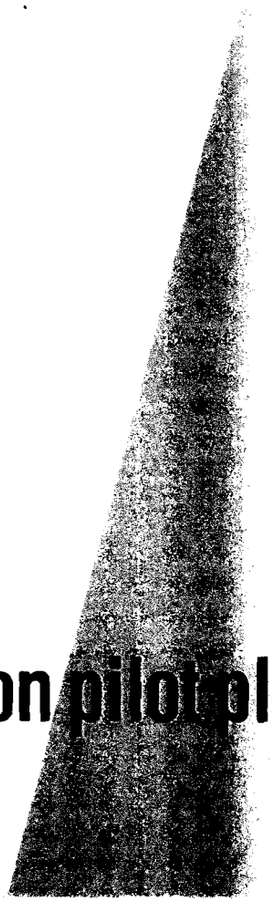
CORRELATION OF DRILLHOLE AND SHAFT LOGS

TME 3179



waste isolation pilot plant

TME 3179

CORRELATION OF DRILLHOLE AND SHAFT LOGS WASTE ISOLATION PILOT PLANT (WIPP) PROJECT SOUTHEASTERN NEW MEXICO

March 1983

U.S. DEPARTMENT OF ENERGY
WASTE ISOLATION PILOT PLANT
ALBUQUERQUE, NEW MEXICO

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TME 3179

CORRELATION OF DRILLHOLE AND SHAFT LOGS WASTE ISOLATION PILOT PLANT (WIPP) PROJECT SOUTHEASTERN NEW MEXICO

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1.0 ABSTRACT

This report on stratigraphic correlations from drillhole and shaft data along a generally north-south section across the potential extent of underground excavations of the Waste Isolation Pilot Plant (WIPP) facility was prepared as part of the Site Validation Field Program Plan. The results provide (1) input for the report entitled "Results of Site Validation Experiments," (2) input for other WIPP-related investigations, including the Design Validation Program, and (3) a framework for further underground activities at WIPP.

In general, this correlation study confirmed previous findings, including:

- Relatively high consistency of thickness and lateral continuity of all beds within the Salado Formation, especially in the host rock interval;
- Gentle, generally south and southeastward dips/slopes of the host rock interval strata;
- Close correspondence between stratigraphic data obtained from the present underground excavations and data derived from the previous investigative drillholes and shafts; and
- Depositional origin of the undulations on the top of Marker Bed (MB) 139 and relatively small variation in its thickness (1.2 to 4.1 feet).

2.0 INTRODUCTION AND SUMMARY

This Technical Memorandum External (TME) has been prepared in response to Task 2.4 (Correlation of Drillhole Logs) of the Site Validation Field Program Plan for the Waste Isolation Pilot Plant (WIPP) in Southeastern New Mexico (McKinney and Newton, 1983) and assumes that the reader is familiar with the basic WIPP concept and geology.

This study was performed and this report prepared by D'Appolonia Consulting Engineers, Inc. (D'Appolonia), under Subcontract S9-CJR-45451 with Westinghouse Electric Corporation, Waste Technology Services Division, under Contract DE-AC04-78-ET05346 with the U.S. Department of Energy (DOE). The Westinghouse team is serving as the Technical Support Contractor (TSC) to the DOE for the WIPP project.

The bases for performing this activity are described in two documents--the "Site Validation Program" (U.S. DOE, 1982) and the "Design Validation Plan" (U.S. DOE, 1983).

The objectives of this study are as follows:

- Determine the lateral extent, continuity, and inclination of the host rock interval[1] and bounding units in a roughly north-south-southeast direction across Zone II (across the extent of the proposed underground workings of the WIPP facility) by correlating lithologic logs from selected drillholes and the two shafts thus far completed.

- Evaluate the correspondence of the stratigraphic data from the present underground workings, including vertical coreholes (Geotechnical Field Data Report [GFDR] No. 9, 1983c), with the data derived from the previous investigative drillholes and shafts.

[1] For definition see Section 3.2, Item 3.

- Assess the origin of undulations on top of Marker Bed (MB) 139 and its thickness.

The resultant information provides:

- A response addressing WIPP Site Qualification Criteria No. 3.0 - Thickness of Host Rock and No. 4.0 - Lateral Extent of the Host Rock; and

- A framework for further planning, designing, constructing, and testing activities.

The following data were used in this study:

- Lithologic and geophysical logs from eight existing deep investigative drillholes within or close to Zone II (B-25, DOE-1, ERDA-9, WIPP-12, 18, 19, 21, 22, and partially WIPP-11);

- Lithologic and geophysical logs from the two shafts;

- Mapping of the underground excavations ("double box" area, south exploratory drift, and a portion of the northern extension of the SPDV excavation);

- Lithologic logs from 27 short vertical coreholes drilled into the roof (12) and floor (15) of the excavated drifts;

- Lithologic logs from four additional short vertical coreholes drilled into MB 139 at the drift intersections;

- Data on MB 139 from six additional drillholes outside the immediate study area (AEC-7 and 8, ERDA-6 and 10, and WIPP-11 and 13).

These data have been either published in Basic Data Reports, TME's, and GFDR's or presented in memoranda (see references). The host rock interval was penetrated by three of the investigative drillholes and two shafts. The remaining five investigative drillholes reached only the top of the Salado Formation. The short coreholes penetrated about 50 feet above and below the facility interval. The depth of the MB 139 holes was about 10 to 16 feet below the drift floor.

In summary, this study indicates the following:

- All principal marker beds within the Salado Formation and within the host rock interval are continuous throughout the studied section across Zone II of the WIPP facility.

- Individual beds and intervals are relatively uniform in thickness between the exploratory shaft and DOE-1, while thinning of strata occurs from the exploratory shaft towards WIPP-12.

- The bedding within the host rock interval between WIPP-12 and DOE-1 has an average apparent dip less than 0.7 degree (1.2 percent) towards the south and southeast. Along the studied sections, the apparent dips average between 0.1 and 1.5 degrees (0.2 and 2.6 percent, respectively). Locally, the dips vary slightly more or may even be reversed due to undulation of the beds. However, gentle, generally south and southeastward dips are expected to occur throughout the entire Zone II.

- Stratigraphic data from the underground excavation and from the vertical coreholes drilled into the roof and floor of the drifts correspond closely with the data derived from the previous deep drillholes and shafts.

- Concerning Marker Bed 139:

  - The undulations on top of MB 139 are reasonably explained as depositional in origin and are probably mounds caused by growth of gypsum crystal clusters which were then slightly crushed by overburden pressure.

  - The relief of MB 139 is not expected to be significantly greater than the relief observed in the drillholes (maximum of 2.9 feet) and in the shafts (maximum of 1.6 feet) since the structure was formed by a process controlled by large-scale environmental/chemical conditions.

  - Statistical evaluation of the observed thickness of MB 139 (ranging from 1.2 to 4.1 feet) indicates an average thickness of 2.6 feet with a standard deviation of 0.6 foot.

3.0 SCOPE OF WORK AND METHODOLOGY

3.1 SCOPE OF WORK

The basic scope of work entailed the correlation of geologic and geophysical logs from deep investigative Drillholes DOE-1, ERDA-9, WIPP-12, and the exploratory and ventilation shafts, all penetrating the 185±-foot-thick host rock interval located between elevations of about 1100 and 1400 feet mean sea level (MSL). In addition, (1) Drillholes B-25, WIPP-18, 19, 21, and 22 were used to correlate the upper strata from the ground surface at an elevation of about 3400 feet MSL to an elevation of approximately 2400 feet MSL and (2) WIPP-11 was used to confirm the continuity of the strata two miles north of the Zone II boundary. Locations of deep investigative drillholes (except WIPP-11) are presented in Figure 1 with (1) the approximate boundaries of WIPP-Zone II indicating the potential extent of the underground excavations, (2) the township sections, and (3) the New Mexico coordinate grid.

The abridged histories of drillholes/shafts as adapted from individual references (Basic Data Reports, etc.) are presented in Appendix A. The compiled basic drillhole/shaft data are presented in Table 1.

Section A-A' (Figure 2) illustrates the entire stratigraphic interval from ground surface to the basal anhydrite of the Castile Formation. The major units, marker beds, and significant interbeds were identified and correlated between boreholes. The section is based on detailed lithologic descriptions and geophysical logs from deep drillholes and the exploratory and ventilation shafts.

The host rock interval between MB 136 and MB 140, including the facility interval, is shown in a fence diagram in Figure 3. Only the principal marker beds and anhydrites "a" and "b" within the host rock interval are illustrated. The results of mapping the underground excavations (GFDR No. 7, 1983b) and geological logs from 27 short vertical coreholes

drilled from the drifts[1] were integrated into the correlation. Locations of these coreholes are shown in Figure 3, their basic data are presented in Table 2, and stratigraphic summaries are provided in Appendix B. Twenty-two of the 50-foot borings comprise 11 pairs in which one borehole was drilled upward into the roof and one downward into the floor. One shallower boring, DH-219A, was cored to a penetration of 11.3 feet to fill in a core-loss gap in adjacent Boring DH-219. Four 10- to 16-foot borings ("MB 139" series) were drilled into MB 139 at the drift intersections.

A more detailed stratigraphic correlation is presented in Figure 4A. This figure has no horizontal scale so as to minimize the apparent distortion of individual beds. It uses the base of MB 139 (shown as a horizontal line in spite of its minor undulation of about ±0.4 foot) as its reference datum. Figure 4B presents the host rock interval of Geologic Section B-B' with data projected from the short vertical coreholes.

Numerical correlation of the lithology/stratigraphy in the host rock interval as encountered in the basic investigative borings is given in Table 3. Stratigraphic summaries of individual investigative drillholes and shafts are presented in Appendix B; a listing of interval/bed thicknesses is provided in Table 4; and a listing of contact dips (apparent dips) is presented in Table 5. Appendix C contains miscellaneous surveying and drillhole correlation notes.

Data concerning MB 139 from six additional deep investigative drillholes (Table 6) were used in the evaluation of the variation in thickness of MB 139 (Table 7) and the origin of the undulation of the top of MB 139. Locations of these additional drillholes are shown in Figure 1c.

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[1] Twenty-three of these coreholes were reported in GFDR No. 9, 1983c issued on February 18, 1983. Four additional coreholes were drilled in the northern part of the 0 East drift later.

Detailed petrographic, mineralogical, or chemical comparison and correlation requiring information not given in the Basic Data Reports or reevaluation of existing cores stored in the U.S. Department of Energy (DOE) core storage library in Carlsbad, New Mexico were not part of this task. However, during the course of this study, no discrepancy that would warrant such additional work was discovered.

3.2 METHODOLOGY

All work performed for this task used existing geological, geophysical, and surveying data presented in various reports and documents (listed in references) from 1979 to 1983. Therefore, this task consisted of the following work items:

1. Gathering available data which consist of:

   - Basic reports on the WIPP:

     - Geological Characterization Report (Powers, et al., 1978),

     - Safety Analysis Report (U.S. DOE, 1980),

   - Basic Data Reports and GFDR's on drillholes and shafts,

   - Geophysical logs of the exploratory and ventilation shafts, and

   - Photographs of the cores and shafts.

2. Review of available data which resulted in the following observation:

   Many different individuals from various organizations participated in the gathering of these data in the course of the field work spanning a time period from 1976 to 1983. This, coupled with an ever-increasing level of knowledge of the site stratigraphy during that time period, caused some nonuniformity in the terminology, reference points, and datums used in various documents. This nonuniformity led to the performance of Items 3 and 4.

3. Development of uniform basic terminology, symbols, and legends which could also be used for further geotechnical work, particularly mapping of the underground excavations. To facilitate discussions and to eliminate ambiguities, the following items were considered:

   - A multiplicity of terms have been used to describe the same vertical divisions of the site stratigraphy, such as "disposal level," "facility stratum," "waste horizon," "facility host rock," etc. To avoid any ambiguity, the following terms are consistently used in this report:

     Host Rock Interval - That portion of the Salado Formation between and including MB 136 and 140. This arbitrary interval is unique to the WIPP site and is not dictated by any technical requirements.

     Facility Interval - The stratigraphic interval in the Salado Formation which is to be actually excavated for drifts and rooms or investigated during experiments for the purpose of testing and disposing of transuranic (TRU) nuclear waste. Previously used terms, such as disposal zone, disposal level, disposal horizon, disposal stratum, waste horizon, and facility stratum, are roughly equivalent to "facility interval."

   - Symbols and legend shown in Figure 4 have a uniform logic allowing graphical expression of most encountered features along with their degree of variability.

4. Review of surveying data[1] revealed the following:

   - Elevation and drillhole depth data as well as depths of geological features (contacts) were used as indicated in the individual Basic Data Reports which had already used appropriate corrections between core depths and geophysical log depths.

[1] Appendix C contains miscellaneous notes on surveying and correlation pertaining to the drillholes/shafts.

- Depths in the exploratory shaft are based on a zero point corresponding to the top of the first bunton at an elevation of 3410 feet MSL.

- Depths in the ventilation shaft are based on a zero point at the shaft collar at an elevation of 3407.9 feet MSL.

- Elevations in both shafts are based on the survey conducted by Cementation West, Inc. (CWI), on December 2, 1982 (using electronic distance meter Lietz RED-2) and referenced to CWI Bench Mark No. CW-1 (brass cap outside the exploratory shaft at an elevation of 3410.08 feet MSL) which was tied to the existing "North Base Line" to the north of the site.

5. Correlation[1] of drillholes and shafts using the following technique:

   A combination of data analysis using simple computer programs, computer plotting, and evaluation of both graphs and tables containing sequences of data (such as those presented in Tables 4 and 5), was used in several loop operations (going back to the original data) to eliminate, to the maximum extent possible, discrepancies resulting from any misinterpretation of nonuniform original data.

6. Assessment of MB 139:

   Logs from drillholes and shafts intercepting MB 139 were reviewed, together with detailed core and shaft photographs, as well as cores from selected drillholes. Variation in MB 139 thickness was evaluated statistically.

[1] Appendix C contains miscellaneous notes on surveying and correlation pertaining to the drillholes/shafts.

4.0 SMALL-SCALE STRATIGRAPHIC CORRELATION (GROUND SURFACE TO CASTILE FORMATION)

The results of the small-scale correlation are presented in the Geologic Section A-A' (Figure 2) extending from Drillhole DOE-1 to the northwest about 1.4 miles toward Drillhole ERDA-9 and the ventilation shaft, then turning and continuing north about one mile toward Drillhole WIPP-12. This section encompasses strata from the ground surface to the basal member of the Castile Formation. The upper strata are penetrated by eight drillholes and the two shafts while data on the lower strata are provided only by drillholes at each end of this 2.5-mile-long section. The three drillholes and two shafts which penetrate the host rock interval are spaced unevenly (three are spaced from 400 to 550 feet apart and the others from 4,400 to 7,300 feet apart). This difference in spacing affects the apparent dip calculations because undulations in individual strata are less apparent (averaged out) over the greater distances. Greater variations in dips are encountered in the host rock interval between the ventilation and exploratory shafts because these are the two most closely spaced control points. Later, this phenomenon was confirmed by the results of the underground excavations and coring (Chapter 5.0).

The correlation effort was concentrated on the host rock interval and its bounding formations/units, i.e., from the top of the Rustler Formation to the base of the Salado Formation. With only minor exceptions, all major contacts and marker beds were positively identified in all drillholes and shafts.

In general, strata thin to the north with two exceptions: (1) a slight thickening of the Rustler Formation and (2) thickening of Halite I in the Castile Formation causing the dip of the overlying strata to steepen in the vicinity of WIPP-12. This steepening diminishes upwards from the top of Halite I and disappears completely in the vicinity of MB 140 in the Salado Formation. The entire Salado Formation thins to the north

from 1,975 feet in ERDA-9 to 1,770 feet in WIPP-12 (a thinning of 205 feet). However, a thinning of only 14 feet from ERDA-9 towards DOE-1 (southeastward) was encountered. Considering the general east to southeast dip and the principal thinning direction of the strata, it appears that the thinning from ERDA-9 directly southwards may be even less.

The thickness differences in both feet and percent change from ERDA-9 are shown on both sides of the geologic section in Figure 2. A thinning of 165 feet (17 percent) occurs in the strata interval between the Union and Cowden anhydrites in the direction of WIPP-12. The same strata are only 30 feet (3 percent) thinner in DOE-1. The change in the host rock interval from ERDA-9 is 41 feet (20 percent) toward WIPP-12 and only 10 feet (5 percent) toward DOE-1.

Detailed interval thicknesses of individual beds are presented in Table 4. The listing indicates much greater uniformity between ERDA-9 and DOE-1 than toward WIPP-12.

Data on the dip of individual contacts/beds are presented in Table 5. This listing indicates a gradual increase of average apparent dip between ERDA-9 and DOE-1 from the top of the Salado Formation at 0.5 degree (0.85 percent) towards the host rock interval at 0.7 degree (1.25 percent) in a southeasterly direction. Assuming that the general dip of the strata is between east and south [based on structural contour maps in the Geological Characterization Report (Powers, et al., 1978)], the true average dip may range from about 0.7 degree (1.2 percent) to 1.0 degree (1.8 percent). It should again be emphasized that these are average dips between widely separated points.

5.0 LARGE-SCALE STRATIGRAPHIC CORRELATION (WIPP HOST ROCK INTERVAL--MB 136 TO MB 140)

Large-scale correlation was performed within the host rock interval (between MB 136 and MB 140). Results of this correlation are presented in Figure 3 as a fence diagram in which the data from the previous deep investigative drillholes/shafts were amended by data from the short coreholes drilled recently from the underground excavations.

A stratigraphic correlation referenced to ("hung on") the base of MB 139 is presented in Figure 4A. The base of MB 139 was used as the horizontal datum[1] from which other strata were plotted using accumulated thicknesses, eliminating the effect of variable elevations. Because the plot has no horizontal scale, the connecting lines between individual drillholes/shafts indicate only the lateral extent and change in thickness of the individual contacts/beds and not their dips.

For clarity, Geologic Section B-B' of the host rock interval was plotted to scale in Figure 4B (beneath the large-scale correlation in Figure 4A) using a relatively small vertical exaggeration (2.5x). The section shows the apparent dips of selected beds and superposition/projection of data from the south exploratory drift.

The symbols indicating lithology in the stratigraphic columns represent a graphical interpretation of the written geologic logs combined with graphical logs for the shafts. The geologic logs were verified by correlation with the geophysical logs. Where data on geologic logs were either missing or not available, contacts were based on interpretation of geophysical logs. All major contacts and marker beds were positively identified except MB 136 and MB 137 in DOE-1.[2] Although several clay

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[1] Minor local undulation of the MB 139 base of about ±0.4 foot is insignificant for the correlation.

[2] More details are included below in the section discussing MB 136.

seams could be correlated between the drillholes, their correlation was ranked only as very probable to probable. Many of the clay partings are apparently of very local extent. Other contacts were not possible to correlate due to (1) minor differences in logging and/or (2) slight lateral facies variations (which are very common in evaporites). Within the facility interval, principal halite units identified during the underground mapping were used in the correlation.

The graphical correlation in Figure 4 is supplemented by detailed data in Tables 4 and 5 and in Appendix B. A compilation of the data most significant for the WIPP facility is presented in Table 3 for all five principal drillhole/shaft locations. This table is based on established elevations of individual contacts; however, its primary value is in the correlation of thicknesses of selected key intervals within the host rock.

Both Table 3 and Figure 4 clearly show thinning (40 feet) of all intervals between MB 136 and MB 140 from ERDA-9 towards WIPP-12 and relatively uniform conditions with only minor thinning (17 feet) toward DOE-1. The most significant stratigraphic interval, between MB 139 and anhydrite "b,"[1] appears to be slightly thickened (1.6 feet) from 25.9 feet (ventilation shaft) to 27.5 feet (DOE-1) while toward WIPP-12 it thins (4.3 feet) to 21.6 feet. Anhydrites "b" and "a" converge in both directions from a maximum separation of 7.1 feet at the ventilation shaft to 4.6 feet at DOE-1 and 5.5 feet at WIPP-12. The vertical distance from anhydrite "a" to MB 138 is very consistent (23.4 feet ± 0.5 foot) toward DOE-1 from ERDA-9 while toward WIPP-12 it thins to 20.4 feet.

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[1] Anhydrite "b" was not identified during logging of the core from ERDA-9; therefore, it was not included in the "reference stratigraphy" used for the WIPP facility design. However, it was identified later (after its detection during mapping of the exploratory shaft) according to its signature on the geophysical logs.

The upper limit of the host rock interval is MB 136 which shows the greatest variations in thickness (from 8 to 17 feet), petrography, and mineralogy. This is clearly expressed in significantly different geophysical log signatures in individual drillholes. An alternative interpretation of the DOE-1 log to that presented in the Basic Data Report (Freeland, 1982) is shown in Figure 4A: MB 136 splits into two anhydrite beds (five and three feet thick) separated by about nine feet of anhydritic and polyhalitic halite, halite and anhydrite, and halite with pods, blebs, and stringers of anhydrite. This alternative interpretation moves MB 137 down to one of the two 0.3-foot-thick anhydrite seams, i.e., almost parallel to MB 138.

The interval between MB 139 and MB 140 thins 10 feet--from 61 feet in ERDA-9 to 51 feet towards DOE-1--while the thickness of MB 140 increases from 9 to 14.5 feet. The thinning in the WIPP-12 direction is quite pronounced--from 61 feet down to 41 feet with slight thickening of MB 140 from 9 to 12 feet. A very consistent anhydrite interbed exists within this interval about 25 feet below MB 139.

The stratigraphic position of MB 139 is relatively uniform although a relatively large undulation of its top (approximately ±0.8 feet), as encountered in both shafts and in ERDA-9, has to be expected along its entire extent. The characteristics of MB 139 are discussed in greater detail in Chapter 6.0.

Correlation of some clay seams and partings between both shafts is relatively consistent, while others are of very local extent. The ERDA-9 log indicates a greater number of partings in comparison with both shafts and other drillholes. Most of these additional partings were not shown on the original log published in Jones (1981) but on the "Engineering Geologic Log" which was prepared after an extremely detailed additional examination of the cores and core photographs. Similar detailed examination of core from Drillholes DOE-1 and WIPP-12, as well as the shafts, may also show additional minor partings and/or breaks not recorded originally.

Detailed lateral correlation of the rock between the marker beds and other major laminar features would require much additional field and laboratory work beyond the scope of this study. General trends and facies variation (normal for evaporites) described in previous reports (e.g., Powers, et al., 1978) were observed and confirmed, particularly lateral changes from anhydrite to polyhalite.

The average apparent dip of the strata within the host rock interval is about 0.7 degree (1.3 percent) southeast between ERDA-9 and DOE-1, although it is flatter at 0.1 degree (0.2 percent) southeast between ERDA-9 and the ventilation shaft and steeper at 1.5 degrees (2.6 percent) south between both shafts. Farther north, the average apparent dip is 0.3 degree (0.6 percent) south for MB 136 and 0.9 degree (1.5 percent) south for MB 140. Using the same assumptions discussed in Chapter 4.0, the probable true average dip between DOE-1, ERDA-9, the ventilation shaft, and the exploratory shaft could be 1 degree (1.7 percent), 0.2 degree (0.3 percent), and 2.1 degrees (3.7 percent), respectively, in a southerly direction. Slight local flexures, as expected, have been recorded in the underground excavations as shown in Figure 3.

Data from WIPP-11 were added to Figure 3 to indicate further lateral continuity of the host rock interval for at least 10,000 feet north beyond the Zone II boundary.

6.0 MARKER BED 139

Special consideration was given to MB 139 because of its proximity to the WIPP facility interval (floor). Two features in particular have been studied:

- Possible origin of the undulations of the top of MB 139 and
- Variation of the relief of MB 139 (thickness, strike, and dip).

Mapping of the exploratory shaft revealed that the upper surface of MB 139 is undulatory. The relief which was exposed in the shaft is about 20 inches and the distance between crests is from 2 to 6 feet.

Possible origins of the undulations include either depositional or deformational processes. Primary or depositional origin should not affect isolation in any known, significant way. A secondary or deformational origin, however, might indicate less long-term structural stability at the facility interval. The Castile Formation underlying the Salado Formation is known to be structurally deformed in the northern part of the WIPP site area (Borns, et al., 1983); however, the deformation is not known to significantly alter beds above the lower Salado Formation. The undulations of MB 139 are not important in this larger structural setting but might be locally important to the WIPP because MB 139 is only several feet below the floor of the underground excavations which basically should follow the course of MB 139. The variation in relief is important for mining operations. If the relief is irregular and sometimes large, the miner may encounter the anhydrite bed.

Prior to the SPDV excavations, the U.S. DOE had drilled nine deep investigative boreholes in the Los Medaños area and two large-diameter shafts which penetrated MB 139 (Table 6). Fifteen short vertical coreholes drilled from the drifts provided additional data on MB 139

(Appendix B). The thickness of MB 139 in the deep drillholes ranges from 2.2 to 3.0 feet. This range is comparable to the local thickness variations of 1.2 to 4.1 feet in the shafts and in the small-diameter coreholes drilled from the mined area.

The encountered thicknesses of MB 139 as summarized in Table 6 have been statistically analyzed with the results shown in Table 7. In the exploratory shaft, the thickness was measured at 20 points around the 38-foot perimeter (in uniform intervals except near maximum or minimum thicknesses, where the intervals were adjusted to incorporate the extreme values). The thickness ranged between 2 and 3.5 feet with an average value of 2.8 feet and a standard deviation of 0.4 foot. Similar measurements were made in the ventilation shaft at 15 points around the 19-foot perimeter with the following results: range of thicknesses between 1.7 and 3.5 feet with an average value of 2.8 feet and a standard deviation of 0.5 foot.

The coreholes drilled from the present excavation plus both shafts and ERDA-9 indicated slightly greater variation ranging from 1.2 to 4.1 feet with an average of 2.6 feet and a standard deviation of 0.7 foot. All available data points produce a range between 1.2 and 4.1 feet with an average of 2.6 feet and a standard deviation of 0.6 foot.

A portable radar unit has been used in an attempt to obtain data on the depth of MB 139 below the floor of the mined-out area of SPDV. The data have been generally uninterpretable with regard to depth of, or undulations on, the upper surface of MB 139.

The known variations in thickness of MB 139 should not present an operational hazard. The overall thickness of the facility interval units is sufficient for operations and the known undulations do not affect the stability of the mined openings. The statistical sample, based only on the previous drillhole data, is small, but the SPDV mining which has been completed increases the confidence considerably. The combined data

strongly suggest that the undulations will, in themselves, not limit mining operations.

Several observations preclude a deformational origin for the relief of MB 139. The base of MB 139, as exposed and mapped in the exploratory shaft, exhibits only minor, gentle relief (about ±2 inches locally and ±5 inches along the entire shaft perimeter) compared to the upper surface. In a thin unit like MB 139, the upper surface is highly unlikely to deform structurally without affecting the lower part of the unit and the base. Halite-rich beds immediately overlying MB 139 show stratification which is nearly horizontal and not parallel the undulations. The lack of fracturing or evidence of plastic flow within MB 139, combined with the "flat" bedding above and below, reasonably rule out deformation as the source of the undulations.

Several additional observations indicate a depositional origin for the relief on MB 139. Core of MB 139 as well as other marker beds from AEC-7 and 8, DOE-1, ERDA-9, and WIPP-12 and 13 exhibit halite pseudomorphs after gypsum with "swallow-tail" morphology (Handford and Bassett, 1982, Figure 2C; Lowenstein, 1982, Figure 4C; Schreiber, et al., 1982, Figure 3). The pseudomorphs from most of these boreholes are about 1 centimeter in length or less. Twinned primary gypsum grew upward in fan-like clusters, sometimes with epitaxial layers. Halite subsequently replaced gypsum or grew into cavities after solution of gypsum crystals. The resulting texture is distinctive. An excellent example of "swallow-tail" morphology is shown in Figure 5, a photograph of MB 136 in Drillhole AEC-8. This shows the halite pseudomorph after original gypsum crystals, some up to six inches in length and demonstrating epitaxial growth, in an anhydrite matrix. Figure 6, a photograph of the upper surface of MB 139 in Drillhole WIPP-13, shows halite pseudomorphs after gypsum with anhydrite rims. These pseudomorphs are more chaotic in appearance than those in the previous figure. The triangular to hexagonal forms of the halite crystals may represent oblique sections through a "swallow-tail" crystal parallel to the 100 twin plane

(Schrieber, et al., 1982, Figure 3) which has subsequently been partially crushed by compaction.

On the wall of the exploratory shaft, zones in the upper part of MB 139 display "swallow-tail" structures, generally without epitaxial growth (Figure 7). The undulations of MB 139 in the exploratory shaft (Figure 8) display a general radial or fan-like pattern similar to the twin planes in the "swallow-tail" structures. There are also fragments with an appearance of "growth lines" parallel to the upper surface of the crests. The "growth lines" are poorly developed in the shaft walls. The "mounds" appear to be caused by localized growth of the twinned gypsum. Precipitation did not keep pace with the gypsum growth. Halite then precipitated which filled the lows and evened the depositional surface. Void space probably existed within the "mounds" during deposition or was created during diagenesis. The weight of overlying sediment soon crushed the mounds slightly to create the present texture. Textures of the original gypsum growths remain, though partially disrupted. In other parts of the basin, conditions were obviously also favorable for gypsum growth, but the growths had either little void space or the void space had been filled by halite to preserve the texture.

In summary, the undulations on MB 139 are reasonably explained as mounds caused by growth of gypsum crystal clusters which were later slightly crushed by overburden pressure. The relief is not likely to be much greater than that observed in the exploratory shaft since the structure was formed by a process controlled by large-scale environmental/chemical conditions.

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TABLE 1
BASIC DATA ON DEEP DRILLHOLES/SHAFTS

BASIC DATA \ BORING/SHAFT			DOE-1	ERDA-9	VENTILATION SHAFT	EXPLORATORY SHAFT	B-25	WIPP-21	WIPP-22	WIPP-19	WIPP-18	WIPP-12
LOCATION	Section	Sec.	28	20	20	20	20	20	20	20	20	17
		Twshp.	T22S	T22S	T22S	T22S	T22S	T22S	T22S	T22S	T22S	T22S
		Range	R31E	R31E	R31E	R31E	R31E	R31E	R31E	R31E	R31E	R31E
	Distance (Ft) From Section Lines	N-S	182 FSL	267.23 FSL	668 FSL	1068 FSL	796 FSL	1451.08 FSL	2544.45 FSL	2987.34 FSL	983.58 FNL	147.9 FSL
		E-W	610 FEL	176.74 FEL	551 FSL	576 FSL	777 FEL	11.74 FEL	10.94 FEL	12.68 FEL	11.45 FEL	83.9 FEL
	New Mexico Grid Coordinates	N	N493503(1)	N498886.02	N499287.23	N499687.23	N499414.91	N500071.84	N501165(1)	N501608(1)	N502913(1)	N504044.90
		E	E672175(1)	E667293.80	E666919.89	E666894.89	E666693.11	E667461.08	E667458(1)	E667453(1)	E667447(1)	E667369.07
ELEVATION (Ft. Above MSL)	Kelly Bushing	KB	3473.2	3420.4	(2)	3417.5	(2)	(2)	(2)	(2)	(2)	3483.7
	Ground Surface	GS	3465.2	3408.9	3407.5	3410.5	3408.7	3417.0	3425.8	3433.1	3456.5	3471.5
	Zero Datum Point of Geolog. Logs		3473.2	3420.4	3407.9(3)	3410.0(4)	3408.7	3417.0	3425.8	3433.1	3456.5	(5)
	Total Depth	TD	-592.1	531.4	1211.5	1112.5	2506.9	2372.0	1975.8	2394.9	2396.5	-453.5
TOTAL DEPTH (Ft) From Ground Surface			4057.3	2877.5	2196.0	2298	901.8	1045	1450	1038.2	1060	3925
DEEPEST ROCK UNIT ENCOUNTERED			Castile Form. Anhydrite I	Castile Form. above Anhydrite III	Lower Salado Below MB 139	Lower Salado Below MB 140	Upper Salado Above MB 10	Upper Salado At MB 103	McNutt Member Below MB 117	Upper Salado Below MB 100	Upper Salado Below MB 102	Castile Form. Halite I
RANGE OF BORING/SHAFT DIAMETER		INCHES	20 - 7 7/8	20 - 9 7/8	108 - 72	180 - 120	9 7/8 - 6 1/4	8 3/4 - 6 1/8	8 3/4 - 6 1/8	8 3/4 - 6 1/8	8 3/4 - 6 1/8	18 - 7 7/8
		FEET	1.7 - 0.7	1.7 - 0.8	9 - 6	15 - 10	0.8 - 0.5	0.7 - 0.5	0.7 - 0.5	0.7 - 0.5	0.7 - 0.5	1.5 - 0.7
BOREHOLE/SHAFT DATA REFERENCE NUMBERS			12	19, 24	13	18	7,24	5, 24	6, 24	4, 24	3, 24	2, 10, 24

NOTES:

(1) Approximate coordinates only, insufficient data available for calculating accurate coordinates.

(2) Data not reported.

(3) Elevation of shaft collar.

(4) Elevation of top bunton guide

(5) For depths of 0-2737.5 ft., the datum was the KB elevation of 3483.7;
below depth of 2737.5 ft., the datum was the GS elevation of 3471.5

TABLE 2
BASIC DATA ON SHORT VERTICAL COREHOLES[1]

The coreholes were drilled from the underground SPDV excavation between November 1982 and February 1983 with a Joy 12B rotary drill, except corehole DO-53, which was drilled with a Longyear 38 rig. The Joy 12B rig and all drilling equipment were mounted on a diesel-powered, truck-like equipment carrier. The drill engine and the water pump were electrically operated from 480-volt power.

Coring was accomplished with a diamond core bit which produces NX-size (2-inch nominal diameter) core. The drill holes were left uncased and have a nominal diameter of three inches. An "M" series, five-foot core barrel was used with two-foot and five-foot drill rods. Brine was used as the drilling fluid. The average core recovery was about 92 percent.

BORING NO.	DIRECTION	COLLAR ELEVATION (FT-MSL)	STATION[2] (FEET)	MINE COORDINATES[3] (FEET)	DEPTH/ PENETRATION (FEET)
MB-139-1	Down	1264.1	N79 W6	N9766 E6888	10.0
MB-139-2	Down	1251.2	S410 E150	N9277 E7044	15.7
MB-139-3	Down	1260.5	S101 E157	N9586 E7051	16.0
MB-139-4	Down	1258.7	S99 W17	N9588 E6877	16.2
DO-45	Up	1285.5[4]	N254 E147	N9941.0 E7041.3	52.4
DO-46	Down	1276.5[4]	N254 E147	N9941.0 E7041.3	51.5
DO-52	Up	1280.4	N146 W4	N9832.5 E6890.5	51.6
DO-53	Down	1266.6	N146 W4	N9832.5 E6890.5	49.2
DO-63	Up	1310.6	N1100 E0	N10796 E6892	52.8
DO-64	Down	1301.5	N1100 E0	N10796 E6892	52.8
DO-201	Up	1262.2	S406 W19	N9280.6 E6874.9	51.7
DO-202	Down	1248.6	S406 W19	N9280.6 E6874.9	51.4
DO-205	Up	1316.5	N1400 E0	N11095 E6892	50.7
DO-206	Down	1308.0	N1400 E0	N11095 E6892	50.6
DH-207	Up	1259.8	S697 E155	N8989.7 E7049.1	53.0
DH-208	Down	1251.6	S698 E150	N8988.8 E7044.0	49.2
DH-211	Up	1270.5	S1320 E163	N8366.5 E7057.1	50.0
DH-212	Down	1261.7	S1320 E163	N8366.5 E7057.1	52.1
DH-215	Up	1272.0	S1960 E153	N7727.2 E7046.9	52.0
DH-216	Down	1262.6	S1960 E153	N7727.2 E7046.9	54.2
DH-219	Up	1266.3	S2422 E162	N7264.9 E7056.6	51.0
DH-219A[5]	Up	1266.1	S2418 E162	N7268.5 E7056.2	11.3
DH-220	Down	1257.4	S2421 E162	N7265.5 E7055.9	51.8
DH-223	Up	1255.1	S3079 E154	N6607.2 E7048.5	52.6
DH-224	Down	1246.6	S3079 E154	N6607.5 E7048.5	52.5
DH-227	Up	1247.0	S3656 E147	N6030.7 E7041.2	51.7
DH-228	Down	1237.8	S3656 E147	N6030.7 E7041.2	50.4

(1) Adapted from GFDR No. 9 (1983c).

(2) Referenced to Exploratory Shaft centerline as Station 0-0.

(3) Referenced to local grid coordinates based on the New Mexico Grid system. Add 660,000 to the E coordinates and 490,000 to the N coordinates.

(4) Estimated because hole was lost under muck before surveying.

(5) Drilled adjacent to DH-219 to fill in gap in core.

TABLE 3

CORRELATION OF LITHOLOGY/STRATIGRAPHY BETWEEN MB 136 AND MB 140 BASED ON DEEP DRILLHOLES/SHAFTS

BORING/SHAFT	DOE-1						ERDA-9						VENTILATION SHAFT						EXPLORATORY SHAFT						WIPP-12						RANGE OF THICKNESSES			
STRATA/CONTACT	Elevation	Thickness of Strata	Interval Thickness Between Strata Bases	Interval Thickness Between Selected Contacts	Elevation of Strata Centers	Interval Thickness Between Strata Centers	Elevation	Thickness of Strata	Interval Thickness Between Strata Bases	Interval Thickness Between Selected Contacts	Elevation of Strata Centers	Interval Thickness Between Strata Centers	Elevation	Thickness of Strata	Interval Thickness Between Strata Bases	Interval Thickness Between Selected Contacts	Elevation of Strata Centers	Interval Thickness Between Strata Centers	Elevation	Thickness of Strata	Interval Thickness Between Strata Bases	Interval Thickness Between Selected Contacts	Elevation of Strata Centers	Interval Thickness Between Strata Centers	Elevation	Thickness of Strata	Interval Thickness Between Strata Bases	Interval Thickness Between Selected Contacts	Elevation of Strata Centers	Interval Thickness Between Strata Centers	Strata	Interval Between Strata Bases	Interval Between Selected Contacts	Interval Between Strata Centers
	FT MSL	FT	FT	FT	FT MSL	FT	FT MSL	FT	FT	FT	FT MSL	FT	FT MSL	FT	FT	FT	FT MSL	FT	FT MSL	FT	FT	FT	FT MSL	FT	FT MSL	FT	FT	FT	FT MSL	FT	FT - FT	FT - FT	FT - FT	FT - FT
MB136-T	1281.1	17.1			1272.6		1377.2	14.9			1369.8		1378.1	14.6			1370.8		1382.6	8.5			1378.4		1412.1	11.5			1406.4		8.5-17.1			
MB136-B	1264.0					18.9	1362.3					24.0	1363.5					NA	1374.1					20.3	1400.6					NA				18.9-24.0
MB137-T	1253.8	0.3	10.5		1253.7		1345.9	0.2	-16.6		1345.8		Not Described		NA		NA		1358.4	0.7	16.4		1358.1		Not Described		NA		NA		0.2-0.7	10.5-16.6		
MB137-B	1253.5					45.6	1345.7					46.1	Not Described					NA	1357.7					46.6	Not Described					NA				45.6-46.6
MB138-T	1208.4	0.7	45.8		1208.1		1300.0	0.7	46.4		1299.7		1300.7	0.5	NA		1300.5		1311.6	0.3	46.4		1311.5		1349.1	0.5	NA		1348.9		0.3-0.7	45.8-46.4		
MB138-B	1207.7			84.8		24.0	1299.3			93.1		23.6	1300.2			93.3		22.8	1311.3			93.3		23.4	1348.6			77.9		19.7			77.9-93.3	19.7-24.0
ANH.A-T	1184.3	0.5	23.9		1184.1		1276.5	0.9	23.7		1276.1		1278.1	0.8	22.9		1277.7		1288.4	0.7	23.6		1288.1		1330.2	2.0	20.4		1329.2		0.5-2.0	20.4-23.9		
ANH.A-B	1183.8					4.4	1275.6					6.8	1277.3					7.3	1287.7					7.1	1328.2					6.4				4.4-7.3
ANH.B-T	1180.2	1.0	6.6		1179.7		1269.4	0.2	6.4		1269.3		1270.5	0.3	7.1		1270.4		1281.1	0.3	6.9		1281.0		1322.8	0.1	5.5		1322.8		0.1-1.0	4.6-7.1		
ANH.B-B	1179.2			27.5		29.1	1269.2			26.1		27.7	1270.2			25.9		27.6	1280.8			27.1		28.7	1322.7			21.6		22.9			21.6-27.5	22.9-29.1
MB139-T	1151.7		29.7				1243.1		29.1				1244.3		28.7				1253.7		29.9				1301.1		23.9					23.9-29.9		
MB139-C	1150.6	2.2		2.2	1150.6		1241.6	3.0		3.0	1241.6		1242.9	2.8		2.8	1242.9		1252.3	2.8		2.8	1252.3		1299.9	2.3		2.3	1299.9		2.2-3.0		2.2-3.0	
MB139-B	1149.5			50.8		59.1	1240.1			61.0		67.1	1241.5			NA		NA	1250.9			63.5		69.4	1298.8			41.2		48.3			41.2-63.5	48.3-69.4
MB140-T	1098.7	14.5	65.3	14.5	1091.5		1179.1	9.2	70.2	9.2	1174.5		Not Penetrated		NA	NA	NA		1187.4	9.0	72.5	9.0	1182.9		1257.6	12.0	53.2	12.0	1251.6		9.0-14.5	53.2-72.5	9.0-14.5	
MB140-B	1084.2						1169.9						Not Penetrated						1178.4						1245.6									

LEGEND:
T - Top of strata/layer
B - Base of strata/layer
C - Center of strata/layer

TABLE 4

INTERVAL/BED THICKNESSES IN DEEP DRILLHOLES/SHAFTS

Lithological Contact	DOE-1	ERDA-9	Ventilation Shaft	B-25	Exploratory Shaft	WIPP-21	WIPP-22	WIPP-19	WIPP-18	WIPP-12
GR. SURFACE	8.0	11.5	0.4	0.0	-0.5	0.0	0.0	0.0	0.0	12.2
HOL/M. CAL		10.5		10.0		6.0	6.0	7.0	5.0	4.0
M. CAL/GAT		3.0		4.0		6.0	7.0	7.0	4.0	3.0
GAT/SR5	125.0	27.0		20.7		27.0				9.6
SR5/DLR		9.0		10.1		34.0	68.0	82.0	129.0	138.2
DLR/RUS	534.5	487.0	536.1	488.2		487.0	493.0	494.0	473.0	473.0
MAGENTA-T	34.5	38.0	17.7	39.7		17.0	16.0	18.0	17.0	63.9
MAGENTA-B	23.0	24.0	22.1	24.3		24.0	24.0	25.0	24.0	23.1
CULEBRA-T	83.6	84.0	21.6	87.1		14.0	14.0	0.0	18.0	95.0
CULEBRA-B	21.9	23.0	21.2	23.9		24.0	22.0	23.0	21.0	24.8
RUS/SAL	126.0	123.0	110.4	114.9	851.1	109.0	112.0	100.0	106.0	119.2
MB100-T		74.0	76.7	38.9 (T.D.)	71.4			115.0		
MB100-B		2.5	0.6		0.8			2.0		
MB101-T	122.5	42.3(118.8)	43.4 (126.7)		48.0(119.2)	18.0	115.0	26.2 (T.D.)	18.0	114.0
MB101-B	3.0	2.7	3.0		4.2	3.0	3.0		3.0	4.5
MB102-T	34.0	42.5	36.9		34.7	36.0	33.0		11.0 (T.D.)	30.5
MB102-B	2.5	1.5	1.1		1.4	1.0	1.0			1.0
MB103-T	20.5	12.5	11.2		12.3	13.0	12.0			14.0
MB103-B	10.0	10.0	15.8		14.1	7.0 (T.D.)	14.0			11.0
MB104-T		11.0	7.1		8.1		8.0			8.0
MB104-B		1.0	1.0		0.5		1.0			1.0
MB105-T	28.0	14.0(26.0)	15.7 (23.8)		15.3(23.9)		14.0(23.0)			17.0 (26.0)
MB105-B	2.0	2.0	0.9		0.4		1.0			0.6
MB106-T	14.0	15.1	15.1		19.5		15.0			14.9
MB106-B	3.0	0.6	0.4		1.0		1.0			1.0
MB107-T	36.0	37.7	38.3		34.0		39.0			38.0
MB107-B	2.0	0.4	0.5		0.3		1.0			1.5
MB108-T	7.0	8.8	9.2		9.2		7.0			9.0
MB108-B	2.0	0.9	0.5		0.5		1.0			0.5
MB109-T	23.0	23.0	23.1		20.9		21.0			21.5
MB109-B	23.5	23.5	25.2		25.5		24.0			24.0
MB110-T					31.6					
MB110-B					1.2					
MB111-T	51.0	49.2	48.3		15.8(48.6)		46.0			45.5
MB111-B	0.8	1.0	0.5		0.2		1.0			0.5
MB112-T	16.8	17.8	17.3		16.9		16.0			14.0
MB112-B	1.7	2.1	2.1		2.9		2.0			4.0
MB113-T	23.2	24.3	24.6		24.8		24.0			23.5
MB113-B	3.9	2.6	1.7		1.6		1.0			1.5
MB114-T	18.3	20.6	21.7		21.5		21.0			21.0
MB114-B	4.1	0.8	1.0		1.3		1.0			1.0
MB115-T	32.6	33.9	34.9		35.0		34.0			33.0
MB115-B	3.9	3.6	3.4		3.0		2.0			2.5
MB116-T	9.2	9.7	9.5		8.5		9.0			10.5
MB116-B	2.6	2.0	2.6		2.6		2.0			1.0
UP. SAL/MCN	8.4	6.6	6.1		6.0		8.0			8.0
V. T. SAND-T	0.0	1.1			3.1		0.0			0.0
V. T. SAND-B	3.8	4.4			1.7		4.0			3.0
MB117-T	65.7(69.5)	63.5(69.0)	69.8		65.5(70.3)		39.0(63.0)			59.5 (62.5)
MB117-B	1.7	1.3	1.3		1.1		1.0			1.0
MB118-T	22.8	22.4	22.1		27.5		23.0(T.D.)			20.5
MB118-B	2.6	2.1	2.6		2.7					3.0
MB119-T	22.4	24.6	24.4		17.9					21.0
MB119-B	3.0	0.6	1.1		1.8					4.5
MB120-T	23.0	19.1	18.7		18.1					15.5
MB120-B	1.0	1.8	0.8		0.9					3.0
MB121-T	12.2	12.1	12.5		10.9					11.0
MB121-B	2.3	2.0	2.6		2.3					2.0
MB122-T	8.0	6.3	6.8		7.0					6.5
MB122-B	1.5	0.8	1.2		1.3					1.5
UN. AN-T	25.4	24.4	25.1		28.4					21.0
UN. AN-B	12.6	8.1	7.5		4.0					8.0
MB123-T	68.0	73.0	72.7		73.1					70.0
MB123-B	7.9	7.4	6.6		5.1					5.8
MB124-T	3.1	7.6	6.1		3.6					7.2
MB124-B	10.8	6.9	9.7		8.0					7.4
MB125-T					51.5					
MB125-B					2.1					
MB126-T	95.5	89.6	89.0		36.1(89.7)					80.6
MB126-B	1.0	0.7	0.9		1.5					2.0
MB127-T	24.2	26.3	25.5		22.9					24.5
MB127-B	2.9	1.4	2.5		3.0					2.5
MB128-T	10.3	8.4	9.3		8.2					9.0
MB128-B	2.0	3.1	2.0		2.9					2.5
MB129-T	22.6	22.1	22.9		23.5					18.0
MB129-B	2.0	1.9	1.9		1.9					2.0
MB130-T	11.7	8.3	9.2		10.0					9.5
MB130-B	0.7	1.5	1.0		0.1					1.0
MB131-T	67.3	68.4	67.7		67.3					61.5
MB131-B	1.8	0.6	0.8		1.3					1.5
MB132-T	29.7	30.1	30.4		33.2					26.0
MB132-B	1.1	0.9	1.0		0.6					1.5
MB133-T	18.4	17.7	17.2		13.8					16.5
MB133-B	1.0	1.8	1.4		0.9					2.0
MB134-T	41.0	41.5	43.8		42.5					39.0
MB134-B	13.0	12.6	11.2		11.7					10.0
MB135-T	18.5	16.5	16.3		16.3					14.0
MB135-B	0.9	1.3	1.2		1.1					1.0
MB136-T	42.7	36.8	38.9		41.4					31.6
MB136-B	17.1	14.9	14.6		8.5					11.5
MB137-T	10.2	16.4			15.7					
MB137-B	0.3	0.2			0.7					
MB138-T	45.1 (55.6)	45.7 (62.3)	62.8		46.1 (62.5)					51.5
MB138-B	0.7	0.7	0.5		0.3					0.5
AN. A-T	23.4	22.8	22.1		9.0					18.3
AN. A-B	0.5	0.9	0.8		0.7					2.0
AN. B-T	3.6	6.2	6.7		6.5					5.4
AN. B-B	1.0	0.2	0.3		0.3					0.1
MB139-T	27.5	26.1	25.9		27.1					21.6
MB139-C	1.1	1.5	1.4		1.4					1.2
MB139-B	1.1	1.5	1.4		1.4					1.1
MB140-T	30.8	61.0	28.8 (T.D.)		63.5					41.2
MB140-B	14.5	9.2			9.0 (T.D.)					12.0
MB141-T	61.0	69.9								51.9
MB141-B	7.0	9.5								6.0
MB142-T	40.0	47.1								36.0
MB142-B	15.0	14.4								12.0
MB143-T	51.5	58.2								37.5
MB143-B	7.0	5.9								6.1
MB144-T	35.5	42.9								25.9
MB144-B	15.5	3.4								10.4
COWDEN-T	26.3	38.5								21.6
COWDEN-B	29.2	22.2								25.5
SAL/CAST	259.5	273.8								266.5
ANJ/HAL2	438.3	52.7 (T.D.)								328.6
HAL2/AN2	225.2									227.9
AN2/HAL1	108.3									109.2
HAL1/AN1	324.0									310.6
T. D.	33.0 (T.D.)									23.4 (T.D.)

NOTES:

1. Indicated thicknesses are calculated from preceding contacts.
2. Numbers in parentheses include one or more higher intervals for comparison with drillholes/shafts where these intervals are missing.
3. Interval thickness next to "(T.D.)" indicates only the depth penetrated into the deepest strata/bed encountered.

TABLE 5

APPARENT DIPS[1] BETWEEN DEEP DRILLHOLES/SHAFTS

Strata/ Contact	DOE-1 Elevations (FT. MSL)	Apparent Dip %[2]	ERDA-9 Elevations (FT. MSL)	Apparent Dip %[2]	Vent.Sh. Elevations (FT. MSL)	Apparent Dip %[2]	Expl. Sh. Elevations (FT. MSL)	Apparent Dip %[2]	WIPP-12 Elevations (FT. MSL)
GR. SURFACE	3465.2	-0.77	3408.9	-0.26	3407.5	0.75	3410.5	1.38	3471.5
MDL/M CAL			3398.4						3467.5
M CAL/GAT			3393.4						3464.5
GAT/SRS	3340.2	0.36	3366.4						3434.9
SRS/DLR	3340.2	0.24	3357.4						3316.7
DLR/RUS	2805.7	0.89	2870.4	0.18	2871.4				2843.7
MAGENTA-T	2751.2	0.84	2812.4	-0.11	2811.8				2779.8
MAGENTA-B	2728.2	0.83	2788.4	0.24	2789.7				2756.7
CULEBRA-T	2644.6	0.82	2704.4	-0.40	2702.2				2661.7
CULEBRA-B	2622.7	0.81	2681.4	-0.07	2681.0				2636.9
RUS/SAL	2496.7	0.85	2558.4	0.88	2563.2	-0.95	2559.4	-0.95	2517.7
MB100-T			2484.4	0.38	2486.5	0.37	2488.0		
MB100-B			2481.9	0.73	2485.9	0.32	2487.2		
MB101-T	2374.2	0.90	2439.6	0.53	2442.5	-0.82	2439.2	-0.80	2403.7
MB101-B	2371.2	0.90	2436.9	0.47	2439.5	-1.12	2435.0	-0.81	2399.2
MB102-T	2337.2	0.79	2394.4	1.50	2402.6	-0.57	2400.3	-0.72	2368.7
MB102-B	2334.7	0.80	2392.9	1.57	2401.5	-0.65	2398.9	-0.71	2367.7
MB103-T	2314.2	0.91	2380.4	1.81	2390.3	-0.92	2386.6	-0.75	2353.7
MB103-B	2304.2	0.91	2370.4	0.75	2374.5	-0.50	2372.5	-0.68	2342.7
MB104-T			2359.4	1.46	2367.4	-0.75	2364.4	-0.67	2334.7
MB104-B			2358.4	1.46	2366.4	-0.62	2363.9	-0.68	2333.7
MB105-T	2276.2	0.94	2344.4	1.15	2350.7	-0.52	2348.6	-0.72	2316.7
MB105-B	2274.2	0.94	2342.4	1.35	2349.8	-0.40	2348.2	-0.73	2316.1
MB106-T	2260.2	0.92	2327.3	1.35	2334.7	-1.30	2328.7	-0.62	2301.2
MB106-B	2257.2	0.96	2326.7	1.39	2334.3	-1.65	2327.7	-0.62	2300.2
MB107-T	2221.2	0.93	2289.0	1.28	2296.0	-0.57	2293.7	-0.71	2262.2
MB107-B	2219.2	0.96	2288.6	1.26	2295.5	-0.52	2293.4	-0.74	2260.7
MB108-T	2212.2	0.93	2279.8	1.19	2286.3	-0.52	2284.2	-0.74	2251.7
MB108-B	2210.2	0.95	2278.9	1.26	2285.8	-0.52	2283.7	-0.74	2251.2
MB109-T	2187.2	0.95	2255.9	1.24	2262.7	0.02	2262.8	-0.75	2229.7
MB109-B	2163.7	0.95	2232.4	0.93	2237.5	-0.05	2237.3	-0.72	2205.7
MB110-T							2205.7		
MB110-B							2204.5		
MB111-T	2112.7	0.97	2183.2	1.09	2189.2	-0.12	2188.7	-0.65	2160.2
MB111-B	2111.9	0.97	2182.2	1.19	2188.7	-0.05	2188.5	-0.65	2159.7
MB112-T	2095.1	0.95	2164.4	1.28	2171.4	0.05	2171.6	-0.59	2145.7
MB112-B	2093.4	0.95	2162.3	1.28	2169.3	-0.15	2168.7	-0.61	2141.7
MB113-T	2070.2	0.93	2138.0	1.22	2144.7	-0.20	2143.9	-0.58	2118.2
MB113-B	2066.3	0.95	2135.4	1.19	2143.0	-0.17	2142.3	-0.58	2116.7
MB114-T	2048.0	0.92	2114.8	1.19	2121.3	-0.12	2120.8	-0.57	2095.7
MB114-B	2043.9	0.96	2114.0	1.15	2120.3	-0.20	2119.5	-0.56	2094.7
MB115-T	2011.3	0.95	2080.1	0.97	2085.4	-0.22	2084.5	-0.52	2061.7
MB115-B	2007.4	0.95	2076.5	1.00	2082.0	-0.12	2081.5	-0.51	2059.2
MB116-T	1998.2	0.94	2066.8	1.04	2072.5	0.12	2073.0	-0.55	2048.7
MB116-B	1995.6	0.95	2064.8	0.93	2069.9	0.12	2070.4	-0.51	2047.7
UP. SAL/MCN	1987.2	0.98	2058.2	1.02	2063.8	0.15	2064.4	-0.56	2039.7
V T SAND-T	1987.2	0.96	2057.1				2061.3	-0.49	2039.7
V T SAND-B	1983.4	0.95	2052.7				2059.6	-0.52	2036.7
MB117-T	1917.7	0.98	1989.2	0.88	1994.0	0.02	1994.1	-0.38	1977.2
MB117-B	1916.0	0.99	1987.9	0.88	1992.7	0.07	1993.0	-0.38	1976.2
MB118-T	1893.2	0.99	1965.5	0.93	1970.6	-1.27	1965.5	-0.22	1955.7
MB118-B	1890.6	1.00	1963.4	0.84	1968.0	-1.30	1962.8	-0.23	1952.7
MB119-T	1868.2	0.97	1938.8	0.88	1943.6	0.32	1944.9	-0.30	1931.7
MB119-B	1865.2	1.00	1938.2	0.78	1942.5	0.15	1943.1	-0.36	1927.2
MB120-T	1842.2	1.06	1919.1	0.86	1923.8	0.30	1925.0	-0.30	1911.7
MB120-B	1841.2	1.05	1917.3	1.04	1923.0	0.27	1924.1	-0.35	1908.7
MB121-T	1829.0	1.05	1905.2	0.97	1910.5	0.67	1913.2	-0.35	1897.7
MB121-B	1826.7	1.05	1903.2	0.86	1907.9	0.75	1910.9	-0.34	1895.7
MB122-T	1818.7	1.08	1896.9	0.77	1901.1	0.70	1903.9	-0.33	1889.2
MB122-B	1817.2	1.09	1896.1	0.69	1899.9	0.67	1902.6	-0.34	1887.7
UN AN-T	1791.8	1.10	1871.7	0.57	1874.8	-0.15	1874.2	-0.17	1866.7
UN AN-B	1779.2	1.16	1863.6	0.68	1867.3	0.72	1870.2	-0.26	1858.7
MB123-T	1711.2	1.09	1790.6	0.73	1794.6	0.12	1795.1	-0.15	1788.7
MB123-B	1703.3	1.10	1783.2	0.88	1788.0	0.30	1790.0	-0.16	1782.9
MB124-T	1700.2	1.04	1775.6	1.15	1781.9	0.62	1784.4	-0.20	1775.7
MB124-B	1689.4	1.09	1768.7	0.64	1772.2	1.05	1776.4	-0.18	1768.3
MB125-T							1724.9		
MB125-B							1722.8		
MB126-T	1593.9	1.17	1679.1	0.73	1683.2	0.87	1686.7	0.02	1687.7
MB126-B	1592.9	1.18	1678.4	0.71	1682.3	0.72	1685.2	0.01	1685.7
MB127-T	1568.7	1.15	1652.1	0.86	1656.8	1.37	1662.3	-0.02	1661.2
MB127-B	1565.8	1.17	1650.7	0.66	1654.3	1.25	1659.3	-0.01	1658.7
MB128-T	1555.5	1.19	1642.3	0.49	1645.0	1.32	1651.1	-0.03	1649.7
MB128-B	1553.5	1.18	1639.2	0.69	1643.0	1.30	1648.2	-0.02	1647.2
MB129-T	1530.9	1.19	1617.1	0.55	1620.1	1.15	1624.7	0.10	1629.2
MB129-B	1528.9	1.19	1615.2	0.55	1618.2	1.15	1622.8	0.10	1627.2
MB130-T	1517.2	1.23	1606.9	0.38	1609.0	0.95	1612.8	0.11	1617.7
MB130-B	1516.5	1.22	1605.4	0.47	1608.0	1.17	1612.7	0.09	1616.7
MB131-T	1449.2	1.21	1537.0	0.60	1540.3	1.27	1545.4	0.22	1555.2
MB131-B	1447.4	1.22	1536.4	0.57	1539.5	1.15	1544.1	0.22	1553.7
MB132-T	1417.7	1.22	1506.3	0.51	1509.1	0.45	1510.9	0.38	1527.7
MB132-B	1416.6	1.22	1505.4	0.49	1508.1	0.55	1510.3	0.36	1526.2
MB133-T	1398.2	1.23	1487.7	0.58	1490.9	1.40	1496.5	0.30	1509.7
MB133-B	1397.2	1.22	1485.9	0.66	1489.5	1.32	1495.6	0.27	1507.7
MB134-T	1356.2	1.21	1444.4	0.24	1445.7	1.85	1453.1	0.35	1468.7
MB134-B	1343.2	1.22	1431.8	0.49	1434.5	1.72	1441.4	0.39	1458.7
MB135-T	1324.7	1.25	1413.3	0.53	1416.2	1.72	1423.1	0.44	1444.7
MB135-B	1323.8	1.24	1414.0	0.55	1417.0	1.75	1424.0	0.45	1443.7
MB136-T	1281.1	1.32	1377.2	0.16	1378.1	1.12	1382.6	0.67	1412.1
MB136-B	1264.0	1.35	1362.3	0.22	1363.5	2.64	1374.1	0.60	1400.6
MB137-T	1253.8	1.27	1345.9				1358.4		
MB137-B	1253.5	1.27	1345.7				1357.7		
MB138-T	1208.4	1.26	1300.0	0.13	1300.7	2.72	1311.6	0.85	1349.1
MB138-B	1207.7	1.26	1299.3	0.16	1300.2	2.77	1311.3	0.85	1348.6
AN A-T	1184.3	1.27	1276.5	0.29	1278.1	2.57	1288.4	0.95	1330.2
AN A-B	1183.8	1.26	1275.6	0.31	1277.3	2.59	1287.7	0.92	1328.2
AN B-T	1180.2	1.23	1269.4	0.20	1270.5	2.64	1281.1	0.95	1322.8
AN B-B	1179.2	1.24	1269.2	0.18	1270.2	2.64	1280.8	0.95	1322.7
MB139-T	1151.7	1.26	1243.1	0.22	1244.3	2.34	1253.7	1.07	1301.1
MB139-C	1150.6	1.25	1241.6	0.24	1242.9	2.34	1252.3	1.08	1299.9
MB139-B	1149.5	1.25	1240.1	0.26	1241.5	2.34	1250.9	1.09	1298.8
MB140-T	1098.7	1.11	1179.1				1187.4	1.59	1257.6
MB140-B	1084.2	1.18	1169.9				1178.4	1.52	1245.6
MB141-T	1023.2	1.06	1100.0						1193.7
MB141-B	1016.2	1.02	1090.5						1187.7
MB142-T	976.2	0.92	1043.4						1151.7
MB142-B	961.2	0.93	1029.0						1139.7
MB143-T	909.7	0.84	970.8						1102.2
MB143-B	902.7	0.86	964.9						1096.1
MB144-T	867.2	0.79	922.0						1070.2
MB144-B	851.7	0.92	918.6						1059.8
COWDEN-T	825.4	0.75	880.1						1038.2
COWDEN-B	796.2	0.85	857.9						1012.7
SAL/CABT	336.7	0.65	384.1						746.2
AN3/HAL2	98.4								417.6
HAL2/AN2	-126.8								189.7
AN2/HAL1	-235.1								80.5
HAL1/AN1	-359.1								-430.1
T.D	-592.1		531.4		1212.8				-453.5

NOTES:

1. Positive values indicate dips to the south or southeast; negative to the north or northwest.
2. For dip angles smaller than about 5°:
   1° = 1.746%
   1% = 0.573°
3. Missing values indicate that the respective strata/ contact was not penetrated, encountered or identified in one or more drillholes/shafts.

TABLE 6

SUMMARY OF MB 139 DATA

DRILLHOLE DESIGNATION	THICKNESS (FT)	COMPOSITION[1]	REMARKS
MB-139-1	1.8	AN-H-P-C	
MB-139-2	3.2	AN-H-P-C	Halite in "mesh" network
MB-139-3	2.3	AN-H-C	
MB-139-4	3.4	AN-H-C	
DO-46	4.1	AN-P-H-C	
DO-53	2.1	AN-H-C	
DO-64	2.2	AN-C	
DO-202	2.8	AN-C	
DO-206	1.2	AN	
DH-208	3.5	AN-C	
DH-212	1.9	AN-C	
DH-216	2.4	AN	
DH-220	2.2	AN-P-C	
DH-224	3.1	AN-H-P-C	
DH-228	2.1	AN-P-C	
Exploratory Shaft	2.8[2]	AN-P-H-C	Many halite pseudomorphs after gypsum
Ventilation Shaft	2.8[3]	AN-P-C	
ERDA-9	3.0/2.3[4]	AN-P-C	Upper contact dipping 45°
DOE-1	2.2	AN-P-H	
WIPP-11	3.0[5]	AN-P	
WIPP-12	2.3	AN-H	
WIPP-13	2.7	P/AN-H	Many halite pseudomorphs after gypsum
ERDA-6	2.9	AN-P-H	
ERDA-10	3.5	AN-P-C	
AEC-7	2.2	AN-H-P-C	Halite pseudomorphs after gypsum
AEC-8	3.1	AN-P-C	

[1] Composition determined by visual estimates listed in decreasing abundance. AN = anhydrite, P = polyhalite, H = halite, C = observed clay underseam.

[2] Average thickness (range = 2.0 to 3.5 ft.)

[3] Average thickness (range = 1.7 to 3.5 ft.)

[4] Maximum and minimum thickness of MB 139 in core; upper contact dips 45°.

[5] Estimated from geophysical logs.

TABLE 7

STATISTICAL EVALUATION OF MB 139 THICKNESS

VALUE		EXPLORATORY SHAFT ONLY(1)	VENTILATION SHAFT ONLY(2)	EXCAVATION AREA DATA + ERDA-9(3)	ALL DRILLHOLE/ SHAFT DATA POINTS(4)
Number of Data Points		20	15	19	27
Thickness (Ft)	Maximum	3.5	3.5	4.1	4.1
	Average	2.8	2.8	2.6	2.6
	Minimum	2.0	1.7	1.2	1.2
Standard Deviation (Ft)		0.4	0.5	0.7	0.6

(1) Thickness measured at 20 points around the perimeter (in uniform intervals except near maximum and minimum thicknesses, where interval was adjusted to incorporate the extreme values).

(2) Same as note (1), except for the number of points.

(3) All eleven vertical coreholes, four MB-139 holes, exploratory shaft and ventilation shaft are considered as one data point each; for ERDA-9, two data points were used -- the minimum and maximum thicknesses (upper contact of MB-139 is dipping 45° in the core).

(4) As in previous column plus AEC-7, AEC-8, DOE-1, ERDA-6, ERDA-10, WIPP-11 (geophysical log), WIPP-12, and WIPP-13.

DRAWN BY M.J.S. 11/23/82 | CHECKED BY | APPROVED BY | DRAWING NUMBER NM78-648-B46

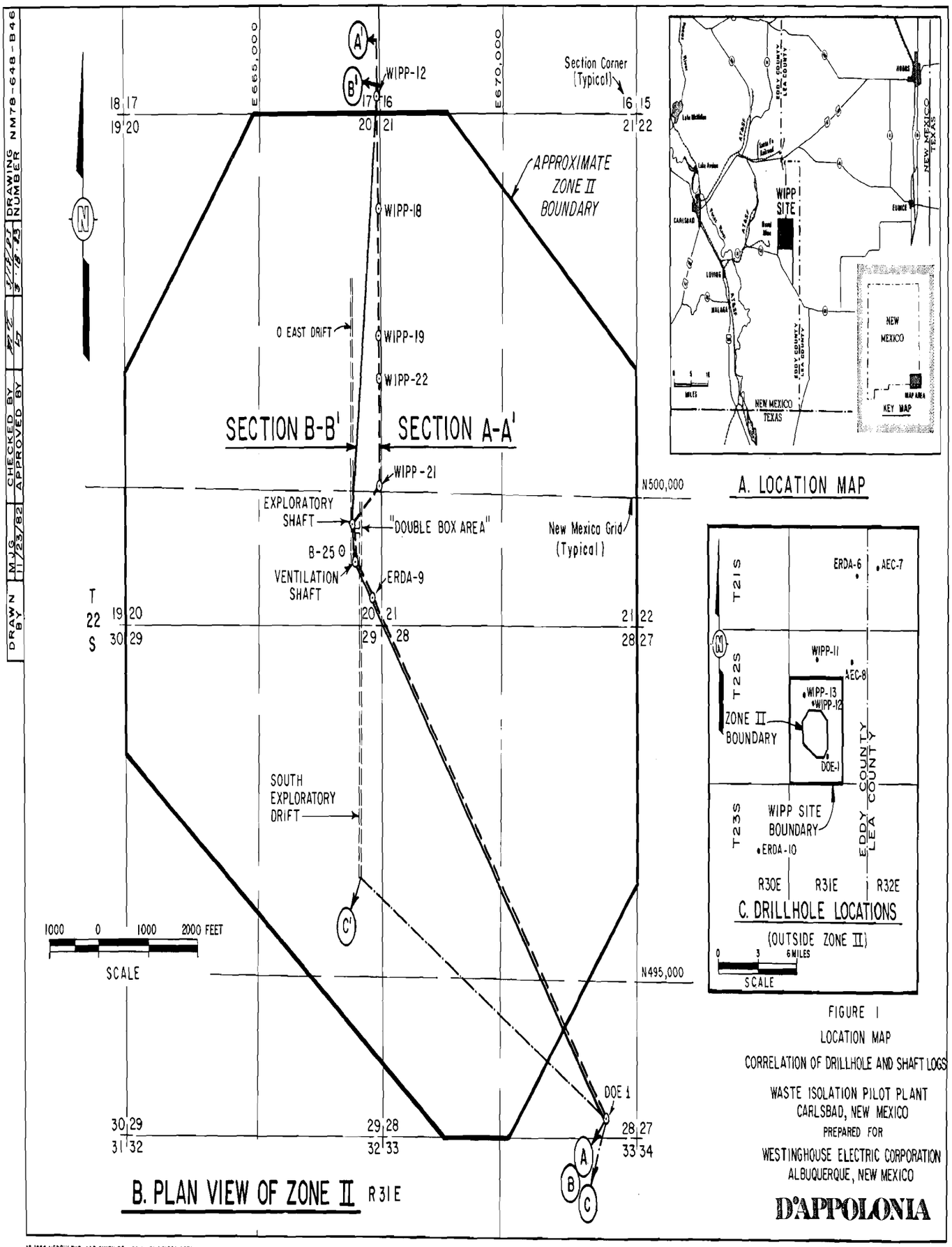

FIGURE 1

LOCATION MAP

CORRELATION OF DRILLHOLE AND SHAFT LOGS

WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

TME 3179

090

DRAWING NUMBER NM78-648-E5

CHECKED BY

APPROVED BY

MJG 11/1/82

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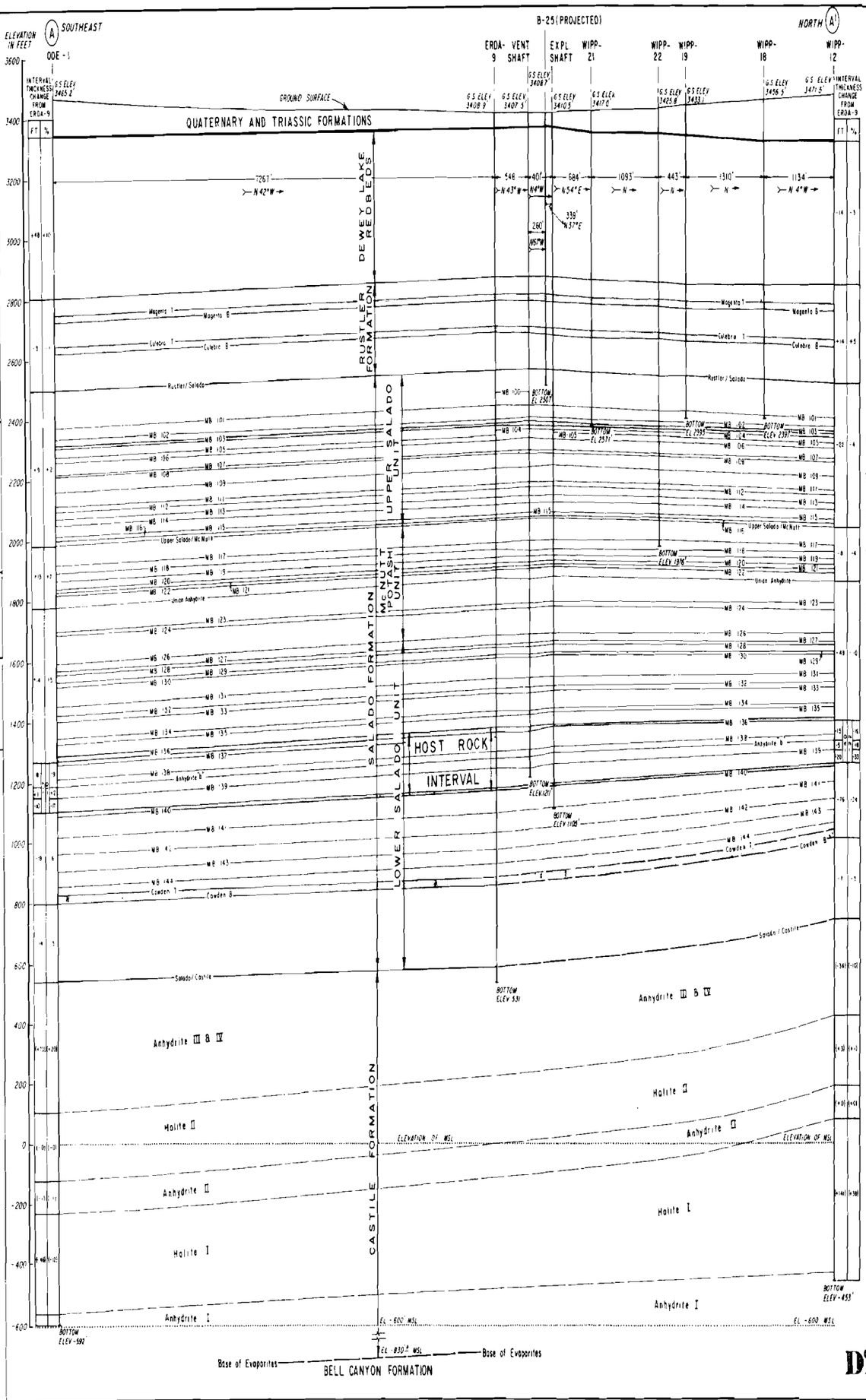
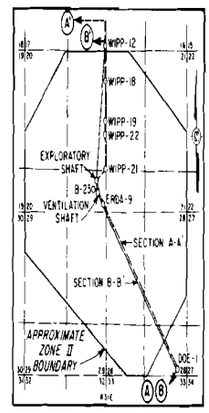




LOCATION KEY

NOTES

1. ONLY BASES SHOWN FOR THIN MARKER BEDS.
2. SELECTED INTERVALS SHADED FOR CLARITY.
3. DASHED LINES INDICATE POSSIBLE CONTACTS
4. MORE DETAILED BORING DATA ARE PRESENTED IN APPENDICES A AND B.
5. DETAILED DATA ON (1) THICKNESSES OF INDIVIDUAL INTERVALS ARE PRESENTED IN TABLE 4, AND (2) APPARENT DIPS OF INDIVIDUAL CONTACTS ARE PRESENTED IN TABLE 5.
6. INTERVAL THICKNESS CHANGES IN CASTILE FORMATION (SHOWN IN PARENTHESIS) ARE BASED ON ASSUMED THICKNESSES BELOW THE BOTTOM OF ERDA-9.

500 0 500 1000 FEET

HORIZONTAL SCALE

VERTICAL EXAGGERATION 2.5X

FIGURE 2

GEOLOGIC SECTION A-A' (GROUND SURFACE TO CASTILE FORMATION)

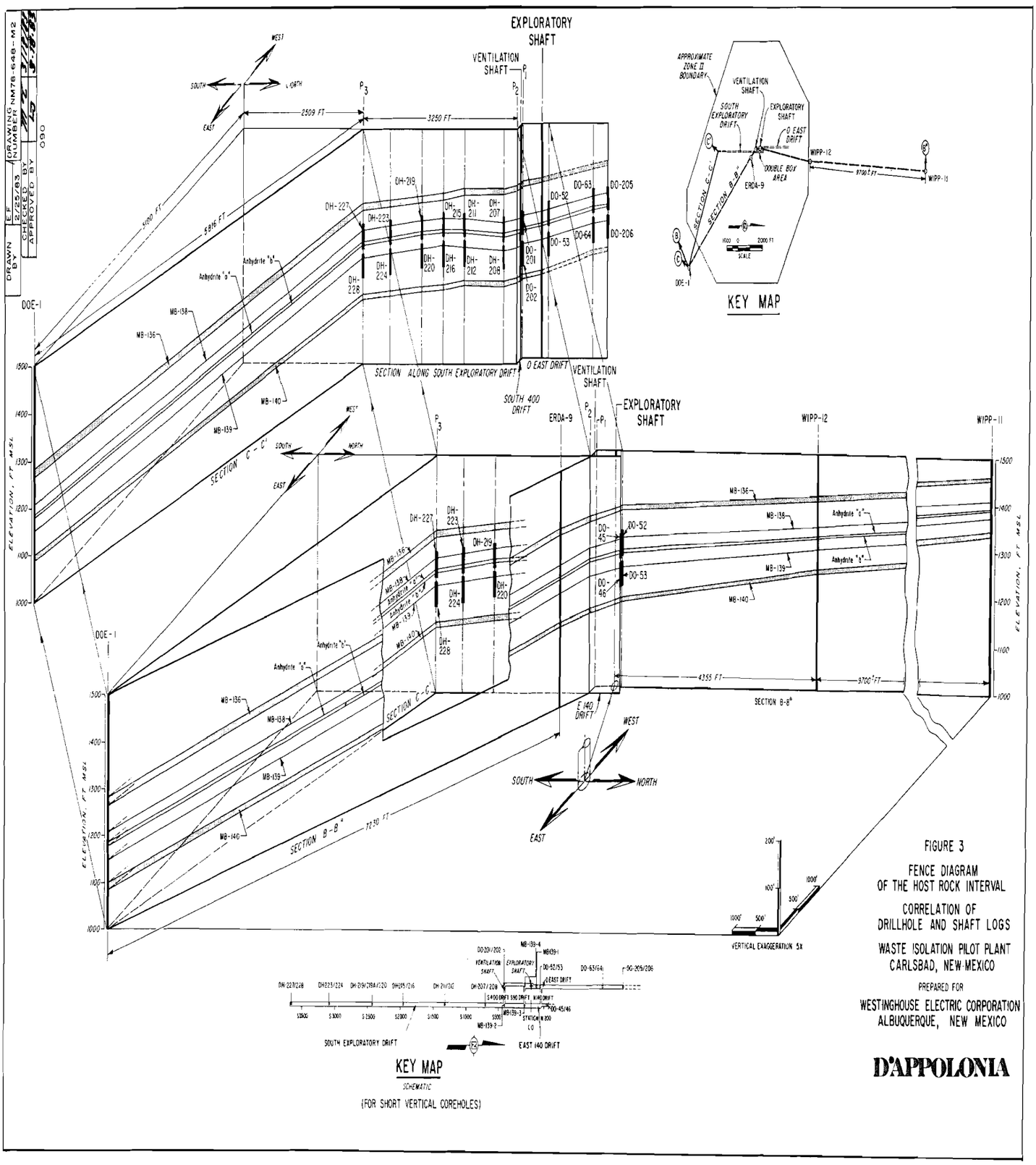
CORRELATION OF DRILLHOLE AND SHAFT LOGS

WASTE ISOLATION PILOT PLANT CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION ALBUQUERQUE, NEW MEXICO

D'APPOLONIA



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E.F.
2/25/83
CHECKED BY
APPROVED BY
DRAWING NUMBER NM78-648-M2
090

FIGURE 3

FENCE DIAGRAM
OF THE HOST ROCK INTERVAL

CORRELATION OF
DRILLHOLE AND SHAFT LOGS

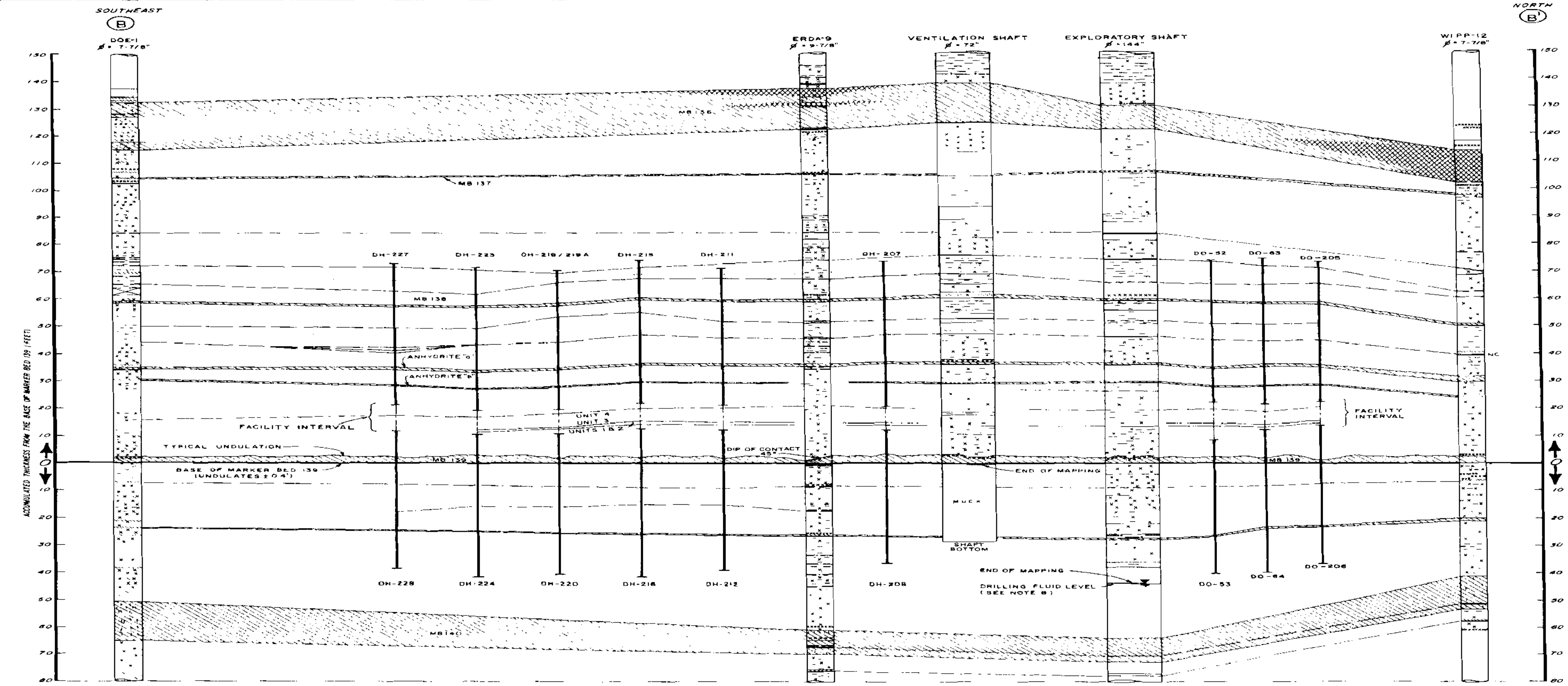
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

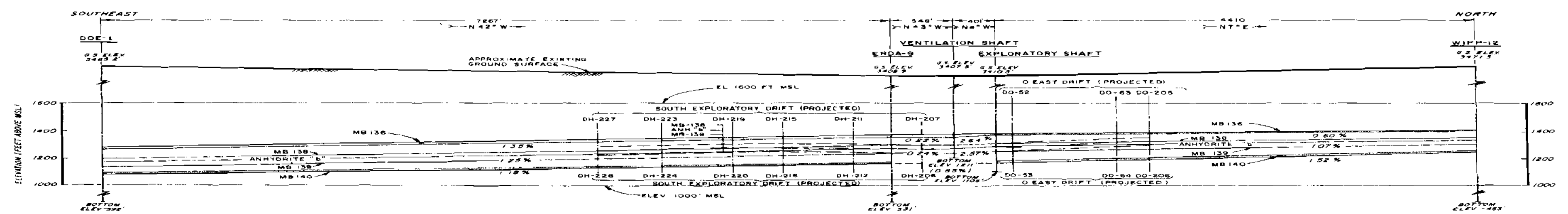
D'APPOLONIA

DRAWN BY MJG 12/6/82 | CHECKED BY [illegible] 3/11/83 | APPROVED BY [illegible] 3-18-83 | DRAWING NUMBER NM78-648-M1



A. STRATIGRAPHIC CORRELATION

(NOT DRAWN TO A HORIZONTAL SCALE)



B. GEOLOGIC SECTION B-B'

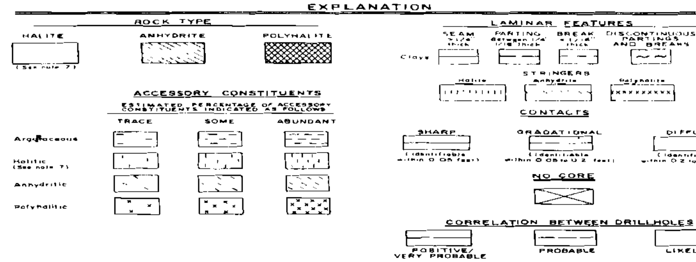
(WITH PROJECTED SOUTH EXPLORATORY DRIFT)

HORIZONTAL SCALE

500 0 500 1000 FEET

VERTICAL EXAGGERATION 25 X

EXPLANATION



NOTES

1. STRATIGRAPHIC SECTION IS RELATED TO THE BASE OF MB 139 WHICH WAS USED AS A DATUM. CONNECTING LINES INDICATE ONLY CHANGES IN THICKNESS OF INDIVIDUAL INTERVALS (SLOPES OF THE LINES HAVE NO OTHER MEANING).
2. SYMBOLS IN THE GEOLOGIC LOG COLUMNS GRAPHICALLY REPRESENT THE WRITTEN GEOLOGIC LOGS.
3. INDICATED DIPS OF THE STRATA IN THE GEOLOGIC SECTION (25 X VERTICAL EXAGGERATION) REPRESENT AVERAGE APPARENT DIPS LOCALLY. THE DIPS MAY VARY DEPENDING ON THE UNDULATION OF INDIVIDUAL BEDS.
4. MORE DETAILED DRILLHOLE DATA ARE PRESENTED IN APPENDICES A AND B.
5. DETAILED DATA ON (1) THICKNESSES OF INDIVIDUAL INTERVALS ARE PRESENTED IN TABLE 4, AND (2) APPARENT DIPS OF INDIVIDUAL CONTACTS IN TABLE 5.
6. DETAILED DATA ON CORRELATION ARE PRESENTED IN TABLE 3.
7. STANDARD SYMBOL FOR HALITE IS NOT USED IN ORDER TO ENHANCE THE CLARITY OF THE LOG COLUMN.
8. DRILLING FLUID AT THIS LEVEL AT TIME OF SHAFT MAPPING.

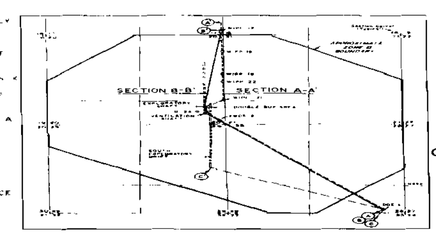


FIGURE 4

STRATIGRAPHIC CORRELATION AND GEOLOGIC SECTION B-B' (HOST ROCK INTERVAL – MB 136 TO MB 140)

CORRELATION OF DRILLHOLE AND SHAFT LOGS

PREPARED FOR WESTINGHOUSE ELECTRIC CORPORATION ALBUQUERQUE, N.M.

D'APPOLONIA

IME 3113

DRAWN BY	CHECKED BY	DRAWING NUMBER
EB	MJC	NM78-648-A148
3/17/83	APPROVED BY	
	3.18.83	

ELEVATION (FT. MSL)

1419.5

1419.0

1418.5

PHOTOGRAPH BY
SANDIA NATIONAL LABORATORIES

ZONE OF LARGE "SWALLOW-TAIL" PSEUDOMORPHS

EPITAXIAL CRYSTAL GROWTH

0 1 2 3 Inches

Scale (Approx.)

FIGURE 5

MARKER BED 136

DRILLHOLE AEC-8
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

32803

DRAWN BY	CHECKED BY	DRAWING NUMBER
EB 3/17/83	APPROVED BY	NM78-648-A147

ELEVATION (FT. MSL)

1252.0

1251.5

TOP OF MB139

EXAMPLE OF TRIANGULAR CRYSTAL FORM

EXAMPLE OF HEXAGONAL CRYSTAL FORM

0 1 2 3 Inches
Scale (Approx.)

PHOTOGRAPH BY SANDIA NATIONAL LABORATORIES

FIGURE 6

MARKER BED 139

DRILLHOLE WIPP-13
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

D'APPOLONIA

32803

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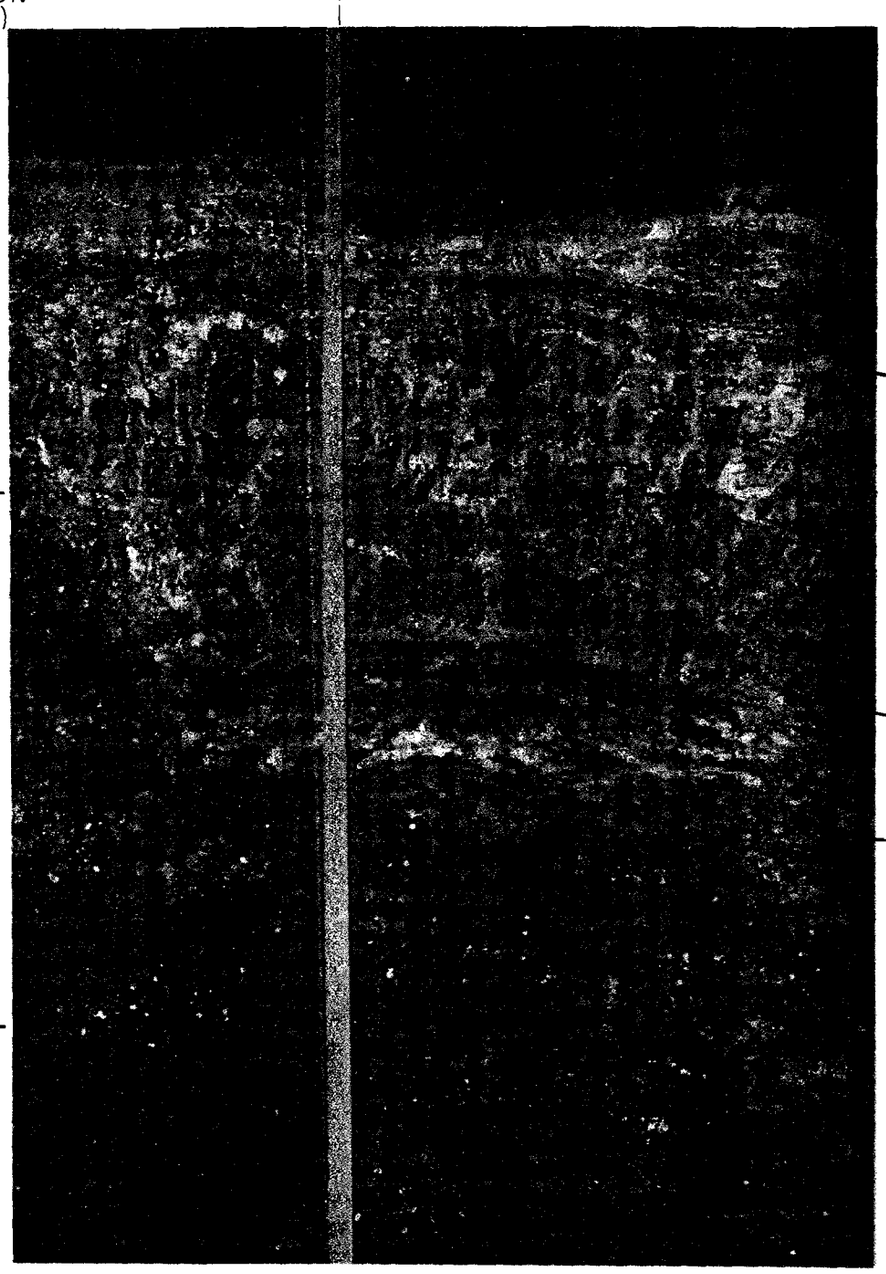
RDB 3-14-83	JWC 3-18-83	LJ	NM78-648-A135



0 3 6 9 12 Inches

Scale (Approx.)

FIGURE 7

MARKER BED 139 IN SOUTH WALL
EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

PHOTOGRAPH BY
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		APPROVED BY	

DRAWING NUMBER NM78-648-A136

0 3 6 9 12 Inches
Scale (Approx.)

FIGURE 8

MARKER BED 139 IN EAST WALL

EXPLORATORY SHAFT
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION
ALBUQUERQUE, NEW MEXICO

PHOTOGRAPH BY
SANDIA NATIONAL LABORATORIES

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D'APPOLONIA

APPENDIX A

ABRIDGED HISTORY OF DRILLHOLES/SHAFTS

APPENDIX A
ABRIDGED HISTORY OF DRILLHOLES/SHAFTS

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	PAGE
LISTING OF CODES	A-1
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DOE-1	A-4
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EXPLORATORY SHAFT	A-8
VENTILATION SHAFT	A-9
WIPP-11	A-10
WIPP-12	A-12
WIPP-18	A-16
WIPP-19	A-18
WIPP-21	A-20
WIPP-22	A-22

LISTING OF CODES USED IN DATA SHEETS

CODE

W=WELEX	D=DRESSER ATLAS
S=SCHLUMBERGER	T=TRIANGLE SERVICES, INC.
B=BIRDWELL	U=USGS
M=MC CULLOUGH	A=SEISMIC REFERENCE SERVICE
SS=SPERRY-SUN	G=GEARHART-OWEN
	N=NEW MEXICO BUREAU OF MINES & MINERAL RESOURCES

3-D	=	3-D
ACB	=	ACOUSTIC CEMENT BOND VDL SIGNATURE
AVDL	=	ACOUSTILOG
BCSL	=	BOREHOLE COMPENSATED SONIC LOG
BCSS	=	BOND CEMENT AND SONIC SEISMOGRAM
BHCA	=	BHC ACOUSTILOG
BHCD	=	BHC DENSITY
BHCN	=	BHC NEUTRON GAMMA RAY
BHCS	=	BHC SONIC
BHCV	=	BHC ACOUSTILOG VDL
CA	=	CYCLIC ACTIVATION
CA-SMO	=	CYCLIC ACTIVATION SI-MG-O
CA-SNO	=	CYCLIC ACTIVATION SI-NA-O
CAV	=	COMPENSATED ACOUSTIC VELOCITY
CD	=	COMPENSATED DENSITY
CDL	=	COMPENSATED DENSILOG
CDM	=	CONTINUOUS DIPMETER
CLML	=	CORE LAB MUD LOG
CLPR	=	CALIPER
CN	=	COMPENSATED NEUTRON
CNFD	=	COMPENSATED NEUTRON FORMATION DENSITY
CNG	=	COMPENSATED NEUTRON GAMMA
COMPD	=	COMPUTED DIPLOG
COND	=	CONTINUOUS DIRECTIONAL
CRA	=	COMPLEX RESERVOIR ANALYSIS
D-6	=	D-6
D-9	=	D-9
DCLPR	=	DUAL CALIPER
DDNL	=	DUAL DETECTOR NEUTRON LIFETIME
DEN	=	DENSITY
DIF	=	DUAL INDUCTION FOCUSED
DISFL	=	DUAL INDUCTION SFL
DL	=	DUAL LATEROLOG
DLLMLL	=	DUAL LATERDOG-MICRO LATERDOG
DLM	=	DUAL LATERLOG MICRO-SFL
DMA	=	DIPMETER ARROW PLOT
DMB	=	DIPMETER - BASIC DATA LOG FOR DIRECTIONAL
DMC	=	DIPMETER - BASIC DATA LOG FOR CONTINUAL DIRECTION
DNL	=	DENSILOG
DPL	=	DIPLOG

Adapted from Reference 24

DPO	=	DIRECTIONAL PRINT OUT
DTEMP	=	DIFFERENTIAL TEMPERATURE
FD	=	FLUID DENSITY
FEA	=	FINAL EVAPORITE ANALYSIS
GCWTC	=	GATED COMPRESSIONAL WITH TIME CURE
GEN	=	GAMMA EPITHERMAL NEUTRON
GM	=	GYRO-MULTISHOT
GR	=	GAMMA RAY
GRC	=	GAMMA RAY-CALIPER
GRD	=	GUARD
GRN	=	GAMMA RAY - NEUTRON
IN	=	INELASTIC NEUTRON
INDC	=	INDUCTION
ITTAP	=	INTERNAL TRANSIT TIME AND ACOUSTIC POROSITY
LEP	=	LITHO - ELASTIC PROPERTIES
MIL	=	MINILOG
MIS	=	MAGNETIC INCLINOMETER SURVEY
ML	=	MAGNELOG
MLL	=	MICRO - LATEROLOG
MSB	=	MICRO-SEISMOGRAM BOND
NL	=	NEUTRON LIFETIME
PEA	=	PRELIMINARY EVAPORITE ANALYSIS
PLM	=	PROXIMITY LOG - MICROLOG
SA	=	SIDEWALL ACOUSTILOG
SASW	=	SIDEWALL ACOUSTILOG SHEAR WAVE
SAVDL	=	SIDEWALL ACOUSTILOG VDL
SC	=	SILICON CALCIUM
SEISV	=	SEISVIEWER
SNG	=	SIDEWALL NEUTRON GAMMA
SON	=	SONAN
SPCTLG	=	SPECTRALOG
SS	=	SEISMIC SURVEY
TEMP	=	TEMPERATURE
TT	=	TRACER - TEMPERATURE

Adapted from Reference 24

ABRIDGED HISTORY OF BOREHOLE B-25

Project: WIPP 12484

Hole Location: N499414.91; E666693.11 New Mexico State Coordinates (SE SE 1/4 Sec. 20, T.22S. R.31E.)

Ground Surface Elevation: 3408.74 feet

Drilling Contractor: Gil's Drilling, Inc.
2245 West Shangri La Road
Phoenix, Arizona 85029

Drilling Rig: Gardner-Denver 2000

Drilling Record:

12/1/78	Commence drilling operations. Drill 9 7/8 inch hole to 22.4 feet and set 8 3/8 inch I.D. surface casing at 17.8 feet.
12/2/78	Set 4 1/4 inch I.D. inner casing at 22.4 feet.
12/2/78-1/5/79	Continuously core NQ sized hole (2 63/64 inch) to 901.8 feet.
1/5/79 to 1/18/79	Ream hole to 6 1/4 inch to 901.0 feet.
1/20/79	Run geophysical logs.
1/20/79-1/21/79 and 2/2/79-2/4/79	Hydrologic testing of Rustler/Salado contact, Culebra Dolomite and Magenta Dolomite.
2/5/79	Set 5 1/2 inch O.D. K-55, 14 lb. casing from 890 feet to surface, with centralizers at 80 feet intervals. Casing cemented with API Class C Pozmix mixed 1:1, with 2% bentonite and 19.4 lbs/sack salt.
2/13/79	Move rig off site.

Adapted from Reference 7

ABRIDGED HISTORY OF BOREHOLE DOE-1

Location: Section 28, T22S, R31E
610 feet from east line
182 feet from south line

Elevation: Ground Level (GL) 3465.2 feet MSL
Kelly Bushing (KB) 3473.2 feet

Datum for depth measurements is the kelly bushing (8.0 feet above ground level).

Lithologic Log Prepared By: S. R. Black, M. H. Freeland, K. M. Maddock, D. Meyer, R. F. McKinney, J. A. Klaiber, July 14, 1982 to July 28, 1982.

Geophysical Logs Recorded By: Dresser Atlas, Birdwell, and U.S. Geological Survey

Drilling Contractor: Salazar Bros. Drilling Company

Drilling Record: Commenced drilling July 14, 1982 and completed on July 28, 1982 at 4065.3 feet (4057.3 feet below ground level).

Casing: 20-inch OD, set and cemented 0 to 49.0 feet.

10 3/4-inch OD casing set and cemented to 1126.2 ft. (28 joints J55-40.5#).

Mud: 49 - 1130 feet: Spud Mud - Fresh Water Gel, Soda Ash, paper.

1130 feet - T.D.: Salt Water Gel, Starch, KCl brine, lime.

Adapted from Reference 12

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Abridged history of borehole ERDA-9

LOCATION: Sec. 20, T. 22 S., R. 31 E.
267.23 feet from south line
176.74 feet from east line
(Revised location, according to resurvey made on November 28, 1978)

ALTITUDE: LS (Land surface) 3,408.86 feet
KB (Kelly bushing)3,420.41 feet
(Revised altitudes, according to resurvey made on November 28, 1978)

LITHOLOGIC LOG PREPARED BY: C. L. Jones, B. M. Madsen, and D. F. Fuqua
April 29 to June 4, 1976
GEOPHYSICAL LOGS PREPARED BY: Dresser Atlas
DRILLING CONTRACTOR: Sonora Drilling Co.

CORING CONTRACTOR: International Diamond Coring, Inc.

DRILLING RECORD: Commenced drilling on April 28, 1976, and completed on June 4, 1976, at 2,889 feet below kelly bushing.

Conductor pipe (16 inch OD) set and cemented at 40 feet below LS (52 feet, i.e. 51.55 feet below KB).

Drilled 9 7/8 inch hole from 52 to 1,076 feet below KB.

Opened hole to 15 inches from 52 to 1,090 feet below KB; 10 3/4 inch casing set at 1,045 feet below KB and cemented to surface (hole deepened 14 feet (1,076 to 1,090 feet) during operation).

Drilled 7 23/32 inch hole while taking consecutive cores from 1,090 to 2,877 feet. Coring directed by International Diamond Coring, Inc.

Opened hole to 9 7/8 inches from 1,090 to 2,889 feet (hole deepened 12 feet (2,877 to 2,889 feet) during operation).

Set 7 inch OD casing at 2,883 feet, and cemented annulas with 122 feet^3 of class "H" cement.

Filled casing with oil-base mud, and prepared borehole for temporary abandonment.

All depth measurements used by core engineer, core handlers, and core photographers are in error by an amount ranging from a minimum of 5.7 feet to a maximum of 25.1 feet.

Adapted from Reference 19

NAME:	ERDA 9	LOCATION:	20 22S 31E
COORD:	267FSL 177FEL	PURPOSE:	GEOEXPL
TOTAL DEPTH:	2886	SIZE:	9 7/8
START DATE:	042876	END DATE:	062676
CORE PLAN:	1076-2870(35)	ELEVATION:	3409

CURRENT STATUS

BORE HOLE RECORD

FROM	TO	DIA
5	40	20
40	1049	15
1049	2886	9 7/8

CASING RECORD

DIA	GRADE	WT/FT	FROM	TO	CEMENT
16			0	40	95 Cu.Ft
10 3/4	J-55	40.5	0	1045	1159 Cu.Ft
7	J-55	23	0	2883	Mud Pack

NOTE: All depths are measured from Kelly Bushing 11.5 ft. above ground level.

OBSERVATIONS:

Centered in proposed site, ERDA 9 confirmed satisfactory stratigraphy, lithology and mineralogy. DST's show that there is no significant amount of fluid within the Salado and that pressure buildups are attributed to nitrogen-brine buildups across clay seams. Numerous core studies have been completed and reported in SAND documents. Lithologic/stratigraphic observations reported in USGS OF81-469.

LOGS	INT. LOG
DIF (D)	64-504
BHCA (D)	0-1070
CD2 (D)	0-1073
GCWTC (D)	200-1071
DL (D)	0-1073
MLL (D)	0-1073
CNG (D)	0-1073
DTEMP (D)	200-1076
CLPR (D)	0-1018
ACB (D)	0-995
DTEMP (D)	0-991
ACB (D)	0-994
SA (D)	1046-2887
SAVOL (D)	1050-2887
CLPR (D)	1046-2885
FD (D)	0-2887
DTEMP (D)	0-2886
BHCA (D)	1046-2882
BHCV (D)	1046-2881
CDL (D)	1046-2885
NL (D)	800-2882
CNG (D)	1120-2887

NO.	DST - INT TESTED
1	1440-1496
2	2026-2106
3	2526-2630
4	2635-2886
5	2524-2635
6	1432-1498
7	2310-2348
8	2635-2725
9	1450-1488

LOGS	INT. LOG
IN (D)	800-2886
COMPD (D)	1050-2886
DIF (D)	1046-2885
SNG (D)	1046-2886
CA (D)	1000-2881
SC (D)	800-2881
SPCTLG (D)	0-2885
DTEMP (D)	0-2884
SON (D)	50-2800
CLPR (D)	1022-2884
DTEMP (D)	0-2845
ACB (D)	2200-2840
ML (D)	0-2843
ACB (D)	640-2200
FEA (D)	1080-2890
Borehole Gravity (U)	200-2790

Adapted from Reference 24

ABRIDGED CONSTRUCTION HISTORY OF THE EXPLORATORY SHAFT

Location:	Eddy County New Mexico New Mexico Grid Coordinates N499687.23, E666894.89
Elevation:	Ground Surface 3410.5 ft MSL
Drilling Contractors, Rig Types:	Meredith Drilling Company - Auger (11.0-93.4 ft) Challenger Drilling Company - National 125 Jacknife Rotary (93.4-2298 ft)
Site Preparation:	May 14, 1981
Spudded:	July 4, 1981
Completed:	December 20, 1981
Casing:	180-inch, corrugated metal pipe, ground surface to 11 feet 144-inch, 1" steel pipe, ground surface to 93.4 feet 120-inch, 5/8" to 1 1/2" steel pipe, ground surface to 844 feet
Drill Hole:	142-inch uncased borehole from 844 feet to total depth of 2298 feet
Directional Survey Contractor:	Sperry-Sun (Gyroscopic Multishot Surveys)
Horizontal Displacement at 2276 feet:	1.59 ft., S 65° 02' W
Geophysical Logging Contractor:	Birdwell/Dresser Atlas

Geophysical Logs:

Fluid Density	1200' to 550'	Dresser Atlas
Fluid Density	750' to 20'	Birdwell
Density	2294' to 50'	Birdwell
Caliper	2294' to 50'	Birdwell
Epithermal Neutron	2294' to 50'	Birdwell
Gamma Ray	2300' to 0'	Birdwell
NCTL	827' to 0'	Birdwell
NAIL	839' to 0'	Birdwell
Fluid Density	2250' to 2003'	Dresser Atlas

NOTE: Depths measured from ground surface.
Adapted from Reference 18

ABRIDGED CONSTRUCTION HISTORY OF THE VENTILATION SHAFT

Location:	Eddy County, New Mexico New Mexico Grid Coordinates N 499287.23, E 666919.89
Elevation:	Ground Surface 3407.5 feet MSL Shaft Collar 3407.9 feet MSL
Drilling Contractors, Rig Types:	Meredith Drilling Company - Auger (8.0 feet to 98.2 feet) Challenger Drilling Company - National 125 Jacknife Rotary (98.2 feet to 2196 feet)
Site Preparation:	June 13, 1981
Spudded:	December 24, 1981
Completed:	March 10, 1982
Casing:	108-inch corrugated metal pipe, ground surface to 8 feet 74-inch casing, ground surface to 96.9 feet
Drill Hole:	72-inch uncased borehole to a total depth of 2196 feet
Drilling Fluid:	Brine
Directional Survey Contractor:	Sperry-Sun (Gyroscopic Multishot Surveys)
Horizontal Displacement at 2177 feet:	2.25 ft, S 60° 12' W
Geophysical Logging Contractor:	Birdwell
Geophysical Logs:	March 8 to 10, 1982
Caliper (3-Curve)	- (2190' to 0')
Caliper (Average)	- (2190' to 0')
Epithermal Neutron	- (2190' to 0')
Density	- (2190' to 0')
Gamma Ray	- (2100' to 0')
Fluid Density	- (2191' to 1800')

NOTE: Depths measured from ground surface

Adapted from Reference 13

Abridged borehole history of WIPP-11

LOCATION: Sec. 9, T. 22 S., R. 31 E.
712 feet from north line
294 feet from west line

ALTITUDE (LAND SURFACE): 3,426.1 feet. Datum for depth measurements in drilling and logging operations is 3,439.1 feet (Kelly Bushing height)

LITHOLOGIC LOG PREPARED BY: J. L. Gonzales (F&S) and C. L. Jones (USGS), February 6, 1978 to March 12, 1978.

DRILLING CONTRACTOR: Verna Drilling Company

DRILLING RECORD: Commenced drilling February 6,1978, and completed on March 12, 1978, at 3,583 feet below Kelly Bushing (3,570 ft below land surface).

Hole temporarily abandoned pending further studies.

Adapted from Reference 1

NAME:	WIPP 11	LOCATION:	9 22S 31E
COORD:	294FWL 711FNL	PURPOSE:	GEOEXPL
TOTAL DEPTH:	3580	SIZE:	8 3/4
START DATE:	020678	END DATE:	031478
CORE PLAN:	727-3534(26)	ELEVATION:	3426

CURRENT STATUS

BORE HOLE RECORD

FROM	TO	DIA
5	40	18
53	985	12 1/4
985	3580	8 3/4

CASING RECORD

DIA	GRADE	WT/FT	FROM	TO	CEMENT
13 3/8	H-40	48	0	40	81 Cu.ft.
9 5/8	J-55	36	0	985	656 Cu.ft.
Open Hole					

NOTE: Hole loaded w/brine based mud, hole temporarily capped pending further testing and/or plugging, all depths are measured from Kelly Bushing 13 ft. above ground level.

OBSERVATIONS:

Confirmed a gentle anticline in the Castile. No brine or anhydrite porosity indicated, no evidence of massive dissolution activity.

LOGS	INT. LOG
CLPR (S)	53-986
BCSL (S)	53-986
BCSL (S)	900-2408
BCSL (S)	2200-3580
CNFD (S)	0-990
CNFD (S)	900-2397
CNFD (S)	2200-3582
DLM (S)	53-989
DLM (S)	900-2397
DLM (S)	2200-3581
DMB (S)	2200-3582
DMC (S)	53-990
DMC (S)	986-2410
DMC (S)	2200-3582
DPO (S)	40-991
DPO (S)	992-2409
DPO (S)	2212-3583
DMA (S)	986-2410
DMA (S)	2200-3582
DMA (S)	2200-3582
CLML (S)	40-3577
Borehole Gravity (U)	250-2390

Adapted from Reference 24

ABRIDGED HISTORY OF BOREHOLE WIPP-12

LOCATION: Sec. 17, T22S, R31E
147.9 feet from the south line
83.91 feet from the east line

ELEVATION: GL (ground level) 3,471.5 feet
KB (kelly bushing) 3,483.7 feet

Datum for depth measurements given in Tables 1,2, and 3 and throughout this report is the kelly bushing (12.2 feet above ground level).

FIELD LITHOLOGIC LOG PREPARED BY: M. M. Bell, D. C. Dale, R. M. Beathard (Bechtel) S. L. Drellack, Jr., S. L. Gonzales, A. F. McIntyre (Fenix and Scisson)

GEOPHYSICAL LOGS RECORDED BY: Dresser Atlas and U.S. Geological Survey

MUD AND CUTTINGS ANALYSIS: Core Laboratories, Inc.

DEVIATION SURVEYS BY: Sperry Sun

DRILLING CONTRACTOR: Verna Drilling

DRILLING RECORD: Commenced drilling November 9, 1978, and completed drilling December 7, 1978 at a total depth of 2785.8 feet below KB.

Casing: 13 3/8" OD, 48# H-40 set and cemented 4 to 50.8 feet.

9 5/8" OD casing set and cemented to 1014 feet (24 joints of 32.30#, H-40 and 1 joint 36.00#, J-55).

Mud: 38-1015 feet: Cooper, Brine-Brine clay (10.1 lb. Brine, brine clay, soda ash, caustic soda, starch, Drispac).

1015-2785.5 feet: Cooper Hydropoly 10.0 lb. brine, starch, Drispac, soda ash, caustic.

Adapted from Reference 2

NAME:	WIPP 12	LOCATION:	17 22S 31E
COORD:	149 FSL 82 FEL	PURPOSE:	GEOEXPL
TOTAL DEPTH:	2790	SIZE:	7 7/8
START DATE:	110978	END DATE:	120778
CORE PLAN:	135-2771 (25)	ELEVATION:	3472

CURRENT STATUS

BORE HOLE RECORD			CASING RECORD					
FROM	TO	DIA	DIA	GRADE	WT/FT	FROM	TO	CEMENT
0	39	18	13 3/8	H-40	48	0	39	81 Cu.Ft.
39	1015	12 1/4	9 5/8	J-55		0	39	
			9 5/8	H-40	32	39	1013	475 Cu.Ft.
1015	2790	7 7/8	Open Hole					

NOTE: Hole loaded with brine base mud pending further tests. All depths are measured from Kelly Bushing 12.2 ft. above ground level.

OBSERVATIONS:

Stratigraphy confirmed to top of Castile indicating thinning of lower Salado and more clay seams relative to ERDA 9. The top of Castile in WIPP 12 is about 140 feet higher than in ERDA 9.

LOGS	INT. LOG	
BHCV (D)	0	1012
BHCV (D)	1012	2783
AC8 (D)	0	1030
CDL (D)	0	1017
CDL (D)	1017	2785
DLM (D)	53	1017
DLM (D)	1017	2785
TEMP (D)	0	1000
TEMP (D)	850	2786
DPL (D)	1014	2783
DPO (D)	1014	2783
SS (A)	40	2783
DTEMP (G)	0	2700

Adapted from Reference 24

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ABRIDGED HISTORY OF WIPP-12 DEEPENING

(Depth of 2776 feet[1] to 3927.5 feet below GL)

Location:	Sec. 17 T22S R31E 147.9 feet from the south line 83.9 feet from the east line
Elevation:	Ground Level (GL) 3471.5 feet Kelly Bushing (KB) 3479.5 feet
Datum for Depth Measurements:	Ground level
Field Lithologic Log:	S. R. Black (D'Appolonia)
Geophysical Logs:	Dresser Atlas, Schulmberger and U.S. Geological Survey
Mud Analysis:	IMCO and Magcobar
Coring Subcontractor:	Christensen Diamond Products
Drilling Contractor:	Salazar Brothers Drilling
Drilling Record:	Commenced drilling November 17, 1982 at a depth of 2276 feet and completed drilling January 1, 1982 at a total depth of 3927.5 feet below land surface.
Casing:[2]	13 3/8' OD, 48#, H-40 set and cemented 4 to 38.6 feet.
Mud:	2776-3047 feet: 10.25 to 11.70 ppg brine with IMCO Brine Gel Clay and Loid as additives.

[1] The recorded depth when WIPP-12 was reentered is 2776 feet (below GL). This disagrees with the total depth reported in the WIPP-12 Basic Data Report (Sandia, 1982) of 2773.6 feet. The 2.4 feet discrepancy is probably a result of slight error in driller's pipe tally.

[2] All casing set during original drilling in 1978.

Adapted from Reference 10

Abridged history of borehole WIPP-18

LOCATION: Sec. 20, T. 22 S., R. 31 E.
983.58 feet from north line
11.45 feet from east line

ALTITUDE: LS (land surface) 3,456.47 feet. Datum for depth measurements in drilling and logging operations.

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

DRILLING CONTRACTOR: Pennsylvania Drilling Co.

DRILLING RECORD: Commenced drilling on March 14, 1978, and completed on March 30, 1978, at 1,060 feet below LS.

Set 7-inch-OD conductor pipe in 8 3/4-inch hole at 16 feet; packed annulus with dirt.

Drilled 6 1/8-hole from 16 to 1,060 feet.

On completion of drilling and logging, borehole filled with salt-base mud and capped pending final decision on future work.

Adapted from Reference 3

NAME:	WIPP 18	LOCATION:	20 22S 31E
COORD:	983FNL 12FEL	PURPOSE:	STRAT
TOTAL DEPTH:	1060	SIZE:	6 1/8
START DATE:	031478	END DATE:	040378
CORE PLAN:	N/A	ELEVATION:	3456

CURRENT STATUS

BORE HOLE RECORD

FROM	TO	DIA
0	16	8 3/4
16	1060	6 1/8

CASING RECORD

DIA	GRADE	WT/FT	FROM	TO	CEMENT
7	Used	20	0	16	None
Open Hole					

NOTE: Hole loaded w/mud pending further testing and/or plugging.

OBSERVATIONS:

Drilled as part of series (WIPP 18, 19, 21, 22) to investigate a possible fault in Rustler Fm. or Dewey Lake Redbeds, interpreted from seismic reflection records. Areas of investigation overlies southern end of "disturbed zone" in Castile Fm. Drilling demonstrates flat, correlative beds above Salado Fm. and does not support faults at that level as interpreted from seismic reflection data. See SAND79-0275 for details.

LOGS	INT. LOG
DLM (S)	16-1058
MLL (S)	16-1058
CNFD (S)	0-1059
BCSL (S)	0-1058
CDM (S)	16-1057
DMC (S)	16-1057
SS (A)	0-1058

Adapted from Reference 24

Abridged history of borehole WIPP-19

LOCATION: sec. 20, T. 22 S., R. 31 E.
2,987.34 feet from south line
12.68 feet from east line

ALTITUDE (LAND SURFACE): 3,433.13 feet. Datum for all depth measurements.

DESCRIPTION OF CORE PREPARED BY: J. L. Gonzales, April 6 to May 4, 1978.

DRILLING CONTRACTOR: Boyles Bros. Drilling Co.

DRILLING RECORD: Commenced drilling April 6, 1978, and completed May 4, 1978, at 1,038.2 feet below land surface.

Set 7-inch outside-diameter casing in an 8 3/4-inch hole at 8 feet; packed annulus with gel.

Cut consecutive cores with 4 1/2-inch bit, 8-14 feet; with 3 7/8-inch bit, 14-48 feet; and with 3 15/16-inch bit, 48-1,038.2 feet.

On completion of coring, hole opened to 6 1/8 inches for geophysical logging and then capped pending decision concerning possible additional work.

Adapted from Reference 4

NAME:	WIPP 19	LOCATION:	20 22S 31E
COORD:	2987FSL 13FEL	PURPOSE:	STRAT
TOTAL DEPTH:	1038	SIZE:	6 1/8
START DATE:	040678	END DATE:	050878
CORE PLAN:	0-1038(120)	ELEVATION:	3433

CURRENT STATUS

BORE HOLE RECORD

FROM	TO	DIA
0	8	8 3/4
8	1038	6 1/8

CASING RECORD

DIA	GRADE	WT/FT	FROM	TO	CEMENT
7	Used	20	0	8	None
Open Hole					

OBSERVATIONS:

Drilled as part of series (WIPP 18, 19, 21, 22) to investigate a possible fault, in Rustler Formation or Dewey Lake Redbeds, interpreted from seismic reflection records. Area of investigation overlies southern end of "disturbed zone" in Castile Formation. Drilling demonstrates flat, correlative beds above Salado Formation and does not support faults at that level as interpreted from seismic reflection data. See SAND79-0276 for details.

LOGS	INT. LOG
DLM (S)	0-1034
CNFD (S)	0-1034
BCSL (S)	0-1033
CDM (S)	0-1028
DMA (S)	0-1028
DMC (S)	0-1028

Adapted from Reference 24

Abridged history of borehole WIPP-21

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

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

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

DRILLING CONTRACTOR: Boyles Bros. Drilling Co.

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

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

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

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

Adapted from Reference 5

NAME:	WIPP 21	LOCATION:	20 22S 31E
COORD:	1451FSL 12FEL	PURPOSE:	STRAT
TOTAL DEPTH:	1049	SIZE:	6 1/8
START DATE:	052478	END DATE:	052778
CORE PLAN:	N/A	ELEVATION:	3417

CURRENT STATUS

BORE HOLE RECORD

FROM	TO	DIA
0	20	8 3/4
20	1045	6 1/8

CASING RECORD

DIA	GRADE	WT/FT	FROM	TO	CEMENT
7	J-55	23	0	20	None
Open Hole					

NOTE: Hole loaded w/brine mud pending further testing and/or plugging.

OBSERVATIONS:

Drilled as part of series (WIPP 18, 19, 21, 22) to investigate a possible fault, in Rustler Formation or Dewey Lake Redbeds, interpreted from seismic reflection records. Area of investigation overlies southern end of "disturbed zone" in Castile Formation. Drilling demonstrates flat, correlative beds above Salado Formation and does not support faults at that level as interpreted from seismic reflection data. See SAND79-0277 for details.

LOGS	INT. LOG
DLM (S)	25-1047
CDM (S)	0-1046
BCSL (S)	0-1034
CNFD (S)	0-1046

Adapted from Reference 24

Abridged history of borehole WIPP-22

LOCATION: sec. 20, T. 22 S., R. 31 E.
2,544.45 feet from south line
10.94 feet from east line

ALTITUDE: LS (land surface) 3,425.83 feet. Datum for all depth measurements.

LITHOLOGIC DESCRIPTION OF CUTTINGS PREPARED BY: S. L. Drellack, Jr., and J. L. Gonzales (F&S), May 8-23, 1978.

DRILLING CONTRACTOR: Boyles Bros. Drilling Co.

DRILLING RECORD: Commenced drilling on May 8, 1978, and completed on May 23, 1978, at 1,450 feet below LS.

Drilled 8 3/4-inch hole to 20 feet, and set 7-inch outside-diameter casing at 20 feet. Packed annulus with dirt.

Drilled 6 1/8-inch hole to 1,450 feet.

On completion of drilling, suite of wireline geophysical logs was run, and hole capped pending decision on further work.

Adapted from Reference 6

NAME:	WIPP 22	LOCATION:	20 22S 31E
COORD:	2544FSL 11FEL	PURPOSE:	STRAT
TOTAL DEPTH:	1450	SIZE:	6 1/8
START DATE:	050878	END DATE:	052478
CORE PLAN:	N/A	ELEVATION:	3426

CURRENT STATUS

BORE HOLE RECORD

FROM	TO	DIA
0	20	8 3/4
20	1450	6 1/8

CASING RECORD

DIA	GRADE	WT/FT	FROM	TO	CEMENT
7	Used	20	0	20	None
Open Hole					

NOTE: Hole loaded w/mud pending further testing and/or plugging.

OBSERVATIONS:

Drilled as part of series (WIPP 18, 19, 21, 22) to investigate a possible fault, in Rustler Formation or Dewey Lake Redbeds, interpreted from seismic reflection records. Area of investigation overlies southern end of "disturbed zone" in Castile Formation. Drilling demonstrates flat, correlative beds above Salado Formation and does not support faults at that level as interpreted from seismic reflection data. See SAND79-0278 for details.

LOGS	INT. LOG
DLM (S)	22-1032
DLM (S)	10-1448
CNFD (S)	20-1033
CNFD (S)	0-1448
CDM (S)	0-1450
BCSL (S)	10-1029
BCSL (S)	10-1447
CDM (S)	20-1032

Adapted from Reference 24

APPENDIX B

STRATIGRAPHIC SUMMARIES OF DRILLHOLES/SHAFTS

APPENDIX B
STRATIGRAPHIC SUMMARIES OF DRILLHOLE/SHAFT

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LISTING OF CODES

General

KB - Kelly bushing
GS - Ground surface
-T - Top of layer/bed
-C - Center of layer/bed
-B - Bottom of layer/bed
/ - Contacts between strata
DISS. RES. - Dissolution residue
MB - Marker bed
SEAM - Clay layer greater than 1/4" thick
PART - Clay parting between 1/16" and 1/4" thick
T.D. - Total depth

Formations/Members/Units (in Descending Stratigraphic Order)

HOL - Holocene deposits
M. CAL - Mescalero Caliche
GAT - Gatuna Formation
SRS - Santa Rosa Sandstone
DLR - Dewey Lake Redbeds
RUS - Rustler Formation
MAGENTA - Magenta Dolomite Member
CULEBRA - Culebra Dolomite Member
SAL - Salado Formation
UP. SAL - Upper Salado Member
MCN - McNutt Potash Member
V.T. SAND - Vaca Triste Sandstone Member
UN. AN - Union Anhydrite
COWDEN - Cowden Anhydrite
CAS - Castile Formation
AN3 - Anhydrite III-IV Member

HAL2 - Halite II Member

AN2 - Anhydrite II Member

HAL1 - Halite I Member

AN1 - Anhydrite I Member

Lithological Facies

H - Halite, colorless

HB - Halite, reddish brown

HAS - Halite, some argillaceous material (HA_s)

HAW - Halite, with abundant argillaceous material (HA_w)

CB - Clay, brown

CG - Clay, gray

POLYH. S - Polyhalite seams

AN. A - Anhydrite "a"

AN. B - Anhydrite "b"

HPTAW - Halite with trace of polyhalite and abundant argillaceous material (HPA_{tw})

HPW - Halite with abundant polyhalite (HP_w)

H + 4P - Halite with four polyhalite bands or seams

AN-CG - Anhydrite and gray clay layer

STRATIGRAPHIC SUMMARY OF BOREHOLE B-25

Depths and elevations indicated refer to GS at elevation of 3408.7 ft MSL.

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
GR. SURFACE	0.0	3,408.7	0.0
HOL/M. CAL	10.0	3,398.7	10.0
M. CAL/GAT	14.0	3,394.7	4.0
GAT/SRS	34.7	3,374.0	20.7
SRS/DLR	44.8	3,363.9	10.1
DLR/RUS	533.0	2,875.7	488.2
MAGENTA-T	592.7	2,816.0	59.7
MAGENTA-B	617.0	2,791.7	24.3
CULEBRA-T	704.1	2,704.6	87.1
CULEBRA-B	728.0	2,680.7	23.9
RUS/SAL	842.9	2,565.8	114.9
T.D.	901.8	2,506.9	58.9

STRATIGRAPHIC SUMMARY OF BOREHOLE DOE-1

Depths and elevations indicated refer to KB at elevation of 3473.2 ft MSL.

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
GR. SURFACE	8.0	3,465.2	8.0
SRS/DLR	133.0	3,340.2	125.0
DLR/RUS	667.5	2,805.7	534.5
MAGENTA-T	722.0	2,751.2	54.5
MAGENTA-B	745.0	2,728.2	23.0
CULEBRA-T	828.6	2,644.6	83.6
CULEBRA-B	850.5	2,622.7	21.9
RUS/SAL	976.5	2,496.7	126.0
MB101-T	1099.0	2,374.2	122.5
MB101-B	1102.0	2,371.2	3.0
MB102-T	1136.0	2,337.2	34.0
MB102-B	1138.5	2,334.7	2.5
MB103-T	1159.0	2,314.2	20.5
MB103-B	1169.0	2,304.2	10.0
MB105-T	1197.0	2,276.2	28.0
MB105-B	1199.0	2,274.2	2.0
MB106-T	1213.0	2,260.2	14.0
MB106-B	1216.0	2,257.2	3.0
MB107-T	1252.0	2,221.2	36.0
MB107-B	1254.0	2,219.2	2.0
MB108-T	1261.0	2,212.2	7.0
MB108-B	1263.0	2,210.2	2.0
MB109-T	1286.0	2,187.2	23.0
MB109-B	1309.5	2,163.7	23.5
MB111-T	1360.5	2,112.7	51.0
MB111-B	1361.3	2,111.9	0.8
MB112-T	1378.1	2,095.1	16.8
MB112-B	1379.8	2,093.4	1.7
MB113-T	1403.0	2,070.2	23.2
MB113-B	1406.9	2,066.3	3.9
MB114-T	1425.2	2,048.0	18.3
MB114-B	1429.3	2,043.9	4.1
MB115-T	1461.9	2,011.3	32.6
MB115-B	1465.8	2,007.4	3.9
MB116-T	1475.0	1,998.2	9.2
MB116-B	1477.6	1,995.6	2.6
UP. SAL/MCN	1486.0	1,987.2	8.4
V. T. SAND-T	1486.0	1,987.2	0.0
V. T. SAND-B	1489.8	1,983.4	3.8
MB117-T	1555.5	1,917.7	65.7

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
MB117-B	1557.2	1,916.0	1.7
MB118-T	1580.0	1,893.2	22.8
MB118-B	1582.6	1,890.6	2.6
MB119-T	1605.0	1,868.2	22.4
MB119-B	1608.0	1,865.2	3.0
MB120-T	1631.0	1,842.2	23.0
MB120-B	1632.0	1,841.2	1.0
MB121-T	1644.2	1,829.0	12.2
MB121-B	1646.5	1,826.7	2.3
MB122-T	1654.5	1,818.7	8.0
MB122-B	1656.0	1,817.2	1.5
UN. AN-T	1681.4	1,791.8	25.4
UN. AN-B	1694.0	1,779.2	12.6
MB123-T	1762.0	1,711.2	68.0
MB123-B	1769.9	1,703.3	7.9
MB124-T	1773.0	1,700.2	3.1
MB124-B	1783.8	1,689.4	10.8
MB126-T	1879.3	1,593.9	95.5
MB126-B	1880.3	1,592.9	1.0
MB127-T	1904.5	1,568.7	24.2
MB127-B	1907.4	1,565.8	2.9
MB128-T	1917.7	1,555.5	10.3
MB128-B	1919.7	1,553.5	2.0
MB129-T	1942.3	1,530.9	22.6
MB129-B	1944.3	1,528.9	2.0
MB130-T	1956.0	1,517.2	11.7
MB130-B	1956.7	1,516.5	0.7
MB131-T	2024.0	1,449.2	67.3
MB131-B	2025.8	1,447.4	1.8
MB132-T	2055.5	1,417.7	29.7
MB132-B	2056.6	1,416.6	1.1
MB133-T	2075.0	1,398.2	18.4
MB133-B	2076.0	1,397.2	1.0
MB134-T	2117.0	1,356.2	41.0
MB134-B	2130.0	1,343.2	13.0
MB135-T	2148.5	1,324.7	18.5
MB135-B	2149.4	1,323.8	0.9
MB136-T	2192.1	1,281.1	42.7
MB136-B	2209.2	1,264.0	17.1
MB137-T	2219.4	1,253.8	10.2
MB137-B	2219.7	1,253.5	0.3
MB138-T	2264.8	1,208.4	45.1
MB138-B	2265.5	1,207.7	0.7
AN. A-T	2288.9	1,184.3	23.4
AN. A-B	2289.4	1,183.8	0.5
CB-PART-C	2289.5	1,183.7	0.1
AN. B-T	2293.0	1,180.2	3.6

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
ANH. B-B	2294.0	1,179.2	1.0
HPTAW/HPW	2315.9	1,157.3	21.9
MB139-T	2321.5	1,151.7	27.5
MB139-C	2322.6	1,150.6	1.1
MB139-B	2323.7	1,149.5	1.1
CG-PART-C	2337.0	1,136.2	13.3
MB140-T	2374.5	1,098.7	50.8
MB140-B	2389.0	1,084.2	14.5
MB141-T	2450.0	1,023.2	61.0
MB141-B	2457.0	1,016.2	7.0
MB142-T	2497.0	976.2	40.0
MB142-B	2512.0	961.2	15.0
MB143-T	2563.5	909.7	51.5
MB143-B	2570.5	902.7	7.0
MB144-T	2606.0	867.2	35.5
MB144-B	2621.5	851.7	15.5
COWDEN-T	2647.8	825.4	26.3
COWDEN-B	2677.0	796.2	29.2
SAL/CAST	2936.5	536.7	259.5
AN3/HAL2	3374.8	98.4	438.3
HAL2/AN2	3600.0	-126.8	225.2
AN2/HAL1	3708.3	-235.1	108.3
HAL1/AN1	4032.3	-559.1	324.0
T. D.	4065.3	-592.1	33.0

STRATIGRAPHIC SUMMARY OF BOREHOLE ERDA-9

Depths and elevations indicated refer to KB at elevation of 3420.4 ft MSL.

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
GR. SURFACE	11.5	3,408.9	11.5
HOL/M. CAL	22.0	3,398.4	10.5
M. CAL/GAT	27.0	3,393.4	5.0
GAT/SRS	54.0	3,366.4	27.0
SRS/DLR	63.0	3,357.4	9.0
DLR/RUS	550.0	2,870.4	487.0
MAGENTA-T	608.0	2,812.4	58.0
MAGENTA-B	632.0	2,788.4	24.0
CULEBRA-T	716.0	2,704.4	84.0
CULEBRA-B	739.0	2,681.4	23.0
RUS/SAL	862.0	2,558.4	123.0
MB100-T	936.0	2,484.4	74.0
MB100-B	938.5	2,481.9	2.5
MB101-T	980.8	2,439.6	42.3
MB101-B	983.5	2,436.9	2.7
MB102-T	1026.0	2,394.4	42.5
MB102-B	1027.5	2,392.9	1.5
MB103-T	1040.0	2,380.4	12.5
MB103-B	1050.0	2,370.4	10.0
MB104-T	1061.0	2,359.4	11.0
MB104-B	1062.0	2,358.4	1.0
MB105-T	1076.0	2,344.4	14.0
MB105-B	1078.0	2,342.4	2.0
MB106-T	1093.1	2,327.3	15.1
MB106-B	1093.7	2,326.7	0.6
MB107-T	1131.4	2,289.0	37.7
MB107-B	1131.8	2,288.6	0.4
MB108-T	1140.6	2,279.8	8.8
MB108-B	1141.5	2,278.9	0.9
MB109-T	1164.5	2,255.9	23.0
MB109-B	1188.0	2,232.4	23.5
MB111-T	1237.2	2,183.2	49.2
MB111-B	1238.2	2,182.2	1.0
MB112-T	1256.0	2,164.4	17.8
MB112-B	1258.1	2,162.3	2.1
MB113-T	1282.4	2,138.0	24.3
MB113-B	1285.0	2,135.4	2.6
MB114-T	1305.6	2,114.8	20.6
MB114-B	1306.4	2,114.0	0.8

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
MB115-T	1340.3	2,080.1	33.9
MB115-B	1343.9	2,076.5	3.6
MB116-T	1353.6	2,066.8	9.7
MB116-B	1355.6	2,064.8	2.0
UP. SAL/MCN	1362.2	2,058.2	6.6
V. T. SAND-T	1363.3	2,057.1	1.1
V. T. SAND-B	1367.7	2,052.7	4.4
MB117-T	1431.2	1,989.2	63.5
MB117-B	1432.5	1,987.9	1.3
MB118-T	1454.9	1,965.5	22.4
MB118-B	1457.0	1,963.4	2.1
MB119-T	1481.6	1,938.8	24.6
MB119-B	1482.2	1,938.2	0.6
MB120-T	1501.3	1,919.1	19.1
MB120-B	1503.1	1,917.3	1.8
MB121-T	1515.2	1,905.2	12.1
MB121-B	1517.2	1,903.2	2.0
MB122-T	1523.5	1,896.9	6.3
MB122-B	1524.3	1,896.1	0.8
UN. AN-T	1548.7	1,871.7	24.4
UN. AN-B	1556.8	1,863.6	8.1
MB123-T	1629.8	1,790.6	73.0
MB123-B	1637.2	1,783.2	7.4
MB124-T	1644.8	1,775.6	7.6
MB124-B	1651.7	1,768.7	6.9
MB126-T	1741.3	1,679.1	89.6
MB126-B	1742.0	1,678.4	0.7
MB127-T	1768.3	1,652.1	26.3
MB127-B	1769.7	1,650.7	1.4
MB128-T	1778.1	1,642.3	8.4
MB128-B	1781.2	1,639.2	3.1
MB129-T	1803.3	1,617.1	22.1
MB129-B	1805.2	1,615.2	1.9
MB130-T	1813.5	1,606.9	8.3
MB130-B	1815.0	1,605.4	1.5
MB131-T	1883.4	1,537.0	68.4
MB131-B	1884.0	1,536.4	0.6
MB132-T	1914.1	1,506.3	30.1
MB132-B	1915.0	1,505.4	0.9
MB133-T	1932.7	1,487.7	17.7
MB133-B	1934.5	1,485.9	1.8
MB134-T	1976.0	1,444.4	41.5
MB134-B	1988.6	1,431.8	12.6
MB135-T	2005.1	1,415.3	16.5
MB135-B	2006.4	1,414.0	1.3
MB136-T	2043.2	1,377.2	36.8
MB136-B	2058.1	1,362.3	14.9
MB137-T	2074.5	1,345.9	16.4

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
MB137-B	2074.7	1,345.7	0.2
H/HB	2075.6	1,344.8	0.9
HB/HAS	2077.4	1,343.0	1.8
HAS/H	2080.4	1,340.0	3.0
H/HAW	2088.8	1,331.6	8.4
CB-SEAM-B	2098.5	1,321.9	9.7
CB-HAL-B	2106.3	1,314.1	7.8
CB-BRK-C	2112.8	1,307.6	6.5
MB138-T	2120.4	1,300.0	7.6
MB138-B	2121.1	1,299.3	0.7
AN. A-T	2143.9	1,276.5	22.8
AN. A-B	2144.8	1,275.6	0.9
AN. B-T	2151.0	1,269.4	6.2
AN. B-B	2151.2	1,269.2	0.2
MB139-T	2177.3	1,243.1	26.1
MB139-C	2178.8	1,241.6	1.5
MB139-B	2180.3	1,240.1	1.5
CG-PART-C	2188.2	1,232.2	7.9
HPS/H	2197.8	1,222.6	9.6
H/HPS	2200.2	1,220.2	2.4
H+4P-T	2205.6	1,214.8	5.4
H+4P-B.	2205.8	1,214.6	0.2
AN-CG-PRT	2206.8	1,213.6	1.0
CG-PART-C	2226.0	1,194.4	19.2
MB140-T	2241.3	1,179.1	15.3
MB140-B	2250.5	1,169.9	9.2
MB141-T	2320.4	1,100.0	69.9
MB141-B	2329.9	1,090.5	9.5
MB142-T	2377.0	1,043.4	47.1
MB142-B	2391.4	1,029.0	14.4
MB143-T	2449.6	970.8	58.2
MB143-B	2455.5	964.9	5.9
MB144-T	2498.4	922.0	42.9
MB144-B	2501.8	918.6	3.4
COWDEN-T	2540.3	880.1	38.5
COWDEN-B	2562.5	857.9	22.2
SAL/CAST	2836.3	584.1	273.8
T. D.	2889.0	531.4	52.7

STRATIGRAPHIC SUMMARY OF THE EXPLORATORY SHAFT

Depths refer to zero datum point (top of first bunton).

Preliminary depths correspond to the CWI approximate surveying performed March to May, 1982.

Correction factors were determined by comparison of CWI electronic surveying of December 2, 1982, and TSC surveying of January 22, 1983, with the preliminary depths of geological logs.

Elevations are referenced to:

(1) Zero datum point for depth measurements (top of first bunton) at elevation of 3410.00 ft. MSL, based on CWI bench mark No. CW-1 at elevation of 3410.080 ft. MSL (brass cap outside the exploratory shaft) and tied to the existing north baseline to the north of the site.

(2) Bottom of concrete (shaft key) at elevation of 2530.38 ft. MSL; and

(3) Steel deck (center of south edge) at elevation of 1259.03 ft. MSL based on CWI bench mark No. 82-D (brass cap at NW corner of the underground power center foundation) at elevation of 1259.59 ft. MSL.

LITHOLOGICAL CONTACT	PRELIMINARY DEPTH (FT)	CORRECTION FACTOR (FT)	CORRECTED DEPTH (FT)	ELEVATION (FT MSL)	INTERVAL THICKNESS(FT) [FROM PRECEDING CONTACT]
GR. SURFACE	-0.5	0.0	-0.5	3,410.5	-0.5
RUS/SAL	850.8	-0.2	850.6	2,559.4	851.1
MB100-T	922.1	-0.1	922.0	2,488.0	71.4
MB100-B	922.9	-0.1	922.8	2,487.2	0.8
MB101-T	970.0	0.8	970.8	2,439.2	48.0
MB101-B	974.2	0.8	975.0	2,435.0	4.2
MB102-T	1008.8	0.9	1009.7	2,400.3	34.7
MB102-B	1010.2	0.9	1011.1	2,398.9	1.4
MB103-T	1022.5	0.9	1023.4	2,386.6	12.3
MB103-B	1036.5	1.0	1037.5	2,372.5	14.1
MB104-T	1044.6	1.0	1045.6	2,364.4	8.1
MB104-B	1045.1	1.0	1046.1	2,363.9	0.5
MB105-T	1060.4	1.0	1061.4	2,348.6	15.3
MB105-B	1060.8	1.0	1061.8	2,348.2	0.4
MB106-T	1080.3	1.0	1081.3	2,328.7	19.5
MB106-B	1081.3	1.0	1082.3	2,327.7	1.0
MB107-T	1115.2	1.1	1116.3	2,293.7	34.0
MB107-B	1115.5	1.1	1116.6	2,293.4	0.3
MB108-T	1124.7	1.1	1125.8	2,284.2	9.2
MB108-B	1125.2	1.1	1126.3	2,283.7	0.5
MB109-T	1146.0	1.2	1147.2	2,262.8	20.9
MB109-B	1171.5	1.2	1172.7	2,237.3	25.5
MB110-T	1203.0	1.3	1204.3	2,205.7	31.6
MB110-B	1204.2	1.3	1205.5	2,204.5	1.2

LITHOLOGICAL CONTACT	PRELIMINARY DEPTH (FT)	CORRECTION FACTOR (FT)	CORRECTED DEPTH (FT)	ELEVATION (FT MSL)	INTERVAL THICKNESS(FT) [FROM PRECEDING CONTACT]
MB111-T	1220.0	1.3	1221.3	2,188.7	15.8
MB111-B	1220.2	1.3	1221.5	2,188.5	0.2
MB112-T	1237.0	1.4	1238.4	2,171.6	16.9
MB112-B	1239.9	1.4	1241.3	2,168.7	2.9
MB113-T	1264.7	1.4	1266.1	2,143.9	24.8
MB113-B	1266.3	1.4	1267.7	2,142.3	1.6
MB114-T	1287.7	1.5	1289.2	2,120.8	21.5
MB114-B	1289.0	1.5	1290.5	2,119.5	1.3
MB115-T	1324.0	1.5	1325.5	2,084.5	35.0
MB115-B	1327.0	1.5	1328.5	2,081.5	3.0
MB116-T	1335.5	1.5	1337.0	2,073.0	8.5
MB116-B	1338.0	1.6	1339.6	2,070.4	2.6
UP. SAL/MCN	1344.0	1.6	1345.6	2,064.4	6.0
V. T. SAND-T	1347.1	1.6	1348.7	2,061.3	3.1
V. T. SAND-B	1348.8	1.6	1350.4	2,059.6	1.7
MB117-T	1414.2	1.7	1415.9	1,994.1	65.5
MB117-B	1415.3	1.7	1417.0	1,993.0	1.1
MB118-T	1442.7	1.8	1444.5	1,965.5	27.5
MB118-B	1445.4	1.8	1447.2	1,962.8	2.7
MB119-T	1463.3	1.8	1465.1	1,944.9	17.9
MB119-B	1465.1	1.8	1466.9	1,943.1	1.8
MB120-T	1483.2	1.8	1485.0	1,925.0	18.1
MB120-B	1484.1	1.8	1485.9	1,924.1	0.9
MB121-T	1495.0	1.8	1496.8	1,913.2	10.9
MB121-B	1497.3	1.8	1499.1	1,910.9	2.3
MB122-T	1504.3	1.8	1506.1	1,903.9	7.0
MB122-B	1505.6	1.8	1507.4	1,902.6	1.3
UN. ANH-T	1534.0	1.8	1535.8	1,874.2	28.4
UN. ANH-B	1538.0	1.8	1539.8	1,870.2	4.0
MB123-T	1613.1	1.8	1614.9	1,795.1	75.1
MB123-B	1618.2	1.8	1620.0	1,790.0	5.1
MB124-T	1623.8	1.8	1625.6	1,784.4	5.6
MB124-B	1631.8	1.8	1633.6	1,776.4	8.0
MB125-T	1683.3	1.8	1685.1	1,724.9	51.5
MB125-B	1685.4	1.8	1687.2	1,722.8	2.1
MB126-T	1721.5	1.8	1723.3	1,686.7	36.1
MB126-B	1723.0	1.8	1724.8	1,685.2	1.5
MB127-T	1745.9	1.8	1747.7	1,662.3	22.9
MB127-B	1748.9	1.8	1750.7	1,659.3	3.0
MB128-T	1757.1	1.8	1758.9	1,651.1	8.2
MB128-B	1760.0	1.8	1761.8	1,648.2	2.9
MB129-T	1783.5	1.8	1785.3	1,624.7	23.5
MB129-B	1785.4	1.8	1787.2	1,622.8	1.9
MB130-T	1795.4	1.8	1797.2	1,612.8	10.0
MB130-B	1795.5	1.8	1797.3	1,612.7	0.1
MB131-T	1862.8	1.8	1864.6	1,545.4	67.3
MB131-B	1864.1	1.8	1865.9	1,544.1	1.3
MB132-T	1897.3	1.8	1899.1	1,510.9	33.2
MB132-B	1897.9	1.8	1899.7	1,510.3	0.6
MB133-T	1911.7	1.8	1913.5	1,496.5	13.8
MB133-B	1912.6	1.8	1914.4	1,495.6	0.9
MB134-T	1954.9	2.0	1956.9	1,453.1	42.5
MB134-B	1966.5	2.1	1968.6	1,441.4	11.7
MB135-T	1982.7	2.2	1984.9	1,425.1	16.3
MB135-B	1983.8	2.2	1986.0	1,424.0	1.1
MB136-T	2025.0	2.4	2027.4	1,382.6	41.4
MB136-B	2033.4	2.5	2035.9	1,374.1	8.5
MB137-T	2049.0	2.6	2051.6	1,358.4	15.7
MB137-B	2049.7	2.6	2052.3	1,357.7	0.7

LITHOLOGICAL CONTACT	PRELIMINARY DEPTH (FT)	CORRECTION FACTOR (FT)	CORRECTED DEPTH (FT)	ELEVATION (FT MSL)	INTERVAL THICKNESS(FT) [FROM PRECEDING CONTACT]
H/HB	2050.3	2.6	2052.9	1,357.1	0.6
HB/HAS	2051.7	2.6	2054.3	1,355.7	1.4
HAS/H	2056.0	2.6	2058.6	1,351.4	4.3
H/HAW	2065.0	2.6	2067.6	1,342.4	9.0
CB-SEAM-B	2072.4	2.6	2075.0	1,335.0	7.4
CB-HAL-B	2081.9	2.6	2084.5	1,325.5	9.5
CB-BRK-C	2089.9	2.6	2092.5	1,317.5	8.0
POLYH.S.-C	2094.9	2.6	2097.5	1,312.5	5.0
MB138-T	2095.8	2.6	2098.4	1,311.6	0.9
MB138-B	2096.1	2.6	2098.7	1,311.3	0.3
CB-PART-C	2097.6	2.6	2100.2	1,309.8	1.5
CB-SEAM-B	2104.0	2.6	2106.6	1,303.4	6.4
AN-SEAM-B	2108.5	2.6	2111.1	1,298.9	4.5
CG-SEAM-B	2110.0	2.6	2112.6	1,297.4	1.5
AN.A-T	2119.0	2.6	2121.6	1,288.4	9.0
AN.A-B	2119.7	2.6	2122.3	1,287.7	0.7
CB-PART-C	2119.8	2.6	2122.4	1,287.6	0.1
AN.B-T	2126.3	2.6	2128.9	1,281.1	6.5
AN.B-B	2126.6	2.6	2129.2	1,280.8	0.3
HAS/HPTAT	2129.7	2.6	2132.3	1,277.7	3.1
HPTAT/HAS	2136.7	2.6	2139.3	1,270.7	7.0
HAS/HPTAT	2139.9	2.6	2142.5	1,267.5	3.2
HPTAT/HPTA	2142.6	2.6	2145.2	1,264.8	2.7
HPTAW/HPSW	2150.1	2.6	2152.7	1,257.3	7.5
MB139-T	2153.7	2.6	2156.3	1,253.7	3.6
MB139-C	2155.1	2.6	2157.7	1,252.3	1.4
MB139-B	2156.5	2.6	2159.1	1,250.9	1.4
CG-PART-C	2165.1	2.6	2167.7	1,242.3	8.6
HPSW/HPTAT	2172.7	2.6	2175.3	1,234.7	7.6
HPTAT/HPS	2177.9	2.6	2180.5	1,229.5	5.2
H+4P-T	2182.0	2.6	2184.6	1,225.4	4.1
H+4P-B	2183.7	2.6	2186.3	1,223.7	1.7
AN-CG-B	2183.9	2.6	2186.5	1,223.5	0.2
CG-PART-C	2184.0	2.6	2186.6	1,223.4	0.1
MB140-T	2220.0	2.6	2222.6	1,187.4	36.0
MB140-B	2229.0	2.6	2231.6	1,178.4	9.0

STRATIGRAPHIC SUMMARY OF THE VENTILATION SHAFT

Preliminary depths refer to shaft collar at elevation 3407.9 ft. MSL.

Correction factors were determined by comparison of preliminary mapping which used the shaft collar as the datum point and later mapping near the facility interval which used temporary survey point Ω at an elevation of 1261.1 ft. MSL as a datum point. The difference of -1.3 ft. between the preliminary mapping and the later mapping at a depth of 2100 ft. was distributed linearly throughout the entire mapped interval.

Corrected depths were calculated by adding the preliminary depth and the correction factor.

Elevations were determined from the preliminary mapping datum point (shaft collar).

LITHOLOGICAL CONTACT	PRELIMINARY DEPTH (FT)	CORRECTION FACTOR (FT)	CORRECTED DEPTH (FT)	ELEVATION (FT MSL)	INTERVAL THICKNESS(FT) [FROM PRECEDING CONTACT]
GR. SURFACE	0.4	0.0	0.4	3,407.5	0.4
DLR/RUS	536.8	-0.3	536.5	2,871.4	536.1
DISS. RES-T	566.6	-0.3	566.3	2,841.6	29.8
DISS. RES-B	578.8	-0.4	578.4	2,829.5	12.1
MAGENTA-T	596.5	-0.4	596.1	2,811.8	17.7
MAGENTA-B	618.6	-0.4	618.2	2,789.7	22.1
DISS. RES-T	677.1	-0.4	676.7	2,731.2	58.5
DISS. RES-B	684.5	-0.4	684.1	2,723.8	7.4
CULEBRA-T	706.1	-0.4	705.7	2,702.2	21.6
CULEBRA-B	727.3	-0.4	726.9	2,681.0	21.2
DISS. RES-T	727.6	-0.4	727.2	2,680.7	0.3
DISS. RES-B	734.8	-0.5	734.3	2,673.6	7.1
RUS/SAL	845.2	-0.5	844.7	2,563.2	110.4
MB100-T	922.0	-0.6	921.4	2,486.5	76.7
MB100-B	922.6	-0.6	922.0	2,485.9	0.6
MB101-T	966.0	-0.6	965.4	2,442.5	43.4
MB101-B	969.0	-0.6	968.4	2,439.5	3.0
MB102-T	1005.9	-0.6	1005.3	2,402.6	36.9
MB102-B	1007.0	-0.6	1006.4	2,401.5	1.1
MB103-T	1018.2	-0.6	1017.6	2,390.3	11.2
MB103-B	1034.0	-0.6	1033.4	2,374.5	15.8
MB104-T	1041.1	-0.6	1040.5	2,367.4	7.1
MB104-B	1042.1	-0.6	1041.5	2,366.4	1.0
MB105-T	1057.9	-0.7	1057.2	2,350.7	15.7
MB105-B	1058.8	-0.7	1058.1	2,349.8	0.9
MB106-T	1073.9	-0.7	1073.2	2,334.7	15.1
MB106-B	1074.3	-0.7	1073.6	2,334.3	0.4
MB107-T	1112.6	-0.7	1111.9	2,296.0	38.3
MB107-B	1113.1	-0.7	1112.4	2,295.5	0.5

LITHOLOGICAL CONTACT	PRELIMINARY DEPTH (FT)	CORRECTION FACTOR (FT)	CORRECTED DEPTH (FT)	ELEVATION (FT MSL)	INTERVAL THICKNESS(FT) [FROM PRECEDING CONTACT]
MB108-T	1122.3	-0.7	1121.6	2,286.3	9.2
MB108-B	1122.8	-0.7	1122.1	2,285.8	0.5
MB109-T	1145.9	-0.7	1145.2	2,262.7	23.1
MB109-B	1171.1	-0.7	1170.4	2,237.5	25.2
MB111-T	1219.5	-0.8	1218.7	2,189.2	48.3
MB111-B	1220.0	-0.8	1219.2	2,188.7	0.5
MB112-T	1237.3	-0.8	1236.5	2,171.4	17.3
MB112-B	1239.4	-0.8	1238.6	2,169.3	2.1
MB113-T	1264.0	-0.8	1263.2	2,144.7	24.6
MB113-B	1265.7	-0.8	1264.9	2,143.0	1.7
MB114-T	1287.4	-0.8	1286.6	2,121.3	21.7
MB114-B	1288.4	-0.8	1287.6	2,120.3	1.0
MB115-T	1323.3	-0.8	1322.5	2,085.4	34.9
MB115-B	1326.7	-0.8	1325.9	2,082.0	3.4
MB116-T	1336.2	-0.8	1335.4	2,072.5	9.5
MB116-B	1338.8	-0.8	1338.0	2,069.9	2.6
UP. SAL/MCN	1344.9	-0.8	1344.1	2,063.8	6.1
MB117-T	1414.8	-0.9	1413.9	1,994.0	69.8
MB117-B	1416.1	-0.9	1415.2	1,992.7	1.3
MB118-T	1438.2	-0.9	1437.3	1,970.6	22.1
MB118-B	1440.8	-0.9	1439.9	1,968.0	2.6
MB119-T	1465.2	-0.9	1464.3	1,943.6	24.4
MB119-B	1466.3	-0.9	1465.4	1,942.5	1.1
MB120-T	1485.0	-0.9	1484.1	1,923.8	18.7
MB120-B	1485.8	-0.9	1484.9	1,923.0	0.8
MB121-T	1498.3	-0.9	1497.4	1,910.5	12.5
MB121-B	1500.9	-0.9	1500.0	1,907.9	2.6
MB122-T	1507.7	-0.9	1506.8	1,901.1	6.8
MB122-B	1508.9	-0.9	1508.0	1,899.9	1.2
UN. AN-T	1534.0	-0.9	1533.1	1,874.8	25.1
UN. AN-B	1541.5	-0.9	1540.6	1,867.3	7.5
MB123-T	1614.3	-1.0	1613.3	1,794.6	72.7
MB123-B	1620.9	-1.0	1619.9	1,788.0	6.6
MB124-T	1627.0	-1.0	1626.0	1,781.9	6.1
MB126-T	1725.8	-1.1	1724.7	1,683.2	89.0
MB126-B	1726.7	-1.1	1725.6	1,682.3	0.9
MB127-T	1752.2	-1.1	1751.1	1,656.8	25.5
MB127-B	1754.7	-1.1	1753.6	1,654.3	2.5
MB128-T	1764.0	-1.1	1762.9	1,645.0	9.3
MB128-B	1766.0	-1.1	1764.9	1,643.0	2.0
MB129-T	1788.9	-1.1	1787.8	1,620.1	22.9
MB129-B	1790.8	-1.1	1789.7	1,618.2	1.9
MB130-T	1800.0	-1.1	1798.9	1,609.0	9.2
MB130-B	1801.0	-1.1	1799.9	1,608.0	1.0
MB131-T	1868.8	-1.2	1867.6	1,540.3	67.7
MB131-B	1869.6	-1.2	1868.4	1,539.5	0.8
MB132-T	1900.0	-1.2	1898.8	1,509.1	30.4
MB132-B	1901.0	-1.2	1899.8	1,508.1	1.0
MB133-T	1918.2	-1.2	1917.0	1,490.9	17.2
MB133-B	1919.6	-1.2	1918.4	1,489.5	1.4
MB134-T	1963.4	-1.2	1962.2	1,445.7	43.8
MB134-B	1974.6	-1.2	1973.4	1,434.5	11.2
MB135-T	1990.9	-1.2	1989.7	1,418.2	16.3
MB135-B	1992.1	-1.2	1990.9	1,417.0	1.2
MB136-T	2031.1	-1.3	2029.8	1,378.1	38.9
MB136-B	2045.7	-1.3	2044.4	1,363.5	14.6
MB138-T	2108.5	-1.3	2107.2	1,300.7	62.8
MB138-B	2109.0	-1.3	2107.7	1,300.2	0.5
AN. A-T	2131.1	-1.3	2129.8	1,278.1	22.1
AN. A-B	2131.9	-1.3	2130.6	1,277.3	0.8
CB-PART-C	2132.0	-1.3	2130.7	1,277.2	0.1
AN. B-T	2138.7	-1.3	2137.4	1,270.5	6.7
AN. B-B	2139.0	-1.3	2137.7	1,270.2	0.3
HAS/H	2141.0	-1.3	2139.7	1,268.2	2.0

LITHOLOGICAL CONTACT	PRELIMINARY DEPTH (FT)	CORRECTION FACTOR (FT)	CORRECTED DEPTH (FT)	ELEVATION (FT MSL)	INTERVAL THICKNESS(FT) [FROM PRECEDING CONTACT]
H/HAS	2149.6	-1.3	2148.3	1,259.6	8.6
HAS/H	2150.5	-1.3	2149.2	1,258.7	0.9
H/HPTAW	2157.3	-1.3	2156.0	1,251.9	6.8
HPTAW/HPW	2161.9	-1.3	2160.6	1,247.3	4.6
MB139-T	2164.9	-1.3	2163.6	1,244.3	3.0
MB139-C	2166.3	-1.3	2165.0	1,242.9	1.4
MB139-B	2167.7	-1.3	2166.4	1,241.5	1.4
T.D.	2196.5	-1.3	2195.2	1,212.7	28.8

STRATIGRAPHIC SUMMARY OF BOREHOLE WIPP-11
(HOST ROCK INTERVAL ONLY)

Depths and elevations indicated refer to KB at elevation of 3439.1 ft MSL.

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
MB136-T	1978.5	1460.6	-
MB136-B	1986.0	1453.1	7.5
MB138-T	2025.0	1414.1	39.0
MB138-B	2027.0	1412.1	2.0
AN.A-T AN.A-B	Not Encountered		
AN.B-T AN.B-B	Not Encountered		
MB139-T	2061.0	1378.1	-
MB139-B	2064.0	1375.1	3.0
MB140-T	2092.0	1347.1	28.0
MB140-B	2105.0	1334.1	13.0

STRATIGRAPHIC SUMMARY OF BOREHOLE WIPP-12

Depths and elevations refer to KB and GS as follows:

1. From depth of 0 to 2737.5 ft (inclusive), the depths and elevations refer to KB at elevation of 3483.7 ft MSL.

2. Below depth of 2737.5 ft,[1] the depths and elevations refer to GS at elevation of 3471.5 ft MSL.

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
GR. SURFACE	12.2	3,471.5	12.2
HOL/M. CAL	16.2	3,467.5	4.0
M. CAL/GAT	19.2	3,464.5	3.0
GAT/SRS	28.8	3,454.9	9.6
SRS/DLR	167.0	3,316.7	138.2
DLR/RUS	640.0	2,843.7	473.0
MAGENTA-T	703.9	2,779.8	63.9
MAGENTA-B	727.0	2,756.7	23.1
CULEBRA-T	822.0	2,661.7	95.0
CULEBRA-B	846.8	2,636.9	24.8
RUS/SAL	966.0	2,517.7	119.2
MB101-T	1080.0	2,403.7	114.0
MB101-B	1084.5	2,399.2	4.5
MB102-T	1115.0	2,368.7	30.5
MB102-B	1116.0	2,367.7	1.0
MB103-T	1130.0	2,353.7	14.0
MB103-B	1141.0	2,342.7	11.0
MB104-T	1149.0	2,334.7	8.0
MB104-B	1150.0	2,333.7	1.0
MB105-T	1167.0	2,316.7	17.0
MB105-B	1167.6	2,316.1	0.6
MB106-T	1182.5	2,301.2	14.9
MB106-B	1183.5	2,300.2	1.0
MB107-T	1221.5	2,262.2	38.0
MB107-B	1223.0	2,260.7	1.5
MB108-T	1232.0	2,251.7	9.0
MB108-B	1232.5	2,251.2	0.5

[1] The recorded depth when WIPP-12 was reentered is 2776 feet (below GL). This disagrees with the total depth reported in the WIPP-12 Basic Data Report (Sandia, 1982) of 2773.6 feet. The 2.4 feet discrepancy is probably a result of slight error in driller's pipe tally.

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
MB109-T	1254.0	2,229.7	21.5
MB109-B	1278.0	2,205.7	24.0
MB111-T	1323.5	2,160.2	45.5
MB111-B	1324.0	2,159.7	0.5
MB112-T	1338.0	2,145.7	14.0
MB112-B	1342.0	2,141.7	4.0
MB113-T	1365.5	2,118.2	23.5
MB113-B	1367.0	2,116.7	1.5
MB114-T	1388.0	2,095.7	21.0
MB114-B	1389.0	2,094.7	1.0
MB115-T	1422.0	2,061.7	33.0
MB115-B	1424.5	2,059.2	2.5
MB116-T	1435.0	2,048.7	10.5
MB116-B	1436.0	2,047.7	1.0
UP. SAL/MCN	1444.0	2,039.7	8.0
V. T. SAND-T	1444.0	2,039.7	0.0
V. T. SAND-B	1447.0	2,036.7	3.0
MB117-T	1506.5	1,977.2	59.5
MB117-B	1507.5	1,976.2	1.0
MB118-T	1528.0	1,955.7	20.5
MB118-B	1531.0	1,952.7	3.0
MB119-T	1552.0	1,931.7	21.0
MB119-B	1556.5	1,927.2	4.5
MB120-T	1572.0	1,911.7	15.5
MB120-B	1575.0	1,908.7	3.0
MB121-T	1586.0	1,897.7	11.0
MB121-B	1588.0	1,895.7	2.0
MB122-T	1594.5	1,889.2	6.5
MB122-B	1596.0	1,887.7	1.5
UN. AN-T	1617.0	1,866.7	21.0
UN. AN-B	1625.0	1,858.7	8.0
MB123-T	1695.0	1,788.7	70.0
MB123-B	1700.8	1,782.9	5.8
MB124-T	1708.0	1,775.7	7.2
MB124-B	1715.4	1,768.3	7.4
MB126-T	1796.0	1,687.7	80.6
MB126-B	1798.0	1,685.7	2.0
MB127-T	1822.5	1,661.2	24.5
MB127-B	1825.0	1,658.7	2.5
MB128-T	1834.0	1,649.7	9.0
MB128-B	1836.5	1,647.2	2.5
MB129-T	1854.5	1,629.2	18.0
MB129-B	1856.5	1,627.2	2.0

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
MB130-T	1866.0	1,617.7	9.5
MB130-B	1867.0	1,616.7	1.0
MB131-T	1928.5	1,555.2	61.5
MB131-B	1930.0	1,553.7	1.5
MB132-T	1956.0	1,527.7	26.0
MB132-B	1957.5	1,526.2	1.5
MB133-T	1974.0	1,509.7	16.5
MB133-B	1976.0	1,507.7	2.0
MB134-T	2015.0	1,468.7	39.0
MB134-B	2025.0	1,458.7	10.0
MB135-T	2039.0	1,444.7	14.0
MB135-B	2040.0	1,443.7	1.0
MB136-T	2071.6	1,412.1	31.6
MB136-B	2083.1	1,400.6	11.5
CB-SEAM-B	2114.9	1,368.8	31.8
CB-HAL-B	2122.8	1,360.9	7.9
CB-BRK-C	2124.8	1,358.9	2.0
MB138T	2134.6	1,349.1	9.8
MB138-B	2135.1	1,348.6	0.5
CB-PART-C	2135.2	1,348.5	0.1
AN. A-T	2153.5	1,330.2	18.3
AN. A-B	2155.5	1,328.2	2.0
AN. B-T	2160.9	1,322.8	5.4
AN. B-B	2161.0	1,322.7	0.1
MB139-T	2182.6	1,301.1	21.6
MB139-C	2183.8	1,299.9	1.2
MB139-B	2184.9	1,298.8	1.1
MB140-T	2226.1	1,257.6	41.2
MB140-B	2238.1	1,245.6	12.0
MB141-T	2290.0	1,193.7	51.9
MB141-B	2296.0	1,187.7	6.0
MB142-T	2332.0	1,151.7	36.0
MB142-B	2344.0	1,139.7	12.0
MB143-T	2381.5	1,102.2	37.5
MB143-B	2387.6	1,096.1	6.1
MB144-T	2413.5	1,070.2	25.9
MB144-B	2423.9	1,059.8	10.4
COWDEN-T	2445.5	1,038.2	21.6
COWDEN-B	2471.0	1,012.7	25.5
SAL/CAST	2737.5	746.2	266.5
AN3/HAL2	3053.9	417.6	328.6
HAL2/AN2	3281.8	189.7	227.9
AN2/HAL1	3391.0	80.5	109.2
HAL1/AN1	3901.6	-430.1	510.6
T.D.	3925.0	-453.5	23.4

STRATIGRAPHIC SUMMARY OF BOREHOLE WIPP-18

Depths and elevations indicated refer to GS at elevation of 3456.5 ft MSL.

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
GR. SURFACE	0.0	3,456.5	0.0
HOL/M. CAL	5.0	3,451.5	5.0
M. CAL/SRS	9.0	3,447.5	4.0
SRS/DLR	138.0	3,318.5	129.0
DLR/RUS	613.0	2,843.5	475.0
DISS. RES-T	643.0	2,813.5	30.0
DISS. RES-B	655.0	2,801.5	12.0
MAGENTA-T	672.0	2,784.5	17.0
MAGENTA-B	696.0	2,760.5	24.0
DISS. RES-T	757.0	2,699.5	61.0
DISS. RES-B	769.0	2,687.5	12.0
CULEBRA-T	787.0	2,669.5	18.0
CULEBRA-B	808.0	2,648.5	21.0
DISS. RES-T	812.0	2,644.5	4.0
DISS. RES-B	822.0	2,634.5	10.0
RUS/SAL	928.0	2,528.5	106.0
MB101-T	1,046.0	2,410.5	118.0
MB101-B	1,049.0	2,407.5	3.0
T. D.	1,060.0	2,396.5	11.0

STRATIGRAPHIC SUMMARY OF BOREHOLE WIPP-19

Depths and elevation indicated refer to GS at elevation of 3433.1 ft MSL.

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
GR. SURFACE	0.0	3,433.1	0.0
HOL/M. CAL	7.0	3,426.1	7.0
M. CAL/SRS	14.0	3,419.1	7.0
SRS/DLR	96.0	3,337.1	82.0
DLR/RUS	590.0	2,843.1	494.0
DISS. RES-T	619.0	2,814.1	29.0
DISS. RES-B	629.0	2,804.1	10.0
MAGENTA-T	647.0	2,786.1	18.0
MAGENTA-B	672.0	2,761.1	25.0
DISS. RES-T	730.0	2,703.1	58.0
DISS. RES-B	756.0	2,677.1	26.0
CULEBRA-T	756.0	2,677.1	0.0
CULEBRA-B	779.0	2,654.1	23.0
DISS. RES-T	781.0	2,652.1	2.0
DISS. RES-B	795.0	2,638.1	14.0
RUS/SAL	895.0	2,538.1	100.0
MB100-T	1010.0	2,423.1	115.0
MB100-B	1012.0	2,421.1	2.0
T. D.	1038.2	2,394.9	26.2

STRATIGRAPHIC SUMMARY OF BOREHOLE WIPP-21

Depths and elevation indicated refer to GS at elevation of 3417.0 ft MSL.

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
GR. SURFACE	0.0	3,417.0	0.0
HOL/M. CAL	6.0	3,411.0	6.0
M. CAL/GAT	12.0	3,405.0	6.0
GAT/SRS	39.0	3,378.0	27.0
SRS/DLR	73.0	3,344.0	34.0
DLR/RUS	560.0	2,857.0	487.0
DISS. RES-T	588.0	2,829.0	28.0
DISS. RES-B	601.0	2,816.0	13.0
MAGENTA-T	618.0	2,799.0	17.0
MAGENTA-B	642.0	2,775.0	24.0
DISS. RES-T	706.0	2,711.0	64.0
DISS. RES-B	715.0	2,702.0	9.0
CULEBRA-T	729.0	2,688.0	14.0
CULEBRA-B	753.0	2,664.0	24.0
DISS. RES-T	755.0	2,662.0	2.0
DISS. RES-B	759.0	2,658.0	4.0
RUS/SAL	868.0	2,549.0	109.0
MB101-T	986.0	2,431.0	118.0
MB101-B	989.0	2,428.0	3.0
MB102-T	1025.0	2,392.0	36.0
MB102-B	1026.0	2,391.0	1.0
MB103-T	1039.0	2,378.0	13.0
T. D.	1046.0	2,371.0	7.0

STRATIGRAPHIC SUMMARY OF BOREHOLE WIPP-22

Depths and elevations indicated refer to GS at elevation of 3425.8 ft MSL.

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
GR. SURFACE	0.0	3,425.8	0.0
HOL/M. CAL	6.0	3,419.8	6.0
M. CAL/SRS	13.0	3,412.8	7.0
SRS/DLR	81.0	3,344.8	68.0
DLR/RUS	574.0	2,851.8	493.0
DISS. RES-T	603.0	2,822.8	29.0
DISS. RES-B	614.0	2,811.8	11.0
MAGENTA-T	630.0	2,795.8	16.0
MAGENTA-B	654.0	2,771.8	24.0
DISS. RES-T	717.0	2,708.8	63.0
DISS. RES-B	728.0	2,697.8	11.0
CULEBRA-T	742.0	2,683.8	14.0
CULEBRA-B	764.0	2,661.8	22.0
DISS. RES-T	767.0	2,658.8	3.0
DISS. RES-B	773.0	2,652.8	6.0
RUS/SAL	885.0	2,540.8	112.0
MB101-T	1000.0	2,425.8	115.0
MB101-B	1003.0	2,422.8	3.0
MB102-T	1036.0	2,389.8	33.0
MB102-B	1037.0	2,388.8	1.0
MB103-T	1049.0	2,376.8	12.0
MB103-B	1063.0	2,362.8	14.0
MB104-T	1071.0	2,354.8	8.0
MB104-B	1072.0	2,353.8	1.0
MB105-T	1086.0	2,339.8	14.0
MB105-B	1087.0	2,338.8	1.0
MB106-T	1102.0	2,323.8	15.0
MB106-B	1103.0	2,322.8	1.0
MB107-T	1142.0	2,283.8	39.0
MB107-B	1143.0	2,282.8	1.0
MB0108-T	1150.0	2,275.8	7.0
MB108-B	1151.0	2,274.8	1.0
MB109-T	1172.0	2,253.8	21.0
MB109-B	1196.0	2,229.8	24.0
MB111-T	1242.0	2,183.8	46.0
MB118-B	1243.0	2,182.8	1.0
MB112-T	1259.0	2,166.8	16.0
MB112-B	1261.0	2,164.8	2.0

LITHOLOGICAL CONTACT	DEPTH (FT) [BELOW DATUM]	ELEVATION (FT. MSL)	INTERVAL THICKNESS (FT) [FROM PRECEDING CONTACT]
MB113-T	1285.0	2,140.8	24.0
MB113-B	1286.0	2,139.8	1.0
MB114-T	1307.0	2,118.8	21.0
MB114-B	1308.0	2,117.8	1.0
MB115-T	1342.0	2,083.8	34.0
MB115-B	1344.0	2,081.8	2.0
MB116-T	1353.0	2,072.8	9.0
MB116-B	1355.0	2,070.8	2.0
UP. SAL/MCN	1363.0	2,062.8	8.0
V. T. SAND-T	1363.0	2,062.8	0.0
V. T. SAND-B	1367.0	2,058.8	4.0
MB117-T	1426.0	1,999.8	59.0
MB117-B	1427.0	1,998.8	1.0
T. D.	1450.0	1,975.8	23.0

STRATIGRAPHIC SUMMARY OF SHORT VERTICAL COREHOLES

	DO-45/46		DO-52/53		DO-63/64		DO-201/202		DO-205/206		DH-207/208		DH-211/212		DH-215/216	
	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)
MB138-T	1325.5	-	1317.3	-	1347.4	-	1301.1	-	1352.7	-	1299.7	-	1309.0	-	1310.4	-
MB138-B	1324.9	0.6	1316.9	0.4	1346.7	0.7	1300.5	0.6	1351.9	0.8	1298.9	0.8	1308.5	0.5	1309.8	0.6
AN.A-T	1302.1	22.8	1292.9	24.0	1325.4	21.3	1277.7	22.8	1330.0	21.9	1276.2	22.7	1285.6	22.9	1286.5	23.3
AN.A-B	1301.5	0.6	1292.4	0.5	1324.2	1.2	1277.0	0.7	1329.3	0.7	1275.5	0.7	1285.0	0.6	1286.0	0.5
AN.B-T	1292.5	9.0	1285.9	6.5	1317.3	6.9	1270.1	6.9	1322.8	6.5	1268.7	6.8	1278.4	6.6	1279.6	6.4
AN.B-B	1292.4	0.1	1285.7	0.2	1317.1	0.2	1269.9	0.2	1322.6	0.2	1268.6	0.1	1278.3	0.1	1279.4	0.2
MB139-T	1267.7	24.8	1260.1	25.6	1290.9	26.2	1243.8	26.1	1294.8	27.8	1242.5	26.1	1251.0	27.3	1252.7	26.7
MB139-B	1263.5	4.1	1258.0	2.1	1288.7	2.2	1241.0	2.8	1293.6	1.2	1239.0	3.5	1249.1	1.9	1251.1	1.6

	DH-219/220		DH-223/224		DH-227/228		MB-139-1		MB-139-2		MB-139-3		MB-139-4	
	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)	ELEVATION (ft MSL)	THICKNESS (ft)
MB138-T	1305.2	-	1293.7	-	1283.6	-								
MB138-B	1304.4	0.8	1293.0	0.7	1282.9	0.7								
AN.A-T	1281.4	23.0	1270.3	22.7	1260.8	22.1								
AN.A-B	1280.8	0.6	1269.3	1.0	1260.0	0.8								
AN.B-T	1274.4	6.4	1263.4	5.9	1254.2	5.8								
AN.B-B	1274.3	0.1	1263.3	0.1	1254.1	0.1								
MB139-T	1248.6	25.7	1239.0	24.3	1227.6	26.5	1257.3	-	1241.5	-	1250.9	-	1250.2	-
MB139-B	1246.4	2.2	1239.5	3.1	1226.3	1.3	1255.5	1.8	1238.3	3.2	1248.6	2.3	1246.8	3.4

APPENDIX C

SURVEYING AND DRILLHOLE/SHAFT CORRELATION NOTES

SURVEYING NOTES

The following section describes several inconsistencies or minor variances that were discovered during an attempt to establish accurate locations for the drillholes and correct depths for the shafts. None of the inconsistencies affect the drillhole correlations. The most significant variance could be in the slight mislocation of individual drillholes; however, a field check is not warranted for present purposes.

1. Data generated and assembled during the early years of WIPP were often referenced to different systems (distances from section lines versus New Mexico Grid coordinates) and used surveying of different orders of accuracies. Under these conditions, minor surveying inconsistencies exist.

2. All present surveying at the WIPP plant site is tied to stabilized baselines, the data for which are shown on Bechtel Drawing No. 21-C-011, Rev. 7, submitted on August 13, 1982, which also contains revised New Mexico grid coordinates for ERDA-9 (center of the borehole casing).(1)

3. Coordinates of selected section corners are shown on Bechtel Drawing 21-C-010, Rev. 2. The data on Corners/Stations 301 to 313, which were surveyed by John West Engineering Company at the second order of accuracy (while previous survey work by Bohannan Huston, Inc., was only of the third order), are the most recent. These data are based on field surveying of the corner monuments as installed in about 1916. The actual distances vary by several feet from the theoretical one square mile section. This variance

(1) A concrete brass cap reference monument located 4.21 feet southwest of ERDA-9 has the following coordinates:

N 498 884.23
E 667 289.99

affects the angles between intersecting section lines which are slightly off from 90 degrees. Coordinates of section corners not recently surveyed cannot be accurately established without a field survey.

4. When a point (drillhole) location is surveyed from the section lines, the distances are surveyed parallel to the section lines (established in the field), taking into account the actual angle between the section lines; hence, the distances shown do not have to be the shortest (perpendicular) if the angle is other than exactly 90 degrees. This relationship must be considered when transforming distances from section lines into grid coordinates.

5. The greatest uncertainty appears to be the actual drillhole locations with regard to the location surveyed. Sometimes the driller positions the rig off the surveyed location. Without proper correction and/or resurveying, an error occurs.

6. Elevation and drillhole depth datums as well as depths of geological features (contacts) were used as indicated in the individual Basic Data Reports which had already used appropriate corrections between core depths and geophysical log depths.

7. Geological mapping (logging) of the exploratory shaft, performed from March through May 1982, was based on CWI preliminary depths (100-foot tape hung from hooks installed in 100± foot intervals along the south wall of the shaft). Zero datum point for the preliminary depths corresponded to the top of the first bunton at an elevation of 3410.00 feet MSL. A survey mark indicated by a yellow cross was spray painted on the south wall of the shaft below the steel liner every five feet in the vertical direction.

   The horizontal control during geologic mapping of the key and station zones was extended from the marks on the south wall by three

yellow spray-painted crosses in both directions every five feet on the circumference (corresponding to a 12-foot diameter; adjustments were made to compensate for a variable shaft diameter). The remaining length of the circumference was split in half to obtain north. The sidelines (4 plumb lines hanging from the shaft collar) could not be used for horizontal control because they were catching on the galloway and not hanging freely.

8. Depths in the ventilation shaft are based on a zero point at the shaft collar at an elevation of 3407.9 feet MSL. Subsequent depths were determined by using a 200-foot fiberglass tape hung from points (hooks) typically installed at 100-foot intervals.

9. A precision depth survey of both shafts, performed by CWI on December 2, 1982, using electronic distance measurement (EDM) instruments (Lietz Model RED-2), established elevations in the shafts and station areas. Also, a loop through the shafts was closed. This survey was based on CWI Bench Mark No. CW-1 at an elevation of 3410.080 feet MSL (brass cap outside the exploratory shaft collar) which was tied to the existing "North Base Line" to the north of the site.

10. To correlate the geological features to the established elevations in the exploratory shaft, an additional survey was performed by TSC geologists on January 22, 1983. A 200-foot fiberglass tape was hung in seven intervals starting at RC Instrument Level 814, and relative depths of selected recognizable geological features together with instrument levels and other significant features (such as shaft key features, surveying hooks from the preliminary CWI survey, etc.) were recorded. This survey showed very good correlation with the EDM data for the zone between the concrete bottom of the shaft key and the steel deck in the station which was tied to CWI Bench Mark No. 82-D (brass cap at northwest corner of the underground power center foundation) at an elevation of 1259.59

feet MSL. The tape survey was only 0.65 foot longer than the EDM survey in a total distance of 1,272 feet from the shaft key area to the station level, a difference of only 0.05 percent.

The vertical difference within the station zone between (1) the preliminary CWI depths, established by a fiberglass tape and used during the geologic mapping, and (2) depths established by the EDM was 2.6 feet, representing only about 0.1 percent of the total distance (depth) of the exploratory shaft (about 2,150 feet).

11. To identify the depth corrections in the exploratory shaft for the depths obtained with the fiberglass tape, the geological data and available records on the preliminary CWI depths were analyzed and compared to the new surveys. This resulted in the establishment of the "best fit" correction factors (Jarolimek, et al., 1983). Intervals between selected depths were corrected by interpolation. Depths or elevations for a given point are generally accurate to within ±0.25 foot (±3 inches). This level of accuracy reflects the undulations and other irregularities of geological features, local rock deformations since excavation,(1) and the conditions under which the geological and surveying data were obtained. Thicknesses of thin layers or individual beds can be reported with greater accuracy since thicknesses are determined as the differences between geologic contacts and are not related to artificial control points.

12. The vertical difference in the ventilation shaft within the station zone between the taped depth (using a fiberglass tape) and the

(1) From the time geotechnical instrumentation was installed in the vicinity of the station zone to February 1983, the maximum measured deformation was approximately 0.2 foot (2-1/2 inches) (GFDR No. 4, 1983a).

electronically measured depth (using an EDM) was 1.3 feet, repre senting only about 0.06 percent of the total depth of about 2,160 feet.

Correction factors were determined by comparison of preliminary depths used during mapping which used the shaft collar as the datum point and later mapping near the facility interval which used temporary survey point Ω as a datum point at an elevation of 1260.915 feet MSL (tied to the definitive elevations). The difference of -1.3 foot between the preliminary mapping depths and the later mapping at a depth of 2,100 feet was distributed linearly throughout the entire mapped interval. Corrected depths were calculated by adding the preliminary depth and the correction factor.

DRILLHOLE/SHAFT CORRELATION NOTES

Significant differences in size and logging techniques between drillholes and shafts contribute to nonuniformity of data, as illustrated in the following examples:

- Core from drillholes which have small diameters is usually clean, allows easy and repeated examination from all sides, and could be easily broken for examination from "within" for mineralogy, structure, and texture.

- On the other hand, core is often lost (not recovered) from weakened layers of the rock (i.e., clay seams, partings, and breaks) with washing away of the clayey material.

- Coring through undulating beds such as MB 139 provides only one point for determination of thickness and relief and may provide misleading information concerning the slope of the contacts.

- Examination and logging of shaft walls is commonly performed under relatively adverse conditions, such as:

  - Dirt, film, or incrustation on shaft walls requiring cleaning before any logging can commence

  - Time and space constraints and limitations

  - Inaccessibility of certain sections of the shaft perimeter and/or shaft intervals

  - Adverse environmental conditions, such as dust, noise, moisture, and poor lighting, as well as harsh ambient temperature and humidity.

- Core logging gives better conditions for identifying mineralogy and individual interfaces while laminar features could be either missed (if not preserved in the core) or misinterpreted with regard to the indication of lateral continuity.

- Shaft wall logging cannot provide highly detailed data or mineralogy from wall examination and presents a good chance of missing an interface covered by dirt and/or incrustation. On the other hand, laminar features are generally well preserved and visible.