WIPP-21*--Continued

Lithologic description	Depth interval Feet
Anhydrite, light-olive-gray (5Y 6/1) to olive-gray (5Y 4/1), very finely crystalline, with heavy trace white (N9) gypsum----------	660-670
Anhydrite, same as above, with trace of white (N9) gypsum----------	670-680
Anhydrite (80 percent), light-olive-gray (5Y 6/1), very finely crystalline; white (N9) to very light gray (N8), very finely crystalline gypsum (20 percent)----------	680-720
Anhydrite (90 percent), medium-light-gray (N6) to medium-gray (N5), very finely crystalline; gypsum (10 percent), same as above----------	720-730
Dolomite (90 percent), light-olive-gray (5Y 6/1) to pale-yellowish-brown (10YR 6/2), very finely crystalline, pitted; anhydrite (10 percent), same as above with trace of gypsum, same as above----------	730-740
Dolomite, light-olive-gray (5Y 6/1), very finely crystalline; trace of white (N9) selenite----------	740-750
Dolomite, same as above, with trace of moderate-orange-pink (10R 7/4), very finely crystalline anhydrite----------	750-760
Gypsum (70 percent), very light gray (N8) to white (N9), with pinkish-gray (5YR 8/1) tint; light-gray (N7) to light-olive-gray (5Y 6/1), very finely crystalline anhydrite (30 percent); with trace of dolomite, same as above----------	760-770
Anhydrite (60 percent), same as above; gypsum (20 percent), same as above; halite (30 percent), colorless, slightly argillaceous----------	770-780
Halite (40 percent), colorless, slightly argillaceous; anhydrite (30 percent), same as above; gypsum (20 percent), same as above; dark-reddish-brown (10R 3/4) siltstone (10 percent)----------	780-790
Halite (90 percent), colorless to dark-reddish-brown (10R 3/4), highly argillaceous; gypsum and anhydrite (10 percent), same as above----------	790-800
Siltstone (90 percent), dark-reddish-brown (10R 3/4), halitic; anhydrite and gypsum (10 percent), same as above----------	800-810
Sandstone, grayish-red (10R 4/2) to brownish-gray (5YR 4/1), very fine grained, silty, very hard to friable----------	810-820
Siltstone (40 percent), dark-reddish-brown (10R 3/4); light-gray (N7) to light-olive-gray (5Y 6/1), very finely crystalline anhydrite (30 percent); grayish-red (10R 4/2) to brownish-gray (5YR 4/1), very fine grained, silty, very hard sandstone (30 percent)----------	820-830
Sandstone (40 percent), same as above; siltstone (40 percent), same as above; anhydrite (20 percent), same as above----------	830-840
Mudstone (70 percent), medium-dark-gray (N4), soft and clayey; medium-dark-gray (N4) siltstone (20 percent); siltstone (10 percent); same as above; trace of anhydrite, same as above----------	840-850

Table 3.--*Lithologic log of borehole WIPP-21*--Continued

Lithologic description	Depth interval Feet
Clay (60 percent), medium-dark-gray (N4); medium-dark-gray (N4) siltstone (20 percent); light-bluish-gray (5B 7/1), very finely crystalline anhydrite (10 percent); dark-reddish-brown (10R 3/4) siltstone (10 percent)---	850-870
Siltstone (60 percent), medium-dark-gray (N4) and dark-reddish-brown (10R 3/4); clay (30 percent), same as above; anhydrite (10 percent), same as above----------	870-880
Halite, clear to milky, slightly argillaceous----------	880-890
Halite, clear to milky, slightly more argillaceous than above, with moderate-reddish-orange (10R 6/6) tint----------	890-900
Halite (70 percent), predominantly clear but some milky; moderate-reddish-orange (10R 6/6) siltstone (30 percent)----------	900-920
Halite, predominantly clear with trace of argillaceous halite----------	920-940
Halite (90 percent), colorless; moderate-reddish-orange (10R 6/6), very finely crystalline polyhalite (10 percent)----------	940-950
Halite, colorless, with trace of moderate-reddish-orange (10R 6/6) siltstone----------	950-970
Halite, colorless, with trace of moderate-reddish-orange (10R 6/6) siltstone, and moderate-reddish-orange (10R 6/6) polyhalite----------	970-980
Halite, colorless, slightly argillaceous with trace of polyhalite, same as above----------	980-990
Halite (60 percent), colorless, slightly argillaceous; moderate-reddish-orange (10R 6/6), very finely crystalline polyhalite (40 percent)----------	990-1,000
Halite (90 percent), same as above; polyhalite (10 percent), same as above------	1,000-1,010
Halite, same as above with trace of polyhalite, same as above----------	1,010-1,020
Halite (60 percent), same as above; polyhalite (40 percent), same as above------	1,020-1,030
Halite (70 percent), same as above; polyhalite (30 percent), same as above------	1,030-1,040
Halite (90 percent), colorless; polyhalite (10 percent), same as above----------	1,040-1,045

4.0 HYDROLOGIC DATA

No hydrologic test data have been obtained to date from WIPP 21, and there are no plans at present to convert these boreholes for hydrologic testing.

5.0 REMARKS

The immediate objective of testing for stratigraphic continuity of the Rustler Formation and upper Salado was reached through drilling of the complementary boreholes WIPP 18, 19, 21, 22. As a consequence, the seismic reflection data down to the upper Salado are treated with extreme caution; the apparent reflectors are generally considered unreliable for this area. Later generations of seismic reflection data ("Y" series, Hern et al., 1978; "GG" series, Bell and Murphy, 1979), synthetic seismograms, and review of field data contribute to understanding of the seismic data in this particular area. Interpretive reports will deal with this aspect.

Trenches were dug through the Mescalero caliche in the road at the projected surface trace of the inferred fault. The caliche was examined by the USGS for displacements, but none were observed. This examination and caliche data are not reported explicitly for this problem, but the information is available in more general form (Bachman, USGS, in preparation.

6.0 BIBLIOGRAPHY

Bachman, G. O., in preparation, Regional geology and Cenozoic history of the Pecos region of southeast New Mexico: U.S. Geological Survey Open-file Report.

Bell and Murphy and Associates, 1979, Geophysical investigation of the Waste Isolation Pilot Plant, Eddy County, New Mexico: report to the Department of Energy.

Elliot, C. L., 1977, Evaluation of the proposed Los Medanos nuclear waste disposal site by means of electrical resistivity surveys, Eddy and Lea Counties, New Mexico: vols. I and II, unpublished report to Sandia Laboratories.

Goddard, E. N., chm., and others, 1948, Rock-Color Chart: Washington, National Research Council (reprinted by Geological Society of America, 1975).

Hern, J. L., Powers, D. W., and Barrows, L. J., 1979, Seismic reflection data report, Waste Isolation Pilot Plant (WIPP) site, Southeastern New Mexico: vols. I & II, SAND79-0264, Sandia Laboratories, Albuquerque, NM.

Jones, S. L., 1978, Test drilling for potash resources: Waste Isolation Pilot Plant Site, Eddy County, New Mexico: U.S. Geological Survey Open-file Report 78-592, 2 vols., 431 p.

Powers, D. W., Lambert, S. J., Shaffer, S-E., Hill, L. R., and Weart, W. D., editors, 1978. Geological Characterization Report, Waste Isolation Pilot Plant (WIPP) Site, Southeastern New Mexico: Vol. I & II, SAND78-1596, Sandia Laboratories, Albuquerque, NM.

Insert Fig. 4, WIPP 21 here

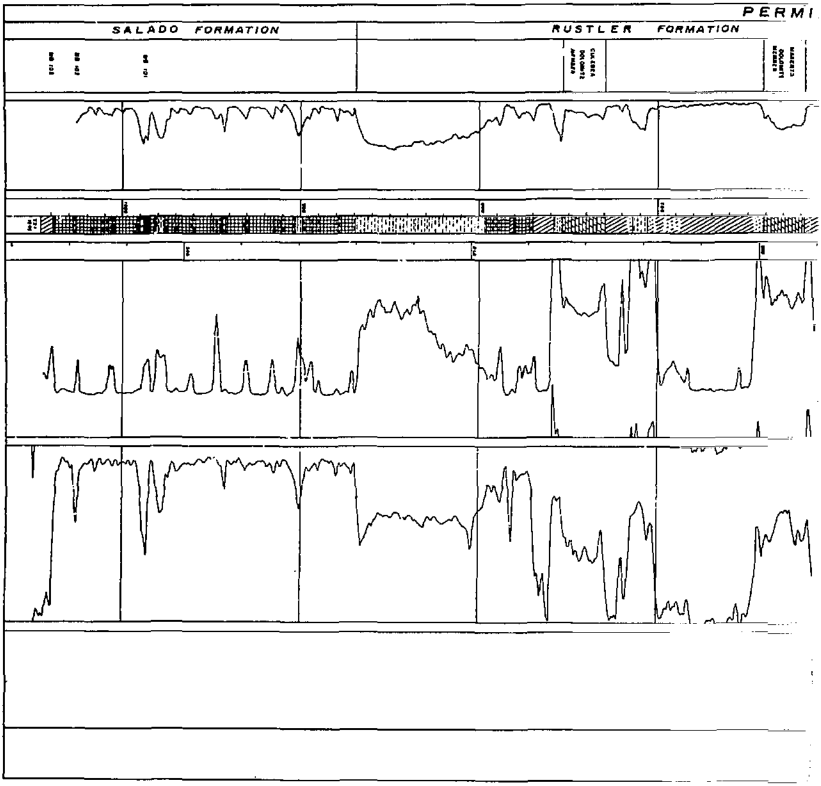
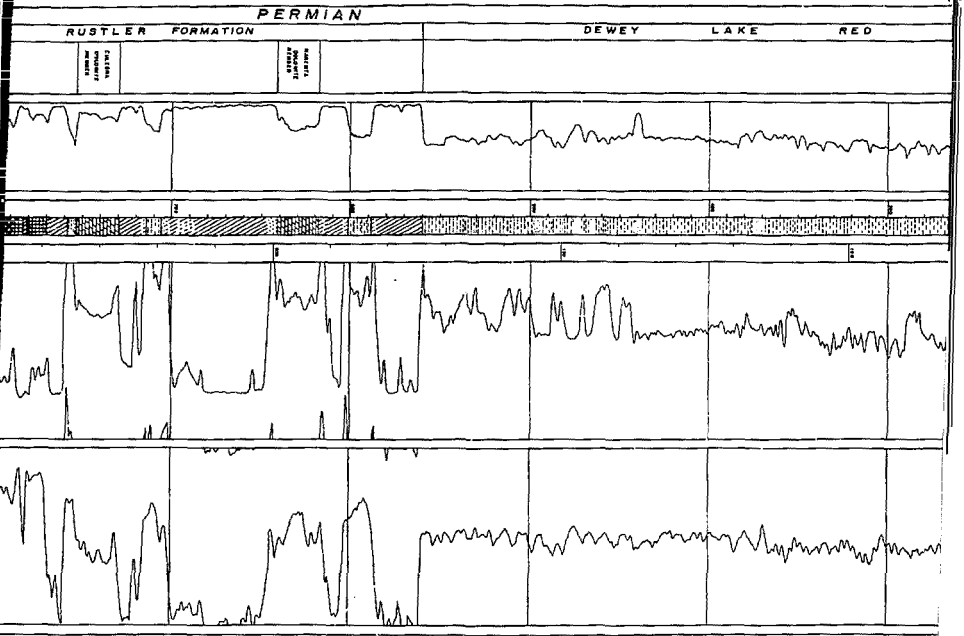
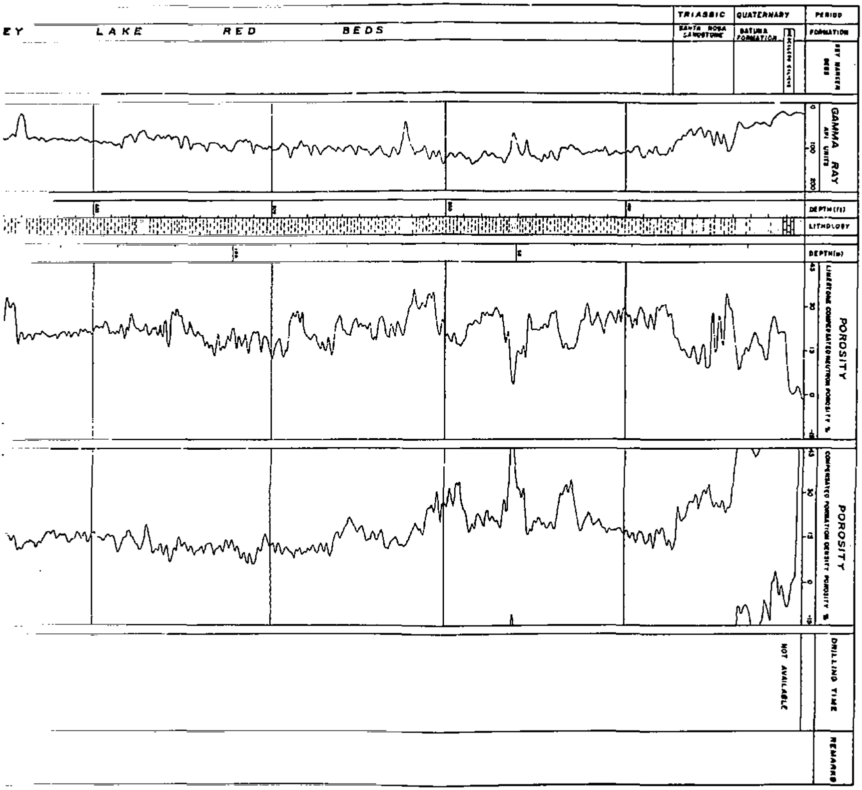


Figure 4.--Lithologic and geophysical log of borehole WIPP-21


PERMIAN
RUSTLER FORMATION
DEWEY LAKE RED
CULEBRA DOLOMITE MEMBER
MAGENTA DOLOMITE MEMBER


EY
LAKE RED BEDS
TRIASSIC
QUATERNARY
PERIOD
SANTA ROSA SANDSTONE
GATUÑA FORMATION
FORMATION
KEY MARKER BEDS
GAMMA RAY
API UNITS
0
100
200
DEPTH (ft)
LITHOLOGY
DEPTH (m)
POROSITY
LIMESTONE COMPENSATED NEUTRON POROSITY %
45
30
15
0
-15
POROSITY
COMPENSATED FORMATION DENSITY POROSITY %
NOT AVAILABLE
DRILLING TIME
REMARKS

U.S. GEOLOGICAL SURVEY
WELL RECORD

Company DEPT OF ENERGY
Well WIPP 21
Sec. 20 Twp. 22S Rg. 31E
Location [illegible]
County EDDY State N. MEX.
Area LOS MEDANOS

Feet above or below datum
Log Measured From [illegible]
Drilling Measured From [illegible]
Datum [illegible]

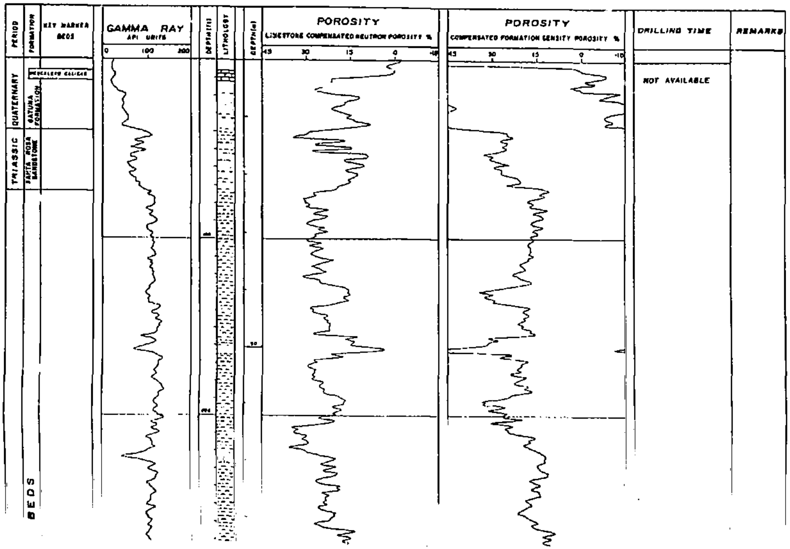
Elevation
GL [illegible]
KB [illegible]
DF [illegible]

Contractor [illegible]
Spud. [illegible] Comp. [illegible]
TD 1046'
Geologist(s) on well [illegible]

Casing
Conductor [illegible]
Surface

EXPLANATION

- MUDSTONE
- SILTSTONE
- SANDSTONE
- ANHYDRITE
- GYPSIFEROUS ANHYDRITE
- GYPSUM
- CALICHE
- DOLOMITE
- POLYHALITE
- HALITE
- ARGILLACEOUS HALITE
- MB MARKER BED



[redacted]

[redacted]

INTRODUCTION TO APPENDIX A, JUSTIFICATION

Appendix A consists of relevant portions of two related documents:

1) memorandum from D. W. Powers to L. R. Hill, dated 2/15/78, "Stratigraphic Test Holes," and
2) memorandum from D. W. Powers to L. R. Hill, dated 3/15/78, "Shallow Cores for Testing Displacement of Pleistocene Sediments."

These documents provide details of background information and program options as understood at the time of initiation. The reader is cautioned, therefore, that details of the program may have been altered as information became available and that preliminary interpretive hypotheses or ideas guiding the program formulation may need revision based on information presented in this report. Later interpretive reports may deal with such items.

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date: February 15, 1978

to L.R. Hill 5311

from D.W. Powers 5311

subject Stratigraphic Test Holes

Objective: to determine the depth of the top of the Salado Formation rather precisely over a half-mile interval beginning about a half-mile north of ERDA 9, section 20, T22S, R31E. In addition, the stratigraphy of the beds above the Salado will be evaluated, and some core from the upper part of the Salado Formation may be taken. One of the holes may be established as a hydrology hole.

Method: 3-5 drill holes may be required along seismic reflection line X-2. If necessary, 2 drill holes may be located along or near line X-5. Extensive logging will be required to support stratigraphic inferences, and some of the holes may be cored extensively.

Details: WIPP 18 should be rotary drilled to the top of the Salado at an expected depth of about 1100'. The logs required are sonic, gamma ray, neutron, microlaterolog, and diplog. In addition, determination of the seismic velocity through downhole measurements will probably be required. The USGS/WRD should plan to log this hole to provide continuity between commercial logs on this, and other holes, and the USGS/WRD logs on the potash holes, particularly P-5. WIPP 18 should be located at vibrating point (VP) 179 of X-2.

WIPP 19 should be cored from "grassroots" to the top of the Salado at an expected depth of about 900'. Logs should be run as on 18, with the exception of the seismic velocity log. The location is at VP 191 of X-2. Core in this hole may help to locate the depth of faults more precisely, and help determine the character of any fault (including fluid movement). If the stratigraphy is relatively undisturbed through normal aquifer zones, the hole may be cased for hydrologic studies.

This hole is located to intersect both possible faults to aid projections toward the surface, and should intersect the top of the Salado immediately south of the fault zone on the hanging wall. This borehole should, with WIPP 18, provide boundaries for the zone of apparent displacement.

WIPP 20 should be drilled to a depth of about 700' (contingent on the depths indicated in WIPP 18), and then cored to a depth of about 1500'. Logs should be similar to WIPP 19. The location is at VP 187 of X-2. The core will indicate the depth of faults, and the nature of the fault plane(s). Solutioning of salt may be determined by examination of core within the Salado.

This hole is located in the zone showing greatest probable disturbance. It may be the last of the test holes necessary around this anomaly.

WIPP 21 may be drilled to a depth of about 1200-1300' to obtain additional data on the disturbed zone. Logs are similar to WIPP 19. The location is at VP 185 of X-2. Some core may be required to determine the effects of faulting and any dissolution of salt. The location and need for this hole are tentative.

An alternative location (WIPP 23) for this hole is at VP 110 on line X-5. This area shows about 100' difference in depth to top of Salado when compared with hole F-82 about one-quarter mile north. In addition, apparent faulting of the top of the Salado occurs at about VP 120.

WIPP 22 may be drilled to the top of the Salado at a depth of about 900'. The logs would be the same as for WIPP 19. The location is VP 195 along X-2. This location is tentative, and may be used only if WIPP 19 is more disturbed than expected. This location might be an alternative for conversion to hydrologic purposes.

An alternate location (WIPP 24) is near P-82 to confirm information on the top of the Salado in that hole.

Background: interpretation of the recently acquired seismic reflection data in the WIPP area indicates a possible northwest trending fault through this area. The displacement on the fault, if properly interpreted, may be 100-250'. There is a need to confirm or reject this interpretation in order to further assess the study area as suitable for the WIPP. This drilling program is expected to provide appropriate data.

Field Support: support for engineering programs is requested from Division 1133. Geologic field support is expected through the USGS and F&S.

DWP:5311:dp

Distribution:
1133 R.D. Statler (3)
1135 P.D. Seward
5310 W.D. Weart
5311 D.W. Powers (2)
5311 Archives (2)

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date: March 15, 1978

to: L.R. Hill 5311

from: D.W. Powers 5311

subject: Shallow cores for testing displacement of Pleistocene sediments

Objective: to provide core of significant stratigraphic horizons from very shallow depths north of ERDA 9 to test for displacement.

Method: use normal soil coring techniques to provide generally continuous core from above the caliche to a depth of 5-15 feet into the uppermost Permian or Triassic sediments. Contacts of the caliche and any Gatuna are most significant; other traceable horizons may be useful as well. Surveying of the drilling locations will provide the lateral and vertical control necessary to establish possible displacement.

Location: the location of interest for these 10-12 coreholes is between vibrating points (VP) 191 and 195 of seismic line X-2. The locations are in section 20, T22S, R31E, and are between about 2500 and 3000' north of the south boundary of the section. The line of holes will probably be located west of the access road through section 20 to avoid caliche disturbed by construction.

Timing: shallow coring will be initiated as soon as practicable after WIPP 19 has drilled the redbed section. This will allow further refinements to the location of initial shallow cores.

Background: This program is directed at further delineation of the zone north of ERDA 9 where possible faulting has been interpreted on the basis of recent seismic reflection data. If the drilling of WIPP 18 and 19 disproves such faulting, this program for shallow core drilling will not be necessary. If WIPP 18 and 19 indicate the presence of faulting, this program will help determine how recently such faulting has been active.

Field Support: support in establishing the contracting, surveying, and other field engineering is requested from Division 1133. Geologic field support is expected from the USGS, F&S, and the New Mexico Bureau of Mines and Mineral Resources (Dr. John Hawley).

DWP:5311:dp

Distribution:
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APPENDIX B

DRILLING AND TESTING PLAN

compiled by

R. D. Statler
Division 1133
and
P. D. Seward
Division 1135
Sandia Laboratories

INTRODUCTION TO APPENDIX B, DRILLING AND TESTING PLAN

The drilling and testing plan is the translation of technical objectives contained in documents in Appendix A into field engineering terms. Changes or amendments are included as well. The approvals and permits obtained from various agencies prior to drilling are kept on file but are not included here.

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

Date: February 27, 1978

To: Distribution

R. D. Statler

From: R. D. Statler - SLA 1133

Subject: WIPP Nos. 18 thru 22, Drilling Program Schedule and Coring Plan

The attached document describes the plans and program for drilling up to five exploratory holes designated as WIPP 18, 19, 20, 21, and 22. It is expected these holes will begin during March 1978 and be completed by the end of May 1978, presuming necessary clearances and permits can be quickly obtained.

RDS:rj

Distribution:
DOE/ALO D. Davis
USGS Denver C. Jones
USGS Albuq. J. Mercer
F&S Las Vegas R. E. Ashlock
F&S Carlsbad W. E. Cunningham

1130 H. E. Viney
1135 P. D. Seward
1135 J. E. Magruder
5311 L. R. Hill
5311 D. W. Powers (3)
5311 S. J. Lambert
5311 Archives (2)
5342 J. W. McKiernan
9512 F. L. McFarling
1133 R. D. Statler (5)

WIPP 18, 19, 20, 21 22
OPERATIONAL PROCEDURE, CORING & TEST PLANS

A. OBJECTIVE (Ref Memo of Record, D. W. Powers, 5311, dtd 2/15/78)
To determine depth of the top of Salado formation precisely over a half-mile interval within the mile immediatley north of ERDA 9. To evaluate the stratigraphy in the overlying beds above the Salado and possibly establish a hydrological test well.

B. SCHEDULING SEQUENCE

WIPP 18 will be initiated first by rotary drilling to the top of Salado. After a suite of logs are run, the hole will be plugged to surface and abandoned. Expect to begin mid-March and be complete in about one week.

WIPP 19 will be set up second to take continuous core from "grass-roots" to the top of Salado. After a suite of logs have been run and evaluated, the hole may be opened and then casing stood and cemented for subsequent conversion into a hydrological test well. If hole not considered suitable, it will be plugged to surface and abandoned.

WIPP 20 will be drilled third to a depth of about 700' (contingent on evaluation of results from WIPP 18 and 19) and then a continuous core taken to a depth of about 1500'. After suite of logs taken, hole will be plugged to surface and abandoned.

WIPP 21 may be drilled to a depth of 1200-1300' to obtain additional data if information from 18, 19 and 20 is considered incomplete. Suite of logs will be run and several hundred feet of core may be taken. Hole will then be plugged to surface and abandoned. Location may be moved to an alternate site along seismic line X-5.

WIPP 22 may be drilled to the top of Salado. After suite of logs, hole will be evaluated and either plugged or set up as hydrologic test well.

C. ORGANIZATION

Technical direction will originate within Sandia Division 5311 under Dennis Powers. Field operations, managed by Bob Statler, Sandia Division 1133, will be conducted by W. E. Cunningham, Fenix & Scisson. Drilling contract and associated support service contracts will be let and administered by F&S as arranged for by Federal agency order through Nevada Operations Office, DOE.

Identification of marker beds, core logging and other geologic interpretations will be provided by Charlie Jones, USGS-Special Projects, Jerry Mercer, USGS-WRD, and Joe Gonzales, F&S.

Quality Assurance Program will be administered by F. L. McFarling and Jim Jones, Sandia Division 9517.

Industrial Safety program will be administered by specialists from Fenix & Scisson, Las Vegas.

Administrative assistance logistical support of Sandia Programs will be provided by P. D. Seward and J. E. Magruder, Sandia Division 1135.

D. FIELD OPERATIONS

1. Sites selected and archaeological survey conducted. Land survey made. BLM permits obtained. "Notice of Intention to Drill Exploratory Well" filed with NM State Engineer's office.

2. Award dirt contract. Construct 3/4 mile of 12' wide access road, 6" thick caliche base, five each 100' x 100' drill pads around drill site stake.

3. Begin WIPP 18 as follows:

3. (Continued)

WIPP 18 (located adjacent to seismic shot point 179 of X-2).

a. Set nominal diameter conductor pipe to permit use of rotary bit to make a 6" ± diameter hole to total depth.

b. Rotary hole to top of Salado salt; collect drill cuttings every 10'; use drilling fluids to match formation.

c. Run commercial logs as follows:
   (1) BHC Sonic
   (2) Dual Induction
   (3) Micro-Laterolog
   (4) Compensated Neutron
   (5) Formation Density
   (6) Gamma
   (7) Continuous Dip Meter

d. Plug hole to surface using 50/50 PoZ mix, Class "C" cement.

d. Rig down.

4. WIPP 19 (located adjacent to shot point 191 of line X-2)

a. Move in rig and associated equipment for taking continuous core from "grass-roots" to the top of Salado.

b. Dry punch hole and extract first core using Pitcher Sampler. Continue using until formation appears competent enough to begin using wire line rotary diamond coring procedures. Estimated to be 7-10'.

c. Pick up 3-1/4" x 2-1/4" diamond core bit with split barrel and take continuous core to approximately 30'.

4. (Continued)

d. Pick up 8-3/4" bit and ream hole to approximately 30'. Set 8-5/8"+ O.D. conductor pipe, cement to surface. Install appropriate well head equipment to protect from gas pockets.

e. Pick up 3-1/4" x 2-1/4" diameter core bit and take continuous core to total depth.

f. Open hole as necessary to accommodate taking commercial logs with 4-5/8" diameter tool.

g. Call out and run same suite of logs as for WIPP 18.

h. If hole shows bore-hole fluids of interest, hole may be cased with 5-1/2" casing, cemented to surface and set up for hydrological test well.

i. If no fluids of interest, plug hole to surface as WIPP 18.

j. Rig down.

5. WIPP 20 (located adjacent to shot point 187 of X-2)

a. Move in rig and associated equipment for alternating between rotary drilling and diamond coring.

b. Pick up 8-3/4" bit and rotary to approximatley 30'. Set 8-5/8"+ conductor pipe, cement to surface. Install appropriate well head equipment to protect from gas pockets.

c. Pick up nominal 6" diameter rotary bit and rotary to an approximate depth of 700', taking cuttings every 10'. Actual depth will depend on review of findings from WIPP 18 and 19.

5. (Continued)

d. Pick up 3-1/4" x 2-1/4" diameter core bit and take continuous core to a depth of about 1500'.

e. Open hole as necessary to accommodate use of commercial logging tool 4-5/8" diameter.

f. Call out and run same suite of logs as for WIPP 18.

g. Plug hole to surface as in WIPP 18.

h. Rig down.

b. WIPP 21 & 22 (location to be determined after review of WIPP 18, 19, 20)

a. Move in rig and associated equipment for alternating between rotary drilling and diamond coring. Take cutting every 10'.

b. Pick up 8-3/4" bit and rotary to approximately 30'; set 8-5/8"+ O.D. conductor pipe, cement to surface. Install appropriate well head equipment to protect from gas pockets.

c. Pick up nominal 6" diameter rotary bit and drill to 900-1200'. Selected 2-1/4" cores may be taken.

d. Open hole and condition to accommodate commercial logging tool 4-5/8" diameter.

e. Either hole may be selected as hydro test well if significant fluids are encountered while drilling. If so, prepare hole to run 5-1/2" casing and cement to surface.

f. If not set up as hydro well, plug to surface and abandon.

g. Rig down.

E. CORE HANDLING PROGRAM

Cores with 2-1/4" nominal diameter are to be taken. One from ground surface to the total depth. It is recognized that formations may be encountered which are soft and/or rubblized; therefore, particular attention must be paid to rate of rotation, penetration and drilling fluid properties to assure as complete a recovery as possible.

A split core barrel is to be utilized to ease the removal of core from the barrel and to lessen the possibility of damaging or mixing core components.

A duty geologist will log and measure core as it is removed from core barrel. Core will then be sealed within plastic sleeving and packaged in standard cardboard boxes. If core is soft and/or badly rubblized, additional cushioning material will be placed around core within box. Boxes will then be marked with hole identity and core interval. Core will then be carefully loaded in a transport vehicle by contractor personnel as supervised by duty geologist, and taken to core storage in Carlsbad.

A coring record should be kept showing: date and tour, sequence of core interval, depth of interval, footage of core recovered and percentage. If significant intervals are missing, the depth and interval of missing core should be recorded as well as any determinable physical properties of the formation. Rig operating conditions such as RPM, weight on bit, circulating pressure should also be kept.

For sake of consistency, a routine has been established for handling and marking core at the drill pad as follows:

1. Coring contractor and roustabouts will lay barrel down and open barrel. The duty geologist will photograph core and supervise removal from core barrel and placement in troughs in the order they come out of barrel for inspection and measurement. Troughs are marked orange or red indicating top end and black indicating down direction.

2. If core is suitable for marking, each major piece should be marked with a water-proof black ink arrow, pointing in the direction the hole is advancing. If core is not suitable for marking, the above is to be marked on sleeving using an indelible, water-proof black marking pen.

3. Log, identify and measure all core pieces, express to closest 1/10th of foot. Note; All depth measurements are from the top side of the Kelly Bushing unless otherwise specified.

4. Move troughs to core shed and separate into appropriate lengths. Sleeve and seal and insert into boxes. Tape boxes and mark outside of box with hole identity and depths of core interval.

5. Transport boxed core to core storage taking particular care in handling and delivery to avoid core damage.

F. LOGGING PROGRAM

The original records and 10 copies of all logs should be delivered to F&S, Carlsbad. F&S will distribute as follows:

USGS-WRD, Albuq. - J. W. Mercer (1)
USGS-Spec. Proj., Denver - C. Jones (1)
F&S, Carlsbad - W. Cunningham (2)
5311 D. W. Powers (Orig. & 1)
5311 S. J. Lambert (1)
5311 Archives (2)
F&S Carlsbad (2)

G. PLUGGING AND ABANDONMENT

1. Notice of intention to plug must be filed with appropriate agencies including State Engineer, since all wells are believed to be within a Water District as declared by the State Engineer of New Mexico.

2. Plugging should be in manner to confine water in the separate strata originally containing them.

3. A length of 4" steel tubing approximately 20' long will be placed in the freshly poured plug with 4' protruding above the ground surface. The identity of the well, i.e., WIPP 18, as well as the location: X feet FEL, X feet FSL, Section, Township and Range, shall be welded or stamped in the tubing.

RDStatler:rj

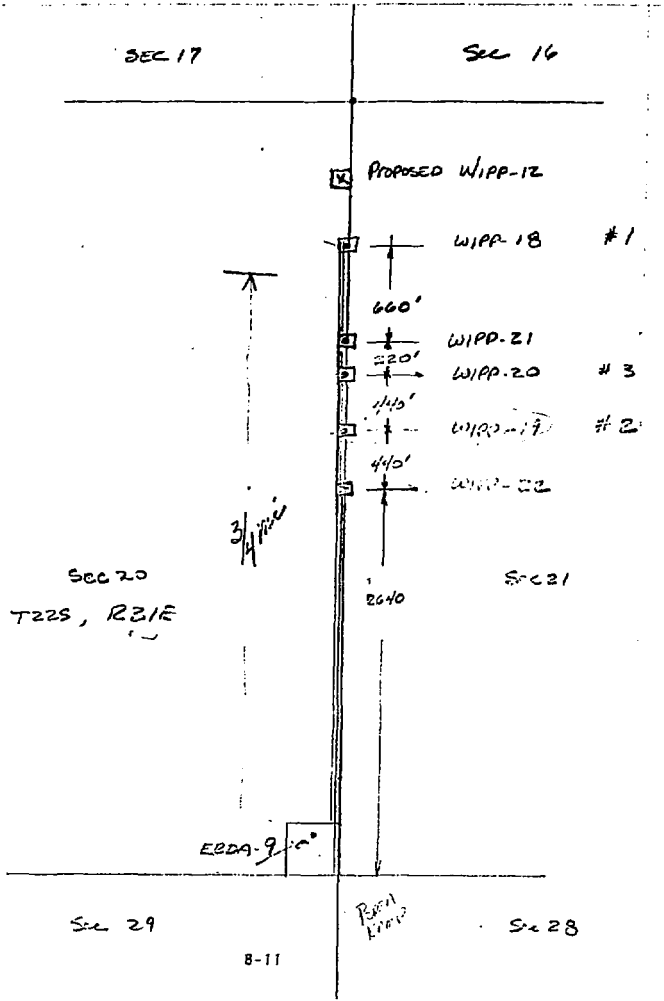

SEC 17
Sec 16
PROPOSED WIPP-12
WIPP-18
#1
660'
WIPP-21
220'
WIPP-20
#3
1445'
#2
440'
3/4 MILE
2640
Sec 20
T22S, R31E
Sec 21
EDDA-9
Sec 29
Sec 28
BOUNDARY

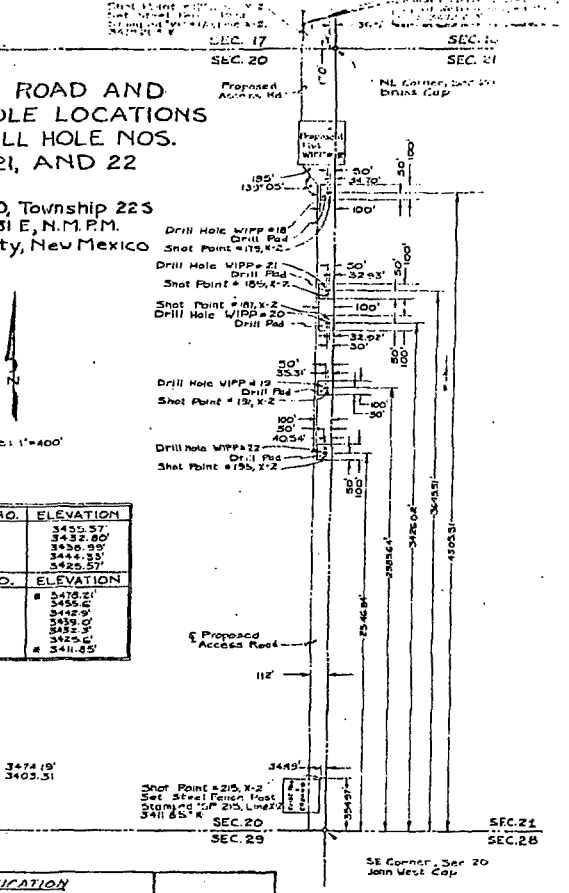
Table 3.--*Lithologic log of borehole WIPP-21*

[Color designation from Rock-Color Chart (Goddard and others, 1948)]

Lithologic description	Depth interval Feet
Dune sand, moderate-reddish-brown (10R 4/4), unconsolidated (includes fill for drill pad)	0- 6
Caliche, very pale orange (10YR 8/2); sandy	6- 12
Sandstone, moderate-reddish-brown (10R 4/6), with grayish-purple (5P 4/2) tint, very fine grained	12- 20
Sandstone, moderate-reddish-brown (10R 4/6), very fine grained; grading to silt	20- 30
Mudstone (50 percent), moderate-reddish-brown (10R 4/6); moderate-reddish-brown (10R 4/6) siltstone (50 percent), speckled with gray-yellowish-green (5GY 7/2) reduction spots	30- 40
Mudstone (90 percent), dark-reddish-brown (10R 3/4), with grayish-purple (5P 4/2) tint; moderate-reddish-brown (10R 4/6) siltstone (10 percent)	40- 50
Sandstone (40 percent), dark-reddish-brown (10R 3/4), very fine grained; mudstone (60 percent), same as above	50- 60
Sandstone (90 percent), dark-reddish-brown (10R 3/4), very fine grained, with some gray-yellowish-green (5GY 7/2) sandstone; dark-reddish-brown (10R 3/4) siltstone (10 percent)	60- 70
Mudstone (70 percent), moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4); moderate-reddish-brown (10R 4/6) siltstone (30 percent)	70- 90
Mudstone (90 percent), moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4); moderate-reddish-brown (10R 4/6) siltstone (10 percent)	90-100
Mudstone (80 percent) same as above; siltstone (20 percent), same as above	100-110
Mudstone, moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4)	110-120
Siltstone (70 percent), dark-reddish-brown (10R 3/4); mudstone (30 percent), same as above	120-130
Mudstone (60 percent), moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4); dark-reddish-brown (10R 3/4) siltstone (40 percent)	130-140
Mudstone (70 percent), same as above; siltstone (30 percent), same as above; trace of very pale green (10G 8/2) mudstone	140-150
Siltstone (90 percent), dark-reddish-brown (10R 3/4); mudstone (10 percent), same as above; trace of very pale green (10G 8/2) siltstone	150-160
Mudstone, moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4), trace of dark-reddish-brown (10R 3/4) siltstone	160-17[illegible]
Mudstone, dark-reddish-brown (10R 3/4), peppered with gray-yellowish-green (5GY 7/2) reduction spots	[illegible]

ACCESS ROAD AND DRILL HOLE LOCATIONS WIPP DRILL HOLE NOS. 18, 19, 20, 21, AND 22

Section 20, Township 22 S
Range 31 E, N.M.P.M.
Eddy County, New Mexico



N

Scale: 1"=400'

DRILL HOLE NO.	ELEVATION
WIPP # 18	3455.57'
WIPP # 19	3452.80'
WIPP # 20	3436.99'
WIPP # 21	3444.55'
WIPP # 22	3425.57'
SHOT POINT NO.	**ELEVATION**
170	# 3478.21'
179	3455.6'
189	3442.9'
187	3439.0'
191	3432.3'
195	3425.6'
215	# 3411.85'

Top of Post Elevation
Ground Elev at SP 170 is 3474.19'
Ground Elev at SP 215 is 3403.31

CERTIFICATION

I, Charles W. Wetterhorn, do hereby certify that the foregoing plat was made under my direction and supervision and is a true representation of a survey on the ground, to the best of my knowledge and belief.

Charles W. Wetterhorn

Charles W. Wetterhorn, N.M. P.E. & L.S. No. 2064

MOLZEN-CORBIN & Assoc.
Consulting Engineers
Carlsbad New Mexico
Client Sandia Labs Date 1/31/78

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date: May 18, 1978

to: W. E. Cunningham - F&S, Carlsbad

R. D. Statler

from: R. D. Statler - 1133, SLA

subject: Land-Use Permit for Relocating Drill Sites for WIPP 20 and 21

On this date we have received verbal permission from BLM to relocate the hole locations of WIPP 20 and 21.

You are authorized to proceed with the necessary dirt work to prepare drill pads for WIPP 21, 1000' due south of WIPP 22, and for WIPP 20, 770' due south of WIPP 22.

You are also authorized to resume drilling of WIPP 22 and then proceed with the program as outlined in my memorandum to you dated May 17, 1978, subject, Stratigraphic Hole Drilling Plans.

RDS:1133:rj

Copy to:
C. Jones, USGS, Special Projects Branch, Denver, CO
J. Mercer, USGS-WRD, Albuquerque, NM
1135 P. D. Seward
5311 D. W. Powers
1133 File (2)

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date: May 23, 1978

to: W. E. Cunningham - F&S, Carlsbad

R. D. Statler/rj

from: R. D. Statler - 1133, SLA

subject: Land-Use Permit for Relocating Drill Sites for WIPP 20 and 21

Ref: Memo, Statler to Cunningham, dtd 5/18/78, same subject

This memorandum is to correct the Southerly dimension on the WIPP 21 drill location as quoted in the referenced memorandum. The attached survey plat gives the correct location.

PDS:1135:rj

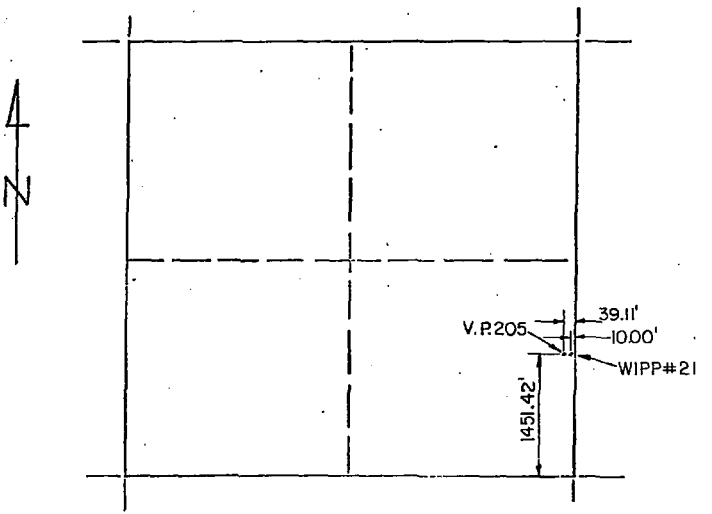
Copy to:
C. Jones, USGS, Special Projects Branch, Denver, CO
J. Mercer, USGS-WRD, Albuquerque, NM
G. Bachman, USGS-WRD, Albuquerque, NM
1135 P. D. Seward
5311 D. W. Powers
1133 File (2)

DRILL HOLE LOCATION

DRILL HOLE NO. WIPP#21

SECTION 20, TOWNSHIP 22S, RANGE 31E, N.M.P.M.

EDDY COUNTY, NEW MEXICO



GROUND ELEVATION AT HOLE: 3417.05'

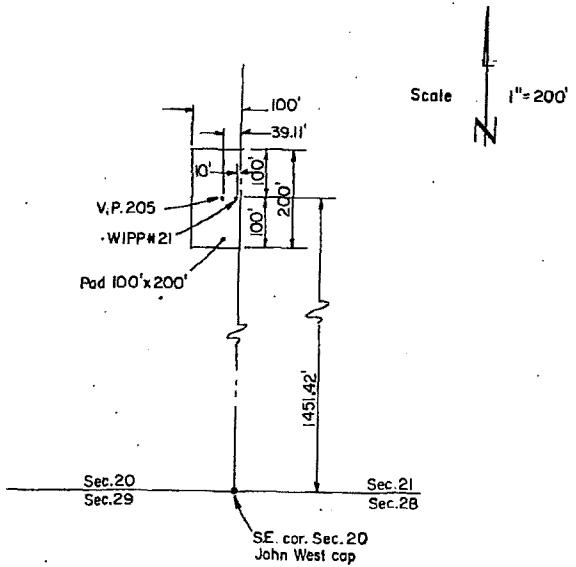
MOLZEN-CORBIN & ASSOCIATES
CONSULTING ENGINEERS
CARLSBAD, NEW MEXICO
DATE: MAY 19,1978

PAD AND
DRILL HOLE LOCATION

DRILL HOLE NO. WIPP # 21

SECTION 20, TOWNSHIP 22S, RANGE 31E, N.M.P.M.

EDDY COUNTY, NEW MEXICO



MOLZEN-CORBIN & ASSOC
CONSULTING ENGINEERS
CARLSBAD, NEW MEXIC

8-17

DATE: MAY 19,1978

APPENDIX C

HOLE HISTORY

compiled by

R. D. Statler
Division 1133
and
P. D. Seward
Division 1135
Sandia Laboratories

APPENDIX C

HOLE HISTORY

compiled by

R. D. Statler
Division 1133
and
P. D. Seward
Division 1135
Sandia Laboratories

INTRODUCTION TO APPENDIX C, HOLE HISTORY

The hole history is a document provided soon after completion of the borehole, and it summarizes the relevant information on the daily log kept by the contractor. The hole history is not edited to ensure conformance in every detail with later information developed for previous chapters. Further information may be obtained as necessary through examination of the original daily time logs.

PENIX & SCISSON, INC.
HOLE HISTORY DATA

DATE: 11-6-78 Rev. #1 10-16-78

HOLE NO.: WIPP #2	W. O. NO.:	I. D. NO.:
USER: Sandia Lab.	TYPE HOLE: Exploratory	
LOCATION: New Mexico	COUNTY: Eddy	AREA: WIPP
SURFACE COORDINATES: *1452.80' FSL, 13.46' FEL, Sec. 20, T22S, R31E		
GROUND ELEVATION: *	PAD ELEVATION:	TOP CASING ELEVATION:
RIG ON LOCATION:	SPUDDED: 5-24-78	COMPLETED: 5-26-78
CIRCULATING MEDIA: Salt base mud		
MAIN RIG & CONTRACTOR		NO. OF COMPRESSORS & CAPACITY:

BORE HOLE RECORD			CASING RECORD							
FROM	TO	SIZE	I. D.	WT./FT.	WALL	GRADE	CPL'G.	FROM	TO	CU. FT. CMT.
0'	20'	8-3/4"	6.366"	23#		J-55		0'	20'	Dirt
20'	1045'	6-1/8"								

TOTAL DEPTH: 1045'GL | AVERAGE MANDREL DEPTH: | FROM REFERENCE ELEVATION ?

JUNK & PLUGS LEFT IN HOLE:

SURVEYS PAGE: | CORING PAGE: | CU. FT. CMT. TOTAL IN PLUGS, ETC:

LOGGING DATA: Page 1

BOTTOM HOLE COORDINATES: 1442.60' FSL Sec.20, 5.54' FWL Sec. 21 @1047' | REFERENCE: Schlumberger

RIGS USED *(Site Prep Rigs *)*

RIG NO.	NAME	TYPE	*CLASS	DAYS OPERATING	SECURED W CREW	SECURED W/O CREW	TOTAL DAYS ON LOC.
3625	Boyles Bros.	Failing 2000		2.79	-	-	2.79

REMARKS: * *Site Prep Items*

Sample Description Attached

* Location of brass monument: 1449.17' FSL, 15.37' FWL, Sec.20, T22S, R31E, Elevation 3417.00.

PREPARED BY:

TIME BREAKDOWN ON NEXT PAGE

WIPP #21
HOLE HISTORY

5-24-78 Moved in Boyles Bros. rig #3625 and rigged up. Mixed up salt base mud. Drilled 8-3/4" hole from 0' to 15'. Set 7" O.D. casing at 15' and backfilled annulus with dirt. Drilled 6-1/8" hole from 15' to 558'.

6-25-78 Drilled 6-1/8" hole from 558' to 960'. Made trips for bits at 579' and 825'.

5-26-78 Drilled 6-1/8" hole from 960' to 1045'. Ran Schlumberger and USGS logs. Rigged down and released rig at 2400 hours. Hole completed.

BIT RECORD

BIT NO	MAKE	SIZE	TYPE	DEPTH OUT	FEET DRILLED	ROTATING HOURS
1	Hughes	8-3/4	OSC3J	15	15	1/4
2	Security	6-1/8	S3J	579	564	17-3/4
3	Security	6-1/8	S3J	825	246	14
4	Hughes	6-1/8	OSC3J	1045	220	6-1/4

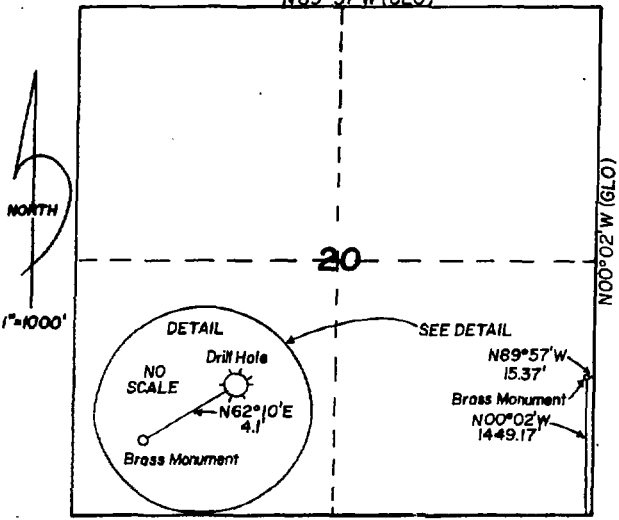
LOG INDEX SHEET

TYPE LOG	DATE	RUN NO	DEPTH DRILLER	DEPTH LOGGER	LOGGED FROM	LOGGED TO
SCHLUMBERGER						
Dual Laterolog-Micro SFL	5-26-78	1	1045	1049	25	1047
Compensated Neutron-Formation Density	5-26-78	1	1045	1047	0	1046
Borehole Compensated Sonic	5-26-78	1	1045	1047	0	1034
Dipmeter-Computed	5-26-78	1	1045	1047	-	1046
Dipmeter-Basic Data	5-26-78	1	1045	1047	-	1046
Directional	5-26-78	1	1045	1047	-	1046

NOTE: Logs furnished F&S/Mercury.

SURVEY MONUMENT "AS BUILT"
W.I.P.P. 21
SECTION 20, TOWNSHIP 22 S, RANGE 31 E N.M.P.M.
EDDY COUNTY, NEW MEXICO

ELEVATION OF BRASS MONUMENT 3417.00'
1449.17' FSL & 15.37' FEL

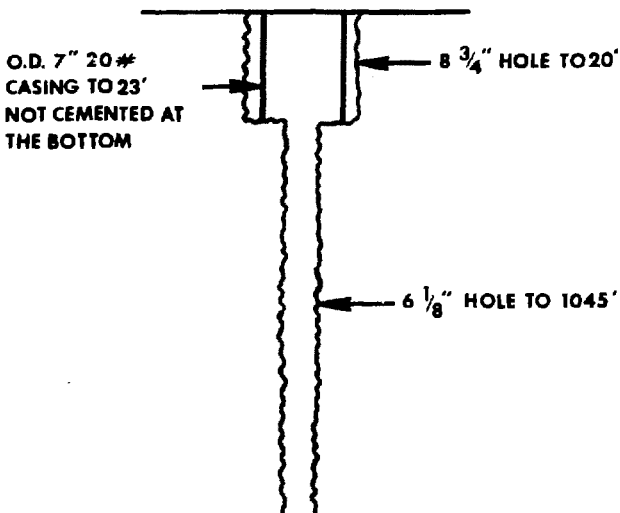


This is to certify that the foregoing plat was made from field notes of a berfetak survey made by me and is true and correct to the best of my knowledge and belief.

Dan R. Reddy
N.M.P.E. & L.S. # 5412

DAN R. REDDY
NEW MEXICO
5412
LAND SURVEYOR
REGISTERED PROFESSIONAL ENGINEER

WIPP 21
AS BUILT HOLE CONDITIONS
AS OF 5/26/78



NOT TO SCALE

APPENDIX D

LOGS

compiled by

S-E. Shaffer
Division 4511
Sandia Laboratories

WIPP 21 Logs[1]

Log	Company	ELSI#[2]	Top of Logged Interval[3] (feet)	Bottom Logged Interval (feet)	Date
BHC Sonic Log	Schlumberger	W7107Z	Surf.	1034	5/26/78
Compensated Neutron Formation Density	Schlumberger	W7107X	Surf.	1046	5/26/78
Dual Laterolog Micro-SFL	Schlumberger	W7107Y	25	1047	5/26/78
4-Arm High Resolution Continuous Dipmeter	Schlumberger	W7108S	80	1046	5/26/78

[1]Original data is retained in Sandia WIPP Central File, Division 4542, Sandia Laboratories, Albuquerque, NM, 87185.

[2]Order number for logs available through West Texas Electric Log Service, Inc. (ELSI), 105 West Wall Avenue, Midland, TX.

[3]Depths measured from ground surface; elevation officially 3417.09' above MSL.