Waste Isolation Pilot Plant
Shaft Sealing System
Compliance Submittal Design Report

Volume 2 of 2:
Appendix E

Repository Isolation Systems Department
Sandia National Laboratories
Albuquerque, NM 87185

ABSTRACT
This is the second volume of a two-volume report describing a shaft sealing system design for the Waste Isolation Pilot Plant. This appendix contains detailed drawings of the shaft sealing system and its components.
## WASTE ISOLATION PILOT PLANT
### CARLSBAD, NM
#### SHAFT SEALING SYSTEM DESIGN

### DESIGN DRAWINGS

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GENERAL NOTES:

2. THE AS-BUILT DIMENSIONS AND ELEVATIONS SHOWN IN THESE DRAWINGS ARE NOMINAL. IN THAT DIMENSIONS MAY CHANGE DUE TO LOCAL VARIANCE OF THE SUBSTRATE. OPERATIONAL MODIFICATIONS MADE TO SUIT THE CREEP CLOSURE OF THE HALITE, AND OTHER OPERATIONAL REQUIREMENTS. THEREFORE THE AS-BUILT DIMENSIONS AND THE PERMITTED ELEVATIONS FOR THE SEALS SEATING SYSTEM SHALL BE VERIFIED BY FIELD SURVEYING AND EXPLORATORY CORE DRILLING DURING SITE PREPARATION FOR THE FINAL CONSTRUCTION.

3. DRAWING NUMBERS:
   FOR CLARITY OF DETAILS AND SECTION DESIGNATIONS, AND NOTES, ONLY THE SHEET NUMBER IS SHOWN.

LEGEND FOR PROPOSED SHAFT SEALING SYSTEM:

- SECTION DESIGNATION:
  SHEET ON WHICH SECTION IS DRAWN
  SHEET FROM WHICH SECTION IS TAKEN

- DETAIL DESIGNATION:
  SHEET ON WHICH DETAIL IS DRAWN
  SHEET FROM WHICH DETAIL IS TAKEN

- SECTION OR DETAIL TAKEN AND DRAWN ON THE SAME SHEET, OR STANDARD SECTION OR DETAIL.

- EXISTING STRUCTURE TO BE DEMOLISHED
- NEW STRUCTURE
- EXISTING STRUCTURE
- NEW STRUCTURE
- EXISTING STRUCTURE TO BE DEMOLISHED

ABBREVIATIONS:
- E: CENTERLINE
- M: ANNOTATE
- DMP: Corrugated Metal Plate
- CONC: CONCRETE
- DOE: DEPARTMENT OF ENERGY
- DWG: DRAWING
- E: EAST
- EL: ELEVATION
- EXIST: EXISTING
- FT: FOOT
- FT. FEET
- HD: HOIST
- H.D.: INSIDE DIAMETER
- IN.: INCHES
- M: METER
- MB: MANNER BED
- MNL: MINIMUM
- MSL: MEAN SEA LEVEL
- N: NORTH
- NO.: NUMBER
- R: RADIUS
- S: SOUTH
- SHEET: SHEET NUMBER
- SRC: SOURCES CONCRETE
- W: WEST
- W: WASTE ISLASTION DIVISION
- WLP: WASTE ISLASTION PLANT

SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT

WIPP SHAFT SEALING SYSTEM

SHAFT LOCATION PLAN, ABBREVIATIONS, GENERAL NOTES AND LEGEND

REF 59/1 5/23/92 ISSUE FOR RECORDS PACKAGE
MCG 1/17/92 DUE

SANDIA NATIONAL LABORATORIES
LITHOLOGY:

- Primary Rock/Sediment Types:
  - WISSSTONE/FLAPSTONE
  - SEDIMENTARY
  - MUDSTONE/CYSTONE
  - CYSTONE
  - SILTSTONE
  - WISSTONE
  - ANHIDRITE/GYPSUM
  - DOLOMITE
  - LITE
  - POLYHALITE

- Secondary Constituents:
  - ARGILLACEOUS
  - SULFATIC
  - DOLOMILLIC
  - SILICAREOUS
  - WLITIC
  - POLYHALITIC

STRATIGRAPHY:

- Shaft:
  - Top of Concrete EL: 3408.5 MSL
  - Concrete Lining

- Shaft Levels:
  - EL 3404.8 MSL
  - EL 3404.0 MSL
  - EL 3403.6 MSL

- Shaft Sections:
  - 2829.0 MSL
  - 2847.0 MSL

NOTES:

1. The Stratigraphy and groundwater brine seepage/wEEP materials are based on the lithologic information compiled during the geologic mapping of the waste handling shafts walls, used in the 038, geotechnical activities in the waste handling shafts. Waste isolation pilot plant (WIPP) project southeast in New Mexico. 1994, and Appendix A of report DOE WIPP-05-5117, "Waste isolation pilot plant sealing system design report," 1993.

2. Stratigraphic contact at the top of the Dewey Lake beds was not recorded during mapping. Elevation shown is interpreted from recordings of the salt handling and exhaust shafts.

3. Asterisk (*) within the Rustler and Supra Rustler formations indicates groundwater observed during shaft mapping. Asterisk (**) indicates potential brine seepage/wEEP intervals, located above the shaft station level, MSL based on observed intervals of brine seepage/wEEPS in the air intake shaft that have been projected to the waste shaft.

4. The mapping of the waste shaft (Spear & Powers, 1981/TCMD-111-38) did not indicate observed seepage intervals within the Saltado formation.

5. Reference as-built drawings from WIPP.

Waste Shaft 311 shaft development sections 31-R-001-010
Waste Shaft 311 shaft lining & key sections 31-R-002-010
Waste handling building 411 hoist tower foundation plans, elevations, 76'-0" & 89'-0"
Waste handling building 411 hoist tower foundation sections

AS-BUILT FOR WASTE SHAFT COLLAR

SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT
WIPP SHAFT SEALING SYSTEM
NEAR-SURFACE/RUSTLER FORMATIONS
WASTE SHAFT STRATIGRAPHY & AS-BUILT ELEMENTS
WASTE SHAFT

Waste Shaft

SECTION

NOTES:
1. SEE SHEET 1 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.

SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT
WIPP SHAFT SEALING SYSTEM
WASTE SHAFT
SHAFT STATION MONOLITH

SCALE 1" = 10 FT
STRATIGRAPHY

(SEE NOTE 2)

DEPTH

(SEE NOTE 3)

COMPACTED EARTHEN FILL

CONCRETE PLUG

COMPACTED EARTHEN FILL

RUSTLER/COMPACTED CLAY COLUMN

CONCRETE PLUG

NOTES:
1. SEE SHEET 1 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.
2. SEE SHEET 2 FOR LITHOLOGY AND NOTES.
3. DEPTHS SHOWN ARE DISTANCES BELOW THE TOP OF CONCRETE, LOCATED AT EL. 3408.5' ABOVE MSL. USGS 1977 NORTH AMERICAN DATUM.
LITHOLOGY:

PRIMARY ROCK/SEDIMENT TYPES
- MUDSTONE/CLAYSTONE
- CONCRETIZED MUDSTONE
- CLAYSTONE/CEG
- CLAYSTONE
- SILETISTONE
- SANDSTONE
- AGEINTORITE/OPHYRM
- DOLomite
- DIAMORITE
- CALCITE
- MARL
- MARLITE
- SULFATE
- SULFATE
- SOME QMARTITE

SECONDARY CONSTITUENTS
- ARGILLACEOUS
- SEDIMENTARY
- CALCEOUS
- POLYHLE]
- LAGENCOQUE

NOTES:
ASTRINGENCY INDICATES GROUNDWATER, DOLERITE/CEMITE FORMATIONS OR BRINE SEEPAGE/MEEP (CEMITE FORMATIONS) OBSERVED DURING THE MAPPING OF THE AIR INTAKE SHAFT.
2. REFERENCE AS-BUILT DRAWINGS FROM WIP:
   - AIR INTAKE SHAFT 331 - SHAFT COLLAR / AIR INTAKE PLATFORM PLAN, SECTIONS AND DETAILS
   - AIR INTAKE SHAFT 331 - STRUCTURE PLAN, SECTIONS AND DETAILS
   - AIR INTAKE SHAFT 331 - KEY PLAN, SECTIONS AND DETAILS
   - AIR INTAKE SHAFT 331 - Lining DETAILS
   - AIR INTAKE SHAFT 331 - EXCAVATION AS-CONCRETE
   - AIR INTAKE SHAFT 331 - GENERAL ARRANGEMENT
   - AIR INTAKE SHAFT 331 - SHIELD PLAN, SECTIONS AND DETAILS

SCALE IN FEET

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<td>M</td>
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STANDARD NATIONAL LABORATORIES
WIPP A/E SUPPORT
WIPP SHAFT SEALING SYSTEM
NEAR-SURFACE/CEMITE FORMATIONS
AIR INTAKE SHAFT STRATIGRAPHY & AS-BUILT ELEMENTS

SANDIA NATIONAL LABORATORIES
5971 NEW MEXICO
1. See sheet 1 for general notes, legend, and abbreviations.
2. See sheet 7 for lithology and notes.
3. Depths shown are distances below the top of concrete, located at EL 3410.0 above MSL uses 1927 North American Datum.
STRATIGRAPHY

LITHOLOGY:

PRIMARY ROCK/SEGMENT TYPES
- Mudstone/Claystone
- Claystone Bed
- Siltstone
- Sandstone
- Anhydrite/Gypsum
- Dolomite
- Halite
- Polylithic
- Cauche

SECONDARY CONSTITUENTS
- Argillaceous
- Sulfatic
- Calcareous
- Halite
- Polyhalite
- Cauche

NOTE:
1. The stratigraphy and groundwater brine seepage/welp intervals are based on the lithologic information compiled during the geologic mapping of the exhaust shaft walls. DOE-WPP-86-008, "Geotechnical activities in the exhaust shaft", and Appendix A of report DOE/WIP-85-3137, "Waste isolation pilot plant sealing system design report", 1993.

2. Retrace AS-BUILT drawings from WDP.
   - Exhaust Shaft 351, Shaft Lining and Key Section and Details
   - Exhaust Shaft 351, General Arrangement, Plans and Sections
   - Exhaust Shaft Murch and Cavern Layout - Shows OGL-S-001-1FB Permanent Collar Structure
   - Exhaust Shaft, Shaft Development, Plan, Sections WDP 3900004 and Detail.

SCALE IN FEET
STRATIGRAPHY

SEE NOTE 2

12TH OF KEY
2508.0' MSL
WATER/SALADO INTERFACE

2502.0' MSL
BOTTOM OF KEY

KEY

STRATIGRAPHY

1. SEE SHT 1 FOR GENERAL NOTES AND ABBREVIATIONS
2. SEE SHT 12 FOR LITHOLOGY AND NOTES.

NOTES:

SCALE IN FEET

0 10 20 30 40 50

ALBERT W. DENNIS
NEW MEXICO
971

SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT
WIPP SHAFT SEALING SYSTEM
SALADO FORMATION
EXHAUST SHAFT STRATIGRAPHY & AS-BUILT ELEMENTS

A. W. Dennis
8-2-91
STRATIGRAPHY

DEPTH

COMPACTED SALT COLUMN
LOWER CONCRETE-ASPHALT WATERSTOP
LOWER SALADO COMPACTED CLAY COLUMN
SHAFT STATION MONUMENT
SMC FILL
BASE OF SUMP

SANDIA NATIONAL LABORATORIES
SWP&F A/E SUPPORT
SWP SH AFT SEALING SYSTEM
SALADO FORMATION
SALT HANDLING SHAFT
STRATIGRAPHY & SEALING
SUBSYSTEM PROFILE

NOTES:
1. SEE SHEET 1 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS
2. SEE SHEET 17 FOR LITHOLOGY AND NOTES
3. SEE NOTE 3 OF SHEET 19
4. SEE NOTE 2
SALT HANDLING SHAFT
SECTION - SCHEMATIC

BASE OF SUMP

SECTION

NOTE:
1. See Sht. 1 for general notes, legend and abbreviations.
| Table 1 |
|-----------------|-----------------|-----------------|
| **SHAFT** | **NOMINAL SHAFT DIAMETER D** | **UPPER SALADO COMPACTED CLAY COLUMN** | **LOWER SALADO COMPACTED CLAY COLUMN** |
| | | **TOP EL. (FT. MSL)** | **BOTTOM EL. (FT. MSL)** | **TOTAL HT. (FT.)** | **TOP EL. (FT. MSL)** | **BOTTOM EL. (FT. MSL)** | **TOTAL HT. (FT.)** |
| WASTE | 20'-0" | 2389.0 | 2037.5 | 351.5 | 1382.0 | 1286.0 | 96.0 |
| AIR INTAKE | 20'-3" | 2397.0 | 2053.0 | 344.0 | 1389.5 | 1296.0 | 93.5 |
| EXHAUST | 15'-0" | 2382.0 | 2042.0 | 340.0 | 1383.0 | 1285.0 | 98.0 |
| SALT HANDLING | 11'-10" | 2386.0 | 2051.0 | 335.0 | 1391.0 | 1284.0 | 107.0 |

**DETAIL**

*See Table 1 for details*
TABLE 1

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<tr>
<th>NOMINAL SHAFT DIAMETER D</th>
<th>COMPACTED SALT COLUMN</th>
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<td>TOP EL. (FT. MSL)</td>
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<td>WASTE 20'-0&quot;</td>
<td>1987.5</td>
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<tr>
<td>AIR INTAKE 20'-3&quot;</td>
<td>2003.0</td>
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<td>EXHAUST 15'-0&quot;</td>
<td>1992.0</td>
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<tr>
<td>SALT HANDLING 11'-10&quot;</td>
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TABLE 1

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<tr>
<th>SHAFT</th>
<th>Nominal Shaft Diameter D</th>
<th>Rustler Compacted Clay Column</th>
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<td>WASTE</td>
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<tr>
<td>AIR INTAKE</td>
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<td>14'-0&quot;</td>
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<tr>
<td>SALT HANDLING</td>
<td>10'-0&quot;</td>
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WASTE ISOLATION PILOT PLANT
CARLSBAD, NM

SHAFT SEALING SYSTEM DESIGN

EQUIPMENT AND CONSTRUCTION SKETCHES

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<td>WIPP SHAFT SEALING SYSTEM SMALLER GALLOWAY GENERAL ARRANGEMENT PLANS AND SECTIONS</td>
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<td>SKETCH E-2</td>
<td>WIPP SHAFT SEALING SYSTEM LARGER GALLOWAY GENERAL ARRANGEMENT PLANS AND SECTIONS</td>
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<td>SKETCH E-3</td>
<td>WIPP SHAFT SEALING SYSTEM TYPICAL HEADFRAME PLANS AND SECTIONS</td>
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<td>SKETCH E-4</td>
<td>WIPP SHAFT SEALING SYSTEM PERSPECTIVE HEADFRAME AND ASSOCIATED SURFACE FACILITIES</td>
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PLAN - TOP DECK

1/8" GALLOWAY

1/4" GALLOWAY PAPER (A)

TOS TOP DECK

GALLOWAY GRIPPER, HYDRAULIC JACK (TOP & BOTTOM)

ACCESS LADDER

ACCESS LADDER

TOS MIDDLE DECK

FOLDABLE 3/4" SLICING CONNECTION

VENTILATION DUCT TRANSITION PIECE

POLAR CRANE, CURVED TRACK

SECTION A

PLAN - MIDDLE DECK

E(internal)

GALLOWAY PERMANENT CURTAIN (TOP & BOTTOM)

VENTILATION DUCT (REMOVABLE & ATTACHED TO GALLOWAY STRUCTURE)

GALLOWAY PAPER (TOP & BOTTOM)

FOLDABLE 3/4" SLICING CONNECTION

VENTILATION DUCT TRANSITION PIECE

POLAR CRANE, CURVED TRACK

SECTION B

PLAN - BOTTOM DECK

1/8" GALLOWAY

TOS BOTTOM DECK

GALLOWAY GRIPPER, HYDRAULIC JACK (TOP & BOTTOM)

ACCESS LADDER

ACCESS LADDER

GALLOWAY PERMANENT CURTAIN (TOP & BOTTOM)

VENTILATION DUCT (REMOVABLE & ATTACHED TO GALLOWAY STRUCTURE)

GALLOWAY PAPER (TOP & BOTTOM)

FOLDABLE 3/4" SLICING CONNECTION

VENTILATION DUCT TRANSITION PIECE

POLAR CRANE, CURVED TRACK

SECTION B

SCALE 1/4" = 1 FT

GALLOWAY DESIGN DATA

<table>
<thead>
<tr>
<th></th>
<th>SALT SHAFT</th>
<th>BRINE SHAFT</th>
<th>DRY SHAFT</th>
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<tbody>
<tr>
<td>Base Diameter</td>
<td>96</td>
<td>128</td>
<td>177</td>
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<tr>
<td>Angle of Rake</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Base of Galloway</td>
<td>24 in</td>
<td>24 in</td>
<td>24 in</td>
</tr>
<tr>
<td>No. of Galloway</td>
<td>8</td>
<td>8</td>
<td>8</td>
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<tr>
<td>No. of Gallowage</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>No. of Cables</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Wire of Cables</td>
<td>1/2</td>
<td>1/2</td>
<td>1/2</td>
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<tr>
<td>Wire of Galloway</td>
<td>2600 lb</td>
<td>4000 lb</td>
<td>4000 lb</td>
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<tr>
<td>Wire of Gallowage</td>
<td>3000 lb</td>
<td>4000 lb</td>
<td>4000 lb</td>
</tr>
<tr>
<td>Total Weight of Wire</td>
<td>7800 lb</td>
<td>7800 lb</td>
<td>7800 lb</td>
</tr>
<tr>
<td>Total Weight of Galloway</td>
<td>2500 lb</td>
<td>2500 lb</td>
<td>2500 lb</td>
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MPW SHAFT SEALING SYSTEM

LARGER GALLOWAY GENERAL ARRANGEMENT PLANS & SECTIONS SKETCH E-2
PLAN - COLLAR LEVEL

TYPICAL HEADFRAME PLANS & SECTIONS
SKETCH E.3
WIPP UC721 Distribution List

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Acting Director, RW-10
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Office of Program Mgmt. & Integ.
Director, RW-40
Office of Waste Accept., Stor., & Tran.

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Washington, DC 20585

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Minneapolis, MN 55415

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Los Alamos, NM 87544

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<th>Section</th>
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<td>J.R. Tillerson, Sandia</td>
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<td>Section 2, Site Geologic, Hydrologic, &amp; Geochemical Setting</td>
<td>A.W. Dennis and S.J. Lambert, Sandia</td>
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<td>Section 3, Design Guidance</td>
<td>A.W. Dennis, Sandia</td>
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<td>Section 4, Design Description</td>
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<td>Section 5, Material Specifications</td>
<td>F.D. Hansen, Sandia</td>
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<td>Section 6, Construction Techniques</td>
<td>E.H. Ahrens, Sandia</td>
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<td>Section 7, Structural Analyses of Shaft Seals</td>
<td>L.D. Hurtado, Sandia; M.C. Loken and L.L. Van Sambeek, REISPEC</td>
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<td>Section 8, Hydrologic Evaluation of the Shaft Seal System</td>
<td>M.K. Knowles, Sandia; V.A. Kelley, INTERA</td>
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<tr>
<td>Section 9, Conclusions</td>
<td>J.R. Tillerson and A.W. Dennis, Sandia</td>
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<td>Appendix A, Material Specifications</td>
<td>F.D. Hansen, Sandia</td>
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<td>Appendix B, Shaft Sealing Construction Procedures</td>
<td>E.H. Ahrens, Sandia, with the assistance of Parsons Brinckerhoff Construction and Scheduling staff</td>
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<td>Appendix C, Fluid Flow Analyses</td>
<td>M.K. Knowles, Sandia; V.A. Kelley, INTERA</td>
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<td>Appendix E, Design Drawings</td>
<td>A.W. Dennis, Sandia; C.D. Mann, Parsons Brinckerhoff, with the assistance of the Parsons Brinckerhoff Design staff</td>
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</table>

Design reviews provided by Malcolm Gray, Atomic Energy Canada Ltd., Whiteshell Laboratory; Stephen Phillips, Phillips Mining, Geotechnical & Grouting, Inc.; and John Tinucci, Itasca Consulting Group Inc. are appreciated, as are document reviews provided by Don Galbraith, U.S. Department of Energy Carlsbad Area Office; William Thompson, Carlsbad Area Office Technical Assistance Contractor; Robert Stinebaugh, Palmer Vaughn, Deborah Coffey, and Wendell Weart, Sandia.

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