Title 40 CFR Part 191
Subparts B and C
Compliance Recertification Application
for the
Waste Isolation Pilot Plant

Appendix DATA-2009
Monitoring Data and Reports

United States Department of Energy
Waste Isolation Pilot Plant

Carlsbad Field Office
Carlsbad, New Mexico

Appendix DATA-2009
Monitoring Data and Reports

Table of Contents

Attachments

Acronyms and Abbreviations

CCA	Compliance Certification Application
CH-TRU	contact-handled transuranic
CMP	Compliance Monitoring Program
COMP	compliance monitoring parameter
CRA	Compliance Recertification Application
DBDSP	Delaware Basin Drilling Surveillance Program
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ft	foot
GMP	Geotechnical Monitoring Program
GWMP	Groundwater Monitoring Program
m	meter
PA	performance assessment
PABC	Performance Assessment Baseline Calculation
RH-TRU	remote-handled transuranic
SMP	Subsidence Monitoring Program
TRU	transuranic
WIPP	Waste Isolation Pilot Plant
WWIS	WIPP Waste Information System

This page intentionally left blank.

DATA-1.0 Introduction

Appendix DATA-2009 provides references to the data used to develop the 2009 Compliance Recertification Application (CRA-2009). Interpretation and analysis of those data are provided in the appropriate sections of CRA-2009.

40 CFR § 194.15(a)(1), (2), (3), and (5) (U.S. Environmental Protection Agency 1996), Content of Recertification Applications, require that the U.S. Department of Energy (DOE) provide information obtained since the Compliance Certification Application (CCA) (U.S. Department of Energy 1996) related to site geology, hydrology, and meteorology. Additional monitoring results and the results of laboratory investigations completed after the CRA-2004 (U.S. Department of Energy 2004) must also be provided, as well as information regarding the waste emplaced in the disposal system.

In the initial U.S. Environmental Protection Agency (EPA) certification of compliance for the Waste Isolation Pilot Plant (WIPP) (U.S. Environmental Protection Agency 1998), the EPA agreed that 10 compliance monitoring parameters (COMPs) would be monitored during the operational period of the project.

The DOE uses various programs to capture and analyze all relevant information. These programs and the information they collect are discussed in the appropriate sections of this appendix.

DATA-1.1 Reported Data

This document also provides monitoring data related to the COMPs. The locations, in this appendix, of the data for the COMPs are listed below:

COMP	Location in Appendix DATA-2009
Change in the Culebra groundwater flow	Section DATA-5.0, Section DATA-10.0, and Section DATA-11.0
Creep closure and stresses	Section DATA-4.0 and Section DATA-10.0
Culebra groundwater composition	Section DATA-5.0, Section DATA-10.0, and Section DATA-11.0
Displacement of deformation features	Section DATA-4.0 and Section DATA-10.0
Drilling rate	Section DATA-2.0 and Section DATA-10.0
Extent of brittle deformation	Section DATA-4.0, Section DATA-9.0, and Section DATA-10.0
Initiation of brittle deformation	Section DATA-4.0 and Section DATA-10.0
Probability of encountering a Castile brine reservoir	Section DATA-2.0 and Section DATA-10.0
Subsidence measurement	Section DATA-3.0 and Section DATA-10.0
Waste activity	Section DATA-7.0 and Section DATA-10.0

Monitoring is performed to detect substantial deviations from the assumptions used in the CCA. The above COMPs are being monitored during the preclosure period. Parameters not being monitored but used by performance assessment (PA) can be found in Fox 2008.

DATA-2.0 Delaware Basin Drilling Surveillance Program

The Delaware Basin Drilling Surveillance Program (DBDSP) monitors drilling activities in the vicinity of the WIPP. This section provides a brief discussion of the program and identifies the relevant data reports.

DATA-2.1 Program Overview

The EPA requires the DOE to demonstrate the expected containment performance of the disposal system using a PA. The PAs documented in the CCA and CRA-2004 demonstrated that the WIPP complies with the EPA's containment standards for undisturbed and human intrusion scenarios.

The criteria in 40 CFR § 194.33 (U.S. Environmental Protection Agency 1996) require the use of historic drilling information to derive the drilling rate for PA intrusion scenarios. The DBDSP continues to monitor drilling-related activities, providing data used to determine whether the assumptions and scenarios used in PA remain valid, and uses the monitoring data to determine the drilling rate. These monitoring activities will continue until the DOE and the EPA agree that no additional benefit can be gained by further monitoring.

DATA-2.2 Reported Data

The two COMP parameters monitored by the DBDSP are the drilling rate (58.5 boreholes per square kilometer) and the probability of encountering a Castile brine reservoir (0.05%), which are discussed in the annual reports for this program and also in the COMPS assessments described in Section DATA-10.0. Other information collected by this program include drilling related data, mining information, and seismic information.

Relevant data generated through the Delaware Basin Monitoring Program are provided in the following reports:

- Delaware Basin Monitoring Annual Report; DOE/WIPP-99-2308 Rev. 4, September 2003.
- Delaware Basin Monitoring Annual Report; DOE/WIPP-99-2308 Rev. 5, September 2004.
- Delaware Basin Monitoring Annual Report; DOE/WIPP-99-2308 Rev. 6, September 2005.
- Delaware Basin Monitoring Annual Report; DOE/WIPP-06-2308, September 2006.
- Delaware Basin Monitoring Annual Report; DOE/WIPP-07-2308, September 2007.
- Callicoat, J., Calculation of Shallow Drilling for 2007, Memo to File, Washington Regulatory and Environmental Services, Carlsbad, NM, July 2, 2008. WRES:08:251.
- Hughes, D., Status of Potash Activities – 2007, Memo to File, Washington Regulatory and Environmental Services, Carlsbad, NM, July 2, 2008. WRES:08:250.

- Hughes, D., Castile Brine Encounters. 2007, Memo to File, Washington Regulatory and Environmental Services, Carlsbad, NM, WRES:08:302.

- Hughes, D., Seismic Activity within the Delaware Basin, Memo to File, Washington Regulatory and Environmental Services, Carlsbad, NM, WRES:08:303.

DATA-3.0 Subsidence Monitoring Program

Subsidence monitoring measures vertical movement of the land surface relative to a reference location. This section provides a brief discussion of the Subsidence Monitoring Program (SMP) and identifies the relevant data reports.

DATA-3.1 Program Overview

The SMP uses a leveling survey to measure the relative vertical height differences between benchmarks. A level survey consists of taking one benchmark as having a constant elevation and determining the elevation of all other benchmarks relative to it. Comparison between level surveys allows vertical movement patterns to be established over time. These comparative surveys would allow substantial deviation of actual subsidence from expected subsidence to be detected.

DATA-3.2 Reported Data

Each year approximately 15 miles of leveling surveying was completed utilizing nine vertical control loops consisting of 48 subsidence monuments and 14 National Geodetic Survey vertical control points. Subsidence rates are small and are approximately at the resolution level of the survey accuracy. The benchmarks with the highest rates are seen above the mined panels. All subsidence rates fall within the predicted values. Data generated through the SMP are provided in the following reports. Each report includes previous years' data as well.

- WIPP Subsidence Monument Leveling Survey 2003, DOE/WIPP 04-2293, October 2003.
- WIPP Subsidence Monument Leveling Survey 2004, DOE/WIPP 05-2293, December 2004.
- WIPP Subsidence Monument Leveling Survey 2005, DOE/WIPP 06-2293, December 2005.
- WIPP Subsidence Monument Leveling Survey 2006, DOE/WIPP 07-2293, December 2006.
- WIPP Subsidence Monument Leveling Survey 2007, DOE/WIPP 08-2293, December 2007.

DATA-4.0 Geotechnical Monitoring Program

The geotechnical monitoring program (GMP) measures in situ geotechnical data in the WIPP repository. This section provides a brief discussion of the GMP and identifies the relevant data reports.

DATA-4.1 Program Overview

The GMP obtains in situ data to support the continuous assessment of underground facilities. A detailed description of the geotechnical programs and procedures is presented in WP07-1, Geotechnical Engineering Program Plan. Specifically, the program provides for

- Early detection of conditions that could affect operational safety
- Guidance for design modifications and remedial actions
- Data for interpreting the behavior of underground openings compared to established design criteria

The GMP collects data from instruments and observation. These data are used to confirm the understanding of geomechanical characteristics, and aid in assessing the stability and performance of the underground facility. Constituent programs, described below, include the Geosciences Program, the Geomechanics Program, and the Rock Mechanics Program.

The Geosciences Program includes the collection of underground data used to assess the repository by documenting the existing geologic conditions and characteristics and monitoring excavation response. Activities associated with this program include geologic and fracture mapping of the excavation surface, core logging, and borehole observations.

The Geomechanics Program monitors the geomechanical response of the underground openings after mining using instrumentation installed in the shafts and drifts of the facility. Geotechnical instrumentation installed underground in the shafts and drifts includes tape extensometer points, convergence meters, borehole extensometers, piezometers, strain gauges, load cells, and crack meters. The instrumentation is sensitive enough to detect small changes in rock displacements and stresses.

To determine significant deviations from expected conditions, the Rock Mechanics Program assesses the performance of the underground excavation for safety and stability during the operational phase. The results from these assessments allow the identification of potentially instable areas and the application of remedial actions, if necessary. Field data are used to compare the actual mechanical performance of the excavations to expected results. Analytical methods, such as numerical modeling, determine the potential effects of mining new excavations, excavation sequence, and long-term behavior of the repository. Extensive experimental work and observations have established an understanding of time-dependent geomechanical properties of the salt that are used to predict its in situ mechanical performance. These assessments rely heavily on the in situ instrumentation data and field observations from the geosciences and geomechanics programs.

DATA-4.2 Reported Data

Data generated through the GMP are reported annually in the Geotechnical Analysis Report. References for reports prepared since the development of the CRA-2004 are provided below. Each report includes previous years' data as well. Four parameters the DOE is required to monitor and assess were identified relating to the information collected by the GMP are creep closure, extent of deformation, initiation of brittle deformation, and displacement of deformation features. Creep closure and displacement of deformation features can be quantified. The other two are qualitative. These four parameters are discussed and analyzed in the COMPs reports listed in Section DATA-10.2.

- Washington TRU Solutions, LLC, 2004, Geotechnical Analysis Report for July 2002–June 2003, DOE/WIPP 04-3177, Carlsbad, NM.

- Washington TRU Solutions, LLC, 2005, Geotechnical Analysis Report for July 2003–June 2004, DOE/WIPP 05-3177, Carlsbad, NM.

- Washington TRU Solutions, LLC, 2006, Geotechnical Analysis Report for July 2004–June 2005, DOE/WIPP 06-3177, Carlsbad, NM.

- Washington TRU Solutions, LLC, 2007, Geotechnical Analysis Report for July 2005–June 2006, DOE/WIPP 07-3177, Carlsbad, NM.

- Washington TRU Solutions, LLC, 2008, Geotechnical Analysis Report for July 2006–June 2007, DOE/WIPP 08-3177, Carlsbad, NM.

DATA-5.0 Groundwater Monitoring Program

The Groundwater Monitoring Program (GWMP) collects and analyzes data for various wells at or near the WIPP site. This section briefly describes the GWMP and identifies relevant reports.

DATA-5.1 Program Overview

One function of the GWMP is the collection of Culebra groundwater data, such as water levels and water quality, from numerous wells located at and near the facility. The Culebra Dolomite Member of the Rustler Formation (hereafter referred to as the Culebra) was selected as the focus of the GWMP. It has been extensively studied during past hydrologic characterization programs and was found to be the most likely hydrologic pathway to the accessible environment for any potential human-intrusion-caused release scenario. Data obtained through this program are used to generate the Culebra groundwater composition and the Culebra groundwater flow COMPs. Details on how the program is implemented are provided in Appendix MON-2009.

DATA-5.2 Reported Data

The water quality data collected by the GWMP is discussed and analyzed in the reports listed below and also in the COMPs reports listed in Section DATA-10.2. This analysis provides validation of the various CCA models. Appendix HYDRO-2009 and the COMPs reports provide analysis of the water levels and the fluid density of the water columns in the various wells used in gathering data for the WIPP hydrological model.

- U.S. Department of Energy, 2003, Waste Isolation Pilot Plant Site Environmental Report for Calendar Year 2002, DOE/WIPP 03-2225, Carlsbad, NM.

- U.S. Department of Energy, 2004, Waste Isolation Pilot Plant Site Environmental Report for Calendar Year 2003, DOE/WIPP 04-2225, Carlsbad, NM.

- U.S. Department of Energy, 2005, Waste Isolation Pilot Plant Site Environmental Report for Calendar Year 2004, DOE/WIPP 05-2225, Carlsbad, NM.

- U.S. Department of Energy, 2006, Waste Isolation Pilot Plant Site Environmental Report for Calendar Year 2005, DOE/WIPP 06-2225, Carlsbad, NM.

- U.S. Department of Energy, 2007, Waste Isolation Pilot Plant Site Environmental Report for Calendar Year 2006, DOE/WIPP 07-2225, Carlsbad, NM.

DATA-6.0 Meteorological Monitoring Program

The Meteorological Monitoring Program measures atmospheric data for the WIPP site. This section provides a brief description of the program and a list of relevant reports.

DATA-6.1 Program Description

The primary WIPP meteorological station is located 600.5 meters (m) (1,970 feet (ft)) northeast of the Waste Handling Building. The main function of the station is to provide data for atmospheric modeling. The station measures and records wind speed, wind direction, and temperature at elevations of 2, 10, and 50 m (6.5, 33, and 165 ft). The station records ground-level measurements of barometric pressure, relative humidity, precipitation, and solar radiation.

DATA-6.2 Reported Data

The annual site environmental reports listed in Section DATA-5.2 provide data relevant to the Meteorological Monitoring Program. The CCA, Appendix CLI provides information on past (long-term) climatic conditions and predicted future conditions at the WIPP site. A discussion of the wind, rainfall, and temperature variation can be found in 40 CFR § 194.15.

DATA-7.0 Waste Information

Two types of information related to waste characteristics are collected: (1) information regarding waste that has been emplaced in the WIPP underground repository and (2) information regarding future inventory that will be emplaced in the WIPP underground repository during the entire lifetime of the project. This section provides a brief description of the programs and a list of relevant reports.

DATA-7.1 Program Overview

Information concerning waste that has been emplaced in the repository is tracked and recorded using the WIPP Waste Information System (WWIS). Information concerning future wastes is developed through periodic updates of the Transuranic Waste Baseline Inventory Report (the CCA, Appendix BIR). The inventory for the CRA-2009 PA is the same inventory that was used for the CRA-2004 Performance Assessment Baseline Calculation (PABC). This approach is consistent with the fact that the CRA-2009 PA is based on the CRA-2004 PABC. Since the CRA-2004 PABC was completed, the *Annual Transuranic Waste Inventory Report–2007* (U.S. Department of Energy 2008) was published and provides updated inventory information. The DOE anticipates that these inventory updates will have only a small impact on normalized releases relative to the CRA-2009 PA, and therefore have no significant impact on compliance.

DATA-7.2 Reported Data

Summary information on emplaced waste and radionuclides generated through the WWIS are provided in the following reports. See page 25 of the Annual Change Report 2006/2007, DOE/WIPP-07-3317 for a detailed listing of the emplaced waste in the repository.

- U.S. Department of Energy, Letter to EPA dated November 13, 2003, 2003 Annual Change Report.

- U.S. Department of Energy, Annual Change Report 2003/2004, DOE/WIPP 04-3317, November 10, 2004.

- U.S. Department of Energy, Annual Change Report 2004/2005, DOE/WIPP 05-3317, November 10, 2005.

- U.S. Department of Energy, Annual Change Report 2005/2006, DOE/WIPP 06-3317, October 2006.

- U.S. Department of Energy, Annual Change Report 2006/2007, DOE/WIPP 07-3317, November 16, 2007.

Information regarding future inventories planned for emplacement in the WIPP are provided in U.S. Department of Energy, Annual Transuranic Waste Inventory Report–2007, DOE/TRU-2008-3379, Revision 1 (U.S. Department of Energy 2008).

DATA-8.0 WIPP Boreholes

Information regarding WIPP monitoring wells is identified in this section and relevant data are provided.

DATA-8.1 Program Overview

Information provided in this section was reported in DOE/WIPP 95-2092, Rev. 1, Waste Isolation Pilot Plant Borehole Data Report (the CCA, Appendix BH). The CCA, Appendix BH serves as a central document providing data on boreholes. The report contains a comprehensive database of wells drilled in support of the WIPP and boreholes that were located within the 16-section land withdrawal area.

DATA-8.2 Reported Data

Attachment A to this appendix provides updates on all of the monitoring wells used in the CCA, Appendix BH and the new monitoring wells drilled since the initial certification. The attachment also adds wells that were in use, but inadvertently omitted from the CCA, Appendix BH. There were 21 wells drilled and 19 old wells plugged during the CRA monitoring period from October 1, 2002, through September 30, 2007.

DATA-9.0 Repository Investigations Program

The WIPP Repository Investigations Program conducts research activities to confirm assumptions, reduce uncertainty, and resolve issues regarding the conceptual models and parameters used in PA. The program is briefly described in this section and references to relevant reports are provided.

DATA-9.1 Program Overview

The DOE has implemented and/or continued several experimental activities designed to address specific issues and needs of the WIPP repository. In addition, other investigations have been initiated to examine impacts of planned changes. The general areas covered under these investigations include

- Geochemistry
- Actinide chemistry
- Engineered barriers
- Rock mechanics

DATA-9.2 Reported Data

Data acquired by the DOE from the repository investigations are available in the following reports published since the CRA-2004:

- Borkowski, M., D.T. Reed, J.F. Lucchini, M.K. Richmann. "Solubility of Neodymium in Simulated WIPP (Waste Isolation Pilot Plant) Brines." Poster, 24th Rare Earth Research Conference, June 26-30, 2005, Keystone, CO –LAUR-05-3916.

- Borkowski, M., J.F. Lucchini, M.K. Richmann, and D.T. Reed, "Neodymium Analog Study of An(III) Solubility in WIPP Brine," poster presented at Plutonium Futures 2006 Conference, July 2006, Monterey, CA. LA-UR 06-2900.

- Borkowski, M., J.F. Lucchini, M.K. Richmann, and D.T. Reed. "Actinide Chemistry and Repository Science Program in support of the Waste Isolation Pilot Plant (WIPP)." Oral Communication presented at the American Nuclear Society's 14th Biennial Topical Meeting of the Radiation Protection and Shielding Division, April 3–6, 2006, Carlsbad, NM, USA–LAUR-05-9615.

- Borkowski, M., J.F. Lucchini, M.K. Richmann, S. Ballard, and D.T. Reed, "Effect of carbonate and borate complexation on Nd^{3+} and UO_2^{2+} solubility in WIPP brine," presented at the National American Chemical Society Meeting, Chicago, IL, March 2007. LAUR-06-8317.

- Borkowski, M., J.F. Lucchini, M.K. Richmann, and D.T Reed. 2008. Actinide (III) Solubility in WIPP Brine: Data Summary and Recommendations. LCO-ACP-08, LANL\ACRSP Report. Los Alamos, NM: Los Alamos National Laboratory.

- Borkowski, M., D.T. Reed, and M.K. Richmann, "Plutonium Speciation in a Salt-Based Repository," presented at American Nuclear Society Annual Meeting "Nuclear Science and Technology: Now Arriving on Main Street," Anaheim, CA, June 8–12, 2008. LA-UR 08-03605.

- Brush, L.H. 2004b. "Review of the Calculations of the Quantity of MgO That Could Be Lost from the WIPP By Dissolution in Brine: Mg Solubility in Castile Brine." Analysis report, September 1, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 536580.

- Brush, L.H., H. Deng, J.W. Garner; C.D. Leigh, M.B. Nemer, E.J. Nowak, D.E. Wall, N.A. Wall, and Y.-L. Xiong. 2006. "Overview of Long-Term, Near-Field WIPP Geochemistry," Invited presentation at the 14th Biennial Topical Meeting of the American Nuclear Society Radiation Protection and Shielding and Protection, April 4, 2006, Carlsbad, NM. ERMS 543167. SAND2006-2167C.

- Brush, L.H., H. Gao, A.C. Snider, D.E. Wall, N.A. Wall, and Y.-L. Xiong. 2004. "Overview of Near-Field Geochemical Processes and Conditions Expected in the WIPP," Abstracts with Programs, Geological Society of America 2004 Annual Meeting, Denver, CO, November 7-10, 2004. 108. ERMS 536288. SAND2004-2728A.

- Brush, L.H., and J.W. Garner. 2005. "Additional Justification of the Insignificant Effect of Np on the Long-Term Performance of the WIPP." Memorandum to D.S. Kessel, February 1, 2005. Carlsbad, NM: Sandia National Laboratories. ERMS 538533.

- Brush L.H. 2005. "Results of Calculations of Actinide Solubilities for the WIPP Performance-Assessment Baseline Calculations," Carlsbad, NM: Sandia National Laboratories Carlsbad Programs Group. May 18, 2005. ERMS 539800.

- Brush, L.H. and Y. Xiong. 2003. "Calculation of Actinide Solubilities for the WIPP Compliance Recertification Application." Unpublished analysis report. May 8, 2003. Carlsbad, NM: Sandia National Laboratories. ERMS 529131.

- Brush, L.H., and Y. Xiong. 2003. "Calculation of Actinide Solubilities for the WIPP Compliance Recertification Application." Analysis Plan AP-098, Rev 1. Unpublished analysis plan. Carlsbad, NM: Sandia National Laboratories. ERMS 527714.

- Brush, L.H., and Y. Xiong. 2003. "Calculation of Organic Ligand Concentrations for the WIPP Compliance Recertification Application." Unpublished analysis report. Carlsbad, NM: Sandia National Laboratories. ERMS 527567.

- Brush, L.H., and Y. Xiong. 2003. "Calculation of Organic Ligand Concentrations for the WIPP Compliance Recertification Application and for Evaluating Assumptions of

Homogeneity in WIPP PA." Unpublished analysis report. Carlsbad, NM: Sandia National Laboratories. ERMS 531488.

- Brush, L.H., and Y.-L. Xiong, 2005. "Calculation of Organic-Ligand Concentrations for the WIPP Performance-Assessment Baseline Calculations." Analysis report. May 4, 2005. Carlsbad, NM: Sandia National Laboratories. ERMS 539635.

- Brush, L.H., J.W. Garner and E. Vugrin. 2005. "PA Implementation of Uncertainties Associated with Calculated Actinide Solubilities." Memorandum to D.S. Kessel, February 2, 2005. Carlsbad, NM: Sandia National Laboratories. ERMS 538537.

- Brush, L.H. A.C. Snider, Y.-L. Xiong, and C.D. Leigh. 2004. "Use of MgO as the Engineered Barrier in the WIPP," Abstracts with Programs, Geological Society of America 2004 Annual Meeting, Denver, CO, November 7-10, 2004. 296. ERMS 536279. SAND2004-2729A.

- Brush, L.H., and G.T. Roselle. 2006. "Geochemical Information for Calculation of the MgO Effective Excess Factor." Memorandum to E.D. Vugrin, November 17, 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 544840.

- Brush, L.H., and Y.-L. Xiong. 2004. "Sensitivities of the Solubilities of +III, +IV, and +V Actinides to the Concentrations of Organic Ligands in WIPP Brines, Rev. 0." Analysis report, December 15, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 538203.

- Brush, L.H., Y.-L. Xiong, J.W. Garner, A. Ismail, and G.T. Roselle. 2006. "Consumption of Carbon Dioxide by Precipitation of Carbonate Minerals Resulting from Dissolution of Sulfate Minerals in the Salado Formation in Response to Microbial Sulfate Reduction in the WIPP." Analysis report, November 17, 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 544785.

- Callahan, G.D. "Disposal Room Calculations with Alternative TRUE Waste Models," 2004. Topical Report RSI-1783.

- Clayton, D.J. 2006. "Update of the Minimum Brine Volume for a Direct Brine Release and New Maximum Castile and Salado Brine Volumes in a Waste Panel." Memorandum to L.H. Brush, October 11, 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 544453.

- Clayton, D.J., and M.B. Nemer. 2006. "Normalized Moles of Castile Sulfate Entering the Repository and Fraction of MgO Lost Due to Brine Flow Out of the Repository." Memorandum to E.D. Vugrin, October 9, 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 544385.

- Clayton, D., "Justification of Relative Permeability and Capillary Pressure Model Parameters for Use by BRAGFLO Version 6.0," 2007. Carlsbad NM: Sandia National Laboratories. ERMS 545764.

- Clayton, D., "Corrections to Input Files for DBR PABC Calculations," 2007. Carlsbad NM: Sandia National Laboratories. ERMS 546311.

- Crawford, B.A., and C.D. Leigh. 2003. "Estimate of Complexing Agents in TRU Waste for the Compliance Recertification Application." Analysis report, August 28, 2003. Carlsbad, NM: Los Alamos National Laboratory. ERMS 531107.

- Deng, H., S.R. Johnsen, G.T. Roselle, and M.B. Nemer. 2006. "Analysis of Martin Marietta MagChem 10 WTS-60 MgO." Analysis report, November 14, 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 544712.

- Deng, H., M.B. Nemer, and Y. Xiong. 2007. "Experimental Study of MgO Reaction Pathways and Kinetics, Rev. 1." TP 06-03, Rev. 1, January 10, 2007. Carlsbad, NM: Sandia National Laboratories. ERMS 545182.

- Deng, H., Y. Xiong, and M.B. Nemer. 2007. "Experimental Work Conducted on MgO Characterization and Hydration." Milestone report, August 7, 2007. Carlsbad, NM: Sandia National Laboratories. ERMS 546570.

- Downes, P.S. 2003. "Spreadsheet Calculations of Actinide Solubilities for the WIPP Compliance Recertification Application." Unpublished memorandum to L.H. Brush, April 23, 2003. Carlsbad, NM: Sandia National Laboratories. ERMS 528395.

- Downes, P.S. 2003. "Spreadsheet Calculations of Actinide Solubilities for the WIPP Compliance Recertification Application in Support of AP-098, 'Calculation of Actinide Solubilities for the WIPP Recertification Application, Analysis Plan AP-098, Rev 1.'" Unpublished analysis report. Carlsbad, NM: Sandia National Laboratories. ERMS 530441.

- Dunagan, S., C. Hansen, and W. Zelinski, "Effect of Increasing Cellulosics, Plastics, and Rubbers on WIPP Performance Assessment," 2005. Carlsbad NM: Sandia National Laboratories. ERMS 538445.

- Giambalvo, E.R. 2002. "Recommended μ^0 /RT Values for Modeling the Solubility of Oxalate Solids in WIPP Brines." Unpublished memorandum to L.H. Brush, July 31, 2002. Carlsbad, NM: Sandia National Laboratories. ERMS 523057.

- Giambalvo, E.R. 2003. "Release of FMT Database FMT_021120.CHEMDAT." Memorandum to L.H. Brush, March 10, 2003. Carlsbad, NM: Sandia National Laboratories, ERMS 526372.

- Hansen, F.D., "A Revisit of Waste Shear Strength," 2005. Carlsbad NM: Sandia National Laboratories. ERMS 541354.

- Hansen, F.D., and J.S. Stein, "WIPP Room Evolution and Performance Assessment Implications," 2005. Carlsbad NM: Sandia National Laboratories. ERMS 538870.

- Herrick, C.G., M. Riggins, and B.Y. Park, "Recommendation for the Lower Limit of the Waste Shear Strength (Parameter BOREHOLE: TAUFAIL)," 2007. Carlsbad NM: Sandia National Laboratories. ERMS 546033.

- Herrick, C.G., M. Riggins, B.Y. Park, and E.D. Vugrin, "Recommendation for the Lower Limit of the Waste Shear Strength (Parameter BOREHOLE: TAUFAIL)," Revision 1, 2007. Carlsbad NM: Sandia National Laboratories. ERMS 546343.

- Holcomb, D., and R. Hardy, "Status of Ultrasonic Wave Speed Measurements Undertaken to Characterize the DRZ in the Access Drift to Q Room," 2001. Carlsbad NM: Sandia National Laboratories. ERMS 545575.

- Ismail, A.E., "Revised Porosity Estimates for the DRZ," 2007. Carlsbad NM: Sandia National Laboratories. ERMS 545755.

- Ismail, A.E., and B.Y. Park, "Revised Permeability Estimates for the Disturbed Rock Zone (DRZ)," 2007. Carlsbad NM: Sandia National Laboratories. ERMS 545746.

- Kanney, J.F., and E.D. Vugrin. 2006. "Updated Analysis of Characteristic Time and Length Scales for Mixing Processes in the WIPP Repository to Reflect the CRA-2004 PABC Technical Baseline and the Impact of Supercompacted Mixed Waste and Heterogeneous Waste Emplacement." Memorandum to D.S. Kessel, August 31, 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 544248.

- Kanney, J.F., and W. Zelinski. 2004. "Input for CaCO3 precipitation Modeling." Memorandum to Y.-L. Xiong, September, 9, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 536665.

- Kirchner, T.B., and E.D. Vugrin. 2006. "Uncertainty in Cellulose, Plastic, and Rubber Measurements for the Waste Isolation Pilot Plant Inventory." Memorandum to D.S. Kessel, June 12, 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 543848.

- Leigh, C.D. 2005. "Organic Ligand Masses TRU Waste Streams from TWBID Revision 2.1, Version 3.13, Data Version D4.15, Revisions 1." Memorandum to L.H. Brush, April 18, 2005, Carlsbad, NM: Sandia National Laboratories. ERMS 539550.

- Lucchini, J.F. , D.T. Reed, M. Borkowski, A. Rafalski, and J. Conca. "Influence of Radiolytic Products on the Chemistry of Uranium VI in Brines." Oral Communication, 227th ACS National Meeting, March 28-April 1, 2004, Anaheim, CA, USA–Poster, International Conference ATALANTE 2004, June 21-24, 2004, Nimes, France. LAUR-03-9026.

- Lucchini, J.F., M. Borkowski, M.K. Richmann, and D.T. Reed. "Solubility of Uranium (VI) in Brine." Poster, International Conference MIGRATION 05, September 18–23, 2005, Avignon, France–LAUR-05-7011.

- Lucchini, J.F., M. Borkowski, M.K. Richmann, and D.T. Reed. "Interactions and Stability of Hypochlorite, Hydrogen Peroxide and Uranium (VI) in Brine." Poster, International Conference MIGRATION 05, September 18-23, 2005, Avignon, France–LAUR-05-7009.

- Lucchini, J.F. , M. Borkowski, M. K. Richmann, and D. T. Reed, "Uranium (VI) Solubility from Over-saturation in Carbonate-free Brines," poster presented at Plutonium Futures 2006 Conference, July 2006, Monterey, CA. LAUR-06-1307.

- Lucchini, J.F., "Review of spent fuel matrix alteration with respect to alpha-radiolysis," presented at the American Nuclear Society's 14th Biennial Topical Meeting of the Radiation Protection and Shielding Division, Carlsbad, NM, USA. April 3-6, 2006. LAUR–05-9617.

- Lucchini, J-F, M. Borkowski, M.K. Richmann, S. Ballard, and D.T. Reed. 2007. "Solubility of Nd^{3+} and UO_2^{2+} in WIPP Brine as Oxidation-State Invariant Analogs for Plutonium." *Journal of Alloys and Compounds*, vol. 444/445: 506–11. LAUR-06-7222.

- Lucchini, J.F., S. Ballard, H. Khaing, M. Borkowski, S. Pepper, M.K. Richmann, and D.T. Reed, "Effect of Carbonate on U(VI) Solubility in WIPP Brine," presented at the International Conference MIGRATION 07, August 26–31, 2007, Munchen, Germany–LAUR-07-5377.

- Lucchini, J.F. , H. Khaing, M. Borkowski, M.K. Richmann, and D.T. Reed. 2008. *Actinide (VI) Solubility in Carbonate-free WIPP Brine: Data Summary and Recommendations*. LCO-ACP-10, LANL\ACRSP Report. Los Alamos, NM: Los Alamos National Laboratory.

- Lucchini, Jean Francois, Hnin Khaing, Michael K. Richmann, Marian Borkowski, Donald T. Reed, "Plutonium (VI) and Uranium (VI) Reduction by Iron (II) at High pH under Subsurface Conditions," presented at the International Conference Plutonium Futures–The Science, July 7–11, 2008, Dijon, France–LAUR-08-04292.

- Nemer, M.B. 2006. "Expected Brine volumes, Cumulative Brine Inflow, and MgO-to-Brine Solid-to-Liquid Ratio from PABC BRAGFLO Results." Memorandum to the SNL/WIPP Records Center, March 3, 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 542612.

- Nemer, M.B., J.S. Stein, and W. Zelinski. 2005. "Analysis Report for BRAGFLO Preliminary Modeling Results with New Gas Generation Rates Based on Recent Experiments." Analysis report, April 20, 2005. Carlsbad, NM: Sandia National Laboratories. ERMS 539437.

- Nowak, E.J., 2005. "Recommended Change in the FMT Thermodynamic Data Base." Memorandum to L. H. Brush, April 1, 2005. Carlsbad, NM: Sandia National Laboratories. ERMS 539227.

- Nowak, E.J., and D.J. Clayton. 2007. "Analysis of MgO Hydration Laboratory Results and Calculation of Extent of Hydration and Resulting Water Uptake versus Time under

Postulated WIPP Conditions." Analysis report, September 5, 2007. Carlsbad, NM: Sandia National Laboratories. ERMS 546769.

- Olive, Daniel, Marian Borkowski, Jean Francois Lucchini, Hnin Khaing, Michael Richmann, Donald Reed, and Jeff Terry, "Physicochemical Properties of Neodymium WIPP Solids," presented at the 2008 Argonne Advanced Photon Source Users Meeting, May 4–8, 2008, Argonne, IL–LAUR-08-2288.

- Park, B.Y., and J.F. Holland, "Error in DRZ Calculation in the Clay Seam G Analysis," 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 545053.

- Park, B.Y., A.E. Ismail, D.J. Holcomb, and C.G. Herrick, "Analysis Report for Prediction of the Extent and Permeability of the Disturbed Rock Zone around a WIPP Disposal Room," Revision 0, 2007. Carlsbad, NM: Sandia National Laboratories. ERMS 546370.

- Pepper, Sarah E., Marian Borkowski, and Donald T. Reed, "The Analysis of Ferric and Ferrous Iron in Actinide Redox Systems using Solvent Extraction," presented on 31st Annual Actinide Separations Conference in Las Vegas, NV, 2007.

- Reed, D. T., M. Borkowski, and J. F. Lucchini, "Reduction of Higher-Valent Actinides in the WIPP," presented at the GSA WIPP session, Denver, CO, November 7, 2004. LAUR-04-7954.

- Reed, D.T., J.-F. Lucchini, S.B. Aase, and A.J. Kropf. 2006. "Reduction of Plutonium (VI) in Brine under Subsurface Conditions." *Radiochim. Acta*, vol. 94: 591–97.

- Reed, D.T., G. Smith, R. Deo, B. Rittmann, J.F. Lucchini, M. Borkowski, and M.K. Richmann. "Subsurface Bio-mediated Reduction of Higher-Valent Uranium and Plutonium." Presentation, Plutonium Futures – The Science 2006 Conference, July 9-13, 2006, Pacific Grove, CA.

- Reed, D.T., M. Borkowski, J.F. Lucchini, and M.K. Richmann, "Actinide Solubility and Speciation in the WIPP," Los Alamos Earth and Environmental Sciences Frontiers in Geoscience Colloquium, August 8, 2006.

- Reed, D.T., M. Borkowski, J.F. Lucchini, and M.K. Richmann, "Subsurface Biogeochemistry of Plutonium in the WIPP," Poster presented at the Los Alamos National Laboratory, Earth and Environmental Sciences Division review, April 2006.

- Reed, D.T., S.E. Pepper, and B.E. Rittmann. 2007. "Subsurface Bio-Mediated Reduction of Higher-Valent Uranium and Plutonium." *Journal of Alloys and Compounds*, vol. 444/445: 376–82.

- Reed, D.T., Invited Presentation, "Key Interactions and Speciation of Plutonium under Subsurface Conditions," University of Texas at El Paso, chemistry department, March 23, 2007.

- Reed, D.T., S.E. Pepper, B.E. Rittmann, and R. Deo, "Role of Fe (II) in the abiotic and biotic reduction of higher-valent uranium and plutonium," presented at the National American Chemical Society Meeting, Chicago, IL, March 2007.

- Reed, D.T., invited presentation, "WIPP Actinide Chemistry Research Project," New Mexico State University, chemistry department seminar, April 26, 2007.

- Reed, D.T., invited presentation, "Key Interactions and Speciation of Plutonium under Subsurface Conditions," Valparaiso University chemistry department, March 30, 2007.

- Reed, D.T., D. Moody, and R. Patterson. "Waste Isolation Pilot Plant (WIPP) Transuranic Repository," Invited talk at Migration 2007, Munich, Germany, September 2007.

- Reed, D.T., H. Boukhalfa, G.A. Icopini, S.D. Reilly, and M. Neu, "Plutonium Reduction By Metal-Reducing Bacteria," presented at Migration 2007, Munich, Germany, September 2007.

- Reed, D.T., J.-F. Lucchini; M. Borkowski, and M.K. Richmann. 2008. *Pu(VI) Reduction by Iron under WIPP-Relevant Conditions: Data Summary and Recommendations*. LCO-ACP-09, LANL\ACRSP Report. Los Alamos, NM: Los Alamos National Laboratory.

- Reed, D.T., M. Borkowski, M.K. Richmann, Jean-Francois Lucchini, and Hnin Khaing, "Plutonium Speciation in a Salt-Based Repository," presented at Plutonium Futures "The Science" Conference–Dijon, France, July 2008.

- Reed, D.T., "Actinide Speciation in the WIPP," D.T. Reed. Invited talk as part of technical exchange with the INE German salt repository program, Karlsruhe, Germany, July 4, 2008.

- Richmann, M.K., J.F. Lucchini, M. Borkowski, S.E. Pepper, S. Ballard, H. Khaing, and D.T Reed, "Actinide Speciation in the WIPP," presented at the International Conference MIGRATION 07, August 26–31, 2007, Munchen, Germany–LAUR-07-1903.

- Snider, A.C. 2003. Verification of the Definition of Generic Weep Brine and the Development of a Recipe for This Brine. Unpublished Report. Carlsbad, NM: Sandia National Laboratories. ERMS 527505.

- Snider, A.C. 2003. Calculation of MgO Safety Factors for the WIPP Compliance Recertification Application and for Evaluating Assumptions of Homogeneity in WIPP PA. Unpublished analysis report. Carlsbad, NM: Sandia National Laboratories. ERMS 531508.

- Snider, A.C., and Y.-L. Xiong. 2004. "Continuing Investigations of the Hydration and Carbonation of Premier Chemical MgO." Milestone report, October 12, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 537188.

- Snider, A.C., Y.-L. Xiong, and N.A. Wall. 2004. "Experimental Study of WIPP Engineered Barrier MgO at Sandia National Laboratories Carlsbad Facility." TP 00-07, Rev. 3, August 26, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 536591.

- Stein, J.S., and M.B. Nemer. 2005. "Analysis Plan for Updating the Microbial Degradation Rates for Performance Assessment." AP-116, Rev. 0, February 3, 2005. Carlsbad, NM: Sandia National Laboratories. ERMS 538596.

- Stein, J.S. 2005. "Estimate of Volume of Brine in Repository That Leads to a Brine Release." Memorandum to L.H. Brush, April 19, 2005. Carlsbad, NM: Sandia National Laboratories. ERMS 539372.

- Vugrin, E.D., M.B. Nemer, and S.W. Wagner. 2006. "Uncertainties Affecting MgO Effectiveness and Calculation of the MgO Effective Excess Factor," Rev. 0. Analysis report, November 17, 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 544781.

- Wall, D.E., N.A. Wall, and L.H. Brush. 2006. "Speciation and Solubility Modeling of Actinides in the Waste Isolation Pilot Plant," Separations for the Nuclear Fuel Cycle in the 21st Century. Eds. G.J. Lumetta, K.L. Nash, S.B. Clark, and J.L. Friese. Washington, DC: American Chemical Society. ACS Symposium Series, Vol. 933, 313-334. ERMS 541051. SAND2004-6355J.

- Wall, N.A. 2005. "Preliminary Results for the Evaluation of Potential New MgO." January 27, 2005. Carlsbad, NM: Sandia National Laboratories. ERMS 538514.

- Wall, N.A., and D. Enos. 2006. "Iron and Lead Corrosion in WIPP-Relevant Conditions, TP 06-02, Rev. 1." April 24, 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 543238.

- Wall, N.A. and D.E. Wall. 2004. "Discussion on the Influence of Organic Ligands on the Solubility of U(VI)." Memorandum to Records, November 30, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 537938.

- Xiong, Y.-L. 2004a. "A Correction of the Molecular Weight of Oxalate in FMT_021120. CHEMDAT, and Incorporation of Calcium Oxalate Monohydrate (Whewellite) into CHEMDAT with Its Recommended Dimensionless Standard Chemical Potential (μ0/RT) Value." Memorandum to L.H. Brush, June 8, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 535813.

- Xiong, Y.-L. 2004. "Incorporation of Six Solid Phases Including Hydromagnesite (5424) and Hydromagnesite (4323) into EQ3/6 HMW Database and Its Modified Version HMP." Memorandum to L. H. Brush, August 4, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 536321.

- Xiong, Y.-L. 2004. "An Update on the Dimensionless Standard Chemical Potential of NpO2Ac(aq) in FMT CHEMDAT." Memorandum to L.H. Brush, November 11, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 537838.

- Xiong, Y.-L. 2004. "A Correction of the Dimensionless Standard Chemical Potential of NpO2Ac(aq) in FMT_041116. CHEMDAT." Memorandum to L.H. Brush, December 10, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 538162.

- Xiong, Y.-L. 2005. "Release of FMT_050405.CHEMDAT." E-mail to J.F. Kanney and J.J. Long, April 5, 2005. Carlsbad, NM: Sandia National Laboratories. ERMS 539304.

- Xiong, Y.-L. 2006. "Incorporation of Calcium Citrate Hydrate, Earlandite; Calcium Oxalate Monohydrate, Whewellite; and Aqueous Species of Citrate and Oxalate into the EQ3/6 HMP Database and Its Modified Version HMY." Memorandum to L.H. Brush, October 18, 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 544529.

- Xiong, Y.-L. 2006. "Incorporation of Amorphous Calcium Carbonate into the EQ3/6 HMY Database and Its Modified Version HML." Memorandum to L.H. Brush, October 26, 2006. Carlsbad, NM: Sandia National Laboratories. ERMS 544629.

- Xiong, Y.-L. 2007. "Incorporation of Amorphous Calcium Carbonate with Higher Solubility (CaCO3(am-cpa)), Aqueous Complexes of Magnesium and Calcium with Acetate, Citrate, EDTA, and Oxalate, and Aqueous Species of Acetate and EDTA into the EQ3/6 HML Database and its Modified Version HMO". Memorandum to L.H. Brush, February 7, 2007. Carlsbad, NM. Sandia National Laboratories. ERMS 545276.

- Xiong, Y.-L. 2007. "Analysis Plan for Derivation of Pitzer Parameters in Support of Experimental Work at LANL-CO." June 7, 2007. Carlsbad, NM: Sandia National Laboratories. ERMS 546249.

- Xiong, Y.-L. In prep. "Thermodynamic Properties of Brucite Determined by Solubility Studies and Their Significance to Nuclear Waste Isolation," accepted by Aquatic Geochemistry, with minor revisions. ERMS 546279. SAND2007-3373J.

- Xiong, Y.-L., L.H. Brush, D.E. Wall, and N.A. Wall. 2004. "Predictions of Actinide Solubilities under Near-Field Conditions Expected in the WIPP," Abstracts with Programs, Geological Society of America 2004 Annual Meeting, Denver, CO, November 7–10, 2004. 108. ERMS 536297. SAND2004-2730A.

- Xiong, Y.-L., and A.C.S. Lord. In press. "Experimental Investigations of the Reaction Path in the MgO–CO2–H2O System in Solutions with Various Ionic Strengths, and Their Applications to Nuclear Waste Isolation," Applied Geochemistry. ERMS 544728. SAND2006-7185J.

- Xiong, Y.-L., E.J. Nowak, and L.H. Brush. 2004. "Updated Uncertainty Analysis of Actinide Solubilities for the Response to EPA Comment C-23-16." Analysis report, December 17, 2004. Carlsbad, NM: Sandia National Laboratories. ERMS 538219.

- Xiong, Y.-L., E.J. Nowak, and L.H. Brush. 2005. "Updated Uncertainty Analysis of Actinide Solubilities for the Response to EPA Comment C-23-16 (Supersedes ERMS 538219)." Analysis report, April 29, 2005. Carlsbad, NM: Sandia National Laboratories. ERMS 539595.

- Xiong, Y.-L., E.J. Nowak, and L.H. Brush. 2005. "Predicting Actinide Solubilities in Concentrated Brines: The Fracture-Matrix Transport (FMT) Code." Presentation at the 15th

Goldschmidt International Conference, May 20–25, 2005, Moscow, ID. Carlsbad, NM: Sandia National Laboratories. ERMS 541555. SAND2005-2836C.

DATA-10.0 Compliance Monitoring Program

Annually, the Compliance Monitoring Program (CMP) extracts data from the repository investigations and five of the monitoring programs described above (DBDSP, SMP, GMP, GWMP, and WWIS) to derive values for the 10 COMPs described in Section DATA-1.0 and to evaluate whether significant changes in the parameters have occurred. The CMP activities are briefly described in this section. Data generated under the CMP are also identified.

DATA-10.1 Program Overview

The objective of the CMP is to provide assurance that any deviations from the expected long-term performance of the repository are identified at the earliest possible time. The CMP is implemented in accordance with DOE/WIPP-99-3119, 40 CFR Parts 191 and 194, Compliance Monitoring Implementation Plan. Annual evaluations of the compliance parameters follow the requirements found in Sandia Analysis Plan AP-069, An Analysis Plan for Annually Deriving Compliance Monitoring Parameters and their Assessment Against Performance Expectations to Meet the Requirements of 40 CFR § 194.42 (U.S. Environmental Protection Agency 1996).

DATA-10.2 Reported Data

The data and the results of the annual COMPs assessments performed in accordance with the requirements of the CMP are provided in the reports cited below. There are no COMPs data or results that indicate a reportable event or condition adverse to predicted performance.

- Sandia National Laboratories, "Sandia National Laboratories Annual Compliance Monitoring Parameter Assessment for 2003, WBS 1.3.1, Revision 1, June 2004," Carlsbad, NM.

- Sandia National Laboratories, "Sandia National Laboratories Annual Compliance Monitoring Parameter Assessment for 2004, WBS 1.3.1, February 2005," Carlsbad, NM.

- Sandia National Laboratories, "Sandia National Laboratories Annual Compliance Monitoring Parameter Assessment for 2005, WBS 1.3.1, November 2005," Carlsbad, NM.

- Sandia National Laboratories, "Sandia National Laboratories Annual Compliance Monitoring Parameter Assessment for 2006, WBS 1.3.1, October 2006," Carlsbad, NM.

- Sandia National Laboratories, "Sandia National Laboratories Annual Compliance Monitoring Parameter Assessment for 2007, WBS 1.3.1, January 2008," Carlsbad, NM.

DATA-11.0 Hydrological Investigation

The Exhaust Shaft Hydraulic Assessment, now the Shallow Subsurface Investigation, was initiated in September 1996 to investigate the source and extent of water seepage into the exhaust shaft at the WIPP, and an investigation of rising water levels in the Culebra was initiated in 1999. These hydrologic investigations are briefly described in this section. Sources of data generated from the investigations are also identified.

DATA-11.1 Program Overview

DATA-11.1.1 Shallow Subsurface Investigation

Investigations of water entering the exhaust shaft led to the observation of a shallow perched groundwater horizon in a saturated layer within the lower Santa Rosa Formation and the upper Dewey Lake Redbeds Formation, about 15 m (49 ft) below ground surface. During the original drilling and geological mapping of the shaft, no water was encountered at that horizon, indicating that the presence of water may be related to site activities subsequent to shaft drilling. Three wells and 12 piezometers were installed over an 80-acre area between September 1996 and July 1997 (INTERA 1997). In 2007, three more piezometers were installed. Water level and water quality parameters have been monitored and reported on a regular basis since installation.

DATA-11.1.2 Culebra Water-Level Rise Investigation

During the 1999 annual COMPs assessment, Culebra water levels in many of the WIPP monitoring wells exceeded the CCA ranges of uncertainty established for equilibrium freshwater heads to calibrate transmissivity fields needed for Culebra flow and transport calculations. Culebra water-level rises had also been observed at the time of the CCA submittal in 1996, but were attributed to natural recovery of water levels following years of hydraulic well testing at the WIPP site and grouting of the WIPP shafts. Subsequent to the 1999 COMPs assessment, Culebra water levels showed a continued rise even though water levels at the WIPP site were thought to have fully recovered from hydraulic testing and shaft grouting. In response to this observation, the DOE initiated an investigation into the cause of the water-level rise and the impact of the rise on the long-term performance of the WIPP, which is discussed in Appendix HYDRO-2009.

DATA-11.2 Reported Data

Data acquired from the two hydrologic investigations are provided in the reports cited below for the Shallow Subsurface Investigation and the Culebra water-level rise investigation.

DATA-11.2.1 Shallow Subsurface Investigation

The Geotechnical Analysis Reports listed in Section DATA-4.2 provide data relevant to the Shallow Subsurface Investigation. In addition, the following two reports contain detailed information on this subject:

- U.S. Department of Energy, Basic Data Report for Piezometers PZ-13, PZ-14, and PZ-15 and Shallow Subsurface Water, Revision 1, DOE-WIPP 08-3375, April 2008.

- Daniel B. Stephens & Associates, Inc. 2003. Water Budget Analysis of the Shallow Subsurface Water at the Waste Isolation Pilot Plant, Carlsbad, NM.

DATA-11.2.2 Culebra Water-Level Rise Investigation

The following reports are related to Culebra water-level investigations:

- Beauheim, R.L. 2002b. Routine Calculations Report In Support of Task 3 of AP-088, Calculation of Culebra Freshwater Heads in 1980, 1990, and 2000 for Use in T-Field Calibration. ERMS 522580. Carlsbad, NM: Sandia National Laboratories, WIPP Records Center.

- Beauheim, R.L. 2003. Analysis Report for AP-100 Task 1: Development and Application of Acceptance Criteria for Culebra Transmissivity (T) Fields. ERMS 531136. Carlsbad, NM: Sandia National Laboratories, WIPP Records Center.

- Beauheim, R.L. 2003. Analysis Plan for Evaluation of Culebra Water-Level-Rise Scenarios, AP-110. ERMS 532799. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Beauheim, R.L. 2004. Analysis Plan for Evaluation and Recalibration of Culebra Transmissivity Fields, AP-114. ERMS 537208. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Beauheim, R.L. 2008. Analysis Plan for Evaluation and Recalibration of Culebra Transmissivity Fields, AP-114, Revision 1. ERMS 548162. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Beauheim, R.L., and B.L. Fox. 2003. Records Package for AP-088 Task 4, Conditioning of Base T Fields to Transient Heads: Compilation and Reduction of Transient Head Data. ERMS 527572. Carlsbad, NM: Sandia National Laboratories, WIPP Records Center.

- Beauheim, R.L., and S.A. McKenna. 2003. Analysis Plan for Optimization and Minimization of the Culebra Monitoring Network for the WIPP, AP-111. ERMS 533092. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Johnson, P.B. 2005. Routine Calculations Report In Support of Task 6 of AP-114, Potentiometric Surface, Adjusted to Equivalent Freshwater Heads, of the Culebra Dolomite Member of the Rustler Formation near the WIPP Site, March–April 2004. ERMS 541154. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Johnson, P.B. 2008. Routine Calculations Report In Support of Task 6 of AP-114, Potentiometric Surface, Adjusted to Equivalent Freshwater Heads, of the Culebra Dolomite

Member of the Rustler Formation near the WIPP Site, May 2007. ERMS 548227. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Kanney, J.F. 2003. Analysis Report for AP-100 Tasks 4-6: Extraction of Flow Field Values for SECOTP2D, Scaling of Flow Field for Climate Change, and Radionuclide Transport Calculations. ERMS 532320. Carlsbad, NM: Sandia National Laboratories, WIPP Records Center.

- Klise, K.A., and R.L. Beauheim. 2005. Task 3 of AP-114, Evaluation of Alternatives to the Southwestern No-Flow Boundary Condition. ERMS 542147. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Leigh, C., R. Beauheim, and J. Kanney. 2003. Analysis Plan for Calculations of Culebra Flow and Transport: Compliance Recertification Application, AP-100. ERMS 530172. Carlsbad, NM: Sandia National Laboratories, WIPP Records Center.

- Lowry, T.S., and R.L. Beauheim. 2004. Analysis Report, Task 2 of AP-110, Evaluation of Water-Level Rise in the Culebra Due to Recharge from Refining Process Water Discharged onto Potash Tailings Piles. ERMS 536239. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Lowry, T.S., and R.L. Beauheim. 2005. Analysis Report, Task 3 of AP-110, Evaluation of Water-Level Rise in the Culebra Due to Leakage Through Poorly Plugged and Abandoned Potash Boreholes. ERMS 540187. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- McKenna, S.A. 2004. Analysis Report, AP-111, Culebra Water Level Monitoring Network Design. ERMS 540477. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Powers, D.W. 2004. Analysis Report, Task 1A of AP-110, Identify Potash Holes Not Sealed Through the Culebra with Cement, and Units to Which the Culebra Might Be Connected. ERMS 535377. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Powers, D.W. 2004. Analysis Report, Task 1B of AP-110, Identify Plugged and Abandoned Oil or Gas Wells Not Sealed Through the Culebra with Cement, and Units to Which the Culebra Might Be Connected. ERMS 538279. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Powers, D.W. 2007. Analysis Report for Task 1A of AP-114: Refinement of Rustler Halite Margins Within the Culebra Modeling Domain. ERMS 547559. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Powers, D.W. 2006. Analysis Report, Task 1B of AP-114, Identify Possible Area of Recharge to the Culebra West and South of WIPP. ERMS 543094. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Powers, D.W. 2006. Analysis Report, Task 1D of AP-114, Collect Current and Historic Information on Water Levels and Specific Gravity in Potash Tailings Ponds within the Culebra Modeling Domain. ERMS 543124. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Toll, N.J., and P.B. Johnson. 2006. Routine Calculations Report In Support of Task 6 of AP-114, SNL-14 August 2005 Pumping Test Observation Well Data Processing, Summary of Files. ERMS 543371. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

- Toll, N.J., and P.B. Johnson. 2006. Routine Calculations Report In Support of Task 6 of AP-114, WIPP-11 February 2005 Pumping Test Observation Well Data Processing– Summary of Files. ERMS 543651. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

DATA-12.0 Waste Containers and Emplacement

Information regarding WIPP waste emplacement containers and underground waste emplacement layouts are provided in this section. Approved containers that are inside other containers, such as pipe overpacks, will not be discussed.

DATA-12.1 Program Overview

Information provided in this section was compiled from several sources to serve as a central document describing both waste emplacement containers and waste emplacement layouts. Both contact-handled (CH) transuranic (TRU) (CH-TRU) and remote-handled (RH) transuranic (TRU) (RH-TRU) waste containers are described along with CH-TRU and RH-TRU waste emplacement layouts in a typical panel in the repository. Only containers approved for disposal in the repository will be discussed.

DATA-12.2 Reported Data

Attachment B to this appendix provides detailed information on the various waste containers and their emplacement in the underground repository.

DATA-13.0 References

Beauheim, R.L. 2002. *Routine Calculations Report in Support of Task 3 of AP-088: Calculation of Culebra Freshwater Heads in 1980, 1990, and 2000 for Use in T-Field Calibration* (June 13). ERMS 522580. Carlsbad, NM: Sandia National Laboratories.

Beauheim, R.L. 2003a. *Analysis Plan for Evaluation of Culebra Water-Level-Rise Scenarios* (Revision 0). AP-110. ERMS 532799. Carlsbad, NM: Sandia National Laboratories.

Beauheim, R.L. 2003b. *Analysis Report for AP-100, Task 1: Development and Application of Acceptance Criteria for Culebra Transmissivity (T) Fields*. ERMS 531136. Carlsbad, NM: Sandia National Laboratories.

Beauheim, R.L. 2004. *Analysis Plan for Evaluation and Recalibration of Culebra Transmissivity Fields* (Revision 0). AP-114. ERMS 537208. Carlsbad, NM: Sandia National Laboratories.

Beauheim, R.L. 2008. *Analysis Plan for Evaluation and Recalibration of Culebra Transmissivity Fields* (Revision 1). AP-114. ERMS 548162. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

Beauheim, R.L., and B.L. Fox. 2003. *Records Package for AP-088, Task 4; Conditioning of Base T Fields to Transient Heads: Compilation and Reduction of Transient Head Data*. ERMS 527572. Carlsbad, NM: Sandia National Laboratories.

Beauheim, R.L., and S.A. McKenna. 2003. *Analysis Plan for Optimization and Minimization of the Culebra Monitoring Network for the WIPP* (Revision 0). AP-111. ERMS 533092. Carlsbad, NM: Sandia National Laboratories.

Borkowski, M., D.T. Reed, and M.K. Richmann. 2008. "Plutonium Speciation in a Salt-Based Repository." American Nuclear Society Annual Meeting. June 8–12. LA-UR 08-03605. Anaheim, CA.

Borkowski, M., D.T. Reed, J.F. Lucchini, and M.K. Richmann. 2005. "Solubility of Neodymium in Simulated WIPP (Waste Isolation Pilot Plant) Brines." Poster. 24th Rare Earth Research Conference. June 26–30. Keystone, CO.

Borkowski, M., J.F. Lucchini, M.K. Richmann, and D.T. Reed. 2006a. "Actinide Chemistry and Repository Science Program in support of the Waste Isolation Pilot Plant (WIPP)." Oral Communication. American Nuclear Society's 14th Biennial Topical Meeting of the Radiation Protection and Shielding Division. April 3–6. LAUR-05-9615. Carlsbad, NM.

Borkowski, M., J.F. Lucchini, M.K. Richmann, and D.T. Reed. 2006b. "Neodymium Analog Study of An(III) Solubility in WIPP Brine." Poster. Plutonium Futures 2006 Conference. July. LA-UR 06-2900. Monterey, CA.

Borkowski, M., J.F. Lucchini, M.K. Richmann, and D.T. Reed. 2008. *Actinide (III) Solubility in WIPP Brine: Data Summary and Recommendations*. LCO-ACP-08. LANL\ACRSP Report. Los Alamos, NM: Los Alamos National Laboratory.

Borkowski, M., J.F. Lucchini, M.K. Richmann, S. Ballard, and D.T. Reed. 2007. *Effect of carbonate and borate complexation on Nd^{3+} and UO_2^{2+} solubility in WIPP brine*. National American Chemical Society Meeting. March. LAUR-06-8317. Chicago, IL.

Brush, L.H. 2004. *Review of the Calculations of the Quantity of MgO That Could Be Lost from the WIPP By Dissolution in Brine: Mg Solubility in Castile Brine*. Analysis report. September 1, 2004. ERMS 536580. Carlsbad, NM: Sandia National Laboratories.

Brush, L.H. 2005. *Results of Calculations of Actinide Solubilities for the WIPP Performance-Assessment Baseline Calculations*. ERMS 539800. Carlsbad, NM: Sandia National Laboratories.

Brush, L.H., A.C. Snider, Y. Xiong, and C.D. Leigh. 2004. "Use of MgO as the Engineered Barrier in the WIPP," Abstracts with Programs, Geological Society of America 2004 Annual Meeting. November 7–10. ERMS 536279. SAND2004-2729A. Denver, CO.

Brush, L.H., and G.T. Roselle. 2006. Memorandum to E.D. Vugrin (Subject: Geochemical Information for Calculation of the MgO Effective Excess Factor). 17 November 2006. ERMS 544840. U.S. Department of Energy, Sandia National Laboratories, Carlsbad, NM.

Brush, L.H., and J.W. Garner. 2005. Letter to D. Kessel. (Subject: Additional Justification for the Insignificant Effect of Np on the Long-Term Performance of the WIPP). 1 February 2005. ERMS 538533. Carlsbad, NM: Sandia National Laboratories.

Brush, L.H., and Y. Xiong. 2003a. *Calculation of Actinide Solubilities for the WIPP Compliance Recertification Application* (May 8). ERMS 529131. Carlsbad, NM: Sandia National Laboratories.

Brush, L.H., and Y. Xiong. 2003b. *Calculation of Actinide Solubilities for the WIPP Compliance Recertification Application, Analysis Plan AP-098, Rev. 1* (Revision 1). AP-098. ERMS 527714. Carlsbad, NM: Sandia National Laboratories.

Brush, L.H., and Y. Xiong. 2003c. *Calculation of Organic Ligand Concentrations for the WIPP Compliance Recertification Application and for Evaluating Assumptions of Homogeneity in WIPP PA*. ERMS 531488. Carlsbad, NM: Sandia National Laboratories.

Brush, L.H., and Y. Xiong. 2003b. *Calculation of Organic Ligand Concentrations for the WIPP Compliance Recertification Application*. ERMS 527567. Carlsbad, NM: Sandia National Laboratories.

Brush, L.H., and Y. Xiong. 2004. *Sensitivities of the Solubilities of +III, +IV, and +V Actinides to the Concentrations of Organic Ligands in WIPP Brines,* Rev. 0. Analysis report. December 15. ERMS 538203. Carlsbad, NM: Sandia National Laboratories.

Brush, L.H., and Y. Xiong. 2005. *Calculation of Organic-Ligand Concentrations for the WIPP Performance-Assessment Baseline Calculations* (May 4). ERMS 539635. Carlsbad, NM: Sandia National Laboratories.Brush, L.H., H. Deng, J.W. Garner, C.D. Leigh, M.B. Nemer, E.J. Nowak, D.E. Wall, N.A. Wall, and Y.L. Xiong. 2006. "Overview of Long-Term, Near-Field WIPP Geochemistry." 14th Biennial Topical Meeting of the American Nuclear Society Radiation Protection and Shielding and Protection. April 4. ERMS 543167. SAND2006-2167C. Carlsbad, NM.

Brush, L.H., H. Gao, A.C. Snider, D.E. Wall, N.A. Wall, and Y.L. Xiong. 2004. "Overview of Near-Field Geochemical Processes and Conditions Expected in the WIPP," Abstracts with Programs. Geological Society of America 2004 Annual Meeting. November 7–10. ERMS 536288. SAND2004-2728A. Denver, CO.

Brush, L.H., J.W. Garner and E. Vugrin. 2005. Memorandum to D.S. Kessel (Subject: PA Implementation of Uncertainties Associated with Calculated Actinide Solubilities). 2 February 2005. ERMS 538537. Carlsbad, NM: Sandia National Laboratories.

Brush, L.H., Y. Xiong, J.W. Garner, A. Ismail, and G.T. Roselle. 2006. *Consumption of Carbon Dioxide by Precipitation of Carbonate Minerals Resulting from Dissolution of Sulfate Minerals in the Salado Formation in Response to Microbial Sulfate Reduction in the WIPP* (November 17). ERMS 544785. Carlsbad, NM: Sandia National Laboratories.

Callahan, G.D. 2004. *Disposal Room Calculations with Alternative TRUE Waste Models.* Topical Report RSI-1783.

Callicoat, J. 2008. Memorandum to File (Subject: Calculation of Shallow Drilling for 2007). 2 July 2008. WRES:08:251. Carlsbad, NM: Washington Regulatory and Environmental Services.

Clayton, D.J. 2006. Memorandum to L.H. Brush (Subject: Update of the Minimum Brine Volume for a Direct Brine Release and New Maximum Castile and Salado Brine Volumes in a Waste Panel). 11 October 2006. ERMS 544453. Carlsbad, NM: Sandia National Laboratories.

Clayton, D.J. 2007a. *Justification of Relative Permeability and Capillary Pressure Model Parameters for Use by BRAGFLO Version 6.0.* ERMS 545764. Carlsbad NM: Sandia National Laboratories.

Clayton, D.J. 2007b. Memorandum to E. Vugrin, M. Lee, and D. Kessel (Subject: Corrections to Input Files for DBR PABC Calculations). 6 June 2007. ERMS 546311. U.S. Department of Energy, Sandia National Laboratories, Carlsbad, NM.

Clayton, D.J., and M.B. Nemer. 2006. Memorandum to E.D. Vugrin (Subject: Normalized Moles of Castile Sulfate Entering the Repository and Fraction of MgO Lost Due to Brine Flow Out of the Repository). 9 October 2006. U.S. Department of Energy, Sandia National Laboratories, Carlsbad, NM.

Crawford, B.A., and C.D. Leigh. 2003. *Estimate of Complexing Agents in TRU Waste for the Compliance Recertification Application* (August 28). ERMS 531107. Carlsbad, NM: Los Alamos National Laboratory.

Daniel B. Stephens & Associates, Inc. 2003. *Water Budget Analysis of the Shallow Subsurface Water at the Waste Isolation Pilot Plant*. Carlsbad, NM.

Deng, H., M.B. Nemer, and Y. Xiong. 2007. *Experimental Study of MgO Reaction Pathways and Kinetics* (Rev. 1, January 10). TP 06-03. ERMS 545182. Carlsbad, NM: Sandia National Laboratories.

Deng, H., S. Johnson, Y. Xiong, G.T. Roselle, and M. Nemer. 2006. *Analysis of Martin Marietta MagChem 10 WTS-60 MgO* (November 14). ERMS 544712. Carlsbad, NM: Sandia National Laboratories.

Deng, H., Y. Xiong, and M. Nemer. 2007. *Experimental Work Conducted on MgO Characterization and Hydration, Milestone Report*. ERMS 546570. Carlsbad, NM: Sandia National Laboratories.

Downes, P.S. 2003a. Memorandum to L.H. Brush. Subject: Spreadsheet Calculations of Actinide Solubilities for the WIPP Compliance Recertification Application. 21 April 2003. ERMS 528395. Carlsbad, NM: Sandia National Laboratories.

Downes, P.S. 2003b. *Spreadsheet Calculations of Actinide Solubilities for the WIPP Compliance Recertification Application in Support of AP-098*, Calculation of Actinide Solubilities for the WIPP Compliance Recertification Application, Analysis Plan AP-098, Rev. 1. ERMS 530441. Carlsbad, NM: Sandia National Laboratories.

Dunagan, S., C. Hansen, and W. Zelinski. 2005. *Effect of Increasing Cellulosics, Plastics, and Rubbers on WIPP Performance Assessment*. ERMS 538445. Carlsbad NM: Sandia National Laboratories.

Fox, B. 2008. *Parameter Summary Report for the CRA-2009* (Revision 0). ERMS 549747. Carlsbad, NM: Sandia National Laboratories.

Giambalvo, E.R. 2002. Memorandum to L.H. Brush (Subject: Recommended μ^0/RT Values for Modeling the Solubility of Oxalate Solids in WIPP Brines). 31 July 2002. ERMS 523057. U.S. Department of Energy, Sandia National Laboratories, Carlsbad, NM.

Giambalvo, E.R., 2003. Memorandum to L.H. Brush (Subject: Release of FMT Database FMT_021120.CHEMDAT). 10 March 2003. ERMS 526372. U.S. Department of Energy, Sandia National Laboratories, Carlsbad, NM.

Hansen, F.D. 2005. *A Revisit of Waste Shear Strength*. ERMS 541354. Carlsbad NM: Sandia National Laboratories.

Hansen, F.D., and J.S. Stein. 2005. *WIPP Room Evolution and Performance Assessment Implications*. ERMS 538870. Carlsbad NM: Sandia National Laboratories.

Herrick, C.G., M. Riggins, and B.Y. Park. 2007. *Recommendation for the Lower Limit of the Waste Shear Strength (Parameter BOREHOLE: TAUFAIL)*. ERMS 546033. Carlsbad NM: Sandia National Laboratories.

Herrick, C.G., M. Riggins, B.Y Park, and E.D. Vugrin. 2007. *Recommendation for the Lower Limit of the Waste Shear Strength (Parameter BOREHOLE:TAUFAIL)* (Rev. 1). ERMS 546343. Carlsbad, NM: Sandia National Laboratories.

Holcomb, D., and R. Hardy. 2001. *Status of Ultrasonic Wave Speed Measurements Undertaken to Characterize the DRZ in the Access Drift to Q Room*. ERMS 545575. Carlsbad NM: Sandia National Laboratories.

Hughes, D. 2007. Memorandum to File (Subject: Castile Brine Encounters). WRES:08:302. Washington Regulatory and Environmental Services, Carlsbad, NM.

Hughes, D. 2008a. Memorandum to File (Subject: Seismic Activity within the Delaware Basin). WRES:08:303. Washington Regulatory and Environmental Services, Carlsbad, NM.

Hughes, D. 2008b. Memorandum to File: (Subject: Status of Potash Activities – 2007). 2 July 2008. WRES:08:250. Washington Regulatory and Environmental Services, Carlsbad, NM.

INTERA. 1997. *Exhaust Shaft Hydraulic Assessment Data Report*. DOE-WIPP 97-2219. Carlsbad, NM: Waste Isolation Pilot Plant.

Ismail, A.E. 2007. Memorandum to File (Subject: Revised Porosity Estimates for the DRZ). 10 April 2007. ERMS 545755. U.S. Department of Energy, Sandia National Laboratories, Carlsbad, NM.

Ismail, A.E., and B.Y. Park. 2007. *Revised Permeability Estimates for the Disturbed Rock Zone (DRZ)*. ERMS 545746. Carlsbad NM: Sandia National Laboratories.

Johnson, P.B. 2005. *Routine Calculations Report In Support of Task 6 of AP-114, Potentiometric Surface, Adjusted to Equivalent Freshwater Heads, of the Culebra Dolomite Member of the Rustler Formation near the WIPP Site, March–April 2004*. ERMS 541154. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

Johnson, P.B. 2008. *Routine Calculations Report In Support of Task 6 of AP-114, Potentiometric Surface, Adjusted to Equivalent Freshwater Heads, of the Culebra Dolomite Member of the Rustler Formation near the WIPP Site, May 2007*. ERMS 548227. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

Kanney, J. 2003. *Analysis Report for AP-100 Tasks 4-6: Extraction of Flow Field Values for SECOTP2D, Scaling of Flow Field for Climate Change, and Radionuclide Transport Calculations*. ERMS 532320. Carlsbad, NM: Sandia National Laboratories, WIPP Records Center.

Kanney, J.F., and E.D. Vugrin. 2006. Memorandum to D.S. Kessel (Subject: Updated Analysis of Characteristic Time and Length Scales for Mixing Processes in the WIPP Repository to Reflect the CRA-2004 PABC Technical Baseline and the Impact of Supercompacted Mixed Waste and Heterogeneous Waste Emplacement). 31 August 2006. ERMS 544248. U.S. Department of Energy, Sandia National Laboratories, Carlsbad, NM.

Kanney, J.F., and W. Zelinski. 2004. Memorandum to Y. Xiong (Subject: Input for CaCO3 precipitation Modeling). 9 September 2004. ERMS 536665. Carlsbad, NM: Sandia National Laboratories.

Kirchner, T., and E. Vugrin. 2006. Memorandum to D.S. Kessel (Subject: Uncertainty in Cellulose, Plastic, and Rubber Measurements for the Waste Isolation Pilot Plant Inventory). 12 June 2006. ERMS 543848. U.S. Department of Energy, Sandia National Laboratories, Carlsbad, NM.

Klise, K.A., and R.L. Beauheim. 2005. *Task 3 of AP-114, Evaluation of Alternatives to the Southwestern No-Flow Boundary Condition*. ERMS 542147. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

Leigh, C., R. Beauheim, and J. Kanney. 2003. *Analysis Plan for Calculations of Culebra Flow and Transport: Compliance Recertification Application*. AP-100. ERMS 530172. Carlsbad, NM: Sandia National Laboratories.

Leigh, C.D. 2005. Memorandum to L.H. Brush (Subject: Organic Ligand Masses TRU Waste Streams from TWBID Revision 2.1, Version 3.13, Data Version D4.15, Revisions 1). 18 April 2005. ERMS 539550. Carlsbad, NM: Sandia National Laboratories.

Lowry, T.S., and R.L. Beauheim. 2004. *Analysis Report: Task 2 of AP-110; Evaluation of Water-Level Rise in the Culebra Due to Recharge from Refining Process Water Discharged onto Potash Tailings Piles*. ERMS 536239. Carlsbad, NM: Sandia National Laboratories.

Lowry, T.S., and R.L. Beauheim. 2005. *Analysis Report: Task 3 of AP-110; Evaluation of Water-Level Rise in the Culebra Due to Leakage through Poorly Plugged and Abandoned Potash Boreholes*. ERMS 540187. Carlsbad, NM: Sandia National Laboratories.

Lucchini, J.F. 2006. "Review of spent fuel matrix alteration with respect to alpha-radiolysis." American Nuclear Society's 14th Biennial Topical Meeting of the Radiation Protection and Shielding Division. April 3–6. LAUR–05-9617. Carlsbad, NM.

Lucchini, J.F., D.T. Reed, M. Borkowski, A. Rafalski, and J. Conca. 2004. "Influence of Radiolytic Products on the Chemistry of Uranium VI in Brines." Oral Communication. 227th ACS National Meeting. March 28–April 1. Anaheim, CA. LAUR-03-9026. Poster. International Conference ATALANTE 2004. June 21-24. Nimes, France.

Lucchini, J.F., H. Khaing, M. Borkowski, M.K. Richmann, and D.T. Reed. 2008. *Actinide (VI) Solubility in Carbonate-free WIPP Brine: Data Summary and Recommendations*. LCO-ACP-10, LANL\ACRSP Report. Los Alamos, NM: Los Alamos National Laboratory.

Lucchini, J.F., H. Khaing, M.K. Richmann, M. Borkowski, D.T. Reed. 2008. *Plutonium (VI) and Uranium (VI) Reduction by Iron (II) at High pH under Subsurface Conditions*. International Conference Plutonium Futures–The Science. July 7–11. LAUR-08-04292. Dijon, France.

Lucchini, J.F., M. Borkowski, M.K. Richmann, and D.T. Reed. 2005. "Interactions and Stability of Hypochlorite, Hydrogen Peroxide and Uranium (VI) in Brine." Poster. International Conference MIGRATION 05. September 18–23. LAUR-05-7009. Avignon, France.

Lucchini, J.F., M. Borkowski, M.K. Richmann, and D.T. Reed. 2005. "Solubility of Uranium (VI) in Brine". Poster. International Conference MIGRATION 05. September 18–23. LAUR-05-7011. Avignon, France.

Lucchini, J.F., M. Borkowski, M.K. Richmann, and D.T. Reed. 2006. "Uranium (VI) Solubility from Over-saturation in Carbonate-free Brines." Poster. Plutonium Futures 2006 Conference. July. LAUR-06-1307. Monterey, CA.

Lucchini, J.F., M. Borkowski, M.K. Richmann, S. Ballard, and D.T. Reed. 2007. "Solubility of Nd^{3+} and UO_2^{2+} in WIPP Brine as Oxidation-State Invariant Analogs for Plutonium." Journal of Alloys and Compounds, vol. 444/445: 506–11.

Lucchini, J.F., S. Ballard, H. Khaing, M. Borkowski, S. Pepper, M.K. Richmann, and D.T. Reed. 2007. *Effect of Carbonate on U(VI) Solubility in WIPP Brine*. International Conference MIGRATION 07. August 26–31. LAUR-07-5377. Munchen, Germany.

McKenna, S.A. 2004. *Analysis Report: AP-111; Culebra Water-Level Monitoring Network Design*. ERMS 540477. Carlsbad, NM: Sandia National Laboratories.

Nemer, M., J. Stein, and W. Zelinski. 2005. *Analysis Report for BRAGFLO Preliminary Modeling Results With New Gas Generation Rates Based on Recent Experimental Results*. ERMS 539437. Carlsbad, NM: Sandia National Laboratories.

Nemer, M.B. 2006. Memorandum to the SNL/WIPP Records Center (Subject: Expected Brine volumes, Cumulative Brine Inflow, and MgO-to-Brine Solid-to-Liquid Ratio from PABC BRAGFLO Results). 3 March 2006. ERMS 542612. Carlsbad, NM: Sandia National Laboratories.

Nowak, E.J. 2005. Memorandum to L.H. Brush (Subject: Recommended Change in the FMT Thermodynamic Data Base). 1 April 2005. ERMS 539227. Carlsbad, NM: Sandia National Laboratories.

Nowak, E.J., and D.J. Clayton. 2007. *Analysis of MgO Hydration Laboratory Results and Calculation of Extent of Hydration and Resulting Water Uptake versus Time under Postulated WIPP Conditions*. Analysis report. September 5. ERMS 546769. Carlsbad, NM: Sandia National Laboratories.

Olive, D., M. Borkowski, J.F. Lucchini, H. Khaing, M. Richmann, D. Reed, and J. Terry. 2008. *Physicochemical Properties of Neodymium WIPP Solids*. 2008 Argonne Advanced Photon Source Users Meeting. May 4–8. LAUR-08-2288. Argonne, IL.

Park, B.Y., A.E. Ismail, D.J. Holcomb, and C.G. Herrick. 2007. *Analysis Report for Prediction of the Extent and Permeability of the Disturbed Rock Zone around a WIPP Disposal Room* (Revision 0). ERMS 546370. Carlsbad, NM: Sandia National Laboratories.

Park, B.Y., and J.F. Holland. 2006. Error in DRZ Calculation in the Clay Seam G Analysis. ERMS 545053. Carlsbad, NM: Sandia National Laboratories.

Pepper, S.E., M. Borkowski, and D.T. Reed. 2007. *The Analysis of Ferric and Ferrous Iron in Actinide Redox Systems using Solvent Extraction*. 31st Annual Actinide Separations Conference. Las Vegas, NV.

Powers, D.W. 2004a. *Analysis Report: Task 1A of AP-110: Identify Potash Holes Not Sealed Through the Culebra with Cement, and Units to Which the Culebra Might Be Connected*. ERMS 535377. Carlsbad, NM: Sandia National Laboratories.

Powers, D.W. 2004b. *Analysis Report: Task 1B of AP-110: Identify Plugged and Abandoned Oil or Gas Wells Not Sealed Through the Culebra with Cement, and Units to Which the Culebra Might Be Connected*. ERMS 538279. Carlsbad, NM: Sandia National Laboratories.

Powers, D.W. 2006a. *Analysis Report: Task 1B of AP-114; Identify Possible Area of Recharge to the Culebra West and South of WIPP* (April 1). ERMS 543094. Carlsbad, NM: Sandia National Laboratories.

Powers, D.W. 2006b. *Analysis Report: Task 1D of AP-114; Collect Current and Historic Information on Water Levels and Specific Gravity in Potash Tailings Ponds within the Culebra Modeling Domain* (March 31). ERMS 543124. Carlsbad, NM: Sandia National Laboratories.

Powers, D.W. 2007. *Analysis Report for Task 1A of AP-114: Refinement of Rustler Halite Margins within the Culebra Modeling Domain* (October 5). ERMS 547559. Carlsbad, NM: Sandia National Laboratories.

Reed, D.T. 2007a. "Key Interactions and Speciation of Plutonium under Subsurface Conditions." March 30. Valparaiso University chemistry department.

Reed, D.T. 2007b. "Key Interactions and Speciation of Plutonium under Subsurface Conditions." Oral. March 23. University of Texas at El Paso, chemistry department.

Reed, D.T. 2007. "WIPP Actinide Chemistry Research Project." Oral. April 26. New Mexico State University, chemistry department.

Reed, D.T. 2008. "Actinide Speciation in the WIPP." Oral. INE German salt repository program. July 4. Karlsruhe, Germany.

Reed, D.T., D. Moody, and R. Patterson. 2007. "Waste Isolation Pilot Plant (WIPP) Transuranic Repository." Oral. Migration 2007. September. Munich, Germany.

Reed, D.T., G. Smith, R. Deo, B. Rittmann, J.F. Lucchini, M. Borkowski, and M.K. Richmann. 2006. "Subsurface Bio-mediated Reduction of Higher-Valent Uranium and Plutonium." Presentation. Plutonium Futures – The Science 2006 Conference. July 9–13. Pacific Grove, CA.

Reed, D.T., H. Boukhalfa, G.A. Icopini, S.D. Reilly, and M. Neu. 2007. "Plutonium Reduction By Metal-Reducing Bacteria." Presentation. Migration 2007. September. Munich, Germany.Reed, D.T., J.F. Lucchini, M. Borkowski, and M.K. Richmann. 2009. *Pu(VI) Reduction by Iron under WIPP-Relevant Conditions: Data Summary and Recommendations*. LCO-ACP-09, LANL\ACRSP Report. Los Alamos, NM: Los Alamos National Laboratory.

Reed, D.T., J.F. Lucchini, S.B. Aase, and A.J. Kropf. 2006. "Reduction of Plutonium (VI) in Brine under Subsurface Conditions." Radiochimica Acta, vol. 94: 591–97.

Reed, D.T., M. Borkowski, and J. F. Lucchini. 2004. *Reduction of Higher-Valent Actinides in the WIPP*. GSA WIPP session. November 7. LAUR-04-7954. Denver, CO.

Reed, D.T., M. Borkowski, J.F. Lucchini, and M.K. Richmann. 2006a. "Actinide Solubility and Speciation in the WIPP". Los Alamos Earth and Environmental Sciences Frontiers in Geoscience Colloquium. August 8.

Reed, D.T., M. Borkowski, J.F. Lucchini, and M.K. Richmann. 2006b. "Subsurface Biogeochemistry of Plutonium in the WIPP." Poster. Los Alamos National Laboratory, Earth and Environmental Sciences Division review. April.

Reed, D.T., M. Borkowski, M.K. Richmann, J.F. Lucchini, and H. Khaing. 2008. "Plutonium Speciation in a Salt-Based Repository". Plutonium Futures "The Science" Conference. July. Dijon, France.

Reed, D.T., S.E. Pepper, B.E. Rittmann, and R. Deo. 2007. "Role of Fe (II) in the abiotic and biotic reduction of higher-valent uranium and plutonium." National American Chemical Society Meeting. March. Chicago, IL.

Reed, D.T., S.E. Pepper, M.K. Richmann, G. Smith, R. Deo, and B.E. Rittmann. 2007. "Subsurface Bio-Mediated Reduction of Higher-Valent Uranium and Plutonium." Journal of Alloys and Compounds, vol. 444/445: 376–82.

Richmann, M.K., J.F. Lucchini, M. Borkowski, S.E. Pepper, S. Ballard, H. Khaing, and D.T Reed. 2007. "Actinide Speciation in the WIPP." International Conference MIGRATION 07. August 26–31. LAUR-07-1903. Munchen, Germany.

Sandia National Laboratories (SNL). 2004. *Sandia National Laboratories Annual Compliance Monitoring Parameter Assessment for 2003* (Revision 1, June). ERMS 535825. Carlsbad, NM: Sandia National Laboratories.

Sandia National Laboratories (SNL). 2005a. *Sandia National Laboratories Annual Compliance Monitoring Parameter Assessment for 2004* (February). ERMS 538645. Carlsbad, NM: Sandia National Laboratories.

Sandia National Laboratories (SNL). 2005b. *Sandia National Laboratories Annual Compliance Monitoring Parameter Assessment for 2005* (November). ERMS 541759. Carlsbad, NM: Sandia National Laboratories.

Sandia National Laboratories (SNL). 2006. *Sandia National Laboratories Annual Compliance Monitoring Parameter Assessment for 2006* (October). ERMS 544616. Carlsbad, NM: Sandia National Laboratories.

Sandia National Laboratories (SNL). 2008. *Sandia National Laboratories Compliance Monitoring Parameter Assessment for 2007* (January). ERMS 548041. Carlsbad, NM: Sandia National Laboratories.

Snider, A.C. 2003a. *Calculation of MgO Safety Factors for the WIPP Compliance Recertification Application and for Evaluating Assumptions of Homogeneity in WIPP PA* (September 11). ERMS 531508. Carlsbad, NM: Sandia National Laboratories.

Snider, A.C. 2003b. *Verification of the Definition of Generic Weep Brine and the Development of a Recipe for This Brine* (April 8). ERMS 527505. Carlsbad, NM: Sandia National Laboratories.

Snider, A.C., and Y. Xiong. 2004. *Continuing Investigations of the Hydration and Carbonation of Premier Chemical MgO* (October 12). ERMS 537188. Carlsbad, NM: Sandia National Laboratories.

Snider, A.C., Y. Xiong, and N.A. Wall. 2004. Experimental Study of WIPP Engineered Barrier MgO at Sandia National Laboratories Carlsbad Facility (Rev. 3, August 26). TP 00-07. ERMS 536591. Carlsbad, NM: Sandia National Laboratories.

Stein, J.S. 2005. Memorandum to L.H. Brush (Subject: Estimate of Volume of Brine in Repository That Leads to a Brine Release). 13 April 2005. ERMS 539372. Albuquerque, NM: Sandia National Laboratories.

Stein, J.S., and M.B. Nemer. 2005. *Analysis Plan for Updating the Microbial Degradation Rates for Performance Assessment*. AP-116, Rev. 0. February 3. ERMS 538596. Carlsbad, NM: Sandia National Laboratories.

Toll, N.J., and P.B. Johnson. 2006. *Routine Calculations Report In Support of Task 6 of AP-114, SNL-14 August 2005 Pumping Test Observation Well Data Processing, Summary of Files*. ERMS 543371. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

Toll, N.J., and P.B. Johnson. 2006. *Routine Calculations Report In Support of Task 6 of AP-114, WIPP-11 February 2005 Pumping Test Observation Well Data Processing–Summary of Files*. ERMS 543651. Carlsbad, NM: Sandia National Laboratories WIPP Records Center.

Triay, I.R. 2003. Letter to F. Marcinowski (Subject: 2003 Annual Change Report; 3 Enclosures). 13 November 2003. U.S. Department of Energy. Carlsbad Field Office, Carlsbad, NM.

U.S. Department of Energy (DOE). 1996. *Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant* (October). 21 vols. DOE/CAO 1996-2184. Carlsbad, NM: Carlsbad Area Office.

U.S. Department of Energy (DOE). 2003a. *Delaware Basin Monitoring Annual Program Report* (Rev. 4, September). DOE/WIPP-99-2308. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2003b. *Waste Isolation Pilot Plant Site Environmental Report: Calendar Year 2002* (Rev. 1, September). DOE/WIPP 03-2225. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2003c. *WIPP Subsidence Monument Leveling Survey* (October). DOE/WIPP-04-2293. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2004a. *Annual Change Report 2003/2004* (November 10). DOE/WIPP 04-3317. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2004b. *Delaware Basin Monitoring Annual Program Report* (Rev. 5, September). DOE/WIPP-99-2308. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2004c. *Geotechnical Analysis Report for July 2002–June 2003* (March; vol. 1). DOE/WIPP 04-3177. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2004d. *Title 40 CFR Part 191 Compliance Recertification Application for the Waste Isolation Pilot Plant* (March). 10 vols. DOE/WIPP 2004-3231. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2004e. *Waste Isolation Pilot Plant 2003 Site Environmental Report*. DOE/WIPP 04-2225. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2004f. *WIPP Subsidence Monument Leveling Survey* (December). DOE/WIPP-05-2293. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2005a. *Annual Change Report 2004/2005* (November 10). DOE/WIPP 05-3317. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2005b. *Delaware Basin Monitoring Annual Program Report* (Rev. 6, September). DOE/WIPP-99-2308. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2005c. *Geotechnical Analysis Report for July 2003–June 2004* (March; vol. 1). DOE/WIPP 05-3177. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2005d. *Waste Isolation Pilot Plant 2004 Site Environmental Report*. DOE/WIPP 05-2225. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2005e. *WIPP Subsidence Monument Leveling Survey* (December). DOE/WIPP-06-2293. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2006a. *Annual Change Report 2005/2006* (October). DOE/WIPP 06-3317. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2006b. *Delaware Basin Monitoring Annual Program Report* (September). DOE/WIPP-06-2308. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2006c. *Geotechnical Analysis Report for July 2004–June 2005* (April; vol. 1). DOE/WIPP 06-3177. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2006d. *Waste Isolation Pilot Plant Annual Site Environmental Report for 2005* (September). DOE/WIPP 06-2225. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2006e. *WIPP Subsidence Monument Leveling Survey 2006* (December 2006). DOE/WIPP 07-2293. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2007a. *Annual Change Report 2006/2007: From July 1, 2006, to June 30, 2007* (November 16). DOE/WIPP 07-3317. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2007b. *Delaware Basin Monitoring Annual Report* (September). DOE/WIPP 07-2308. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2007c. *Geotechnical Analysis Report for July 2005–June 2006* (March; vol. 1). DOE/WIPP 07-3177. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2007d. *Waste Isolation Pilot Plant Annual Site Environmental Report for 2006* (September). DOE/WIPP 07-2225. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2007e. *WIPP Subsidence Monument Leveling Survey* (December). DOE/WIPP-08-2293. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2008a. *Annual Transuranic Waste Inventory Report—2007* (Revision 1). DOE/TRU 2008-3379. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2008b. *Basic Data Report for Piezometers PZ-13, PZ-14, and PZ-15 and Shallow Subsurface Water* (Revision 1, April). DOE/WIPP 08-3375. Carlsbad, NM: Carlsbad Field Office.

U.S. Department of Energy (DOE). 2008c. *Geotechnical Analysis Report for July 2006–June 2007* (March). 2 vols. DOE/WIPP 08-3177. Carlsbad, NM: Carlsbad Field Office.

U.S. Environmental Protection Agency (EPA). 1996. "40 CFR Part 194: Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations; Final Rule." Federal Register, vol. 61 (February 9, 1996): 52234–45.

U.S. Environmental Protection Agency (EPA). 1998. "40 CFR Part 194: Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the

Disposal Regulations: Certification Decision; Final Rule." Federal Register, vol. 63 (May 18, 1998): 27353–406.

Vugrin, E.D., M.B. Nemer, and S.W. Wagner. 2006. *Uncertainties Affecting MgO Effectiveness and Calculation of the MgO Effective Excess Factor* (Rev. 0, November 17). ERMS 544781. Carlsbad, NM: Sandia National Laboratories.

Wall, D.E., N.A. Wall, and L.H. Brush. 2006. "Speciation and Solubility Modeling of Actinides in the Waste Isolation Pilot Plant." Separations for the Nuclear Fuel Cycle in the 21st Century. Eds. G.J. Lumetta, K.L. Nash, S.B. Clark, and J.L. Friese. ACS Symposium Series, Vol. 933, 313-334. ERMS 541051. SAND2004-6355J. Washington, DC: American Chemical Society.

Wall, N.A. 2005. *Preliminary Results for the Evaluation of Potential New MgO* (January 27). ERMS 538514. Carlsbad, NM: Sandia National Laboratories.

Wall, N.A. and D.E. Wall. 2004. Memorandum to Records (Subject: Discussion on the Influence of Organic Ligands on the Solubility of U(VI)). 30 November 2004. ERMS 537938. Carlsbad, NM: Sandia National Laboratories.

Wall, N.A., and D. Enos. 2006. *Iron and Lead Corrosion in WIPP-Relevant Conditions, TP 06-02, Rev. 1*. April 24. ERMS 543238. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y. 2004a. Memorandum to L.H. Brush (Subject: A Correction of the Dimensionless Standard Chemical Potential of NpO2Ac(aq) in FMT_041116. CHEMDAT). 10 December 2004. ERMS 538162. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y. 2004b. Memorandum to L.H. Brush (Subject: A Correction of the Molecular Weight of Oxalate in FMT_021120. CHEMDAT, and Incorporation of Calcium Oxalate Monohydrate (Whewellite) into CHEMDAT with Its Recommended Dimensionless Standard Chemical Potential (μ0/RT) Value). 8 June 2004. ERMS 535813. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y. 2004c. Memorandum to L.H. Brush (Subject: Incorporation of Six Solid Phases Including Hydromagnesite (5424) and Hydromagnesite (4323) into EQ3/6 HMW Database and Its Modified Version HMP). 4 August 2004. ERMS 536321. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y. 2004d. Memorandum to L.H. Brush (Subject: An Update on the Dimensionless Standard Chemical Potential of NpO2Ac(aq) in FMT CHEMDAT). 11 November 2004. ERMS 537838. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y. 2005. E-mail to J.F. Kanney and J.J. Long (Subject: Release of FMT_050405.CHEMDAT). 5 April 2005. ERMS 539304. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y. 2006a. Memorandum to L.H. Brush (Subject: Incorporation of Amorphous Calcium Carbonate into the EQ3/6 HMY Database and Its Modified Version HML). 26 October 2006. ERMS 544629. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y. 2006b. Memorandum to L.H. Brush (Subject: Incorporation of Calcium Citrate Hydrate, Earlandite; Calcium Oxalate Monohydrate, Whewellite; and Aqueous Species of Citrate and Oxalate into the EQ3/6 HMP Database and Its Modified Version HMY). 18 October 2006. ERMS 544529. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y. 2007a. *Analysis Plan for Derivation of Pitzer Parameters in Support of Experimental Work at LANL-CO*. June 7. ERMS 546249. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y. 2007b. Memorandum to L.H. Brush (Subject: Incorporation of Amorphous Calcium Carbonate with Higher Solubility (CaCO3(am-cpa)), Aqueous Complexes of Magnesium and Calcium with Acetate, Citrate, EDTA, and Oxalate, and Aqueous Species of Acetate and EDTA into the EQ3/6 HML Database and its Modified Version HMO). 7 February 2007. ERMS 545276. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y. In prep. *Thermodynamic Properties of Brucite Determined by Solubility Studies and Their Significance to Nuclear Waste Isolation*. ERMS 546279. SAND2007-3373J. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y., and A.S. Lord. 2008. "Experimental Investigations of the Reaction Path in the MgO-CO2-H2O System in Solution with Various Ionic Strengths, and Their Applications to Nuclear Waste Isolation." Applied Geochemistry, vol. 23: 1634–59. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y., E.J. Nowak, and L.H. Brush. 2004. *Updated Uncertainty Analysis of Actinide Solubilities for the Response to EPA Comment C-23-16*. Analysis report. December 17. ERMS 538219. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y., E.J. Nowak, and L.H. Brush. 2005. "Predicting Actinide Solubilities in Concentrated Brines: The Fracture-Matrix Transport (FMT) Code." Presentation. 15th Goldschmidt International Conference. May 20–25. Moscow, ID. ERMS 541555. SAND2005-2836C. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y., E.J. Nowak, and L.H. Brush. 2005. *Updated Uncertainty Analysis of Actinide Solubilities For the Response to EPA Comment C-23-16, Rev. 1* (April 28). ERMS 539595. Carlsbad, NM: Sandia National Laboratories.

Xiong, Y., L.H. Brush, D.E. Wall, and N.A. Wall. 2004. "Predictions of Actinide Solubilities under Near-Field Conditions Expected in the WIPP." Abstracts with Programs. Geological Society of America 2004 Annual Meeting. November 7–10. ERMS 536297. SAND2004-2730A. Denver, CO.

Title 40 CFR Part 191
Subparts B and C
Compliance Recertification
Application
for the
Waste Isolation Pilot Plant

Appendix DATA
Attachment A: WIPP Borehole Update

United States Department of Energy
Waste Isolation Pilot Plant

Carlsbad Field Office
Carlsbad, New Mexico

Appendix DATA
Attachment A: WIPP Borehole Update

Table of Contents

List of Tables

This page intentionally left blank.

Acronym List

BLM	Bureau of Land Management
CCA	Compliance Certification Application
CRA	Compliance Recertification Application
DOE	Department of Energy
WIPP	Waste Isolation Pilot Plant

This page intentionally left blank.

DATA-A-1.0 WIPP Boreholes

The U.S. Department of Energy (DOE) prepared DOE/WIPP 95-2092, Rev. 1, Waste Isolation Pilot Plant (WIPP) Borehole Data Report (the Compliance Certification Application [CCA], Appendix BH) to serve as a central document, providing data on boreholes used in characterizing the site. The report contains a comprehensive database on wells drilled in support of the Waste Isolation Pilot Plant (WIPP) and boreholes located within the 16-section land withdrawal area.

The CCA, Appendix BH describes seven groups of boreholes: commercially drilled boreholes, DOE wells, geologic exploration boreholes, hydrologic test boreholes, potash boreholes, subsurface exploration boreholes, and Water Quality Sampling Program boreholes. There are 179 boreholes listed in the report. At the time of the CCA, 80 of those boreholes were being used as monitoring wells. The rest of the boreholes were plugged and abandoned after being drilled for their specific purpose, i.e., potash information, hydrocarbon information, or WIPP site characterization information.

The 2004 Compliance Recertification Application (CRA-2004), Appendix DATA, Attachment G, WIPP Borehole Update, was provided to add the new monitoring wells drilled since the initial certification and wells that were in use but omitted from the CCA, Appendix BH. The CRA-2004, Appendix DATA, Attachment G provided information on 112 boreholes.

For the CRA-2009, a thorough search was performed to define the number of boreholes associated with the WIPP site characterization and monitoring. Currently, there are 215 boreholes that were either specifically drilled to support the WIPP site characterization process or obtained for monitoring purposes. This update provides the status for those boreholes.

Table DATA-A-1 provides the status of all 215 boreholes, including the name of the formation being monitored, whether the borehole is currently configured as a water or observation well, and whether it has been plugged and abandoned. A status of "N/A" means the borehole was not being used or had not yet been drilled at the time of the status report. "Observation" means the borehole was drilled for site characterization, but left unplugged for future monitoring purposes.

Table DATA-A-1. Status of WIPP Boreholes October 2007 WIPP

Well Name	CCA Status	CRA-04 Status	CRA-09 Status	Original Depth	Year Drilled
AEC-7	Culebra	Culebra	Culebra	4,734 ft.	1974
AEC-8	Bell Canyon	Bell Canyon	Plugged	4,922 ft.	1974
B-1	Observation	Observation	Observation	58 ft.	1978
B-1A	Observation	Observation	Observation	13 ft.	1978
B-2	Plugged	Plugged	Plugged	34 ft.	1978
B-3	Plugged	Plugged	Plugged	29 ft.	1978
B-4	Observation	Observation	Observation	39 ft.	1978
B-4A	Observation	Observation	Observation	14 ft.	1978
B-5	Plugged	Plugged	Plugged	32 ft.	1978

Table DATA-A-1. Status of WIPP Boreholes October 2007 WIPP (Continued)

Well Name	CCA Status	CRA-04 Status	CRA-09 Status	Original Depth	Year Drilled
B-6	Plugged	Plugged	Plugged	26 ft.	1978
B-7	Plugged	Plugged	Plugged	35 ft.	1978
B-8	Plugged	Plugged	Plugged	100 ft.	1979
B-9	Plugged	Plugged	Plugged	38 ft.	1978
B-10	Plugged	Plugged	Plugged	32 ft.	1978
B-11	Plugged	Plugged	Plugged	30 ft.	1978
B-12	Plugged	Plugged	Plugged	41 ft.	1978
B-13	Observation	Observation	Observation	28 ft.	1978
B-14	Plugged	Plugged	Plugged	25 ft.	1978
B-15	Plugged	Plugged	Plugged	57 ft.	1978
B-16	Observation	Observation	Observation	31 ft.	1978
B-17	Plugged	Plugged	Plugged	26 ft.	1978
B-18	Observation	Observation	Observation	33 ft.	1978
B-19	Plugged	Plugged	Plugged	39 ft.	1978
B-20	Observation	Observation	Observation	14 ft.	1978
B-20A	Observation	Observation	Observation	34 ft.	1978
B-21	Plugged	Plugged	Plugged	40 ft.	1978
B-22	Plugged	Plugged	Plugged	28 ft.	1978
B-23	Plugged	Plugged	Plugged	41 ft.	1978
B-24	Plugged	Plugged	Plugged	29 ft.	1978
B-25	Plugged	Plugged	Plugged	902 ft.	1978
B-26	Plugged	Plugged	Plugged	28 ft.	1979
B-27	Plugged	Plugged	Plugged	26 ft.	1979
B-28	Plugged	Plugged	Plugged	27 ft.	1979
B-29	Plugged	Plugged	Plugged	29 ft.	1978
B-30	Plugged	Plugged	Plugged	28 ft.	1978
B-31	Plugged	Plugged	Plugged	31 ft.	1978
B-32	Plugged	Plugged	Plugged	100 ft.	1979
B-33	Plugged	Plugged	Plugged	31 ft.	1978
B-34	Plugged	Plugged	Plugged	100 ft.	1979
B-35	Plugged	Plugged	Plugged	32 ft.	1979
B-36	Plugged	Plugged	Plugged	28 ft.	1979
B-37	Plugged	Plugged	Plugged	28 ft.	1979
B-37A	Plugged	Plugged	Plugged	22 ft.	1979
B-38	Observation	Observation	Observation	50 ft.	1979
B-39	Plugged	Plugged	Plugged	28 ft.	1979
B-40	Plugged	Plugged	Plugged	28 ft.	1979

Table DATA-A-1. Status of WIPP Boreholes October 2007 WIPP (Continued)

Well Name	CCA Status	CRA-04 Status	CRA-09 Status	Original Depth	Year Drilled
B-41	Plugged	Plugged	Plugged	100 ft.	1979
B-42	Plugged	Plugged	Plugged	100 ft.	1979
B-43	Plugged	Plugged	Plugged	100 ft.	1979
B-44	Plugged	Plugged	Plugged	100 ft.	1979
B-45	Plugged	Plugged	Plugged	100 ft.	1979
B-46	Plugged	Plugged	Plugged	100 ft.	1979
B-47	Plugged	Plugged	Plugged	18 ft.	1979
B-48	Plugged	Plugged	Plugged	16 ft.	1979
B-49	Plugged	Plugged	Plugged	19 ft.	1979
B-50	Plugged	Plugged	Plugged	24 ft.	1979
B-51	Plugged	Plugged	Plugged	15 ft.	1979
B-52	Plugged	Plugged	Plugged	30 ft.	1979
B-53	Plugged	Plugged	Plugged	30 ft.	1979
B-54	Observation	Observation	Observation	210 ft.	1979
B-301	Plugged	Plugged	Plugged	40 ft.	1979
B-302	Plugged	Plugged	Plugged	39 ft.	1979
B-303	Plugged	Plugged	Plugged	39 ft.	1979
B-304	Plugged	Plugged	Plugged	42 ft.	1979
B-305	Plugged	Plugged	Plugged	41 ft.	1979
B-306	Plugged	Plugged	Plugged	38 ft.	1979
B-307	Plugged	Plugged	Plugged	40 ft.	1979
B-308	Plugged	Plugged	Plugged	40 ft.	1979
B-309	Plugged	Plugged	Plugged	39 ft.	1979
C-2505	N/A	Santa Rosa/Dewey Lake	Santa Rosa/Dewey Lake	97 ft.	1996
C-2506	N/A	Santa Rosa/Dewey Lake	Santa Rosa/Dewey Lake	69 ft.	1996
C-2507	N/A	Santa Rosa/Dewey Lake	Santa Rosa/Dewey Lake	73 ft.	1996
C-2737	N/A	Culebra/Magenta	Culebra/Magenta	800 ft.	2001
C-2811	N/A	Santa Rosa/Dewey Lake	Santa Rosa/Dewey Lake	80 ft.	2001
CB-1	Culebra	Culebra/Bell Canyon	Bell Canyon	4,299 ft.	1974
D-268	Culebra	Rancher's Water Well	Rancher's Water Well	1,411 ft.	1984
DOE-1	Culebra	Culebra	Plugged	4,057 ft.	1982
DOE-2	Culebra	Magenta	Bell Canyon	4,325 ft.	1984
ERDA-6	Plugged	Plugged	Plugged	2,775 ft.	1975
ERDA-9	Culebra	Culebra	Culebra	2,886 ft.	1976
ERDA-10	Plugged	Plugged	Plugged	4,430 ft.	1977
ERDA-11	Plugged	Plugged	Plugged	40 ft.	1977
ES-001	N/A	Plugged	Plugged	54 ft.	1996

Table DATA-A-1. Status of WIPP Boreholes October 2007 WIPP (Continued)

Well Name	CCA Status	CRA-04 Status	CRA-09 Status	Original Depth	Year Drilled
ES-002	N/A	Plugged	Plugged	19 ft.	1996
H-1	Culebra/Magenta	Plugged	Plugged	856 ft.	1976
H-2A	Culebra	Culebra	Plugged	672 ft.	1977
H-2B1	Magenta	Magenta	Magenta	661 ft.	1977
H-2B2	Culebra	Culebra	Culebra	660 ft.	1983
H-2C	Magenta	Culebra	Plugged	795 ft.	1977
H-3B1	Magenta	Magenta	Magenta	902 ft.	1976
H-3B2	Culebra	Culebra	Culebra	725 ft.	1983
H-3B3	Magenta	Culebra	Plugged	730 ft.	1983
H-3D	Dewey Lake	Dewey Lake/Forty-niner	Santa Rosa/Dewey Lake	554 ft.	1987
H-4A	N/A	Plugged	Plugged	532 ft.	1978
H-4B	Culebra	Culebra	Culebra	529 ft.	1978
H-4C	Magenta	Magenta	Magenta	661 ft.	1978
H-5A	Culebra	Culebra	Plugged	930 ft.	1978
H-5B	Culebra	Culebra	Culebra	925 ft.	1978
H-5C	Magenta	Magenta	Not in Use	1,076 ft.	1978
H-6A	Culebra	Culebra	Plugged	637 ft.	1978
H-6B	Culebra	Culebra	Culebra	640 ft.	1978
H-6C	Culebra	Culebra	Magenta	741 ft.	1978
H-7A	N/A	Plugged	Plugged	154 ft.	1979
H-7B1	Culebra	Culebra	Culebra	286 ft.	1979
H-7B2	Culebra	Culebra	Plugged	295 ft.	1983
H-7C	N/A	N/A	Rancher's Water Well	420 ft.	1979
H-8A	Magenta	Magenta	Magenta	505 ft.	1979
H-8B	N/A	Rancher's Water Well	Rancher's Water Well	624 ft.	1979
H-8C	Rustler	Rustler	Rancher's Water Well	808 ft.	1979
H-9A	Culebra	Plugged	Plugged	692 ft.	1979
H-9B	Culebra	Culebra	Not in Use	708 ft.	1979
H-9C	Culebra	Magenta	Culebra/Magenta	816 ft.	1979
H-10A	Magenta	Magenta	Magenta	1,318 ft.	1979
H-10B	Magenta	Plugged	Plugged	1,398 ft.	1979
H-10C	N/A	Culebra	Culebra	1,550 ft.	1979
H-11B1	Culebra	Culebra	Plugged	785 ft.	1983
H-11B2	Culebra	Magenta	Magenta	776 ft.	1983
H-11B3	Culebra	Plugged	Plugged	789 ft.	1983
H-11B4	N/A	Culebra	Culebra	765 ft.	1988
H-12	Culebra	Culebra	Culebra	1,001 ft.	1983

Table DATA-A-1. Status of WIPP Boreholes October 2007 WIPP (Continued)

Well Name	CCA Status	CRA-04 Status	CRA-09 Status	Original Depth	Year Drilled
H-14	Culebra	Magenta	Magenta	589 ft.	1986
H-15	Culebra	Magenta	Culebra/Magenta	900 ft.	1986
H-16	Dewey Lake	N/A	Rustler	851 ft.	1987
H-17	Culebra	Culebra	Culebra	880 ft.	1987
H-18	Culebra	Magenta	Magenta	840 ft.	1987
H-19B	N/A	N/A	N/A	40 ft.	1995
H-19B0	N/A	Culebra	Culebra	779 ft.	1995
H-19B1	N/A	Plugged	Plugged	733 ft.	1995
H-19B2	N/A	Culebra	Culebra	785 ft.	1995
H-19B3	N/A	Culebra	Culebra	785 ft.	1995
H-19B4	N/A	Culebra	Culebra	782 ft.	1995
H-19B5	N/A	Culebra	Culebra	786 ft.	1995
H-19B6	N/A	Culebra	Culebra	788 ft.	1995
H-19B7	N/A	Culebra	Culebra	785 ft.	1995
IMC-461	N/A	N/A	Culebra	1,316 ft.	2004
P-1	Plugged	Plugged	Plugged	1,591 ft.	1976
P-2	Plugged	Plugged	Plugged	1,895 ft.	1976
P-3	Plugged	Plugged	Plugged	1,676 ft.	1976
P-4	Plugged	Plugged	Plugged	1,857 ft.	1976
P-5	Plugged	Plugged	Plugged	1,830 ft.	1976
P-6	Plugged	Plugged	Plugged	1,573 ft.	1976
P-7	Plugged	Plugged	Plugged	1,574 ft.	1976
P-8	Plugged	Plugged	Plugged	1,660 ft.	1976
P-9	Plugged	Plugged	Plugged	1,796 ft.	1976
P-10	Plugged	Plugged	Plugged	2,009 ft.	1976
P-11	Plugged	Plugged	Plugged	1,940 ft.	1976
P-12	Plugged	Plugged	Plugged	1,598 ft.	1976
P-13	Plugged	Plugged	Plugged	1,576 ft.	1976
P-14	Culebra	Plugged	Plugged	1,545 ft.	1976
P-15	Culebra	Plugged	Plugged	1,465 ft.	1976
P-16	Plugged	Plugged	Plugged	1,585 ft.	1976
P-17	Culebra	Culebra	Plugged	1,660 ft.	1976
P-18	Culebra	Plugged	Plugged	1,998 ft.	1976
P-19	Plugged	Plugged	Plugged	2,000 ft.	1976
P-20	Plugged	Plugged	Plugged	1,995 ft.	1976
P-21	Plugged	Plugged	Plugged	1,915 ft.	1976
PZ-1	N/A	Santa Rosa	Santa Rosa/Dewey Lake	68 ft.	1997

Table DATA-A-1. Status of WIPP Boreholes October 2007 WIPP (Continued)

Well Name	CCA Status	CRA-04 Status	CRA-09 Status	Original Depth	Year Drilled
PZ-2	N/A	Santa Rosa	Santa Rosa/Dewey Lake	65 ft.	1997
PZ-3	N/A	Santa Rosa	Santa Rosa/Dewey Lake	71 ft.	1997
PZ-4	N/A	Santa Rosa	Santa Rosa/Dewey Lake	65 ft.	1997
PZ-5	N/A	Santa Rosa	Santa Rosa/Dewey Lake	72 ft.	1997
PZ-6	N/A	Santa Rosa	Santa Rosa/Dewey Lake	66 ft.	1997
PZ-7	N/A	Santa Rosa	Santa Rosa/Dewey Lake	72 ft.	1997
PZ-8	N/A	Santa Rosa	Santa Rosa/Dewey Lake	68 ft.	1997
PZ-9	N/A	Santa Rosa	Santa Rosa/Dewey Lake	82 ft.	1997
PZ-10	N/A	Santa Rosa	Santa Rosa/Dewey Lake	57 ft.	1997
PZ-11	N/A	Santa Rosa	Santa Rosa/Dewey Lake	82 ft.	1997
PZ-12	N/A	Santa Rosa	Santa Rosa/Dewey Lake	72 ft.	1997
PZ-13	N/A	N/A	Santa Rosa/Dewey Lake	77 ft.	2007
PZ-14	N/A	N/A	Santa Rosa/Dewey Lake	73 ft.	2007
PZ-15	N/A	N/A	Gatuña/Santa Rosa	56 ft.	2007
SNL-1	N/A	N/A	Culebra	644 ft.	2004
SNL-2	N/A	N/A	Culebra	614 ft.	2003
SNL-3	N/A	N/A	Culebra	970 ft.	2003
SNL-5	N/A	N/A	Culebra	687 ft.	2004
SNL-6	N/A	N/A	Culebra	1,360 ft.	2005
SNL-8	N/A	N/A	Culebra	981 ft.	2005
SNL-9	N/A	N/A	Culebra	845 ft.	2003
SNL-10	N/A	N/A	Culebra	651 ft.	2006
SNL-12	N/A	N/A	Culebra	905 ft.	2003
SNL-13	N/A	N/A	Culebra	480 ft.	2005
SNL-14	N/A	N/A	Culebra	719 ft.	2005
SNL-15	N/A	N/A	Culebra	950 ft.	2005
SNL-16	N/A	N/A	Culebra	224 ft.	2006
SNL-17A	N/A	N/A	Culebra	375 ft.	2006
SNL-17	N/A	N/A	Plugged	365 ft.	2006
SNL-18	N/A	N/A	Culebra	566 ft.	2006
SNL-19	N/A	N/A	Culebra	381 ft.	2006
WIPP-11	N/A	N/A	Culebra	3,580 ft.	1978
WIPP-12	Culebra	Culebra	Plugged	3,928 ft.	1978
WIPP-13	Culebra	Culebra	Culebra	3,856 ft.	1978
WIPP-14	Plugged	Plugged	Plugged	1,000 ft.	1981
WIPP-15	Water Well	Rancher's Water Well	Rancher's Water Well	810 ft.	1978
WIPP-16	Plugged	Plugged	Plugged	1,300 ft.	1980

Table DATA-A-1. Status of WIPP Boreholes October 2007 WIPP (Continued)

Well Name	CCA Status	CRA-04 Status	CRA-09 Status	Original Depth	Year Drilled
WIPP-18	Culebra	Magenta	Magenta	1,060 ft.	1978
WIPP-19	Culebra	Culebra	Culebra	1,038 ft.	1978
WIPP-21	Culebra	Culebra	Plugged	1,045 ft.	1978
WIPP-22	Culebra	Culebra	Plugged	1,450 ft.	1978
WIPP-25	Culebra/Magenta	Culebra/Magenta	Culebra/Magenta	650 ft.	1978
WIPP-26	Culebra	Culebra	Plugged	503 ft.	1978
WIPP-27	Culebra/Magenta	Culebra	Plugged	592 ft.	1978
WIPP-28	Rustler	Plugged	Plugged	801 ft.	1978
WIPP-29	Culebra	Culebra	Plugged	377 ft.	1978
WIPP-30	Culebra/Magenta	Culebra/Magenta	Culebra/Magenta	913 ft.	1978
WIPP-31	Plugged	Plugged	Plugged	1,982 ft.	1980
WIPP-32	Plugged	Plugged	Plugged	390 ft.	1979
WIPP-33	Plugged	Plugged	Plugged	840 ft.	1979
WIPP-34	Plugged	Plugged	Plugged	1,820 ft.	1979
WQSP-1	Culebra	Culebra	Culebra	737 ft.	1994
WQSP-2	Culebra	Culebra	Culebra	846 ft.	1994
WQSP-3	Culebra	Culebra	Culebra	879 ft.	1994
WQSP-4	Culebra	Culebra	Culebra	800 ft.	1994
WQSP-5	Culebra	Culebra	Culebra	681 ft.	1994
WQSP-6	Culebra	Culebra	Culebra	617 ft.	1994
WQSP-6A	Dewey Lake	Dewey Lake	Dewey Lake	225 ft.	1994

1

DATA-A-2.0 Individual Well Reports

This section provides basic data on the new wells drilled (21) and the wells plugged (19) during the CRA-2009 monitoring period (October 2002 through September 2007).

The Bureau of Land Management (BLM) controls the drilling, operation, and abandonment of hydrocarbon wells on federal land in New Mexico. The New Mexico Oil Conservation Division controls the drilling, operation, and abandonment of hydrocarbon wells on state and patented lands in New Mexico. The New Mexico Office of the State Engineer regulates the drilling, operation, and abandonment of groundwater wells (this includes mineral exploration, monitoring, and observation wells) in the State of New Mexico. This agency has regulatory oversight of wells in the WIPP land withdrawal area. All WIPP monitoring wells have been permitted through this agency and drilled according to the regulations in place at the time of drilling. Right-of-way permits have been acquired from the BLM when monitoring wells are located on federal lands.

DATA-A-2.1 New Wells (since CRA-2004)

IMC-461
Location: T22S-R30E-22 Year Drilled: 2004 Total Depth: 1316 ft (401 m)
Status: Culebra Monitoring Well Elevation: 3281 ft (1000 m)

PZ-13
Location: T22S-R31E-21 Year Drilled: 2007 Total Depth: 77 ft (23 m)
Status: Santa Rosa/Dewey Lake Monitoring Well Elevation: 3422 ft (1043 m)

PZ-14
Location: T22S-R31E-21 Year Drilled: 2007 Total Depth: 73 ft (22 m)
Status: Santa Rosa/Dewey Lake Monitoring Well Elevation: 3420 ft (1042 m)

PZ-15
Location: T22S-R31E-21 Year Drilled: 2007 Total Depth: 56 ft (17 m)
Status: Santa Rosa Monitoring Well Elevation: 3431 ft (1046 m)

SNL-1
Location: T21S-R31E-16 Year Drilled: 2004 Total Depth: 644 ft (196 m)
Status: Culebra Monitoring Well Elevation: 3510 ft (1070 m)

SNL-2
Location: T22S-R30E-12 Year Drilled: 2003 Total Depth: 614 ft (187 m)
Status: Culebra Monitoring Well Elevation: 3321 ft (1012 m)

SNL-3
Location: T21S-R31E-34 Year Drilled: 2003 Total Depth: 970 ft (296 m)
Status: Culebra Monitoring Well Elevation: 3488 ft (1063 m)

SNL-5
Location: T22S-R31E-06 Year Drilled: 2004 Total Depth: 687 ft (209 m)
Status: Culebra Monitoring Well Elevation: 3377 ft (1029 m)

SNL-6
Location: T21S-R32E-07 Year Drilled: 2005 Total Depth: 1360 ft (414 m)
Status: Culebra Monitoring Well Elevation: 3643 ft (1110 m)

SNL-8
Location: T22S-R31E-14 Year Drilled: 2005 Total Depth: 981 ft (299 m)
Status: Culebra Monitoring Well Elevation: 3552 ft (1083 m)

SNL-9
Location: T22S-R30E-23 Year Drilled: 2003 Total Depth: 845 ft (257 m)
Status: Culebra Monitoring Well Elevation: 3358 ft (1024 m)

SNL-10
Location: T22S-R31E-30 Year Drilled: 2006 Total Depth: 651 ft (198)
Status: Culebra Monitoring Well Elevation: 3374 ft (1028 m)

SNL-12
Location: T23S-R31E-20 Year Drilled: 2003 Total Depth: 905 ft (275 m)
Status: Culebra Monitoring Well Elevation: 3337 ft (1017 m)

SNL-13
Location: T23S-R30E-01 Year Drilled: 2005 Total Depth: 480 ft (146 m)
Status: Culebra Monitoring Well Elevation: 3291 ft (1003 m)

SNL-14
Location: T23S-R31E-04 Year Drilled: 2005 Total Depth: 719 ft (219 m)
Status: Culebra Monitoring Well Elevation: 3365 ft (1026 m)

SNL-15
Location: T22S-R31E-26 Year Drilled: 2005 Total Depth: 950 ft (290 m)
Status: Culebra Monitoring Well Elevation: 3477 ft (1060 m)

SNL-16
Location: T22S-R30E-33 Year Drilled: 2006 Total Depth: 224 ft (68 m)
Status: Culebra Monitoring Well Elevation: 3132 ft (955 m)

SNL-17
Location: T22S-R30E-12 Year Drilled: 2006 Total Depth: 375 ft (114 m)
Status: Plugged Elevation: 3235 ft (986 m)

SNL-17A
Location: T22S-R30E-12 Year Drilled: 2006 Total Depth: 365 ft (111 m)
Status: Culebra Monitoring Well Elevation: 3235 ft (986 m)

SNL-18
Location: T21S-R31E-20 Year Drilled: 2006 Total Depth: 566 ft (172 m)
Status: Culebra Monitoring Well Elevation: 3372 ft (1028 m)

SNL-19
Location: T21S-R30E-35 Year Drilled: 2006 Total Depth: 381 ft (116 m)
Status: Culebra Monitoring Well Elevation: 3219 ft (981 m)

DATA-A-2.2 Plugged Wells

AEC-8
Location: T22S-R31E-11 Year Drilled: 1974 Total Depth: 4922 ft (1500 m)
Status: Plugged in 2005 Elevation: 3532 ft (1077 m)
Notes: Plugged solid with Class C neat cement.

DOE-1
Location: T22S-R31E-28 Year Drilled: 1982 Total Depth: 4057 ft (1237 m)
Status: Plugged in 2006 Elevation: 3466 ft (1056 m)
Notes: Hole was plugged with a salt-saturated cement to the top of the salt formation, and Class C neat cement from there to the surface.

H-2A
Location: T22S-R31E-29 Year Drilled: 1977 Total Depth: 672 ft (204 m)
Status: Plugged in 2005 Elevation: 3378 ft (1030 m)
Notes: During a sampling event, a pump and packer assembly was dropped into the well and jammed at the bottom of the casing. Retrieval attempts proved unsuccessful. The regulating agency approved leaving the gear in the hole. The well was cemented to the surface using Class C neat cement.

H-2C
Location: T22S-R31E-29 Year Drilled: 1977 Total Depth: 795 ft (242 m)
Status: Plugged in 2005 Elevation: 3378 ft (1030 m)
Notes: The well was cemented to the surface using Class C neat cement.

H-3B3
Location: T22S-R31E-29 Year Drilled: 1983 Total Depth: 730 ft (222 m)
Status: Plugged in 2005 Elevation: 3389 ft (1033 m)
Notes: The well was cemented to the surface using Class C neat cement.

H-5A
Location: T22S-R31E-15 Year Drilled: 1978 Total Depth: 930 ft (283 m)
Status: Plugged in 2005 Elevation: 3506 ft (1069 m)
Notes: Attempts were made to remove packer assembly. Retrieval attempts proved unsuccessful. The regulating agency approved leaving the packer in the well but driving it as far down the well bore as possible. The well was cemented to the surface using Class C neat cement.

H-6A
Location: T22S-R31E-18 Year Drilled: 1978 Total Depth: 637 ft (194 m)
Status: Plugged in 2005 Elevation: 3348 ft (1020 m)
Notes: Attempts were made to remove packer assembly. Retrieval attempts proved unsuccessful. The regulating agency approved leaving the packer in the well but driving it as far down the well bore as possible. The well was cemented to the surface using Class C neat cement.

H-7C
Location: T23S-R30E-14 Year Drilled: 1979 Total Depth: 420 ft (128 m)
Status: Water Well Elevation: 3162 ft (964 m)
Notes: The well was converted to a water well for local rancher use and removed from the WIPP monitoring well system.

H-7B2
Location: T23S-R30E-14 Year Drilled: 1983 Total Depth: 295 ft (90 m)
Status: Plugged in 2005 Elevation: 3164 ft (964 m)
Notes: Prior to plugging, circulation was lost due to split casing while the well was being cleaned out. To allow sufficient cementing, Baro-Seal® was used to assist in plugging open spaces. The well was cemented to the surface using Class C neat cement.

H-8C
Location: T24S-R30E-23 Year Drilled: 1979 Total Depth: 808 ft (246 m)
Status: Water Well Elevation: 3433 ft (1046 m)
Notes: The well was converted to a water well for local rancher utilization and removed from the WIPP monitoring well system.

H-11B1
Location: T22S-R31E-33 Year Drilled: 1983 Total Depth: 785 ft (239 m)
Status: Plugged in 2005 Elevation: 3411 ft (1040 m)
Notes: The well was cemented to the surface using Class C neat cement.

P-17
Location: T23S-R31E-04 Year Drilled: 1976 Total Depth: 1660 ft (505 m)
Status: Plugged in 2006 Elevation: 3336 ft (1017 m)
Notes: The well was cemented to the surface using Class C neat cement.

SNL-17
Location: T22S-R30E-12 Year Drilled: 2006 Total Depth: 365 ft (111 m)
Status: Plugged in 2006 Elevation: 3235 ft (986 m)
Notes: Well was plugged after being drilled due to the failure of the bottom plug.

WIPP-12
Location: T22S-R31E-17 Year Drilled: 1978 Total Depth: 3928 ft (1197 m)
Status: Plugged in 2005 Elevation: 3472 ft (1058 m)
Notes: During the deepening of this well in 1982, a pressurized brine pocket in the Castile was encountered. In 1983, the brine reservoir was sealed from the upper part of the well bore by installing a borehole plug. During plugging, extra precautions were taken to protect workers and

the environment from the possible release of brine or H_2S. None was encountered. The well was cemented to the surface using Class C neat cement.

WIPP-21
Location: T22S-R31E-20 Year Drilled: 1978 Total Depth: 1045 ft (318 m)
Status: Plugged in 2005 Elevation: 3419 ft (1042 m)
Notes: The well was cemented to the surface using Class C neat cement.

WIPP-22
Location: T22S-R31E-20 Year Drilled: 1978 Total Depth: 1450 ft (441 m)
Status: Plugged in 2005 Elevation: 3428 ft (1045 m)
Notes: The well was cemented to the surface using Class C neat cement.

WIPP-26
Location: T22S-R30E-29 Year Drilled: 1978 Total Depth: 503 ft (153 m)
Status: Plugged in 2006 Elevation: 3150 ft (960 m)
Notes: The well was cemented to the surface using Class C neat cement.

WIPP-27
Location: T21S-R30E-21 Year Drilled: 1978 Total Depth: 592 ft (180 m)
Status: Plugged in 2006 Elevation: 3179 ft (969 m)
Notes: The well was cemented to the surface using Class C neat cement.

WIPP-29
Location: T22S-R29E-34 Year Drilled: 1978 Total Depth: 377 ft (114 m)
Status: Plugged in 2005 Elevation: 2978 ft (908 m)
Notes: The well was cemented to the surface using Class C neat cement.

Title 40 CFR Part 191
Subparts B and C
Compliance Recertification Application
for the
Waste Isolation Pilot Plant

Appendix DATA
Attachment B: WIPP Waste Containers and Emplacement

United States Department of Energy
Waste Isolation Pilot Plant

Carlsbad Field Office
Carlsbad, New Mexico

Appendix DATA
Attachment B: WIPP Waste Containers and Emplacement

Table of Contents

List of Figures

List of Tables

This page intentionally left blank.

Acronym List

CH-TRU	contact-handled transuranic
EPA	U.S. Environmental Protection Agency
gal	gallon
RH-TRU	remote-handled transuranic
SWB	Standard Waste Box
TDOP	10-Drum Overpack
TRU	transuranic

This page intentionally left blank.

DATA-B-1.0 Authorized Waste Emplacement Containers

DATA-B-1.1 Container Descriptions

The Compliance Certification Application to the U.S. Environmental Protection Agency (EPA) identified the following containers as outer containment vessels for waste emplacement in the repository:

- 55-gallon (gal) Drum
- 85-gal Drum (Short)
- 85-gal Drum (Tall)
- 100-gal Drum
- Standard Waste Box (SWB)
- Ten-Drum Overpack (TDOP)
- Remote-handled (RH) transuranic (TRU) (RH-TRU) 72B Cask Removable Lid Canister (RH-TRU Waste Canister)

DATA-B-1.2 Dunnage Containers

Dunnage containers are empty containers used to complete a shipping configuration, such as the seven-pack, if too few containers that meet transportation requirements are available. Dunnage containers are clearly marked "Empty." The TDOP and the RH-TRU Waste Canister are not used as dunnage containers for shipping purposes. For emplacement purposes in the repository, the 55-, 85-, and 100-gal drums can be used as dunnage containers only if they arrive in a shrink-wrapped package assembly, such as the seven-pack, four-pack, or three-pack. To date, only 55-gal drums and several SWBs have been emplaced in the repository as dunnage containers.

DATA-B-1.3 Payload Descriptions

This section gives a brief description of each payload container and its configuration for emplacement. This description also includes a figure and a table for each container.

The 55-gal drum is shipped in a seven-pack configuration and is normally emplaced in the repository in the same configuration, but can be emplaced as an individual unit should the need arise. A single drum can be used for collecting and storing site-derived waste. An illustration of the 55-gal drum components and emplacement configuration is provided in Figure DATA-B-1. The drum specifications are provided in Table DATA-B-1.

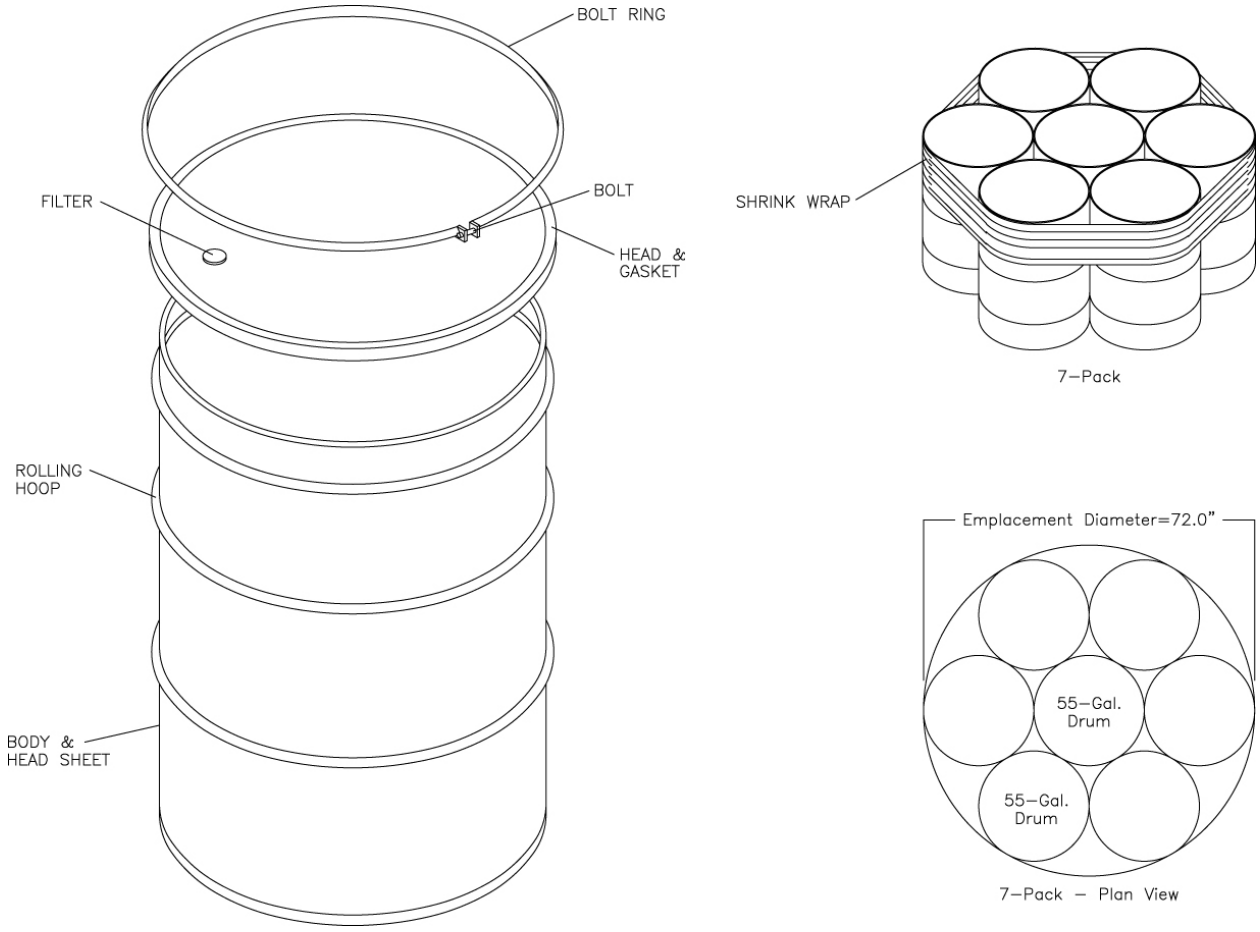

Figure DATA-B-1. 55-gal Drum Components and Emplacement Configuration

Table DATA-B-1. 55-gal Drum Specifications

Dimension	Approximate Measurement			
	Inside Dimension (inches)	Outside Dimension (inches)	Inside Dimension (mm)	Outside Dimension (mm)
Height	33 ¼	35	845	889
Diameter	22 ½	24	572	610
—	—	—	—	—
—	—	—	—	—

The 85-gal drum (short) is shipped in a four-pack configuration and will be emplaced in the repository in the same configuration, but can be emplaced as an individual unit should the need arise. A single drum can be used for collecting and storing site-derived waste or for overpacking a 55-gal drum. An illustration of the 85-gal drum (short) components and emplacement configuration is provided in Figure DATA-B-2. The drum specifications are provided in Table DATA-B-2.

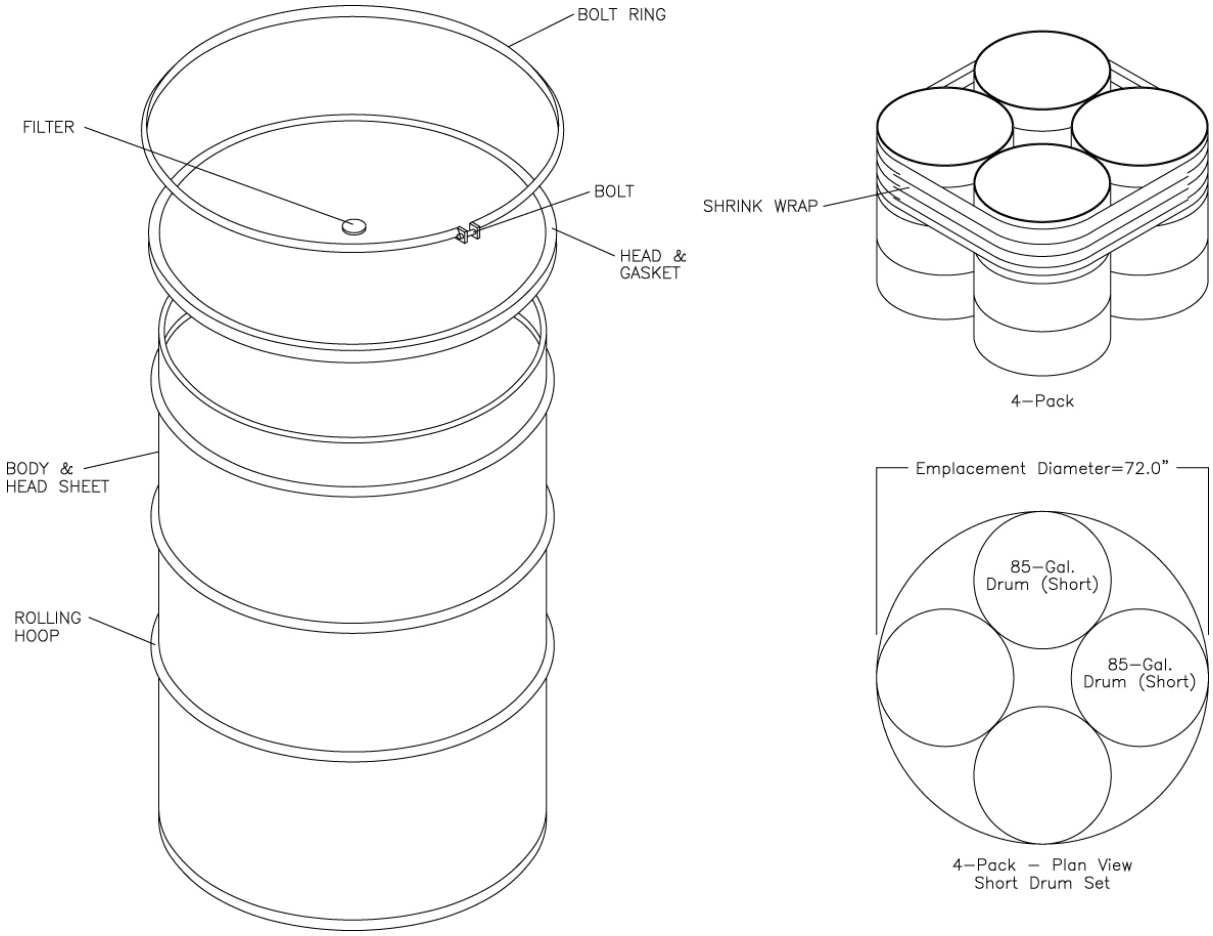

Figure DATA-B-2. 85-gal Drum (Short) Components and Emplacement Configuration

Table DATA-B-2. 85-gal Drum (Short) Specifications

Dimension	Approximate Measurement			
	Inside Dimension (inches)	Outside Dimension (inches)	Inside Dimension (mm)	O.D. (mm)
Height	33 ¼	35	845	889
Diameter	27 ⅛	29 ¾	689	756
—	—	—	—	—
—	—	—	—	—

The 85-gal drum (tall) is shipped in a four-pack configuration and will be emplaced in the repository in the same configuration. It is also used for overpacking 55-gal drums that are individually emplaced in the repository. A single drum can be used for collecting and storing site-derived waste. An illustration of the 85-gal drum (tall) components and emplacement configuration is provided in Figure DATA-B-3. The drum specifications are provided in Table DATA-B-3.

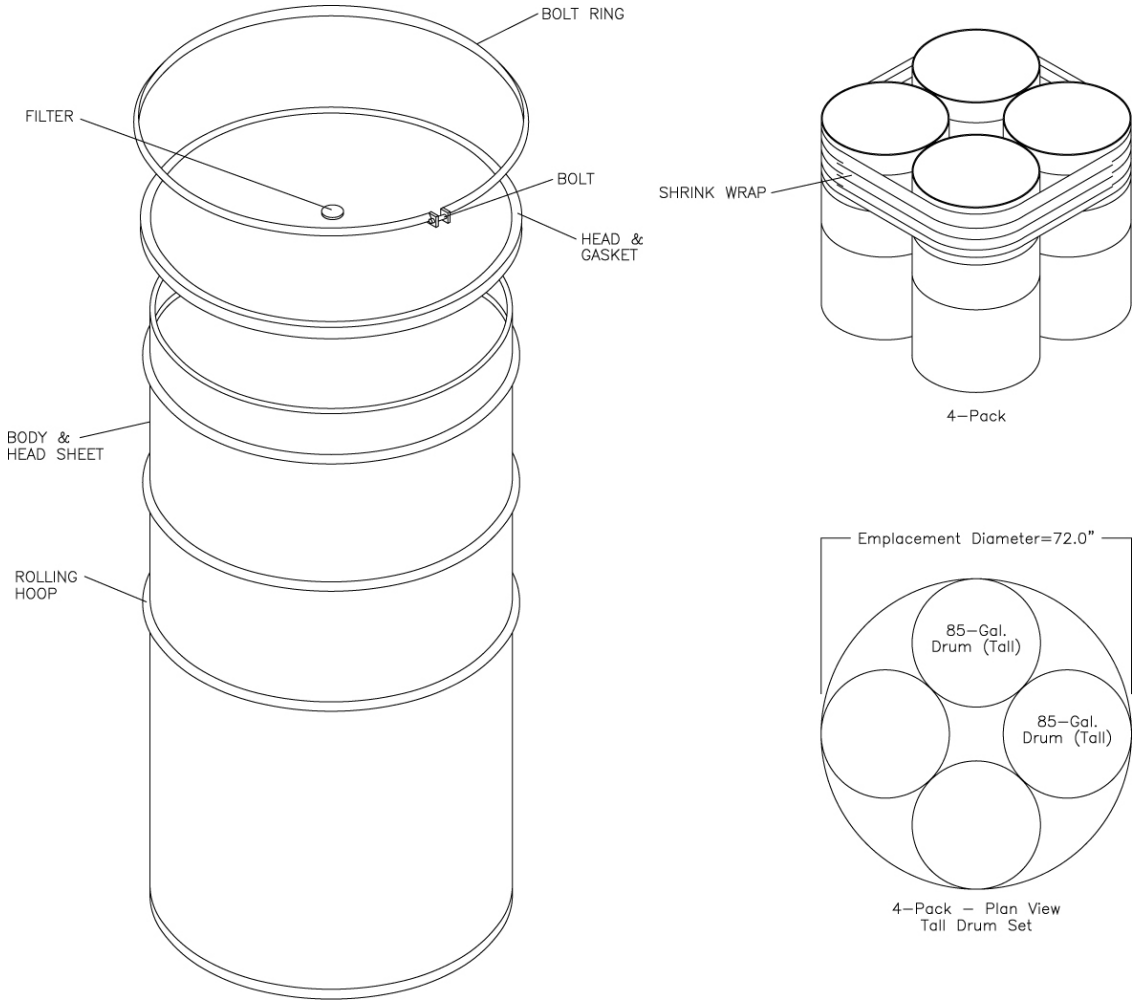

Figure DATA-B-3. 85-gal Drum (Tall) Components and Emplacement Configuration

Table DATA-B-3. 85-gal Drum (Tall) Specifications

Dimension	Approximate Measurement			
	Inside Dimension (inches)	Outside Dimension (inches)	Inside Dimension (mm)	Outside Dimension (mm)
Height	38 ¼	40 ¼	972	1,022
Diameter	26	28 ⅝	660	728
—	—	—	—	—
—	—	—	—	—

The 100-gal drum is shipped in a three-pack configuration and will be emplaced in the repository in the same configuration. The 100-gal drum can be emplaced as an individual unit should the need arise. An illustration of the 100-gal drum components and emplacement configuration is provided in Figure DATA-B-4. The drum specifications are provided in Table DATA-B-4.

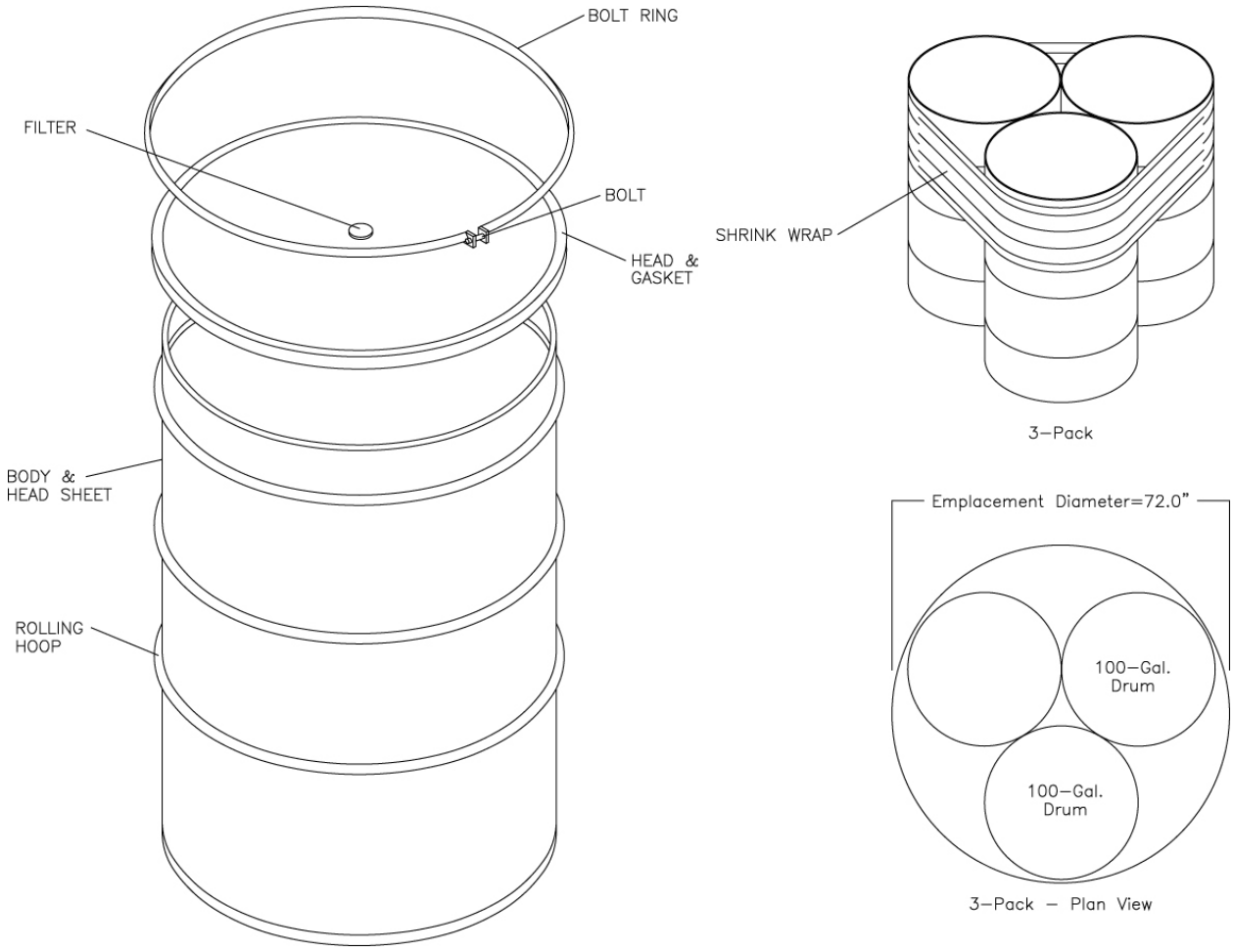

Figure DATA-B-4. 100-gal Drum Components and Emplacement Configuration

Table DATA-B-4. 100-gal Drum Specifications

Dimension	Approximate Measurement			
	Inside Dimension (inches)	Outside Dimension (inches)	Inside Dimension (mm)	Outside Dimension (mm)
Height	33	35	838	889
Diameter	30	32	762	813
—	—	—	—	—
—	—	—	—	—

The SWB is shipped and emplaced as an individual unit. Typically, two SWBs are shipped in a TRUPACT-II shipping container. An illustration of the SWB is provided in Figure DATA-B-5. The box specifications are provided in Table DATA-B-5.

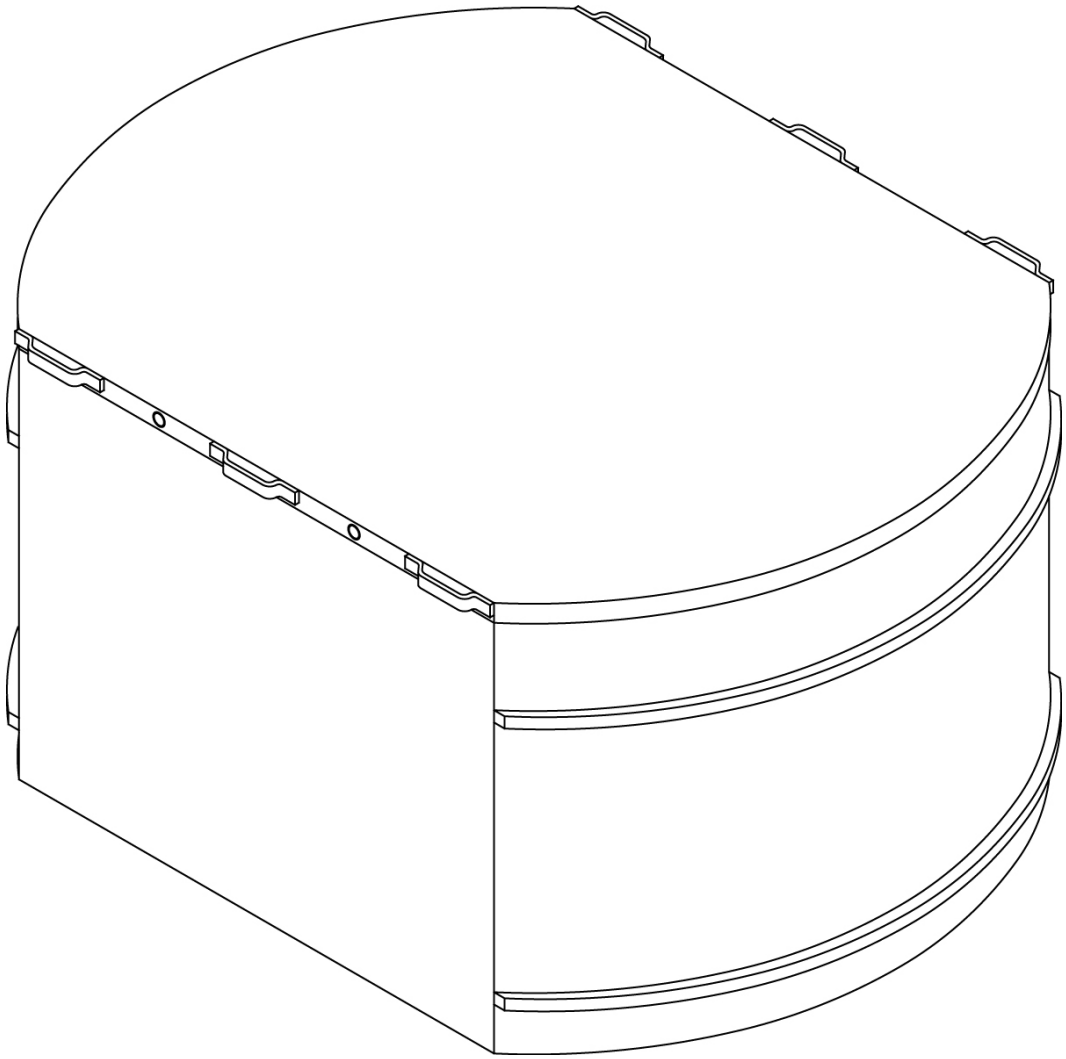

Figure DATA-B-5. Illustration of an SWB

Table DATA-B-5. SWB Specifications

Dimension	Approximate Measurement			
	Inside Dimension (inches)	Outside Dimension (inches)	Inside Dimension (mm)	Outside Dimension (mm)
Height	36 9/16	36 7/8	929	937
Length	68 3/4	71	1,746	1,803
Width	52	54 1/2	1,321	1,384
—	—	—	—	—

The TDOP is shipped as an individual unit and emplaced as an individual unit. An illustration of the TDOP's components is provided in Figure DATA-B-6. The TDOP specifications are provided in Table DATA-B-6.

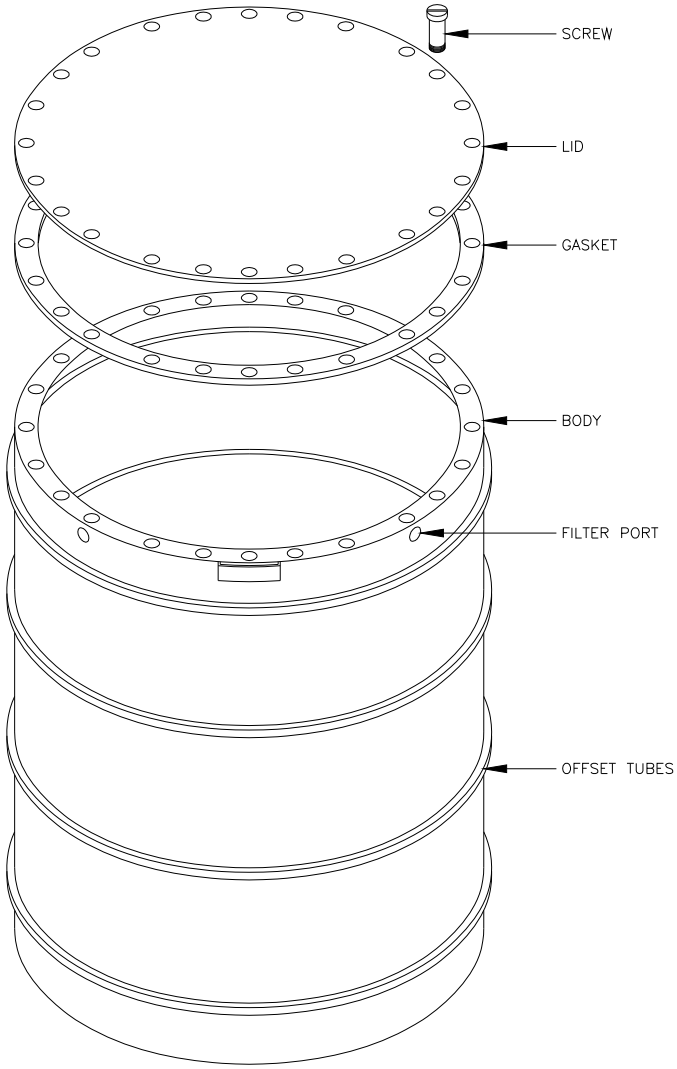

Figure DATA-B-6. TDOP Components

Table DATA-B-6. TDOP Specifications

Dimension	Approximate Measurement			
	Inside Dimension (inches)	Outside Dimension (inches)	Inside Dimension (mm)	Outside Dimension (mm)
Height	72 ⅝	73 ⅛	1845	1,858
Diameter	68 ¾	71 ¼	1,746	1,810
—	—	—	—	—
—	—	—	—	—

The RH-TRU Waste Canister is shipped as a single unit and emplaced as a single unit. Illustrations of the canister's components are provided in Figure DATA-B-7. The canister specifications are provided in Table DATA-B-7.

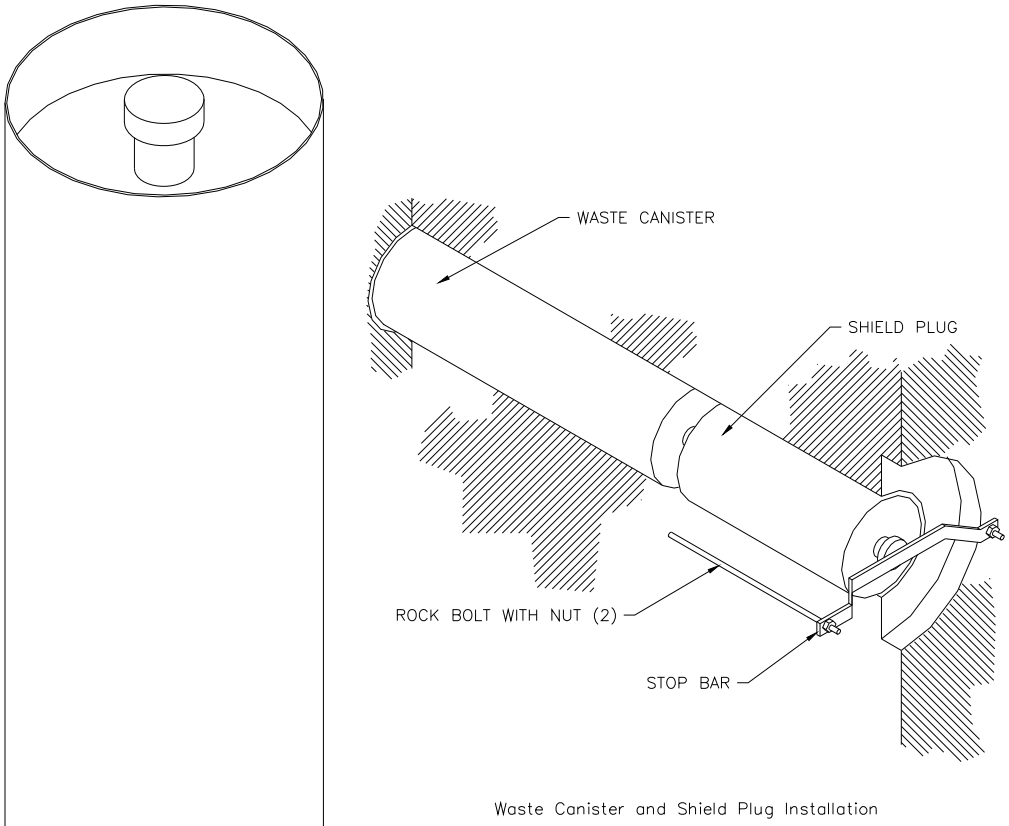

Figure DATA-B-7. RH-TRU Waste Canister Components

Table DATA-B-7. RH-TRU Waste Canister Specifications

Dimension	Approximate Measurement			
	Inside Dimension (inches)	Outside Dimension (inches)	Inside Dimension (mm)	Outside Dimension (mm)
Height	108	120 ½	2,743	3,061
Diameter	25 ½	26	648	660
—	—	—	—	—
—	—	—	—	—

DATA-B-1.4 Emplacement Configurations

Shown in Figure DATA-B-8 is the typical position for waste emplacement containers randomly emplaced in the room of a panel. TDOPs are only emplaced on the bottom position with another assembly stacked on top. All of the other assemblies can be stacked three high before the MgO supersack is emplaced on the top of the stack. Contact-handled (CH) transuranic TRU (CH-TRU) waste emplacement within the repository panels is shown in Figure DATA-B-9. The planned RH-TRU waste emplacement is shown in Figure DATA-B-10.

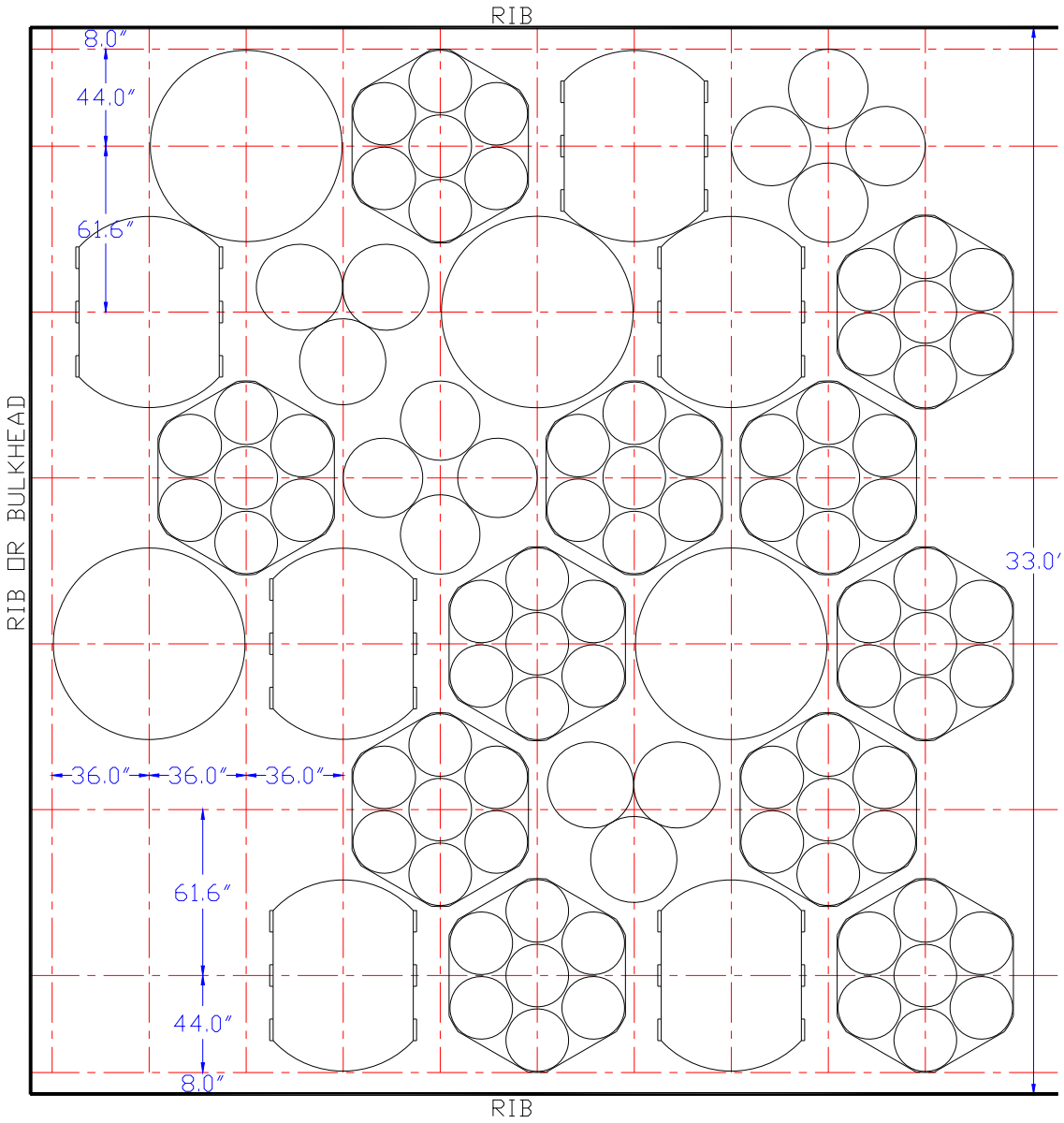

Figure DATA-B-8. CH-TRU Waste Emplacement Layout

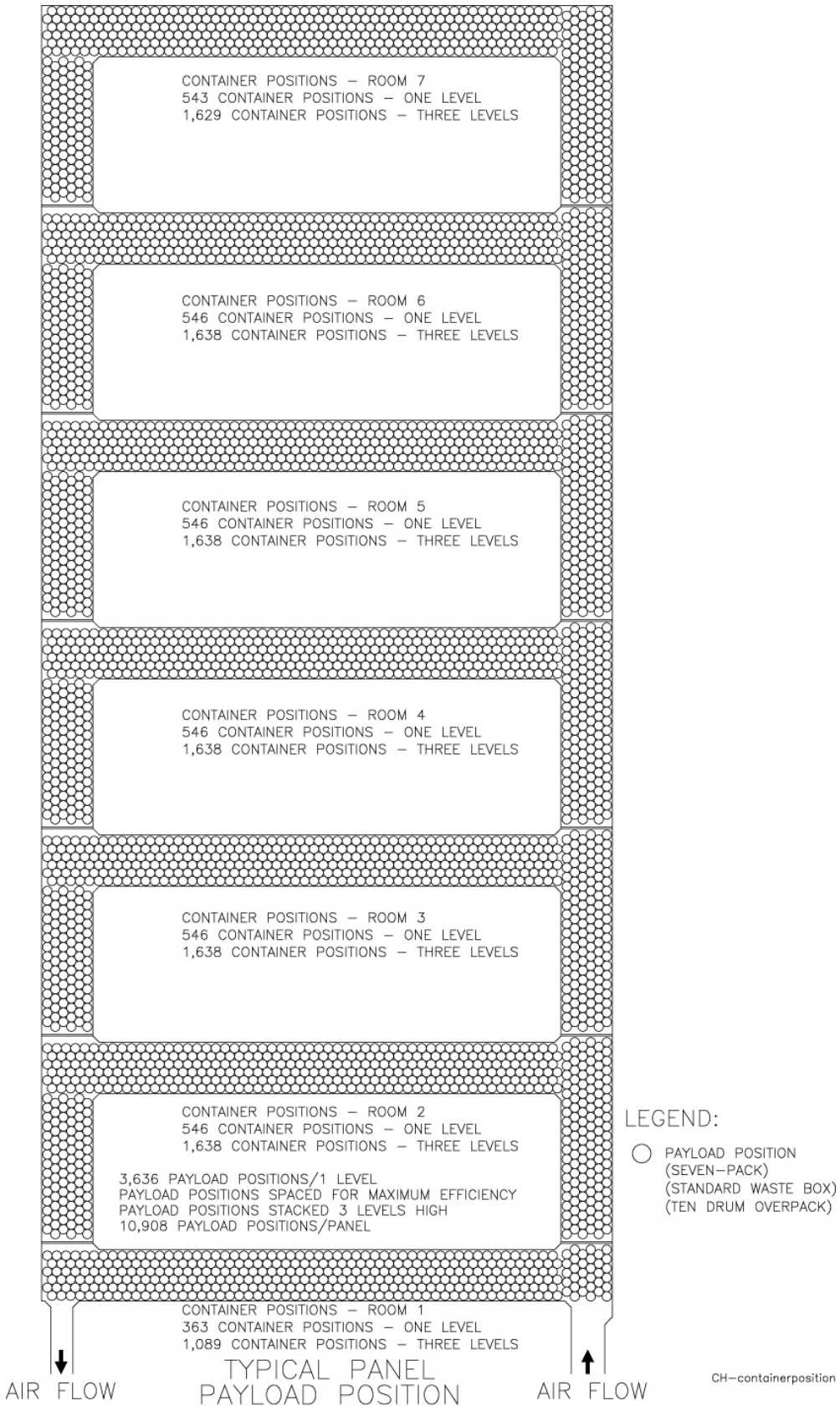

Figure DATA-B-9. CH-TRU Waste Emplacement

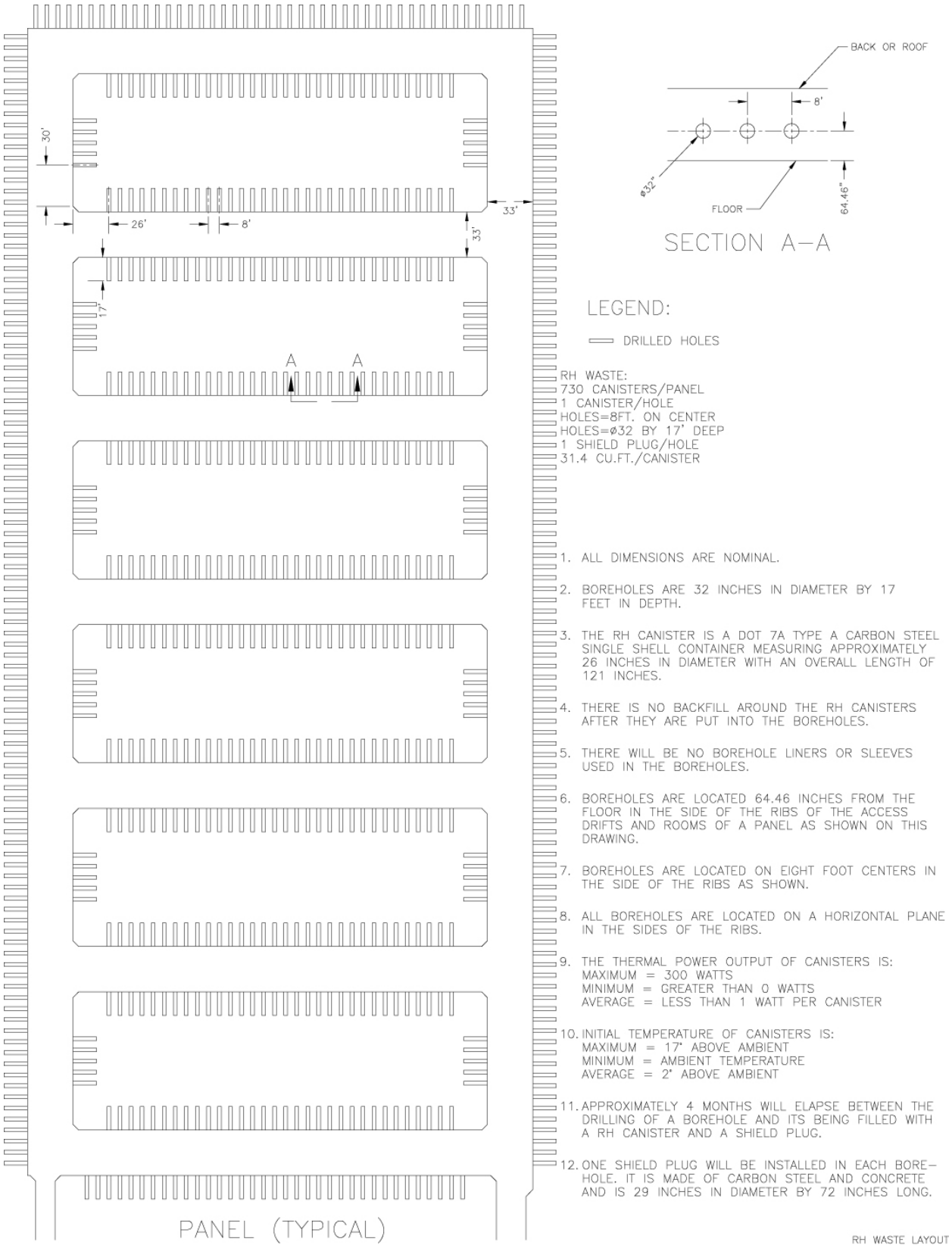

Figure DATA-B-10. RH-TRU Waste Emplacement