SANDIA REPORT SAND81-2643 • Unlimited Release • UC-70
Printed November 1981

Basic Data Report for Drillhole WIPP 34 (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

TABLE OF CONTENTS

		Page
1.0	ABSTRACT	1
2.0	INTRODUCTION	1
2.1	Purpose of WIPP	1
2.2	Purpose of Borehole WIPP 34 by R. P. Snyder, USGS, and S. L. Drellack, Jr., F&S	3
3.1	Abstract	3
3.2	Introduction	3
3.3	Description of WIPP 34	6
4.0	HYDROLOGICAL DATA	51
5.0	REMARKS	51
6.0	BIBLIOGRAPHY	52

APPENDICES

A. Justification
by D. W. Powers, 4511

B. Drilling and Testing Plan
compiled by R. D. Statler, 1133 and
P. D. Seward, 1135

C. Hole History
compiled by R. D. Statler, 1133 and
P. D. Seward, 1135

D. Logs
compiled by S-E Shaffer, 4511

1.0 ABSTRACT

Borehole WIPP 34 was drilled to investigate a structural low in an area about 2-1/2 miles north of the center of the WIPP site. The borehole is located in Section 9, T22S, R31E, in east-central Eddy County, New Mexico, and was drilled during August and September 1979. The hole was drilled to a depth of 1,820 feet, and encountered from top to bottom, surficial Holocene deposits (10', including artificial fill for drill pad), the Santa Rosa Sandstone (144'), the Dewey Lake Red Beds (503'), the Rustler Formation (316'), and the Salado Formation (847'). Cuttings and cores were taken at selected intervals. Geophysical logs were run for the entire length of the hole. The structural low was verified by data from WIPP 34, however it was not apparently caused by dissolution of halite.

2.0 INTRODUCTION

The introduction describes background information on the Waste Isolation Pilot Plant (WIPP) and the investigation at WIPP 34.

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.

2.2 The Purpose of Borehole WIPP 34

WIPP 34 was drilled to establish the reason for the structural low found by exploration work. The records provided to the U.S. Geological Survey by various potash operators were used in conjunction with drilling for the WIPP project to produce structure contour and isopach maps (e.g., Griswold, 1977; Powers, et al, 1978). These maps, particularly the structure map of Marker Bed 124, indicate a structural low in the vicinity of FC-92, an industry potash testhole two miles north of ERDA 9. Though the structural low at FC-92 indicated closure of only 50 feet, Anderson (1978) pointed out the approximate alignment of this low with Bell Lake and Slick Sink. He postulated a fault or fracture along this trend and speculated that dissolution along this trend is the origin of the low. Since then, it has been speculated that a nascent breccia pipe caused the FC-92 low. Structure contour maps of upper Salado and Rustler Formations were examined by the U.S. Geological Survey and Sandia National Laboratories; these maps indicated a broader low over much of Section 9 (T22S, R.31E). The borehole location was ultimately chosen about 2000' east of FC-92 to test for structure and its possible causes nearer the center of the apparent structural low. A direct retest of FC-92 was not considered necessary; the original drilling did not indicate breccia. The location was chosen to test the implications of a broader low which corresponded to a part of the "disturbed zone" (Powers, et al, 1978). The borehole test was planned to permit later deepening into the Castile if desired.

3.0 GEOLOGIC DATA FOR BOREHOLE WIPP 34

by

R.P. Snyder[1] and S.L. Drellack, Jr.[2]

3.1 Abstract

Exploration work at the WIPP site in southeastern New Mexico identified a structural low (closure of about 20-40 feet) in an area centered about 2-1/2 miles north of the center of the site. Borehole WIPP 34 was drilled to establish the reason for the low. The hole was drilled and cored to a depth of 1,820 feet below a surface elevation of 3,432.7 feet. The evaporite section in this area includes halite units in the Rustler Formation of Permian age, and there is evidence from other holes that these units, as well as some of the halite at the top of the underlying Salado Formation (Permian), are missing because of dissolution. Borehole WIPP 34 penetrated through the lower unnamed member of the Rustler and into the underlying Salado Formation. No indication of dissolution was found in the lower member or at the top of the Salado Formation.

3.2 Introduction

Borehole WIPP 34 was drilled in the east-central part of Eddy County, NM, on the WIPP site, about 2 miles north and 2000 feet east of the center of the site (Fig. 1). The purpose of the hole was to investigate a structural low which was defined by structure maps drawn on various horizons in the Rustler and Salado Formation of Permian age.

---

[1]U.S. Geological Survey, Denver, CO.

[2]Fenix & Scisson, Inc., Carlsbad, NM.

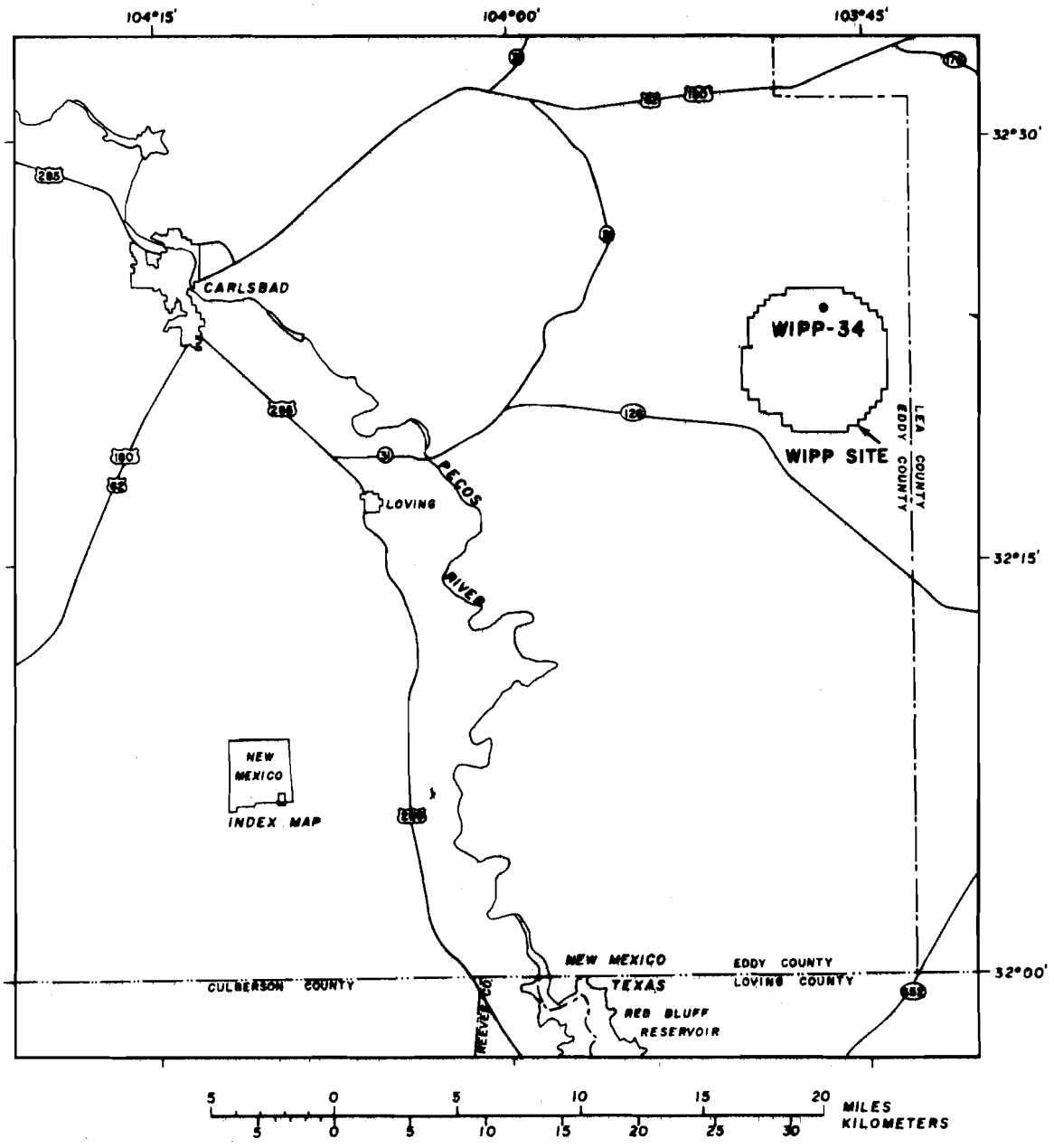


Figure 1. Index map of southeastern New Mexico showing WIPP site and location of borehole WIPP 34.

Solution of halite in the Rustler Formation was the principal target of the investigation. The borehole was drilled to a depth of 1,820 feet. his depth is below the lowest halite in the Rustler and evidence of dissolution would be seen if present. The normal stratigraphic section of the Rustler (Jones, 1973) contains halite above and below the two dolomite marker beds (Magenta and Culebra). The halite in the Rustler at the drill site was missing above the Culebra Dolomite, but was present below the dolomite. This pattern of dissolution is also present in boreholes in the immediate vicinity of WIPP 34. The structural low was verified by the additional data from WIPP 34; however, the low was not caused by dissolution of halite in the Rustler Formation.

To aid in the interpretation of the lithology and as a check on drilling depths, a series of geophysical logs was run. These logs, on Fig. 2, include a gamma-ray log, a neutron log, and a compensated density log. Drilling was done on behalf of the WIPP Project Office of the U.S. Department of Energy (DOE).

All measurements related to the drill site are in English units. These measurements include: the survey to locate the drill hole (both horizontally and vertically); the drilling depth 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 English units. If metric units are desired, the following conversion factors should be used:

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

3.3 Description of WIPP 34

Borehole WIPP 34 is located in eastern Eddy County, NM, in the SE 1/4, SW 1/4, Section 9, T.22S., R.31E. The hole was drilled during August and September 1979 to a depth of 1,820 feet measured from a land surface altitude of 3,432.7 feet above MSL (mean sea level). Table 1 is an abridged borehole history and Table 2 is a stratigraphic summary of the hole. General stratigraphy for the area is summarized elsewhere (Jones, 1973).

WIPP 34 penetrated 10 feet of dune sand and caliche; 144 feet of sandstone and siltstone of the Santa Rosa Sandstone (Triassic); 503 feet of siltstone, claystone, and sandstone of the Dewey Lake Red Beds (Permian); 316 feet of anhydrite, gypsum, siltstone, dolomite, and halite of the Rustler Formation (Permian), and 847 feet of halite, anhydrite, and polyhalite of the Salado Formation (Permian). The base of the Salado Formation was not reached.

The halite units above the Magenta and Culebra Dolomite Members of the Rustler Formation have been removed by dissolution but the halite below the Culebra is still present. This pattern of dissolution is present in nearby drillholes and reflects only the present progress of the dissolution front present in the Rustler Formation as the front moves from west to east across the WIPP site. No dissolution of halite was seen in the core below the Culebra Dolomite Member of the Rustler or in the Salado Formation to the total depth of the hole.

In drilling WIPP 34, a rock bit was used to a depth of 632 feet and cuttings were collected at 10-foot intervals. Core was continuously taken from a depth of 632 to 1,795 feet (except for 2-foot interval at

657 feet), and cuttings were collected at 10-foot intervals from 1,795 to 1,820 feet (TD). Descriptions of cuttings and core were prepared at the site by J.L. Gonzales, S.L. Drellack, Jr., and A.F. McIntyre of Fenix & Scisson, Inc., and R.P. Snyder of the U.S. Geological Survey (USGS). Identification of rock units was made in collaboration with C.L. Jones of the USGS.

The geophysical logs run in the borehole by Dresser Atlas included a gamma-ray curve that recorded variations in potassium and other radioactive elements, a neutron curve that recorded variations in the distribution of hydrogen, and a density log that measured densities of the rock types. These logs are correlated with the geologic section on Fig. 2.

Table 1.--Abridged history of borehole WIPP-34

LOCATION: Sec. 9, T. 22 S., R. 31 E.
201.78 feet from south line
1,999.73 feet from west line

ALTITUDE (LAND SURFACE): 3,433 feet, datum for depth measurements in drilling and logging operations. Actual surveyed elevation is 3,432.7 feet

LITHOLOGIC LOG PREPARED BY: S. L. Drellack, Jr., J. L. Gonzales, C. L. Jones, A. F. McIntyre, and R. P. Snyder

DRILLING CONTRACTOR: Pennsylvania Drilling Company

DRILLING RECORD: Commenced drilling on August 16, 1979, and completed on September 1, 1979, at 1,820 feet below land surface.

After completion of drilling the hole was filled with brine-based mud.

Core No.	Depth interval, in feet[1]	RPM	Weight on bit (lbs)	Circulating pressure (lbs/in^2)	Interval Feet cored	Interval Feet recovered	Percent recovered
1	627.0- 636.0	120	12,000	50	9.0	7.6	84
2	636.0- 645.0	120	12,000	50	9.0	7.8	87
3	645.0- 654.0	120	12,000	50	9.0	8.0	89
4	656.0- 662.0	100	6,000	50	6.0	6.1	102
5	662.0- 672.0	120	6,000	75	10.0	9.9	99
6	672.0- 682.0	100	6,000	75	10.0	10.0	100
7	682.0- 692.0	100	5,000	150	10.0	7.3	73
8	692.0- 702.0	100	5,000	150	10.0	8.9	89
9	[2]702.0- 712.0	100	5,000	150	10.3	10.3	100
10	712.0- 722.0	100	5,000	150	10.0	9.4	94
11	722.0- 732.0	100	5,000	150	10.0	10.0	100
12	732.0- 742.0	100	5,000	150	10.0	10.1	101
13	742.0- 752.0	100	5,000	150	10.0	10.0	100
14	752.0- 762.0	120	5,000	150	10.0	9.9	99
15	762.0- 772.0	120	5,000	150	10.0	10.2	102
16	772.0- 782.0	120	5,000	150	10.0	10.0	100
17	782.0- 792.0	120	5,000	150	10.0	10.1	101
18	792.0- 802.0	120	5,000	150	10.0	9.9	99
19	802.0- 807.7	120	5,000	150	5.7	5.7	100
20	807.7- 817.0	120	5,000	150	9.3	9.2	99
21	817.0- 822.0	120	6,000	150	5.0	5.2	104
22	822.0- 832.0	120	6,000	75	10.0	10.1	101
23	832.0- 842.0	120	6,000	75	10.0	4.4	44
24	842.0- 852.0	120	4,000	50	10.0	0.4	4
25	852.0- 857.0	130	6,000	50	5.0	0.6	12
26	857.0- 858.0	120	6,000	50	1.0	0.2	20
27	858.0- 862.0	120	6,000	50	4.0	0.8	20
28	862.0- 867.0	120	6,000	50	5.0	4.7	94
29	867.0- 877.0	120	6,000	50	10.0	10.0	100
30	877.0- 882.0	120	6,000	50	5.0	5.3	106

Table 1.--Abridged history of borehole WIPP-34--Continued

Core No.	Depth interval, in feet[1]	RPM	Weight on bit (lbs)	Circulating pressure (lbs/in^2)	Interval Feet cored	Interval Feet recovered	Interval Percent recovered
31	882.0- 892.0	120	6,000	50	10.0	9.6	96
32	892.0- 902.0	120	6,000	50-100	10.0	9.9	99
33	902.0- 912.0	120	6,000	50-100	10.0	10.2	102
34	912.0- 922.0	120	6,000	50-100	10.0	10.2	102
35	922.0- 932.0	120	6,000	50-100	10.0	9.9	99
36	932.0- 942.0	120	6,000	50-100	10.0	10.0	100
37	942.0- 944.0	100	5,000	50-100	2.0	2.0	100
38	944.0- 952.0	100	6,000	150	8.0	6.8	85
39	952.0- 962.0	100	6,000	150	10.0	10.0	100
40	962.0- 972.0	120	6,000	50-100	10.0	9.9	99
41	972.0- 982.0	120	6,000	5- 20	10.0	9.8	98
42	982.0- 992.0	120	6,000	5- 20	10.0	10.2	102
43	992.0-1,002.0	100	6,000	50-100	10.0	10.1	101
44	1,002.0-1,013.4	100	6,000	50-100	11.4	11.5	101
45	1,013.4-1,033.4	120	6,000	50-100	20.0	20.3	102
46	1,033.4-1,053.4	100	6,000	50-100	20.0	19.7	99
47	1,053.4-1,073.4	100	6,000	50-100	20.0	20.4	102
48	1,073.4-1,093.4	120	6,000	50-150	20.0	20.2	101
49	1,093.4-1,113.4	120	6,000	50-150	20.0	20.2	101
50	1,113.4-1,133.4	120	6,000	50-150	20.0	20.1	101
51	1,133.4-1,153.4	120	6,000	150	20.0	20.1	101
52	1,153.4-1,173.4	120	6,000	150	20.0	20.3	102
53	1,173.4-1,193.4	120	6,000	150	20.0	20.5	103
54	1,193.4-1,213.4	100	6,000	150	20.0	20.2	101
55	1,213.4-1,233.4	100	6,000	150	20.0	20.3	102
56	1,233.4-1,253.4	100	6,000	150	20.0	20.2	101
57	1,253.4-1,273.4	100	6,000	150	20.0	20.0	100
58	1,273.4-1,293.4	120	6,000	150	20.0	20.1	101
59	1,293.4-1,313.4	120	6,000	150	20.0	20.0	100
60	1,313.4-1,333.4	120	6,000	150	20.0	20.5	103
61	1,333.4-1,353.4	100	6,000	150	20.0	20.4	102
62	1,353.4-1,373.4	100	6,000	150	20.0	20.5	103
63	1,373.4-1,393.4	100	6,000	150	20.0	20.4	102
64	1,393.4-1,413.4	120	6,000	150	20.0	20.4	102
65	1,413.4-1,433.4	120	6,000	150	20.0	17.0	85
66	1,433.4-1,453.4	100	6,000	125	20.0	5.0	25
67	1,453.4-1,473.4	100	6,000	125	20.0	20.2	101
68	1,473.4-1,493.4	120	6,000	150	20.0	20.4	102
69	1,493.4-1,513.4	120	6,000	150	20.0	20.1	101
70	1,513.4-1,533.4	120	6,000	150	20.0	20.1	101
71	1,533.4-1,553.4	120	6,000	150	20.0	18.0	90
72	1,553.4-1,573.4	120	6,000	150	20.0	20.5	103
73	1,573.4-1,593.4	120	6,000	150	20.0	20.1	101
74	1,593.4-1,613.4	120	6,000	150	20.0	20.2	101
75	1,613.4-1,633.4	120	6,000	150	20.0	20.0	100

Table 1.--Abridged history of borehole WIPP-34--Continued

Core No.	Depth interval in feet[1]	RPM	Weight on bit (lbs)	Circulating pressure (lbs/in)	Interval Feet cored	Interval Feet recovered	Percent recovered
76	1,633.4-1,653.4	120	6,000	150	20.0	20.2	101
77	1,653.4-1,673.4	120	6,000	150	20.0	20.0	100
78	1,673.4-1,693.4	100	6,000	150	20.0	20.1	101
79	1,693.4-1,713.4	100	6,000	150	20.0	20.2	101
80	1,713.4-1,733.4	100	6,000	150	20.0	20.5	103
81	1,733.4-1,753.4	100	6,000	150	20.0	20.0	100
82	1,753.4-1,773.4	100	6,000	150	20.0	20.2	101
83	1,773.4-1,793.4	100	6,000	150	20.0	20.2	101

[1]Depths given in this table are from driller's records. Changes in footages in the body of the report have been made to match the lithology to the depths recorded on geophysical logs.

[2]Some discrepancies in core footage matched against depth interval are not resolved in this table. Footage in question is generally very minor (i.e., 0.3 ft).

Table 2.--Stratigraphic summary of borehole WIPP-34

[MB marker bed (anhydrite, polyhalite, or both), depth is base of unit to nearest foot]

Rock unit	Depth interval[1] in feet
Quaternary deposits[2]	0- 11
Triassic rocks	
Santa Rosa Sandstone	11- 154
Permian rocks	
Dewey Lake Red Beds	154- 657
Rustler Formation	657- 973
Magenta Dolomite Member	716- 741
Culebra Dolomite Member	834- 861
Salado Formation	973-1,820+
Upper unit	973-1,437
MB 101	1,092
MB 102	1,122
MB 103	1,148
MB 104	1,158
MB 105	1,173
MB 106	1,191
MB 107	1,228
MB 108	1,237
MB 109	1,280
MB 110	1,317
MB 111	1,326
MB 112	1,344
MB 113	1,366
MB 114	1,396
MB 115	1,420
MB 116	1,430
McNutt potash unit	1,437-1,751
Vaca Triste Sandstone Member[3]	1,437-1,442
MB 117	1,498
MB 118	1,520
MB 119	1,540
MB 120	1,560
MB 121	1,573
MB 122	1,580
Union anhydrite[4]	1,599-1,607
MB 123	1,676
MB 124	1,690
MB 125	---
MB 126	1,751

Table 2.--Stratigraphic summary of borehole WIPP-34--Continued

Rock unit	Depth interval[1] in feet
Lower unit	1,751-1,820+
MB 127	1,768
MB 128	1,775
MB 129	1,785

[1]Depths from density log.

[2]Includes artificial fill for drill pad.

[3]Of Adams, 1944.

[4]Informal unit of Salado Formation.

Table 3.--Lithologic log of boehole WIPP-34

[Color designations are from the Rock-Color Chart (Goddard and others, 1948); no core designates intervals where core was lost during drilling operations. From 1,433.2-1,453.4 feet, pulled inner barrel from drill hole without retaining "shoe" on bottom of barrel. Core strung out the length of the drill pipe. Lithology reconstructed from geophysical logs and drilling time log]

Lithologic description	Depth in feet	
No sample	0-	5.0
Sand (90 percent), moderate-reddish-brown (10R 6/6), fine- to medium-grained, unconsolidated; caliche (10 percent), grayish-orange-pink (10R 8/2) to white (N9)	5.0-	30.0
Sand (70 pecent), pale-reddish-brown (10R 5/4) to dark-reddish-brown (10R 2/3), very fine to fine-grained, unconsolidated, rounded to subrounded; silt (20 percent) pale-reddish-brown (10R 5/4) to dark-reddish-brown (10R 3/4) poorly consolidated; caliche (10 percent) as in unit at 5-30 feet	30.0-	45.0
No cuttings	45.0-	60.0
Sandstone (90 percent), grayish-red (5R 4/2) to dark-reddish-brown (10R 3/4), fine-grained, poorly consolidated, rounded to subrounded; caliche (10 percent) same as in unit at 5-30 feet	60.0-	95.0
Siltstone (60 percent), grayish-red, (5R 4/2) to dark-reddish-brown (10R 3/4), poorly consolidated; sandstone (40 percent), grayish-red (5R 4/2) to dark-reddish-brown (10R 3/4), very fine grained; trace of gray (5G 6/1) silt and grayish-orange-pink (10R 8/2) caliche	95.0-	120.0
Sandstone (95 percent), grayish-red (5R 4/2) to dark-reddish-brown (10R 3/4), friable, very fine grained; caliche (5 percent), same as unit at 5-30 feet; trace of siltstone	120.0-	145.0
Siltstone, grayish-red (5R 4/2) to dark-reddish-brown		

(10R 3/4); trace of caliche and sandstone.....	145.0-	265.0
Siltstone (80 percent), same as unit at 145-265 feet; mudstone (20 percent), dark-reddish-brown (10R 3/4).....	265.0-	290.0
Siltstone (90 percent), dark-reddish-brown (10R 3/4) to grayish-red (10R 4/2), well-cemented; selenite (10 percent), transparent to translucent, fibrous.....	290.0-	410.0
Siltstone (80 percent), same as unit at 290-410 feet; sandstone (10 percent), grayish-red (10R 4/2), very fine grained; selenite (10 percent), same as unit at 290-410 feet.....	410.0-	445.0
Siltstone, same as unit at 290-410 feet; trace of selenite.....	445.0-	520.0
Siltstone (95 percent), same as unit at 290-410 feet; selenite (5 percent).....	520.0-	550.0
Siltstone (60 percent), same as unit at 290-410 feet; sandstone (40 percent), grayish-red (5R 4/2), very fine grained; trace of selenite.....	550.0-	590.0
Siltstone, grayish-red (10R 4/2) to dark-reddish-brown (10R 3/4), well-cemented; trace of chalky to transparent and translucent selenite.....	590.0-	631.7
Siltstone, moderate-reddish-brown (10R 4/6), very fine grained, indurated; numerous translucent to transparent, wavy selenite veinlets dipping 0^{o} to 13^{o} ; numerous greenish-gray (5G 6/1) to pale-green (10G 6/2) reduction spots 1 mm-1 cm in diameter, a few as large as 4 cm; selenite vein at 635.9 feet.....	631.7-	638.3
No core.....	638.3-	639.7
Siltstone, same as unit at 631.7-638.3 feet; very numerous 1-4 mm thick selenite veinlets in complex interconnecting network; two parallel veins, 1-3 mm thick dipping 63^{o} and 72^{o}; translucent to transparent selenite at 639.6 and 640.4 ft.....	639.7-	647.5
No core.....	647.5-	649.7
Siltstone, same as unit at 639.7 to 647.5 feet; contact with unit below irregular and has 1-cm-thick band of greenish-gray (5G 6/1) fissile		

mudstone	649.7-	657.0
Rock bit, no core	657.0-	659.0
Anhydrite, dark-yellowish-brown (10YR 4/2) mottled with dusky-yellowish-brown (10YR 2/2), very finely crystalline, faintly laminated; wavy bands of gypsum 1-4 mm thick from 661.6 to 664.1 feet, 2 cm thick gypsum bands at 662.6, 663.3, 677.3, 678.5, and 679.8 feet; unit becomes gypsiferous in bottom 1.3 feet	659.0-	683.7
Gypsum, dark-yellowish-brown (10YR 4/2), very fine to finely crystalline; moderate-brown (5YR 3/4), and dark-reddish-brown (10R 3/4) argillaceous laminae; remnant anhydrite, dark-yellowish-brown (10YR 4/2) and medium-light-gray (N6) through unit	683.7-	684.7
Gypsum, dark-yellowish-brown (10YR 4/2) finely crystalline, argillaceous laminae in upper foot; rock becomes dusky yellowish brown (10YR 2/2) in lower foot	684.7-	686.7
Mudstone, moderate-brown (5YR 3/4) with dark-reddish-brown (10R 3/4) tint, silty, indurated; greenish-gray (5GY 6/1) reduction spots at 686.7-687.7 feet and mudstone inclusions and bands at 687.6-689.3 feet	686.7-	691.0
No core	691.0-	693.7
Mudstone, same as unit at 686.7-691.0 feet	693.7-	695.1
Siltstone, moderate-brown (5YR 3/4) with dark-reddish-brown (10R 3/4) tint, indurated, upper 0.3 foot mottled greenish gray (5G 6/1)	695.1-	696.2
Mudstone, greenish-gray (5G 6/1) to dark-greenish-gray (5GY 4/1), indurated, silty in lower half; trace of pyrite and chalky, white (N9) gypsum at 697.0 feet; upper and lower contacts		

gradational	696.2-	697.1
Gypsum, dusky-yellowish-brown (10YR 2/2), finely crystalline, mottled and laminated, matrix contains dark-greenish-gray (5GY 4/1) clay at 697.4-698.3 feet	697.1-	699.1
Anhydrite, light-gray (N7) and dark-yellowish-brown (10YR 4/2), dense, minor argillaceous laminae, minor light-olive-gray (5Y 6/1) gypsiferous laminae, some "chicken-wire" and nodular texture	699.1-	702.6
No core	702.6-	703.7
Anhydrite, same as unit at 699.1-702.6 feet	703.7-	709.7
Gypsiferous anhydrite, alternating bands and laminae of light-gray (N7) and dark-yellowish-brown (10YR 4/2), dense, nodular, and "chicken-wire" appearance; a few argillaceous laminae	709.7-	714.0
Gypsum, olive-gray (5Y 4/1), laminated and mottled with olive-black (5Y 2/1), very fine to finely crystalline	714.0-	715.8
Dolomite, light-olive-gray (5Y 6/1), very finely crystalline; numerous blebs of gypsum, 1-3 mm in diameter and gypsum veinlets 1-3 mm thick; minor laminations and 1-2 cm thick beds	715.8-	717.2
Dolomite, light-olive-gray (5Y 6/1), light-gray (5Y 4/1), and olive-black (5Y 2/1); prominent small-scale crossbedding, very thin to thinly bedded; numerous 1-3 mm blebs of white (N9) gypsum; horizontal, 1-3 mm thick translucent to transparent gypsum veins at 717.2 and 717.4 feet	717.2-	723.4
No core	723.4-	723.6
Dolomite, same as unit at 717.2-723.4 feet	723.6-	733.6
Dolomite, colors the same as in unit at 717.2-		

723.4 feet, unit is laminated instead of very thinly bedded; contact with underlying gypsum is wavy 733.6- 740.9

Gypsum, olive-gray (5Y 4/1) and olive-black (5Y 2/1), very fine to finely crystalline; numerous wavy, irregular light-olive-gray (5Y 6/1) dolomite laminae 740.9- 743.7

Anhydrite, olive-gray (5Y 4/1) and olive-black (5Y 2/1) grading downward to medium-light-gray (N7) and dark- to dusky-yellowish-brown (10YR 4/2 to 10YR 2/2), very finely crystalline, minor dolomite bands in upper 1.3 feet; mottled appearance, with "chicken-wire" texture; 1.5 cm thick horizontal selenite vein at 768.4 feet 743.7- 778.0

Gypsiferous anhydrite, dusky-yellowish-brown (10YR 4/2) and olive-gray (5Y 4/1) with pale-olive (10Y 6/2) banding; gypsum and clay seam 2 cm thick at 779.2 feet 778.0- 786.7

Gypsum, grayish-olive (10Y 4/2) and dark-yellowish-brown (10YR 4/2), coarsely crystalline; pale-olive (10Y 6/2) wavy laminae increasing downward from 791.2 to 794.5 feet; few scattered 1-2 cm thick anhydrite bands in lower 2 feet 786.7- 796.5

Gypsum, medium-gray (N5) to medium-dark-gray (N4), minor pale-olive (10Y 6/2), very finely crystalline; slightly argillaceous; numerous rehealed fractures 1-4 mm thick; aggregate of argillaceous gypsum and selenite crystals between 801.2 and 803.5 feet 796.5- 804.1

Gysum, medium-light-gray (N6) and dark-greenish-gray (5GY 4/1), finely to medium-crystalline, argillaceous; laminae and thin bands of light-olive-gray (5Y 6/1) and dark-greenish-gray (5GY 4/1) gypsum;

numerous randomly oriented rehealed fractures; a 23 cm thick gypsiferous clay parting, medium-gray (N5) at 808.6 feet; medium-light-gray (N6) contorted laminated dolomitic siltstone band at 808.7-809.0 feet; gypsum banding near bottom of unit dips 20° 804.1- 809.8

Gypsum, olive-gray (5Y 4/1) to light-olive-gray (5Y 6/1), very finely crystalline; zone of recrystallized medium to coarse blotches of gypsum, translucent to transparent at 810.2-810.4 feet 809.8- 810.4

Clay, greenish-gray (5G 6/1), soft; numerous very irregular bands and blebs of gypsum, chalky white (N9) and olive-black (5Y 2/1) 810.4- 810.6

Clay, moderate-reddish-brown (10R 4/6) to dark-reddish-brown (10R 3/4), soft; chalky white (N9) gypsum as thin irregular bands and blebs; transparent to translucent gypsum crystals as blades and rosettes; 1-5 mm blebs of greenish-gray (5G 6/1) clay at 812.0, 812.9, to 814.7 and 818.0 to 818.2 feet; mottled argillaceous, white (N9) and olive-black (5Y 2/1) gypsum bands 2-3 cm thick at 813.6 feet dip 51°; 6-7 cm thick gypsum bands at 814.3 feet are horizontal as are 3-4 cm thick bands at 817.6-817.8 feet 810.6- 818.2

Gypsum, olive-black (5Y 2/1) to greenish-black (5GY 2/1), minor amount of medium-light-gray (N6), finely to medium-crystalline 818.2- 821.0

Gypsiferous anhydrite, medium-light-gray (N6), minor light-bluish-gray (5B 7/1) and light-olive-gray (5Y 6/1), minor mottling and blebs 821.0- 824.2

Gypsum, olive-black (5Y 2/1) to olive-gray (5Y 4/1); numerous small medium-light-gray (N6)

anhydrite blebs; few very thin stringers and blebs of moderate-red (5R 4/6) gypsum; dusky-brown (5YR 2/2) siltstone band 6 cm thick at 824.8 feet 824.2- 825.9

Gypsiferous anhydrite, same as unit at 821.0-824.2 feet 825.9- 827.4

Gypsum, olive-black (5Y 2/1) to dusky-yellowish-brown (10YR 2/2), finely to medium-crystalline, mottled argillaceous, dusky-brown (5YR 2/2) in portions of unit; few thin wavy laminae 827.4- 828.1

Gypsiferous anhydrite, dusky-yellowish-brown (10YR 2/2), dark-yellowish-brown (10YR 4/2), olive-gray (5Y 4/1), and medium-light-gray (N6), mottled, faint laminae, some argillaceous 828.1- 829.7

Anhydrite, olive-black (5Y 2/1) to olive-gray (5Y 4/1); rehealed fractures dip 43°-80°..... 829.7- 832.8

Gypsum, olive-black (5Y 2/1) to dusky-yellowish-brown (10YR 2/2), finely crystalline, mottled, wavy laminae, some argillaceous, dipping as much as 6°..... 832.8- 834.2

Argillaceous dolomite, light-olive-gray (5Y 6/1) to dark-yellowish-brown (5YR 3/4) and grayish-brown (5YR 3/2) dip 32°..... 834.2- 834.3

Dolomite, moderate-yellowish-brown (10YR 5/4) and light-brown (5YR 5/6), argillaceous; thin wavy laminae dip 72°; few laminae of light-olive-gray (5Y 6/1), very finely crystalline dolomite 1-4 mm thick 834.3- 834.8

Dolomite, light-olive-gray (5Y 6/1), very finely crystalline, pitted, few horizontal bands as thick as 3 cm of argillaceous dolomite; thin horizontal laminae of dusky-yellowish-brown

(10YR 2/2) from 834.8 to 834.9 feet; several open fractures dip 65°-85°; traces of moderate-brown (5YR 4/4) clay coating on some fracture surfaces; 1-2 mm diameter pits throughout unit but concentrated in 838.0-838.7 feet interval, few pits as large as 3 cm 834.8- 838.7

No core 838.7- 844.0

Dolomite, same as unit at 834.8-838.7 feet 844.0- 844.4

No core 844.4- 854.0

Dolomite, same as unit at 834.8-838.7 feet, highly fractured, dark-yellowish-orange (10YR 6/6) stain on one fracture surface 854.0- 854.6

No core 854.6- 859.0

Dolomite, same as unit at 834.3-838.7 feet 859.0- 859.2

No core 859.2- 860.0

Dolomite, light-olive-gray (5Y 6/1) to olive-gray (5Y 4/1), highly fractured 860.0- 860.8

No core 860.8- 864.3

Mudstone, dark-reddish-brown (10R 3/4), soft but firm; contains numerous 1-4 mm rounded gypsum fragments; 0.5-1 foot gypsum fragment at 867.6-868.1 feet; dark-gray (N3) mud marbled through unit 864.3- 869.0

Gypsiferous anhydrite and gypsum, moderate-red (5R 5/4) to pale-reddish-brown (10R 5/4) mostly very finely crystalline but some scattered 2-5 mm crystals of gypsum, very argillaceous dark-reddish-brown (10R 3/4) in upper 5 cm; remnant anhydrite in irregular masses 869.0- 870.0

Anhydrite, medium-light-gray (N6), very finely crystalline, faintly and sparsely laminated with moderate-reddish-brown (10R 4/6) and pale-olive (10Y 6/2) argillaceous laminae,

laminae concentrated in 875.4-876.2 feet interval; scattered coarsely crystalline gypsum bands, one band 6 cm thick at 871.5 feet and one 3 cm thick band at 871.8 feet	870.0-	877.0
Siltstone, grayish-green (10GY 5/2), contains 5 mm to 4 cm irregular masses of gypsiferous anhydrite	877.0-	877.5
Siltstone, dark-reddish-brown (10R 3/4), well consolidated	877.5-	877.9
Halite, translucent to transparent, finely crystalline, very argillaceous, dark-reddish-brown (10R 3/4) clay; minor patches of greenish-gray (10GY 5/2) clay; minor small masses of anhydrite	877.9-	884.3
Halite, translucent to transparent, medium- to very coarsely crystalline; prominent irregular bands of siltstone, moderate-reddish-brown (10R 4/6) 1-6 cm thick; same color interstitial clay in halite	884.3-	886.4
Halite, same as unit at 884.3-886.4 feet, but medium- to coarsely crystalline, and contains small patches of moderate-reddish-brown (10R 4/6) siltstone	886.4-	889.1
Anhydrite, very light gray (N7) to medium-gray (N5), numerous halite crystals	889.1-	890.0
Halite, same as unit at 886.4-889.1 feet	890.0-	890.6
Halite, translucent to transparent, minor amount of moderate-reddish-brown (10R 4/6) clay and stringers and blebs of very light gray (N8) to light-gray (N7) anhydrite; minor moderate-reddish-orange (10R 6/6) potash mineral	890.6-	893.9
Anhydrite, same as unit at 889.1-890.0 feet	893.9-	894.3
Anhydritic siltstone, grayish-red (10R 4/2) to		

dark-reddish-brown (10R 3/4)	894.3-	895.4
Siltstone, dark-reddish-brown (10R 3/4), few blebs and stringers of halite	895.4-	897.6
Siltstone, dark-reddish-brown (10R 3/4), very halitic, minor reddish-orange (10R 6/6) polyhalite blebs	897.6-	912.1
Siltstone, moderate-reddish-brown (10R 4/6) laminated with medium-bluish-gray (5B 5/1), medium-light-gray (N6), grayish-red (10R 4/2), greenish-gray (5GY 4/1), and dark-greenish-gray (5GY 4/1); horizontal wavy laminae; minor halite blebs and bands in upper 1.3 feet; gypsiferous in gray and blue sections 1 mm to 6 cm thick	912.1-	918.1
Sandstone, moderate-reddish-brown (10R 4/6), very fine grained, well-indurated, laminated and banded with greenish-gray (5GY 6/1) and moderate-brown (5YR 3/4); minor inclusions of white (N9) to light-gray (N7) gypsum; few healed fractures 1-2 mm wide dipping 45°-90° filled with moderate-reddish-brown (10R 4/6) siltstone and clear halite	918.1-	929.1
Siltstone, olive-gray (5Y 4/1), light-olive-gray (5Y 6/1), and pale-brown (5YR 5/2), laminated and banded; small-scale crossbedding; clear halite filled fractures 6 cm wide from 929.6 to 933.4 feet dipping 65°-90°, halite engulfs angular fragments of siltstone and crystals oriented at right angle to fracture planes	929.1-	933.6
Siltstone, olive-black (5Y 2/1) to greenish-black (5GY 2/1), well-indurated, laminated, some small-scale crossbedding; discontinuous fractures healed with moderate-brown (5YR 3/4) siltstone; small		

gypsum inclusions scattered in upper 4.7 feet, unit grades to mudstone in several places; lower 4 feet highly fractured	933.6-	952.9
No core	952.9-	954.0
Siltstone, same as unit at 933.6-952.9 feet; clear halite filled fracture at 959.0 feet dips 60°	954.0-	964.0
Siltstone, medium-gray (N5) to medium-dark-gray (N4) and minor medium-bluish-gray (5B 5/1), well-indurated, open fracture at 964.2 feet dips 49°, halite healed fracture at 957.8 feet dips 66°; grayish-black (N2) contorted laminae at 968.0 to 968.8 feet	964.0-	968.8
Siltstone, dark-reddish-brown (10R 3/4), well-indurated; fracture dipping 78° healed with gypsum and halite at 969.9 feet; gypsiferous siltstone medium-light-gray (N6) to grayish-blue (5PB 5/2) in lower 0.1 foot	968.8-	970.1
Anhydrite, medium-light-gray (N6) to grayish-blue (5PB 5/2), very finely crystalline; thin band of light-red (5R 6/6) polyhalite at 970.4 feet, thin band of dark-reddish-brown (10R 3/4) siltstone at 970.6 feet; laminae of siltstone in lower 0.5 foot	970.1-	971.0
Siltstone, moderate-reddish-brown (10R 4/6) to grayish-red (10R 4/2), well-indurated; numerous blebs of halite, minor small blebs of [illegible]erate-red (5R 4/6) potash mineral; patches of greenish-gray (5G[illegible]/1) siltstone 1-6 mm in length, 1 cm thick band of anhydrite near top of unit	971.0-	972.4
Halite, very coarsely crystalline; very argillaceous, moderate-reddish-brown (10R 4/6); numerous moderate-red (5R 4/6) polyhalite blebs	972.4-	977.5
Siltstone, moderate-reddish-brown (10R 4/6), halitic, numerous medium-gray (N5) clay blebs	977.5-	978.0
Halite, same as unit at 972.4-977.5 feet but medium-		

crystalline	978.0-	981.0
Halite, moderate-reddish-orange (10R 6/6), polyhalitic, minor stringers of very light gray (N7) anhydrite	981.0-	983.3
Halite, translucent to transparent, medium-crystalline; numerous stringers and blebs of white (N9) potash mineral	983.3-	984.9
Potash mineral, white (N9) and moderate-pink (5R 7/4), porous; cavities filled with halite	984.9-	985.4
Silt, reddish-orange (10R 6/6), poorly consolidated	985.4-	985.6
Halite, translucent to transparent, finely crystalline; numerous blebs of moderate-red (5R 4/6) polyhalite	985.6-	985.9
Halite, moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline; small blebs and stringers of polyhalite and light-gray (N7) anhydrite decreasing downward to 994.9 feet; numerous leached areas; very polyhalitic in lower 0.8 foot	985.9-	995.7
Halitic siltstone and argillaceous halite, moderate-reddish-brown (10R 4/6) and dark-reddish-brown (10R 3/4), halite is finely crystalline; small blebs and stringers of polyhalite and anhydrite	995.7-	997.3
Halite, moderate-reddish-orange (10R 6/6), medium-crystalline, polyhalitic from 997.3 to 998.5 and 999.0 to 999.6 feet, argillaceous from 998.5 to 999.0, moderate- to dark-reddish-brown (10R 4/6 to 10R 3/4); minor polyhalite blebs in middle portion; minor stringers of anhydrite, lower 0.1 foot is dark-reddish-brown (10R 3/4) clay seam dipping 14°	997.3-	999.6
Argillaceous halite, same as unit at 995.7-997.3 feet, 3 cm thick greenish-gray (5GY 6/1) mud seam at 1,003.1 feet	999.6-	1,004.0

Halitic siltstone, moderate-reddish-brown (10R 4/6) 3 cm greenish-gray (5GY 6/1) bands at 1,004.0 and 1,004.2 feet; trace of anhydrite blebs.....	1,004.0-1,006.0
Siltstone, moderate-brown (5YR 4/4) and moderate-reddish-brown (10R 4/6); mottled with irregular greenish-gray (5GY 6/1) blotches.....	1,006.0-1,009.3
Halite, moderate-reddish-brown (10R 4/6), medium-crystalline, argillaceous; trace of moderate-red (5R 4/6) to moderate-reddish-brown (10R 4/6) polyhalite at 1,010.1 feet.....	1,009.3-1,010.7
Halite, brown (10R 4/6), moderate-reddish-orange (10R 6/6) and dark-reddish-brown (10R 3/4), medium-crystalline, argillaceous; scattered polyhalite and anhydrite blebs.....	1,010.7-1,020.3
Argillaceous halite, dark-reddish-brown (10R 3/4) to moderate-reddish-brown (10R 4/6), finely to medium-crystalline; few scattered blebs of anhydrite.....	1,020.3-1,023.4
Halite, moderately argillaceous, dark-reddish-brown (10R 3/4), moderate-reddish-brown (10R 4/6) and light-gray (N7), medium- to coarsely crystalline; scattered blebs and stringers of anhydrite; numerous voids as large as 2 cm.....	1,023.4-1,027.7
Halite, translucent to transparent, medium-crystalline, scattered light-gray (N7) anhydrite blebs and stringers; few scattered voids less than 2 cm.....	1,027.7-1,034.3
Argillaceous halite, same as unit at 1,020.3-1,023.4 feet.....	1,034.3-1,042.1
Halite, moderate-reddish-brown (10R 4/6) to pale-reddish-brown (10R 5/4), medium- to coarsely crystalline; argillaceous in scattered intervals, anhydritic in lower 1.0 foot, light-gray (N7).....	1,042.1-1,050.1
Argillaceous halite, same as unit at 1,020.3-	

1,023.4 feet; unit is leached from top to 1,052.0 feet; unit becomes less argillaceous toward bottom	1,050.1-1,060.0
Halite, same as unit at 1,027.7 to 1,034.3 feet	1,060.0-1,065.0
Argillaceous halite, same as unit at 1,050.1-1,060.0 feet	1,065.0-1,067.2
Halite, moderate-reddish-brown (10R 4/6), medium-crystalline, moderately argillaceous, slightly polyhalitic	1,067.2-1,073.1
Argillaceous halite, same as unit at 1,050.1-1,060.0 feet; moderate-reddish-brown (10R 4/6) siltstone at 1,073.6 to 1,074.0 feet	1,073.1-1,075.6
Halite, moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline, polyhalitic; numerous stringers of very light gray (N8) anhydrite; unit is very polyhalitic in lower 0.1 foot; few scattered 2-3 mm voids	1,075.6-1,078.1
Polyhalite; moderate-reddish-orange (10R 6/6); numerous stringers of light-gray (N7) anhydrite	1,078.1-1,078.3
Halite, moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline, heavily polyhalitic, minor amount of moderate-reddish-brown (10R 4/6) silt in lower 0.5 foot	1,078.3-1,079.0
Siltstone, pale-red (10R 6/2) grading downward to moderate-reddish-orange (10R 6/6) and moderate-reddish-brown (10R 4/6); scattered greenish-gray (5GY 6/1) siltstone blebs at 1,083.0 to 1,083.8 feet; numerous fine to medium halite crystals in lower 1.7 feet	1,079.0-1,085.5
Halite, reddish-brown (10R 4/6), finely to medium-crystalline; moderately argillaceous, moderate-reddish-orange (10R 6/6) polyhalite	1,085.5-1,087.3
Polyhalite, moderate-reddish-orange (10R 6/6)	1,087.3-1,087.5

Halite, moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6), medium- to coarsely crystalline; very polyhalitic	1,087.5-1,088.5
Polyhalite, pale-red (10R 6/2) and light-gray (N7); large crystals of transparent halite at 1,089.6 feet	1,088.5-1,090.0
Halite, same as unit at 1,087.5-1,088.5 feet	1,090.0-1,090.5
Halite, translucent to transparent, finely to medium-crystalline; stringers of anhydrite	1,090.5-1,090.7
Polyhalite, pale-red (10R 6/2) and light-gray (N7); numerous crystals and stringers of halite at 1,091.2-1,091.4 and 1,091.6-1,091.8 feet	1,090.7-1,092.0
Halite, same as unit at 1,090.5-1,090.7 feet	1,092.0-1,093.2
Polyhalite, same as unit at 1,088.5-1,090.0 feet	1,093.2-1,093.3
Halite, same as unit at 1,087.5-1,088.5 feet	1,093.3-1,093.7
Halite, same as unit at 1,085.5-1,087.3 feet	1,093.7-1,099.3
Halite, same as unit at 1,087.5-1,088.5 feet	1,099.3-1,103.8
Halite, same as unit at 1,085.5-1,087.3 feet	1,103.8-1,104.7
Halite, same as unit at 1,075.6-1,078.1; unit has fewer anhydrite stringers	1,104.7-1,106.2
Siltstone, same as unit at 1,079.0-1,085.5 feet; irregular horizontal band of greenish-gray (5G 6/1) siltstone at 1,107.8-1,108.0 feet	1,106.2-1,109.9
Halite, moderate-reddish-brown (10R 4/6), medium- to coarsely crystalline; very argillaceous; moderate-reddish-orange (10R 6/6) polyhalite	1,109.9-1,114.6
Halite, moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline, minor disseminated polyhalite; stringers and bands of very light gray (N7) anhydrite, heavy concentration at 1,116.6 feet	1,114.6-1,121.3
Anhydrite, very light gray (N8) to light-gray	

(N7), microcrystalline..... 1,121.3-1,121.5

Polyhalite; moderate-reddish-orange (10R 6/6) to moderate-red (5R 4/6); minor light-gray (N7) anhydrite stringers; greenish-gray (5GY 6/1) clay bands at 1,122.1 and 1,122.3 feet..... 1,121.5-1,122.3

Halite, moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline; moderate amount of disseminated polyhalite; moderate-reddish-brown (10R 4/6) clay from 1,223.0 to 1,223.5 feet..... 1,122.3-1,126.5

Halite, grayish-red (5R 4/2) and moderate-reddish-brown (10R 4/6), finely to medium-crystalline; argillaceous..... 1,126.5-1,129.2

Halite, grayish-brown (10R 4/7), medium-crystalline; argillaceous from 1,130.0 to 1,131.6 feet; scattered blebs and stringers of moderate-reddish-orange (10R 6/6) polyhalite, heavy in lower foot..... 1,129.2-1,132.3

Halite, very pale orange (1YR 8/2); scattered light-gray (N7) anhydrite blebs and stringers in lower half of unit, anhydrite band 1 cm thick near base, finely to medium-crystalline, polyhalitic..... 1,132.3-1,135.1

Anhydrite; slightly gypsiferous, dark-yellowish-brown (10YR 4/2) to olive-gray (5Y 4/1) and light-olive-gray (5Y 5/2) and medium-light-gray (N6), faintly laminated and halitic, some argillaceous laminae from 1,143.0 to 1,146.4 feet..... 1,135.1-1,147.2

Clay, dark-greenish-gray (5GY 4/1), soft; halite healed fracture 1 mm thick dipping 80° through unit..... 1,147.2-1,147.8

Halite, moderate-reddish-brown (10R 4/6) and moderate-reddish-orange (10R 6/6), finely to medium-crystalline, argillaceous; scattered blebs of polyhalite, slightly anhydritic in lower

0.3 foot	1,147.8-1,153.5
Halite, moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline; polyhalitic, stringers of light-gray (N7) anhydrite in lower half, 1 cm thick anhydrite band at 1,156.5 feet	1,153.5-1,156.8
Anhydrite, light-olive-gray (5Y 6/1) to light-gray (N7), dense, slightly halitic	1,156.8-1,157.2
Halite, translucent to transparent, medium-crystalline, very slightly polyhalitic; numerous blebs and stringers of light-gray (N7) anhydrite	1,157.2-1,161.2
Anhydrite, light-gray (N7) to light-olive-gray (5Y 6/1), dense; halite band 1 cm thick in middle of unit	1,161.2-1,161.4
Halite, clear and moderate-reddish-orange (10R 6/6), moderate amount of disseminated polyhalite, minor blebs of light-gray (N7) anhydrite	1,161.4-1,165.8
Halite, moderate-reddish-brown (10R 4/6), finely to medium-crystalline, argillaceous; scattered blebs of moderate-reddish-orange (10R 6/6) polyhalite	1,165.8-1,169.2
Halite, same as unit at 1,161.4 to 1,165.8 feet	1,169.2-1,170.9
Halite, same as unit at 1,147.8 to 1,153.5 feet	1,170.9-1,172.1
Anhydrite, moderate-red (5GY 6/1); greenish-gray (5GY 6/1) clay seam at top of unit	1,172.1-1,172.2
Clay, greenish-gray (5GY 6/1); wavy light-olive-gray (5Y 6/1) anhydrite laminae in lower 0.1 foot	1,172.2-1,172.4
Halite, translucent to transparent, finely to medium-crystalline; numerous stringers and blebs of moderate-reddish-brown (10R 4/6) anhydrite	1,172.4-1,172.8
Anhydrite, same as unit at 1,156.8 to 1,157.2;	

greenish-gray (5GY 6/1) clay seam at base of unit	1,172.8-1,172.9
Clay, moderate-reddish-brown (10R 4/6), halitic	1,172.9-1,173.1
Halite, moderate-reddish-brown (10R 4/6), finely to medium-crystalline, argillaceous; clay seam at 1,173.4 to 1,173.8 feet	1,173.1-1,174.6
Halite, grayish-red (5R 4/2) and moderate-reddish-brown (10R 4/6), medium- to coarsely crystalline, slightly argillaceous	1,174.6-1,178.0
Halite, moderate-reddish-orange (10R 6/6), medium-crystalline; disseminated polyhalite; zones of moderate-reddish-brown (10R 4/6) argillaceous halite; very polyhalitic at 1,179.4-1,179.7 and 1,189.9-1,190.5 feet; moderate-reddish-brown (10R 4/6) clay seam at 1,179.7 feet; moderate-brown (5YR 3/4) clay seam at 1,190.5 feet; 1 cm thick polyhalite band at 1,190.4 feet	1,178.0-1,190.5
Halite, same as unit at 1,147.8-1,153.5 feet	1,190.5-1,192.4
Halite, same as unit at 1,132.3 to 1,135.1 feet	1,192.4-1,194.8
Halite, moderate-reddish-brown (10R 4/6), medium-crystalline, highly argillaceous; many blebs and stringers of moderate-reddish-brown (10R 4/6) and moderate-red (5R 5/4) polyhalite; few scattered voids less than 1 cm in diameter	1,194.8-1,195.8
Polyhalite, pale-red (10R 6/2), very finely crystalline	1,195.8-1,195.9
Clay, dark-reddish-brown (10R 3/4)	1,195.9-1,196.1
Halite, same as unit at 1,194.8 to 1,195.8 feet	1,196.1-1,197.0
Halite, moderate-reddish-brown (10R 4/6), slightly argillaceous, grading downward to polyhalitic, moderate-reddish-orange (10R 6/6)	1,197.0-1,199.4
Halite, same as unit at 1,194.8-1,195.8 feet	1,199.4-1,201.7
Halite, moderate-reddish-orange (10R 6/6), finely	

to medium-crystalline, polyhalitic, slightly argillaceous in lower 1.3 feet	1,201.7-1,206.4
Halite, same as unit at 1,194.8-1,195.8 feet	1,206.4-1,207.9
Halite, same as unit at 1,201.7-1,206.4, medium-crystalline, numerous stringers and blebs of polyhalite; 0.1-foot-thick band of polyhalite at 1,211.1 feet; becomes very polyhalitic in lower 1.8 feet	1,207.9-1,215.2
Argillaceous halite, moderate-reddish-brown (10R 4/6), finely crystalline	1,215.2-1,217.4
Halite, moderate-reddish-brown (10R 4/6), finely to medium-crystalline, argillaceous	1,217.4-1,223.5
Halite, moderate-reddish-orange (10R 6/6), finely to medium-crystalline; disseminated polyhalite blebs and stringers; zones of concentrated polyhalite	1,223.5-1,227.0
Polyhalite, moderate-reddish-orange (10R 4/6), crumbly; traces of light-gray (N7) anhydrite; medium-light-gray (N6) clay filling void in center of unit	1,227.0-1,227.4
Halite, moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline; disseminated polyhalite; medium-reddish-brown (10R 4/6) argillaceous halite at 1,227.4-1,228.9 and 1,229.9-1,231.9 feet; scattered stringers of light-gray (N7) anhydrite	1,227.4-1,231.9
Halite, translucent to transparent, medium-crystalline, minor disseminated moderate-reddish-orange (10R 6/6) polyhalite; heavy concentration of polyhalite in lower 0.8 foot	1,231.9-1,235.7
Polyhalite, moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6), very finely crystalline; halitic; light-gray (N7) clay seam at 1,236.1 feet	1,235.7-1,236.3
Argillaceous halite; same as unit at 1,215.2-	

1,217.4 feet; trace of light-bluish-gray (5B 7/1) clay	1,236.3-1,239.1
Halite, same as unit at 1,227.4-1,231.9 feet	1,239.1-1,245.9
Halite, same as unit at 1,231.9-1,235.7 feet	1,245.9-1,248.5
Halite, same as unit at 1,227.4-1,231.9 feet	1,248.5-1,250.5
Halite, same as unit at 1,231.9-1235.7 feet	1,250.5-1,253.3
Halite, moderate-reddish-orange (10R 6/6), finely to medium-crystalline; large amount of polyhalite	1,253.3-1,254.8
Halite, moderate-reddish-brown (10R 4/6), finely to medium-crystalline, large amounts of argillaceous halite and moderate-reddish-orange (10R 6/6) polyhalite	1,254.8-1,257.0
Anhydrite, light-gray (N7) microcrystalline, small to medium blebs of halite; polyhalite, pale-red (10R 6/2) and moderate-reddish-orange (10R 6/6) in upper 0.3 foot and lower 3.2 feet	1,257.0-1,262.6
Clay, medium-light-gray (N5) to medium-bluish-gray (5B 5/1)	1,262.6-1,262.7
Halite, same as unit at 1,254.8-1,257.0 feet	1,262.7-1,263.4
Halite, same as unit at 1,253.3-1,254.8 feet	1,263.4-1,268.1
Halite, same as unit above, but contains numerous stringers of anhydrite	1,268.1-1,269.5
Anhydrite, light-gray (N7), microcrystalline, numerous blebs of halite	1,269.5-1,269.9
Halite, same as unit at 1,268.1-1,269.5 feet	1,269.9-1,270.4
Anhydrite, same as unit at 1,269.5-1,269.9 feet	1,270.4-1,270.6
Halite, same as unit at 1,268.1-1,269.5 feet; anhydrite seam 0.05 foot thick at 1,271.4 feet	1,270.6-1,272.7
Anhydrite, same as unit at 1,269.5-1,269.9 feet	1,272.7-1,272.9
Halite, same as unit at 1,263.4-1,268.1 feet	1,272.9-1,273.9
Anhydrite, light-olive-gray (5Y 6/1) and light-gray (N7)	1,273.9-1,274.7
Mud, light-olive-gray (5Y 6/1)	1,274.7-1,274.9

Polyhalite, light-olive-gray (5Y 6/1), dense, halitic	1,274.9-1,276.2
Halite, moderate-reddish-orange (10R 6/6), medium-crystalline, polyhalitic; scattered blebs and stringers of light-olive-gray (5Y 6/1) to light-gray (N7) anhydrite	1,276.2-1,277.6
Anhydrite, same as unit at 1,273.9-1,274.7 feet	1,277.6-1,278.0
Polyhalite, same as unit at 1,274.9-1,276.2 feet	1,278.0-1,279.8
Halite, same as unit at 1,276.2-1,277.6 feet	1,279.8-1,281.6
Halite, medium-gray (N5) and olive-gray (5Y 4/1), finely crystalline, argillaceous; few scattered blebs of moderate-reddish-orange (10R 6/6) polyhalite	1,281.6-1,282.1
Halite, moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6), finely to medium-crystalline, polyhalitic	1,282.1-1,287.4
Argillaceous halite, moderate-reddish-brown (10R 4/2) and greenish-gray (5G 6/1), finely crystalline	1,287.4-1,288.0
Halite, moderate-reddish-brown (10R 4/6) and grayish-red (5R 4/2), finely to medium-crystalline, argillaceous	1,288.0-1,289.4
Halite, same as unit at 1,282.1-1,287.4 feet	1,289.4-1,290.3
Argillaceous halite, moderate-reddish-brown (10R 4/6), finely crystalline, clay parting at 1,290.7 feet	1,290.3-1,291.3
Halite, same as unit at 1,288.0-1,289.4 feet	1,291.3-1,293.7
Halite, same as unit at 1,282.1-1,287.4 feet	1,293.7-1,296.9
Halite, same as unit at 1,288.0-1,289.4 feet	1,296.9-1,297.9
Halite, same as unit at 1,282.1-1,287.4 feet	1,297.9-1,300.8
Halite, grayish-red (10R 4/2), medium-crystalline, slightly argillaceous; minor polyhalite, moderate-reddish-orange (10R 6/6)	1,300.8-1,302.3
Halite, moderate-reddish-orange (10R 6/6), medium-crystalline; minor disseminated polyhalite; some	

polyhalite concentrated in 0.2-foot-thick bands; argillacous in portions of lower third of unit..... 1,302.3-1,310.3

Argillaceous halite, same as unit at 1,290.3-1,291.3 feet..... 1,310.3-1,312.7

Halite, moderate-reddish-brown (10R 4/6), medium-crystalline; moderate amounts of clay and moderate-reddish-orange (10R 6/6) polyhalite blebs and stringers..... 1,312.7-1,313.9

Halite, translucent to transparent, coarsely crystalline in portions containing no clay or polyhalite, finely crystalline in portions containing minor concentrations of grayish-red (5R 4/2) clay or heavy concentrations of moderate-reddish-orange (10R 6/6) and moderate-reddish-brown (10R 4/6) polyhalite..... 1,313.9-1,315.8

Polyhalite, moderate-reddish-orange (10R 6/6), dense..... 1,315.8-1,315.9

Halite, same as unit at 1,313.9-1,315.8 feet..... 1,315.9-1,317.4

Polyhalite, same as unit at 1,315.8-1,315.9 feet..... 1,317.4-1,317.6

Halite, medium-light-gray (N6) and light-bluish-gray (5B 7/1), finely to medium-crystalline, very few scattered blebs of moderate-reddish-brown (10R 4/6) polyhalite..... 1,317.6-1,319.3

Halite, translucent to transparent, finely to medium-crystalline; portions contain moderate-reddish-orange (10R 6/6) disseminated polyhalite; scattered stringers and seams of polyhalite..... 1,319.3-1,325.7

Polyhalite, light-gray (N7) and light-olive-gray (5Y 6/1), dense..... 1,325.7-1,326.0

Halite, same as unit at 1,319.3-1,325.7 feet..... 1,326.0-1,330.1

Halite, moderate-reddish-brown (10R 4/6), finely to medium-crystalline, grading downward to medium crystalline; argillaceous, minor amounts of light-

gray (N7) and medium-light-gray (N6); moderate reddish-brown (10R 4/6) clay band 0.3 foot thick at 1,331.4 feet	1,330.1-1,334.1
Halite, transparent to translucent, finely to medium-crystalline; moderate amount of light-gray (N7) clay	1,334.1-1,334.9
Halite, alternating bands as thick as 0.8 foot of moderate-reddish-brown (10R 4/6) and moderate-reddish-orange (10R 6/6) with light-gray (N7) clay, finely to medium-crystalline	1,334.9-1,339.8
Halite, moderate-reddish-orange (10R 6/6) and moderate-reddish-brown (10R 4/6), medium- to coarsely crystalline; disseminated polyhalite, heavy concentration of polyhalite in lower 0.3 foot	1,339.8-1,341.1
Polyhalite, moderate-reddish-orange (10R 6/6) and moderate-reddish-brown (10R 4/6), dense, slightly halitic in upper 0.2 foot	1,341.1-1,342.5
Halite, transparent, coarsely crystalline; disseminated polyhalite, moderate-reddish-orange (10R 6/6)	1,342.5-1,343.0
Polyhalite, same as unit at 1,341.1-1,342.5 feet, medium-light-gray (N7) clay seam at base	1,343.0-1,343.2
Halite, medium-crystalline, same as unit at 1,342.5-1,343.0 feet	1,343.2-1,343.5
Clay, medium-light-gray (N6), slightly halitic	1,343.5-1,343.7
Halite, translucent, coarsely to very coarsely crystalline, slightly argillaceous, light-gray (N7) in upper 0.5 foot	1,343.7-1,345.0
Halite, same as unit at 1,334.9-1,339.8 feet	1,345.0-1,354.3
Argillaceous halite, moderate- to dark-reddish-brown (10R 4/6-10R 3/4), minor amounts of	

medium-light- to light-gray (N6-N7); scattered stringers of polyhalite	1,354.3-1,358.8
Polyhalite, same as unit at 1,341.1-1,342.5 feet, light-gray (N7) clay seam at base	1,358.8-1,359.1
Halite, alternating bands of argillaceous halite, polyhalitic halite and halite, moderate-reddish-brown (10R 4/6) at 1,359.1-1,359.3, and 1,361.8-1,362.3 feet; polyhalitic halite, moderate-reddish-orange (10R 6/6) at 1,359.3-1,361.8, 1,362.3-1,364.4, and 1,365.0-1,365.9 feet; translucent halite at 1,364.4-1,365.0 feet	1,359.1-1,365.9
Polyhalite; same as unit at 1,341.1-1,342.5 feet; light-gray (N7) clay seam at base	1,365.9-1,366.3
Halite, alternating argillaceous halite, polyhalitic halite, and translucent halite, medium- to coarsely crystalline, argillaceous; light-gray (N7) and moderate-reddish-brown (10R 4/6) halite from 1,366.3-1,368.4, 1,369.3-1,369.7, 1,373.1-1,374.1, 1,376.3-1,376.9, and 1,377.2-1,379.0 feet; moderate-reddish-orange (10R 6/6) polyhalitic halite from 1,368.4-1,369.3, 1,369.7-1,370.4, 1,371.0-1,373.1, 1,374.1-1,376.3, and 1,376.9-1,377.2 feet; translucent halite from 1,370.4-1,371.0 feet	1,366.3-1,379.0
Argillaceous halite, moderate-reddish-brown (10R 4/6), finely to medium-crystalline	1,379.0-1,379.8
Halite, moderate-reddish-brown (10R 4/6), medium- to coarsely crystalline, argillaceous, scattered stringers and blebs of moderate-reddish-orange (10R 6/6) polyhalite	1,379.8-1,382.8
Halite, moderate-reddish-orange (10R 6/6), medium-crystalline, moderate amount of disseminated polyhalite; numerous stringers and blebs of polyhalite	1,382.8-1,386.2
Polyhalite, moderate-reddish-orange (10R 6/6), very	

finely crystalline, halitic	1,386.2-1,386.4
Halite, same as unit at 1,382.8-1,386.2 feet	1,386.4-1,387.2
Polyhalite, same as unit at 1,386.2-1,386.4 feet	1,387.2-1,387.5
Halite, same as unit at 1,382.8-1,386.2 feet; thin band of polyhalite at 1,388.4 feet; moderate-reddish-brown (10R 4/6) clay seam at base	1,387.5-1,389.6
Halite, moderate-reddish-brown (10R 4/6) in upper 0.5 feet, argillaceous; argillaceous content decreases in lower 1.8 feet and unit is pale-red (5R 6/2) to grayish-red (5R 4/2), medium to coarsely crystalline	1,389.6-1,391.9
Halite, translucent to transparent, coarsely to very coarsely crystalline; very minor moderate-reddish-orange (10R 6/6) disseminated polyhalite	1,391.9-1,394.1
Halite, same as above with increased polyhalite both disseminated and in stringers and blebs	1,394.1-1,395.6
Polyhalite, pale-red (10R 6/2) to moderate-red (5R 4/6), microcrystalline; minor blebs of halite	1,395.6-1,396.0
Halite, same as unit at 1,394.1-1,395.6 feet	1,396.0-1,397.0
Halite, same as upper 0.5 foot in unit at 1,389.6-1,391.9 feet	1,397.0-1,400.5
Halite, moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline, minor amount of disseminated polyhalite	1,400.5-1,401.6
Halite, same as unit at 1,394.1-1,395.6 feet	1,401.6-1,402.3
Halite, same as unit at 1,400.5-1,401.6 feet, trace of disseminated polyhalite	1,402.3-1,403.4
Halite, dark-reddish-brown (10R 3/4) and grayish-red (5R 4/2), finely to medium-crystalline, argillaceous; clay parting at 1,406.1-1,406.3 feet; polyhalitic in lower 3.0 feet	1,403.4-1,409.4
Argillaceous halite, moderate-reddish-brown (10R 4/6) finely to medium-crystalline	1,409.4-1,409.8

Halite, same as unit at 1,403.4-1,409.4 feet, translucent halite in lower 0.4 foot	1,409.8-1,413.6
Halite, same as unit at 1,394.1-1,395.6 feet	1,413.6-1,414.2
No core	1,414.2-1,415.2
Halite, same as unit at 1,396.0-1,397.0 feet	1,415.2-1,417.3
Polyhalite, moderate-reddish-brown (10R 4/6) to light-brown (5YR 5/6) grading downward to moderate-reddish-orange (10R 6/6); very finely crystalline; upper portion laminated; numerous blebs of halite	1,417.3-1,420.4
No core	1,420.4-1,421.4
Halite, similar to unit at 1,396.0-1,397.0 feet, more polyhalitic both disseminated and in stringers and blebs	1,421.4-1,422.7
Halite, translucent to transparent, medium- to coarsely crystalline; minor amount of light-gray (N7) anhydrite at 1,423.0 feet	1,422.7-1,425.9
Halite, light-brown (5YR 5/6) and moderate-reddish-brown (10R 4/6), medium-crystalline; polyhalitic, light-olive-gray (5Y 6/1) anhydrite band at 1,428.0	1,425.9-1,428.2
Polyhalite, same as unit at 1,417.3-1,420.4 feet; banded with light-olive-gray (5Y 6/1) and light-gray (N7) anhydrite	1,428.2-1,430.2
Halite, same as unit at 1,425.9-1,428.2 feet	1,430.2-1,433.2
No core	1,433.2-1,440.3
Silty mudstone, moderate-brown (5YR 3/4) and dark-reddish-brown (10R 3/4), halitic; trace of olive-black (5Y 2/1) and greenish-gray (5G 6/1) clay	1,440.3-1,442.0
Halite, translucent to transparent, finely to medium-crystalline; minor moderate-reddish-orange (10R 6/6) disseminated polyhalite	1,442.0-1,443.4
Argillaceous halite, transparent; moderate-brown	

(5YR 4/4) clay, trace of polyhalite blebs	1,443.4-1,445.0
No core	1,445.0-1,453.4
Halite, dark-reddish-brown (10R 3/4), medium- to coarsely crystalline, argillaceous; scattered polyhalite stringers; lower contact gradational	1,453.4-1,455.6
Halite, translucent to transparent and moderate-reddish-orange (10R 6/6), medium to coarsely crystalline, very polyhalitic; thick polyhalite stringer at 1,458.3 feet	1,455.6-1,465.0
Argillaceous halite, same as unit at 1,443.4-1,445.0 feet	1,465.0-1,466.8
Halite, moderate-reddish-orange (10R 6/6), medium-crystalline, moderate amount of disseminated polyhalite; heavy polyhalite in stringers at 1,467.6 feet	1,466.8-1,468.2
Argillaceous halite, moderate-reddish-brown (10R 4/6), medium-crystalline; minor greenish-gray (5G 6/1) clay blebs and moderate-reddish-orange (10R 6/6) polyhalite blebs and stringers	1,468.2-1,470.7
Halite, moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline; very polyhalitic; polyhalite both disseminated and in stringers	1,470.7-1,471.8
Polyhalite, moderate-reddish-orange (10R 6/6), 0.1-foot bands at top and bottom of unit; polyhalitic halite in middle of unit	1,471.8-1,472.3
Halite, pale-yellowish-brown (10YR 6/2) and pale-red (10R 6/2), finely to medium-crystalline; slightly argillaceous	1,472.3-1,473.0
Halite, same as unit at 1,470.7-1,471.8 feet	1,473.0-1,474.6
Clay, greenish-gray (5G 6/1)	1,474.6-1,474.8
Argillaceous halite, same as unit at 1,443.4-1,445.0 feet	1,474.8-1,476.3
Halite, greenish-gray (5G 6/1) and moderate-	

reddish-brown (10R 4/6), finely to medium-crystalline, slightly argillaceous in upper 0.4 foot; polyhalitic in lower 2.3 feet, both blebs and stringers of polyhalite..... 1,476.3-1,479.0

Halite, moderate-reddish-brown (10R 4/6) and greenish-gray (5G 6/1)..... 1,479.0-1,480.5

Halite, same as unit at 1,476.3-1,479.0 feet; polyhalitic only..... 1,480.5-1,486.0

Halite, same as unit at 1,479.0-1,480.5 feet, lower contact gradational..... 1,486.0-1,489.0

Halite, same as unit at 1,476.3-1,479.0 feet; very polyhalitic in lower 1.3 feet..... 1,489.0-1,496.0

Polyhalite, moderate-reddish-orange (10R 6/6), dense, halitic in upper 0.3 foot..... 1,496.0-1,497.3

Clay, light-gray (N7) to medium-light-gray (N6)..... 1,497.3-1,497.5

Halite, translucent to transparent, medium- to coarsely crystalline, moderately polyhalitic, zones 0.1-0.6 foot thick slightly argillaceous..... 1,497.5-1,506.2

Halite, same as unit at 1,479.0-1,480.5 feet..... 1,506.2-1,509.0

Halite, polyhalitic, same as unit at 1,497.5-1,506.2 feet..... 1,509.0-1,511.0

Halite, moderate-reddish-brown (10R 4/6) and dark-reddish-brown (10R 3/4), finely to medium-crystalline grading downward to coarsely crystalline; argillaceous and slightly polyhalitic in upper 3.0 feet, grading downward to very polyhalitic, moderate-reddish-orange (10R 6/6) in lower 4.4 feet; numerous stringers of polyhalite in lower 1.4 feet; 0.1-foot polyhalite band at 1,517.1 feet..... 1,511.0-1,518.4

Polyhalite, pale-red (10R 4/2) to pale-reddish-brown (10R 5/4); stringers of light-gray (N7) anhydrite, minor halite inclusions..... 1,518.4-1,519.9

Halite, translucent to transparent, medium- to coarsely crystalline, slightly polyhalitic; abundant greenish-gray (5GY 6/1) clay in middle 0.5 foot of unit	1,519.9-1,521.0
Halite, translucent to transparent, coarsely crystalline, polyhalitic; moderate-reddish-orange (10R 6/6), minor disseminated potash minerals	1,521.0-1,523.1
Polyhalite, light-gray (N6), microcrystalline, minor halite inclusions	1,523.1-1,523.3
Halite, same as unit at 1,521.0-1,523.1 feet; increase in polyhalite both disseminated and stringers	1,523.3-1,524.5
Polyhalite, same as unit at 1,518.4-1,519.9 feet	1,524.5-1,525.0
Halite, greenish-gray (5G 6/1), finely to medium-crystalline	1,525.0-1,526.0
Halite, same as unit at 1,521.0-1,523.1 feet	1,526.0-1,528.0
Halite, moderate-reddish-brown (10R 4/6), finely to medium-crystalline, very argillaceous in upper 3.0 feet, clay content decreases downward from 1,531.0 feet to base of unit; greenish-gray (5GY 6/1) clay in upper 0.4 foot	1,528.0-1,533.0
Halite, same as unit at 1,523.3-1.524.5 feet	1,533.0-1,536.0
Polyhalite, same as unit at 1,518.4-1,519.9 feet	1,536.0-1,536.3
Halite, same as unit at 1,523.3-1,524.5 feet	1,536.3-1,538.8
Polyhalite, same as unit at 1,518.4-1,519.9 feet	1,538.8-1,538.9
Halite, same as unit at 1,523.3-1,524.5 feet	1,538.9-1,539.2
Polyhalite, same as unit at 1,518.4-1,519.9 feet; laminated in lower 0.3 foot	1,539.2-1,540.0
Clay, greenish-gray (5Y 6/1)	1,540.0-1,540.3
Halite, dark-reddish-brown (10R 3/4), medium- to coarsely crystalline, argillaceous	1,540.3-1,543.3
Halite, moderate-reddish-orange (10R 6/6), medium-	

to coarsely crystalline, polyhalitic; numerous blebs and stringers, minor light-gray (N7) anhydrite; indication of potash minerals..... 1,543.3-1,547.3

Halite, dark-reddish-brown (10R 3/4), finely to medium-crystalline, very argillaceous..... 1,547.3-1,549.0

Argillaceous halite, grayish-red (10R 4/2), greenish-gray (5GY 6/1), and light-gray (N7), finely crystalline; leached areas indicating a soluble potash mineral; concentrated zones of carnallite and polyhalite..... 1,549.0-1,552.2

No core..... 1,552.2-1,552.9

Argillaceous halite, same as unit at 1,549.0-1,552.2 feet..... 1,552.9-1,553.0

Halite, pale-red (5R 6/2) and moderate-reddish-brown (10R 4/6), medium- to coarsely crystalline; minor amount of sylvite and greenish-gray (5GY 6/1) clay..... 1,553.0-1,555.0

Halite, moderate-reddish-orange (10R 6/6), coarsely crystalline, disseminated grayish-orange-pink (5YR 7/2) polyhalite stringers; moderate amount of sylvite..... 1,555.0-1,559.0

Anhydrite, light-olive-gray (5Y 6/1); white (N9) potash mineral..... 1,559.0-1,559.2

Halite, same as unit at 1,555.0-1,559.0 feet..... 1,559.2-1,559.8

Polyhalite, moderate-red (5R 4/6) and moderate-reddish-brown (10R 4/6); trace of sylvite..... 1,559.8-1,560.0

Clay, greenish-gray (5GY 6/1) and light-gray (N7)..... 1,560.0-1,560.2

Halite, translucent, medium-crystalline, argillaceous, dark-reddish-brown (10R 3/4)..... 1,560.2-1,561.0

Halite, same as unit at 1,555.0-1,559.0 feet; 0.3-foot zone at base of unit leached, indicating presence of soluble potash minerals..... 1,561.0-1,563.9

Halite, moderate- to dark-reddish-brown (10R 4/6-10R 3/4), finely to medium-crystalline, argillaceous; blebs and stringers of polyhalite;

numerous voids (dissolved potash mineral).....	1,563.9-1,569.3
Halite, same as unit at 1,555.0-1,559.0 feet.....	1,569.3-1,572.0
Polyhalite, same as unit at 1,559.8-1,560.0 feet.....	1,572.0-1,573.3
Clay, greenish-gray (5G 6/1).....	1,573.3-1,573.5
Halite, same as unit at 1,563.9-1,569.3 feet.....	1,573.5-1,573.8
Halite, moderate-reddish-orange (10R 6/6), medium-crystalline, polyhalitic; minute blebs of sylvite.....	1,573.8-1,577.5
Halite, translucent, finely to medium-crystalline; numerous stringers and blebs of polyhalite.....	1,577.5-1,579.5
Polyhalite, moderate-red (5R 4/6); halite inclusions at top and bottom of unit.....	1,579.5-1,580.4
Halite, same as unit at 1,577.5-1,579.5 feet.....	1,580.4-1,581.2
Halite, same as unit at 1,560.2-1,561.0 feet; no potash.....	1,581.2-1,582.2
Halite, same as unit at 1,555.0-1,559.0 feet.....	1,582.2-1,584.7
Halite, same as unit at 1,560.2-1,561.0 feet; no potash.....	1,584.7-1,586.7
Halite, same as unit at 1,555.0-1,559.0 feet.....	1,586.7-1,589.3
Halite, same as unit at 1,560.2-1,561.0 feet; no potash.....	1,589.3-1,596.2
Halite, moderate-reddish-brown (10R 4/6) and moderate-reddish-orange (10R 6/6), medium-crystalline, polyhalitic; 1-3 cm thick band of sucrosic yellowish-gray (5Y 7/1) potash mineral at 1,596.5 feet.....	1,596.2-1,598.5
Polyhalite, moderate-reddish-brown (10R 4/6), very finely crystalline, halitic laminae and bands dip up to 35°.....	1,598.5-1,602.3
Anhydrite, light-olive-gray (5Y 6/1) and medium-light-gray (N6), massive, halite bands as thick as 0.1 foot.....	1,602.3-1,603.2
Potash mineral (carnallite), yellowish-gray (5Y 7/1), sucrosic, halitic, trace of moderate-reddish-orange (10R 6/6) polyhalite and light-	

olive-gray (5Y 6/1) to medium-light-gray (N6) anhydrite	1,603.2-1,603.6
Polyhalite and anhydrite, moderate-reddish-brown (10R 4/6) polyhalite and medium-light-gray (N6) anhydrite interlaminated, laminae dips as much as 15° vertical halite healed fracture from 1,604.4 to 1,605.9 feet, 5 mm thick greenish-gray (5G 6/1) clay-filled fracture dipping 48° at base of unit	1,603.6-1,607.4
Halite, dusky-yellowish-brown (10YR 1/1) to dark-yellowish-orange (10YR 6/6), finely to medium-crystalline, argillaceous; minor amount of olive-gray (5Y 4/1) clay; trace of moderate-reddish-brown (10R 4/6) polyhalite	1,607.4-1,609.0
Halite, moderate-reddish-orange (10R 6/6), medium-crystalline, disseminated polyhalite; numerous stringers of moderate-reddish-brown (10R 4/6) polyhalite	1,609.0-1,610.3
Halite, same as unit at 1,607.4-1,609.0 feet	1,610.3-1,611.7
Halite, same as unit at 1,609.0-1,610.3 feet	1,611.7-1,617.0
Halite, transparent to translucent, olive-gray (5Y 4/1) to medium-dark-gray (N4) tint, finely crystalline; medium-dark-gray clay (N4), argillaceous, trace of moderate-reddish-brown (10R 4/6) polyhalite	1,617.0-1,617.5
Halite, alternating zones as thick as 0.6 foot of moderate-reddish-orange (10R 6/6) disseminated polyhalitic halite and moderate-reddish-brown (10R 4/6) and dark-reddish-brown (10R 3/4) argillaceous halite, finely to medium-crystalline	1,617.5-1,621.3
Halite, light-bluish-gray (5B 7/1) to greenish-gray (5G 6/1), finely to medium-crystalline, argillaceous; scattered blebs of moderate-reddish-brown (10R 4/6) polyhalite	1,621.3-1,622.2
Halite, moderate-reddish-brown (10R 4/6) to dark-	

reddish-brown (10R 4/6), very finely to finely crystalline, very argillaceous in upper foot of unit, moderately argillaceous in rest of unit; scattered blebs of polyhalite; greenish-gray (5GY 6/1) argillaceous halite at 1,624.9 feet; clear halite bands at 1,624.7 and 1,625.1 feet.....	1,622.2-1,627.2
Halite, translucent to transparent, medium- to coarsely crystalline; disseminated polyhalite; scattered blebs and stringers of polyhalite.....	1,627.2-1,632.3
Halite, moderate-brown (5YR 3/4), medium-crystalline, argillaceous; minor stringers of polyhalite.....	1,632.3-1,634.1
Halite, same as unit at 1,627.2-1,632.3 feet; few small voids, probably from leaching of potash minerals; greenish-gray (5G 6/1) to light-bluish-gray (5B 7/1) clay parting at base.....	1,634.1-1,638.7
Halite, same as unit at 1,632.3-1,634.1 feet.....	1,638.7-1,641.2
Halite, same as unit at 1,627.2 to 1,632.3 feet; some leaching of potash minerals as in 1,634.1-1,638.7 feet; very polyhalitic in upper 0.7 foot.....	1,641.2-1,645.2
Halite, moderate-reddish-brown (10R 4/6) to moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline, argillaceous; trace of greenish-gray (5G 6/1) clay; blebs as large as 2 cm of light-bluish-gray (5B 7/1) potash mineral generally in upper 0.5 foot.....	1,645.2-1,654.4
Halite, moderate-reddish-orange (10R 6/6) and pale-reddish-brown (10R 5/4), medium- to coarsely crystalline; disseminated polyhalite; numerous pale-reddish-brown (10R 5/4) blebs of polyhalite; 1 [illegible] thick polyhalite stringers at 1,656.1 and 1,656.5 feet.....	1,654.4-1,659.1
Halite, same as unit at 1,645.2-1,654.4 feet.....	1,659.1-1,666.0

Halite, same as unit at 1,654.4-1,659.1 feet; numerous light-gray (N7) anhydrite stringers and patches as large as 0.2 foot in lower 1.5 feet	1,666.0-1,670.6
Polyhalite, light-olive-gray (5Y 6/1) and medium-light-gray (N6), very finely crystalline, massive; minor laminae of halite and pseudomorphs of halite after polyhalite scattered through unit	1,670.6-1,673.8
Halite, translucent, finely to medium-crystalline; bands of light-gray (N7) anhydrite at 1,677.2-1,677.4 feet and at 1,678.5 feet	1,673.8-1,681.6
Anhydrite, light-olive-gray (5Y 6/1) and medium-light-gray (N6), banded to laminated; pseudomorphs of halite after anhydrite	1,681.6-1,687.0
Polyhalite, light-olive-gray (5Y 6/1) and moderate-brown (5YR 4/4), laminated	1,687.0-1,687.8
Clay, medium-gray (N5), slightly halitic	1,687.8-1,688.1
Polyhalite, moderate-reddish-brown (10R 4/6) and moderate-reddish-orange (10R 6/6), very finely crystalline; numerous medium-gray (N5) clay inclusions	1,688.1-1,689.2
Clay, same as unit at 1,687.8-1,688.1 feet	1,689.2-1,689.4
Halite, moderate-reddish-orange (10R 6/6) alternating with clear bands, finely to medium-crystalline; disseminated polyhalite; scattered blebs and stringers of polyhalite	1,689.4-1,693.9
Halite, moderate-reddish-brown (10R 4/6), moderate-reddish-orange (10R 6/6) and medium-light-gray (N6), finely crystalline; argillaceous, minor amounts of polyhalite blebs and medium-bluish-gray (5B 5/1) clay	1,693.9-1,695.0
Halite and langbeinite, moderate-reddish-orange (10R 6/6) and yellowish-gray (5Y 8/1); halite, is	

finely to medium-crystalline, langbeinite is sucrosic; medium-bluish-gray (5B 5/1) clay and trace of polyhalite	1,695.0-1,697.7
Halite, same as unit at 1,689.4-1,693.9 feet	1,697.7-1,700.8
Argillaceous halite, dusky-yellowish-green (5GY 5/2), finely crystalline	1,700.8-1,701.8
Halite, same as unit at 1,689.4-1,693.9 feet	1,701.8-1,703.2
Halite, medium-light-gray (N6) and pale-reddish-brown (10R 5/4) alternating with moderate-reddish-orange (10R 6/6), argillaceous and polyhalitic, medium- to coarsely crystalline	1,703.2-1,709.0
Halite, moderate-reddish-orange (10R 6/6), finely to medium-crystalline; much disseminated polyhalite, numerous bands of polyhalite	1,709.0-1,712.6
Halite, same as unit at 1,693.9-1,695.0 feet	1,712.6-1,713.1
Halite, same as unit at 1,709.0-1,712.6 feet	1,713.1-1,715.0
Halite, moderate-reddish-orange (10R 6/6), coarsely crystalline	1,715.0-1,716.5
Halite, same as unit at 1,709.0-1,712.6 feet	1,716.5-1,717.3
Langbeinite and halite, clear to pale-red (10R 6/2) and moderate-reddish-orange (10R 6/6); langbeinite is sucrosic, halite finely crystalline	1,717.3-1,718.5
Halite, dark-reddish-brown (10R 3/4) to blackish-red (5R 2/2) grading downward to grayish-red (10R 4/2), and moderate-reddish-orange (10R 6/6), finely to medium-crystalline, argillaceous; scattered langbeinite in upper part of unit: polyhalitic in lower part; medium-gray (N5) clay seam at base	1,718.5-1,722.4
Halite, moderate-reddish-orange (10R 6/6) and moderate-reddish-brown (10R 4/6), medium to coarsely crystalline; polyhalitic; scattered zones of clear halite; minor argillaceous zones	

at 1,726.1 and 1,727.0-1,727.3 feet	1,722.4-1,728.2
Argillaceous halite, medium-light-gray (N6), moderate-reddish-brown (10R 4/6) and light-olive-gray (5Y 6/1), very finely crystalline	1,728.2-1,729.7
Halite, medium-gray (N5), light-olive-gray (5Y 6/1) and moderate-reddish-brown (10R 4/6), finely to medium-crystalline, argillaceous; scattered stringers and blebs of polyhalite; coarsely crystalline in lower 0.5 foot	1,729.7-1,735.2
Halite, moderate-orange-pink (10R 7/4), medium- to coarsely crystalline; trace of disseminated polyhalite	1,735.2-1,735.7
Halite, same as unit at 1,729.7-1,735.2 feet	1,735.7-1,737.2
Halite, same as unit at 1,735.2-1,735.7 feet; increased amount of polyhalite stringers	1,737.2-1,739.2
Halite, light-gray (N7) and moderate-reddish-brown (10R 4/6), medium- to coarsely crystalline; argillaceous; trace of polyhalite blebs	1,739.2-1,747.2
Halite, same as unit at 1,722.4-1,728.2 feet; very polyhalitic near base of unit	1,747.2-1,750.4
Polyhalite, moderate-reddish-brown (10R 4/6), silty	1,750.4-1,750.9
Clay, moderate-reddish-brown (10R 4/6), silty, halitic	1,750.9-1,751.2
Halite, same as unit at 1,722.4-1,728.2 feet	1,751.2-1,751.8
Argillaceous halite, moderate-reddish-brown (10R 4/6), finely crystalline	1,751.8-1,752.0
Halite, moderate-reddish-brown (10R 4/6) and moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline, argillaceous with polyhalitic zones	1,752.0-1,754.0
Halite, translucent, medium-light-gray (N6), and pale-brown (5YR 5/2), medium- to coarsely	

crystalline, slightly argillaceous; minor stringers of polyhalite..... 1,754.0-1,757.0

Halite, medium-light-gray (N6), grayish-red (10R 4/2), moderate-reddish-orange (10R 6/6) and translucent, finely to medium-crystalline, argillaceous; numerous stringers and blebs of polyhalite, large blob of polyhalite at 1,758.2 feet..... 1,757.0-1,764.2

Halite, translucent to moderate-reddish-orange (10R 6/6), medium- to very coarsely crystalline; numerous zones of polyhalite blebs, bands of polyhalite at 1,766.6 and 1,767.1-1,767.2 feet..... 1,764.2-1,767.4

Polyhalite, pale-red (10R 6/1), microcrystalline..... 1,767.4-1,767.6

Siltstone, medium-light-gray (N6), well-indurated, halitic..... 1,767.6-1,767.8

Halite, translucent to pale-red (10R 6/2), finely to medium-crystalline, polyhalitic..... 1,767.8-1,768.3

Polyhalite, same as unit at 1,767.4-1,767.6 feet..... 1,768.3-1,768.4

Halite, same as unit at 1,767.8-1,768.3 feet..... 1,768.4-1,768.6

Clay, dark-gray (N3), soft..... 1,768.6-1,768.7

Halite, medium-gray (N5) and pale-red (10R 6/1), finely crystalline, argillaceous; numerous blebs of polyhalite..... 1,768.7-1,769.0

Halite, translucent to moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline; zones of translucent halite alternating with zones of slightly and heavily polyhalitic halite; zone of polyhalite and anhydrite at 1,773.9-1,774.3 feet..... 1,769.0-1,774.5

Polyhalite, same as unit at 1,767.4-1,767.6 feet; dark-gray (N3) clay seam at base..... 1,774.5-1,775.1

Halite, transparent to medium-gray (N5), and moderate-reddish-orange (10R 6/6), medium- to coarsely crystalline; zones of clear, argillaceous, and

polyhalitic halite	1,775.1-1,778.8
Halite, olive-gray (5Y 4/1) to medium-dark-gray (N4), medium-crystalline, argillaceous	1,778.8-1,781.0
Halite, moderate-brown (5YR 3/4) and dark-reddish-brown (10R 3/4), finely to medium-crystalline, argillaceous; halite filled fracture, 15 mm wide dipping 78 at 1,783.1-1,783.4 feet	1,781.0-1,783.9
Halite, same as unit at 1,775.1-1,778.8 feet	1,783.9-1,785.0
Halite, moderate-reddish-orange (10R 6/6) to moderate-reddish-brown (10R 4/6), medium-crystalline, very polyhalite	1,785.0-1,786.3
Polyhalite, moderate-red (10R 6/2) to moderate-reddish-orange (10R 6/6), microcrystalline; 2 cm thick halite band at 1,786.4 feet; 2 cm thick medium-light-gray (N6) clay seam at base	1,786.3-1,787.2
Halite, medium-light-gray (N6), olive-gray (5Y 6/1), and moderate-reddish-brown (10R 4/6) finely to medium-crystalline, argillaceous; minor zones of translucent halite; numerous needlelike crystals as long as 1 cm from 1,788.4-1,788.7 feet	1,787.2-1,789.6
Halite, translucent to very light gray (N8) and moderate-reddish-brown (10R 4/6), medium-crystalline, polyhalitic in lower half of unit	1,789.6-1,791.6
Polyhalite, moderate-reddish-brown (10R 4/6), very finely crystalline	1,791.6-1,791.8
Halite, same as unit at 1,778.8-1,781.0 feet	1,791.8-1,793.6
Halite, same as lower part of unit at 1,789.6-1,791.6 feet	1,793.6-1,794.5
Halite, same as unit at 1,778.8-1,781.0 feet	1,794.5-1,795.0
End of cored interval	1,795.0
Halite, moderate-reddish-brown (10R 4/6), slightly argillaceous; trace of polyhalite	1,795.0-1,820.0
Total depth.	1,820.0

4.0 HYDROLOGICAL DATA

No hydrological data have been obtained to date from WIPP 34.

5.0 REMARKS

Drilling at WIPP 34 indicated a broad structural low over much of Section 9 (T.22S., R.31E) which has closure of a few tens of feet. There was no obvious advantage to drilling deep at WIPP 34 (or any other nearby location) to see if deeper structures affected this broader area. More recently WIPP 34 was discussed as a possible location for an additional test (since WIPP 13 was deepened) of the "disturbed zone", but there is no specific structure known to be at WIPP 34 which would add to our understanding of the "disturbed zone".

A basic data report on WIPP 14 is in preparation which will give further information on shallow structure near WIPP 34.

6.0 BIBLIOGRAPHY

1. Adams, J.E., 1944, Upper Permian Ochoa series of the Delaware Basin, West Texas and southeastern New Mexico: American Association of Petroleum Geologists Bulletin, v. 28, p.1595-1625.

2. Anderson, R.Y., 1978, Deep dissolution of salt, northern Delaware Basin, New Mexico: unpublished report to Sandia National Laboratories, revised May 1978.

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

4. Griswold, G.B., 1977, Site selection and evaluation studies of the Waste Isolation Pilot Plant (WIPP), Los Medanos, Eddy County, New Mexico: SAND77-0946, Sandia National Laboratories, Albuquerque, NM.

5. Jones, C.L., 1973, Salt deposits of Los Medanos area, Eddy and Lea Counties. Mew Mexico, with sections on groundwater hydrology by M.E. Cooley and surficial geology by G.O. Bachman: U.S. Geological Survey Open-File Report USGS-4339-7, 67 p.

6. Powers, D.W., Lambert, S.J., Shaffer, S-E, Hill, L.R., Weart, W.D., eds., 1978, Geological characterization report, Waste Isolation Pilot Plant (WIPP), southeastern New Mexico; SAND78-1596, vol. I and II, Sandia National Laboratories, Albuquerque, NM.

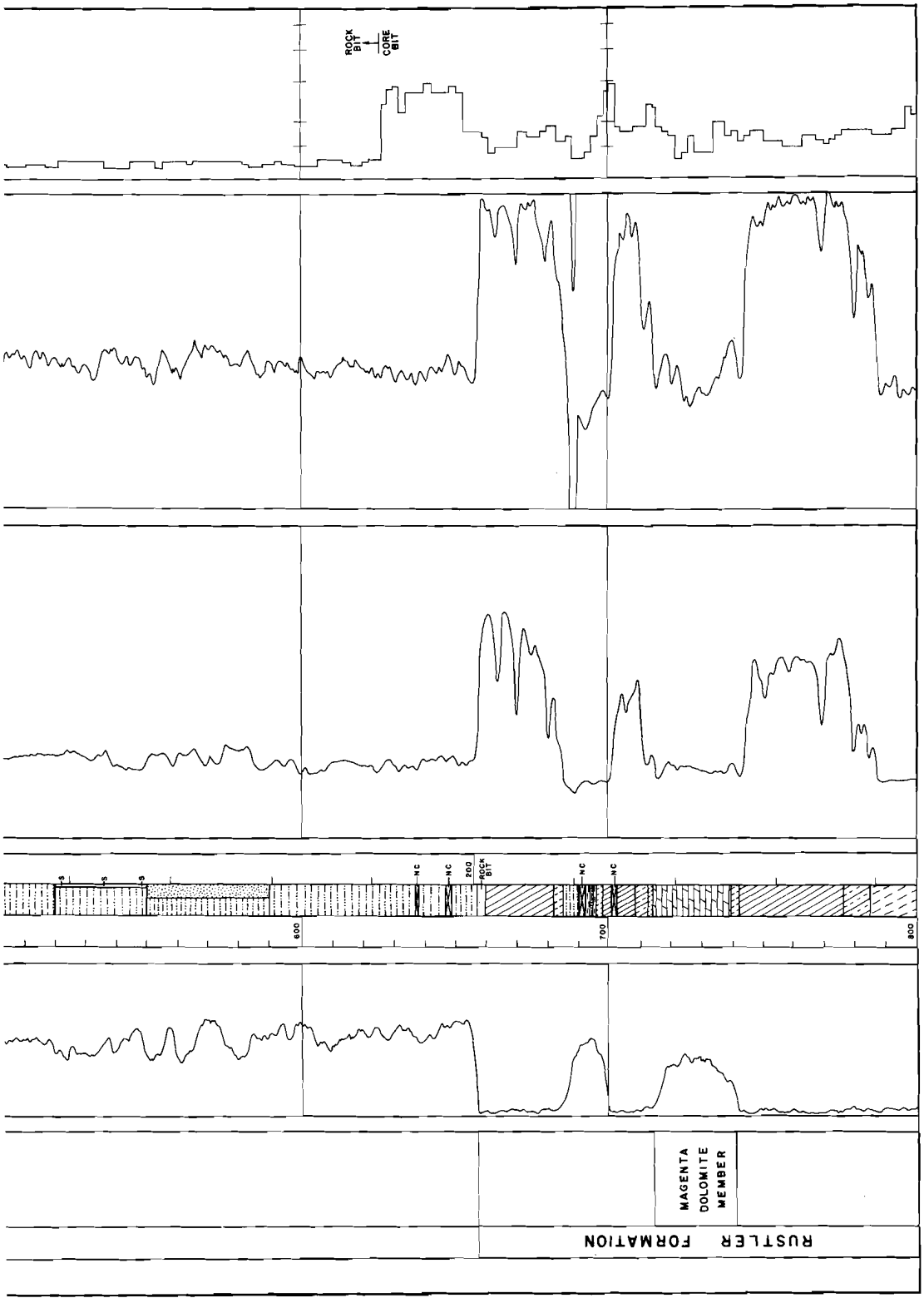
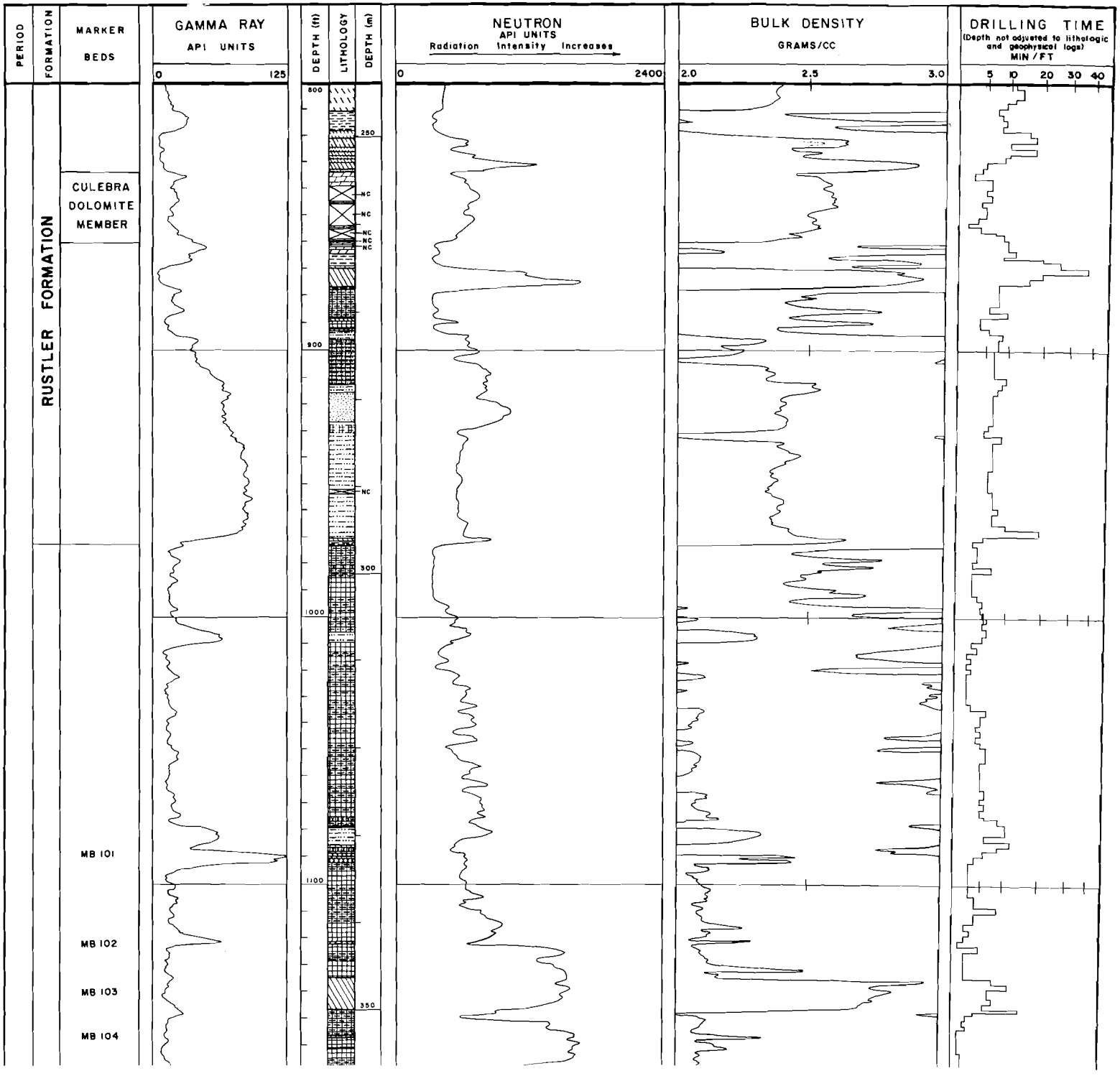


FIGURE 2A.--LITHOLOGIC AND GEOPHYSICAL LOGS OF BOREHOLE WIPP-34

(See figure 2a for explanation of symbols)



Appendix A

JUSTIFICATION

by

D. W. Powers
Division 4511
Sandia National Laboratories

INTRODUCTION TO APPENDIX A, JUSTIFICATION

Appendix A consists of the memorandum from D.W. Powers to W.D. Weart, dated 8/6/79, "WIPP 34 Scope of Work" and the memorandum from W.D. Weart to R.D. Statler, dated 8/15/79, "WIPP 34 Scope of Work Modification". These documents provide 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.

Draft: July 17, 1979
Approval Issue: August 6, 1979

WIPP

STATEMENT OF WORK

FOR

WIPP 34

Prepared By: Dennis W. Powers
D. W. Powers, Principal Investigator

Organization Approval: Wendell D. Weart
W. D. Weart, Division Supv. (Acting)

Reviewed By: L. J. Barrows
L. J. Barrows, Peer Reviewer

H. C. Walker
H. C. Walker, Peer Reviewer

J. T. Henderson
J. T. Henderson, QA Chief

Approved By: Wendell D. Weart
W. D. Weart, Project Manager

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date August 6, 1979

to W. D. Weart, 4511 (Acting)

Dennis W. Powers

from D. W. Powers, 4511

subject WIPP 34, Scope of Work

Objective: WIPP 34 will primarily be a test of the nature and origin of the closed contours (e.g. Figure 1) on marker beds from top of Salado to top of Rustler in Section 9, T22S, R31E. Maps of these beds, produced by the USGS, are based on borehole data from the WIPP and also from the potash industry. These maps were prepared partly for evaluation of the disturbed zone indicated by seismic reflection surveys. The borehole may be deepened, during a later phase of drilling, to test the effects of the Castile or lower Salado on the Rustler.

Method: The borehole will be drilled to the 126 marker bed which is expected to be about 1800 feet deep. The borehole will be cored from top of Rustler to the 126 marker bed. In addition, the borehole will be drilled to minimize re-entry work if the borehole is later deepened to test the Castile Formation. The borehole will also be drilled to maintain the option for later hydrologic testing.

Details: The borehole will be logged to determine the formation radioactivity, acoustic properties, density, hydrogen content, porosity, attitudes, and resistivity. These logs may be required by the project leader at one or more stages during drilling, possibly before or during coring, and at the total depth. After reaching total depth, an up-hole velocity survey will be conducted. All borehole logs will be recorded on magnetic tapes and tapes duplicated before delivery to Sandia. In addition, the mud should be continuously monitored for nitrogen, carbon dioxide, hydrocarbon gases, and hydrogen sulfide, although these gases are not expected to be of any consequence. The record should include times of all gas occurrences.

Extraordinary coring measures are not now identified since the target is broad. Coring from about the top of the Rustler to about the 126 marker bed should be continuous although complete recovery is not expected. The minimum acceptable size core is NX. Core will require marking, handling, photography and storage in accordance with standard procedures similar to those applied to AEC 7.

Hydrologic testing, if appropriate, will be based on field conditions at the time of drilling.

Borehole Prognosis:

Prognosis for WIPP 34

Location: about 2000' fwl, 100' fsl, Section 9, T22S, R31E

Surface elevation: about 3440' above mean sea level

Horizon	Approximate Depth[1] in Feet
top of Rustler Fm	655
top of Magenta Dolomite	720
top of Culebra Dolomite	825
top of Salado Fm	990
top of Salado salt	990
base of MB 124	1730
base of MB 126	1810

[1]Depths based primarily on preliminary structure contour maps by R. P. Snyder, USGS, Denver.

The location of WIPP 34 is within the general boundaries of the "disturbed zone" as defined by seismic reflection data. There is little information on prognosis to be added from present geophysical information.

The geologic anomalies being examined appear relatively minor and no extraordinary safety measures should be necessary for gas occurrences. As usual, some possibility of encountering a nitrogen pocket within the Salado exists.

Field Support and Coordination: Division 4511 will be responsible for the technical program on WIPP 34 (see Figure 2). Division 1133 will provide field engineering support for all drilling activities. The USGS will be responsible for core description and will provide technical expertise regarding the geology and hydrology. The USGS/WRD is expected to undertake geophysical logging of the hole to complement commercial logging.

Quality Assurance: The overall quality classification of this program is minor because the validity of tests and measurements can be ascertained by review and the activity does not represent a major programmatic impact to the WIPP mission. The nature of the program requires professional geologists and hydrologists to carry out measurements and description. The USGS is responsible for core description; the USGS is responsible internally for quality assurance for its part of this program. Sandia Laboratories will apply appropriate quality measures to drilling and logging. Borehole logging is an important interpretive tool, and the logging should be completed by an experienced logging engineer using industry standards and practices. The project leader, D. W. Powers, will review the geologic information and inspect geological operations as necessary.

Further Studies: The extent of core examination and study will depend on the apparent reasons for the structure contours. Visual examination and slabbing can be expected; petrographic examination may then be deemed necessary. Geochemical studies of solution residues or mineralization may be undertaken if appropriate. Hydrologic testing may be warranted by unusual borehole conditions. Acoustic properties will be used to better understand the seismic reflection data. Extraordinary measures or techniques may be described elsewhere when appropriate.

DWP:4511:rmf

Copy to:
W. P. Armstrong, WPO, DOE/ALO
W. S. Twenhofel, USGS, Special Projects Branch, Denver, CO
J. McLean, USGS, Water Resources Division, Albuquerque, NM
1133 R. D. Statler
1135 P. D. Seward
4500 E. H. Beckner
4510 W. D. Weart
4511 L. J. Barrows
4511 D. D. Gonzalez
4511 S. J. Lambert
4542 Sandia WIPP Central File (original)
4511 D. W. Powers

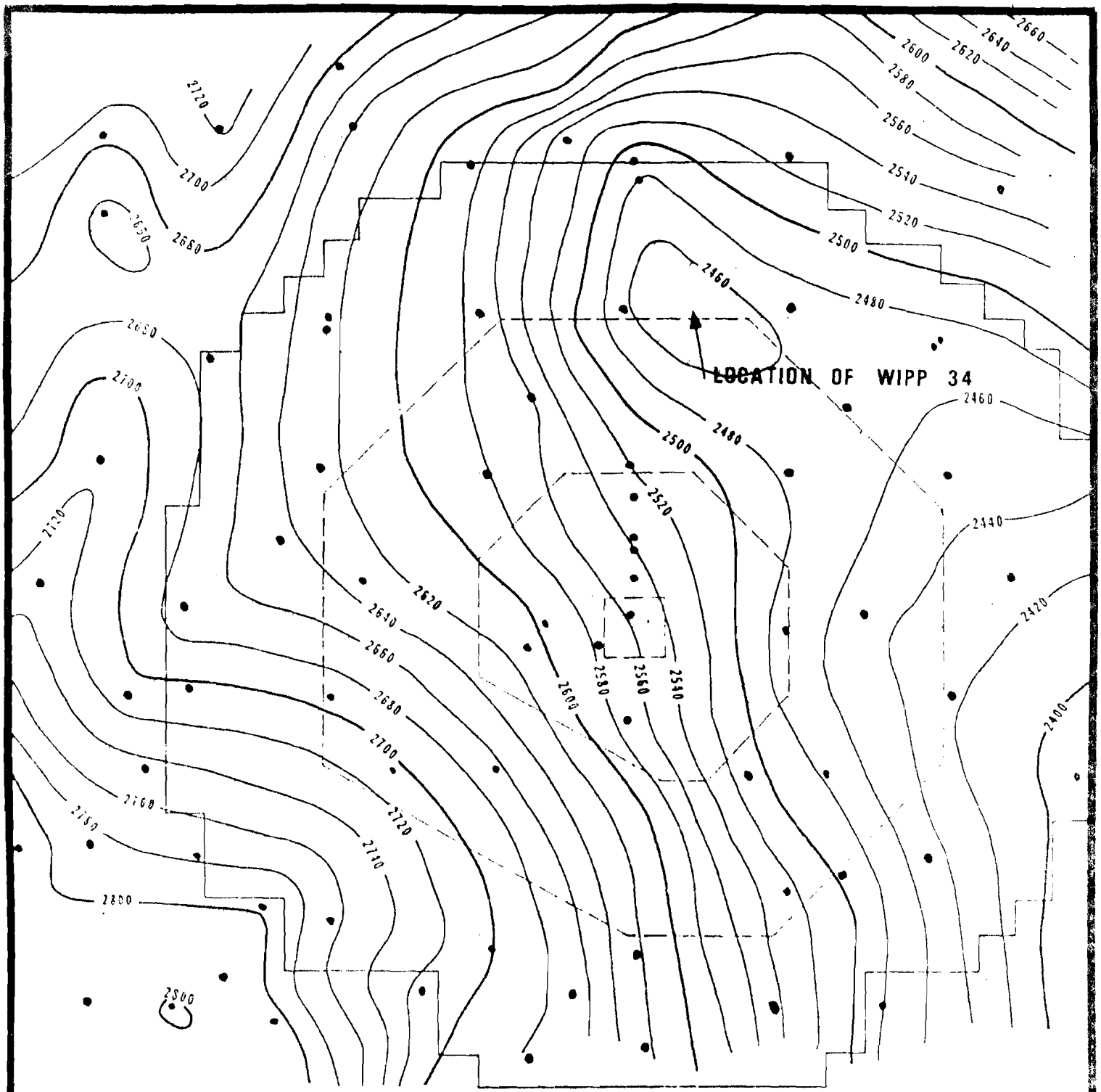


Figure 1: Structural interpretation from borehole data.

WIPP 34 ORGANIZATION

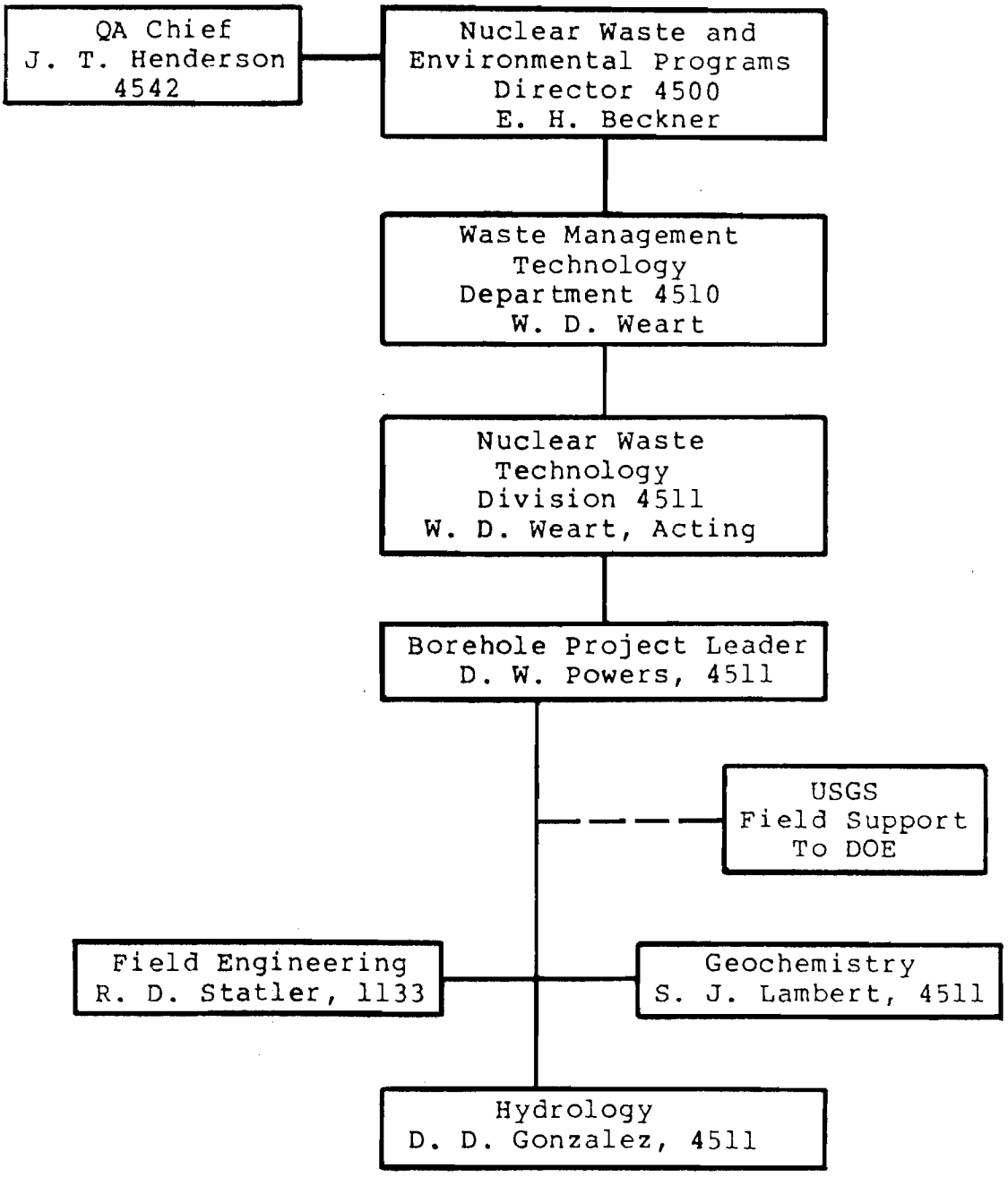


Figure 2

MODIFICATION
August 15, 1979

WIPP

STATEMENT OF WORK

FOR

WIPP 34

Prepared by: _____
D. W. Powers, Principal Investigator

Organization Approval: _____
W. D. Weart, Division Supv. (Acting)

Reviewed By: _____
L. J. Barrows, Peer Reviewer

_____
H. C. Walker, Peer Reviewer

_____
J. T. Henderson, QA Chief

Approved By: _____
W. D. Weart, Project Manager

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date: August 15, 1979

to: R. D. Statler, 1133

from: W. D. Weart, 4510

subject: WIPP 34 Scope of Work Modification

Please modify the memo, D. W. Powers to W. D. Weart, dated August 6, 1979, regarding the WIPP 34 Scope of Work as follows:

The paragraph entitled "Details:" Delete the sentence which begins, "In addition, the mud should be continuously monitored . . . " and replace it with the sentence which states, "Mud logging will not be required for the initial drilling phase during which the borehole will extend to the 126 marker bed. Should the hole be deepened beyond this point in the future, the mud should be continuously monitored for nitrogen, carbon dioxide, hydrocarbon gases, and hydrogen sulfide, although these gases are not expected to be of any consequence."

WDW:4510:pz

Copy to:
W. P. Armstrong, WPO, DOE/ALO
W. S. Twenhofel, USGS, Special Projects Branch, Denver, CO
J. McLean, USGS, Water Resources Division, Albuquerque, NM
1135 P. D. Seward
4500 E. H. Beckner
4511 D. W. Powers
4511 L. J. Barrows
4511 D. D. Gonzalez
4511 S. J. Lambert
4542 Sandia WIPP Central File
4510 W. D. Weart

Appendix B

Drilling and Testing Plan

compiled by

R.D. Statler
Division 1133
and
P.D. Seward
Division 1135
Sandia Natonal 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: July 26, 1979

to: Distribution

from: R. D. Statler, 1133

subject: Site Investigations for WIPP 34

The attached document contains the Field Operations Plan for an exploratory hole WIPP 34. 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:1133:tdv

Distribution:
C. L. Jones, USGS, Special Projects Div., Denver, CO
J. W. Mercer, USGS/WRD, Albuquerque, NM (3)
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
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
"Disturbed Zone"

Exploratory Well: WIPP 34

Los Medanos Area: Section 9, Township 22S, Range 31E

Eddy County, New Mexico

Purpose: To determine the nature and origin of thin formations above the Salado as defined by projecting adjacent borehole data.

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

Reviewed by P. O. Lewis
R. L. Parker 7/27

Approved by W. D. Weart 7/27/77
W. D. Weart, Acting Supervisor
Nuclear Waste Technology
Division 4511

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

TABLE OF CONTENTS

		Page
	INTRODUCTION	i
1.	FIELD OPERATIONS PROGRAM CRITERIA	1
2.	FIELD OPERATIONS PLAN	
	2.1 Organization	5
	2.2 Support Data	5
	2.3 Drilling Parameters and Expected Drilling Requirements	6
	2.4 Discussion of Potential Hazards	6
3.	FIELD OPERATING PROCEDURES FOR QUALITY CONTROL REQUIREMENTS	
	3.1 Measurement of Surface Location and Elevation	8
	3.2 Coring Operations Procedure	9
	3.2.1 Introduction	9
	3.2.2 Scope of Work	9
	3.2.3 Organization	9
	3.2.4 Operations	9
	3.2.5 Records	12
	3.3 Borehole Geophysical Logging Operations Procedure	14
	3.3.1 Introduction	14
	3.3.2 Scope of Work	14
	3.3.3 Organization	14
	3.3.4 Operations	14
	3.3.5 Records	15
4.	REPORTS	
	4.1 Daily Report	21
	4.2 Hole History	21
	4.3 Miscellaneous Records	21

INTRODUCTION

This document begins with a scope of work for an exploratory well, WIPP 34, to obtain information and samples to aid in interpretation of the origin and age of a "disturbed zone" as defined by seismic reflection data. 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 following memorandum has been published as the design criteria for WIPP 34, and it is being reproduced here in its entirety.

(The above referenced document, WIPP 34, Scope of Work, is deleted from the reproduction of the Field Operations Plan. The SOW has been reproduced, with modifications, in Appendix A.)

2. FIELD OPERATIONS PLAN - WIPP 34

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 34 Sec 9, T22S, R31E 200'fsl, 2000'fwl

Geology

The geology of the drill location is not certain and the stratigraphy may prove unusual. The following prognosis, provided by C. L. Jones, USGS, and D. W. Powers, 4511, is based on projections from nearby holes assuming normal conditions:

Ground Elevation above Sea Level	3435'
Top Rustler	~650'
Magenta	~705'
Culebra	~825'
Salado	~965'
Est TD	1810'

2.3 Drilling Parameters and Expected Drilling Requirements

2.3.1 Construct suitable access road. 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 one joint of a 30-40' x 13-3/8" O.D. surface casing.

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

2.3.3 Move in and rig up to rotary drill 7-7/8" diameter hole to top of Rustler (~650'). Begin continuous coring taking NC size or larger to a TD of 1810'. 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 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 ± 1' of the nearest NGS monument and the lateral coordinates within ± 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 done as part of an investigation to test the nature and origin of the closed contours above the Salado Formation. Coring operation will consist of taking approximately 1200' of NC size core or larger to a TD of approximately 1810'. 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 NC size or larger diamond core bit and a nominal 10' split core barrel is planned.

3.2.4.1 (continued)

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 (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 accidently 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.

Page ____ of ____

DAILY CORE LOGGING RECORD

Date _____ DUTY GEOLOGIST _____

LOG HEADINGS:

Company _____

Well Number ____ WIPP No. _____

Field _____ County _____ State New Mexico

Location _____

Section _____ Township _____ Range _____

Permanent Datum _____ Elevations: K.B. _____

D.F. _____

G.L. _____

NO.	INTERVAL	FEET	RPM	WEIGHT ON BIT	CIRCUL. PRESS. P.S.I.	FEET CORED	FEET RECOVERED	PERCENT RECOVERY	BOX NUMBE

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 commerical 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 the intent of this document 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/NVOO for their contractor, F&S, to prepare and administer a drilling program and associated subcontracts from criteria provided by Sandia which includes borehole logging.

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.

3.3.4.4 (continued)

- 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 obsrrve 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

3.3.5.2 (continued)

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

LOG QUALITY REPORT

Hole _____ Log Date _____ Current Date _____

Log _____ Run # _____ Engr. _____

Field Print ☐ Final Print ☐ Log Analyst _____

CHECK ALL BOXES -- ACCEPTABLE YES OR UNACCEPTABLE NO
Sections not applicable to a particular service, Leave Blank.

	YES	NO
A. HEADING		
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		
B. CALIBRATIONS AND SCALES		
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		
C. VALIDITY OF LOG		
1. Curves Functioning Correctly		
2. Do Log values fall within reasonable limits		
3. Curves on Depth		
4. Logging Speed Indicated		
5. Logging Speed Correct		
D. APPEARANCE		
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		

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

FENIS & SCISSON, INC.

Page ____ of ____

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)

Copy to:
W. S. Twenhofel, Special Projects Branch, USGS, Denver, CO
Attn: L. M. Gard, C. L. Jones, R. P. Snyder
J. McLean, Water Resources Division, USGS, Albuquerque, NM
Attn: J. W. Mercer
W. E. Cunningham, F&S, Carlsbad, NM
1135 P. D. Seward
4510 W. D. Weart
4511 L. J. Barrows
4511 S. J. Lambert
4511 D. W. Powers

Sandia Laboratories

Albuquerque, New Mexico
Livermore, California

date August 8, 1979

to R. D. Statler, 1133

Dennis W. Powers

from D. W. Powers, 4511

subject Scales for Geophysical Logs on Geological Boreholes

The following suite of logs have been fairly standard for commercial logging of geological boreholes for the WIPP.

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

We should record all log information on magnetic tapes as a standard practice. Mylars or "film" should be obtained for each log. In addition, the following primary paper scales are recommended for standard practice and each unit would have "wrap-around" or backup scales.

1.	BHC Acoustic or Sonic	40-140 μsec/ft (140 to 280)
2.	Compensated Neutron	-15% to 45%
3.	Densilog	2.0 to 3.0 (1.0 to 2.0)
4.	Gamma Ray	0 to 150 API units (150 to 300)
5.	Microlaterlog - Dual Laterlog	0.2 - 1000 ohms m^2/m (1000 and up)

Changes to the above can be specified on a hole-by-hole basis, though recording on magnetic tape will reduce the requirements for such changes.

Other logs which may be required in the field are diplogs. Standard industry presentation is acceptable for the diplog.

Up-hole velocity surveys are required for some holes. Vibroseis systems offer advantages in data acquisition and manipulation that are very useful to WIPP; we should continue to see those systems. The number and locations of check points will be determined in the field by a qualified observer representing Sandia.

DWP:4511:rmf

United States Department of the Interior
GEOLOGICAL SURVEY
Box 25046
Denver Federal Center
Denver, Colorado 80225

IN REPLY REFER TO: Mail Stop 954

August 24, 1979

Memorandum

To: Distribution

From: Charles L. Jones

Subject: Geophysical logging program for WIPP-34 and WIPP-13

For WIPP-34 and WIPP-13, the maximum lithologic details and physical-property data from the Salado and Castile Formations are required to facilitate geologic studies. To accomplish this objective, the standardized geophysical logging program should be expanded to include a standard gamma ray-neutron log, and the primary "paper" scale (with backup) for selected logs through the Salado and Castile should be as follows:

1.	BHC Acoustic (or sonic)	40-100 μs/ft (100-160)
2.	Gamma-ray	0-125 API units (125-250)
3.	Neutron	0-2,400 API units (2,400-4,800)

Charles L. Jones

CC: Distribution

L. Hill
D. Powers
R. D. Statler
J. W. Mercer
J. Hudson
R. P. Snyder
L. M. Gard

Appendix C

Hole History

compiled by

R.D. Statler
Division 1133

and

P.D. Seward
Division 1135
Sandia National 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: 11-28-79

HOLE No.: WIPP #34	W.O. No.:	I.D. No.:
USER: Sandia Lab	TYPE HOLE: Exploratory	
LOCATION: New Mexico	COUNTY: Eddy	AREA: WIPP
SURFACE COORDINATES: * 201.78' FSL, 1999.73' FWL		GROUND ELEVATION: *
RIG ON LOCATION:	SPUDDED: 8-16-79	COMPLETED: 9-4-79
CIRCULATING MEDIA: Brine Mud		
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'	5'	Excav.			(5' x 5' cellar)			0'	5'	Dirt
5'	38'	18"	12.715"	48#				0'	38'	
38'	1820'	6-3/4"								

TOTAL DEPTH: 1820' | MANDREL DEPTH | PLUGS:

JUNK:

LOGGING DATA: Page 2 | SURVEYS PAGE: | CORING PAGE: 3

BOTTOM HOLE COORDINATES: @ | REFERENCE:

NON-OPERATIONAL TIME		OPERATIONAL DELAY TIME		WORKING TIME	
Move Rig up & down Gov. Mat'l	0.17 days	Equipment Repair	1.05 days	Drilling Time	2.75 days
Secured	1.13 days	Caving	____ days	Trip Time	0.30 days
Boil & Run Mondrel	____ days	Lost Circ.	____ days	Single Shot Survey Time	____ days
Logging	1.16 days	Fishing	0.05 days		____ days
Survey	____ days	W.O. Equipment	____ days	Total	3.05 days
Casing, Run & Remove	2.99 days	Mix & Condition Mud	0.32 days	Total Suspended Time	____ days
Cement	____ days		____ days	Non-Operational Time	14.74 days
Coring	9.08 days		____ days	Operational Delay Time	1.42 days
Lay Down Drill Pipe	0.21 days		____ days	Working Time	3.05 days
TOTAL	14.74 days	TOTAL	1.42 days	TOTAL ELAPSED TIME	19.21 days

REMARKS: * Location of brass monument:
197.89' FSL, 2003.76 FWL, Sec. 9, T22S, R31E. Elevation 3432.74'

Rig No.	Name	Type	
1	Pennsylvania Drilling Co.		19.21 days
			____ days
			____ days
			____ days
			____ days
			____ days

WDS/it

FENIX & SCISSON, INC.

HOLE HISTORY DATA

DATE: 11-28-79

HOLE No.: WIPP #34	W. O. No.:	I. D. No.:
USER: Sandia Lab	TYPE HOLE: Exploratory	
LOCATION: New Mexico	COUNTY: Eddy	AREA: WIPP
SURFACE COORDINATES: * 201.78' FSL, 1999.73' FWL		GROUND ELEVATION: *
RIG ON LOCATION:	SPUDDED: 8-16-79	COMPLETED: 9-4-79
CIRCULATING MEDIA: Brine Mud		
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'	5'	Excav.			(5' x 5' cellar)			0'	5'	Dirt
5'	38'	18"	12.715"	48#				0'	38'	
38'	1820'	6-3/4"								

TOTAL DEPTH: 1820' | MANDREL DEPTH | PLUGS:

JUNK:

LOGGING DATA: Page 2 | SURVEYS PAGE: | CORING PAGE: 3

BOTTOM HOLE COORDINATES: @ | REFERENCE:

NON-OPERATIONAL TIME		OPERATIONAL DELAY TIME		WORKING TIME	
Move Rig up & down Gov. Mat'l	0.17 days	Equipment Repair	1.05 days	Drilling Time	2.75 days
Secured	1.13 days	Caving	____ days	Trip Time	0.30 days
Bail & Run Mandrel	____ days	Lost Circ.	____ days	Single Shot Survey Time	____ days
Logging	1.16 days	Fishing	0.05 days		____ days
Survey	____ days	W. O. Equipment	____ days	Total	3.05 days
Casing, Run & Remove	2.99 days	Mix & Condition Mud	0.32 days	Total Suspended Time	____ days
Cement	____ days		____ days	Non-Operational Time	14.74 days
Coring	9.08 days		____ days	Operational Delay Time	1.42 days
Lay Down Drill Pipe	0.21 days		____ days	Working Time	3.05 days
TOTAL	14.74 days	TOTAL	1.42 days	TOTAL ELAPSED TIME	19.21 days

REMARKS: * Location of brass monument:

197.89' FSL, 2003.76 FWL, Sec. 9, T22S, R31E. Elevation 3432.74'

Rig No.	Name	Type	
1	Pennsylvania Drilling Co.		19.21 days
			____ days
			____ days
			____ days
			____ days
			____ days

WDS/it

WIPP #34
HOLE HISTORY

8-15-79	Moved in Pennsylvania Drilling Company's rig #1 and rigged up over existing cellar with 13-3/8" casing cemented at 38'.
8-16-79	Completed rigging up. Drilled 6-3/4" hole from 38' to 304' using brine base mud.
8-17-79	Drilled 6-3/4" hole from 304' to 627'. Made up 9' split type core barrel with a 6-3/4" x 3-1/2" core head. Cut core #1 from 627' to 632'.
8-18-79	Completed core #1 from 632' to 636', recovered 7.6'. Cut core #2 and #3 from 636' to 654'. Ran 6-3/4" bit in the hole and drilled from 654' to 656'. Ran 4-1/2" O.D., 9.50#, J-55 casing in the hole and hung at 656'.
8-19-79	Made up 10' split core barrel with a 3.75' x 2.4" core head. Cut core #4 thru #6 from 656' to 682'. Cut core #7 from 682' to 683'.
8-20-79	Completed core #7 from 683' to 692'. Cut core #8 thru #17 from 692' to 792'.
8-21-79	Cut core #18 thru #28 from 792' to 867'.
8-22-79	Cut core #29 thru #37 from 867' to 944'. Stuck drill pipe and worked free. Lost circulation while stuck, mixed mud and circulated hole.
8-23-79	Cut core #38 thru #45 from 944' to 1033'.
8-24-79	Cut core #46 thru #54 from 1033' to 1213'.
8-25-79	Cut core #55 thru #59 from 1213' to 1313' with no returns.
8-26-79	Cut core #60 thru #67 from 1313' to 1473' with 25% returns to no returns at 1453'.
8-27-79	Cut core #68 thru #77 from 1473' to 1673'.
8-28-79	Cut core #78 thru #83 from 1673' to 1793'. Laid down drill pipe.
8-29-79	Attempted to pull 4-1/2" O.D. casing, could not work free. Rigged up Bowen jars and jarred on casing.
8-30-79	Ran free point indicator and shot casing. Recovered 18 joints. Ran a spear and jars in the hole and latched onto casing no recovery.

8-31-79	Continued fishing for 4-1/2" O.D. casing with a spear and recovered balance of casing. Ran 6-3/4" bit in the hole and washed to bottom at 1793'. Made up hole opener and reamed 3.75" hole to 6-3/4" from 656' to 798'.
9-1-79	Opened 3.75" hole to 6-3/4" from 798' to 1793' and drilled 6-3/4" hole to 1820'. Conditioned hole to log.
9-2-79	Ran Dresser Atlas and Birdwell logs.
9-3-79	Rig secured.
9-4-79	Rigged down.

LOG INDEX

TYPE LOG	DATE	RUN NO.	DEPTH DRILLER	DEPTH LOGGER	LOGGED FROM	LOGGED TO
BIRDWELL LOG						
Seismic Velocity Survey	9-2-79	1	1820	1819	20	1800
DRESSER ATLAS LOGS						
Acoustilog, BHC	9-2-79	1	1820	1819	0	1812
Densilog Neutron	9-2-79	1	1820	1819	0	1818
Gamma Ray Neutron	9-2-79	1	1820	1819	0	1818
Dual Laterolog Micro Laterolog	9-2-79	1	1820	1819	0	1816

CORE RECORD

CORE NO.	INTERVAL FEET	FEET CORED	FEET RECOVERED
1	627' - 636'	9	7.6
2	636' - 645'	9	7.8
3	645' - 654'	9	8
4	656' - 662'	6	6.15
5	662' - 672'	10	10
6	672' - 682'	10	10
7	682' - 692'	10	7.3
8	692' - 702'	10	8.9
9	702' - 712'	10	10.3
10	712' - 722'	10	9.4
11	722' - 732'	10	10
12	732' - 742'	10	10.1
13	742' - 752'	10	10
14	752' - 762'	10	9.9
15	762' - 772'	10	10.2
16	772' - 782'	10	10
17	782' - 792'	10	10.1
18	792' - 802'	10	9.9
19	802' - 807'	5	5.7
20	807' - 816'	9	9.2
21	816' - 822'	6	5.2
22	822' - 832'	10	10
23	832' - 842'	10	4.4
24	842' - 852'	10	0.4
25	852' - 857'	5	0.6
26	857' - 858'	1	0.2
27	858' - 862'	4	0.8
28	862' - 867'	5	4.7
29	867' - 877'	10	10
30	877' - 882'	5	5.3
31	882' - 892'	10	9.6
32	892' - 902'	10	9.9
33	902' - 912'	10	10.2
34	912' - 922'	10	10.2
35	922' - 932'	10	9.9
36	932' - 942'	10	10
37	942' - 944'	2	2
38	944' - 952'	8	6.8
39	952' - 962'	10	10
40	962' - 972'	10	9.9
41	972' - 982'	10	9.85
42	982' - 992'	10	10.2
43	992' - 1002'	10	10.1
44	1002' - 1013	11	11.5
45	1013' - 1033	20	20.3

WIPP #34
HOLE HISTORY
PAGE 4

CORE NO	INTERVAL FEET	FEET CORED	FEET RECOVERED
46	1033' - 1053'	20	19.7
47	1053' - 1073'	20	20.4
48	1073' - 1093'	20	20.2
49	1093' - 1113'	20	20.2
50	1113' - 1133'	20	20.1
51	1133' - 1153'	20	20.1
52	1153' - 1173'	20	20.3
53	1173' - 1193'	20	20.5
54	1193' - 1213'	20	20.2
55	1213' - 1233	20	20.3
56	1233' - 1253'	20	20.3
57	1253' - 1273'	20	20
58	1273' - 1293'	20	20.1
59	1293' - 1313	20	20
60	1313' - 1333	20	20.5
61	1333' - 1353'	20	20.4
62	1353' - 1373'	20	20.5
63	1373' - 1393'	20	20.35
64	1393' - 1413	20	20.35
65	1413' - 1433'	20	
66	1433' - 1453'	20	5
67	1453' - 1473'	20	20.2
68	1473' - 1493'	20	20.2
69	1493' - 1513'	20	20.2
70	1513' - 1533'	20	20.1
71	1533' - 1553'	20	18
72	1553' - 1573'	20	20.5
73	1573' - 1593'	20	20.1
74	1593' - 1613'	20	20.2
75	1613' - 1633'	20	20
76	1633' - 1653'	20	20
77	1653' - 1673'	20	20
78	1673' - 1693'	20	20.1
79	1693' - 1713'	20	20.5
80	1713' - 1733'	20	20
81	1733' - 1753'	20	20
82	1753' - 1773'	20	20.2
83	1773' - 1793'	20	20.1

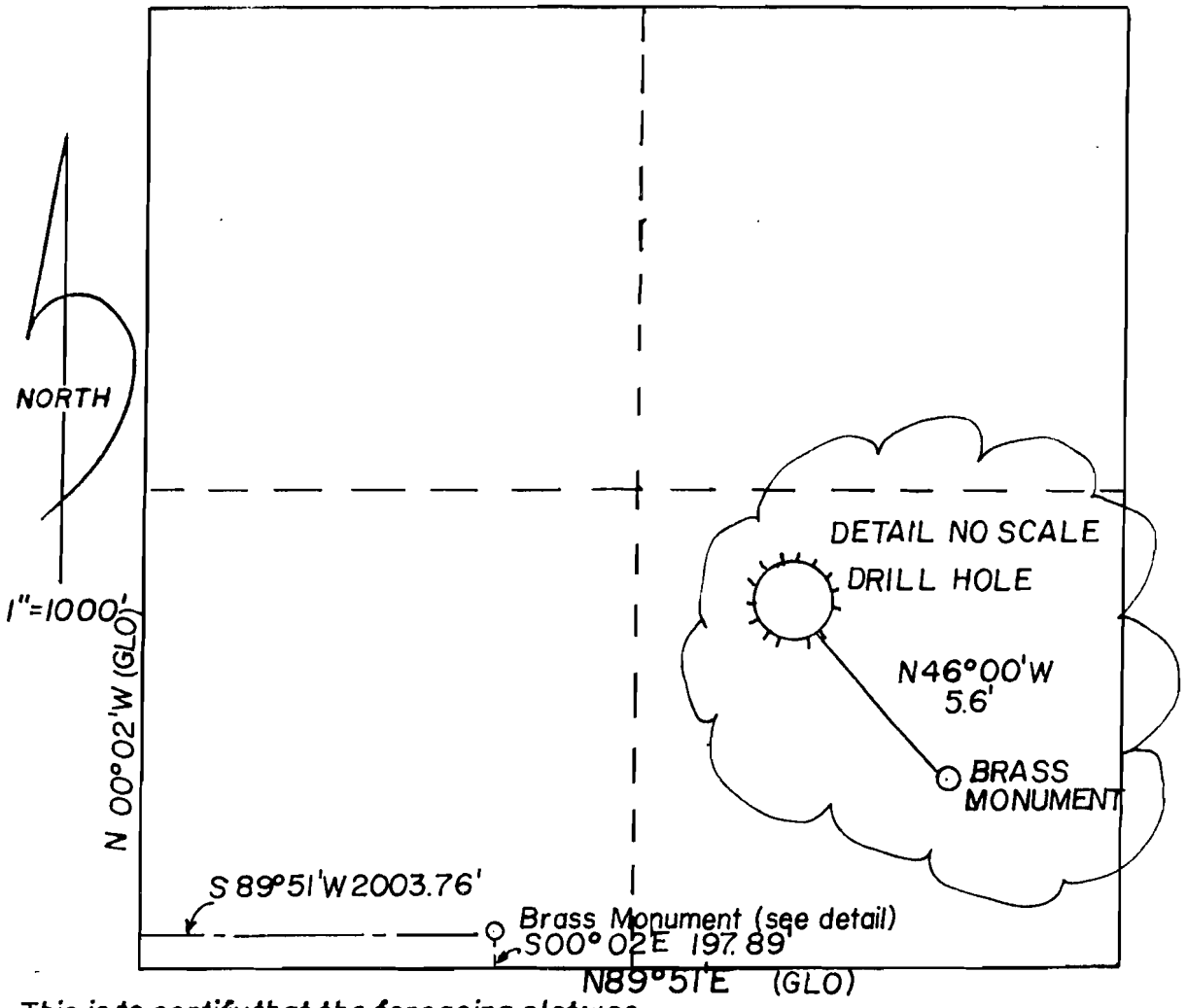
NOTE: Core information taken from drilling records.

SURVEY MONUMENT "AS BUILT"

WIPP 34

SECTION 9, TOWNSHIP 22 S, RANGE 31 E N.M.P.M.
COUNTY, NEW MEXICO

ELEVATION OF BRASS MONUMENT 3432.74'
197.89' FSL & 2003.76' FWL



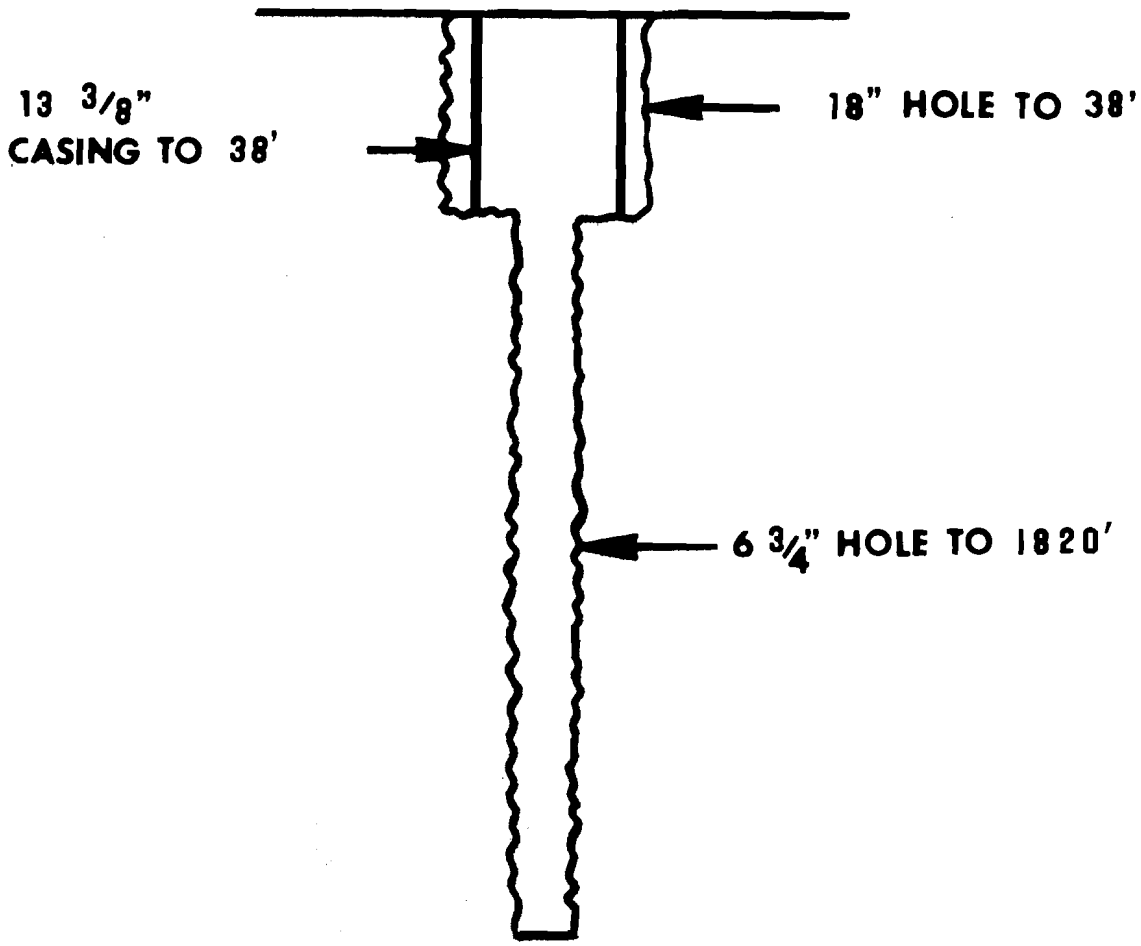
This is to certify that the foregoing plat was made from field notes of a bonafide survey made by me and is true and correct to the best of my knowledge and belief.

Dan R. Reddy

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

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

WIPP 34
AS BUILT HOLE CONDITIONS
AS OF 11/28/79



NOT TO SCALE

Appendix D

LOGS

compiled by

S-E Shaffer
Division 4511
Sandia National Laboratories

Appendix D

WIPP 34 LOGS[1]

Log	Company	ELSI#[2]	Top of Logged Interval[3] (feet)	Bottom Logged Interval (feet)	Date
BHC Acoustilog	Dresser Atlas	W9442Z	Surface	1812	9-2-79
Compensated Densilog/ Compensated Neutron	"	W9443S	"	1818	"
Dual Lateralog/ Micro Lateralog	"	W9443X	"	1816	"
Gamma Ray Neutron	"	W9443W	"	1818	"
Seismic Velocity Survey and Log Calibration	Birdwell[4] Division	N/A	"	1819	"

[1]Original data is retained in Sandia WIPP Central File, Division 4542, Sandia National 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 3433' above MSL.
[4]Seismographic Service Corporation, P.O. Box 1590, Tulsa, OK 74102.

DISTRIBUTION

U.S. Department of Energy, Headquarters
Office of Nuclear Waste Management
Washington, DC 20545
Larry Harmon, Project Coordinator (WIPP)
Colin A. Heath, Director, Division of Waste Isolation (2)

U.S. Department of Energy, Albuquerque Operations
P.O. Box 5400
Albuquerque, NM 87185
J. M. McGough, Manager, WIPP Project Office (2)
D. Jackson, Director, Public Affairs Division

U.S. Department of Energy
Carlsbad WIPP Project Office
Room 113, Federal Building
Carlsbad, NM 88220

U.S. Department of Energy
c/o Battelle Office of Nuclear
Waste Isolation
505 King Avenue
Columbus, OH 43201
Jeff O. Neff

Battelle Memorial Institute
Office of Nuclear Waste Isolation
505 King Avenue
Columbus, OH 43201
S. Goldsmith, Manager
ONWI Library

Battelle Memorial Institute
Project Management Division
505 King Avenue
Columbus, OH 43201
Neal Carter, General Manager

Westinghouse Electric Corporation
P.O. Box 40039
Albuquerque, NM 87196
R. K. Brown
R. Jones (TSC)

Bechtel National, Inc.
Fifty Beale Street
P. O. Box 3965
San Francisco, CA 94119
D. L. Ledbetter
Dale Roberts

National Academy of Sciences, WIPP Panel:

Frank L. Parker, Chairman
Department of Environmental and
Water Resources Engineering
Vanderbilt University
Nashville, TN 37235

Konrad B. Krauskopf, Vice Chairman
Department of Geology
Stanford University
Stanford, CA 94305

Karl P. Cohen, Member
Consultant
928 N. California Avenue
Palo Alto, CA 94303

Neville G. W. Cook, Member
Dept. of Material Sciences and Engineering
University of California at Berkeley
Hearst Mining Building, #320
Berkeley, CA 94720

Fred M. Ernsberger, Member
Glass Research Center
PPG Industries, Inc.
Box 11472
Pittsburgh, PA 15238

Harold L. James, Member
1617 Washington St.
Port Townsend, WA 98368

Richard R. Parizek, Member
Department of Hydrogeology
Pennsylvania State University
University Park, PA 16802

D'Arcy A. Shock, Member
233 Virginia
Ponca City, OK 74601

John W. Winchester, Member
Department of Oceanography
Florida State University
Tallahassee, FL 32306

John T. Holloway
Senior Staff Officer
2101 Constitution Avenue, NW
Washington, DC 20418

WIPP Public Reading Room
Atomic Museum, Kirtland East AFB
Albuquerque, NM 87185
Attn: Ms. Gwynn Schreiner

WIPP Public Reading Room
Carlsbad Municipal Library
101 S. Hallagueno St.
Carlsbad, NM 88220
Attn: Lee Hubbard, Head Librarian

Thomas Brannigan Library
106 W. Hadley St.
Las Cruces, NM 88001
Attn: Don Dresp, Head Librarian

Roswell Public Library
301 N. Pennsylvania Avenue
Roswell, NM 88201
Attn: Ms. Nancy Langston

Hobbs Public Library
509 N. Ship St.
Hobbs, NM 88248
Ms. Marcia Lewis, Librarian

State of New Mexico
Environmental Evaluation Group
320 Marcy Street
P.O. Box 968
Santa Fe, NM 87503
Robert H. Neill, Director (2)

NM Department of Energy & Minerals
P.O. Box 2770
Santa Fe, NM 87501
Larry Kehoe, Secretary
Kasey LaPlante, Librarian

New Mexico State Geologist
P. O. Box 2860
Santa Fe, NM 87501
Emery C. Arnold

New Mexico State Library
P.O. Box 1629
Santa Fe, NM 87503
Ms. Ingrid Vollenhofer

New Mexico Tech
Martin Speer Memorial Library
Campus Street
Socorro, NM 87801

Zimmerman Library
University of New Mexico
Albuquerque, NM 87131
Ms. Alice Clark

USGS, Water Resources Division
P. O. Box 26659
Albuquerque, NM 87125
J. W. Mercer (2)

USGS, Conservation Division
Office of Mining & Resource Evaluation
P. O. Box 506
Carlsbad, NM 88220
C. B. John

USGS, Conservation Division
P. O. Box 1857
Roswell, NM 88201
W. Melton

USGS, Special Projects Branch
Federal Center, Bldg. 25
Denver, CO 80225
R. P. Snyder (20)

New Mexico Bureau of Mines and Mineral Resources
Socorro, NM 87801
F. E. Kottlowski, Director (2)

Klaus Kuhn
Gesellschaft fuer Strahlen-und
Umweltforschung MBH Muenchen
Institut fuer Tieflagerung
Berliner Strasse 2
3392 Clausthal-Zellerfeld
Federal Republic of Germany

Klaus Eckart Maass
Hahn-Meitner-Institut fuer Kernforschung
Glienicker Strasse 100
1000 Berlin 39
Federal Republic of Germany

Michael Langer
Bundesanstalt fuer Geowissenschaften
und Rohstoffe
Postfach 510 153
3000 Hannover 51
Federal Republic of Germany

Helmut Rothemeyer
Physikalisch-Technische
Bundesanstalt
Bundesalle 100
3300 Braunschweig
Federal Republic of Germany

Rolf-Peter Randl
Bundesministerium fuer Forschung
und Technologie
Postfach 200 706
5300 Bonn 2
Federal Republic of Germany

Fenix & Scisson, Inc.
3170 W. Sahara Avenue
Spanish Oaks D-12
Las Vegas, NV 89102
J. A. Cross

Fenix & Scisson, Inc.
401 N. Canal Street
Carlsbad, NM 88220
Matt Wilson (2)

Gayle Pawloski, L-222
Geologist CSDP
Lawrence Livermore Laboratory
Livermore, CA 94550

U.S. Nuclear Regulatory Commission (3)
Division of Waste Management
Mail Stop 69755
Washington, DC 20555
Attn: J. Martin, M. Bell, H. Miller

Sandia Internal:
1133 R. D. Statler
1135 P. D. Seward
3141 L. J. Erickson (5)
3151 W. L. Garner, For: DOE/TIC (Unlimited Release) (3)
3154-3 C. H. Dalin, For: DOE/TIC (25)
4500 E. H. Beckner
4510 W. D. Weart
4511 D. W. Powers
4511 L. J. Barrows
4511 D. J. Borns
4511 D. D. Gonzalez
4511 S. J. Lambert
4511 K. L. Robinson
4511 S. E. Shaffer
4540 M. L. Kramm
4542 Sandia WIPP Central Files (11)
8214 M. A. Pound

Org.	Bldg.	Name	Rec'd by	Org.	Bldg.	Name	Rec'd by

Sandia National Laboratories