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Basic Data Report for Drillhole WIPP 32 (Waste Isolation Pilot Plant - WIPP)

Sandia National Laboratories and United States Geological Survey

Prepared by Sandia National Laboratories, Albuquerque, New Mexico 87185
and Livermore, California 94550 for the United States Department of Energy
under Contract DE-AC04-76DP00789

Printed November 1980

Sandia National Laboratories

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Printed in the United States of America

Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

Price: Printed Copy \$6.00; Microfiche \$3.00

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for
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WIPP 32

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Compiled by
Sandia Laboratories
(Division 4511)

and

United States Geological Survey
(Special Projects Branch)

Printed November, 1980

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1.0 ABSTRACT

WIPP 32 is an exploratory borehole drilled to examine the subsurface at a small topographic high in Nash Draw. The borehole is located in east-central Eddy County, New Mexico, in NE 1/4 SE 1/4 Sec. 33, T.22S., R.29E. and was drilled in August, 1979. The hole was drilled to a depth of 390 feet, and encountered, from top to bottom, the Rustler Formation (166') and the upper Salado Formation (224'). Core was taken from 4 to 353 feet. Geophysical logs were run the full length of the hole to measure formation properties.

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 and the investigations involving WIPP 32.

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 Borehole WIPP 32

The borehole WIPP 32 was drilled to examine the extent of solution in a small topographic high which had been described by Vine (1963) as a domal karst feature. This is the closest such feature to the WIPP site; it was drilled as a candidate for a breccia pipe even though mapping then underway (reported in Bachman, in preparation) did not indicate it was a breccia pipe. WIPP 32 was conducted as a prospecting or exploratory hole. Had it revealed brecciated strata, a more elaborate investigation would have been undertaken.

3.0 GEOLOGICAL DATA FOR BOREHOLE WIPP 32

by
R. P. Snyder¹ and A. F. McIntyre²

3.1 Abstract

Borehole WIPP 32 was drilled to investigate the subsurface at a small topographic high in Nash Draw, east-central Eddy County, New Mexico. The borehole penetrated 166 feet of the Rustler Formation and 224 feet of the Salado Formation, both of Permian age. Dissolution of all the halite and much of the dolomite and gypsum in the Rustler and all halite in the upper Salado was apparent from examination of the core. Dissolution of the halite in the Salado Formation occurred as deep as 114 feet below the top of the formation. Polyhalite and anhydrite marker beds in the upper 114 feet in the Salado have been altered to gypsum. Dissolution has not removed halite deeper than 280 feet below the surface and halite and unaltered polyhalite beds are found below this depth.

3.2 Introduction

Borehole WIPP 32 was drilled to explore a small topographic high which had been described by Vine (1963) as a domal karst feature. The drilling of WIPP 32 was done to determine to what depth, if any, solution has occurred. Core was taken from near surface to a depth of 353 feet to aid in several studies: (1) determine the stratigraphy of the near-surface formations, (2) examine the relationships between subsurface structure and surficial features and deposits, and (3) investigate the dissolution of soluble rocks (halite, gypsum, and dolomite) by ground water.

The drilling was done on behalf of the WIPP (Waste Isolation Pilot Plant) project office of the DOE (U. S. Department of Energy).

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²Fenix & Scisson, Inc., Carlsbad, NM.

3.3 Description of Borehole WIPP 32

WIPP 32 is located in east-central Eddy County, N. Mex., in the NE 1/4 SE 1/4 sec. 33, T. 22 S., R. 29 E. (fig. 1). The borehole was drilled in August 1979, to a depth of 390 feet, measured from a land surface of 3,023.26 feet above MSL (mean sea level). Table 1 is an abridged borehole history, and table 2 is a stratigraphic summary of the rocks penetrated by the drill hole. General stratigraphy for the area is summarized by Jones (1973). WIPP 32 penetrated 166 feet of dolomite, limestone, gypsum, mudstone, and siltstone of the Rustler Formation and 224 feet of halite, gypsum after polyhalite and anhydrite, mudstone, and polyhalite of the Salado Formation, both of Permian age.

Examination of the core indicates all of the halite in the Rustler Formation has been removed by solution and the anhydrite has been hydrated to gypsum. Some of this gypsum has been dissolved and most of the dolomitic cement of the Magenta Dolomite Member has also been removed. Both the Magenta and Culebra Dolomite Members have been fractured by subsidence as halite below the members was removed.

Dissolution in the Salado Formation has extended downward to the Vaca Triste Sandstone Member which is the top of the McNutt potash unit (Adams, 1944), the middle unit of the formation. Halite above this unit has been removed and polyhalitic and anhydritic marker beds have been altered to gypsum. These marker beds include the 101 thru the 116 (fig. 2). The soluble material between MB 110 and MB 112 has been removed allowing 3 marker beds to rest one atop another. In areas of the WIPP site where no dissolution has occurred there is about 500 feet of Salado Formation above the Vaca Triste Sandstone Member. At the WIPP 32 site, there is 110 feet. Below the Vaca Triste to the total depth of the drill hole, the Salado exhibited normal stratigraphy.

Additional stratigraphic details are summarized in table 3 and on figure 2. Core was taken from 4 to 353 feet. The hole was deepened to 390 feet using a rock bit; there was no circulation of the drilling fluid and no cuttings were obtained. Stratigraphic data shown on figure 2 below 353 feet are interpreted from geophysical logs. Core was examined at the drill site by A. F. McIntyre of F&S and Kevin Dennehy of the USGS

and identification of rock units was made in collaboration with C. L. Jones of the USGS.

As part of the exploratory work, geophysical logs were taken the full length of the borehole. The logging was done to facilitate the identification and correlation of gross lithologies (i.e., dolomite, anhydrite, gypsum, halite, and polyhalite). These logs were used to identify rock units between 352 and 390 feet where no core was taken and no cuttings were obtained. The geophysical logs include: (1) a gamma-ray curve that recorded variations in potassium and other radioactive elements, (2) a neutron curve that recorded variations in the distribution of hydrogen, and (3) a densilog that recorded densities of the rock types (fig. 2).

All measurements related to the drill site are in the inch-pound system. These measurements include: the survey to locate the drill hole (both horizontally and vertically), the drilling depths as furnished by the driller, and the wireline logs as furnished by the logging company. Borehole location and depths in the borehole are given in this report in the inch-pound system. If metric units are desired, the following conversion factors should be used:

<u>Multiply inch-pound</u>	<u>By</u>	<u>To obtain metric unit</u>
foot (ft)	0.3048	meter (m)
inch (in)	25.4	millimeter (mm)
pounds per square inch (lb/in ²)	0.006895	megapascal (MPa)

Figure 1.--Map showing location of borehole WIPP 32

Table 1.--Abridged history of borehole WIPP-32

LOCATION: sec. 33, T. 22 S., R. 29 E.

1,673.22 feet from south line

29.14 feet from east line

ALTITUDE (LAND SURFACE): 3,023.26 feet. Datum for depth measurements in drilling and logging operations.

LITHOLOGIC LOG PREPARED BY: A. F. McIntyre and Kevin Dennehy, August 7-16, 1979.

DRILLING CONTRACTOR: Pennsylvania Drilling Co.

DRILLING RECORD: Commenced drilling on August 7, 1979, and completed on August 16, 1979.

Circulation lost intermittently from top of hole to bottom. Air pocket hit at 280 feet.

After completion of drilling, hole cemented to surface including 4-foot collar. No casing in hole.

Core No.	Depth interval (ft)	RPM	Weight on bit (lbs.)	Circular pressure (lb./in ²)	Interval		Percent recovered
					feet cored	feet recovered	
1	4.0- 9.0	50	500	100	5	.5	10
2	9.0-13.0	50	500	100	4	.8	20
3	13.0-18.0	50	500	50	5	1.4	28
4	18.0-23.0	50	500	50	5	2.5	50
5	23.0-24.0	50	500	50	1	1.3	130
6	24.0-25.0	50	500	50	1	.5	50
7	25.0-30.0	50	600	50	5	3.6	72
8	30.0-36.6	50	600	50	6.6	3.6	55
9	36.6-41.6	50	600	50	5.0	2.8	56
10	41.6-46.6	50	600	50	5.0	4.9	98
11	46.6-48.2	50	800	50	1.6	.8	50
12	48.2-54.0	50	800	50	5.8	3.9	67
13	54.0-56.0	50	800	50	2.0	1.2	60
14	56.0-57.0	50	800	50	1.0	1.0	100
15	57.0-57.6	50	800	50	.6	.6	100
16	57.6-61.6	50	800	50	4.0	1.3	33
17	61.6-63.8	50	800	50	2.2	.6	27
18	63.8-67.8	50	800	50	4.0	2.2	55
19	67.8-72.7	50	800	50	4.9	4.5	92
20	72.7-73.7	50	800	50	1.0	1.0	100
21	73.7-74.5	50	800	50	.8	.3	38
22	74.5-76.6	50	800	50	2.1	2.1	100
23	76.6-81.6	50	800	50	5.0	4.1	82
24	77.6-82.6	100	1,000	25	5.0	4.7	94

Table 1.--Abridged history of borehole WIPP 32--Continued

Core No.	Depth interval (ft)	RPM	Weight on bit (lbs.)	Circular pressure (lb./in ²)	Interval		Percent recovered
					feet cored	feet recovered	
25	82.6-87.6	100	1,200	25	5.0	4.4	88
26	87.6-89.3	100	1,200	25	1.7	1.4	82
27	89.3-92.7	100	1,200	25	3.4	3.1	91
28	92.7-102.7	100	1,200	25	10.0	9.4	94
29	102.7-112.7	100	1,200	25	10.0	9.7	97
30	112.7-122.7	100	1,200	25	10.0	10.1	101
31	122.7-132.2	100	1,400	50	9.5	7.1	75
32	132.2-137.7	100	1,400	50	5.5	5.6	102
33	137.7-142.7	125	1,400	50	5.0	5.0	100
34	142.7-147.7	125	1,600	0-50	5.0	5.2	104
35	147.7-152.7	125	1,600	0-50	5.0	5.0	100
36	152.7-157.7	125	1,600	0-50	5.0	5.2	104
37	157.7-161.8	125	1,600	25	4.1	3.5	85
38	161.8-167.0	125	1,600	25	5.2	4.7	90
39	167.0-172.0	125	1,800	25	5.0	5.4	108
40	172.0-177.0	125	1,800	25	5.0	5.3	106
41	177.0-182.0	125	1,800	25	5.0	5.9	118
42	182.0-187.0	125	1,800	25	5.0	4.7	94
43	187.0-191.0	125	1,800	25	4.0	4.5	113
44	191.0-202.7	125	2,000	25	10.0	9.9	99
45	202.7-210.2	125	2,000	25	7.5	7.8	104
46	210.2-212.7	125	2,200	50	2.5	2.4	96
47	212.7-217.7	125	2,200	50	5.0	5.1	102
48	217.7-227.0	125	2,200	50	9.3	9.6	103
49	227.0-228.0	125	2,200	50	1.0	.7	70
50	228.0-231.7	100	2,400	50	3.7	3.6	97
51	231.7-242.1	100	2,400	50	10.4	10.2	98
52	242.1-251.7	100	2,600	50	9.6	9.6	100
53	251.7-261.7	100	2,600	50	10.0	10.3	103
54	261.7-271.7	100	2,600	50	10.0	9.9	99
55	271.7-280.2	100	2,800	50	8.5	7.1	84
56	280.2-290.2	100	2,800	50	10.0	9.6	96
57	290.2-292.7	100	2,800	50	2.5	2.4	96
58	292.7-302.7	100	3,000	50	10.0	10.0	100
59	302.7-312.7	100	3,000	50	10.0	10.1	101
60	312.7-322.7	100	3,000	50	10.0	10.0	100
61	322.7-332.7	100	3,000	50	10.0	10.0	100
62	332.7-342.7	100	3,200	50	10.0	10.1	101
63	342.7-352.7	100	3,200	50	10.0	10.1	101

Table 2.--Stratigraphic summary of borehole WIPP 32
[MB, marker bed]

Rock unit	Depth interval ¹ Feet
Permian rocks	
Rustler Formation-----	0-166
Magenta Dolomite Member-----	19- 36
Dissolution residue-----	36- 61
Culebra Dolomite Member-----	61- 90
Dissolution residue-----	104-120
Salado Formation-----	166-390 total depth
Upper member-----	166-276
Dissolution residue-----	166-276
MB 101-----	² 196
MB 102-----	² 205
MB 103-----	² 221
MB 104-----	² 226
MB 105-----	² 226
MB 106-----	² 226
MB 107-----	² 226
MB 108-----	² 226
MB 109-----	² 235
MB 110-----	² 250
MB 111-----	² 250
MB 112-----	² 250
MB 113-----	² 256
MB 114-----	Not observed
MB 115-----	² 275
MB 116-----	² 275
McNutt Potash unit:	
Vaca Triste Sandstone Member ³ -----	275
Lower part-----	280-390 total depth
MB 117-----	² 320
MB 118-----	² 348
MB 119-----	² 369

¹Depth interval from density log.

²Base of rock unit.

³Of Adams, 1944.

Table 3.--Lithologic log of borehole WIPP 32

[Color designations are from the Rock-Color Chart (Goddard and others, 1948);
no core designates where core was lost during coring operations]

Lithologic description	Depth interval Feet
No core-----	0- 4.0
Siltstone, moderate-reddish-brown (10R 4/6), some dark-reddish-brown (10R 3/4), some greenish-gray (5Gy 6/1), with numerous greenish-gray (5Gy 6/1) reduction spots, poorly consolidated, calcitic cement-----	4.0- 4.5
No core-----	4.5- 9.0
Siltstone, same as unit at 4.0-4.5 feet-----	9.0- 9.8
No core-----	9.8-13.0
Siltstone, same as unit at 4.0-4.5 feet, with zones of soft, calcitic, grayish-red (10R 4/2) to moderate-reddish-brown (10R 4/6) clay-----	13.0-14.4
No core-----	14.4-19.0
Mudstone, dark-reddish-brown (10R 3/4), calcitic, moderately hard; interlayered beds 0.5-1.5 cm thick, moderately hard, calcitic, moderate-reddish-brown (10R 4/6), grayish-red (10R 4/2) and greenish- gray (5Gy 6/1) mudstone at 19.0-19.3 and 20.0-20.3 feet-----	19.0-20.3
Siltstone, pale-red (10R 6/2), grayish-red (10R 4/2), and pale-reddish- brown (10R 5/4), slightly wavy, very thinly laminated; horizontal, irregular fracture, 1-5 mm displacement, filled with dark-reddish- brown (10R 3/4) clay at 21.2 feet-----	20.3-21.5
No core-----	21.5-24.0
Siltstone, same as unit at 20.3-21.5 feet-----	24.0-24.5
Mudstone, same as unit at 19.0-20.3 feet-----	24.5-25.3
Siltstone, pale-reddish-brown (10R 5/4), argillaceous, very hard, calcitic-----	25.3-25.8
No core-----	25.8-26.4
Sandstone, pale-reddish-brown (10R 5/4), very hard, calcitic, friable, with laminae and bands, 0°-12° dip; hard, calcitic, dark-reddish-brown (10 R3/4) to grayish-red (10R 4/2) siltstone-----	26.4-29.4
No core-----	29.4-31.4
Sandstone, same as unit at 26.4-29.4 feet-----	31.4-31.6
Limestone and siltstone breccia; limestone, light-olive-gray (5y 6/1) to olive-gray (5y 4/1), very hard; 0.3-4 cm angular breccia, vuggy, with matrix of hard, calcitic, arenaceous, moderate-reddish-brown (10R 4/6) siltstone-----	31.6-35.0
Limestone, light-olive-gray (5y 6/1), with moderate-reddish-brown (10R 4/6) dispersed laminae; highly fractured, vugs 1-5 mm in diameter-----	35.0-36.0

Table 3.--Lithologic log of borehole WIPP 32--Continued

Lithologic description	Depth interval Feet
Mudstone, dark-yellowish-orange (10YR 6/6) to burnt-orange, calcitic, fissile, hard; with some horizontal laminae of MnO ₂ staining-----	36.0-36.5
Siltstone and mudstone conglomerate, dark-reddish-brown (10R 3/4), grayish-red (10R 4/2), dark-yellowish-orange (10YR 6/6) and burnt orange, calcitic, friable-----	36.5-36.9
Siltstone, dusky-yellow (5Y 6/4) to moderate-yellow (5Y 7/6), very friable, calcitic; with wavy, horizontal MnO ₂ stained laminae-----	36.9-37.8
No core-----	37.8-39.9
Mudstone, moderate-reddish-brown (10R 4/6), silty, calcitic, moderately hard, competent-----	39.9-41.9
Silt, moderate-reddish-brown (10R 4/6), loosely consolidated, slightly clayey, calcitic-----	41.9-43.2
Silt, same as unit at 41.9-43.2 feet, with friable, calcitic green-gray (5GY 6/1) silt-----	43.2-43.5
No core-----	43.5-43.6
Siltstone, moderate-reddish-brown (10R 4/6), calcitic, moderately consolidated, slightly clayey-----	43.6-44.4
No core-----	44.4-45.2
Mudstone, same as unit at 39.9-41.9 feet-----	45.2-46.1
Mudstone, same as unit at 39.9-41.9 feet; very soft, calcitic, moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4) clay at 47.0-47.3 feet; dispersed, blebby band of calcitic, medium-bluish-gray (5B 5/1) clay at 48.1 feet; calcitic, silty, dispersed blebs of moderate-yellow (5Y 7/6) to dusky-yellow (5Y 6/4) clay at 46.8 and 47.4-47.7 feet; very finely crystalline, angular fragment, 3 cm wide and 5 cm long of yellowish-gray (5Y 7/2) limestone at 49.0 feet-----	46.1-49.1
No core-----	49.1-51.0
Mud/clay and limestone breccia: mud/clay, moderate-reddish-brown (10R 4/6), soft, some moderately hard, slightly calcitic, with sub-angular to subrounded, 0.2-3 cm in size; limestone breccia, light-olive-gray (5Y 6/1) to medium-light-gray (N6)-----	51.0-51.6
Siltstone and clay breccia: siltstone, moderate-reddish-brown (10R 4/6), calcitic; clay, grayish-red (10R 4/2), soft, calcitic-----	51.6-52.1
Limestone, light-olive-gray (5Y 6/1) to greenish-gray (5GY 6/1)-----	52.1-52.2
No core-----	52.2-53.0
Limestone, light-olive-gray (5Y 6/1), some olive-gray (5Y 4/1), argillaceous in parts, with few moderate-reddish-brown (10R 4/6) very irregular veinlets and blebs; very finely crystalline zones of 0.2-2 cm recemented angular breccia; numerous solution pits 1-8 mm in diameter; very irregular fractures, 1-2 mm displacement, filled with moderate-reddish-brown (10R 4/6) clay at 53.0-53.2 feet-----	53.0-54.0

Table 3.--Lithologic log of borehole WIPP 32--Continued

Lithologic description	Depth interval Feet
Limestone, same as unit at 53.0-54.0 feet-----	54.0-55.9
No core-----	55.9-58.6
Limestone, light-olive-gray (5Y 6/1), very finely crystalline, slightly argillaceous, recemented, 0.2-1 cm angular breccia, numerous pits 1-5 mm in diameter-----	58.6-59.2
No core-----	59.2-60.8
Limestone, same as unit at 58.6-59.2 feet-----	60.8-61.0
Dolomite, light-olive-gray (5Y 6/1), with some olive-gray (5Y 4/1) to light-olive-gray (5Y 5/2) horizontal limy laminae; numerous pits 1-6 mm in diameter; numerous healed fractures, with 1-2 mm displacement, filled with calcite; some pits filled with calcite crystals, 1 mm or less in size at 62.5-63.0 feet; calcitic, soft, very light gray (N8) clay at 61.2 feet-----	61.0-63.0
No core-----	63.0-66.2
Dolomite, light-olive-gray (5Y 6/1), with some continuous, horizontal, slightly wavy olive-gray (5Y 4/1) laminae; numerous pits 1-8 mm in diameter, some lens shaped, as much as 2.5 cm long, some filled with calcite crystals, 1 mm or less in size; some zones highly fractured, 1-8 mm angular breccia, healed with calcite at 66.2-66.3 feet-----	66.2-66.7
No core-----	66.7-67.4
Dolomite, light-olive-gray (5Y 6/1), with numerous pits, 1-3 mm in diameter, some filled with calcite; highly fractured; numerous, irregular voids, mostly filled with calcite, within crumbly yellowish- gray (5Y 7/2) dolomite-----	67.4-68.4
Dolomite, light-olive-gray (5Y 6/1), very finely crystalline, numerous 1-2 mm in diameter pits, some filled with calcite, some coated with moderate-yellow (5Y 7/6) limonite-----	68.4-68.7
No core-----	68.7-69.6
Dolomite, light-olive-gray (5Y 6/1); some zones crumbly and yellowish- gray (5Y 7/2), very finely crystalline; numerous pits 1-2 mm in diameter filled with moderate-yellow (5Y 7/6) limonite and (or) calcite; some zones highly fractured and filled with calcite and moderate-yellow (5Y 7/6) limonite; two parallel hairline fractures, 1 mm displacement, filled with limonite, 32° dip at 70.2 feet-----	69.6-75.8
No core-----	75.8-77.4
Dolomite, same as unit at 69.6-75.8 feet-----	77.4-82.1

Table 3.--Lithologic log of borehole WIPP 32--Continued

Lithologic description	Depth interval Feet
No core-----	82.1-82.6
Dolomite, same as unit at 69.6-75.8 feet, with pits increasing in size to 1-2 cm-----	82.6-87.0
No core-----	87.0-88.1
Dolomite, same as unit at 69.6-75.8 feet-----	88.1-88.6
Dolomite, greenish-gray (5Gx 6/1) to light-olive-gray (5x 6/1); with numerous very thin laminae of moderate-yellow (5x 7/6) limonite and 0.3-1 cm thick beds, clayey, light-olive-gray (5x 6/1) dolomite, irregular pits; dolomitic clay partings. 16° dip-----	88.6-89.5
No core-----	89.5-90.0
Clay, dark-greenish-gray (5Gx 4/1) to greenish-black (5Gx 2/1), some light-olive-gray (5x 6/1); competent, slightly calcitic; with common irregular stringers and blebs of moderate-yellow (5x 7/6) limonite; hairline veinlets of sucrosic and finely crystalline white (N9) gypsum dip 0°-32°; zones of blebs and stringers of chalky, calcitic, translucent to transparent gypsum at 92.2-93.1 feet; continuous irregular horizontal band, 2-3 cm thick, of finely crystalline, calcitic, translucent to transparent gypsum at 92.7 feet-----	90.0-93.1
No core-----	93.1-93.4
Clay, olive-gray (5x 4/1) and medium-dark-gray (N4), with predominant blebs and stringers of sucrosic, fibrous, chalky, translucent, trans- parent, and white (N9) gypsum; irregular, horizontal, 1-2 cm thick, translucent to transparent, selenite band at 93.5 feet-----	93.4-94.9
Clay, moderate-reddish-brown (10R 4/6), firm, slightly calcareous; with blebs and stringers of sucrosic, fibrous, chalky, translucent, transparent, and white (N9) gypsum; very irregular, horizontal, with branching veinlets, fibrous, 2-3 cm, translucent to transparent, selenite band at 95.1 feet-----	94.9-95.4
Selenite band, translucent to transparent, very coarsely crystalline, horizontal, continuous, regular-----	95.4-95.5
Clay, same as unit at 94.9-95.4 feet-----	95.5-95.7
Gypsum, light-olive-gray (5x 6/1) to olive-gray (5x 4/1), very finely to finely crystalline, mottled; few argillaceous continuous laminae, 1-3 mm thick, dipping 31°-38°, moderate-reddish-orange (10R 6/6) to moderate- red (5R 4/6) gypsum; numerous, irregular, healed fractures, 1-4 mm dis- placement, some partially filled with moderate-reddish-brown (10R 4/6) clay, zone is argillaceous with pale-reddish-brown (10R 5/4) tint at 97.5- 100.6 feet; healed fracture, 3 cm thick, 45° dip, medium-crystalline, pale-reddish-brown (10R 5/4) gypsum at 98.1 feet; irregular zones of medium crystalline translucent to transparent gypsum at 97.1-97.3 and 100.3-100.6 feet-----	95.7-98.8

Table 3.--Lithologic log of borehole WIPP 32--Continued

Lithologic description	Depth interval Feet
No core-----	98.8- 99.4
Gypsum, same as unit at 95.7-98.8 feet-----	99.4-103.5
Gypsum, translucent to transparent, medium to coarsely crystalline, nodular; with interstitial light-olive-brown (5Y 5/8) to grayish-olive (10Y 4/2) clay-----	103.5-104.0
Clay, grayish-olive (10Y 4/2) to light-olive-brown (5Y 5/8), firm; minor gypsum nodules; top and bottom clay contacts dip 36°-----	104.0-104.5
Clay, moderate-reddish-brown (10R 4/6), firm, slightly silty; numerous medium-bluish-gray (5B 5/1) clay blebs and few friable, grayish-orange (10YR 7/4) silt blebs; wavy, irregular, 3-4 cm thick, medium to coarsely crystalline, moderate-reddish-brown (10R 4/6), translucent to transparent nodular gypsum bands at 104.6-104.8 and 10R feet-----	104.5-108.5
Gypsum, olive-gray (5Y 4/1) and pale-reddish-brown (10R 5/4), very finely crystalline; some bands of recrystallized, translucent to transparent gypsum at 108.6-108.8, 109.5-109.7, and 110.2-110.4 feet; fracture filled with moderate-reddish-brown (10R 4/6) clay, 3-4 mm displacement, 41° dip at 109.6 feet-----	108.5-111.1
Clay, moderate-reddish-brown (10R 4/6), very firm, very silty; with rounded gypsum fragments 1 mm to 3 cm across and 1-2 mm thick; dis- continuous and continuous, fibrous, chalky, white (N9) gypsum veinlets dip 28°-32°-----	111.1-113.0
No core-----	113.0-113.2
Clay, same as unit at 111.1-113.0 feet-----	113.2-114.0
Gypsum, olive-black (5Y 2/1) to olive-gray (5Y 4/1), medium to coarsely crystalline, numerous irregular, healed fractures, moderate-reddish- brown (10R 4/6) clay at 114.9-115.1 feet-----	114.0-115.8
Clay, moderate-reddish-brown (10R 4/6), very firm, very silty, with irregular blebs, 2 mm to 2 cm in size and few discontinuous bands of greenish-gray (5GY 6/1) siltstone; filled fractures, 1-1.5 cm displacement, subparallel (41°, 52°, and 45° dips), of medium crystalline, chalky, white (N9), translucent, and transparent gypsum at 117.0, 117.9, and 118.6 feet; numerous blebs and stringers, chalky, white (N9) gypsum at 117.9-118.0 feet-----	115.8-119.6
Siltstone, moderate-reddish-brown (10R 4/6) and grayish-orange (10YR 7/4); some clayey zones dark-reddish-brown (10R 3/4), well consolidated; numerous wavy, parallel, 19°-20° dips, of olive-gray (5Y 4/1) irregular filled fractures, 103 mm displacement, chalky, white (N9) gypsum at 119.6-120.3 feet; dispersed band, 3-4 cm thick of greenish-gray (5GY 6/1) clay at 121.5 feet; two fractures, 3-6 mm displacement, 54° dip, filled with chalky, finely to medium-crystalline, white (N9) gypsum at 122.1 feet-----	119.6-122.8

Table 3.--Lithologic log of borehole WIPP 32--Continued

Lithologic description	Depth interval Feet
Siltstone, moderate-reddish-brown (10R 4/6) with dark-reddish-brown (10R 3/4), very thin, wavy, horizontal laminae; and medium-light-gray (N6) siltstone with dark-gray (N3), very thin, wavy, horizontal laminae, very predominant at 124.2-126.1 feet, competent, friable-----	122.8-126.1
Clay, moderate-reddish-brown (10R 4/6), soft, pliable-----	126.1-128.1
Clay, moderate-reddish-brown (10R 4/6), with some concentrations of 1-3 mm thick, horizontal, wavy, continuous, medium-gray (N5) to medium-dark-gray (N4) laminae-----	128.1-129.9
No core-----	129.9-132.3
Siltstone, medium-gray (N5), some medium-dark-gray (N4), competent to friable; some parts clayey, some zones of medium-dark-gray (N4) and medium-light-gray (N6) laminae-----	132.3-157.3
Siltstone, medium-gray (N5), with light-bluish-gray (5B 7/1) tint, hard-----	157.3-158.1
Siltstone, same as unit at 132.3-157.3 feet-----	158.1-161.6
No core-----	161.6-161.8
Siltstone, clayey, medium-light-gray (N6) to light-bluish-gray (5B 7/1)-----	161.8-163.0
Mudstone, medium-gray (N4), with numerous, irregular blebs of moderate-reddish-brown (10R 4/6) mudstone; few irregular, 2 mm to 1 cm, chalky, rounded, white (N9) gypsum fragments-----	163.0-165.9
Clay, dark-reddish-brown (10R 3/4), with rounded to subrounded, 1-6 cm grayish-red (10R 4/2) and medium-bluish-gray (5B 5/1) clay fragments and numerous 3-7 cm, rounded to subrounded, olive-black (5Y 2/1), moderate-red (5R 4/6) and white (N9) gypsum fragments-----	165.9-166.5
No core-----	166.5-167.0
Clay, same as unit at 165.9-166.5 feet; gray (N6) siltstone fragment at 170.8 feet-----	167.0-171.2
Clay, pale-brown (5YR 5/2), soft, with numerous, very large, rounded to subrounded, medium-light-gray (N6) siltstone fragments-----	171.2-172.4
Siltstone, medium-gray (N5), very hard, with some faint laminae of MnO ₂ mineral and staining-----	172.4-172.8
Clay, moderate-reddish-brown (10R 4/6) and medium-gray (N5), numerous subrounded, 0.5-8 cm medium-gray (N5) siltstone fragments; few irregular, rounded to subrounded, 2 mm to 3 cm chalky, white (N9) gypsum fragments-----	172.8-177.2
Clay, moderate-reddish-brown (10R 4/6), moderately hard, with numerous, 1-8 cm, subrounded to subangular, medium-gray (N5) siltstone fragments; few 2 mm to 3 cm rounded, chalky, moderate-red (5R 4/6) and white (N9) gypsum fragments-----	177.2-186.1

Table 3.--Lithologic log of borehole WIPP 32--Continued

Lithologic description	Depth interval Feet
Clay, moderate-reddish-brown (10R 4/6), hard; few rounded to subrounded, medium-gray (N5) siltstone and moderate-red (5R 4/6) gypsum fragments; numerous fractures, 2 mm to 1.5 cm displacement, irregular, discontinuous, filled with chalky, fibrous, white (N9) and olive-black (5Y 2/1) gypsum; fracture 1-2 cm displacement, 54° dip, filled with chalky, fibrous, white (N9) and olive-black (5Y 2/1) gypsum at 187.1 feet-----	186.1-188.8
Siltstone, moderate-reddish-brown (10R 4/6), very hard, few irregular hairline fractures filled with selenite; hairline selenite-filled fracture, dips 72° at 190.2 feet; very concentrated, irregular blebs and stringers, greenish-gray (5G 6/1) silt at 192.0-192.3 feet; very clayey at 192.6-192.8 feet-----	188.8-192.8
Clay, moderate-reddish-brown (10R 4/6), soft; few fibrous, translucent to transparent gypsum blebs; numerous irregular fragments, medium-bluish-gray (5B 5/1) clay and moderate-red (5R 4/6) gypsum at 194.4-194.6 feet-----	192.8-194.6
Gypsum after polyhalite, moderate-red (5R 4/6), moderate-reddish-brown (10R 4/6), white (N9), and olive-black (5Y 2/1), very finely to finely crystalline; few argillaceous moderate-reddish-brown (10R 4/6) laminae dip 12°-20°; moderate-red (5R 4/6) gypsum at 194.6-195.0 and 196.0-196.6 feet-----	194.6-196.6
Clay, moderate-reddish-brown (10R 4/6), hard, silty, brecciated; with numerous, very irregular stringers and fragments of rounded to subrounded, 2 mm to 6 cm moderate-red (5R 4/6) to moderate-reddish-orange (10R 6/6) gypsum after polyhalite; white (N9) to olive-black (5Y 2/1) gypsum, and medium-bluish-gray (5B 5/1) siltstone fragments-----	196.6-203.0
Siltstone, moderate-reddish-brown (10R 4/6), friable, hard; with numerous, subrounded to subangular, breccia fragments of medium-bluish-gray (5B 5/1) to medium-gray (N5) siltstone and white (N9), olive-black (5Y 2/1), some moderate-reddish-orange (10R 6/6) gypsum; few very irregular, fibrous, 1-3 mm thick, white (N9) gypsum veinlets-----	203.0-204.0
Clay, same as unit at 196.6-203.0 feet; very irregular, fibrous, 1-3 mm thick, white (N9) gypsum veinlets-----	204.0-204.7
Gypsum after anhydrite, same as unit at 194.6-196.6 feet-----	204.7-205.6
Clay, same as unit at 196.6-203.0 feet-----	205.6-207.8
Gypsum after anhydrite, same as unit at 194.6-196.6 feet-----	207.8-208.3
Clay, moderate-reddish-brown (10R 4/6), silty, hard; few chalky, fibrous, irregular, white (N9) and olive-black (5Y 2/1) gypsum fragments; fracture 1-3 cm displacement, dips 76°, filled with chalky, white (N9) and olive-black (5Y 2/1) gypsum at 209.2 feet-----	208.3-210.0
Gypsum, same as unit at 194.6-196.6 feet-----	210.0-210.5

Table 3.--Lithologic log of borehole WIPP 32--Continued

Lithologic description	Depth interval Feet
Gypsum after anhydrite, olive-black (5Y 2/1), very finely to finely crystalline, mottled; with 1 mm or less thick, continuous, regular, some faint, 12°-20° dip, some parallel, dark-gray (N3) laminae; some very irregular fractures, 1-6 mm displacement, filled with moderate-reddish-brown (10R 4/6) clay; continuous, regular, parallel fractures, 1-3 mm thick, 28°-36° dips, filled with moderate-reddish-brown (10R 4/6) clay at 211.5, 212.3, and 212.4 feet-----	210.5-212.9
Gypsum after anhydrite, olive-black (5Y 2/1), very finely to finely crystalline, mottled; few 1 mm or less, thick, slightly wavy, moderate-reddish-brown (10R 4/6) and light-olive-gray (5Y 5/2) laminae that dip 25°-32°-----	212.9-219.6
Gypsum after anhydrite, moderate-reddish-orange (10R 6/6) moderate-red (5R 4/6), finely to medium crystalline, mottled; some very irregular fractures, 1-5 mm displacement, filled with soft moderate-reddish-brown (10R 4/6) and medium-crystalline translucent to transparent gypsum-----	219.6-221.0
Clay, same as unit at 196.6-203.0 feet-----	221.0-222.0
Gypsum, same as unit at 212.9-219.6 feet, olive-gray (5Y 4/1)-----	222.0-223.3
Clay, same as unit at 196.6-203.0 feet-----	223.3-224.9
Gypsum, same as unit at 212.9-219.6 feet-----	224.9-225.1
Clay, same as unit at 196.6-203.0 feet-----	225.1-225.5
Gypsum, same as unit at 212.9-219.6 feet-----	225.5-225.8
Clay, same as unit at 196.6-203.0 feet-----	225.8-226.3
Gypsum, same as unit at 212.9-219.6 feet-----	226.3-227.8
Gypsum, light-olive-gray (5Y 6/1) to olive-gray (5Y 4/1), very finely crystalline, "chicken wire" appearance-----	227.8-228.3
Anhydrite, medium-light-gray (N6), very finely crystalline, with very irregular, interconnecting network of olive-black (5Y 2/1) gypsum veinlets-----	228.3-229.8
Gypsum, olive-black (5Y 2/1), very finely to finely crystalline, mottled and "chicken wire" appearance of medium-light-gray (N6) gypsum-----	229.8-231.9
Gypsum, olive-gray (5Y 4/1) to olive-black (5Y 2/1); some moderate-reddish-brown (10R 4/6), very finely to finely crystalline; laminated, wavy, thin, less than 1 mm thick fractures present, healed by colorless to white (N9) gypsum, some filled with moderate-reddish-brown (10R 4/6) clay-----	231.9-235.4
Siltstone, greenish-gray (5G 6/1) to medium-bluish-gray (5B 5/1), hard-----	235.4-236.1

Table 3.--Lithologic log of borehole WIPP 32--Continued

Lithologic description	Depth interval Feet
Gypsum and siltstone breccia: gypsum fragments, medium-light-gray (N6) to white (N9), some moderate-reddish-brown (10R 4/6) gypsum and fragments in a moderate-reddish-brown (10R 4/6) clay matrix, light-olive-gray (5Y 6/1) siltstone-----	236.1-241.8
Gypsum, olive-gray (5Y 4/1) to olive-black (5Y 2/1), very finely to finely crystalline, laminated, pitted, some pits filled with moderate-reddish-brown (10R 4/6) clay; few blebs of moderate-reddish-orange (10R 6/6) polyhalite-----	241.8-242.8
Gypsum breccia, rounded to subrounded fragments 2-5 cm, blocks 0.2-0.5 foot, and fragments 0.2-1 cm moderate-reddish-orange (10R 6/6) gypsum after polyhalite in a moderate-reddish-brown (10R 4/6) clay matrix-----	242.8-246.8
Gypsum, pale-reddish-brown (10R 5/4) to moderate-red (5R 4/6), very finely to finely crystalline, mottled; some faint, irregular fractures filled with fibrous, translucent to transparent gypsum; horizontal bands, finely crystalline, olive-black (5Y 2/1) gypsum at 247.0 and 249.0 feet; brecciated zone, olive-black (5Y 2/1) gypsum within a moderate-reddish-brown (10R 4/6) clay matrix at 248.0-248.6 feet-----	246.8-250.0
Gypsum, olive-black (5Y 2/1), finely crystalline, mottled; fracture, 0.2-1.5 cm displacement, filled with moderate-reddish-brown (10R 4/6) to olive-gray (5Y 4/1) clay at 250.1-250.3 feet-----	250.0-251.7
Gypsum, same as unit at 250.0-251.7 feet; blotchy zone at 253.3-255.0 feet; faint olive-black (5Y 2/1), thin laminae at 255.0-256.0 feet; very mottled, with numerous, fibrous, translucent to transparent gypsum blebs at 256.0-256.8 feet; moderate-reddish-orange (10R 6/6) gypsum at 256.4-256.8 feet; irregular, horizontal fractures, 2-15 mm thick, filled with moderate-reddish-brown (10R 4/6) clay at 254.8-255.6 and 257.0-257.1 feet-----	251.7-257.1
Clay, moderate-reddish-brown (10R 4/6), silty; fragments and nodules 0.2-6 cm of rounded to subrounded, white (N9), olive-black (5Y 2/1), and moderate-reddish-orange (10R 6/6) gypsum-----	257.1-263.3
Gypsum, after polyhalite, moderate-reddish-orange (10R 6/6) to moderate-red (5R 4/6), very finely crystalline, gypsiferous-----	263.3-264.0
Clay, same as unit at 257.1-263.3 feet-----	264.0-266.9
Gypsum after polyhalite, same as unit at 263.3-264.0 feet-----	266.9-268.1
Clay, moderate-reddish-brown (10R 4/6), firm-----	268.1-268.3
Clay, greenish-gray (5G 6/1), firm-----	268.3-268.5
Gypsum, white (N9) to olive-gray (5Y 4/1); with argillaceous, moderate-reddish-brown (10R 4/6) stringers, finely crystalline, mottled-----	268.5-269.3
Clay, same as unit at 257.1-263.3 feet-----	269.3-270.1

Table 3.--Lithologic log of borehole WIPP 32--Continued

Lithologic description	Depth interval Feet
Gypsum, light-olive-gray (5Y 6/1) and moderate-reddish-brown (10R 4/6), very finely to finely crystalline; becoming anhydritic at 270.6-271.6 feet-----	270.1-271.6
Gypsum, light-olive-gray (5Y 6/1), very finely crystalline-----	271.6-272.1
Gypsum, moderate-reddish-orange (10R 6/6), pale-reddish-brown (10R 5/4), some light-olive-gray (5Y 6/1), altered polyhalite, mottled-----	272.1-273.5
Gypsum, light-olive-gray (5Y 6/1), finely to medium crystalline, recrystallized-----	273.5-274.3
Gypsum, moderate-reddish-orange (10R 6/6) to moderate-red (5R 4/6) and translucent, finely to medium, some coarsely crystalline-----	274.3-275.8
Clay, dark-reddish-brown (10R 3/4), soft; few rounded to subrounded fragments, 1-3 cm in size, of moderate-reddish-orange (10R 6/6) gypsum-----	275.8-278.9
Gypsum, same as unit at 272.1-273.5 feet, halitic-----	278.9-279.0
No core-----	279.0-280.2
Halite, translucent to transparent, medium to coarsely, some very coarsely crystalline; 2-7 mm, horizontal, irregular, moderate-reddish-orange (10R 6/6) polyhalite blebs and stringers at 281.6-281.8 feet-----	280.2-281.8
Halite, translucent to transparent, medium to coarsely crystalline, argillaceous; numerous small to medium clots of dark-reddish-brown (10R 3/4) clay-----	281.8-284.0
Halite, translucent to transparent and moderate-reddish-orange (10R 6/6), medium-crystalline; with moderate-reddish-orange (10R 6/6) polyhalite blebs and stringers and few small to medium clots of greenish-gray (5G 6/1) and dark-reddish-brown (10R 3/4) clay; horizontal band of 1.5 cm thick, moderate-red (5R 4/6) polyhalite at 286.0 feet-----	284.0-288.0
Halite, translucent to transparent, finely to medium crystalline, with numerous moderate-reddish-orange (10R 6/6) polyhalite blebs and stringers-----	288.0-288.8
Halite, translucent to transparent, medium to coarsely crystalline, with numerous minute to small clots of dark-reddish-brown (10R 3/4) clay and minute to small moderate-reddish-orange (10R 6/6) polyhalite blebs-----	288.8-289.7
Halite, same as unit at 288.0-288.8 feet-----	289.7-289.8
No core-----	289.8-290.2
Halite, same as unit at 288.0-288.8 feet-----	290.2-291.9
Siltstone, moderate-reddish-brown (10R 4/6) and greenish-gray (5G 6/1), friable, hard, halitic-----	291.9-292.0

Table 3.--Lithologic log of borehole WIPP 32--Continued

Lithologic description	Depth interval Feet
Halite, same as unit at 288.8-289.7 feet-----	292.0-294.8
Halite, translucent to transparent, medium to coarsely crystalline; with minute to small clots of dark-reddish-brown (10R 3/4) clay and minute to small blebs and thin to medium stringers of moderate-reddish-brown (10R 4/6) polyhalite-----	294.8-296.5
Halite, translucent to transparent, medium to coarsely, some very coarsely crystalline, with minute to small, some medium blebs and thin to medium stringers of moderate-red (5R 4/6) to moderate-reddish-orange (10R 6/6) polyhalite-----	296.5-297.8
Halite, translucent to transparent, finely to medium crystalline-----	297.8-299.2
Halite, same as unit at 296.5-297.8 feet-----	299.2-302.7
Halite, same as unit 296.5-297.8 feet; some irregular vugs 0.5-1.5 cm wide, 5 mm to 2 cm deep, some rimmed with moderate-reddish-orange (5R 4/6) sylvite-----	302.7-307.3
Halite, translucent to transparent, medium crystalline, with numerous minute to small clots of greenish-gray (5G 6/1) silt and small to medium, some red rimmed vugs, moderate-reddish-orange (10R 6/6) to moderate-red (5R 4/6) polyhalite-----	307.3-308.0
Halite, same as unit at 288.8-289.7 feet, some irregular, red-rimmed voids; moderate-red (5R 4/6) polyhalite-----	308.0-312.1
Halite, same as unit at 296.5-297.8 feet-----	312.1-316.0
Halite, same as unit at 286.3-288.8 feet-----	316.0-318.5
Polyhalite, moderate-reddish-orange (10R 6/6) to burnt-orange, micro- crystalline; greenish-gray (5G 6/1) seam at base-----	318.5-319.5
Halite, translucent to transparent, medium-crystalline; with minute to small clots of greenish-gray (5G 6/1) silt and minute to small blebs and thin to medium stringers of moderate-reddish-orange (10R 6/6) polyhalite-----	319.5-321.6
Halite, same as unit at 296.5-297.8 feet-----	321.6-322.8
Halite, same as unit at 296.5-297.8 feet; with few irregular vugs from leached potash minerals-----	322.8-326.8
Halite, translucent to transparent, medium, some coarsely crystalline; few small and medium blebs of moderate-red (5R 4/6) polyhalite; few vugs from leached potash minerals; vug, 2-4 cm, partially filled with milky white bloedite-----	326.8-328.9
Halite, same as unit at 294.8-296.5 feet-----	328.9-331.1
Halite, same as unit at 288.8-289.7 feet-----	331.1-332.0
Halite, same as unit at 319.5-321.6 feet-----	332.0-332.8

Table 3.--Lithologic log of borehole WIPP 32--Continued

Lithologic description	Depth interval Feet
Halite, same as unit at 288.8-289.7 feet-----	332.8-335.3
Halite, same as unit at 326.8-328.9 feet; vugs, 3-5 cm, rimmed with moderate- red (5R 4/6) silvite at 328.8 feet; 1-1.5 cm thick horizontal band of moderate-reddish-orange (10R 6/6) polyhalite-----	335.3-339.0
Halite, same as unit at 319.5-321.6 feet-----	339.0-340.8
Halite, same as unit at 296.5-297.8 feet; concentrated stringers of light-gray (N7) anhydrite at 341.8-342.0 and 342.8-342.9 feet-----	340.8-342.9
Polyhalite, light-gray (N7), some pale-red (10R 6/2), microcrystalline; numerous vugs partially filled with finely crystalline, translucent to transparent halite-----	342.9-345.3
Polyhalite, light-gray (N7) and olive-gray (5Y 4/1); few 1-2 mm thick hairline fractures filled with medium-dark-gray (N4) clay at 346.6 feet and medium blebs at 347.5 feet-----	345.3-348.2
Halite, translucent to transparent, medium to coarsely crystalline; with very numerous large blebs and thick stringers of pale-red (10R 5/4) and olive-gray (5Y 4/1) polyhalite and anhydrite-----	348.2-349.1
Halite, translucent to transparent, medium to coarsely crystalline; with minute to small clots of greenish-black (5G 2/1) clay and small blebs of moderate-red (5R 4/6) polyhalite-----	349.1-349.3
Halite, same as unit at 296.5-297.8 feet-----	349.3-350.5
Halite, translucent to transparent, coarsely to very coarsely crystalline---	350.5-352.2
Polyhalite, same as unit at 318.5-319.5 feet; few minute blebs of translucent to transparent halite-----	352.2-352.9
Halite, translucent to transparent, with numerous small to medium clots of greenish-black (5G 2/1) clay-----	352.9-353.0

4.0 HYDROLOGICAL DATA

None. At this time hydrological data are being obtained from WIPP 29, a nearby hole in Nash Draw.

5.0 REMARKS

None

6.0 BIBLIOGRAPHY

Adams, J. E., 1944, Upper Permian Ochoan Series of Delaware Basin, west Texas and southeastern New Mexico: American Association of Petroleum Geologists Bulletin, V. 28, no. 11, p. 1596-1625.

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Jones, C. L., 1973, Salt deposits of Los Medanos area, Eddy and Lea Counties, New Mexico, with sections on Ground-water hydrology, by M. E. Cooley and Surficial geology, by G. O. Bachman: U.S. Geological Survey Open-file report (USGS-4339-7), 67 p.

Vine, J. D., 1963, Surface geology of the Nash Draw quadrangle, Eddy County, New Mexico: U.S. Geological Survey Bulletin 1141-B, 46 p.

APPENDIX A

JUSTIFICATION

by

D. W. Powers
Division 4511
Sandia Laboratories

INTRODUCTION TO APPENDIX A, JUSTIFICATION

Appendix A consists of the memorandum from D. W. Powers to R. D. Statler, dated 3/7/79, "Exploratory Drilling of Possible Breccia Pipes, Scope of Work." This document provides details of background information and program options as understood at the time of initiation. The reader is cautioned, therefore, that the 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: March 7, 1979

to: R. D. Statler, 1133

Dennis W. Powers

from: D. W. Powers, 4511

subject: Exploratory Drilling of Possible Breccia Pipes, Scope of Work

Objective: To determine, through an exploratory drilling and logging program, if structural and geomorphic features located in the northern part of the Delaware Basin represent deep seated solution features and should be further investigated through drilling and testing programs. The primary targets at this time are located in section 34, T22S, R30E, and section 24, T23S, R30E on the basis of unpublished mapping conducted by George O. Bachman of the U.S. Geological Survey for the WIPP program. The feature in section 34 is expected to be the first to be explored through drilling (WIPP 32) because it is nearer to the WIPP site, and should be testable through very shallow drilling.

Secondary targets for such exploratory drilling are in the general area of Malaga Bend. Field mapping will continue on those features while drilling is underway on primary targets. Should the primary targets not be suitable for further investigation of solution features, one or more of the mapped structures near Malaga Bend may then be selected.

Any of these boreholes may be considered for hydrologic evaluation if the stratigraphy is appropriate.

Method: One drill hole per location is expected to provide the preliminary prospecting information to assess the feature to determine if deep dissolution has occurred. The hole will be drilled to below an identifiable marker bed near the top of the Salado Fm or the equivalent depth. For the feature located in section 34, the total depth of the exploratory hole should be about 350'. Logging of the hole is to provide information on the acoustic velocities, formation resistivities, porosity, density, natural radioactivity, and formation attitudes.

Details: WIPP 32 should be nearly all core drilling with some provision for switching to rotary drilling as judged appropriate during drilling operations. The core should be at least NX in size. Provisions will be made for photography,

wrapping and storage of core in accordance with recent practice by Sandia Laboratories (see WIPP 11 Drilling Program, Schedule, and Test Plan, Appendix A, from R.D. Statler to Distribution, January 26, 1978).

Logging undertaken by commercial concerns shall include compensation for hole effects. The USGS/Water Resources Division, Albuquerque, should independently plan to log the resulting hole for cross-documentation.

Data Requirements: The following data requirements support the WIPP 32 program of prospecting to find a "breccia pipe" that reveals deep seated dissolution. When such a structure is located, a new program for full evaluation will be established.

The hole location shall be established on the basis of the field site selection, and shall be determined areally $\pm 10'$ relative to the nearest readily accessibly permanent corner marker and $\pm 1'$ vertically relative to the nearest readily accessible NGS permanent marker.

Continuous coring is the initial requirement for WIPP 32. All core taken will be marked to the nearest foot relative to measurements of drilling pipe, and will be sealed in heavy plastic as in ERDA 9. Further core handling instructions have previously been established and are adequate when appropriately modified for hole number and size (see WIPP 11 Drilling Program, Schedule, and Test Plan, Appendix A, from R.D. Statler to Distribution, January 26, 1978).

Borehole geophysical logging is required to supply information on stratigraphy, formation density, porosity, formation resistivity, and formation attitude. Depths measured by logging tools should be accurate to 1 foot per thousand feet depth. A trained logging engineer is required to perform the logging task.

Hole plugging programs may be deferred for the moment since the hole is likely to remain open for some time or be re-entered. Ultimate hole plugging may follow the program outlined in the memorandum: WIPP 18 through 22 Drill Holes, Plugging Plan, dated March 28, 1978, from C.W. Gulick to R.D. Statler.

Field Support: Division 4511 will depend on Division 1133 for support in obtaining permits, carrying out the drilling and logging programs, establishing procedures, and supplying field support. Support from the USGS/WRD for logging and core description is requested, as is support from the Special Projects Division in examining the stratigraphy.

March 7, 1979

Decision Points: The total depth of the hole is expected to be about 350', deep enough to confirm the stratigraphy in the upper Salado Fm or determine that abnormalities persist into the Salado.

If the stratigraphy is abnormal and indicating brecciation, the hole will be logged at total depth, and may be readied for later testing of zones within the hole that indicate possible fluids. If the stratigraphy is indicating solution collapse very near the surface, the hole will be drilled to total depth to ascertain that a localized surficial feature is not present. If the hole continues to show such abnormal features to that depth, it is anticipated that the hole will be abandoned temporarily, and a separate drilling program for the testing of breccia pipes or deep dissolution may then be implemented.

Background: A field mapping program was initiated by the USGS (George Bachman) to identify possible breccia pipes within the northern Delaware Basin for exploratory drilling. The initial results indicate two possible candidates, one of which is presently preferred for the initial drilling.

The processes governing the formation of these features and the rates at which they form need to be discovered to evaluate the effects, if any, on the WIPP site. WIPP 32 is therefore by nature a simple prospecting exercise designed to examine a feature that may be further tested. If a solution collapse feature of significance is found, further testing will be carried out under a more elaborate plan at a later date.

Approved:

Leslie R. Hill
L. R. Hill, Supervisor
Nuclear Waste Technology
Division 4511

DWP:4511:rmf

Copy to:

W. P. Armstrong, WPO, DOE/ALO
W. S. Twenhofel, USGS, SPD, Denver
C. L. Jones, USGS, SPD, Denver
W. E. Hale, USGS, WRD, Albuquerque
G. O. Bachmann, USGS, WRD, Albuquerque
J. W. Mercer, USGS, WRD, Albuquerque
4510 W. D. Weart
4511 L. R. Hill
4511 L. J. Barrows
4511 S. J. Lambert
4542 Sandia WIPP Central File (2)
4511 D. W. Powers

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: June 26, 1979

to: Distribution

from: R. D. Statler, 1133

subject: Site Investigations for WIPP 32

The attached document contains the Field Operations Plan for conducting WIPP 32. Drilling, logging, coring, and cementing procedures are included for your use and information. Revisions and additions shall be added to this document as required and appropriate distribution made.

RDS:mw

Distribution:

C. L. Jones, USGS, Special Projects Div., Denver, CO
J. W. Mercer, USGS/WRD, Albuquerque, NM
G. O. Bachman, USGS/WRD, Albuquerque, NM
R. Taft, DOE/NVOO, Las Vegas, NV
D. Schueler, DOE/ALO
J. Cross, F&S, Las Vegas, NV
W. E. Cunningham, F&S, Carlsbad, NM (3)
W. E. Armstrong, DOE/Carlsbad
W. S. Twenhofel, USGS, Special Projects Div., Denver, CO
W. E. Hale, USGS/WRD, Albuquerque, NM
D. Van Sickle, USGS/Area Geologist, Roswell, NM

1130 H. E. Viney
1133 C. W. Gulick
1133 W. C. Wilson
1135 P. D. Seward
1135 J. E. Magruder
4510 W. D. Weart
4511 W. D. Weart (actg)
4511 S. J. Lambert
4511 D. W. Powers
4511 D. D. Gonzales
4542 J. T. Henderson
4542 J. W. McKiernan
4542 WIPP Central Files
1133 R. D. Statler (3)

Field Operations Plan of Sandia Laboratories
WIPP Site Investigations
Possible Breccia Pipes

Exploratory Well: WIPP 32

Los Medanos Area: Section 33, Township 22S, Range 29E

Eddy County, New Mexico

Purpose: To determine if structural and geomorphic features represent a deep solution feature and gather information with which to assess the need for additional drilling and testing.

Prepared by

R. D. Statler
R. D. Statler, Supervisor
Field Engineering Projects
Division 1133

Reviewed by

C. W. Zuch

Approved by

W. D. Weart 6-27-79
W. D. Weart, Acting Supervisor
Nuclear Waste Technology
Division 4511

Approved by

J. W. McKiernan
J. W. McKiernan, Supervisor
Nuclear Waste Programs
Division 4542

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INTRODUCTION

This document begins with a scope of work for an exploratory well, WIPP 32, to investigate a surface collapse and determine if existing features require additional drilling and testing. It describes the operational plan for conducting the field activities required to meet specified objectives. It includes procedures with drawings, specifications, and instructions necessary for quality control of essential features.

1. FIELD OPERATIONS PROGRAM CRITERIA

The memorandum from D. W. Powers to R. D. Statler dated 3/7/79 "Exploratory Drilling of Possible Breccia Pipes, Scope of Work" has been accepted as the design criteria for WIPP 32. It is reproduced in its entirety as Appendix A.

2. FIELD OPERATION PLAN - WIPP 32

2.1 Organization

Technical direction will originate within Sandia Division 4511. 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 duty geologist.

Quality control and inspection will be conducted by designated experts.

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

2.2 Support Data - WIPP 32

Geology

The geology of the drill location is not certain and the stratigraphy may prove unusual. The following prognosis, provided by G. O. Bachman, USGS, is based on projections from nearby holes assuming normal conditions:

Ground Elevation above Sea Level	3020'
Magenta Dolomite Tops	Near Surface
Culebra Dolomite Tops	30'
Top of Salado	280'
Expected TD	350'

2.3 Drilling Parameters and Expected Drilling Requirements

It should be recognized that the stratigraphy may be unusual, therefore, the drilling program may be adjusted to provide for abnormalities. If the conditions are found to be relatively normal, the following program is expected to be employed:

2.3.1 Level and prepare a surface location of 100' x 200' minimal size using approximately 6" caliche base.

2.3.2 Machine auger a conductor hole of sufficient depth and diameter to permit installation and cementing of a 30-40' x 9-5/8" O.D. conductor pipe.

Construct a timber-cribbed cellar which will be compatible with appropriate wellhead safety equipment and other associated drilling equipment.

2.3.3 Move in rig and rig up to take continuous NX size core from base of conductor pipe to a TD of approximately 350'. Use circulating fluids best suited to enhance full core recovery.

All core is to be logged, marked and handled according to procedures outlined in Section 3.2.

2.3.4 Following coring operations, hole should be opened and conditioned for running logs by commercial service and USGS/WRD. Logs to be run include sonic, resistivity, density, gamma, neutron, dip-log and possibly up-hole velocity. Procedures for logging program are outlined in Section 3.3.

2.3.5 When rotary drilling, take drill cuttings at 5' intervals, log, mark, and retain for storage in 100' bundles.

2.3.6 When logging is completed, recondition hole and fill with fluid compatible with formation encountered.

2.3.7 Clean up pad area, fill in pits and leave hole temporarily abandoned pending subsequent reoccupation for possible testing.

As stated previously, the drilling program may be adjusted to provide for a study of abnormalities. If the drilling program reveals abnormal stratigraphy, the progress may be revised in the field.

2.4 Discussion of Potential Hazards

Drilling this hole may produce unusual fluids and/or gas pockets. Preparations should be included for monitoring and flaring combustible gases.

3. FIELD OPERATING PROCEDURES FOR QUALITY CONTROL REQUIREMENTS

Some parts of this program are considered important enough to establish specific procedures for their conduct. These activities are:

- Measurement of Surface Location and Elevation. See Section 3.1
- Coring Operations. See Section 3.2
- Geophysical Logging Operations. See Section 3.3

The above activities should be monitored in detail or reviewed by designated experts whose education, knowledge and/or experience makes him qualified to assure adherence to operating procedures or to ascertain or certify that desired objectives have been met.

When designated, this individual shall take appropriate measure to negotiate with pertinent officials to whatever extent necessary to assure acceptable results.

3.1 Measurement of Surface Location and Elevation

The general location will be established by Division 4511 following a review of resistivity surveys, surface features, accessibility and other geo-political considerations. A preliminary land survey shall be conducted by a Registered Land Surveyor to establish access routes and set stakes for drill location and pad boundaries. Dimension of the location will be established with nearest section boundaries and nearest marked section corners to provide data necessary for obtaining land use permits. Drawings or sketches suitable for construction use shall be submitted. After pad construction is complete and at the time of hole spudding, a concrete monument with a brass cap will be set in the immediate vicinity of the borehole such that it can be used as the datum point for all borehole vertical measurements. Once this monument is established, this monument and its lateral relation to borehole axis is to be surveyed by a Registered Land Surveyor to establish the vertical elevation within $\pm 1'$ of the nearest NGS monument and the lateral coordinates within $\pm 1'$ with respect to nearest section boundaries and recoverable section corners.

3.2 Coring Operations Procedure of Sandia Laboratories - WIPP Site Investigations

3.2.1 Introduction

This procedure is prepared by the Field Engineering Division 1133 for use in Sandia Laboratories' WIPP Program. The objective is to establish the methods and techniques to be used in coring operations in order to obtain reliable samples in a uniform manner.

3.2.2 Scope of Work

This coring operation is to be done as a part of exploratory drilling of possible breccia pipes. Coring operation will consist of taking approximately 300' of NX size core to a TD of approximately 350'. Core is to be removed from the core barrel, logged, measured, cleaned, marked, photographed, packaged, transported and stored according to the procedures presented in this document.

3.2.3 Organization

Sandia Laboratories is conducting this field work under technical direction from Division 4511 and the Sandia Field Engineering Division 1133 will manage the field operations.

Sandia Labs has arranged with Nevada Operations Office, DOE, for their contractor, Fenix & Scisson, to prepare and administer a field program on behalf of Sandia and from criteria provided by Sandia that includes the taking of core. The drilling contractor, the coring contractor and the roustabout contractor are under contract to Fenix & Scisson.

Sandia Labs has arranged with Albuquerque Operations, DOE, for support of USGS. USGS will provide the duty geologist for logging and identifying the core and supervision of core handling in the field.

Sandia Labs will provide core photography.

Sandia Labs will provide core storage.

3.2.4 Operations

3.2.4.1 Coring (F&S and their contractors)

Continuous wireline coring with NX size diamond core bit and a nominal 10' split core barrel is required.

Other equipment and material such as drill-collars and stabilizers, drilling fluid should be utilized according to best judgment to match the formation and produce optimum core recovery.

Select and use drilling weight, rotary speed and circulation rates that will produce optimum core recovery.

Maintain a daily record which shows: date; tour and operating personnel; sequence of core interval; depth of core interval; drilling time of core interval; drilling weight; rotary speed and circulation rate; and, type circulating fluid.

- 3.2.4.2 Removal from Barrel (F&S and their contractors)
Core should be removed from core barrel as gently as possible to cause a minimum alteration of the core. Light hammering or jarring is permissible but heavy hammering or pounding the barrel on its end is to be avoided. Removal by pumping is permissible.

As the core is removed it will be placed in troughs in the order coming out of the barrel. Troughs will be marked with red at top end and black at bottom indicating down direction.

- 3.2.4.3 Logging and (USGS Duty Geologist)

If core is suitable for marking, each major piece should be marked with a visible water-proof ink arrow pointing in the direction the hole is advancing. Each core piece should be measured, identified and logged indexing each foot with footage expressed to the closest 1/10 of a foot. Depths should be reconciled from measurements of the drill pipe to the nearest foot taken from the top side of the Kelly bushing (KB) unless otherwise specified. Any lost recovery should be logged at the bottom of each core interval unless known to be otherwise and so explained on the core log.

3.2.4.4 Cleaning (F&S and contractors)

Core will be wiped or brushed to remove soft mud cake and excess mud as soon as possible following removal from the core barrel. A rag dampened in drilling fluid will be used to wipe the core. If core is accidentally washed with fresh water, it will be noted in the log stating intervals exposed and time of occurrence.

3.2.4.5 Photograph (Sandia and Duty Geologist)

After core has been logged, labeled and cleaned it will be carefully moved to the core/photo shed and prepared for photography. Core may be wetted to enhance photo coverage. Core should be positioned by the duty geologist to promote coverage of pertinent features such as fractures, bedding plane, color or any other significant characteristics. Each photo should have a title block showing well number, date, core interval and photo number.

3.2.4.6 Preservation (Duty Geologist, F&S Contractor)

After core has been photographed it will be wiped dry and preserved for transportation and storage in the following method.

3.2.4.6.1 Sealing in Plastic Bags

Core pieces will be separated into lengths appropriate to fit into the core boxes. Pieces will be placed into plastic sleeves of appropriate length or wrapped and taped with plastic sheet. When using sleeves, use a hot iron sealing tool, seal both ends of plastic sleeve after squeezing all air possible from sleeve. Place sleeved or wrapped core into box and tape shut. When core intervals are missing, spacers marked with missing footage figures may be inserted in the box as necessary to preserve sequence. Boxes should be labeled in sequence with name of agency, well number, date, core number and depth of core pieces in the box.

3.2.4.7. Handling and Storage (Sandia, Duty Geologist, F&S)

After core pieces have been properly boxed they should be stored under protective cover to avoid adverse weather and temperature extremes until ready for transportation to core library in Carlsbad. The duty geologist will be responsible for assuring correct markings on the exterior of all the boxes, accurate inventory of core being transported, safe transport of core from drill pad to core library in Carlsbad.

Duty geologist will prepare a record for placing the core into storage and delivery to core library custodian at the time of core delivery. Record will include name of agency, well number, location of well, date core taken, depth of core interval and number of boxes being delivered and name of duty geologist.

3.2.5 Records (F&S and Duty Geologist)

- 3.2.5.1 A daily core drilling record will be maintained which shows - date, tour, operating personnel, drilling weight, rotary speed, lengths of drilling tools used, number and time of core interval being drilled, depths, circulation rate.
- 3.2.5.2 A daily core logging record will be maintained which shows - date, name of duty geologist, well number, location, permanent datum, elevations of Kelly bushing, ground level, interval drilled, footage drilled, footage cored, feet recovered, percent recovered.

3.3 Borehole Geophysical Logging Operations Procedure of Sandia Laboratories - WIPP Site Investigations

3.3.1 Introduction

This procedure is prepared by the Sandia Laboratories Field Engineering Division 1133 for use in Sandia's WIPP Site Investigation. The objective is to establish standard routines and methods for borehole geophysical logging in order to assure qualified data in a reliable manner.

3.3.2 Scope of Work

Geophysical logging of boreholes in the WIPP site investigations may include a wide variety of individual logging services. Logging services may be provided by several different commercial firms utilizing different types of tools and techniques. Services may be purchased directly by Sandia Labs or through engineering firms such as Fenix & Scisson.

The scope of logging services will change from borehole to borehole and will depend on the specific objectives of the borehole program.

It is not the intent of this document to tell the logger how to run his business. Rather it is to establish standard routines and "check list" to make certain the objectives of the logging program as stated by the technical director can be achieved through the exchange of pertinent information and utilization of qualified personnel.

3.3.3 Organization

The Sandia Laboratories is conducting this field work with Technical Director from Division 4511. Field operations is managed by Sandia Field Engineering Division 1133.

Sandia Labs has arranged with DOE/NVVO for their contractor, F&S, to prepare and administer a drilling program and associated subcontracts from criteria provided by Sandia which includes borehole logging on WIPP 32.

3.3.4 Operations

3.3.4.1 The Field Operations Plan prepared for each borehole will identify the probable logs to be run. Since the logging program is usually customized to fit the hole conditions, the specific logs to be run may not be included but will be the subject of a written supplement to the Field Operations Plan and distributed in time to select the proper service.

- 3.3.4.2 Prior to selecting a logging service, a Sandia representative will meet with Fenix & Scisson and prepare the form "Instructions to Logging Company" for the specific logs to be run.
- 3.3.4.3 Prior to logging a qualified representative of Sandia Labs will meet with the logging service company's logging engineer. He will present the "Instructions ...." and discuss:
- a) the entire logging program and special requirements,
  - b) hole conditions that may cause problems, and
  - c) zones of special interest.
- 3.3.4.4 During the pre-log conference, the Sandia representative will discuss and request the following be done:
- The equipment will be "warmed up" for the adequate amount of time and tools will be checked to see that they are functioning properly upon arrival at the location.
  - Rm, Rmf, and Rmc will be measured on mud samples. Estimated values are not acceptable. The service company should run the sample through a mud press.
  - All Sidewall and Compensated Neutron logs and all density porosity curves will be run on limestone matrix over the zones of interest, regardless of the lithology.
  - Equipment will be tested while running in hole.
  - Before and after log calibrations will be shown for all curves.
  - Panel calibrations will be shown for all density and neutron logs, integration checks will be shown for all integrated Acoustic logs.
  - In addition to caliper rings, the caliper calibration should show "tool full open" and casing readings.

- A minimum 200 feet repeat must be shown.
- Overlap previous runs by at least 200 feet.
- All headings information will be completely filled out.

3.3.4.5 The Sandia logging representative will be present and observe the logging operation to the extent necessary to assure objectives have been met. He should complete a "Log Quality Report" following the operation and, along with a copy of "Instructions to Logging Company," forward to Sandia Field Engineering Division 1133.

3.3.5 Records

3.3.5.1 "Instruction to Logging Company"

F&S should prepare, following a conference with Sandia representative.

Distribution should be made as follows:

- 1 Logging Company
- 1 Sandia Representative - observing log operations
- 1 F&S
- 1 Sandia Carlsbad Hole File
- 3 Sandia Division 1133, ABQ (3 copies)
- 1 USGS, Spec. Proj., Denver
Attn: C. Jones
- 1 USGS/WRD, ABQ, Attn: J. Mercer
- 1 USGS/WRD, ABQ, Attn: G. O. Bachman

3.3.5.2 Log Quality Report

Sandia representative should prepare and distribute as follows:

- 3 Original and two copies to Sandia Field Engineering Division 1133, ABQ, who will be responsible for forwarding to WIPP Central Files
- 1 Sandia Carlsbad Hole File
- 1 F&S, Carlsbad

3.3.5.3 Geophysical Logs (Field Prints)

F&S Carlsbad should obtain 9 copies of log field prints and distribute as follows:

- 1 Sandia Carlsbad Hole File
- 1 USGS, Spec. Proj., Denver
Attn: C. Jones
- 1 USGS/WRD, ABQ, Attn: J. Mercer
- 1 USGS/WRD, ABQ, Attn: G. O. Bachman
- 1 Sandia Division 4511, ABQ
Attn: D. W. Powers
- 4 F&S Carlsbad (4 copies)

3.3.5.4 Geophysical Logs (Final Prints)

F&S should order 15 final copies of logs and two copies of library magnetic tapes of the logs and distribute as follows:

- 1 Sandia Carlsbad Hole File
- 2 USGS, Spec. Proj., Denver
Attn: C. Jones
- 1 USGS/WRD, ABQ, Attn: J. Mercer
- 1 USGS/WRD, ABQ, Attn: G. O. Bachman
- 3 Sandia Division 4511, ABQ
Attn: D. W. Powers
- 2 Sandia Division 4512, WIPP Central
File, ABQ; 2 copies logs and
2 copies tapes
- 1 F&S Carlsbad
- 1 F&S Las Vegas
- 1 State Engineer, Roswell, NM
- 1 USGS Area Geologist, Roswell, NM
- 1 West Texas Electric Log Service

Hole _____ Log Date _____ Current Date _____

Log _____ Run #: _____ Engr. _____

Field Print Final Print Log Analyst

REMARKS: Code Remarks with the proper Section Number.
For Example: Remarks concerning before log
calibrations would be coded B-5.

YES NO

1. Correct Heading Used
2. Heading Data Properly Completed
3. Equipment Used Section Completed
4. Equipment Data Section Completed
5. Scale Changes Noted on Heading
6. Are all abnormal conditions explained in the remarks section

1. Scales Correct for Area
2. Scales Labelled
3. Scale Changes Labelled
4. Zeroes Recorded
5. Before Log Calibrations
6. After Log Calibrations
7. Repeat Section Recorded
8. Repeat Section Acceptable

1. Curves Functioning Correctly
2. Do Log values fall within reasonable limits
3. Curves on Depth
4. Logging Speed Indicated
5. Logging Speed Correct

1. Printing or Typing Neat
2. Printing or Typing Accurate
3. Grid and Pen Traces
4. Splices Straight and Clean
5. Film Correctly Processed
6. General Print Quality

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There is no text or other markings on the paper.

INSTRUCTIONS TO LOGGING COMPANY

Date _____ Logging Company _____
Logging Engineer _____
Witnessed By _____

Log Headings:

Company Fenix & Scisson, Inc. for Sandia Laboratories
Well Number WIPP No.
Field _____ County _____ State New Mexico
Location _____
Section _____ Township _____ Range _____
Permanent Datum _____ Elevations: K.B. _____
Log Measured From _____ D.F. _____
Drilling Measured From _____ G.L. _____

Hole Status: SIZE FROM TO SIZE FROM TO
Casings _____ Borehole _____
_____ _____
_____ _____

Type Fluid in Borehole _____ Fluid Level _____
Density _____ pH _____
Viscosity _____ Fluid Loss _____

Purpose of Logging Program, Zones of Special Interest, Critical Hole
Conditions, Remarks, Etc. _____
_____
_____
_____

Number of Prints: Field _____ Final _____

Invoice To: Fenix & Scisson, Inc.
401 N. Canal Street
Carlsbad, NM 88220

Log. No. _____

- (a) Vertical Depth Scales 2-inches/100-feet and 5-inches/100-feet
- (b) Horizontal Logging Scales _____
- (c) Logging Speed Desired _____
- (d) Interval to be Logged _____
- (e) Zones of Special Interest _____

(f) Special Instruction _____

*****

Log. No. _____

- (a) Vertical Depth Scales 2-inches/100-feet and 5-inches/100-feet
- (b) Horizontal Logging Scales _____
- (c) Logging Speed Desired _____
- (d) Interval to be Logged _____
- (e) Zones of Special Interest _____

(f) Special Instruction _____

*****

Log. No. _____

- (a) Vertical Depth Scales 2-inches/100-feet and 5-inches/100-feet
- (b) Horizontal Logging Scales _____
- (c) Logging Speed Desired _____
- (d) Interval to be Logged _____
- (e) Zones of Special Interest _____

(f) Special Instruction _____

4. REPORTS

Distribution Instructions:

4.1 Daily Report

F&S, Carlsbad, shall provide to Sandia, Carlsbad, a copy of the daily report. Sandia, Carlsbad, will telefax weekdays to DOE, Carlsbad office and Statler, 1133. A copy of the daily report is to be kept by Sandia, Carlsbad.

4.2 Hole History

Compiled by F&S, Carlsbad, and Las Vegas, NV. Send copy to R. D. Statler, 1133, for Sandia, Albuquerque distribution.

4.3 Miscellaneous Records shall be provided by F&S, Carlsbad, including the following, with original to be kept on file at F&S, Carlsbad, and one copy to Sandia, Carlsbad:

Drillers Logs, Bit Records, Drill Fluid Recaps
Equipment Certification
Drilling History Chart
Cost Records (copy also to R. D. Statler, 1133,
Albuquerque)

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date. August 16, 1979

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

from: R. D. Statler, SLA, 1133

subject: Supplement to Field Ops Plan for WIPP-32

The Field Ops Plan for WIPP-32 describes a plan for taking commercial logs in paragraph 2.3.4.

Delete the plans for a dip-log and an up-hole velocity log and arrange for the following commercial logs to TD.

1. BHC Acoustic or Sonic
2. Compensated Neutron
3. Densilog
4. Micro-Laterolog - Dual Laterolog
5. Gamma Ray

Initial Paper Scales

Gamma Ray	API 0-125 units/wrap around
Density	2.0 - 3.0
Neutron	30% at upper end
Acoustilog	40-140 μ sec/ft
Micro-Lat.- Dual-Lat.	0.2-1000 ohms m^2/m

Log data should be recorded on magnetic tapes with distribution as specified in the Field Ops Plan.

The Field Ops Plan paragraph 2.3.6 and 2.3.7 should be amended to read as follows:

- 2.3.6 When logging is completed, prepare the hole and plug to surface according to regulations set by State Engineer.
- 2.3.7 Clean up pad area, fill in pits and abandon the hole.

RDS:1133:b1

Distribution on page 2.

Copy to:

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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.

FENIX & SCISSON, INC.

HOLE HISTORY DATA

DATE: 11-5-79

HOLE No.: WIPP #32	W. O. No.:	I. D. No.:
USER: Sandia Lab	TYPE HOLE: Exploratory	
LOCATION: New Mexico	COUNTY: Eddy	AREA: WIPP
SURFACE COORDINATES: * 1673.22' FSL, 29.14' FEL		GROUND ELEVATION: *
RIG ON LOCATION:	SPUDED: 8-7-79	Plugged: 8-23-79

CIRCULATING MEDIA: Brine mud and brine water

No. of COMPRESSORS & SIZE:

BORE HOLE RECORD			CASING RECORD							
FROM	TO	SIZE	I. D.	WT./FT.	WALL	GRADE	CPL'G	FROM	TO	CU. FT. CMT.
0'	4'	Excavated								
4'	390'	6-3/4"								

TOTAL DEPTH: 390'

MANDREL DEPTH

PLUGS: Plugged to surface

JUNK:

LOGGING DATA: Page 3

SURVEYS PAGE:

CORING PAGE:

BOTTOM HOLE COORDINATES:

@

REFERENCE:

NON-OPERATIONAL TIME		OPERATIONAL DELAY TIME		WORKING TIME	
Move Rig up & down	_____ days	Equipment Repair	0.55 days	Drilling Time	0.05 days
Secured W/O Crew	7.75 days	Caving	0.02 days	Trip Time	0.03 days
Bail & Run Mandrel	_____ days	Lost Circ.	_____ days	Single Shot Survey Time	_____ days
Logging	1.01 days	Fishing	_____ days	Open Hole	1.00 days
Survey	_____ days	W. O. Equipment	_____ days	Total	1.08 days
Casing	0.05 days	W. O. Mud	0.16 days	Total Suspended Time	_____ days
Cement	_____ days	Mix & Condition Mud	0.02 days	Non-Operational Time	13.24 days
Coring	3.22 days		_____ days	Operational Delay Time	0.75 days
Plug Back	1.21 days		_____ days	Working Time	1.08 days
TOTAL	13.24 days	TOTAL	0.75 days	TOTAL ELAPSED TIME	15.07 days

REMARKS: * Location of brass monument:

1669.26' FSL, 25.18' FEL, Sec. 33, T22S, R29E. Elevation

3023.26'.

Rig No.	Name	Type
2	Pennsylvania Drilling Co.	15.07 days
		_____ days
		_____ days
		_____ days
		_____ days

WDS/it

WIPP #32
HOLE HISTORY

Excavated and installed a 5' x 5' cellar 4' deep.

- 8-6-79 Moved in Pennsylvania Drilling Company's rig #2.
- 8-7-79 Rigged up. Picked up 2-7/8" O.D. x 5' long coring assembly and cut core #1 from 4' to 9' using water, recovered 0.5'. Cut core #2 from 9' to 13', recovered 0.8'. Reamed 2-7/8" hole to 6-1/8" to 13'. Made up 10' split core barrel with a 3-3/4" x 2.4" core head. Cut core #3 from 13' to 18', recovered 1.4'. Worked days only.
- 8-8-79 Reamed core hole to 6-1/8" from 13' to 15'. Cut core #4 from 18' to 23', lost circulation at 20'. Cut core #5 from 23' to 24', recovered 1.3'. Cut core #6 from 24' to 25', recovered 0.5'. Rigged up to mix mud.
- 8-9-79 Cut core #7 from 25' to 30' using brine mud, recovered 3'. Cut core #8 from 30' to 36.65', recovered 3.7'. Cut core #9 from 36.65' to 41.65', recovered 2.8'. Cut core #10 from 41.65' to 46.65', recovered 4.9'. Cut core #11 from 46.65' to 48.15', recovered 0.8'. Cut core #12 from 48.15' to 54.05' with brine water, recovered 3.9'. Change back to brine mud and cut core #13 from 54.05' to 55.95', recovered 1.25'. Cut core #14 from 55.95' to 56.65', recovered 1'.
- 8-10-79 Cut core #15 from 56.65' to 57.25', recovered 0.6'. Cut core #16 from 57.25' to 61.65', recovered 1.3'. Cut core #17 from 61.65' to 63.65', recovered 0.6'. Cut core #18 from 63.65' to 67.85', recovered 2.2'. Cut core #19 from 67.85' to 72.65', recovered 4.5'. Cut core #20 from 72.65' to 73.75'. Cut core #21 from 73.75' to 74.45', recovered 0.5'. Cut core #22 from 74.45' to 76.65', recovered 2.1'. Cut core #23 from 76.65' to 81.65', recovered 4.1'.
- 8-11-79 Measured drill pipe in the hole and corrected depth to 77.65'. Cut core #24 from 77.65' to 82.65', recovered 4.7'. Cut core #25 from 82.65' to 87.65', recovered 4.4'. Cut core #26 from 87.65' to 89.65', recovered 1.4'. Cut core #27 from 89.65' to 92.65', recovered 3.1'. Cut core #28 from 92.65' to 102.65', recovered 9.4'. Cut core #29 from 102.65' to 112.65', recovered 9.7'. Cut core #30 from 112.65' to 122.65'.
- 8-12-79 Rig secured.
- 8-13-79 Recovered 10.1' on core #30. Cut core #31 from 122.65' to 132.15' and lost circulation, recovered 7.1'. Cut core #32 from 132.15' to 137.65', recovered 5.6'. Cut core #33 from 137.65' to 142.65', recovered 5'. Cut core #34 from 142.65' to 147.65', recovered 5.2'. Cut core #35 from 147.65' to 152.65', recovered 5'. Cut core #36 from 152.65' to 157.65', recovered 5.2'. Surface pipe fell, added 1-5' joint of 4-1/2" O.D., 9.50#, J-55 casing. Cut core #37 from 157.65' to 161.75', recovered 3.5'. Cut core #38 from 161.75' to 167.65'. Cored with brine water, no returns.

- 8-14-79 Cut core #39 from 167.65' to 172.65', recovered 5.4'. Cut core #40 from 172.65' to 177.65', recovered 5.3'. Cut core #41 from 177.65' to 182.65', recovered 5.9'. Cut core #42 from 182.65' to 187.65', recovered 4.7'. Cut core #43 from 187.65' to 192.65'. Cut core #44 from 192.65' to 202.65', recovered 9.9'. Cut core #45 from 202.65' to 210.15', recovered 7.8'. Cut core #46 from 210.15' to 212.65', recovered 2.4'. Cut core #47 from 212.65' to 217.65', recovered 5.1'. Cut core #48 from 217.65' to 226.95', recovered 9.6'. Cut core #49 from 226.95' to 228', recovered 0.7'. Cut core #50 from 228' to 232', recovered 3.6'. Cut core #51 from 232' to 242.10', recovered 10.1'. Cut core #52 from 242.10' to 251.10', recovered 9.6'.
- 8-15-79 Cut core #53 from 251.10' to 261.65', recovered 10.3'. Cut core #54 from 261.65' to 271.65', recovered 9.9'. Cut core #55 from 271.65' to 280.15' and hit air pocket. Bled down air and recovered 7.1' of core. Cut core #56 from 280.15' to 290.15', recovered 9.8'. Cut core #57 from 290.15' to 292.65', recovered 2.5'. Cut core #58 from 292.65' to 302.65', recovered 10'. Cut core #59 from 302.65' to 312.65', recovered 10.1'. Cut core #60 from 312.65' to 322.65', recovered 10.1'. Cut core #61 from 322.65' to 332.65', recovered 10'. Cut core #62 from 332.65' to 342.65', recovered 10'. Cut core #63 from 342.65' to 352.65', recovered 10.1'.
- 8-16-79 Made up 6-3/4" hole opener with a 3-7/8" pilot bit on bottom. Reamed hole from 15' to 127' with brine water, no returns.
- 8-17-79 Reamed hole to 6-3/4" from 127' to 248'.
- 8-18-79 Reamed hole to 6-3/4" from 248' to 353' and drilled 6-3/4" hole to 390'. Fluid level at 50'. Mixed mud for logging.
- 8-19-79 Rig secured.
- 8-20-79 Ran Dresser Atlas logs.
- 8-21-79 Ran rods in the hole to 390' and displaced mud. Plugged back hole using Dowell as follows:

Plug No.	Interval	Cement Used-Ft3	CIP	
1	390' - 275'	79 neat cement + 2% CaCl ₂	0845	Hours
2	275' - 75'	38 RFC cement		
		53 neat cement + 2% CaCl ₂	1130	"
3	75' - 71'	33 "	1400	"
4	71' - 58'	33 "		
8-22-79	58' - 55'	39 RFC cement	0840	"
	55' - 53'	39 "	1000	"
	53' - 51'	39 "	1042	"
	51' - 51'	39 "	1153	"
	51' - 0'	108 Ready mix concrete	1320	"

WIPP #32
HOLE HISTORY
PAGE 3

8-23-79   Moved out rig. Hole plugged. No casing in hole.

LOG INDEX SHEET

<u>TYPE LOG</u>	<u>DATE</u>	<u>RUN NO</u>	<u>DEPTH DRILLER</u>	<u>DEPTH LOGGER</u>	<u>LOGGED</u>	
					<u>FROM</u>	<u>TO</u>
<u>DRESSER ATLAS</u>						
Acoustilog, BHC	8-20-79	1	390	391	0	383
Densilog, Compensated	8-20-79	1	390	391	0	389
Gamma Ray Neutron	8-20-79	1	390	391	0	389
Micro-Laterolog	8-20-79	1	390	391	0	388
Dual Laterolog	8-20-79	1	390	391	0	388
Compensated Neutron Gamma	8-20-79	1	390	391	7	389

NOTE: Logs furnished F&S/Mercury.

PROPOSED DRILL HOLE LOCATION

B.P. SECONDARY(W.I.P.P. 32)

SECTION 33, TOWNSHIP 22 S, RANGE 29 E N.M.P.M.

EDDY COUNTY, NEW MEXICO

GROUND ELEVATION 3020.3'

1677' FSL & 29' FEL

CERTIFICATION

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

Dan R. Roddy
Dan R. Roddy
New Mexico P.E. #5412

3/19/79
Date

WIPP 32

SE 1/4 Sec 33 T22S R29E

APPENDIX D

LOGS

compiled by

S-E. Shaffer
Division 4511
Sandia Laboratories

WIPP 32 Logs¹

Log	Company	ELSI# ²	Top of Logged Interval ³ (feet)	Bottom Logged Interval (feet)	Date
Micro-Laterolog	Dresser Atlas	W9264X	Surf.	388	8/20/79
BHC Acoustilog	Dresser Atlas	W9263Z	Surf.	383	8/20/79
Densilog	Dresser Atlas	W9264S	Surf.	389	8/20/79
Compensated Neu- tron/Gamma Ray	Dresser Atlas	W9264Y	7	389	8/20/79
Dual Laterolog	Dresser Atlas	W9264W	Surf.	388	8/20/79
Gamma Ray/ Neutron	Dresser Atlas	W9263Y	Surf.	389	8/20/79

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

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

³Depths measured from ground surface; elevation officially 3023.26' above MSL.

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