ATTACHMENT A

GENERAL FACILITY DESCRIPTION AND PROCESS INFORMATION

ATTACHMENT A

GENERAL FACILITY DESCRIPTION AND PROCESS INFORMATION

TABLE OF CONTENTS

ATTACHMENT A

GENERAL FACILITY DESCRIPTION AND PROCESS INFORMATION

A-1 Facility Description

Abstract

NAME OF FACILITY:	Waste Isolation Pilot Plant
OWNER and CO-OPERATOR:	U.S. Department of Energy (DOE) P.O. Box 3090 Carlsbad, NM 88221
CO-OPERATOR:	Nuclear Waste Partnership LLC (NWP) P.O. Box 2078 Carlsbad, NM 88221
RESPONSIBLE OFFICIALS:	Reinhard Knerr Manager, DOE/Carlsbad Field Office Sean Dunagan Project Manager, Nuclear Waste Partnership LLC
FACILITY MAILING ADDRESS:	U.S. Department of Energy P.O. Box 3090 Carlsbad, NM 88221
FACILITY LOCATION:	34 Louis Whitlock Road, Carlsbad, NM 88220
TELEPHONE NUMBER:	575/234-7300
U.S. EPA I.D. NUMBER:	NM4890139088
GEOGRAPHIC LOCATION: (WGS84)	32.3697706 -103.7913501
DATE OPERATIONS BEGAN:	November 26, 1999

A-2 Description of Activities

The Waste Isolation Pilot Plant (**WIPP**) is a facility for the management, storage, and disposal of transuranic (**TRU**) mixed waste subject to regulation under 20.4.1.500 New Mexico Administrative Code (**NMAC**), incorporating Title 40 of the Code of Federal Regulations (**CFR**) Part 264. Both contact-handled (**CH**) and remote-handled (**RH**) TRU mixed wastes are permitted for storage and disposal at the WIPP facility.

A-3 Property Description

The WIPP property has been divided into functional areas. The Property Protection Area (**PPA**) is surrounded by a security barrier, which encompasses approximately 34 acres without the New Filter Building (**NFB**) and approximately 44 acres with the NFB and provides security and protection for ~~all~~ the major surface structures. A second PPA consisting of a nominal 22 acres surrounds Shaft #5. The DOE Off Limits Area encloses the PPA, and is approximately 1,454 acres. These areas define the DOE exclusion zone within which certain items and material are prohibited. The final zone is marked by the WIPP Site Boundary~~ (WIPP Land Withdrawal Area)~~, a 16-section Federal land area (Land Withdrawal Area) under the jurisdiction of the DOE.

A-4 Facility Type

There are three basic groups of structures associated with the WIPP facility: surface structures, shafts and underground structures. The surface structures accommodate the personnel, equipment, and support services required for the receipt, preparation, and transfer of TRU mixed waste from the surface to the underground. There are two surface locations where TRU mixed waste is managed and stored. The first area is the Waste Handling Building (**WHB**) Container Storage Unit (**WHB Unit**) for TRU mixed waste management and storage. The WHB Unit consists of the WHB ~~contact-handled (**CH**)~~CH Bay, Room 108, and the ~~remote-handled (**RH**)~~RH Complex. The second area designated for managing and storing TRU mixed waste is the Parking Area Container Storage Unit (~~**Parking Area Unit**~~**PAU**), an outside container storage area which extends south from the WHB to the ~~rail siding~~chain-link security fence. The ~~Parking Area Unit~~PAU provides storage space for ~~up to 50 loaded Contact-Handled Packages~~CH shipping containers referred to as CH packages and ~~14 loaded Remote-Handled Packages~~RH shipping containers referred to as RH packages on an asphalt and concrete surface. Permit Part 3 ~~of the permit~~ authorizes the storage and management of CH and RH TRU mixed waste containers in these two surface locations. The technical requirements of 20.4.1.500 NMAC (incorporating 40 CFR §§264.170 to 264.178) are applied to the operation of the WHB Unit and the ~~Parking Area Unit~~PAU. Permit Attachment A1 describes the container storage units, the TRU mixed waste management facilities and operations, and compliance with the technical requirements of 20.4.1.500 NMAC (incorporating 40 CFR §§264.170 to 264.178.

Four vertical shafts connect the surface facility to the underground. These are the Waste Shaft, the Salt Handling Shaft, the Exhaust Shaft, and the Air Intake Shaft. A fifth shaft, Shaft #5, located nominally 1,200 feet west of the Air Intake Shaft also connects the underground facility to the surface. The Waste Shaft is the only shaft used to transport TRU mixed waste to the underground. The WIPP facility underground structures are located in a mined salt bed approximately 2,150 feet below the surface. The underground facility is defined in 20.4.1.100 NMAC (incorporating 40 CFR §260.10) as a “miscellaneous unit.” As a miscellaneous unit, hazardous waste management units within the repository are subject to permitting according to

20.4.1.900 and 20.4.1.901 NMAC (incorporating 40 CFR Part 270) and are regulated under 20.4.1.500 NMAC (incorporating 40 CFR 264, Subpart X, *Miscellaneous Units*).

~~The WIPP is a geologic repository mined within a bedded salt formation, which is defined in 20.4.1.100 NMAC (incorporating 40 CFR §260.10) as a miscellaneous unit. As such, hazardous waste management units within the repository are subject to permitting according to 20.4.1.900 and .901 NMAC (incorporating 40 CFR §270), and are regulated under 20.4.1.500 NMAC, Miscellaneous Units.~~

The underground structures include the underground Hazardous Waste Disposal Units (**HWDUs**), ~~an area~~areas for future underground HWDUs, the shaft pillar area, interconnecting drifts and other areas unrelated to the Hazardous Waste Facility Permit. The underground HWDUs are defined as waste panels, each consisting of seven rooms and two access drifts. The WIPP facility underground area is designated as Panels 1 through ~~10~~12, although only Panels ~~1~~7 through ~~8~~12, will be used under the terms of this ~~permit~~Permit, because Panels 1-6 are filled and closed. Each of the seven rooms is approximately 300 feet long, 33 feet wide and 13 feet high in Panels 1-7, and approximately 300 feet long, 33 feet wide, and 16 feet high in Panel 8. Permit Part 4 of the permit authorizes the management and disposal of CH and RH TRU mixed waste containers in underground HWDUs.

The Disposal Phase of the WIPP Project consists of receiving loaded CH and RH ~~TRU mixed waste shipping containers~~packages, unloading and transporting the waste containers to the underground HWDUs, emplacing the waste in the underground HWDUs, and subsequently achieving closure of the underground HWDUs in compliance with applicable ~~State~~ state and ~~Federal~~ federal regulations. As required by 20.4.1.500 NMAC (incorporating 40 CFR §264.601), the Permittees shall ensure that the environmental performance standards for a miscellaneous unit, which are applied to the underground HWDUs in the geologic repository, will be met. Permit Attachment A2 describes the underground HWDUs, the TRU mixed waste management facilities and operations, and compliance with the technical requirements of 20.4.1.500 NMAC (incorporating 40 CFR Part 264). Permit Attachments G, G1, and G2 describe the closure activities.

A-5 Waste Description

Wastes destined for disposal at the WIPP facility are byproducts of nuclear weapons production and have been identified in terms of waste streams based on the processes that produced them. ~~Each waste~~Waste streams identified by generators ~~is~~ are assigned to a Waste Summary Category to ~~facilitate RCRA waste characterization, and~~ reflect the final waste forms acceptable for ~~WIPP~~ transportation and disposal. Details regarding the Summary Category Groups and waste characterization can be found in Permit Attachment C.

~~These Waste Summary Categories are:~~

~~S3000 – Homogeneous Solids~~

~~Solid process residues defined as solid materials, excluding soil, that do not meet the applicable regulatory criteria for classification as debris [20.4.1.800 NMAC, (incorporating 40 CFR §268.2(g) and (h))]. Solid process residues include inorganic process residues, inorganic sludges, salt waste, and pyrochemical salt waste. Other waste streams are included in this Waste Summary Category based on the specific waste stream types and~~

~~final waste form. This category includes wastes that are at least 50 percent by volume solid process residues.~~

~~S4000 – Soils/Gravel~~
~~This waste summary category includes waste streams that are at least 50 percent by volume soil. Soils are further categorized by the amount of debris included in the matrix.~~

~~S5000—Debris Wastes~~
~~This waste summary category includes waste that is at least 50 percent by volume materials that meet the NMAC criteria for classification as debris (20.4.1.800 NMAC (incorporating 40 CFR §268.2)). Debris means solid material exceeding a 2.36 inch (60 millimeter) particle size that is intended for disposal and that is: 1) a manufactured object, 2) plant or animal matter, or 3) natural geologic material.~~

~~The S5000 Waste Summary Category includes metal debris, metal debris containing lead, inorganic nonmetal debris, asbestos debris, combustible debris, graphite debris, heterogeneous debris, and composite filters, as well as other minor waste streams. Particles smaller than 2.36 inches in size may be considered debris if the debris is a manufactured object and if it is not a particle of S3000 or S4000 material.~~

~~If a waste does not include at least 50 percent of any given category by volume, characterization shall be performed using the waste characterization process required for the category constituting the greatest volume of waste for that waste stream.~~

Wastes may be generated at the WIPP facility as a direct result of managing the TRU and TRU mixed wastes received from the off-site generators. Such waste may be generated in either the WHB or the underground. This waste is referred to as “derived waste~~.~~,” which means its hazardous waste characteristics are derived from the off-site waste that produced it. ~~All s~~Such derived waste will be placed in the rooms in HWDUs along with the TRU mixed waste for disposal.

Non-mixed hazardous wastes generated at the WIPP facility, through activities where contact with TRU mixed waste does not occur, are characterized, placed in containers, and stored (for periods not exceeding the limits specified in 20.4.1.300 NMAC (incorporating 40 CFR §262.17)) until they are transported off site for treatment and/or disposal at a ~~permitted~~ designated facility. This waste generation and accumulation activity, when performed in compliance with 20.4.1.300 NMAC (incorporating 40 CFR ~~§~~Part 262), is not subject to RCRA permitting requirements and, as such, is not addressed in the permit, with the exception of the requirements of 20.4.1.300 NMAC (incorporating 40 CFR Part 262, Subpart M), which are addressed in Permit Attachment D.

A-6 Chronology of Events Relevant to Changes in Ownership or Operational Control

December 19, 1997	The New Mexico Environment Departments (**NMED**) received notification of a change of name/ownership from Westinghouse Electric Corporation to CBS Corporation. The WIPP facility Management and Operating Contractor (**MOC**), Westinghouse Waste Isolation Division (**WID**), became a division of Westinghouse Electric Company, which in turn was a division of CBS Corporation. Notification to NMED was made by the permit applicant in a letter dated December 18, 1997. The ~~permit~~ Permit application was under review, but a draft ~~permit~~ Permit was not yet issued.
September 22, 1998	The NMED received notification of a pending transfer of ownership for the MOC, Westinghouse WID, from CBS Corporation to an as-yet-to-be-named limited liability company owned jointly by British Nuclear Fuels, plc and Morrison-Knudsen Corporation. The transfer of ownership was scheduled to occur on or about December 15, 1998. Notification to NMED was made by the permit applicant in a letter dated September 17, 1998. The draft ~~permit~~ Permit had been issued for public comment, but the final ~~permit~~ Permit was not yet issued.
March 9, 1999	The NMED again received notification of the pending divestiture of the MOC, Westinghouse WID, by CBS Corporation to the limited liability company owned jointly by British Nuclear Fuels, plc and Morrison-Knudsen Corporation known as MK/BNFL GESCO LLC. The new MOC would be renamed to Westinghouse Government Environmental Services Company LLC (**WGES**). Notification to NMED was made by the permit applicant in a letter dated March 2, 1999. The public hearing on the ~~permit~~ Permit was underway, but the final ~~permit~~ Permit was not yet issued.
March 26, 1999	The NMED received official notification of the divestiture of Westinghouse Electric Company by CBS Corporation to MK/BNFL GESCO LLC effective March 22, 1999. The MOC was renamed ~~Westinghouse Government Environmental Services Company LLC (**WGES**)~~WGES, of which Westinghouse ~~Waste Isolation Division~~WID was a division. This transaction constituted a change of operational control under 20.4.1.900 NMAC (incorporating 40 CFR §270.40). Notification to NMED was made by the permit applicant in a letter dated March 24, 1999. The public hearing on the ~~permit~~ Permit was nearly concluded, but the final ~~permit~~ Permit was not yet issued.
April 28, 1999	The NMED received a revised Part A Permit Application in a letter dated April 21, 1999, reflecting that the Westinghouse ~~Waste Isolation Division~~WID, co-operator of the WIPP ~~hazardous waste~~ facility, was now a part of WGES. However, the final ~~permit~~Permit, issued October 27, 1999, did not reflect the change in ownership.
July 25, 2000	The NMED received a Class 1 permit modification in a letter dated July 21, 2000, changing the name in the Permit from ~~Westinghouse Electric~~

	~~Corporation to Westinghouse Government Environmental Services Company LLC (**WGES**)~~ WGES, ~~Waste Isolation Division (**WID**)~~WID. ~~However, t~~This notification did not constitute the required permit modification under 20.4.1.900 NMAC (incorporating 40 CFR §270.40) necessary to reflect the transfer of the permit to a new operator.
December 15, 2000	The DOE announced that it had awarded a five-year contract for management and operation of the WIPP facility to Westinghouse TRU Solutions LLC, a limited liability company owned jointly by WGES LLC and Roy F. Weston, Inc. The announcement further stated that, following a brief transition period, the new contractor would assume MOC responsibilities on February 1, 2001. This transaction constituted a change of operational control under 20.4.1.900 NMAC (incorporating 40 CFR §270.40) requiring a Class 1 permit modification with prior written approval of NMED.
February 5, 2001	The NMED received a Class 1 permit modification in a letter dated February 2, 2001, which notified NMED of an organizational name change of the MOC from ~~Westinghouse Government Environmental Services Company LLC Waste Isolation Division~~WGES WID to Westinghouse TRU Solutions LLC. ~~However, t~~This notification did not constitute the required permit modification under 20.4.1.900 NMAC (incorporating 40 CFR §270.40) necessary to reflect the transfer of the permit to a new operator.
December 31, 2002	The NMED received a Class 1 permit modification in a letter dated December 27, 2002, which changed the name of the MOC from Westinghouse TRU Solutions LLC to Washington TRU Solutions LLC (**WTS**). ~~Again, t~~This notification did not constitute the required permit modification under 20.4.1.900 NMAC (incorporating 40 CFR §270.40) necessary to reflect the transfer of the permit to a new operator.
February 28, 2003	The NMED received a Class 1 permit modification requiring prior agency approval in a letter dated February 28, 2003, to satisfy the requirements specified in 20.4.1.900 NMAC (incorporating 40 CFR §270.40) to reflect the transfer of the permit to a new operator.
September 16, 2004	The NMED received a Class 1 permit modification requiring prior agency approval in a letter dated September 16, 2004, describing a change of ownership of~~ Washington TRU Solutions LLC (**WTS**)~~WTS. WTS is owned jointly by WGES, managing member, and Weston Solutions, Inc. WGES had been owned jointly by Washington Group International, Inc. (**WGI**), and BNFL Nuclear Services, Inc. However, WGI has acquired BNFL's prior interest in the former Westinghouse government services businesses, which includes BNFL's prior interest in WGES.
August 6, 2007	The NMED received notification in a letter dated August 2, 2007 of the pending acquisition of WGI by URS Corporation at an unknown future date. This acquisition would be related to operational control, because WGI is the sole owner of WGES, managing member of the joint venture,

	along with Weston Solutions, Inc., that owns WTS, the WIPP facility MOC. This notification was submitted to assure compliance with 20.4.1.900 NMAC (incorporating 40 CFR §270.40(b)).
November 26, 2007	The NMED received a Class 1 permit modification requiring prior agency approval in a letter dated November 19, 2007, describing a change of ownership of WTS. On November 15, 2007, WGI was acquired by URS Corporation. WTS is owned jointly by WGES, managing member, and Weston Solutions, Inc. WGES, formerly owned by WGI, is now owned by URS Corporation.
October 1, 2012	The NMED received a Class 1 permit modification requiring prior agency approval in a letter dated June 25, 2012 describing a change in the MOC for the WIPP facility. The new MOC for the WIPP facility will be Nuclear Waste Partnership LLC. The new MOC is comprised of URS Energy & Construction, Inc. and Babcock and Wilcox Technical Services Group, Inc.
April 1, 2014	URS announced an organizational realignment to move Global Management and Operational Services Group (GMOS) from URS Energy & Construction to URS Federal Services Division. Nuclear Waste Partnership LLC is part of GMOS and remains in this group. The MOC is comprised of URS Federal Services, Inc. and Babcock and Wilcox Technical Services Group, Inc.
January 5, 2015	On January 5, 2015 URS merged with AECOM. The ~~WIPP Management and Operating Contractor (~~MOC~~)~~, Nuclear Waste Partnership LLC, is comprised of URS Energy & Construction, Inc. (an organization within AECOM) and Babcock and Wilcox Technical Services Group, Inc. This merger is therefore not related to a change in operational control because URS Energy & Construction, Inc. continues to be 70% owner of Nuclear Waste Partnership LLC.
July 1, 2015	On June 8, 2015 the Babcock & Wilcox Company announced its intent to change the name to BWXT Technical Services Group, Inc. (BWXT TSG). This change was effective July 1, 2015. No changes are being made to the ~~Management and Operating Contractor (~~MOC~~)~~. The MOC is comprised of URS Energy & Construction, Inc. and BWXT Technical Services Group, Inc.
September 19, 2016	URS Energy & Construction, Inc. changed its name to AECOM Energy & Construction, Inc. This name change was effective September 19, 2016. No changes are being made to the ~~Management and Operating Contractor (~~MOC~~)~~. This is a name change only; there was no change in operational control. The MOC, Nuclear Waste partnership LLC, is comprised of AECOM Energy & Construction, Inc. and BWXT Technical Services Group, Inc. This change does not constitute the required permit modification under 20.4.1.900 NMAC (incorporating 40 CFR §270.40) necessary to reflect the transfer of the ~~permit~~ Permit to a new operator.

January 31, 2020	Lindsay Goldberg/American Securities purchased AECOM's Management Services group, forming a new company named Amentum. Included in that transaction was AECOM Energy & Construction, Inc., which continues to be the legal guarantor and majority owner of the MOC, Nuclear Waste Partnership LLC. No changes are being made to the MOC. Nuclear Waste Partnership LLC is still comprised of AECOM Energy & Construction, Inc. and BWXT Technical Services Group, Inc. This is a change in ultimate parent company only; there was no change in operational control. Therefore, this change does not constitute the required permit modification under 20.4.1.900 NMAC (incorporating 40 CFR §270.40) necessary to reflect the transfer of the permit to a new operator.

ATTACHMENT A1

CONTAINER STORAGE

ATTACHMENT A1

CONTAINER STORAGE

TABLE OF CONTENTS

LIST OF TABLES

~~LIST OF FIGURES~~

ATTACHMENT A1

CONTAINER STORAGE

Introduction

Management and storage of transuranic (**TRU**) mixed waste in the Waste Isolation Pilot Plant (**WIPP**) facility is subject to regulation under 20.4.1.500 New Mexico Administrative Code (**NMAC**). The technical requirements of 20.4.1.500 NMAC (incorporating Title 40 of the Code of Federal Regulations (**CFR**) §§264.170 to 264.178) are applied to the operation of the Waste Handling Building **(WHB)** Container Storage Unit (**WHB Unit**) (Figure M-1~~A1-1~~), and the Parking Area Container Storage Unit (**~~Parking Area Unit~~PAU**) (Figure M-2~~A1-2~~). This Permit Attachment describes the container storage units, the TRU mixed waste management facilities and operations, and compliance with the technical requirements of 20.4.1.500 NMAC. The configuration of the WIPP facility consists of completed structures, including ~~all~~ buildings, ~~and~~ systems, and components for the operation of the facility.

A1-1 Container Storage

The waste containers ~~that will be~~ used at the WIPP facility qualify as "containers," in accordance with 20.4.1.101 NMAC (incorporating 40 CFR §260.10). That is, they are "portable devices in which a material is stored, transported, treated, disposed of, or otherwise handled."

A1-1a Containers with Liquid

The Permit Treatment, Storage, and Disposal Facility (**TSDF**) Waste Acceptance Criteria (**WAC**) and the Waste Analysis Plan (Permit Attachment C) prohibit the shipment of waste to the WIPP facility with liquid in excess of one percent of the volume of the waste container (e.g., drum, standard waste box [**SWB**], or canister). Since the maximum amount of liquid is one percent, calculations made to determine the secondary containment as required by 20.4.1.500 NMAC (incorporating §264.175) are based on ten percent of one percent of the volume of the containers, or one percent of the largest container, whichever is greater.

A1-1b Description of Containers

The regulations at 20.4.1.500 NMAC (incorporating 40 CFR §264.171) require~~s~~ that containers holding waste be in good condition as provided in Permit Part 3, Section 3.3, *Condition of Containers*. Waste containers shall be in good condition (e.g., high integrity, intact, no severe rusting, no apparent structural defects, no signs of pressurization) prior to shipment from ~~the~~ a generator ~~sites~~site~~, i.e., containers will be of high integrity, intact, and free of surface contamination above DOE limits~~. The Manager of the U.S. Department of Energy (**DOE**) Carlsbad Field Office has the authority to suspend a generator's certification to ship TRU mixed waste to the WIPP facility should the generator fail to meet this requirement. ~~The containers will be certified free of surface contamination above DOE limits upon shipment. This condition shall be verified upon receipt of the waste at WIPP.~~ The level of rigor applied in these areas to ensure container integrity ~~and the absence of external contamination~~ on both ends of the transportation process ~~will~~ ensures that waste containers entering the waste management process line at the WIPP facility meet the applicable Resource Conservation and Recovery Act (**RCRA**) requirements for container condition.

Transuranic mixed waste containers meet the requirements for U.S. Department of Transportation (**DOT**) specification 7A regulations. These containers are required to be vented through one or more DOE-approved filter vents to prevent internal container pressurization caused by gas generation and to prevent radioactive particulate material from escaping.

A1-1b(1) CH TRU Mixed Waste Containers

Contact-~~-~~handled (**CH**) TRU mixed waste containers ~~will be~~are either 55-~~gal~~ gallon (**gal**) (208-~~L~~liter (**L**)) drums singly or arranged into ~~7~~seven-packs, 85-gal (322-L) drums singly or arranged into ~~4~~four-packs, 100-gal (379 L) drums singly or arranged into ~~3~~three-packs, ten-drum overpacks (**TDOP**), standard large box 2s (**SLB2**), or SWBs. These CH mixed waste containers may be either direct-loaded or used to overpack CH TRU mixed containers that are leaking or are not in good condition. The CH TRU mixed waste containers are constructed of steel. Drums may also contain rigid, molded polyethylene (or other material compatible with TRU mixed waste) liners. A summary description of each CH TRU mixed waste container type is provided ~~below~~in Table A1-1, and the containers are illustrated in Figures M-3 through M-8. The maximum loaded, or gross, weights of these containers are listed in Table A1-2.

~~Standard 55-Gallon Drums~~

~~Standard 55-gal (208-L) drums meet the requirements for U.S. Department of Transportation (**DOT**) specification 7A regulations.~~

~~A standard 55-gal (208-L) drum has a gross internal volume of 7.4 cubic feet (ft^3) (0.21 cubic meters (m^3)). Figure A1-3 shows a standard TRU mixed waste drum. One or more filtered vents (as described in Section A1-1d(1)) will be installed in the drum lid to prevent the escape of any radioactive particulates and to eliminate any potential of pressurization.~~

~~Standard 55-gal (208-L) drums are constructed of mild steel and may also contain rigid, molded polyethylene (or other compatible material) liners. These liners are procured to a specification describing the functional requirements of fitting inside the drum, material thickness and tolerances, and quality controls and required testing. A quality assurance surveillance program is applied to all procurements to verify that the liners meet the specification.~~

~~Standard 55-gal (208-L) drums may be used to collect derived waste.~~

~~Standard Waste Boxes~~

~~The SWBs meet all the requirements of DOT specification 7A regulations.~~

~~One or more filtered vents (as described in Section A1-1d(1)) will be installed in the SWB body and located near the top of the SWB to prevent the escape of any radioactive particulates and to eliminate any potential of pressurization. They have an internal volume of 66.3 ft^3 (1.88 m^3). Figure A1-4 shows a SWB.~~

~~The SWB is the largest container that may be used to collect derived waste.~~

~~Ten-Drum Overpack~~

~~The TDOP is a metal container, similar to a SWB, that meets DOT specification 7A and is certified to be noncombustible and to meet all applicable requirements for Type A packaging. The TDOP is a welded-steel, right circular cylinder, approximately 74 inches (in.) (1.9 meters (m)) high and 71 in. (1.8 m) in diameter (Figure A1-5). The maximum loaded weight of a TDOP is 6,700 pounds (lbs) (3,040 kilograms (kg)). A bolted lid on one end is removable; sealing is accomplished by clamping a neoprene gasket between the lid and the body. One or more filter vents are located near the top of the TDOP on the body to prevent the escape of any radioactive particulates and to eliminate any potential of pressurization. A TDOP may contain up to ten standard 55-gal (208-L) drums or one SWB. TDOPs may be used to overpack drums or SWBs containing CH TRU mixed waste. The TDOP may also be direct loaded with CH TRU mixed waste. Figure A1-5 shows a TDOP.~~

~~Eighty-Five Gallon Drum~~

~~The 85-gal (322-L) drums meet the requirements for DOT specification 7A regulations. An 85-gal (322-L) drum has a gross internal volume of 11.4 ft^3 (0.32 m^3). One or more filtered vents (as described in Section A1-1d(1)) will be installed in the 85-gal drum to prevent the escape of any radioactive particulates and to eliminate any potential of pressurization.~~

~~85-gal (322-L) drums are constructed of mild steel and may also contain rigid, molded polyethylene (or other compatible material) liners. These liners are procured to a specification describing the functional requirements of fitting inside the drum, material thickness and tolerances, and quality controls and required testing. A quality assurance surveillance program is applied to all procurements to verify that the liners meet the specification.~~

~~The 85-gal (322-L) drum, which is shown in Figure A1-6, will be used for overpacking contaminated 55-gal (208 L) drums at the WIPP facility. The 85-gal drum may also be direct loaded with CH TRU mixed waste.~~

~~85-gal (322-L) drums may be used to collect derived waste.~~

~~100-Gallon Drum~~

~~100-gal (379-L) drums meet the requirements for DOT specification 7A regulations.~~

~~A 100-gal (379-L) drum has a gross internal volume of 13.4 ft^3 (0.38 m^3). One or more filtered vents (as described in Section A1-1d(1) will be installed in the drum lid or body to prevent the escape of any radioactive particulates and to eliminate any potential of pressurization.~~

~~100-gal (379-L) drums are constructed of mild steel and may also contain rigid, molded polyethylene (or other compatible material) liners. These liners are procured to a specification describing the functional requirements of fitting inside the drum, material thickness and tolerances, and quality controls and required testing. A quality assurance surveillance program is applied to all procurements to verify that the liners meet the specification.~~

~~100-gal (379-L) drums may be direct loaded.~~

~~Standard Large Box 2~~

~~The SLB2 meets the requirements of DOT specification 7A requirements. The SLB2 is a welded steel container with a gross internal volume of 261 ft^3 (7.39 m^3).~~

~~One or more filtered vents will be installed in the SLB2 body and located near the top of the SLB2 to prevent the escape of radioactive particulates and to prevent internal pressurization. Figure A1-34 shows an SLB2.~~

A1-1b(2) RH TRU Mixed Waste Containers

Remote-h~~H~~andled (**RH**) TRU mixed waste containers include RH-~~-~~TRU 72-B Canisters, which are received at the WIPP facility loaded singly in an RH-TRU 72-B cask;~~,~~ Facility Canisters, which are used to configure 55-gal (208-L) drums for emplacement; shielded containers, which are received in HalfPACTs;~~,~~ and 55-~~gallon~~ gal (208-L) drums, which are received in a CNS 10-160B cask. The RH TRU mixed waste containers are constructed of steel. The shielded container is constructed with approximately one inch of lead shielding on the sides and approximately three inches of steel on the top and bottom of the container and is used to emplace RH TRU mixed waste; however, the shielding allows it to be managed and stored in accordance with CH TRU mixed waste handling practices. A summary description of each RH TRU mixed waste container type is provided in Table A1-1, and the containers are illustrated in Figures M-9 through M-11. The maximum loaded, or gross, weights of these containers are listed in Tables A1-2 and A1-3.

~~RH TRU Canister~~

~~The RH TRU Canister is a steel single shell container which is constructed to be of high integrity. An example canister is depicted in Figure A1-16a. The RH TRU Canister is vented and will have a nominal internal volume of 31.4 ft^3 (0.89 m^3) and shall contain waste packaged in small containers (e.g., drums) or waste loaded directly into the canister.~~

~~Standard 55-Gallon Drums~~

~~Standard 55-gal (208-L) drums meet the requirements for U.S. Department of Transportation (DOT) specification 7A regulations. A detailed description of a standard 55-gallon drum is provided above. Up to ten 55-gallon drums containing RH TRU mixed waste are arranged on two drum carriage units in the CNS 10-160B cask (up to five drums per drum carriage unit). The drums are transferred to an RH TRU mixed waste Facility Canister that will contain three drums.~~

~~Shielded Container~~

~~Remote-Handled TRU mixed waste received at the WIPP facility in shielded containers will be arranged as three-packs. A summary description of the shielded container is provided below. The shielded container meets the requirements for DOT specification 7A (Figure A1-37).~~

~~Each shielded container has a gross internal volume of 7.4ft^3 (0.21m^3). One or more filter vents will be installed in the shielded container lid to prevent the escape of radioactive particulates and to prevent internal pressurization. The shielded container is constructed with approximately one inch of lead shielding on the sides and approximately three inches of steel on the top and~~

~~bottom of the container and will be used to emplace RH TRU mixed waste. The shielding will allow it to be managed and stored as CH TRU mixed waste.~~

A1-1b(3) Container Compatibility

~~All c~~Containers ~~will be~~are made of steel, and some ~~will~~ contain rigid, molded polyethylene liners. The compatibility study, documented in Appendix C1 of the WIPP RCRA Part B Permit Application (DOE, 1997a), included container materials to assure containers are compatible with the waste. Therefore, these containers meet the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.172).

A1-1c Description of the Container Storage Units

A1-1c(1) Waste Handling Building Container Storage Unit (WHB Unit)

The ~~Waste Handling Building (**WHB**)~~WHB is the surface facility where TRU mixed waste handling activities ~~will~~ take place (Figure M-12~~A1-1a~~). The WHB has a total area of approximately 84,000 square feet (**ft^2**) (7,804 square meters (**m^2**)) of which 32,307 ft^2 (3,001 m^2) are designated for the waste handling and container storage of CH TRU mixed waste and 17,403 ft^2 (1,617 m^2) are designated for handling and storage of RH TRU mixed waste, as shown in Figures M-1, M-13 through M-16~~A1-1, A1-14a, and A1-17a, b, c, and d~~. These areas ~~are being permitted as~~comprise the WHB Unit. The concrete floors are ~~sealed with a coating that is~~ sufficiently impervious to ~~the chemicals in~~contain leaks and spills of TRU mixed waste to meet the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.175(b)(1)). The concrete floors are sealed with a coating that has been demonstrated to be compatible with TRU mixed waste.

CH Bay Surge Storage Area

The Permittees ~~will~~ coordinate shipments with the generator/storage sites in an attempt to minimize the use of surge storage. However, there may be circumstances causing shipments to arrive that would exceed the maximum capacity of the CH Bay Storage Area, as specified in Permit Part 3, Table 3.1.1, *WHB Unit*. The Permittees may use the CH Bay Surge Storage Area as specified in Permit Part 3, Section 3.1.1.3 (see Figure M-1~~A1-1~~) only when the maximum capacities in the CH Bay Storage Area (except for the Shielded Storage Room) and the Parking Area Unit are reached and at least one of the following conditions is met (as discussed in Section A1-1e(2), the PAU may not be full, but the shipping package has reached day 59 of its Nuclear Regulatory Commission (**NRC**) 60-day venting period limit, and the waste containers must be removed from the shipping package and placed into storage in the WHB Unit):

- Surface or underground waste handling equipment malfunctions prevent the Permittees from moving waste to disposal locations;
- Hoisting or underground ventilation equipment malfunctions prevent the Permittees from moving waste into the underground;
- Power outages cause a suspension of waste emplacement activities;
- Inbound shipment delays are imminent because ~~Parking Area Container Storage Unit~~the PAU Surge Storage is in use; or

- Onsite or offsite emergencies cause a suspension of waste emplacement activities.

The Permittees must notify the NMED and those on the e-mail notification list (as specified in Permit Part 1, Section~~s~~ 1.11 and Permit Part 3, Section 3.1.1.4) upon using the CH Bay Surge Storage Area and provide justification for its use.

CH TRU Mixed Waste

The ~~Contact-Handled Packages~~CH packages used to transport TRU mixed waste containers ~~will be~~are received through one of three air-lock entries to the CH Bay of the WHB Unit. The WHB heating, ventilation and air conditioning (**HVAC**) system maintains the interior of the WHB at a pressure lower than the ambient atmosphere to ensure that air flows into the WHB, preventing the inadvertent release of any hazardous or radioactive constituent~~s~~ contamination as the result of a contamination event. The doors at each end of the air lock are interlocked to prevent both from opening simultaneously and equalizing CH Bay pressure with outside atmospheric pressure.

- TRUPACT-II and HalfPACT Management

  The CH Bay houses two TRUPACT-II Docks (**TRUDOCKs**), each equipped with overhead cranes for opening and unloading ~~Contact-Handled Packages~~CH packages. The TRUDOCKs are within the TRUDOCK Storage Area of the WHB Unit. The cranes are rated to lift the ~~Contact-Handled Packaging~~CH package lids ~~as well as their~~and package contents. The cranes are designed to remain on their tracks and hold their load even in the event of a design-basis earthquake.

  Upon receipt and removal of CH TRU mixed waste containers from the ~~Contact-Handled Packaging~~CH package, the ~~waste containers are required to be in good condition as provided in Permit Part 3. The~~ waste containers ~~will be~~are visually inspected for physical damage ~~(severe rusting, apparent structural defects, signs of pressurization, etc.)~~ and leakage to ensure they are in good condition prior to storage. Waste containers ~~will~~ are also ~~be~~ checked for external radiological surface contamination through the use of swipes and radiation monitoring equipment, consistent with radiological control procedures pursuant to 10 CFR Part 835. ~~If a primary waste container is not in good condition, the Permittees will overpack the container, repair/patch the container in accordance with 49 CFR §173 and §178 (e.g., 49 CFR §173.28), or return the container to the generator. The Permittees may initiate local decontamination, return unacceptable containers to a DOE generator site or send the Contact-Handled Package to a third party contractor.~~ Decontamination activities will not be conducted on containers ~~which~~ that are not in good condition~~,~~ or ~~which~~ are leaking. If the waste container is not in good condition, the Permittees will either overpack the container with another approved container, repair/patch the container in accordance with appropriate standards and guidance (e.g., 40 CFR §173.28), return the container to the generator, or send the CH package to a third-party contractor. If local decontamination activities are opted for, the work will be conducted in the WHB Unit, consistent with radiological control procedures~~on the TRUDOCK. These processes are described in Section A1-1d.~~

  Once unloaded from the ~~Contact-Handled Packaging~~CH package, CH TRU mixed waste containers (~~7~~seven-packs, ~~3~~three-packs, ~~4~~four-packs, SWBs, or TDOPs) are placed in one of two positions on the facility pallet or on a containment pallet. The waste containers are stacked, on the facility pallets (one- or two-high, depending on weight considerations). Waste on containment pallets ~~will be~~are stacked one-high. The use of facility or containment pallets ~~will~~ elevates the waste at least 6 inches (**in.**) (15 centimeters (**cm**)) from the floor surface. Pallets of waste ~~will~~ are then ~~be relocated to~~maintained in the CH Bay Storage Area of the WHB Unit for normal storage.

In addition, four ~~Contact-Handled Packages~~CH packages, containing up to eight ~~7~~seven-packs, ~~3~~three-packs, 4four-packs, SWBs, or four TDOPs, may occupy positions at the TRUDOCKs. If waste containers are left in this area, they will be in the ~~Contact-Handled Package~~CH package with or without the shipping container lids removed. ~~The maximum TRU mixed waste volume in containers in four Contact-Handled Packages is 640 ft^3 (18.1 m^3).~~

- TRUPACT-III Management

The TRUPACT-III containing one SLB2 ~~will be~~is transferred to a Yard Transfer Vehicle in the ~~Parking Area Unit~~PAU using a forklift. The Yard Transfer Vehicle then transports the TRUPACT-III into the CH Bay through one of the airlocks and into Room 108 for unloading (Figure M-1~~A1-1b~~). The TRUPACT-III is first transported to the bolting station where the overpack cover and closure lid are removed using a bolting robot, or manually as required, and a monorail hoist. The TRUPACT-III is then moved to the ~~payload~~ Payload ~~transfer~~ Transfer ~~station~~ Station where the SLB2 is removed from the TRUPACT-III.

The SLB2 ~~will be~~is visually inspected for physical damage and leakage in a similar manner as containers removed from a TRUPACT-II or HalfPACT ~~(i.e., severe rusting, apparent structural defects, or signs of pressurization) and for leakage~~ to ensure it is in good condition. The SLB2 ~~will also be~~is also checked for external radiological surface contamination through the use of swipes and radiation monitoring equipment, consistent with radiological control procedures pursuant to 10 CFR Part 835. ~~If the SLB2 is not in good condition, the Permittees will repair/patch the container in accordance with 49 CFR §173 and §178 (e.g., 49 CFR §173.28), or return the container to the generator. The Permittees may initiate local decontamination, return unacceptable containers to a DOE generator site or send the SLB2 to a third-party contractor.~~ Decontamination activities will not be conducted on containers that are not in good condition or are leaking. If the waste container is not in good condition, the Permittees will either repair/patch the container in accordance with appropriate standards and guidance (e.g., 49 CFR §173.28), return the container to the generator, or send the SLB2 to a third-party contractor. If local decontamination activities are opted for, the work will be conducted in the WHB Unit consistent with radiological control procedures pursuant to 10 CFR Part 835.

Once the SLB2 is unloaded from the TRUPACT-III in Room 108, it ~~will be~~is placed on a facility pallet and moved to a pallet stand or floor storage location in the CH Bay or Room 108 for storage or to the conveyance loading room for waste emplacement.

~~The CH Bay Storage Area, which is~~As ~~shown~~ indicated in Figure M-1~~A1-1~~, ~~will be clearly marked to indicate the lateral limits of the storage area~~the shaded areas of the CH Bay and Room 108 (CH Bay Storage Area) are available for TRU mixed waste storage as long as sufficient aisle space (i.e., minimum of 44 in. (1.1 m)) is maintained. ~~This CH Bay Storage Area will have a maximum capacity of 13 pallets (4,160 ft^3 [118 m^3]) of TRU mixed waste containers during normal operations~~Transuranic mixed waste may be stored in the CH Bay Storage Area of the WHB Unit in quantities not to exceed the maximum capacities specified in Permit Part 3, Table 3.1.1.

The Derived Waste Storage Area of the WHB Unit is on the north wall of the CH Bay. This area ~~will~~ may contain containers up to the volume of ~~a~~ an SWB for collecting derived waste from all TRU mixed waste handling processes in the WHB Unit. The Derived Waste Storage Area ~~is being permitted to allow~~can accommodate containers in size up to ~~a~~ an SWB to be used to accumulate derived waste. The TRU mixed waste volume stored in this area will ~~be up to 66.3 ft^3 (1.88 m^3)~~not exceed the maximum capacity specified in Permit Part 3, Table 3.1.1. The derived waste containers in the Derived Waste Storage Area ~~will be~~are stored on ~~standard drum~~containment pallets, which are polyethylene trays with a grated deck, which ~~will~~ elevate the derived waste containers ~~approximately~~ at least 6 in. (15 cm) from the floor surface, and provide approximately 50 gal (190 L) of secondary containment capacity.

~~Aisle space shall be maintained in all WHB Unit TRU mixed waste storage areas.~~ The aisle space in the WHB Unit TRU mixed waste storage areas ~~shall be~~is adequate to allow unobstructed movement of fire-fighting personnel, spill-control equipment, and decontamination equipment that would be used in the event of an off-normal event. ~~An~~ A minimum aisle ~~space~~ spacing of 44 in. (1.1 m) between loaded facility pallets ~~will be~~is maintained in ~~all~~ the WHB Unit TRU mixed waste storage areas. ~~An aisle space of 60 in. (1.5 m) will be maintained between the west wall of the CH Bay and facility pallets.~~

The WHB has been designed to meet DOE design and associated quality assurance requirements. The 2009 Amended Renewal Application, Chapter M1, Table M1-1 (DOE, 2009) provided a summary of basic design requirements, principal codes, and standards for the WIPP facility. ~~Table A1-1 summarizes basic design requirements, principal codes, and standards for the WIPP facility.~~ Appendix D2 of the WIPP RCRA Part B Permit Application (DOE, 1997a) provided engineering design-basis earthquake and tornado reports. The design-basis earthquake report provides the basis for seismic design of WIPP facility structures, including the WHB foundation. The WIPP facility design-basis earthquake is 0.1 g. The WIPP facility design-basis tornado includes a maximum windspeed of 183 miles per hour (**mi/hr**) (294.5 kilometers per hr (**km/hr**)), which is the vector sum of ~~all~~ the velocity components. It is also limited to a translational velocity of 41 mi/hr (66 km/hr) and a tangential velocity of 124 mi/hr (200 km/hr). Other parameters are a radius of maximum wind of 325 ft (99 m), a pressure drop of 0.5 pound per square inch (**lb**/~~ per~~ **in.^{2}**) (3.4 kilopascals [**kPa**]), and a rate-of-pressure drop of 0.09 pounds per square inch per second (**lb/in.^{2}/s**) (0.6 kilopascals per second (**kPa/s**)). A design-basis flood report is not available because flooding is not a credible phenomenon at the WIPP facility. Design calculations for the probable maximum precipitation (**PMP**) event, provided in Appendix D7 of the WIPP RCRA Part B Permit Application (DOE, 1997a), illustrated run-on protection for the WIPP facility.

The WIPP facility does not lie within a 100-year floodplain. There are no major surface-water bodies within 5 miles (**mi**) (8 kilometers (**km**)) of the site, and the nearest river, the Pecos River, is approximately 12 mi (19 km) away. The general ground elevation in the vicinity of the surface facilities (approximately 3,400 feet (**ft**) [1,036 meters (**m**)] above mean sea level) is about 500 ft (152 m) above the riverbed and 400 ft (122 m) above the 100-year floodplain. Protection from flooding or ponding caused by PMP events is provided by the diversion of water away from the

WIPP facility by a system of peripheral interceptor berms and dikes. Additionally, grade elevations of roads and surface facilities are designed so that storm water will not collect within the Property Protection Area under the most severe conditions.

The following are the major pieces of equipment that ~~will be~~are used to manage CH TRU mixed waste in the container storage units. A summary of equipment capacities, as required by 20.4.1.500 NMAC is included in Table A1-2.

TRUPACT-II Type B Packaging

The TRUPACT-II (Figure M-17~~A1-8a~~) is a cylindrical shipping container 8 ft (2.4 m) in diameter and 10 ft (3 m) high. It ~~meets~~ is an NRC-certified Type B ~~shipping container~~package designed to meet the applicable requirements of 10 CFR Part 71 and has successfully completed rigorous container-integrity tests. The payload consists of approximately 7,265 ~~lbs~~ pounds (**lb**) (3,300 kilogram (**kg**)) gross weight in up to fourteen 55-gal (208-L) drums, eight 85-gal (322-L) drums, six 100-gal (379-L) drums, two SWBs, or one TDOP.

HalfPACT Type B Packaging

The HalfPACT (Figure M-18~~A1-8b~~) is a right cylindrical shipping container 8 ft (2.4 m) in diameter and 7.6 ft (2.3 m) high. It ~~meets~~ is an NRC-certified Type B ~~shipping container~~package designed to meet the applicable requirements of 10 CFR Part 71 and has successfully completed rigorous container-integrity tests. The payload consists of approximately 7,600 ~~lbs~~ lb (3,500 kg) gross weight in up to seven 55-gal (208-L) drums, one SWB, ~~or~~ four 85-~~gallon~~ gal (322-L) drums, or three shielded containers.

TRUPACT-III Type B Packaging

The TRUPACT-III (Figure M-19~~A1-33~~) is an NRC-certified Type B package designed to meet the ~~containment and shielding~~applicable requirements of 10 CFR Part 71. The nominal dimensions for a TRUPACT-III are 14 feet 1 inch long, 8 feet 2 inches wide and 8 feet 8 inches high. The TRUPACT-III is specifically certified to safely transport TRU wastes packaged in an SLB2.

This package, unlike the TRUPACT-II or HalfPACT, is horizontally loaded and ~~will be~~is unloaded horizontally as well.

The TRUPACT-III has a bolted overpack cover that is secured to the TRUPACT-III container.

The maximum weight of a TRUPACT-III is 55,116 ~~lbs~~ lb (25,000 kg) when loaded with the maximum allowable contents of 11,486 ~~lbs~~ lb (5,210 kg).

Unloading Docks

Each TRUDOCK is designed to accommodate up to two ~~Contact-Handled Packages~~CH packages. The TRUDOCK functions as a work platform, providing TRU mixed waste handling personnel easy access to the container during unloading operations (see Figure M-12~~A1-1a~~) ~~(Also see Drawing 41-M-001-W in Appendix D3 of the WIPP RCRA Part B Permit Application (DOE, 1997a))~~.

The ~~payload~~ Payload ~~transfer~~ Transfer ~~station~~ Station serves as the unloading dock for TRUPACT-III and can accommodate a single TRUPACT-III package (see Figure M-20).

Forklifts

Forklifts may be used to transfer the ~~Contact-Handled Packages~~CH packages into the WHB Unit and may be used to transfer palletized CH TRU mixed waste containers to the ~~facility~~ Facility ~~transfer~~ Transfer ~~vehicle~~Vehicle. Another forklift ~~will be~~is used for general-purpose transfer operations. This forklift has attachments and adapters to handle individual TRU mixed waste containers, if required.

Cranes, Unloading Devices, and ~~Adjustable Center-of-Gravity~~ Lift Fixtures

At each TRUDOCK, an overhead bridge crane is used with a specially designed lift fixture for ~~disassembly~~ removing the lids and contents of the ~~Contact-Handled Packages~~CH packages. Separate lifting attachments have been specifically designed to accommodate SWBs and TDOPs. ~~The lift fixture, attached to the crane, has built-in level indicators and two counterweights that can be moved to adjust the center of gravity of unbalanced loads and to keep them level.~~

The TRUPACT-III is unloaded horizontally in Room 108. The Payload Transfer Station, Yard Transfer Vehicle, ~~and~~ Facility Transfer Vehicle, or forklift are used to perform the unloading and movement functions. The Payload Transfer Station includes retractable arms that are used to position the SLB2 onto the Facility Transfer Vehicle and facility pallet.

Facility or Containment Pallets

The facility pallet is a fabricated steel unit designed to support ~~7~~seven-packs, 4four-packs, or ~~3~~three-packs of drums, SWBs, TDOPs, ~~or~~ an SLB2, or shielded container assemblies~~and has a rated load of 25,000 lbs. (11,430 kg)~~. The facility pallet ~~will~~ can accommodate up to four ~~7~~seven-packs, four ~~3~~three-packs, or four 4four-packs of drums;~~,~~ four SWBs (in two stacks of two units);~~,~~ two TDOPs;~~,~~ ~~or an~~one SLB2; or two shielded container three-pack assemblies. Loads are secured to the facility pallet during transport to the emplacement area. Facility pallets are shown in Figure M-21~~A1-10~~. Fork pockets in the side of the pallet allow the facility pallet to be lifted and transferred by forklift to prevent direct contact between TRU mixed waste containers and forklift tines. This arrangement reduces the potential for puncture accidents. Facility pallets may also be moved by facility transfer vehicles. WIPP facility operational documents define the operational load of the facility pallet to ensure that the rated load of a facility pallet is not exceeded.

Containment pallets are fabricated units having a containment capacity of at least ten percent of the volume of the containers and designed to support a minimum of either a single drum, a single SWB or a single TDOP. The pallets ~~will~~ have a rated load capacity of equal to or greater than the gross weight limit of the container(s) to be supported on the pallet. Loads are secured to the containment pallet during transport. A typical containment pallet is shown in Figure M-22~~A1-10a~~. Fork pockets in the side of the pallet allow the containment pallet to be lifted and transferred by forklift. WIPP facility operational documents define the operational load of the containment pallet to assure that the rated load of a containment pallet is not exceeded.

Facility Transfer Vehicle

The ~~facility~~ Facility ~~transfer~~ Transfer ~~vehicle~~ Vehicle is an electric battery~~ or electric ~~-powered automated vehicle ~~that either operates on tracks or has~~with an on-board guidance system that allows the vehicle to operate on the floor of the WHB. It has a feature that allows it to lower integrated rail wheels so that it can operate on the Waste Hoist tracks. It is designed with a flat bed that has adjustable height capability ~~and~~ that may be used to transfer waste payloads placed on facility pallets on or off the facility pallet stands in the CH Bay storage area~~, and on and off~~ or the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance by raising and lowering the bed (see Figure M-23~~A1-11~~).

Yard Transfer Vehicle

The Yard Transfer Vehicle (Figure M-24~~A1-35~~) is an electric battery-powered vehicle that transports the TRUPACT-III shipping container from the PAU into the WHB and into Room 108. ~~The Yard Transfer Vehicle is an electric vehicle with a load capacity of 60,000 pounds.~~

RH TRU Mixed Waste

The RH TRU mixed waste is handled and stored in the RH Complex of the WHB Unit which comprises the following locations: RH Bay~~ (12,552 ft^2 (1,166 m^2))~~, the Cask Unloading Room ~~(382 ft^2 (36 m^2))~~, the Hot Cell~~ (1,841 ft^2 (171 m^2))~~, the Transfer Cell ~~(1,003 ft^2 (93 m^2))~~ (Figures M-1 and M-13 through M-15~~A1-17a, b and c~~), and the Facility Cask Loading Room ~~(1,625 ft^2 (151 m^2))~~ (Figure M-16~~A1-17d~~). The maximum storage capacities of each of these locations are prescribed in Permit Part 3, Table 3.1.1.

The RH Bay (Figure M-13~~A1-14a~~) is a high-bay area for receiving casks and subsequent handling operations. The trailer carrying the RH-TRU 72-B or CNS 10-160B shipping cask (Figures M-25 through M-28~~A1-18, A1-19, A1-20 and A1-21~~) enters the RH Bay through a set of double doors on the east side of the WHB. The RH Bay houses the Cask Transfer Car. The RH Bay is served by the RH Bay Overhead Bridge Crane used for cask handling and maintenance operations. Storage in the RH Bay occurs in the RH-TRU 72-B or CNS 10-160B casks. The storage occurs after the trailer containing the cask is moved into the RH Bay and prior to moving the cask into the Cask Unloading Room to stage the waste for disposal operations. ~~A maximum of two loaded casks and one 55-gallon drum for derived waste (156 ft^3 (4.4 m^3)) may be stored in the RH Bay.~~

The Cask Unloading Room (Figure M-13~~A1-17a~~) provides for transfer of the RH-TRU 72-B cask to the Transfer Cell, or the transfer of drums from the CNS 10-160B cask to the Hot Cell. Storage in the Cask Unloading Room ~~will occur~~occurs in the RH-TRU 72-B or CNS 10-160B casks. Storage in this area typically occurs to facilitate operations during a shift, at the end of a shift, or in an off-normal event that results in the suspension of waste handling operations. ~~A maximum of one cask (74 ft^3 (2.1 m^3)) may be stored in the Cask Unloading Room.~~

The Hot Cell (Figure M-14~~A1-17b~~) is a concrete shielded room in which drums of RH TRU mixed waste ~~will be~~are transferred remotely from the CNS 10-160B cask, staged in the Hot Cell, and loaded into a Facility Canister. The loaded Facility Canister is then lowered from the Hot Cell into the Transfer Cell Shuttle Car containing a Shielded Insert. Storage in the Hot Cell occurs in either drums or Facility Canisters. Drums that are stored are either on the drum carriage unit that was removed from the CNS 10-160B cask or in ~~a~~ Facility Canisters. ~~A~~

~~maximum of 12 55-gallon drums and one 55-gallon drum for derived waste (94.9 ft^3 (2.7 m^3)) may be stored in the Hot Cell.~~

The Transfer Cell (Figure M-15~~A1-17c~~) houses the Transfer Cell Shuttle Car, which moves the RH-TRU 72-B cask or Shielded Insert into position for transferring the canister to the Facility Cask. Storage in this area typically occurs to facilitate operations during a shift, at the end of a shift, or in an off-normal event that results in the suspension of a waste handling evolution. ~~A maximum of one canister (31.4 ft^3 (0.89 m^3)) may be stored in the Transfer Cell in the Transfer Cell Shuttle Car.~~

The Facility Cask Loading Room (Figure M-16~~A1-17d~~) provides for transfer of a canister to the Facility Cask (Figure M-29) for subsequent transfer to the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance and to the ~~U~~underground Hazardous Waste Disposal Unit (**HWDU**). The Facility Cask Loading Room also functions as an air lock between the Waste Shaft and the Transfer Cell. Storage in this area typically occurs to facilitate operations during a shift, at the end of a shift, or in an off-normal event that results in the suspension of waste handling operations. ~~A maximum of one canister (31.4 ft^3 (0.89 m^3)) may be stored in the Facility Cask (Figure A1-23) in the Facility Cask Loading Room.~~

Following is a description of major pieces of equipment that are used to manage RH TRU mixed waste in the WHB Unit. A summary of equipment capacities, as required by 20.4.1.500 NMAC, is included in Table A1-3.

Casks

The RH-TRU 72-B cask (Figure M-27~~A1-20~~) is a ~~cylinder~~ cylindrical~~designed to meet U.S. Department of Transportation (**DOT**)~~ NRC-certified Type B ~~shipping container~~package designed to meet the applicable requirements of 10 CFR Part 71. It consists of a separate ~~Inner Containment Vessel (**ICV**)~~inner vessel within a stainless steel, lead-shielded outer cask protected by impact limiters at each end, made of ~~stainless steel~~stainless-steel skins filled with polyurethane foam. The ~~ICV~~ inner vessel is made of stainless steel and provides an internal containment boundary and a cavity for the payload. Neither the outer cask nor the ~~ICV~~ inner vessel is vented. Payload capacity of each RH-TRU 72-B shipping cask is 8,000 lbs (3,628 kg). The payload consists of a canister of RH TRU mixed waste, which may contain up to 31.4 ft^3 (0.89 m^3) of directly loaded waste or waste in smaller containers.

The CNS 10-160B cask (Figure M-28~~A1-21~~) is ~~designed to meet DOT~~an NRC-certified Type B ~~container~~ package designed to meet the applicable requirements of 10 CFR Part 71. ~~and~~ It consists of two carbon steel shells and a lead shield, welded to a carbon steel bottom plate. A 12-gauge stainless steel thermal shield surrounds the cask outer shell, which is equipped with two steel-encased, rigid polyurethane foam impact limiters attached to the top and bottom of the cask. The CNS 10-160B cask is not vented. Payload capacity of each CNS 10-160B cask is 14,500 lbs (6,577 kg). The payload consists of up to ten 55-~~gallon~~ gal (208-L) drums.

Shielded Insert

The Shielded Insert (Figure M-30~~A1-30~~) is specifically designed to be used in the Transfer Cell to hold and transport loaded Facility Canisters from the Hot Cell until loaded into the Facility Cask. The Shielded Insert, designed and constructed similar to the RH-TRU 72-B shipping cask, has a 29 in. inside diameter with an inside length of 130.5 in. (331.5 cm) to accommodate the Facility Canister~~, which is 28.5 in. in diameter by 117.5 in. long~~. The Shielded Insert is installed on and removed from the Transfer Cell Shuttle Car in the same manner as the RH-TRU 72-B shipping cask.

CNS 10-160B Drum Carriage

The CNS 10-160B drum carriage (Figure M-31~~A1-25~~) is a steel device used to handle drums in the CNS 10-160B cask. The drum carriages are stacked two high in the CNS 10-160B cask during shipment. They are removed from the cask using a below-the-hook lifting device termed a pentapod. The drum carriage is rated to lift up to five drums~~ with a maximum weight of 1000 pounds each~~.

RH Bay Overhead Bridge Crane

In the RH Bay, an overhead bridge crane is used to lift the cask from the trailer and place it on the Cask Transfer Car. It is also used to remove the impact limiters from the casks and may be used to remove the outer lid of the RH-TRU 72-B cask.

Cask Lifting Yoke

The lifting yoke is a lifting fixture that attaches to the RH Bay Overhead Bridge Crane and is designed to lift and rotate the RH-TRU 72-B cask onto the Cask Transfer Car.

Cask Transfer Cars

The Cask Transfer Cars (Figures M-32~~A1-22a~~ and M-33~~A1-22b~~) are self-propelled, rail-guided vehicles that transport casks between the RH Bay and the Cask Unloading Room.

6.25 Ton Grapple Hoist

A 6.25 Ton Grapple Hoist is used to hoist the canister from the Transfer Cell Shuttle Car into the Facility Cask.

Facility Canister

The Facility Canister is a cylindrical container designed to hold three 55-~~gallon~~ gal (208-L) drums of either RH TRU waste or dunnage (Figure M-9~~A1-16~~).

Facility Cask

The Facility Cask, or Light Weight Facility Cask, body consists of two concentric steel cylinders. The annulus between the cylinders is filled with lead, and gate shield valves are located at either end. Figure M-29~~A1-23~~ provides an outline configuration of the Facility Cask. The canister is placed inside the Facility Cask for shielding during canister transfer from the RH Complex to the ~~U~~underground HWDU for emplacement.

Facility Cask Transfer Car

The Facility Cask Transfer Car (Figure M-34~~A1-24~~) is a self-propelled rail car that is used to move the Facility Cask between the Facility Cask Loading Room and the Shaft Station in the underground.

Hot Cell Bridge Crane

The Hot Cell Bridge Crane, outfitted with a rotating block and the Hot Cell Facility Grapple, ~~will be~~is used to lift the CNS 10-160B lid and the drum carriage units from the cask located in the Cask Unloading Room, into the Hot Cell. The Hot Cell Bridge Crane is also used to lift the empty Facility Canisters into place within the Hot Cell, move loaded drums into the Facility Canister, and lower loaded Facility Canisters into the Transfer Cell.

Overhead Powered Manipulator

The Overhead Powered Manipulator is used in the Hot Cell to lift individual drums from the drum carriage unit and lower each drum into the Facility Canister and support miscellaneous Hot Cell operations.

Manipulators

There is a maximum of two operational sets of fixed Manipulators in the Hot Cell. The Manipulators are used to collect swipes of drums as they are being lifted from the drum carriage unit, ~~and~~ transfer the swipes to the Shielded Material Transfer Drawer for pertinent analysis, and support Hot Cell operations.

Shielded Material Transfer Drawer

The Shielded Material Transfer Drawer is used to transfer swipe samples obtained by the fixed Manipulators to the Hot Cell Gallery for radiological counting and transferring small equipment into and out of the Hot Cell.

Closed-Circuit Television Cameras

The Closed-Circuit Television Camera system is used to monitor operations throughout the Hot Cell and Transfer Cell. These cameras are used to perform inspections of waste containers and waste management areas. This camera system is operated from the shielded room in the Facility Cask Loading Room, Cask Unloading Room, and Hot Cell Gallery. The camera system has a video recording capability as an operational aid.

Transfer Cell Shuttle Car

The Transfer Cell Shuttle Car (Figure M-35~~A1-31~~) positions the loaded RH-TRU 72-B cask and Shielded Insert within the Transfer Cell.

Cask Unloading Room Crane

The Cask Unloading Room Crane lifts and suspends the RH-TRU 72-B cask or Shielded Insert from the Transfer Car and lowers the cask or Shielded Insert into the Transfer Cell Shuttle Car.

Facility Cask Rotating Device

The Facility Cask Rotating Device, a floor mounted hydraulically operated structure, is designed to rotate the Facility Cask from the horizontal position to the vertical position for waste canister loading and then back to the horizontal position after the waste canister has been loaded into the Facility Cask (Figure M-36~~A1-32~~).

A1-1c(2) Parking Area Container Storage Unit (~~Parking Area Unit~~PAU)

The parking area south of the WHB (see Figure M-2~~A1-2~~) ~~will be~~is used for storage of waste containers within sealed shipping containers awaiting unloading. The area extending south from the WHB within the security-fenced enclosure identified as the Controlled Area ~~on Figure A1-2~~ is defined as the ~~Parking Area Unit~~PAU. The ~~Parking Area Unit~~PAU provides storage space for up to 6,734 ft^3 (191 m^3) of TRU mixed waste, contained in up to 40 loaded ~~Contact-Handled Packages~~CH packages and ~~8~~ eight ~~Remote-Handled Packages~~RH packages. Secondary containment and protection of the waste containers from standing liquid are provided by the ~~Contact-Handled or Remote-Handled Packaging~~CH or RH packaging. Wastes placed in the ~~Parking Area Unit~~PAU ~~will~~ remain sealed in their ~~Contact-Handled or Remote-Handled Packages~~CH or RH packages~~, at all times~~ while in this area.

The ~~Nuclear Regulatory Commission (**NRC**)~~NRC Certificate of Compliance requires that sealed ~~Contact-Handled or Remote-Handled Packages~~CH or RH packages ~~which contain~~containing waste be vented every 60 days to avoid unacceptable levels of internal pressure. ~~During normal operations the maximum residence time of any one container in the Parking Area Unit is typically five days. Therefore, during normal waste handling operations, no Contact-Handled or Remote-Handled Packages will require venting while located in the Parking Area Unit.~~ Any off-normal event which results in the need to store a waste container in the ~~Parking Area Unit~~PAU for a period of time approaching ~~fifty-nine (~~59~~)~~ days shall be handled in accordance with Section A1-1e(2) of this Permit Attachment. Under no circumstances shall a ~~Contact-Handled or Remote-Handled Package~~CH or RH package be stored in the ~~Parking Area Unit~~PAU for more than ~~fifty-nine (~~59~~)~~ days after the date that ~~the ICV of the Contact-Handled or Remote-Handled Package~~CH or RH package was sealed at the generator site, as recorded in the ICV Closure Date field of the WIPP Waste Information System (**WWIS**) database.

Parking Area Unit Surge Storage Area

The Permittees ~~will~~ coordinate shipments with the generator/storage sites in an attempt to minimize the use of surge storage. However, there may be circumstances causing shipments to arrive that would exceed the maximum capacity of the ~~Parking Area~~PAU, as specified in Permit Part 3, Table 3.1.2, *Parking Area Unit*. The Permittees may use the ~~Parking Area~~PAU Surge Storage Area as specified in Permit Part 3, Section 3.1.2.3 (see Figure M-2~~A1-2~~) only when the maximum capacity in the ~~Parking Area~~PAU is reached and at least one of the following conditions is met:

- Surface or underground waste handling equipment malfunctions prevent the Permittees from moving waste to disposal locations;
- Hoisting or underground ventilation equipment malfunctions prevent the Permittees from moving waste into the underground;
- Power outages cause a suspension of waste emplacement activities;
- Inbound shipment delays are imminent because the ~~Parking Area~~PAU is full~~ (not applicable to RH TRU waste shipments)~~; or
- Onsite or offsite emergencies cause a suspension of waste emplacement activities.

The Permittees must notify NMED and those on the e-mail notification list (as specified in Permit Part 1, Section~~s~~ 1.11, and Permit Part 3, Section 3.1.2.4) upon using the ~~Parking Area~~PAU Surge Storage Area and provide justification for its use.

A1-1d Container Management Practices

20.4.1.500 NMAC (incorporating 40 CFR §264.173) requires that containers be managed in a manner that does not result in spills or leaks. ~~Containers are required to be closed at all times, unless waste is being placed in the container or removed.~~ Because containers at the WIPP facility ~~will~~ contain radioactive waste, safety concerns require that containers be continuously vented to ~~obviate~~ prevent the buildup of gases within the container. These gases could result from radiolysis, which is the breakdown of moisture by radiation. The vents~~, which are nominally 0.75 in. (1.9 centimeters [cm]) in diameter,~~ are generally installed on or near the lids of the containers. These vents are filtered so that gas can escape while radioactive particulates are retained.

TRU mixed waste containers, containing off-site waste, are never opened at the WIPP facility. Derived waste containers are kept closed at all times unless waste is being added or removed.

Off-normal (unplanned) events could interrupt normal operations in the waste management process line. Shipments of waste from the generator sites will be stopped in an off-normal event which results in an interruption to normal waste handling operations that exceeds three days and could potentially cause the maximum permitted storage capacities and/or time limits to be exceeded. These off-~~-~~normal events typically fall into the following categories:

- Waste management system equipment malfunctions that prevent unloading or downloading waste to the underground
- Waste shipments with unacceptable levels of surface contamination that prevent unloading or downloading waste to the underground
- Hazardous Waste Manifest discrepancies that are not immediately resolved and prevent unloading or downloading waste to the underground
- A suspension of emplacement activities for regulatory reasons

~~Shipments of waste from the generator sites will be stopped in any event which results in an interruption to normal waste handling operations that exceeds three days.~~

~~Prior to receipt of TRU mixed waste at the WIPP facility, waste operators will be thoroughly trained in the safe use of TRU mixed waste handling and transport equipment. The training will include both classroom training and on-the-job training.~~

A1-1d(1) Derived Waste

The WIPP facility operational philosophy is to introduce no new hazardous chemical components into TRU mixed waste or TRU mixed waste residues that could be present in the controlled area. This ~~will be~~is accomplished principally through written procedures and the use of Safe Work Permits (**SWP**)[1] and Radiological Work Permits (**RWP**)[2] which govern the

---

[1] SWPs are prepared to assure that any hazardous work (not already covered by a procedure) is performed with due precaution. SWPs are issued by the Permittees after a job supervisor completes the proper form detailing the job location, work description,

activities within a controlled area involving TRU mixed waste. The purpose of this operating philosophy is to avoid generating TRU mixed waste that is compositionally different than the TRU mixed waste shipped to the WIPP facility for disposal.

Some additional TRU mixed waste, such as used personal protective equipment, swipes, and tools, may result from decontamination operations and off-normal events. Such waste will be assumed to be contaminated with RCRA-regulated hazardous constituents in the TRU mixed waste containers from which it was derived. Derived waste may be generated as the result of decontamination activities during the waste handling process. Should radiological decontamination activities be performed, the work will be conducted consistent with radiological control procedures pursuant to 10 CFR Part 835. For decontamination of hazardous waste constituents, water and a cleaning agent such as those listed in Permit Attachment D will be used. Derived waste will be considered acceptable for management at the WIPP facility, because any TRU mixed waste shipped to the facility will have already been determined to be acceptable and because no new hazardous waste constituents will be added. Data on the derived waste will be entered into the WWIS database. Derived waste will be contained in standard DOT approved Type A containers.

~~The Safety Analysis Report (DOE 1997b) for packaging requires the lids of TRU mixed waste containers to be vented through high efficiency particulate air (**HEPA**)-grade filters to preclude container pressurization caused by gas generation and to prevent particulate material from escaping. Filtered vents used in CH TRU mixed waste containers (55-gal (208-L) drums, 85-gal (322 L) drums, 100-gal (379-L) drums, TDOPs, and SWBs) have an orifice approximately 0.375-in. (9.53-millimeters) in diameter through which internally generated gas may pass. The filter media can be any material (e.g., composite carbon, sintered metal).~~

As each derived waste container is filled, it ~~will be~~is closed with a lid containing a high efficiency particulate air (**HEPA**)-grade~~.~~ filter and moved to an ~~U~~underground ~~Hazardous Waste Disposal Unit (**HWDU**)~~HWDU using the same equipment used for handling TRU mixed waste.

A1-1d(2) CH TRU Mixed Waste Handling

~~CH~~ Contact-handled TRU mixed waste containers ~~will~~ arrive by tractor-trailer at the WIPP facility in sealed shipping containers (e.g., TRUPACT-IIs, HalfPACTs, or TRUPACT-IIIs) (see Figure M-37~~A1-12~~). Prior to unloading the packages from the trailer, they ~~will~~ undergo security and radiological checks and shipping documentation reviews. A forklift ~~will~~ removes the ~~Contact-Handled Packages~~CH packages which ~~will be~~are transported by forklift or Yard Transfer Vehicle through an air lock that is designed to maintain differential pressure in the WHB. The forklift ~~will~~ places the shipping containers at either one of the two TRUDOCKs in the TRUDOCK Storage Area of the WHB Unit or the Yard Transfer Vehicle ~~will~~ locates the TRUPACT-III at the bolting station in Room 108. An external survey of the ~~Contact-Handled Package~~CH package Inner Containment Vessel (**ICV**) lid (Figure M-17~~A1-8a~~ and M-18~~A1-8b~~) ~~will be~~is performed as the

---

personnel involved, specific hazards involved, and protective requirements. The Permittees review the form, check on the adequacy of the protective measures, and if sufficient, approve the work permit. Conditions of the SWPs must be met while any hazardous work is proceeding. Examples of activities covered by the SWP program include confined space entry, overhead work, and work on energized equipment.

[2] RWPs are used to control entry into and performance of work within a controlled area (**CA**). Managers responsible for work within a CA must generate a work permit that specifies the work scope, limiting conditions, dosimetry, respiratory protection, protective clothing, specific worker qualifications, and radiation safety technician support. RWPs are approved by the Permittees after thorough review. No work can proceed in a CA without a valid RWP.

Outer Confinement Vessel (**OCV**) lid is removed. The ICV lid or closure lid ~~will be~~is lifted under the Vent Hood System (**VHS**), and the contents ~~will be~~are surveyed during and after this process is complete. The VHS[3] is attached to the ~~Contact-Handled Package~~CH package to provide atmospheric control and confinement of headspace gases at their source. It also prevents potential personnel exposure and facility contamination due to the spread of radiologically contaminated airborne dust particles and minimizes personnel exposure to VOCs.

Contamination surveys at the WIPP facility are based in part on radiological surveys used to indicate potential releases of hazardous constituents from containers by virtue of detection of radioactive contamination (see Permit Attachment G3). Radiological surveys may be applicable to most hazardous constituent releases except the release of gaseous VOCs from TRU mixed waste containers. Radiological surveys provide the WIPP facility with a very sensitive method of indicating the potential release of nongaseous hazardous constituents through the use of surface sampling (swipes) and radioactivity counting. Radiological surveys are used in addition to the more conventional techniques such as visual inspection to identify spills.

Under normal operations, it is not expected that the waste containers will be externally contaminated pursuant to 10 CFR Part 835~~or that removable surface contamination on the shipping package or the waste containers will be in excess of the DOE's free release limits (i.e.; < 20 disintegrations per minute (**dpm**)[4] per 100 cm^2 alpha or < 200 dpm per 100 cm^2 beta/gamma). In such a case, no further decontamination action is needed. The shipping package and waste container will be handled through the normal process~~. However, should ~~the magnitude of~~there be contamination in excess~~exceed the free release~~ of the radiological control limits pursuant to 10 CFR Part 835, ~~yet still fall within the criteria for small area "spot" decontamination (i.e., less than or equal to 100 times the free release limit and less than or equal to 6 ft^2 [0.56 m^2]),~~ the shipping package or the waste container will be ~~decontaminated~~managed in accordance with radiological control procedures pursuant to 10 CFR Part 835. Decontamination activities will not be conducted on containers ~~which~~ that are not in good condition~~,~~ or ~~containers which~~ are leaking. Containers ~~which~~ that are not in good condition, and containers ~~which~~ that are leaking, will be overpacked (if applicable) in an approved container, repaired/patched in accordance with ~~49 CFR §173 and §178 (e.g., 49 CFR §173.28), or~~appropriate standards and guidance (e.g., 49 CFR §173.28), returned to the generator, or sent to a third-party contractor. In addition, if during the waste handling process at the WIPP facility, a waste container is breached, it will be overpacked (if applicable) in an approved container, repaired/patched in accordance with ~~49 CFR §173 and §178 (e.g., 49 CFR §173.28), or returned to the generator~~appropriate standards and guidance (e.g., 49 CFR

---

[3] The TRU mixed waste container headspace may contain radiologically contaminated airborne dust particles.

1. Without the VHS, a potential mechanism will exist to spread contamination (if present) in the immediate CH TRU mixed waste handling area, because lid removal will immediately expose headspace gases to prevailing air currents induced by the building ventilation system.
2. With the VHS, a confined and controlled set of prevailing air currents will be induced by the system blower. The VHS will function as a local exhaust system to effectively control radiologically contaminated airborne dust particles (and VOCs) at essentially atmospheric pressure conditions.

Functionally, the VHS will draw the TRU mixed waste container headspace gases, convey them through a HEPA filter, and ultimately duct them through the WHB exhaust ventilation system. VOCs will pass through the HEPA filter and will be conveyed to the ventilation exhaust duct system. The system principally consists of a functional aggregation of 1) vent hood assembly, 2) HEPA filter assemblies (to capture any airborne radioactive particles), 3) blower (to provide forced airflow), 4) ductwork, and 5) flexible hose.

~~[4] The unit "dpm" stands for "disintegration per minute" and is the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.~~

§173.28), or managed in accordance with radiological control procedures pursuant to 10 CFR Part 835. The overpacked or repaired container will be labeled and emplaced in an underground HWDU for disposal. Should WIPP facility structures or equipment become contaminated, waste handling operations in the affected area will be ~~immediately suspended~~managed in accordance with standard operating procedures, and the contaminated structures or equipment will be managed consistent with radiological control procedures pursuant to 10 CFR Part 835.

Hazardous waste decontamination activities will use water and cleaning agents (see Permit Attachment D) so as to not generate any waste that cannot be considered derived waste. Items that are radiologically contaminated are also assumed to be contaminated with the hazardous wastes that are in the container involved in the spill or release. A complete listing of these waste components can be obtained from the ~~WIPP Waste Information System (**WWIS**)~~WWIS, as described in Permit Attachment C, for the purpose of characterizing derived waste.

It is assumed that the process of localized surface decontamination will remove the hazardous waste constituents along with the radioactive waste constituents. Therefore, waste containers will be emplaced in the underground HWDUs without further action once localized radiological contamination is removed unless there is visible evidence of hazardous waste spills or hazardous waste on the container. Hazardous waste decontamination will be conducted, if necessary, in accordance with the requirements of the Permit and the standards of 20.4.1.500 NMAC (incorporating 40 CFR Part 264).~~To provide verification of the effectiveness of the removal of hazardous waste constituents, once a contaminated surface is demonstrated to be radiologically clean, the “swipe” will be sent for analysis for hazardous constituents. The use of these confirmation analyses is as follows:~~

~~**For waste containers**, the analyses becomes documentation of the condition of the container at the time of emplacement. The presence of hazardous waste constituents on a container after decontamination will be at trace levels and will likely not be visible and will not pose a threat to human health or the environment. These containers will be placed in the underground without further action once the radiological contamination is removed unless there is visible evidence of hazardous waste spills or hazardous waste on the container and this contamination is considered likely to be released prior to emplacement in the underground.~~

~~**For area contamination**,~~In the event of area contamination, a radiological boundary will be established in accordance with radiological control procedures. Inside this boundary, cleanup activities are controlled with protocols for the cleanup of spills and releases. As dictated by cleanup protocols, decontamination will be managed consistent with radiological control procedures pursuant to 10 CFR Part 835. ~~once~~ Once the area is cleaned up and is shown to be radiologically clean, it will be sampled for the presence of hazardous waste residues. Hazardous waste decontamination will be conducted in accordance with the requirements of the Permit and the standards of 20.4.1.500 NMAC (incorporating 40 CFR Part 264). ~~If the area is large, a~~A sampling plan will be developed, as needed, which incorporates the guidance of ~~EPA's~~ SW~~-~~-846 (EPA, 2015) in selecting random samples over large areas. Selection of constituents for sampling analysis will be based on information (in the WWIS) about the waste that was spilled and information on cleanup procedures. ~~If the area is small, swipes will be used.~~ If the results of the analysis show that residual contamination remains, a decision will be made whether further cleaning will be beneficial or whether final ~~clean up~~clean-up ~~shall~~ will be deferred until closure. ~~For example, if hazardous constituents react with the floor coating and are essentially nonremovable without removing the coating, then clean up will be deferred until closure when the coatings will be stripped. In any case, appropriate~~Appropriate notations will be entered into the ~~operating~~ Operating ~~record~~ Record to assure proper consideration of formerly contaminated areas at the time of closure. Furthermore, measures such as covering, barricading, and/or placarding will be used as needed to mark areas that remain contaminated.

~~Small area decontamination, if needed, will occur in the area in which it is detected for contamination that is less than 6 ft^2 (0.56 m^2) in area and is less than 100 times the free release limit. The free release limit is defined by DOE Orders as alpha contamination less than 20 dpm/100 cm^2 and beta-gamma contamination less than 200 dpm/100 cm^2. Overpacking would occur in the event the WIPP staff damages an otherwise intact container during handling activities. In such a case, a radiological boundary will be established, inside which all activities are carefully controlled in accordance with the protocols for the cleanup of spills or releases. A plan of recovery will be developed and executed, including overpacking or repairing the damaged container. The overpacked or repaired container will be properly labeled and sent underground for disposal. The area will then be decontaminated and verified to be free of contamination using both radiological and hazardous waste sampling techniques (essentially, this is done with "swipes" of the surface for counting in sensitive radiation detection equipment or, if no radioactivity is present, by analysis for hazardous waste by an offsite laboratory).~~

In the event ~~a large~~that extensive area contamination is discovered within a ~~Contact-Handled Package~~CH package during unloading, the waste will be left in the ~~Contact-Handled Package~~CH package and the shipping container will be resealed. The DOE considers such contamination problems the responsibility of the shipping site. Therefore, ~~the shipper will have several options for disposition. These are as follows~~the shipping package will be dispositioned according to the following options:

- The ~~Contact-Handled~~CH Package can be returned to the shipper for decontamination and repackaging of the waste. Such waste would have to be re-approved prior to shipment to the WIPP.

- Shipment to another DOE site for management in the event the original shipper does not have suitable facilities for decontamination. If the repairing site wishes to return the waste to WIPP, the site will have to meet the characterization requirements of the Waste Analysis Plan~~WAP~~.

- The waste could go to a third (non-DOE) party for decontamination. In such cases, the repaired shipment would go to the original shipper and be recertified prior to shipment to the WIPP.

Written procedures specify materials, protocols, and steps needed to put an object into a safe configuration for decontamination of surfaces. ~~A RWP will always be prepared prior to decontamination activities.~~ TRU mixed waste products from decontamination will be managed as derived waste~~.~~[5] and in accordance with radiological control and waste handling procedures.

~~[5] Note that the DOE had previously proposed use of an Overpack and Repair Room to deal with major decontamination and overpacking activities. The DOE has eliminated the need for this area by: 1) limiting the size of contamination events that will be dealt with as described in this section, and 2) by performing overpacking at the point where a need for overpacking is identified instead of moving the waste to another area of the WHB. This strategy minimizes the spread of contamination.~~

The TRUPACT-II may hold up to two ~~7~~seven-packs, two ~~4~~four-packs, and two ~~3~~three-packs of drums;~~,~~ two SWBs;~~,~~ or one TDOP. A HalfPACT may hold seven 55-gal (208-L) drums, one SWB, three shielded containers, or four 85-~~gallon~~ gal drums. The TRUPACT-III holds a single SLB2. An overhead bridge crane or ~~Facility Transfer Vehicle~~Payload Transfer Station ~~will be~~is used to remove the contents of the ~~Contact-Handled Package~~CH package and place them on a facility pallet. ~~The containers will be visually inspected for physical damage (severe rusting, apparent structural defects, signs of pressurization, etc.) and leakage to ensure they are in good condition prior to storage. Waste containers will also be checked for external surface contamination. If a primary waste container is not in good condition, the Permittees will overpack the container, repair/patch the container in accordance with 49 CFR §173 and §178 (e.g., 49 CFR §173.28), or return the container to the generator.~~

For inventory control purposes, TRU mixed waste container identification numbers ~~will be~~are verified ~~against the Uniform Hazardous Waste Manifest and the WWIS~~in accordance with Permit Attachment C, Section C-5b(1). Inconsistencies will be resolved with the generator before TRU mixed waste is emplaced. Discrepancies that are not resolved within 15 days will be reported to the NMED in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.72).

Each facility pallet has two recessed pockets to accommodate two sets of ~~7~~seven-packs (see Figure M-21~~A1-10~~), two sets of ~~4~~four-packs, two sets of ~~3~~three-packs;~~, or~~ two sets of SWBs stacked two-high;~~,~~ two TDOPs;~~,~~ two shielded container assemblies, or three-packs; or any combination thereof. Each facility pallet will accommodate one SLB2. Each stack of waste containers ~~will be~~is secured prior to transport underground. A forklift or the ~~facility~~ Facility ~~transfer~~ Transfer ~~vehicle~~ Vehicle will transport the loaded facility pallet to the conveyance loading room located adjacent to the Waste Shaft. The conveyance loading room serves as an air lock between the CH Bay and the Waste Shaft, preventing excessive air flow between the two areas. The ~~facility~~ Facility ~~transfer~~ Transfer ~~vehicle~~ Vehicle ~~will be~~is driven onto the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance deck, where the loaded facility pallet ~~will be~~is transferred to the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~Conveyance, and the ~~facility~~ Facility ~~transfer~~ Transfer ~~vehicle~~ Vehicle ~~will be~~is backed off. Containers of CH TRU mixed waste (55-gal (208-~~-~~L) drums, SWBs, 85-gal (322-~~-~~L) drums, 100-gal (379-L) drums, and TDOPs) or shielded container assemblies can be handled individually, if needed, using the forklift and lifting attachments (i.e., drum handlers, parrot beaks).

The ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance will lower the loaded facility pallet to the ~~Underground HWDUs~~Waste Shaft Station underground. From there, an underground transporter is used to transport the CH TRU mixed waste to the underground HWDU. Figures M-38 and M-39 ~~A1-13 is a~~are flow diagrams of the CH TRU mixed waste handling process.

A1-1d(3) RH TRU Mixed Waste Handling

The RH TRU mixed waste that is not in a shielded container will be received in the RH-TRU 72-B cask or CNS 10-160B cask loaded on a trailer, as illustrated in process flow diagrams in Figures M-40~~A1-26~~ and M-41~~A1-27~~, respectively. ~~These are shown schematically in Figures A1-28 and A1-29.~~ Remote-~~Handled~~ handled TRU mixed waste received in shielded containers ~~will be~~is managed and stored as CH TRU mixed waste. Prior to unloading the cask from the trailer, external radiological surveys, security checks, shipping documentation reviews are performed, and the Uniform Hazardous Waste Manifest is signed. The generator's copy of the Uniform Hazardous Waste Manifest is returned to the generator. Should the results of the contamination survey exceed acceptable levels, the shipping cask and transport trailer remain outside the WHB in the ~~Parking Area Unit~~PAU, and the appropriate radiological boundaries (i.e., ropes, placards) are erected around the shipping cask and transport trailer. A determination will be made whether to return the cask to the originating site or to decontaminate the cask.

Following cask inspections, the shipping cask and trailer are moved into the RH Bay or held in the ~~Parking Area Unit~~PAU. The waste handling process begins in the RH Bay where the impact limiter(s) are removed from the shipping cask while it is on the trailer. Additional radiological surveys are conducted on the end of the cask previously protected by the impact limiter(s) to verify the absence of contamination. The cask is unloaded from the trailer using the RH Bay Overhead Bridge Crane and placed on a Cask Transfer Car.

Whenever RH TRU mixed waste is present, ~~Differential~~ differential air pressure between the RH TRU mixed waste handling locations in the RH Complex protects workers and prevents potential spread of contamination during handling of RH TRU mixed waste. Airflow between key rooms in the WHB is controlled by maintaining differential pressures between the rooms. The CH Receiving Bay is maintained with a negative pressure relative to outside atmosphere. The RH Receiving Bay is maintained with a requirement to be positive pressure relative to the CH Receiving Bay. The RH Hot Cell is maintained with a negative differential pressure relative to the RH Receiving Bay. The Hot Cell ventilation is exhausted through high-efficiency particulate air filters prior to venting through the WHB filtered exhaust.

RH-TRU 72-B Cask Unloading

The Cask Transfer Car ~~then~~ moves the RH-TRU 72-B cask to a work stand in the RH Bay. The work stand allows access to the head area of the RH-TRU 72-B cask for conducting radiological surveys, performing physical inspections or minor maintenance, and decontamination, if necessary. The outer lid bolts on the RH-TRU 72-B cask are removed, ~~and~~ after which the outer lid is removed to provide access to the lid of the cask ~~ICV~~inner vessel. The RH-TRU 72-B cask is moved into the Cask Unloading Room by a Cask Transfer Car and is positioned under the Cask Unloading Room Bridge Crane. The Cask Unloading Room Bridge Crane attaches to the RH-TRU 72-B cask and lifts and suspends the ~~RH-TRU 72-B~~ cask to clear the Cask Transfer Car. The suspended RH-TRU 72-B cask is then aligned over the Cask Unloading Room port.

The Cask Unloading Room shield valve is opened, and the cask is lowered through the port into the Transfer Cell Shuttle Car. The Cask Unloading Room Bridge Crane is unhooked and retracted, and the Cask Unloading Room shield valve is closed. After the cask is lowered into the Transfer Cell Shuttle Car, the bolts on the lid of the cask ~~ICV~~ inner vessel are loosened by a robotic Manipulator. The Transfer Cell Shuttle Car is then aligned directly under the Transfer Cell shield valve in preparation for removing the ~~ICV~~ inner-vessel lid and transferring the canister to the Facility Cask. Operations in the Transfer Cell are monitored by closed-circuit video cameras.

Using the remotely-operated fixed 6.25 Ton Grapple Hoist in the Facility Cask Loading Room, the ~~ICV~~ inner-vessel lid is lifted clear of the RH-TRU 72-B cask, and ~~the~~ a robotic Manipulator takes swipe samples and places them in a swipe delivery system for counting outside the Transfer Cell. If found to be contaminated above acceptable surface contamination levels as described in 10 CFR Part 835, the Permittees have the option to decontaminate consistent with radiological control procedures, ~~or~~ return the RH TRU Canister to the generator/storage site or another site for remediation, or manage the RH TRU Canister consistent with radiological control procedures pursuant to 10 CFR Part 835. Hazardous waste decontamination, if needed, will be conducted in accordance with the requirements of the Permit and the standards of 20.4.1.500 NMAC (incorporating 40 CFR Part 264). If no contamination is found, the Transfer Cell Shuttle Car moves a short distance, and the ~~ICV~~ inner-vessel lid is lowered onto a stand on the Transfer Cell Shuttle Car~~. The~~, after which the canister is transferred to the Facility Cask as described below.

CNS 10-160B Cask Unloading

After the lid bolts are removed, the CNS 10-160B cask is moved using the Cask Transfer Car from the RH Bay into the Cask Unloading Room and centered beneath the Hot Cell shield plug port. The Cask Unloading Room shield door is closed, and the inner and outer Hot Cell shield plugs are removed simultaneously and set aside on the floor of the Hot Cell using the remotely operated Hot Cell Bridge Crane. The Hot Cell Bridge Crane is then lowered through the Hot Cell port and is connected to the CNS 10-160B cask lid rigging or lifting device. The Hot Cell Bridge Crane lifts the CNS 10-160B cask lid through the Hot Cell port and sets the lid aside on the Hot Cell floor.

Operations in the Hot Cell are monitored by closed-circuit television cameras. The drum carriage unit lifting fixture (hereafter referred to as lifting fixture) is attached to the Hot Cell Bridge Crane and lowered through the Hot Cell port. The lifting fixture is connected to the upper drum carriage unit contained in the CNS 10-160B cask. The Hot Cell Bridge Crane lifts the upper drum carriage unit from the CNS 10-160B cask through the port into the Hot Cell and sets it near the Hot Cell inspection station. The Hot Cell Bridge Crane again lowers the lifting fixture through the Hot Cell port and connects to the lower drum carriage unit. The Hot Cell Bridge Crane lifts the lower drum carriage unit from the CNS 10-160B cask through the port into the Hot Cell and sets it near the upper drum carriage unit.

The Hot Cell Bridge Crane lifts the CNS 10-160B cask lid from the Hot Cell floor, lowers it through the Hot Cell port and onto the top of the CNS 10-160B cask. The inner and outer Hot Cell shield plugs are replaced simultaneously. The Cask Unloading Room shield door is opened, and the CNS 10-160B cask is moved into the RH Bay using the Cask Transfer Car. The CNS 10-160B cask is inspected and surveyed, the lid and impact limiter are reinstalled on the CNS 10-160B cask, and it is prepared for transportation off-site.

The Hot Cell Bridge Crane connects to an empty Facility Canister, places it into a sleeve at the inspection station, and removes the canister lid. The Overhead Powered Manipulator or Hot Cell Crane lifts one drum from the drum carriage unit. The Hot Cell Manipulators collect swipe samples from the drum and transfer the swipes via the Transfer Drawer to the Hot Cell Gallery for counting. If the 55-~~gallon~~ gal (208-L) drums are contaminated, the Permittees may decontaminate the 55-~~gallon~~ gal (208-L) drums or return them to the generator/storage site or another site for remediation. The drum identification number is recorded, and the recorded numbers are verified against the WWIS. If there are any discrepancies, the drum(s) in question are stored within the Hot Cell, and the generator/storage site is contacted for resolution. Discrepancies that are not resolved within 15 days will be reported to the NMED as required by 20.4.1.500 NMAC (incorporating 40 CFR §264.72).

Either the Overhead Powered Manipulator or Hot Cell Bridge Crane lowers the drum into the Facility Canister. This process is repeated to place three drums in the Facility Canister. The Hot Cell Bridge Crane or powered Manipulator lifts the canister lid and places it onto the Facility Canister. The lid is locked in place using a Manipulator. Each CNS 10-160B cask shipment will contain up to ten drums. Drums ~~will be~~are managed in sets of three. If there is a tenth drum, it will be placed in a Facility Canister or stored until ~~WIPP~~ receipt of the next CNS 10-160B cask shipment at the WIPP facility. The Hot Cell Bridge Crane lifts the Facility Canister and lowers it into the Transfer Cell.

To prepare to transfer a loaded Facility Canister from the Hot Cell to the Transfer Cell, a Shielded Insert is placed onto a Cask Transfer Car in the RH Bay. The Cask Transfer Car is then moved into the Cask Unloading Room and positioned under the Cask Unloading Room Bridge Crane. The Bridge Crane attaches to the Shielded Insert. The Cask Unloading Room Bridge Crane lifts and suspends the Shielded Insert clear of the Cask Transfer Car. The Shielded Insert is aligned over the Cask Unloading Room port. The floor valve is opened, and the Shielded Insert is lowered into the Transfer Cell Shuttle Car. The Cask Unloading Room Bridge Crane is unhooked and retracted, and the Cask Unloading Room shield valve is closed. The Shielded Insert is positioned under the Hot Cell port.

The Hot Cell Bridge Crane lifts a loaded, closed Facility Canister and positions it over the Hot Cell port. The Hot Cell shield valve is opened, and the crane lowers the Facility Canister through the port into the Shielded Insert positioned in the Transfer Cell Shuttle Car in the Transfer Cell. The Hot Cell Bridge Crane is disconnected from the Facility Canister and raised until the crane hook clears the Hot Cell shield valve. The Hot Cell shield valve is then closed.

Transfer of Disposal Canister into the Facility Cask

The transfer of a canister into the Facility Cask from the Transfer Cell is monitored by closed-circuit television cameras. The Transfer Cell Shuttle Car positions the RH-TRU 72-B cask or Shielded Insert under the Facility Cask Loading Room port and the shield valve is opened. Then the remotely operated 6.25 Ton Grapple Hoist attaches to the canister, and the canister is lifted through the open shield valve into the vertically-oriented Facility Cask located on the Facility Cask Transfer Car in the Facility Cask Loading Room. During this cask-to-cask transfer, the telescoping port shield is in contact with the underside of the Facility Cask to assure shielding continuity, as does the shield bell located above the Facility Cask.

For canisters received at the WIPP facility from the generator site in a RH-TRU 72-B cask, the identification number is verified using cameras, which also provide images of the canister surfaces during the lifting operation. Identification numbers are verified ~~against the WWIS~~in accordance with Permit Attachment C, Section C-5b(1). If there are any discrepancies, the canister is returned to the RH-TRU 72-B cask, returned to the ~~Parking Area Unit~~PAU, and the generator is contacted for resolution. Discrepancies that are not resolved within 15 days will be reported to the NMED as required by 20.4.1.500 NMAC (incorporating 40 CFR §264.72). As the canister is being lifted from the RH-TRU 72-B cask into the Facility Cask, additional swipe samples may be taken.

Transfer of the Canister to the Underground

When the canister is fully within the Facility Cask, the lower shield valve is closed. The 6.25 Ton Grapple Hoist detaches from the canister and is raised until the 6.25 Ton Grapple Hoist clears the Facility Cask, at which time the upper shield valve is closed. The 6.25 Ton Grapple Hoist and shield bell are then raised clear of the Facility Cask, and the telescoping port shield is retracted. The Facility Cask Rotating Device rotates the Facility Cask until it is in the horizontal position on the Facility Cask Transfer Car. The shield doors on the Facility Cask Loading Room are opened, and the ~~facility~~ Facility Cask Transfer Car moves onto the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance and is lowered to the ~~waste~~ Waste Shaft Station underground. At the ~~waste~~ Waste Shaft Station underground, the Facility Cask Transfer Car moves the Facility Cask from the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~Conveyance. A forklift is used to remove the Facility Cask from the Facility Cask Transfer Car and to transport the Facility Cask to the ~~U~~underground HWDU.

Returning the Empty Cask

The empty RH-TRU 72-B cask or Shielded Insert is returned to the RH Bay by reversing the process. In the RH Bay, swipe samples are collected from inside the empty cask. If necessary, the inside of the cask is decontaminated. The RH-TRU 72-B cask lids are replaced, and the cask is replaced on the trailer using the RH Bay Bridge Crane. The impact limiters are replaced, and the trailer and the RH-TRU 72-B cask are then moved out of the RH Bay. The Shielded Insert is stored in the RH Bay until needed.

A1-1d(4) Handling Waste in Shielded Containers

Remote-~~Handled~~ handled TRU mixed waste received at the WIPP facility in shielded containers ~~will be~~are managed, stored, and emplaced as CH TRU mixed waste using the CH TRU mixed waste handling equipment described in this Permit. Shielded containers with RH TRU mixed waste will arrive by tractor-trailer at the WIPP facility in sealed HalfPACTs. Prior to unloading the packages from the trailer, they will undergo security and radiological checks and shipping documentation reviews. Consistent with the handling of HalfPACT shipping packages in Section A1-1d(2), a forklift will remove the HalfPACT and transport it into the WHB and place the HalfPACT at either one of the two TRUDOCKs in the TRUDOCK Storage Area of the WHB Unit.

An external survey of the HalfPACT ICV lid ~~will be~~is performed as the OCV lid is removed. The ICV lid ~~or closure lid will be~~is lifted under the VHS, and the contents ~~will be~~are surveyed during and after this process is complete. A description of the VHS and criteria that are applied if radiological contamination is detected are discussed in Section A1-1d(2).

Shielded containers ~~will be~~are received as three-pack assemblies in HalfPACTs. An overhead bridge crane ~~will be~~is used to remove the ~~contents of the~~ shielded container assembly and place them on a facility pallet. The containers ~~will be~~are visually inspected for physical damage ~~(severe rusting, apparent structural defects, signs of pressurization, etc.)~~ and leakage to ensure they are in good condition prior to storage. Waste containers ~~will~~ are also ~~be~~ checked for external radiological surface contamination through the use of swipes and radiation monitoring equipment, consistent with radiological control procedures pursuant to 10 CFR Part 835. If a primary waste container is not in good condition, the Permittees will either overpack the container with another approved container, repair/patch the container in accordance with ~~49 CFR §173 and §178 (e.g., 49 CFR §173.28)~~appropriate standards and guidance (e.g., 40 CFR §173.28), ~~or~~ return the container to the generator, or send the HalfPACT to a third-party contractor. If local decontamination activities are opted for, the work will be conducted in the WHB Unit, consistent with radiological control procedures.

Once the shielded container assembly is on the facility pallet, the TRU mixed waste container identification numbers ~~will be~~are verified ~~against the Uniform Hazardous Waste Manifest and the WWIS~~in accordance with Permit Attachment C, Section C-5b(1). Inconsistencies will be resolved as discussed in Section A1-1d(2) of this Permit Attachment. Up to two three-pack assemblies of shielded containers ~~will be~~are placed on a facility pallet. The use of facility pallets ~~will~~ elevates the waste at least 6 in. (15 cm) from the floor surface. Pallets of waste ~~will~~ are then ~~be relocated to~~maintained in the CH Bay Storage Area of the WHB Unit for normal storage or ~~will be~~are transported to the conveyance loading room as described in Section A1-1d(2).

A1-1e Inspections

Inspection of containers and container storage area are required by 20.4.1.500 NMAC (incorporating 40 CFR §264.174). These inspections are described in this section.

A1-1e(1) WHB Unit

The waste containers in storage ~~will be~~are inspected visually or by closed-circuit television camera prior to each movement and, at a minimum, weekly, to ensure that the waste containers are in good condition and that there are no signs that a release has occurred. ~~Waste containers will be visually inspected for physical damage (severe rusting, apparent structural defects, signs of pressurization, etc.) and leakage. If a primary waste container is not in good condition, the Permittees will overpack the container, repair/patch the container in accordance with 49 CFR §173 and §178 (e.g., 49 CFR §173.28), or return the container to the generator.~~ This visual inspection of CH TRU mixed waste containers shall not include the center drums of ~~7~~seven-packs and waste containers positioned such that visual observation is precluded due to the arrangement of waste assemblies on the facility pallets. If waste handling operations should stop for any reason with containers located at the TRUDOCK while still in the ~~Contact-Handled Package~~CH package, primary waste container inspections will not be accomplished until waste handling operations are resumed and the containers of waste are removed from the ~~Contact-Handled Package~~CH package. If the lid to the ~~Contact-Handled Package~~CH package ICV is removed, radiological checks (swipes of ~~Contact-Handled Package~~CH package inner surfaces) ~~will be~~are used to determine if there is contamination within the ~~Contact-Handled Package~~CH package. Such contamination could indicate a possible waste container leak or spill. Using radiological surveys, a detected spill or leak of a radioactive contamination from a waste container will also be assumed to be a hazardous waste spill or release.

~~Waste containers residing within a Contact-Handled Package are not inspected, as described in the first bullet in Section A1-1e(2).~~

~~Waste containers will be inspected prior to reentering the waste management process line for downloading to the underground. Waste containers stored in this area will be inspected at least once weekly.~~

Loaded RH-TRU 72-B and CNS 10-160B casks ~~will be~~are inspected when present in the RH Bay. Physical or closed-circuit television camera inspections of the RH Complex are conducted as described in Table ~~D~~E-1a. Canisters loaded in an RH-TRU 72-B cask are inspected in the Transfer Cell during transfer from the cask to the Facility Cask. Waste containers received in CNS 10-160B casks are inspected in the Hot Cell during transfer from the cask to the Facility Canister by camera and/or visual inspection (through shield windows).

A1-1e(2) Parking Area Unit

Inspections ~~will be~~are conducted in the ~~Parking Area Unit~~PAU at a frequency not less than once weekly when waste is present. These inspections are applicable to loaded, stored ~~Contact-~~

~~Handled and Remote-Handled Packages~~CH and RH packages. The perimeter fence located at the lateral limit of the ~~Parking Area Unit~~PAU, coupled with personnel access restrictions into the WHB, ~~will~~ provides the needed security. The perimeter fence and the southern border of the WHB shall mark the lateral limit of the ~~Parking Area Unit~~PAU (Figure M-2~~A1-2~~). Inspections of the ~~Contact-Handled or Remote-Handled Packages~~CH or RH packages stored in the ~~Parking Area Unit~~PAU ~~will~~ focus on the inventory and integrity of the shipping containers and the spacing between ~~Contact-Handled and Remote-Handled Packages~~CH or RH packages. This spacing ~~will be~~is maintained at a minimum of four feet.

~~Contact-Handled and Remote-Handled Packages located in the Parking Area Unit will be inspected weekly during use and prior to each reuse.~~

Inspection of waste containers is not possible when the containers are in their shipping container~~ (e.g., casks, TRUPACT-II or HalfPACTs)~~. Inspections can be accomplished by bringing the shipping containers into the WHB Unit and opening them and ~~lifting~~ removing the waste containers ~~out~~ for inspection. The DOE, however, believes that removing containers strictly for the purposes of inspection results in unnecessary worker exposures and subjects the waste to additional handling. The DOE has proposed that waste containers need not be inspected ~~at all~~ until they are ready to be removed from the shipping container for emplacement underground. Because shipping containers are sealed and are of robust design, no harm can come to the waste while in the shipping containers and the waste cannot leak or otherwise be released to the environment. ~~Contact-Handled or Remote-Handled Packages shall be opened every 60 days for the purposes of venting, so that t~~The longest amount of time waste containers would be uninspected would be for ~~60~~ 59 days ~~from the date that the ICV of the Contact-Handled or Remote-Handled Package was closed at the generator site~~after the ICV Closure Date, as recorded in the WWIS. ~~Venting the Contact-Handled or Remote-Handled Packages involves removing the outer lid and installing a tool in the port of the inner lid.~~

The following strategy will be used for inspecting waste containers that will be retained within their shipping containers for an extended period of time; this will minimize the amount of shipping and waste handling, while maintaining a reasonable inspection schedule:

- If the reason for retaining the TRU mixed waste containers in the shipping container is due to an unresolved manifest discrepancy, the DOE will return the shipment to the generator prior to the expiration of the 60-~~-~~day NRC venting period or within 30 days after receipt at the WIPP facility, whichever comes sooner. In this case, no inspections of the internal containers will be performed. The stored ~~Contact-Handled or Remote-Handled Package~~CH or RH package will be inspected weekly as described above.

- If the reason for retaining the TRU mixed waste containers in the ~~Contact-Handled or Remote-Handled Package~~CH or RH package is due to an equipment malfunction that prevents unloading the waste in the WHB Unit, the DOE will return the shipment to the generator prior to the expiration of the 60-~~-~~day NRC venting period. In this case, the DOE would have to ship the TRU mixed waste containers back with sufficient time for the generator to vent the shipment within the 60-~~-~~day ~~limit~~NRC venting period. In this case, no inspections of the internal containers will be performed. The stored ~~Contact-Handled or Remote-Handled Package~~CH or RH package will be inspected weekly as described above.

- If the reason for retaining the TRU mixed waste containers is due to an equipment malfunction that prevents the timely movement of the waste containers into the underground, the waste containers ~~will~~ may be kept in the ~~Contact-Handled or Remote-Handled Package~~CH or RH package no longer than day 59 ~~until day 30 (after receipt at the WIPP) or the expiration~~ of the 60-~~-~~day ~~limit~~NRC venting period~~,~~ ~~whichever comes sooner~~. At that time the ~~Contact-Handled or Remote-Handled Package~~CH or RH package will be moved into the WHB Unit. Contact-~~Handled~~ handled TRU mixed waste containers will be removed ~~and placed in one of the permitted storage areas in the WHB Unit~~from their shipping package; if the maximum capacity of the CH Bay Storage Area has been reached, the Permittees may implement CH Bay Surge Storage in accordance with the notification requirements of Permit Part 3, Section 3.1.1.3. The ~~Remote-Handled Package~~RH package will be vented, however, the containers will not be removed from the shipping package. If there is no additional space within the permitted storage areas of the WHB Unit, the ~~DOE~~ Permittees will discuss an emergency permit with the NMED for the purposes of storing the waste ~~elsewhere in the WHB Unit~~. Waste containers will be inspected when removed from the ~~Contact-Handled Packaging~~CH packaging and weekly while in storage in the WHB Unit. ~~Contact-Handled or Remote-Handled Packages~~The CH or RH packages will be inspected weekly while they contain TRU mixed waste containers as discussed above.

~~The DOE believes that this strategy minimizes both the amount of shipping that is necessary and the amount of waste handling, while maintaining a reasonable inspection schedule. The DOE will stop shipments of waste for any equipment outage that will extend beyond three days.~~

A1-1f Containment

The WHB Unit has concrete floors, which are sealed with a coating that is designed to resist all but the strongest oxidizing agents. Such oxidizing agents do not meet the TSDF-WAC and ~~will~~ are not ~~be~~ accepted in TRU mixed waste at the WIPP facility. Therefore, TRU mixed wastes pose no compatibility problems with respect to the WHB Unit floor. ~~The floor coating consists of Carboline® 1340 clear primer-sealer on top of prepared concrete, Carboline® 191 primer epoxy, and Carboline® 195 surface epoxy. The manufacturer's chemical resistance guide shows "Very Good" for acids and "Excellent" for alkalies, solvents, salt, and water. Uses are indicated for nuclear power plants, industrial equipment and components, chemical processing plants, and pulp and paper mills for protection of structural steel and concrete. During the Disposal Phase, should the floors need to be re-coated, any floor coating used in the WHB Unit TRU mixed waste handling areas will be compatible with the TRU mixed waste constituents and will have chemical resistance at least equivalent to the Carboline® products. Figure A1-1 shows where TRU mixed waste handling activities discussed in this section occur.~~

During normal operations, ~~the floor of~~ the storage areas within the WHB Unit ~~shall be~~are visually inspected on a weekly basis to verify that ~~it~~ the concrete floor is in good condition and free of obvious cracks and gaps. Floor areas of the WHB Unit in use during off-normal events ~~will be~~are inspected prior to use and weekly thereafter. ~~All TRU~~Transuranic mixed waste containers located in the permitted storage areas ~~shall be~~are elevated at least 6 in. (15 cm) from the surface of the floor. TRU mixed waste containers that have been removed from ~~Contact-Handled or Remote-Handled Packaging~~CH or RH packages ~~shall be~~are stored ~~at a designated storage area~~ inside the WHB Unit so as to preclude exposure to the elements.

Secondary containment at the CH Bay Storage Area inside the WHB Unit ~~shall be~~is provided by the WHB Unit concrete floor (See Figure M-1~~A1-1~~). The WHB Unit is engineered such that during normal operations, the floor capacity is sufficient to contain liquids upon release. Secondary Containment at the Derived Waste Storage Area of the WHB Unit ~~will be~~is provided by a polyethylene ~~standard drum~~containment pallet. The ~~Parking Area Unit~~PAU and TRUDOCK Storage Area of the WHB Unit require no engineered secondary containment since no waste is to be stored there unless it is protected by the ~~Contact-Handled or Remote-Handled Packaging~~CH or RH packaging.

Calculations to determine the floor surface area required to provide secondary containment in the event of a release are based on the maximum quantity of liquid which could be present within ten percent of one percent of the volume of ~~all~~ the containers or one percent of the capacity of the largest single container, whichever is greater.

Secondary containment at storage locations inside the RH Bay and Cask Unloading Room is provided by the cask. Secondary containment at storage locations inside the Transfer Cell is provided by the RH-TRU 72-B cask or Shielded Insert. Secondary containment at storage locations in the Facility Cask Loading Room is provided by the Facility Cask. In the Hot Cell, waste containers are stored in either the drum carriage unit or in ~~canister sleeves~~Facility Canisters. The Lower Hot Cell provides secondary containment as described in section A1-f(2). In addition, the RH Bay, Hot Cell, and Transfer Cell contain 220-~~gallon~~ gal (833-L) (Hot Cell), 11,400-~~gallon~~ gal (43,152-L) (RH Bay), and 220-~~gallon~~ gal (833-L) (Transfer Cell) sumps, respectively, to collect any liquids.

A1-1f(1) Secondary Containment Requirements for the WHB Unit

The maximum TRU mixed waste volume on facility pallets that ~~will~~ could be stored in the CH Bay Storage and Surge Storage Areas of the WHB is 18 facility pallets @ 2 TDOPs per pallet = 36 TDOPs of waste. 36 TDOPs @ 1,200 gal (4,540 L) per TDOP = 43,200 gal (163,440 L) waste container capacity. 43,200 gal (163,440 L) x ten percent of the total volume = 4,320 gal (16,344 L) of waste. Since 4,320 gal (16,344 L) is greater than 1,200 gal (4,540 L), the configuration of possible TDOPs in the storage area is used for the calculation of secondary containment requirements. 4,320 gal (16,344 L) of liquid x one percent liquids = 43.2 gal (163.4 L) of liquid for which secondary containment is needed.

The maximum TRU mixed waste volume that ~~will~~ could be stored in the Derived Waste Storage Area of the WHB Unit is one SWB. 1 SWBs @ 496 gal (1,878 L) per SWB = 496 gal (1,878 L) waste container capacity. Since the maximum storage volume of 496 gal (1,878 L) is equal to the volume of the largest single container, the volume of ~~the~~ a single SWB is used for the calculation of secondary containment requirements. 496 gal (1,878 L) of liquid x one percent liquids = 4.96 gal (18.8 L) of liquid for which secondary containment is needed.

The maximum TRU mixed waste volume that ~~will~~ could be stored in the Hot Cell is 13 RH TRU drums @ 55 gal (210 L) per drum = 715 gal (2,730 L) of waste in drums. 715 gal (2,730 L) of waste x ten percent of total volume = 71.5 gal (273 L) of waste. Secondary containment for liquids will need to have a capacity of 71.5 gal (273 L). Since 71.5 gal (273 L) is less than the volume of the single container of 235 gal (890 L) therefore, the larger volume is used for determining the secondary containment requirements. 235 gal (890 L) of waste x one percent liquids = 2.35 gal (8.9 L) of liquid needed for secondary containment.

The maximum TRU mixed waste volume that ~~will~~ could be stored in the Transfer Cell is one RH-TRU 72-B Canister or one Facility Canister @ 235 gal (890 L) per canister x ten percent of total volume = 23.5 gal (8.90 L) of waste. Since 23.5 gal (8.90 L) is less than the volume of the single container of 235 gal (890 L) therefore, the larger volume is used for determining the secondary containment requirements. 235 gal (890 L) of waste x one percent liquids = 2.35 gal (8.9 L) of liquid needed for secondary containment.

A1-1f(2) Secondary Containment Description

The following is a calculation of the surface area the quantities of liquid would cover. Using a conversion factor of 0.1337 ft^3/gal (0.001 m^3/L) and assuming the spill is 0.0033 ft (0.001 m) thick, the following calculation can be used:

gallons × cubic feet per gallon ÷ thickness in feet = area covered in square feet

CH Bay Storage Area

$$43.2 \text{ gal} \times 0.1337 \text{ ft}^3/\text{gal} \div 0.0033 \text{ ft} = 1{,}750 \text{ ft}^2 \ (162.7 \text{ m}^2)$$

Hot Cell

$$2.35 \text{ gal} \times 0.1337 \text{ ft}^3/\text{gal} \div 0.0033 \text{ ft} = 95 \text{ ft}^2 \ (8.8 \text{ m}^2)$$

Transfer Cell

$$2.35 \text{ gal} \times 0.1337 \text{ ft}^3/\text{gal} \div 0.0033 \text{ ft} = 95 \text{ ft}^2 \ (8.8 \text{ m}^2)$$

The WHB Unit has 33,175 ft^2 (3,082 m^2) of floor space, the CH Bay Storage Area has 26,151 ft^2 ~~(~~(2,430 m^2) of floor space. The CH Bay Storage Area requires 1,750 ft^2 (162.7 m^2) for containment, Thus, the floor area of the CH Bay Storage Area of the WHB Unit provide sufficient secondary containment to contain a release of ten percent of one percent of the volume of ~~all of~~ the containers, or one percent of the capacity of the largest container, whichever is greater.

The Hot Cell and Transfer Cell are the only portions of the RH Complex managing RH TRU mixed waste outside of casks or canisters. The Hot Cell has 1,841 ft^2 (171 m^2) of floor space and the Transfer Cell has 1,003 ft^2 (93 m^2) of floor space. The Hot Cell and Transfer Cell require only 95 ft^2 for containment, therefore there is sufficient floor space to contain a release of ten percent of one percent of containers in these storage areas.

In addition, both the Hot Cell and the Transfer Cell each contain a 220 gal (833 L) sump that will collect ~~any~~ liquids that spill from containers.

Derived Waste Storage Area

The derived waste containers in the Derived Waste Storage Area ~~will be~~are stored on ~~standard drum~~containment pallets, which provides approximately 50 gal (190 L) of secondary containment capacity. Thus, the secondary containment capacity of the ~~standard drum~~containment pallet is sufficient to contain a release of ten percent of one percent of the largest container (4.96 gal or 18.8 L).

Parking Area Unit

Containers of TRU mixed waste to be stored in the ~~Parking Area Unit~~PAU ~~will be~~are in ~~Contact-Handled or Remote-Handled Packages~~CH or RH packages. There ~~will be~~are no additional requirements for engineered secondary containment systems.

A1-1g Special Requirements for Ignitable, Reactive, and Incompatible Waste

Special requirements for ignitable, reactive, and incompatible waste are addressed in 20.4.1.500 NMAC (incorporating 40 CFR §§264.176 and 264.177). Permit Part 2 precludes ignitable, reactive, or incompatible waste at the WIPP facility. No additional measures are required.

A1-1h Closure

Clean closure is planned in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.178) for ~~all~~ permitted container storage areas. The applicable areas and the plans for clean closure are detailed in Permit Attachment G.

A1-1i Control of Run On

The WHB Unit is located indoors which prevents run-on from a precipitation event. In addition, the CH TRU containers are stored on facility pallets~~,~~ or containment pallets~~, or standard drum pallets~~, which elevate the CH TRU mixed waste containers at least 6 in. (15 cm) off the floor, or in ~~Contact-Handled or Remote-Handled Packages~~CH or RH packages, so that any firewater released in the building will not pool around containers. Within the RH Bay, Cask Unloading Room, Transfer Cell, and Facility Cask Loading Room, waste containers are stored in casks or Shielded Inserts and protected from any potential run on. Any firewater released in the building will not pool around the waste containers as they are stored in casks, or Shielded Inserts. Within the Hot Cell, there is no source of water during operations. However, control of run-on is provided by the Lower Hot Cell, which lies below a sloped floor surrounded by a grating and ~~canister sleeves~~Facility Canisters in the Hot Cell above.

In the ~~Parking Area Unit~~PAU, the containers of TRU mixed waste are always in ~~Contact-Handled or Remote-Handled Packages~~CH or RH packages which protect them from precipitation and run on. Therefore, the WIPP facility container storage units will comply with the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.175(b)(4)).

References

DOE, 1997a. Resource Conservation and Recovery Act Part B Permit Application, Waste Isolation Pilot Plant (WIPP), Carlsbad, New Mexico, Rev. 6.5, 1997.

~~DOE, 1997b. Waste Isolation Pilot Plant Safety Analysis Report (DOE/WIPP-95-2065, Rev. 1), U.S. Department of Energy, Carlsbad Area Office, Carlsbad, NM, April 1997.~~

DOE, 2009. WIPP Hazardous Waste Facility Permit Amended Renewal Application, Carlsbad, New Mexico, September 2009.

EPA. 2015. SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* Office of Solid Waste and Emergency Response, Washington, D.C.

TABLES

~~Table A1-1~~
~~Basic Design Requirements, Principal Codes, and Standards~~

	~~Structure/Supports~~			~~Liquid and Process Air Handling Processing and storage equipment~~							~~Air Hdlg Ducting & Fans~~	~~HVAC filters~~		~~Mechanical Handling Equipment~~			~~Instrumentation and Electrical~~			~~Quality Assurance Program~~	
					~~Piping & Valves~~																
	~~DBE DBT ACI-318 AISC~~	~~ANSI A58.1~~	~~Site-specific Require-ments~~	~~Vessel ASME VIII NFPA~~^{e}	~~ANSI BBB,1 NFPA~~^{e}	~~UP~~	~~Pumps API-610 NFPA~~^{e}	~~Storage Tanks API-650 or API-620~~	~~Heat Exchgrs ASME VIII TEMA~~	~~All Other Equip-ment Mfrs Std~~	~~ARI SMACNA AMCA~~	~~Pre-filters ASHRAE 52.68~~	~~HEPA Filters MIL F 51068C ANSI N 509 ANSI N 510~~	~~Crane and Related equipment CMAA~~	~~CMAA AISC AWS~~	~~All Other Equip-meant Mfrs STD~~	~~A-NE~~	~~ANSI Sods or Nat'l Elect-trial Code~~	~~IA/ Mfrs Std~~	~~ANSI/ASME NQA-1 and Supple-ments~~	~~Com. and Industry Practices~~
~~Design Class I~~	~~X~~		~~a~~	~~X~~ ~~f~~			~~X~~	~~X~~	~~X~~		~~X~~ ~~c~~	~~X~~ ~~c,d~~	~~X~~ ~~c~~	~~X~~	~~X~~		~~X~~	~~X~~		~~X~~	
~~Design Class Ii~~	~~a,b~~	~~X~~	~~a~~	~~X~~	~~X~~		~~X~~	~~X~~	~~X~~		~~X~~ ~~c~~	~~X~~ ~~c~~	~~X~~ ~~c~~	~~X~~	~~X~~			~~X~~	~~X~~	~~X~~	
~~Design Class Iiia~~	~~a~~	~~X~~	~~a~~	~~a~~	~~X~~		~~a~~			~~X~~	~~X~~ ~~c~~	~~X~~ ~~c~~	~~X~~ ~~c~~	~~a~~	~~a~~	~~X~~		~~X~~	~~X~~	~~X~~	
~~Design Class Iii~~		~~X~~	~~g~~		~~a~~	~~X~~				~~X~~	~~X~~	~~X~~	~~X~~			~~X~~		~~X~~	~~X~~		~~X~~

~~X = Minimum Requirements~~

[a] ~~Requirements to be determined on a case-by-case basis.~~
[b] ~~Required for structure and supports needed for confinement and control of radioactivity.~~
[c] ~~Except structures and supports that are designed to withstand a design-basis earthquake (DBE)/design-basis tornado (DBT) when specified in column 1 of this table.~~
[d] ~~Underwriter's Laboratory (UL) Class I Listed.~~
[e] ~~For fire-protection systems.~~
[f] ~~American Society for Mechanical Engineers (ASME) III for other Class I vessels.~~
[g] ~~Design of underground structures, mining equipment, and facilities are basically governed by the MSHA and experience in local mines.~~

~~ACI = American Concrete Institute~~
~~AISC = American Institute of Steel Construction~~
~~AMCA = Air Moving and Conditioning Association~~
~~ANSI = American National Standards Institute~~
~~API = American Petroleum Institute~~
~~ARI = Air Conditioning and Refrigeration Institute~~
~~ASHRAE = American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc.~~
~~AWS = American Welding Society~~
~~CMAA = Crane Manufacturers Association~~
~~DBE = Design-basis earthquake~~
~~DBT = Design-basis tornado~~
~~HEPA = High-efficiency particulate air~~
~~HVAC = Heating, Ventilation, and Air-Conditioning~~
~~A = Institute of Electronics and Electronic Engineers~~
~~IA = Instrument Society of America~~
~~MFR = Manufacturer~~
~~MIL = Military (specification)~~
~~MSHA = Mine Safety and Health Administration~~
~~NFPA = National Fire Protection Association~~
~~NQA = Nuclear Quality Assurance (Standard)~~
~~SMACNA = Sheet Metal and Air Conditioning Contractors National Association, Inc.~~
~~STD = Standard~~
~~TEMA = Tubular Exchanger Manufacturers Association~~
~~UP = Uniform Plumbing Code~~

Table A1-1
TRU Mixed Waste Containers[a]

DESCRIPTION	VOLUME		DIMENSIONS (inches)			LINER	USE FOR DERIVED WASTE	FIGURE
	CUBIC FEET	CUBIC METERS	LENGTH	WIDTH OR DIAMETER	HEIGHT			
55-gal (208-L) drum	7.4	0.21	N/A	24	35	Optional	Yes	M-3
Standard waste box	66.3	1.88	71	54	36	No	Yes	M-4
Ten-drum overpack	160	4.5	N/A	72	73	No	Yes, in under-ground	M-5
85-gal (322-L) drum	11.4	0.32	N/A	26	36	Optional	Yes	M-6
100-gal (379-L) drum	13.4	0.38	N/A	32	35	Optional	No	M-7
Standard large box 2	261	7.39	108	69	73	No	No	M-8
Facility canister	31.4	0.89	N/A	28	117	No	No	M-9
RH TRU canister	31.4	0.89	N/A	26	120	Insert optional	No	M-10
Shielded container	7.4	0.21	N/A	23	36	1 inch of lead shielding	No	M-11

N/A Not applicable to drums

[a] TRU mixed waste containers may also be used to overpack waste containers that, upon removal from the shipping package, have been determined to be leaking or not in good condition.

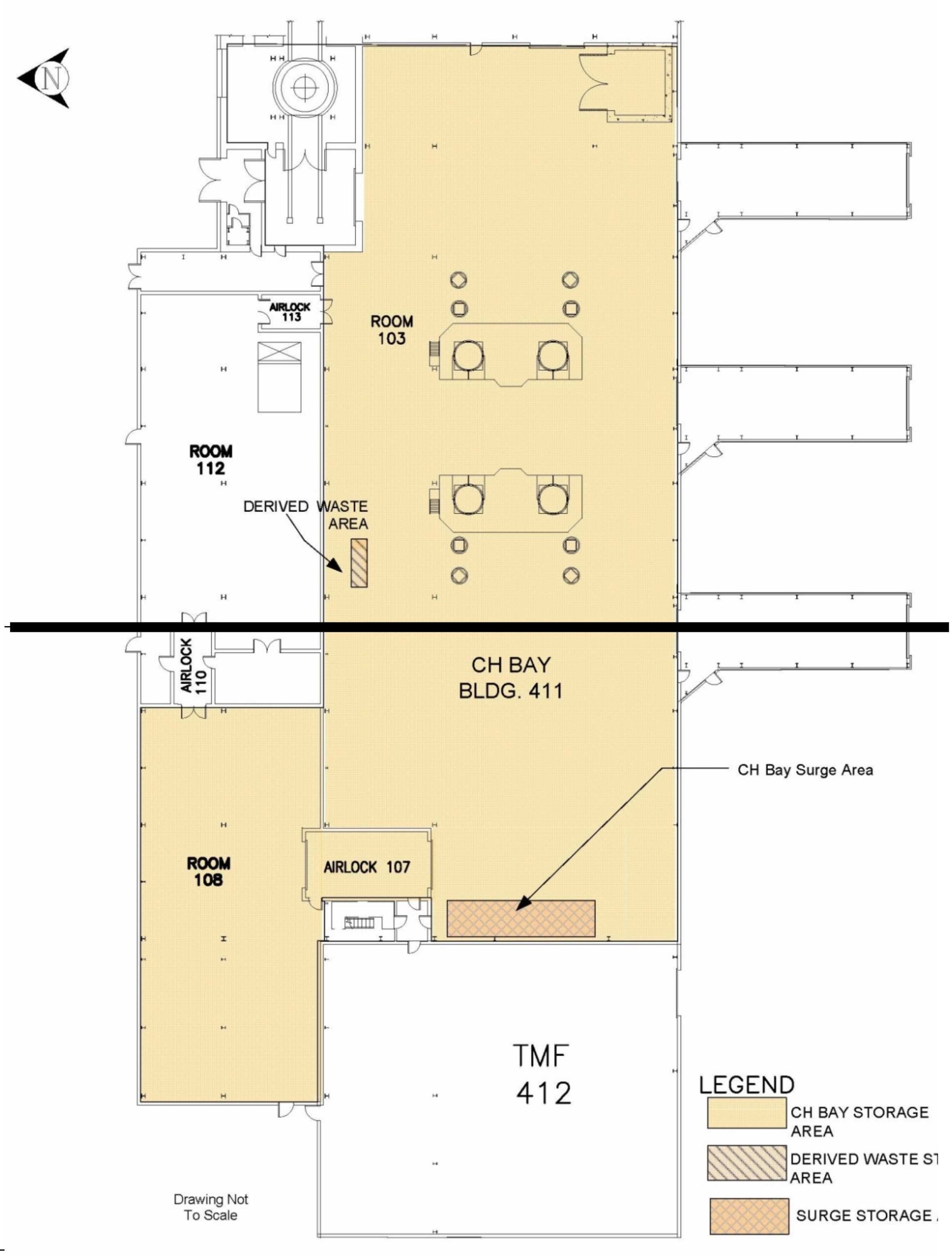
Table A1-2
CH TRU Mixed Waste Handling Equipment Capacities

CAPACITIES FOR EQUIPMENT (lb)	
CH Bay overhead bridge crane	12,000 ~~lbs.~~
Surface forklifts	26,000 ~~lbs.~~ (CH Bay forklift) 70,000 ~~lbs.~~ (TRUPACT-III Handler forklift)
Facility Pallet	25,000 ~~lbs.~~
~~Adjustable center-of-gravity lift fixture~~LIft Fixture	10,000 ~~lbs.~~
Facility Transfer Vehicle	30,000 ~~lbs.~~
Yard Transfer Vehicle	60,000 ~~lbs.~~
MAXIMUM GROSS WEIGHTS OF CONTAINERS (lb)	
Seven-pack of 55-~~gallon~~ gal (208-L) drums	7,000 ~~lbs.~~
Four-pack of 85-~~gallon~~ gal (322-L) drums	~~4,500~~4,000 ~~lbs.~~
Three-pack of 100-~~gallon~~ gal (379-L) drums	3,000 ~~lbs.~~
Ten-drum overpack	6,700 ~~lbs.~~
Standard waste box	4,000 ~~lbs.~~
Standard large box 2	10,500 ~~lbs.~~
Shielded container	2,260 ~~lbs.~~
Three-pack of shielded containers	7,000 ~~lbs.~~
MAXIMUM NET EMPTY WEIGHTS OF EQUIPMENT (lb)	
TRUPACT-II	13,140 ~~lbs.~~
HalfPACT	10,500 ~~lbs.~~
TRUPACT-III	43,600 ~~lbs.~~
~~Adjustable center of gravity lift fixture~~Lift Fixture	2,500 ~~lbs.~~
Facility pallet	4,120 ~~lbs.~~

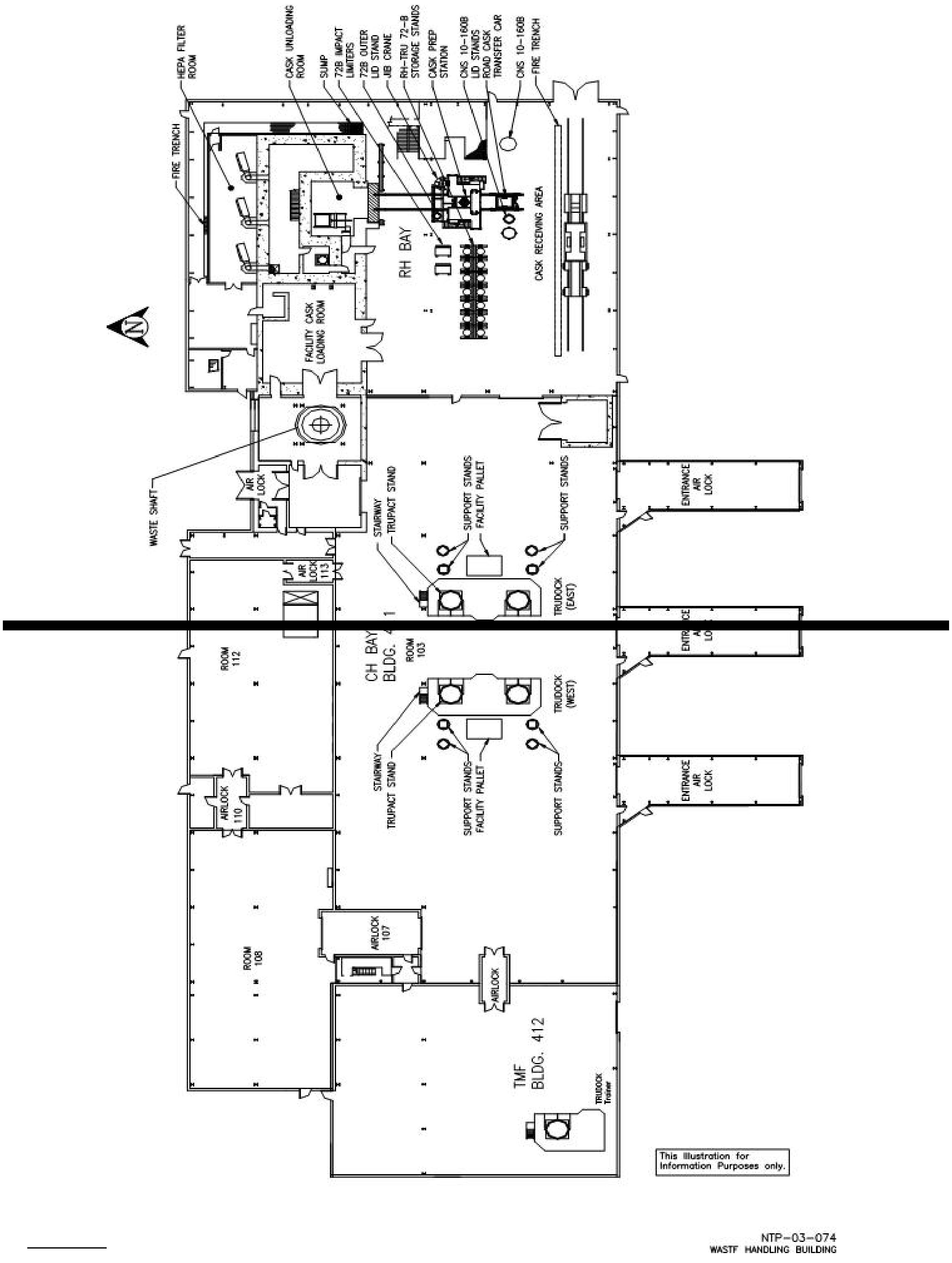
Table A1-3
RH TRU Mixed Waste Handling Equipment Capacities

CAPACITIES FOR EQUIPMENT (tons)	
RH Bay Overhead Bridge Crane	140 ~~tons~~ main hoist 25 ~~tons~~ auxiliary hoist
RH-TRU 72-B Cask Transfer Car	20 ~~tons~~
CNS 10-160B Cask Transfer Car	35 ~~tons~~
Transfer Cell Shuttle Car	29 ~~tons~~
Hot Cell Bridge Crane	15 ~~tons~~
Overhead Powered Manipulator	2.5 ~~tons~~
Facility Cask Rotating Device	No specific load rating
Cask Unloading Room Crane	25 ~~tons~~
6.25 Ton Grapple Hoist	6.25 ~~tons~~
Facility Cask Transfer Car	40 ~~tons~~
MAXIMUM GROSS WEIGHTS OF RH TRU CONTAINERS (lb)	
RH TRU Canister	8,000 ~~lbs~~
55-~~Gallon~~ gal (208-L) Drum	1,000 ~~lbs~~
Facility Canister	10,000 ~~lbs~~
MAXIMUM NET EMPTY WEIGHTS OF EQUIPMENT (lb)	
RH-TRU 72-B Cask	37,000 ~~lbs~~
CNS 10-160B Cask	57,500 ~~lbs~~
Facility Cask	67,700 ~~lbs~~
Light Weight Facility Cask	48,450
Shielded Insert	26,300 ~~lbs~~

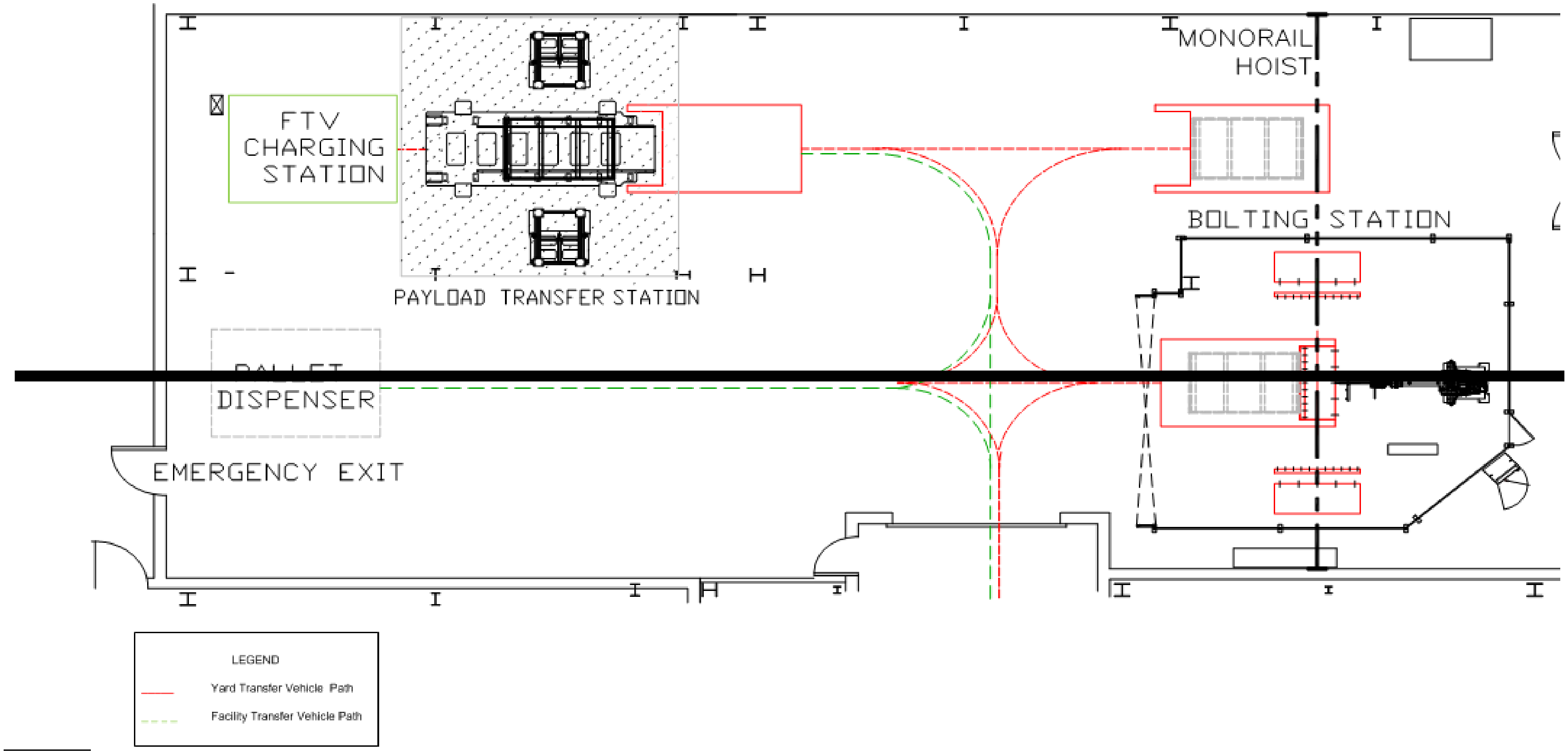
~~FIGURES~~



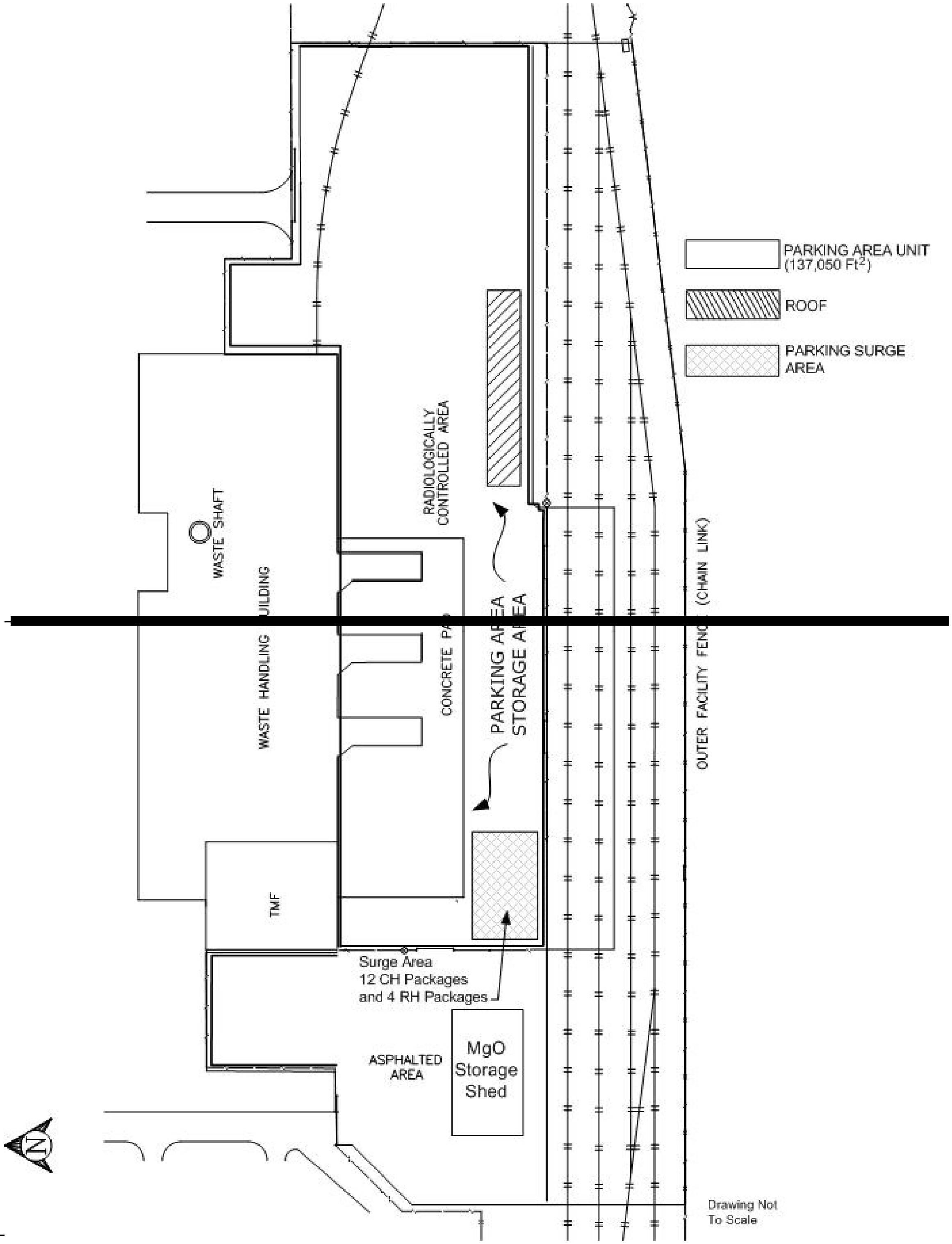
~~Figure A1-1~~
~~Waste Handling Building - CH TRU Mixed Waste Container Storage and Surge Areas~~



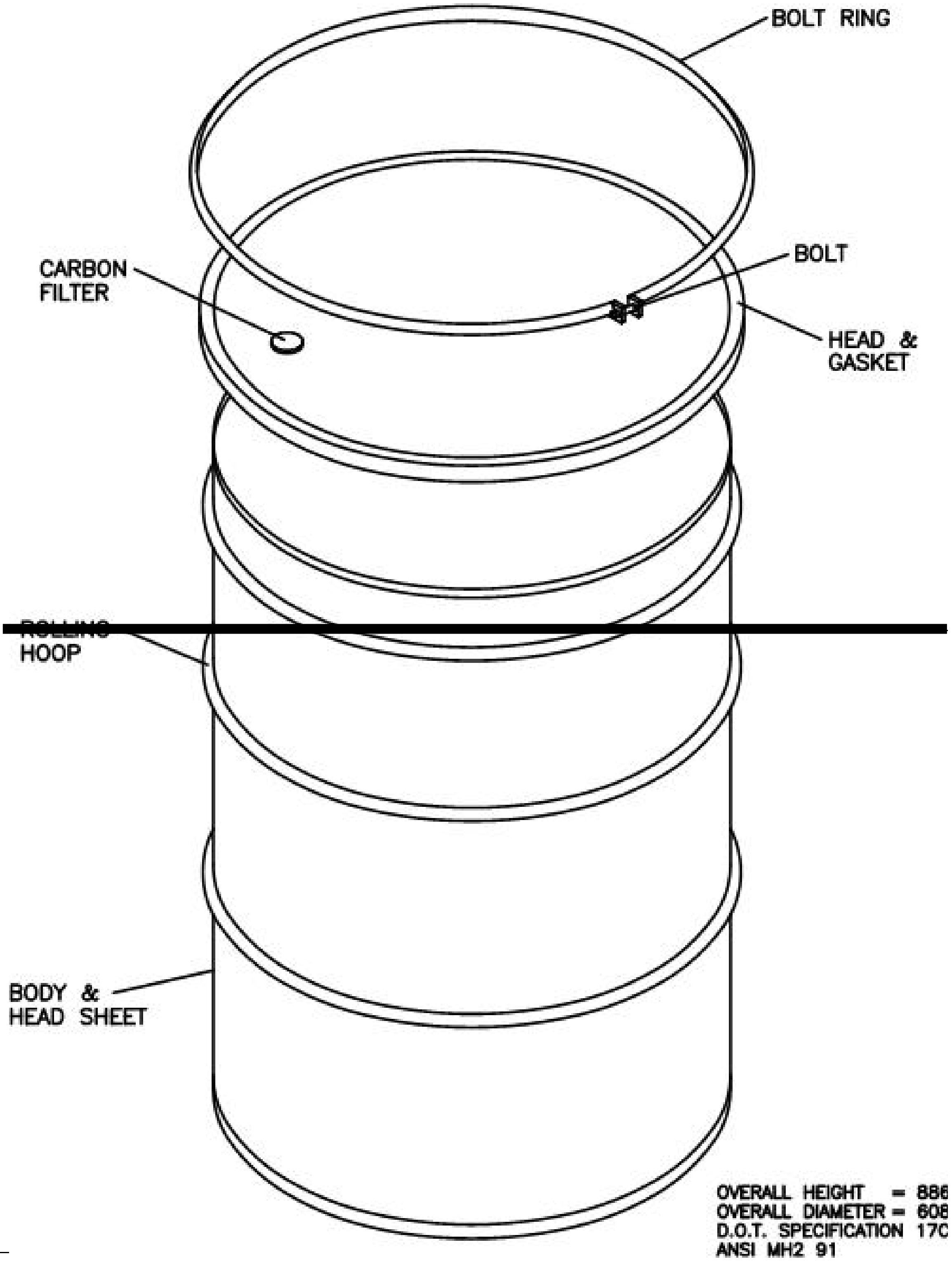
~~**Figure A1-1a**~~
~~**Waste Handling Building Plan (Ground Floor)**~~



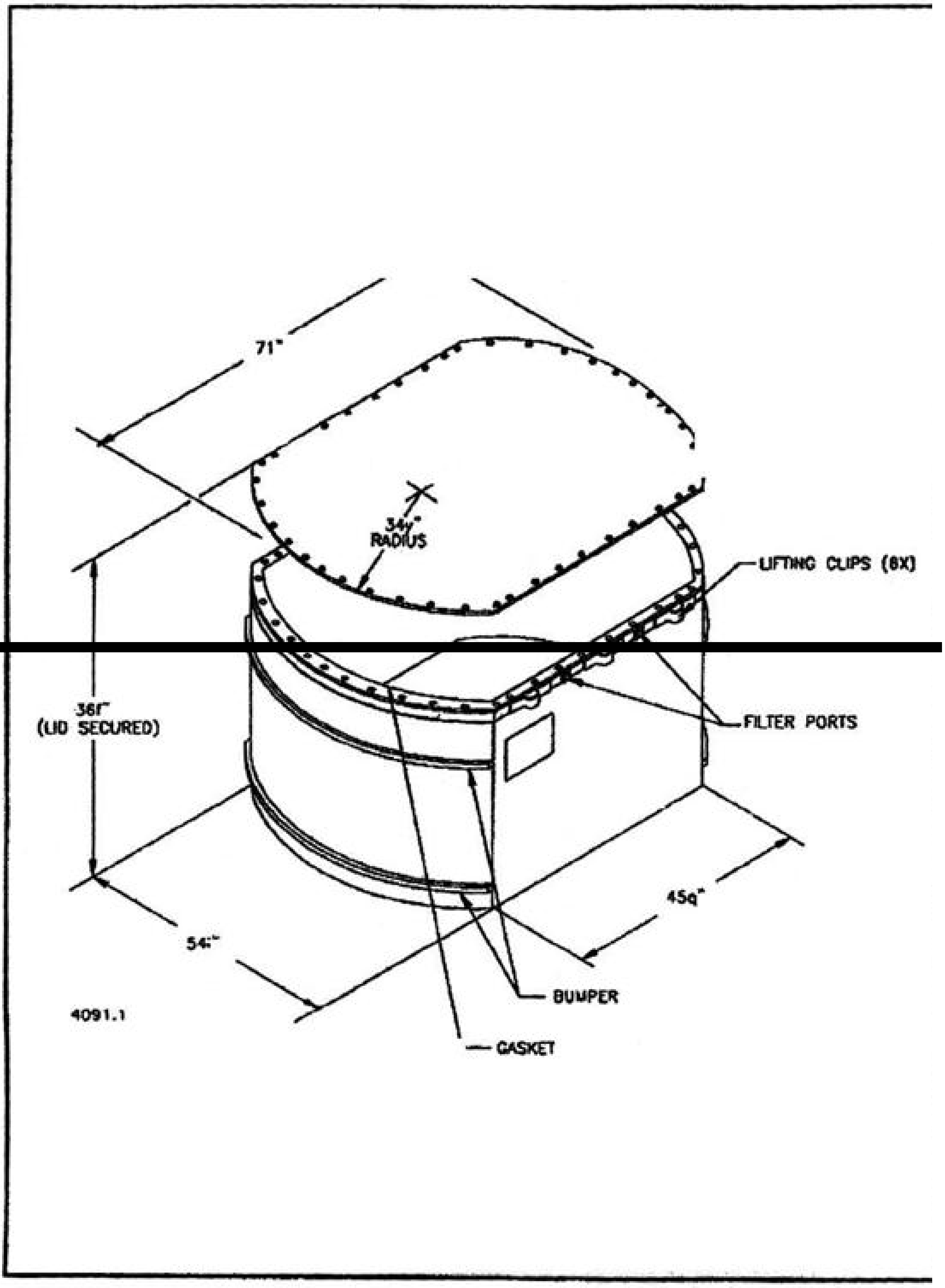
~~Figure A1-1b~~
~~Waste Handling Building Plan (Room 108 Detail)~~



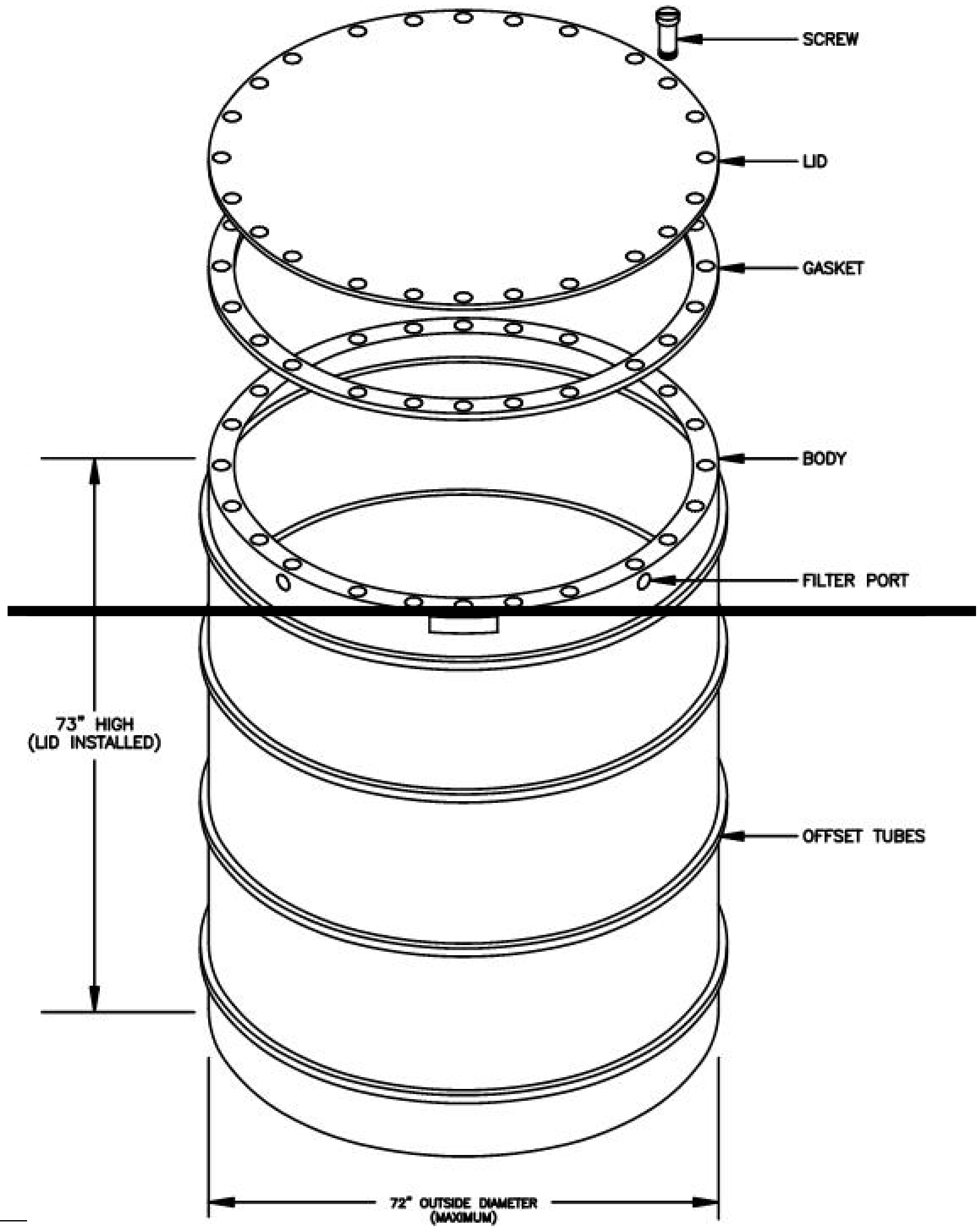
~~Figure A1-2~~
~~Parking Area - Container Storage and Surge Areas~~



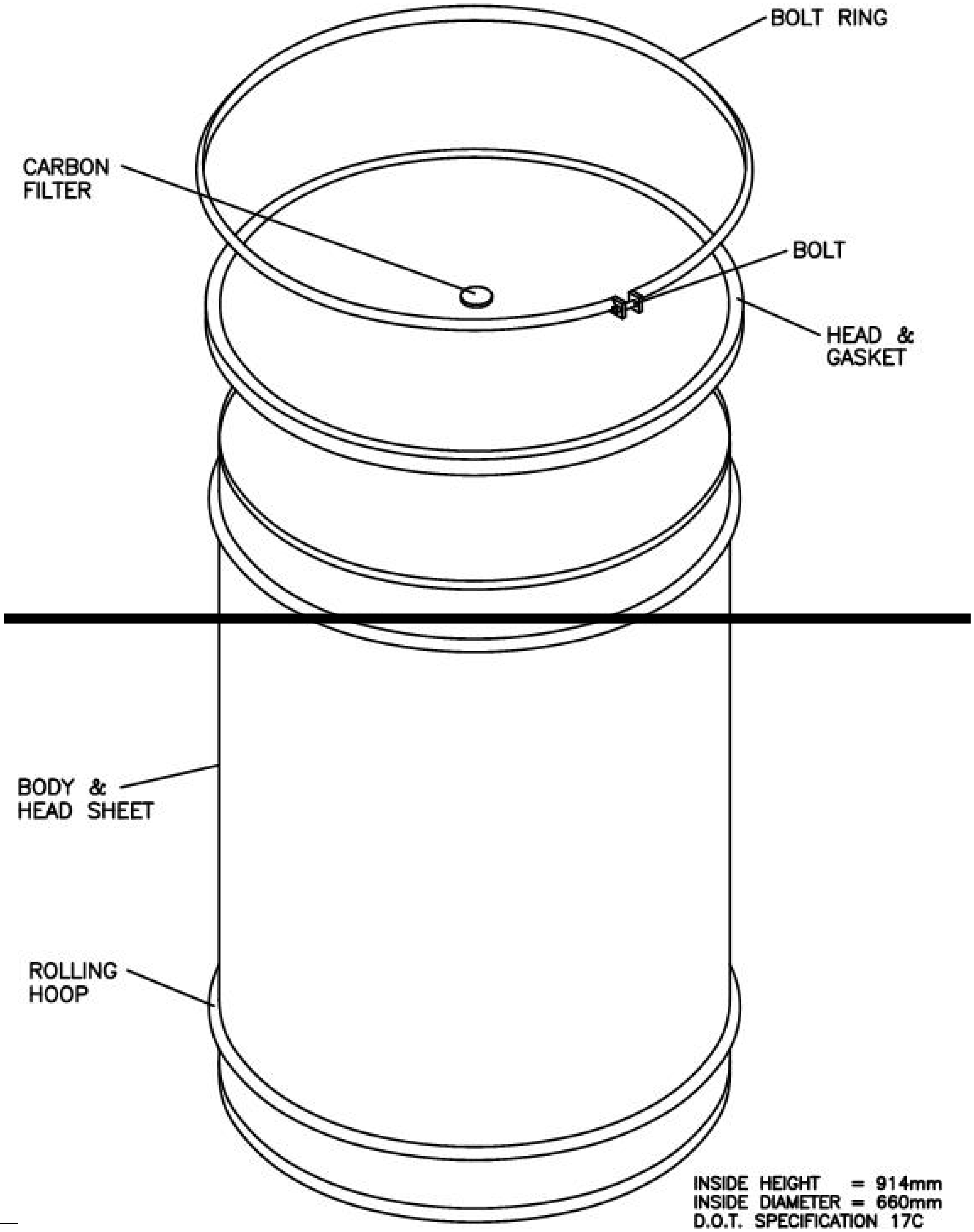
~~Figure A1-3~~
~~Standard 55-Gallon Drum (Typical)~~



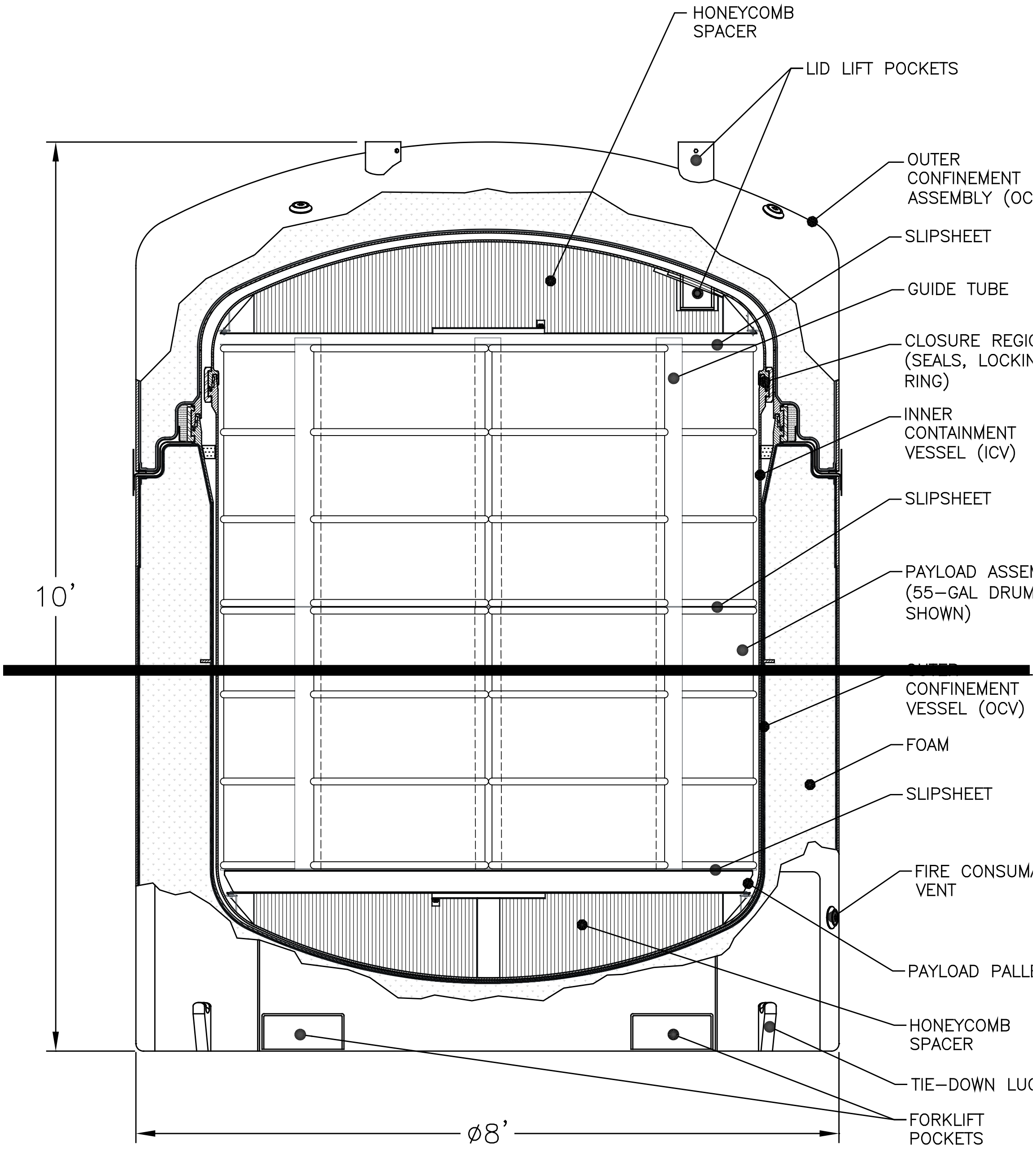
~~Figure A1-4~~
~~Standard Waste Box~~



~~Figure A1-5~~
~~Ten-Drum Overpack~~

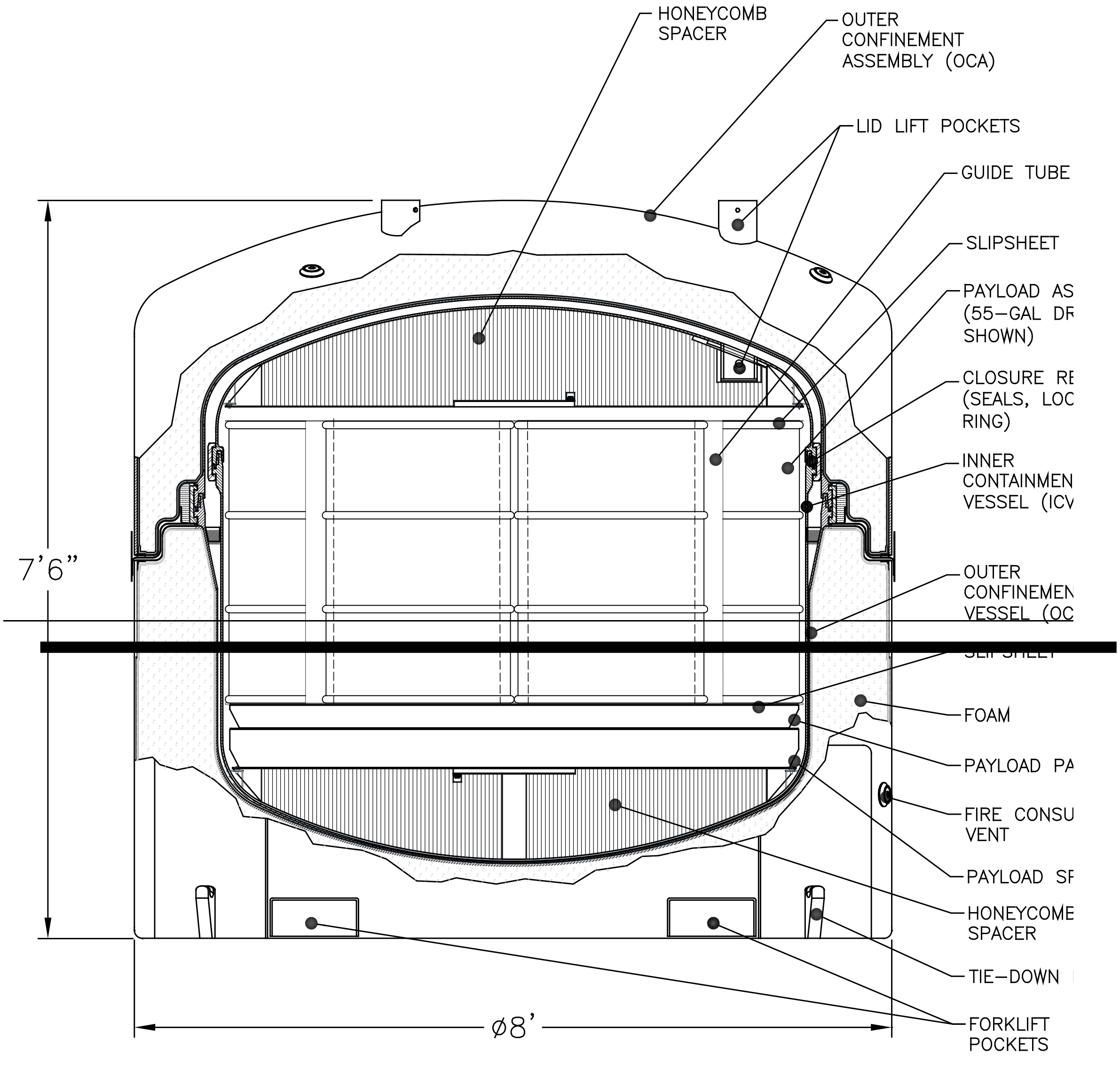


~~Figure A1-6~~
~~85-Gallon Drum~~



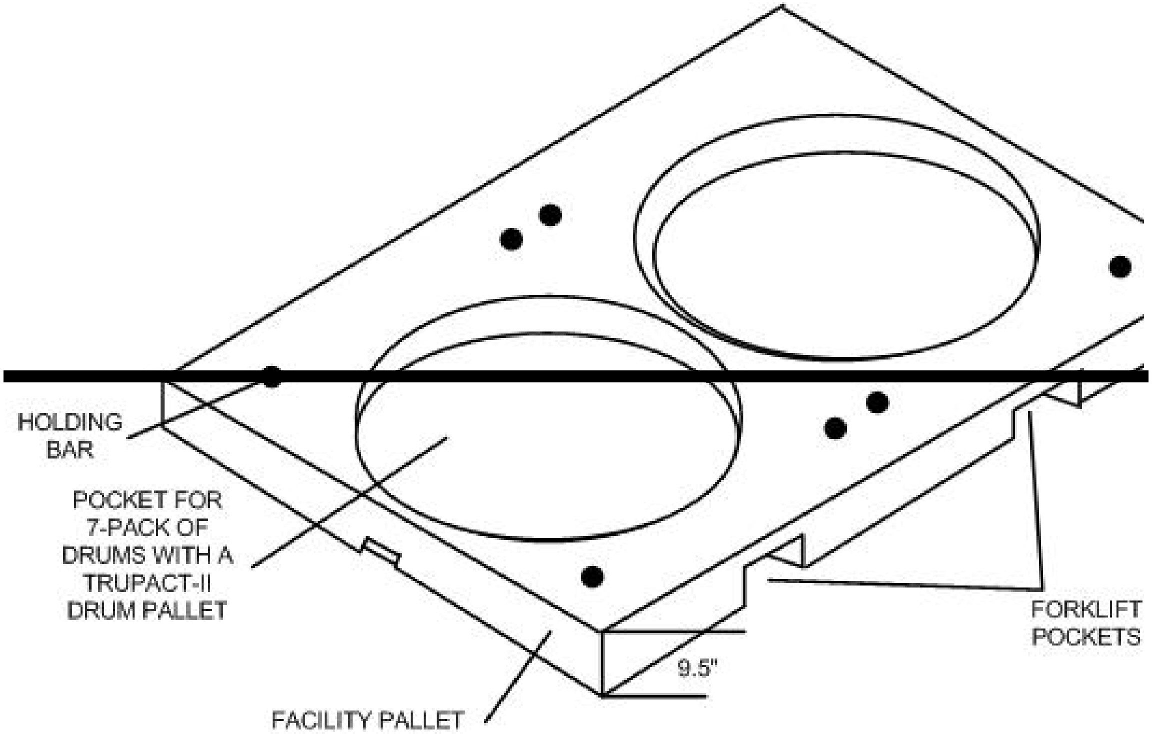
THIS ILLUSTRATION FOR INFORMATIONAL PURPOSES ON
NOT TO SCALE

~~Figure A1-8a~~
~~TRUPACT-II Shipping Container for CH Transuranic Mixed Waste (Schematic)~~

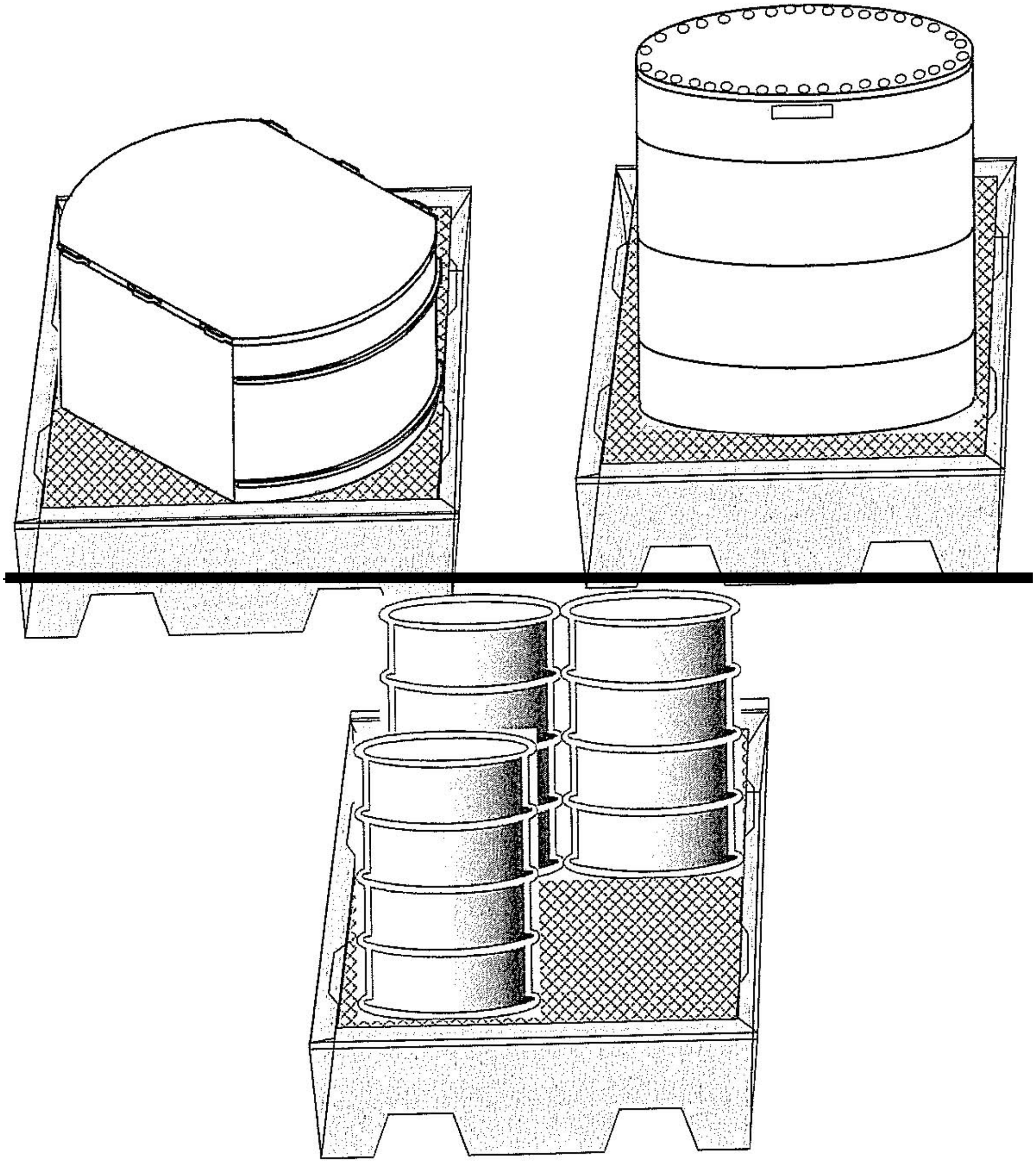


THIS ILLUSTRATION FOR INFORMATIONAL PURPOSES
NOT TO SCALE

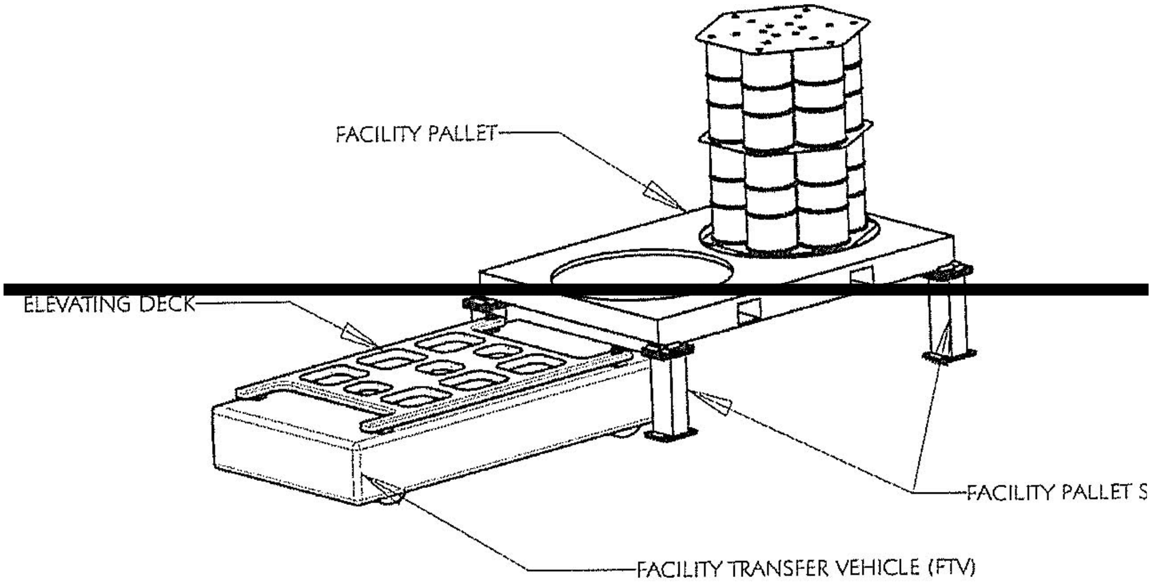
~~Figure A1-8b~~
~~Typical HalfPACT Shipping Container for CH Transuranic Mixed Waste (Schematic)~~



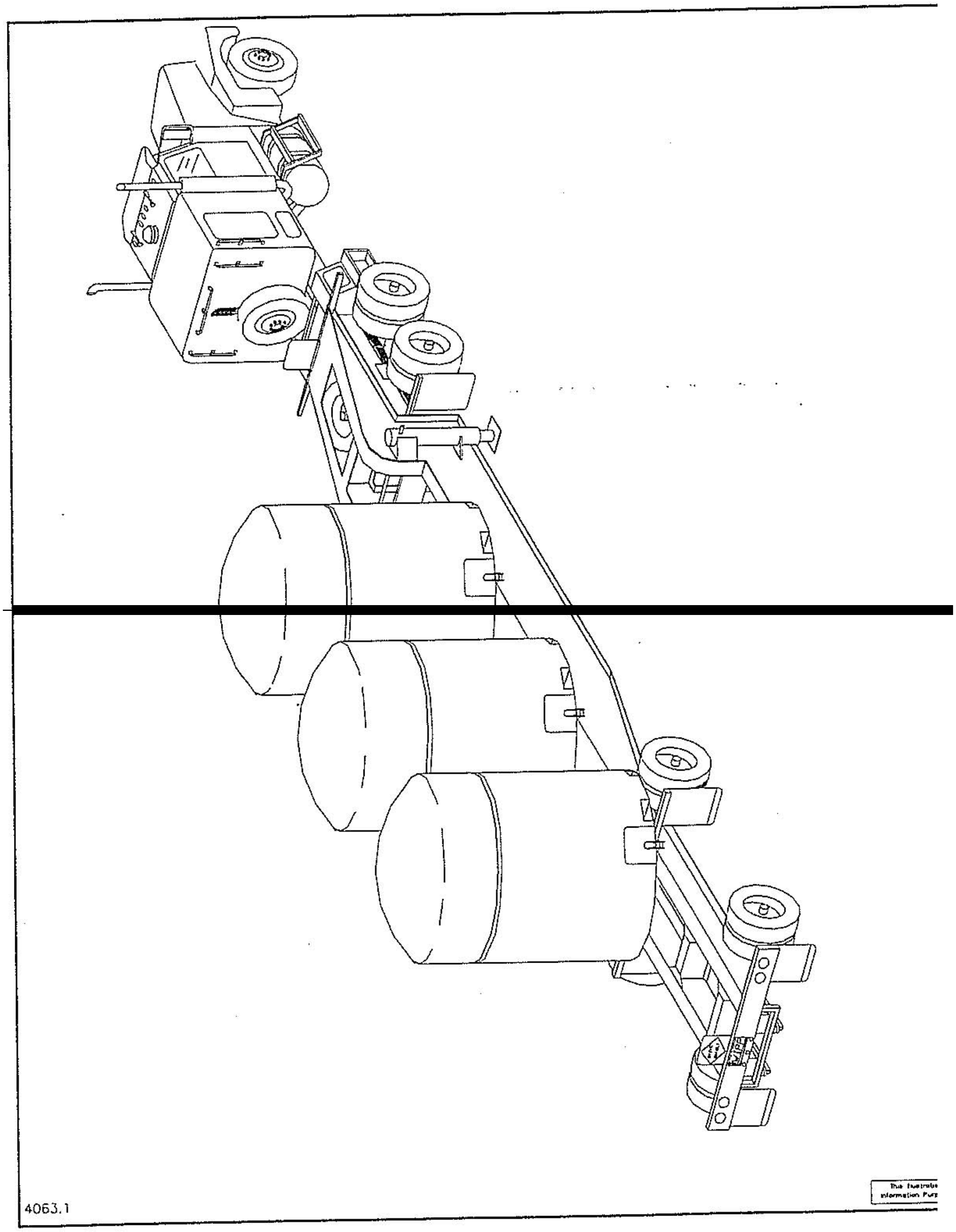
~~**Figure A1-10**~~
~~**Facility Pallet for Seven-Pack of Drums**~~



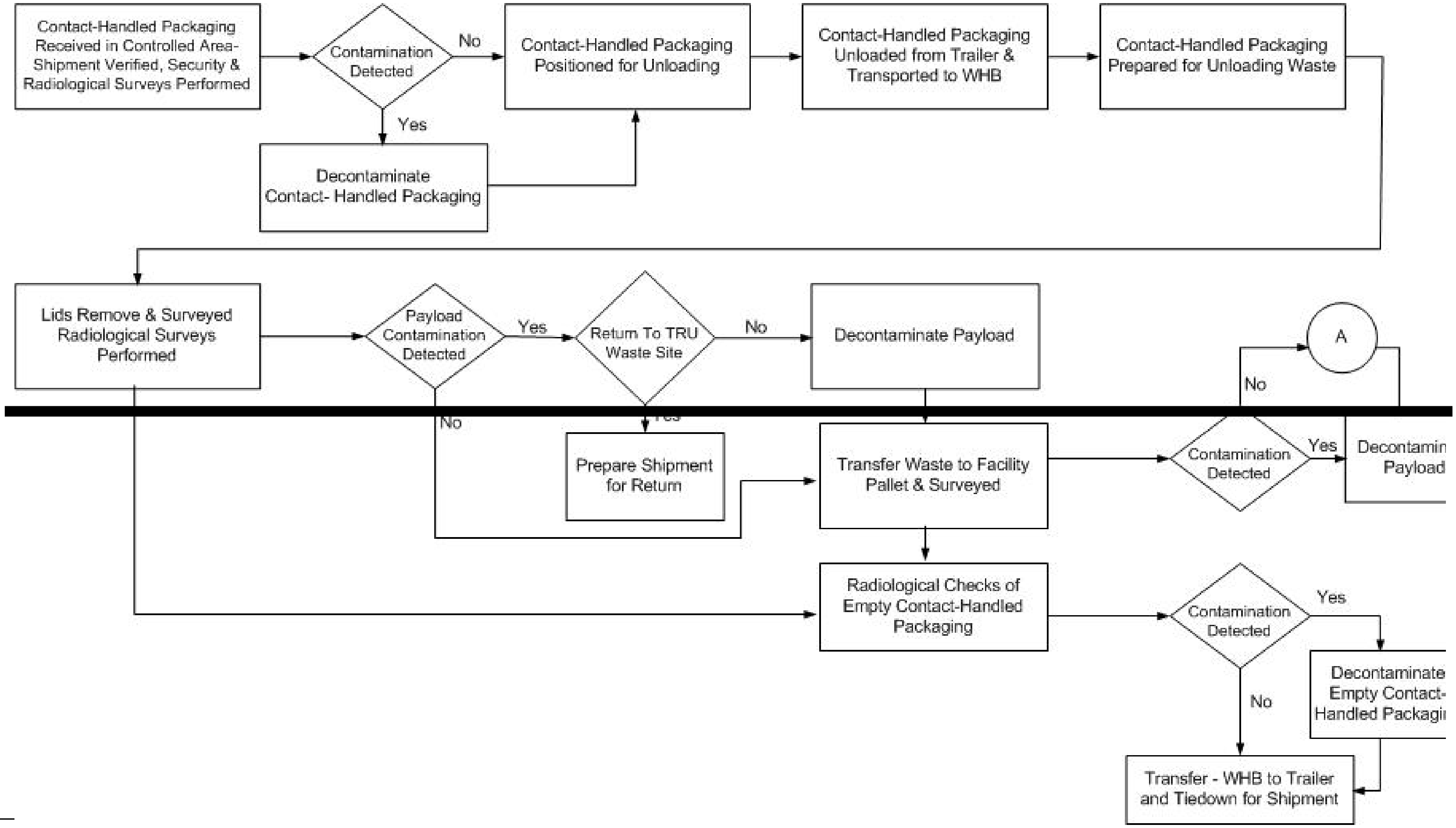
~~Figure A1-10a~~
~~Typical Containment Pallet~~



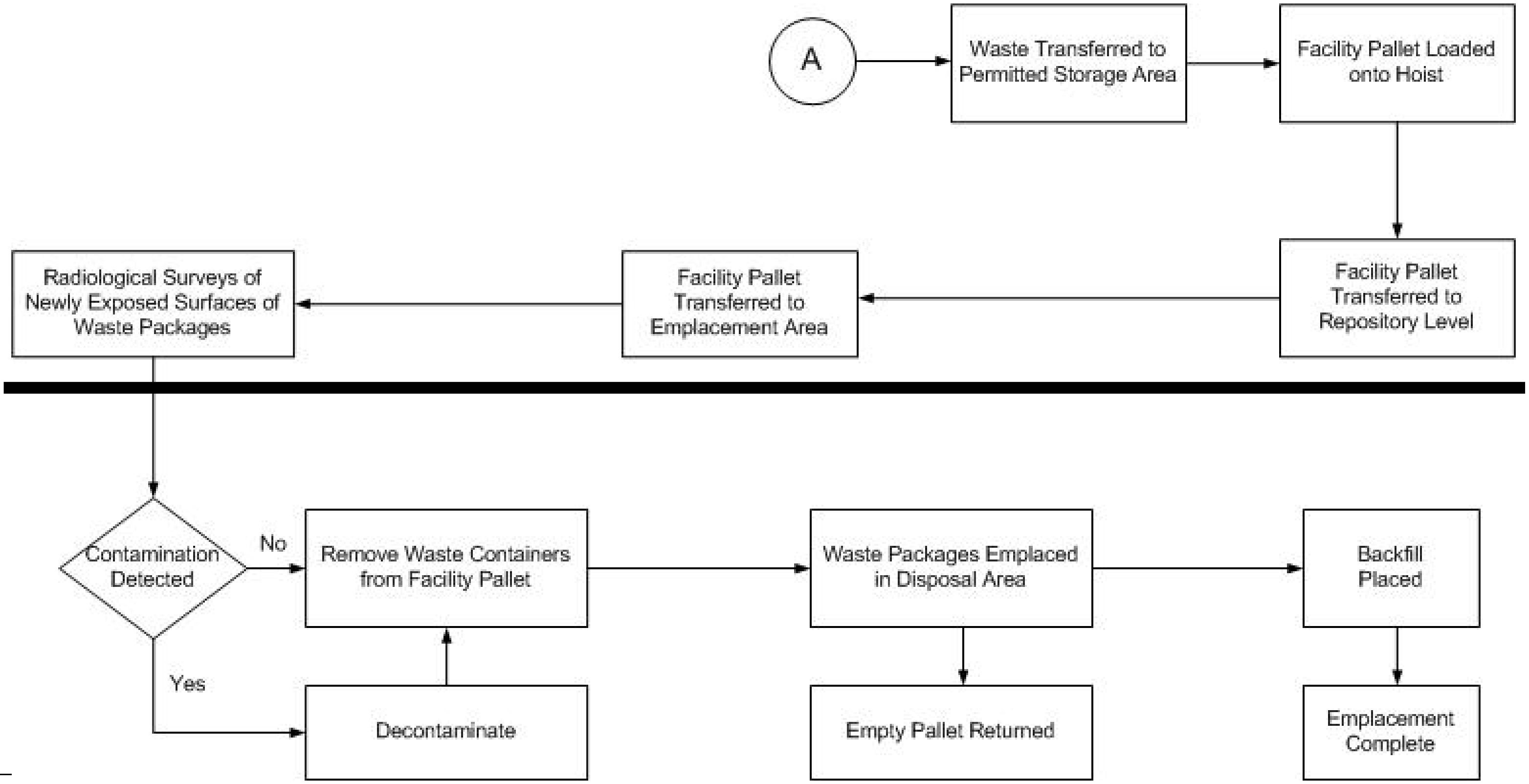
~~**Figure A1-11**~~
~~**Facility Transfer Vehicle, Facility Pallet, and Typical Pallet Stand**~~



~~Figure A1-12~~
~~TRUPACT-II Containers on Trailer~~

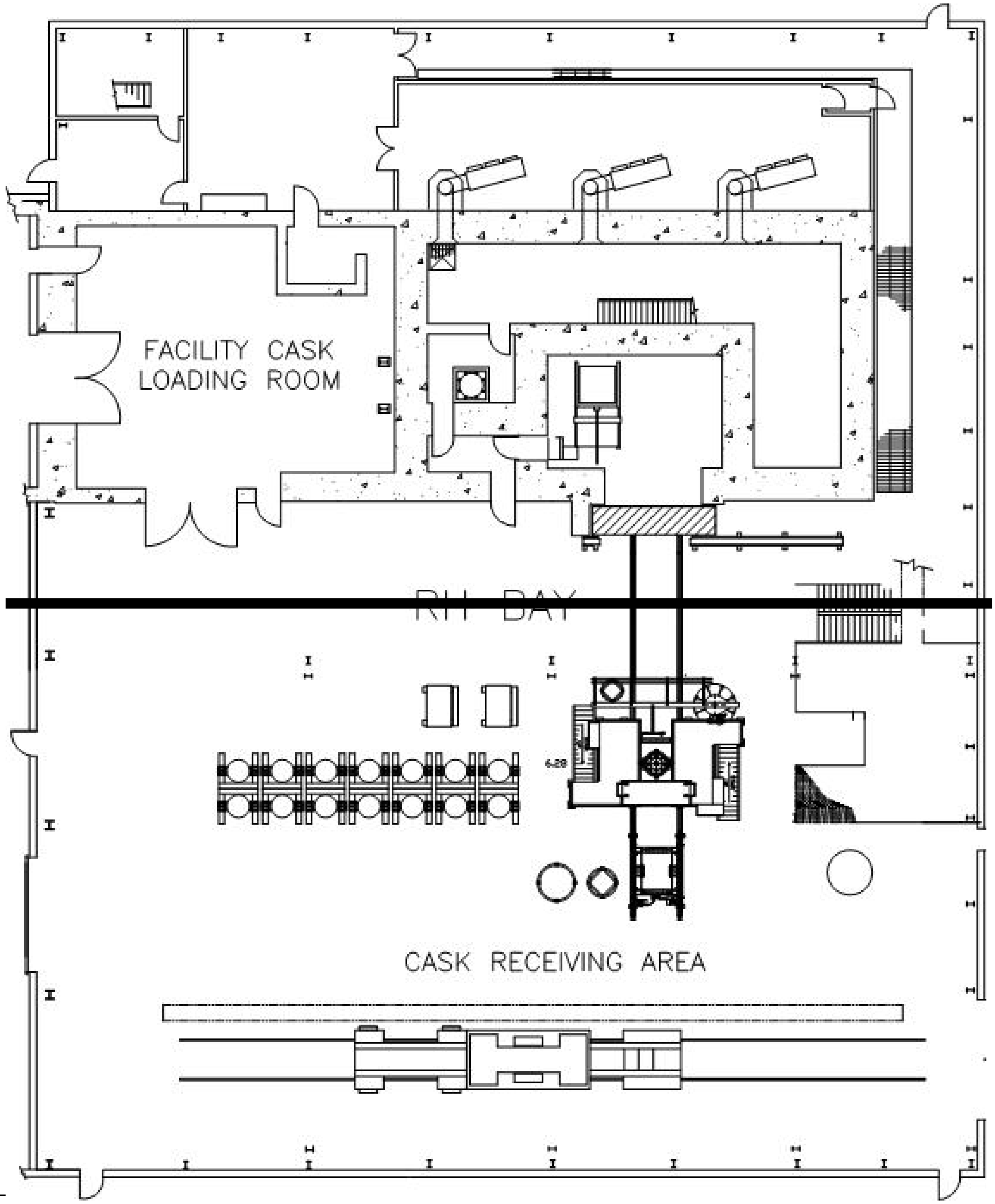


~~**Figure A1-13**~~
~~**WIPP Facility Surface and Underground CH Transuranic Mixed Waste Process Flow Diagram**~~

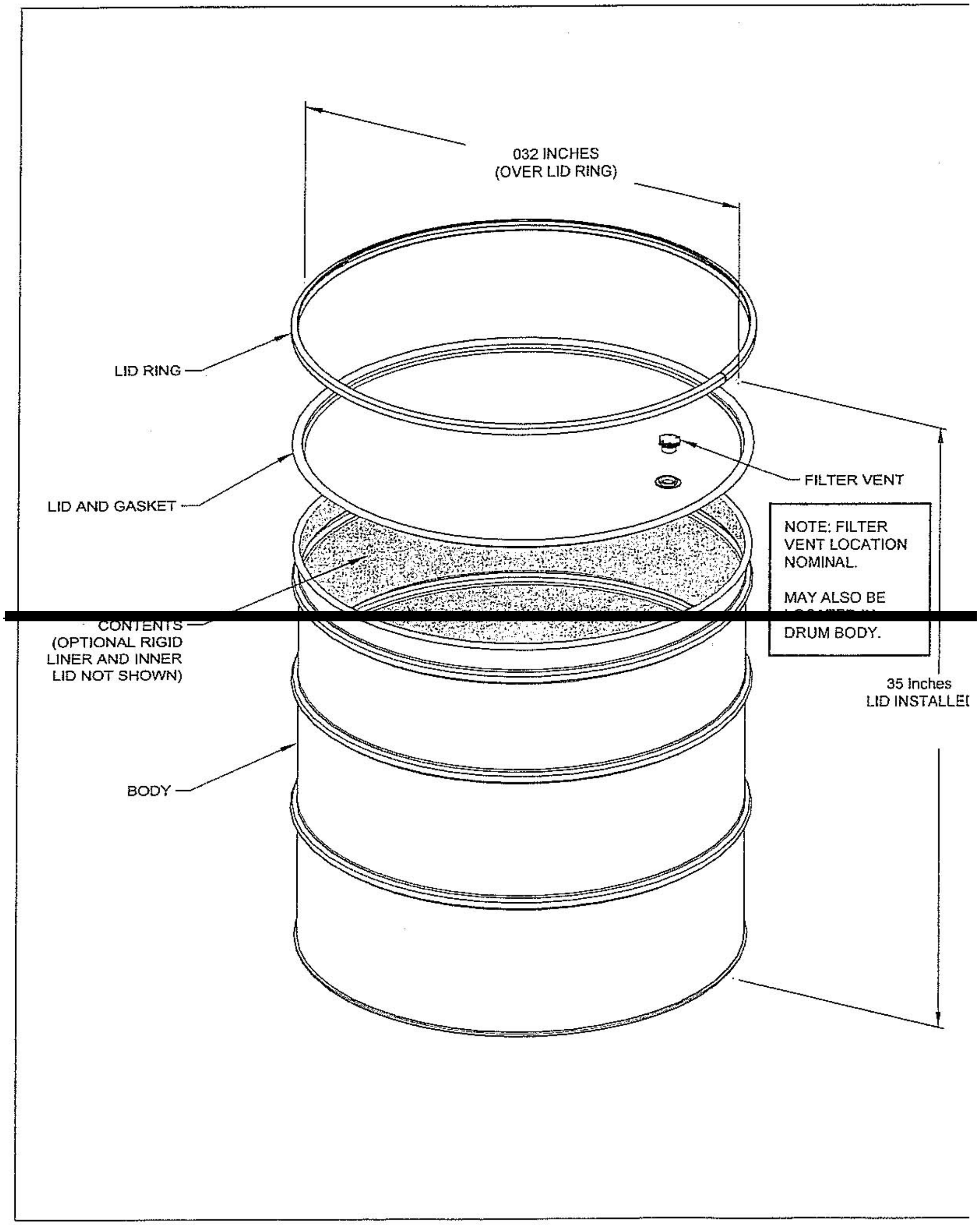


~~**Figure A1-13**~~

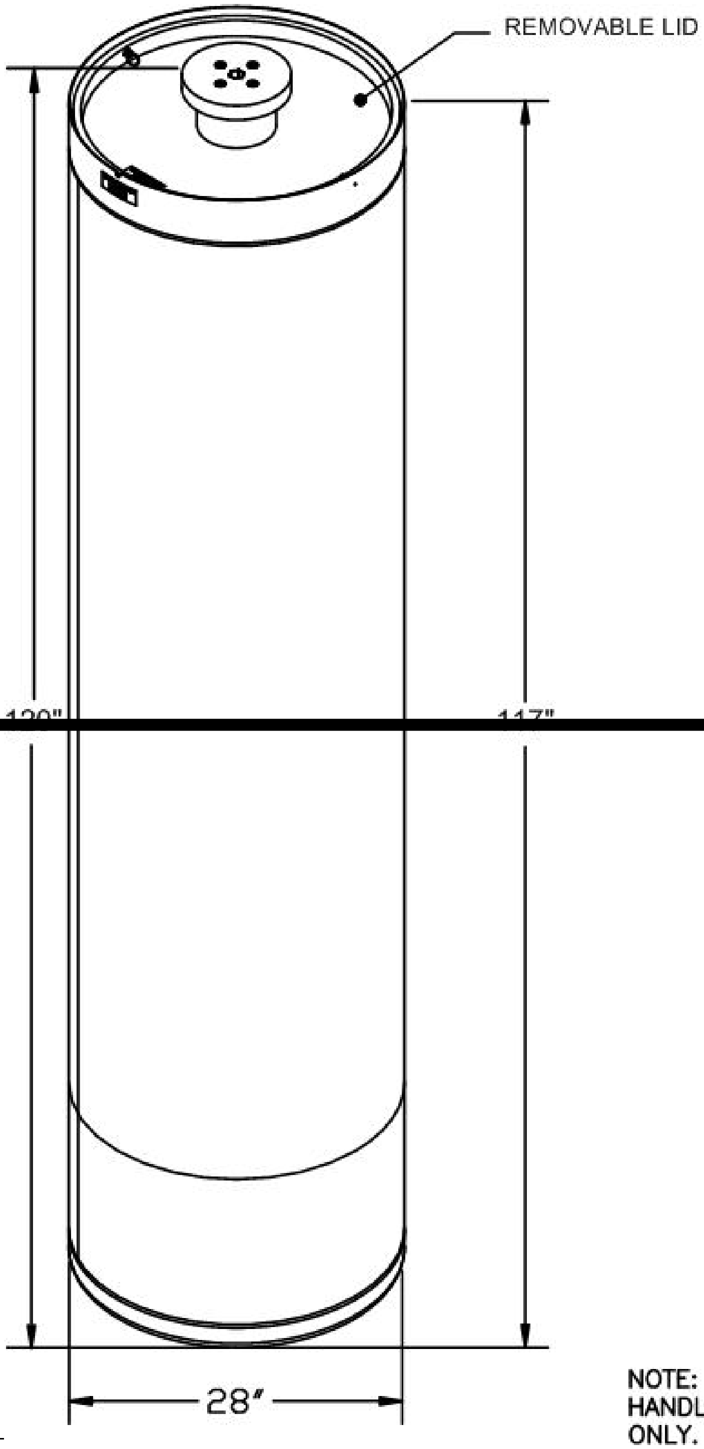
~~**WIPP Facility Surface and Underground CH Transuranic Mixed Waste Process Flow Diagram (Continued)**~~



~~Figure A1-14a~~
~~RH Bay Ground Floor~~

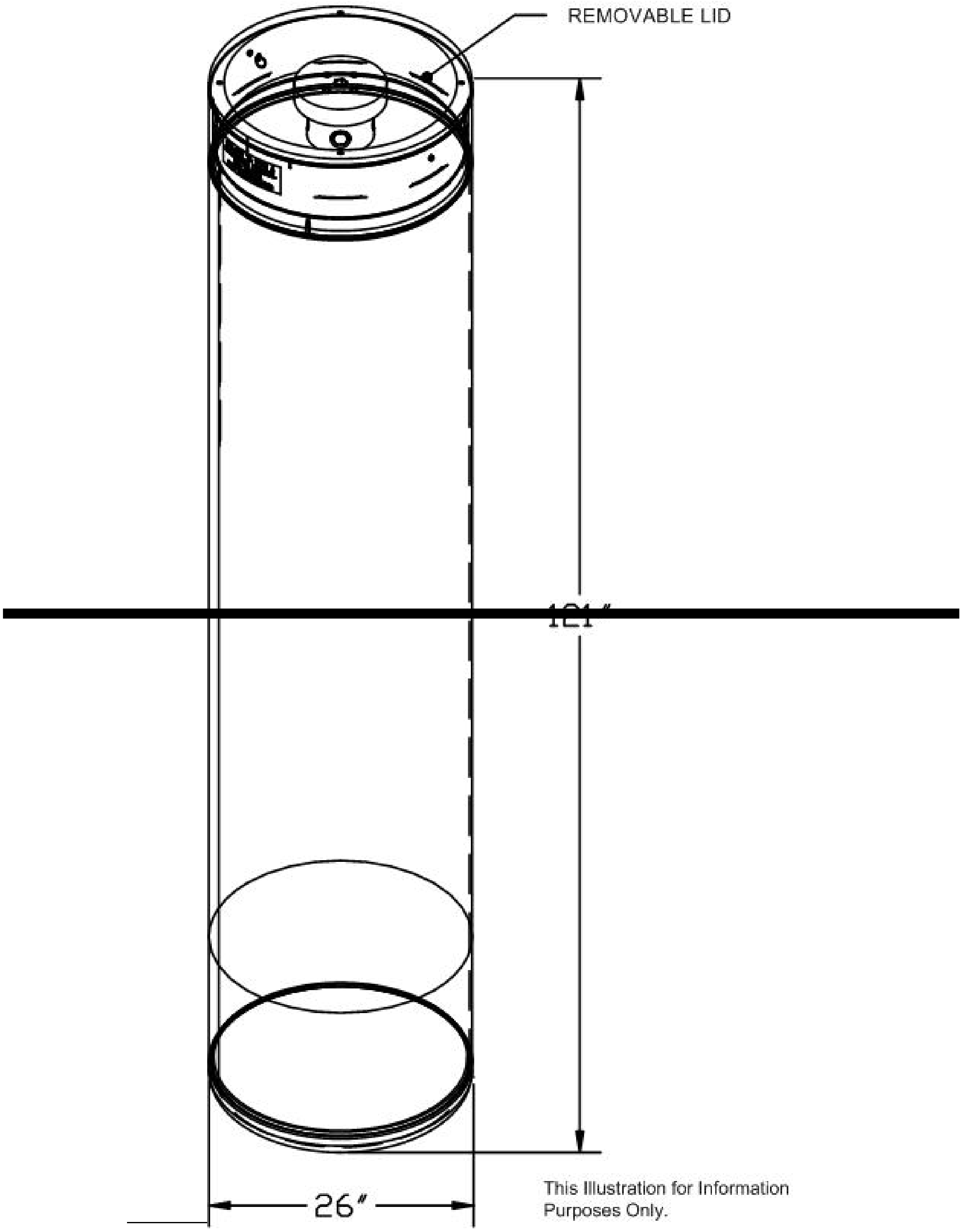


~~Figure A1-15~~
~~100-Gallon Drum~~

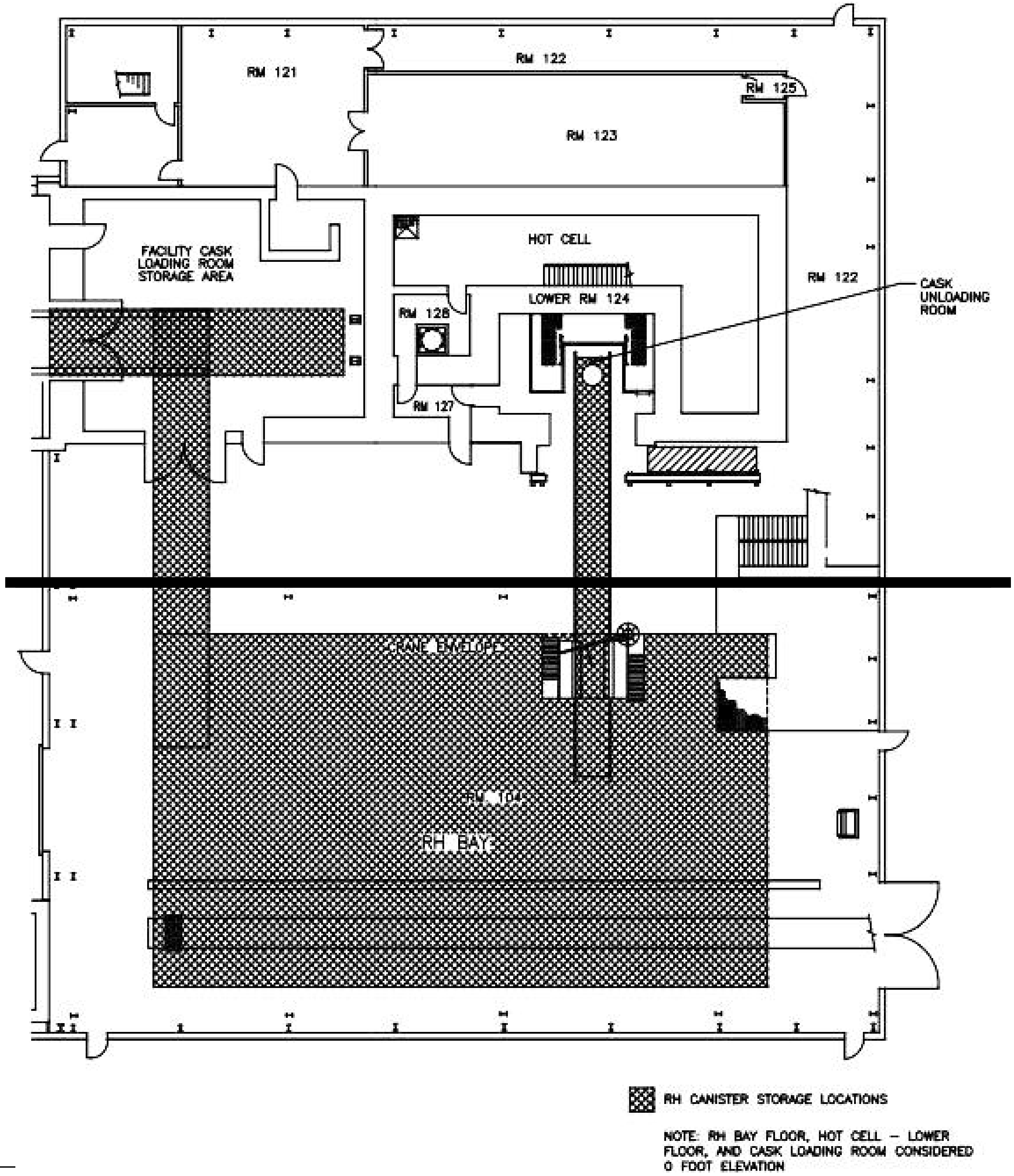


NOTE: CANISTER USED TO HANDLE TYPE A DRUMS ONLY.

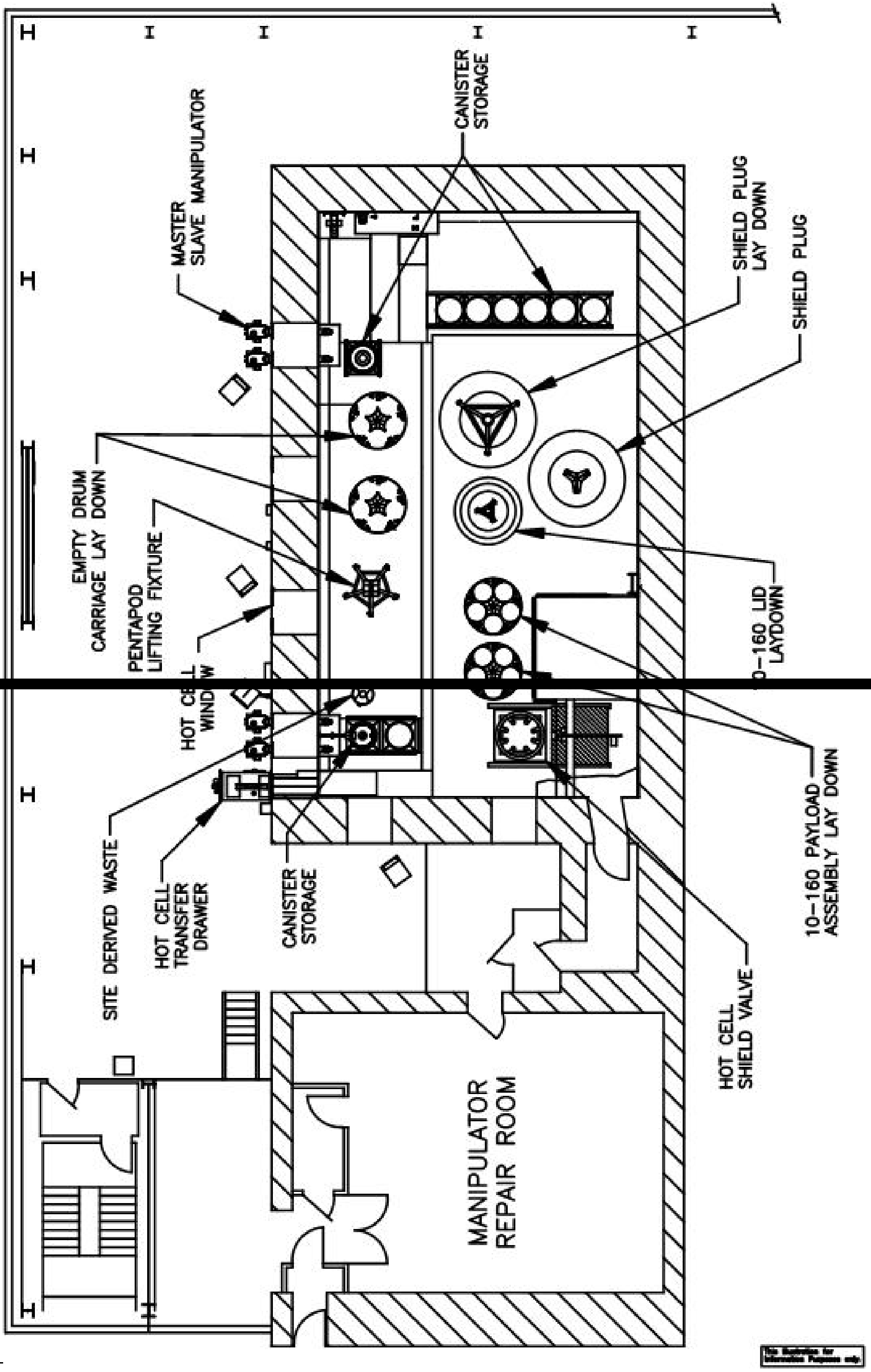
~~**Figure A1-16**~~
~~**Facility Canister Assembly**~~



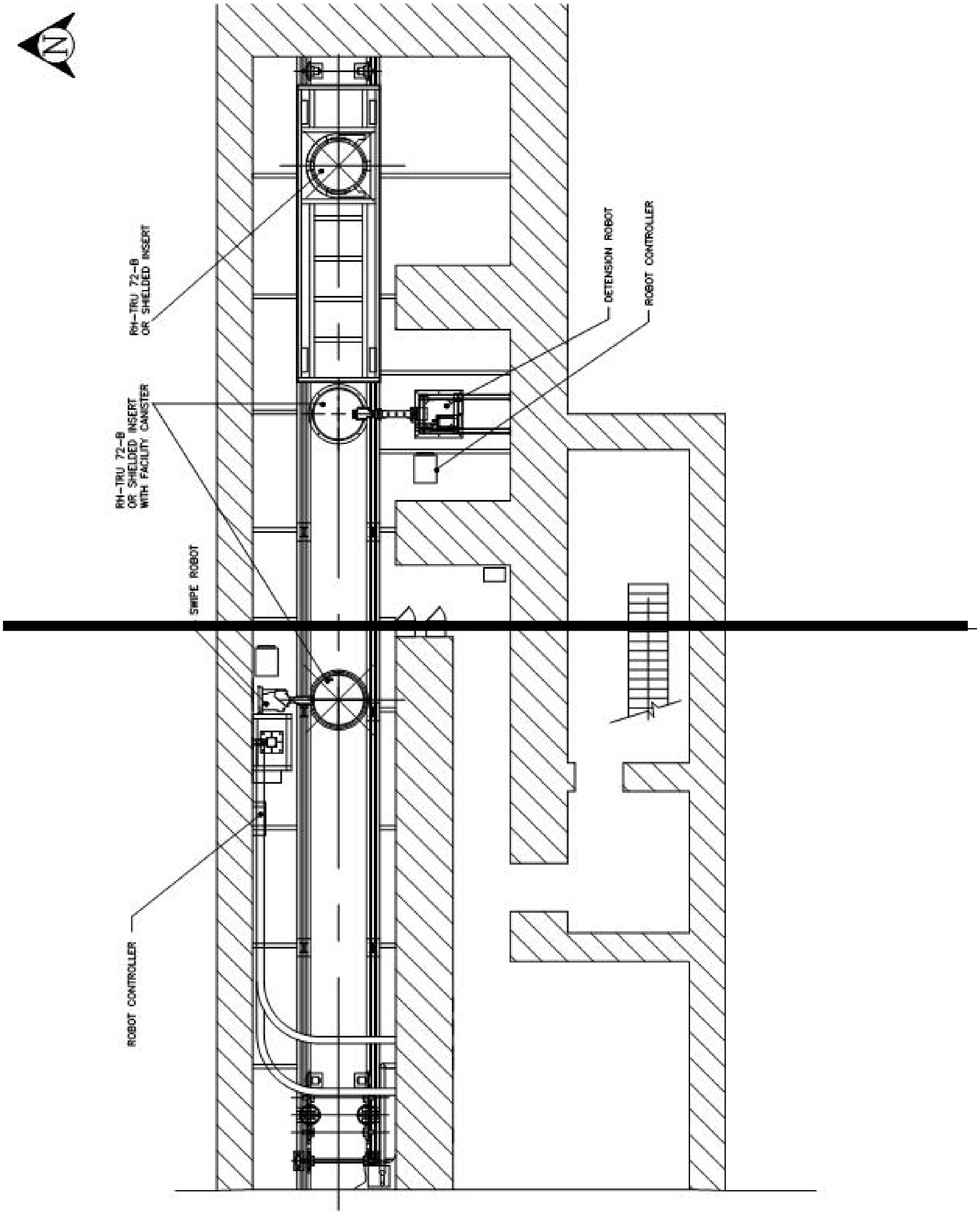
~~Figure A1-16a~~
~~RH-TRU 72-B Canister Assembly~~



~~Figure A1-17a~~
~~RH Bay, Cask Unloading Room, Hot Cell, Facility Cask Loading Room~~

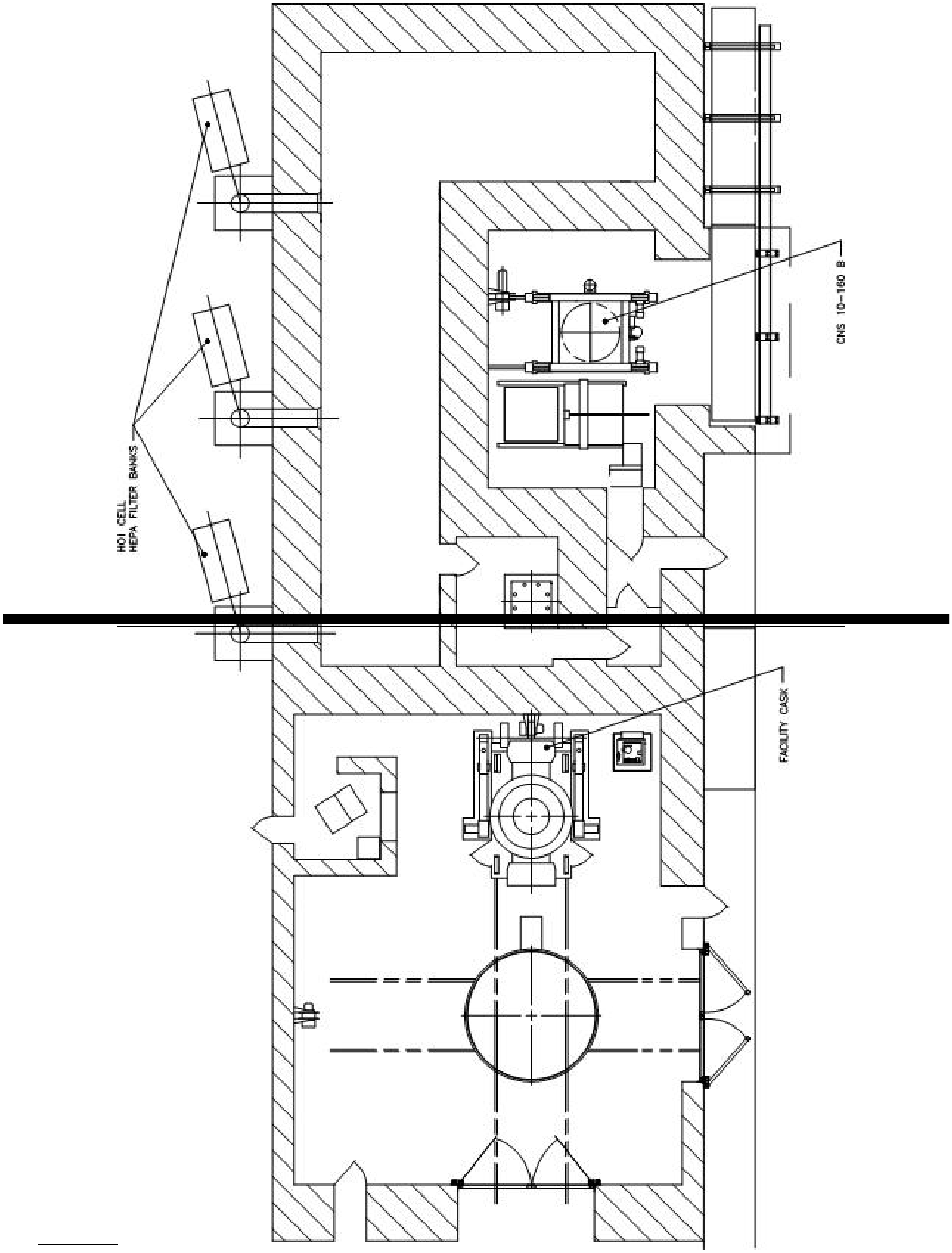


~~Figure A1-17b~~
~~RH Hot Cell Storage Area~~

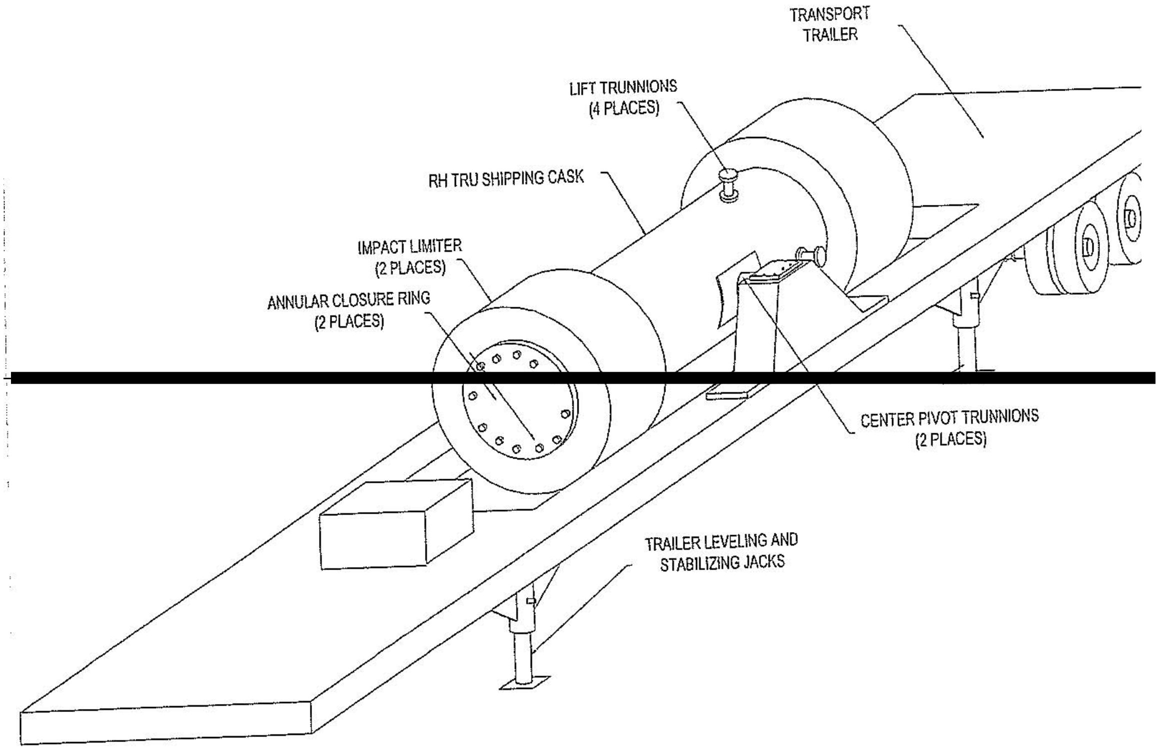


This Illustration for Information Purposes only.

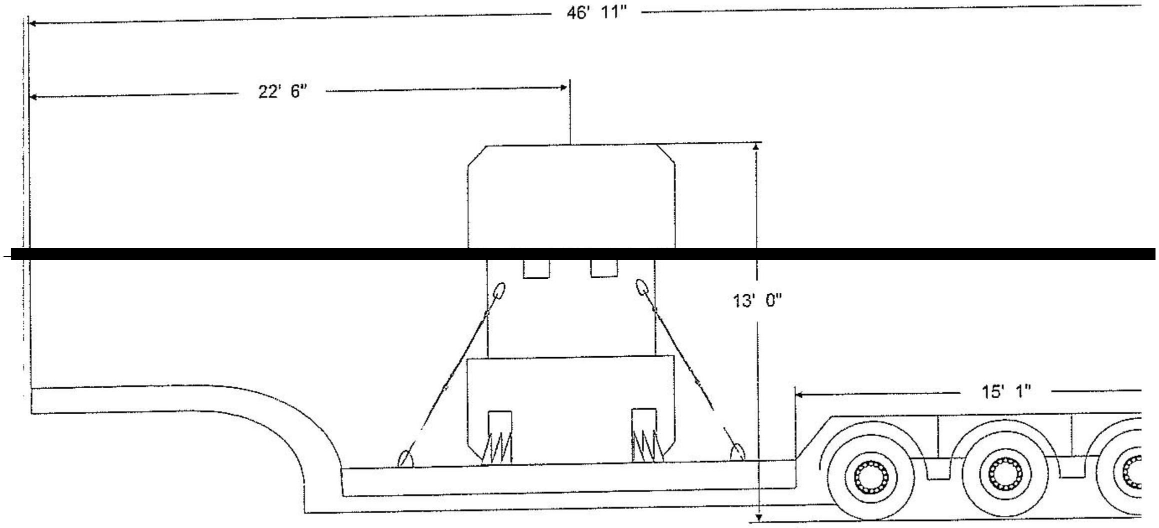
~~Figure A1-17c~~
~~RH Canister Transfer Cell Storage Area~~



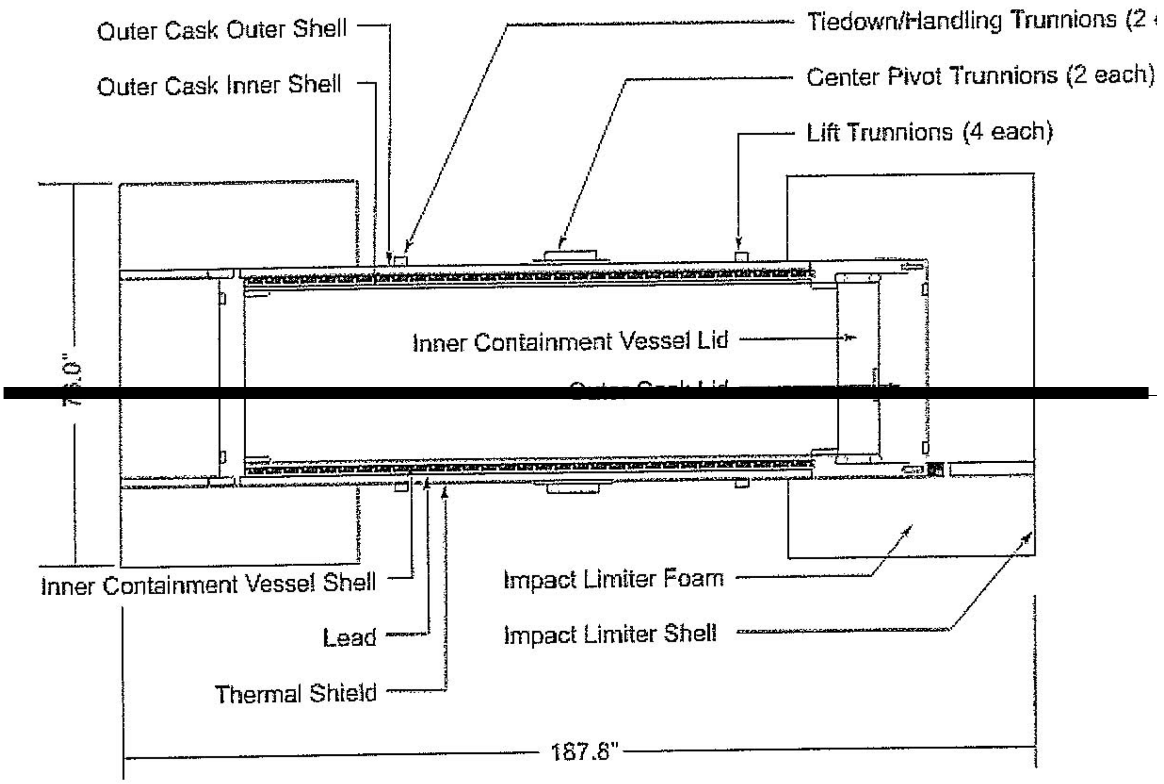
~~Figure A1-17d~~
~~RH Facility Cask Loading Room Storage Area~~



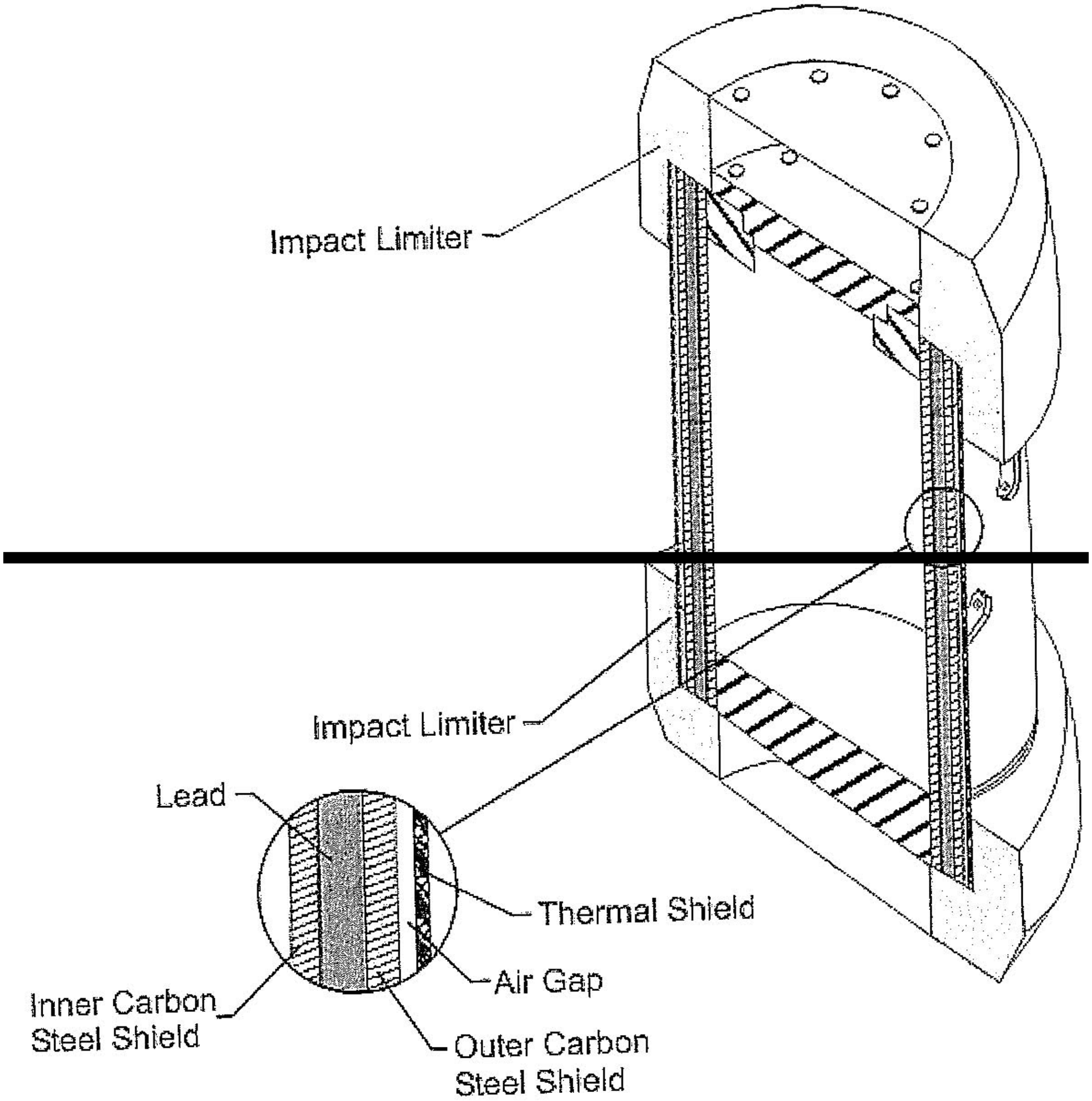
~~Figure A1-18~~
~~RH-TRU 72-B Shipping Cask on Trailer~~



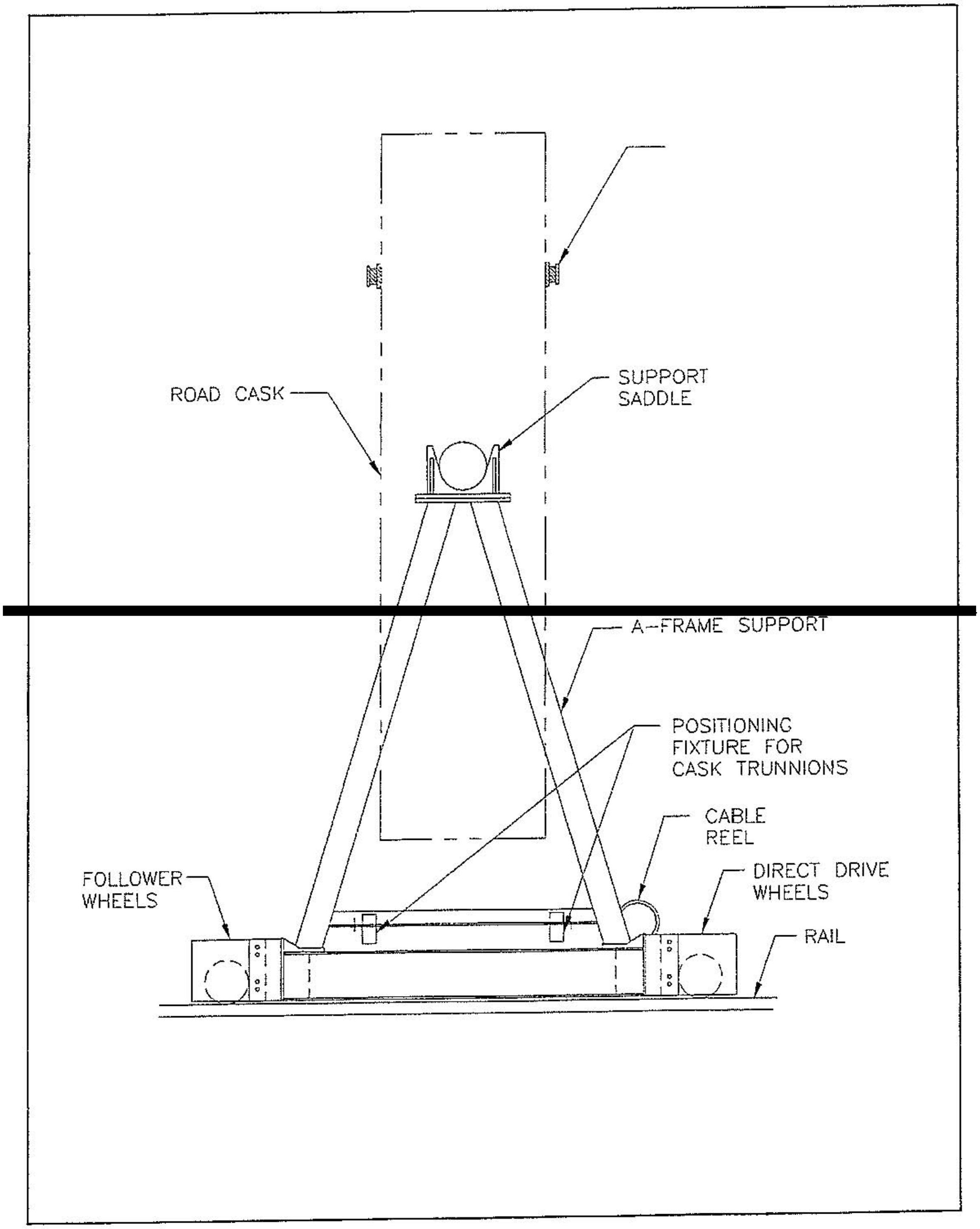
~~Figure A1-19~~
~~CNS 10-160B Shipping Cask on Trailer~~



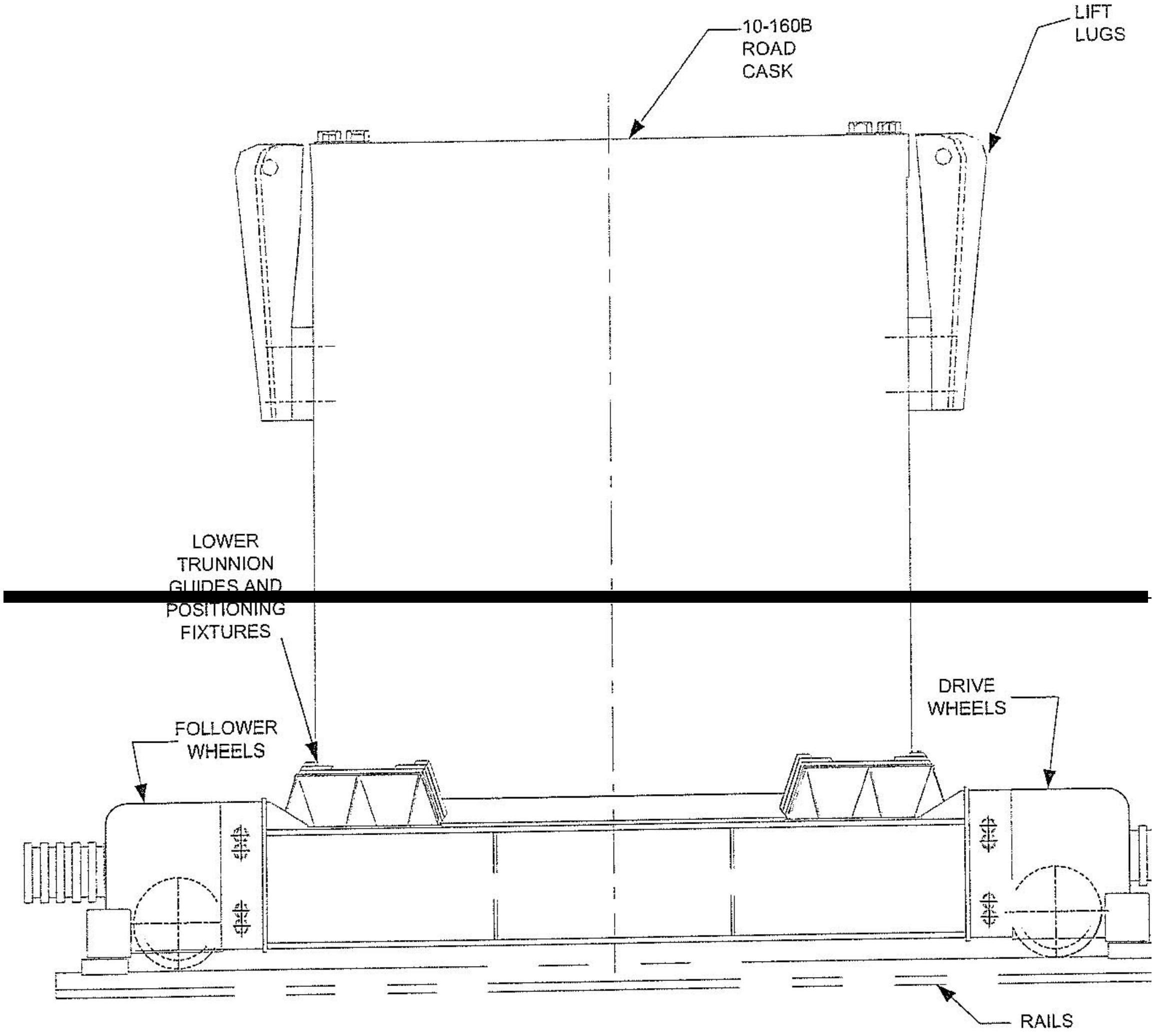
~~Figure A1-20~~
~~RH-TRU 72-B Shipping Cask for RH Transuranic Waste (Schematic)~~



~~Figure A1-21~~
~~CNS 10-160B Shipping Cask for RH Transuranic Waste (Schematic)~~

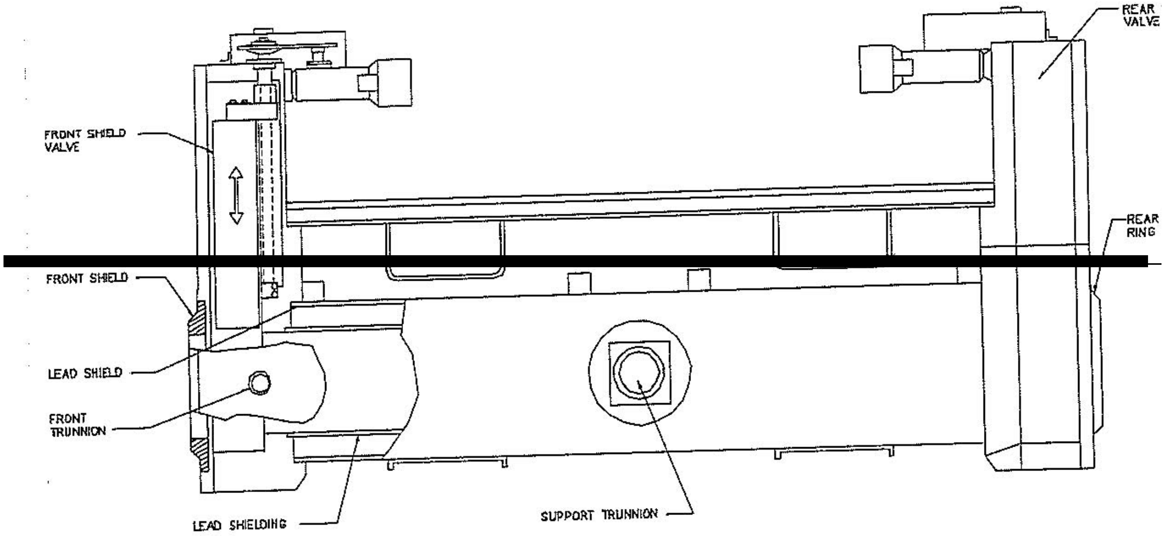


~~**Figure A1-22a**~~
~~**RH-TRU 72-B Cask Transfer Car**~~

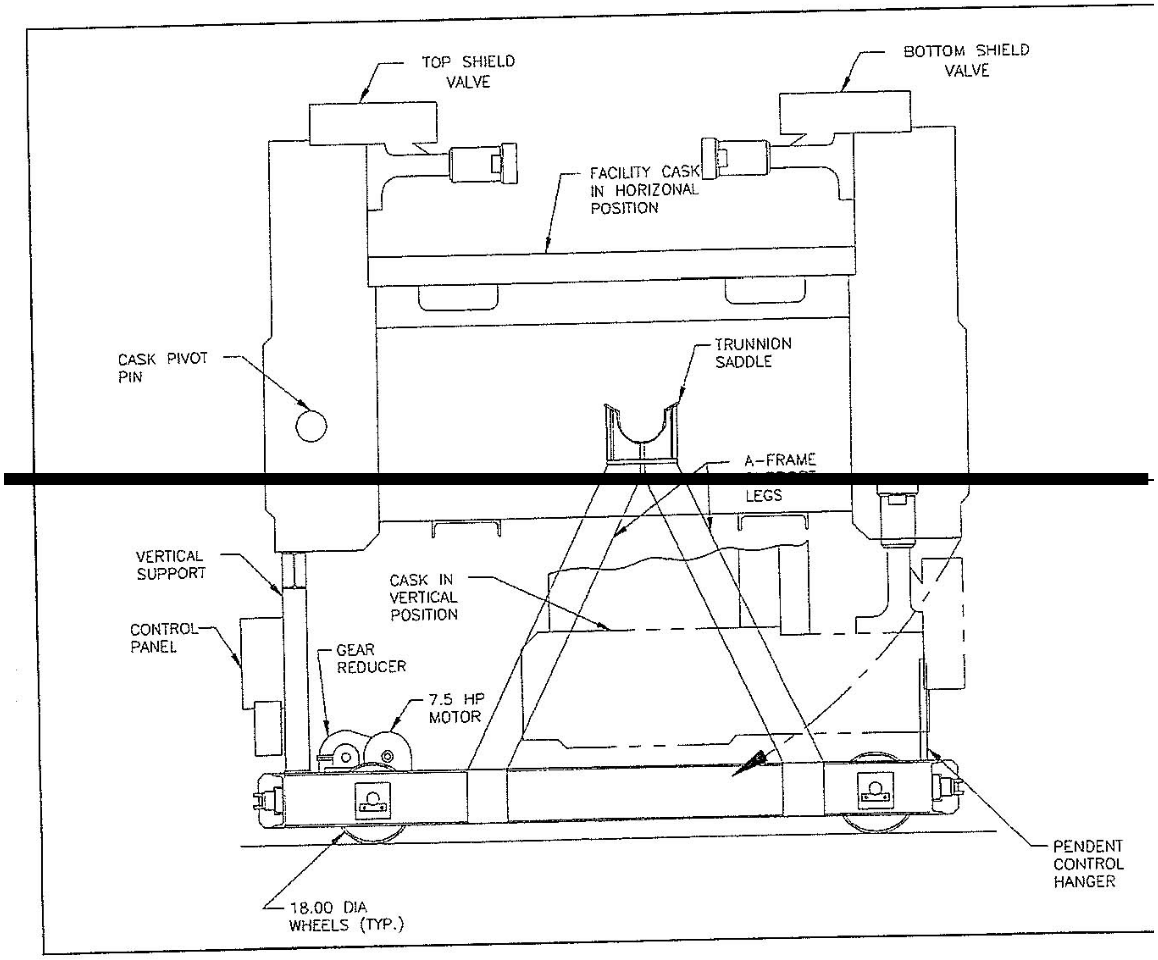


This Illustration for Information Purposes Only

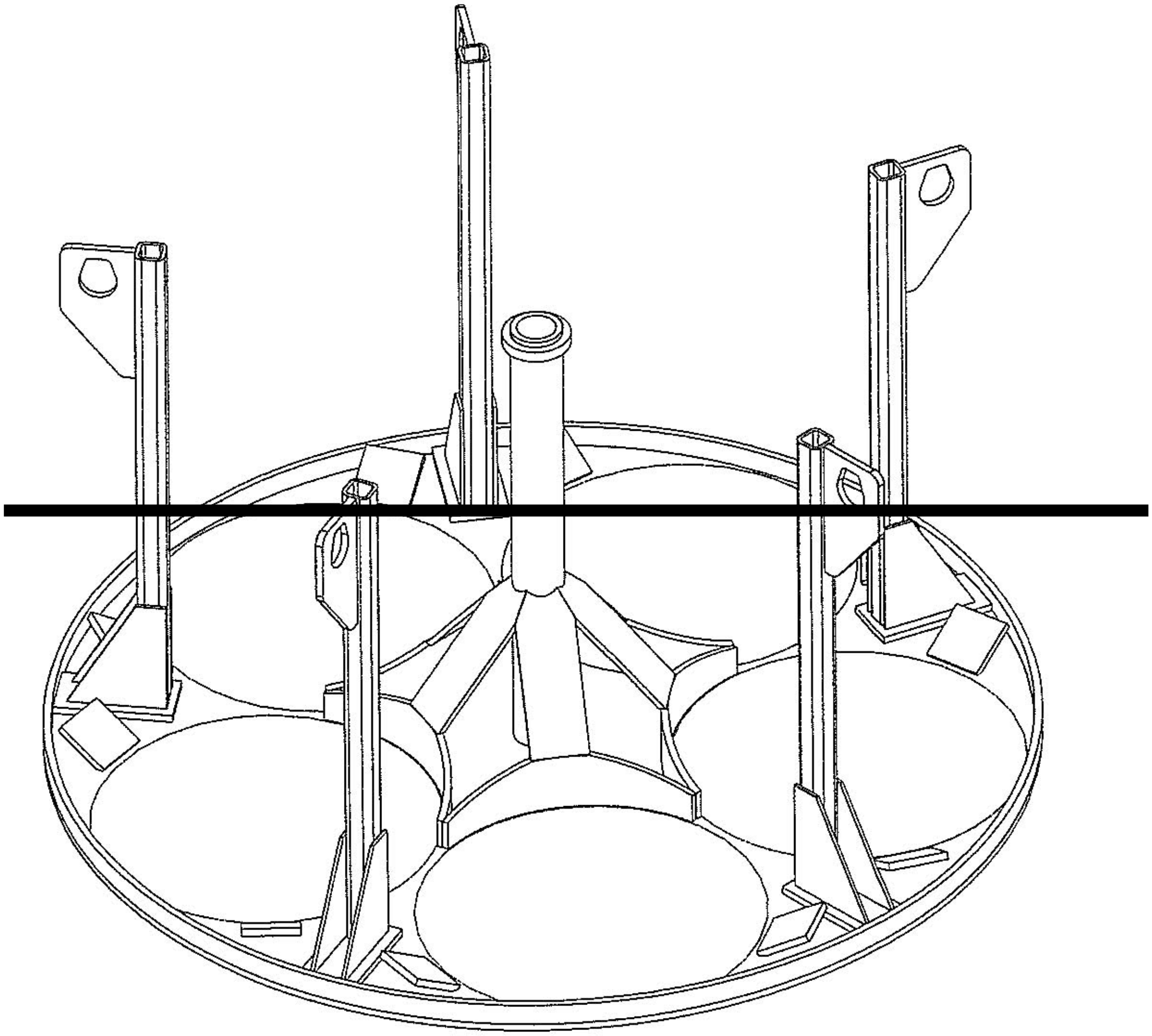
~~Figure A1-22b~~
~~CNS 10-160B Cask Transfer Car~~



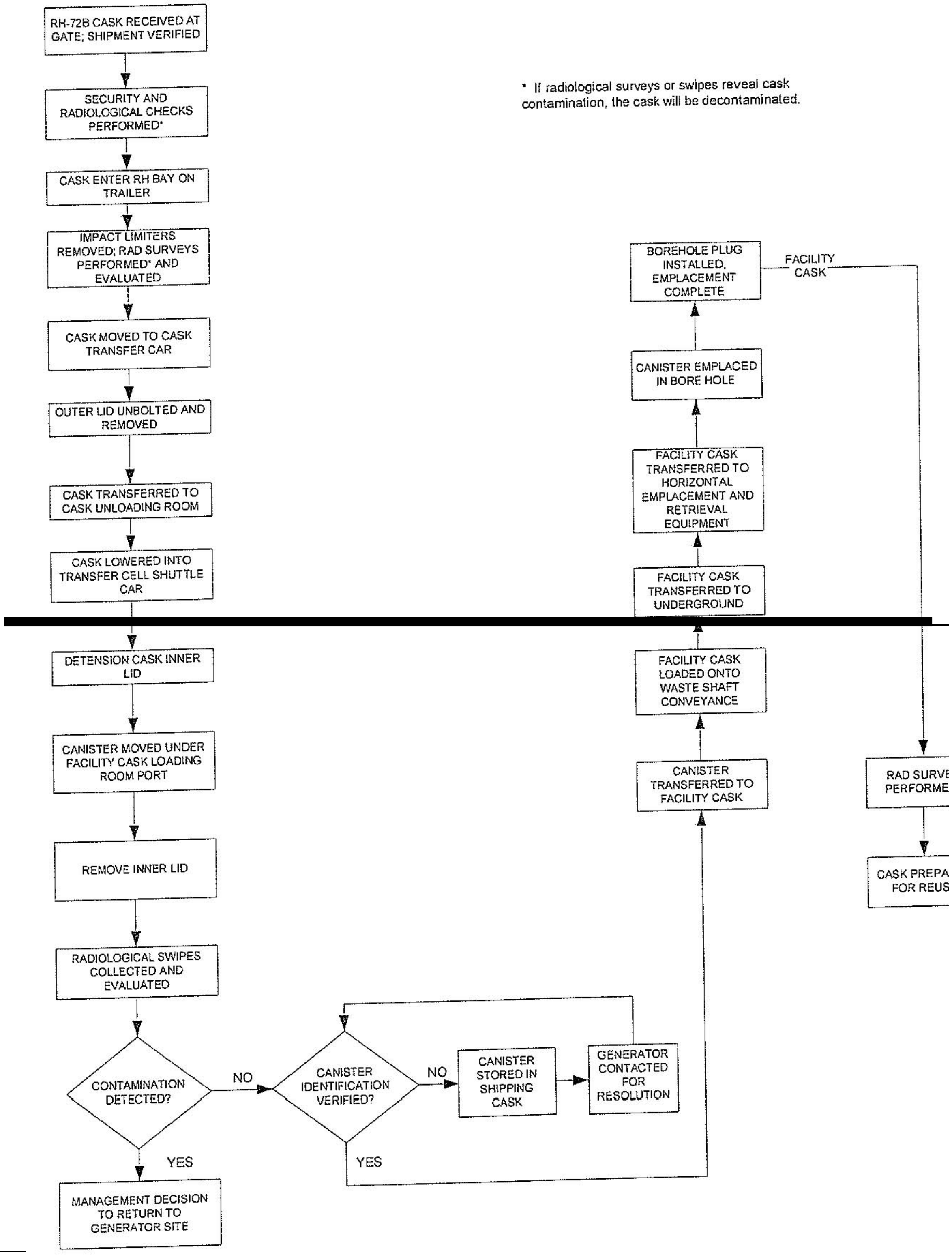
~~**Figure A1-23**~~
~~**RH Transuranic Waste Facility Cask**~~



~~Figure A1-24~~
~~RH Facility Cask Transfer Car (Side View)~~



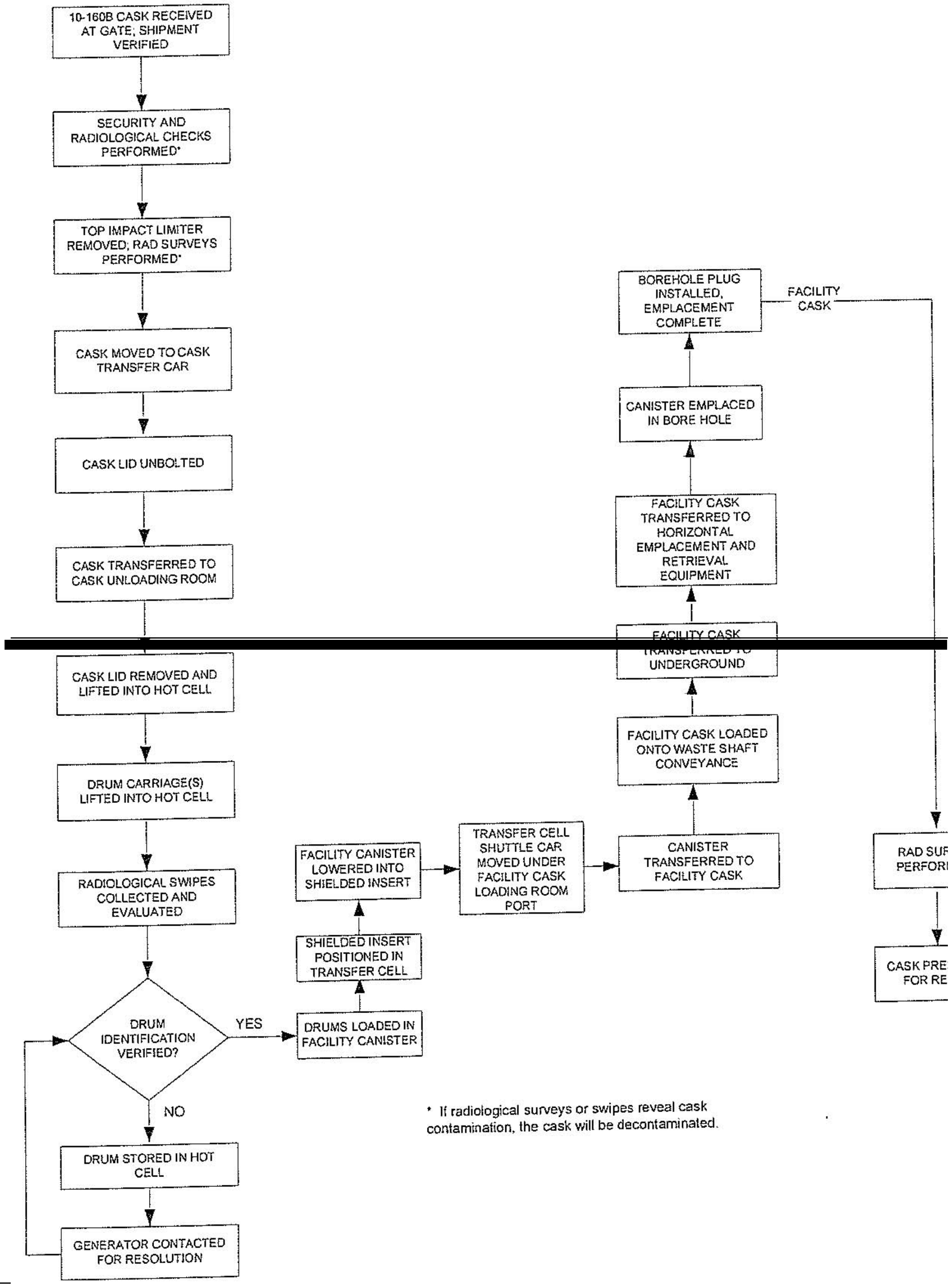
~~**Figure A1-25**~~
~~**CNS 10-160B Drum Carriage**~~



* If radiological surveys or swipes reveal cask contamination, the cask will be decontaminated.

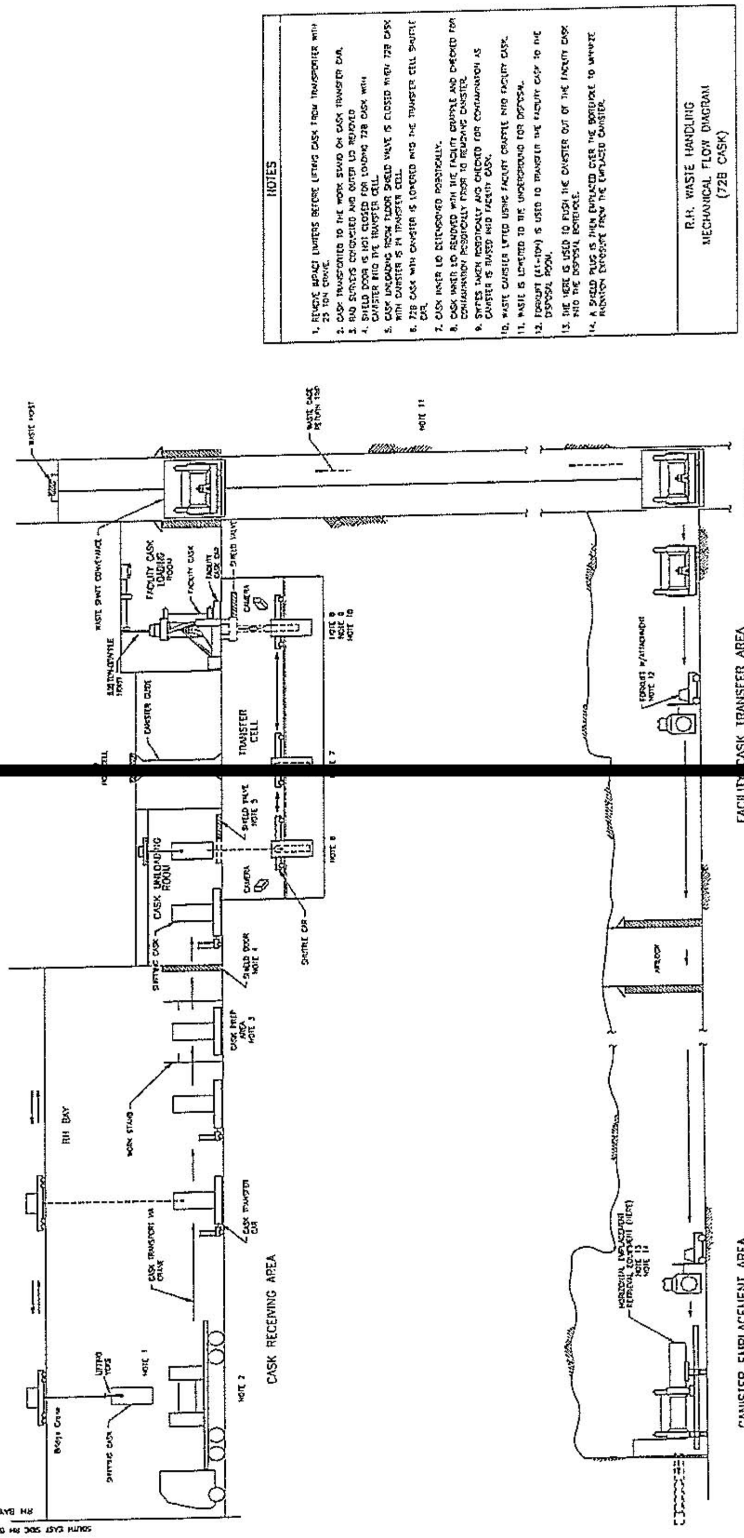
~~**Figure A1-26**~~

~~**Surface and Underground RH Transuranic Mixed Waste Process Flow Diagram for RH-TRU 72-B Shipping Cask**~~



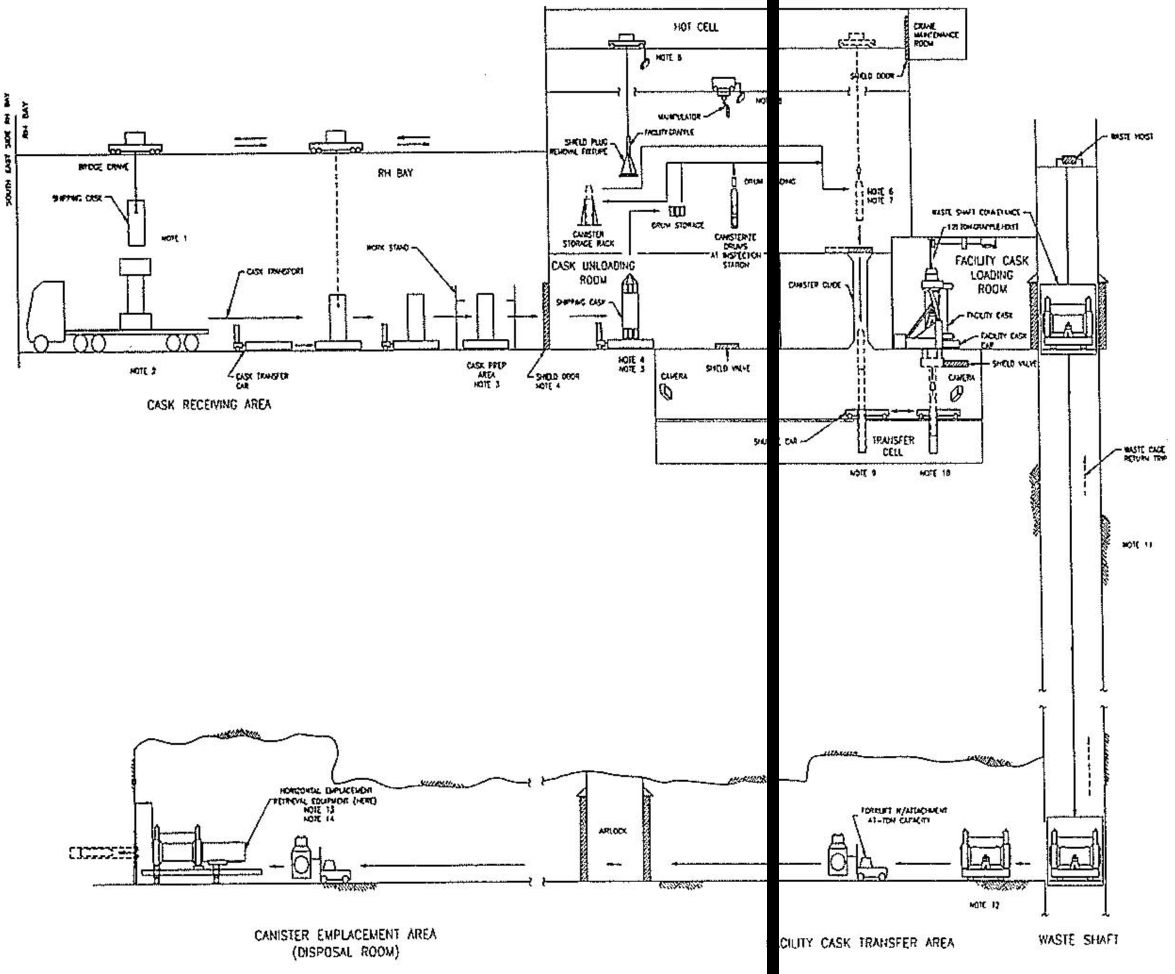
* If radiological surveys or swipes reveal cask contamination, the cask will be decontaminated.

~~Figure A1-27~~
~~Surface and Underground RH Transuranic Mixed Waste Process Flow Diagram for CNS 10-160B Shipping Cask~~



1. REMOVE IMPACT LIMITERS BEFORE LIFTING CASK FROM TRANSPORTER WITH 25 TON CRANE.
2. CASK TRANSPORTED TO THE WORK STAND ON CASK TRANSFER CAR.
3. RAD SURVEYS CONDUCTED AND OUTER LID REMOVED
4. SHIELD DOOR IS NOT CLOSED FOR LOADING 72B CASK WITH CANISTER INTO THE TRANSFER CELL.
5. CASK UNLOADING ROOM FLOOR SHIELD VALVE IS CLOSED WHEN 72B CASK WITH CANISTER IS IN TRANSFER CELL.
6. 72B CASK WITH CANISTER IS LOWERED INTO THE TRANSFER CELL SHUTTLE CAR.
7. CASK INNER LID DETENSIONED ROBOTICALLY.
8. CASK INNER LID REMOVED WITH THE FACILITY GRAPPLE AND CHECKED FOR CONTAMINATION ROBOTICALLY PRIOR TO REMOVING CANISTER.
9. SWIPES TAKEN ROBOTICALLY AND CHECKED FOR CONTAMINATION AS CANISTER IS RAISED INTO FACILITY CASK.
10. WASTE CANISTER LIFTED USING FACILITY GRAPPLE INTO FACILITY CASK.
11. WASTE IS LOWERED TO THE UNDERGROUND FOR DISPOSAL.
12. FORKLIFT (41-TON) IS USED TO TRANSFER THE FACILITY CASK TO THE DISPOSAL ROOM.
13. THE HERE IS USED TO PUSH THE CANISTER OUT OF THE FACILITY CASK INTO THE DISPOSAL BOREHOLE.
14. A SHIELD PLUG IS THEN EMPLACED OVER THE BOREHOLE TO MINIMIZE RADIATION EXPOSURE FROM THE EMPLACED CANISTER.

~~Figure A1-28~~
~~Schematic of the RH Transuranic Mixed Waste Process for RH-TRU 72-B Shipping Cask~~



[redacted]

NOTES

1. REMOVE TOP IMPACT LIMITER BEFORE LIFTING CASK FROM TRANSPORTER. LOWER IMPACT LIMITER REMAINS ON TRANSPORTER.

2. RAD SURVEYS ARE PERFORMED ON THE END OF THE CASK FROM WHICH IMPACT LIMITER IS REMOVED.

3. CASK IS MOVED USING CASK TRANSFER CAR.

4. SHIELD VALVE AND DOOR ARE CLOSED WHEN OFF-LOADING DRUMS FROM THE 10-160B CASK. CASK LID IS LIFTED INTO HOT CELL AND STORED FOR DRUM UNLOADING.

5. DRUMS ARE HELD IN A CARRIAGE UNIT WHICH IS LIFTED FROM THE CASK USING THE HOT CELL CRANE.

6. DRUM I.D. NUMBERS ARE VERIFIED, AND RADIOLOGICAL SWIPES ARE COLLECTED. WASTE IS MOVED TO CANISTER USING HOT CELL CRANE.

7. WASTE CANISTER IS LIFTED USING HOT CELL GRAPPLE.

8. CAMERAS MOUNTED ON CRANE AND POWERED MANIPULATOR

9. CANISTER LOADED INTO SHIELDED INSERT OR CASK IN SHUTTLE CAR USING HOT CELL CRANE AND GRAPPLE.

10. WASTE CANISTER LIFTED FROM SHIELDED INSERT OR CASK TO FACILITY CASK USING THE FACILITY GRAPPLE.

11. FACILITY CASK IS LOWERED TO UNDERGROUND ON WASTE HOIST.

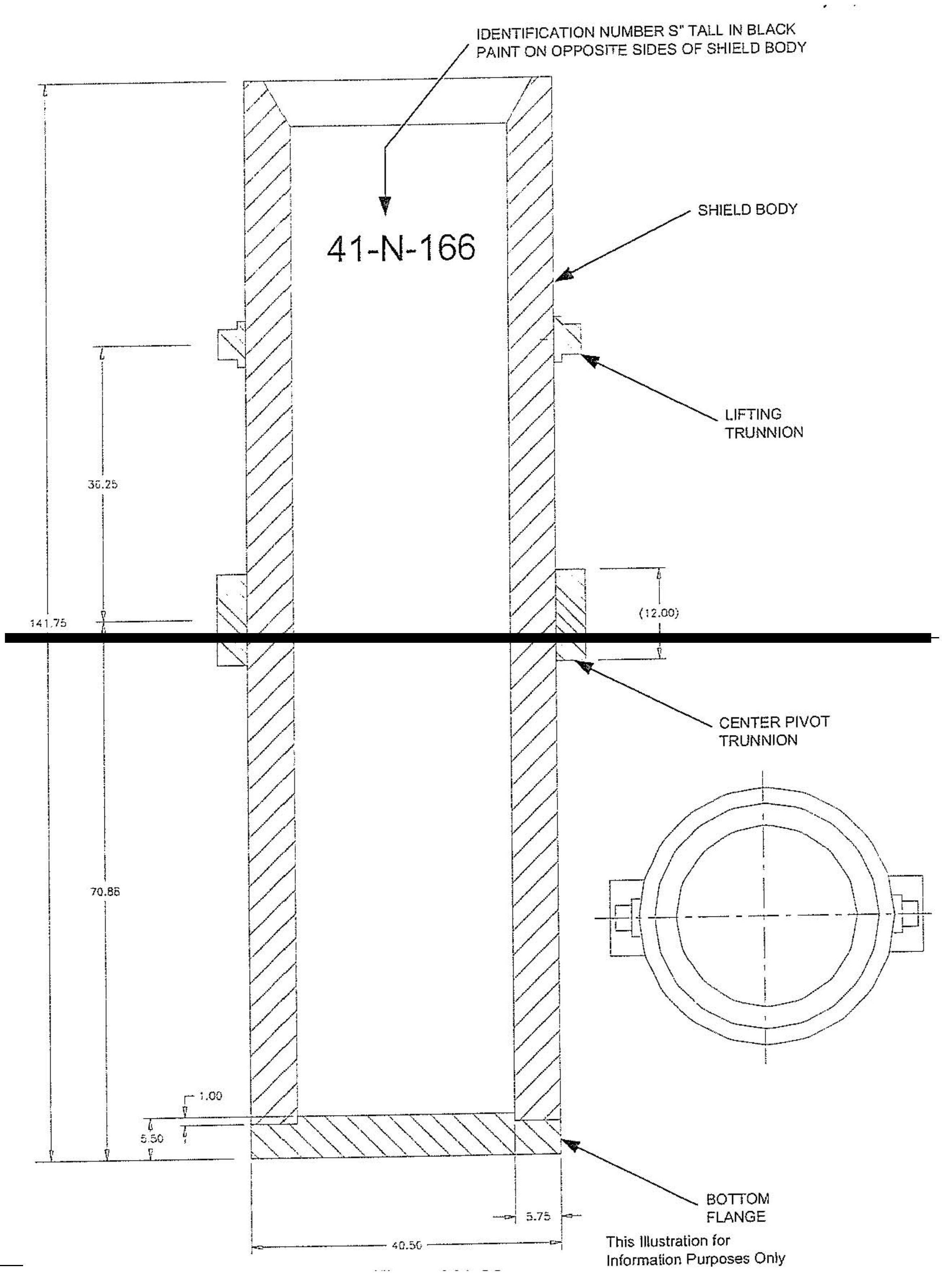
12. FORKLIFT (41-TON) TRANSPORTS FACILITY CASK TO DISPOSAL ROOM.

13. THE HERE IS USED TO PUSH THE CANISTER OUT OF THE FACILITY CASK INTO THE DISPOSAL BOREHOLE.

14. A SHIELD PLUG IS EMPLACED INTO THE BOREHOLE TO LIMIT RADIATION EXPOSURE FROM THE EMPLACED CANISTER.

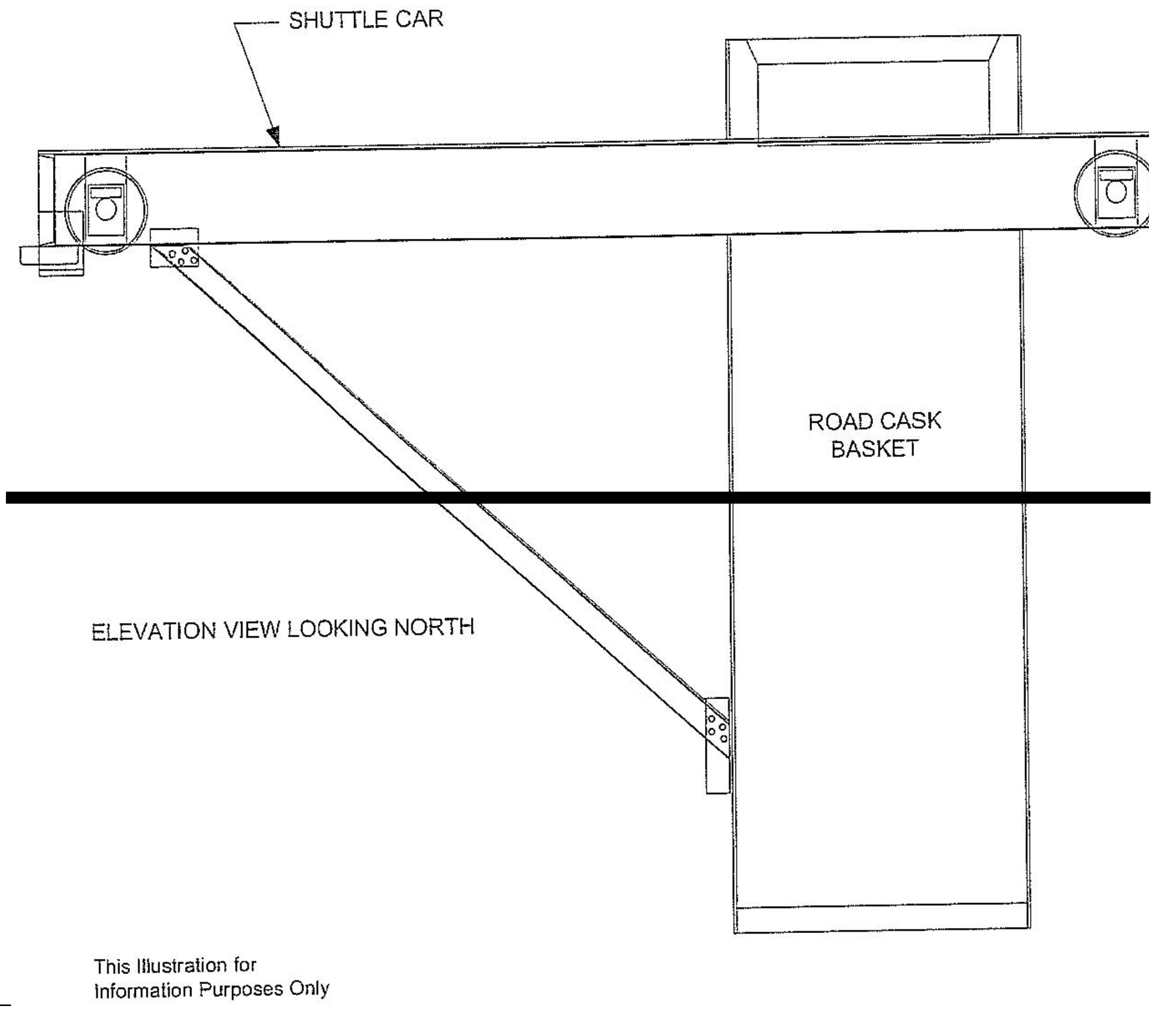
R.H. WASTE HANDLING
MECHANICAL FLOW DIAGRAM
(10-160B ROAD CASK)

~~Figure A1-29~~
~~Schematic of the RH Transuranic Mixed Waste Process for CNS 10-160B Shipping Cask~~

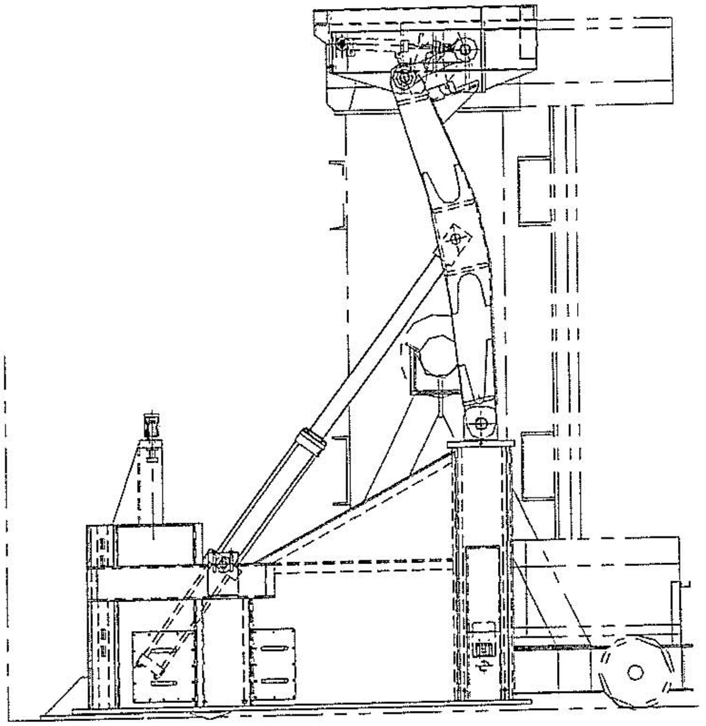


This Illustration for Information Purposes Only

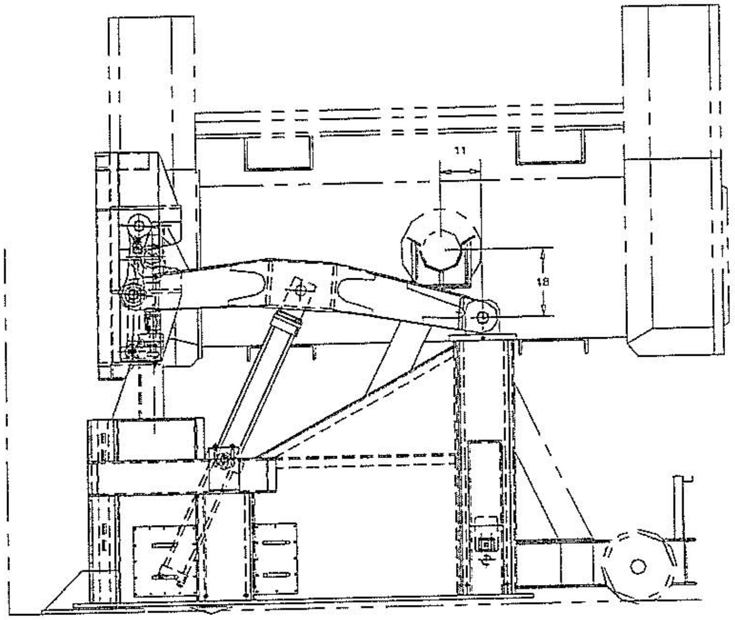
~~Figure A1-30~~
~~RH Shielded Insert Assembly~~



~~**Figure A1-31**~~
~~**Transfer Cell Shuttle Car**~~



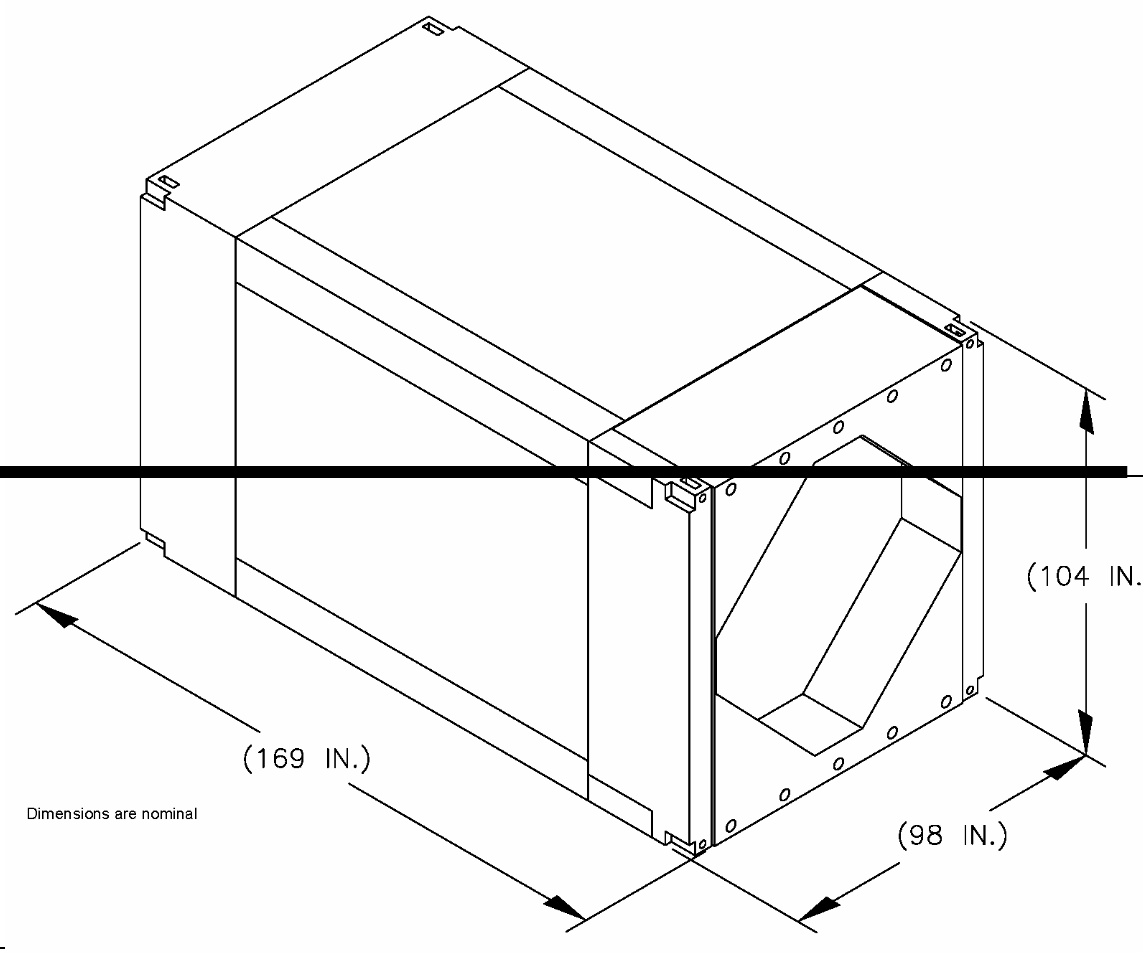
FRONT ELEVATION
CASK VERTICAL



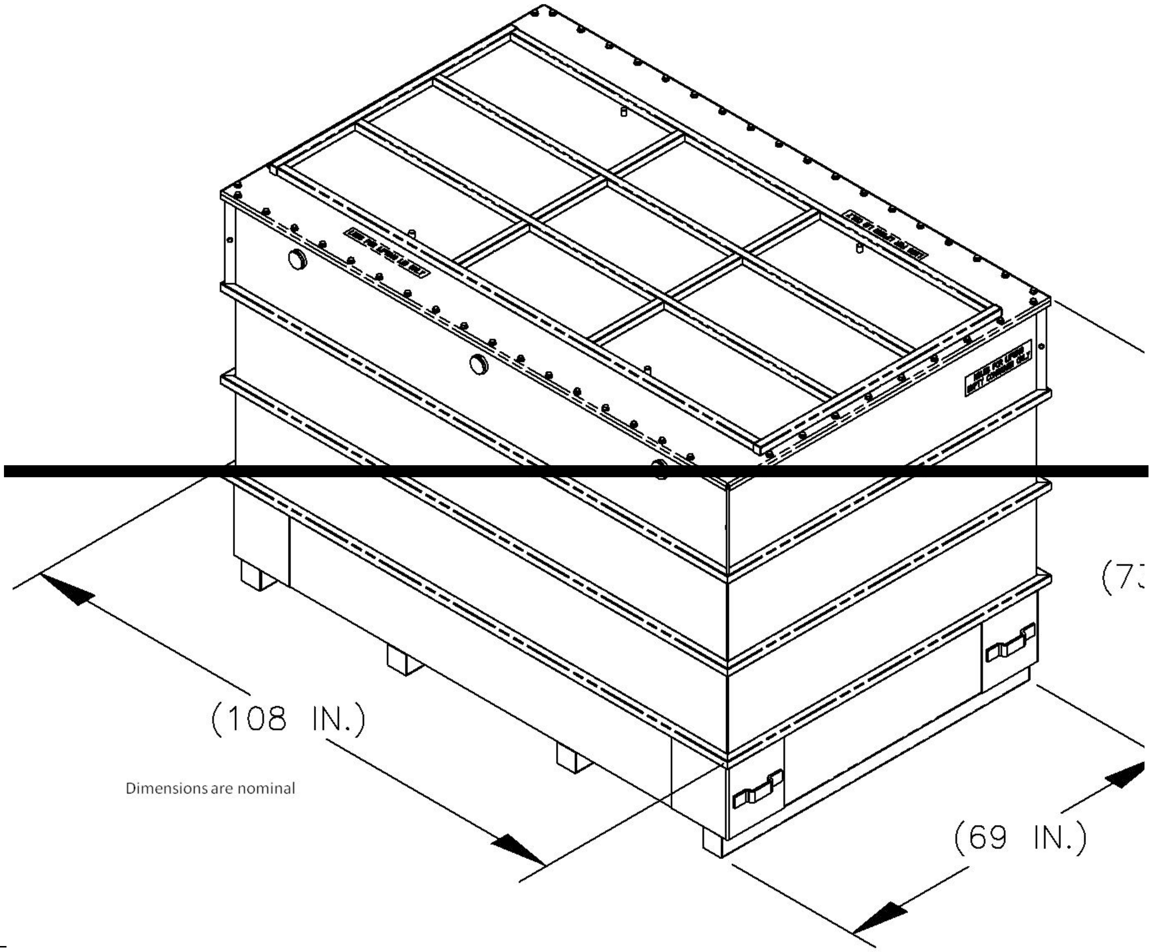
FRONT ELEVATION
CASK HORIZONTAL

This Illustration for
Information Purposes Only

~~Figure A1-32~~
~~Facility Rotating Device~~

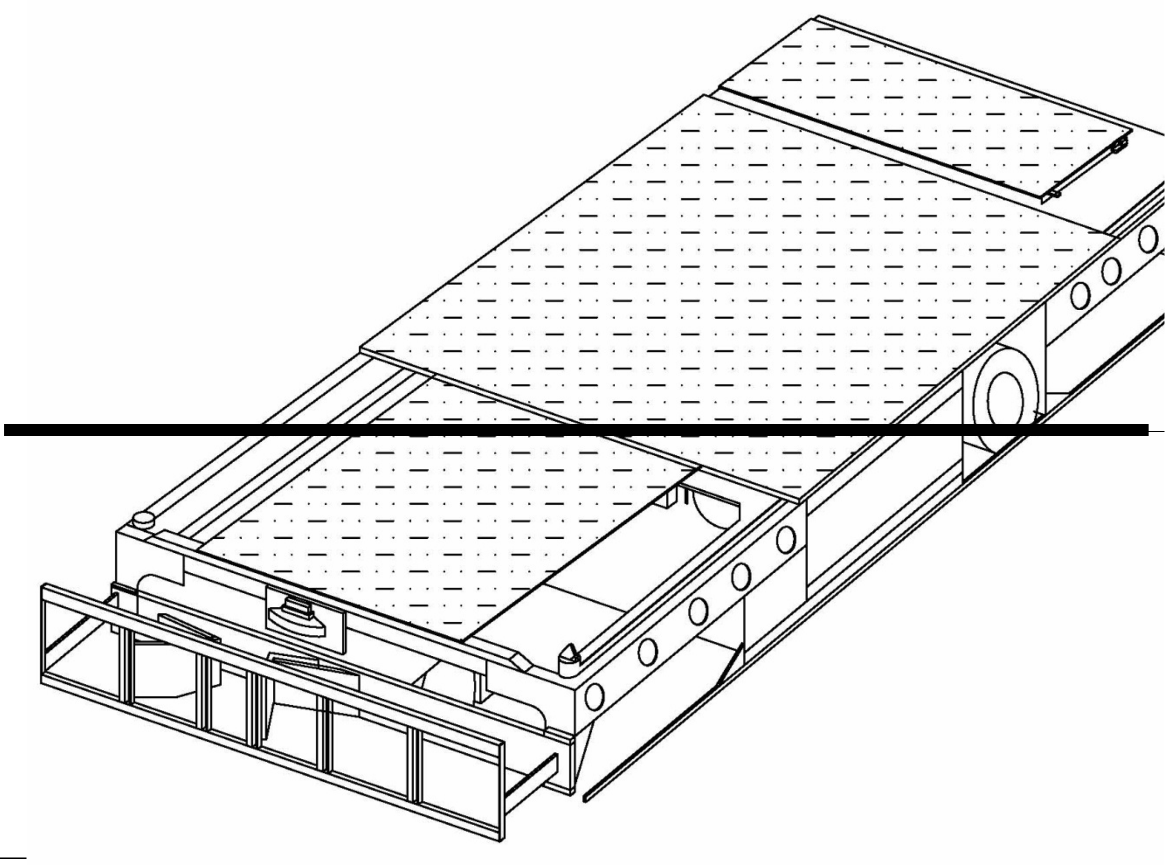


~~Figure A1-33~~
~~Typical TRUPACT-III~~

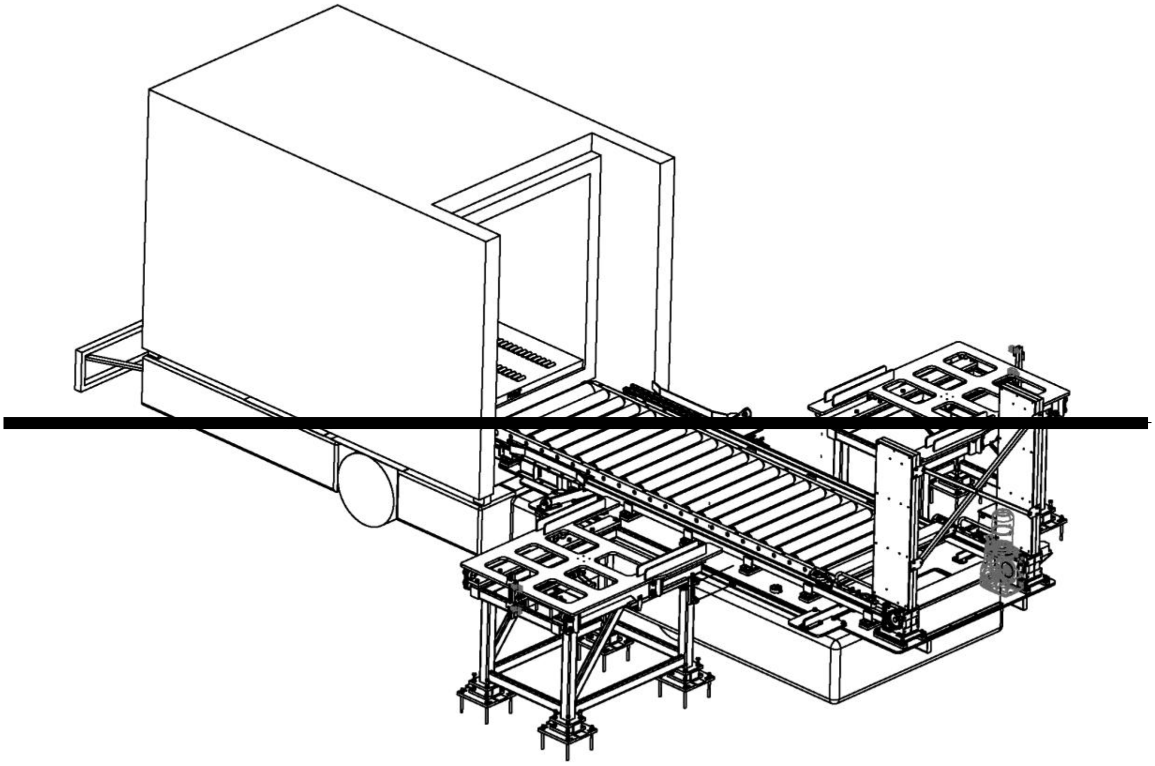


Dimensions are nominal

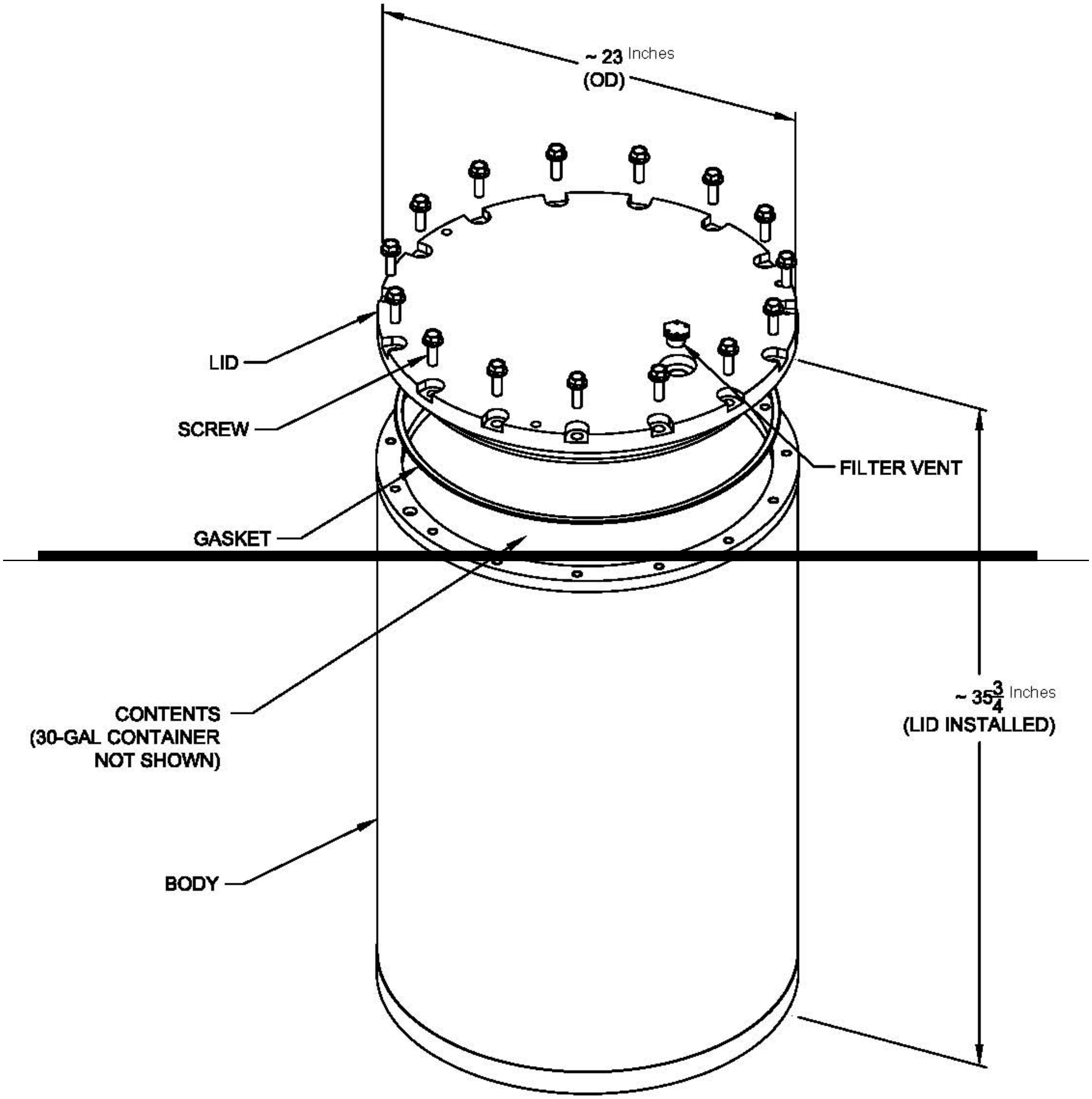
~~Figure A1-34~~
~~Typical Standard Large Box 2~~



~~Figure A1-35~~
~~Typical Yard Transfer Vehicle~~



~~Figure A1-36~~
~~Payload Transfer Station~~



~~Figure A1-37~~
~~Typical Shielded Container~~

ATTACHMENT A2

GEOLOGIC REPOSITORY

ATTACHMENT A2

GEOLOGIC REPOSITORY

TABLE OF CONTENTS

LIST OF TABLES

~~LIST OF FIGURES~~

ATTACHMENT A2

GEOLOGIC REPOSITORY

A2-1 Description of the Geologic Repository

Management, storage, and disposal of transuranic (**TRU**) mixed waste in the Waste Isolation Pilot Plant (**WIPP**) geologic repository is subject to regulation under 20.4.1.500 New Mexico Administrative Code (**NMAC**). The WIPP ~~is a~~ geologic repository is mined within a bedded salt formation, which is defined in 20.4.1.~~101~~ 100 NMAC (incorporating Title 40 of the Code of Federal Regulations (**CFR**) §260.10) as a ~~miscellaneous~~Miscellaneous ~~unit~~Unit. As such, ~~HWMUs~~ hazardous waste management units within the repository are eligible for permitting ~~according to 20.4.1.101 NMAC (incorporating 40 CFR §260.10),~~ and are regulated under 20.4.1.500 NMAC~~,~~ (incorporating 40 CFR Part 264, *Miscellaneous Units*). The underground Hazardous Waste Disposal Units (**HWDUs**) consist of eight excavated panels, known as Panels 1 through 8. Each panel contains seven rooms and two access drifts. A typical disposal panel is depicted in Figure M-42.

As required by 20.4.1.500 NMAC (incorporating 40 CFR §264.601), the Permittees shall ensure that the environmental performance standards for a ~~miscellaneous~~ Miscellaneous ~~unit~~Unit, which are applied to the ~~Underground~~ underground ~~Hazardous Waste Disposal Units (**HWDUs**)~~HWDUs in the geologic repository, ~~will be~~are met.

The Disposal Phase will consist of receiving contact-handled (**CH**) and remote-handled (**RH**) TRU mixed waste shipping containers, unloading and transporting the waste containers to the ~~Underground~~ underground HWDUs, emplacing the waste in the ~~Underground~~ underground HWDUs, and subsequently achieving closure of the ~~Underground~~ underground HWDUs in compliance with applicable ~~State~~ state and ~~Federal~~ federal regulations.

The WIPP geologic repository is mined within a ~~2,000-feet (ft) (610-meters (m))-thick~~ bedded-salt formation called the Salado Formation, which is 2,000 feet (**ft**) (610 meters (**m**)) thick. The ~~Underground~~ underground HWDUs (miscellaneous units) are located approximately 2,150 ft (655 m) beneath the ground surface. ~~TRU~~ Transuranic mixed waste management activities underground will be confined to the southern portion of the 120-acre (~~48.6 hectares~~48.6 hectare) mined area and the western portion of the 29.2-acre (11.8 hectares) mined area during the Disposal Phase. During the ten-year term of this Permit, disposal of TRU mixed waste ~~will occur only~~is authorized in the HWDUs designated as Panels ~~5 through 8~~7, 8, 11, and 12 ~~and in any currently active panel~~ (~~See~~ see Figure ~~A2-1~~M-43). ~~RH TRU mixed waste disposal began in Panel 4. The Permittees may also request in the future a Permit to allow disposal of containers of TRU mixed waste in the areas designated as Panels 9 and 10 in Figure A2-1. This Permit, during its 10-year term, authorizes the excavation of Panels 6 through 10 and the disposal of waste in Panels 1 through 8.~~In the future, the Permittees may request Permit modifications to allow disposal of TRU mixed waste in other areas of the underground, one of which may be Panel 10.

Panels 1 through 8, 11, and 12 ~~will~~ consist of seven rooms and two access drifts each. ~~Panels 9 and 10 have yet to be designed.~~ Access drifts connect the rooms and have the same cross section (see Section A2-2a(3)). The closure system installed ~~in~~ for each HWDU, after it is filled, will prevent anyone from entering the HWDU and will restrict ventilation airflow. The point of compliance for air emissions from the ~~Underground~~ underground is defined in Permit

Attachment N (Volatile Organic Compound Monitoring Plan). The point of compliance is the location where the concentration of volatile organic compounds (**VOCs**) in the air emissions from the ~~Underground~~ underground HWDUs will be measured and then compared to the VOC action levels (10^{-5} for carcinogens and ~~HI~~Hazard Index>1 for non-carcinogens) as required by Permit Part 4, Section 4.6.2.3.

Description of Four-Shaft Configuration

Four shafts connect the underground area with the surface. The Waste Shaft Conveyance headframe and hoist are located within the Waste Handling Building (**WHB**) and ~~will be~~are used to transport containers of TRU mixed waste, equipment, and materials to the repository horizon. The ~~waste~~ Waste ~~hoist~~ Hoist can also be used to transport personnel. The Air Intake Shaft and the Salt Handling Shaft provide ventilation to all areas of the mine except for the Waste Shaft Station. This area is ventilated by the Waste Shaft itself. The Salt Handling Shaft is also used to hoist mined salt to the surface and serves as the principal personnel transport shaft. The Exhaust Shaft serves as a common exhaust air duct (air pathway) for ~~all areas of~~ the mine. In some cases (such as during mining activities), the Salt Handling Shaft ~~will be~~is used as an unfiltered exhaust shaft. The Salt Handling Shaft exhaust air ~~will come~~comes from the North or Construction Circuits (i.e., areas of the underground that are not contaminated and do not need High-Efficiency Particulate Air (**HEPA**) filtration). The relationship between the WIPP surface facility, the four shafts, and the geologic repository horizon is shown on Figure ~~A2-2~~M-44.

Description of Five-Shaft Configuration (with Shaft #5)

A fifth shaft, Shaft #5 (**S#5**), also connects the underground facility with the surface. The relationship between the WIPP surface facility, the five shafts, and the underground facility horizon is shown in Figure A2-2-S#5. With S#5 in use, the configuration of the shafts is as follows:

- Shaft #5 provides the majority of the intake air for the underground facility.

- The Air Intake Shaft provides the exhaust air pathway for the construction area of the underground facility.

- The Waste Shaft Conveyance headframe and hoist are located within the WHB and are used to transport containers of TRU mixed waste, equipment, and materials to the repository horizon. The waste hoist can also be used to transport personnel.

- The Waste Shaft provides intake air for the Waste Shaft Station.

- The Salt Handling Shaft provides a portion of the ventilation for the north area of the underground facility and is also used to hoist mined salt to the surface and serve as the principle personnel transport shaft.

- The Exhaust Shaft serves as a common exhaust air pathway for the north, disposal, and Waste Shaft Station areas of the underground facility.

The HWDUs identified as Panels 1 through 8, 11, and 12 (Figure ~~A2-1~~M-43) provide room for up to ~~5,244,900~~6,569,200 cubic feet (ft^3) (~~148,500~~186,000 cubic meters (m^3)) of CH TRU mixed waste. The CH TRU mixed waste containers may be stacked up to three high across the width of the room.

Panels 4 through 8, 11, and 12 provide room for up to ~~93,050~~138,950 ft^3 (~~2,635~~3,935 m^3) of RH TRU mixed waste. ~~RH~~ Remote-handled TRU mixed waste may be disposed of in up to 730 boreholes per panel, subject to the limitations in Permit Part 4, Section 4.1.1.2.ii. These boreholes ~~shall be~~are drilled on nominal eight-foot centers, horizontally, about mid-height in the ribs of a disposal room. The thermal loading from RH TRU mixed waste shall not exceed 10 kilowatts per acre when averaged over the area of a panel, ~~as shown in Permit Attachment A3,~~ plus 100 feet of each of a ~~Panel's~~ panel's adjoining barrier pillars for Panels 4 through 8, and 150 feet of each of a Panel's adjoining barrier pillars for Panels 11 and 12.

The WIPP facility is located in a sparsely populated area with site conditions favorable to isolation of TRU mixed waste from the biosphere. Geologic and hydrologic characteristics of the site related to its TRU mixed waste isolation capabilities are discussed in Addendum L1 of the WIPP Hazardous Waste Facility Permit ~~Amended~~ Renewal Applications (DOE, 2009, 2020). ~~Hazard prevention programs are described in this Permit Attachment.~~ Contingency and emergency response actions to minimize impacts of unanticipated events, such as ~~spills~~releases of TRU mixed waste, are described in Permit Attachment D. The closure plan for the WIPP facility is described in Permit Attachment G.

A2-2 Geologic Repository Design and Process Description

A2-2a Geologic Repository Design and Construction

Compliance with the Permit ensures operations at ~~The~~the WIPP facility are~~, when operated in compliance with the Permit, will ensure~~ safe ~~operations~~ and ~~be~~ protective of human health and the environment.

As a part of the design validation process, geomechanical tests were conducted in ~~SPDV~~ Site and Preliminary Design Validation test rooms. During the tests, salt creep rates were measured. Separation of bedding planes and fracturing were also observed. Consequently, a ground-control strategy was implemented. The ground-control program at the WIPP facility mitigates the potential for roof or rib falls and maintains normal excavation dimensions, as long as access to the excavation is possible.

A2-2a(1) CH TRU Mixed Waste Handling Equipment

The following are the major pieces of equipment used to manage CH TRU waste in the geologic repository. A summary of equipment capacities, as required by 20.4.1.500 NMAC is included in Table A2-1.

Facility Pallets

The facility pallet is a fabricated steel unit designed to support ~~7~~seven-packs, ~~3~~three-packs, or ~~4~~four-packs of drums, standard waste boxes (**SWBs**), ten-drum overpacks (**TDOPs**), or a standard large box 2 (**SLB2**)~~, and has a rated load of 25,000 pounds (lbs.) (11,430 kilograms (kg))~~. The facility pallet ~~will~~ accommodates up to four ~~7~~seven-packs, four ~~3~~three-packs, or four four-packs of drums; two ~~3~~three-packs of shielded containers;~~, four 4-packs of drums,~~ four SWBs (in two stacks of two units)~~,~~; two TDOPs~~,~~; or one SLB2. Loads are secured to the facility pallet during transport to the emplacement area. Facility pallets are shown in Figure ~~A2-3~~M-21. Fork pockets in the side of the pallet allow the facility pallet to be lifted and transferred by forklift to prevent direct contact between TRU mixed waste containers and forklift tines. This arrangement reduces the potential for puncture accidents. WIPP facility operational documents define the operational load of the facility pallet to ensure that the rated load of a facility pallet is not exceeded.

Backfill

Magnesium oxide (**MgO**) ~~will be~~is used as a backfill ~~in order~~ to provide chemical control over the solubility of radionuclides in order to comply with the requirements of 40 CFR §191.13. The MgO backfill ~~will be~~is ~~purchased prepackaged~~ packaged appropriately ~~in the proper containers~~ for emplacement in the underground. ~~Purchasing prepackaged backfill eliminates handling and placement problems associated with bulk materials, such as dust creation. In addition, prepackaged materials will be easier to emplace, thus reducing potential worker exposure to radiation.~~ Magnesium oxide is benign; therefore, ~~S~~should a backfill ~~container~~ package be breached, ~~MgO is benign and cleanup is simple. N~~no hazardous waste would result from a spill of backfill.

~~The MgO backfill will be managed in accordance with Specification D-0101 (MgO Backfill Specification) and WP05-WH1025 (CH Waste Downloading and Emplacement). These documents are kept on file at the WIPP facility by the Permittees.~~

~~Backfill will be handled in accordance with standard operating procedures.~~ Typical backfill emplacement configurations are shown in Figures ~~A2-5 and A2-5a~~M-45. Some emplacement configurations may include the use of MgO emplacement racks, as shown in Figure ~~A2-5a~~M-45. The backfill emplacement process does not require additional operational considerations (e.g., ventilation flow and control) beyond those required for TRU mixed waste emplacement.

~~Quality control will be provided within standard operating procedures to record that the correct number of sacks are placed and that the condition of the sacks is acceptable.~~

~~Backfill placed in this manner is protected until exposed when sacks are broken during creep closure of the room and compaction of the backfill and waste. Backfill in sacks utilizes existing techniques and equipment and eliminates operational problems such as dust creation and introducing additional equipment and operations into waste handling areas. There are no mine operational considerations (e.g. ventilation flow and control) when backfill is placed in this manner.~~

The Waste Shaft Conveyance

The hoist systems in the shafts and ~~all~~ related shaft furnishings are designed to resist the dynamic forces of the hoisting system and to withstand a design-basis earthquake (**DBE**) of 0.1 g. Appendix D2 of the WIPP RCRA Part B Permit Application (DOE, 1997) provided an engineering design-basis earthquake report, which provides the basis for seismic design of WIPP facility structures. The ~~waste~~ Waste ~~hoist~~ Hoist is equipped with a control system that ~~will~~ detects malfunctions or abnormal operations of the hoist system (such as overtravel, overspeed, power loss, circuitry failure, or starting in a wrong direction) and ~~will~~ triggers an alarm that automatically shuts down the hoist.

The ~~waste~~ Waste ~~hoist~~ Hoist moves the Waste Shaft Conveyance and is a multirope, friction-type hoist. A counterweight is used to balance the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~Conveyance. The ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance (outside dimensions) is 30 ft (9 m) high by 10 ft (3 m) wide by 15 ft (4.5 m) deep and can carry a payload of 45 tons (40,824 kilograms (**kg**)). During loading and unloading operations, it is steadied by fixed guides. The hoist's maximum rope speed is 500 ft (152.4 m) per minute.

The Waste Shaft hoist system has two sets of brakes, with two units per set, plus a motor that is normally used to stop the hoist. The brakes are designed so that either set, acting alone, can stop a fully loaded conveyance under ~~all~~ emergency conditions.

The Underground Waste Transporter

The underground waste transporter is a commercially available diesel-powered tractor. The trailer was designed specifically for the WIPP facility for transporting facility pallets from the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance to the ~~Underground~~ underground HWDU ~~in use~~. This transporter is shown in Figure ~~A2-6~~M-46.

Underground Forklifts

~~CH~~ Contact-handled TRU mixed waste containers loaded on slipsheets ~~will be~~are removed from the facility pallets using forklifts with a push-pull attachment (Figure ~~A2-7~~M-47) attached to the forklift-truck front carriage. The push-pull attachment grips the edge of the slipsheet (on which the waste containers sit) to pull the containers onto the platen. After the forklift moves the waste containers to the emplacement location, the push-pull attachment pushes the containers into position. The use of the push-pull attachment prevents direct contact between waste containers and forklift tines. ~~SWBs~~ Standard waste boxes and TDOPs may also be removed from the facility pallet by using forklifts equipped with special adapters for these containers. These special adapters ~~will~~ prevent direct contact between SWBs or TDOPs and forklift tines. In addition, the low clearance forklift that is used to emplace MgO may be used to emplace waste if necessary.

A forklift ~~will be~~is used to offload the SLB2 from the underground transporter and emplace the waste container in the waste stack.

A2-2a(2) Shafts

Four-Shaft Configuration

The WIPP facility uses four shafts: the Waste Shaft, the Salt Handling Shaft, the Air Intake Shaft, and the Exhaust Shaft. These shafts are vertical openings that extend from the surface to the repository level.

The Waste Shaft is located beneath the WHB and ~~is~~ varies from 19 to 20 ft (5.8 to 6.1 m) in diameter. The Salt Handling Shaft, located north of the Waste Shaft beneath the salt handling headframe, ~~is~~ varies from 10 to 12 ft (3 to 3.6 m) in diameter. Salt mined from the repository horizon is removed through the Salt Handling Shaft. The Salt Handling Shaft is the main personnel and materials hoist and also serves as a secondary supply air pathway for the underground areas. The Air Intake Shaft, northwest of the WHB, varies in diameter from 16 ft 7 ~~in.~~inches (**in**) (4.51 m) to 20 ft 3 in. (6.19 m) and is the primary source of fresh air underground.

The Exhaust Shaft, east of the WHB, ~~is~~ varies from 14 to 15 ft (4.3 to 4.6 m) in diameter and serves as the exhaust air pathway for the underground air. In some cases, the Salt Handling Shaft may be used as an unfiltered exhaust shaft to ventilate areas of the underground that do not need filtration.

Five-Shaft Configuration (with S#5)

A fifth shaft, S#5, also extends from the surface to the repository level. The inside diameter of S#5 is approximately 26 ft (8 m). With S#5 in use, it is the primary source of fresh air to the underground facility. With S#5 in use, the ventilation functions of the existing shafts are as follows:

- Salt Handling Shaft serves as a secondary supply-air (intake air) pathway for the underground facility.

- The Waste Shaft serves as the supply-air (intake air) pathway for the Waste Shaft Station.

- The Air Intake Shaft serves as the exhaust air pathway for the construction area of the underground facility.

- The Exhaust Shaft serves as the exhaust air pathway for the north, disposal and Waste Shaft Station areas of the underground facility.

General Shaft Description

Openings excavated in salt experience closure because of salt creep, ~~(~~or time-dependent deformation at constant load~~)~~. The closure affects the design of ~~all of~~ the openings discussed in this section. Underground excavation dimensions, therefore, are nominal, because they change with time. The unlined portions of the shafts have larger diameters than the lined portions, which allows for closure caused by salt creep. Each shaft includes a shaft collar, a shaft lining, and a shaft key section. Permit Attachment G2 describes each shaft in detail including shaft construction, location of the shaft liners, shaft keys, water collection rings, and tubes.~~The Final Design Validation Report in Appendix D1 of the WIPP RCRA Part B Permit Application (DOE, 1997) discusses the original four shafts and shaft components in greater detail.~~

~~The reinforced-concrete shaft collars extend from the surface to the top of the underlying consolidated sediments. Each collar serves to retain adjacent unconsolidated sands and soils and to prevent surface runoff from entering the shafts. The shaft linings extend from the base of the collar to the top of the salt beds approximately 850 ft (259 m) below the surface. Grout injected behind the shaft lining or a polymeric spray coating retards water seeping into the shafts from water-bearing formations, and the liner is designed to withstand the natural water pressure associated with these formations. The shaft liners are concrete, except in the Salt Handling Shaft, where a steel shaft liner has been grouted in place.~~

~~The shaft key is a circular reinforced concrete section emplaced in each shaft below the liner in the base of the Rustler and extending about 50 ft (15 m) into the Salado. The key functions to resist lateral pressures and assures that the liner will not separate from the host rocks or fail~~

~~under tension. This design feature also aids in preventing the shaft from becoming a route for groundwater flow into the underground facility.~~

~~On the inside surface of each shaft, excluding the Salt Handling Shaft and S#5, there are three water- collection rings: one just below the Magenta, one just below the Culebra, and one at the lowermost part of the key section. These collection rings will collect water that may seep into the shaft through the liner. The Salt Handling Shaft has a single water collection ring in the lower part of the key section. Water collection rings are drained by tubes to the base of the shafts where the water is accumulated. Shaft #5 is outfitted with water stops at each shaft liner cold joint throughout the lined portion of the shaft.~~

~~WIPP s~~Shafts and other underground facilities are, for all practical purposes, dry. Minor quantities of water (which accumulate in some shaft sumps) are insufficient to affect the waste disposal area. This water is collected, brought to the surface, and disposed of in accordance with current standards and regulations.

The Waste Shaft is protected from precipitation by the roof of the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance headframe tower. The Exhaust Shaft is configured at the top with a 14 ft- (4.3 m-) diameter duct that diverts air into the exhaust filtration system or to the atmosphere, as appropriate. The Salt Handling and Air Intake Shaft collars are open except for the headframes. Rainfall into the shafts is evaporated by ventilation air. Shaft #5 is covered to direct intake air into the underground facility using fans located on the surface. The fans are connected to the shaft via ducting and a plenum.

With S#5 in use, the Air Intake Shaft is converted to an exhaust shaft for Construction Circuit air by routing the air through a plenum and ducting to an unfiltered exhaust stack.

The ~~waste~~ Waste ~~hoist~~ Hoist system in the Waste Shaft and ~~all~~ Waste Shaft furnishings are designed to resist the dynamic forces of the hoisting system, which are greater than the seismic forces on the underground facilities. In addition, the Waste Shaft ~~conveyance~~ Conveyance headframe is designed to withstand the ~~design-basis earthquake (**DBE**)~~DBE. Maximum operating speed of the hoist is 500 ft (152.4 m) per minute. During loading and unloading operations, the ~~waste~~ Waste ~~hoist~~ Hoist is steadied by fixed guides. The ~~waste~~ Waste ~~hoist~~ Hoist is equipped with a control system that will detect malfunctions or abnormal operations of the hoist system, such as overtravel, overspeed, power loss, or circuitry failure. The control response is to annunciate the condition and shut the hoist down. Operator response is required to recover from the automatic shutdown. Waste ~~hoist~~ Hoist operation is continuously monitored by the Central Monitoring System (**CMS**). A battery-~~-~~powered ~~FM~~ transmitter/receiver allows communication between the ~~hoist conveyance~~Waste Shaft Conyenance and the hoist house.

The ~~waste~~ Waste ~~hoist~~ Hoist has two pairs of brake calipers acting on independent brake paths. The hoist motor is normally used for braking action of the hoist. The brakes are used to hold the hoist in position during normal operations and to stop the hoist under emergency conditions. Each pair of brake calipers is capable of holding the hoist in position during normal operating conditions and stopping the hoist under emergency conditions. In the event of power failure, the brakes will set automatically.

The ~~waste~~ Waste ~~hoist~~ Hoist is protected by a fixed automatic fire suppression system. Portable fire extinguishers are also provided on the hoist floor and in equipment areas.

A2-2a(3) Subsurface Structures

The subsurface structures in the repository, located at 2,150 ft (655 m) below the surface, include the HWDUs, the northern experimental areas, and the support areas. Appendix D3 of the WIPP RCRA Part B Permit Application (DOE, 1997) provided details of the underground layout. Figure ~~A2-8~~M-48 shows the proposed waste emplacement configuration for the HWDUs.

The status of ~~important~~ designated underground equipment, including fixed fire-protection systems, the ventilation system, and contamination~~-~~-detection systems, ~~will be~~are monitored by a ~~central monitoring system~~CMS, located in the Support Building adjacent to the WHB. Backup power will be provided as discussed below. The subsurface support areas are constructed and maintained to conform to ~~Federal~~ federal mine safety codes.

Underground Hazardous Waste Disposal Units (HWDUs)

During the terms of this and the preceding Permit, the final TRU mixed waste volumes emplaced in the repository will not exceed the maximum capacities listed in Permit Part 4, Table 4.1.1 for each HWDU. ~~CH~~ Contact-handled TRU mixed waste will be disposed of in ~~Underground~~ underground HWDUs identified as Panels 1 through 8, 11, and 12. ~~RH~~ Remote-handled TRU mixed waste may be disposed of in Panels 4 through 8, 11, and 12.

Main entries and cross cuts in the repository provide access and ventilation to the HWDUs. The main entries link the shaft pillar/service area with the TRU mixed waste management area and are separated by pillars. Each of the ~~Underground~~ underground HWDUs labeled Panels 1 through 8, 11, and 12 will have seven rooms. The locations of these HWDUs are shown in Figure ~~A2-1~~M-43. The rooms in Panels 1-7 will have nominal dimensions of 13 ft (4.0 m) high by 33 ft (10 m) wide by 300 ft (91 m) long and ~~will be~~are ~~supported~~ separated by 100 ft (30 m) wide pillars. The rooms in Panel 8 will have nominal dimensions of 16 ft (5.0 m) high by 33 ft (10 m) wide by 300 ft (91 m) long and will be supported by 100 ft (30 m) wide pillars.

As currently planned, future Permits may allow disposal of TRU mixed waste containers in ~~two~~ additional panels, ~~identified as Panels 9 and~~one of which may be Panel 10. Disposal of TRU mixed waste in Panel~~s 9 and~~ 10 is prohibited under this Permit. If TRU mixed waste volumes disposed of in ~~the eight panels~~Panels 1 through 8 fail to reach the stated design capacity, the Permittees may request a Permit modification to allow disposal of TRU mixed waste in the four main entries and crosscuts adjacent to the waste panels (referred to as the disposal area access drifts). These ~~areas~~access drifts are labeled Panel~~s 9 and~~ 10 in Figure M-43~~A2-1~~. A ~~permit modification or~~ future permit modification request would be submitted describing the condition of those drifts and the controls exercised for personnel safety and environmental protection while disposing of waste in these ~~areas~~access drifts. These ~~areas~~ access drifts have the following nominal dimensions:

- The E-140 waste transport route south of the Waste Shaft Station is mined to be 25 ft wide nominally and its height ranges from about 14 ft to 20 ft~~.~~
- The W-30 waste transport route south of S-700 is mined to be 20 ft wide nominally and its height ~~will be~~is mined to at least 14 ft~~.~~
- ~~All other~~Other drifts that are part of the waste transport route ~~will be~~are at least 20 ft wide and 14 ft high to accommodate waste transport equipment~~.~~

- Other drifts (i.e. mains and cross-cuts) vary in width and height according to their function typically ranging from 14 ft to 20 ft wide and 12 ft to 20 ft high.

The layout of these excavations is shown on Figure ~~A2-1~~M-43.

Underground Facilities Ventilation System

The underground facilities ventilation system ~~will provide~~provides a safe and suitable environment for underground operations during normal WIPP facility operations. The underground system is designed to provide control of potential airborne contaminants in the event of an accidental release or an underground fire.

The underground is divided into specific areas that are supported by different ventilation flows referred to as ventilation circuits. Consequently, the underground ventilation system is comprised of four separate circuits, as designated on Figure ~~A2-9a~~M-49: one serving the northern experimental areas (North Circuit), one serving the construction areas (Construction Circuit), one serving the waste disposal areas (Disposal Circuit), and one serving the ~~waste~~ Waste ~~shaft~~ Shaft ~~station~~ Station area (Waste Shaft Station Circuit). The air from the four circuits ~~are~~ is recombined near the bottom of the Exhaust Shaft, which serves as a common exhaust route from the underground level to the surface. In some cases, the Salt Handling Shaft may be used as an unfiltered exhaust shaft (Figure ~~A2-9b~~M-50) to ventilate areas of the underground that do not need filtration.

With S#5 in use (Figure ~~A2-9c~~M-51), the Salt Handling Shaft serves as the secondary supply-air pathway for the underground facility while S#5 serves as the primary supply-air pathway for the underground facility. The Waste Shaft supplies the intake air for the Waste Shaft Station. The Air Intake Shaft provides the exhaust route for the Construction Circuit while the Exhaust Shaft provides the exhaust route for the North, Disposal, and Waste Shaft Station Circuits.

Underground Ventilation System Description

The underground ventilation system consists of centrifugal exhaust fans, two identical HEPA-filter assemblies arranged in parallel, isolation dampers, a filter bypass arrangement, two skid-mounted HEPA-filter assemblies arranged in parallel, and associated ductwork. The fans, connected by the ductwork to the underground exhaust shaft so that they can independently draw air through the Exhaust Shaft, are divided into three groups. One group consists of three main exhaust fans, two of which are utilized to provide the nominal ~~air flow~~airflow of 425,000 standard ft^3 per minute (**scfm**) throughout the WIPP facility underground during normal (unfiltered) operation. One main fan may be operated in the alternate mode to provide 260,000 scfm underground ventilation flow. These fans are located near the Exhaust Shaft. The second group consists of three filtration fans, and each can provide 60,000 scfm of ~~air flow~~airflow. These fans, located at the Exhaust Filter Building, can be operated in the filtration mode, where exhaust is diverted through HEPA filters, or in the reduced or minimum ventilation mode, where air is not drawn through the HEPA filters. The third group consists of two skid-mounted filtration fans and HEPA-filter assemblies, each of which can provide approximately 23,000 scfm of ~~air flow~~airflow. The skid-mounted filtration fan and HEPA-filter assemblies, referred to as the Interim Ventilation System (**IVS**) located south of the Exhaust Filter Building, are only operated in filtration mode, where exhaust is diverted through HEPA filters. In addition to the surface fans, an underground fan has been installed to ventilate ~~uncontaminated~~ areas in the North and Construction Circuits. This system is referred to as the Supplemental Ventilation System (**SVS**) and ~~will be~~is used in conjunction with IVS (as shown in Figure ~~A2-9b~~M-50). When this fan is operating, the Salt Shaft ~~will~~ serve as an unfiltered exhaust shaft for the North and Construction Circuits. A portion of the airflow provided by the SVS to the Construction Circuit ~~can~~ is also ~~be~~ used to provide fresh air to the Disposal Circuit~~, if needed~~. In this case, the air from the Disposal Circuit will continue to be exhausted through the HEPA filtration system.

When the repository is configured to use five shafts, two fans located on the surface and connected via ducting and a plenum to S#5, supply the majority of the intake air to the underground facility. One fan operates at a time, while the idle fan is available as a back-up fan. The Salt Handling Shaft serves as a secondary air intake shaft for the north area and the Waste Shaft serves as the air intake shaft for the Waste Shaft Station area of the underground facility. The Air Intake Shaft serves as an unfiltered exhaust shaft for the construction area of the underground facility. The north, disposal, and Waste Shaft Station areas of the underground facility are exhausted through the Exhaust Shaft and the associated filtration system.

The underground mine ventilation is designed to supply sufficient quantities of air to ~~all areas~~ of the repository. During normal operating mode (simultaneous mining and waste emplacement operations), approximately 140,000 actual ft^3 (3,962 m^3) per min can be supplied to the panel area. This quantity ~~is necessary in order to~~can support the level of activity and the pieces of diesel equipment that are expected to be in operation.

At any given time during waste emplacement activities, there may be significant activities in multiple rooms in a panel. For example, one room may be receiving CH TRU mixed waste containers, another room may be receiving RH TRU mixed waste canisters, and the drilling of RH TRU mixed waste emplacement boreholes may be occurring in another room. The remaining rooms in a panel will either be completely filled with waste; be idle, awaiting waste handling operations; or being prepared for waste receipt. A minimum ventilation rate of 35,000 standard ft^3 (990 standard m^3) per minute ~~will be~~is maintained in each active room when waste disposal is taking place and workers are present in the room. ~~This~~ Based on calculations in Appendix D9 of the RCRA Part B Permit Application (DOE, 1997), this quantity of air is required to ~~support the numbers and types of diesel equipment that are expected to be in operation in the area, and to support~~protect ~~the~~ underground waste handling personnel working in ~~that area~~an active disposal room. The remainder of the air is needed in order to account for air leakage through inactive rooms. ~~If an active room ventilation rate of 35,000 scfm cannot be met, actions as described in Permit Attachment O shall be taken during waste disposal operations when workers are present.~~

Air ~~will be~~is routed into a panel from the intake side. Air is routed through the individual rooms within a panel using any of the following flow control devices: underground bulkheads, brattice-cloth barricades, bulkheads with doors or air regulators. Bulkheads are constructed by erecting framing of rectangular steel tubing and screwing galvanized sheet metal to the framing. Bulkhead members use telescoping extensions that are attached to framing and the salt which adjust to creep. Flexible flashing attached to the bulkhead on one side and the salt on the other completes the ~~seal of the ventilation~~bulkhead installation. Where controlled airflow is required, a louver-style damper or a slide-gate (sliding panel) regulator is installed on the bulkhead. Personnel access is available through most bulkheads, and vehicular access is possible through selected bulkheads. Vehicle ~~roll-up~~ doors in the panel areas are not equipped with warning bells or strobe lights since these doors are to be used for limited periodic maintenance activities in the return air path. Flow is also controlled using brattice-~~-~~cloth barricades. These consist of chain link fence that is bolted to the salt or attached to a structural member and covered with brattice cloth; and are used in instances where the only flow control requirement is to block the air. A brattice-~~-~~cloth air barricade is shown in Figure ~~A2-11~~M-52. Ventilation ~~will be~~is maintained only in ~~all~~ active rooms within a panel until waste emplacement activities are completed and the panel-closure system is installed. The air ~~will be~~is routed simultaneously through ~~all~~ the active rooms within the panel. The filled rooms ~~will be~~are isolated from the ventilation system, while the active rooms that are actively being filled ~~will~~ receive a minimum of 35,000 scfm of air when workers are present to assure worker safety. If an active room ventilation rate of 35,000 scfm cannot be met, actions as described in Permit Attachment O shall be taken during waste disposal operations when workers are present. After ~~all~~ the rooms within a panel are filled, the panel will be closed using a closure system described Permit Attachment G and Permit Attachment G1.

Once a disposal room is filled and is no longer needed for emplacement activities, it will be barricaded against entry and isolated from the mine ventilation system. This may be accomplished by any of the following: by removing the air regulator bulkhead, closing bulkhead doors, constructing chain link/brattice- cloth barricades and, if necessary, constructing bulkheads at each end. A typical bulkhead is shown in ~~Figure A2-11a~~Permit Attachment G1, Appendix G1-B. There is no requirement for air for these rooms since personnel and/or equipment will not be in these areas.

The ventilation path for the waste disposal side is separated from the construction (e.g., mining) side by means of air locks, bulkheads, and salt pillars. A pressure differential is maintained between the construction side and the waste disposal side to ensure that any leakage is towards the disposal side. The pressure differential is produced by the surface fans in conjunction with the underground air regulators.

Underground Ventilation Filtration System Description with Buildings 416 and 417

The Underground Ventilation Filtration System (**UVFS**) fans, which are part of the New Filter Building (**NFB**) (Building 416), provide enhanced ventilation in the underground, sufficient to allow concurrent mining and waste emplacement while in filtration mode (Figure M-53). The UVFS will provide filtered airflow through a surface mounted ventilation and filtration system. The intake duct to the surface ventilation and filtration facility is connected to the Exhaust Shaft. The exhaust from the underground will be directed to the salt-~~-~~reduction system located in the Salt-~~-~~Reduction Building (**SRB**) (Building 417).

Prior to passing through the NFB, air from the Exhaust Shaft may be directed through the SRB, which contains de-dusters, commonly used in the mining industry, and de-misters for salt dust and brine/water mist removal. The salt-~~-~~reduction system consists of multiple parallel de-dusting units. The exhaust from the de-dusting units is directed to the filter supply manifold and then to the filtration units. The combination of the de-duster and de-mister ~~combination~~ has a water wash-~~-~~down system that is connected to a water collection, treatment and sludge tank. The outlet of the water collection, treatment, and sludge tank is piped out of the SRB to an evaporative pond. Accumulated water and salt will be characterized and disposed of in accordance with WIPP facility standard operating procedures.

Differential-~~-~~pressure instrumentation, located at each filter bank, will be provided with a high differential pressure alarm, which is monitored in the CMR. The exhaust from each of the filter banks is directed to a plenum which has a single duct that discharges to the environment through a stack.

Underground Ventilation Modes of Operation

When the repository is configured to use four shafts, the underground ventilation system is designed to perform under three types of operation: normal (the HEPA exhaust filtration system is bypassed), filtered (the exhaust is filtered through the HEPA filtration system), if radioactive contaminants are detected or suspected, or a combined mode in which the air in the Disposal Circuit is filtered and the air in the North and Construction Circuits is unfiltered.

The possible modes of exhaust fan operation are as follows:

- ~~2~~Two main fans in operation
- ~~1~~One main fan in operation
- ~~1~~One filtration fan in filtered operation
- ~~2~~Two fans in filtered operation (one filtration fan and one IVS fan or two IVS fans)
- ~~3~~Three fans in filtered operation (one filtration fan and two IVS fans)
- ~~1~~One filtration fan in unfiltered operation
- ~~2~~Two filtration fans in unfiltered operation
- ~~1~~One main and ~~1~~One filtration fan in unfiltered operation
- ~~3~~Three fans in filtered operation (one filtration fan and two IVS fans exhausting through the Exhaust Shaft) and an underground SVS fan in operation (boosting fresh air into the mine causing the Salt Handling Shaft to serve as an unfiltered exhaust shaft for the North and Construction Circuits)

Underground Ventilation Filtration System Modes of Operation with Building 416

The UVFS, which includes the NFB, is designed to perform under two types of operation: filtered (the exhaust is filtered through the HEPA filtration system), and bypassed (the HEPA exhaust filtration system is bypassed).

For UVFS Filtration Mode

- ~~1~~One exhaust fan
- ~~2~~Two exhaust fans
- ~~3~~Three exhaust fans
- 4Four exhaust fans

For UVFS Bypass Mode

- ~~1~~One to ~~4~~four exhaust fans

Under some circumstances (e.g. power outages and maintenance activities), exhaust fan operation may be discontinued for short periods of time.

In the normal mode, two main surface exhaust fans, located near the Exhaust Shaft, ~~will~~ provide continuous ventilation of the underground areas. In this mode, underground airflows join at the bottom of the Exhaust Shaft before discharge to the atmosphere. However, in some cases, the Salt Handling Shaft may be used as an unfiltered exhaust shaft to ventilate areas of the underground that do not need filtration.

Typically, outside air ~~will be~~is supplied to the construction areas and the waste disposal areas through the Air Intake Shaft, the Salt Handling Shaft, and access entries. A small quantity of outside air ~~will~~ flows down the Waste Shaft to ventilate the Waste Shaft ~~station~~Station. The ventilation system is designed to operate with the Air Intake Shaft as the primary source of fresh air. Under these circumstances, sufficient air ~~will be~~is available to simultaneously conduct ~~all~~ underground operations (e.g., waste handling, mining, experimentation, and support). Ventilation may be supplied by operating fans in the configurations listed in the above description of the ventilation modes.

An underground SVS fan, located in the S-90 drift, provides additional ventilation to the underground facility, as needed. The SVS ventilates the following:

- The North and Construction Circuits, exhausting through the Salt Handling Shaft and

- The disposal areas of the underground, exhausting through the Exhaust Shaft and through the filtration system

When the repository is configured to use five shafts, two intake fans located on the surface and connected to S#5 via ducting and a plenum, supply the majority of the intake air to the underground facility. The fans are designed to operate one fan at a time with the second fan available as a back-up fan. The fans have variable frequency drives that can adjust the intake flow at S#5 to meet the requirements of the underground ventilation filtration system and the Construction Circuit.

If the nominal flow of 425,000 scfm (12,028 m^3/min) is not available (e.g., only one of the main ventilation fans is available), underground operations may proceed; however, the number of activities that can be performed in parallel may be limited~~.~~ depending on the quantity of air available. Ventilation may be supplied by operating one or more of the filtration exhaust fans. To accomplish this, the isolation dampers will be opened, which will permit air to flow from the main exhaust duct to the filter outlet plenum or to the IVS. The filtration fans may also be operated to bypass the HEPA plenum. The isolation dampers of the filtration exhaust fan(s) to be employed will be opened, and the selected fan(s) will be switched on. In this mode, underground operations will be limited, because filtration exhaust fans cannot provide sufficient airflow to support the use of numerous pieces of diesel equipment.

If the nominal flow of 425,000 scfm (12,028 m^3/min) is not available because the facility is operating in filtration mode, the exhaust air will pass through HEPA-filter assemblies, with filtration fans operating (i.e., ~~all~~ other fans are stopped). This system provides a means for removing the airborne particulates ~~that may contain radioactive and hazardous waste particulates~~ before they are discharged through the exhaust stack to the atmosphere. The filtration mode is activated manually or automatically if the radiation monitoring system detects abnormally high concentrations of airborne radioactive particulates (an alarm is received from the continuous air monitor in the exhaust drift of the active waste panel) or a waste handling incident with the potential for a waste container breach is observed. The filtration mode is not initiated by the release of gases such as VOCs.

If ~~utility~~ electrical power fails, the exhaust filter system is powered by backup diesel generators. Normal TRU mixed waste handling and related operations cease upon loss of ~~utility~~ electric power and are not resumed until normal ~~utility~~ electric power is returned. As specified in Permit Part 2, ~~all~~ waste handling equipment will "fail safe," meaning that it will retain its load ~~during~~ in the event of a power outage.

~~Underground Ventilation Normal Mode Redundancy~~

~~The underground ventilation system has been provided redundancy in normal ventilation mode by the addition of a third main fan. Ductwork leading to that new fan ties into the existing main exhaust duct.~~

Electrical System

The WIPP facility uses electrical power ~~(utility power)~~ supplied by the regional electric utility company. If there is a loss of ~~utility~~ power, TRU mixed waste handling and related operations will cease.

Backup, alternating current power will be provided on site by diesel generators. These units provide a high degree of reliability. Each of the diesel generators can carry predetermined equipment loads while maintaining additional power reserves. Predetermined loads include lighting and ventilation for underground facilities, lighting and ventilation for the TRU mixed waste handling areas, and the Air Intake Shaft hoist. The diesel generators can be brought ~~on line~~online within 30 minutes either manually or from the control panel in the ~~Central Monitoring Room (**CMR**)~~CMR.

Uninterruptible power supply (**UPS**) units are also ~~on line~~online providing power to predetermined monitoring systems. These systems ensure that the power to the radiation detection system for airborne contamination, the local processing units, the computer room, and the CMR will always be available, even during the interval between the loss of off-site power and initiation of backup diesel generator power.

A2-2a(4) RH TRU Mixed Waste Handling Equipment

The following are the major pieces of equipment used to manage RH TRU mixed waste in the geologic repository. A summary of equipment capacities is included in Table A2-3.

The Facility Cask Transfer Car

The Facility Cask Transfer Car is a self-propelled rail car (Figure ~~A2-14~~M-34) that operates between the Facility Cask Loading Room and the geologic repository. After the Facility Cask is loaded, the Facility Cask Transfer Car moves onto the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~

Conveyance and is then transported underground. At the underground ~~waste~~ Waste ~~shaft~~ Shaft ~~station~~Station, the Facility Cask Transfer Car proceeds away from the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance to provide forklift access to the Facility Cask.

Horizontal Emplacement Machine~~and Retrieval Equipment~~ or Functionally Equivalent Equipment

~~The Horizontal~~A horizontal ~~Emplacement~~ emplacement machine (**HEM**) ~~and Retrieval Equipment (**HERE**) or functionally equivalent equipment~~ (Figure ~~A2-15~~M-54), or functionally equivalent equipment, emplaces canisters into a borehole in a room wall of an ~~Underground~~ underground HWDU. Once the canisters have been emplaced, the ~~HERE~~ HEM then fills the borehole opening with a shield plug.

A2-2b Geologic Repository Process Description

~~Prior to receipt of TRU mixed waste at the WIPP facility, waste operators will be thoroughly trained in the safe use of TRU mixed waste handling and transport equipment. The training will include both classroom training and on-the-job training.~~

RH TRU Mixed Waste Emplacement

The Facility Cask Transfer Car ~~is loaded~~loaded with a Facility Cask is moved onto the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance and is lowered to the ~~waste~~ Waste ~~shaft~~ Shaft ~~station~~ Station underground. At the ~~waste~~ Waste ~~shaft~~ Shaft ~~station~~ Station underground, the Facility Cask is moved from the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance by the Facility Cask Transfer Car (Figure ~~A2-16~~M-55). A forklift is used to remove the Facility Cask from the Facility Cask Transfer Car and to transport the Facility Cask to the Underground HWDU. There, the Facility Cask is placed on the ~~HERE (Figure A2-17)~~HEM. The ~~HERE~~ HEM is used to emplace the RH TRU mixed waste canister into the borehole. The borehole ~~will be~~is visually inspected for obstructions prior to aligning the ~~HERE~~ HEM and emplacement of the RH TRU mixed waste canister. The Facility Cask is moved forward to mate with the shield collar, and the transfer carriage is advanced to mate with the rear Facility Cask shield valve. The shield valves on the Facility Cask are opened, and the transfer mechanism advances to push the canister into the borehole. After retracting the transfer mechanism into ~~the Facility Cask~~its housing, the ~~forward~~ shield valve(s) is closed~~, and the transfer mechanism is further retracted into its housing~~. The transfer mechanism is moved to the rear, and the shield plug carriage containing a shield plug is placed on the emplacement machine cask carriage. The transfer mechanism is used to push the shield plug ~~into the Facility Cask. The front shield valve is opened, and the shield plug is pushed~~ into the borehole ~~(Figure A2-18)~~, thereby completing the emplacement. ~~The transfer mechanism is retracted, the shield valves close on the Facility Cask, and the Facility Cask is removed from the HERE.~~

A shield plug is a concrete filled cylindrical steel shell (Figure ~~A2-21~~M-56) approximately 61 in~~.~~ (155 cm) long and 29 in~~.~~ (74 cm) in diameter, made of concrete shielding material inside a 0.24 in~~.~~- (0.61 cm)- thick steel shell with a removable pintle at one end. Each shield plug has integral forklift pockets and weighs approximately 3,750 ~~lbs~~pounds (**lb**) (1,700 kg). The shield plug is inserted with the pintle end closest to the ~~HERE~~ HEM to provide the necessary shielding , limiting the borehole radiation dose rate at 11.8 in (30 cm) to less than 10 millirem~~mrem~~ per hour for a canister surface dose rate of 100 rem per hour~~/hr~~ . Additional shielding is provided at the direction of the ~~Radiological~~ radiological ~~Control~~ control ~~Technician~~ technician based on dose rate surveys following shield plug emplacement. This additional shielding is provided by the manual emplacement of one or more shield plug supplemental shielding plates and a retainer (Figures ~~A2-19 and A2-20~~M-56).

The amount of RH TRU mixed waste ~~disposal~~ disposed in each panel is limited based on thermal and geomechanical considerations and shall not exceed 10 kilowatts per acre as described in ~~Permit Attachment~~Section A2-1. ~~RH~~ Remote-handled TRU mixed waste emplacement boreholes ~~shall be~~are drilled in the ribs of the panels at a nominal spacing of 8 ft (2.4 m) center-to-center, horizontally.

Figures ~~A1-26~~M-40 and ~~A1-27~~M-41 are flow diagrams of the RH TRU mixed waste handling process for the RH-TRU 72-B and CNS 10-160B casks, respectively.

CH TRU Mixed Waste Emplacement

~~CH TRU mixed waste containers and shielded containers will arrive by tractor-trailer at the WIPP facility in sealed shipping containers. Prior to unloading the packages from the trailer, they will undergo security and radiological checks and shipping documentation reviews. The trailers carrying the shipping containers will be stored temporarily at the Parking Area Container Storage Unit (Parking Area Unit). A forklift will remove the Contact Handled Packages from the transport trailers and a forklift or Yard Transfer Vehicle will transport them into the Waste Handling Building Container Storage Unit for unloading of the waste containers. Each TRUPACT-II may hold up to two 7-packs, two 4-packs, two 3-packs, two SWBs, or one TDOP. Each HalfPACT may hold up to seven 55-gal (208 L) drums, one SWB, one three-pack of shielded containers or four 85-gal (322 L) drums. Each TRUPACT-III will hold one SLB2. An overhead bridge crane or Facility Transfer Vehicle with transfer table will be used to remove the waste containers from the Contact Handled Packaging and place them on a facility or containment pallet. Each facility pallet has two recessed pockets to accommodate two sets of 7-packs, two sets of 3-packs, two sets of 4-packs, two SWBs stacked two-high, two TDOPs, or one SLB2. Each stack of waste containers will be secured prior to transport underground (see Figure A2-3).~~ A forklift or the facility transfer vehicle ~~will~~ transports the loaded facility pallet to the conveyance loading room adjacent to the Waste Shaft. The facility transfer vehicle ~~will be~~is driven onto the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance deck, where the loaded facility pallet ~~will be~~is transferred to the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~Conveyance, and the facility transfer vehicle ~~will be~~is backed off. Containers of CH TRU mixed waste (55-gal (208-~~-~~L) drums, SWBs, 85-gal (322-~~-~~L) drums, 100-gal (379-~~-~~L) drums, and TDOPs) or shielded containers can be handled individually, if needed, using the forklift and appropriate lifting attachments (~~i.e.~~e.g., drum handlers, parrot beaks).

The ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance ~~will~~ lowers the loaded facility pallet to the underground. At the ~~waste~~ Waste ~~shaft~~ Shaft ~~station~~Station, the CH TRU underground transporter ~~will~~ is backed up to the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~Conveyance, and the facility pallet ~~will be~~is transferred from the ~~waste~~ Waste ~~shaft~~ Shaft ~~conveyance~~ Conveyance onto the transporter (see Figure ~~A2-6~~M-46). The transporter ~~will~~ is then used to move the facility pallet to the appropriate ~~Underground~~ underground HWDU for emplacement. The underground waste transporter is equipped with a fire suppression system, rupture-resistant diesel fuel tanks, and reinforced fuel lines to minimize the potential for a fire involving the fuel system.

A forklift in the HWDU ~~near the waste stack will be~~is used to remove the waste containers from the facility pallets and to place them in the waste stack using a push-pull attachment or, in the case of an SLB2, the SLB2 ~~will be~~is lifted from the facility pallet and placed directly on the floor of the emplacement room. The waste will be emplaced room by room in Panels 1 through 8. Each panel will be closed off from active ventilation when filled. If a waste container is damaged during the Disposal Phase, it will be immediately overpacked or repaired. ~~CH~~ Contact-handled TRU mixed waste containers ~~will be~~are continuously vented. The filter vents ~~will~~ allow aspiration, preventing internal pressurization of the container~~ and minimizing the buildup of flammable gas concentrations~~.

Once a waste panel ~~is~~ has been mined and any initial ground control established, flow control devices ~~will be~~are constructed to assure adequate control over ventilation during waste emplacement activities. The first room to be filled with waste ~~will be~~is typically Room 7, which is the one that is farthest from the main access ~~ways~~drifts. A ventilation control point ~~will be~~is established for Room 7 either just outside the exhaust side of Room 6 or at the inlet side of Room 7. This ventilation control point ~~will~~ consists of a flow control device (e.g., bulkhead with a ventilation regulator, or brattice cloth~~ barricade~~). When RH TRU mixed waste canister emplacement is completed in a room, CH TRU mixed waste emplacement can begin in that room. Stacking of CH TRU mixed waste ~~will~~ typically begins at the exhaust side of the room and proceed down the access drift, through the room and up the intake access drift until the entrance of Room 6 is reached. At that point, a brattice-cloth and chain-link barricade and, if necessary, bulkheads will be ~~emplaced~~installed. This process ~~will be~~is typically repeated for Room 6, and so on until Room 1 is filled. At that point, the panel closure system ~~will be~~is constructed.

The emplacement of CH TRU mixed waste into the HWDUs ~~will~~ is typically ~~be~~ in the order received and unloaded from the ~~Contact Handled Packaging~~CH packaging. There is no specification for the amount of space to be maintained between the waste containers themselves, or between the waste containers and the walls. Containers ~~will be~~ are stacked in the best manner to provide stability for the stack (~~which is~~ up to three containers high) and to make best use of available space. ~~It is anticipated that t~~The space between the wall and the container ~~could be~~ranges from 8 to 18 in~~.~~ (20 to 46 cm). This space is a function of disposal room wall irregularities, container type, and sequence of emplacement. ~~Bags of backfill will occupy some of this space.~~ Space is required over the stacks of containers to assure adequate ventilation for waste handling operations. A minimum of 16 in~~.~~ (41 cm) was specified in the Final Design Validation Report (Appendix D1, Chapter 12 of the WIPP RCRA Part B Permit Application (DOE, 1997)) to maintain ~~air flow~~airflow. Typically, the space above a stack of containers ~~will be~~is 36 to 48 in. (90 to 122 cm). However, ~~18 in. (0.45 m) will contain~~ backfill material, consisting of bags of ~~Magnesium Oxide (~~MgO~~)~~, will take up 18 in (45 cm) of height. Figure ~~A2-8~~M-48 shows a typical container configuration, although this figure does not mix containers on any row. Such mixing, while inefficient, ~~will be~~is allowed to assure timely movement of waste into the underground. No aisle space ~~will be~~is maintained for personnel access to emplaced waste containers. No roof maintenance behind stacks of waste is planned.

The anticipated schedule for the filling of each of the ~~Underground~~ underground HWDUs known as Panels 1 through 8, 11, and 12, is shown in Permit Attachment G, Table G-1. Panel closure in accordance with the Closure Plan in Permit Attachment G and Permit Attachment G1 is estimated to require an additional ~~150~~ 180 days following placement of the final waste in the panel.

Figures ~~A2-12~~M-38 and M-39 ~~is a~~are flow diagrams of the CH TRU mixed waste handling process.

A2-3 Waste Characterization

~~TRU~~ Transuranic mixed waste characterization is described in Permit Attachment C.

A2-4 Treatment Effectiveness

~~TRU~~ Transuranic mixed waste treatment, as defined in 20.4.1.~~101~~ 100 NMAC (incorporating 40 CFR §260.10), for which a permit is required, ~~will not be~~is not performed at the WIPP facility.

A2-5 Maintenance, Monitoring, and Inspection

A2-5a Maintenance

A2-5a(1) Ground-Control Program

The ground-control program at the WIPP facility ~~will~~ ensures that any room in an HWDU in which waste will be placed ~~will be~~is sufficiently supported to assure waste disposal activities can be carried out safely. In addition, ~~compliance with the applicable portions of~~ the Land Withdrawal Act (**LWA**)~~, which~~ requires a regular review of roof-support plans and practices by the Mine Safety and Health Administration (**MSHA**). ~~Support is installed to~~Ground control is performed in accordance with standard operating procedures that incorporate the requirements of 30 CFR ~~§~~Part 57, Subpart B.

A2-5b Monitoring

A2-5b(1) Groundwater Monitoring

Groundwater monitoring for the ~~WIPP U~~underground HWDUs ~~will be~~is conducted in accordance with Permit Part 5 and Permit Attachment L~~ of this permit~~.

A2-5b(2) Geomechanical Monitoring

The geomechanical monitoring program at the WIPP facility is an integral part of the ground-control program~~ (See Figure A2-13)~~. ~~HWDUs~~Hazardous waste disposal units~~,~~ and drifts~~, and geomechanical test rooms will be~~ are monitored to provide confirmation of structural integrity. Geomechanical data on the performance of the repository shafts and excavated areas ~~will be~~are collected as part of the geotechnical field-monitoring program. The results of the geotechnical investigations ~~will be~~are reported annually in the Geotechnical Analysis Report (**GAR**). The report ~~will~~ describes monitoring programs and geomechanical data collected during the previous year.

A2-5b(2)(a) Description of the Geomechanical Monitoring System

The Geomechanical Monitoring System (**GMS**) provides in situ data to support the continuous assessment of the design for underground facilities. Specifically, the GMS provides for:

- Early detection of conditions that could affect operational safety,
- Evaluation of disposal room closure that ensures adequate access,

- Guidance for design modifications and remedial actions, and

- Data for interpreting the behavior of underground openings, in comparison with established design criteria.

The instrumentation in Table A2-2 is available for use in support of the geomechanical program.

The minimum instrumentation for each of the ~~eight~~ ten panels ~~will be~~is one borehole extensometer installed in the roof ~~at~~ near the center of each disposal room. The roof extensometers ~~will~~ monitor the dilation of the immediate salt roof beam and possible bed separations along clay seams. Additional instrumentation will be installed as conditions warrant.

Remote polling of the geomechanical instrumentation ~~will be~~is performed at least once every month. This frequency may be increased to accommodate any changes that may develop.

The results from the remotely read instrumentation ~~will be~~are evaluated after each scheduled polling. Documentation of the results ~~will be~~are provided annually in the ~~Geotechnical Analysis Report~~GAR.

Data from remotely read instrumentation ~~will be~~are maintained as part of a geotechnical instrumentation system. The instrumentation system provides for data maintenance, retrieval, and presentation. The Permittees ~~will~~ retrieve the data from the instrumentation system and verify data accuracy by confirming the measurements were taken in accordance with applicable instructions and equipment calibration is known. Next, the Permittees ~~will~~ review the data after each polling to assess the performance of the instrument and of the excavation. Anomalous data will be investigated to determine the cause (instrumentation problem, error in recording, changing ~~rock~~ ground conditions). The Permittees ~~will~~ calculate various parameters such as the change between successive readings and deformation rates. This assessment ~~will be~~is reported to the Permittees' cognizant ground control engineer and operations personnel. The Permittees will investigate unexpected deformation to determine if remediation is needed.

The stability of an open panel excavation is generally determined by the rock deformation rate. The excavation may be unstable when there is a continuous increase in the deformation rate that cannot be controlled by the installed support system. The Permittees ~~will~~ evaluate the performance of the excavation. These evaluations assess the effectiveness of the roof support system and estimate the stand-up time of the excavation. If an open panel shows the trend is toward adverse (unstable) conditions, the results will be reported to determine if it is necessary to terminate waste disposal activities in the open panel. This report of the trend toward adverse conditions in an open HWDU will also be provided to the Secretary of the NMED within seven (7) calendar days of issuance of the report.

~~A2-5b(2)(b) System Experience~~

~~Much experience in the use of geomechanical instrumentation was gained as the result of performance monitoring of Panel 1, which began at the time of completion of the panel excavation in 1988. The monitoring system installed at that time involved simple measurements and observations (e.g., vertical and horizontal convergence rates, and visual inspections). Minimal maintenance of instrumentation is required, and the instrumentation is easily replaced if it malfunctions. Conditions throughout Panel 1 are well known. The monitoring program~~

~~continues to provide data to compare the performance of Panel 1 with that established elsewhere in the underground. Panel 1 performance is characterized by the following:~~

- ~~The development of bed separations and lateral shifts at the interfaces of the salt and the clays underlying the anhydrites "a" and "b."~~
- ~~Room closures. A closure due only to the roof movement will be separated from the total closure.~~
- ~~The behavior of the pillars.~~
- ~~Fracture development in the roof and floor.~~
- ~~Distribution of load on the support system.~~

~~Roof conditions are assessed from observation boreholes and extensometer measurements. Measurements of room closure, rock displacements, and observations of fracture development in the immediate roof beam are made and used to evaluate the performance of a panel. A description of the Panel 1 monitoring program was presented to the members of the Geotechnical Experts Panel (in 1991) who concurred that it was adequate to determine deterioration within the rooms and that it will provide early warning of deteriorating conditions.~~

The assessment and evaluation of the condition of WIPP repository excavations is an interactive, continuous process using the data from the monitoring programs. Criteria for corrective action are continually reevaluated and reassessed based on total performance to date. Actions taken are based on these analyses and planned utilization of the excavation. Because ~~WIPP~~ excavations are in a natural geologic medium, there is inherent variability from point to point. The principle adopted is to anticipate potential ground control requirements and implement them in a timely manner rather than to wait until a need arises.

A2-5b(3) Volatile Organic Compound Monitoring

The volatile organic compound monitoring for the WIPP Underground HWDUs will be conducted in accordance with Permit Part 4 and Permit Attachment N ~~of this permit~~.

A2-5c Inspection

~~The inspection~~Inspections of the ~~WIPP U~~underground HWDUs ~~will be~~are conducted in accordance with Permit Part 2 and Permit Attachment E ~~of this permit~~.

References

DOE, 1997. Resource Conservation and Recovery Act Part B Permit Application, Waste Isolation Pilot Plant (WIPP), Carlsbad, New Mexico, Revision 6.5, 1997.

DOE, 2009. WIPP Hazardous Waste Facility Permit Amended Renewal Application, Carlsbad, New Mexico, September 2009.

DOE, 2020. WIPP Hazardous Waste Facility Permit Renewal Application, Carlsbad, New Mexico, March 2020.

TABLES

Table A2-1
CH TRU Mixed Waste Handling Equipment Capacities

Capacities for Equipment (lb)	
Facility Pallet	25,000 ~~lbs.~~
Facility Transfer Vehicle	26,000 ~~lbs.~~
Underground transporter	28,000 ~~lbs.~~
Underground forklift	12,000 ~~lbs.~~
SLB2 forklift	36,000
Maximum Gross Weights of Containers (lb)	
Seven-pack of 55-~~gallon~~gal (208-L) drums	7,000 ~~lbs.~~
Four-pack of 85-~~gallon~~ gal (322-L) drums	4,500 ~~lbs.~~
Three-pack of 100-~~gallon~~ gal (379-L) drums	3,000 ~~lbs.~~
Ten-drum overpack	6,700 ~~lbs.~~
Standard waste box	4,000 ~~lbs.~~
Standard large box 2	10,500 ~~lbs.~~
Shielded container	2,260 ~~lbs.~~
Three-pack of shielded containers	7,000 ~~lbs.~~
Maximum Net Empty Weights of Equipment (lb)	
TRUPACT-II	13,140 ~~lbs.~~
HalfPACT	10,500 ~~lbs.~~
TRUPACT-III	43,600 ~~lbs.~~
Facility pallet	4,120 ~~lbs.~~

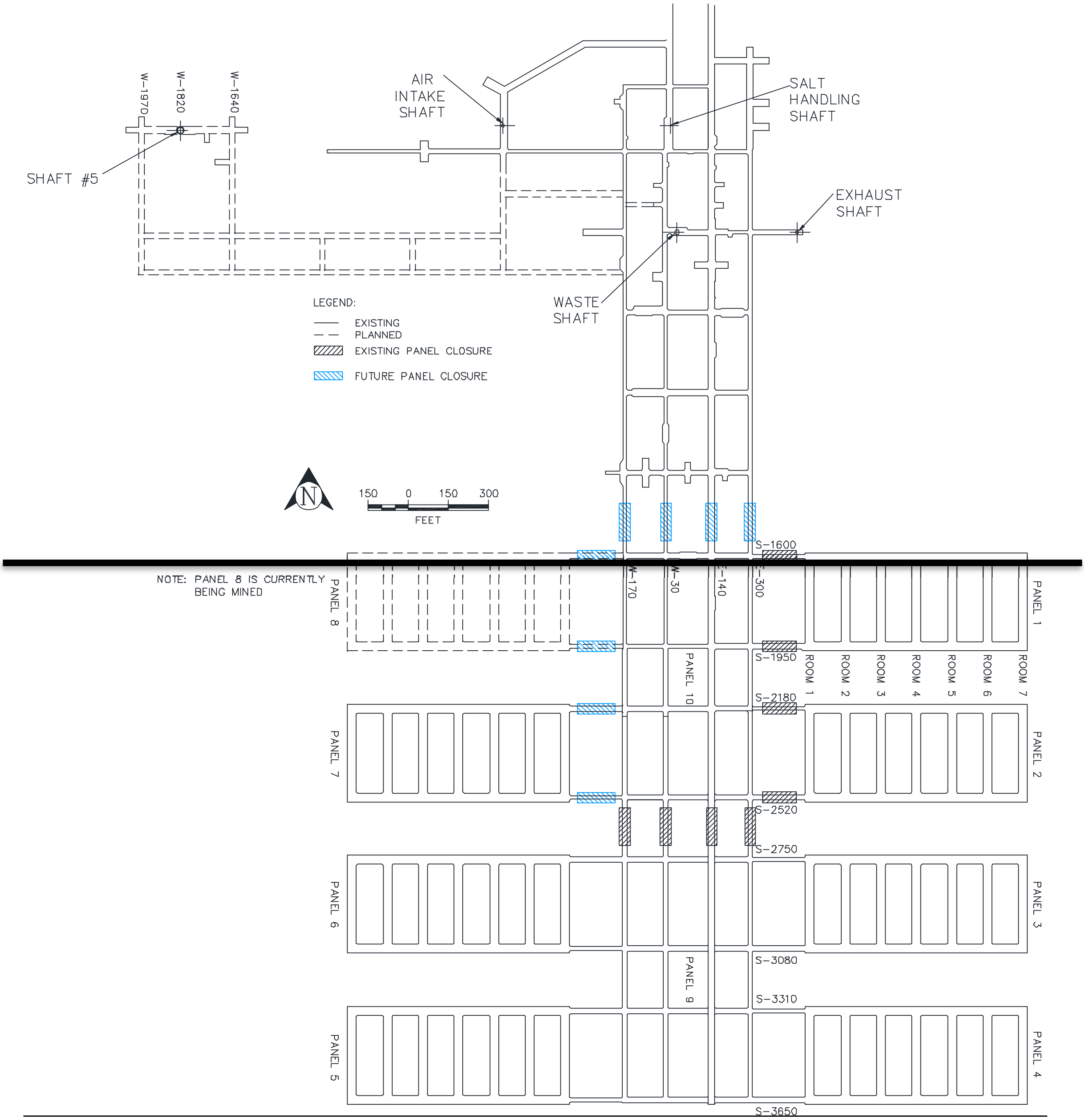
Table A2-2
Instrumentation Used in Support of the Geomechanical Monitoring System

Instrument Type	Features	Parameter Measured	Range
Borehole Extensometer	The extensometer provides for monitoring the deformation parallel to the borehole axis. Units suitable for up to 5 measurements anchors in addition to the reference head. Maximum borehole depths ~~shall be~~are 50 feet.	Cumulative Deformation	0-2 ~~inches~~in
Borehole Television Camera	Closed circuit television may be used for monitoring areas otherwise inaccessible, such as boreholes or shafts.	Video Image	N/A
Convergence Points and Tape Extensometers	Mechanically anchored eyebolts to which a portable tape extensometer is attached.	Cumulative Deformation	2-50 ~~feet~~ft
Convergence Meters	Includes wire and sonic meters. Mounted on rigid plates anchored to the rock surface.	Cumulative Deformation	2-50 ~~feet~~ft
~~Inclinometers~~	~~Both vertical and horizontal inclinometers are used. Traversing type of system in which a probe is moved periodically through casing located in the borehole whose inclination is being measured.~~	~~Cumulative Deformation~~	~~0-30 degrees~~
Rock Bolt Load Cells	Spool type units suitable for use with rock bolts. Tensile stress is inferred from strain gauges mounted on the surface of the spool.	Load	0-300 kips
Earth Pressure Cells	Installed between concrete keys and rock. Preferred type is a hydraulic pressure plate connected to a vibrating wire transmitter.	Lithostatic Pressure	0-1,000 pounds per square inch (**psi**)
Piezometer Pressure Transducers	Located in shafts and of robust design and construction. Periodic checks on operability required.	Fluid Pressure	0-500 psi
Strain Gauges	Installed within the concrete shaft key. Suitably sealed for the environment. Two types used:~~--~~ surface mounted and embedded.	Cumulative Deformation	0-3,000 microinches per inch (**µin/in**) (embedded) 0-2,500 µin/in (surface)

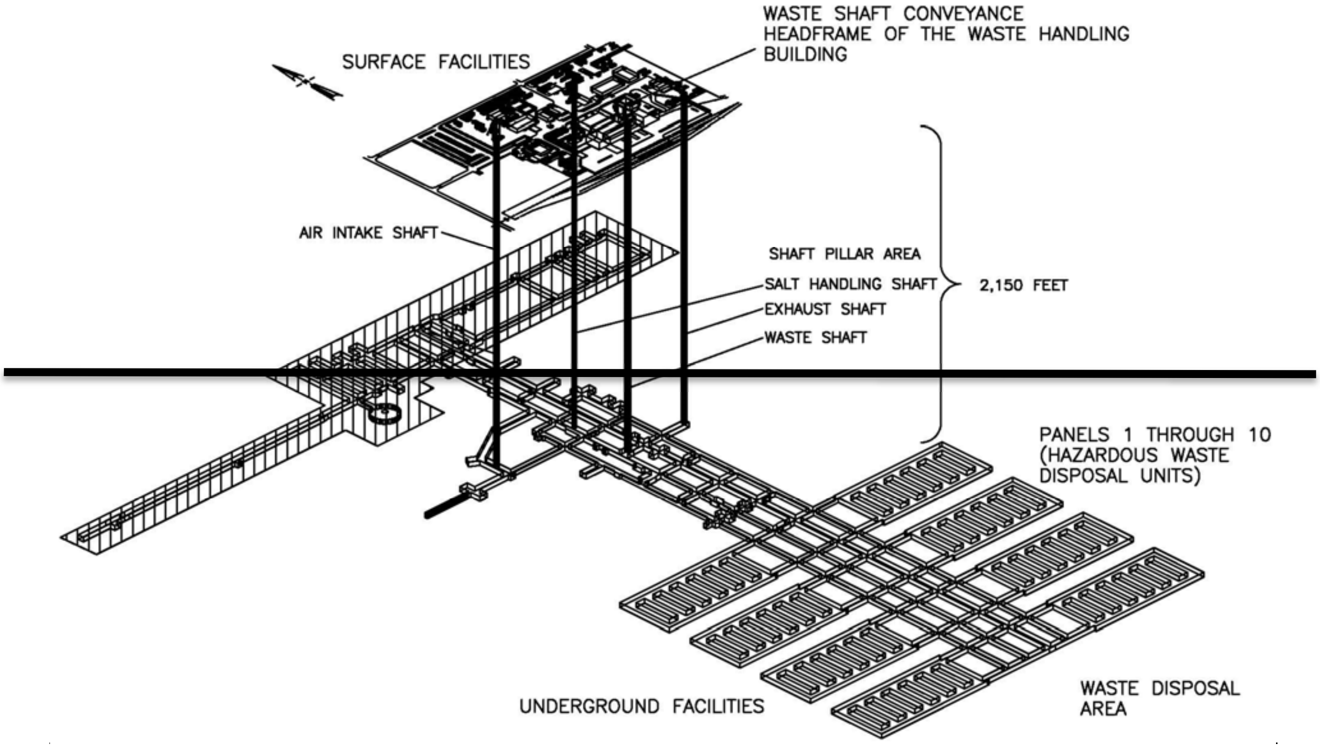
Table A2-3
RH TRU Mixed Waste Handling Equipment Capacities

Capacities for Equipment (lb)	
41-Ton Forklift	82,000 ~~lbs~~
Maximum Gross Weights of RH TRU Containers (lb)	
RH TRU Facility Canister	10,000 ~~lbs~~
55-~~Gallon~~ gal (208-L) Drum	1,000 ~~lbs~~
RH TRU Canister	8,000 ~~lbs~~
Maximum Net Empty Weights of Equipment (lb)	
Facility Cask	67,700 ~~lbs~~
Light Weight Facility Cask	48,450

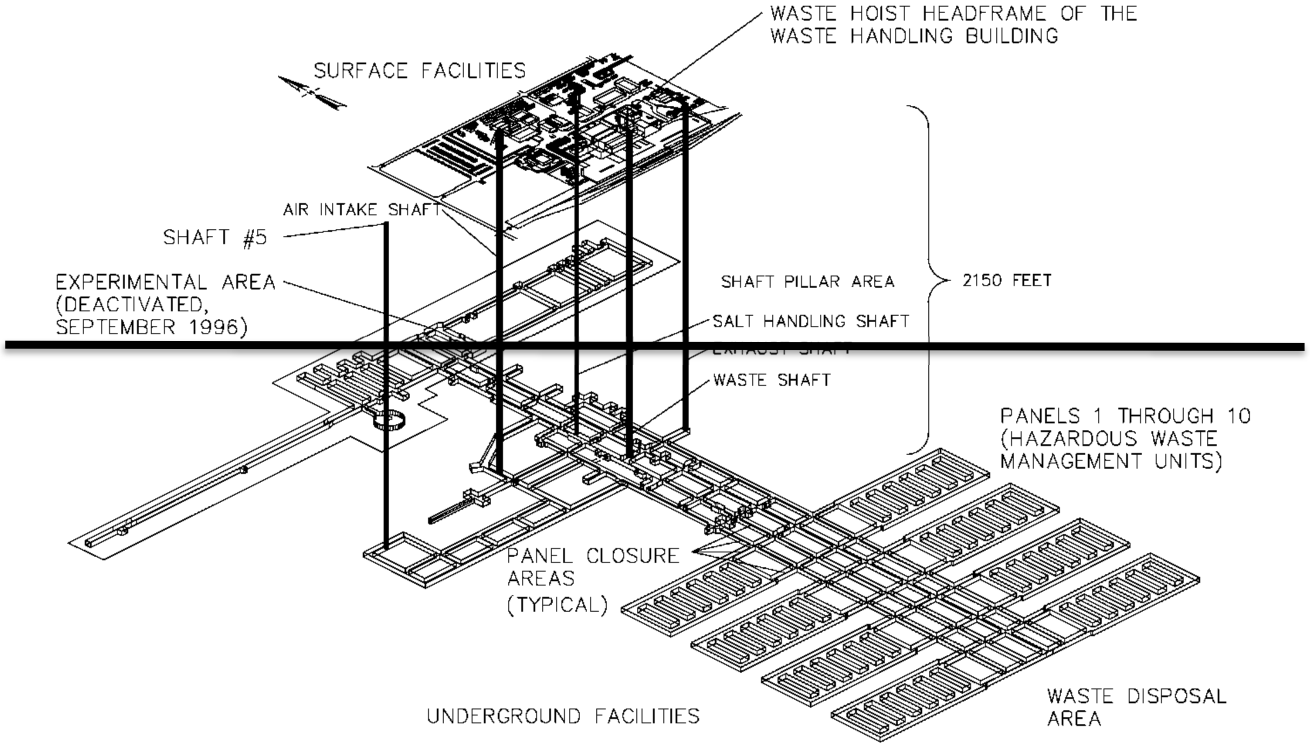
~~FIGURES~~



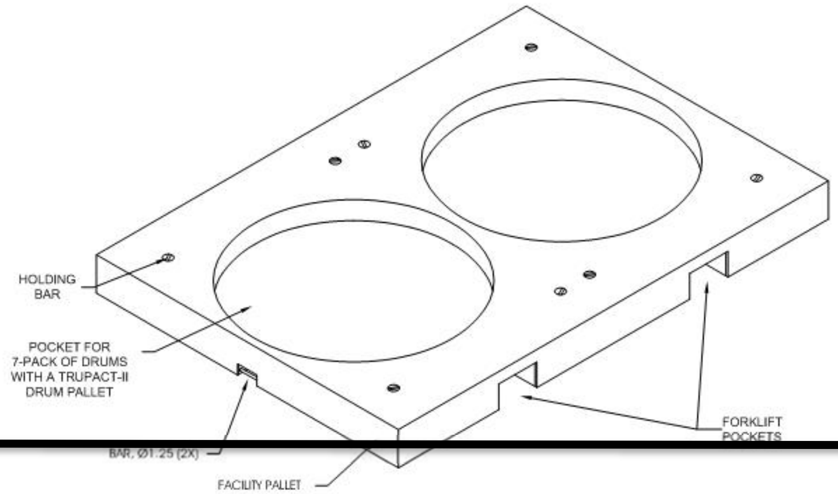
~~**Figure A2-1**~~
~~**Repository Horizon**~~



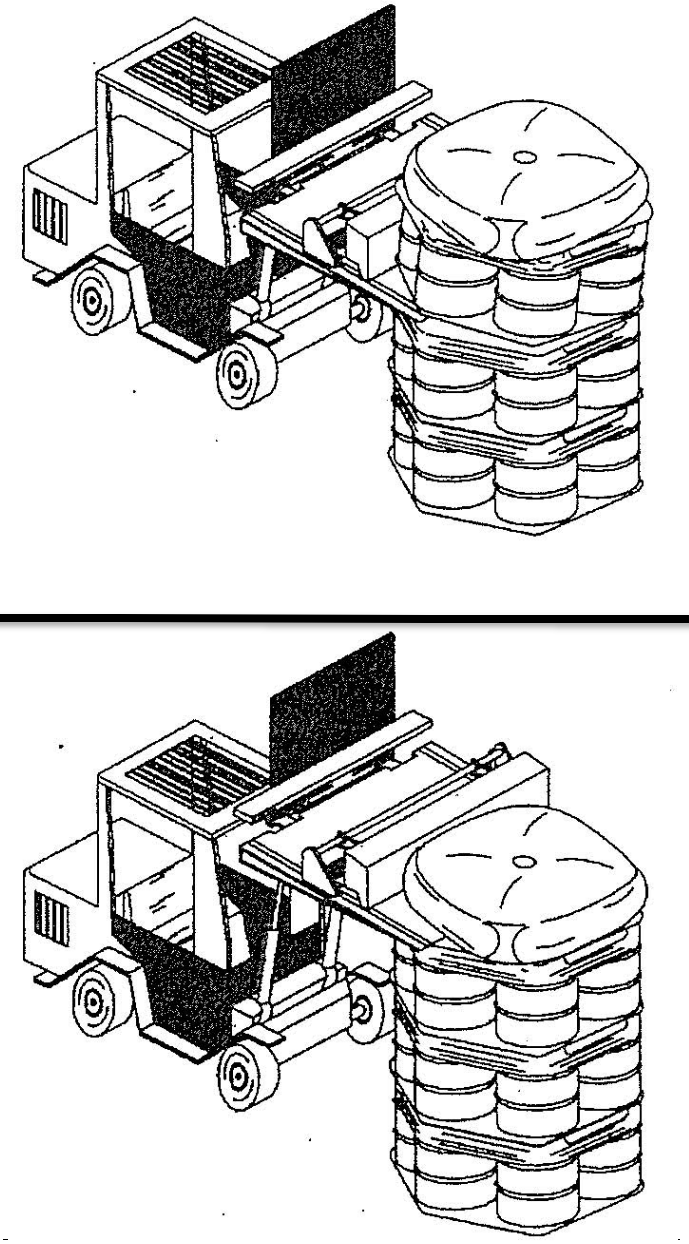
~~**Figure A2-2**~~
~~**Spatial View of the Miscellaneous Unit and Waste Handling Facility**~~



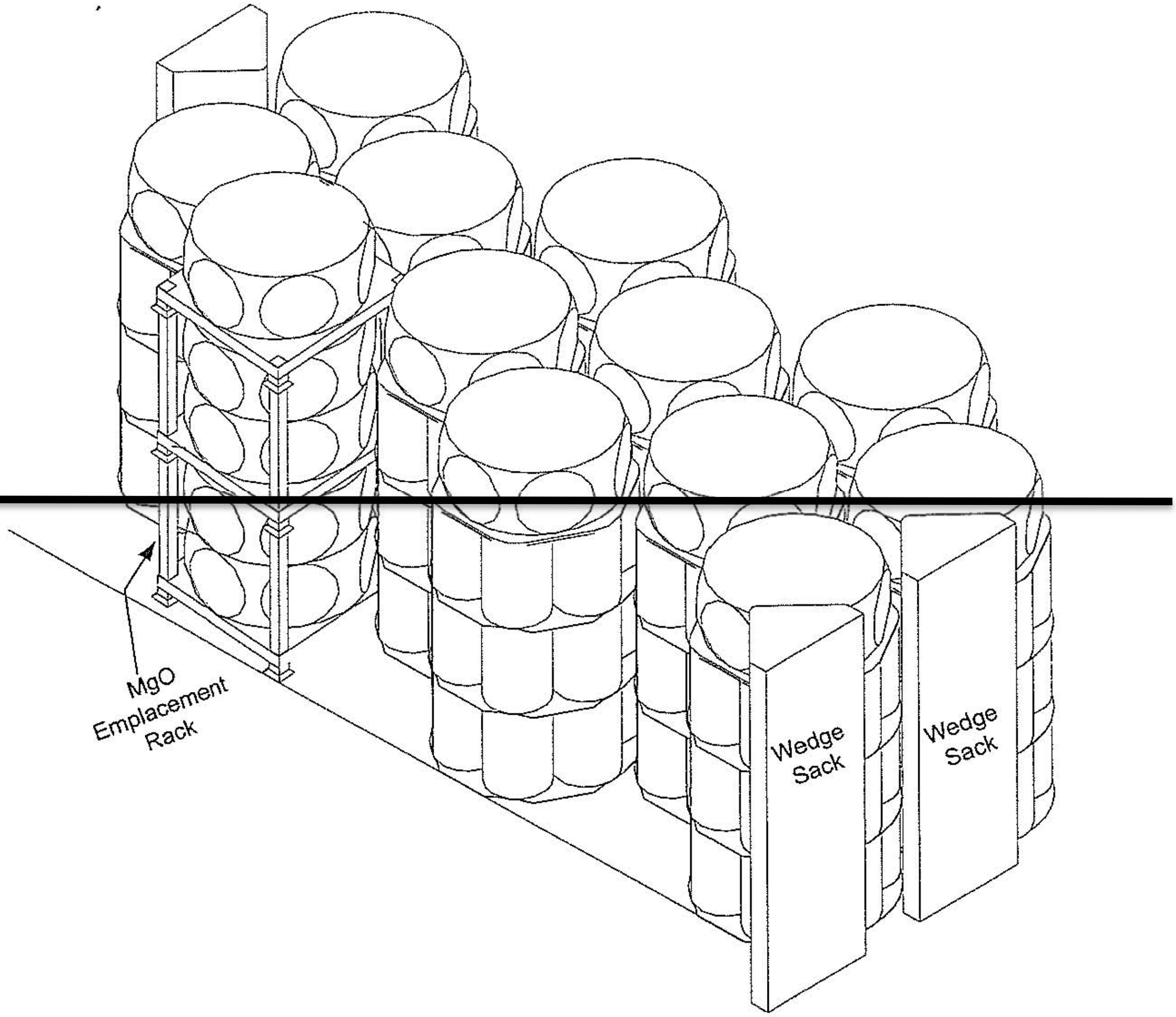
~~Figure A2-2-S#5~~
~~Spatial View of the Miscellaneous Unit and Waste Handling Facility (with S#5)~~



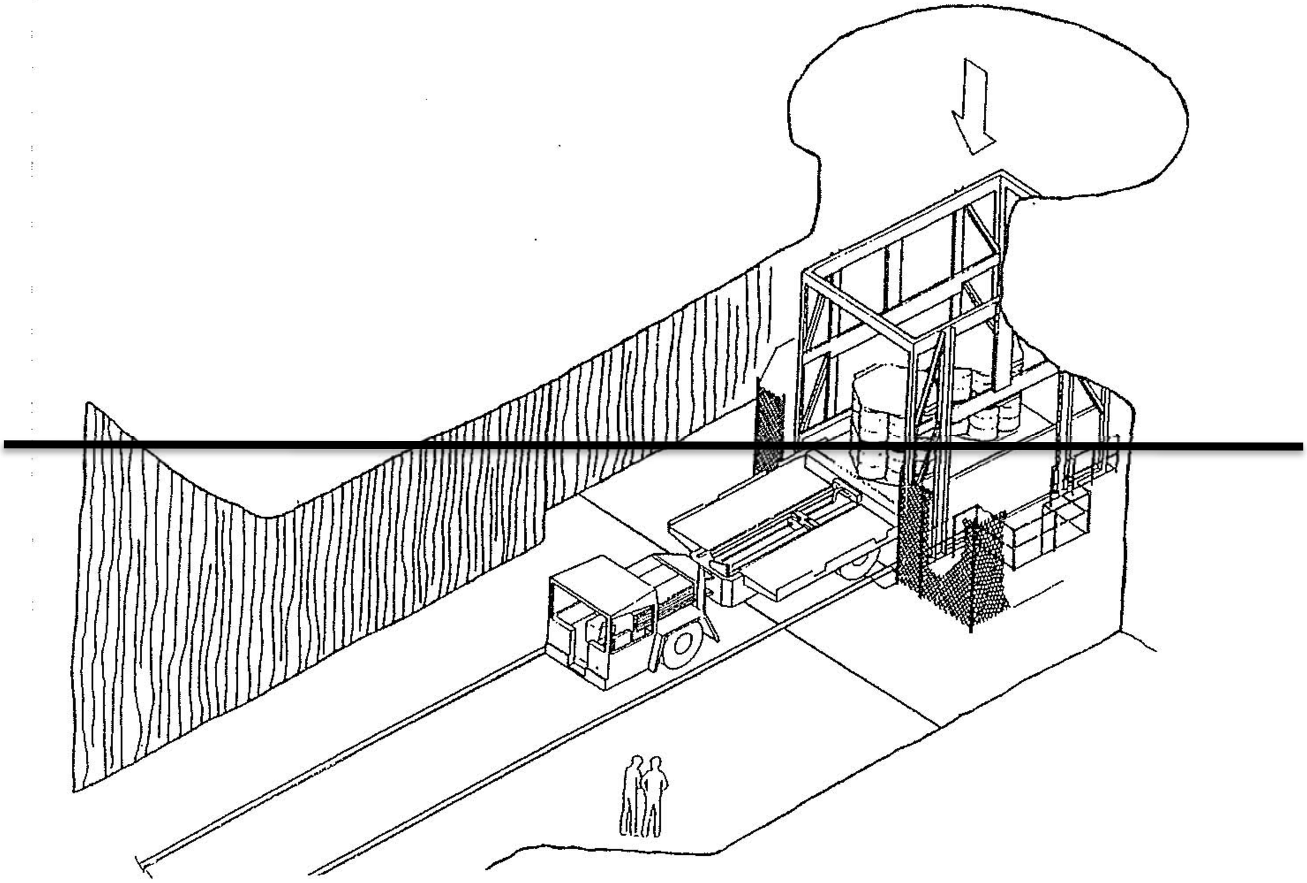
~~Figure A2-3~~
~~Facility Pallet for Seven-Pack of Drums~~



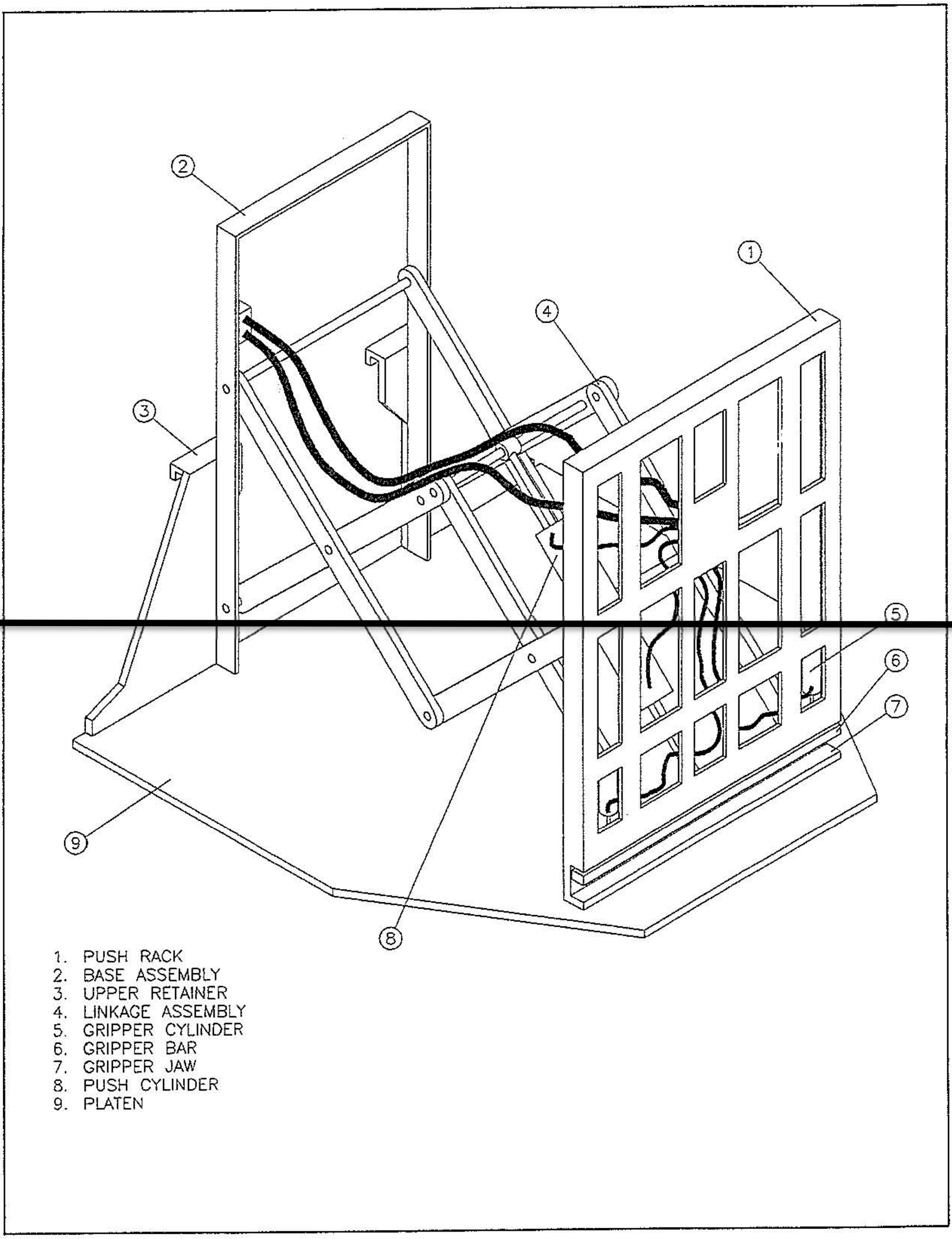
~~Figure A2-5~~
~~Typical Backfill Sacks Emplaced on Drum Stacks~~



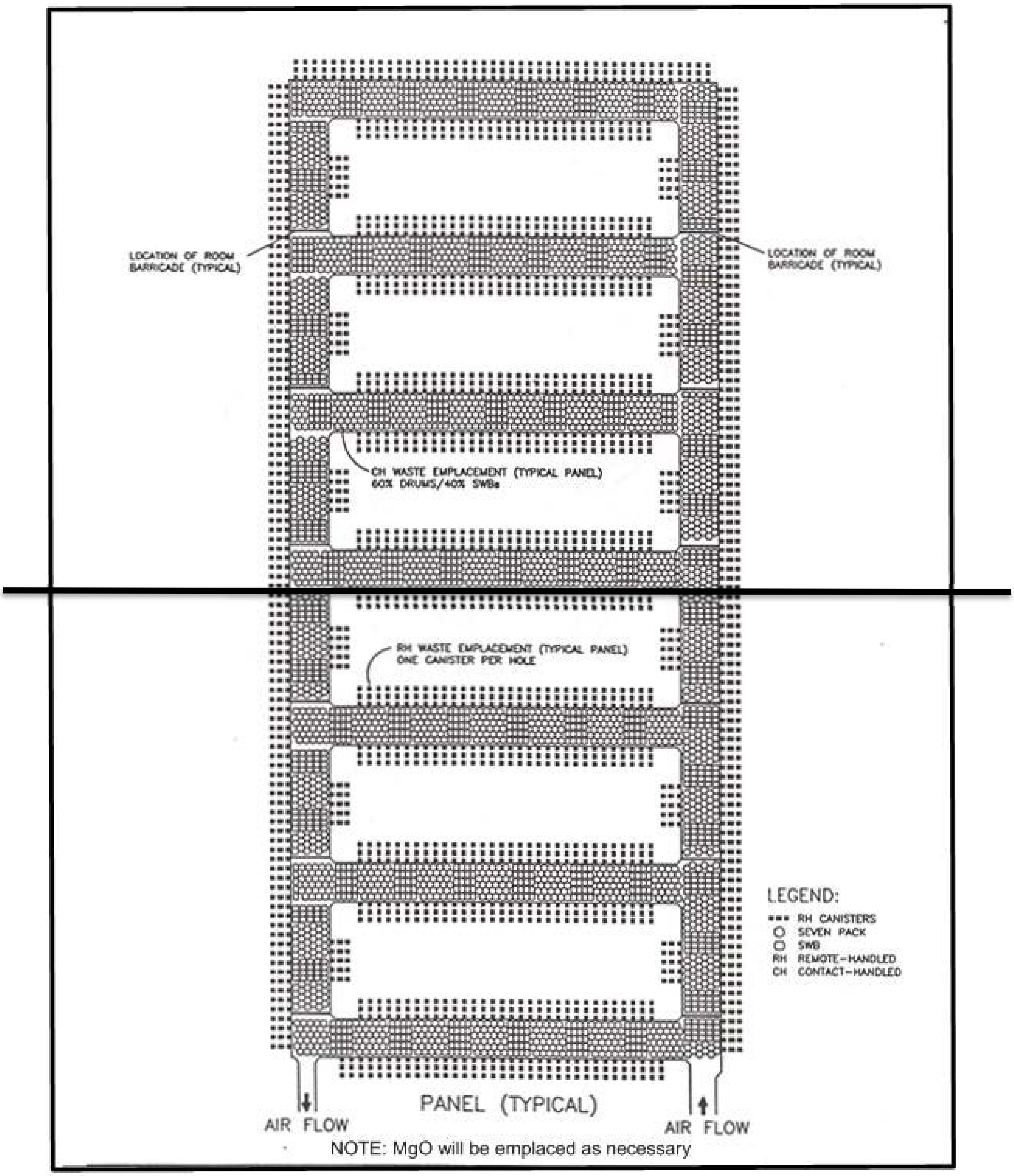
~~Figure A2-5a~~
~~Potential MgO Emplacement Configurations~~



~~Figure A2-6~~
~~Waste Transfer Cage to Transporter~~

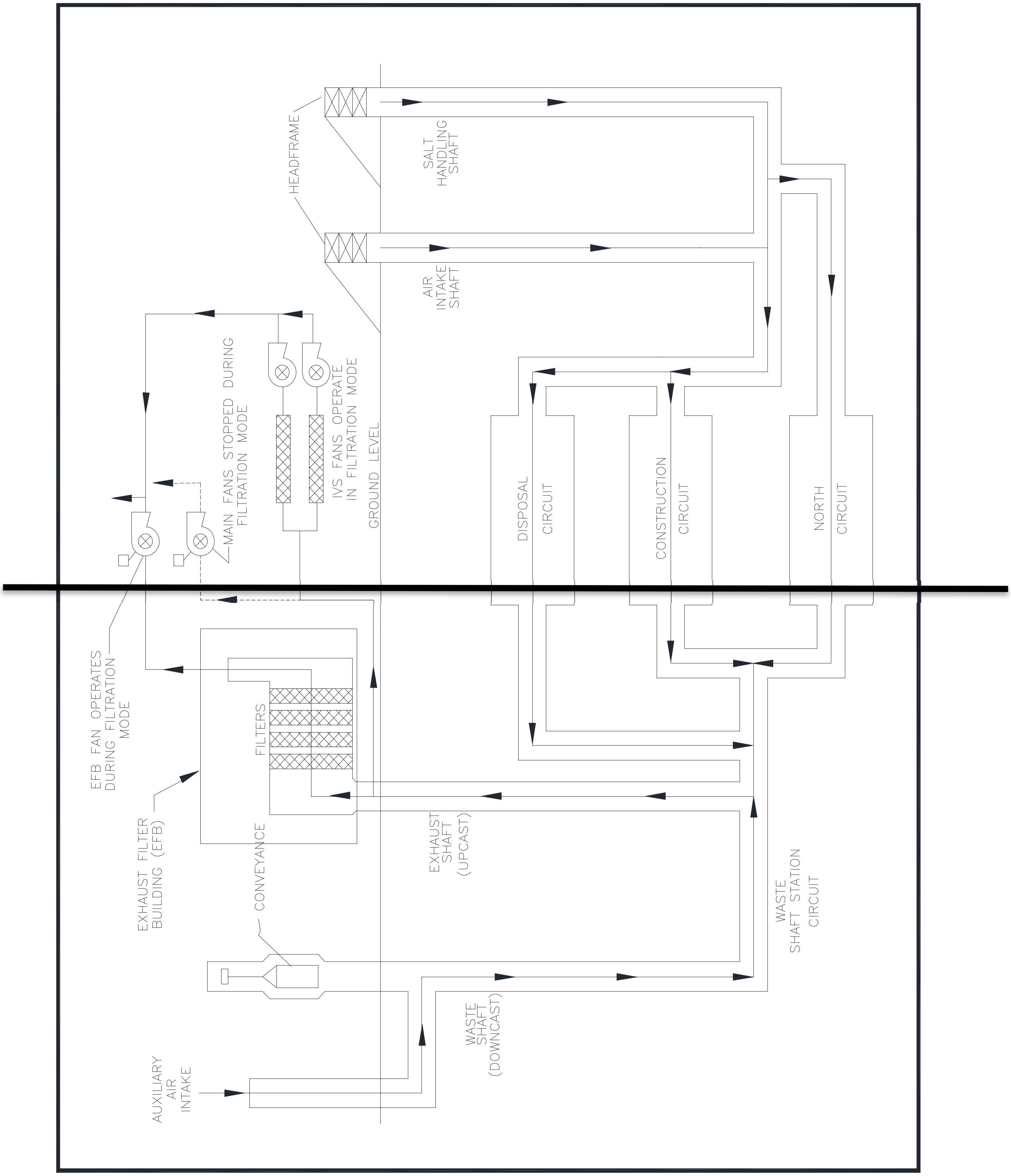


~~Figure A2-7~~
~~Push-Pull Attachment to Forklift to Allow Handling of Waste Containers~~

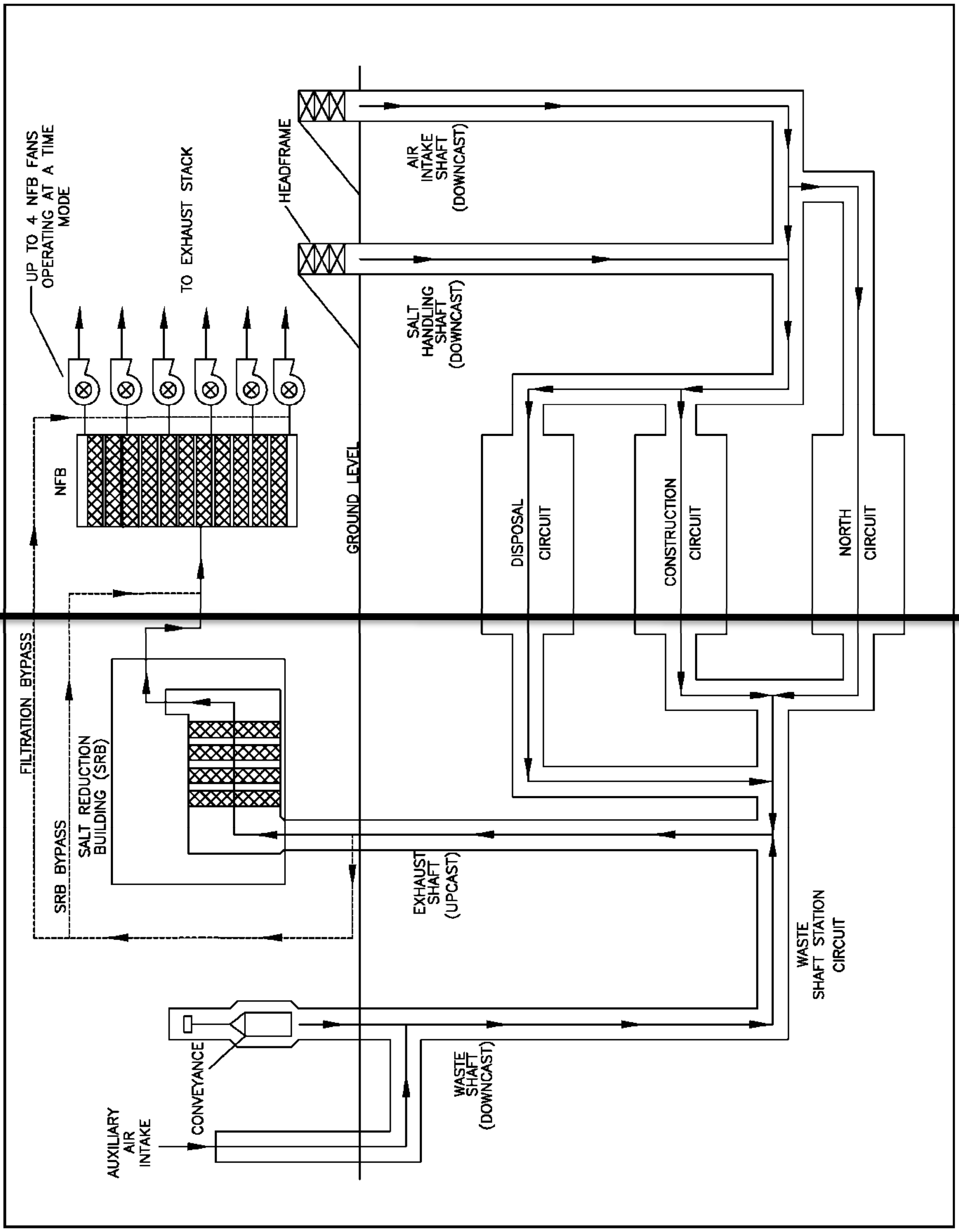


NOTE: MgO will be emplaced as necessary

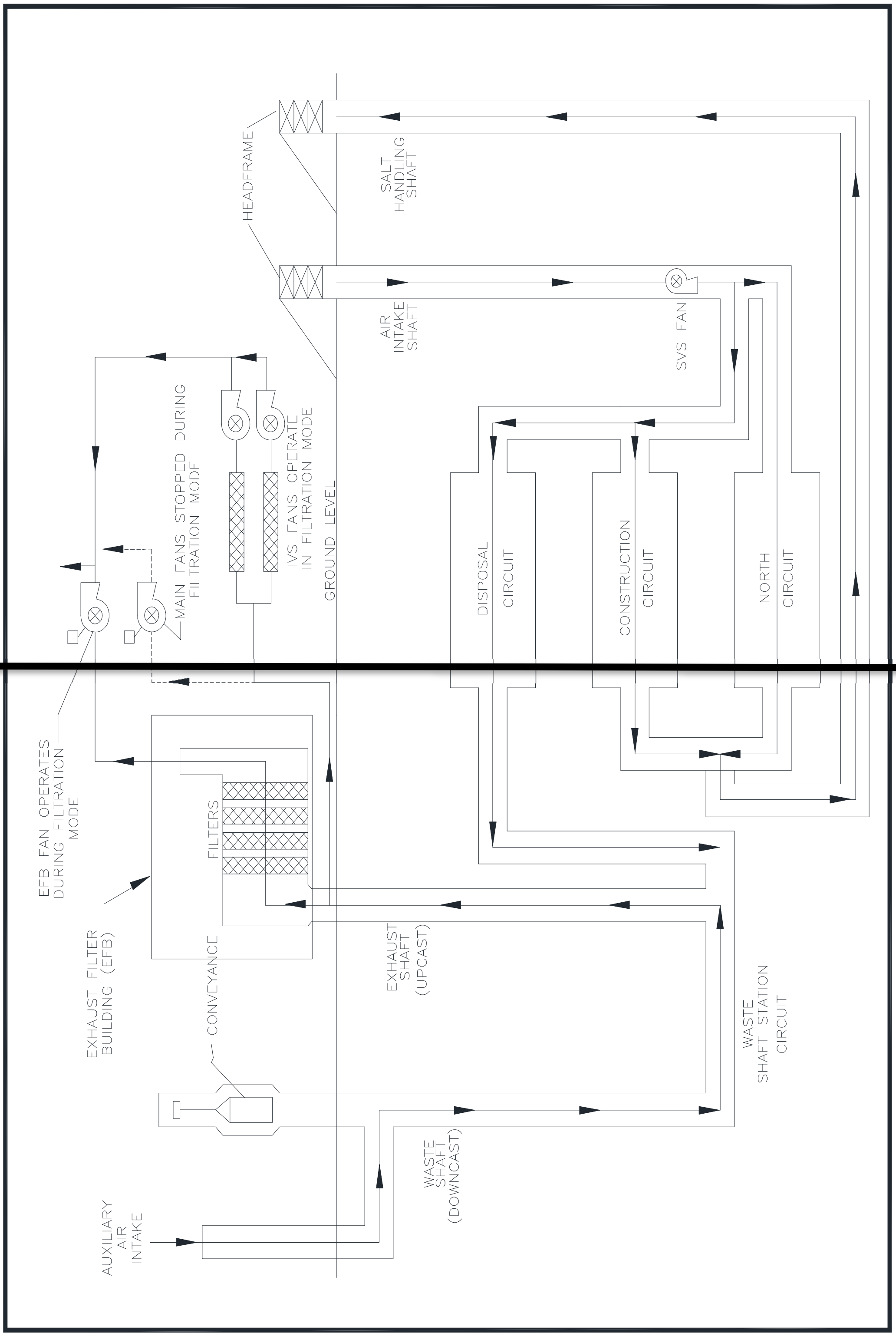
~~Figure A2-8~~
~~Typical RH and CH Transuranic Mixed Waste Container Disposal Configuration~~



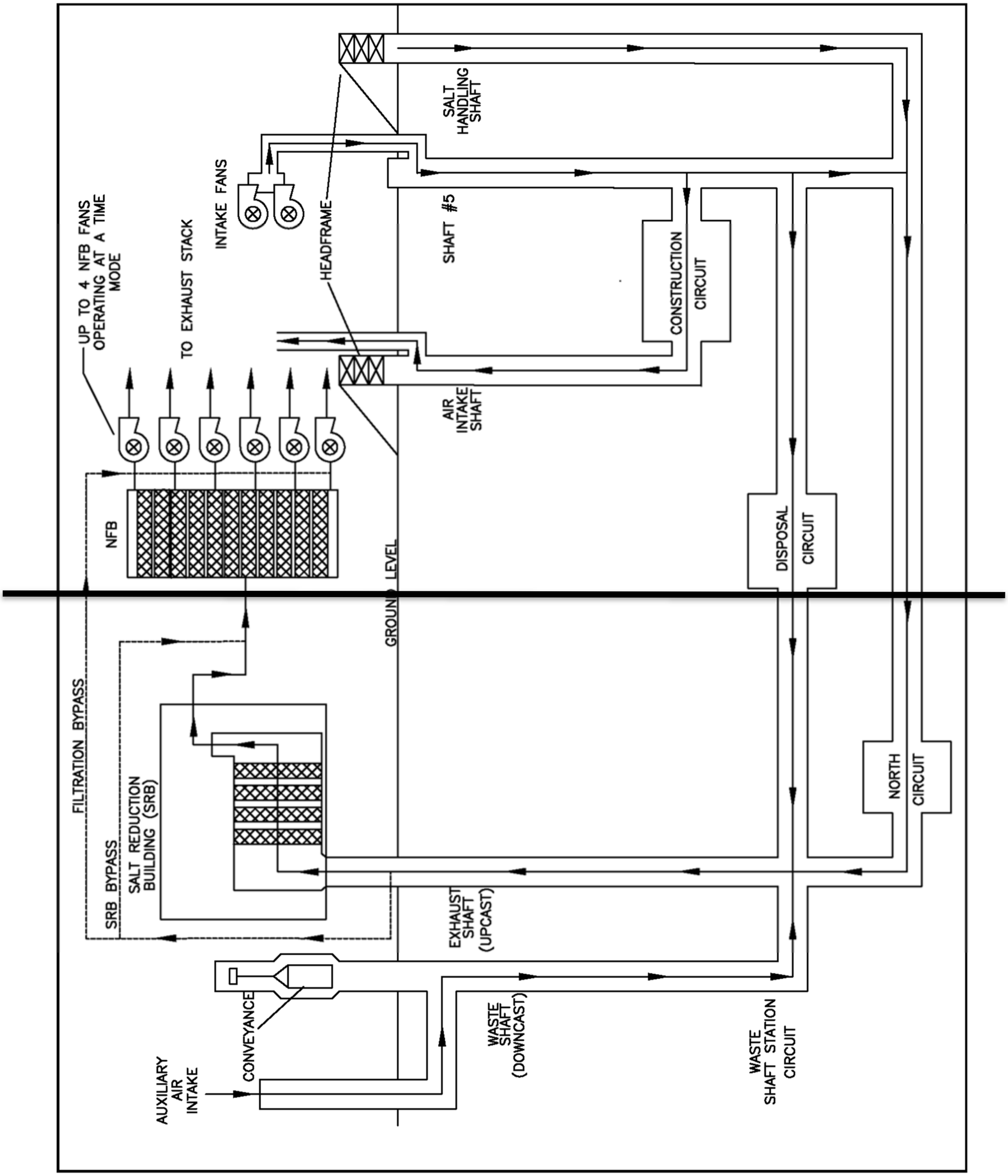
~~Figure A2-9a~~
~~Underground Ventilation System Airflow~~



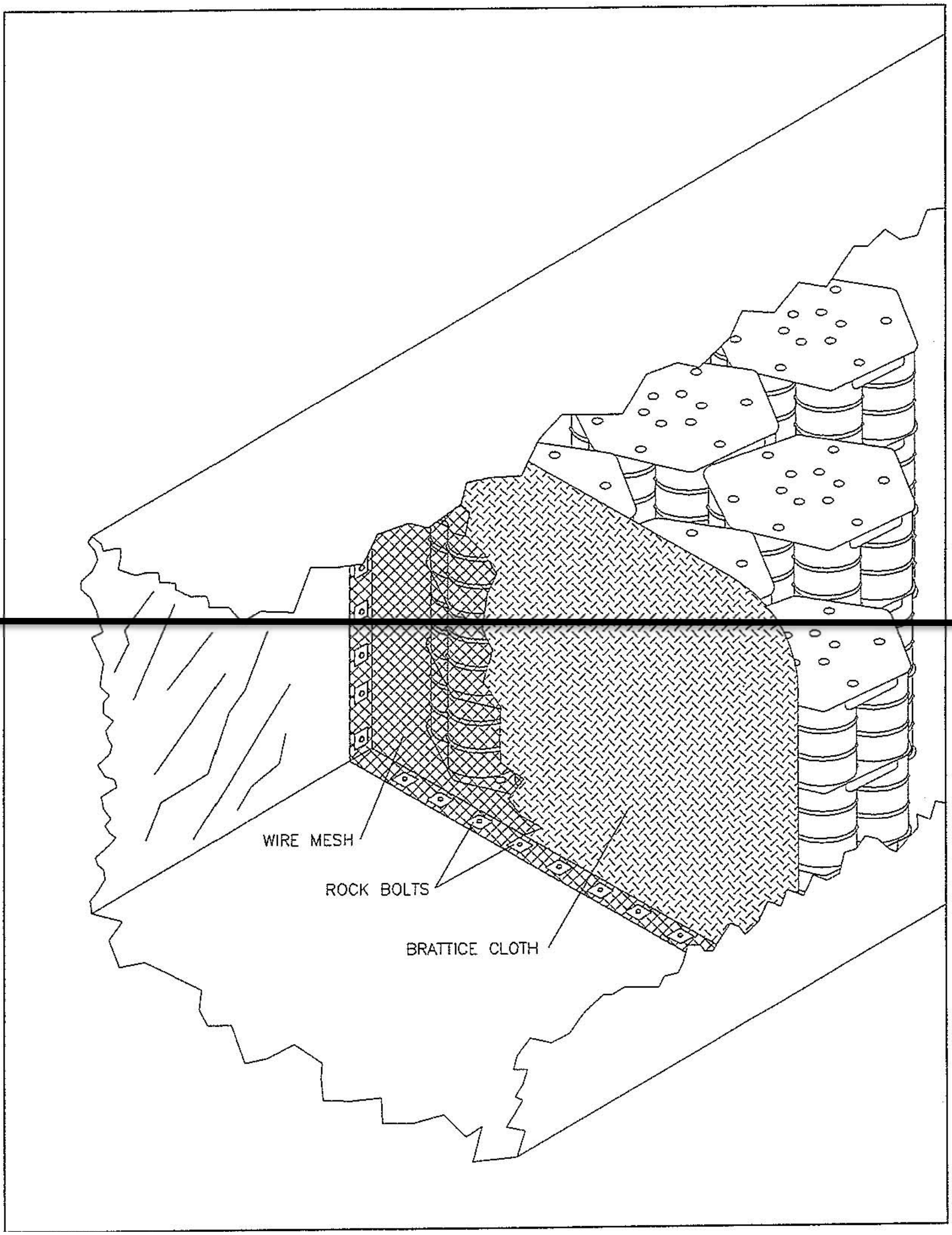
~~Figure A2-9a-NFB~~
~~Underground Ventilation System Airflow (with Building 416)~~



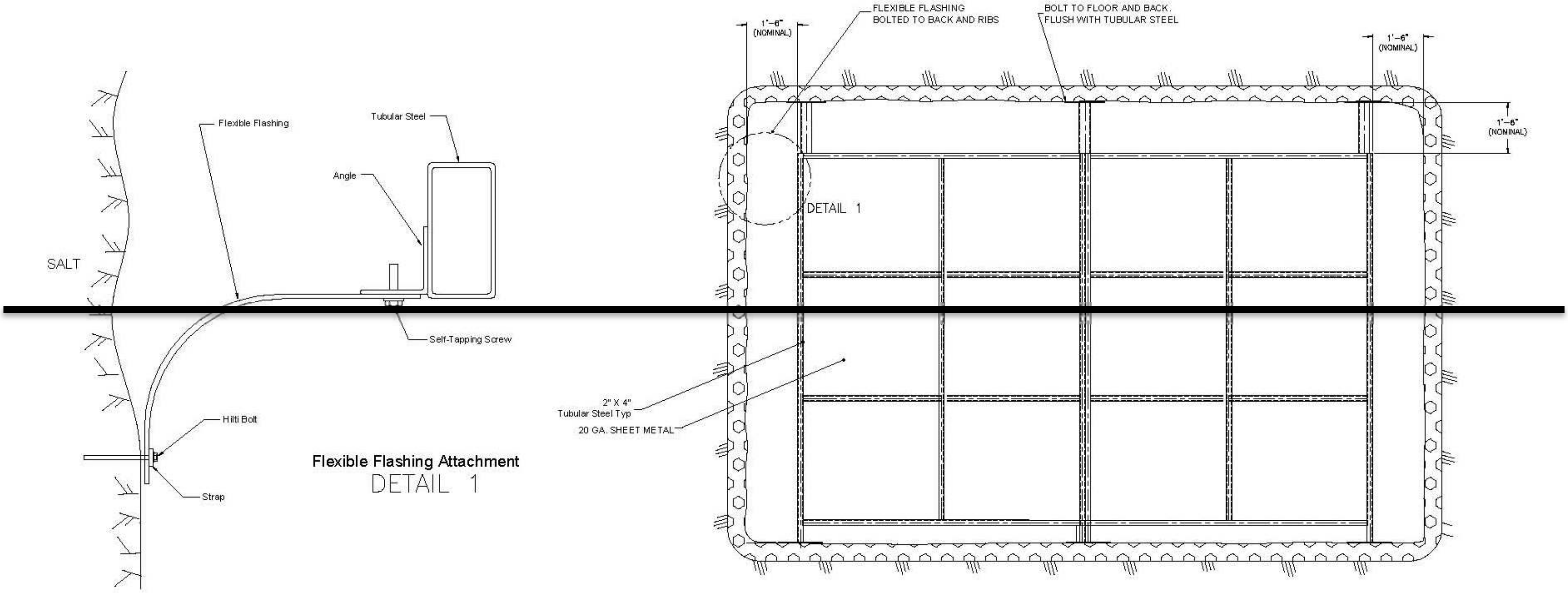
~~Figure A2-9b~~
~~Underground Ventilation System Airflow (with SVS)~~



~~Figure A2-9c~~
~~Underground Ventilation System Airflow (with S#5)~~

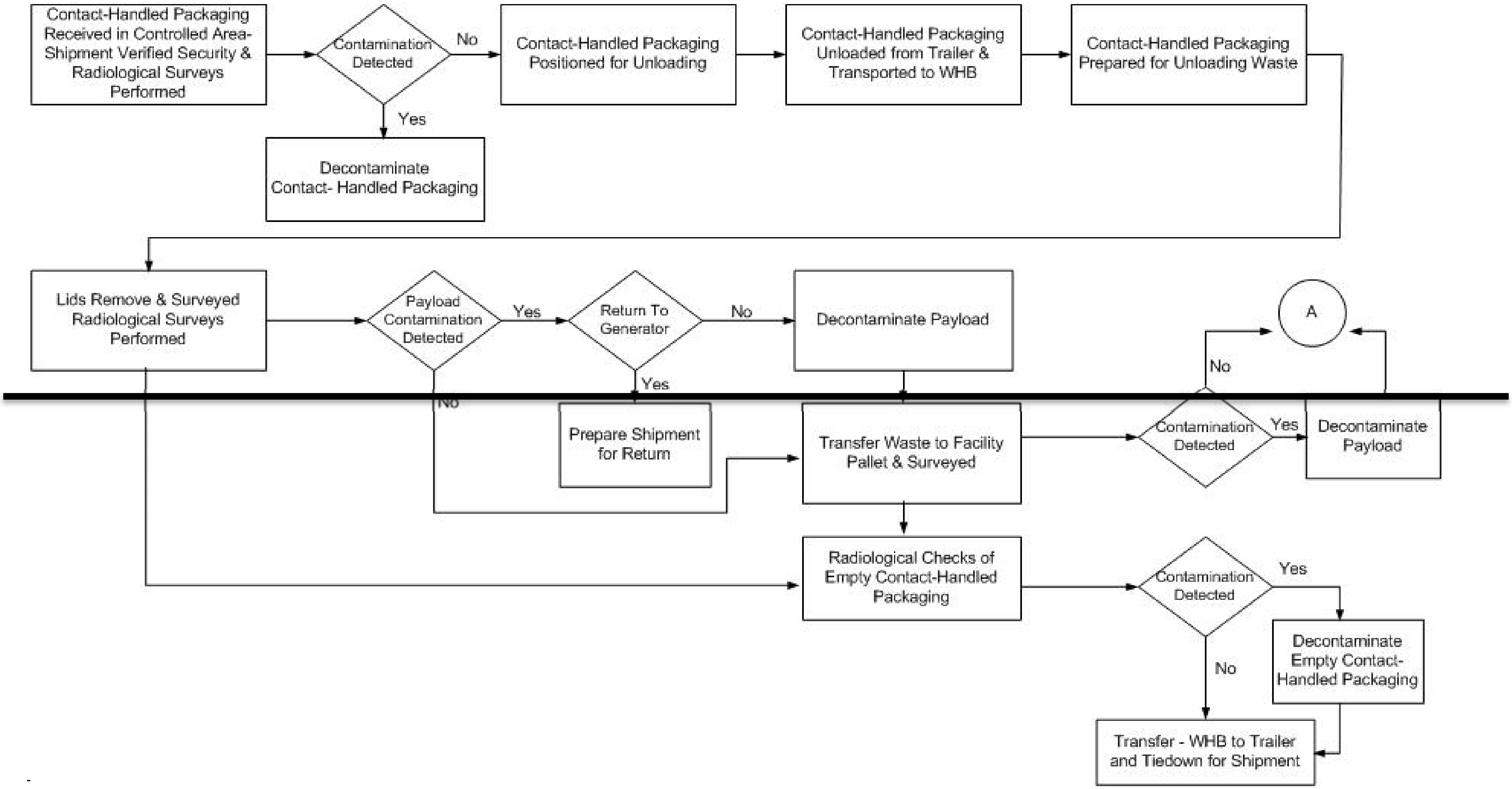


~~**Figure A2-11**~~
~~**Typical Room Barricade**~~



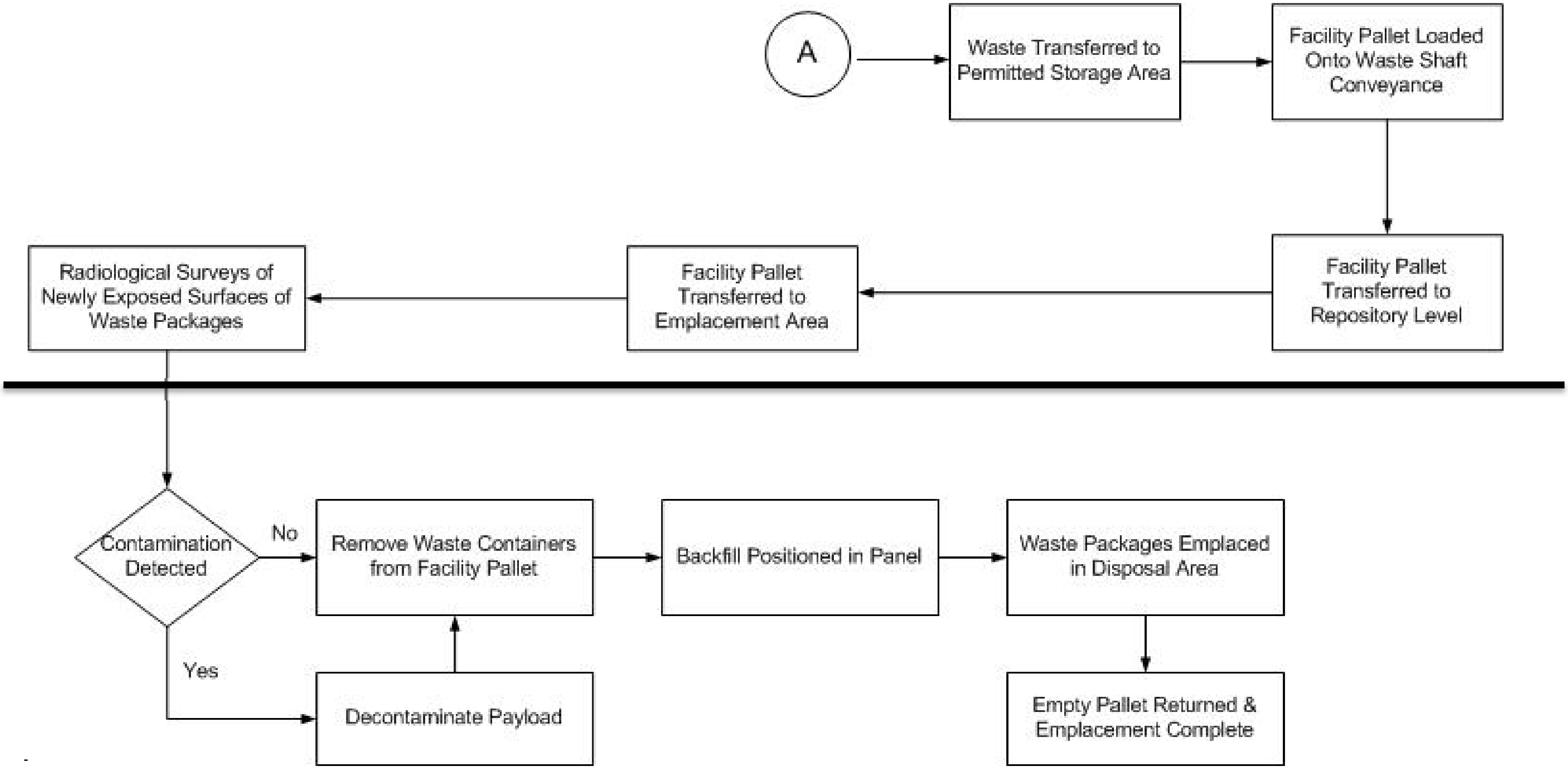
Not to Scale. All dimensions are nominal.

~~Figure A2-11a~~
~~Typical Bulkhead~~



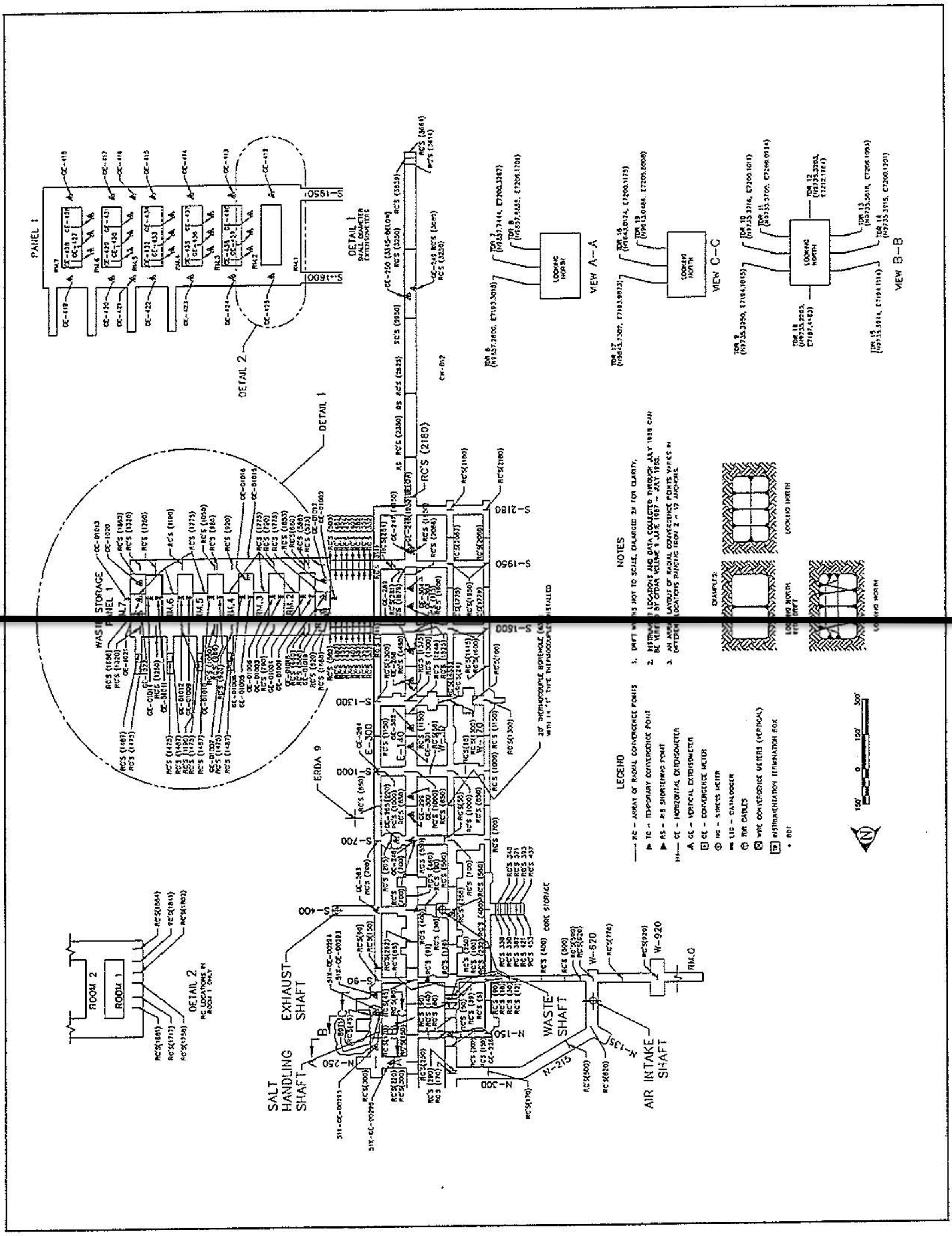
~~**Figure A2-12**~~

~~**WIPP Facility Surface and Underground CH Transuranic Mixed Waste Process Flow Diagram**~~

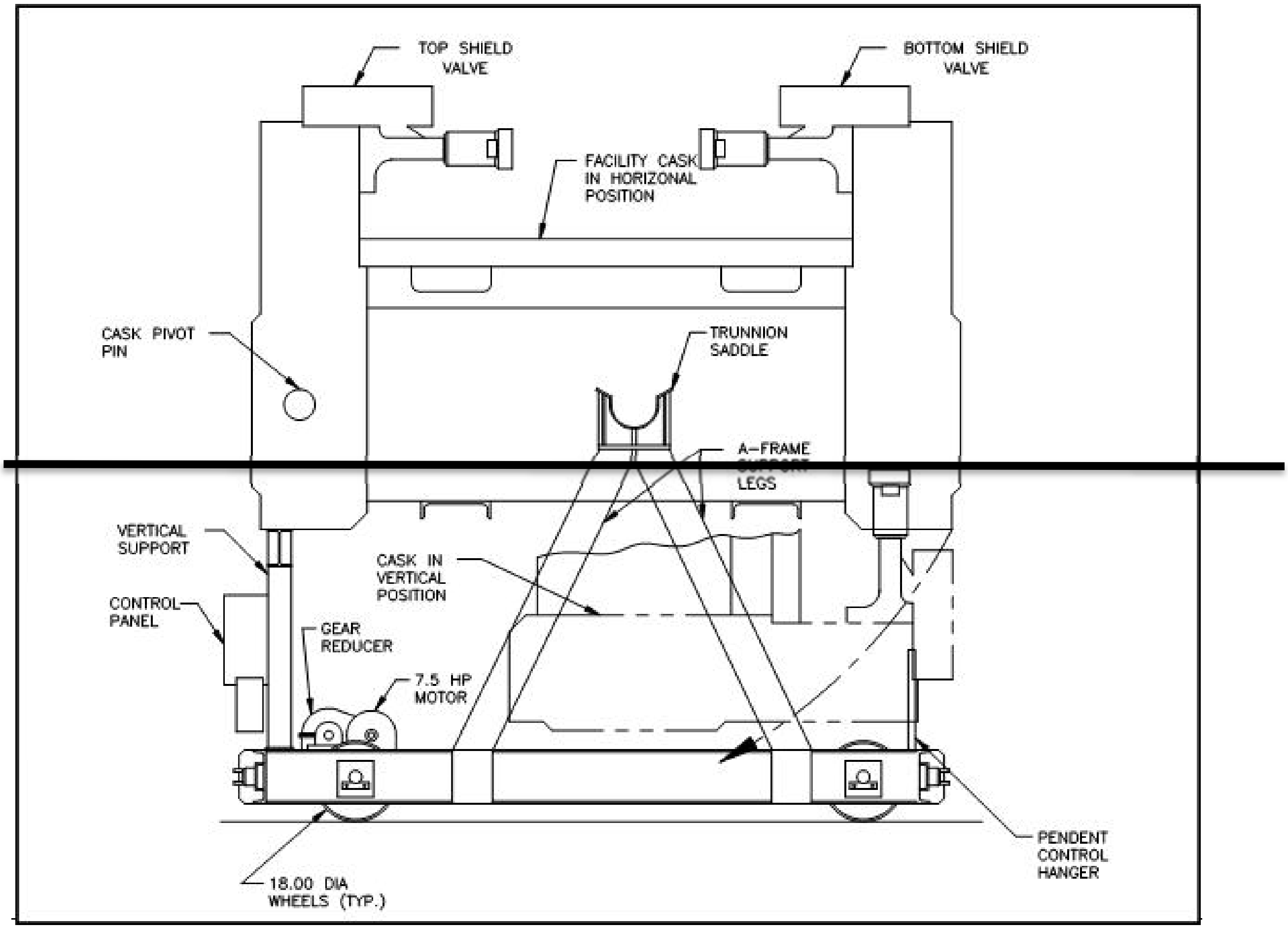


~~Figure A2-12~~
~~WIPP Facility Surface and Underground CH Transuranic Mixed Waste Process Flow Diagram (Continued)~~

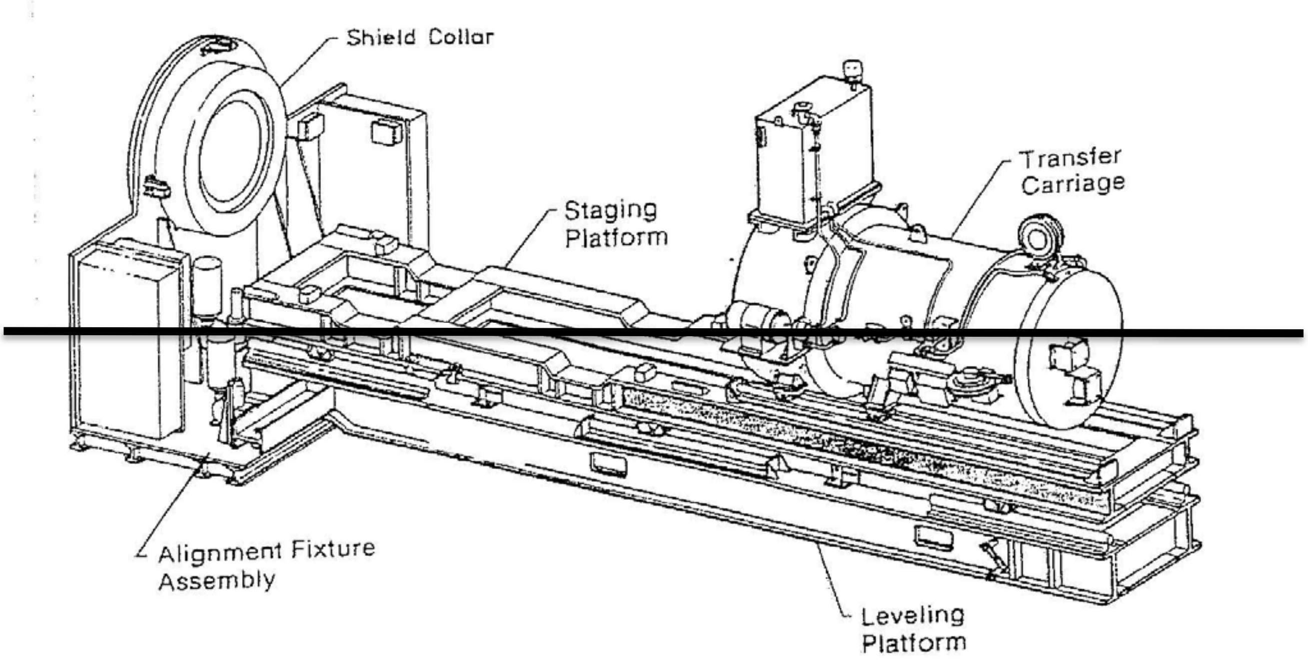
1



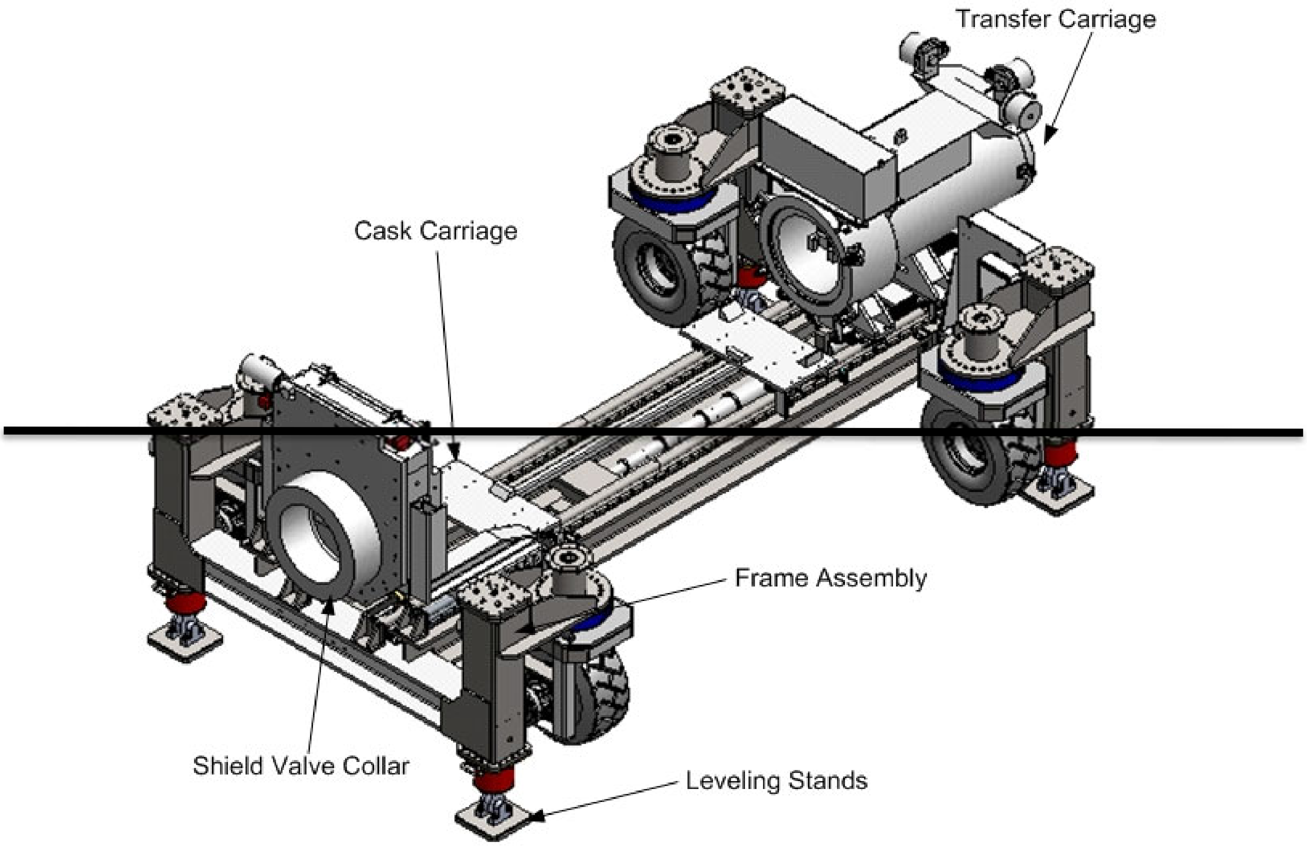
~~Figure A2-13~~
~~Layout and Instrumentation - As of 1/96~~



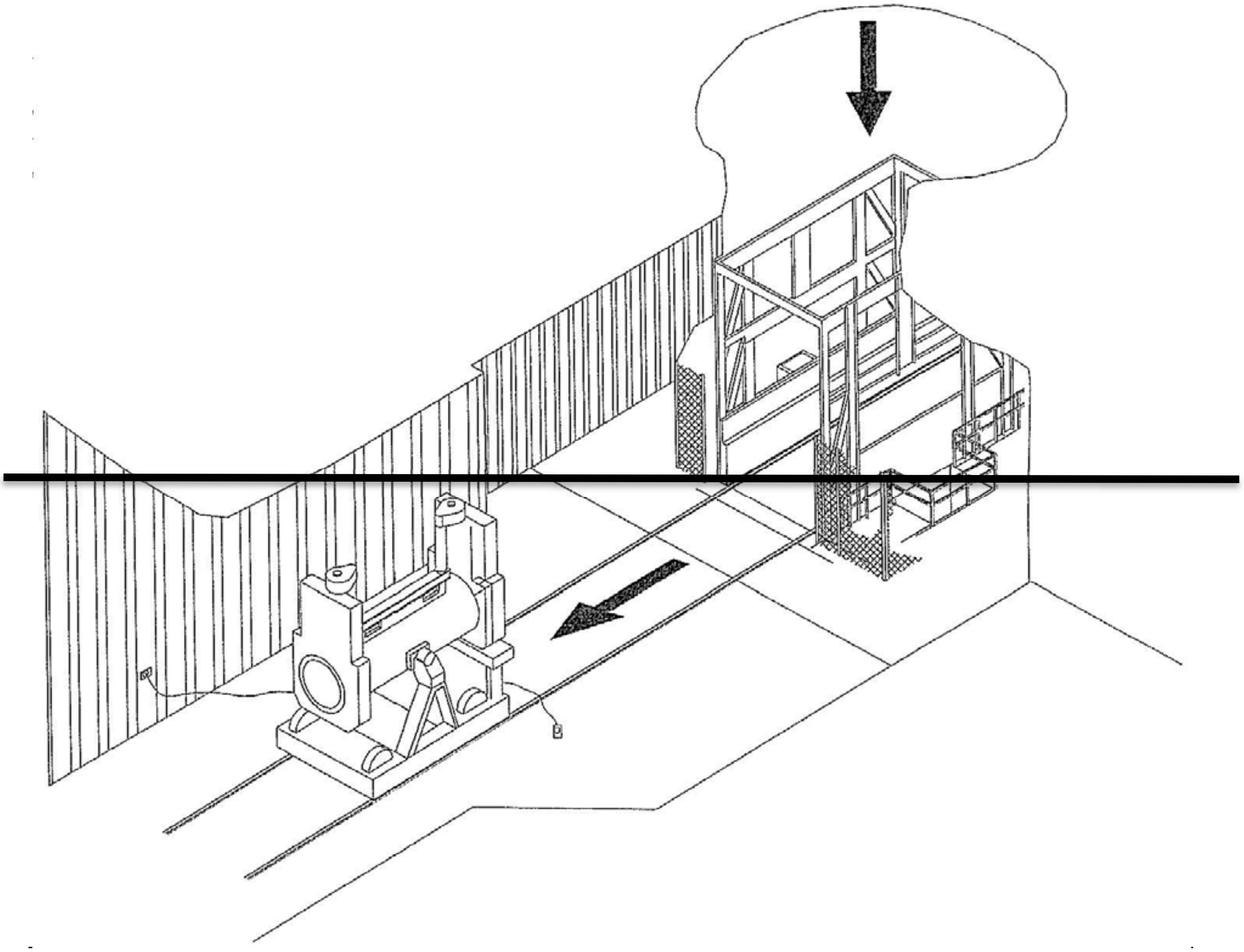
~~Figure A2-14~~
~~Facility Cask Transfer Car (Side View)~~



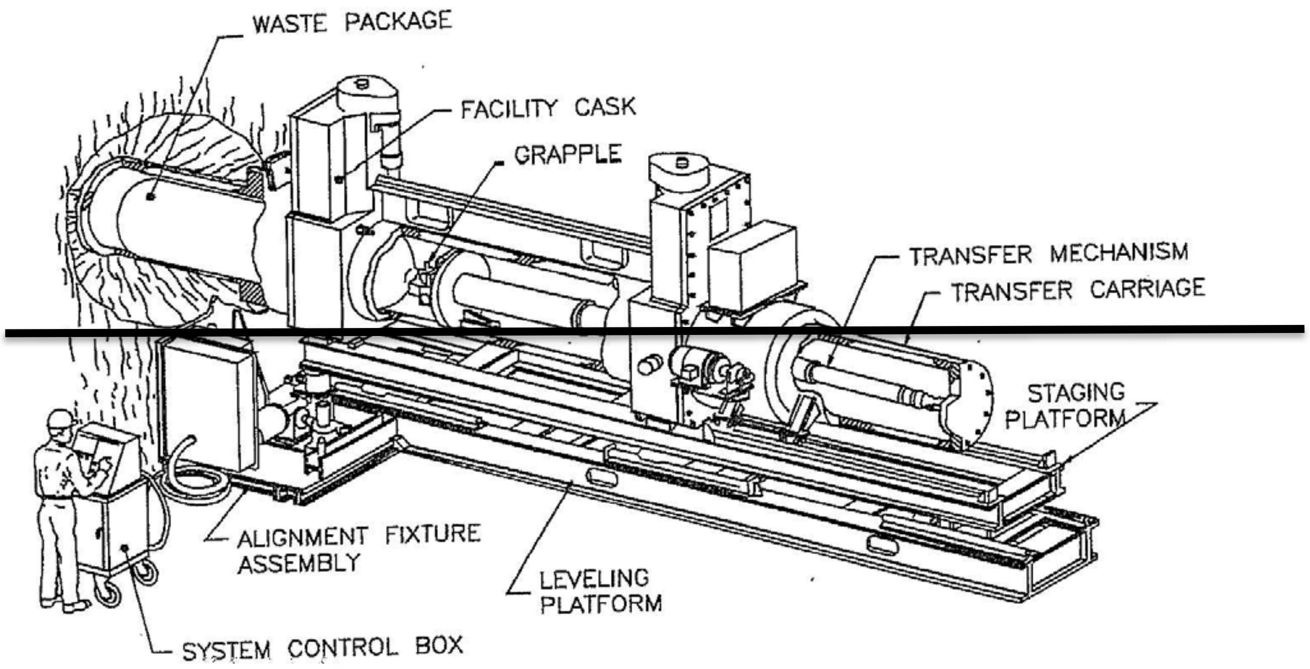
~~Figure A2-15~~
~~Typical Emplacement Equipment~~



~~**Figure A2-15a**~~
~~**Typical Emplacement Equipment**~~

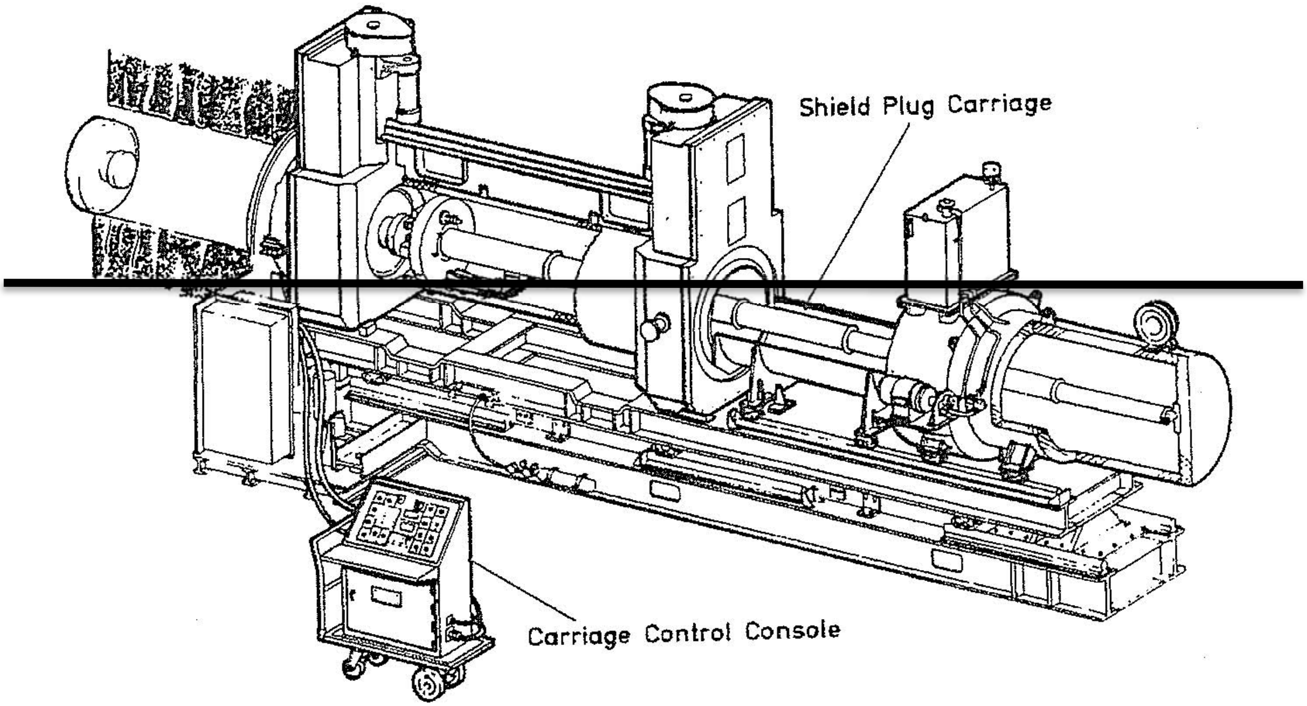


~~Figure A2-16~~
~~RH TRU Waste Facility Cask Unloading from Waste Shaft Conveyance~~

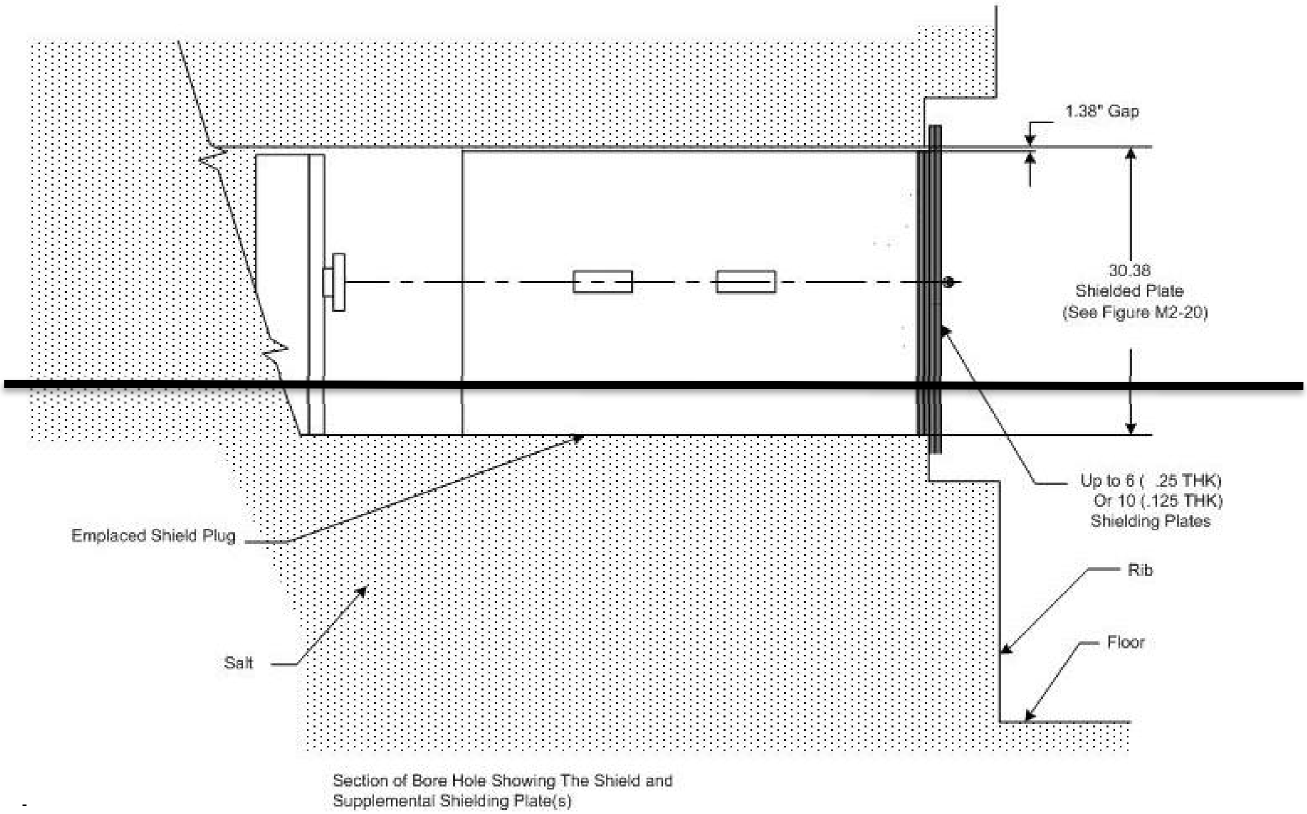


~~**Figure A2-17**~~
~~**Facility Cask Installed on the Typical Emplacement Equipment**~~

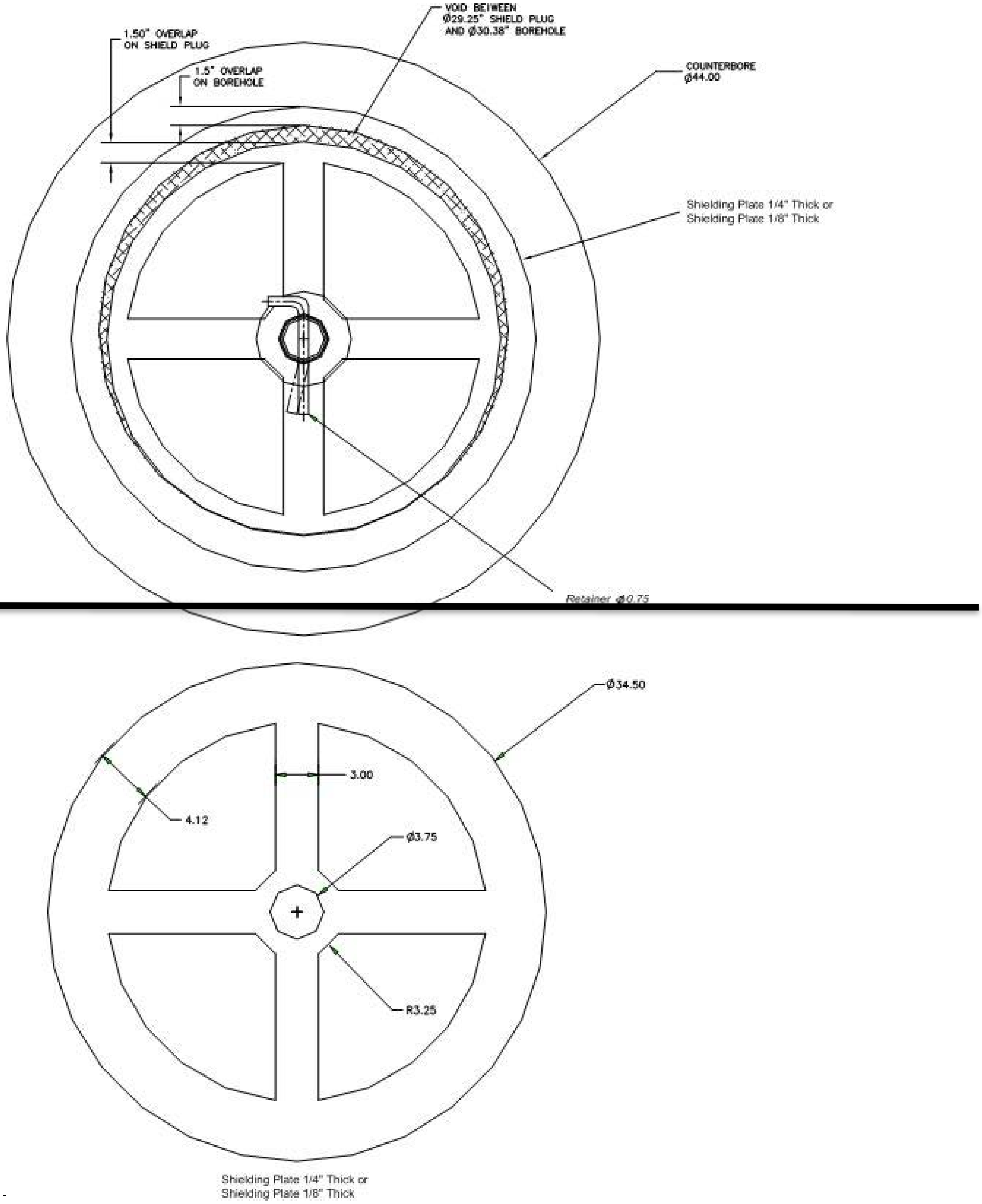
FACILITY CASK AGAINST SHIELD COLLAR, TRANSFER CARRIAGE RETRACTED, SHIELD PLUG CARRIAGE ON STAGING PLATFORM, SHIELD PLUG BEING INSTALLED



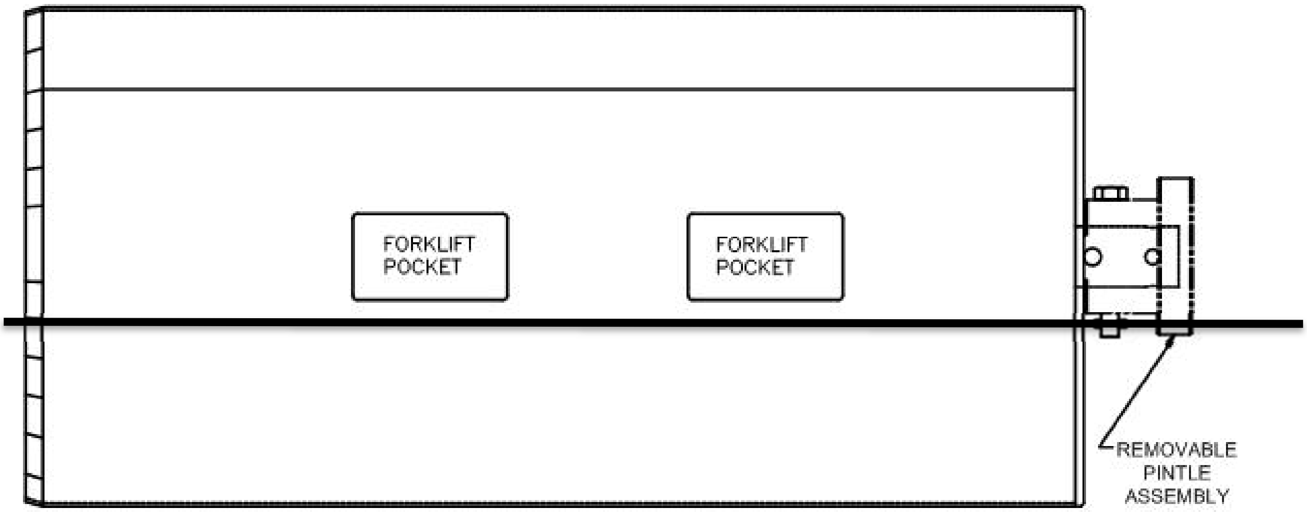
~~Figure A2-18~~
~~Installing Shield Plug~~



~~Figure A2-19~~
~~Shield Plug Supplemental Shielding Plate(s)~~



~~Figure A2-20~~
~~Shielding Layers to Supplement RH Borehole Shield Plugs~~



TYPICAL DIMENSION: APPROXIMATELY 29 INCHES DIAMETER X 61 INCHES SHIELDING LENGTH

Composition: Cylindrical steel shell filled with concrete
Weight: Approximately 3750 pounds

~~**Figure A2-21**~~
~~**Shield Plug Configuration**~~

ATTACHMENT ~~A4~~A3

TRAFFIC PATTERNS

ATTACHMENT ~~A4~~A3

TRAFFIC PATTERNS

TABLE OF CONTENTS

~~LIST OF TABLES~~

~~LIST OF FIGURES~~

ATTACHMENT ~~A4~~A3

TRAFFIC PATTERNS

~~A4~~A3-1 Traffic Information and Traffic Patterns

Access to the Waste Isolation Pilot Plant (**WIPP**) facility is provided ~~by two access roads~~via Louis Whitlock Road that connects with U.S. Highway 62/180, 13 miles (**mi**) (21 kilometers (**km**)) to the north, and NM State Highway 128 (Jal Highway), 4 mi (6.4 km) to the south (Figure M-57~~A4-1~~) via the South Access Road. These access roads were built for the Permittees to transport transuranic (**TRU**) mixed waste to the ~~site~~WIPP facility. Both access roads are owned and maintained by the Department of Energy (**DOE**). Signs and pavement markings are located in accordance with the Uniform Traffic Control Devices Manual. Access-road design designation parameters, such as traffic volume, ~~are~~ were presented in ~~Table A4-1~~the 2009 Amended Renewal Application, Chapter G, Table G-1 (DOE, 2009).

~~A4~~A3-2 Facility Access and Traffic

Access to the WIPP facility for personnel, visitors, and trucks carrying supplies and TRU mixed waste is provided through a security checkpoint (vehicle trap). After passing through the security checkpoint, TRU mixed waste transport trucks ~~will~~ normally turn right (south) before reaching the Support Building and then left (east) to park in the ~~parking area HWMU~~Parking Area Container Storage Unit (**PAU**) just east of the air locks (Figure M-58~~A4-2~~). Outgoing trucks depart the same way they arrived, normally out of the west end of the ~~parking area~~PAU, north through the fence gate and out through the vehicle trap. An alternate inbound route is to continue straight ahead (east) from the security checkpoint to the second road and to turn south to enter the ~~truck parking area~~PAU. The alternate outbound route is also the reverse of this route. Salt transport trucks, which remove mined salt from the Salt Handling Shaft area, ~~will~~ do not cross paths with TRU mixed waste transporters; instead, they ~~will~~ proceed from the Salt Handling Shaft northward to the salt pile. After passing through security, access for large equipment may be provided through the east gate. Figures M-58 and M-59~~A4-2~~ shows surface traffic flow at the WIPP facility.

The ~~site~~ WIPP facility speed limit for motor vehicles is 10 miles per hour (**mph**) (16 kilometers per hour (**kph**)) and 5 mph (8 kph) for rail movements. Speed limits are clearly posted at the entrance to the ~~site~~ facility and enforced by security officers. There are no traffic signals. Stop signs are located at the major intersections of roadways with the main east-west road. Safety requirements are communicated ~~to all site personnel~~ via General Employee Training which must be completed by site personnel within 30 days of their employment. Employee access to on-site facilities requires an annual refresher course to reinforce the safety requirements. Security officers monitor vehicular traffic for compliance with site restrictions~~,~~ and provide instructions to off-site delivery shipments. Vehicular traffic other than the waste transporters use the same roads, but there ~~will be~~is no interference because there are two lanes available on the primary and alternate routes for waste shipments. Pedestrian traffic is limited to the sidewalks and prominently marked crosswalks. ~~Site traffic~~Traffic within the security fence is composed mostly of pickup trucks and electric carts with ~~a~~ an approximate frequency of ~~perhaps~~ 10 per hour at peak periods. Emergency vehicles are exercised periodically for maintenance and personnel training, with an average frequency of one each per day. They are used for their intended purpose on an as-required basis.

The traffic circulation system is designed in accordance with American Association of State Highway and Transportation Officials (**AASHTO**) Site Planning Guides for lane widths, lateral clearance to fixed objects, minimum pavement edge radii, and other geometric features. Objects in or near the roadway are prominently marked.

On-site roads, sidewalks, and paved areas are used for the distribution and storage of vehicles and personnel and are designed to handle ~~all~~ traffic generated by employees, visitors, TRU mixed waste shipments, and movements of operational and maintenance vehicles. The facility entrance and TRU mixed waste haul roads are designed for AASHTO H20-S16 wheel loading. Service roads are designed for AASHTO H10 wheel loading. Access and on-site paved roads are designed to bear the anticipated maximum load of 115,000 ~~lbs~~ lb (52,163.1 kg), the maximum allowable weight of a truck/trailer carrying loaded ~~Contact~~contact-~~Handled~~ handled (**CH**) or ~~Remote~~remote-~~Handled~~ handled (**RH**) ~~Packages~~packages. The facility is designed to handle approximately eight truck trailers per day, each carrying one or more ~~Contact-Handled~~CH or ~~Remote-Handled~~RH ~~Packages~~packages. This is equivalent to 3,640 TRU mixed waste-carrying vehicles per year.

The calculations to support the anticipated maximum load of 115,000 ~~lbs.~~lb ~~are shown below:~~were provided in the 2009 Amended Renewal Application, Chapter G (DOE, 2009).

~~Soil Resistance R (psi) - is taken directly from the WIPP Soil Report and Bechtel calculation because there is no change.~~

~~A. Pavement Thickness~~

~~The traffic frequency increase from 10 shipments per day to 10.15 shipments per day has only minimal impact on the Total Expanded Average Load (**EAL**) and the traffic index (**TI**) as shown below, both important parameters in pavement design.~~

~~Total EAL (TEAL):~~

~~13,780 ~ constant for 5 or more axles over 20 years, taken from Table 7-651.2A - Highway Design Manual (HDM).~~

~~TEAL = 13,780 × 25yr./20yr. = 17,225~~

~~Using 10.15 shipments per day ~ 17,225 × 10.15 = 174,834~~

~~Conversion of EAL to Traffic Index (TI).~~

~~For TEAL of 174,834 ~ TI = 7.5 - (from HDM, Table 7-651.2B)~~

~~Asphalt Concrete Thickness TAC:~~

~~GE = 0.0032 × TI × (100 -R)....R = 80~~

~~GE - Gravel Equivalent (Ft).~~

~~GE = 0.0032 × 7.5 × 20 = 0.48′ ...GfAC = 2.01⇒ TAC = 0.48/2.01 = 0.24′ ⇒ use 2½″ AC Surface Course.~~

~~(Actually used: 3″)~~

~~Gf - Gravel Equivalent Factor (constant from Table 7-651.2C from HDM).~~

~~B. Bituminous Treated Base~~

~~GE = 0.0032 × TI × (100 -R) .... R = 55 ~ caliche subbase ⇒ GE = 1.08′ GEBTB = 1.08 - 2.01 × 0.21 = 0.66′~~

~~TBTB = GEBTB/GfBTB = 0.66/1.2 = 0.55′ ⇒ Use 4″ BTB~~

~~GfBTB ~ taken from table 7-651.2C~~

~~C. Caliche Subbase ~ TCSB~~

~~GE = 0.0032 × TI × (100 -R) .....R = 50 - prepared subgrade~~

~~GE = 1.2~~

~~GECSB = 1.2 - (0.21× 2.07) - (0.33 × 1.2) ⇒ 0.37′~~

~~TCBS = 0.37/1.0 = 0.37′ ~ 4½″~~

~~Based on the results of the above calculation, the site paved roads designated for waste transportation are safe to be used by the heavier truckloads carrying shipping casks used in RH TRU mixed waste transportation to the WIPP.~~

~~A4~~A3-3 Waste Handling Building Traffic

~~CH~~ Contact-handled TRU mixed waste ~~will~~ arrives by tractor-trailer at the WIPP facility in sealed ~~Contact Handled~~CH ~~Packages~~packages. Prior to unloading the packages from the trailer, security checks, radiological surveys, and shipping documentation reviews ~~will be~~are performed. A forklift or Yard Transfer Vehicle ~~will~~ removes the ~~Contact Handled~~CH ~~Packages~~ packages and transports them a short distance through an air lock that is designed to maintain differential pressure in the Waste Handling Building (**WHB**). The forklift or Yard Transfer Vehicle ~~will place~~places the shipping containers at one of the two TRUPACT-II unloading docks (**TRUDOCKs**) inside the WHB or, in the case of the TRUPACT-III, at the ~~payload transfer~~bolting station in Room 108 in the WHB.

The TRUPACT-II may hold up to two 55-gallon **(gal)** drum seven-packs, two 85-~~gallon~~ gal drum four-packs, two 100-~~gallon~~ gal drum three-packs, two standard waste boxes (**SWBs**), or one ten-drum overpack (**TDOP**). A HalfPACT may hold seven 55-~~gallon~~ gal drums, one SWB, ~~or~~ four 85-~~gallon~~ gal drums, or three shielded containers. The TRUPACT-III holds a single standard large box 2 (**SLB2**). A six-ton overhead bridge crane or Facility Transfer Vehicle with a transfer table ~~will be~~is used to remove the contents of the ~~Contact Handled~~CH ~~Package~~package. Waste containers ~~will be~~are surveyed for radioactive contamination and decontaminated or returned to the ~~Contact Handled~~CH ~~Package~~package, as necessary.

Each facility pallet ~~will~~ accommodates four 55-~~gallon~~ gal drum seven-packs, four SWBs, four 85-~~gallon~~ gal drum four-packs, four 100-~~gallon~~ gal drum three-packs, two TDOPs, ~~or~~ an SLB2, or two three-packs of shielded container assemblies. Waste containers ~~will be~~are secured to the facility pallet prior to transfer. A forklift or facility transfer vehicle ~~will~~ transports the loaded facility pallet into the air lock at the Waste Shaft (Figures M-60~~A4-3, A4-3a, and A4-3b~~). The facility transfer vehicle ~~will be~~is driven onto the waste shaft conveyance deck, where the loaded facility pallet ~~will be~~is transferred to the waste shaft conveyance and downloaded for emplacement.

Remote-handled~~RH~~ TRU mixed waste ~~will~~ arrives at the WIPP facility in a payload container contained in a shielded cask loaded on a tractor-trailer. Prior to unloading the cask from the trailer, radiological surveys, security checks, and shipping documentation reviews ~~will be~~are performed, and the trailer carrying the cask ~~will be~~is moved into the ~~Parking Area~~ PAU or directly into the RH Bay of the Waste Handling Building Container Storage Unit.

The cask is unloaded from the trailer in the RH Bay and is placed on the Cask Transfer Car. The Cask Transfer Car is used to move the cask to the Cask Unloading Room. At this point, a crane moves the waste to the Hot Cell or the Transfer Cell. Some RH TRU mixed waste may be moved to the Hot Cell for overpacking before being moved to the Transfer Cell. Once in the Transfer Cell, the Transfer Cell Shuttle Car moves the waste to a location beneath the facility cask. A crane is used to move the waste from the Transfer Cell Shuttle Car into the facility cask. The Facility Cask Transfer Car then moves the facility cask to the underground. A more detailed description of waste handling in the WHB is included in Attachment A1. Figures ~~A4-5, A4-6 and A4-7~~M-13, M-15, and M-16 show RH TRU mixed waste transport routes.

~~A4~~A3-4 Underground Traffic

The Permittees ~~shall~~ designate the traffic routes of TRU mixed waste handling equipment and construction equipment and record this designation on a map that is posted in a location where it can be examined by personnel entering the underground. The map will be updated whenever the routes are changed. Maps will be available in facility files until facility closure. The ventilation and traffic flow path in the TRU mixed waste handling areas underground are restricted and separate from those used for mining and haulage (construction) equipment, except that during waste transport in W-30, ventilation need not be separated north of S-1600 (~~Figures A4-4 and A4-4a~~Figure M-43). In general, the Permittees restrict waste traffic to the intake ventilation drift to maximize isolation of this activity from personnel. ~~The exhaust drift in the waste disposal area will normally not be used for personnel access.~~ Non-waste and non-construction traffic is generally comprised of escorted visitors only and is minimized during each of the respective operations.

Adequate clearances that exceed the mining regulations of Title 30 of the Code of Federal Regulations (**CFR**) ~~§~~Part 57 exist underground for safe passage of vehicles and pedestrians. Pedestrians/personnel are required to yield to vehicles in the WIPP underground facility. This condition is reinforced through the WIPP facility equipment operating procedures, the WIPP Safety Manual, the WIPP facility safety briefing required for ~~all~~ underground visitors, the General Employee Training annual refresher course, and the ~~Underground~~ underground annual refresher course that are mandated by 30 CFR ~~§~~Part 57, the New Mexico Mine Code, and DOE Order 5480.20A.

In addition, other physical means are utilized to safeguard pedestrians/personnel when underground such as:

- ~~All e~~Equipment operators are required to sound the vehicle horn when approaching intersections.

- ~~All a~~Airlock and bulkhead vehicle doors are equipped with warning bells or strobe lights to alert personnel when door movement (opening or closing) is imminent.

- Hemispherical mirrors are used at blind intersections so that persons can see around corners.

- ~~All h~~Heavy equipment is required to have operational back-up alarms.

- Heavily used intersections are well lighted.

Typically, the traffic routes during waste disposal in ~~all Panels will~~ Panels 1-8 use the same main access drifts, while traffic routes during waste disposal in Panels 11 and 12 will use the designated access drifts in the West Mains.

~~All t~~Traffic safety is regulated and enforced by the ~~Federal~~ federal and ~~State~~ state mine codes of regulations (30 CFR ~~§~~Part 57 and New Mexico State Mine Code). The agencies that administer these codes make regular inspection tours of the WIPP underground facilities for the purpose of enforcement.

~~All u~~Underground equipment is designed for off-road use since ~~all~~ driving surfaces are excavated in salt. ~~No loads on the underground roadways will exceed the bearing strength of in situ halite.~~

References

DOE, 2009. WIPP Hazardous Waste Facility Permit Amended Renewal Application, Carlsbad, New Mexico, September 2009.

~~TABLES~~

~~Table A4-1~~
~~Waste Isolation Pilot Plant Site Design Designation Traffic Parameters~~ [a]

~~Traffic Parameter~~	~~North Access Road (No. of Vehicles, unless otherwise stated)~~	~~South Access Road (No. of Vehicles, unless otherwise stated)~~	~~On-Site Waste Haul Roads Contact-Handled and Remote-Handled Package Traffic)~~
~~Average Daily Traffic (ADT)~~[b]	~~800~~	~~800~~	~~8~~
~~Design Hourly Volume (DHV)~~[c]	~~144~~	~~144~~	~~NA~~ [g]
~~Hourly Volume~~ ~~(Max. at Shift Change)~~	~~250~~	~~250~~	~~NA~~
~~Distribution (D)~~[d]	~~67%~~	~~67%~~	~~NA~~
~~Trucks (T)~~[e]	~~2%~~	~~2%~~	~~100%~~
~~Design Speed~~ [h, i]	~~70 mph (113 kph)~~	~~60 mph (97 kph)~~	~~25 mph (40 kph)~~
~~Control of Access~~ [f]	~~None~~	~~None~~	~~Full~~

[a] ~~For WIPP personnel and TRU mixed waste shipments only.~~

[b] ~~ADT—Estimated number of vehicles traveling in both directions per day.~~

[c] ~~DHV—A two-way traffic count with directional distribution.~~

[d] ~~D—The percentage of DHV in the predominant direction of travel.~~

[e] ~~T—The percentage of ADT comprised of trucks (excluding light delivery trucks).~~

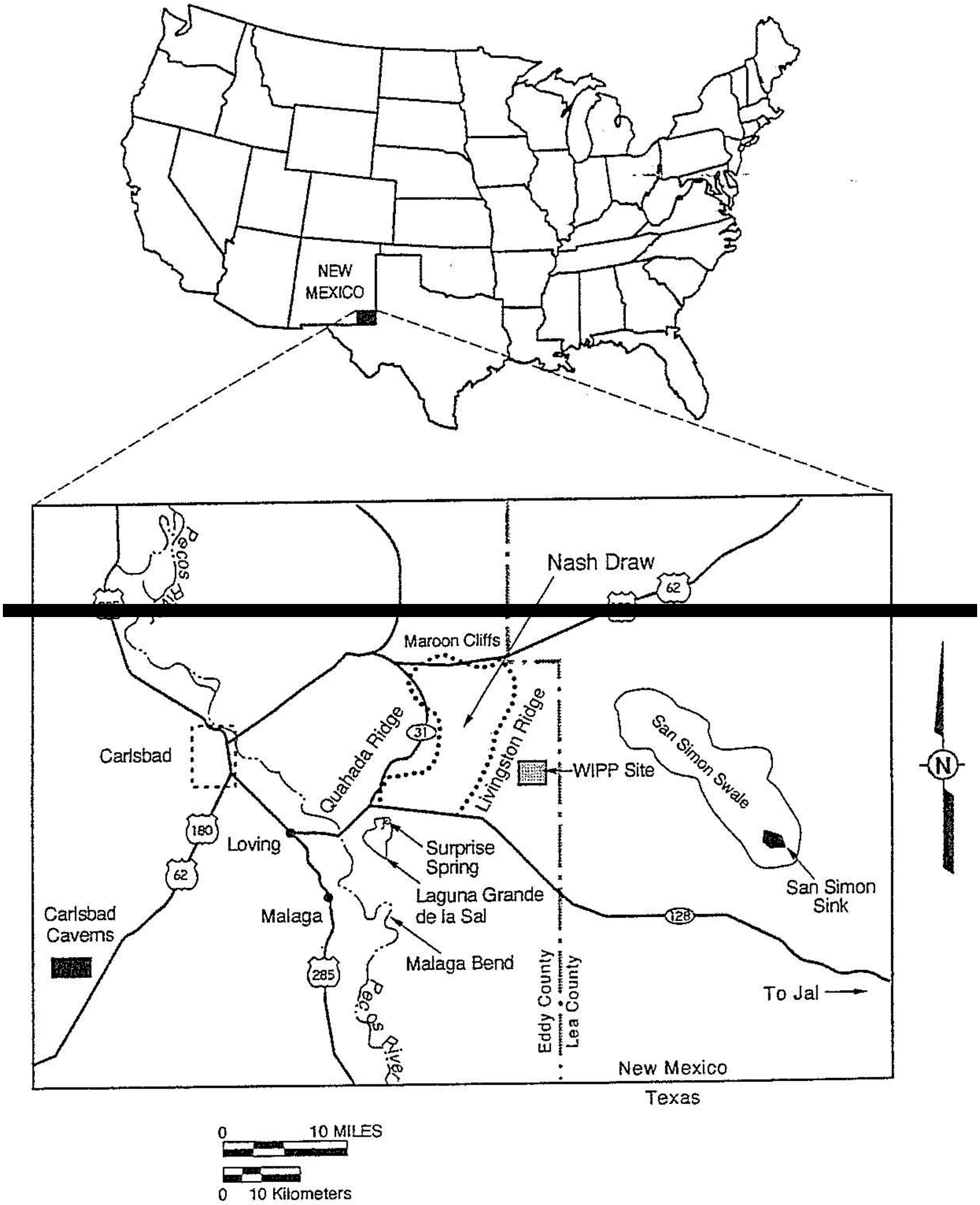
[f] ~~Control of Access—The extent of roadside interference or restriction of movement.~~

[g] ~~NA—Not applicable.~~

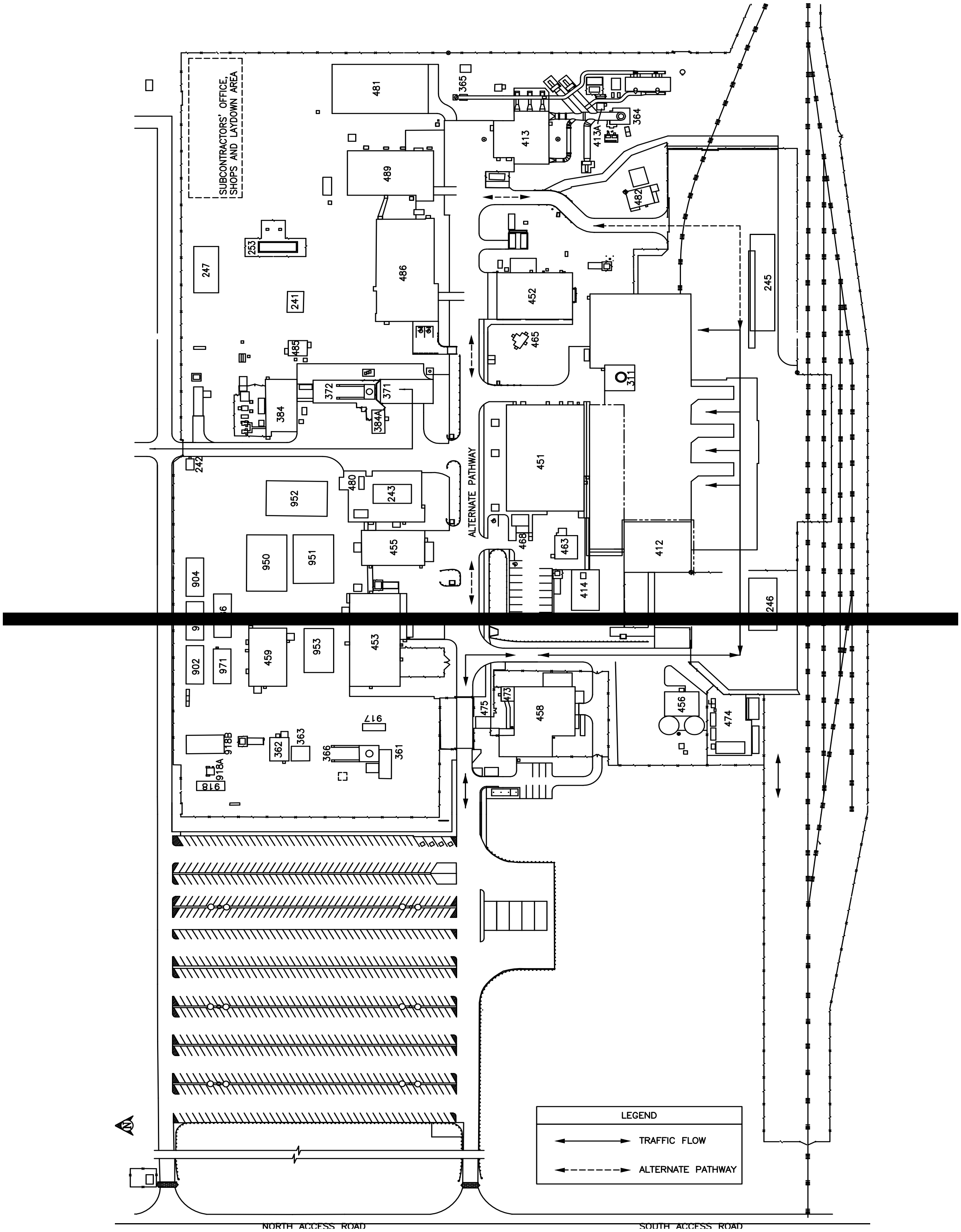
[h] ~~mph—miles per hour.~~

[i] ~~kph—kilometers per hour.~~

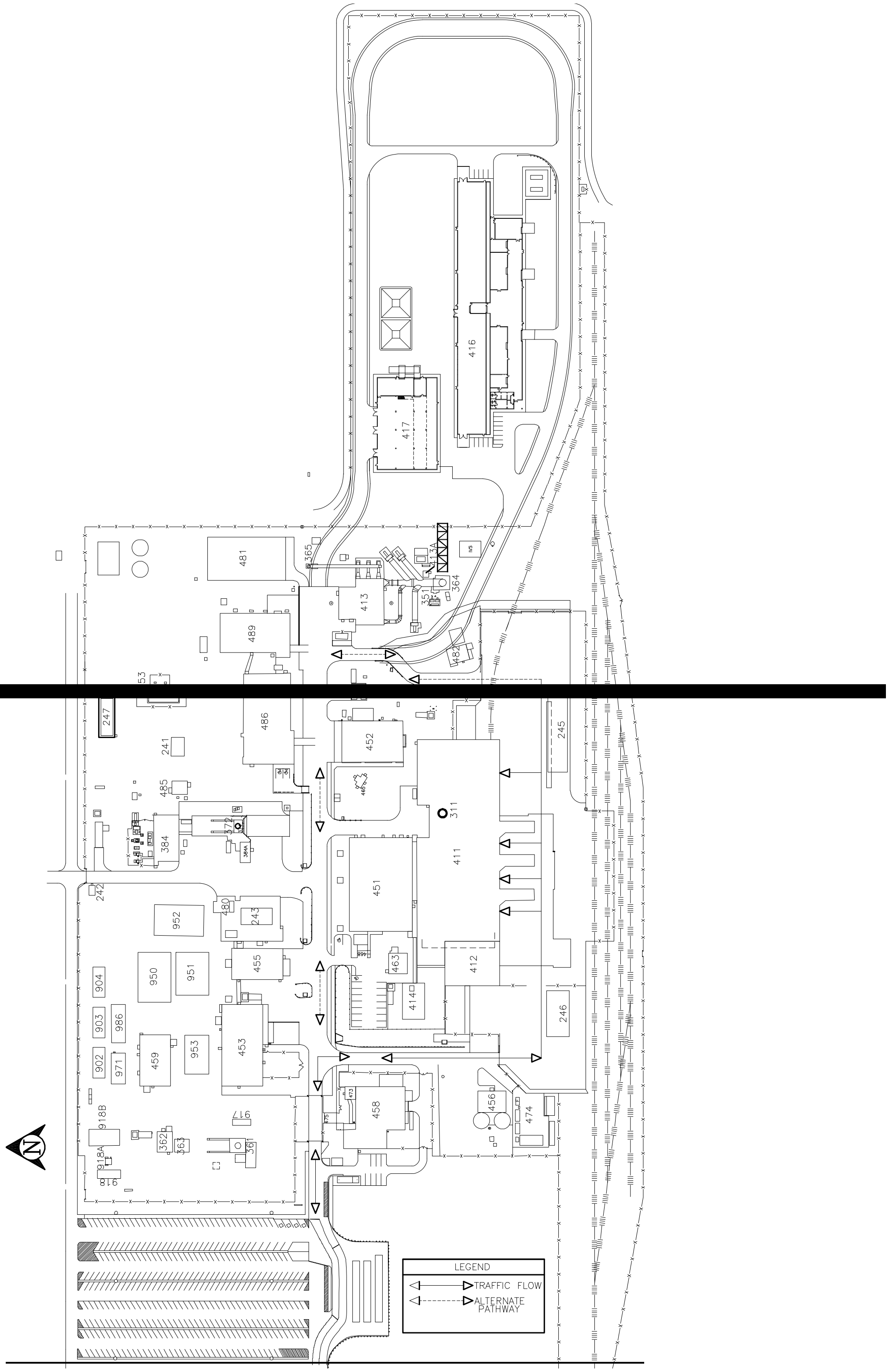
~~FIGURES~~



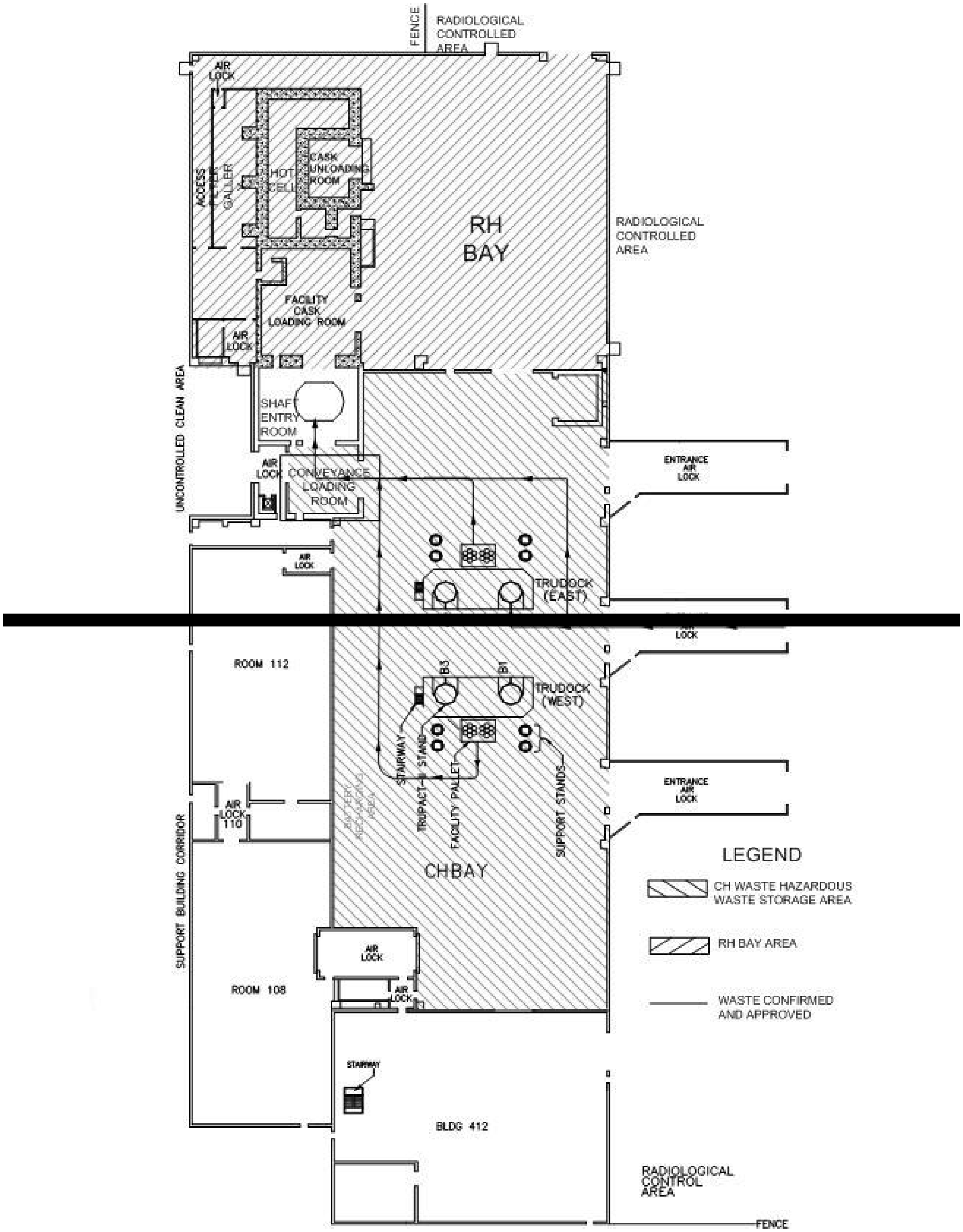
~~Figure A4-1~~
~~General Location of the WIPP Facility~~



~~Figure A4-2~~
~~WIPP Traffic Flow Diagram~~

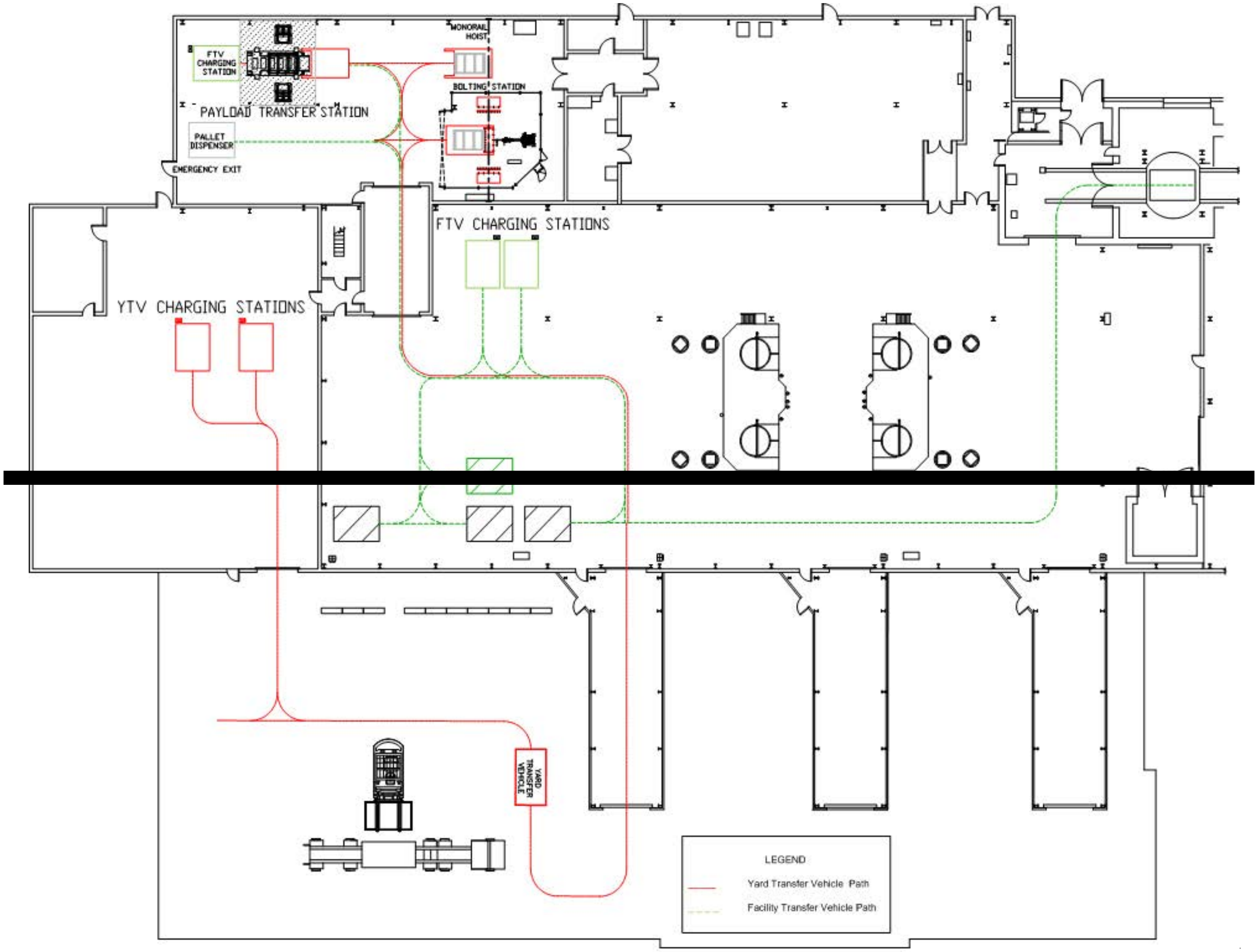


~~**Figure A4-2-NFB**~~
~~**WIPP Traffic Flow Diagram with Building 416**~~

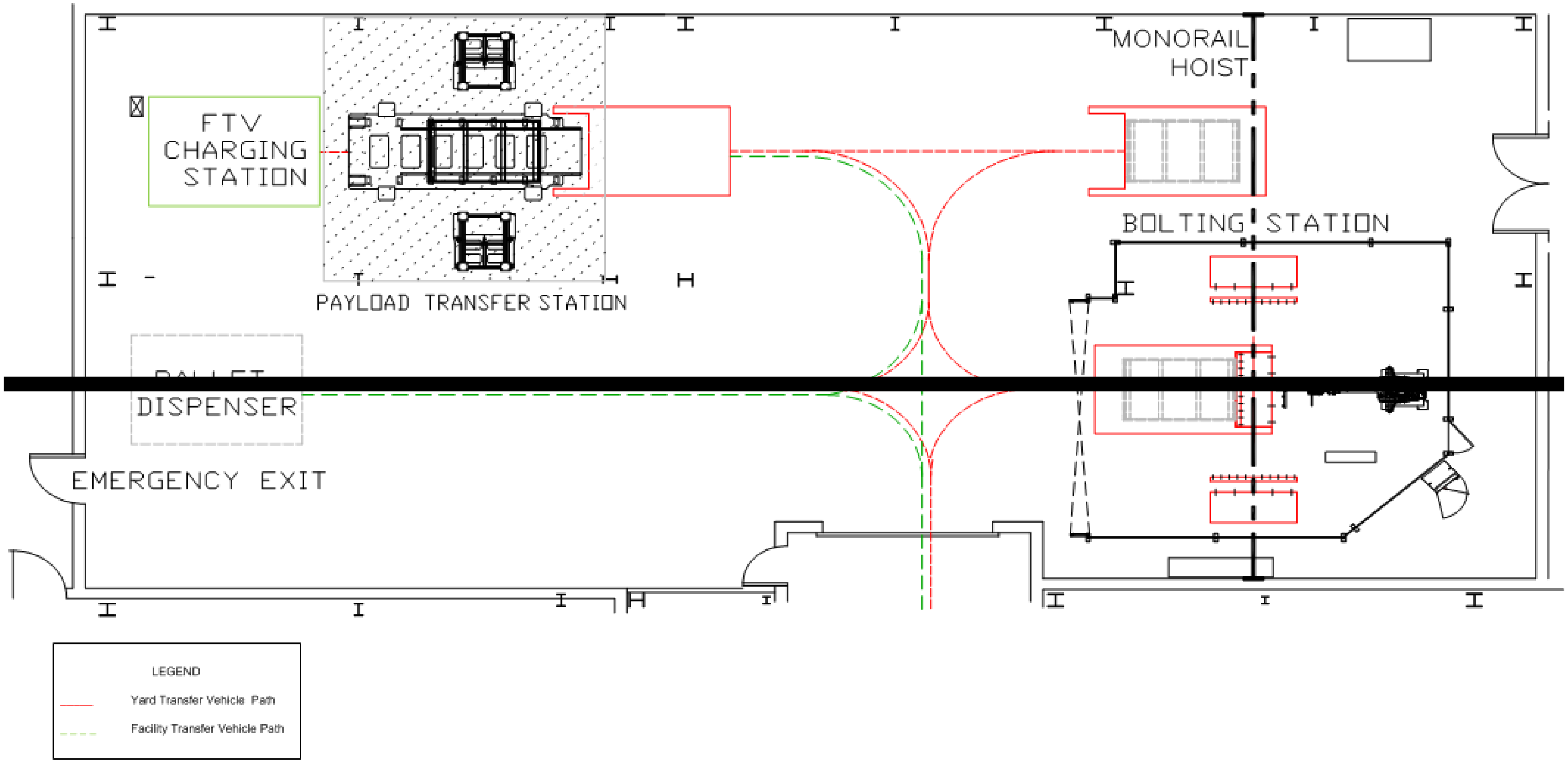


[redacted]

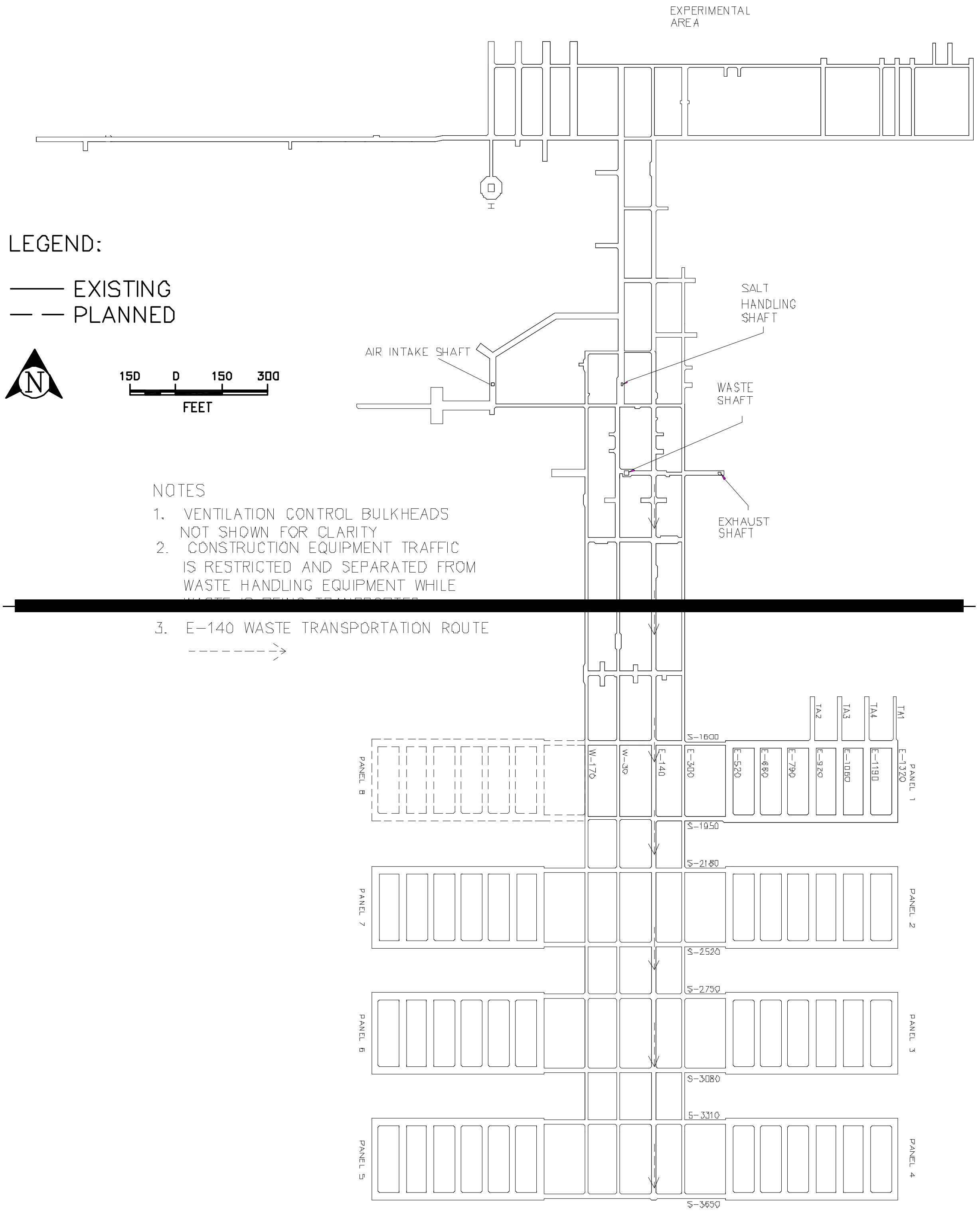
~~Figure A4-3~~
~~Waste Transport Routes in Waste Handling Building - Container Storage Unit~~



~~**Figure A4-3a**~~
~~**Typical Transport Route for TRUPACT-III and Standard Large Box 2**~~



~~**Figure A4-3b**~~
~~**Typical Transport Route for TRUPACT-III and Standard Large Box 2 in Room 108**~~



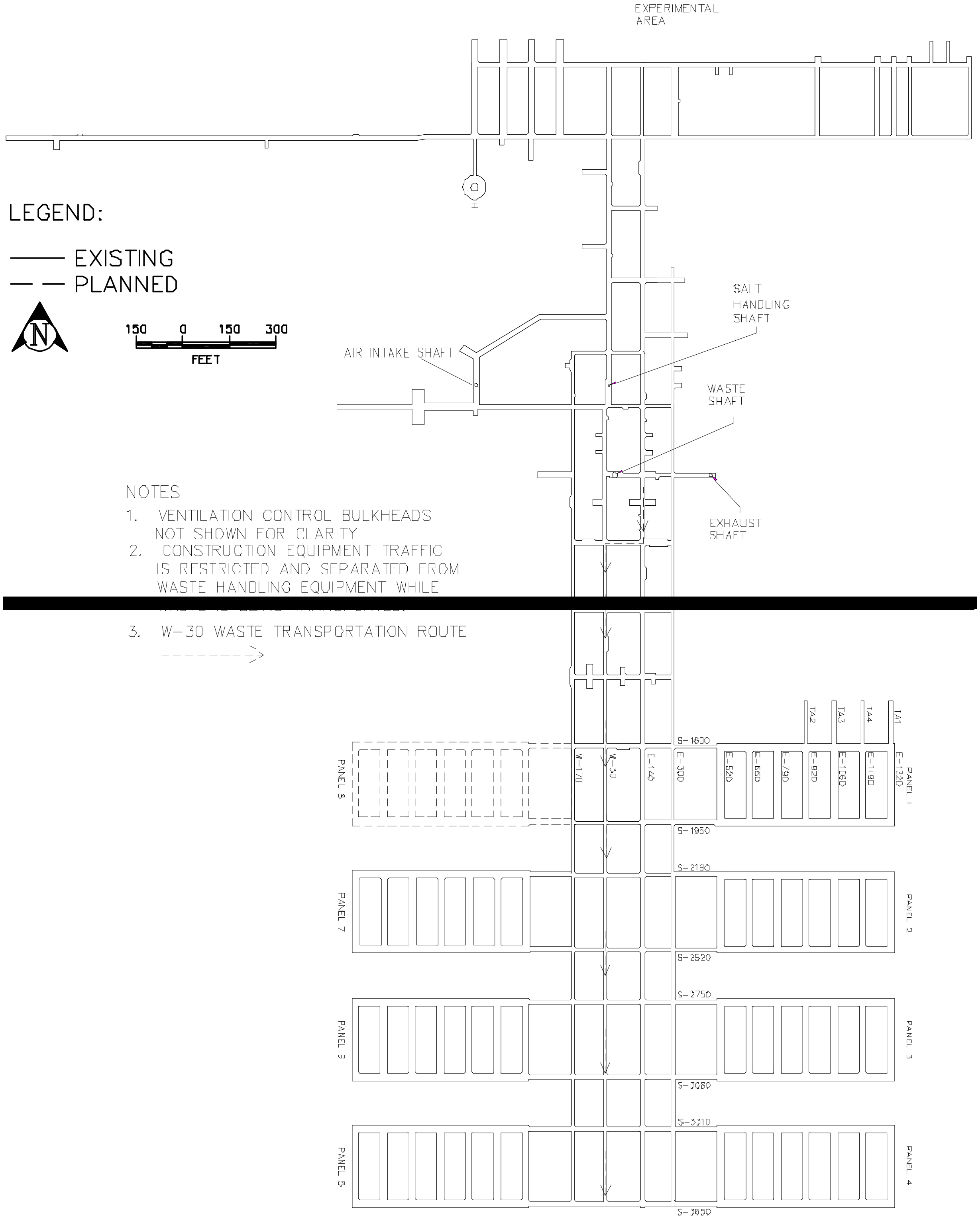
NOTES

1. VENTILATION CONTROL BULKHEADS NOT SHOWN FOR CLARITY
2. CONSTRUCTION EQUIPMENT TRAFFIC IS RESTRICTED AND SEPARATED FROM WASTE HANDLING EQUIPMENT WHILE [redacted]
3. E-140 WASTE TRANSPORTATION ROUTE

--------->

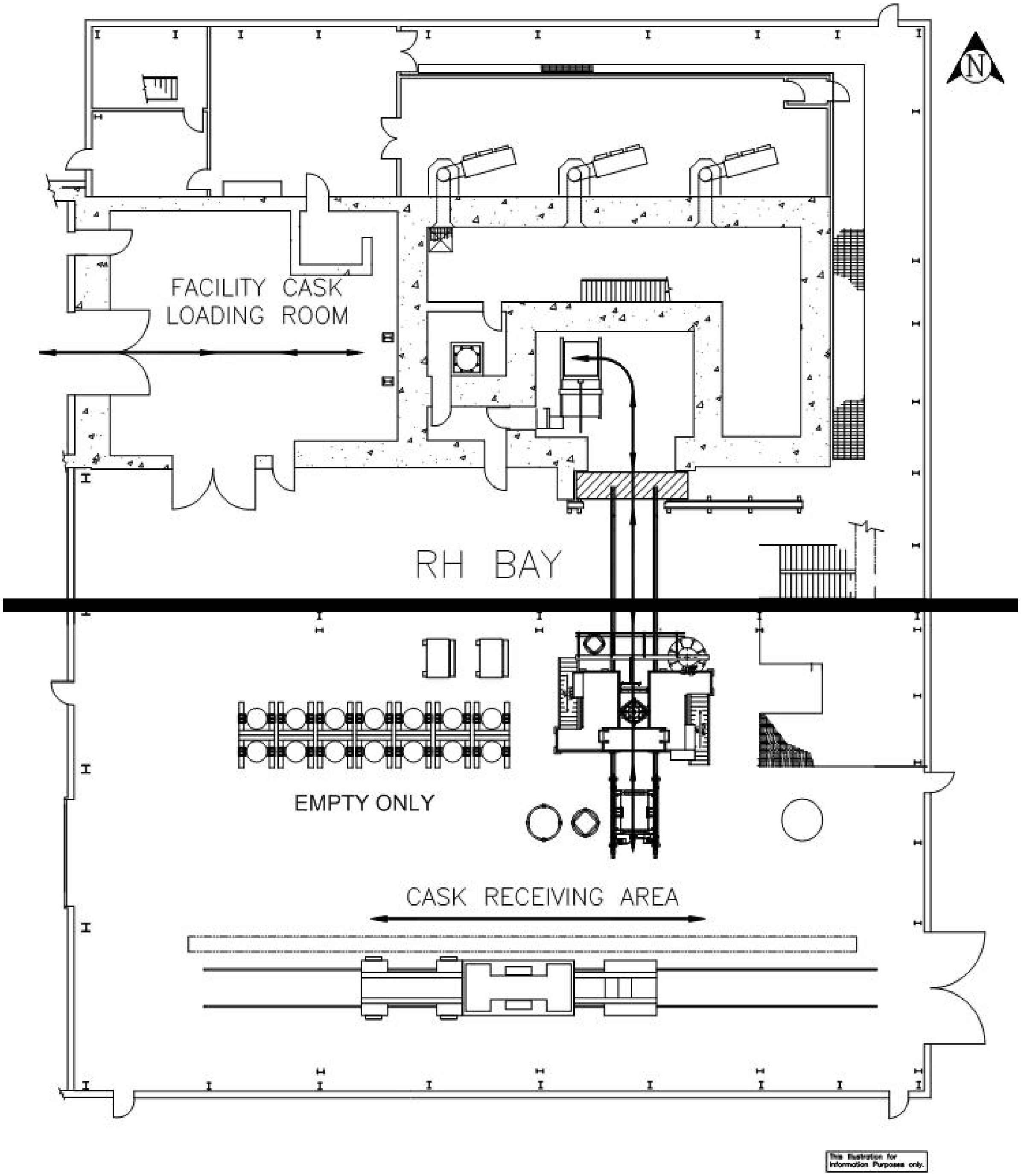
~~**Figure A4-4**~~

~~**Typical Underground Transport Route Using E-140**~~

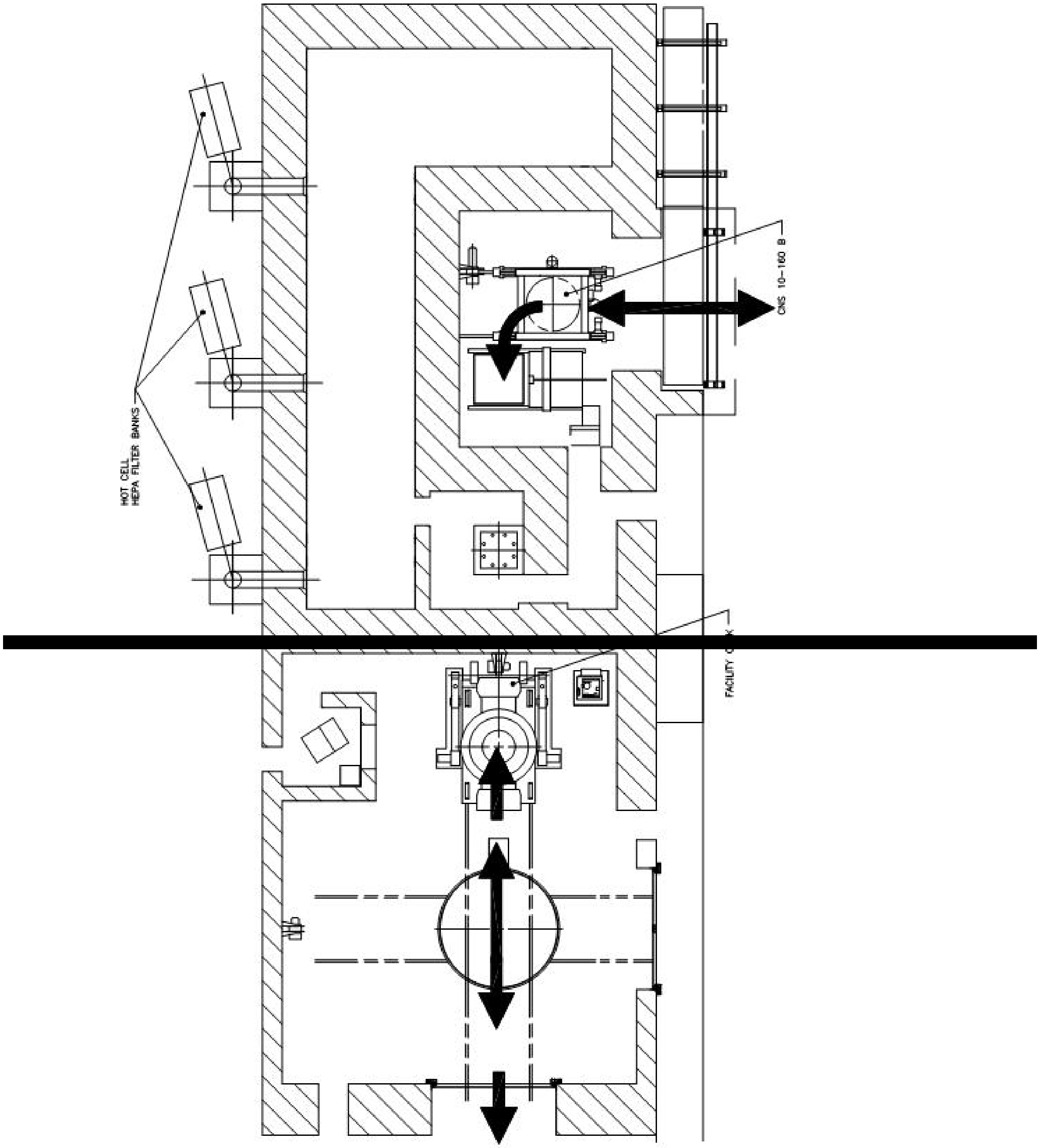


NOTES
1. VENTILATION CONTROL BULKHEADS NOT SHOWN FOR CLARITY
2. CONSTRUCTION EQUIPMENT TRAFFIC IS RESTRICTED AND SEPARATED FROM WASTE HANDLING EQUIPMENT WHILE [redacted]
3. W-30 WASTE TRANSPORTATION ROUTE
- - - - - - - ->

~~**Figure A4-4a**~~
~~**Typical Underground Transport Route Using W-30**~~



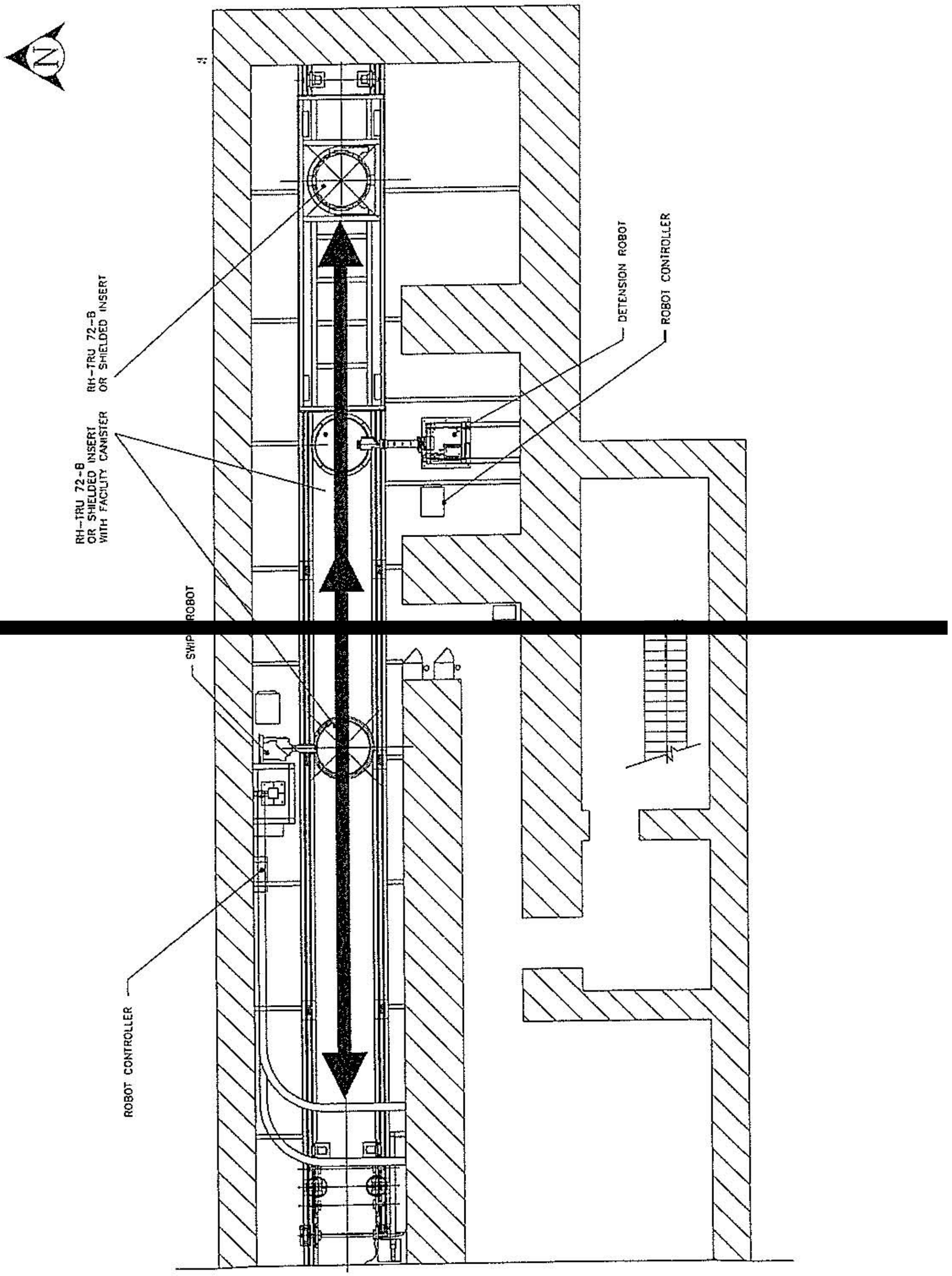
~~**Figure A4-5**~~
~~**RH Bay Waste Transport Routes**~~



This Illustration for Information Purposes only.

CASK LOADING ROOM

~~Figure A4-6~~
~~RH Bay Cask Loading Room Waste Transport Route~~



~~**Figure A4-7**~~
~~**RH Bay Canister Transfer Cell Waste Transport Route**~~

ATTACHMENT B

(RESERVED FOR PERMIT ATTACHMENT B, HAZARDOUS WASTE PERMIT APPLICATION PART A)

ATTACHMENT C

WASTE ANALYSIS PLAN

ATTACHMENT C
WASTE ANALYSIS PLAN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ATTACHMENT C

WASTE ANALYSIS PLAN

C-0 Introduction and Attachment Highlights

This waste analysis plan (**WAP**) has been prepared for management, storage, or disposal activities to be conducted at the Waste Isolation Pilot Plant (**WIPP**) facility to meet requirements set forth in 20.4.1.500 New Mexico Administrative Code (**NMAC**) (incorporating Title 40 of the Code of Federal Regulations (**CFR**) §264.13). Guidance in the most recent U.S. Environmental Protection Agency (**EPA**) manual on waste analysis has been incorporated into the preparation of this WAP (EPA, ~~1994~~2015). This WAP includes test methods and details of planned waste analysis for complying with the general waste analysis requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.13), a description of the waste shipment screening and verification process, and a description of the quality assurance (**QA**)/quality control (**QC**) program. Before the Permittees manage, store, or dispose transuranic (**TRU**) mixed waste from a generator/storage site (**site**), the Permittees shall require that site to implement the applicable requirements of this WAP.

~~TRU~~Transuranic mixed waste that may be stored or disposed at the WIPP facility are or were generated at U.S. Department of Energy (**DOE**) generator/storage sites by various specific processes and activities. Examples of the major types of operations that generate this waste include:

- Production of Nuclear Products—Production of nuclear products includes reactor operation, radionuclide separation/finishing, and weapons fabrication and manufacturing. The majority of the TRU mixed waste was generated by weapons fabrication and radionuclide separation/finishing processes. More specifically, wastes consist of residues from chemical processes, air and liquid filtration, casting, machining, cleaning, product quality sampling, analytical activities, and maintenance and refurbishment of equipment and facilities.

- Plutonium Recovery—Plutonium recovery wastes are residues from the recovery of plutonium-contaminated molds, metals, glass, plastics, rags, salts used in electrorefining, precipitates, firebrick, soot, and filters.

- Research and Development (**R&D**)—R&D projects include a variety of hot cell or glovebox activities that often simulate full-scale operations described above, producing similar TRU mixed wastes. Other types of R&D projects include metallurgical research, actinide separations, process demonstrations, and chemical and physical properties determinations.

- Decontamination and Decommissioning—Facilities and equipment that are no longer needed or usable are decontaminated and decommissioned, resulting in TRU mixed wastes consisting of scrap materials, cleaning agents, tools, piping, filters, Plexiglas™, gloveboxes, concrete rubble, asphalt, cinder blocks, and other building materials. These materials are expected to be the largest category by volume of TRU mixed waste to be generated in the future.

~~TRU~~ Transuranic mixed waste contains both TRU radioactive and hazardous components, as defined in Permit Part 1, Section 1.5.7. It is designated and separately packaged as either contact-handled (**CH**) waste or remote-handled (**RH**) waste, based on the radiological dose rate at the surface of the waste container.

The hazardous components of the TRU mixed waste to be managed at the WIPP facility are designated in Table C-5. Some of the waste may also be identified by unique state hazardous waste codes or numbers. These wastes are acceptable at the WIPP facility as long as the Treatment, Storage, and Disposal Facility Waste Acceptance Criteria (**TSDF-WAC**) in Permit Part 2 are met. This WAP describes the measures that will be taken to ensure that the TRU mixed wastes received at the WIPP facility are within the scope of Table C-5 as established by 20.4.1.500 NMAC (incorporating 40 CFR ~~§~~Part 264), and that they comply with unit-specific requirements of 20.4.1.500 NMAC (incorporating 40 CFR Part 264, Subpart X~~§264.600)~~, Miscellaneous Units).

~~Some TRU mixed waste is retrievably stored at the DOE generator/storage sites. Additional TRU mixed waste will be generated and packaged into containers at these generator/storage sites in the future. TRU mixed waste will be retrieved from storage areas at a DOE generator/storage site.~~ Retrievably stored waste is defined as TRU mixed waste generated after 1970 and before the New Mexico Environment Department (**NMED**) notifies the Permittees, by approval of the final audit report, that the characterization requirements of the WAP at a generator/storage site have been implemented. Newly generated waste is defined as TRU mixed waste generated after NMED approves the final audit report for a generator/storage site. Acceptable knowledge (**AK**) information is assembled for both retrievably stored and newly generated waste. Waste characterization of retrievably stored TRU mixed waste ~~will be~~is performed on an ongoing basis, as the waste is retrieved. Waste characterization of newly generated TRU mixed waste is typically performed as it is generated, although some characterization occurs post-generation.

Waste characterization is defined in Permit Part 1 as the activities performed by the waste generator to satisfy the general waste analysis requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.13(a)) before waste containers have been certified for disposal at the WIPP facility. The characterization process for WIPP waste is presented in Figure C-2. Generator/storage site waste characterization programs are first audited by DOE, with NMED approving the final audit report. After this, generator/storage sites determine whether AK alone is sufficient for characterization, or whether radiography or visual examination (**VE**) in conjunction with AK is necessary to adequately characterize wastes. If an AK Sufficiency Determination is sought, information is provided to the Permittees for their review and DOE's provisional approval.~~;~~ An NMED determination of adequacy of the AK information is required before final approval by the DOE. If the radiography or VE route is chosen, sites proceed to perform radiography or VE in conjunction with AK and in accordance with this WAP. Once an AK Sufficiency Determination is obtained, or when required radiography or VE data are obtained, sites ~~would~~ then prepare and submit the Waste Stream Profile Form (**WSPF**) for the DOE's approval. Once the WSPF is approved, a site may ship waste to the WIPP facility. The Permittees will perform waste confirmation prior to shipment of the waste from the generator/storage site to the WIPP facility pursuant to Permit Attachment C7, by performing radiography or visual examination of a representative subpopulation of certified waste containers, to ensure that the wastes meet the applicable requirements of the TSDF-WAC.

C-0a Waste Characterization

Characterization requirements for individual containers of TRU mixed waste are specified on a waste stream basis. A waste stream is defined as waste materials that have common physical form, that contain similar hazardous constituents, and that are generated from a single process or activity. Waste streams are ~~grouped by~~assigned to Waste Matrix Code Groups related to the physical and chemical properties of the waste. Generator/storage sites shall use the characterization techniques described in this WAP to assign appropriate Waste Matrix Code Groups to waste streams for WIPP disposal. The Waste Matrix Code Groups are solidified inorganics, solidified organics, salt waste, soils, lead/cadmium metal, inorganic nonmetal waste, combustible waste, graphite, filters, heterogeneous debris waste, and uncategorized metal. Waste Matrix Code Groups can be grouped into three Summary Category groups: Homogeneous Solids (Summary Category S3000), Soil/Gravel (Summary Category S4000), and Debris Waste (Summary Category S5000).

Transuranic~~TRU~~ mixed wastes are initially categorized into the three broad Summary Category Groups that are related to the final physical form of the wastes. This categorization is based on the Summary Category Group constituting the greatest volume of waste for a waste stream. Waste characterization requirements for these groups are specified in Section C-2 of this WAP. Each of the three groups is described below.

S3000 - Homogeneous Solids

Homogeneous solids are defined as solid materials, excluding soil, that do not meet the NMED criteria for classification as debris (20.4.1.800 NMAC (incorporating 40 CFR §268.2[g] and [h])). Included in the series of homogeneous solids are inorganic process residues, inorganic sludges, salt waste, and pyrochemical salt waste. Other waste streams are included in this Summary Category Group based on the specific waste stream types and final waste form. This Summary Category Group is expected to contain toxic metals and spent solvents. This category includes wastes that are at least 50 percent by volume homogeneous solids.

S4000 - Soils/Gravel

This Summary Category Group includes S4000 waste streams that are at least 50 percent by volume soil/gravel. This Summary Category Group is expected to contain toxic metals.

S5000 - Debris ~~Wastes~~Waste

This Summary Category Group includes heterogeneous waste that is at least 50 percent by volume materials that meet the criteria specified in 20.4.1.800 NMAC (incorporating 40 CFR §268.2 (g)). Debris means solid material exceeding a 2.36 inch (**in**~~.~~) (60 millimeter) particle size that is intended for disposal and that is:

1. a manufactured object, or
2. plant or animal matter, or
3. natural geologic material.

Particles smaller than 2.36 inches in size may be considered debris if the debris is a manufactured object and if it is not a particle of S3000 or S4000 material.

The most common hazardous constituents in the TRU mixed waste to be managed in the WIPP facility consist of the following:

Metals

Some of the TRU mixed waste to be emplaced in the WIPP facility contains metals for which 20.4.1.200 NMAC (incorporating 40 CFR §261.24), toxicity characteristics are~~were~~ established (EPA hazardous waste numbers D004 through D011). Cadmium, chromium, lead, mercury, selenium, and silver are present in discarded tools and equipment, solidified sludges, cemented laboratory liquids, and waste from decontamination and decommissioning activities. A large percentage of the waste consists of lead-lined gloveboxes, leaded rubber gloves and aprons, lead bricks and piping, lead tape, and other lead items. Lead, because of its radiation-shielding applications, is the most prevalent toxicity-characteristic metal present.

Halogenated Volatile Organic Compounds

Some of the TRU mixed waste to be emplaced in the WIPP facility contains spent halogenated volatile organic compound (**VOC**) solvents identified in 20.4.1.200 NMAC (incorporating 40 CFR, §261.31) (EPA hazardous waste numbers F001 through F005). Tetrachloroethylene; trichloroethylene; methylene chloride; carbon tetrachloride; 1,1,1-trichloroethane; and 1,1,2-trichloro-1,2,2-trifluoroethane (EPA hazardous waste numbers F001 and F002) are the most prevalent halogenated organic compounds identified in TRU mixed waste that may be managed at the WIPP facility during the Disposal Phase. These compounds are commonly used to clean metal surfaces prior to plating, polishing, or fabrication; to dissolve other compounds; or as coolants. Because they are highly volatile, only small amounts typically remain on equipment after cleaning or, in the case of treated wastewaters, in the sludges after clarification and flocculation.~~ Radiolysis may also generate halogenated volatile organic compounds.~~

Nonhalogenated Volatile Organic Compounds

Xylene, methanol, and n-butanol are the most prevalent nonhalogenated VOCs in TRU mixed waste that may be managed at the WIPP facility during the Disposal Phase. Like the halogenated VOCs, they are used as degreasers and solvents and are similarly volatile. The same analytical methods that are used for halogenated VOCs are used to detect the presence of nonhalogenated VOCs.~~ Radiolysis may also generate non-halogenated volatile organic compounds.~~

The generator/storage sites shall characterize their waste in accordance with this WAP and associated Permit Attachments, and ensure that waste proposed for storage and disposal at the WIPP facility meets the applicable requirements of the TSDF-WAC in Permit Part 2, Section 2.3.3. The generator/storage site shall assemble the ~~Acceptable Knowledge (~~AK~~)~~ information into an auditable record[1] for the waste stream as described in Permit Attachment C4. For those waste streams with an approved AK Sufficiency Determination (see below), radiography or VE per the methods described in Permit ~~Attachments~~Attachment C1 is not required.

~~All waste~~Waste characterization activities specified in this WAP and associated Permit Attachments shall be carried out at generator/storage sites in accordance with this WAP. The

---

[1] "Auditable records" mean those records which allow the Permittees to conduct a systematic assessment, analysis, and evaluation of the Permittees' compliance with the WAP and this Permit.

DOE will audit generator/storage site waste characterization programs and activities as described in Section C-3. Waste characterization activities at the generator/storage sites include the following, as discussed in Section C-3:

- Radiography, which is an x-ray technique to determine physical contents of containers
- Visual examination of opened containers as an alternative way to determine their physical contents
- Compilation of AK documentation into an auditable record

C-0b AK Sufficiency Determination

Generator/storage sites may submit a request to the Permittees for an AK Sufficiency Determination (Determination Request) to be exempt from the requirement to perform radiography or ~~visual examination (~~VE~~)~~ based on AK. The contents of the Determination Request are specified in Permit Attachment C4, Section C4-3d.

The Permittees shall evaluate the Determination Request for completeness and technical adequacy. This evaluation shall include, but not be limited to, whether the Determination Request is technically sufficient for the following:

- The Determination Request must include ~~all~~ information specified in Permit Attachment C4, Section C4-3d
- The AK Summary must identify relevant hazardous constituents, and must correctly identify ~~all~~ toxicity characteristic and listed hazardous waste numbers~~.~~
- ~~All hazardous~~Hazardous waste number assignments must be substantiated by supporting data and, if not, whether this lack of substantiation compromises the interpretation~~.~~
- Resolution of data discrepancies between different AK sources must be technically correct and documented~~.~~
- The AK Summary must include ~~all~~ the identification of waste material parameter weights by percentage of the material in the waste stream, and determinations must be technically correct~~.~~
- ~~All prohibited~~Prohibited items specified in the TSDF-WAC should be addressed, and conclusions drawn must be technically adequate and substantiated by supporting information~~.~~
- If the AK record includes process control information specified in Permit Attachment C4, Section C4-3b, the information should include procedures, waste manifests, or other documentation demonstrating that the controls were adequate and sufficient~~.~~

- The site must provide the supporting information necessary to substantiate technical conclusions within the Determination Request, and this information must be correctly interpreted~~.~~

The Permittees will review the Determination Request for technical adequacy and compliance with the requirements of the Permit, using trained and qualified individuals in accordance with standard operating procedures that shall, at a minimum, address ~~all of~~ the technical and procedural requirements listed above. The Permittees shall resolve comments with the generator/storage site.

If the DOE determines that the AK is sufficient, it shall inform the public of the Determination Request, the Permittees' evaluation of it, and the date and time of a public meeting to provide information to and solicit comments from interested members of the public regarding the Determination Request. Notice of the meeting and comment period shall be provided by the following methods:

1. Written notice to ~~all~~ individuals on the facility mailing list~~;~~
2. Public notice in area newspapers, including the Carlsbad Current-Argus, Albuquerque Journal, and Santa Fe New Mexican
3. Notice as specified in Permit Part 1, Section 1.11~~on the WIPP Home Page;~~
4. E-mail notification as specified in Permit Part 1, Section 1.11~~.~~

The DOE shall take written comment on the Determination Request for at least 30 days following the public meeting. DOE shall compile ~~all~~ such comments, including any disagreement between the DOE and commenters.

If the DOE provisionally approves the Determination Request, it may forward it along with ~~all~~ relevant information submitted with the Determination Request to NMED for an evaluation that the provisional approval made by DOE is adequate. The DOE shall also provide to NMED, as a separate appendix to the Determination Request, the compilation of ~~all~~ comments and DOE's response to each comment. After submitting a Determination Request to the NMED, the Permittees will post a link to the transmittal letter to the NMED as specified in Permit Part 1, Section 1.11. ~~on the WIPP Home Page and inform those on the e-mail notification list as specified in Permit Section 1.11.~~ The NMED will evaluate the Determination Request, determine the adequacy of the Determination Request, and notify the DOE as to whether or not it concurs with its provisional approval. Based on the results of NMED's evaluation, the Permittees will notify the generator/storage sites whether the AK information is sufficient and the Determination Request is approved. The DOE will not approve a Determination Request that NMED has determined to be inadequate unless the generator/storage site resolves the inadequacies and provides the resolution to NMED for evaluation of adequacy. Should the inadequacies not be resolved to NMED's satisfaction, the DOE shall not submit a Determination Request for the same waste stream at a later date. The DOE shall not submit a Determination Request if a previous Determination Request is pending evaluation by the NMED.

In the event the DOE disagrees, in whole or in part, with an evaluation performed by the NMED resulting in a determination by the NMED that the DOE's provisional approval for a particular waste stream is inadequate, DOE may seek dispute resolution. The dispute resolution process is specified in Permit Part 1, Section 1.16. The Secretary’s final decision under Permit Part 1, Section 1.16.4 shall constitute a final agency action.

By July 1 of each year, the Permittees shall submit to the NMED a list of waste streams that the Permittees may submit for an AK Sufficiency Determination during the upcoming federal fiscal year, only if there are actual plans to seek an AK Sufficiency Determination; otherwise no action is required. The Permittees will post a link to the transmittal letter to the NMED and announce a public meeting to discuss the list with interested members of the public on the WIPP Home Page and inform those on the e-mail notification list as specified in Permit Section 1.11.

If a generator/storage site does not submit a Determination Request, or if the DOE does not approve a Determination Request, or if the NMED finds that the DOE’s provisional approval of a Determination Request is inadequate, the generator/storage site shall perform radiography or VE on 100% of the containers in a waste stream.

If a generator/storage site submits a Determination Request, the DOE provisionally approves the Determination Request and the NMED finds that the DOE’s provisional approval is adequate, neither radiography nor VE of the waste stream is required.

C-0c Waste Stream Profile Form Completion

After a complete AK record has been compiled and either a Determination Request has been approved by the DOE or the generator/storage site has completed the applicable testing requirements specified in Permit Attachments C1, the generator/storage site will complete a ~~Waste Stream Profile Form (~~WSPF~~)~~ and a Characterization Information Summary (**CIS**). The requirements for the completion of a WSPF and a CIS are specified in Permit Attachment C3, Sections C3-6b(1) and C3-6b(2) respectively.

The WSPF and the CIS for the waste stream resulting from waste characterization activities shall be transmitted to the Permittees, who shall review them for completeness, and screen them for acceptance prior to loading any TRU mixed waste into the ~~Contact-Handled~~CH or ~~Remote-Handled~~RH Packaging at the generator facility, as described in Section C-4. The review and approval process will ensure that the submitted waste analysis information is sufficient to meet the Data Quality Objectives (**DQOs**) for AK in Section C-4a(1) and allow the Permittees to demonstrate compliance with the requirements of this WAP. Only TRU mixed waste and TRU waste that has been characterized in accordance with this WAP and that meets the TSDF-WAC specified in this Permit will be accepted at the WIPP facility for disposal in a permitted Underground Hazardous Waste Disposal Unit (**HWDU**). The DOE will approve and provide NMED with copies of the approved WSPF and accompanying CIS prior to waste stream shipment. Upon notification of the DOE’s approval of the WSPF, the generator/storage site may be authorized to ship waste to the WIPP facility.

In the event the Permittees request detailed information on a waste stream, the site will provide a Waste Stream Characterization Package (Permit Attachment C3, Section C3-6b(3~~2~~)). For each waste stream, this package will include the WSPF, the CIS, and the complete AK summary. The Waste Stream Characterization Package will also include specific Batch Data Reports (**BDRs**) and raw data associated with waste container characterization as requested by the Permittees.

C-0d Waste Confirmation

The Permittees will perform waste confirmation on a representative subpopulation of each waste stream shipment after certification and prior to shipment pursuant to Permit Attachment C7. The Permittees will use radiography, review of radiography audio/video recordings, VE, or review of VE records (e.g., VE data sheets or packaging logs) to examine at least ~~7~~seven percent of each waste stream shipment to confirm that the waste does not contain ignitable, corrosive, or reactive waste. Waste confirmation will be performed by the Permittees prior to shipment of the waste from the generator/storage site to the WIPP facility.

C-1 Identification of TRU Mixed Waste to be Managed at the WIPP Facility

C-1a Waste Stream Identification

~~TRU~~Transuranic mixed waste destined for disposal at the WIPP facility will be characterized on a waste stream basis. Generator/storage sites will delineate waste streams using ~~acceptable knowledge~~AK. Required ~~acceptable knowledge~~AK is specified in Section C-3a and Permit Attachment C4.

C-1b Waste Summary Category Groups and Hazardous Waste Accepted at the WIPP Facility

Once a waste stream has been delineated, generator/storage sites will assign a Waste Matrix Code to the waste stream based on the physical form of the waste. Waste streams are then assigned to one of three broad Summary Category Groups; S3000-Homogeneous Solids, S4000-Soils/Gravel, and S5000-Debris Wastes. These Summary Category Groups are used to determine further characterization requirements.

The Permittees will only allow generators to ship those TRU mixed waste streams with EPA hazardous waste numbers listed in Table C-5. Some of the waste may also be identified by unique state hazardous waste codes or numbers. These wastes are acceptable at the WIPP facility as long as the TSDF-WAC are met. The Permittees will require sites to perform characterization of ~~all~~ waste streams as required by this WAP. If during the characterization process, new EPA hazardous waste numbers are identified, those wastes will be prohibited for disposal at the WIPP facility until a permit modification has been submitted to and approved by NMED for these new EPA hazardous waste numbers. Similar waste streams at other generator/storage sites will be examined by the Permittees to ensure that the newly identified EPA hazardous waste numbers do not apply to those similar waste streams. If the other waste streams also require new EPA hazardous waste numbers, shipment of these similar waste streams will also be prohibited for disposal at the WIPP facility until a permit modification has been submitted to and approved by the NMED.

C-1c Waste Prohibited at the WIPP Facility

The following TRU mixed ~~waste~~ wastes are prohibited at the WIPP facility:

- liquid waste is not acceptable at the WIPP facility. Liquid in the quantities delineated below is acceptable:
  - Observable liquid shall be no more than ~~1~~one percent by volume of the outermost container at the time of radiography or visual examination

  - Internal containers with more than 60 milliliters or ~~3~~three percent by volume observable liquid, whichever is greater, are prohibited

  - Containers with Hazardous Waste Number U134 assigned shall have no observable liquid

  - Overpacking the outermost container that was examined during radiography or visual examination or redistributing untreated liquid within the container shall not be used to meet the liquid volume limits

- non-radionuclide pyrophoric materials, such as elemental potassium

- hazardous wastes not occurring as co-contaminants with TRU mixed wastes (non-mixed hazardous wastes)

- wastes incompatible with backfill, seal and panel closures materials, container and packaging materials, shipping container materials, or other wastes

- wastes containing explosives or compressed gases

- wastes with polychlorinated biphenyls (**PCBs**) not authorized under an EPA PCB waste disposal authorization

- wastes exhibiting the characteristic of ignitability, corrosivity, or reactivity (EPA Hazardous Waste Numbers of D001, D002, or D003)

- waste that has ever been managed as high-level waste and waste from tanks specified in Table C-4, unless specifically approved through a Class 3 permit modification

- any waste container from a waste stream (or waste stream lot) which has not undergone either radiographic or visual examination of a statistically representative subpopulation of the waste stream in each shipment, pursuant to Permit Attachment C7

- any waste container from a waste stream which has not been preceded by an appropriate, certified WSPF (see Section C-1d)

Before accepting a container holding TRU mixed waste, the Permittees will perform waste confirmation activities pursuant to Permit Attachment C7 on each waste stream shipment to confirm that the waste does not contain ignitable, corrosive, or reactive waste and the assigned EPA hazardous waste numbers are allowed for storage and disposal by this Permit. Waste confirmation activities will be performed on at least ~~7~~seven percent of each waste stream shipped, equating to examination of at least one of fourteen containers in each waste stream shipment. If a waste stream shipment contains fewer than fourteen containers, one container will be examined to satisfy waste confirmation requirements. Section C-4 and Permit Attachment C7 include descriptions of the waste confirmation processes~~ that~~ the Permittees~~ will~~ conduct prior to receiving a shipment at the WIPP facility.

Containers are vented through filters, allowing any gases that are generated by radiolytic and microbial processes within a waste container to escape, thereby preventing over pressurization or development of conditions within the container that would lead to the development of ignitable, corrosive, reactive, or other characteristic wastes.

To ensure the integrity of the WIPP facility, waste streams identified to contain incompatible materials or materials incompatible with waste containers cannot be shipped to the WIPP facility unless they are treated to remove the incompatibility. Only those waste streams that are compatible or have been treated to remove incompatibilities will be shipped to the WIPP facility.

C-1d Control of Waste Acceptance

Every waste stream shipped to the WIPP facility shall be preceded by a WSPF (Figure C-1) and a CIS. The required WSPF information and the CIS elements are found in Permit Attachment C3, Section C3-6b(1) and Section C3-6b(2).

Generator/storage sites will provide the WSPF to the Permittees for each waste stream prior to its acceptance for disposal at the WIPP facility. The WSPF and the CIS will be transmitted to the Permittees for each waste stream from a generator/storage site. If continued waste characterization reveals discrepancies that identify different EPA hazardous waste numbers or indicates that the waste belongs to a different waste stream, the waste will be redefined to a separate waste stream and a new WSPF submitted. Generator/storage sites will develop criteria to determine the specific circumstances under which a WSPF is revised versus when a new WSPF is required. These criteria will be evaluated by DOE during site audits (Attachment C6).

The Permittees are responsible for the review of WSPFs and CISs to verify compliance with the restrictions on TRU mixed wastes destined for disposal at the WIPP facility. ~~for WIPP disposal.~~ The DOE will approve and submit completed WSPFs to the NMED prior to waste stream shipment. The Permittees will be responsible for the review of shipping records (Section C-5) to ensure that each waste container has been prepared and characterized in accordance with applicable provisions of this WAP. Waste characterization data shall ensure the absence of prohibited items specified in Section C-1c.

Any time the Permittees request additional information concerning a waste stream, the generator/storage site will provide a Waste Stream Characterization Package (Permit Attachment C3, Section C3-6b(3~~2~~)). The option for the Permittees to request additional information ensures that the waste being offered for disposal is adequately characterized and accurately described on the WSPF.

C-1e Waste Generating Processes at the WIPP Facility

Waste generated as a result of the waste containers handling and processing activities at the WIPP facility is termed “derived” waste. Because derived wastes can contain only those RCRA-regulated materials present in the waste from which they were derived, no additional characterization of the derived waste is required for disposal purposes. In other words, the generator/storage site’s characterization data and knowledge of the processes at the WIPP facility will be used to identify and characterize hazardous waste and hazardous constituents in derived waste. The management of derived waste is addressed in Permit Attachment A1.

C-2 Waste Characterization Program Requirements and Waste Characterization Parameters

The Permittees shall require the sites to develop the procedure(s) which specify their programmatic waste characterization requirements. The DOE will evaluate the procedures during audits conducted under the Audit and Surveillance Program (Section C-5a(3)) and may also evaluate the procedures as part of the review and approval of the WSPF. Sites must notify the Permittees and obtain DOE approval prior to making data-affecting modifications to procedures (Permit Attachment C3, Section C3-9). Program procedures shall address the following minimum elements:

- Waste characterization and certification procedures for retrievably stored and newly generated wastes to be sent to the WIPP facility
- Methods used to ensure prohibited items are documented and managed~~.~~; ~~These~~ these will include procedures for performing radiography, VE, or treatment, if these methods are used to ensure prohibited items are not present in the waste prior to shipment of the waste to the WIPP facility~~.~~
- Identify the organization(s) responsible for compliance with waste characterization and certification procedures~~.~~
- Identify the oversight procedures and frequency of actions to verify compliance with waste characterization and certification procedures~~.~~
- Develop training specific to waste characterization and certification procedures~~.~~
- Ensure that personnel may stop work if noncompliance with waste characterization or certification procedures is identified~~.~~
- Develop a nonconformance process that complies with the requirements in Permit Attachment C3 of the WAP to document and establish corrective action~~s~~.
- As part of the corrective action process, assess the potential time frame of the noncompliance, the potentially affected waste population(s), and the reassessment and recertification of those wastes~~.~~
- A listing of ~~all~~ approved EPA hazardous waste numbers which are acceptable at the WIPP facility are included in Table C-5~~.~~

For those waste streams or containers that are not amenable to radiography (e.g., RH TRU mixed waste, direct loaded ten-drum overpacks (**TDOPs**)) for waste confirmation by the Permittees pursuant to Permit Attachment C7, generator/storage site VE data may be used for waste acceptance. In those cases, the Permittees will review the generator/storage site VE procedures to ensure that data sufficient for the Permittees' waste acceptance activities pursuant to Permit Attachment C7 will be obtained and the procedures meet the minimum requirements for visual examination specified in Permit Attachment C1, Section C1-2~~1~~.

The following waste characterization parameters shall be obtained from the generator/storage sites:

- Determination whether TRU mixed waste streams comply with the applicable provisions of the TSDF-WAC
- Determination whether TRU mixed wastes exhibit a hazardous characteristic (20.4.1.200 NMAC, incorporating 40 CFR ~~§~~Part 261, Subpart C)
- Determination whether TRU mixed wastes are listed (20.4.1.200 NMAC, incorporating 40 CFR ~~§~~Part 261, Subpart D)
- Estimation of waste material parameter weights

Table C-1 provides the parameters of interest for the various constituent groupings and testing methodologies. The following sections provide a description of the acceptable methods to evaluate these parameters for each waste Summary Category Group.

C-3 Generator Waste Characterization Methods

The characterization techniques used by generator/storage sites includes ~~acceptable knowledge~~AK and may also include, as necessary, radiography and ~~visual examination~~VE. ~~All characterization~~ Characterization activities are performed in accordance with the WAP. Table C-1 provides a summary of the characterization requirements for TRU mixed waste.

C-3a Acceptable Knowledge

Acceptable knowledge ~~(**AK**)~~ is used in TRU mixed waste characterization activities in ~~five~~ the following ways:

- To delineate TRU mixed waste streams
- To assess whether TRU mixed wastes comply with the TSDF-WAC
- To assess whether TRU mixed wastes exhibit a hazardous characteristic (20.4.1.200 NMAC, incorporating 40 CFR ~~§~~Part 261, Subpart C)
- To assess whether TRU mixed wastes are listed (20.4.1.200 NMAC, incorporating 40 CFR ~~§~~Part 261, Subpart D)
- To estimate waste material parameter weights

Acceptable knowledge is discussed in detail in Permit Attachment C4, which outlines the minimum set of requirements and DQOs which shall be met by the generator/storage sites in order to use ~~acceptable knowledge~~AK. In addition, Section C-5a(3) of this permit attachment describes the assessment of ~~acceptable knowledge~~AK through the Audit and Surveillance Program.

C-3b Radiography and Visual Examination

Radiography and ~~visual examination (**VE**)~~VE are nondestructive qualitative and quantitative techniques used to identify and verify waste container contents as specified in Permit Attachment C1. Generator/storage sites shall perform radiography or VE of 100 percent of CH

TRU mixed waste containers in waste streams except for those waste streams for which the DOE approves a Determination Request. No RH TRU mixed waste will be shipped to the WIPP facility for storage or disposal without documentation of radiography or VE of 100 percent of the containers as specified in Permit Attachment C1. Radiography and/or VE will be used, when necessary, to examine a waste container to verify the physical form of the waste matches its waste stream description as determined by AK. These techniques can detect observable liquid in excess of TSDF-WAC limits and containerized gases, which are prohibited from disposal at the WIPP facility~~for WIPP disposal~~. The prohibition of liquid in excess of TSDF-WAC limits and containerized gases prevents the shipment of corrosive, ignitable, or reactive wastes. Radiography and/or VE are also able to verify that the physical form of the waste matches its waste stream description (i.e. Homogeneous Solids, Soil/Gravel, or Debris Waste [including uncategorized metals]). If the physical form does not match the waste stream description, the waste will be designated as another waste stream and assigned the preliminary EPA hazardous waste numbers associated with that new waste stream assignment. That is, if radiography and/or VE indicates that the waste does not match the waste stream description arrived at by ~~acceptable knowledge~~AK characterization, a non-conformance report (**NCR**) will be completed and the inconsistency will be resolved as specified in Permit Attachment C4, and the NCR will be dispositioned as specified in Permit Attachment C3, Section C3-7. The proper waste stream assignment will be determined (including preparation of a new WSPF), the correct hazardous waste numbers will be assigned, and the resolution will be documented. Refer to Permit Attachment C4 for a discussion of ~~acceptable knowledge~~AK and its verification process.

For generator/storage sites that use VE, the detection of any liquid in non-transparent internal containers, detected from shaking the internal container, will be handled by assuming that the internal container is filled with liquid and adding this volume to the total liquid in the container being characterized using VE. The container being characterized using VE would be rejected and/or repackaged to exclude the internal container if it is over the TSDF-WAC limits. When radiography is used, or ~~visual examination~~VE of transparent containers is performed, if any liquid in internal containers is detected, the volume of liquid shall be added to the total for the container being characterized using radiography or VE. Radiography, or the equivalent, will be used as necessary on the existing/stored waste containers to verify the physical characteristics of the TRU mixed waste correspond with its waste stream identification/waste stream Waste Matrix Code and to identify prohibited items. Radiographic examination protocols and QA/QC methods are provided in Permit Attachment C1. Radiography and VE shall be subject to the Audit and Surveillance Program (Permit Attachment C6).

C-4 Data Verification and Quality Assurance

The Permittees will ensure that applicable waste characterization processes performed by generator/storage sites sending TRU mixed waste to the WIPP facility for disposal meets WAP requirements through data validation, usability and reporting controls. Verification occurs at three levels: 1) the data generation level, 2) the project level, and 3) the Permittee level. The validation and verification process and requirements at each level are described in Permit Attachment C3, Section C3-4. The validation and verification process at the Permittee level~~Level~~ is also described in Section C-5.

C-4a Data Generation and Project Level Verification Requirements

C-4a(1) Data Quality Objectives

The waste characterization data obtained through WAP implementation will be used to ensure that the Permittees meet regulatory requirements with regard to both regulatory compliance and to ensure that ~~all~~ TRU mixed wastes are properly managed during the Disposal Phase. To satisfy the RCRA regulatory compliance requirements, the following DQOs are established by this WAP:

- Acceptable Knowledge
    - To delineate TRU mixed waste streams~~.~~
    - To assess whether TRU mixed wastes comply with the applicable requirements of the TSDF-WAC~~.~~
    - To assess whether TRU mixed wastes exhibit a hazardous characteristic (20.4.1.200 NMAC, incorporating 40 CFR ~~§~~Part 261, Subpart C)~~.~~
    - To assess whether TRU mixed wastes are listed (20.4.1.200 NMAC, incorporating 40 CFR ~~§~~Part 261, Subpart D)~~.~~
    - To estimate waste material parameter weights~~.~~
- Radiography and VE
    - To verify the TRU mixed waste streams contain no prohibited items and to verify that physical form of the waste matches the waste stream description as determined by AK~~.~~

Reconciliation of these DQOs by the Generator/Storage Site Project Manager, as applicable, is addressed in Permit Attachment C3. Reconciliation requires determining whether sufficient type, quality, and quantity of data have been collected to ensure the DQOs cited above can be achieved.

C-4a(2) Quality Assurance Objectives

The generator/storage sites shall demonstrate compliance with each Quality Assurance Objective (**QAO**) associated with the characterization methods as presented in Permit Attachment C3. Generator/Storage Site Project Managers are further required to perform a reconciliation of the data with the DQOs established in this WAP. The Generator/Storage Site Project Manager shall conclude that ~~all of~~ the DQOs have been met for the characterization of the waste stream prior to submitting a WSPF to DOE for approval (Permit Attachment C3). The following QAO elements shall be considered for each technique, as a minimum:

- Precision
    - Precision is a measure of the mutual agreement among multiple measurements~~.~~

- Accuracy
  - Accuracy is the degree of agreement between a measurement result and the true or known value~~.~~
- Completeness
  - Completeness is a measure of the amount of valid data obtained from a method compared to the total amount of data obtained that is expressed as a percentage~~.~~
- Comparability
  - Comparability is the degree to which one data set can be compared to another~~.~~
- Representativeness
  - Representativeness expresses the degree to which data represent characteristics of a population~~.~~

A more detailed discussion of the QAOs can be found in Permit Attachment C3, which describes the QAOs associated with each test method.

C-4a(3) Data Generation

~~BDRs~~Batch data reports, in a format approved by DOE, will be used by each generator/storage site for reporting waste characterization data. This format will be included in the generator/storage site Quality Assurance Project Plan (**QAPjP**), controlled electronic databases, or procedures referenced in the QAPjP (Permit Attachment C5) and will include ~~all of~~ the elements required by this WAP for ~~BDR~~BDRs (Permit Attachment C3).

The DOE shall perform audits of the generator/storage site waste characterization programs, as implemented by the generator/storage site QAPjP, to verify compliance with the WAP and the DQOs in this WAP (See Permit Attachment C6 for a discussion of the content of the audit program). The primary functions of these audits are to review generator/storage sites' adherence to the requirements of this WAP and ensure adherence to the WAP characterization program. The DOE shall provide the results of each audit to NMED. If audit results indicate that a generator/storage site is not in compliance with the requirements of this WAP, the DOE will take appropriate action as specified in Permit Attachment C6.

C-4a(4) Data Verification

~~BDRs~~Batch data reports will document the testing results from the required characterization activities, and document required QA/QC activities. Data validation and verification at both the data-generation level and the project level will be performed as required by this Permit before the required data are transmitted to the Permittees (Permit Attachment C3). The NMED may request, through the Permittees, copies of any BDR, and/or the raw data validated by the generator/storage sites, to check the DOE's audit of the validation process.

C-4a(5) Data Transmittal

~~BDRs~~Batch data reports will include the information required by Permit Attachment C3, Section C3-4 and will be transmitted by hard copy or electronically (provided a hard copy is available on demand) from the data generation level to the project level.

The generator/storage site ~~will~~ transmits waste container information electronically via the WIPP Waste Information System (**WWIS**). Data will be entered into the WWIS in the exact format required by the database. Refer to Section C-5a(1) for WWIS reporting requirements and the *Waste Data System User's Manual* (DOE, ~~2009~~2019) for the WWIS data fields and format requirements.

Once a waste stream is characterized, the Site Project Manager will also submit to the Permittees a WSPF (Figure C-1) accompanied by the CIS for that waste stream which includes reconciliation with DQOs (Permit Attachment C3, Sections C3-6b(1) and C3-6b(2)). The WSPF, the CIS, and information from the WWIS will be used as the basis for acceptance of waste characterization information on TRU mixed wastes to be disposed of at the WIPP facility.

C-4a(6) Records Management

Records related to waste characterization activities performed by the generator/storage sites will be maintained in the testing facility files or generator/storage site project files, or at the WIPP Records Archive facility. Raw data obtained by testing TRU mixed waste in support of this WAP will be identifiable, legible, and provide documentary evidence of quality. ~~TRU~~Transuranic mixed waste characterization records submitted to the Permittees shall be maintained in the WIPP facility ~~operating record~~Operating Record and be available for inspection by the NMED.

Records inventory and disposition schedule (**RIDS**) or an equivalent system shall be prepared and approved by generator/storage site personnel. ~~All records~~Records relevant to an enforcement action under this Permit, regardless of disposition, shall be maintained at the generator/storage site until the NMED determines they are no longer needed for enforcement action, and then dispositioned as specified in the approved RIDS. ~~All waste~~Waste characterization data and related QA/QC records for TRU mixed waste to be shipped to the WIPP facility are designated as either Lifetime Records or Non-Permanent Records.

Records that are designated as Lifetime Records shall be maintained for the life of the waste characterization program at a participating generator/storage site plus six years or transferred for permanent archival storage to the WIPP Records Archive facility.

Waste characterization records include historical characterization records (i.e. headspace gas sampling/analysis and homogeneous solids and soil/gravel sampling/analysis) generated through implementation of previous requirements in this WAP. Those waste characterization records designated as Non-Permanent Records shall be maintained for ten years from the date of (record) generation at the participating generator/storage site or at the WIPP Records Archive facility and then dispositioned according to their approved RIDS. If a generator/storage site ceases to operate, ~~all~~ records shall be transferred before closeout to the Permittees for management at the WIPP Records Archive facility. Table C-2 is a listing of records designated as Lifetime Records and Non-Permanent Records. Classified information will not be transferred to the WIPP facility. Notations will be provided to the Permittees indicating the absence of classified information. The approved generator/storage site RIDS ~~will~~ identify appropriate disposition of classified information. Nothing in this Permit is intended to, nor should it be interpreted to, require the disclosure of any U.S. Department of Energy classified information to persons without appropriate clearance to view such information.

C-5 Permittee Level Waste Screening and Verification of TRU Mixed Waste

Permittee waste screening is a two-phased process. Phase I will occur prior to configuring shipments of TRU mixed waste. Phase II will occur after configuration of shipments of TRU mixed waste but before it is disposed at the WIPP facility. Figure C-3 presents Phase I and a portion of Phase II of the TRU mixed waste screening process. Permit Attachment C7 presents the TRU mixed waste confirmation portion of Phase II activities.

C-5a Phase I Waste Stream Screening and Verification

The first phase of the waste screening and verification process will occur before TRU mixed waste is shipped to the WIPP facility. Before the Permittees begin the process of accepting TRU mixed waste from a generator/storage site, an initial audit of that generator/storage site will be conducted as part of the Audit and Surveillance Program (Permit Attachment C6). The RCRA portion of the generator/storage site audit program will provide on-site verification of characterization procedures; BDR preparation; and recordkeeping to ensure that ~~all~~ applicable provisions of the WAP requirements are met. Another portion of the Phase I verification is the WSPF approval process. At the WIPP facility, this process includes verification that ~~all of~~ the required elements of the WSPF and the CIS are present (Permit Attachment C3, C3-6b(1)) and that the waste characterization information meet acceptance criteria required for compliance with the WAP (Section C3~~-6b(1)~~)).

A generator/storage site must first prepare a QAPjP, which includes applicable WAP requirements, and submit it to DOE for review and approval (Permit Attachment C5). Once approved, a copy of the QAPjP is provided to NMED for examination. The generator/storage site will implement the specific parameters of the QAPjP after it is approved. An initial audit will be performed after QAPjP implementation and prior to the generator/storage site being certified for shipment of waste to the WIPP facility. ~~Additional~~ Subsequent audits, focusing on the results of waste characterization, will be performed at least annually. The DOE has the right to conduct unannounced audits and to examine any records that are related to the scope of the audit. See Section C-5a(3) and Permit Attachment C6 for further information regarding audits.

When the required waste stream characterization data have been collected by a generator/storage site and the initial generator/storage site audit has been successfully completed, the generator/storage Site Project Manager will verify that waste stream characterization meets the applicable WAP requirements as a part of the project level verification (Permit Attachment C3, Section C3-4b). If the waste characterization does not meet the applicable requirements of the WAP, the mixed waste stream cannot be managed, stored, or disposed at the WIPP facility until those requirements are met. The Site Project Manager will then complete a WSPF and submit it to the Permittees, along with the accompanying CIS for that waste stream (Permit Attachment C3, Section C3-6b(1)). ~~All data~~Data necessary to check the accuracy of the WSPF will be transmitted to the Permittees for verification. This provides notification that the generator/storage site considers that the waste stream (identified by the waste stream identification number) has been adequately characterized for disposal prior to shipment to the WIPP facility. The Permittees will compare radiographic and visual examination data obtained subsequent to submittal and approval of the WSPF (and prior to submittal) with characterization information presented on this form. If the Permittees determine (through the data comparison) that the characterization information is adequate, DOE will approve the WSPF. Prior to the first shipment of containers from the approved waste stream, the approved WSPF and accompanying CIS will be provided to NMED. If the data comparison indicates that analyzed containers have hazardous wastes not present on the WSPF, or a different Waste Matrix Code applies, the WSPF is in error and shall be resubmitted. Ongoing WSPF examination is discussed in detail in Section C-5a(2).

Audits of generator/storage sites will be conducted as part of the Audit and Surveillance Program (Permit Attachment C6). The RCRA portion of the generator/storage site audit program will provide on-site verification of waste characterization procedures; BDR preparation; and record keeping to ensure that ~~all~~ applicable provisions of the WAP requirements are met. As part of the waste characterization data submittal, the generator/storage site will also transmit the data on a container basis via the WWIS. This data submittal can occur at any time as the data are being collected, but will be complete for each container prior to shipment of that container. The WWIS will conduct internal edit/limit checks as the data are entered, and the data will be available to the Permittees as supporting information for WSPF review. The NMED will have read-only access to the WWIS as necessary to determine compliance with the WAP. The initial WSPF check performed by the Permittees will include WWIS data submitted by the generator/storage site for each waste container submitted for the WSPF review and the CIS. The Permittees will compare ongoing characterization data obtained and submitted via the WWIS to the approved WSPF. If this comparison shows that containers have hazardous wastes not reported on the WSPF, or a different Waste Matrix Code applies, the data are rejected and the waste containers are not accepted for shipment until a new or revised WSPF is submitted to the Permittees and approved by the DOE.

If discrepancies regarding hazardous waste number assignment or Waste Matrix Code designation arise as a result of the Phase I review, the generator/storage sites will be contacted by the Permittees and required to provide the necessary additional information to resolve the discrepancy before that waste stream is approved for disposal at the WIPP facility. If the discrepancy is not resolved, the waste stream will not be approved. The DOE will notify the NMED in writing of any discrepancies identified during WSPF review and the resulting discrepancy resolution prior to waste shipment. The Permittees will not manage, store, or dispose the waste stream until this discrepancy is resolved in accordance with this WAP.

C-5a(1) WWIS Description

All generator/storage sites planning to ship TRU mixed waste to the WIPP facility will supply the required data to the WWIS. The WWIS Data Dictionary includes ~~all of~~ the data fields, the field format and the limits associated with the data as established by this WAP. These data will be subjected to edit and limit checks that are performed automatically by the database, as defined in the *Waste Data System User's Manual* (DOE, 2019~~2009~~).

The Permittees will coordinate the data transmission with each generator/storage site. Actual data transmission will use appropriate technology to ensure the integrity of the data transmissions. The Permittees will require sites with large waste inventories and large databases to populate a data structure provided by the Permittees that contains the required data dictionary fields that are appropriate for the waste stream (or waste streams) at that site. The Permittees will access these data via the Internet to ensure an efficient transfer of this data. Small quantity sites will be given a similar data structure by the Permittees that is tailored to their types of waste. Sites with very small quantities of waste will be provided with the ability to assemble the data interactively to this data structure on the WWIS.

The Permittees will use the WWIS to verify that ~~all of~~ the supplied data meet the edit and limit checks prior to the shipment of any TRU mixed waste to the WIPP facility. The WWIS automatically will notify the generator/storage site if any of the supplied data fails to meet the requirements of the edit and limit checks via an appropriate error message. The generator/storage site will be required to correct the discrepancy with the waste or the waste data and re-transmit the corrected data prior to acceptance of the data by the WWIS. The Permittees will review data reported for each container of each shipment prior to providing notification to the shipping generator/storage site that the shipment is acceptable. ~~Read-only access to the WWIS will be provided to NMED.~~ Table C-3 contains a listing of the data fields contained in the WWIS that are required as part of this Permit.

The WWIS will generate the following:

- Waste Emplacement Report

  This report will be added to the ~~operating record~~Operating Record to track the quantities of waste, date of emplacement, and location of authorized containers or container assemblies in the repository. The Permittees will document the specific panel room or drift that an individual waste container is placed in as well as the row/column/height coordinates location of the container or containers assembly. This report will be generated on a weekly basis. Locations of containers or container assemblies will also be placed on a map separate from the WWIS. Reports and maps that are included as part of the ~~operating record~~Operating Record will be retained ~~at the WIPP site~~ by the Permittees, for the life of the facility.

- Shipment Summary Report

  This report will contain the container identification numbers (**IDs**) of every container in the shipment, listed by Shipping Package number and by assembly number (for seven-packs, four-packs, and three-packs), for every assembly in the Shipping Package. This report is used by the Permittees to verify containers in a shipment and will be generated on a shipment basis.

- Waste Container Data Report

  This report will be generated on a waste stream basis and will be used by the Permittees during the WSPF review and DOE approval process. This report will contain the data listed in the Characterization Module on Table C-3. This report will be generated and attached to the WSPF for inclusion in the facility ~~operating record~~Operating Record and will be kept for the life of the facility.

- Reports of Change Log

  This will consist of a short report that lists the user ID and the fields changed. The report will also include a reason for the change. A longer report will list the information provided on the short report and include a before and after image of the record for each change, a before-record for each deletion, and the new information for added records. These reports will provide an auditable trail for the data in the database.

Access to the WWIS will be controlled by the Permittees' Data Administrator (**DA**) who will control the WWIS users based on approval from management personnel. Training for the WWIS Data Administrator job position will be in accordance with the WWIS Retrieval Characterization Transportation Data Administrator Task Card on file at the WIPP facility.

The TRU mixed waste generator/storage sites will only have access to data that they have supplied, and only until the data have been formally accepted by the Permittees. After the data have been accepted, the data will be protected from indiscriminate change and can only be changed by an authorized DA.

The WWIS has a Change Log that requires a reason for the change from the DA prior to accepting the change. The data change information, the user ID of the authorized DA making the change, and the date of the change will be recorded in the data change log automatically. The data change log cannot be revised by any user, including the DA. The data change log will be subject to internal and external audits and will provide an auditable trail for ~~all~~ changes made to previously approved data.

C-5a(2) Examination of the Waste Stream Profile Form and Container Data Checks

The Permittees ~~will~~ verify the completeness and accuracy of the Waste Stream Profile Form (Section C3-6b(1)). Figure C-2 includes the waste characterization and waste stream approval process. The assignment of the waste stream description, Waste Matrix Code Group, and Summary Category Groups; the acceptable knowledge summary documentation; the methods used for characterization; the DOE certification, and the appropriate designation of EPA hazardous waste number(s) will be examined by the Permittees. If the WSPF is inaccurate, efforts will be made to resolve discrepancies by contacting the generator/storage site in order for the waste stream to be eligible for shipment to the WIPP facility. If discrepancies in the waste stream are detected at the generator/storage site, the generator/storage site will implement a non-conformance program to identify, document, and report discrepancies (Permit Attachment C3).

The WSPF shall pass ~~all~~ verification checks by the Permittees in order for the waste stream to be approved by DOE for shipment to the WIPP facility. The WSPF check against waste container data will occur during the initial WSPF approval process (Section C-5a).

The EPA hazardous waste numbers for the wastes that appear on the Waste Stream Profile Form will be compared to those in Table C-5 to ensure that only approved wastes are accepted for management, storage, or disposal at the WIPP facility. Some of the waste may also be identified by unique state hazardous waste codes or numbers. These wastes are acceptable at WIPP as long as the TSDF-WAC are met. The CIS will be reviewed by the Permittees to verify that the waste has been classified correctly with respect to the assigned EPA hazardous waste numbers. The Permittees will verify that the applicable requirements of the TSDF-WAC have been met by the generator/storage site.

Waste data transferred via the WWIS after WSPF approval will be compared with the approved WSPF. Any container from an approved hazardous waste stream with a description different from its WSPF will not be managed, stored, or disposed at the WIPP facility.

The Permittees will also verify that three different types of data specified below are available for every container holding TRU mixed waste before that waste is managed, stored, or disposed at WIPP: 1) an assignment of the waste stream's waste description (by Waste Matrix Codes) and Waste Matrix Code Group; 2) a determination of ignitability, reactivity, and corrosivity; and 3) a determination of compatibility. The verification of waste stream description will be performed by reviewing the WWIS for consistency in the waste stream description and WSPF. The CIS will indicate if the waste has been checked for the characteristics of ignitability, corrosivity, and reactivity. The final verification of waste compatibility will be performed using Appendix C1 of the WIPP RCRA Part B Permit Application (DOE, 1997), the compatibility study.

Any container with unresolved discrepancies associated with hazardous waste characterization will not be managed, stored, or disposed at the WIPP facility until the discrepancies are resolved. If the discrepancies cannot be resolved, DOE will revoke the approval status of the waste stream, suspend shipments of the waste stream, and notify NMED. Waste stream approval will not be reinstated until the generator/storage site demonstrates ~~all~~ that corrective actions have been implemented and the generator/storage site waste characterization program is reassessed by the Permittees ~~DOE~~.

C-5a(3) Audit and Surveillance Program

An important part of the Permittees' verification process is the Audit and Surveillance Program. The focus of this audit program is compliance with this WAP and the Permit. This audit program addresses ~~all~~ AK implementation and testing activities, from waste stream classification assignment through waste container certification, and ensures compliance with SOPs and the WAP. Audits will ensure that containers and their associated documentation are adequately tracked throughout the waste handling process. Operator qualifications will be verified, and implementation of QA/QC procedures will be surveyed. A final report that includes generator/storage site audit results and applicable WAP-related corrective action report (**CAR**) resolution will be provided to NMED for approval, and will be kept in the WIPP facility ~~operating record~~Operating Record until closure of the WIPP facility.

The DOE will perform an initial audit at each generator/storage site performing waste characterization activities prior to the formal acceptance of the WSPFs and/or any waste characterization data supplied by the generator/storage sites. Audits will be performed at least annually thereafter, including the possibility of unannounced audits (i.e., not a regularly scheduled audit). These audits will allow NMED to verify that the Permittees have implemented the WAP and that generator/storage sites have implemented a QA program for the characterization of waste and meet applicable WAP requirements. The accuracy of physical waste description and waste stream assignment provided by the generator/storage site will be verified by review of the radiography results, and visual examination of data records and radiography images (as necessary) during audits conducted by DOE. More detail on this audit process is provided in Permit Attachment C6.

C-5b Phase II Waste Shipment Screening and Verification

As presented in Figure C-3, Phase II of the waste shipment screening and verification process begins with confirmation of the waste pursuant to Permit Attachment C7 after waste shipments are configured. After the waste shipment has arrived, the Permittees will screen the shipments to determine the completeness and accuracy of the EPA Hazardous Waste Manifest and the land disposal restriction notice completeness. The Permittees will verify there are no waste shipment irregularities and the waste containers are in good condition. Only those waste containers that are from shipments that have been confirmed pursuant to Permit Attachment C7 and that pass ~~all~~ Phase II waste screening and verification determinations will be emplaced at WIPP. For each container shipped, the Permittees shall ensure that the generator/storage sites provide the following information:

Hazardous Waste Manifest Information:

- Generator/storage site name and EPA ID
- Generator/storage site contact name and phone number
- Quantity of waste
- List of up to six state and/or federal hazardous waste numbers in each line item
- Listing of ~~all~~ shipping container IDs (Shipping Package serial number)
- Signature of authorized generator representative

Specific Waste Container information:

- Waste Stream Identification Number
- List of Hazardous Waste Numbers per Container
- Certification Data
- Shipping Data (Assembly numbers, ship date, shipping category, etc.)

This information shall also be supplied electronically to the WWIS. The container-specific information will be supplied electronically as described in Section C-5a(1), and shall be supplied prior to the Permittees' management, storage, or disposal of the waste.

The Permittees will verify each approved shipment upon receipt at the WIPP facility against the data on the WWIS shipment summary report to ensure containers have the required information. A Waste Receipt Checklist will be used to document the verification.

C-5b(1) Examination of the EPA Uniform Hazardous Waste Manifest and Associated Waste Tracking Information

Upon receipt of a TRU mixed waste shipment, the Permittees will make a determination of EPA Uniform Hazardous Waste Manifest completeness and sign the manifest to allow the driver to depart. For CH TRU mixed waste, the Permittees will then make a determination of waste shipment completeness by checking the unique, bar-coded identification number found on ~~each container~~waste containers holding TRU mixed waste against the WWIS database after opening the Shipping Package.

The WWIS links the bar-coded identification numbers of ~~all~~ containers in a specific waste shipment to the waste assembly (for ~~7~~seven-packs, ~~4~~four-packs, ~~3~~three-packs and ~~5~~five-drum carriages) and to the shipment identification number, which is also written on the EPA Hazardous Waste Manifest.

For shipments in the RH-TRU 72B cask, the identification number of the single payload container is read during cask-to-cask transfer in the Transfer Cell and then checked against the WWIS database. For shipments in the CNS 10-160B cask, the Permittees will make a determination of waste shipment completeness by checking the unique identification number found on each container holding TRU mixed waste in the Hot Cell against the WWIS database after unloading the cask.

Generators electronically transmit the waste shipment information to the WWIS before the TRU mixed waste shipment is transported. Once a TRU mixed waste shipment arrives, the Permittees verify the identity of each cask or container (or one container in a bound ~~7~~seven-pack, ~~4~~four-pack, or ~~3~~three-pack) using the data already in the WWIS.

The WWIS will maintain waste container receipt and emplacement information provided by the Permittees. It will include, among other items, the following information associated with each container of TRU mixed waste:

- Package Inner Containment Vessel **(ICV)** or shipping cask closure date
- Package (container or canister) receipt date
- Overpack identification number (if appropriate)
- Container or canister ~~Package (container or canister)~~ emplacement date
- Container or canister ~~Package (container or canister)~~ emplacement location

Manifest discrepancies will be identified during manifest examination and container bar-code WWIS data comparison. A manifest discrepancy is a difference between the quantity or type of hazardous waste designated on the manifest and the quantity or type of hazardous waste the ~~WIPP facility~~Permittees actually receives. The generator/storage site technical contact (as listed on the manifest) will be contacted to resolve the discrepancy. If the discrepancy is identified prior to the containers being removed from the package or shipping cask, the waste will be retained in the parking area. If the discrepancy is identified after the waste containers are removed from the package or cask, the waste will be retained in the Waste Handling Building (**WHB**) until the discrepancy is resolved. Errors on the manifest can be corrected by the Permittees at the WIPP facility with a verbal (followed by a mandatory written) concurrence by the generator/storage site technical contact. ~~All d~~Discrepancies that are unresolved within fifteen (15) days of receiving the waste will be immediately reported to the NMED in writing. Notifications to the NMED will consist of a letter describing the discrepancies, discrepancy resolution, and a copy of the manifest. If the manifest discrepancies have not been resolved within thirty (30) days of waste receipt, the shipment will be returned to the generator/storage facility. If it becomes necessary to return waste containers to the generator/storage site, a new EPA Uniform Hazardous Waste Manifest may be prepared by the Permittees.

Documentation of the returned containers will be recorded in the WWIS. Changes will be made to the WWIS data to indicate the current status of the container(s). The reason for the WWIS data change and the record of the WWIS data change will be maintained in the change log of the WWIS, which will provide an auditable record of the returned shipment.

The Permittees will be responsible for the resolution of discrepancies, notification of the NMED, as well as returning the original copy of the manifest to the generator/storage site.

C-5b(2) Examination of the Land Disposal Restriction (**LDR**) Notice

~~TRU~~Transuranic mixed waste designated by the Secretary of Energy for disposal at the WIPP facility is exempt from the LDRs by the WIPP Land Withdrawal Act Amendment (Public Law 104-201). This amendment states that WIPP "Waste is exempted from treatment standards promulgated pursuant to section 3004(m) of the Solid Waste Disposal Act (42 U.S. C. 6924(m)) and shall not be subjected to the Land Disposal prohibitions in section 3004(d), (e), (f), and (g) of the Solid Waste Disposal Act." Therefore, with the initial shipment of a TRU mixed waste stream, the generator shall provide the Permittees with a one time written notice. The notice must include the information listed below:

Land Disposal Restriction Notice Information:

- EPA Hazardous Waste Number(s) and Manifest Numbers of first shipment of a mixed waste stream

- Statement: this waste is not prohibited from land disposal

- Date the waste is subject to prohibition

This information is the applicable information taken from column "268.7(a)(4)" of the "Generator Paperwork Requirements Table" in 20.4.1.800 NMAC (incorporating 40 CFR §268.7(a)(4)). Note that item "5" from the "Generator Paperwork Requirements Table" is not applicable since waste analysis data are provided electronically via the WWIS and item "7" is not applicable since waste designated by the Secretary of Energy for disposal at the WIPP facility is exempted from the treatment standards.

The Permittees will review the LDR notice for accuracy and completeness. The generator will prepare this notice in accordance with the applicable requirements of 20.4.1.800 NMAC (incorporating 40 CFR §268.7(a)(4)).

C-5b(3) Verification

The Permittees will make a determination of TRU mixed waste shipment irregularities. The following items will be inspected for each TRU mixed waste shipment arriving at the WIPP facility:

- Whether the number and type of containers holding TRU mixed waste match the information in the WWIS

- Whether the containers are in good condition

The Permittees will verify that the containers (as identified by their container ID numbers) are the containers for which accepted data already exists in the WWIS. A check will be performed by the Permittees comparing the data on the WWIS Shipment Summary Report for the shipment to the actual shipping papers (including the EPA Hazardous Waste Manifest). This check also verifies that the containers included in the shipment are those for which approved shipping data already exist in the WWIS Transportation Data Module (Table C-3). For standard waste boxes (**SWBs**) and ten drum overpacks (**TDOPs**), this check will include comparing the barcode on the container with the container number on the shipping papers and the data on the

WWIS Shipment Summary Report. For ~~7~~seven-pack assemblies, one of the seven container barcodes will be read by the barcode reader and compared to the assembly information for this container on the WWIS Shipment Summary Report. This will automatically identify the remaining six containers in the assembly. This process enables the Permittees to identify ~~all of~~ the containers in the assembly with minimum radiological exposure. If ~~all of~~ the container IDs and the information on the shipping papers agree with the WWIS Shipment Summary Report, and the shipment was subject to waste confirmation by the Permittees prior to shipment to the WIPP facility pursuant to Permit Attachment C7, the containers will be approved for storage and disposal at the WIPP facility.

C-6 Permittees' Waste Shipment Screening QA/QC

Waste shipment screening QA/QC ensures that TRU mixed waste received is that which has been approved for shipment during the Phase I and Phase II screening. This is accomplished by maintaining QA/QC control of the waste shipment screening process. The screening process will be controlled by administrative processes which will generate records documenting waste receipt that will become part of the waste receipt record. The waste receipt record documents that container identifications correspond to shipping information and approved TRU mixed waste streams. The Permittees will extend QA/QC practices to the management of ~~all~~ records associated with waste shipment screening determinations.

C-7 Records Management and Reporting

As part of the ~~WIPP facility's operating record~~Operating Record, data and documents associated with waste characterization and waste confirmation are managed in accordance with standard records management practices.

~~All waste~~Waste characterization data for each TRU mixed waste container transmitted to the WIPP facility shall be maintained by the Permittees for the active life of the WIPP facility plus two years. The active life of the WIPP facility is defined as the period from the initial receipt of TRU mixed waste at the facility until NMED receives certification of final closure of the facility. After their active life, the records shall be retired to the WIPP Records Archive facility and maintained for 30 years. These records will then be offered to the National Archives. However, this disposition requirement does not preclude the inclusion of these records in the permanent marker system or other requirements for institutional control.

The storage of the Permittees' copy of the manifest, LDR information, waste characterization data, WSPFs, waste confirmation activity records, and other related records will be identified on the appropriate ~~records inventory and disposition schedule~~RIDS.

The following records will be maintained for waste characterization and waste confirmation purposes as part of the ~~WIPP facility operating record~~Operating Record:

- Completed WIPP WSPFs and accompanying CIS, including individual container data as transferred on the WWIS (or received as hard-copy) and any discrepancy-related documentation as specified in Section C-5a

- Radiography and visual examination records (data sheets, packaging logs, and video and audio recordings) of waste confirmation activities

- Completed Waste Receipt Checklists and discrepancy-related documentation as specified in Section C-5b
- WIPP WWIS Waste Emplacement Report as specified in Section C-5a(1)
- Audit reports and corrective action reports from the Audit and Surveillance Program audits as specified in Section C-5a(3) and Permit Attachment C6
- ~~CARs~~ Corrective action reports and closure information for corrective actions taken due to nonconforming waste being identified during waste confirmation by the Permittees

These records will be maintained for ~~all~~ TRU mixed waste managed at the WIPP facility.

Waste characterization and waste confirmation data and documents related to waste characterization that are part of the ~~WIPP facility operating record~~Operating Record are managed in accordance with the following guidelines:

C-7a General Requirements

- Records shall be legible
- Corrections shall be made with a single line through the incorrect information, and the date and initial of the person making the correction shall be added
- Black ink is encouraged, unless a copy test has been conducted to ensure the other color ink will copy
- Use of highlighters on records is discouraged
- Records shall be reviewed for completeness
- Records shall be validated by the cognizant manager or designee

C-7b Records Storage

- Active records shall be stored when not in use
- Quality records shall be kept in a one-hour (certified) fire-rated container or a copy of a record shall be stored separately (sufficiently remote from the original) in order to prevent destruction of both copies as a result of a single event such as fire or natural disaster
- Unauthorized access to the records is controlled by locking the storage container or controlling personnel access to the storage area

C-8 Reporting

The Permittees will provide a biennial report in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.75) on EPA Form 8700-13 A/B to the NMED that includes information on TRU mixed waste volume and waste descriptions received for disposal during the ~~time period covered by the report~~previous year.

C-9 List of References

U.S. Department of Energy (DOE), 2019~~2009~~, “Waste Data System User’s Manual,”~~,~~ DOE/WIPP 09-3427, U.S. Department of Energy.

U.S. Department of Energy (DOE), 1997, Resource Conservation and Recovery Act Part B Permit Application for the Waste Isolation Pilot Plant”, Revision 6.5, U.S. Department of Energy.

~~U.S. Environmental Protection Agency (EPA), April 1994, “Waste Analysis at Facilities that Generate, Treat, Store, and Dispose of Hazardous Waste, a Guidance Manual,” OSWER 9938.4-03, Office of Solid Waste and Emergency Response, Washington, D.C.~~U.S. Environmental Protection Agency (EPA), April 2015, EPA 530-R-12-001, “Waste Analysis at Facilities that Generate, Treat, Store, and Dispose of Hazardous Wastes - Final, A Guidance Manual,” Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), April 1980,~~.~~ “A Method for Determining the Compatibility of Hazardous Wastes,” EPA-600/2-80-076, California Department of Health Services and the U.S. Environmental Protection Agency, Office of Research and Development.

TABLES

Table C-1
Summary of Parameters, Characterization Methods, and Rationale for Transuranic Mixed Waste

Waste Matrix Code Summary Categories	Waste Matrix Code Groups	Characterization Parameter	Method	Rationale
S3000-Homogeneous Solids	• Solidified inorganics • Salt waste • Solidified organics	Physical waste form Hazardous constituents • Listed • Characteristic	Acceptable knowledge, radiography and/or visual examination Acceptable knowledge	• Determine waste matrix • Demonstrate compliance with waste acceptance criteria (e.g., no liquid in excess of TSDF-WAC limits, no incompatible wastes, no compressed gases) • Determine assignment of EPA hazardous waste numbers
S4000-Soil/Gravel	• Contaminated soil/debris			
S5000–Debris Waste	• Uncategorized metal (metal waste other than lead/cadmium) • Lead/cadmium waste • Inorganic nonmetal waste • Combustible waste • Graphite waste • Heterogeneous debris waste • Composite filter waste			

Table C-2
Required Program Records Maintained in Generator/Storage Site Project Files

Lifetime Records

- Field sampling data forms
- Field and laboratory chain-of-custody forms
- Test facility and laboratory batch data reports
- Waste Stream Characterization Package
- Sampling Plans
- Data reduction, validation, and reporting documentation
- Acceptable knowledge documentation
- Waste Stream Profile Form and Characterization Information Summary

Non-Permanent Records

- Nonconformance documentation
- Variance documentation
- Assessment documentation
- Gas canister tags
- Methods performance documentation
- Performance Demonstration Program documentation
- Sampling equipment certifications
- Calculations and related software documentation
- Training/qualification documentation
- QAPjPs (generator/storage sites) documentation (including~~all~~ revisions)
- Calibration documentation
- Analytical raw data
- Procurement documentation
- QA procedures (including~~all~~ revisions)
- Technical implementing procedures (including~~all~~ revisions)
- Audio/video recording (radiography, visual, etc.)

Table C-3
WIPP Waste Information System Data Fields[a]

Characterization Module Data Fields [b]	
Container ID [c] Generator EPA ID Generator Address Generator Name Generator Contact EPA Hazardous Waste Number~~Hazardous Code~~ Layers of Packaging Liner Exists Liner Hole Size Filter Model Number of Filters Installed Item Description Code ~~Haz.~~ Hazardous Waste Manifest Number NDE Complete [e]	Transporter EPA ID Transporter Name Visual Exam Container [e] Waste Material Parameter [d] Waste Material Weight [d] Waste Matrix Code Waste Matrix Code Group Waste Stream Profile Number
Certification Module Data Fields	
Container ID [c] Container type Container Weight Contact Dose Rate Container Certification date Container Closure Date	Handling Code
Transportation Data Module	
Contact~~-~~-Handled Package Number Assembly Number[f] Container IDs [c,d] ICV Closure Date	Ship Date Receive Date
Disposal Module Data	
Container ID [c] Disposal Date Disposal Location	

[a] This is not a complete list of the WWIS data fields.

[b] Some of the fields required for characterization are also required for certification and/or transportation.

[c] Container ID is the main relational field in the WWIS Database.

[d] This is a ~~multiple occurring~~recurring field for each waste material parameter, nuclide, etc.

[e] These are logical fields requiring only a yes/no.

[f] Required for ~~7~~seven-packs of 55-gal drums, ~~4~~four-packs of 85-gal drums, or ~~3~~three-packs of 100-gal drums to tie ~~all of~~ the drums in that assembly together. This facilitates the identification of waste containers in a shipment without need to breakup the assembly.

Table C-4
Waste Tanks Subject to Exclusion

Hanford Site - 177 Tanks	
A-101 through A-106	C-201 through C-204
AN-101 through AN-107	S-101 through S-112
AP-101 through AP-108	SX-101 through SX-115
AW-101 through AW-106	SY-101 through SY-103
AX-101 through AX-104	T-101 through T-112
AY-101 through AY-102	T-201 through T-204
B-101 through B-112	TX-101 through TX-118
B-201 through B-204	TY-101 through TY-106
BX-101 through BX-112	U-101 through U-112
BY-101 through BY-112	U-201 through U-204
C-101 through C-112	
Savannah River Site - 51 Tanks	
Tank 1 through 51	
Idaho National Engineering and Environmental Laboratory - 15 Tanks	
WM-103 through WM-106	WM-180 through 190

Table C-5
Listing of Permitted EPA Hazardous Waste Numbers

EPA Hazardous Waste Numbers			
F001	D019	D043	U079
F002	D021	P015	U103
F003	D022	P030	U105
F004	D026	P098	U108
F005	D027	P099	U122
F006	D028	P106	U133*
F007	D029	P120	U134*
F009	D030	U002*	U151
D004	D032	U003*	U154*
D005	D033	U019*	U159*
D006	D034	U037	U196
D007	D035	U043	U209
D008	D036	U044	U210
D009	D037	U052	U220
D010	D038	U070	U226
D011	D039	U072	U228
D018	D040	U078	U239*

* Acceptance of U-numbered wastes listed for reactivity, ignitability, or corrosivity characteristics is contingent upon a demonstration that the wastes no longer exhibit the characteristic of reactivity, ignitability, or corrosivity.

FIGURES

Page 1 of 2

WASTE STREAM PROFILE FORM

Waste Stream Profile Number: ____________________
Generator/Storage Site Name: ____________________ Technical Contract: ____________________
Generator/Storage Site EPA ID: ____________________ Technical Contact Phone Number: ______________
Date of audit report approved by NMED: ____________________
Title, version number and date of documents used for WAP Certification ____________________
____
Did your facility generate this waste? ☐ Yes ☐ No
If no, provide the name and EPA ID of the original generator: ____________________
____
WIPP ID: ____________________ Summary Category Group ____________________
Waste Stream Name: ____________________
Description from the WTWBIR: ____________________
____
Defense Waste: ☐ Yes ☐ No Check one: ☐ CH ☐ RH
Number of SWBs ______________ Number of Drums ______________ Number of Canisters ______________
Batch Data Report numbers supporting this waste stream characterization:____________________
List applicable EPA Hazardous Waste Numbers (2)____________________
Applicable TRUCON Content Numbers:____________________

Acceptable Knowledge Information(1)
(for the following, enter supporting documentation used (i.e., references and dates))

Required Program Information
Map of site: ____________________
Facility mission description: ____________________
Description of operations that generate waste: ____________________
____
Waste Identification/categorization schemes: ____________________
Types and quantities of waste generated: ____________________
Correlation of waste streams generated from the same building and process, as applicable ____________________
____
Waste certification procedures: ____________________
Required Waste Stream Information
Area(s) and building(s) from which waste stream was generated: ____________________
Waste stream volume and time period of generation: ____________________
Waste generating process description for each building: ____________________
Waste process flow diagrams: ____________________
____
Material inputs or other information identifying chemical/radionuclide content and physical waste form: ___________
____
Waste material parameter estimates per unit of waste:____________________
Which Defense Activity generated the waste (check all that apply)
- ☐ Weapons activities including defense inertial confinement fusion
- ☐ Naval reactors development
- ☐ Verification and control technology
- ☐ Defense research and development
- ☐ Defense nuclear waste and material by products management
- ☐ Defense nuclear material production
- ☐ Defense nuclear waste and materials security and safeguards and security investigations

Figure C-1
WIPP Waste Stream Profile Form (Example Only)

Page 2 of 2

WASTE STREAM PROFILE FORM

Supplemental Documentation

Process design documents: ____________________
Standard operating procedures: ____________________
Safety Analysis Reports: ____________________
Waste packaging logs: ____________________
Test plans/research project reports: ____________________
Site data bases: ____________________
Information from site personnel: ____________________
Standard industry documents: ____________________
Previous analytical data: ____________________
Material safety data sheets: ____________________
Sampling and analysis data from comparable/surrogate waste: ____________________
Laboratory notebooks: ____________________

Confirmation Information(2)

(for the following, when applicable, enter procedure title(s), number(s), and date(s))

Radiography: ____________________

Visual Examination: ____________________

Waste characterization procedures used (procedure number, revision number, date): ____________________

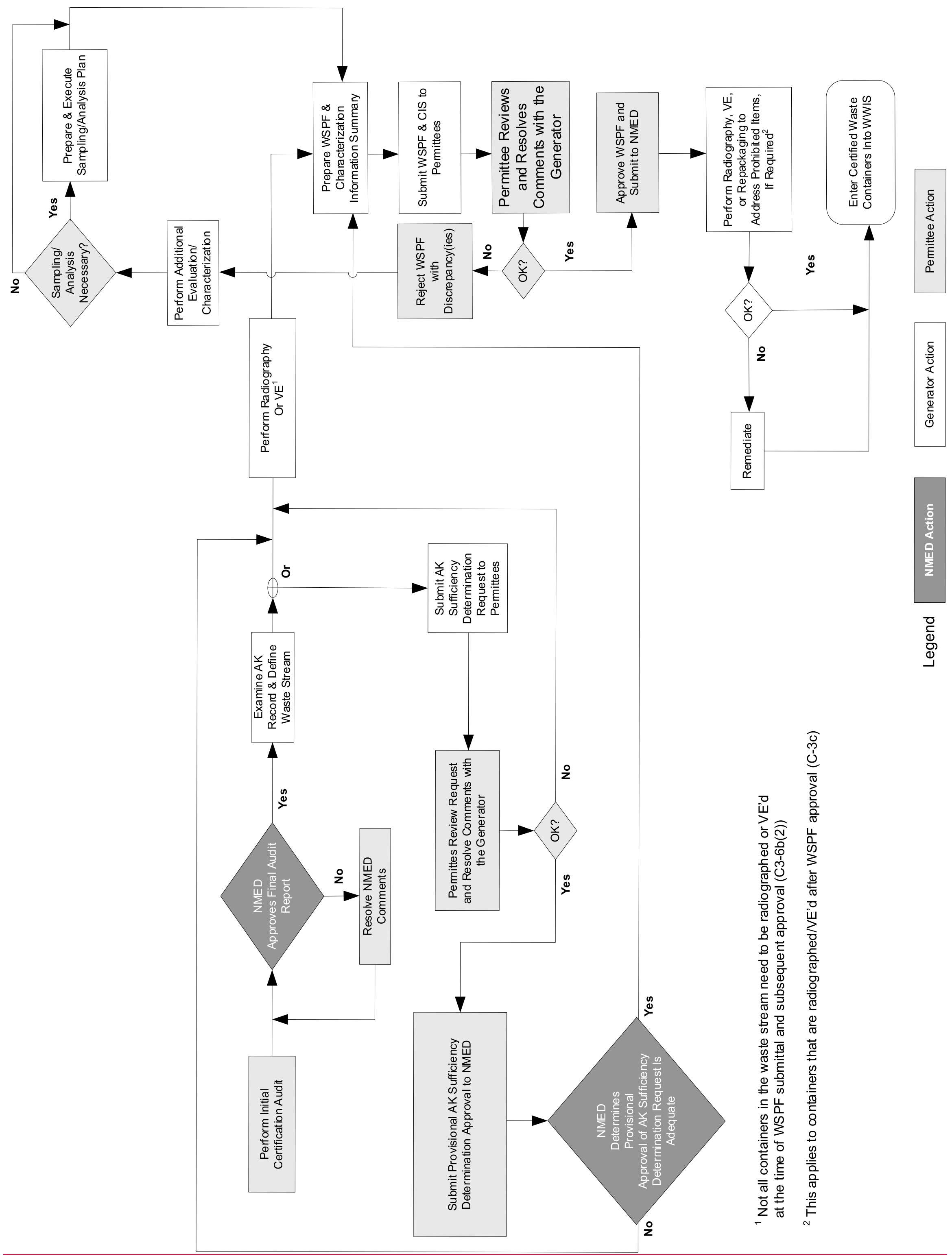
Waste Stream Profile Form Certification

I hereby certify that I have reviewed the information in this Waste Stream Profile Form, and it is complete and accurate to the best of my knowledge. I understand that this information will be made available to regulatory agencies and that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

Signature of Site Project Manager	Printed Name and Title	Date

NOTE: (1) Use back of sheet or continuation sheets, if required.
(2) If, radiography, visual examination were used to confirm EPA Hazardous Waste Numbers, attach signed Characterization Information Summary documenting this determination.

Figure C-1
WIPP Waste Stream Profile Form (Example Only – Continued)



[1] Not all containers in the waste stream need to be radiographed or VE'd at the time of WSPF submittal and subsequent approval (C3-6b(2))

[2] This applies to containers that are radiographed/VE'd after WSPF approval (C-3c)

Figure C-2
Waste Characterization Process

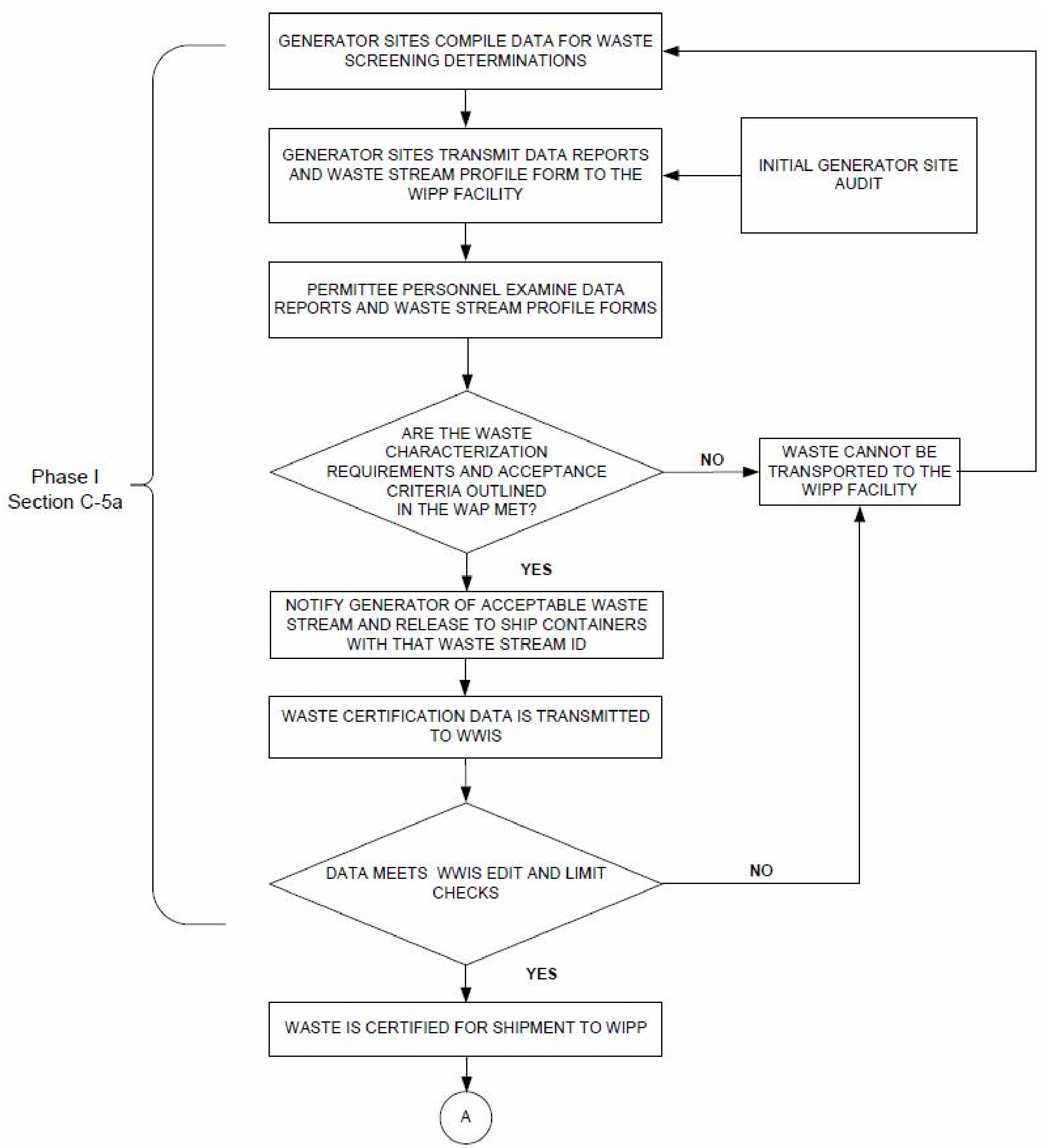


Figure C-3
TRU Mixed Waste Screening and Verification

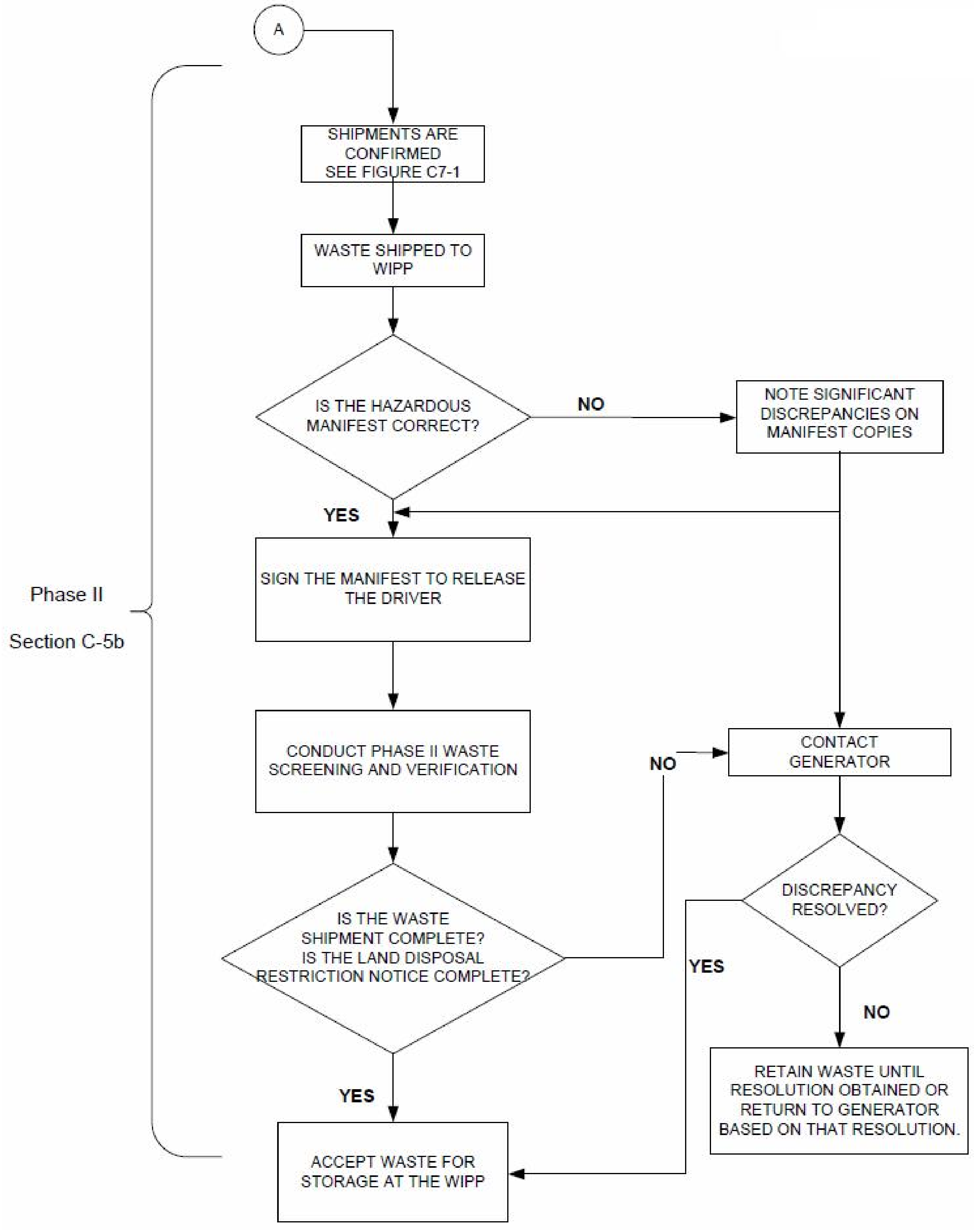


Figure C-3
TRU Mixed Waste Screening and Verification (Continued)

1

ATTACHMENT C1

WASTE CHARACTERIZATION TESTING METHODS

ATTACHMENT C1

WASTE CHARACTERIZATION TESTING METHODS

TABLE OF CONTENTS

ATTACHMENT C1

WASTE CHARACTERIZATION TESTING METHODS

Introduction

The Permittees will require generator/storage sites (**sites**) to use the following testing methods, as applicable, for characterization of transuranic~~TRU~~ mixed waste, which is managed, stored, or disposed at the WIPP facility. These methods include requirements for radiography or visual examination. Additionally, this Attachment provides quality control requirements.

C1-1 Radiography

Radiography has been developed by the Permittees specifically to aid in the examination and identification of containerized waste. The Permittees shall require that sites describe ~~all~~ activities required to achieve the radiography objectives in site Quality Assurance Project Plans (**QAPjPs**) and standard operating procedures (**SOPs**). These SOPs should include instructions specific to the radiography system(s) used at the site. For example, to detect liquids, some systems require the container to be rotated back and forth while other systems require the container to be tilted.

A radiography system (e.g., real time radiography, digital radiography/computed tomography) normally consists of an X-ray-producing device, an imaging system, an enclosure for radiation protection, a waste container handling system, an audio/video recording system, and an operator control and data acquisition station. Although these six components are required, it is expected there will be some variation within a given component between sites. The radiography system shall have controls or an equivalent process which allow the operator to control image quality. On some radiography systems, it should be possible to vary the voltage, typically between 150 to 400 kilovolts ~~(**kV**)~~, to provide an optimum degree of penetration through the waste. For example, high-density material should be examined with the X-ray device set on the maximum voltage. This ensures maximum penetration through the waste container. Low-density material should be examined at lower voltage settings to improve contrast and image definition. The imaging system typically utilizes either a fluorescent screen and a low-light television camera or x-ray detectors to generate the image.

To perform radiography, the waste container is scanned while the operator views the television screen. A video and audio recording is made of the waste container scan and is maintained as a non-permanent record. A radiography data form is also used to document the Waste Matrix Code to ensure that the waste container contains no ignitable, corrosive, or reactive waste by documenting the absence of liquids in excess of Treatment, Storage, and Disposal Facility Waste Acceptance Criteria (**TSDF-WAC**) limits or compressed gases, and verify that the physical form of the waste is consistent with the waste stream description documented in the Acceptable Knowledge (**AK**) Summary. Containers whose contents prevent full examination of the remaining contents shall be subject to visual examination unless the site certifies that visual examination would provide no additional relevant information for that container based on the ~~acceptable knowledge~~AK information for the waste stream. Such certification shall be documented in the generator/storage site's record.

For containers which contain classified shapes and undergo radiography, the radiography video and audio recording will be considered classified. The radiography data forms will not contain classified information.

The radiography system involves qualitative and semiquantitative evaluations of visual displays. Operator training and experience are the most important considerations for ensuring quality controls in regard to the operation of the radiography system and for interpretation and disposition of radiography results. Only trained personnel shall be allowed to operate radiography equipment.

Standardized training requirements for radiography operators shall be based upon existing industry standard training requirements.

The Permittees shall require each site to develop a training program that provides radiography operators with both formal and on-the-job (**OJT**) training. Radiography operators shall be instructed in the specific waste generating practices, typical packaging configurations, and associated waste material parameters expected to be found in each Waste Matrix Code at the site. The OJT and apprenticeship shall be conducted by an experienced, qualified radiography operator prior to qualification of the training candidate. The training programs will be site-specific due to differences in equipment, waste configurations, and the level of waste characterization efforts. For example, certain sites use digital radiography equipment, which is more sensitive than real-time radiography equipment. In addition, the particular physical forms and packaging configurations at each site will vary; therefore, radiography operators shall be trained on the types of waste that are generated, stored, and/or characterized at that particular site.

Although the Permittees shall require each site to develop its own training program, all of the radiography ~~QC~~ quality-control requirements specified in this WAP shall be incorporated into the training programs and radiography operations. In this way data quality and comparability will not be affected.

Radiography training programs will be the subject of the Audit and Surveillance Program (Permit Attachment C6).

~~One or more training~~Training containers ~~with items~~ (including prohibited items and internal containers of various sizes) common to the waste streams to be characterized and internal containers of various sizes shall be scanned semiannually by each operator. The audio and video media shall then be reviewed by a supervisor to ensure that operators' interpretations remain consistent and accurate. Imaging system characteristics shall be verified on a routine basis.

Independent replicate scans and replicate observations of the video output of the radiography process shall be performed under uniform conditions and procedures. Independent replicate scans shall be performed on one waste container per day or once per testing batch, whichever is less frequent, by a qualified radiography operator that was not involved in the original scan of the waste container. Independent observations of one scan (not the replicate scan) shall also be made once per day or once per testing batch, whichever is less frequent, by a qualified radiography operator that was not involved in the original scan of the waste container. A testing batch is a suite of waste containers undergoing radiography using the same testing equipment. A testing batch can be up to 20 waste containers without regard to waste matrix.

Oversight functions include periodic audio/video media reviews of accepted waste containers and shall be performed by qualified radiography operators that were not involved in the original scans of the waste containers. The results of this independent verification shall be available to the radiography operators who performed the original scans. The Permittees shall require the site project manager to be responsible for monitoring the quality of the radiography data and calling for corrective action, when necessary.

C1-2 Visual Examination

The waste container contents may be verified directly by visual examination (**VE**) of the waste container contents. Visual examination may be performed by physically examining the contents of waste containers to verify the Waste Matrix Code and to verify that the container is properly included in the appropriate waste stream. Visual examination shall be conducted on a waste container to identify and describe ~~all~~ waste items, packaging materials, and waste material parameters in the waste container. Visual examination activities shall be documented on video/audio media, or by using a second operator to provide additional verification by reviewing the contents of the waste container to ensure correct reporting. When VE is performed using a second operator, each operator performing the VE shall observe for themselves the waste being placed in the waste container or the contents within the examined waste container when waste is not removed. The results of ~~all~~ VE shall be documented on VE data forms, which are used to document the Waste Matrix Code, ensure that the waste container contains no ignitable, corrosive, or reactive waste by documenting the absence of liquids in excess of TSDF-WAC limits or compressed gases, and to verify that the physical form of the waste is consistent with the waste stream description documented in the AK Summary.

Visual examination recorded on video/audio media shall meet the following minimum requirements:

- The video/audio media shall record the waste packaging event for the container such that ~~all~~ waste items placed into the container are recorded in sufficient detail and shall contain an inventory of waste items in sufficient detail that another trained VE operator can identify the associated waste material parameters~~.~~
- The video/audio media shall capture the waste container identification number~~.~~
- The personnel loading the waste container shall be identified on the video/audio media or on packaging records traceable to the loading of the waste container~~.~~
- The date of loading of the waste container will be recorded on the video/audio media or on packaging records traceable to the loading of the waste container~~.~~

Visual examination performed using two generator/storage site personnel shall meet the following minimum requirements:

- At least two generator/storage site personnel who witnessed the packaging of the waste shall approve the data forms or packaging records attesting to the contents of the waste container~~.~~

- The data forms or packaging records shall contain an inventory of waste items in sufficient detail that another trained VE operator can identify the associated waste material parameters~~.~~

- The waste container identification number shall be recorded on the data forms or packaging records~~.~~

Visual examination video/audio media of containers which contain classified shapes shall be considered classified information. Visual examination data forms or packaging records will not contain classified information.

Waste container packaging records may be used to meet the VE data quality objectives (**DQOs**) (Permit Attachment C, Section C-4a(1)). These records must meet the minimum requirements listed above for either VE recorded on video/audio media or VE performed by two generator/storage site personnel, and shall be reviewed by operators trained and qualified to the requirements listed below. The operators will prepare data forms based on the visual examination records. Visual examination batch data reports will be prepared, reviewed, and approved as described in Permit Attachment C, Section C-4, and Permit Attachment C3.

Standardized training for VE shall be developed. Visual examination operators shall be instructed in the specific waste generating processes, typical packaging configurations, and waste material parameters expected to be found in each Waste Matrix Code at the site. The training shall be site specific to include the various waste configurations generated/stored at the site. For example, the particular physical forms and packaging configurations at each site will vary so operators shall be trained to examine the types of waste that are generated, stored, and/or characterized at that particular site. Training will include the following regardless of Summary Category Group:

- Identifying and describing the contents of a waste container by examining ~~all~~ items in waste containers of previously packaged waste

- Identifying when VE cannot be used to meet the DQOs

Visual examination personnel shall be requalified once every two years.

Each VE facility shall designate a VE expert. The VE expert shall be familiar with the waste generating processes that have taken place at that site and also be familiar with ~~all of~~ the types of waste being characterized at that site. The VE expert shall be responsible for the overall direction and implementation of the VE at that facility. The Permittees shall require site QAPjPs to specify the selection, qualification, and training requirements of the VE expert.

ATTACHMENT C2

RESERVED

ATTACHMENT C3

QUALITY ASSURANCE OBJECTIVES AND DATA VALIDATION TECHNIQUES FOR WASTE CHARACTERIZATION METHODS

ATTACHMENT C3

QUALITY ASSURANCE OBJECTIVES AND DATA VALIDATION TECHNIQUES FOR WASTE CHARACTERIZATION METHODS

TABLE OF CONTENTS

LIST OF TABLES

ATTACHMENT C3

QUALITY ASSURANCE OBJECTIVES AND DATA VALIDATION TECHNIQUES FOR WASTE CHARACTERIZATION METHODS

C3-1 Validation Methods

The Permittees shall require the generator/storage sites (**sites**) to perform data validation ~~of all data~~ so that data used for Waste Isolation Pilot Plant (**WIPP**) compliance programs will be of known and acceptable quality.

The qualitative data or descriptive information generated by radiography and visual examination is not amenable to statistical data quality analysis. However, radiography and visual examination are complementary techniques yielding similar data for determining the waste matrix code. The waste matrix code is determined to ensure that the container is properly included in the appropriate waste stream.

Data validation will be used to assess the quality of waste characterization data collected based upon project precision, accuracy, completeness, comparability, and representativeness objectives. These objectives are described below:

Precision

Precision is a measure of the mutual agreement among multiple measurements.

Accuracy

Accuracy is the degree of agreement between a measured result and the true or known value.

Completeness

Completeness is a measure of the amount of valid data obtained from a method compared to the total amount of data obtained.

Comparability

Comparability is the degree to which one data set can be compared to another.

Representativeness

Representativeness is the degree to which a sample represents~~represent~~ a characteristic of a population.

C3-2 Non Destructive Examination Methods

Quality Assurance Objectives

The quality assurance objectives (**QAOs**) for ~~non destructive~~ non-destructive examination (**NDE**) methods are detailed in this section. Non-destructive examination~~NDE~~ can be either radiography or visual examination (**VE**). If the QAOs described below are not met, then corrective action shall be taken. It should be noted that NDE is primarily a qualitative determination. The objective of NDE for the program is to verify that the physical form of the waste matches the waste stream description as determined by acceptable knowledge (**AK**) and the absence of prohibited items. The Permittees shall require each site to describe ~~all~~ activities required to achieve these objectives in the site quality assurance project plan (**QAPjP**) and standard operating procedures (**SOPs**~~**SOP**~~).

C3-2a Radiography

Data to meet these objectives must be obtained from a video and audio recorded scan provided by trained radiography operators at the sites. Results must also be recorded on a radiography data form. The precision, accuracy, completeness, and comparability objectives for radiography data are presented below.

Precision

Precision is maintained by reconciling any discrepancies between two radiography operators with regard to identification of the waste matrix code, liquids in excess of Treatment, Storage, and Disposal Facility Waste Acceptance Criteria (**TSDF-WAC**) limits, and compressed gases through independent replicate scans and independent observations. Additionally, the precision of radiography is verified prior to use by tuning precisely enough to demonstrate compliance with QAOs through viewing an image test pattern.

Accuracy

Accuracy is obtained by using a target to tune the image for maximum sharpness and by requiring operators to successfully identify 100 percent of the items required to meet the data quality objectives (**DQOs**) for radiography specified in Permit Attachment C, Section C-4a(1) in a training container during their initial qualification and subsequent requalification.

Completeness

A video and audio media recording of the radiography examination and a validated radiography data form will be obtained for 100 percent of the waste containers subject to radiography. ~~All video~~Video and audio media recordings and radiography data forms will be subject to validation as indicated in Section C3-4.

Comparability

The comparability of radiography data from different operators shall be enhanced by using standardized radiography procedures and operator qualifications.

C3-2b Visual Examination

Results must be recorded on a VE data form. The precision, accuracy, completeness, and comparability objectives for VE data are presented below.

Precision

Precision is maintained by reconciling any discrepancies between the operator and the independent technical reviewer with regard to identification of waste matrix code, liquids in excess of TSDF-WAC limits, and compressed gases.

Accuracy

Accuracy is maintained by requiring operators to pass a comprehensive examination and demonstrate satisfactory performance in the presence of the VE expert during their initial qualification. Visual examination~~VE~~ operators shall be requalified every two years.

Completeness

A validated VE data form will be obtained for 100 percent of the waste containers subject to VE.

Comparability

The comparability of VE data from different operators shall be enhanced by using standardized VE procedures and operator qualifications.

C3-3 Acceptable Knowledge

Acceptable knowledge~~ documentation~~ provides primarily qualitative information that cannot be assessed according to specific data quality goals that are used for quantitative techniques. To ensure that the AK~~acceptable knowledge~~ process is consistently applied, the Permittees shall require sites to comply with the following data QAOs ~~quality requirements ~~for ~~acceptable knowledge documentation~~AK:

- Precision - The qualitative determinations, such as compiling and assessing ~~acceptable knowledge documentation~~AK, do not lend themselves to statistical evaluations of precision. However, the ~~acceptable knowledge information~~AK will be addressed by~~ the~~ independent reviews ~~review of acceptable knowledge information~~ during internal and external audits.

- Accuracy - The percentage of waste containers which require reassignment to a new waste matrix code and/or designation of different U.S. Environmental Protection Agency (**EPA**) hazardous waste numbers based on testing data and discrepancies identified by the Permittees during waste confirmation will be reported as a measure of ~~acceptable knowledge~~AK accuracy.

- Completeness - The AK~~acceptable knowledge~~ record must contain 100 percent of the required information (Permit Attachment C4, Section C4-3). The usability of the AK~~acceptable knowledge~~ information will be assessed for completeness during audits.

- Comparability - Comparability is ensured through sites meeting the training requirements and complying with the minimum standards outlined for procedures that are used to implement the ~~acceptable knowledge~~AK process. ~~All sites must assign hazardous waste numbers in accordance with Permit Attachment C4-3b~~

~~and provide this information regarding its waste to other sites who store or generate a similar waste stream.~~

- Representativeness - Representativeness is a qualitative parameter that will be satisfied by ensuring that the process of obtaining, evaluating, and documenting ~~acceptable knowledge~~AK information is performed in accordance with the minimum standards established in Permit Attachment C4, Section C4-3. Sites also must assess and document the limitations of the ~~acceptable knowledge~~AK information used to assign EPA hazardous waste numbers (e.g., purpose and scope of information, date of publication, type and extent to which waste parameters are addressed).

The Permittees shall require each generator/storage site to comply with the nonconformance notification and reporting requirements of Section C3-7 if the results of testing specified in Permit Attachment C are inconsistent with ~~acceptable knowledge~~AK ~~documentation~~.

The Permittees shall require each site to address quality control by tracking its performance with regard to the use of ~~acceptable knowledge~~AK by: 1) assessing the frequency of inconsistencies among information, and 2) documenting ~~acceptable knowledge~~AK inconsistencies identified through radiography and visual examination. In addition, the ~~acceptable knowledge~~AK process and waste stream documentation must be evaluated through internal assessments by generator/storage site quality assurance organizations and assessments by auditors external to the organization (i.e., the Permittees).

C3-4 Data Review, Validation, and Verification Requirements

Procedures shall be developed for the review, validation, and verification of data at the data generation level; the validation and verification of data at the project level; and the verification of data at the Permittee level. Data review determines if raw data have been properly collected and ensures raw data are properly reduced. Data validation verifies that the data reported satisfy the requirements of this Waste Analysis Plan (**WAP**) and is accompanied by signature release. Data verification authenticates that data as presented represent the testing activities as performed and have been subject to the appropriate levels of data review. The requirements presented in this section ensure that WAP records furnish documentary evidence of quality.

The Permittees shall require the sites to generate the following Batch Data Reports **(BDRs)** for data validation, verification, and quality assurance activities:

- A Testing ~~Batch Data Report~~BDR or equivalent includes ~~all~~ data pertaining to radiography or visual examination for up to 20 waste containers without regard to waste matrix. Table C3-3 lists ~~all of~~ the information required in Testing ~~Batch Data Reports~~BDRs (identified with an “X”) and other information that is necessary for data validation, but is optional in Testing ~~Batch Data Reports~~BDRs (identified with an “O”).

C3-4a Data Generation Level

The following are minimum requirements for raw data collection and management which the Permittees shall require for each site:

- ~~All raw~~Raw data shall be signed and dated in reproducible ink by the person generating it. Alternately, unalterable electronic signatures may be used.

- ~~All data~~Data must be recorded clearly, legibly, and accurately in field records.

- ~~All changes~~Changes to original data must be lined out, initialed, and dated by the individual making the change. A justification for changing the original data may also be included. Original data must not be obliterated or otherwise disfigured so as not to be unreadable~~readable~~. Data changes shall only be made by the individual who originally collected the data or an individual authorized to change the data.

- ~~All data~~Data must be transferred and reduced from field records completely and accurately.

- ~~All field~~Field records must be maintained as specified in Permit Attachment C, Table C-2~~ of Attachment C~~.

- Data must be organized into a standard format for reporting purposes (~~Batch Data Report~~BDR), as outlined in specific testing procedures.

- ~~All electronic~~Electronic and video data must be stored appropriately to ensure that waste container and associated quality control (**QC**)~~QC~~ data are readily retrievable. In the case of classified information, additional security provisions may apply that could restrict retrievability. The additional security provisions will be documented in generator/storage site procedures as outlined in the QAPjP in accordance with prevailing classified information security standards.

Data review, validation, and verification at this level involves scrutiny and signature release from qualified independent technical reviewer(s) not involved in the generation or recording of the data under review, as specified below. Individuals conducting this data review, validation, and verification must use checklists that address ~~all of~~ the items included in this section. Completed checklists must be forwarded with ~~Batch Data Reports~~BDRs to the project level.

C3-4a(1) Independent Technical Review

The independent technical review ensures by review of raw data that data generation and reduction are technically correct; calculations are verified correct; deviations are documented; and quality assurance (**QA**)/QC~~QA/QC~~ results are complete, documented correctly, and compared against WAP criteria. This review validates and verifies ~~all of~~ the work documented by the originator.

One hundred percent of the ~~Batch Data Reports~~BDRs must receive an independent technical review by a trained and qualified individual who was not involved in the generation or recording of the data under review. This review shall be performed by an individual other than the data generator who is qualified to have performed the initial work. The independent technical review must be performed as soon as practicably possible in order to determine and correct negative quality trends in the testing process. However at a minimum, the independent technical review must be performed before any waste associated with the data reviewed is managed, stored, or disposed at the WIPP facility. The reviewer(s) must release the data as evidenced by signature, and as a consequence ensure the following:

- Data generation and reduction were conducted in a technically correct manner in accordance with the methods used (procedure with revision). Data were reported in the proper units and correct number of significant figures.

- Calculations have been verified by a valid calculation program, a spot check of verified calculation programs, and/or 100 percent check of ~~all~~ hand calculations. Values that are not verifiable to within rounding or significant difference discrepancies must be rectified prior to completion of independent technical review.

- The data have been reviewed for transcription errors.

- The testing data QA documentation for ~~Batch Data Reports~~BDRs is complete and includes, as applicable, raw data, calculation records, calibration records (or references to an available calibration package). Corrective action will be taken to ensure that ~~all~~ ~~Batch Data Reports~~BDRs are complete and include ~~all~~ necessary raw data prior to completion of the independent technical review.

- Radiography tapes have been reviewed (independent observation) on a waste container basis at a minimum of once per testing batch or once per day of operation, whichever is less frequent (Attachment C1, Section C1-1). The radiography tape will be reviewed against the data reported on the radiography form to ensure that the data are correct and complete.

- QAOs have been met according to the methods outlined in Sections C3-2 and C3-3.

C3-4b Project Level

Data validation and verification at this level involves scrutiny and signature release from the Site Project Manager (or designee). The Permittees shall require each site to meet the following minimum requirements for each waste container. ~~Any~~A nonconformance identified during this process shall be documented on a nonconformance report (Section C3-7).

~~The Site Project Manager shall ensure that a repeat of the data generation level review, validation, and verification is performed on the data for a minimum of one randomly chosen waste container quarterly (every three months). This exercise will document that the data generation level review, validation, and verification is being performed according to implementing procedures.~~

C3-4b(1) Site Project Manager Review

The Site Project Manager Review is the final validation that ~~all of~~ the data contained in ~~Batch Data Reports~~BDRs from the data generation level are complete and have been properly reviewed as evidenced by signature release and completed checklists.

One hundred percent of the ~~Batch Data Reports~~BDRs must have Site Project Manager signature release. At a minimum, the Site Project Manager signature release must be performed before any waste associated with the data reviewed is managed, stored, or disposed at the WIPP facility. This signature release must ensure the following:

- Testing batch QC checks (e.g., replicate scans, measurement system checks) were properly performed. Radiography data are complete and acceptable based on evidence of videotape review of one waste container per day or once per testing batch, whichever is less frequent, as specified in Permit Attachment C1, Section C1-1.

- Data generation level independent technical review, validation, and verification have been performed as evidenced by the completed review checklists and appropriate signature releases.

- Independent technical reviewers were not involved in the generation or recording of the data under review.

- Batch data review checklists are complete.

- Batch Data Reports are complete and data are properly reported (e.g., data are reported in the correct units, and with the correct number of significant figures).

- Verify that data are within established data assessment criteria and meet ~~all~~ the applicable QAOs (Sections C3-2 and C3-3).

C3-4b(2) Prepare Site Project Manager Summary and Data Validation Summary

To document the project-level validation and verification described above, the Permittees shall require each Site Project Manager (or designee) to prepare a Site Project Manager Summary and a Data Validation Summary. These reports may be combined to eliminate redundancy. The Site Project Manager Summary includes a validation checklist for each BDR~~Batch Data Report~~. Checklists for the Site Project Manager Summary must be sufficiently detailed to validate ~~all~~ aspects of a BDR~~Batch Data Report~~ that affect data quality. The Data Validation Summary provides verification that, on a per waste container basis as evidenced by ~~Batch Data Report~~BDR reviews, ~~all~~ data have been validated in accordance with the site QAPjP. The Data Validation Summary must identify each ~~Batch Data Report~~BDR reviewed (including ~~all~~ waste container numbers), describe how the validation was performed and whether or not problems were detected (e.g., nonconformance reports), and include a statement indicating that ~~all~~ the data are acceptable. Summaries must include release signatures.

C3-4b(3) Prepare Waste Stream Characterization Package

In the event the Permittees request detailed information on a waste stream, the Site Project Manager will provide a Waste Stream Characterization Package. The Site Project Manager must ensure that the Waste Stream Characterization Package (Section C3-6b(3)) will support waste characterization determinations.

C3-4c Permittee Level

The final level of data verification occurs at the Permittee level and must, at a minimum, consist of reviewing a sample of the ~~Batch Data Reports~~BDRs during audits of generator/storage sites to verify completeness. During such audits, the DOE is responsible for the verification that ~~Batch Data Reports~~BDRs include the following:

- Project-level signature releases
- Listing of ~~all~~ the waste containers being presented in the report
- Listing of ~~all~~ the testing, batch numbers associated with each waste container being reported in the package
- Site Project Manager Summary
- Data Validation Summary

For each Waste Stream Profile Form (**WSPF**) submitted for approval, DOE must verify that each submittal (i.e., WSPF and Characterization Information Summary) is complete and notify the originating site in writing of the WSPF approval. The DOE will maintain the data as appropriate for use in the regulatory compliance programs. For subsequent shipments made after the initial WSPF approval, the verification will also include WWIS internal limit checks (Permit Attachment C, Section C-5a(1)).

C3-5 Reconciliation with Data Quality Objectives

Reconciling the results of waste testing with the DQOs provides a way to ensure that data will be of adequate quality to support the regulatory compliance programs. Reconciliation with the DQOs will take place at both the project level and the Permittees' level. At the project level, reconciliation will be performed by the Site Project Manager, while at the Permittees' level, reconciliation will be performed as described below.

C3-5a Reconciliation at the Project Level

The Permittees shall require each Site Project Manager to ensure that ~~all~~ the data generated and used in decision making meet the DQOs provided in Permit Attachment C, Section C-4a(1) ~~of Permit Attachment C~~. To do so, the Site Project Manager must assess whether data of sufficient type, quality, and quantity have been collected. For each waste stream characterized, the Permittees shall require each Site Project Manager to determine if sufficient data have been collected to determine the following WAP-required waste parameters, as applicable:

- Waste matrix code
- Waste material parameter weights
- If each waste container of waste contains transuranic (**TRU**)~~TRU~~ radioactive waste
- Whether the waste stream exhibits a toxicity characteristic (**TC**) under 20.4.1.200 New Mexico Administrative Code (**NMAC**) (incorporating Title 40 of the Code of Federal Regulations (**CFR**) Part 261, Subpart C)
- Whether the waste stream contains listed waste found in 20.4.1.200 NMAC (incorporating 40 CFR Part 261, Subpart D)

- Whether the waste stream can be classified as hazardous or nonhazardous
- Whether the overall completeness, comparability, and representativeness QAOs were met for each of the testing procedures as specified in Sections C3-2 and C3-3 prior to submittal of a WSPF for a waste stream or waste stream lot.

If the Site Project Manager determines that insufficient data have been collected to make the determinations listed above, additional data collection efforts must be undertaken. The reconciliation of a waste stream shall be performed, as described in Permit Attachment C4, prior to submittal of WSPF and Characterization Information Summary **(CIS)** to the Permittees for that waste stream. The Permittees shall not manage, store, or dispose a TRU mixed waste stream at the WIPP facility unless the Site Project Manager determines that the WAP-required waste parameters listed above have been met for that waste stream.

C3-5b Reconciliation at the Permittee Level

The Permittees must also ensure that data of sufficient type, quality, and quantity are collected to meet WAP DQOs. The Permittees will ensure sufficient data have been collected to determine if the waste characterization information is adequate to demonstrate the Permittees' compliance with Permit Attachment C, Section C-4a(1). This is performed during the Permittees' review of the WSPF and CIS~~Characterization Information Summary~~ and is documented by the DOE's approval of the WSPF.

C3-6 Data Reporting Requirements

Data reporting requirements define the type of information and the method of transmittal for data transfer from the data generation level to the project level and from the project level to the Permittees.

C3-6a Data Generation Level

Data shall be transmitted by hard copy or electronically (provided a hard copy is available on demand) from the data generation level to the project level. Transmitted data shall include ~~all Batch Data Reports~~BDRs and data review checklists. The ~~Batch Data Reports~~BDRs and checklists used must contain ~~all of~~ the information required by the testing techniques described in Permit Attachments C1 through C6, as well as the signature releases to document the review, validation, and verification as described in Section C3-4. ~~All~~ Batch Data Reports and checklists shall be in approved formats, as provided in site-specific documentation.

Batch Data Reports shall be forwarded to the Site Project Manager. ~~All~~ Batch Data Reports shall be assigned serial numbers, and each page shall be numbered. The identification~~serial~~ number used for ~~Batch Data Reports~~BDRs can be the same as the testing batch number.

~~QA~~ Quality assurance documentation, including raw data, shall be maintained in either testing facility files, or site project files for those facilities located on site in accordance with the document storage requirements of site approved site QAPjPs.

C3-6b Project Level

The site project office shall prepare a WSPF for each waste stream certified for shipment to the WIPP facility based on information obtained from ~~acceptable knowledge~~AK and ~~Batch Data Reports~~BDRs, if applicable. In addition, the site project office must ensure that the CIS~~Characterization Information Summary~~ and the Waste Stream Characterization Package (when requested by the Permittees) are prepared as appropriate. The Site Project Manager must also verify these reports are consistent with information found in batch reports. Summarized testing data are included in the CIS~~Characterization Information Summary~~. The contents of the WSPF, CIS~~Characterization Information Summary~~, and Waste Stream Characterization Package are discussed in the following sections.

After approval of a WSPF and the associated CIS~~Characterization Information Summary~~ by the DOE, the generator/storage site are required to maintain a cross reference of container identification numbers to each BDR~~Batch Data Report~~.

A Waste Stream Characterization Package shall be transmitted by hard copy or electronically from the Site Project Manager to the Permittees when requested.

C3-6b(1) Waste Stream Profile Form

The ~~Waste Stream Profile Form~~WSPF (~~WSPF,~~ Permit Attachment C, Figure C-1) shall include the following information:

- Generator/storage site name
- Generator/storage site EPA ID
- Date of audit report approval by NMED (if obtained)
- Original generator of waste stream
- Whether waste is ~~Contact-Handled~~ contact-handled or remote-handled~~Remote-Handled~~
- The Waste Stream WIPP Identification Number
- Summary Category Group
- Waste Matrix Code Group
- Waste Material Parameter Weight Estimates per unit of waste
- Waste stream name
- A description of the waste stream
- Applicable EPA hazardous waste numbers
- Applicable TRUCON codes

- A listing of ~~acceptable knowledge~~AK documentation used to identify the waste stream

- The waste characterization procedures used and the revision number and date of the procedure

- Certification signature of Site Project Manager, name, title, and date signed

C3-6b(2) Characterization Information Summary

The CIS~~Characterization Information Summary~~ shall include the following elements, if applicable:

- Data reconciliation with DQOs

- Radiography and VE summary to document that ~~all~~ prohibited items are absent in the waste and to verify that the physical form of the waste matches the waste stream description as determined by AK (if applicable).

- A justification for the selection of radiography and/or VE as an appropriate method for characterizing the waste.

- A complete listing of ~~all~~ the container identification numbers used to generate the WSPF, cross-referenced to each BDR.~~Batch Data Report~~

- Complete AK summary, including stream name and number, point of generation, waste stream volume (current and projected), generation dates, TRUCON codes, Summary Category Group, Waste Matrix Code(s) and Waste Matrix Code Group, other TRU Waste Baseline Inventory Report~~TWBIR~~ information, waste stream description, areas of operation, generating processes, Resource Conservation and Recovery Act~~RCRA~~ determinations, radionuclide information, ~~all~~ the references used to generate the AK summary, and any other information required by Permit Attachment C4, Section C4-2b.

- Method for determining Waste Material Parameter Weights per unit of waste.

- List of ~~any~~ AK Sufficiency Determinations requested for the waste stream, if applicable.

- Certification through ~~acceptable knowledge~~AK or testing that any waste assigned the EPA hazardous waste number of U134 (hydrofluoric acid) no longer exhibits the characteristic of corrosivity. This is verified by ensuring that no liquid is present in U134 waste.

C3-6b(3) Waste Stream Characterization Package

The Waste Stream Characterization Package includes the following information:

- Waste Stream Profile Form (~~WSPF,~~ Section C3-6b(1))
- Accompanying CIS~~Characterization Information Summary~~ (Section C3-6b(2))
- Complete AK summary (Section C3-6b(2))
- Batch Data Reports supporting the characterization of the waste stream and any others requested by the Permittees
- Raw testing data requested by the Permittees

C3-6b(4) WIPP Waste Information System ~~(**WWIS**)~~ Data Reporting

The WIPP Waste Information System (**WWIS**)~~WWIS~~ Data Dictionary includes ~~all of~~ the data fields, the field format and the limits associated with the data as established by this WAP. These data will be subjected to edit and limit checks that are performed automatically by the database, as defined in the *Waste Data System User's Manual* (DOE, 2019~~2009~~).

C3-7 Nonconformances

The Permittees shall require the status of work and the WAP activities at participating generator/storage sites to be monitored and controlled by the Site Project Manager. This monitoring and control shall include nonconformance identification, documentation, and reporting.

The nonconformances and corrective action processes specified in this section describe procedures between the Permittees and the generator/storage sites.

Nonconformances

Nonconformances are uncontrolled and unapproved deviations from an approved plan or procedure. Nonconforming items and activities are those that do not meet the WAP requirements, procurement document criteria, or approved work procedures. Nonconforming items shall be identified by marking, tagging, or segregating, and the affected generator/storage site(s) notified. Any waste container for which a nonconformance report (**NCR**) has been written will not be shipped to the WIPP facility unless the condition that led to the NCR for that container has been dispositioned in accordance with DOE's Quality Assurance Program Description (**QAPD**). Disposition of nonconforming items shall be identified and documented. The QAPjPs shall identify the person(s) responsible for evaluating and dispositioning nonconforming items and shall include referenced procedures for handling them. For each container selected for confirmation pursuant to Permit Attachment C7, the Permittees will examine the respective NCR documentation to verify NCRs have been dispositioned for the selected container.

Management ~~at all levels~~ shall foster a “no-fault” attitude to encourage the identification of nonconforming items and processes. Nonconformances may be detected and identified by anyone performing WAP activities, including

- Project staff - during field operations, supervision of subcontractors, data validation and verification, and self-assessment
- Testing Facility staff - during the preparation for and performance of laboratory testing; calibration of equipment; QC activities; data review, validation, and verification; and self-assessment
- QA personnel - during oversight activities or audits

A NCR shall be prepared for each nonconformance identified. Each NCR shall be initiated by the individual(s) identifying the nonconformance. The NCR shall then be processed by knowledgeable and appropriate personnel. For this purpose, a NCR including, or referencing as appropriate, results of QC tests, audit reports, internal memoranda, or letters shall be prepared. The NCR must provide the following information:

- Identification of the individual(s) identifying or originating the nonconformance
- Description of the nonconformance
- Method(s) or suggestions for correcting the nonconformance (corrective action)
- Schedule for completing the corrective action
- An indication of the potential ramifications and overall usability of the data, if applicable
- Any approval signatures specified in the site nonconformance procedures

The Permittees shall require the Site Project Manager to oversee the NCR process and be responsible for developing a plan to identify and track ~~all~~ nonconformances and report this information to the Permittees. The Site Project Manager is also responsible for notifying project personnel of the nonconformance and verifying completion of the corrective action for nonconformances.

Nonconformance to DQOs

For any non-administrative nonconformance related to applicable requirements specified in this WAP which are first identified at the Site Project Manager signature release level (i.e., a failure to meet a DQO), the Permittees shall receive written notification within seven calendar days of identification and shall also receive a NCR within 30 calendar days of identification of the incident. The DOE shall require the generator/storage site to implement a corrective action which remedies the nonconformance prior to management, storage, or disposal of the waste at the WIPP facility. The Permittees shall send NMED a monthly summary of nonconformances identified during the previous month, indicating the number of nonconformances received and the generator/storage sites responsible. If nonconformances are not identified in a given month, a report is not required.

DOE's Corrective Action Process

The DOE shall initiate a corrective action process when internal nonconformances and nonconformances at the generator/storage sites are identified. Activities and processes that do not meet requirements are documented as deficiencies.

When a deficiency is identified by the Permittees, the following process action steps are required:

- The condition is documented on a Corrective Action Report (**CAR**) by the individual identifying the problem.
- The DOE has designated the CAR Initiator and Assessment Team Leader to review the CAR, determine validity of the finding (determine that a requirement has been violated), classify the significance of the condition, assign a response due date, and issue the CAR to the responsible party.
- The responsible organization reviews the CAR, evaluates the extent and cause of the deficiency and provides a response to DOE, indicating remedial actions and actions to preclude recurrence that will be taken.
- The DOE reviews the response from the responsible organization and, if acceptable, communicates the acceptance to the responsible organization.
- The responsible organization completes remedial actions and actions to preclude recurrence of the condition.
- After ~~all~~the corrective actions have been completed, DOE schedules and performs a verification to ensure that corrective actions have been completed and are effective. When ~~all~~ the corrective actions have been completed and verified as being effective, the CAR is closed by the CAR Initiator and Assessment Team Leader on behalf of DOE.
- As part of the planning process for subsequent audits and surveillances, past deficiencies are reviewed and the previous deficient activity or process is subject to reassessment.

C3-8 Special Training Requirements and Certifications

Before performing activities that affect WAP quality, ~~all~~ personnel are required to receive indoctrination into the applicable scope, purpose, and objectives of the WAP and the specific QAOs of the assigned task. Personnel assigned to perform activities for the WAP shall have the education, experience, and training applicable to the functions associated with the work. Evidence of personnel proficiency and demonstration of competence in the task(s) assigned must be demonstrated and documented. ~~All personnel~~Personnel designated to work on specific aspects of the WAP shall maintain qualification (i.e., training and certification) throughout the duration of the work as specified in this WAP and applicable QAPjPs/procedures. Job performance shall be evaluated and documented at periodic intervals, as specified in the implementing procedures.

Personnel involved in WAP activities shall receive continuing training to ensure that job proficiency is maintained. If not specified by this WAP, the due date for required continuing training courses and requalification shall be the end of the month of the anniversary date when the training was previously completed. Training includes both education in principles and enhancement of skills. Each participating site shall include in its QAPjP a description of the procedures for implementing personnel qualification and training. ~~All training~~Training records that specify the scope of the training, the date of completion, and documentation of job proficiency shall be maintained as QA Records in the site project file.

The minimum qualifications for certain specified positions for the WAP are summarized in Table C3-2. QAPjPs, or their implementing SOPs, shall specify the site-specific titles and minimum training and qualification requirements for personnel performing WAP activities. QAPjPs/procedures shall also contain the requirements for maintaining records of the qualification, training, and demonstrations of proficiency by these personnel.

An evaluation of personnel qualifications shall include comparing and evaluating the requirements specified in the job/position description and the skills, training, and experience included in the current resume of the person. This evaluation also must be performed for personnel who change positions because of a transfer or promotion as well as personnel assigned to short-term or temporary work assignments that may affect the quality of the WAP. QAPjPs/procedures shall identify the responsible person(s) for ensuring that ~~all~~ personnel maintain proficiency in the work performed and identify any additional training that may be required.

C3-9 Changes to WAP-Related Plans or Procedures

Controlled changes to WAP-related plans or procedures shall be managed through the document control process described in the QAPD. The Site Project Manager shall review ~~all~~ the non-administrative changes and evaluate whether those changes could impact DQOs specified in the Permit. After site certification, any changes to WAP-related plans or procedures that could positively or negatively impact DQOs (i.e., those changes that require prior approval of the DOE as defined in Attachment C5, Section C5-2) shall be reported to the DOE within five days of identification by the project level review. The Permittees shall send the NMED a monthly summary briefly describing the changes to data-quality affecting plans and procedures identified pursuant to this section during the previous month. If changes to data-quality affecting plans and procedures are not identified in a given month, a report is not required.

C3-10 List of References

DOE, 2019~~2009~~. Waste Data System User's Manual. DOE/WIPP 09-3427, Current Revision, Carlsbad, New Mexico, Carlsbad Area Office, U.S. Department of Energy.

~~Pasternack B. S. and N. H. Harley. 1971. "Detection Limits for Radionuclides in the Analysis of Multi-Component Gamma-Spectrometric Data."~~ ~~*Nucl. Instr. and Meth,*~~ ~~No. 91: pp. 533-40.~~

TABLES

Table C3-1
Waste Material Parameters and Descriptions

Waste Material Parameter	Description
Iron-based Metals/Alloys	Iron and steel alloys in the waste; does not include the waste container materials
Aluminum-based Metals/Alloys	Aluminum or aluminum-based alloys in the waste materials
Other Metals	~~All other~~Other metals found in the waste materials
Other Inorganic Materials	Nonmetallic inorganic waste including concrete, glass, firebrick, ceramics, sand, and inorganic sorbents
Cellulosics	Materials generally derived from high-polymer plant carbohydrates; (e.g., paper, cardboard, wood, and cloth)
Rubber	Natural or man-made elastic latex materials; (e.g., surgeons' gloves, and leaded rubber gloves)
Plastics (waste materials)	Generally man-made materials, often derived from petroleum feedstock; (e.g., polyethylene and polyvinylchloride)
Organic Matrix	Cemented organic resins, solidified organic liquids and sludges
Inorganic Matrix	Any homogeneous materials consisting of sludge or aqueous-based liquids that are solidified with cement, calcium silicate, or other solidification agents; (e.g., wastewater treatment sludge, cemented aqueous liquids, and inorganic particulates)
Soils/gravel	Generally consists of naturally occurring soils that have been contaminated with inorganic waste materials
Steel (packaging materials)	55-gallon (208-Liter) drums
Plastics (packaging materials)	90-millimeter polyethylene drum liner and plastic bags

Table C3-2
Minimum Training and Qualifications Requirements

Personnel	Requirements
Radiography Operators [a]	Site-specific training based on waste matrix codes and waste material parameters; requalification every 2 years

[a] Operators are those persons responsible for the actual operation of testing equipment. QAPjPs shall include the site-specific title for this position.

Table C3-3
Testing Batch Data Report Contents

Required Information	Radiography	Visual Examination	Comment
Batch Data Report Date	X	X	
Batch number	X	X	
Waste container number	X	X	
Waste stream name and/or number	O	O	
Waste Matrix Code	X	X	Summary Category Group included in waste matrix code
Implementing procedure (specific version used)	X	X	If procedure cited contains more than one method, the method used must also be cited. Can use revision number, date, or other means to track specific version used.
Container type	O	O	Drums, Standard Waste Box, Ten Drum Overpack, etc.
Video media reference	X	X	Reference to Video media applicable to each container. For visual examination of newly generated waste, video media not required if two trained operators review the contents of the waste container to ensure correct reporting.
Imaging check	O		
Camera check		O	
Audio check	O	O	
QC documentation	X	X	
Verification that the physical form matches the waste stream description and Waste Matrix Code.	X	X	Summary Category Group included in waste matrix code
Comments	X	X	
Reference to or copy of associated NCRs, if any	X	X	Copies of associated NCRs must be available.
Verify absence of prohibited items	X	X	
Operator signature and date of test	X	X	Signatures of both operators required for Visual Verification of ~~Acceptable Knowledge~~AK
Data review checklists	X	X	~~All data~~Data review checklists will be identified

LEGEND:

X - Required in batch data report.

O - Information must be documented and traceable; inclusion in batch data report is optional.

ATTACHMENT C4

TRU MIXED WASTE CHARACTERIZATION USING ACCEPTABLE KNOWLEDGE

ATTACHMENT C4

TRU MIXED WASTE CHARACTERIZATION USING ACCEPTABLE KNOWLEDGE

TABLE OF CONTENTS

LIST OF FIGURES

ATTACHMENT C4

TRU MIXED WASTE CHARACTERIZATION USING ACCEPTABLE KNOWLEDGE

C4-1 Introduction

The Resource Conservation and Recovery Act (**RCRA**) regulations codified in Title 40 of the Code of Federal Regulations (**CFR**) Parts 260 through 265, 268, and 270, and the New Mexico Hazardous Waste Management Regulations in 20.4.1 New Mexico Administrative Code (**NMAC**) Subparts 100 through 600, Subpart 800, and Subpart 900, authorize the use of acceptable knowledge (**AK**) in appropriate circumstances by waste generators, or treatment, storage, or disposal facilities to characterize hazardous waste. ~~Acceptable knowledge~~The AK is described in *Waste Analysis: EPA Guidance Manual for Facilities That Generate, Treat, Store and Dispose of Hazardous Waste* (EPA, 1994). ~~Acceptable knowledge~~The AK, as an alternative to sampling and analysis, can be used to meet all or part of the waste characterization requirements under the RCRA (EPA, 1994).

The Environmental Protection Agency's (**EPA's**) 1994 ~~Waste Analysis~~ Guidance Manual broadly defines the term "acceptable knowledge" to include process knowledge, whereby detailed information on the wastes is obtained from existing published or documented waste analysis data or studies conducted on hazardous waste generated by processes similar to that which generated the waste; facility records of analysis performed before the effective date of RCRA; and waste analysis data obtained from generators of similar wastes that send their wastes off-site for treatment, storage, or disposal (EPA, 1994). If a generator/storage site determines that AK alone is insufficient to accurately characterize a waste, the site may use radiography and/or visual examination (**VE**) (specified in Permit Attachment C1) to complete the waste characterization process and satisfy the requirements of the Waste Analysis Plan (**WAP**) specified in Permit Attachment C. ~~Acceptable knowledge~~The AK is used in transuranic (**TRU**) mixed waste characterization activities in five ways:

- To delineate TRU mixed waste streams
- To assess whether TRU mixed wastes comply with the applicable requirements of the Treatment, Storage, and Disposal Facility Waste Acceptance Criteria (**TSDF-WAC**)
- To assess whether TRU mixed wastes exhibit a hazardous characteristic (20.4.1.200 NMAC, incorporating 40 CFR ~~§~~Part 261, Subpart C)
- To assess whether TRU mixed wastes are listed (20.4.1.200 NMAC, incorporating 40 CFR ~~§~~Part 261, Subpart D)
- To estimate waste material parameter weights

Radiography and/or VE may be performed to augment the characterization of wastes based on ~~acceptable knowledge~~AK when an AK Sufficiency Determination has not been requested by the generator/storage site or, if requested, has not been granted by the U.S. Department of Energy (**DOE**) (see Section C4-3d). ~~TRU~~ Transuranic mixed waste streams shall undergo applicable provisions of the ~~acceptable knowledge~~AK process prior to management, storage, or disposal by the Permittees at the WIPP facility.

C4-2 Acceptable Knowledge Documentation

The Permittees shall obtain from each DOE TRU mixed waste generator/storage site (**site**) a logical sequence of ~~acceptable knowledge~~AK information that progresses from general facility information (TRU Mixed Waste Management Program Information) to more detailed waste-specific information (TRU Mixed Waste Stream Information). Traceability of ~~acceptable knowledge~~AK information for a selected container in the audited Waste Summary Category Group(s) will be examined during DOE's audit of a site (Section C4-3g). The consistent presentation of ~~acceptable knowledge~~AK documentation among sites in auditable records[1] will allow DOE to verify the completeness and adequacy of ~~acceptable knowledge~~AK for TRU mixed waste characterization during the audit process. The Permittees shall require sites to implement the ~~acceptable knowledge~~AK process as specified in this Permit to characterize TRU mixed wastes and obtain sufficient waste characterization data to demonstrate compliance with the Permit. The New Mexico Environment Department (**NMED**) may independently validate the implementation of and compliance with applicable provisions of the WAP at each generator/storage site by participation in the Audit and Surveillance Program (Permit Attachment C6). The DOE shall provide the NMED with current audit schedules and notify NMED in writing no later than thirty (30) calendar days prior to each audit. The NMED may choose to accompany DOE on any audit of the WAP implementation.

The following sections include the information the Permittees will require for each site to characterize TRU mixed waste using ~~acceptable knowledge~~AK. Because waste generating processes are site-specific, sites shall, as necessary, augment the required ~~acceptable knowledge~~AK records with additional supporting information (see Section C4-2c, Additional Acceptable Knowledge Information). If the required information is not available for a particular waste stream, the waste stream will not be eligible for an AK Sufficiency Determination as specified in Section C4-3d.

C4-2a Required TRU Mixed Waste Management Program Information

~~TRU~~Transuranic mixed waste management program information shall clearly define waste categorization schemes and terminology, provide a breakdown of the types and quantities of TRU mixed waste that are generated and stored at the site, and describe how waste is tracked and managed at the site, including historical and current operations. Information related to TRU mixed waste certification procedures and the types of documentation (e.g., waste profile forms) used to summarize ~~acceptable knowledge~~AK shall also be provided. The following information shall be included as part of the ~~acceptable knowledge~~AK written record:

- Map of the site with the areas and facilities involved in TRU mixed waste generation, treatment, and storage identified

---

[1] "Auditable records" mean those records which allow the Permittees to conduct a systematic assessment, analysis, and evaluation of the Permittees compliance with the WAP and this Permit.

- Facility mission description as related to TRU mixed waste generation and management (e.g., nuclear weapons research may involve metallurgy, radiochemistry, and nuclear physics operations that result in specific waste streams)

- Description of the operations that generate TRU mixed waste at the site (e.g., plutonium recovery, weapons design, or weapons fabrication)

- Waste identification or categorization schemes used at the facility (e.g., item description codes, content codes)

- Types and quantities of TRU mixed waste generated, including historical generation through future projections

- Correlation of waste streams generated from the same building and process, as appropriate (e.g., sludge, combustibles, metals, and glass)

- Waste certification procedures for retrievably stored and newly generated wastes to be sent to the WIPP facility

C4-2b Required TRU Mixed Waste Stream Information

Sites may use ~~acceptable knowledge~~AK to delineate site-specific waste streams. For each TRU mixed waste stream, the Permittees shall require sites to compile ~~all~~ the process information and data that support the ~~acceptable knowledge~~AK used to characterize that waste stream. The type and quantity of supporting documentation will vary by waste stream, depending on the process generating the waste and site-specific requirements imposed by the Permittees. At a minimum, the waste process information shall include the following written information:

- Area(s) and/or building(s) from which the waste stream was or is generated

- Waste stream volume and time period of generation (e.g., 100 standard waste boxes of retrievable stored waste generated from June 1977 through December 1977)

- Waste generating process described for each building (e.g., batch waste stream generated during decommissioning operations of glove boxes), including processes associated with U134 [hydrofluoric acid] waste generation, if applicable.

- Documentation regarding how the site has historically managed the waste, including the historical regulatory status of the waste (i.e., TRU mixed versus TRU non-mixed waste)

- Process flow diagrams (e.g., a diagram illustrating glove boxes from a specific building to a size reduction facility to a container storage area)~~.~~; ~~In~~ in the case of research/development, analytical laboratory waste, or other similar processes where process flow diagrams cannot be created, a description of the waste generating processes, rather than a formal process flow diagram, may be included if this modification is justified and the justification is placed in the auditable record

- Material inputs or other information that identifies the chemical content of the waste stream and the physical waste form (e.g., glove box materials and chemicals handled during glove box operations; events or processes that may have modified the chemical or physical properties of the waste stream after generation; data obtained through visual examination **(VE)** of newly generated waste that later undergoes radiography; information demonstrating neutralization of U134 ~~[hydrofluoric acid]~~ and waste compatibility)

The ~~acceptable knowledge~~AK written record shall include a summary that identifies ~~all~~ the sources of waste characterization information used to delineate the waste stream. The basis and rationale for delineating each waste stream, based on the parameters of interest, shall be clearly summarized and traceable to referenced documents. Assumptions made in delineating each waste stream also shall be identified and justified. If discrepancies exist between required information, then sites may consider applying ~~all~~the EPA hazardous waste numbers indicated by the information to the subject waste stream, but must assess and evaluate the information to determine the appropriate EPA hazardous waste numbers consistent with RCRA requirements. The Permittees shall obtain from each site, at a minimum, procedures that comply with the following ~~acceptable knowledge~~AK requirements:

- Procedures for identifying and assigning the physical waste form of the waste

- Procedures for delineating waste streams and assigning Waste Matrix Codes

- Procedures for resolving inconsistencies in ~~acceptable knowledge~~AK documentation

- Procedures for ~~visual examination~~VE and/or radiography, if applicable

- For newly generated waste, procedures describing process controls used to ensure prohibited items (specified in the WAP, Permit Attachment C) are documented and managed

- Procedures to ensure radiography and ~~visual examination~~VE include a list of prohibited items that the operator shall verify are not present in each container (e.g., liquid exceeding TSDF-WAC limits, corrosives, ignitables, reactives, and incompatible wastes)

- Procedures to document how changes to Waste Matrix Codes, waste stream assignment, and associated ~~Environmental Protection Agency (**EPA**)~~EPA hazardous waste numbers based on material composition are documented for any waste

- Procedures that ensure the assignment of EPA hazardous waste numbers is appropriate, consistent with RCRA requirements, and considers site historical waste management

- Procedures for estimating waste material parameter weights

C4-2c Additional Acceptable Knowledge Information

The generator/storage sites shall obtain additional ~~acceptable knowledge~~AK information. Sites shall collect information as appropriate to augment required information and provide any other information obtained to further delineate waste streams. Adequacy of this information shall be assessed by DOE during audits (Section C4-3g). Sites will use this information to compile the ~~acceptable knowledge~~AK written record.

~~All additional~~Additional specific, relevant ~~acceptable knowledge~~AK documentation assembled and used in the ~~acceptable knowledge~~AK process, whether it supports or contradicts any required ~~acceptable knowledge~~AK documentation, shall be identified and an explanation provided for its use (e.g., identification of a toxicity characteristic). Additional documentation may be used to further document the rationale for the hazardous characterization results. The collection and use of additional information shall be assessed by DOE during site audits to ensure that hazardous waste characterization is supported, as necessary, by such information. Similar to required information, if discrepancies exist between additional information and the required information, then sites may consider applying ~~all~~the EPA hazardous waste numbers indicated by the additional information to the subject waste stream, but must assess and evaluate the information to determine the appropriate EPA hazardous waste numbers consistent with RCRA requirements. ~~All~~The information considered must be documented and placed in the auditable record, including applicable discrepancy resolution documentation.

Additional ~~acceptable knowledge~~AK documentation includes, but is not limited to, the following information:

- Process design documents (e.g., Title II Design)
- Standard operating procedures that may include a list of raw materials or reagents, a description of the process or experiment generating the waste, and a description of wastes generated and how the wastes are managed at the point of generation
- Preliminary and final safety analysis reports and technical safety requirements
- Waste packaging records
- Test plans or research project reports that describe reagents and other raw materials used in experiments
- Site databases (e.g., chemical inventory database for Superfund Amendments and Reauthorization Act Title III requirements)
- Information from site personnel (e.g., documented interviews)
- Standard industry documents (e.g., vendor information)
- Analytical data relevant to the waste stream, including results from fingerprint analyses, spot checks, routine verification sampling, or other processes that collect information pertinent to the waste stream~~.~~; ~~This~~ this may also include new information

which augments required information (e.g., ~~visual examination~~VE not performed in compliance with the WAP, radiography screening for prohibited items)

- Material Safety Data Sheets/Safety Data Sheets, product labels, or other product package information
- Sampling and analysis data from comparable or surrogate waste streams (e.g., equivalent nonradioactive materials)
- Laboratory notebooks that detail the research processes and raw materials used in an experiment

C4-3 Acceptable Knowledge Training, Procedures and Other Requirements

The Permittees shall require consistency among sites in using ~~acceptable knowledge~~AK information to characterize TRU mixed waste by the use of the following: 1) compiling the required and additional ~~acceptable knowledge~~AK documentation in an auditable record, 2) auditing ~~acceptable knowledge~~AK records, and 3) Waste Stream Profile Form (**WSPF**) approval and waste confirmation. This section specifies qualification and training requirements, describes each phase of the process, specifies the procedures that the Permittees shall require ~~all~~ sites to develop to implement the requirements for using ~~acceptable knowledge~~AK, and specifies data quality requirements for ~~acceptable knowledge~~AK.

C4-3a Qualifications and Training Requirements

Site personnel responsible for compiling ~~acceptable knowledge~~AK, assessing ~~acceptable knowledge~~AK, and resolving discrepancies associated with ~~acceptable knowledge~~AK shall be qualified and trained in the following areas at a minimum:

- WIPP WAP in Permit Attachment C, *Waste Analysis Plan*, and the TSDF-WAC specified in this permit
- State and Federal RCRA regulations associated with solid and hazardous waste characterization
- Discrepancy resolution and reporting processes
- Site-specific procedures associated with waste characterization using ~~acceptable knowledge~~AK

C4-3b Acceptable Knowledge Assembly and Compilation

The Permittees shall obtain from sites ~~acceptable knowledge~~AK procedures which require consistent application of the ~~acceptable knowledge~~AK process and requirements. Site-specific ~~acceptable knowledge~~AK procedures shall address the following:

- Sites shall prepare and implement a written procedure outlining the specific methodology used to assemble ~~acceptable knowledge~~AK records, including the origin of the documentation, how it will be used, and any limitations associated with the information (e.g., identify the purpose and scope of a study that included limited sampling and analysis data).

- Sites shall develop and implement a written procedure to compile the required ~~acceptable knowledge~~AK record.

- Sites shall develop and implement a written procedure that ensures unacceptable wastes (e.g., reactive, ignitable, corrosive) are identified and segregated from TRU mixed waste populations sent to the WIPP facility.

- Sites shall prepare and implement a written procedure to evaluate ~~acceptable knowledge~~AK and resolve discrepancies. For example, if different sources of information indicate different hazardous wastes are present, then sites shall include the~~all~~ sources of information in its records and may choose to either conservatively assign EPA hazardous waste numbers or assign only those numbers deemed appropriate and consistent with RCRA requirements. ~~All information~~ Information used to justify assignment of EPA hazardous waste numbers must be placed in the auditable record. Further, the assignment of EPA hazardous waste numbers shall be tracked in the auditable record to ~~all~~the required documentation.

- Sites shall prepare and implement a written procedure to identify hazardous wastes and assign the appropriate EPA hazardous waste numbers to each waste stream. The following are minimum baseline requirements/standards that site-specific procedures shall include to ensure comparable and consistent characterization of hazardous waste:

  - Compile ~~all of~~ the required information in an auditable record.

  - Review the compiled information and delineate waste streams. Delineation of waste streams must comply with the definition in Permit Attachment C, Section C-0a, and justify combining waste historically managed separately as TRU mixed and TRU non-mixed waste streams into a single waste stream.

  - Review the compiled information to determine if the waste stream is compliant with the TSDF-WAC.

  - Review the required information to determine if the waste is listed under 20.4.1.200 NMAC (incorporating 40 CFR ~~§~~Part 261), Subpart D. Assign ~~all~~the listed EPA hazardous waste numbers unless the sites choose to justify an alternative assignment and document the justification in the auditable record.

  - Review the required information to determine if the waste exhibits a hazardous characteristic or may contain hazardous constituents included in the toxicity characteristics specified in 20.4.1.200 NMAC (incorporating 40 CFR ~~§~~Part 261), Subpart C. If a toxicity characteristic contaminant is identified and is not included as a listed waste, sites may evaluate available data and assign the toxicity characteristic EPA hazardous waste number consistent with RCRA requirements. ~~All data~~Data examined to reach the EPA hazardous waste number determination must be placed in the auditable record and must present a clear justification for the EPA hazardous waste number analyses.

  - Review the compiled information to provide an estimate of material parameter weights for each container to be stored or disposed of at the WIPP facility.

For newly generated wastes, procedures shall be developed and implemented to characterize hazardous waste using ~~acceptable knowledge~~AK prior to packaging the waste.

- Sites shall ensure that results of audits of the site's TRU mixed waste characterization programs ~~at the site~~ are available in the records.

- Sites shall identify the ~~all~~ process controls (implemented to ensure that the waste contains no prohibited items and to control hazardous waste content and/or physical form) that may have been applied to retrievably stored waste and/or may presently be applied to newly generated waste. Process controls are applied at the time of waste generation/packaging to control waste content, whereas any activities performed after waste generation/packaging to identify prohibited items, hazardous waste content, or physical form are waste characterization activities, not process controls. The AK record must contain specific process controls and supporting documentation identifying when these process controls are used to control waste content. See Permit Attachment C, Section C-2 for programmatic requirements related to process controls.

C4-3c Criteria for Assembling an Acceptable Knowledge Record and Delineating the Waste Stream

Figure C4-1 provides an overview of the process for assembling ~~acceptable knowledge~~AK documentation into an auditable record. The first step is to assemble ~~all of~~ the required ~~acceptable knowledge~~AK information and any additional information regarding the materials and processes that generate a specific waste stream. The Permittees shall require the sites to implement procedures which comply with the following criteria to establish ~~acceptable knowledge~~AK records:

- Acceptable knowledge information shall be compiled in an auditable record, including a road map for ~~all~~the applicable information.

- The overview of the facility and TRU mixed waste management operations in the context of the facility's mission shall be correlated to specific waste stream information.

- Correlations between waste streams, with regard to time of generation, waste generating processes, and site-specific facilities shall be clearly described. For newly generated wastes, the rate and quantity of waste to be generated shall be defined.

- A reference list shall be provided that identifies documents, databases, Quality Assurance protocols, and other sources of information that support the ~~acceptable knowledge~~AK information.

Container inventories for TRU mixed waste currently in retrievable storage shall be delineated into waste streams by correlating the container identification to ~~all of~~ the required ~~acceptable knowledge~~AK information and any additional ~~acceptable knowledge~~AK information.

C4-3d AK Sufficiency Determination Request Contents

Generator/storage sites may submit an AK Sufficiency Determination Request (**Determination Request**) to meet all or part of the waste characterization requirements. The Determination Request shall include, at a minimum:

- A complete AK Summary that addresses the following technical requirements:
    - Executive Summary;
    - Waste Stream Identification Summary, including a demonstration that the waste stream has been properly delineated and meets the Permit definition of waste stream (Permit Attachment C, *Introduction*);
    - Mandatory Program Information (including, but not limited to, facility location and description, mission, defense waste assessment, spent nuclear fuel and high-level waste assessment, description of waste generating processes, research/development [as necessary], facility support operations [as applicable], types and quantities of TRU waste generated, correlation of waste streams to buildings/processes, waste identification and categorization, physical form identifiers);
    - Mandatory Waste Stream Information (including, but not limited to, Area and Building of Generation, waste stream volume/period of generation (including, for newly generated waste, the rate and quantity of waste to be generated), waste generating activities, types of waste generated, material input related to physical form and identification of percentage of each waste material parameter in the waste stream, chemical content information including hazardous constituents and hazardous waste identification, prohibited item content (including documented evidence that the waste meets the TSDF-WAC presented in Permit Part 2, Sections 2.3.3.1 through 2.3.3.10), waste packaging, presence of filter vents, number of layers of confinement);
    - Types of additional information gathered;
    - Container specific data (if available and relevant); and
    - A complete reference list including ~~all~~ mandatory and additional information.
- An AK roadmap (defined as a cross reference between mandatory programmatic and mandatory waste stream information, with references supporting these requirements).
- A complete reference list including ~~all~~ mandatory and additional documentation.
- Additional relevant information for the required programmatic and waste stream data addressed in the AK Summary, examples of which are presented in Permit Attachment C4, Section C4-2c.
- Identification of any mandatory requirements supported only by upper tier documents (i.e., there is insufficient supporting data).

- Description or other means of demonstrating that the AK process described in the Permit was followed (for example, AK personnel were appropriately trained; discrepancies were documented~~, etc~~).

- Information showing that the generator/storage site has developed a written procedure for compiling the AK information and assigning EPA hazardous waste numbers as required in Section~~Permit Attachment~~ C4-3b.

- Information showing that the generator/storage site has assessed the AK process (e.g. internal audits, Section~~Permit Attachment~~ C4-3b).

The Permittees shall evaluate the Determination Request for completeness and technical adequacy as specified in Permit Attachment C.

C4-3e Requirements for Re-evaluating Acceptable Knowledge Information

Acceptable knowledge includes information regarding the physical form of the waste, the base materials composing the waste, and the process that generates the waste. Waste testing (i.e., radiography or ~~visual examination~~VE) may be used to augment ~~acceptable knowledge~~AK information.

The ~~Waste Stream Profile Form (**WSPF**)~~WSPF and Characterization Information Summary (including the ~~acceptable knowledge~~AK summary) will be reviewed by the Permittees for each waste stream prior to DOE approval of the WSPF. The Permittees' review will ensure that the submitted AK information was collected under procedures that ensure implementation of the WAP, provides data sufficient to meet the DQOs in Permit Attachment C,~~Section~~ C-4a(1), and allow the Permittees to demonstrate compliance with the waste analysis requirements of the Permit. A detailed discussion of the Permittees' waste stream review and the DOE's WSPF approval process is provided in Permit Attachment C,~~Section~~ C-1d.

The Permittees shall require sites to establish procedures for reevaluating ~~acceptable knowledge~~AK if the results of waste confirmation indicate that the waste to be shipped does not match the approved waste stream, or if data obtained from radiography or ~~visual examination~~VE for waste streams without an AK Sufficiency Determination exhibit this discrepancy. Site procedures shall describe how the waste is reassigned, ~~acceptable knowledge~~AK reevaluated, and appropriate EPA hazardous waste numbers assigned. If the reevaluation requires that the Waste Matrix Code be changed for the waste stream or the waste does not match the approved waste stream, the following minimum steps shall be taken to reevaluate ~~acceptable knowledge~~AK:

- Review existing information based on the container identification number and document ~~all~~ the differences in EPA hazardous waste number assignments

- If differences exist in the EPA hazardous waste numbers that were assigned, reassess and document ~~all~~ the required ~~acceptable knowledge~~AK information (Section C4-3b) associated with the new designation

- Reassess and document ~~all~~ testing data associated with the waste

- Verify and document that the reassigned Waste Matrix Code was generated within the specified time period, area and buildings, waste generating process, and that the process material inputs are consistent with the waste material parameters identified during radiography or ~~visual examination~~VE

- Record ~~all~~ changes to ~~acceptable knowledge~~AK records

- If discrepancies exist in the ~~acceptable knowledge~~AK information for the revised Waste Matrix Code, document the segregation of the affected portion of the waste stream, and define the actions necessary to fully characterize the waste

C4-3f Acceptable Knowledge Data Quality Requirements

The data quality objectives for testing techniques are provided in Permit Attachment C3. Testing results will be used to augment the characterization of wastes based on ~~acceptable knowledge~~AK. To ensure that the ~~acceptable knowledge~~AK process is consistently applied, the Permittees shall require sites to comply with the data quality requirements for ~~acceptable knowledge~~AK documentation in Permit Attachment C3.

Each site shall address quality control by tracking its performance with regard to the use of ~~acceptable knowledge~~AK by: 1) assessing the frequency of inconsistencies among information, and 2) documenting the results of waste discrepancies identified by the generator/storage site during waste characterization or the Permittees during waste confirmation using radiography, review of radiography audio/video recordings, ~~visual examination~~VE, or review of ~~visual examination~~VE records. In addition, the ~~acceptable knowledge~~AK process and waste stream documentation shall be evaluated through internal assessments by generator/storage site quality assurance organizations.

C4-3g Audits of Acceptable Knowledge

The DOE will conduct an initial audit of each site prior to certifying the site for shipment of TRU mixed waste to the WIPP facility. This initial audit will establish an approved baseline that will be reassessed annually by the DOE. These audits will verify compliance with the requirements specified in the WAP (Permit Attachment C). The audits will be used to verify compliance with the compilation, application, and interpretation requirements of ~~acceptable knowledge~~AK information specified in this Permit at ~~all~~the sites, and to evaluate the completeness and defensibility of site-specific ~~acceptable knowledge~~AK documentation related to hazardous waste characterization. Permit Attachment C6 gives a description of the overall audit program and a required checklist. Figure C4-2 includes the primary steps associated with the audit process of ~~acceptable knowledge~~AK.

Site-specific audit plans will be prepared by the DOE and provided to the NMED, and will identify the scope of the audit, requirements to be assessed, participating personnel, activities to be audited, organizations to be notified, applicable documents, and schedule. Audits will be performed in accordance with written procedures and site-specific checklists that will be developed by the DOE prior to the audit and provided to the NMED. The site-specific audit checklists will include items associated with the compilation and evaluation of the required ~~acceptable knowledge~~AK information as specified in the checklist required by Permit Attachment C6.

Audit checklists shall include Permit Attachment C6, Table C6-2 ~~in Permit Attachment C6~~, and will include but not be limited to the following elements for review during the audit:

- Documentation of the process used to compile, evaluate, and record ~~acceptable knowledge~~AK is available and implemented;
- Personnel qualifications and training are documented;
- ~~All of the~~The required ~~acceptable knowledge~~AK documentation specified in Section C4-2 has been compiled in an auditable record;
- ~~All of the~~The required procedures specified in Section C4-3 have been developed and implemented, including but not limited to:
  - A procedure exists for assigning EPA hazardous waste numbers to waste streams in accordance with Section C4-3;
  - A procedure exists for resolving discrepancies in ~~acceptable knowledge~~AK documentation in accordance with Section C4-3; and
- Results of other audits of the TRU mixed waste characterization programs at the site are available in site records.

Members of the audit team will be knowledgeable regarding the required ~~acceptable knowledge~~AK information, RCRA regulations and EPA guidance regarding the use of ~~acceptable knowledge~~AK for waste characterization, RCRA hazardous waste characterization, and the WAP requirements (Permit Attachment C). Audit team members will be independent of all TRU mixed waste management operations at the site being audited.

Auditors will evaluate ~~acceptable knowledge~~AK documentation for at least one waste stream from the Summary Category Group(s) being audited, and will audit ~~acceptable knowledge~~AK traceability for at least one container from the audited Summary Category Group(s). For these waste streams, auditors will review ~~all~~ the procedures and associated processes developed by the site for documenting the process of compiling ~~acceptable knowledge~~AK documentation; correlating information to specific waste inventories; assigning EPA hazardous waste numbers; and identifying, resolving, and documenting discrepancies in ~~acceptable knowledge~~AK records. The adequacy of ~~acceptable knowledge~~AK procedures and processes will be assessed and any deficiencies in procedures documented in the audit report.

Auditors will review the ~~acceptable knowledge~~AK documentation for selected waste streams for logic, completeness, and defensibility. The criteria that will be used by auditors to evaluate the logic and defensibility of the ~~acceptable knowledge~~AK documentation include completeness and traceability of the information, consistency of application of information, clarity of presentation, degree of compliance with this Permit Attachment with regard to ~~acceptable knowledge~~AK data, nonconformance procedures, and oversight procedures. Auditors will evaluate compliance with written site procedures for developing the ~~acceptable knowledge~~AK record. A completeness review will evaluate the availability of ~~all~~ required TRU mixed waste management program information and TRU mixed waste stream information (Section C4-2). Records will be reviewed for correlation to specific waste streams and the basis for characterizing hazardous waste. Auditors will verify that sites include ~~all~~ required information and assigned appropriate EPA hazardous waste numbers as indicated by the ~~acceptable knowledge~~AK records and consistent with RCRA requirements. ~~All deficiencies~~Deficiencies in the ~~acceptable knowledge~~AK documentation will be included in the audit report.

Auditors will verify and document that sites use administrative controls and follow written procedures to characterize hazardous waste for newly-generated and retrievably stored wastes. Procedures to document changes in ~~acceptable knowledge~~AK documentation and changes to EPA hazardous waste number assignments to specific waste streams also will be evaluated for compliance with the WAP (Permit Attachment C).

After the audit is complete, the DOE will provide the site with preliminary results at a close-out meeting. The DOE will prepare a final audit report that includes the~~all~~ observations and findings identified during the audit. Sites shall respond to ~~all~~ the audit findings and identify corrective actions. Audit results will be included in the final audit report (Permit Attachment C6). If ~~acceptable knowledge~~AK procedures do not exist, the required information is not available, or corrective actions (i.e., CARs) are ~~identified~~ associated with deficiencies in the ~~acceptable knowledge~~AK compilation process (i.e., the minimum required information in Section C4-2 has not been collected and organized to present the required information on the subject waste stream(s)), and/or EPA hazardous waste number assignment is not accurate~~characterization~~, the Permittees will not manage, store, or dispose TRU mixed waste for the subject waste stream(s) ~~summary category~~. Permit Attachment C3, Section C3-7, *Nonconformances*, requires the responsible organization(s) to review CARs and evaluate the extent of condition. If, during the corrective action process, the extent of condition is determined to be applicable to other waste streams, the Permittees will not manage, store, or dispose of TRU mixed waste from those affected waste streams. Management, storage, or disposal of the affected waste streams~~subject waste summary category~~ at the WIPP facility will not resume until the DOE agrees~~find~~ that ~~all~~ the corrective actions have been implemented and the site complies with ~~all~~the applicable requirements of the WAP.

The DOE disseminates information regarding TRU mixed waste characterization requirements and program status through the WIPP Home Page. The Permittees will use this web page to disseminate information regarding TRU mixed waste streams, RCRA compliance, and operational and programmatic issues, methods development, and waste characterization information, including the application of ~~acceptable knowledge~~AK. The DOE is provided the required waste characterization information prior to management, storage, or disposal of that waste at WIPP and also will conduct audits at least annually. The Permittees will maintain an ~~operating record~~Operating Record for review during regulatory agency audits. The NMED may also review any information relevant to the scope of the audit during site audits. The DOE will notify the NMED regarding any site's failure to implement corrective actions associated with hazardous waste characterization as specified in Permit Parts 1 and 2 and Permit Attachment C3.

FIGURES

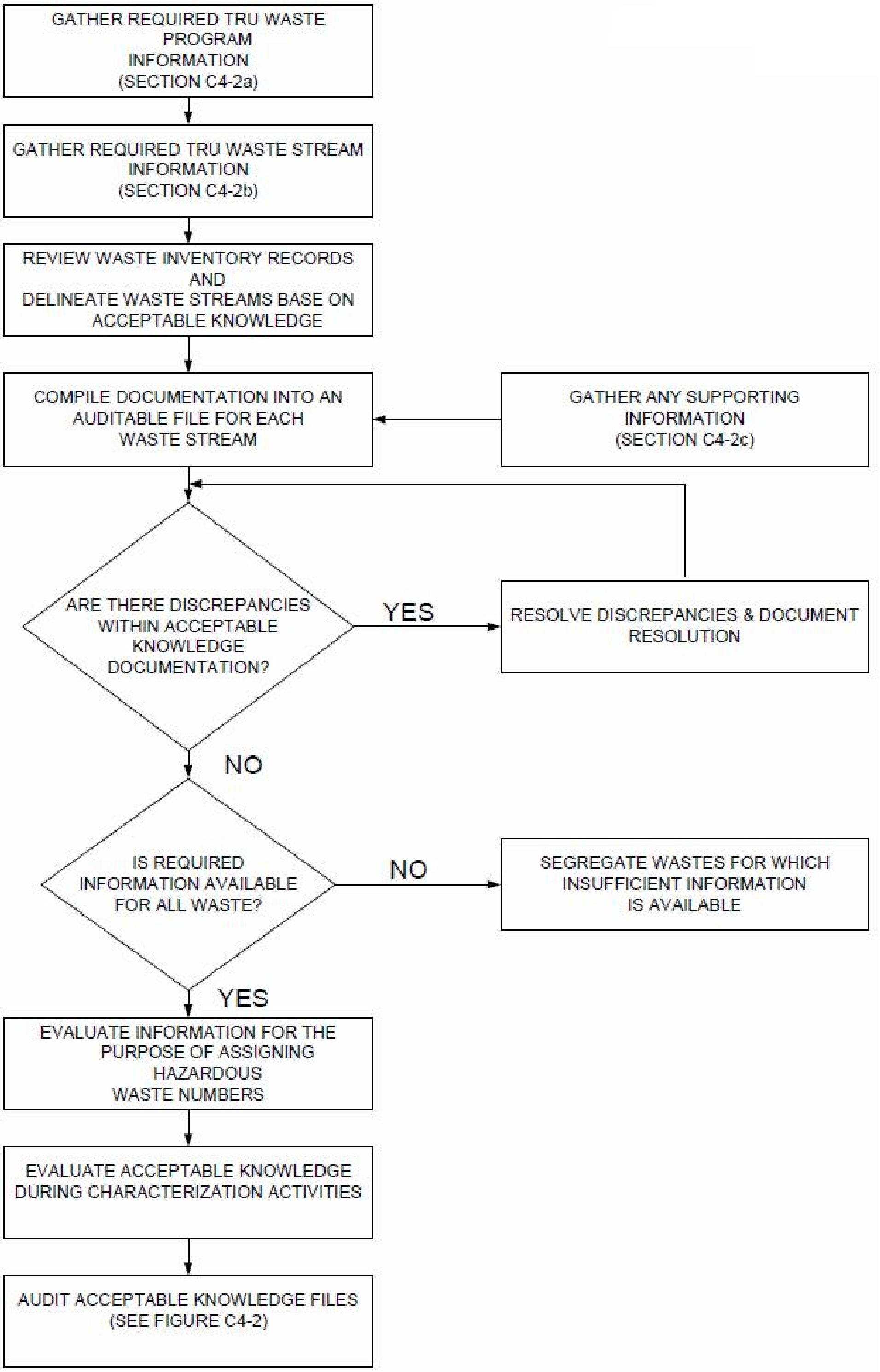


Figure C4-1
Compilation of Acceptable Knowledge Documentation

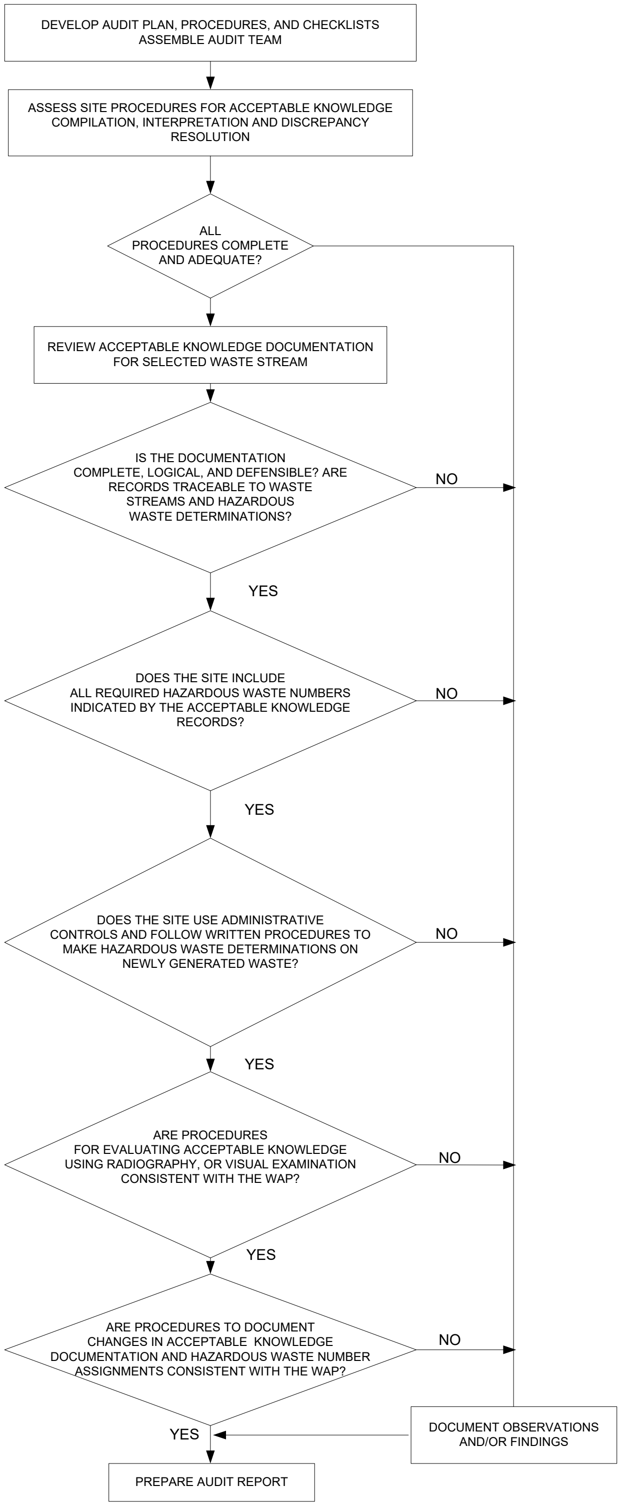


Figure C4-2
Acceptable Knowledge Auditing

ATTACHMENT C5

QUALITY ASSURANCE PROJECT PLAN REQUIREMENTS

ATTACHMENT C5

QUALITY ASSURANCE PROJECT PLAN REQUIREMENTS

TABLE OF CONTENTS

ATTACHMENT C5

QUALITY ASSURANCE PROJECT PLAN REQUIREMENTS

C5-1 Quality Assurance Project Plans

Prior to management, storage, or disposal of a generator/storage site's transuranic (**TRU**) mixed waste at the Waste Isolation Pilot Plant (**WIPP**) facility~~WIPP~~, the Permittees shall require that each participating site develops and implements a quality assurance project plan (**QAPjP**) that addresses ~~all~~ the applicable requirements specified in ~~Waste Isolation Pilot Plant~~ the waste analysis plan (**WAP**) in Permit Attachment C. The U.S. Department of Energy (**DOE**) will approve QAPjPs from ~~all~~ the generator/storage sites that intend to send TRU mixed waste to the WIPP facility~~Waste Isolation Pilot Plant~~. The DOE shall ensure that these QAPjPs include the qualitative or quantitative criteria for determining whether waste characterization program activities are being satisfactorily performed. The DOE shall also ensure that QAPjPs identify the organization(s) and position(s) responsible for their implementation. Additionally, the QAPjPs shall also reference site-specific documentation that details how each of the required elements of the characterization program will be performed.

The DOE shall ensure that prior to the implementation of characterization activities at participating sites, standard operating procedures (**SOPs**) were developed for ~~all~~the activities which affect the quality of the waste characterization program elements specified in the WAP. For the purposes of the quality assurance (**QA**) program, the term SOP refers to any site-specific implementing document. Compliance with SOPs will ensure that tasks are performed in a consistent manner that results in achieving the quality required for the QA~~quality assurance~~ program. The organization, format, content, and designation of SOPs shall be described in the QAPjPs. Site-specific SOPs will be reviewed for consistency with the QAPjP according to the Audit and Surveillance Program specified in Permit Attachment C6.

C5-2 Document Review, Approval, and Control

The DOE shall ensure that the preparation, issuance, and change to documents that specify quality requirements or prescribe activities affecting quality for the ~~transuranic~~ TRU mixed waste characterization program elements specified in the WAP be controlled to assure that correct and current documents are used and referenced. The QAPjPs shall include a document control format consisting of a unique document identification number, current revision number, date, and page number which will be placed on the individual pages of the document. ~~All~~ Quality~~quality~~ documents for the waste characterization program shall be reviewed prior to approval and issuance by qualified and independent individuals. The QAPjP review shall consider the technical adequacy, completeness, and correctness of the QAPjP, and the inclusion of and compliance with the requirements established by the WAP (Permit Attachment C). The DOE shall ensure that appropriate QAPjP approval is indicated by a signature and date page included in the front of each document.

At a minimum, the DOE shall ensure that revisions to documents that implement the requirements of the WAP are denoted by including the current revision number on the document title page, the revised signature page, and each page that has been revised. Only revised pages need to be reissued. Changes to documents, other than those defined as editorial changes or minor changes, shall be reviewed and approved by the same functional organizations that performed the original review and approval, unless other organizations are specifically designated in accordance with approved procedures. Editorial or minor changes may be made without the same level of review and approval as the original or otherwise changed document. The following items are considered editorial or minor changes:

- Correcting grammar or spelling (the meaning has not changed)
- Renumbering sections or attachments
- Updating organizational titles
- Changes to nonquality-affecting schedules
- Revised or reformatted forms, providing the original intent of the form has not been altered
- Attachments marked "Example," "Sample," or exhibits that are clearly intended to be representative only

A change in an organizational title accompanied by a change in the responsibilities is not considered an editorial change. Changes to the text shall be clearly indicated in the document. The DOE shall provide the QAPjP for each site and ~~all~~ subsequent revisions to ~~NMED~~the New Mexico Environment Department upon approval by the DOE.

The DOE shall ensure that QAPjPs include a detailed description of the reporting and approval requirements for changes to approved QA documents and SOPs, including procedures for implementing changes to these documents. ~~All members~~Members of the site project staff are responsible for reporting any obsolete or superseded information to the ~~site project manager~~Site Project Manager (**SPM**). ~~All site-specific~~ Site-specific changes shall be evaluated and approved by the ~~site project manager~~SPM before implementation. The SPM~~site project manager~~ shall notify the appropriate personnel and the affected documents shall be revised as necessary. The site project manager shall also be responsible for notifying the DOE field office of the changes. The DOE shall ensure that changes that affect performance criteria or data quality, testing procedures, quality assurance objectives, calibration requirements, or ~~QC~~quality control sample acceptance criteria comply with the WAP ~~(Permit Attachment C)~~ and shall not be made without prior approval of the DOE.

ATTACHMENT C6

AUDIT AND SURVEILLANCE PROGRAM

ATTACHMENT C6

AUDIT AND SURVEILLANCE PROGRAM

TABLE OF CONTENTS

LIST OF TABLES

ATTACHMENT C6

AUDIT AND SURVEILLANCE PROGRAM

C6-1 Introduction

The Waste Isolation Pilot Plant (**WIPP**) Audit and Surveillance Program shall ensure that: 1) the operators of each generator/storage site (**site**) that plan to transport transuranic (**TRU**) mixed waste to the WIPP facility conduct testing of wastes in accordance with the current WIPP Waste Analysis Plan (**WAP**) (Permit Attachment C), and 2) the information supplied by each site to satisfy the waste screening and acceptability requirements of Permit Attachment C, Section C-4 of the WAP is being managed properly. The U.S. Department of Energy (**DOE**) will conduct these audits and surveillances at each site performing these activities in accordance with a standard operating procedure (**SOP**). The New Mexico Environment Department (**NMED**) personnel may observe these audits and surveillances to validate the implementation of WAP requirements~~ (Permit Attachment C)~~ at each site. Only personnel with appropriate DOE~~U.S. Department of Energy~~ clearances will have access to classified information during audits. Classified information will not be included in audit reports and records. The audit SOP will contain steps for selecting audit personnel, reviewing applicable background information, preparing an audit plan, preparing audit checklists, conducting the audit, developing an audit report, and following up audit deficiencies. A deficiency is any failure to comply with an applicable provision of the WAP. The checklists for each site shall include, at a minimum, the appropriate checklists found in Tables C6-1 through C6-4 for the summary category groups undergoing audit.

C6-2 Audit Procedures

Audit procedures shall establish the responsibilities and methodology for planning, scheduling, performing, reporting, verifying, and closing announced and unannounced audits of sites. Records of ~~all ~~audit activities shall be part of the WIPP Operating Record and maintained at the WIPP facility until closure. The NMED shall be provided unlimited access to these records.

Approved ~~procedures~~SOPs shall be used to describe audit activities and requirements. These SOPs~~Procedures~~ define the responsibilities of specific positions necessary to manage this audit program. The DOE manager who oversees the audit program shall ensure that the following tasks are performed:

- Schedule audits
- Designate lead auditor(s)
- Appoint auditor and lead auditor trainees
- Maintain auditor training and qualification records
- Assure that ~~all ~~auditors have been given appropriate training, including training on the WAP
- Assign auditors and lead auditors to perform ~~annual ~~certification audits

- Review and approve final audit reports
- Oversee tracking and closure of ~~all~~ deficiencies and any observations requiring action
- Assure records are entered into the WIPP Operating Record and are properly maintained until facility closure

C6-3 Audit Position Functions

The DOE will approve lead auditors, auditors, and technical specialists based upon the expertise required for the functions being examined according to the audit scope. The DOE will supply auditors/technical specialists with expertise in the Resource Conservation and Recovery Act (**RCRA**) requirements and knowledge of the testing and documentation methods required to verify the hazardous waste characterization performed by the sites. The DOE shall identify ~~all~~ audit team members to the NMED prior to the audit, and shall provide upon request the qualifications of ~~all~~ audit team members.

The lead auditor assigned to be the audit team leader must perform the following tasks:

- Concur that assigned auditors and technical specialists have the collective experience and training commensurate with the scope, complexity, or special nature of the activities to be audited
- Develop an audit plan and coordinate the preparation of an overall checklist to cover the scope of the audit, with consideration given to ~~all~~ nonconformances reported as specified in Permit Attachment C3 and to previous audit results from that site
- Assign specific audit areas to individual auditors and technical specialists within their particular specialty and provide guidance on checklist development
- Review individual auditor checklists to assure complete coverage of assigned scope, and approve the checklists
- Conduct the audit at the site
- Encourage observers to participate according to the protocol established by the DOE
- Communicate audit results at the conclusion of the audit, including any deficiencies and observations
- Prepare and sign the audit report
- Maintain complete records of each audit and transfer them to the DOE manager when the audit report is issued

Auditors and technical specialists assigned to the specific audit will report to the audit team leader for supervision and may perform the following tasks:

- Attend any required specific training and team orientation and planning meetings as directed by the audit team leader

- Prepare specific audit checklists to verify that the WAP Quality Assurance Objectives (~~**QAO**~~**QAOs**) are met for the areas being audited

- Obtain audit team leader approval of checklist

- Review acceptable knowledge **(AK)** documentation packages, test report data, and documentation of data verification activities

- Obtain and evaluate objective evidence by means of observation, document reviews, or the conduct of interviews with operators, technicians, and others necessary to determine the adequacy and effective implementation of the WAP

- Conduct inspection tours of waste generating station~~s~~, waste testing facilities, calibration facilities, administrative, and document control/record facility

- Complete checklist during the audit indicating the objective evidence observed verifies that the site has met the QAOs for the program elements, methods, and the activities being audited~~.~~; ~~Add~~ add other items to the checklist as they are observed or as needed during the audit

- Prepare narrative statements that clearly and concisely identify the conditions involved regarding ~~for all~~ deficiencies, and observations ~~that clearly and concisely identify the conditions involved~~

- Prepare any portion of the final audit report assigned by the lead auditor~~.~~

Audits will be conducted at least annually for each site involved in the waste characterization program. Both announced and unannounced audits will address the following:

- Results of previous audits
- Changes in programs or operations
- New programs or activities being implemented
- Changes in key personnel

~~Annual certification~~Certification audits shall address contact-handled (**CH**) and remote-handled (**RH**) waste characterization activities if the site has approval or is seeking approval for such wastes. At a minimum, the audit shall evaluate ~~acceptable knowledge~~AK documentation for CH and RH waste separately by Summary Category Group, as applicable.

C6-4 Audit Conduct

The conduct of the audit shall commence with an entrance meeting, conducted by the audit team leader, with site management. At this meeting, the audit objectives and scope, the specific areas to be audited, the processes or functions to be observed, and the site participation required, including site interfaces, will be identified. The purpose of this meeting is to confirm the audit scope, discuss the audit sequence, establish channels of communication, and confirm the daily and exit meeting. Audits shall be performed using approved audit checklists that include the checklists in Tables C6-1 to C6-4 for the summary category groups undergoing audit. Consistency of evaluation shall be ensured before the audit through site QAPjP approval (see Permit Attachment C5). The QAPjPs for each site shall incorporate the same requirements from the WAP. Objective evidence shall be examined (to the depth necessary) to determine if the identified activities, procedures, or QAOs are adequate and are being effectively implemented.

Audits may not include all waste summary category groups, and thus some audit checklists or portions of checklists (Tables C6-1 through C6-4) may not be applicable to some sites (e.g., approved ~~acceptable knowledge~~AK sufficiency determination request for one or more waste streams at a site). In these instances, DOE shall indicate non-applicability~~nonapplicability~~ in the appropriate checklist row, and justify the exclusion under the “Comment” column. In addition, in cases where discrepancies exist between the audit checklists in Tables C6-1 through C6-4 and the Permit, Permit requirements take precedence. The DOE may add to the checklists as necessary to clarify Permit requirements, but any additions will be clearly designated on the checklists (i.e., redline the additions).

Audits shall include site personnel interviews, document and record reviews, observations of operations, and any other activities deemed necessary by the auditors to meet the objectives of the audit. Observations or deficiencies identified during the audit will be investigated or evaluated, as necessary, to determine if they are isolated conditions or represent a general breakdown of the waste characterization quality assurance program. During audit interviews or audit meetings, site personnel may be advised of deficiencies identified within their areas of responsibility to establish a clear understanding of the identified condition.

The site personnel will be given the opportunity to correct any deficiency that can be corrected during the audit period. Deficiencies and observations will be documented and included as part of the final audit report. Those items that have been resolved during the audit (isolated deficiencies that do not require a root cause determination or actions to preclude recurrence), will be verified prior to the end of the audit, and the resolution will be described in the audit report. Those items that affect the quality of the program, and/or the data generated by that program, which are required by the WAP will be documented on a Corrective Action Report (**CAR**) and included as a part of the final audit report. The CAR will be entered into the DOE’s CAR tracking system and tracked until closure. Resource Conservation and Recovery Act ~~RCRA-~~related items will be uniquely identified within the CAR tracking system so that they can be tracked separately. Resource Conservation and Recovery Act ~~RCRA-~~related CARs identified by the site during self-audits will be evaluated during the DOE’s audit and surveillance program and tracked in the DOE’s CAR tracking system~~systems~~.

When a deficiency is identified by the audit team, the audit team member who identified the deficiency prepares the CAR. The DOE reviews the CAR, determine validity (assures that a requirement has in fact been violated), classify the significance of the deficiency, assign a response due date, and issue the CAR to the site. The site reviews the CAR, evaluates the extent and cause of the deficiency, and provides a response to the DOE indicating the remedial actions and actions taken to preclude recurrence. The DOE reviews the response from the site and, if acceptable, communicate the acceptance to the site. The site completes remedial actions and actions to preclude recurrence. After ~~all~~ corrective actions have been completed, DOE may schedule and perform a verification visit to assure that corrective actions have been completed and are effective. NMED personnel may participate as observers in these verification visits. When ~~all~~ actions have been completed and verified as being effective, the CAR is closed by the

DOE manager responsible for quality assurance. As part of the planning process for subsequent audits and surveillances, past deficiencies will be reviewed and the previous deficient activity or process is subject to reassessment.

The NMED may submit a written Observer Inquiry to the DOE if necessary to seek resolution to a question raised or issue posed during the audit. The DOE shall be responsible for obtaining a response to the Observer Inquiry and submitting a written response to the NMED within 30 days of inquiry submission. The NMED will examine the response and consider this information as part of the audit review and approval process.

The sites shall submit corrective action plans to eliminate the deficiency stated on the CAR, including a resolution of the acceptability of any data generated prior to the resolution of the corrective action.

The corrective action response will include a discussion of the investigation performed to determine the extent and impact of the deficiency, a description of the remedial actions taken, determination of root cause, and actions to preclude recurrence.

An exit meeting will be conducted by the lead auditor prior to departure of the audit team from the site. This meeting will include site management personnel, and may include DOE field office personnel. ~~All draft~~ Draft audit results will be presented to the site management.

The audit report will be prepared, approved, and issued to the site within 30 days of the completion of the audit by the DOE. The NMED shall receive a copy of the audit report upon issuance for information purposes. A formal final audit report will be provided to the NMED which will include WAP-related CAR resolution results and audit results that will include, as a minimum, sections describing the scope, purpose, summary of deficiencies, and observations in narrative format, completed audit checklists, audited procedures, and other applicable documents which provide evidence of WAP implementation. The report will also include an identification of the organization audited, the dates of the audit, and the requested response date. NMED will make the final audit report available for public review and comment. One copy of the formal final audit report shall be submitted to the NMED in hard copy, but any additional copies may be submitted in electronic format. The audited site will respond to any deficiencies and observations within (30 days after receipt of any CARs and indicate the corrective action taken or to be taken. If the corrective action has not been completed, the response must indicate the expected date the action will be completed. The CARs applicable to WAP requirements shall be resolved prior to waste shipment. Subsequent audits or specific verifications, announced or unannounced, will determine if the corrective action has been satisfactorily implemented. Deficiencies (items corrected during the audit [**CDAs**] and CARs) ~~and observations~~ will be tracked to completion according to established procedure(s). In addition, deficiencies will be trended to determine if similar situations exist system wide. Trend reports will be issued as necessary to provide a “lessons learned” announcement to other sites who might benefit from program improvements implemented as a result of resolutions to the specific situations discovered at the performance of these audits.

The final audit report provided to the NMED and audit records will be maintained at the WIPP facility as a part of the Operating Record. These records will be included on the Record Inventory and Disposition Schedule and maintained on-site until closure of the WIPP facility. The NMED shall be provided unlimited access to these records.

TABLES

Table C6-1
Waste Analysis Plan (WAP) General Checklist for use at DOE'S Generator/Storage Sites

		Procedure Documented		**Example of Implementation/ Objective Evidence, as applicable**		
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	**Comment (e.g., any change in procedure since last audit, etc.)**
	Waste Stream Identification					
1	Does the generator/storage site define "waste stream" as waste materials that have common physical form, that contain similar hazardous constituents, and that are generated from a single process or activity? (~~Attachment C~~ Section C-0a)					
2	Are procedures in place to ensure that the generator/storage site assigns one of the Summary Category Groups (S3000-homogeneous solids, S4000-soils/gravel, S5000-debris waste) to each waste stream? (Section C-1b)					
3	Are procedures in place to ensure that the generator/storage site assigns Waste Matrix Code Subgroups Groups (e.g., solidified inorganics, solidified organics, salt waste, soils, combustible waste, filters, graphite, heterogeneous debris waste, inorganic nonmetal waste, lead/cadmium metal, uncategorized metal) to each waste stream? (Section C-0a)					
4	Are procedures in place to ensure that the generator/storage site assigns a Waste Stream WIPP Identifier (ID) to each waste stream? (Section C3-6b(1))					

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[1]	Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
4a	Are procedures in place for generator/storage sites to submit an AK Sufficiency Determination (Determination Request) to the Permittees to meet ~~all or part of~~ the waste characterization requirements including: • ~~All information~~Information specified in Permit Attachment C4, Section C4-3d • Identification of relevant hazardous constituents, and correctly identifies ~~all~~ toxicity characteristic and listed hazardous waste numbers • Hazardous ~~All hazardous~~ waste number assignments must be substantiated by supporting data and, if not, whether this lack of substantiation compromises the interpretation • Resolution of data discrepancies between different AK sources must be technically correct and documented • The AK Summary includes ~~all~~ the identification of waste material parameter weights by percentage of the material in the waste stream, and determinations are technically correct • ~~All prohibited~~ Prohibited items specified in the TSDF-WAC should be addressed, and conclusions drawn are technically adequate and substantiated by supporting information • If the AK record includes process control information specified in Permit Attachment C4, Section C4-3b, the information should include procedures, waste manifests, or other documentation demonstrating that the controls were adequate and sufficient. • The site must provide the supporting information necessary to substantiate technical conclusions within the Determination Request, and this information must be correctly interpreted. (Section C-0b, Section C4-3d)					
4b	If a generator/storage site does not submit a Determination Request or if the Determination Request is not approved, are procedures in place for the generator/storage site to perform radiography or VE on 100 percent ~~100%~~ of the containers in a waste stream as specified in Permit Attachment C1? (Section C-0b)					

	WAP Requirement[1]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
4c	Are procedures in place to ensure that the generator/storage sites complete a Waste Stream Profile Form (WSPF) and Characterization Information Summary (CIS) as specified in Permit Attachment C3, Sections C3-6b(1) and C3-6b(2)? (Section C-0c)					
6	Are procedures in place to ensure that the generator/storage site assigns EPA hazardous waste numbers associated with the waste? If so, do these assigned EPA hazardous waste numbers correspond to the permitted EPA hazardous waste numbers in Table C-5? Are there any assigned EPA hazardous waste numbers that are not permitted EPA hazardous waste numbers on the Table C-5? If so, did the generator/storage site reject the waste for shipment to and disposal at the WIPP facility? Did the generator assign a state hazardous waste codes or numbers? If so, is it assigned to waste that is permitted at the WIPP facility? (Section C-1b)					
7	Are procedures in place to ensure that Summary Category Groups are defined as follows: S3000- Homogeneous solids are solid material, inorganic process residues, inorganic sludges, salt waste, and pyrochemical salt waste excluding soils, that do not meet NMED criteria for classification as debris and are at least 50 percent by volume homogeneous solids or comprise the majority of the waste stream S4000- Waste streams that are at least 50 percent by volume soil/gravel, or comprise the majority of the waste stream S5000- Waste streams that are at least 50 percent volume materials that meet the NMED criteria for debris, or comprise the majority matrix of materials. The criteria for debris are solid materials intended for disposal that exceed 2.36 inch particle size and is a manufactured object, plant or animal matter, or natural geologic material. Particles smaller than 2.36 inches in size may be considered debris if the debris is a manufactured object and if it is not a particle of S3000 or S4000 material. (Section C-0a)					

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[1]	Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
8	Does the generator/storage facility have procedures in place to ensure that the following waste characterization parameters will be obtained:~~obtained~~: • Determination whether TRU mixed waste streams comply with the applicable provisions of the TSDF-WAC • Determination whether TRU mixed wastes exhibit a hazardous characteristic per 20.4.1.200 NMAC (incorporating 40 CFR 261 Subpart C) • Determination whether TRU mixed wastes are listed per 20.4.1.200 NMAC (incorporating 40 CFR 261 Subpart D) • Estimation of waste material parameter weights (Section C-2)					
9	Are procedures in place to ensure that waste streams identified to contain incompatible materials or materials incompatible with waste containers cannot be shipped unless treated to remove the incompatibility? (Section C-1c)					
10	Are procedures in place to ensure that the generator/storage site uses ~~acceptable knowledge~~AK and, as necessary, radiography and ~~visual examination~~VE analysis as specified in Table C-1? (Section C-3)					

		Procedure Documented		**Example of Implementation/ Objective Evidence, as applicable**		**Comment (e.g., any change in procedure since last audit, etc.)**
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
	Unacceptable Waste					

12	Are procedures in place to ensure that the generator/storage site ensures, through administrative and operational procedures and characterization techniques, that waste containers do not include the following unacceptable waste:
	• liquid waste is not acceptable for disposal at the WIPP facility. Liquid in the quantities delineated below is acceptable
	  ◦ Observable liquid shall be no more than ~~1~~one percent by volume of the outermost container at the time of radiography or ~~visual examination~~VE
	  ◦ Internal containers with more than 60 milliliters or ~~3~~three percent by volume observable liquid, whichever is greater, are prohibited
	  ◦ Containers with Hazardous Waste Number U134 assigned shall have no observable liquid
	  ◦ Overpacking the outermost container that was examined during radiography or ~~visual examination~~VE or redistributing untreated liquid within the container shall not be used to meet the liquid volume limits
	• non-radionuclide pyrophoric materials
	• hazardous wastes not occurring as co-contaminants with TRU wastes (non-mixed hazardous wastes)
	• wastes incompatible with backfill, seal and panel closures materials, container and packaging materials, shipping container materials, or other wastes
	• wastes containing explosives or compressed gases (continued below)					

	WAP Requirement[1]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
12a	• wastes with polychlorinated biphenyls (PCBs) not authorized under an EPA PCB waste disposal authorization • wastes exhibiting the characteristic of ignitability, corrosivity, or reactivity (EPA Hazardous Waste Numbers of D001, D002, or D003) • waste that has ever been managed as high-level waste and waste from tanks specified in Permit Attachment C, Table C-4, unless specifically approved through a Class 3 permit modification • any waste container from a waste stream (or waste stream lot) which has not undergone either radiographic or ~~visual examination~~VE of a statistically representative subpopulation of the wastes stream in each shipment pursuant to Permit Attachment C7 • any waste container from a waste stream which has not been preceded by an appropriate, certified Waste Stream Profile Form (see Section C-1d) (Section C-1c)					
	Waste Acceptance Control					
14	Are procedures in place to ensure that the generator/storage site uses a ~~Waste Stream Profile Form (~~WSPF~~)~~ which includes, at a minimum, the information indicated on the attached WSPF found in Permit Attachment C, Figure C-1 and a ~~Characterization Information Summary (~~CIS~~)~~ prior to waste disposal at the WIPP? (Section C-1d)					
16	Are procedures in place to ensure that additional WSPFs are provided to WIPP and NMED for waste streams or portions of waste streams that are reclassified based upon waste characterization information? (Section C-1d)					
16a	Are criteria in place to determine the specific circumstances under which a WSPF is revised versus when a new WSPF is required? (Section C-1d)					
	General Characterization Requirements					
25	Are procedures in place to ensure that ~~Acceptable Knowledge~~AK is used in waste characterization activities to delineate TRU mixed waste streams, to assess whether TRU mixed wastes comply with the TSDF-WAC, to assess whether TRU mixed waste exhibits a hazardous characteristic (20.4.1.200 NMAC, incorporating 40 CFR 261 Subpart C), and to assess whether TRU wastes are listed (20.4.1.200 NMAC, incorporating 40 CFR 261 Subpart D), and to estimate waste material parameter weights? (Section C-3a)					

		Procedure Documented		**Example of Implementation/ Objective Evidence, as applicable**		**Comment (e.g., any change in procedure since last audit, etc.)**
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
26	Are procedures in place to ensure that radiography and/or ~~visual examination~~VE are used as necessary to: • Examine a waste container to determine the physical form • Identify observable liquid in excess of TSDF-WAC limits and containerized gases • Verify the physical form matches the waste stream description (Section C-3b)					
28	Are procedures in place to ensure that the following characterization activities shall occur: • Acceptable Knowledge for ~~all~~ wastes, with testing as necessary to augment AK including; – Visual examination or radiography for ~~all~~ waste containers (Section C4-3e)					
	Data Generation, Verification, Validation, Documentation, and Quality Assurance					
30	Are procedures in place to ensure that the following Data Quality Objectives are met: • Use ~~Acceptable Knowledge~~AK to delineate TRU mixed waste streams, assess whether TRU mixed wastes comply with the applicable requirements of the TSDF-WAC, assess whether TRU mixed wastes exhibit a hazardous characteristic, assess whether TRU mixed wastes are listed and to estimate waste material parameter weights • Use radiography or ~~visual examination~~VE to verify the physical form of the waste matches its waste stream description as determined by AK and to verify the absence of prohibited items (Section C-4a(1))					

	WAP Requirement[1]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
31	Are procedures in place to ensure that the following Quality Assurance Objectives are adequately defined and assessed for each characterization method: • Precision as a measure of the mutual agreement among multiple measurements. • Accuracy as the degree of agreement between a measurement result and a true or known value. • Completeness is a measure of the amount of valid data obtained from a method compared to the total amount of data obtained that is expressed as a percentage. • Comparability is the degree to which one data set can be compared to another data set. • Representativeness as an expression of the degree to which data represent characteristics of a population. (Section C-4a(2))					
32	With respect to data generation, are procedures in place to ensure that the generator/storage site's waste characterization program meets the following general requirements: • Testing data packages and ~~batch data reports~~BDRs must be reported accurately in a pre-approved format, must be maintained in permanent files, and must be traceable? • ~~All data~~ Data must receive a technical review by another qualified operator? (Section C3-4a)					
33	Are procedures in place to ensure that the generator/storage site performs validation of waste characterization data for each waste container? (Section C-4)					
34	Are procedures in place to ensure that the generator/storage site has a pre-approved format for reporting waste characterization data? (Section C-4a(3))					
35	Are procedures in place to ensure that the generator/storage site prepares testing ~~batch data reports~~ BDRs to meet the requirements of their own site-specific QAPjP and/or SOPs? (Section C-4a(3))					

		Procedure Documented		**Example of Implementation/ Objective Evidence, as applicable**		**Comment (e.g., any change in procedure since last audit, etc.)**
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
36	Are procedures in place to ensure that~~ all~~ raw data is collected and managed at the data generation level in accordance with the following criteria: • Raw ~~All raw~~ data shall be signed and dated in reproducible ink by the individual collecting the data, or signed and dated using electronic signatures • Data ~~All data~~ shall be recorded clearly, legibly, and accurately in field records • ~~All changes~~Changes to original data shall be lined out, initialed, and dated by the individual making the change. Original data may not be obliterated or otherwise be made unreadable • ~~All data~~Data shall be transferred and reduced from field records completely and accurately • ~~All field~~Field records shall be maintained as specified in Table C--2 of Attachment C • Data shall be organized into standard reporting formats for reporting purposes. • ~~All electronic~~Electronic and video data must be stored to ensure that waste container and QC data are readily retrievable (Section C3-4a)					

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
37	Are procedures in place to ensure that 100 percent~~100 %~~ of ~~batch data reports~~BDRs are subject to independent technical review by an individual qualified to review the data who was not involved in the generation or recording of the data under review. The reviewer shall release the data through signature with an associated review checklist prior to characterization of the associated waste and shipment to the WIPP facility. The review shall ensure the following, as applicable: • Data generation and reduction were conducted according to the methods used and reported in the proper units and significant figures • Calculations have been verified by a valid calculation program, a spot check of verified calculation programs, and/or a 100 percent check of~~ all~~ hand calculations • The data have been reviewed for transcription errors • The testing QA documentation for BDRs is complete and includes, as applicable, raw data, calculation records, calibration records • Radiography tapes are reviewed on a waste container basis at a minimum of once per testing batch or once per day of operation, whichever is less frequent. The radiography tape will be reviewed against the data on the radiography form to ensure that data are complete and correct • QAOs have been met (Section C3-4a(1))					

	WAP Requirement[1]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
40	Are procedures in place to ensure that 100 percent of ~~all batch data reports~~BDRs receive a Site Project Manager (SPM) signature release with an associated review checklist prior to characterization of the associated waste and shipment to the WIPP. This release shall ensure the following: • Testing batch QC checks were properly performed. Radiography data are complete and acceptable based on evidence of videotape review of one waste container per day or once per testing batch, whichever is less frequent • Data generation level independent technical review, validation, and verification have been performed as evidenced by the completed review checklists and appropriate signature releases. • Independent technical reviewers were not involved in the generation or recording of the data under review. • Batch Data review checklists are complete • Batch Data Reports are complete and data properly reported • Verify that data are within established data assessment criteria and meet ~~all~~ applicable QAOs (Section C3-4b(1))					
~~42~~	~~Are procedures in place to ensure that a repeat of the data review process at the data generation level will be performed on a minimum of one randomly chosen waste container every quarter to determine if the verification and validation is performed according to documented procedures? (Section C3-4b)~~					
43	Are procedures in place and checklists ~~are~~ available to prepare a ~~Site Project Manager (~~SPM~~)~~ Summary and a Data Validation Summary (the summaries may be in the same document)? The SPM Summary includes a validation checklist for each batch that is of sufficient detail to document ~~all~~ aspects of a ~~batch data report~~BDR that could affect data quality. The Data Validation Summary must identify each ~~Batch Data Report~~BDR reviewed, ~~reviewed ,~~ describe how the validation was performed, identify ~~all~~ problems, and identify ~~all~~ acceptable and unacceptable data. Summaries must include release signatures. (Section C3-4b(2))					

	WAP Requirement[1]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
44	Are procedures in place to ensure that non-administrative, WAP-related nonconformances first identified at the ~~site project manager~~SPM level are reported to the Permittees within seven calendar days of identification, ~~that~~ nonconformance reports are prepared within 30 calendar days, and ~~that~~ corrective action is implemented prior to waste shipment? (Section C3-7)					
45	Are procedures in place to ensure that any waste container for which a nonconformance report (NCR) has been written will not be shipped to the WIPP facility unless the condition that led to the NCR for that container is appropriately identified, reconciled, corrected, and documented? Are nonconformance reports prepared for nonconformances identified? Are nonconformances identified and tracked, and does the ~~Site Project Manager~~SPM oversee the nonconformance report process? (Section C3-7)					
	Data Transmittal					
48	Are procedures in place to ensure that the generator/storage site transmits data by hard copy or electronic copy from the data generation level to the site project level? If electronic, does the generator/site have a hard copy available on demand? (Section C-4a(5))					
50	Are procedures in place to ensure that the generator/storage site inputs the data into the WWIS manually or electronically? (Section C-4a(5))					
51	Are procedures in place to ensure that the generator/storage site enters the data into the WWIS in the exact format required by the database? (Section C-4a(5))					
52	Are procedures in place to ensure ~~all of~~ the data presented on Table C-3 of the Permit is transmitted to the WWIS? (Table C-3)					
	Records and Record Management					
55	Are procedures in place to ensure that the generator/storage site's hard copy and/or electronic data reports follow the Permittees' format requirements? (Section C-4a(3))					

	WAP Requirement[1]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
56	Are procedures in place to ensure that hard copy or electronic Waste Stream Profile Form will include the following • Generator/storage site name • Generator/storage site EPA ID • Date of audit report approval by the NMED (if obtained) • Original generator of waste stream • Whether waste is ~~Contact-Handled~~contact-handled or ~~Remote-Handled~~remote-handled • Waste Stream WIPP Identification Number • Summary Category Group • Waste Matrix Code Group • Waste Material Parameter Weight Estimates per unit of waste • Waste stream name • A description of the waste stream • Applicable EPA hazardous waste numbers • Applicable TRUCON codes • A listing of ~~acceptable knowledge~~AK documentation used to identify the waste stream • The waste characterization procedures used and the reference and date of the procedure • Certification signature of ~~Site Project Manager~~SPM, name, title, and date signed (Section C3-6b(1))					

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
56a	Are procedures in place to ensure that hard copy or electronic Characterization Information Summary will include the following: • Data reconciliation with DQOs • Radiography and ~~visual examination~~VE summary to document that ~~all~~ prohibited items are absent in the waste and to verify that the physical form of the waste matches its waste stream description as determined by AK (if applicable). • A complete listing of ~~all~~ container identification numbers used to generate the ~~Waste Stream Profile Form~~WSPF, cross-referenced to each ~~Batch Data Report~~BDR. • Complete AK summary, including stream name and number, point of generation, waste stream volume (current and projected), generation dates, TRUCON codes, Summary Category Group, Waste Matrix Code(s) and Waste Matrix Code Group, other TWBIR information, waste stream description, areas of operation, generating processes, RCRA determinations, radionuclide information, ~~all~~ references used to generate the AK summary, and any other information required by Permit Attachment C4, Section C4-2b. • Method for determining Waste Material Parameter Weights per unit of waste. • List of any AK Sufficiency Determinations requested for the waste stream. • Certification through ~~acceptable knowledge~~AK or testing that any waste assigned the hazardous waste number of U134 (hydrofluoric acid) no longer exhibits the characteristic of corrosivity. This is verified by ensuring that no liquid is present in U134 waste. • A justification for the selection of radiography and/or VE as an appropriate method of characterizing the waste. (Section C3-6b(2))					
56b	Are procedures in place to assure that ongoing container characterization results are cross referenced to ~~Batch Data Reports~~BDRs? (Section C3-6b)					
58	Are procedures in place to ensure that project level reports are compiled into Characterization Information Summaries (Section C3-6b)					

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
59	Are procedures in place to ensure that the generator/storage site uses forms for data reporting that are pre-approved forms in site-specific documentation? (Section C3-6)					
60	Are procedures in place to ensure that the generator/storage site’s ~~site project manager~~SPM submits to the WIPP facility a summary of the waste stream information and reconciliation with data quality objectives (DQOs) once a waste stream is characterized? (Section C-4a(5))					
61	Are procedures in place to ensure that the generator/storage site project office completes a WSPF based on the ~~Batch Data Reports~~BDRs? (Section C3-6b)					
62	Are procedures in place to ensure that the generator/storage site’s ~~Site Project Manager~~ SPM submits the WSPF to the Permittees for DOE’s approval along with the accompanying Characterization Information Summary for that waste stream? (Section C-4a(5))					
63	Are procedures in place to ensure that the generator/storage site maintains records related to waste characterization testing activities in the testing facility files, or site project files for those facilities located on-site? (Section C-4a(6))					
64	Are procedures in place to ensure that the appropriate documented training and indoctrination is performed for ~~all~~ individuals and that procedures are documented in site specific QAPjPs and procedures? (Section C3-8)					
66	Are procedures in place to ensure that the generator/storage site has an appropriate records inventory and disposition schedule (RIDS) or equivalent that was prepared and approved by appropriate site personnel? (Section C-4a(6))					
67	Are procedures in place to ensure that the generator/storage site maintains ~~all~~ records relevant to an enforcement action, regardless of disposition, until they are no longer needed for enforcement action, and then dispositioned per the approved RIDS? (Section C-4a(6))					

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
68	Are procedures in place to ensure that the generator/storage site maintains records that are designated as Lifetime Records for the life of the waste characterization program plus six years, or that the records have been transferred for permanent archival storage to the WIPP Records Archive facility? Lifetime Records include: • Test facility ~~Batch Data Reports~~BDRs, • Waste Stream Characterization Package, • Data reduction, validation, and reporting documentation, • Acceptable knowledge documentation, • WSPF and Characterization Information Summary (Section C-4a(6), Table C-2)					
69	Are procedures in place to ensure that the generator/storage site maintains records that are designated as Non-Permanent Records for ten years from the date of record generation, and then dispositioned according per the approved RIDS or transferred to the WIPP Records Archive facility? Non-Permanent Records include: • Nonconformance documentation, • Variance documentation, • Assessment documentation, • Calculations and related software documentation, • Training/qualification documentation, • QAPjP documentation (including~~all~~ revisions), • Calibration documentation, • Procurement documentation, • Quality Assurance~~QA~~ procedures (including ~~all~~ revisions), • Technical implementing procedures (including~~all~~ revisions), and • Audio/video recording (radiography, visual, etc.). (Section C-4a(6), Table C-2)					
70	Are procedures in place to ensure that the generator/storage site has raw data that is identifiable and legible, and provides documentary evidence of quality? (Section C-4a(6))					

		Procedure Documented		**Example of Implementation/ Objective Evidence, as applicable**		**Comment (e.g., any change in procedure since last audit, etc.)**
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
71	Are procedures in place to ensure that if the generator/storage site ceases to operate, that ~~all~~ records be transferred before closeout? (Section C-4a(6))					
	Shipment					
72	Are procedures in place to ensure that the generator/storage site accurately completes an EPA Hazardous Waste Manifest prior to shipping the waste to WIPP that contains the following information: • Generator/storage site name and EPA ID • Generator/storage site contact name and phone number • Quantity of waste • List of up to six state and/or federal hazardous waste numbers in each line item • Listing of ~~all~~ container IDs~~IDS~~ • Signature of authorized generator representative (Section C-5b)					
73	Are procedures in place to ensure that the generator/storage site accurately completes the following container specific information: • Waste stream identification number • List of EPA hazardous waste numbers per container • Certification data • Shipping data (Section C-5b)					

---

1. The WAP requirements should be presented in documents, such as procedures. Each of the questions posed under WAP requirements are meant to ask whether procedures are in place or whether documents are evident which demonstrate that the specific WAP requirement is or can be met

Table C6-2
Acceptable Knowledge (AK) Checklist[1]

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[2]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
	General Requirements					
134	Are the primary document(s) required in Permit Attachment C4 containing ~~acceptable knowledge~~AK information available? (Section C4-2)					
135	Has the generator developed a methodology whereby a logical sequence of ~~acceptable knowledge~~AK information that progresses from general facility to more detailed waste-specific information can be acquired? (Section C4-2)					
136	Does the site have adequate procedures in place to ensure that the ~~Acceptable Knowledge~~AK process is adequately implemented? Do these procedures facilitate the mandatory traceability analysis performed for each Summary Waste Category Group examined during the audit? (Section C4-2)					
137	Does the generator site's TRU mixed waste management program information clearly define (or provide a methodology for defining) waste categorization schemes and terminology, provide a breakdown of the types and quantities of TRU mixed waste generated/stored at the site, and describe how waste is tracked and managed at the generator site (including historical and current operations? Do procedures ensure that waste streams are adequately identified? (Section C4-2a)					
138	Does site documentation procedures indicate that the site will document, justify, and consistently define waste streams and assign EPA hazardous waste numbers? (Section C4-2b)					

		Procedure Documented		**Example of Implementation/ Objective Evidence, as applicable**		
	WAP Requirement[2]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	**Comment (e.g., any change in procedure since last audit, etc.)**
	Required and Additional Information					
140	Does the generator site document that the following must be included in the ~~acceptable knowledge~~AK record: • Map of the site with the areas and facilities involved in TRU waste generation, treatment, and storage identified • Facility mission description as related to TRU waste generation and management (e.g., nuclear weapons research may involve metallurgy, radiochemistry, and nuclear physics operations that result in specific waste streams) • Description of the operations that generate TRU waste at the site (e.g., plutonium recovery, weapons design, or weapons fabrication) • Waste identification or categorization schemes used at the facility (e.g., item description codes, content codes) • Types and quantities of TRU mixed waste generated, including historical generation through future projections • Correlation of waste streams generated from the same building and process, as appropriate (e.g., sludge, combustibles, metals, and glass) • Waste certification procedures for retrievably stored and newly generated wastes to be sent to the WIPP facility (Section C4-2a)					

	WAP Requirement[2]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
141	Does the generator site document that the following shall be collected for each waste stream: A. Area(s) and/or building(s) from which the waste stream was or is generated B. Waste stream volume and time period of generation (e.g., 100 standard waste boxes of retrievable stored waste generated from June 1977 through December 1977) C. Waste generating process described for each building (e.g., batch waste stream generated during decommissioning operations of glove boxes), including processes associated with U134 waste generation, if applicable. D. Documentation demonstrating how the site has historically managed the waste, including the historical regulatory status of the waste (i.e., TRU mixed versus TRU non-mixed waste) E. Process flow diagrams (e.g., a diagram illustrating glove boxes from a specific building to a size reduction facility to a container storage area). In the case of research/development, analytical laboratory waste, or the similar processes where process flow diagrams cannot be created, a description of the waste generating processes, rather than a formal process flow diagram, may be included if this modification is justified and the justification is placed in the auditable record F. Material inputs or other information that identifies the chemical content of the waste stream and the physical waste form (e.g., glove box materials and chemical handled during glove box operations, events or processes that may have modified the chemical or physical properties of the waste stream after generation, data obtained through ~~visual examination~~VE of newly generated waste that later undergoes radiography; information demonstrating neutralization of U134 [hydrofluoric acid] and waste compatibility) (Section C4-2b)					

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[2]	Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
142	Do site documents/procedures require that the facility will provide a summary to the Permittees that summarizes~~ all~~ information collected, including basis and rationale for~~ all~~ waste stream designations? Is an example of this summary available for audit review? If discrepant hazardous waste data exist in required information, do sites consider applying ~~all~~ hazardous waste numbers, but assess and evaluate the information to determine the appropriate EPA hazardous waste numbers consistent with RCRA requirements? (Section C4-2b)					
143	Do site procedures indicate that if the required AK information is not available for a particular waste stream, that the waste stream will not be eligible for an AK Sufficiency Determination? (Section C4-2)					
144	Have the following procedures been prepared? A. Procedures for identifying and assigning the physical waste form of the waste B. Procedures for delineating waste streams and assigning Waste Matrix Codes C. Procedures for resolving inconsistencies in ~~acceptable knowledge~~AK documentation D. Procedures for ~~visual examination~~VE and/or radiography, if applicable E. For newly generated waste, procedures describing process controls used to ensure prohibited items (specified in the WAP, Permit Attachment C) are documented and managed F. Procedures to ensure radiography and ~~visual examination~~VE include a list of prohibited items that the operator shall verify are not present in each container (e.g. liquid exceeding TSDF-WAC limits, corrosives, ignitables, reactives, and incompatible wastes) G. Procedures to document how changes to Waste Matrix Codes, waste stream assignment, and associated EPA~~Environmental Protection Agency~~ hazardous waste numbers based on material composition are documented for any waste H. Procedures that ensure the assignment of EPA hazardous waste numbers is appropriate, consistent with RCRA requirements, and adequately considers site historical waste management I. Procedures for estimating waste material parameter weights (Section C4-2b)					

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[2]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
145	Does the generator provide procedures or written commitment to collect additional ~~acceptable knowledge~~AK information, as available and as necessary to augment mandatory information? (Section C4-2c)					
146	Does the generator site document that ~~all~~ additional specific, relevant information used in the ~~acceptable knowledge~~AK process will be identified and its use explained? Is ~~all~~ the necessary additional information assembled and has it been appropriately used? (Section C4-2c)					
147	Does the generator site discrepancy analysis documentation (for ~~acceptable knowledge~~AK additional and required documentation) indicate that if discrepancies are detected, the site may consider applying ~~all~~ EPA hazardous waste numbers indicated in the required and additional information, but must assess and evaluate the information to determine the appropriate EPA hazardous waste numbers consistent with RCRA requirements? (Section C4-2c)					
	Training					
148	Does the generator site have procedures to ensure that ~~all~~ the personnel involved with ~~acceptable knowledge~~AK waste characterization have the following training, and is this training documented? A. WIPP WAP in Permit Attachment C and the TSDF-WAC specified in this permit B. State and Federal RCRA regulations associated with solid and hazardous waste characterization C. Discrepancy resolution and reporting D. Site-specific procedures associated with waste characterization using ~~acceptable knowledge~~AK (Section C4-3a)					

	WAP Requirement[2]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
	Procedures					
149	Has the generator site developed the following procedures, and are these procedures technically sufficient? A. Sites must prepare and implement a written procedure outlining the specific methodology used to assemble ~~acceptable knowledge~~AK records, including the origin of the documentation, how it will be used, and any limitations associated with the information (e.g., identify the purpose and scope of a study that included limited sampling and analysis data). B. Sites must develop and implement a written procedure to compile the required ~~acceptable knowledge~~AK record. C. Sites must develop and implement a written procedure that ensures unacceptable wastes (e.g., reactive, ignitable, corrosive) are identified and segregated from TRU mixed waste populations sent to the WIPP facility. D. Sites must prepare and implement a written procedure to evaluate ~~acceptable knowledge~~AK and resolve discrepancies. For example, ~~Example~~ if different sources of information indicate different hazardous wastes are present, then sites must include ~~all~~ sources of information in its records and may choose to either conservatively assign EPA hazardous waste numbers or assign only those numbers deemed appropriate and consistent with RCRA requirements. ~~All information~~Information used to justify assignment of EPA hazardous waste numbers must be placed in the auditable record. Further, the assignment of EPA hazardous waste numbers shall be tracked in the auditable record to ~~all~~ required documentation.					

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[2]	Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
149a	E. Sites must prepare and implement a written procedure to identify hazardous wastes and assign the appropriate hazardous waste numbers to each waste stream. The following are minimum baseline requirements/standards that site-specific procedures must include to ensure comparable and consistent characterization of hazardous waste: 1. Compile ~~all of~~ the required information in an auditable record. 2. Review the compiled information and delineate waste streams. Delineation of waste streams must comply with the definition in Permit Attachment C, Section C-0a, and justify combining waste historically managed separately as TRU mixed and TRU non-mixed waste streams into a single waste stream. 3. Review the compiled information to determine if the waste stream is compliant with the TSDF-WAC 4. Review the required information to determine if the waste is listed under 20.4.1.200 NMAC (incorporating 40 CFR § 261), Subpart D. Assign ~~all~~ the listed EPA hazardous waste numbers, unless the site chooses to justify an alternative assignment and document the justification in the auditable record. 5. Review the required information to determine if the waste exhibits a hazardous characteristic or may contain hazardous constituents included in the toxicity characteristics specified in 20.4.1.200 NMAC (incorporating 40 CFR § 261, Subpart C. If a toxicity characteristic contaminant is identified and is not included as a listed waste, sites may evaluate available data and assign the toxicity characteristic EPA hazardous waste number consistent with RCRA requirements. ~~All data~~Data examined to reach the hazardous waste number determination must be placed in the auditable record and must present a clear justification for the EPA hazardous waste number analyses. 6. Review the compiled information to provide an estimate of the material parameter weights for each container to be stored or disposed of at the WIPP facility. For newly generated waste, procedures shall be developed and implemented to characterize hazardous waste using ~~acceptable knowledge~~AK prior to packaging.					

	WAP Requirement[2]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
149b	F. Sites shall ensure that results of audits of the site's TRU mixed waste characterization programs ~~at the site~~ are available in the records. G. Sites shall identify ~~all~~ process controls (implemented to ensure that the waste contains no prohibited items and to control hazardous waste content and/or physical form) that have been applied to retrievably stored waste and/or may presently be applied to newly generated waste. Process controls are applied at the time of waste generation/packaging to control waste content, whereas any activities performed after waste generation/packaging to identify prohibited items, hazardous waste content, or physical form are waste characterization activities, not process controls. The AK record must contain specific process control and supporting documentation identifying when these process controls are used to control waste content. See Permit Attachment C, Section C-2 for programmatic requirements related to process controls. (Section C4-3b)					
150	Does the site have implemented procedures which comply with the following criteria to establish ~~acceptable knowledge~~AK records: A. Acceptable knowledge information shall be compiled in an auditable record, including a road map for ~~all~~ the applicable information. B. The overview of the facility and TRU mixed waste management operations in the context of the facility's mission shall be correlated to specific waste stream information. C. Correlations between waste streams, with regard to time of generation, waste generating processes, and site-specific facilities shall be clearly described. For newly generated wastes, the rate and quantity of waste to be generated shall be defined. D. A reference list shall be provided that identifies documents, databases, Quality Assurance protocols, and other sources of information that support the ~~acceptable knowledge~~AK information. E. Container inventories for TRU mixed waste in retrievable storage shall be delineated into waste streams by correlating the container identification to ~~all of~~ the required and additional AK information. (Section C4-3c)					

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		
	WAP Requirement[2]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	**Comment (e.g., any change in procedure since last audit, etc.)**
151	If the generator site submitted an AK Sufficiency Determination Request for a specific waste stream, did the site provide ~~all of~~ the requisite information for which approval is sought? (Section C-0b)					
	Re-evaluating Acceptable Knowledge					
152	Does the generator site have written procedures for the augmentation of ~~all~~ the ~~acceptable knowledge~~AK information using testing?~~.~~ Testing consists of radiography and ~~visual examination~~VE. Do site procedures indicate that the following testing will be conducted based upon the results of the Determination Request AKSD denied ~~-~~= 100 percent~~100%~~ RTR or VE (Sections C4-1, C-0b)					
155	Does the generator site have procedures for reevaluating ~~acceptable knowledge~~AK if the results of the waste confirmation indicate that the waste to be shipped does not match the approved waste stream or if the data from radiography or ~~visual examination~~VE for waste streams without an AK Sufficiency Determination exhibit this discrepancy? Does this procedure describe how the waste is reassigned, ~~acceptable knowledge~~AK reevaluation, and appropriate EPA hazardous waste numbers are assigned? (Section C4-3e)					
156	Do site procedures indicate that debris wastes are assigned toxicity characteristic EPA hazardous waste numbers based on AK regardless of the quantity or concentration? (Section C4-3e)					

		Procedure Documented		**Example of Implementation/ Objective Evidence, as applicable**		**Comment (e.g., any change in procedure since last audit, etc.)**
	WAP Requirement[2]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
	Criteria for Assembling an Acceptable Knowledge Record Delineating the Waste Stream					
158	If wastes are reassigned to a different waste matrix code based on site ~~visual examination~~VE or radiography or Permittee confirmation activities, does the generator site have written documentation to ensure that the following steps are followed: F. Review existing information based on the container identification number and document ~~all~~ differences in EPA hazardous waste number assignments G. If differences exist in the EPA hazardous waste numbers that were assigned, reassess and document ~~all~~ required ~~acceptable knowledge~~AK information (Section C4-3b) associated with the new designation H. Reassess and document ~~all~~ testing data associated with the waste I. Verify and document that the reassigned waste matrix code was generated within the specified time period, area and buildings, waste generating process, and that the process material inputs are consistent with the waste material parameters identified during radiography or ~~visual examination~~VE J. Record ~~all~~ any changes to ~~acceptable knowledge~~AK records K. If discrepancies exist in the ~~acceptable knowledge~~AK information for the revised waste matrix code, document the segregation of the affected portion of the waste stream, and define the actions necessary to fully characterize the waste (Section C4-3e)					

	WAP Requirement[2]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
	Data Quality Requirements					
168	Are ~~acceptable knowledge~~AK processes consistently applied among~~ all~~ generator sites, and does each generator site comply with the following data quality requirements for ~~acceptable knowledge~~AK documentation: A. Precision -. The qualitative determinations, such as compiling and assessing ~~acceptable knowledge~~AK documentation, do not lend themselves to statistical evaluations of precision. However, the ~~acceptable knowledge~~AK information will be addressed by the independent review of ~~acceptable knowledge~~AK information during internal and external audits. B. Accuracy - The percentage of waste containers which require reassignment to a new waste matrix code and/or designation of different hazardous waste numbers based on testing data and discrepancies identified by the Permittees during waste confirmation will be reported as a measure of ~~acceptable knowledge~~AK accuracy. C. Completeness - The ~~acceptable knowledge~~AK record must contain 100 percent of the information (Permit Attachment C4, Section C4-3). The usability of the ~~acceptable knowledge~~AK information will be assessed for completeness during audits.					
168a	D. Comparability - Comparability is ensured through sites meeting the training requirements and complying with the minimum standards outlined for procedures that are used to implement the ~~acceptable knowledge~~AK process. ~~All sites~~Sites must assign hazardous waste numbers in accordance with Permit Attachment C4, Section C4-4 and provide this information regarding its waste to other sites who store or generate a similar waste stream. E. Representativeness - Representativeness is a qualitative parameter that will be satisfied by ensuring that the process of obtaining, evaluating, and documenting ~~acceptable knowledge~~AK information is performed in accordance with the minimum standards established in Permit Attachment C4. Sites also must assess and document the limitations of the ~~acceptable knowledge~~AK information used to assign hazardous waste numbers (e.g., purpose and scope of information, date of publication, type and extent to which waste parameters are addressed). (Section C3-3)					

	WAP Requirement[2]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
169	Does the generator site address quality control by tracking its performance with regard to the use of ~~acceptable knowledge~~AK by: 1) assessing the frequency of inconsistencies among information, and 2) documenting the results of waste discrepancies identified by the generator/storage site during waste characterization or the Permittees during waste confirmation using radiography, review of radiography audio/video recordings, ~~visual examination~~VE, or review of ~~visual examination~~VE records. In addition, the ~~acceptable knowledge~~AK process and waste stream documentation must be evaluated through internal assessments by generator/storage site quality assurance organizations. (Section C4-3e)					

1. The NMED expects a traceability analysis to be performed, the results of which should be presented on this checklist under the “Examples of Implementation” column. Further, the traceability analysis process and results should be discussed in the Final Audit Report.
2. The WAP requirements should be presented in documents, such as procedures. Each of the questions posed under WAP requirements are meant to determine whether procedures are in place or whether documents are evident which demonstrate that the specific WAP requirement is or can be met.

Table C6-3
Radiography Checklist

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
	Quality Assurance Objectives					
233	Are process procedures in place to meet the following Quality Assurance Objectives? Precision • Does the site describe in its QAPjP and SOP(s) activities to reconcile any discrepancies between two radiography operators with regard to identification of the waste matrix code, liquids in excess of TSDF-WAC limits, and compressed gases through independent replicate scans and independent observations? ~~And additionally~~In addition, does the site describe in its QAPjP and SOP(s) activities to verify the precision of radiography prior to use by tuning precisely enough to demonstrate compliance with QAOs through viewing an image test pattern? Accuracy • Was accuracy obtained by using a target to tune the image for maximum sharpness and by requiring operators to successfully identify 100 percent of the required items in a training container during their initial qualification and subsequent requalification?					
233a	Completeness • Was an audio/videotape (or equivalent media) of the radiography examination and a radiography data form validated according to the requirements in Permit Attachment C3, Section C3-4? • Was an audio/videotape (or equivalent media) of the radiography examination and a radiography data form obtained for 100 percent~~100%~~ of the waste containers subject to radiography? Comparability • Is comparability ensured through the use of standardized radiography procedures and operator training and qualifications (Section C3-2a)					

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
	Characterization and System Requirements					
234	Does the site have procedures to ensure that radiography is used to identify and verify waste container contents and verify the waste's physical form? Does the site have procedures to identify prohibited materials? (Sections C-3b; C1-1)					
235	Do procedures or other supporting documentation ensure that every waste container will undergo radiography and/or VE as necessary to augment AK? (Section C-3b)					
236	Do procedures ensure that containers whose contents prevent full examination are examined by ~~visual examination~~VE rather than by radiography unless the site certifies that ~~visual examination~~VE would provide no additional relevant information for that container based on the AK information for the waste stream? (Section C1-1)					
237	Do procedures or other supporting documentation ensure that the physical form determined by radiography is compared with the waste stream descriptions? If discrepancies are noted, will a new waste stream be identified? (Section C-3b)					
238	Are there procedures to ensure the data is obtained from an audio/video recorded scan provided by trained radiography operators? (Section C1-1)					
239	Were ~~all~~ activities required to achieve the radiography objective described in site Quality Assurance Project Plans (QAPjPs) and Standard Operating Procedures (SOPs)? (Section C3-2)					
240	Did the radiography system consist of the following equipment or equivalent: • an X-ray producing device? • an imaging system? • an enclosure for radiation protection? • a waste container handling system? • an audio/video recording system or equivalent? • an operator control and data acquisition station? (Section C1-1)					

	WAP Requirement[1]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
241	Did the X-ray producing device have controls which allow the operator to vary voltage, thereby controlling image quality? Was it possible to vary the voltage, typically between 150-400 kV, to provide an optimum degree of penetration through the waste? Was high-density material examined with the X-ray device set on the maximum voltage? Was low-density material examined at lower voltage settings to improve contrast and image definition? (Section C1-1)					
242	Do procedures or other documentation ensure that an audio/videotape or equivalent is made of the waste container scan and maintained as a non-permanent record? (Section C1-1)					
	Data Compilation					
243	Are there procedures to ensure that a radiography data form is used to document the waste matrix code, ensure the waste container contains no ignitable, corrosive or reactive waste by documenting the absence of liquids in excess of TSDF-WAC limits or compressed gases, and verify that the physical form of the waste is consistent with the waste stream description documented on the WSPF? (Section C1-1)					
245	If radiography indicates that the waste does not match the waste stream description, do procedures ensure that the appropriate corrective action was taken? (Section C-3b)					
246	If a discrepancy is noted, do procedures ensure that the proper waste stream assignment is determined, the correct EPA hazardous waste numbers assigned, and the resolution documented? (Section C-3b)					
	Training					
247	Do site procedures ensure that only trained personnel are allowed to operate radiography equipment? (Section C1-1)					
248	Do site procedures ensure that training requirements for radiography operators is based upon existing industry standard training requirements? (Section C1-1)					
249	Does the documented training program provide radiography operators with both formal and on-the-job training (OJT)? (Section C1-1)					

	WAP Requirement[1]	Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
		Location	Adequate? Y/N (Why?)	Item Reviewed	Adequate? Y/N	
250	Does the documented training program ensure that the radiography operators are instructed in the specific waste generating practices and typical packaging configurations expected to be found in each waste stream at the site? (Section C1-1)					
251	Does the documented training program ensure that the OJT and apprenticeship are conducted by an experienced, qualified radiography operator prior to qualification of the candidate? (Section C1-1)					
252	Is the documented training program site specific? (Section C1-1)					
262	Does the documented training program ensure that a training drum with various container sizes is scanned by each operator on a semiannual basis? Is the videotape reviewed by a supervisor to ensure that operators' interpretations are~~remain~~ consistent and accurate? (Section C1-1)					
263	Do site procedures ensure that the site prepares Testing Batch Data Reports or equivalent which includes~~ all~~ data pertaining to radiography for up to 20 waste containers without regard to waste matrix? (Section C3-4)					
	Quality Assurance					
265	Does the documented training program ensure that the imaging system characteristics are verified on a routine basis? (Section C1-1)					
266	Do procedures ensure that independent replicate scans and replicate observations of the video output of the radiography process are performed under uniform conditions and procedures? Are independent replicate scans performed on one waste container per day or per testing batch of 20 samples, ~~which ever~~whichever is less frequent, by a qualified radiography operator that was not involved in the original scan of the waste container? Are independent observations of one scan (not the replicate scan) performed once per day or per testing batch, ~~which ever~~whichever is less frequent, by a qualified radiography operator that was not involved in the original scan of the waste container? (Section C1-1)					
267	Do procedures ensure that oversight functions include periodic audio/video media reviews of accepted waste containers, are performed by qualified radiography operators that were not involved in the original scans of the waste containers? (Section C1-1)					

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
268	Is the ~~site project manager~~ SPM responsible for monitoring the quality of the radiography data and calling for corrective action, when necessary? (Section C1-1)					
	Data Validation, Review, Verification and Reporting					
277	Do procedures ensure that ~~all~~ applicable data generation review verification and validation activities specified in Permit Attachment C3, Section C3-4 are followed, including ~~all~~ signatory releases? (Section C3-4)					
278	Do procedures ensure that radiography tapes have been reviewed at a frequency of one waste container per day or once per testing batch, whichever is less frequent, to ensure data are correct and completed? (Section C1-1)					
279	Do procedures ensure that ~~all~~ applicable project-level signatory releases and DQOs (Section C3-3) as specified in the WAP are performed? (Section C3-4b)					
282	At the data generation level, do procedures ensure that ~~all~~ electronic and video data stored appropriately to ensure that waste container, sample, and associated QA data are readily retrievable? Are radiography tapes reviewed, at a frequency of one waste container per day or once per testing batch, whichever is less frequent, against the data reported on the radiography form? (Sections C3-4a, C3-4a(1))					
283	At the project level, do procedures require the ~~Site Project Manager~~SPM to certify that the radiography data are complete and acceptable based on the videotape review of at least one waste container per testing batch or daily, whichever is less frequent? (Section C3-4b(1))					

1. The WAP requirements should be presented in documents, such as procedures. Each of the questions posed under WAP requirements are meant to determine whether procedures are in place or whether documents are evident which demonstrate that the specific WAP requirement is or can be met.

Table C6-4
Visual Examination (VE) Checklist

		Procedure Documented		Example of Implementation/ Objective Evidence, as applicable		Comment (e.g., any change in procedure since last audit, etc.)
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
	Training					
296	Is there documentation which shows that a standardized training program for ~~visual examination~~VE operators has been developed? Is it specific to the site and include the various waste configurations generated/stored at the site? (Section C1-2)					
297	Is there documentation which shows that the ~~visual examination~~VE operators receive training on the specific waste generating processes, typical packaging configurations, and waste material parameters expected to be found in each Waste Matrix Code at the site? (Section C1-2)					
298	Are the ~~visual examination~~VE personnel requalified once every two years? (Section C1-2)					
298a	Does the training include the following regardless of Summary Category Group? • Identifying and describing the contents of a waste container by examining ~~all~~ items in waste containers of previously packaged waste. • Identifying when VE cannot be used to meet the DQOs, (Section C1-2)					
	Visual Examination Expert Requirements					
300	Does documentation ensure that the site has designated a ~~visual examination~~VE expert? Is the ~~visual examination~~VE expert familiar with the waste generating processes that have taken place at the site? Is the ~~visual examination~~VE expert familiar with ~~all of~~ the types of waste being characterized at that site? (Section C1-2)					
301	Does documentation ensure that the ~~visual examination~~VE expert shall be responsible for the overall direction and implementation of the ~~visual examination~~VE aspects of the program? Does the site's QAPjP specify the selection, qualification, and training requirements of the ~~visual examination~~VE expert? (Section C1-2)					

		Procedure Documented		**Example of Implementation/ Objective Evidence, as applicable**		**Comment (e.g., any change in procedure since last audit, etc.)**
	WAP Requirement[1]	**Location**	**Adequate? Y/N (Why?)**	**Item Reviewed**	**Adequate? Y/N**	
	Visual Examination Procedures					
304	Do procedures indicate that ~~all visual examination~~VE activities are documented on video/audio media or VE performed by using a second operator to provide additional verification by reviewing the contents of the waste container to ensure correct reporting? (Section C1-2)					
304a	Are procedures in place to ensure that when VE is performed using a second operator, each operator performing VE shall observe for themselves the waste being placed in the container or the contents within the examined waste container when waste is not removed? (Section C1-2)					
313	Do site procedures ensure that when liquid is found, the non-transparent internal container holding the liquid will be assumed to be filled with liquid and this volume will be added to the total liquid in the container being characterized using VE? The container being characterized using VE would then be rejected and/or repackaged to exclude the internal container if it is over the TSDF-WAC limits. (Section C-3b)					

<table>
<tr><th rowspan="2"></th><th rowspan="2">WAP Requirement[1]</th><th colspan="2">Procedure Documented</th><th colspan="2">Example of Implementation/ Objective Evidence, as applicable</th><th rowspan="2">Comment (e.g., any change in procedure since last audit, etc.)</th></tr>
<tr><th>Location</th><th>Adequate? Y/N (Why?)</th><th>Item Reviewed</th><th>Adequate? Y/N</th></tr>
<tr><td></td><td colspan="6">Quality Assurance Objectives</td></tr>
<tr><td>314</td><td>Are process procedures in place to meet the following Quality Assurance Objectives?
Precision
• Precision is maintained by reconciling any discrepancies between the operator and the independent technical reviewer with regard to identification of waste matrix code, liquids in excess of TSDF-WAC limits, and compressed gases.
Accuracy
• Accuracy is maintained by requiring operators to pass a comprehensive examination and demonstrate satisfactory performance in the presence of the VE expert during their initial qualification. ~~VE~~Visual examination operators shall be requalified every two years.
Completeness
• A validated VE data form will be obtained for 100 percent of the waste containers subject to VE.
Comparability
• The comparability of VE data from different operators shall be enhanced by using standardized VE procedures and operator qualifications.
(Section C3-2b)</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

1. The WAP requirements should be presented in documents, such as procedures. Each of the questions posed under WAP requirements are meant to determine whether procedures are in place or whether documents are evident which demonstrate that the specific WAP requirement is or can be met.

ATTACHMENT C7

TRU WASTE CONFIRMATION

ATTACHMENT C7

TRU WASTE CONFIRMATION

TABLE OF CONTENTS

LIST OF FIGURES

ATTACHMENT C7

TRU WASTE CONFIRMATION

Introduction

The Permittees demonstrate compliance with the waste analysis requirements of the Permit by ensuring that the waste characterization processes performed by generator/storage sites (**sites**) produce data compliant with the Waste Analysis Plan (**WAP**) and through the waste screening and verification processes. Verification occurs at three levels: 1) the data generation level, 2) the project level, and 3) the Permittee level. The Permittees also examine a representative subpopulation of waste prior to shipment to confirm that the waste contains no ignitable, corrosive or reactive waste; and that assigned U.S. Environmental Protection Agency ~~(**EPA**)~~ hazardous waste numbers are allowed by the Permit. The waste confirmation activities described herein occur prior to shipment of the waste from the generator/storage site to the Waste Isolation Pilot Plant (**WIPP**) facility~~WIPP~~.

C7-1 Permittee Confirmation of TRU Mixed Waste

Waste confirmation is defined in Permit Part 1, Section 1.5.12 as the activities performed by the Permittees or the co-Permittee the U.S. Department of Energy (**DOE**), pursuant to this Permit Attachment, to satisfy the requirements specified in Section 310 of Pub. L. 108-447. Waste confirmation occurs after waste containers have been certified for shipment to and disposal at the WIPP facility. The general confirmation process for WIPP waste is presented in Figure C7-1.

C7-1a Confirmation of a Representative Subpopulation of the Waste

The Permittees shall confirm that the waste contains no ignitable, corrosive, or reactive waste through radiography (Section C7-1b) or the use of visual examination (**VE**) (Section C7-1c) of a statistically representative subpopulation of the waste. Prior to shipment to the WIPP facility, waste confirmation will be performed on randomly selected containers from each contact-handled~~**CH**~~ and remote-handled~~**RH**~~ transuranic (**TRU**) mixed waste stream shipment. Figure C7-1 presents the overall waste verification and confirmation process.

Waste confirmation encompasses ensuring that the physical characteristics of the TRU mixed waste correspond with its waste stream description and that the waste does not contain liquid in excess of Treatment, Storage, and Disposal Facility-Waste Acceptance Criteria (**TSDF-WAC**) limits or compressed gases. These techniques can detect liquid that exceeds ~~1~~one percent volume of the container and containerized gases, which are prohibited from storage or disposal at the WIPP facility. The prohibition of liquid in excess of TSDF-WAC limits and containerized gases prevents the storage or disposal of ignitable, corrosive, or reactive wastes. Radiography and/or ~~visual examination~~VE will ensure that the physical form of the waste matches its waste stream description (i.e., Homogeneous Solids, Soil/Gravel, or Debris Waste). The results of waste confirmation activities, including radiography and ~~visual examination~~VE records (data sheets, packaging logs, and/or video and audio recordings) will be maintained in the WIPP facility ~~operating record~~Operating Record. Noncompliant waste identified during waste confirmation will be managed as described in Section C7-2.

The Permittees shall randomly select at least ~~7~~seven percent of each waste stream shipment for waste confirmation. This equates to a minimum of one container from each fourteen containers in each waste stream in each designated shipment. If there are less than fourteen containers from a waste stream in a particular shipment, a minimum of one container from the waste stream shipped will be selected. If the random selection of containers in a shipment occurs prior to loading the waste containers into the shipping package~~Shipping Package~~, the randomly selected containers may be consolidated into a single Type B package consistent with transportation requirements. Documentation of the random selection of containers for waste confirmation will be placed in the WIPP facility ~~operating record~~Operating Record.

For each container selected for confirmation in accordance with the process above, the Permittees will examine the respective nonconformance report (**NCR**) documentation to verify NCRs have been dispositioned for the selected container as required by Permit Attachment C3, Section C3-7.

C7-1a(1) TRU Waste Confirmation Training Requirements

Transuranic ~~TRU~~ waste confirmation may be completed by performing actual radiography/~~visual examination~~VE on the waste container(s) or by a review of radiography/~~visual examination~~VE media and records. This allows for a tiered approach for the training of the Permittees'~~WIPP~~ TRU waste confirmation personnel.

The Permittees' TRU waste confirmation personnel may be trained to either review radiography/~~visual examination~~VE media and records (Level 1) or to perform actual radiography/~~visual examination~~VE on the waste container(s) (Level 2). Level 2 personnel may also perform waste confirmation by review of media and records.

C7-1b Radiography Methods Requirements

Radiography has been developed by the Permittees specifically to aid in the examination and identification of containerized waste. The Permittees shall describe ~~all~~the activities required to achieve the radiography objectives in standard operating procedures (**SOPs**). These SOPs shall include instructions specific to the radiography system(s) used by the Permittees at an off-site facility (e.g., the generator/storage site). For example, to detect liquid, some systems require the container to be rotated back and forth while other systems require the container to be tilted.

A radiography system (e.g., real time radiography, digital radiography/computed tomography) normally consists of an ~~X~~x-ray-producing device, an imaging system, an enclosure for radiation protection, a waste container handling system, a video and audio recording system, and an operator control and data acquisition station. ~~Although these six components are required, it~~It is expected there will be some variation within a given component between radiography systems. The radiography system shall have controls, or an equivalent process, which allow the operator to control image quality. On some radiography systems, it should be possible to vary the voltage, typically between 150 to 400 kilovolts ~~(**kV**)~~, to provide an optimum degree of penetration through the waste. For example, high-density material should be examined with the ~~X~~x-ray device set on the maximum voltage. This ensures maximum penetration through the waste container. Low-density material should be examined at lower voltage settings to improve contrast and image definition. The imaging system typically utilizes either a fluorescent screen and a low-light television camera or x-ray detectors to generate the image.

To perform radiography, the waste container is scanned while the operator views the television screen. A video and audio recording is made of the waste container scan and is maintained in the WIPP facility ~~operating record~~Operating Record as a non-permanent record. A radiography data form is also used to document the Waste Matrix Code, ensure that the waste container contains no ignitable, corrosive, or reactive waste by documenting the absence of liquid in excess of TSDF-WAC limits or compressed gases, and verify that the physical form of the waste is consistent with the waste stream description documented on the Waste Stream Profile Form (**WSPF**). Containers whose contents prevent full examination of the remaining contents shall be subject to ~~visual examination~~VE unless the Permittees certify that ~~visual examination~~VE would provide no additional relevant information for that container based on the acceptable knowledge information for the waste stream. Such certification shall be documented in the WIPP facility ~~operating record~~Operating Record.

For containers that have been characterized using radiography by the generator/storage sites in accordance with the method in Permit Attachment C1, Section C1-1~~C1-3~~, the Permittees may perform confirmation by review of the generator/storage site's radiography audio/video recordings.

For containers which contain classified shapes and undergo radiography, the radiography will occur at a facility with appropriate security provisions and the video and audio recording will be considered classified. The radiography data forms will not contain classified information.

C7-1b(1) Radiography Training

The radiography system involves qualitative and semiquantitative evaluations of visual displays. Operator training and experience are the most important considerations for ensuring quality controls in regard to the operation of the radiography system and for interpretation and disposition of radiography results. Only trained personnel shall be allowed to operate radiography equipment.

Radiographer Level 1 personnel performing TRU mixed waste confirmation shall be trained in:

- TRU Waste Confirmation Radiographer Level 1 Qualification.

Radiographer Level 2 personnel performing TRU mixed waste confirmation shall be trained in:

- TRU Waste Confirmation Radiographer Certification Level 2 Qualification.

C7-1b(1)(i) TRU Waste Confirmation Radiographer Certification Level 1 Qualification

Level 1 radiographer operators are instructed in the specific waste-generating practices and typical packaging configurations expected to be found in each Waste Matrix Code at each site shipping waste to the WIPP facility. The on-the-job training (**OJT**) and apprenticeship is conducted by an experienced, qualified radiography operator or trainer prior to the qualification of the training candidate. Radiography operators are qualified once every two years.

The ~~level~~ Level 1 radiography training program includes the following elements:

Formal Training

- Project Requirements
- State and Federal Regulations
- Basic Principles of Radiography
- Radiography of Waste Forms (including the ability to identify liquid and compressed gases which will be verified by the radiography subject matter expert)
- Waste Stream-Specific Instruction (e.g., specific waste-generating processes, typical packaging configurations, waste material parameters)

On-the-Job Training

- System Operation (equipment and procedures used by Level 1 radiographers)
- Identification of Packaging Configurations
- Identification of Waste Material Parameters/Waste Matrix Codes
- Identification of liquid in excess of the TSDF-WAC limits and compressed gases
- Verification of waste stream description

C7-1b(1)(ii) TRU Waste Confirmation Radiographer Level 2 Qualification

Level 2 radiography operators are instructed in the specific waste-generating practices and typical packaging configurations expected to be found in each Waste Matrix Code at each site shipping waste to the WIPP facility. The OJT and apprenticeship are conducted by an experienced qualified radiography operator prior to the qualification of the training candidate. Radiography operators are requalified once every two years.

The Level 2 radiography training program included the following elements:

Formal Training

- Project Requirements
- State and Federal Regulations
- Basic Principles of Radiography
- Radiographic Image Quality
- Radiographic Scanning Techniques
- Application Techniques

- Radiography of Waste Forms
- Standards, Codes, and Procedures for Radiography
- Waste Stream-Specific Instruction

On-the-Job Training

- System Operation
- Identification of Packaging Configurations
- Identification of Waste Material Parameters/Waste Matrix Codes
- Identification of liquid in excess of the TSDF-WAC limits and compressed gases
- Verification of waste stream description

C7-1b(2) Radiography Oversight

The Permittees shall be responsible for monitoring the quality of the radiography data and calling for corrective action, when necessary.

A training drum with internal containers of various sizes shall be scanned biennially by each Level 2 operator. The video and audio media shall then be reviewed by a radiography subject matter expert to ensure that operators' interpretations remain consistent and accurate. Imaging system characteristics shall be verified on a routine basis.

Independent replicate scans and replicate observations of the video output of the radiography process shall be performed under uniform conditions and procedures. Independent replicate scans shall be performed on one waste container per day or once per shipment, whichever is less frequent. Independent observations of one scan (not the replicate scan) shall also be made once per day or once per shipment, whichever is less frequent, by a qualified radiography operator other than the individual who performed the first examination. When confirmation is performed by review of audio/video recorded scans produced by the generator/storage site as specified in Permit Attachment C1, Section C1-1, independent observations shall be performed on two waste containers per shipment or two containers per day, whichever is less frequent.

C7-1c Visual Examination Methods Requirements

Visual examination ~~(VE)~~ may also be used as a waste confirmation method. Visual examination~~VE~~ shall be conducted by the Permittees in accordance with written SOPs to describe the contents of a waste container. Visual examination shall be conducted to identify and describe ~~all~~ waste items, packaging materials, and waste material parameters. Visual examination~~VE~~ may be used to examine a statistically representative subpopulation of the waste certified for shipment to the WIPP facility to confirm that the waste contains no ignitable, corrosive, or reactive waste. This is achieved by confirming that the waste contains no liquid in excess of TSDF-WAC limits or compressed gases, and that the physical form of the waste matches the waste stream description documented on the WSPF. During packaging, the waste container contents are directly examined by trained personnel. This form of waste confirmation may be performed by the Permittees at a generator/storage site. The VE may be documented on video and audio media, or by using a second operator to provide additional verification by reviewing the contents of the waste container to ensure correct reporting. When VE is performed using a second operator, each operator performing the VE shall observe for themselves the waste being placed in the waste container or the contents within the examined waste container when waste is not removed. The results of ~~all~~ VE shall be documented on VE data forms, which are used to document (1) the Waste Matrix Code, (2) that the waste container contains no ignitable, corrosive, or reactive waste by documenting the absence of liquids in excess of TSDF-WAC limits or compressed gases, and (3) that the physical form of the waste is consistent with the waste stream description documented on the WSPF.

In order to keep radiation doses as low as reasonably achievable at generator/storage sites, the Permittees may use their own trained VE operators to perform VE for waste confirmation by reviewing generator/storage site VE data, which includes VE data forms, waste packaging records, and may also include audio/video media. The Permittees shall document their review of generator/storage site VE data on confirmation data forms.

If the generator/storage site documented VE using audio/video media in accordance with Permit Attachment C1, Section C1-2, the Permittees must use the audio/video media to perform confirmation. If the Permittees perform waste confirmation by review of audio/video media, the audio/video record of the VE must be sufficiently complete for the Permittees to confirm the Waste Matrix Code and waste stream description, and verify the waste contains no liquid in excess of TSDF-WAC limits or compressed gases. Generator/storage site VE video/audio media subject to review by the Permittees shall meet the following minimum requirements:

- The video/audio media shall record the waste packaging event for the container such that ~~all~~ waste items placed into the container are recorded in sufficient detail and shall contain an inventory of waste items in sufficient detail that a trained Permittee VE operator can identify the associated waste material parameter.

- The video/audio media shall capture the waste container identification number.

- The personnel loading the waste container shall be identified on the video/audio media or on packaging records traceable to the loading of the waste container.

- The date of loading of the waste container will be recorded on the video/audio media or on packaging records traceable to the loading of the waste container.

~~VE~~Visual examination audio/video media of containers that contain classified shapes shall be considered classified information.

If the generator/storage site did not document VE using audio/video media, the Permittees may use their own trained VE operators to perform VE for waste confirmation by reviewing VE data forms or packaging records prepared by the generator/storage site. To be acceptable, the generator/storage site VE data forms or packaging records must be signed by two generator/storage site personnel who witnessed the packaging of the waste and must provide sufficient information for the Permittees to determine that the waste container contents match the waste stream description on the WSPF and the waste contains no liquids in excess of TSDF-WAC limits or compressed gases. Generator/storage site VE forms or packaging records subject to review by the Permittees shall meet the following minimum requirements:

- At least two generator site personnel who witnessed the packaging of the waste shall approve the data forms or packaging records attesting to the contents of the waste container.

- The data forms or packaging records shall contain an inventory of waste items in sufficient detail that a trained Permittee VE operator can identify the associated waste material parameters.

- The waste container identification number shall be recorded on the data forms or packaging records.

Visual examination video/audio media of containers which contain classified shapes shall be considered classified information. Visual examination data forms will not contain classified information.

C7-1c(1) Visual Examination Training

Visual Examination Operator/Expert Level 1 personnel performing TRU mixed waste confirmation shall be trained in:

- TRU Waste Confirmation Visual Examination Level 1 Qualification.

Visual Examination Operator/Expert Level 2 performing TRU mixed waste confirmation shall be trained in:

- TRU Waste Confirmation Visual Examination Level 2 Qualification.

C7-1c(1)(i) TRU Waste Confirmation Visual Examination Level 1 Qualification

Level 1 ~~visual examination~~VE personnel are instructed in the specific waste-generating processes, typical packaging configurations, and waste material parameters expected to be found in each Waste Matrix Code in the waste stream being confirmed using ~~visual examination~~VE. The OJT and apprenticeship are conducted by an operator experienced and qualified in ~~visual examination~~VE or a qualified trainer prior to qualification of the candidate. The training is waste stream specific to include the various waste configurations being confirmed. For example, the particular physical forms and packaging configurations at each site will vary and operators shall be trained on types of waste that are generated, stored, and/or characterized at that particular site. -Visual examination personnel are requalified once every two years.

The Level 1 ~~visual examination~~VE training program included the following elements:

Formal Training

- Project Requirements

- State and Federal Regulations

- Batch Data Report Forms

- Waste Stream-Specific Instruction (e.g., waste-generating processes, typical packaging configurations, waste material parameters)

On-the-Job Training

- System Operation (equipment and procedures used by Level 1 ~~visual examination~~VE personnel)
- Identification of Packaging Configurations
- Identification of Waste Material Parameters/Waste Matrix Codes
- Identification of liquid in excess of the limits in the TSDF-WAC and compressed gases
- Verification of waste stream description

C7-1c(1)(ii) TRU Waste Confirmation Visual Examination Level 2 Qualification

Level 2 ~~visual examination~~VE personnel are instructed in the specific waste-generating processes, typical packaging configurations, and waste material parameters expected to be found in each Waste Matrix Code in the waste stream being confirmed using ~~visual examination~~VE. The OJT and apprenticeship are conducted by an operator experienced and qualified in ~~visual examination~~VE or a qualified trainer prior to qualification of the candidate. The training is waste stream specific to include the various waste configurations being confirmed. For example, the particular physical forms and packaging configurations at each site will vary so operators shall be trained on types of waste that are generated, stored, and/or characterized at that particular site. Visual examination personnel are requalified once every two years.

The Level 2 ~~visual examination~~VE training program includes the following elements:

Formal Training

- Project Requirements
- State and Federal Regulations
- Batch Data Report Forms
- Application Techniques
- Waste Stream-Specific Instruction (e.g., specific waste-generating processes, typical packaging configurations, waste material parameters)

On-the-Job Training

- Identification of Packaging Configurations
- Identification of Waste Material Parameters/Waste Matrix Codes

- Identification of liquid in excess of the TSDF-WAC limits and compressed gases
- Verification of waste stream description

C7-1c(2) Visual Examination Oversight

The Permittees shall designate at least one VE expert. The VE expert shall be familiar with the processes that were used to generate the waste streams being confirmed using VE. The VE expert shall be responsible for the overall direction and implementation of the ~~Permittees 's~~Permittees' VE program. The Permittees shall specify the selection, qualification, and training requirements of the ~~visual examination~~VE expert in an SOP.

C7-1d Quality Assurance Objectives ~~(**QAOs**)~~ for Radiography and Visual Examination

The Quality Assurance Objectives (**QAOs**)~~QAOs~~ the Permittees must meet for radiography and ~~visual examination~~VE are detailed in this section. If the QAOs described below are not met, then corrective action as specified in Permit Attachment C3, Section C3-7 shall be taken.

C7-1d(1) Radiography Quality Assurance Objectives~~QAOs~~

The QAOs for radiography are detailed in this section. If the QAOs described below are not met, then corrective action shall be taken.

Data to meet these objectives must be obtained from a video and audio recorded scan provided by trained radiography operators. Results must also be recorded on a radiography data form. The precision, accuracy, representativeness, completeness, and comparability objectives for radiography data are presented below.

Precision

Precision is maintained by reconciling any discrepancies between two radiography operators with regard to the waste stream waste confirmation, identification of liquid in excess of TSDF-WAC limits, and identification of compressed gases through independent replicate scans and independent observations.

Accuracy

Accuracy is obtained by using a target to tune the image for maximum sharpness and by requiring operators to successfully identify 100 percent of the required items in a training container during their initial qualification and subsequent requalification.

Representativeness

Representativeness is ensured by performing radiography on a random sample of waste containers from each waste stream in each shipment.

Completeness

A video and audio media recording of the radiography examination and a validated radiography data form will be obtained for 100 percent of the waste containers subject to radiography.

Comparability

The comparability of radiography data from different operators shall be enhanced by using standardized radiography procedures and operator qualifications.

C7-1d(2) Visual Examination Quality Assurance Objectives~~QAOs~~

Results must be recorded on a VE data form. The precision, accuracy, representativeness, completeness, and comparability objectives for VE data are presented below.

Precision

Precision is maintained by reconciling any discrepancies between the operator and the independent technical reviewer with regard to the waste stream waste confirmation, identification of liquid in excess of TSDF-WAC limits, and identification of compressed gases.

Accuracy

Accuracy is maintained by requiring operators to pass a comprehensive examination and demonstrate satisfactory performance in the presence of the VE expert during their initial qualification. Visual examination~~VE~~ operators shall be requalified once every two years.

Representativeness

Representativeness is ensured by performing VE on a random sample of waste containers within each waste stream in each shipment.

Completeness

A validated VE data form will be obtained for 100 percent of the waste containers subject to VE.

Comparability

The comparability of VE data from different operators shall be enhanced by using standardized VE procedures and operator qualifications.

C7-1e Review and Validation of Radiography and Visual Examination Data Used for Waste Examination

This section describes the requirements for review and validation of radiography and VE data by the Permittees.

C7-1e(1) Independent Technical Review

The radiography and/or VE confirmation data for each shipment shall receive an independent technical review. This review will be performed before the affected waste shipment is shipped to the WIPP facility. The review shall be performed by an individual other than the data generator who is qualified to have performed the work. The review will be performed in accordance with approved Permittee SOPs and will be documented on a review checklist. The reviewer(s) must approve the data as evidenced by signature, and as a consequence, ensure the following:

- Data generation and reduction were conducted in a technically correct manner in accordance with the methods used (procedure with revision). Data were reported in the proper units and correct number of significant figures.

- The data have been reviewed for transcription errors.

- Radiography video and audio media recordings have been reviewed (independent observation) on a waste container basis at a minimum of once per shipment or once per day of operation, whichever is less frequent. The radiography video/audio recording will be reviewed against the data reported on the ~~Permittees ‘s~~Permittees’ radiography form to ensure that the data are correct and complete. If review of radiography scans recorded by the generator/storage site was used to perform confirmation, two observations must be performed for each shipment or two observations per day, whichever is less frequent.

C7-1e(2) DOE Management Representative Review

The radiography and/or ~~visual examination~~VE data forms and independent technical review checklist (confirmation data package) for each shipment shall receive a DOE management review. This review will be performed before the affected waste shipment is disposed of at the WIPP facility. The review shall be performed by a designated representative of DOE management. The review will be performed in accordance with approved DOE SOPs and will be documented on a review checklist. The reviewer(s) must approve the confirmation data package as evidenced by signature, and as a consequence, ensure the following:

- The data are technically reasonable based on the technique used.

- The data have received independent technical review.

- The data indicate that the waste examined contained no ignitable, corrosive, or reactive waste and that the physical form of the waste was consistent with the waste stream description in the WSPF.

- Quality control~~QC~~ checks have been performed (e.g., replicate scans, image quality checks).

- The data meet the established QAOs

Upon completion of the DOE ~~management representative~~Management Representative review, the waste confirmation data for the shipment shall be submitted to the WIPP facility ~~operating record~~ Operating Record as non-permanent records. Waste confirmation data includes radiography and VE data forms, video/audio media, and review checklists.

C7-1e(3) DOE Management Representative Training

The DOE Management Representative performing TRU mixed waste confirmation data package review and approval shall be trained in:

- Required Reading:

- The DOE's Quality Assurance Program Document
- Permit Attachments C through C7
- Required Reading identified in DOE's management procedure, *Approval of Contractor-Generator Confirmation Data Packages*

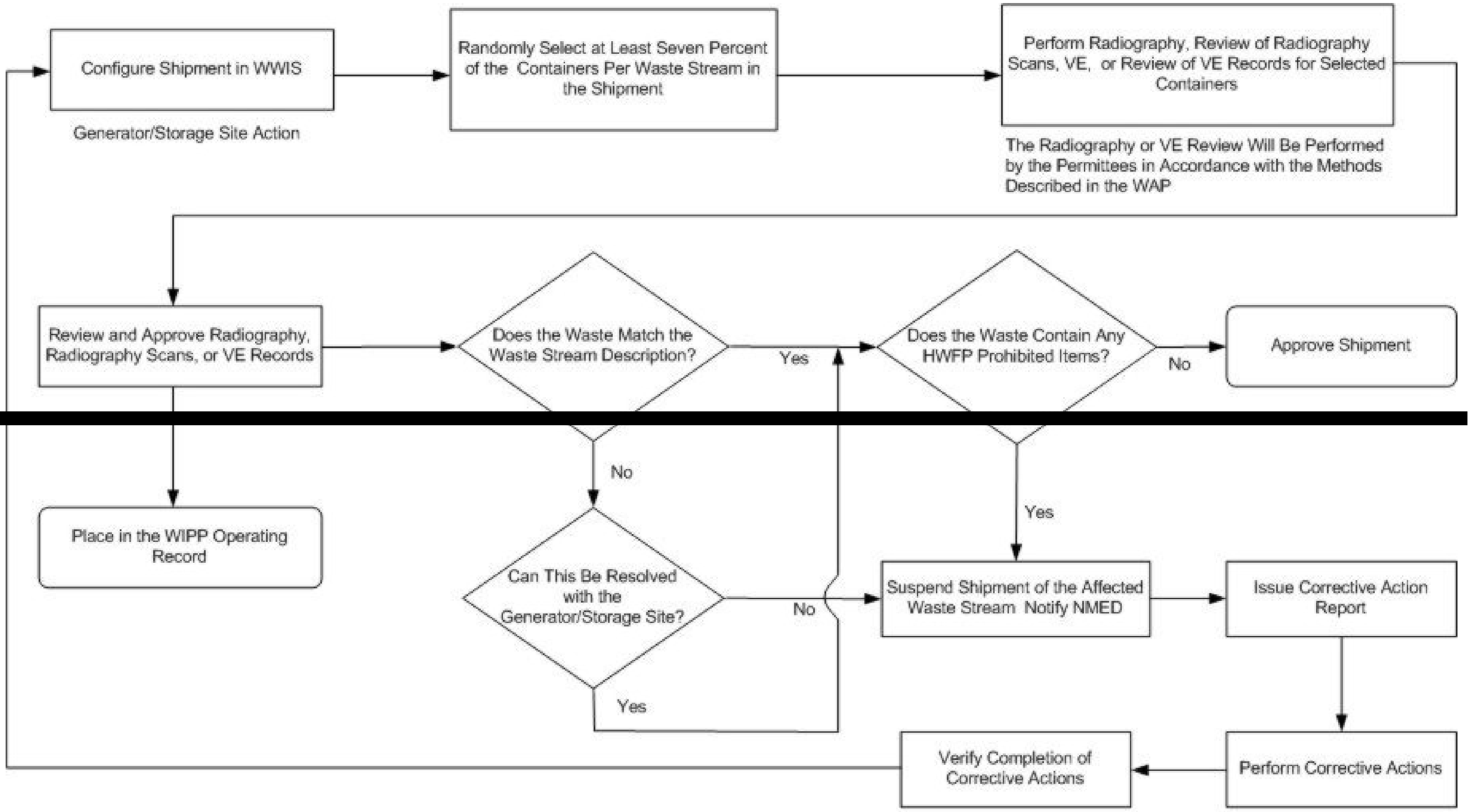
C7-2 Noncompliant Waste Identified During Waste Confirmation

If the Permittees identify noncompliant waste during waste confirmation at a generator/storage site (i.e., the waste does not match the waste stream description documented in the WSPF or there is liquid in excess of TSDF-WAC limits or compressed gases) the waste will not be shipped and the Management and Operating Contractor and the DOE Carlsbad Field Office will be notified. The DOE will suspend further shipments of the affected waste stream and issue a Corrective Action Report (**CAR**) to the generator/storage site. Shipments of affected waste streams shall not resume until the CAR has been closed. The New Mexico Environment Department (**NMED**) will be notified within 24 hours of any suspension of waste stream shipments due to the identification of noncompliant waste during waste confirmation.

As part of the corrective action plan in response to the CAR, the generator/storage site will evaluate whether the waste characterization information documented in the Characterization Information Summary (**CIS**) and/or WSPF for the waste stream must be updated because the results of waste confirmation for the waste stream indicated that the TRU mixed waste being examined did not match the waste stream description. The generator/storage site will thoroughly evaluate the potential impacts on waste that has been shipped to the WIPP facility. The DOE will evaluate the potential that prohibited items were shipped to the WIPP facility and what remedial actions should occur, if any. The results of these evaluations will be provided to the NMED before shipments of affected waste streams resume. If the CIS~~Characterization Information Summary~~ or WSPF requires revision, shipments of the affected waste stream shall not resume until the revised waste stream waste characterization information has been reviewed and approved by the DOE.

If a generator/storage site certifies noncompliant waste more than once during a running 90-day period, the DOE will suspend acceptance of that site's waste until the DOE finds that ~~all~~ corrective actions have been implemented and the site complies with ~~all~~ applicable requirements of the WAP.

FIGURES



~~Figure C7-1~~
~~Overview of Waste Confirmation~~

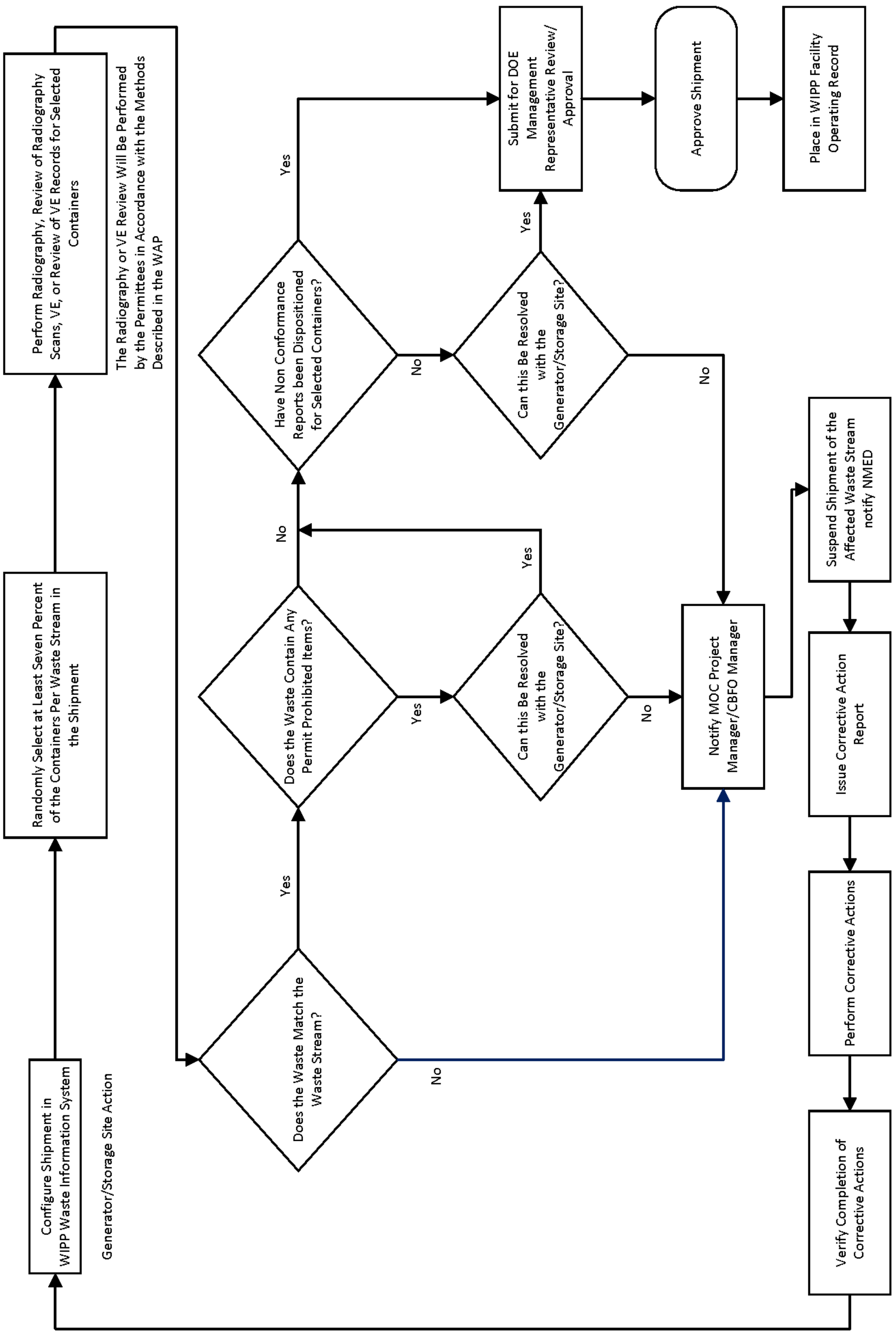


Figure C7-1
Overview of Waste Confirmation

ATTACHMENT D

RCRA CONTINGENCY PLAN

ATTACHMENT D

RCRA CONTINGENCY PLAN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ATTACHMENT D

RCRA CONTINGENCY PLAN

Introduction

This attachment contains the *RCRA Contingency Plan* prepared in accordance with the Resource Conservation and Recovery Act (**RCRA**) requirements codified in 20.4.1.300 New Mexico Administrative Code (**NMAC**) (incorporating Title 40 of the Code of Federal Regulations (**CFR**) Part 262, Subpart M) and 20.4.1.500 NMAC (incorporating 40 CFR Part 264, Subpart D), "Contingency Plan and Emergency Procedures." The purpose of this document is to define responsibilities and to describe the coordination of activities necessary to minimize hazards to human health and the environment from fires, explosions, or any sudden or non-sudden release of hazardous waste, or hazardous waste constituents to air, soil, or surface water in accordance with 20.4.1.300 NMAC (incorporating 40 CFR §262.260(a)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.51(a)). This plan consists of descriptions of emergency responses specific to contact-handled (**CH**) and remote-handled (**RH**) transuranic (**TRU**) mixed waste and site-generated hazardous waste handled at the WIPP facility.

Pursuant to 20.4.1.300 NMAC (incorporating 40 CFR §262.262(b)), the Permittees ensure that a copy of the *Quick Reference Guide to the WIPP Facility RCRA Contingency Plan* is maintained on file at the facility and is available to the emergency response organizations listed in Section D-2a, *Emergency Response Personnel*, and Section D-9, *Location of the RCRA Contingency Plan and Plan Revision*. Whenever the *RCRA Contingency Plan* is revised, the Permittees will update, if necessary, the quick reference guide and redistribute it in accordance with 20.4.1.300 NMAC (incorporating 40 CFR §262.262(c)).

D-1 Scope and Applicability

The regulated units at the WIPP facility subject to this permit include the hazardous waste management units (**HWMUs**) including the Waste Handling Building (**WHB**) Container Storage Unit (i.e., **WHB Unit**) and the Parking Area Container Storage Unit (i.e., **Parking Area Unit**)~~,~~, and the hazardous waste disposal units (**HWDUs**) in the underground disposal panels.

Pursuant to 20.4.1.500 NMAC (incorporating 40 CFR §264.51(a)), owners/operators of treatment, storage, and disposal facilities are required to have formal contingency plans in place that describe actions that facility personnel will take in response to any fire, explosion, or release of hazardous waste or hazardous waste constituents which could threaten human health or the environment. The contingency plan must meet the requirements of NMAC 20.4.1.500 NMAC (incorporating 40 CFR Part 264, Subpart D). The provisions of the *RCRA Contingency Plan* apply to HWDUs in the underground waste disposal panels, HWMUs in the WHB Unit and the Parking Area Unit, the Waste Shaft, and supporting TRU mixed waste handling areas. These areas are shown in Figures D-1 through D-3.

The WIPP facility is a large quantity generator of hazardous waste pursuant to 20.4.1.300 NMAC (incorporating 40 CFR Part 262, "Standards Applicable to Generators of Hazardous Waste"). 20.4.1.300 NMAC (incorporating 40 CFR §262.261(a)) requires that a contingency plan be in place that describes actions that facility personnel will take in response to any fire, explosion, or release of hazardous waste or hazardous waste constituents which could threaten human health or the environment. The provisions of ~~the~~ this *RCRA Contingency Plan* also apply to the site-generated hazardous waste accumulation areas (both the central accumulation areas (**CAAs**), also referred to as the less-than-90-day areas, and satellite accumulation areas (**SAAs**)), the locations of which are specified in the *Quick Reference Guide to the WIPP Facility RCRA Contingency Plan*. For the remainder of this document, the term "site-generated hazardous waste" will mean waste accumulated in both the CAAs and SAAs.

Wastes may also be generated at the WIPP facility as a direct result of managing the TRU and TRU mixed wastes received from the off-site generators. Throughout the remainder of this plan, this waste is referred to as "derived waste." Derived waste will be managed as TRU mixed waste and emplaced in the rooms in HWDUs along with the TRU mixed waste for disposal. Every reasonable effort to minimize the amount of derived waste, while providing for the health and safety of personnel, will be made.

Wastes generated as a result of emergency response actions will be categorized into one of three groups and disposed of accordingly. These are: 1) nonhazardous wastes to be disposed of at an appropriate disposal facility (e.g., low-level waste facility or approved landfill), 2) hazardous nonradioactive wastes (site-generated hazardous waste) to be disposed of at an off-site RCRA permitted facility, and 3) derived waste to be disposed of in the underground HWDUs as TRU mixed waste. Hazardous liquid wastes that may be generated as a result of emergency response actions will be managed as follows:

- Non-Mixed - Accumulated liquids contaminated only with hazardous constituents will be placed into containers and managed in accordance with 20.4.1.300 NMAC (incorporating 40 CFR §262.17) requirements. The waste will be shipped to an approved off-site treatment, storage, or disposal facility.

- Mixed – Accumulated liquids contaminated with TRU mixed waste will be solidified and the solidified materials will be disposed of in the underground WIPP repository as TRU mixed waste.

Waste containing liquid in excess of treatment, storage, or disposal facility Waste Acceptance Criteria (**TSDF-WAC**) limits shall not be emplaced in the underground HWDUs (See Permit Attachment C, Section C-1c).

Off-site waste managed and disposed of at the WIPP facility is radioactive mixed waste, and as a result, response to emergencies must consider the dual hazard associated with this waste. In responding to emergencies involving TRU mixed waste, the actions necessary to protect human health and the environment from the effects of radioactivity may be similar to those actions necessary to provide protection from hazardous waste and hazardous waste constituents. Such responses may require the use of equipment and processes specific to events resulting in radiological contamination (e.g., continuous air monitors, decontamination shower equipment, HEPA vacuums, paint/fixatives) and are not included in the *RCRA Contingency Plan*. Furthermore, the *RCRA Contingency Plan* may require additional actions to be taken to mitigate the hazards associated with the hazardous component of the waste. These measures are not intended to replace actions required to protect human health and the environment in response to radiological emergencies. In this manner, the *RCRA Contingency Plan* complements the radiological response activities.

D-2 Emergency Response Personnel and Training

D-2a Emergency Response Personnel

A RCRA Emergency Coordinator will be on-site at the WIPP facility 24 hours a day, seven days a week, with the responsibility for coordinating emergency response measures. In accordance with 20.4.1.300 NMAC (incorporating 40 CFR §262.261(d)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.52(d)), qualified RCRA Emergency Coordinators are listed in Table D-1 and are trained to the requirements found in Permit Attachment F, Table F-2, under “Emergency Coordinator.”~~.~~

~~In addition, persons~~Persons qualified to act as the RCRA Emergency Coordinator have the authority to commit the necessary resources to implement this *RCRA Contingency Plan*.

During emergencies, the RCRA Emergency Coordinator has three primary responsibilities:

- Assess the Situation—The RCRA Emergency Coordinator shall gather information relevant to the incident, such as the type of event, quantity and type of released waste, and existing or potential hazards to human health and the environment.
- Protect Personnel—The RCRA Emergency Coordinator shall take reasonable measures to ensure the safety of personnel, such as ensuring that alarms have been activated, personnel have been accounted for, any injuries have been attended to, and evacuation of personnel has occurred, if necessary.
- Contain the Release—The RCRA Emergency Coordinator shall take reasonable measures to ensure that fires, explosions, or releases of hazardous waste or hazardous waste constituents do not occur, recur, or spread.

In addition to the RCRA Emergency Coordinator, the following individuals, groups, and organizations have ~~specified~~ responsibilities during ~~any~~a WIPP facility emergency, which may include the following:

- WIPP Fire Department—The primary providers of fire suppression, technical rescue, Emergency Medical Services (EMS), and hazardous materials response for the protection of personnel in both surface and underground facilities. The WIPP Fire Department personnel serve as an Industrial Fire Brigade and are trained to respond to surface and underground emergencies on site, including fires, medical emergencies, and releases of hazardous materials.
- Facility Shift Manager (**FSM**)—A member of the Facility Operations organization who is in charge of plant operations and is the senior shift representative responsible for maintaining the facility in a safe configuration during normal and abnormal conditions. The FSM can concurrently serve as the RCRA Emergency Coordinator, if trained to the requirements of Permit Attachment F (*Facility Personnel Permit Training Program*), or provide support to the qualified RCRA Emergency Coordinator on shift.
- Central Monitoring Room Operator (**CMRO**)—An on-shift operator responsible for Central Monitoring Room (CMR) operations, including coordination of facility

communications. The CMRO documents these activities (e.g., communications, notifications) in a facility log. The CMRO is a member of Facility Operations, and during emergencies, the CMRO supports the RCRA Emergency Coordinator.

- Firefighter—A WIPP Fire Department member who serves as a primary responder to surface and underground emergencies, including fires, medical emergencies, and releases of hazardous materials. Firefighters assigned to the underground will not perform any coordinated firefighting underground and will only respond to incipient-stage fires that threaten TRU mixed waste, if is it safe to do so.

- Fire Department Incident Commander—Upon delegation by the RCRA Emergency Coordinator, and once incident command has been established, the Incident Commander is responsible for direction and supervision of emergency responders during an incident resulting in implementation of the *RCRA Contingency Plan*. The Incident Commander will be a member of the WIPP Fire Department. For security-related incidents that invoke implementation of the *RCRA Contingency Plan*, the Fire Department Incident Commander will establish a unified command with the WIPP Protective Force.

- Mine Rescue Team (**MRT**)— The MRT emergency response capabilities include search, rescue, reentry, and recovery operations. The MRT responds in accordance with the requirements of 30 CFR Part 49. The MRT emergency response actions include extinguishing incipient stage fires, if encountered, and immediately reporting uncontrolled fires.

- Emergency Operations Center (**EOC**) Staff- Upon activation, the EOC supports the RCRA Emergency Coordinator and Incident Commander with emergency management decision-making and associated notifications. Since EOC staff performs duties similar to their normal job functions during an emergency response and provides support related to their area(s) of expertise, no specific RCRA training is required.

D-2b Emergency Response Training

The WIPP Fire Department personnel are trained in accordance with the *WIPP Fire Department Training Plan*, which is kept on file at the WIPP facility. The training plan incorporates current National Fire Protection Association (**NFPA**) standards for training Firefighters.

Fire Department Incident Commanders are also trained in accordance with the *WIPP Fire Department Training Plan*, which incorporates the Federal Emergency Management Agency (**FEMA**), Incident Command System (**ICS**), and the National Incident Management System (**NIMS**) standards.

WIPP personnel who perform EMS duties are licensed through the State of New Mexico Emergency Medical Systems Bureau. Licensure requirements for training, continuing education, and skills maintenance are set forth through state requirements. Licenses are maintained by attending training seminars or conferences.

As described above, emergency response training is conducted in accordance with the *WIPP Fire Department Training Plan*, which is updated whenever the applicable standards are revised. In addition to the emergency response training, WIPP Fire Department personnel are required to complete applicable site-specific training, which is described in Permit Attachment F, *Facility Personnel Permit Training Program.*

D-3 Criteria for Implementation of the *RCRA Contingency Plan*

The provisions of the *RCRA Contingency Plan* shall be implemented immediately whenever there is a fire, an explosion, or a release of hazardous wastes or hazardous waste constituents that could threaten human health or the environment, or whenever the potential for such an event exists as determined by the RCRA Emergency Coordinator, as required under 20.4.1.300 NMAC (incorporating 40 CFR §262.260(b)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.51(b)).

There may be situations ~~which~~ that do not readily lend themselves to an immediate assessment of the possible hazards to human health and the environment. In these cases, the RCRA Emergency Coordinator will implement the *RCRA Contingency Plan* as a precautionary measure, regardless of the emergency situation or occurrence, if the RCRA Emergency Coordinator has reason to believe that a fire, explosion, or release of hazardous waste or hazardous waste constituents has occurred that could threaten human health or the environment.

In accordance with 20.4.1.300 NMAC (incorporating 40 CFR §262.265(i)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.56(i)), the RCRA Emergency Coordinator, on behalf of the Permittees, will record the time, date, and details of the incident that required implementation of the *RCRA Contingency Plan*. The Secretary of the NMED will be immediately notified by the Permittees. Additionally, the Permittees shall submit a written report to the NMED within 15 days of the incident, as specified in Section D-5. The following emergency situations, as they pertain to TRU mixed waste and generated hazardous wastes, warrant immediate implementation of the *RCRA Contingency Plan* by the RCRA Emergency Coordinator in accordance with standard operating procedures on file at the WIPP facility:

- Fires

  - If a fire involving TRU mixed waste or site-generated hazardous waste occurs

  - If a fire (e.g., building, grass, nonhazardous waste fire) occurs within or near a CAA or SAA that threatens to involve site-generated hazardous waste

  - If a fire (e.g., building, grass, nonhazardous waste fire) occurs within or near the permitted HWMUs that threatens to involve TRU mixed waste

  - If a fire occurs in the underground that results in immediate personnel evacuation or prevents normal personnel access to the underground

  For any fire ~~which~~ that does not meet the above criteria, the RCRA Emergency Coordinator shall document the rationale for not implementing the *RCRA Contingency Plan* (e.g., there is no threat to human health or the environment).

- Explosions

  - If an explosion involving TRU mixed waste or site-generated hazardous waste occurs
  - If an explosion occurs within or near a CAA or SAA ~~which~~ that threatens to involve site-generated hazardous waste
  - If an explosion occurs within or near the permitted HWMUs ~~which~~ that threatens to involve TRU mixed waste
  - If an explosion occurs in the underground that results in immediate personnel evacuation or prevents normal personnel access to the underground
  - If there is an imminent danger of an explosion occurring (e.g., gas leak with an ignition source nearby) which could involve TRU mixed or site-generated hazardous waste

For any explosion ~~which~~ that does not meet the above criteria, the RCRA Emergency Coordinator shall document the rationale for not implementing the *RCRA Contingency Plan* (e.g., there is no threat to human health or the environment).

- Unplanned Sudden/Non-Sudden Releases
  - If, prior to waste emplacement, one or more containers of TRU mixed waste has spilled or been breached due to dropping, puncturing, container failure or degradation, or any other physical or chemical means, resulting in a release
  - If, after waste emplacement, one or more containers of TRU mixed waste in an active room has been breached
  - If a continuous air monitor confirms a release of radioactive particulates to the ambient atmosphere, indicating a possible release of TRU mixed waste constituents from the permitted facility
  - If a spill of site-generated hazardous waste occurs in a CAA or SAA and cannot be contained with secondary containment methods or absorbents, thereby threatening a release to air, soil, or surface water
  - If a site-generated hazardous waste spill occurs in a CAA or SAA and results in the release of potentially flammable material, thereby threatening to create a fire or explosion hazard
  - If a site-generated hazardous waste spill occurs in a CAA or SAA and results in the release of potentially toxic fumes that ~~would~~ could threaten human health

For any release of hazardous waste or hazardous waste constituents that does not meet the above criteria, the RCRA Emergency Coordinator shall document the rationale for not implementing the *RCRA Contingency Plan* (e.g., there is no threat to human health or the environment).

- Other Occurrences

- If a natural phenomenon (e.g., earthquake, flood, lightning strike, tornado) occurs that involves TRU mixed waste or site-generated hazardous waste or threatens to involve TRU mixed waste or site-generated hazardous waste

- If an underground structural integrity emergency (e.g., roof fall in an active room) occurs that involves TRU mixed waste or site-generated hazardous waste, threatens to involve TRU mixed waste or site-generated hazardous waste, results in immediate personnel evacuation, or prevents normal personnel access to the underground

For any natural phenomenon or underground structural emergency that does not meet the above criteria, the RCRA Emergency Coordinator shall document the rationale for not implementing the *RCRA Contingency Plan* (e.g., there is no threat to human health or the environment).

D-4 Emergency Response Method

Methods that describe implementation of the *RCRA Contingency Plan* cover the following six areas:

1. *Immediate Notifications* (Section D-4a)

2. *Identification of Released Materials and Assessment of Extent of the Emergency* (Section D-4b)

3. *Assessment of the Potential Hazards* (Section D-4c)

4. *Post-Assessment Notifications* (Section D-4d)

5. *Control and Containment of the Emergency* (Section D-4e)

6. *Post-Emergency Activities* (Section D-4f)

D-4a Immediate Notifications

Notification requirements in the event of implementation of the *RCRA Contingency Plan* are defined by 20.4.1.300 NMAC (incorporating 40 CFR §262.265(a)) and 20.4.1.500 NMAC (incorporating 40 CFR §§264.56(a)). Personnel at the WIPP facility are trained to respond to emergency notifications.

Whenever an emergency situation occurs that warrants implementation of this *RCRA Contingency Plan,* as described in Section D-3, the Permittees will immediately notify the Secretary of the NMED.

D-4a(1) Initial Emergency Response and Alerting the RCRA Emergency Coordinator

The first person to become aware of an incident shall immediately report the situation to the CMRO and, as requested by the CMRO, provide the relevant information. Facility personnel are trained in the process for notifying the CMRO as part of General Employee Training (**GET**).

In addition to receiving incident reports from facility personnel, the CMRO ~~continuously~~ monitors ~~(24 hours a day)~~ the status of alarms 24 hours a day, takes telephone calls and radio messages, initiates calls to emergency staff, and initiates emergency response procedures regarding evacuation, if needed.

Once the CMRO is notified of a fire, explosion, or a release anywhere in the facility (either by eyewitness notification or an alarm), the RCRA Emergency Coordinator is immediately notified. The RCRA Emergency Coordinator ensures that the emergency responders, including the WIPP Fire Department and the MRT, have been notified, as needed. Once incident command has been established, the RCRA Emergency Coordinator has the authority to delegate the responsibilities for mitigation of the incident to the Incident Commander.

The response to an unplanned event will be performed in accordance with standard operating procedures and guides based on the applicable ~~Federal~~federal, ~~State~~state, or local regulations and/or guidelines for that response. These include DOE Order 151.1D, *Comprehensive Emergency Management System;* the U.S. Mine Safety and Health Administration (**MSHA**); the NMAC; the Comprehensive Environmental Response, Compensation, and Liability Act; Chapter 74, Article 4B, New Mexico Statutes Annotated 1978; and the New Mexico Emergency Management Act.

If needed, the RCRA Emergency Coordinator will immediately notify the appropriate federal, state, and local agencies and mining companies in the vicinity of the WIPP facility, listed in Section D-7, with designated response roles.

Depending on the emergency, the EOC may be activated for additional support. In the event that the EOC is activated, decision-making responsibilities related to emergency management and associated notifications may be delegated to the EOC by the RCRA Emergency Coordinator. The EOC will assist in the mitigation of the incident with the use of appropriate communications equipment and technical expertise from available resources. During the emergency, the RCRA Emergency Coordinator will remain in contact with and advise the EOC of the known hazards.

The EOC staff assesses opportunities for coordination and the use of mutual-aid agreements with local agencies making additional emergency personnel and equipment available (Section D-7), as well as the use of specialized response teams available through various ~~State~~state and ~~Federal~~federal agencies. Because the WIPP facility is a DOE-owned facility, the Permittees may also use the resources available from the *National Response Framework.*

D-4a(2) Communication of Emergency Conditions to Facility Employees

Procedures for immediately notifying facility personnel of emergencies are as follows:

- Local Fire Alarms

  The local fire alarms sound an audible tone and may be activated automatically or manually in the event of a fire.

- Surface Evacuation Signal

  The evacuation signal is a yelp tone and is manually activated by the CMRO when needed. The CMRO follows the evacuation signal with verbal instructions and ensures the Site Notification System has been activated.

- Underground Evacuation Warning System

  The underground evacuation signal is a yelp tone and flashing strobe light. In the event of an evacuation signal, underground personnel will follow escape routes to egress hoist stations. Underground personnel are trained to report to the underground assembly areas and await further instruction if ~~all~~ power fails or if ventilation stops. If evacuation of underground personnel is required due to a power failure, ~~this will be done using the~~ a backup generator~~s~~ is available to power the hoisting equipment. Evacuation will be~~and~~ in accordance with the applicable requirements of MSHA.

WIPP facility personnel are trained and given instruction during GET to recognize the various alarm signals and the significance of each alarm. WIPP facility employees and site visitors are required to comply with directions from emergency personnel and alarm system notifications and to follow instructions concerning emergency equipment, shutdown procedures, and emergency evacuation routes and exits.

D-4b Identification of Released Materials and Assessment of the Extent of the Emergency

The identification of hazardous wastes or hazardous waste constituents involved in a fire, an explosion, or a release to the environment is a necessary part of the RCRA Emergency Coordinator's assessment of an incident, as described in 20.4.1.300 NMAC (incorporating 40 CFR §262.265(b)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.56(b)). Immediately after alarms have been activated and required notifications have been made, the RCRA Emergency Coordinator shall direct an investigation to determine pertinent information relevant to the actual or potential threat posed to human health or the environment. The information will include the character, exact source, amount, and areal extent of any released material. This may be done by observation or review of facility records or manifests and, if necessary, by chemical analysis.

The identification of the character and source of released materials at any location is enhanced because hazardous wastes are stored, managed, or disposed at specified locations throughout the WIPP facility.

Sources of information available to identify the hazardous wastes involved in a fire, an explosion, or a release at the WIPP facility include operator/supervisor knowledge of their work areas, materials used, and work activities underway; the WIPP Waste Information System

(**WWIS**), which identifies the location within the facility of emplaced TRU mixed waste, including emplaced derived waste; and waste manifests and other waste characterization information in the ~~operating record~~Operating Record. The WWIS also includes information on wastes that are in the waste handling process. Also available are Safety Data Sheets (SDSs) for hazardous materials in the various user areas throughout the facility, waste acceptance records, and materials inventories for buildings and operating groups at the WIPP facility. Information or data from the derived waste accumulation areas, the site-generated hazardous waste accumulation areas, and nonregulated waste accumulation areas are included. It is anticipated that this information is sufficient for identifying the nature and extent of the released materials. The RCRA Emergency Coordinator has access to this information when needed.

The waste received at the WIPP facility must meet the TSDF-WAC (e.g., no more than one percent liquid), which minimizes the possibility of waste container degradation and liquid spills. Should a spill or release occur from a container of site-generated hazardous or TRU mixed waste, following an initial assessment of the event, the RCRA Emergency Coordinator will ensure that the following actions are immediately taken, consistent with radiological control procedures, in compliance with 20.4.1.300 NMAC (incorporating 40 CFR §262.261(a)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.52(a) and §264.171):

- Assemble the required response equipment, such as protective clothing and gear, heavy equipment, empty drums, overpack drums, hand tools, and absorbent materials

- Transfer the released material to a container that is in good condition and patch or overpack the leaking container into another container that is in good condition

- Once the release has been contained, determine the areal extent of the release and proceed with appropriate cleanup action, such as chemical neutralization, vacuuming, or excavation

D-4c Assessment of the Potential Hazards

Concurrent with the actions described in Sections D-4a and D-4b, and in accordance with 20.4.1.300 NMAC (incorporating 40 CFR §262.265(c)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.56(c)), the RCRA Emergency Coordinator shall assess possible hazards to human health or the environment that may result from the release, fire, or explosion. This assessment will consider both direct and indirect effects of the release, fire, or explosion (e.g., the effects of any toxic, irritating, or asphyxiating gases that are generated, or the effects of any hazardous surface water run-off from water or chemical agents used to control fire and heat-induced explosions). The RCRA Emergency Coordinator will be responsible for identifying and responding to immediate and potential hazards, using the services of trained personnel.

After the materials involved in an emergency are identified, the specific information (e.g., associated hazards, appropriate personal protective equipment (**PPE**), decontamination) may be obtained from SDSs and from appropriate chemical reference materials at the same location. These information sources are available to the RCRA Emergency Coordinator or may be accessed through several WIPP facility organizations.

If, upon completion of the hazards assessment, the RCRA Emergency Coordinator determines that there are no actual or potential hazards to human health or the environment present, this *RCRA Contingency Plan* may be terminated. The RCRA Emergency Coordinator will record the time, date, and details of the incident in the ~~operating record~~Operating Record, and the Permittees will ensure that the reporting requirements of Section D-5 are fulfilled.

D-4d Post-Assessment Notifications

Upon *RCRA Contingency Plan* implementation, post-assessment notifications may be necessary in order to satisfy 20.4.1.300 NMAC (incorporating 40 CFR §262.265(d)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.56(d)). If it has been determined that the facility has had a fire, an explosion, or a release of hazardous waste or hazardous waste constituents that could threaten human health or the environment outside the facility (i.e., outside the Land Withdrawal Boundary), the RCRA Emergency Coordinator, after consultation with the DOE as the owner of the facility, will ensure that the appropriate local authorities are immediately notified by telephone and/or radio in the event that evacuation is needed. The following notifications satisfy the requirements of 20.4.1.300 NMAC (incorporating 40 CFR §262.265(d)(1)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.56(d)(1)):

- New Mexico Department of Homeland Security and Emergency Management (telephone number: (505) 476-9635)

- Eddy County via the Regional Emergency Dispatch Authority (telephone number: (575) 616-7155)

- Lea County via the Regional Emergency Dispatch Authority (telephone number: (575) 397-9265)

The RCRA Emergency Coordinator must be available to help appropriate officials decide whether local areas should be evacuated.

After local authorities are notified, the RCRA Emergency Coordinator must immediately notify either the government official designated as the on-scene coordinator for that geographical area, or the National Response Center. For the purposes of the *RCRA Contingency Plan*, the following notifications satisfy the requirements of 20.4.1.300 NMAC (incorporating 40 CFR §262.265(d)(2)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.56(d)(2)):

- New Mexico Environment Department (NMED)
  Department of Public Safety
  24-Hour Emergency Reporting Telephone Number: (505) 827-9329
  FAX number: (505) 827-9368

- National Response Center
  Telephone number: 1-800-424-8802
  FAX number: (202) 479-7181

This notification shall include the following information:

- The name and phone number of the reporter

- The name and address of the facility

- The type of incident (fire, explosion, or release)
- The date and time of the incident
- The name and quantity of material(s) involved, to the extent known
- The extent of injuries, if any
- Possible hazards to human health and the environment (air, soil, water, wildlife, etc.) outside the facility

Communications beyond those required by the *RCRA Contingency Plan* are the responsibility of the Permittees in accordance with plans and policies on file at the WIPP facility.

D-4e Control and Containment of the Emergency

The RCRA Emergency Coordinator is required to ensure control of an emergency and to minimize the potential for the occurrence, recurrence, or spread of releases due to the emergency situation, as described in 20.4.1.300 NMAC (incorporating 40 CFR §262.265(e) and (f)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.56(e) and (f)). Standard operating procedures and guides are used to implement initial response measures with priority being control of the emergency, and those actions necessary to ensure confinement and containment in the early, critical stages of a spill or leak. The RCRA Emergency Coordinator, in conjunction with the Incident Commander, is responsible for implementing the following measures:

- Stopping processes and operations
- Collecting and containing released wastes and materials
- Removing or isolating containers of hazardous waste posing a threat
- Ensuring that wastes managed during an emergency are handled, stored, or treated with due consideration for compatibility with other wastes and materials on site and with containers utilized (Section D-4f(2))
- Restricting personnel not needed for response activities from the scene of the incident
- Evacuating the area
- Curtailing nonessential activities in the area
- Conducting preliminary inspections of adjacent facilities and equipment to assess damage
- Maintaining fire equipment on standby at the incident site in cases where ignitable liquids have been or may be released and ensuring that ignition sources are kept out of the area. Ignitable liquids will be segregated, contained, confined, diluted, or otherwise controlled to preclude inadvertent explosion or detonation.

No operation that has been shut down in response to the incident will be restarted until authorized by the RCRA Emergency Coordinator. If a release occurs that involves radioactivity, the RCRA Emergency Coordinator actions will be consistent with radiation control policies and practices.

The standard operating procedures for emergency response may include, but are not limited to, the following actions appropriate for control of releases:

1. Isolating the area from unauthorized entry by fences, barricades, warning signs, or other security and site control precautions. Isolation and evacuation distances vary, depending upon the chemical/product, fire, and weather situations.
2. Establishing drainage controls.
3. Stabilizing physical controls (such as dikes or impoundment[s]).
4. Capping contaminated soils to reduce migration.
5. Using chemicals and other materials to retard the spread of the release or to mitigate its effects.
6. Excavating, consolidating, or removing contaminated soils.
7. Removing wastes containers to reduce exposure risk during situations such as fires.

If the facility stops operations in response to a fire, explosion, or release, the RCRA Emergency Coordinator shall ensure continued monitoring for leaks, pressure buildup, gas generation, or ruptures in valves, pipes, or other equipment, wherever appropriate.

Natural and/or synthetic methods will be employed to limit the releases of hazardous wastes or hazardous waste constituents so that effective recovery and treatment can be accomplished with minimal additional risk to human health or the environment.

Emergency response actions taken to mitigate releases may include, but are not limited to, the following:

1. Physical methods of control may involve any of several processes to reduce the area of the spill/leak, or other release mechanism (such as fire suppression).
    a. Absorption (e.g., absorbent sheets; spill control bucket materials specifically for solvents, neutralization, or acids/caustics; and absorbent socks for general liquids or oils)
    b. Dikes or Diversions (e.g., absorbent socks or earth)
    c. Overpacking
    d. Plug and Patch

  e. Transfers from leaking container to new container f. Vapor Suppression (e.g., aqueous foam blanket)

2. Chemical methods of mitigation may include the following:

   a. Neutralization

   b. Solidification

Once the Incident Commander informs the RCRA Emergency Coordinator that the emergency scene is stable, the release has been stopped, any reactions have been controlled, the released hazardous materials have been contained within a localized area, and the area of contamination has been secured from unauthorized entry, the field emergency response activity can be terminated.

D-4e(1) Fires

In the event of a fire that involves or threatens TRU mixed waste or site-generated hazardous waste, emergency response actions may include, but are not limited to, the following:

1. The RCRA Emergency Coordinator will remain in contact with and advise the Incident Commander of the known hazards.

2. The Incident Commander will maintain overall control of the emergency and may accept and evaluate the advice of WIPP facility personnel and emergency response organization members~~,~~ but retains overall responsibility until the emergency is terminated.

3. Only fire extinguishing materials that are compatible with the materials involved in the fire will be used to extinguish fires. Water and dry chemical materials in use at the WIPP facility have been determined to be compatible with ~~all~~ components of the TRU mixed waste and site-generated hazardous waste.

4. In order to ensure that storm drains and/or sewers do not receive potentially hazardous runoff, dikes will be built around storm drains to control discharge as needed. Collected waste will be sampled and analyzed for hazardous constituents, and appropriately disposed.

5. The RCRA Emergency Coordinator will ensure that measures are taken to shut down operational units (e.g., process equipment and ventilation equipment) that have been affected directly or indirectly by the fire.

6. Fire suppression materials used in response to incidents will be retained on-scene, where an evaluation will be performed to determine appropriate recovery and disposal methods.

7. Upon underground evacuation due to a fire in the underground that involves or threatens to involve TRU mixed waste or site-generated hazardous waste, a response plan will be developed depending on the status of the fire. The plan may include

ventilation control, barrier erection, and/or waiting for the fire to self-extinguish or implement active ventilation.

D-4e(2) Explosions

In the event of an explosion that involves or threatens TRU mixed waste or site-generated hazardous waste, emergency response actions may include, but are not limited to, the following:

1. The RCRA Emergency Coordinator will remain in contact with and advise the Incident Commander of the known hazards.
2. The Incident Commander will maintain overall control of the emergency and may accept and evaluate the advice of WIPP facility personnel and emergency response organization members~~,~~ but retains overall responsibility until the emergency is terminated.
3. The RCRA Emergency Coordinator will ensure measures are taken to shut down operational units (e.g., process equipment and ventilation equipment) that have been affected directly or indirectly by the explosion.
4. If, following an explosion, there is an ensuing fire, see Section D-4e(1).
5. If, following an explosion, there is an underground structural integrity emergency, see Section D-4e(4).

D-4e(3) Unplanned Sudden/Non-Sudden Releases

Spills of Site-Generated Hazardous Waste

If a spill of site-generated hazardous waste has occurred, and 1) the spill cannot be contained with secondary containment methods or absorbents, 2) the spill causes a release of flammable material, or 3) the spill results in toxic fumes, the RCRA Emergency Coordinator will ensure implementation of measures that may include, but are not limited to, the following actions:

1. The RCRA Emergency Coordinator will remain in contact with and advise the Incident Commander of the known hazards.
2. The Incident Commander will maintain overall control of the emergency and may accept and evaluate the advice of WIPP facility personnel and emergency response organization members~~,~~ but retains overall responsibility until the emergency is terminated.
3. The immediate area will be evacuated.
4. The source of the release will be mitigated, if possible.
5. A dike to contain runoff will be built, if necessary.
6. Dikes around storm drains to control discharge will be built, as needed, to ensure that storm drains and/or sewers do not receive potentially hazardous runoff.

7. Fire equipment will be maintained on standby at the incident site in cases where ignitable liquids have been or may be released, and ignition sources will be kept out of the area of ignitable liquids.

8. Released waste and contaminated media will be collected and placed into drums or other appropriate containers.

Releases of TRU Mixed Waste

If a release of TRU mixed waste has occurred, the emergency will be managed as a potential radiological release, and radiological control measures will determine the activities that can be performed safely, which may include the following:

1. The RCRA Emergency Coordinator will remain in contact with and advise the Incident Commander of the known hazards.

2. The Incident Commander will maintain overall control of the emergency and may accept and evaluate the advice of WIPP facility personnel and emergency response organization members~~,~~ but retains overall responsibility until the emergency is terminated.

3. Prior to the re-entry following an event involving containers that are managed as TRU mixed waste, a Radiological Work Permit (**RWP**) will be prepared.

4. During the re-entry phase, the extent of radiological contamination will be determined. This information is used by the RCRA Emergency Coordinator to determine an appropriate course of action to recover the area.

5. During the recovery phase, the ~~necessary~~ resources to conduct decontamination and/or overpacking operations will be used as needed.

6. Prior to returning the affected area and/or equipment to normal activities, the RCRA Emergency Coordinator will determine if additional measures are required by the *RCRA Contingency Plan* (e.g., characterization and disposal of contaminated media).

7. The recovery phase will include activities (e.g., placing the waste material in another container, vacuuming the waste material, overpacking or plugging/patching the affected waste container(s), decontaminating or covering the affected area), as specified in the RWP, to minimize the spread of contamination to other areas.

8. The RWPs and other administrative controls will provide protective measures to help ensure that new hazardous constituents will not be added during decontamination activities.

D-4e(4) Other Occurrences

Natural Phenomena

In the event of a natural phenomenon (e.g., earthquake, flood, lightning strike, tornado) that involves hazardous waste or has threatened to cause a release of hazardous waste or hazardous waste constituents, emergency response actions may include, but are not limited to, the following:

1. The RCRA Emergency Coordinator will remain in contact with and advise the Incident Commander of the known hazards.

2. The Incident Commander will maintain overall control of the emergency and may accept and evaluate the advice of WIPP facility personnel and emergency response organization members~~,~~ but retains overall responsibility until the emergency is terminated.

3. Containers ~~which~~ that have not been disposed will be inspected for signs of leakage or damage, and containment systems will be inspected for deterioration.

4. Affected equipment or areas associated with hazardous waste management activities will be inspected, and the operability of monitoring systems will be ensured.

5. Affected electrical equipment and lines will be inspected for damage.

6. Affected buildings and fencing directly related to hazardous waste management activities will be inspected for damage.

7. A general survey of the site will be conducted to check for signs of physical damage.

8. The RCRA Emergency Coordinator will ensure that measures are taken to shut down operational units (e.g., process equipment and ventilation equipment) that have been affected by the natural phenomenon.

Underground Structural Integrity Emergencies

In the event of an underground structural integrity emergency that involves or threatens TRU mixed waste (i.e., occurs in an active disposal room) or site-generated hazardous waste, the emergency will be managed as a potential radiological release, and radiological control measures will determine the activities that can be performed safely, and may include the following:

1. The RCRA Emergency Coordinator will remain in contact with and advise the Incident Commander of the known hazards.

2. The Incident Commander will maintain overall control of the emergency and may accept and evaluate the advice of WIPP facility personnel and emergency response organization members~~,~~ but retains overall responsibility until the emergency is terminated.

3. The RCRA Emergency Coordinator will ascertain whether the roof conditions allow for safe entry and if the waste container or containers in question are accessible.

4. The RCRA Emergency Coordinator may recommend closing the entire panel, or the affected room of waste containers, based on the location of the event and the stability

of the roof and walls in the panel as a method to ensure that measures are taken to shut down affected operational units.

5. Access to the ventilation flow path downstream of the incident will be restricted, as appropriate.

6. Ventilation to the affected room will be restricted to ensure that there is no spread of contamination that may have been released, as appropriate.

7. Accessible containers will be inspected for signs of leakage or damage.

8. The spill area will be covered with material (e.g., plastic, fabric sheets) in a manner that safely isolates the contamination in the area.

9. The RCRA Emergency Coordinator will determine if the covered spill area safely allows for continued waste disposal operations or whether further action is required to reinitiate operations.

D-4f Post-Emergency Activities

Immediately after the emergency, and once initial release or spill control and containment have been completed, the RCRA Emergency Coordinator will ensure that necessary decontamination occurs and that recovered hazardous waste is properly managed, stored, and/or disposed, as required by 20.4.1.300 NMAC (incorporating 40 CFR §262.265(g)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.56(g)). As required by 20.4.1.300 NMAC (incorporating 40 CFR §262.265(h)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.56(h)), the RCRA Emergency Coordinator will ensure that incompatibility of waste and restoration of emergency equipment are addressed.

D-4f(1) Management and Disposition of Released Material

When a release of TRU mixed waste has occurred, priority is given to actions required to minimize radiological exposure to workers and the public. If the release is TRU mixed waste, decontamination and disposition will be in accordance with the RWP. If a release of site-generated hazardous waste occurs, the contaminated surface will be cleaned, and decontamination materials will be placed in containers and dispositioned appropriately. In most cases, ~~these~~ actions taken to address a radiological contamination are sufficient to mitigate any health effects associated with contamination by hazardous waste or hazardous waste constituents.

~~If a release of site-generated hazardous waste occurs, the contaminated surface will be cleaned, and decontamination materials will be placed in containers and dispositioned appropriately. If the release is TRU mixed waste, decontamination and disposition will be in accordance with the RWP.~~

If radioactive contamination is detected on equipment or on structures, radiological cleanup standards will be used to determine the effectiveness of decontamination efforts and/or the final disposition of the equipment or structures. Many types of equipment are difficult to decontaminate and may have to be discarded as derived waste. Fixatives (e.g., paint or water spray on salt in the underground) may be used on contaminated structures if the contamination cannot be safely removed.

Following decontamination, the RCRA Emergency Coordinator will ensure that nonradioactive hazardous waste resulting from the cleanup of a fire, an explosion, or a release involving a nonradioactive hazardous waste at the WIPP facility will be contained and managed as a hazardous waste until such time as the waste is disposed of, or determined to be nonhazardous, as defined in 20.4.1.200 NMAC (incorporating 40 CFR Part 261, Subparts C and D). In most cases, knowledge of the material inventories for the various buildings and areas at the facility will allow a hazardous waste determination for the material resulting from the cleanup of a release. When knowledge of the material inventories is not sufficient, samples of the waste will be collected and analyzed using U.S. Environmental Protection Agency (**EPA**)-approved methods to determine the presence of any hazardous characteristics and/or hazardous waste constituents.

D-4f(2) Incompatible Waste

The RCRA Emergency Coordinator will ensure, in accordance with 20.4.1.300 NMAC (incorporating 40 CFR §262.262(h)(1)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.56(h)(1)), that in the affected area(s) of the facility, no waste that may be incompatible with the released material is treated, stored, or disposed of until cleanup has been completed. The RCRA Emergency Coordinator will not allow hazardous or TRU mixed waste operations to resume in a building or area in which incompatible materials have been released prior to completion of necessary post-emergency cleanup operations to remove potentially incompatible materials. In making the determination of compatibility, the RCRA Emergency Coordinator will have available the resources and information described in Section D-4b, *Identification of Released Materials and Assessment of the Extent of the Emergency*.

D-4f(3) Cleaning and Restoration of Equipment

The RCRA Emergency Coordinator will take measures to ensure, in accordance with 20.4.1.300 NMAC (incorporating 40 CFR §262.262(h)(2)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.56(h)(2)), that in the affected area(s) of the facility, emergency equipment listed in the *RCRA Contingency Plan*, and used in the emergency response, is cleaned and fit for its intended use or replaced before operations are resumed.

Any equipment that cannot be decontaminated will be discarded as waste (e.g., hazardous, mixed, solid), as appropriate. After the equipment has been cleaned, repaired, or replaced, a post-emergency facility and equipment inspection will be performed, and the results will be documented.

D-5 Required Reporting

The RCRA Emergency Coordinator, on behalf of the Permittees, will note in the ~~operating record~~ Operating Record the time, date, and details of the incident that required implementation of the *RCRA Contingency Plan*. In compliance with 20.4.1.300 NMAC (incorporating 40 CFR §262.265(i)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.56(i)), within 15 days after the incident, the Permittees will ensure that a written report on the incident will be submitted to the Secretary of the NMED. The report will include:

- The name, address, and telephone number of the Owner/Operator
- The name, address, and telephone number of the facility
- The date, time, and type of incident (e.g., fire, explosion, or release)
- The name and quantity of material(s) involved
- The extent of injuries, if any
- An assessment of actual or potential hazards to human health or the environment, where this is applicable
- The estimated quantity and disposition of recovered material that resulted from the incident

D-6 Emergency Equipment

A variety of equipment is available at the facility for emergency response, containment, and cleanup operations in the surface HWMUs, the underground HWDUs, and the WIPP facility in general. This includes equipment for spill control, fire control, personnel protection, monitoring, first aid and medical attention, communications, and alarms. This equipment is immediately available to emergency response personnel. A listing of major emergency equipment available at the WIPP facility, as required by 20.4.1.300 NMAC (incorporating 40 CFR §262.261(e)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.52(e)), is shown in Table D-2. Table D-2 also includes the location and a physical description of each item on the list along with a brief outline of its capabilities. The fire-water distribution system map is show in Figure D-5. Equipment specified at the locations listed in Table D-2 are inspected in accordance with the inspection schedule specified in Attachment E, Table E-1, as required by 20.4.1.500 NMAC (incorporating 40 CFR §264.15(b)).

D-7 Emergency Response Agreements

The Permittees have established agreements with federal, state, and local emergency response agencies and mining companies in the vicinity of the WIPP facility for firefighting, medical assistance, hazardous materials response, and law enforcement. In the event that on-site response resources are unable to provide the needed response actions during a medical, fire, hazardous materials, or security emergency, the RCRA Emergency Coordinator will notify appropriate emergency response agencies and request assistance. Once on site, emergency response agency personnel will perform emergency response activities under the direction of the Incident Commander.

The agreements with federal, state, and local agencies and mining companies in the vicinity of the WIPP facility for emergency response capabilities are on file at the WIPP facility. Additional agreements may be established when needed. ~~A description~~Descriptions of the agreements with federal, state, and local agencies and mining operations in the vicinity of the WIPP facility, as required by 20.4.1.300 NMAC (incorporating 40 CFR §§262.256 and 262.261(c)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.37 and §264.52(c)), include, but is not limited to, the following:

- Agreements with local mining companies, including Intrepid Potash NM LLC, White Marble Mine, and Mosaic Potash Carlsbad Inc. provide for mutual aid and assistance, in the form of MRTs, in the event of a mine disaster or other circumstance at either of the facilities. This provision ensures that the WIPP MOC will have two MRTs available at all times when miners are underground.

- An agreement with the U.S. Department of Interior (**DOI**), represented by the Bureau of Land Management (**BLM**), Roswell District, for wildland firefighting support within the WIPP Land Withdrawal Area.

- Agreements for mutual-aid firefighting with Eddy County, the City of Hobbs, and the City of Carlsbad for assistance, including equipment and personnel.

- ~~A m~~Mutual-aid Agreements with the City of Hobbs and the City of Carlsbad for mutual ambulance, medical, rescue, and hazardous material response services; for use of WIPP facility radio frequencies during emergencies; and for mutual security and law enforcement services, within the appropriate jurisdiction limits of each party.

- Agreements with the Covenant Health Hobbs Hospital and the Carlsbad Medical Center for the treatment of persons with radiological contamination who have incurred injuries beyond the treatment capabilities at the WIPP ~~site~~facility. The WIPP facility provides transport of the patient(s) to these facilities.

- Agreements with the Sheriff of Eddy County and the Sheriff of Lea County for mutual law enforcement services support.

- An agreement with the New Mexico Department of Homeland Security and Emergency Management for mutual emergency management support, access to state law enforcement, public works, and transportation assets.

D-8 Evacuation Plan

If it becomes necessary to evacuate all or part of the WIPP facility, on-site assembly and off-site staging areas have been established. The off-site staging areas are outside the security fence. The Permittees have plans and implementation procedures for both surface and underground evacuations. Drills are performed on these procedures at the WIPP facility at least annually. The following sections describe the evacuation plan for the WIPP facility, as required under 20.4.1.300 NMAC (incorporating 40 CFR §262.261(f)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.52(f)).

D-8a Surface Evacuation On-site Assembly and Off-site Staging Areas

Figures ~~D-6~~D-1/Figure D-1-NFB show~~s~~ the surface assembly and staging areas and the evacuation gates. Security officers remain at the ~~primary staging area~~ WIPP facility main gate 24 hours a day, and the vehicle trap is opened for personnel during emergency evacuations. The north gate has a single-person gate and a large gate ~~which~~ that can be opened, similar to the main gate~~s~~, for the primary staging area. Alternative evacuation route exit points are located at the east and south gates. The east and south gates are turnstile gates. Upon notification, security personnel will respond, open gates, and facilitate egress for evacuation.

If a building or area evacuation is necessary, the RCRA Emergency Coordinator, in conjunction with the Incident Commander, will determine which assembly area is to be used and will communicate the selection to facility personnel. The preferred evacuation route is determined based on the nature of the event, prevailing weather conditions, and actual or potential radiological release. If site evacuation is necessary, the RCRA Emergency Coordinator, in conjunction with the Incident Commander, will decide which staging area is to be used and will communicate the selection to facility personnel. The WIPP site evacuation routes are shown in Figure D-8. The surface evacuation alarm and public address system are used to direct personnel evacuation. Persons responsible for surface accountability will direct personnel to the selected staging area outside the security fence.

Personnel report to the designated assembly or staging area where accountability is conducted (Figure ~~D-6~~D-1/Figure D-1-NFB). Personnel who are working in a contaminated area when site evacuation is announced will assemble at specific staging areas for potentially contaminated personnel in order to minimize contact with other personnel during the evacuation.

D-8b Underground Assembly Areas and Egress Hoist Stations

Depending upon the type of emergency and level of response, it may be necessary for personnel in the underground to shelter in place, report ~~top~~ to designated assembly areas (Figure ~~D-7~~D-3), or to evacuate the underground. Underground personnel are trained to immediately report to assembly areas under specific circumstances (i.e., loss of underground power or ventilation). Underground accountability is taken when the underground is sheltered in place or evacuated. The Underground Controller is responsible for underground personnel accountability. Each assembly area contains a mine pager phone, miner's aid station, and evacuation maps.

In accordance with 30 CFR §57.11050, the mine maintains two escapeways. These escapeways are designated as Egress Hoist Stations. When the need for an underground evacuation has been determined, underground personnel report to the Egress Hoist Stations.

Decontamination of underground personnel will be conducted consistent with radiological control procedures pursuant to 10 CFR Part 835~~the same way as described for surface decontamination~~. Contaminated personnel are trained to remain segregated from other personnel until radiological contamination control personnel can respond.

D-8c Plan for Surface Evacuation

Surface evacuation notification is initiated by the CMRO, as directed by the RCRA Emergency Coordinator, via ~~sound-ing~~ sounding of the surface evacuation alarm and providing incident information via the public address system. The persons responsible for surface accountability assist personnel in evacuation from their areas. Egress routes from buildings and site evacuation routes and instructions are posted in designated areas throughout the site. Egress routes from the WHB Unit are shown in Figures ~~D-6a, D-6b, and D-6c~~D-5 through D-7.

D-8d Plan for Underground Evacuation

Notification for underground evacuation will be made using the underground evacuation alarm and strobe light signals.

Personnel will evacuate to the nearest Egress Hoist Station. Primary underground escape routes (identified by green reflectors on the rib) will be used, if possible. Secondary underground escape routes (identified by red reflectors on the rib) will be used if necessary (Figure D-3~~D-4~~). Detailed descriptions of escapeways and an underground escape map are included in the *Underground Escape and Evacuation Plan* on file at the WIPP facility, as required by MSHA, 30 CFR §57.11053, for underground mining situations. The MSHA required map takes precedence over Figure D-3~~D-4~~, *Underground Escape and Evacuation Map*, should an underground mine related event occur necessitating a change to the evacuation routes. The Underground Controller is responsible for underground personnel accountability and for reporting accountability to the RCRA Emergency Coordinator.

Upon reaching the surface, personnel will report to their on-site surface assembly or off-site staging area, as directed, to receive further instructions.

Members of the WIPP Fire Department and the MRT who may be underground, will assist in the evacuation of the underground when an underground evacuation is called for. A reentry by the MRT will be performed according to 30 CFR Part 49 and MSHA regulations for reentry into a mine. The MRTs are trained in compliance with 30 CFR Part 49 in mine mapping, mine gases, ventilation, exploration, mine fires, rescue, and recovery.

D-8e Further Site Evacuation

In the event of an evacuation involving the need to transport employees, the following transportation will be available:

- Buses/vans—WIPP facility buses/vans will be available for evacuation of personnel. The buses/vans are stationed in the employee parking lot.

- Privately Owned Vehicles—Because many employees drive to work in their own vehicles, these vehicles may be used in an emergency. Personnel will be provided routes to be taken when leaving the facility.

These vehicles may be used to transport personnel who have been released from the site by the RCRA Emergency Coordinator.

The primary evacuation route~~s~~ for the WIPP facility is Louis Whitlock Road~~are the main DOE north/south access road~~, which connects to U.S. Highway~~s~~ 62/180 ~~(~~to the north~~)~~ and State Highway 128 via the South Access Road~~(south)~~. Alternate evacuation routes from the facility are provided at the south side and the east side of the facility. Utilization of the alternate evacuation routes leads to either the main DOE north/south access road or Campbell Road, which travels north and intersects with U.S. Highway 62/180. The primary and alternate evacuation routes are depicted in Figures D-8 and D-8a.

D-9 Location of the *RCRA Contingency Plan* and Plan Revision

In accordance with 20.4.1.300 NMAC (incorporating 40 CFR §§262 and 262.262(a)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.53(a)), the owner/operator of the WIPP facility will ensure that copies of this *RCRA Contingency Plan* are maintained at the WIPP facility and are available to the emergency personnel and organizations described in Section D-2. When the *RCRA Contingency Plan* is revised, updated copies are distributed (electronically or via site mail) or hand delivered to applicable WIPP facility emergency personnel and Emergency Operations Centers. In addition, the Permittees will make copies available to the following federal, state, and local agencies and mining companies in the vicinity of the WIPP facility, as required by 20.4.1.300 (incorporating 40 CFR §262.262(a)) and 20.4.1.500 NMAC (incorporating 40 CFR §264.53(b)):

- Intrepid Potash New Mexico LLC
- White Marble Mine
- Mosaic Potash Carlsbad Inc.
- City of Carlsbad
- Carlsbad Medical Center, Carlsbad
- Covenant Health Hobbs Hospital, Hobbs
- City of Hobbs
- BLM, Carlsbad
- New Mexico State Police
- New Mexico Department of Homeland Security and Emergency Management
- Eddy County Commission
- Sheriff of Eddy County
- Sheriff of Lea County
- Eddy County Fire and Rescue
- Eddy County Emergency Management
- Lea County Emergency Management

In accordance with 20.4.1.300 NMAC (incorporating 40 CFR §262.263) and 20.4.1.500 NMAC (incorporating 40 CFR §264.54), the Permittees will ensure that this plan is reviewed and amended whenever:

- The Permit for the WIPP facility is revised in any way that would affect the *RCRA Contingency Plan*;

- This plan fails in an emergency;

- The WIPP facility design, construction, operation, maintenance, or other circumstances change in a way that materially increases the potential for fires, explosions, or releases of hazardous waste or hazardous constituents or change the response necessary in an emergency;

- The list of RCRA Emergency Coordinators changes; or

- The list of WIPP facility emergency equipment changes.

TABLES

Table D-1
Resource Conservation and Recovery Act Emergency Coordinators[1]

Name	Address*	Office Phone	Personal Phone*	24-Hour Emergency Phone
J.E. (Joseph) Bealler		(575) 234-8276 or (575) 234-8916		(575) 234-8111
M.G. (Mike) Proctor		(575) 234-8276 or (575) 234-8143		(575) 234-8111
P.J. (Paul) Paneral		(575) 234-8498		(575) 234-8111
A.C. (Andy) Cooper		(575) 234-8197		(575) 234-8111
C.J. (Chris) Belis		(575) 628-5851		(575) 234-8111
B.R. (Bobby) Franco		(575) 234-8163		(575) 234-8111
G.W. (Gregory) Brown		(575) 234-5862		(575) 234-8111
R.D. (Ryan) Parrish		(575) 234-8638		(575) 234-8111
R.E. (Eric) Chavez		(575) 234-5831		(575) 234-8111
D.L. (Donald) Jurney		(575) 234-8216		(575) 234-8111
R.H. (Robert) Valenzuela		(575) 234-8799		(575) 234-8111
J.R. (James) Bailey		(575) 234-8276		(575) 234-8111
M.L. (Martin) Mendes		(575) 234-5822		(575) 234-8111
D.J. (Derek) Tweedy		(575) 234-8272		(575) 234-8111

* NOTE: Personal information (home addresses and personal phone numbers) has been removed from informational copies of this Permit.

[1] For every shift, one qualified RCRA Emergency Coordinator serves as the primary, and a second qualified RCRA Emergency Coordinator is available to serve as the alternate.

Table D-2
Emergency Equipment Maintained at the Waste Isolation Pilot Plant

Equipment	Description and Capabilities	Location
	Communications	
Building Fire Alarms	Fire alarm panels, fire alarm transmitter, audible alarm devices (e.g., horns, bells, tones) that provide notification of fires; transmitted to the CMR	Guard and Security Building (Building 458), Water Pumphouse (Building 456), Warehouse/Shops Building (Building 453), Exhaust Shaft Filter Building (Building 413), New Filter Building (**NFB**) (Building 416), Salt Reduction Building (**SRB**) (Building 417), Support Building (Building 451), CMR/Computer Room, Waste Handling Building (Building 411), TRUPACT Maintenance Building (Building 412), Salt Handling (**SH**) Shaft Hoisthouse (Building 384), Auxiliary Warehouse Building (Building 455), Engineering Building (Building 486), Training Building (Building 489), Safety and Emergency Services Facility (Building 452), and CAAs (Buildings 474A and 474B)
Underground Fire Alarms	Fire alarm panels, fire alarm transmitter, and audible/visual alarm devices (e.g., horns, bells, strobes) that provide notification of fires; transmitted to the CMR	Fire detection and control panel locations: Waste Shaft Underground Station, SH Shaft Underground Station, Between E-140 and E-300 in S-2180 Drift, Fuel Station (N150/W170)
Site Notification System; Underground Evacuation Alarm System	For surface, alarms and notifications transmitted over paging channel of the public address system, manually initiated; for underground, audible alarm	Site-wide
Public Address System	Includes intercom phones; handset stations and loudspeaker assemblies	Site-wide

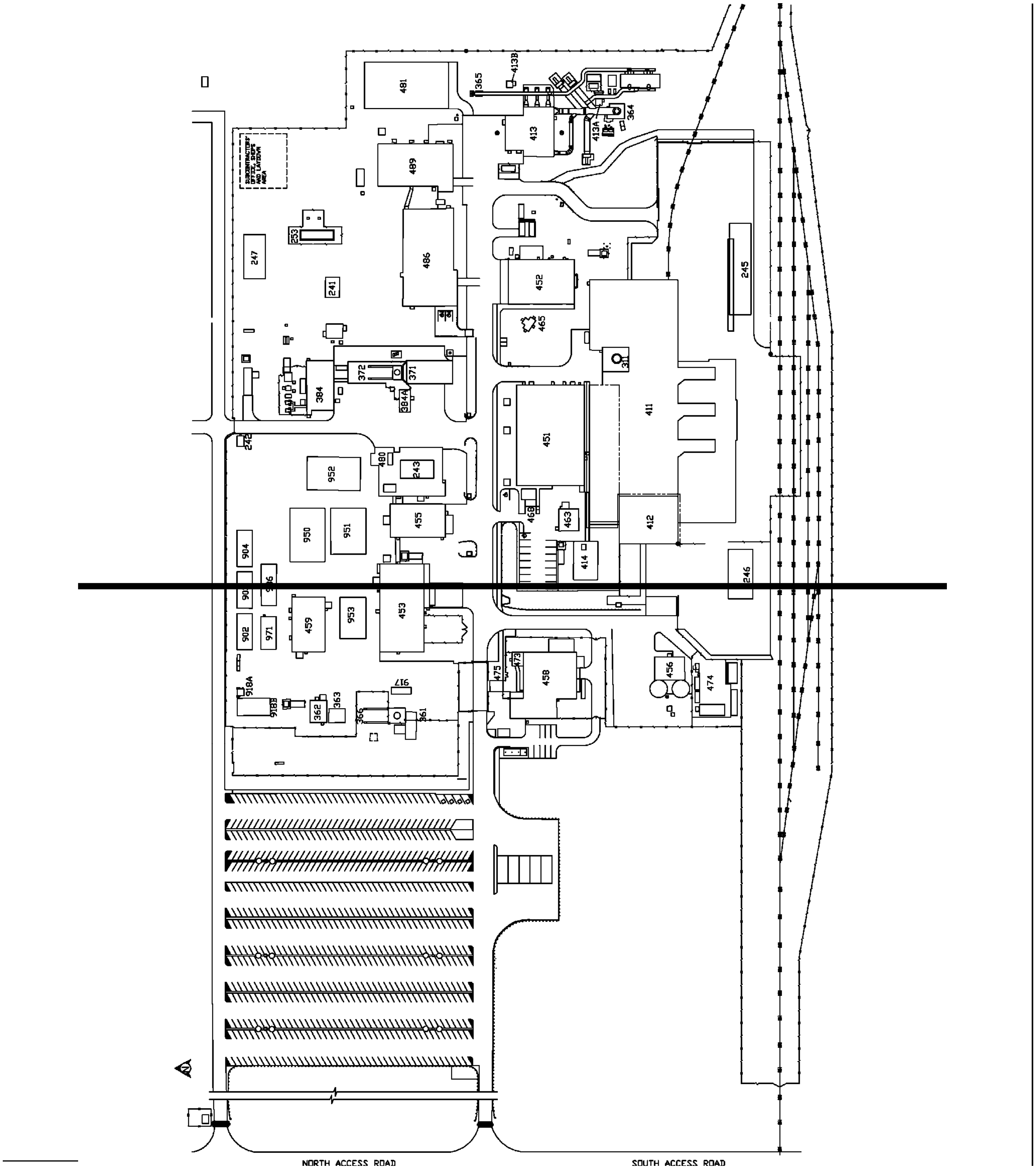
Equipment	Description and Capabilities	Location
Mine Pager Phones	Battery-operated paging system	Underground at S550/W30, S1000/W30, S1950/E140, SH Shaft Collar and Underground Station Waste Shaft Collar and Underground Station; – surface at Support Building (Building 451, FSM desk, CMR, lamproom), Safety and Emergency Services Facility (Building 452, Fire Department workstation area, Mine Rescue Room)
Portable Radios	Two-way, portable; transmits and monitors information to/from other transmitters	Issued to individuals
Plant~~-~~-Based Radios	Two-way, stationary; transmits and monitors information to/from other ~~transmitters~~ radios	Safety and Emergency Services Facility (Building 452), Guard and Security Building (Building 458), Support Building (Building 451, CMR, FSM desk)
Mobile Phones	Provide communications link between emergency response personnel, as needed	Issued to individuals plus emergency vehicles
Spill Response Equipment and Materials		
HAZMAT Equipment	Spill response equipment and supplies, PPE, and decontamination supplies stored and maintained in accordance with NFPA 1901 and as documented in WIPP facility files	Surface, in designated areas near Safety and Emergency Services Facility (Building 452)
Absorbent Materials	Containment or cleanup of spills, including: Pressurized spill-response gun; Absorbent sheets and/or dikes for containment or cleanup of spills of oil, petroleum-based chemicals, and general liquids; Spill-control material for solvents and neutralizing absorbents and for acids/caustics	Surface, in designated areas near Safety and Emergency Services Facility (Building 452)
Medical Resources		
Ambulance	A minimum of one ambulance, maintained and equipped in accordance with the New Mexico Ambulance Standard, 18.3.14 NMAC, and as documented in WIPP facility files	Surface at Safety and Emergency Services Facility (Building 452, Vehicle Bay)
Medical Cart	A minimum of one medical cart, equipped to provide basic life support operations, as documented in WIPP facility files	Underground (Emergency Vehicle Parking/Charging Area at S700/E140)
Miners First Aid Stations	Equipped per 30 CFR 57.15001	Underground (Salt Shaft Area, Waste Shaft Area, E300 Maintenance Shop, and at S1000/W30, S1300/W30, and S1950/E140)

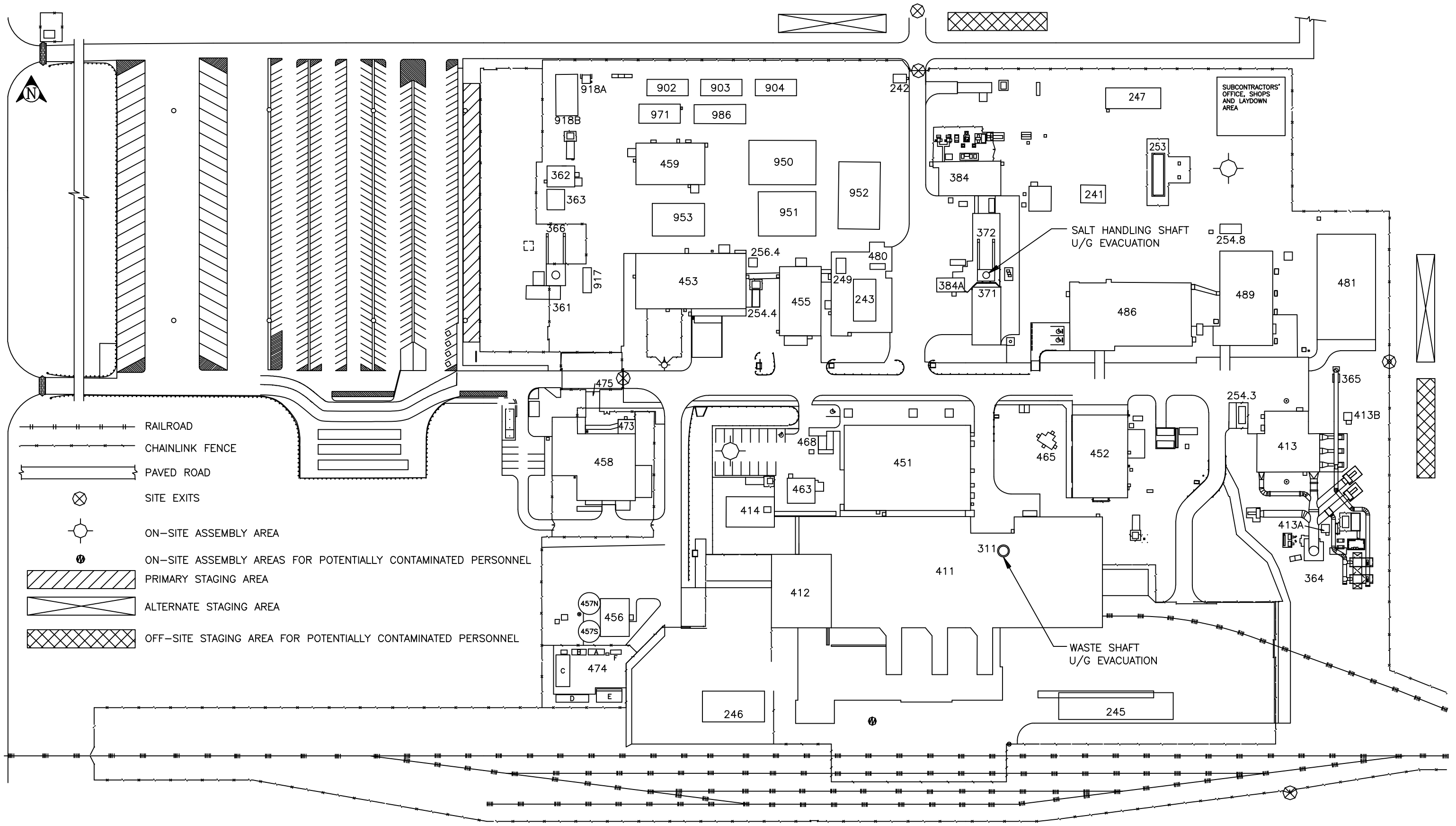
Equipment	Description and Capabilities	Location
Fire Detection and Fire Suppression Equipment		
Building Smoke, Thermal Detectors, or Manual Pull Stations	Devices that trigger an alarm and/or fire suppression system	Guard and Security Building (Building 458), Warehouse/Shops Building (Building 453), Support Building (Building 451, CMR/Computer Room), Waste Handling Building (Building 411), TRUPACT Maintenance Building (Building 412), Underground Fuel Station (N150/W170), SH Shaft Hoisthouse (Building 384), Engineering Building (Building 486), Safety and Emergency Services Facility (Building 452), and Training Building (Building 489)
Fire Trucks	A minimum of two fire trucks with rescue equipment to assist in fighting fires and emergency rescue; firefighter equipped in accordance with NFPA 1901 and/or 1906 and as documented in WIPP facility files	Surface at Safety and Emergency Services Facility (Building 452, Vehicle Bay)
Rescue Cart	A minimum of one light rescue unit, equipped in accordance with the NFPA 1901 and as documented in WIPP facility files	Underground (Emergency Vehicle Parking/Charging Area at S700/E140)
Fire Suppression Cart	A minimum of one special-purpose electric cart to assist in fighting fires; equipped with a minimum of one fire extinguisher	Underground (Emergency Vehicle Parking/Charging Area at S700/E140)
Fire Extinguishers	Hand-held fire extinguishers; located throughout the facility in accordance with NFPA- 10	Surface and underground locations used for hazardous waste management, as documented in WIPP facility files
Automatic Dry Chemical Extinguishing Systems	Automatic; actuated by thermal detectors or by manual pull stations	Underground fuel station (N150/W170)
Automatic Fire Suppression Systems on liquid fueled vehicles	Individual automatic fire suppression systems installed on applicable liquid-fueled vehicles, as determined by a fire risk assessment performed in accordance with NFPA 122	Surface and underground locations used for hazardous waste management, as documented in WIPP facility files

Equipment	Description and Capabilities	Location
Sprinkler Systems	NFPA water-based fire suppression systems	Water Pumphouse (Building 456), Guard and Security Building (Building 458), Waste Handling Building (Building 411, CH Bay, RH Bay, and Overpack Repair Areas only),TRUPACT Maintenance Building (Building 412), Exhaust Shaft Filter Building (Building 413), NFB (Building 416), SRB (Building 417), and CAAs (Buildings 474A and 474B)
Water Tanks, Hydrants	Fire suppression water supply; one 180,000-gallon capacity tank, plus a second tank with 100,000-gallon reserve	Tanks are at southwestern edge of WIPP facility; pipelines and hydrants are throughout the surface
Fire Water Pumps	Fire suppression water supply; pumps are minimally rated at 125 pounds per square inch, 1,500 gallons per minute centrifugal pump, one with electric motor drive, the other with diesel engine; pressure maintenance jockey pump	Water Pumphouse (Building 456)
Personal Protection Equipment		
Head Lamps	Mounted on hard hat; battery operated	Each person underground
Underground Self-Rescuer Units	Short-term self-rescue devices per 30 CFR 57.15030	Each person underground
Self-Contained Self-Rescuer	Air supply; a minimum of 12 caches in the underground; self-contained rescue units shall be adequate to protect an individual for one hour or longer or, alternatively, sufficient to allow the employee time to reach an additional self-contained self-rescue device in the underground per NMSA 69-8-16	Cached throughout the underground
Mine Rescue Self-Contained Breathing Apparatus (SCBA)	Oxygen supply; 4-hour closed circuit units consistent with 30 CFR 49.6; a minimum of 12 units, one for each Mine Rescue Team member	Safety and Emergency Services Facility (Building 452, Mine Rescue Training Room)
Fire Department Self-Contained Breathing Apparatus (SCBA)	Air supply; a minimum of 12 units; SCBAs shall meet the minimum requirements established per NFPA 1981	Surface Fire Trucks and Rescue Truck; Underground Rescue Cart
General Plant Emergency Equipment		
Emergency Lighting	For employee evacuation, and fire/spill containment; linked to main power supply, and selectively linked to back up diesel power supply and/or battery-backed power supply	Waste Handling Building (Building 411); TRUPACT Maintenance Building (Building 412), Exhaust Shaft Filter Building (Building 413) NFB (Building 416), and SRB (Building 417)
Backup Power Sources	A minimum of two diesel generators, and battery-powered uninterruptible power supply (UPS)	Generators are located on the surface. UPS is located at the essential loads

Equipment	Description and Capabilities	Location
Emergency Hoist	Hoist in Air Intake Shaft	Air Intake Shaft (Building 361)
Emergency Showers	For emergency flushing of chemical contact or injury	Waste Handling Building (Building 411) is served by the decontamination shower trailer located north of Building 411, in front of Building 952, between Buildings 243 and 455; and CAAs (Building 474A)
Emergency Eyewash Equipment	For emergency flushing of affected eyes	Waste Handling Building (Building 411, RH Bay, Site Derived Waste Area, Waste Shaft Collar, and Room 108 TRUPACT III only), TRUPACT Maintenance Building (Building 412), Exhaust Shaft Filter Building (Building 413), NFB (Building 416), SRB (Building 417), CAAs, and SAAs
Overpack containers for TRU Mixed Waste	85 Gallon drums SWBs TDOP	Warehouse Annex (Building 481)
Aquaset or Cement	Material for solidification of liquid waste generated as a result of ~~fire fighting~~firefighting water or decontamination solutions	Surface Connex A, located south of Waste Handling Building (Building 411)
TDOP Upender	Upender facilitates overpacking standard waste boxes into TDOPs	Waste Handling Building (Building 411)
~~Non hazardous~~Nonhazardous Decontaminating Agents	For decontamination of surfaces, equipment, and personnel	Waste Handling Building (Building 411); Surface Connex A, located south of Building 411

FIGURES


481
413B
365
413
413A
364
489
SUBCONTRACTORS' OFFICE, SHOPS AND LAYDOWN AREA
253
247
241
486
452
465
245
311
411
372
371
384
384A
242
952
480
243
451
455
950
951
904
468
463
412
414
246
459
953
453
902
971
918A
918B
362
363
366
361
917
475
473
458
456
474
NORTH ACCESS ROAD
SOUTH ACCESS ROAD



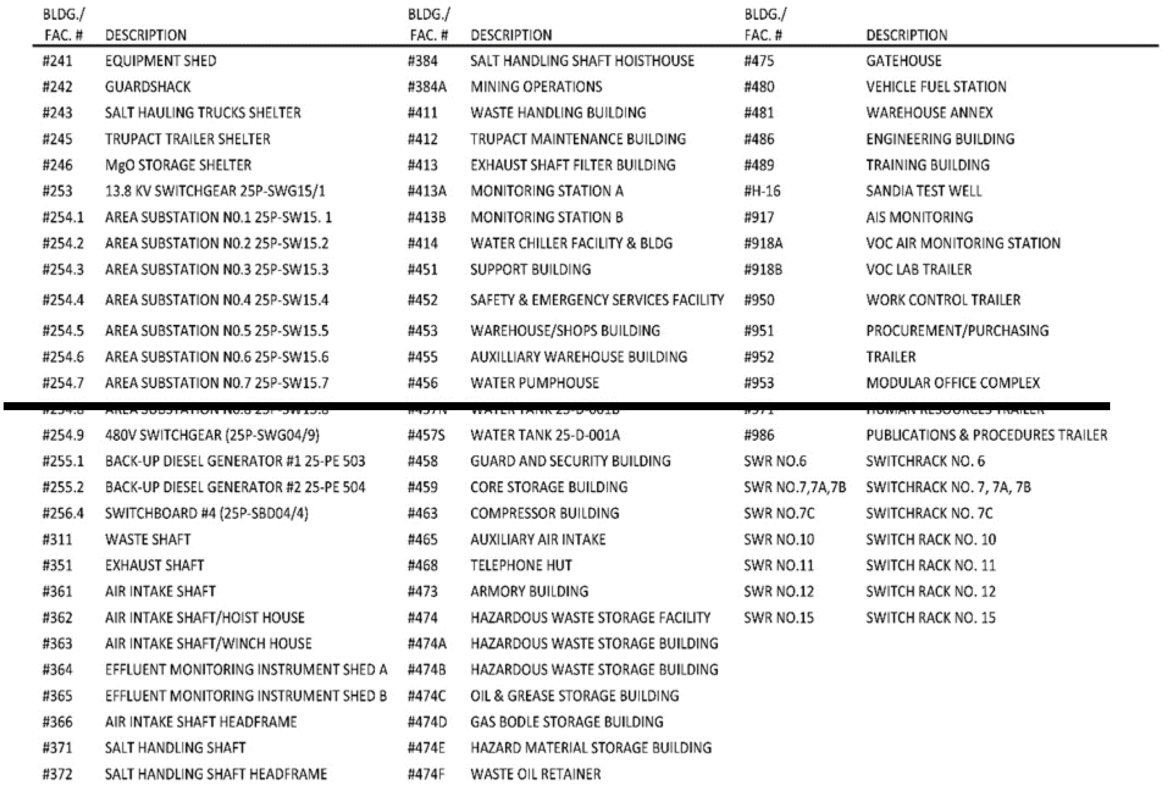
BLDG./ FAC. #	DESCRIPTION
#241	EQUIPMENT SHED
#242	GUARDSHACK
#243	SALT HAULING TRUCKS SHELTER
#245	TRUPAC TRAILER SHELTER
#246	MgO STORAGE SHELTER
#253	13.8 KV SWITCHGEAR 25P-SWG15/1
#254.1	AREA SUBSTATION NO.1 25P-SW15.1
#254.2	AREA SUBSTATION NO.2 25P-SW15.2
#254.3	AREA SUBSTATION NO.3 25P-SW15.3
#254.4	AREA SUBSTATION NO.4 25P-SW15.4
#254.5	AREA SUBSTATION NO.5 25P-SW15.5
#254.6	AREA SUBSTATION NO.6 25P-SW15.6
#254.7	AREA SUBSTATION NO.7 25P-SW15.7
#254.8	AREA SUBSTATION NO.8 25P-SW15.8
#254.9	480V SWITCHGEAR (25P-SWG04/9)
#255.1	BACK-UP DIESEL GENERATOR #1 25-PE 503
#255.2	BACK-UP DIESEL GENERATOR #2 25-PE 504
#256.4	SWITCHBOARD #4 (25P-SBD04/4)
#311	WASTE SHAFT
#351	EXHAUST SHAFT
#361	AIR INTAKE SHAFT
#362	AIR INTAKE SHAFT/HOIST HOUSE

BLDG./ FAC. #	DESCRIPTION
#363	AIR INTAKE SHAFT/WINCH HOUSE
#364	EFFLUENT MONITORING INSTRUMENT SHED A
#365	EFFLUENT MONITORING INSTRUMENT SHED B
#366	AIR INTAKE SHAFT HEADFRAME
#371	SALT HANDLING SHAFT
#372	SALT HANDLING SHAFT HEADFRAME
#384	SALT HANDLING SHAFT HOISTHOUSE
#384A	MINING OPERATIONS
#411	WASTE HANDLING BUILDING
#412	TRUPACT MAINTENANCE BUILDING
#413	EXHAUST SHAFT FILTER BUILDING
#413A	MONITORING STATION A
#413B	MONITORING STATION B
#414	WATER CHILLER FACILITY & BLDG
#451	SUPPORT BUILDING
#452	SAFETY & EMERGENCY SERVICES FACILITY
#453	WAREHOUSE/SHOPS BUILDING
#455	AUXILLIARY WAREHOUSE BUILDING
#456	WATER PUMPHOUSE
#457N	WATER TANK 25-D-001B
#457S	WATER TANK 25-D-001A

BLDG./ FAC. #	DESCRIPTION FAC. # DESCRIPTION
#458	GUARD AND SECURITY BUILDING
#459	CORE STORAGE BUILDING
#463	COMPRESSOR BUILDING
#465	AUXILIARY AIR INTAKE
#468	TELEPHONE HUT
#473	ARMORY BUILDING
#474	HAZARDOUS WASTE STORAGE FACILITY
#474A	HAZARDOUS WASTE STORAGE BUILDING
#474B	HAZARDOUS WASTE STORAGE BUILDING
#474C	OIL & GREASE STORAGE BUILDING
#474D	GAS BOTTLE STORAGE BUILDING
#474E	HAZARD MATERIAL STORAGE BUILDING
#474F	WASTE OIL RETAINER
#475	GATEHOUSE
#480	VEHICLE FUEL STATION
#481	WAREHOUSE ANNEX
#486	ENGINEERING BUILDING
#489	TRAINING BUILDING
#H-16	SANDIA TEST WELL
#902	TRAILER
#903	TRAILER

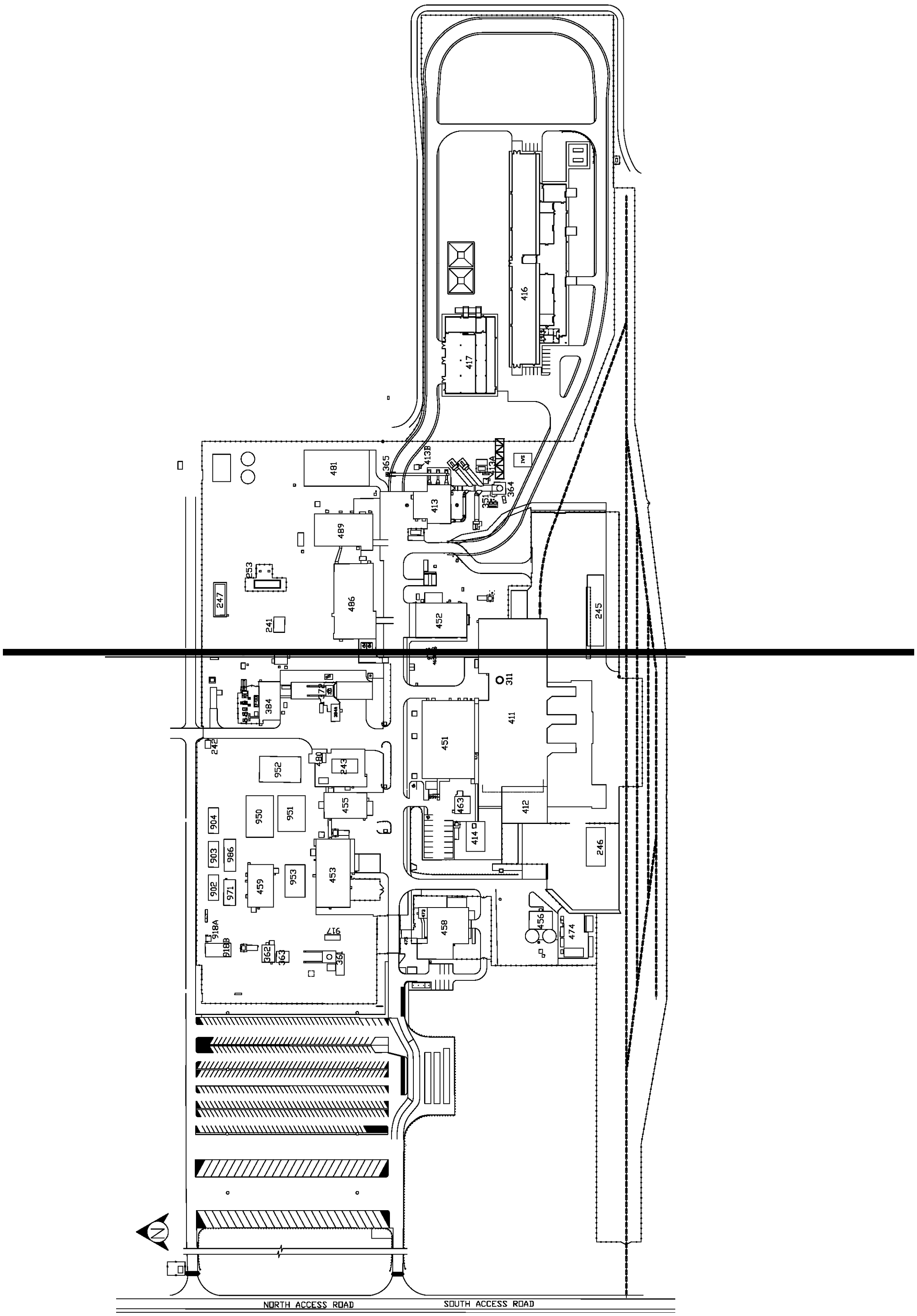
BLDG./ FAC. #	DESCRIPTION
#904	TRAILER
#917	AIS MONITORING
#918A	VOC AIR MONITORING STATION
#918B	VOC LAB TRAILER
#950	WORK CONTROL TRAILER
#951	PROCUREMENT/PURCHASING
#952	TRAILER
#953	MODULAR OFFICE COMPLEX
#971	HUMAN RESOURCES TRAILER
#986	PUBLICATIONS & PROCEDURES TRAILER
SWR NO.6	SWITCHRACK NO. 6
SWR NO.7,7A,7B	SWITCHRACK NO. 7, 7A, 7B
SWR NO.7C	SWITCHRACK NO. 7C
SWR NO.10	SWITCHRACK NO. 10
SWR NO.11	SWITCHRACK NO. 11
SWR NO.12	SWITCHRACK NO. 12
SWR NO.15	SWITCHRACK NO. 15

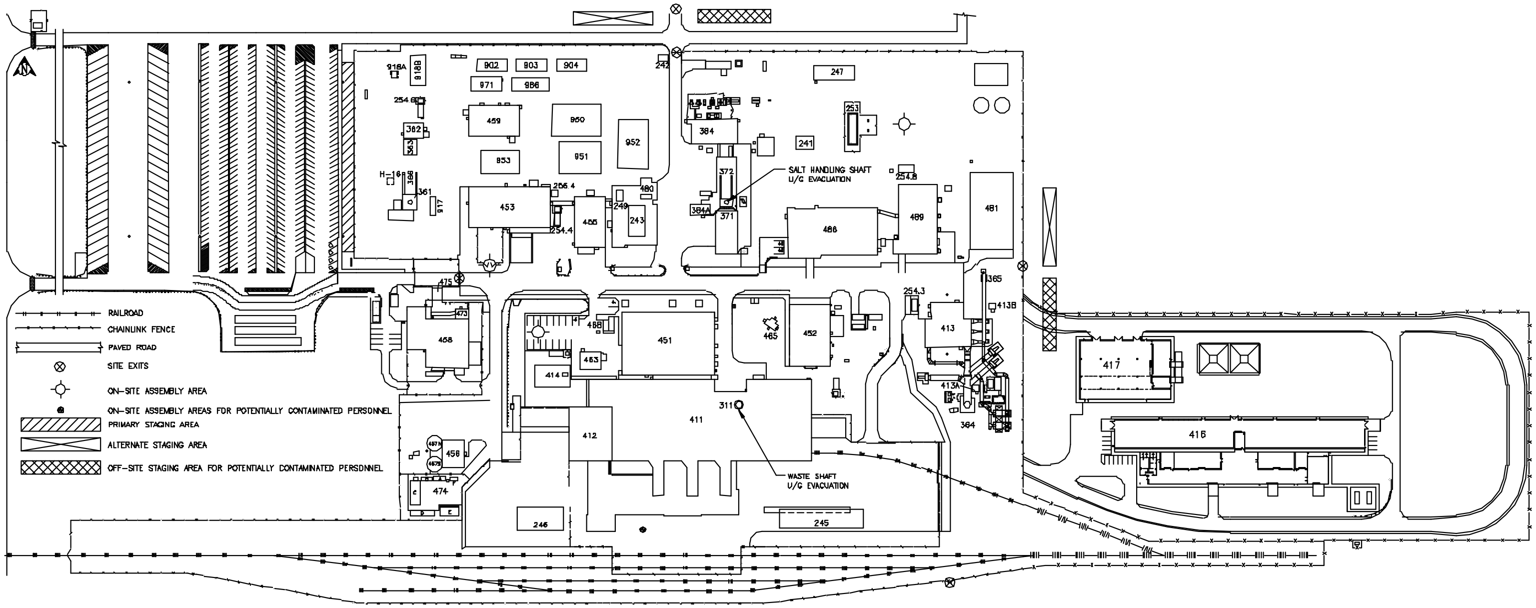
Figure D-1
WIPP Surface Structures



BLDG./ FAC. #	DESCRIPTION	BLDG./ FAC. #	DESCRIPTION	BLDG./ FAC. #	DESCRIPTION
#241	EQUIPMENT SHED	#384	SALT HANDLING SHAFT HOISTHOUSE	#475	GATEHOUSE
#242	GUARDSHACK	#384A	MINING OPERATIONS	#480	VEHICLE FUEL STATION
#243	SALT HAULING TRUCKS SHELTER	#411	WASTE HANDLING BUILDING	#481	WAREHOUSE ANNEX
#245	TRUPACT TRAILER SHELTER	#412	TRUPACT MAINTENANCE BUILDING	#486	ENGINEERING BUILDING
#246	MgO STORAGE SHELTER	#413	EXHAUST SHAFT FILTER BUILDING	#489	TRAINING BUILDING
#253	13.8 KV SWITCHGEAR 25P-SWG15/1	#413A	MONITORING STATION A	#H-16	SANDIA TEST WELL
#254.1	AREA SUBSTATION N0.1 25P-SW15. 1	#413B	MONITORING STATION B	#917	AIS MONITORING
#254.2	AREA SUBSTATION N0.2 25P-SW15.2	#414	WATER CHILLER FACILITY & BLDG	#918A	VOC AIR MONITORING STATION
#254.3	AREA SUBSTATION N0.3 25P-SW15.3	#451	SUPPORT BUILDING	#918B	VOC LAB TRAILER
#254.4	AREA SUBSTATION N0.4 25P-SW15.4	#452	SAFETY & EMERGENCY SERVICES FACILITY	#950	WORK CONTROL TRAILER
#254.5	AREA SUBSTATION N0.5 25P-SW15.5	#453	WAREHOUSE/SHOPS BUILDING	#951	PROCUREMENT/PURCHASING
#254.6	AREA SUBSTATION N0.6 25P-SW15.6	#455	AUXILLIARY WAREHOUSE BUILDING	#952	TRAILER
#254.7	AREA SUBSTATION N0.7 25P-SW15.7	#456	WATER PUMPHOUSE	#953	MODULAR OFFICE COMPLEX
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
#254.9	480V SWITCHGEAR (25P-SWG04/9)	#457S	WATER TANK 25-D-001A	#986	PUBLICATIONS & PROCEDURES TRAILER
#255.1	BACK-UP DIESEL GENERATOR #1 25-PE 503	#458	GUARD AND SECURITY BUILDING	SWR NO.6	SWITCHRACK NO. 6
#255.2	BACK-UP DIESEL GENERATOR #2 25-PE 504	#459	CORE STORAGE BUILDING	SWR NO.7,7A,7B	SWITCHRACK NO. 7, 7A, 7B
#256.4	SWITCHBOARD #4 (25P-SBD04/4)	#463	COMPRESSOR BUILDING	SWR NO.7C	SWITCHRACK NO. 7C
#311	WASTE SHAFT	#465	AUXILIARY AIR INTAKE	SWR NO.10	SWITCH RACK NO. 10
#351	EXHAUST SHAFT	#468	TELEPHONE HUT	SWR NO.11	SWITCH RACK NO. 11
#361	AIR INTAKE SHAFT	#473	ARMORY BUILDING	SWR NO.12	SWITCH RACK NO. 12
#362	AIR INTAKE SHAFT/HOIST HOUSE	#474	HAZARDOUS WASTE STORAGE FACILITY	SWR NO.15	SWITCH RACK NO. 15
#363	AIR INTAKE SHAFT/WINCH HOUSE	#474A	HAZARDOUS WASTE STORAGE BUILDING		
#364	EFFLUENT MONITORING INSTRUMENT SHED A	#474B	HAZARDOUS WASTE STORAGE BUILDING		
#365	EFFLUENT MONITORING INSTRUMENT SHED B	#474C	OIL & GREASE STORAGE BUILDING		
#366	AIR INTAKE SHAFT HEADFRAME	#474D	GAS BODLE STORAGE BUILDING		
#371	SALT HANDLING SHAFT	#474E	HAZARD MATERIAL STORAGE BUILDING		
#372	SALT HANDLING SHAFT HEADFRAME	#474F	WASTE OIL RETAINER		

~~Figure D-1a~~
~~Legend to Figure D-1~~


416
417
481
365
413B
364
351
413
489
253
247
486
241
452
245
311
411
384
372
242
952
480
243
451
455
463
412
950
951
904
903
986
414
246
453
953
459
902
971
456
474
458
918A
918B
917
362
363
361
N
NORTH ACCESS ROAD
SOUTH ACCESS ROAD



BLDG./ FAC. #	DESCRIPTION
#241	EQUIPMENT SHED
#242	GUARDSHACK
#243	SALT HAULING TRUCKS SHELTER
#245	TRUPAC TRAILER SHELTER
#246	MgO STORAGE SHELTER
#253	13.8 KV SWITCHGEAR 25P-SWG15/1
#254.1	AREA SUBSTATION NO.1 25P-SW15.1
#254.2	AREA SUBSTATION NO.2 25P-SW15.2
#254.3	AREA SUBSTATION NO.3 25P-SW15.3
#254.4	AREA SUBSTATION NO.4 25P-SW15.4
#254.5	AREA SUBSTATION NO.5 25P-SW15.5
#254.6	AREA SUBSTATION NO.6 25P-SW15.6
#254.7	AREA SUBSTATION NO.7 25P-SW15.7
#254.8	AREA SUBSTATION NO.8 25P-SW15.8
#254.9	480V SWITCHGEAR (25P-SWG04/9)
#255.1	BACK-UP DIESEL GENERATOR #1 25-PE 503
#255.2	BACK-UP DIESEL GENERATOR #2 25-PE 504
#256.4	SWITCHBOARD #4 (25P-SBD04/4)
#311	WASTE SHAFT
#351	EXHAUST SHAFT
#361	AIR INTAKE SHAFT

BLDG./ FAC. #	DESCRIPTION
#362	AIR INTAKE SHAFT/HOIST HOUSE
#363	AIR INTAKE SHAFT/WINCH HOUSE
#364	EFFLUENT MONITORING INSTRUMENT SHED A
#365	EFFLUENT MONITORING INSTRUMENT SHED B
#366	AIR INTAKE SHAFT HEADFRAME
#371	SALT HANDLING SHAFT
#372	SALT HANDLING SHAFT HEADFRAME
#384	SALT HANDLING SHAFT HOISTHOUSE
#384A	MINING OPERATIONS
#411	WASTE HANDLING BUILDING
#412	TRUPACT MAINTENANCE BUILDING
#413	EXHAUST SHAFT FILTER BUILDING
#413A	MONITORING STATION A
#413B	MONITORING STATION B
#414	WATER CHILLER FACILITY & BLDG
#416	NEW FILTER BUILDING
#417	SALT REDUCTION BUILDING
#451	SUPPORT BUILDING
#452	SAFETY & EMERGENCY SERVICES FACILITY
#453	WAREHOUSE/SHOPS BUILDING
#455	AUXILLIARY WAREHOUSE BUILDING

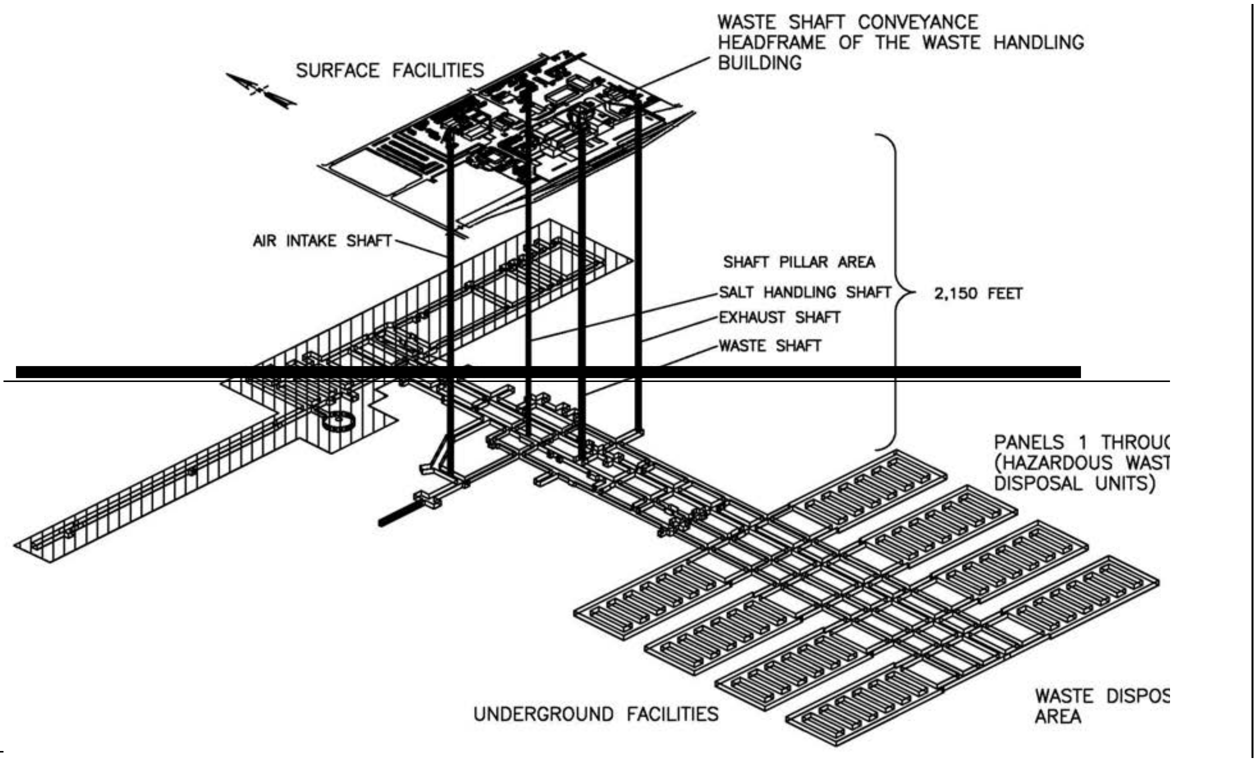
BLDG./ FAC. #	DESCRIPTION
#456	WATER PUMPHOUSE
#457N	WATER TANK 25-D-001B
#457S	WATER TANK 25-D-001A
#458	GUARD AND SECURITY BUILDING
#459	CORE STORAGE BUILDING
#463	COMPRESSOR BUILDING
#465	AUXILIARY AIR INTAKE
#468	TELEPHONE HUT
#473	ARMORY BUILDING
#474	HAZARDOUS WASTE STORAGE FACILITY
#474A	HAZARDOUS WASTE STORAGE BUILDING
#474B	HAZARDOUS WASTE STORAGE BUILDING
#474C	OIL & GREASE STORAGE BUILDING
#474D	GAS BOTTLE STORAGE BUILDING
#474E	HAZARD MATERIAL STORAGE BUILDING
#474F	WASTE OIL RETAINER
#475	GATEHOUSE
#480	VEHICLE FUEL STATION
#481	WAREHOUSE ANNEX
#486	ENGINEERING BUILDING
#489	TRAINING BUILDING

BLDG./ FAC. #	DESCRIPTION
#H-16	SANDIA TEST WELL
#902	TRAILER
#903	TRAILER
#904	TRAILER
#917	AIS MONITORING
#918A	VOC AIR MONITORING STATION
#918B	VOC LAB TRAILER
#950	WORK CONTROL TRAILER
#951	PROCUREMENT/PURCHASING
#952	TRAILER
#953	MODULAR OFFICE COMPLEX
#971	HUMAN RESOURCES TRAILER
#986	PUBLICATIONS & PROCEDURES TRAILER
SWR NO.6	SWITCHRACK NO. 6
SWR NO.7,7A,7B	SWITCHRACK NO. 7, 7A, 7B
SWR NO.7C	SWITCHRACK NO 7C
SWR NO.10	SWITCHRACK NO 10
SWR NO.11	SWITCHRACK NO. 11
SWR NO.12	SWITCHRACK NO. 12
SWR NO.15	SWITCHRACK NO. 15

Figure D-1-NFB
WIPP Surface Structures with Building 416

BLDG./ FAC. #	DESCRIPTION	BLDG./ FAC. #	DESCRIPTION	BLDG./ FAC. #	DESCRIPTION
#241	EQUIPMENT SHED	#384A	MINING OPERATIONS	#475	GATEHOUSE
#242	GUARDSHACK	#411	WASTE HANDLING BUILDING	#480	VEHICLE FUEL STATION
#243	SALT HAULING TRUCKS SHELTER	#412	TRUPACT MAINTENANCE BUILDING	#481	WAREHOUSE ANNEX
#245	TRUPACT TRAILER SHELTER	#413	EXHAUST SHAFT FILTER BUILDING	#486	ENGINEERING BUILDING
#246	MgO STORAGE SHELTER	#413A	MONITORING STATION A	#489	TRAINING BUILDING
#253	13.8 KV SWITCHGEAR 25P-SWG15/1	#413B	MONITORING STATION B	#H-16	SANDIA TEST WELL
#254.1	AREA SUBSTATION N0.1 25P-SW15. 1	#414	WATER CHILLER FACILITY & BLDG	#902	TRAILER
#254.2	AREA SUBSTATION N0.2 25P-SW15.2	#416	NEW FILTER BUILDING	#903	TRAILER
#254.3	AREA SUBSTATION N0.3 25P-SW15.3	#417	SALT REDUCTION BUILDING	#904	TRAILER
#254.4	AREA SUBSTATION N0.4 25P-SW15.4	#451	SUPPORT BUILDING	#917	AIS MONITORING
#254.5	AREA SUBSTATION N0.5 25P-SW15.5	#452	SAFETY & EMERGENCY SERVICES FACILITY	#918A	VOC AIR MONITORING STATION
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
#254.7	AREA SUBSTATION N0.7 25P-SW15.7	#455	AUXILLIARY WAREHOUSE BUILDING	#950	WORK CONTROL TRAILER
~~#254.8~~	~~AREA SUBSTATION N0.8 25P-SW15.8~~	~~#456~~	~~WATER PUMPHOUSE~~	~~#951~~	~~PROCUREMENT/PURCHASING~~
#254.9	480V SWITCHGEAR (25P-SWG04/9)	#457N	WATER TANK 25-D-001B	#952	TRAILER
#255.1	BACK-UP DIESEL GENERATOR #1 25-PE 503	#457S	WATER TANK 25-D-001A	#953	MODULAR OFFICE COMPLEX
#255.2	BACK-UP DIESEL GENERATOR #2 25-PE 504	#458	GUARD AND SECURITY BUILDING	#971	HUMAN RESOURCES TRAILER
#256.4	SWITCHBOARD #4 (25P-SBD04/4)	#459	CORE STORAGE BUILDING	#986	PUBLICATIONS & PROCEDURES TRAILER
#311	WASTE SHAFT	#463	COMPRESSOR BUILDING	SWR NO.6	SWITCHRACK NO. 6
#351	EXHAUST SHAFT	#465	AUXILIARY AIR INTAKE	SWR NO.7,7A,7B	SWITCHRACK NO. 7, 7A, 7B
#361	AIR INTAKE SHAFT	#468	TELEPHONE HUT	SWR NO.7C	SWITCHRACK NO. 7C
#362	AIR INTAKE SHAFT/HOIST HOUSE	#473	ARMORY BUILDING	SWR NO.10	SWITCH RACK NO. 10
#363	AIR INTAKE SHAFT/WINCH HOUSE	#474	HAZARDOUS WASTE STORAGE FACILITY	SWR NO.11	SWITCH RACK NO. 11
#364	EFFLUENT MONITORING INSTRUMENT SHED A	#474A	HAZARDOUS WASTE STORAGE BUILDING	SWR NO.12	SWITCH RACK NO. 12
#365	EFFLUENT MONITORING INSTRUMENT SHED B	#474B	HAZARDOUS WASTE STORAGE BUILDING	SWR NO.15	SWITCH RACK NO. 15
#366	AIR INTAKE SHAFT HEADFRAME	#474C	OIL & GREASE STORAGE BUILDING		
#371	SALT HANDLING SHAFT	#474D	GAS BODLE STORAGE BUILDING		
#372	SALT HANDLING SHAFT HEADFRAME	#474E	HAZARD MATERIAL STORAGE BUILDING		
#384	SALT HANDLING SHAFT HOISTHOUSE	#474F	WASTE OIL RETAINER		

~~Figure D-1a-NFB,~~
~~Legend to Figure D-1-NFB (Building 416)~~


WASTE SHAFT CONVEYANCE HEADFRAME OF THE WASTE HANDLING BUILDING
SURFACE FACILITIES
AIR INTAKE SHAFT
SHAFT PILLAR AREA
SALT HANDLING SHAFT
EXHAUST SHAFT
WASTE SHAFT
2,150 FEET
PANELS 1 THROUG
(HAZARDOUS WAST
DISPOSAL UNITS)
UNDERGROUND FACILITIES
WASTE DISPOS
AREA

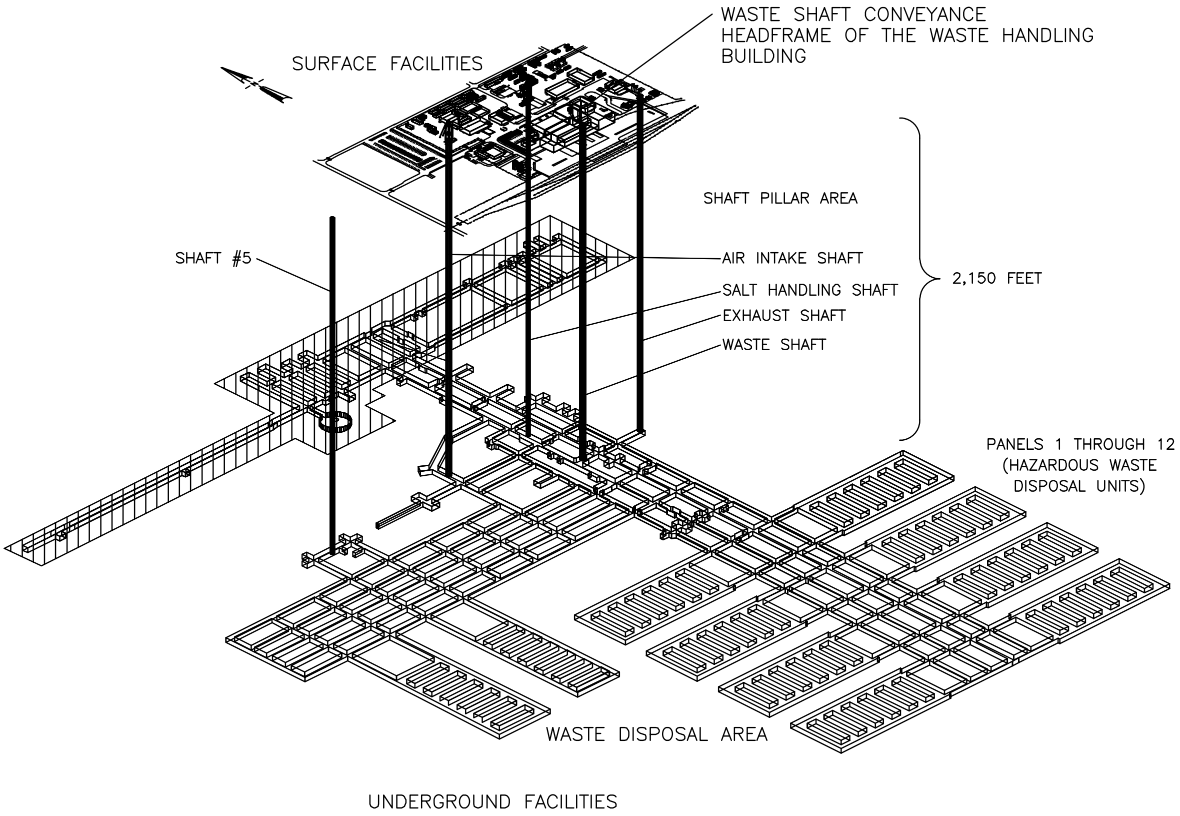
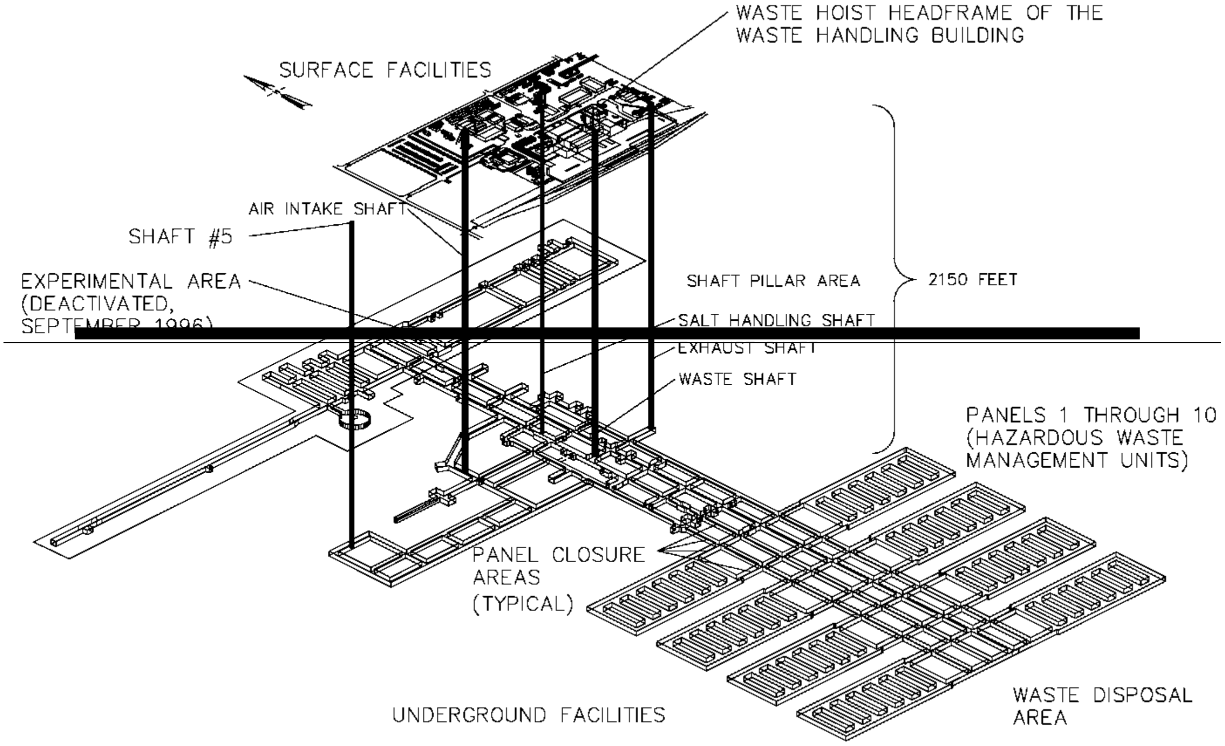
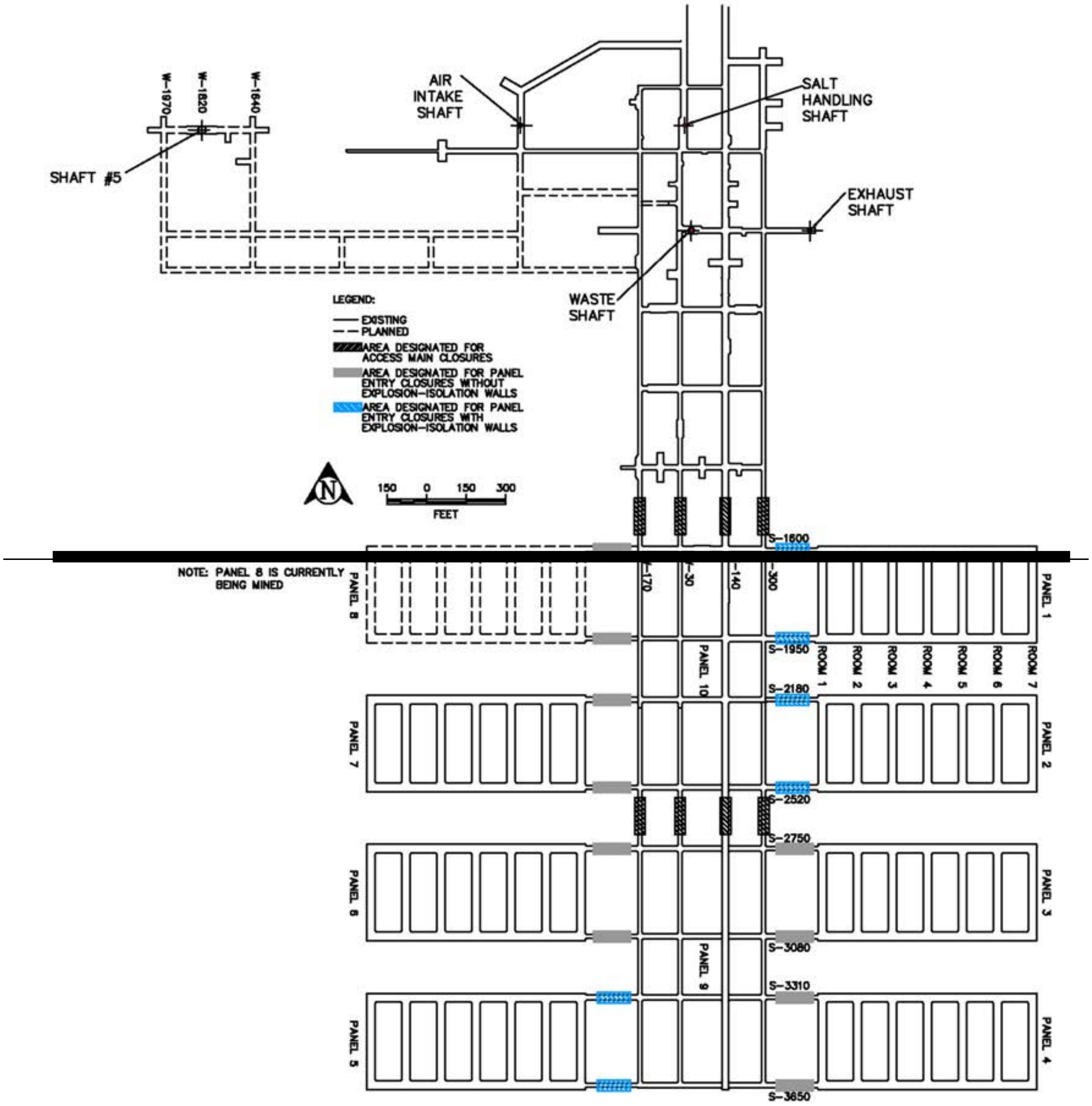


Figure D-2
Spatial View of the WIPP Facility



~~Figure D-2-S#5~~
~~Spatial View of the WIPP Facility (with S#5)~~



~~**Figure D-3**~~
~~**WIPP Underground Facilities**~~

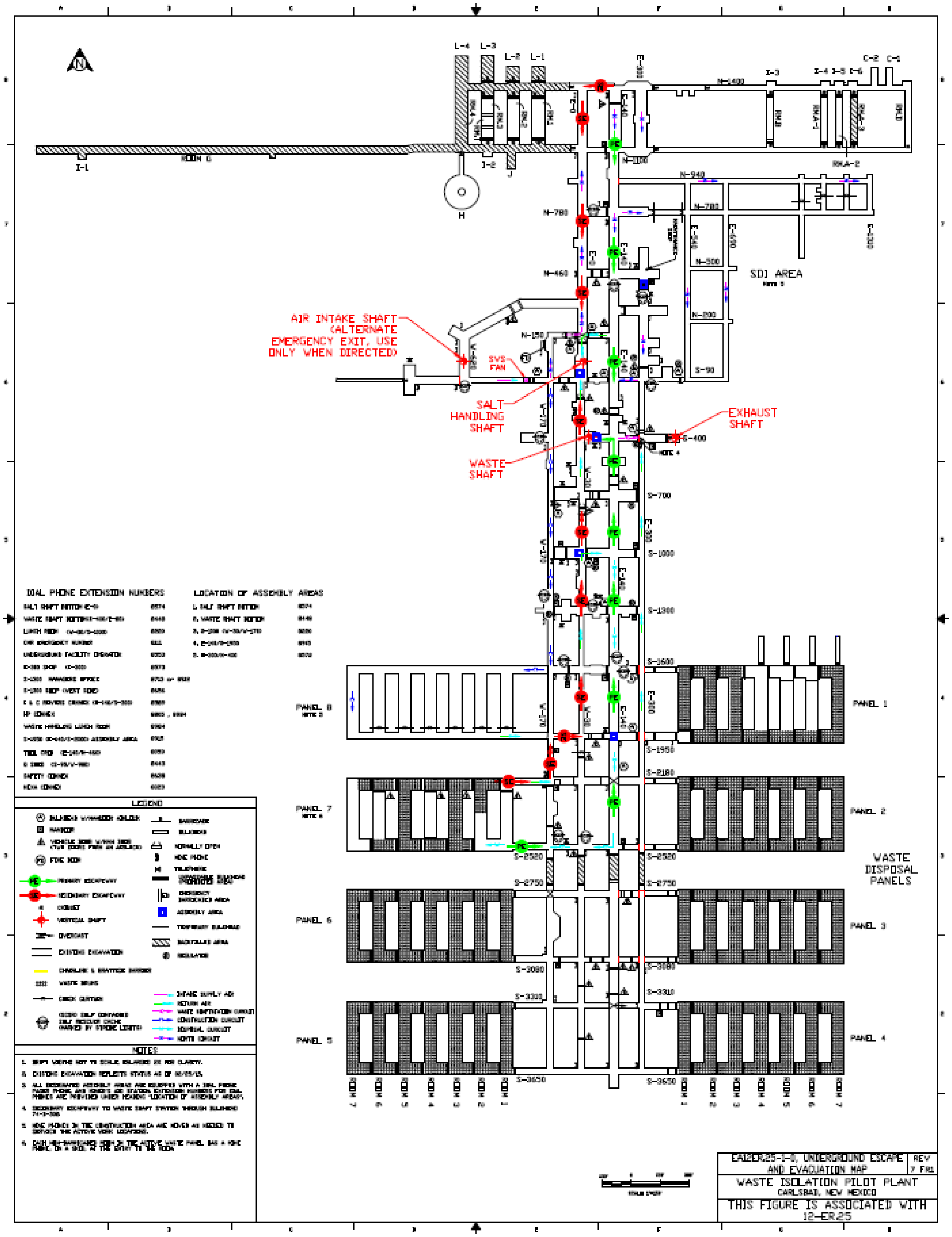


Figure D-34
Underground Escape and Evacuation Map

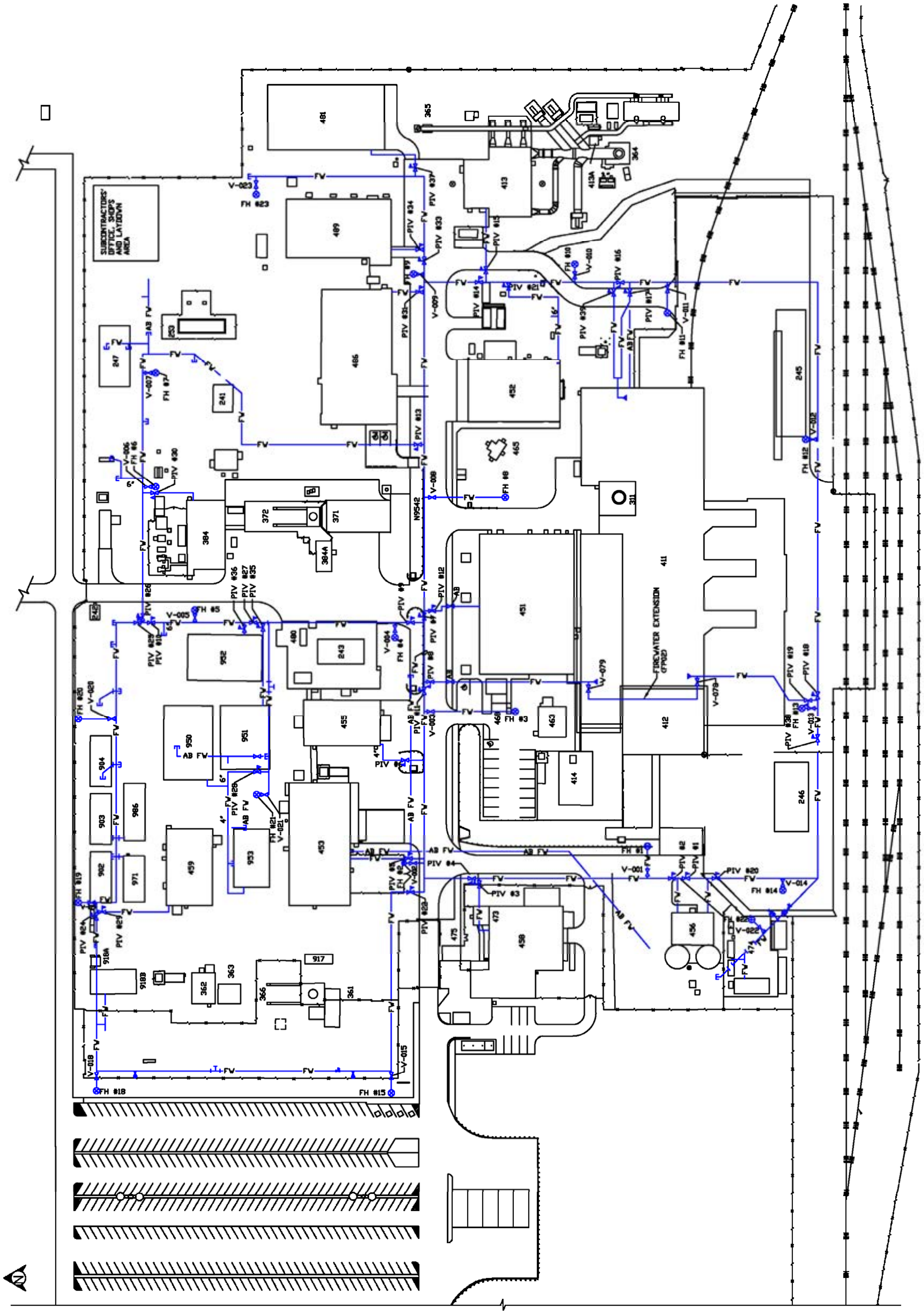


Figure D-4~~5~~
Fire-Water Distribution System

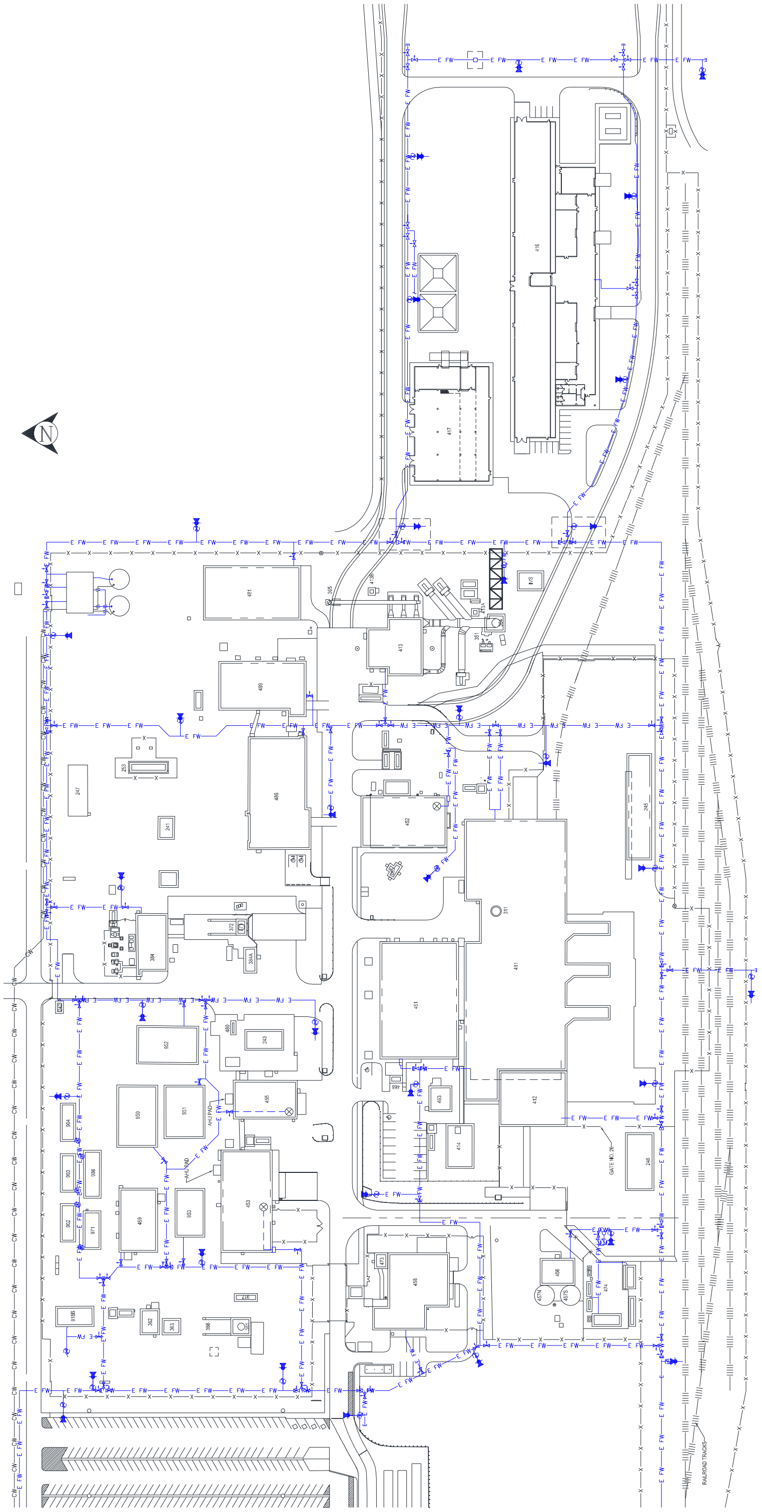


Figure D-4~~5~~-NFB
Fire-Water Distribution System with Building 416

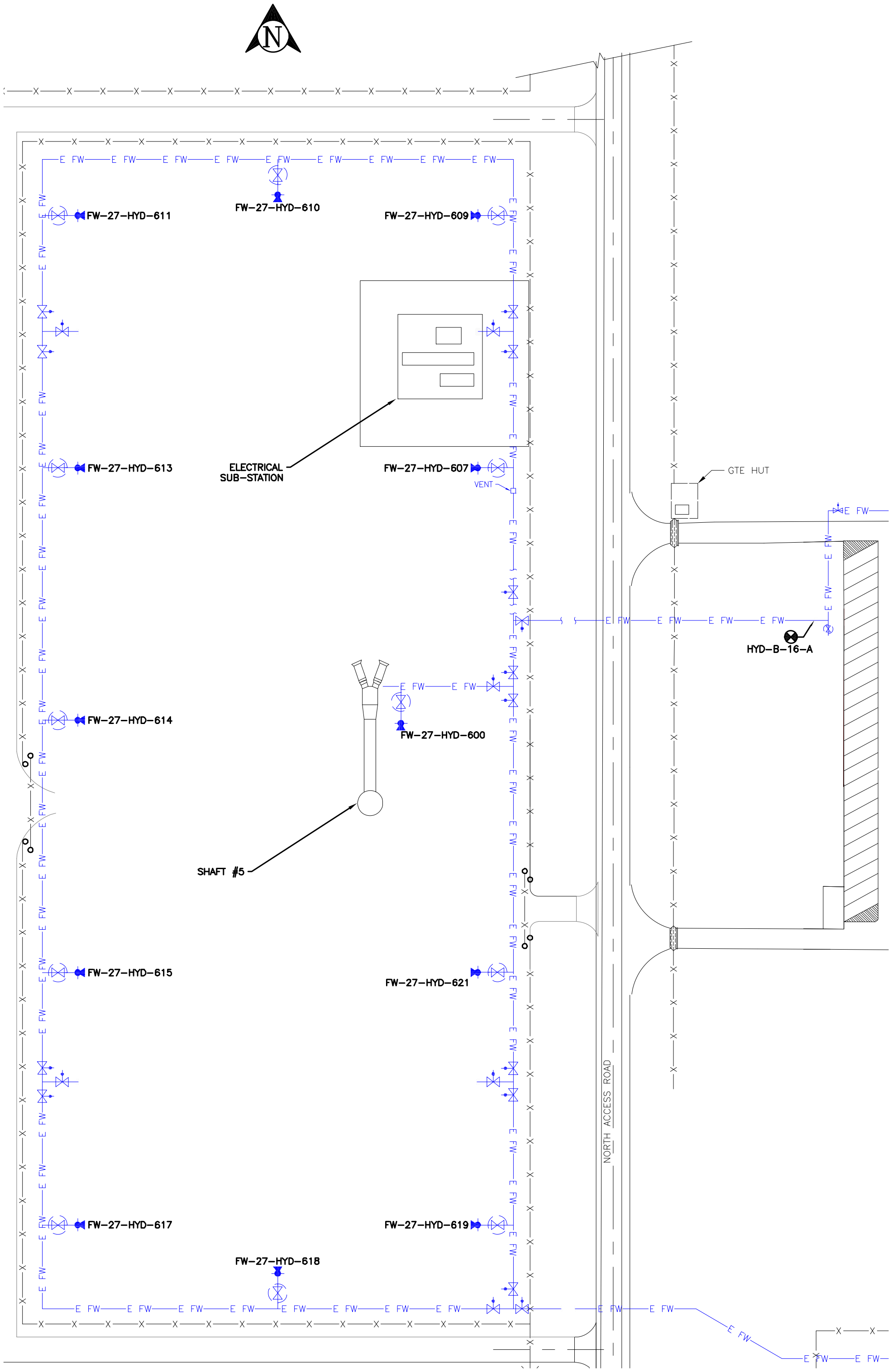
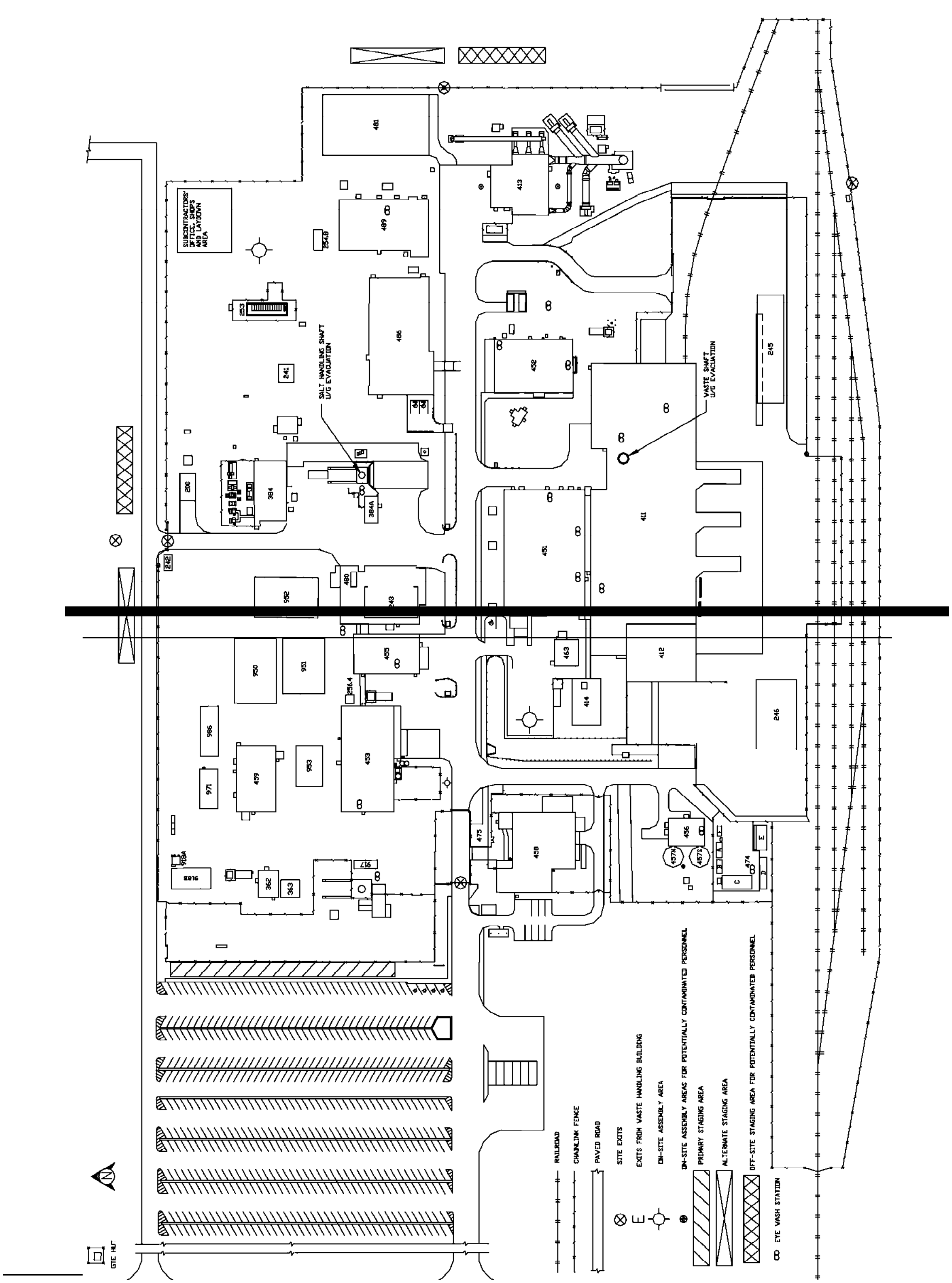
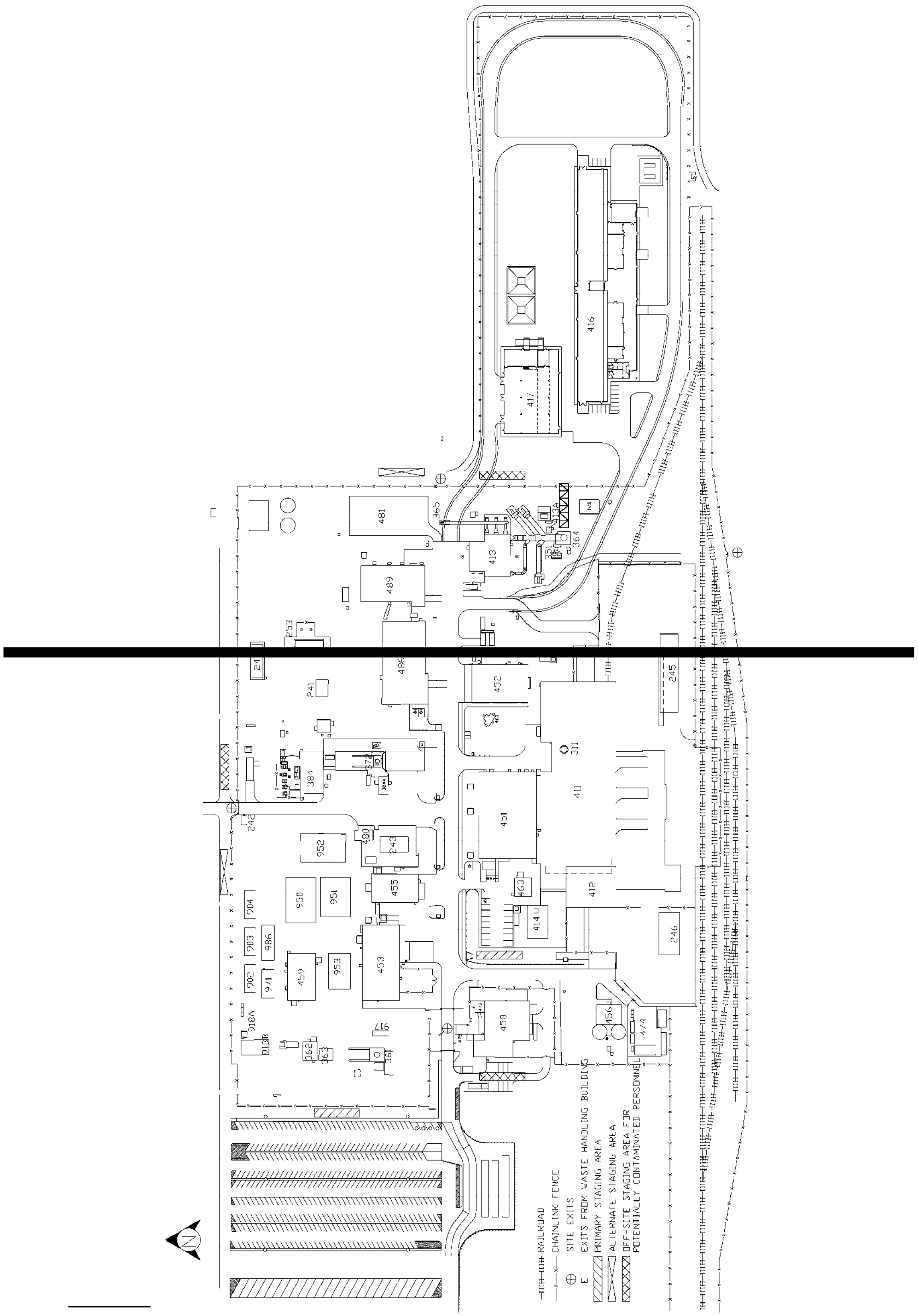


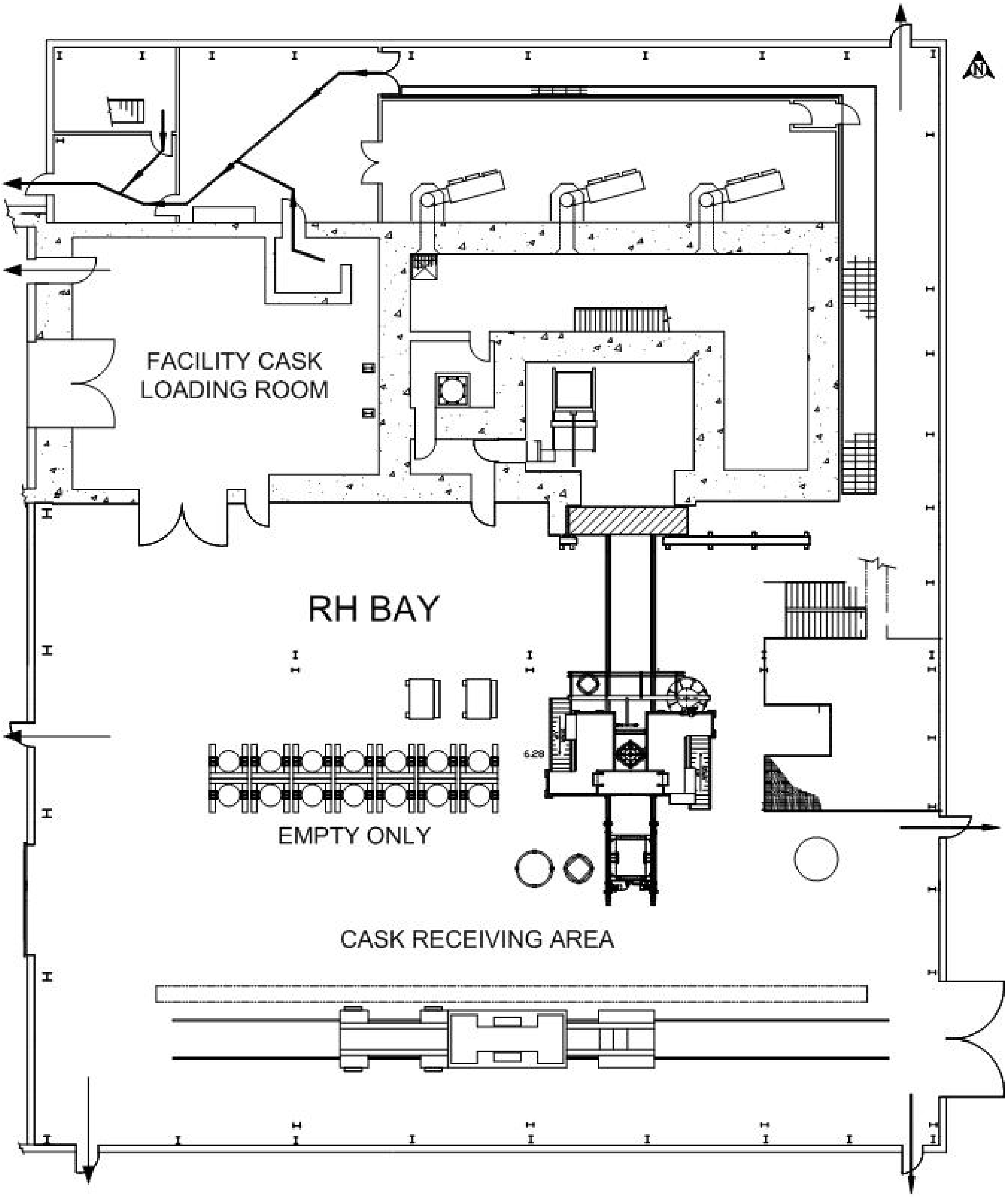
Figure D-4~~5~~-S#5
Fire-Water Distribution System (with S#5)



~~**Figure D-6**~~
~~**WIPP On-Site Assembly Areas and Off-Site Staging Areas**~~

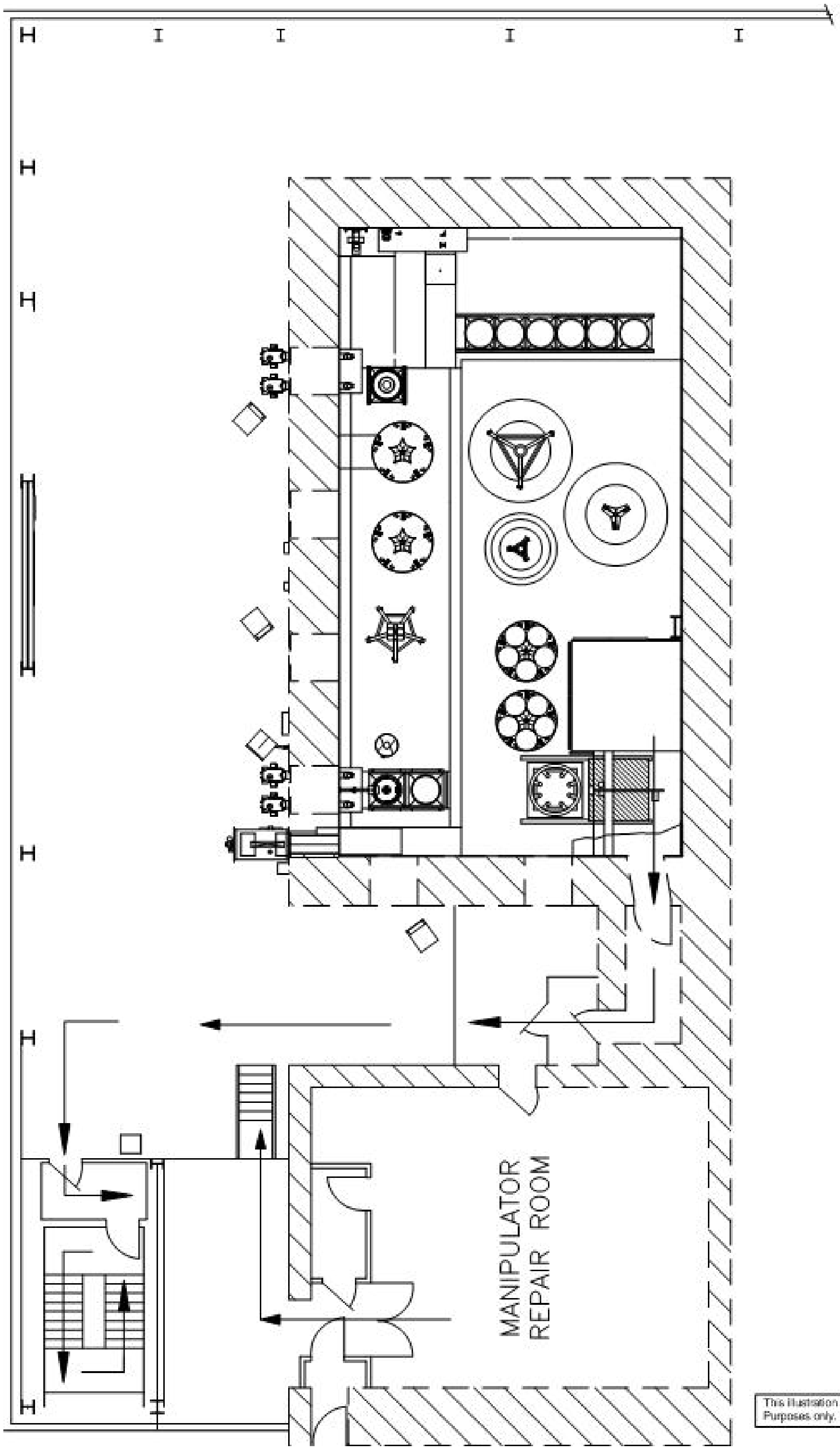


~~Figure D-6-NFB~~
~~WIPP On-Site Assembly Areas and Off-Site Staging Areas with Building 416~~



This Illustration for Information Purposes Only.

Figure ~~D-6a~~D-5
RH Bay Evacuation Routes



This illustration for information Purposes only.

Figure ~~D-6b~~D-6
RH Bay Hot Cell Evacuation Route

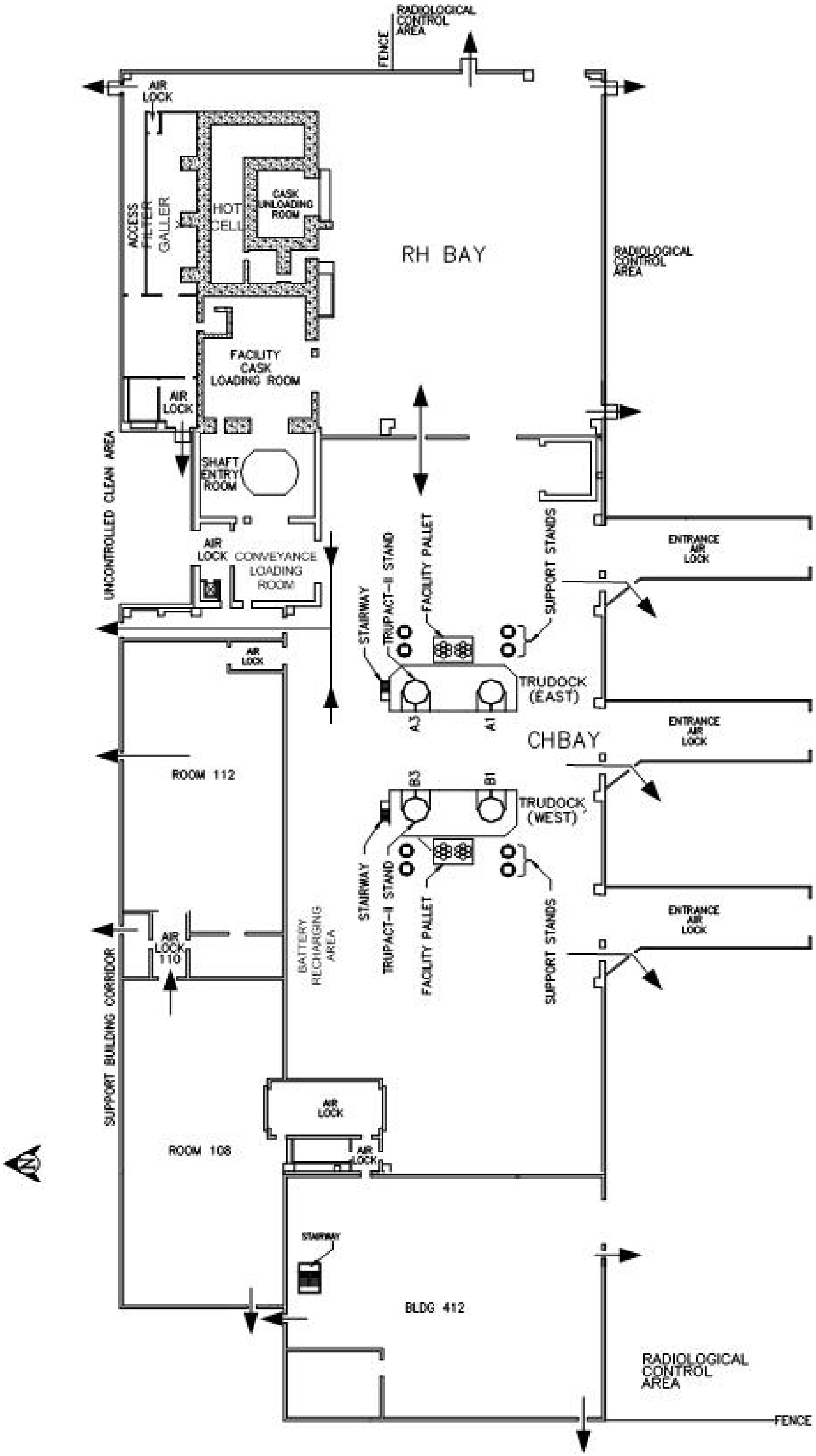
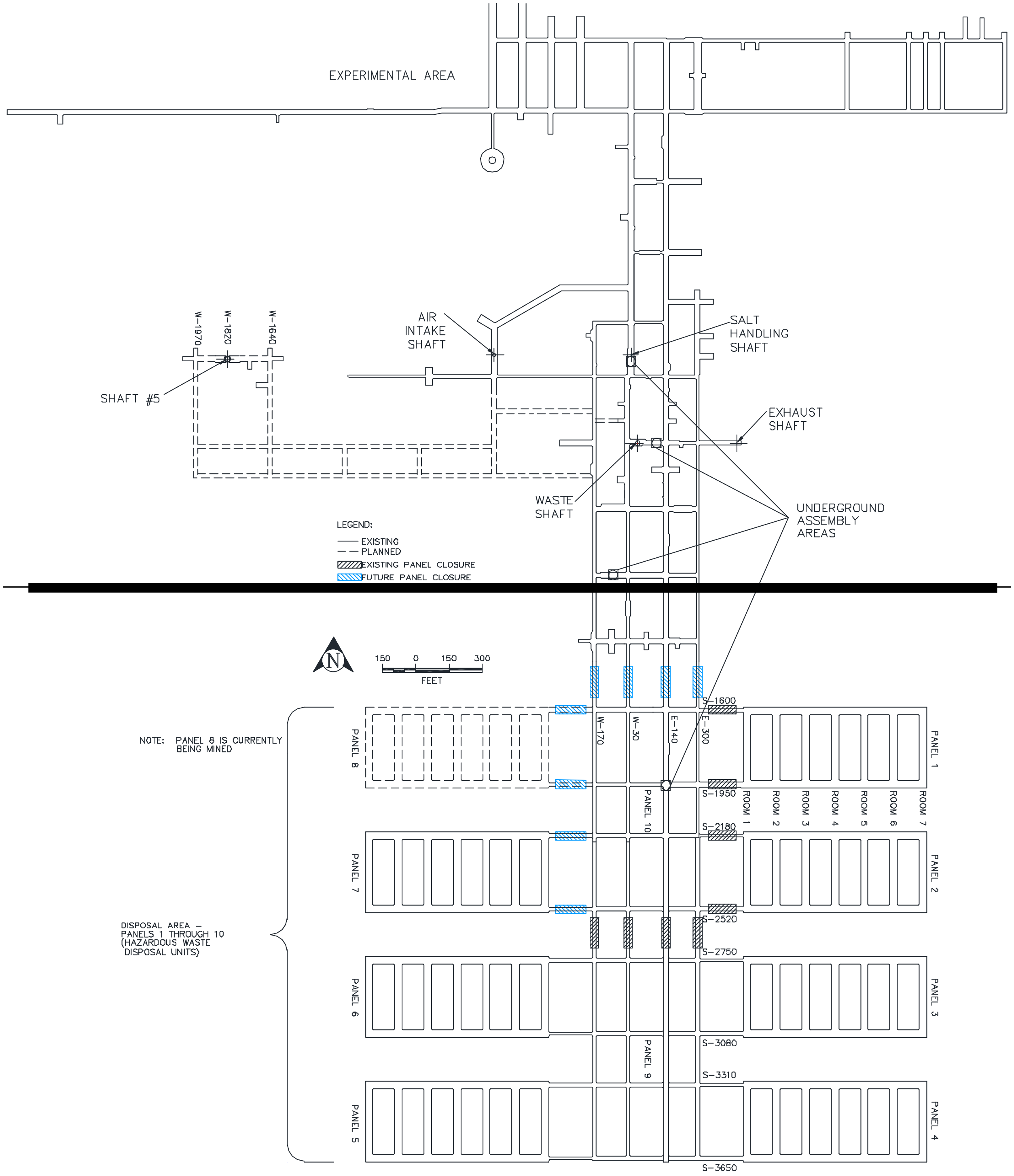


Figure ~~D-6c~~D-7
Evacuation Routes in the Waste Handling Building



~~Figure D-7~~
~~Designated Underground Assembly Areas~~

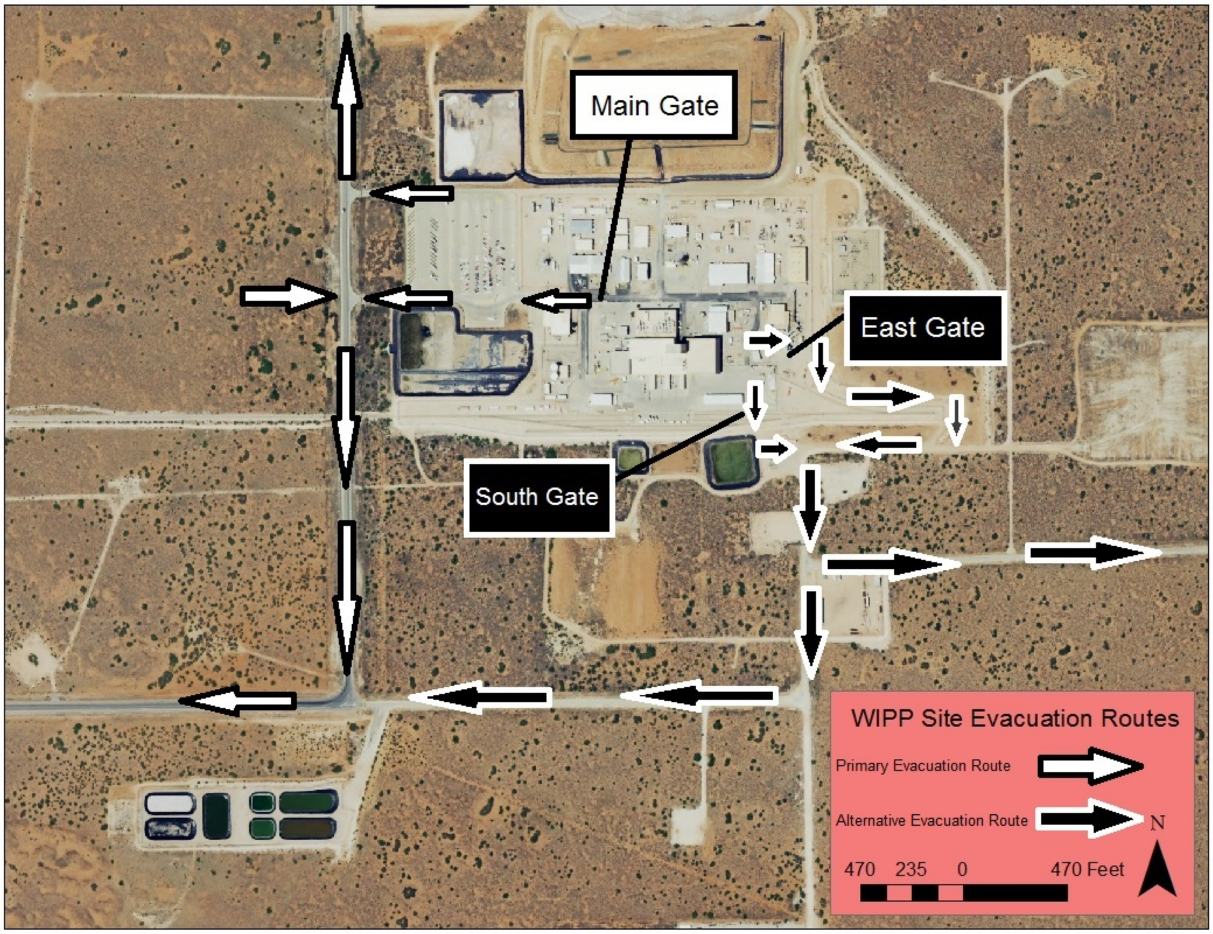
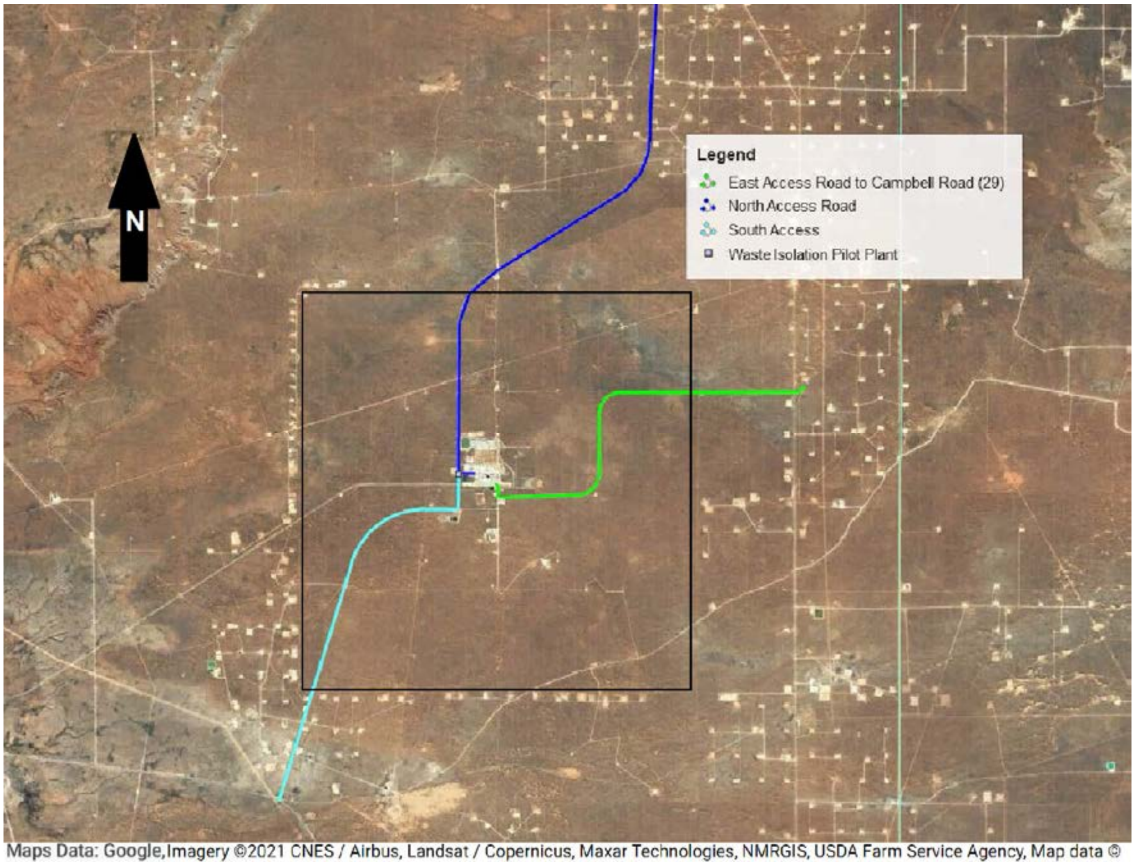


Figure D-8
WIPP Site Evacuation Map



Maps Data: Google,Imagery ©2021 CNES / Airbus, Landsat / Copernicus, Maxar Technologies, NMRGIS, USDA Farm Service Agency, Map data ©

Figure D-8a
WIPP Site Evacuation Routes

ATTACHMENT E

INSPECTION SCHEDULE, PROCESS AND FORMS

ATTACHMENT E

INSPECTION SCHEDULE, PROCESS AND FORMS

TABLE OF CONTENTS

~~LIST OF FIGURES~~

LIST OF TABLES

ATTACHMENT E

INSPECTION SCHEDULE, PROCESS AND FORMS

Introduction

This Permit Attachment describes the facility inspections (including container inspections) that are conducted to detect ~~malfunctions, deterioration, operator errors, and discharges that may cause or lead to releases of hazardous waste or hazardous waste constituents to the environment or that could be a threat to human health~~malfunctions and deterioration, operator errors, and discharges which may be causing—or may lead to—(1) release of hazardous waste constituents to the environment or (2) a threat to human health, in accordance with 20.4.1.500 New Mexico Administrative Code (**NMAC**) (incorporating Title 40 of the Code of Federal Regulations (**CFR**) §264.15(a)).

E-1 Inspection Schedule

Equipment instrumental in preventing, detecting, or responding to environmental or human health hazards, such as monitoring equipment, safety and emergency equipment, security devices, and operating or structural equipment are inspected. ~~The equipment will be inspected for malfunctions, deterioration, potential for operator errors, and discharges which could lead to a release of hazardous waste constituents to the environment or pose a threat to human health.~~

The ~~WIPP facility has~~ Permittees have developed and ~~will~~ maintain a series of written procedures that include all the detailed inspection procedures and forms ~~necessary~~ used to comply with 20.4.1.500 NMAC (incorporating 40 CFR §264.15(b)), during the Disposal Phase. Tables E-1 and E-1a list each item or system requiring inspection under these regulations, the inspection frequency, the organization responsible for the inspection, the applicable inspection procedure, and what to look for during the inspection. The regulations at 20.4.1.500 NMAC (incorporating 40 CFR §§264.15(b), 264.174, and 264.602) list requirements that are applicable to the Waste Isolation Pilot Plant (**WIPP**) facility. Permit Attachment D, Table D-2, *Emergency Equipment Maintained at the Waste Isolation Pilot Plant*, identifies the emergency equipment and corresponding locations to be inspected in accordance with Table E-1.

The Permittees maintain ~~Operational~~operational procedures detailing the inspections required under 20.4.1.500 NMAC (incorporating 40 CFR §§264.15(a) and (b)), ~~are maintained~~ in electronic format on the WIPP computer network~~, in the Operating Record~~ and, as appropriate, in controlled document locations at the WIPP facility. Frequency of inspections is discussed in detail in Section E-1a(2). Inspections are conducted often enough to identify problems in time to correct them before they pose a threat to human health or the environment and are based on regulatory requirements. The operational procedures assign responsibility for conducting the inspection, the frequency of each inspection, the types of problems to be watched for, what to do if items fail inspection, directions on record keeping, and inspector signature, date, and time. ~~The operational procedures are maintained at the WIPP facility. Tables E-1 and E-1a summarize inspections, frequencies, responsible organizations, and the types of anticipated problems as well as the references for the operational procedures.~~ Inspection records are maintained at the WIPP ~~site~~ facility for three years. Beginning with the effective date of this Permit, records that are over the ~~three year~~three-year retention period are either maintained at the WIPP ~~site~~ facility or transferred to the WIPP Records Archive located in Carlsbad, ~~NM~~ New

Mexico until closure. ~~The records maintained at the WIPP Records Archive are stored in facilities that are temperature and humidity controlled especially for the long term storage of records and readily retrievable and available for inspection.~~

Waste handling equipment and area inspections are typically controlled through established procedures and the results are recorded in logbooks or on ~~data sheets~~inspection forms. Operators are trained to consult the logbook to identify the status of ~~any~~ a piece of waste handling equipment prior to its use. Once a piece of equipment is identified to be operable, a preoperational or pre-evolution inspection is initiated in accordance with the appropriate inspection procedure in Tables E-1~~,~~ and E-1a~~, or in operational procedures~~. Inspection results as described below, are entered in the applicable logbook or inspection form.

Inspections include identifying malfunctions or deteriorating equipment and structures. Inspection results and data, including deficiencies, discrepancies, or needed repairs are recorded. A negative inspection result does not necessarily lead to a repair. A deficiency, such as low fluid level, may be corrected by the inspector immediately. A discrepancy, such as an increasing trend of a data point, may necessitate additional inspection prior to the next scheduled frequency. The actions taken (corrected, additional inspection, procurement action, or Action Request (**AR**) for repair submitted) are recorded on the inspection form, the WIPP automated ~~Maintenance~~ maintenance ~~Management~~ management tracking program ~~(**CHAMPS**)~~ work order sheet, or the equipment logbook, whichever is applicable.

Items that are operational with restrictions are operated in accordance with applicable compensatory measures. Items that are not operational are scheduled for repair or replacement in accordance with work authorization procedures. In such cases, compensatory measures may be needed until the equipment is returned to service. These compensatory measures will provide an equivalent level of protection, be documented in WIPP facility files (e.g., equipment logbook, inspection form), and include an appropriate inspection schedule, when applicable.

Normally, the individual inspecting the equipment/system is not qualified to make repairs and consequently, prepares an AR if repairs are needed. The AR is tracked by the WIPP automated maintenance management tracking program~~CHAMPS system~~ through the work~~-~~-control process. When parts are received and work instructions are completed, the work order can be scheduled~~. The schedule is discussed daily to ensure facility configuration can support scheduled~~and work ~~items and to allocate and~~ coordinated with other facility activities ~~the resources necessary~~ in order to complete the items.

Work orders are released for work by the responsible organization. When repairs are complete the responsible organization tests the equipment to ensure the repairs corrected the problem, then closes out the work order~~, to~~ and returns the equipment to an operational status ~~for normal operations to resume~~. Implementation of these procedures constitutes compliance with 20.4.1.500 NMAC (incorporating 40 CFR §264.15(c)).

The Permittees meet the ~~Requirements~~requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.15(d)), ~~are met~~ by performing the inspections for each item or system included in Tables E-1 and E-1a. Beginning with the effective date of this Permit, the results of the inspections are maintained in the ~~operating~~ Operating ~~record~~ Record for three years and are then transferred to the WIPP Records Archive where they are maintained until closure. The inspection logs or summary records include the date and time of inspection, the name of the inspector, a notation of the observations made, and the date and nature of any repairs or other remedial actions. Major pieces of waste handling equipment are inspected using proceduralized inspections. Current copies of inspection forms are ~~maintained in the Operating Record~~on file at the WIPP facility. Non-administrative changes to inspections (i.e., changes that affect the frequency or content of the inspection~~s~~ schedules) ~~to inspection forms~~ must be submitted to the NMED in accordance with the appropriate portions of 20 NMAC 4.1.900 (incorporating 40 CFR §270.42). The status of these pieces of waste handling equipment is ~~maintained~~ recorded in an equipment logbook that is separate from the checklist. The logbook contains information regarding the condition of the equipment. Equipment operators are required, by the inspection checklist, to consult the logbook regarding the status of the equipment~~as the first activity in the inspection procedure~~. This logbook is maintained in the ~~operating~~ Operating ~~record~~Record. ~~CH~~Contact-handled (**CH**) transuranic (**TRU**) mixed waste equipment that is controlled by a logbook includes the waste handling forklifts, ~~all~~ waste handling cranes, the adjustable center of gravity lift fixture, the CH TRU waste underground transporter, the~~ facility~~ transfer vehicles, the trailer jockey, the Ten-Drum Overpack (**TDOP**) Updender, the Payload Transfer Station, and the push-pull attachment. ~~RH~~ Remote-handled (**RH**) TRU mixed waste equipment that is controlled by a logbook includes the 140/25-ton RH Bay overhead bridge crane, cask transfer cars, 25-ton cask unloading room crane, transfer cell shuttle car, RH Bay cask lifting yoke, facility grapple, 6.2- ton overhead hoist, facility cask rotating device, hot cell overhead powered manipulator, 15-ton hot cell crane, facility cask transfer car, 41-ton forklift, facility cask, and emplacement equipment. Inspections of the Cask Unloading Room, Hot Cell, Transfer Cell, Facility Cask Loading Room, and RH Bay ~~and radiation monitoring equipment will be~~are recorded on ~~data sheets~~inspection forms. In addition to the inspections listed in Tables E-1 and E-1a, many pieces of equipment are subject to regular preventive maintenance, which~~. This~~ includes more in-depth inspections of mechanical systems, load testing of lifting systems, calibration of measurement equipment and other actions as recommended by the equipment manufacturer and/or as required by DOE Orders. These preventive maintenance activities, along with the Permit-required inspections in Tables E-1 and E-1a, make mechanical failure of waste handling equipment unlikely. The WIPP ~~Safety Analysis Report~~Documented Safety Analysis (DOE/WIPP-3372~~, 1999~~) ~~and the WIPP Remote-Handled Waste Preliminary Safety Analysis Report (RH PSAR) (DOE, 2000)~~ contains the results of a systematic analysis of waste handling equipment and the hazards associated with potential mechanical failures. ~~Equipment subject to failures that cannot practically be mitigated is retained for analysis and is the basis for contingency planning.~~ The inspection procedures ~~maintained in the Operating Record~~kept on file at the WIPP facility for operational and preventive maintenance are implemented to assure the equipment is maintained. ~~An example equipment inspection checklist and a typical logbook form are shown as Figures E-1 and E-2. Actual checklists or forms are maintained within the Operating Record.~~

E-1a General Inspection Requirements

Tables E-1~~,~~ and E-1a~~, and E-2 of this Permit Attachment~~ list the major categories of monitoring equipment, safety and emergency systems, security devices, and operating and structural equipment that are important to the prevention or detection of, or the response to, environmental or human health hazards caused by hazardous waste. These systems may include numerous subsystems. These systems are inspected according to the ~~frequency~~ frequencies listed in Tables E-1 and E-1a~~, a copy of which is maintained at the WIPP facility~~. ~~The frequency of inspections~~, which ~~is~~ are based on the nature of the equipment or the hazard and regulatory requirements. ~~When in use, daily inspections are made of areas subject to spills, such as TRU mixed waste loading and unloading areas in the WHB Unit, looking for deterioration in structures, mechanical items, floor coatings, equipment, malfunctions, etc., in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.15(b)(4)).~~

As required in 20.4.1.500 NMAC (incorporating 40 CFR §264.33), the WIPP facility inspection procedures for communication and alarm systems, fire-protection equipment, and spill control and decontamination equipment include provisions for testing and maintenance to ensure that the equipment will be operable in an emergency.

E-1a(1) Types of Problems

The inspections for the systems, equipment, and structures~~, etc.~~, listed in Tables E-1 and E-1a, include the types of problems (e.g., malfunctions;~~,~~ visible cracks in tubing, coatings, ~~or~~ welds~~,~~; and deterioration) to be looked for during the inspection of each item or system, if applicable, and are in compliance with 20.4.1.500 NMAC (incorporating 40 CFR §264.15(b)(3)).

E-1a(2) Frequency of Inspections

Tables E-1~~,~~ and E-1a~~, and E-2 of this Permit Attachment~~ list the inspection frequencies and monitoring schedule for equipment and systems subject to the 20.4.1 NMAC hazardous waste management requirements. The frequency is based on the rate of possible deterioration of the equipment and the probability of an environmental or human health incident if the deterioration or malfunction, or any operator error, goes undetected between inspections. When in use, daily inspections are made of areas subject to spills, such as TRU mixed waste loading and unloading areas in the Waste Handling Building (**WHB**) Unit, and involve looking for deterioration in structures, mechanical items, floor coatings, equipment, malfunctions, etc., in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.15(b)(4)).~~Areas subject to spills, such as loading and unloading areas, are inspected daily when in use, consistent with the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.15(b)(4)).~~

When RH TRU mixed waste is present in the RH Complex, inspections are conducted visually and/or using closed-circuit video cameras in order to manage worker dose and to minimize occupational radiation exposures to as low as reasonably achievable (**ALARA**). More extensive inspections of these areas are performed at least annually during routine maintenance periods and when RH TRU mixed waste is not present, as identified in Table E-1a.

E-1a(3) Monitoring Systems

There are two monitoring systems used at the WIPP facility to provide assurance that facility systems are operating correctly, that areas can be used safely, and that there have been no releases of hazardous waste constituents. These systems ~~are shown in Table E-2 and~~ include the geomechanical monitoring system and the central monitoring system (**CMS**). The geomechanical monitoring system is used to assess the condition of mined excavations to ~~assure no~~identify the development of unsafe conditions are allowed to develop. The CMS continuously assesses the status of ~~the fixed radiation monitoring equipment,~~ electrical power, fire alarm systems, ventilation system, and other facility systems including water tank levels. In addition, the CMS collects data from the meteorological monitoring system. Key equipment monitored by these two systems are identified in Table E-1 and include a specified inspection frequency.

E-1b Specific Process Inspection Requirements

The regulation at 20.4.1.500 NMAC (incorporating 40 CFR §264.15(b)(4)), ~~requires~~ require inspections of specific portions of a facility, rather than the general facility. These include container storage areas and miscellaneous units. Both are addressed below.

E-1b(1) Container Inspection

The Permittees use~~Containers~~ containers ~~are used~~ to manage TRU mixed waste at the WIPP facility. These containers are described in Permit Part 3 Section 3.3.1, and Permit Attachment A1, Section A1-1b. ~~Off-site waste that will be managed and stored as CH TRU mixed waste will arrive in 55-gallon drums arranged as seven (7)-packs, in Ten Drum Overpacks (**TDOP**), in 85-gallon drums arranged as four (4) packs, in 100-gallon drums arranged as three (3) packs, in standard waste boxes (**SWB**), in standard large box 2s (**SLB2s**) or shielded containers as (3)-packs.~~ The waste containers ~~will be~~are visually inspected to ensure that the waste containers are in good condition and that there are no signs that a release has occurred. This visual inspection ~~shall~~ does not include the center drums of ~~7~~seven-packs and waste containers positioned such that visual observation is precluded due to the arrangement of waste assemblies on the facility pallets. If CH TRU mixed waste handling operations should stop for any reason with containers located ~~on~~ in the ~~TRUPACT-II~~CH package ~~Unloading Dock~~ (e.g., at the TRUDOCKs ~~storage area of the WHB Unit)~~ or in ~~room~~ Room 108) ~~while still in the Contact-Handled Packages~~, primary waste container inspections ~~could not~~cannot be accomplished until the containers of waste are removed from the ~~shipping containers~~CH package.

As described in Permit Attachment A1, Section A1-1d(3), off-site waste ~~that will be~~ managed and stored as RH TRU mixed waste ~~will~~ arrives in ~~containers inside~~ Nuclear Regulatory Commission ~~(**NRC**)~~-certified cask~~s designed to provide shielding and facilitate safe handling~~. ~~Canisters, will be loaded singly into an RH-TRU 72-B cask. Drums will be loaded into a CNS 10-160B cask.~~ The cask ~~will be~~is visually inspected upon arrival. ~~Because RH TRU mixed waste is stored in the Parking Area Unit in sealed casks, there are no additional requirements for engineered secondary containment systems.~~ Following removal of the canisters ~~and~~ or drums, the interior of the cask ~~will be~~is inspected and surveyed for evidence of contamination that may have occurred during transport.

Off-site waste ~~that will be~~ managed and stored as RH TRU mixed waste is managed and stored in the RH Complex of the WHB. The RH Complex includes the following: RH Bay, the Cask Unloading Room, the Hot Cell, the Transfer Cell, and the Facility Cask Loading Room. ~~As RH TRU mixed waste is held in canisters within a canister rack the physical inspection of the drum or canister is not possible.~~ Inspections of RH TRU mixed waste in these areas occurs remotely via closed-circuit cameras a minimum of once weekly when stored waste is present. ~~Because RH TRU mixed waste is in sealed casks, there are no additional requirements for engineered secondary containment systems. However, the~~The floors in the RH Complex (including the RH Bay, Facility Cask Loading Room and Cask Unloading Room) are coated concrete and during normal operations (i.e., when waste is present), the floor of the RH Complex is inspected visually or by using close-circuit cameras on a weekly basis to verify that it is in good condition and free of visible cracks and gaps.

Inspections of RH TRU mixed waste containers stored in the Hot Cell and Transfer Cell are conducted using remotely operated cameras. ~~RH~~ Remote-handled TRU mixed waste in the Hot Cell is stored in either drums or canisters. The containers in the Hot Cell are inspected to ensure that they are in acceptable condition. ~~RH~~ Remote-handled TRU mixed waste in the Transfer Cell is stored in the RH-TRU 72-B cask or shielded insert; therefore, inspections in this area focus on the integrity of the cask or shielded insert. ~~RH~~ Remote-handled TRU mixed waste in the Facility Cask Loading Room is stored in the facility cask; therefore, inspections in this area focus on the integrity of the facility cask.

Inspections ~~will be~~are conducted in the Parking Area Unit **(PAU)** at a frequency not less than once weekly when waste is present and focus on the inventory and integrity of the shipping containers and the spacing between trailers carrying the CH or RH packages. This aisle spacing is maintained at a minimum of four feet. These inspections are applicable to loaded ~~Contact-Handled~~CH and ~~Remote-Handled~~RH ~~Packages~~packages. ~~The perimeter fence located at the lateral limit of the Parking Area Unit, coupled with personnel access restrictions into the WHB Unit, will provide the needed security. The perimeter fence and the southern border of the WHB shall mark the lateral limit of the Parking Area Unit. Radiologically controlled areas can be established temporarily with barricades. More permanent structures can be installed. The western boundary can be established with temporary barricades since this area is within the perimeter fence. Access to radiologically controlled areas will only be permitted to personnel who have completed General Employee Radiological Training (**GERT**), a program defined by the Permittees, or escorted by personnel who have completed GERT. This program ensures that personnel have adequate knowledge to understand radiological posting they may encounter at the WIPP site. The fence of the Radiologically Controlled Area, south from the WHB airlocks, was moved to provide more maneuvering space for the trucks delivering waste.~~ Since TRU mixed waste to be stored in the ~~Parking Area Unit~~PAU ~~will be~~is in sealed ~~Contact-Handled~~CH or ~~Remote-Handled~~RH ~~Packages~~packages, there ~~will be~~are no additional requirements for engineered secondary containment systems. ~~Inspections of the Contact-Handled and Remote-Handled Packages stored in the Parking Area Unit shall be conducted at a frequency no less than once weekly and will focus on the inventory and integrity of the shipping containers and the spacing between trailers carrying the Contact-Handled or Remote-Handled Packages. This spacing will be maintained at a minimum of four feet.~~

Container inspections ~~will be~~are included as part of the surface TRU mixed waste handling areas ~~(i.e. Parking Area Unit and WHB Unit)~~ inspections described in Tables E-1 and E-1a. These inspections ~~will~~ also include the Derived Waste Storage Areas of the WHB Unit. ~~The Derived Waste Storage Areas will consist of containers of 55 or 85-gallon drums or SWBs for CH TRU mixed waste and 55-gallon drums for RH TRU mixed waste.~~ A ~~Satellite~~ satellite accumulation area (**SAA**) may be required in an area adjacent to the TRUDOCKs for CH TRU mixed waste. An SAA may also be required in the RH Bay and Hot Cell for RH TRU mixed waste. These SAAs will be set up on an as needed basis at or near the point of generation and the derived waste will be discarded into the active derived waste container. ~~All SAAs~~Satellite accumulation areas ~~will be~~are inspected in accordance with 20.4.1.300 NMAC (incorporating 40 CFR §262.17).

E-1b(2) Miscellaneous Unit Inspection

The regulations at20.4.1.500 NMAC (incorporating 40 CFR §264.602)~~,~~ requires that ~~inspections required in~~the inspection requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.15 and §264.33), as well as any additional inspection requirements needed to protect human health and the environment, be met. The requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.15 and §264.33) are discussed in Section E-1 of this Permit Attachment, along with how the WIPP facility complies with those requirements for standard types of inspections. Inspection

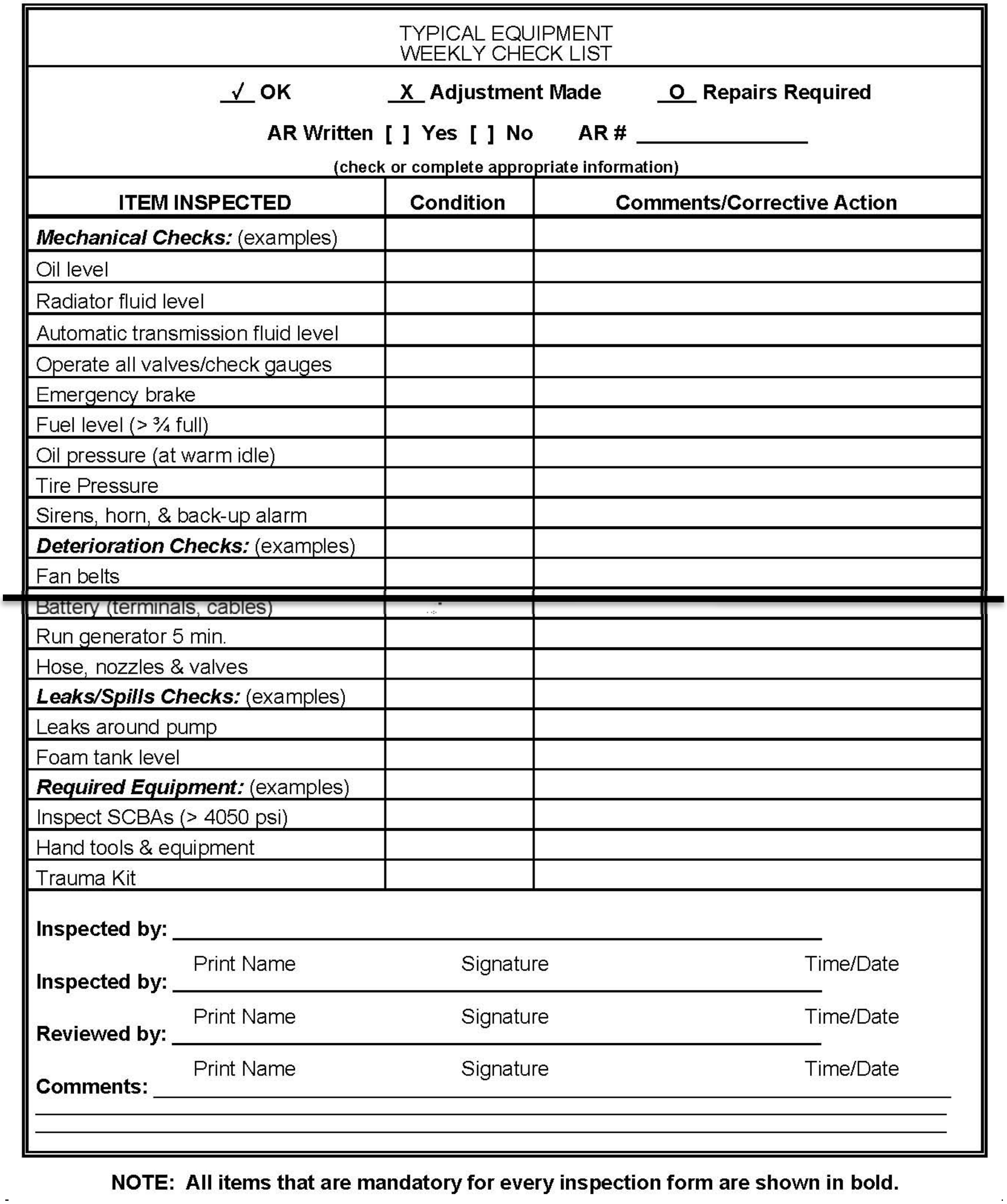
~~frequencies for geomechanical monitoring equipment are provided in Table E-1. The monitoring schedule for~~of the geomechanical instrumentation system is ~~given~~ addressed in Table ~~E-2~~E-1. As described in Permit Attachment A2,Section A2-b(2), the geomechanical monitoring program at the WIPP facility is an integral part of the ground-control program. Hazardous waste disposal units, access drifts, the Waste Shaft Station, and the underground transport route are monitored to provide confirmation of structural integrity. Geomechanical data on the performance of the repository shafts is collected as part of the shaft inspections. The results of geomechanical monitoring are reported annually, as identified in Permit Attachment A2, Section A2-b(2).

References

~~DOE, 1999. "WIPP Safety Analysis Report," DOE/WIPP-95-2065. Rev. 4, U.S. Department of Energy. Washington, D.C.~~DOE/WIPP-3372. *Waste Isolation Pilot Plant Documented Safety Analysis*.

~~DOE, 2000. "WIPP Remote-Handled Waste Preliminary Safety Analysis" (RH PSAR), U.S. Department of Energy. Washington, D.C.~~

~~FIGURES~~



TYPICAL EQUIPMENT
WEEKLY CHECK LIST

_√_ OK **_X_ Adjustment Made** **_O_ Repairs Required**

AR Written [ ] Yes [ ] No AR # ______________

(check or complete appropriate information)

ITEM INSPECTED	**Condition**	**Comments/Corrective Action**
Mechanical Checks: (examples)		
Oil level		
Radiator fluid level		
Automatic transmission fluid level		
Operate all valves/check gauges		
Emergency brake		
Fuel level (> ¾ full)		
Oil pressure (at warm idle)		
Tire Pressure		
Sirens, horn, & back-up alarm		
Deterioration Checks: (examples)		
Fan belts		
Battery (terminals, cables)		
Run generator 5 min.		
Hose, nozzles & valves		
Leaks/Spills Checks: (examples)		
Leaks around pump		
Foam tank level		
Required Equipment: (examples)		
Inspect SCBAs (> 4050 psi)		
Hand tools & equipment		
Trauma Kit		

Inspected by: ____
Print Name Signature Time/Date

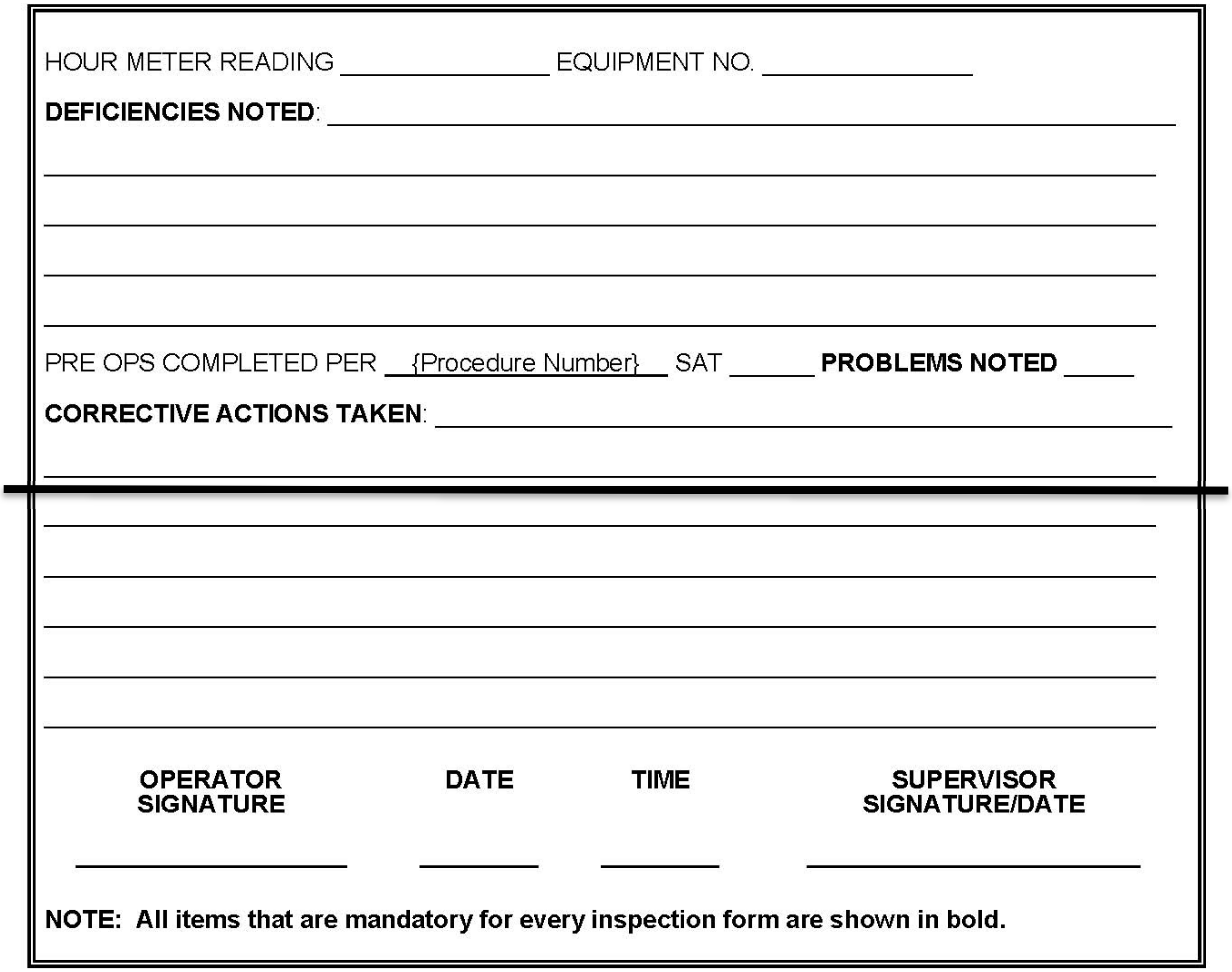
Inspected by: ____
Print Name Signature Time/Date

Reviewed by: ____
Print Name Signature Time/Date

Comments: ____
____
____

NOTE: All items that are mandatory for every inspection form are shown in bold.

~~Figure E-1~~
~~Typical Inspection Checklist~~



HOUR METER READING ______________ EQUIPMENT NO. ______________

DEFICIENCIES NOTED: ____

PRE OPS COMPLETED PER __{Procedure Number}__ SAT ______ **PROBLEMS NOTED** _____

CORRECTIVE ACTIONS TAKEN: ____

OPERATOR SIGNATURE ______________

DATE ________

TIME ________

SUPERVISOR SIGNATURE/DATE ______________

NOTE: All items that are mandatory for every inspection form are shown in bold.

~~**Figure E-2**~~
~~**Typical Logbook Entry**~~

TABLES

Table E-1
Inspection Schedule/Procedures

System/Equipment Name	Responsible Organization	Inspection[a] Frequency	Procedure Number and Inspection Criteria[h]
Air Intake Shaft Hoist	Underground Operations	Preoperational[c]	WP 04-HO1004 Inspecting for Deterioration[b], Safety Equipment, Communication Systems, and Mechanical Operability[m] in accordance with Mine Safety and Health Administration (MSHA) requirements
Ambulance (Surface) and Medical Cart (Underground)	Fire Department	Weekly	WP 12-FP0030 Inspecting for Mechanical Operability[m], Deterioration[b], and Required Equipment[n]
Adjustable Center of Gravity Lift Fixture	Waste ~~Handling~~Operations	Preoperational[c]	WP 05-WH1410 Inspecting for Mechanical Operability[m] and Deterioration[b]
Backup Power Supply Diesel Generators	Facility Operations	Monthly	WP 04-ED1301 Inspecting for Mechanical Operability[m] and Leaks/Spills by starting and operating both generators. Results of this inspection are ~~logged in accordance with WP 04-AD3008.~~recorded on EA04AD3008-47-0
Facility Inspections (Water Diversion Berms)	Facility Engineering	Annually	WP 10-WC3008 Inspecting for Damage, Impediments to water flow, and Deterioration[b]
Central Monitoring Systems (CMS)	Facility Operations	Continuous	Automatic Self-Checking
~~Contact-Handled (CH)~~ TRU Underground Transporter	Waste ~~Handling~~Operations	Preoperational [c]	WP 05-WH1603 WP 05-WH1604 Inspecting for Leaks/Spills, Mechanical Operability[m], Deterioration[b], ~~and~~ area around transporter clear of obstacles, and on-board automatic fire suppression system
Conveyance Loading Car	Waste ~~Handling~~Operations	Preoperational [c]	WP 05-WH1406 Inspecting for Mechanical Operability[m], Deterioration[b], path clear of obstacles, and guards in the proper place

System/Equipment Name	Responsible Organization	Inspection[a] Frequency	Procedure Number and Inspection Criteria[h]
Facility Transfer Vehicle	Waste ~~Handling~~Operations	~~Preoperational [c]~~Pre-evolution[p]	WP 05-WH1204 Pre-evolution Checks and Operating Instructions, Inspecting for Mechanical Operability[m], Deterioration[b], path clear of obstacles, and guards in the proper place
Emergency Lighting	Fire Department	Monthly/~~annually~~Annually	WP 12-FP0051 Inspecting for Deterioration[b], and Operability of indicator lights in accordance with NFPA 101
Exhaust Shaft	Underground Operations	Quarterly	PM041099 Inspecting for Deterioration[b] ~~and Leaks/Spills~~
Eye Wash and Shower Equipment	~~Equipment Custodian~~Environmental, Safety, Industrial Health	Weekly	WP 12-IS1832 Inspecting for Deterioration[b]
		Semi-annually	WP 12-IS1832 Inspecting for Deterioration[b] and Fluid Levels–Replace as Required
Fire Detection and Alarm System	Fire Protection Engineering	Semi-annually/~~annually~~Annually	WP 12-FP0027 Inspecting for Deterioration[b] and Operability of underground fuel station fire suppression system in accordance with NFPA 17 (semi-annual inspection); Inspecting for Deterioration[b] and Operability of the alarm panel and transmitter, audible/visual alarm devices, detectors, and pull stations in accordance with NFPA 72 (annual inspection)
		~~Monthly/quarterly/annually~~	~~WP 12-FP0028~~ ~~Inspecting for Deterioration[b], and Operability of the alarm panel and transmitter, audible/visual alarm devices, detectors, and pull stations in accordance with NFPA 72~~

System/Equipment Name	Responsible Organization	Inspection[a] Frequency	Procedure Number and Inspection Criteria[h]
		Monthly/Quarterly/Annually	WP 12-FP0028 Inspecting for Deterioration[b], and Operability of the alarm panel and transmitter, audible/visual alarm devices, detectors, and pull stations in accordance with NFPA 72
Fire Extinguishers[j]	Fire Department	Monthly	WP 12-FP0036 Inspecting for Deterioration[b], Leaks/Spills, Expiration, seals, fullness, and pressure
Fire Hoses	Fire Department	Annually (minimum)	WP 12-FP0031 Inspecting for Deterioration[b] and Leaks/Spills
Fire Hydrants	Fire Protection Engineering	Semi-annual/~~annually~~Annually	WP 12-FP0034 Inspecting for Deterioration[b] and Leaks/Spills
Fire Pumps	Fire Protection Engineering	Weekly ~~Annually (Electric Pump)~~ ~~Annually (Diesel Pump)~~	WP 12-FP0026 Inspecting for Deterioration[b], Leaks/Spills, fire water valve position(s), and panel light status ~~WP 12-FP5113~~ ~~Inspecting for Deterioration[b], operability, flow, discharge pressure, suction pressure, and pump speed~~ ~~WP 12-FP5114~~ ~~Inspecting for Deterioration[b], operability, flow, discharge pressure, suction pressure, and pump speed~~
		Annually (Electric Pump)	WP 12-FP5113 Inspecting for Deterioration[b], operability, flow, discharge pressure, suction pressure, and pump speed
		Annually (Diesel Pump)	WP 12-FP5114 Inspecting for Deterioration[b], operability, flow, discharge pressure, suction pressure, and pump speed

System/Equipment Name	Responsible Organization	Inspection[a] Frequency	Procedure Number and Inspection Criteria[h]
Fire Sprinkler Systems	Fire Protection Engineering	Monthly	WP 12-FP0023, WP 12-FP0063, and WP 12-FP0064 Inspecting for Deterioration[b], Leaks/Spills, water pressures, and main drain test
		Quarterly	WP 12-FP0024, WP 12-FP0063, and WP 12-FP0064 Inspecting for Deterioration[b], Leaks/Spills, water pressures, and main drain test
		Annually	WP 12-FP0025, WP 12-FP0063, and WP 12-FP0064 Inspecting for Deterioration[b], Leaks/Spills, water pressures, and main drain test
Fire and Emergency Response Vehicles (Fire Trucks, Fire Suppression Cart, and Rescue Cart)	Fire Department	Weekly	WP 12-FP0033 Inspecting for Mechanical Operability[m], Deterioration[b], Leaks/Spills, and Required Equipment[n]
Electric Forklifts Used for Waste Handling	Waste Operations	Preoperational[c]	WP 05-WH1401 WP 05-WH1402 WP 05-WH1403 Inspecting for Leaks/Spills, Mechanical Operability[m], Deterioration[b], and presence of on-board fire extinguisher
Diesel Forklifts Used for Waste Handling ~~(Electric and Diesel forklifts, Push-Pull Attachment)~~	Waste ~~Handling~~Operations	Preoperational [c]	WP 05-WH1201~~,~~ WP 05-WH1207~~, WP 05-WH1401, WP 05-WH1402, WP 05-WH1403, and~~ WP 05-WH1412 Inspecting for Leaks/Spills, Mechanical Operability[m], Deterioration[b], and ~~On~~ on-board automatic fire suppression system
Automatic on-board fire suppression systems	Fire Protection Engineering	Monthly/Semi-annually	WP 12-FP0085 WP 12-FP0060 Inspecting for Mechanical Operability[m] and Deterioration[b]
Hazardous Material Response Equipment	Fire Department	~~Quarterly~~ Monthly	WP 12-FP0033 Inspecting for Deterioration[b], and Required Equipment[n]

System/Equipment Name	Responsible Organization	Inspection[a] Frequency	Procedure Number and Inspection Criteria[h]
Head Lamps	Facility Personnel	Daily[i]	Head lamps are operated daily and are repaired or replaced upon failure
Miners First Aid Station	Fire Department	Quarterly	WP 12-FP0035 Inspecting for Required Equipment[n]
Mobile Phones	Facility Personnel	Daily[i]	Mobile Phones are operated daily and are repaired or replaced upon failure
Mine Pager Phones (between surface and underground)	Facility Operations	Monthly/Annually[o]	WP 04-PC3017 WP 04-PC3018 Testing of Mine Pager Phones at essential locations
MSHA Air Quality Monitor	Maintenance/ Underground Operations	Daily[l]	WP 12-IH1828 Inspecting for Air Quality Monitoring Equipment Functional Check
Perimeter Fence, Gates, Signs	Security	Daily	WP 17-SS1023 Inspecting for Deterioration[b] and ~~Posted Warnings~~Required Permit Part 2, Section 2.6.4 warning signs
Mine Rescue Self-Contained Breathing Apparatus (**SCBA**)	Mine Rescue Team	30 days	WP 12-ER3007 Inspection for Deterioration[b] and Pressure[g]
-Fire Department SCBA	Fire Department	Weekly/~~monthly~~Monthly	WP 12-FP0029 Inspecting for Deterioration[b] and Pressure
Site Notification System; Underground Evacuation Alarm System	Facility Operations	Monthly/Annually	WP 04-PC3017 WP 04-PC3018 Testing of PA and Underground Alarms
Radio Equipment	Facility Personnel	Daily[i]	Radios are operated daily and are repaired or replaced upon failure
Salt Handling Shaft Hoist	Underground Operations	Preoperational [c]	WP 04-HO1002 Inspecting for Deterioration[b], Safety Equipment, Communication Systems, and Mechanical Operability[m] in accordance with MSHA requirements

System/Equipment Name	Responsible Organization	Inspection[a] Frequency	Procedure Number and Inspection Criteria[h]
Self-Rescuers and Self-Contained Self-Rescuers	Underground Operations	Quarterly	WP 04-AU1026 Inspecting for Deterioration[b] and Functionality in accordance with MSHA requirements
Surface CH TRU Mixed Waste Handling Area [k]	Waste ~~Handling~~Operations	Preoperational[c] or Weekly [e]	WP 05-WH1101 Inspecting for Deterioration[b], Leaks/Spills, Required Aisle Space[q], ~~Posted Warnings~~Required Permit Part 2, Section 2.6.4 warning signs, Communication Systems, Container Condition, and Floor coating integrity
TRU Mixed Waste Decontamination Equipment	Waste ~~Handling~~Operations	Annually	WP 05-WH1101 Inspecting for Required Equipment[n]
Underground Openings—Roof Bolts and Travelways	Underground Operations	Weekly	WP 04-AU1007 Inspecting for Deterioration[b] of Accessible Areas
Underground— Geomechanical Instrumentation System (GIS)	Geotechnical Engineering	Monthly	WP 07-EU1301 Inspecting for Deterioration[b]
Underground TRU Mixed Waste Disposal Area	Waste ~~Handling~~Operations	Preoperational [c]	WP 05-WH1810 Inspecting for Deterioration[b], Leaks/Spills, mine pager phones, ~~equipment,~~ unobstructed access, required Permit Part 2, Section 2.6.4 warning signs, debris, and ventilation
Uninterruptible Power Supply (Central UPS)	Facility Operations	Daily	WP 04-ED1542 Inspecting for Mechanical Operability[m] and Deterioration[b] with no malfunction alarms. Results of this inspection are ~~logged in accordance with WP 04-AD3008.~~recorded on EA04AD3008-20-0
TDOP Upender	Waste ~~Handling~~Operations	~~Preoperational~~ [e]Pre-evolution[p]	WP 05-WH1010 Pre-evolution Checks and Operating Instructions, Inspecting for Mechanical Operability[m] and Deterioration[b]

System/Equipment Name	Responsible Organization	Inspection[a] Frequency	Procedure Number and Inspection Criteria[h]
Waste Handling Cranes	Waste ~~Handling~~Operations	Preoperational[c]	WP 05-WH1407 Inspecting for Mechanical Operability[m], Deterioration[b], and Leaks/Spills
Waste Hoist	Underground Operations	Preoperational[c]	WP 04-HO1003 Inspecting for Deterioration[b], Safety Equipment, Communication Systems, and Mechanical Operability[m], Leaks/Spills, in accordance with MSHA requirements
Water Tanks	Facility Operations	Daily	WP 04-AD3008 Inspecting for Deterioration[b], valve lineup, and water levels. Results of this inspection are ~~logged in accordance with WP 04-AD3008.~~recorded on EA04AD3008-12-0 and EA04AD3008-13-0
Push-Pull Attachments	Waste ~~Handling~~Operations	Preoperational[c]	WP 05-WH1401 WP 05-WH1412 Inspecting for Damage, Mechanical Operability[m], and Deterioration[b]
Trailer Jockey	Waste ~~Handling~~Operations	Preoperational[c]	WP 05-WH1405 Inspecting for Leaks/Spills, Mechanical Operability[m] and Deterioration[b]
Closure Bulkheads	Underground Operations	Semi-annually	PM000011 ~~PM000015~~ Integrity and Deterioration[b] ~~of~~ in Accessible Areas
Bolting Robot	Waste ~~Handling~~Operations	Preoperational [c]	WP 05-WH1203 Mechanical Operability[m]
Yard Transfer Vehicle	Waste ~~Handling~~Operations	~~Preoperational [c]~~Pre-evolution[p]	WP 05-WH1205 Pre-evolution Checks and Operating Instructions, Mechanical Operability[m], Deterioration[b], Path clear of obstacles and Guards in proper place
Payload Transfer Station	Waste ~~Handling~~Operations	~~Preoperational [c]~~Pre-evolution[p]	WP 05-WH1208 Pre-evolution Checks and Operating Instructions, Mechanical Operability[m], Deterioration[b], and Guards in proper place

System/Equipment Name	**Responsible Organization**	**Inspection[a] Frequency**	**Procedure Number and Inspection Criteria[h]**
Monorail Hoist	Waste ~~Handling~~Operations	~~Preoperational [c]~~Pre-evolution[p]	WP 05-WH1202 Pre-evolution Checks and Operating Instructions, Mechanical Operability[m], Deterioration[b], and Leaks/Spills
Bolting Station	Waste ~~Handling~~Operations	Preoperational [c]	WP 05-WH1203 Mechanical Operability[m], Deterioration[b], and Guards in proper place

Table E-1 (Continued)
Inspection Schedule/Procedures Notes

[a] Inspection may be accomplished as part of or in addition to regularly scheduled preventive maintenance inspections for each item or system. Certain structural systems of the WHB~~,~~ and Waste Hoist ~~and Station A~~ are also subject to inspection following severe natural events including earthquakes, tornados, and severe storms. Structural systems include columns, beams, girders, anchor bolts and concrete walls.

[b] Deterioration includes: obvious visible cracks, erosion, salt build-up, damage, corrosion, loose or missing parts, malfunctions, and structural deterioration.

[c] “Preoperational” signifies that inspections are required prior to the first use during a calendar day. For calendar days in which the equipment is not in use, no inspections are required. For an area this includes: area is clean and free of obstructions (for emergency equipment); adequate aisle space; emergency and communications equipment is readily available, properly located and sign-posted, visible, and operational. For equipment, this includes: checking fluid levels, pressures, valve and switch positions, battery charge levels, pressures, general cleanliness, and that all functional components and emergency equipment is present and operational.

[e] These weekly inspections apply to container storage areas when containers of waste are present for a week or more.

[g] Inspections are performed per manufacturer’s maintenance instructions.

[h] Inspections and PM’s are not required for equipment that is out of service. However, if compensatory measures have been established to ensure an equivalent level of protection during the period that the equipment is out of service (e.g., required equipment/supplies from an out-of-service emergency vehicle have been temporarily relocated), appropriate inspections will be scheduled, conducted, and documented in the Operating Record, in accordance with Attachment E, Section E-1.

[i] Head Lamps, Mobile Phones, and Radios are not routinely “inspected.” They are typically used in day-to-day operations. They are used until they fail, at which time they are replaced and repaired.

[j] Fire extinguisher inspections are performed in accordance with NFPA 10.

[k] Surface CH TRU mixed waste handling areas include the ~~Parking Area Unit~~PAU, the WHB unit, and unloading areas.

[l] No log forms are used for daily readings. However, readings that are out of tolerance are reported to the CMR and logged by CMR operator. Inspection includes daily functional checks of portable equipment.

[m] Mechanical Operability means that the equipment has been checked and is operating in accordance with site safety requirements (e.g., proper fluid levels and tire pressure; functioning lights, alarms, sirens, and power/battery units; and belts, cables, nuts/bolts, and gears in good condition), as appropriate.

[n] Required Equipment means that the equipment identified in Table D-2 is available and usable (i.e., not expired/depleted and works as designed).

[o] Mine pager phones in non-essential locations are not routinely “inspected”. Many are used in day-to-day operations. They are used until they fail, at which time they are repaired. Mine pager phones are used routinely by Underground Operations.

[p] “Pre-evolution” signifies that inspections are required prior to equipment use in the waste handling process. A TRUPACT-III shipment evolution is considered to be the process that begins with placing a loaded TRUPACT-III package on the Yard Transfer Vehicle (**YTV**) in the PAU, includes waste storage in the WHB Unit, and ends when the empty TRUPACT-III is removed from the YTV in the PAU. Additionally, a TDOP-Upender evolution is considered to be the process that begins with the empty TDOP placed on the Upender, and ends with storage of the overpacked waste container in the WHB Unit.

[q] In the PAU, the aisle spacing between trailers carrying the CH or RH packages are maintained at a minimum of four feet. In the CH Bay Storage Area of the WHB Unit, a minimum aisle space of 44 inches between loaded facility pallets in maintained. Also, in the CH Bay, a minimum aisle space of 44 inches is maintained between the walls of the CH Bay and a loaded facility pallet.

Table E-1a
RH TRU Mixed Waste Inspection Schedule/Procedures

System/ Equipment Name	Responsible Organization [~~j~~][i]	Inspection-[a] Frequency	Procedure Number (Latest Revision)[l]	Inspection Criteria		
				Deterioration[b]	Leaks/ spills	Other
Cask Transfer Car(s)	Waste Operations	Pre-evolution-[c,d,e]	WP 05-WH1701 ~~PM041187 (Semi-Annual)~~	Yes	NA	Pre-evolution Checks and Operating Instructions. ~~Mechanical Inspection for Wear and Lubrication~~
RH Bay Overhead Bridge Crane	Waste Operations	Preoperational-[c,d,e,i]	WP 05-WH1741 ~~PM041232 (Quarterly)~~ ~~PM041117 (Annual)~~	Yes	Yes	Pre-operational Checks and Operating Instructions. ~~Mechanical Inspection for Wear and Lubrication~~
Facility Cask	Waste Operations	Pre-evolution-[c,d,e,f]	WP05-WH1713 ~~PM041201 (Annual)~~ ~~PM041203 (Annual)~~	Yes	~~NA~~Yes	Pre-evolution Checks and Operating Instructions. ~~Mechanical Inspection for Wear and Lubrication.~~ ~~Electrical PM.~~
RH Bay Cask Lifting Yoke	Waste Operations	Preoperational-[c,d,e,i]	WP 05-WH1741 ~~PM041169 (Annual)~~	Yes	NA	Pre-operational Checks and Operating Instructions. ~~Mechanical Inspection for Wear and Lubrication~~
Facility Cask Transfer Car	Waste Operations	Pre-evolution-[c,d,e,f]	WP 05-WH1704 PM041186 (Quarterly) PM041195 (Annual)	Yes	Yes	Pre-evolution Checks and Operating Instructions. ~~Mechanical Inspection for Wear and Lubrication~~ ~~Electrical Inspection~~
Facility Cask Rotating Device	Waste Operations	Pre-evolution-[c,d,e,f]	WP05-WH1713 ~~PM041175 (Annual)~~ ~~PM041176 (Annual)~~	Yes	Yes	Pre-evolution Checks and Operating Instructions. ~~Mechanical Inspection for Wear and Lubrication~~ ~~Electrical Inspection~~
Facility Grapple	Waste Operations	Pre-evolution-[c,d,e,f]	WP 05-WH1721 ~~PM041172 (Quarterly)~~ ~~PM041177 (Annual)~~	Yes	NA	Pre-evolution Checks and Operating Instructions. ~~Mechanical Inspection for Wear. Non-Destructive Examination~~
6.25-Ton Grapple Hoist	Waste Operations	Pre-evolution-[c,d,e,f]	WP05-WH1721 ~~PM411028 (Annual)~~	Yes	Yes	Pre-evolution Checks and Operating Instructions. ~~Mechanical Inspection for Wear and Lubrication~~

System/ Equipment Name	**Responsible Organization** [~~J~~j]	**Inspection- Frequency**[a]	**Procedure Number (Latest Revision)**[l]	**Inspection Criteria**		
				Deterioration[b]	**Leaks/ spills**	**Other**
Transfer Cell Shuttle Car	Waste Operations	Pre-evolution-[c,d,e,f]	WP-05-WH1705 ~~PM041184 (Semi-Annual)~~ ~~PM041222 (Annual)~~	Yes	Yes	Pre-evolution ~~Pre-operational~~ Checks and Operating Instructions. ~~Mechanical Inspection for Wear and Lubrication.~~ ~~Electrical Inspection.~~
Hot Cell Overhead Powered Manipulator	Waste Operations	Preoperational-[c,d,e,i]	WP-05-WH1743 ~~PM041215 (Annual)~~ ~~PM041216 (Annual)~~ ~~IC411037 (Annual)~~	Yes	Yes	Pre-operational Checks and Operating Instructions. ~~Mechanical Inspection for Wear and Lubrication.~~ ~~Electrical Inspection.~~ ~~Load Cell Calibration~~
Hot Cell Bridge Crane	Waste Operations	Preoperational-[c,d,e,i]	WP-05-WH1742 ~~PM041217 (Annual)~~ ~~PM041209 (Annual)~~ ~~IC411038 (Annual)~~	Yes	Yes	Pre-operational Checks and Operating Instructions. ~~Mechanical Inspection for Wear and Lubrication.~~ ~~Electrical Inspection.~~ ~~Load Cell Calibration.~~
Closed Circuit Television Camera	Waste Operations	Preoperational-[c,i]	WP-05-WH1757	NA	NA	Operability
~~Radiation Monitoring Equipment~~	~~Radiation Control~~	~~Preoperational~~ ~~[c,d,e]~~	~~WP12-HP1245~~ ~~IC240010~~ ~~WP12-HP1307~~ ~~IC534000~~ ~~WP12-HP1314 (Annual)~~	~~Yes~~	~~NA~~	~~Operability Checks, Functional Checks, Instrument calibrations, Flow Calibration, Efficiency Checks.~~
Cask Unloading Room Crane	Waste Operations	Preoperational-[c,d,e,i]	WP-05-WH1719 ~~PM041190 (Quarterly)~~ ~~PM041191 (Annual)~~ ~~PM041192 (Annual)~~ ~~IC411035 (Annual)~~	Yes	Yes	Pre-operational Checks and Operating Instructions. ~~Mechanical Inspection for Wear and Lubrication.~~ ~~Electrical Inspection.~~ ~~Load Cell Calibration.~~

System/ Equipment Name	**Responsible Organization [~~J~~j]**	**Inspection~~-~~[a] Frequency**	**Procedure Number (Latest Revision)[l]**	**Inspection Criteria**		
				Deterioration[b]	**Leaks/ spills**	**Other**
Horizontal Emplacement Machine~~and Retrieval Equipment~~ or functionally equivalent equipment	Waste Operations	Pre-evolution~~-~~[c,d,e,f]	WP 05-WH1733* ~~WP05-WH1700~~ ~~PM052010 (Semi-Annual)~~[k] ~~PM052011 (Annual)~~ ~~PM052013~~ ~~PM052012~~ ~~PM052014 (Annual)~~	Yes	Yes	Assembly and Operating Instructions. ~~Electrical Inspection. Position Transducer Calibration. Tilt Sensor Calibration.~~ * Procedure WP 05-WH1733 is currently not active. The procedure number has been designated for the Horizontal Emplacement Machine when activities are initiated to support resumption of RH waste emplacement.
41-Ton Forklift	Waste Operations	Preoperational~~-~~[c,d,e,i]	WP 05-WH1602 ~~PM074061~~ ~~PM052003 (Hours of Use)~~ ~~PM074027 (Quarterly)~~ ~~PM074029 & PM074051 (Annual)~~	Yes	Yes	Pre-Operational Checks~~.~~ and on-board automatic fire suppression system ~~PM performed every 100 hours of operation, every 500 hours of operation or every 5 Years.~~ ~~Quarterly Engine Emission Test.~~ ~~Annual Electrical Inspection.~~ ~~Annual NDE.~~
Surface RH TRU Mixed Waste Handling Area	Waste Operations	Preoperational~~-~~[c,d,e,f,g,h,i]	WP--05 WH1744	Yes	Yes	Inspecting for Deterioration[b], Leaks/Spills, Required Aisle Space[m], Required Permit Part 2, Section 2.6.4 warning signs, ~~Posted Warning,~~ Communication~~s~~, Systems, Container Conditions, and Floor Coating Integrity.

Table E-1a (Continued)
RH TRU Mixed Waste Inspection Schedule/Procedures Notes

[a] Inspection may be accomplished as part of or in addition to regularly scheduled preventive maintenance inspections for each item or system. Certain structural systems of the WHB are also subject to inspection following severe natural events including earthquakes, tornados, and severe storms. Structural systems include columns, beams, girders, anchor bolts, and concrete walls.

[b] Deterioration includes: visible cracks, erosion, salt build-up, damage, corrosion, loose or missing parts, malfunctions, and structural deterioration.

[c] “Pre-evolution” signifies that inspections are required prior to equipment use in the waste handling process. (An evolution is considered to be from the receipt of a cask into the RH Bay through canister emplacement in the underground.) For an area, preoperational inspection includes: area is clean and free of obstructions (for emergency equipment); adequate aisle space; emergency and communications equipment is readily available, properly located and sign-posted, visible, and operational. For equipment, this includes: checking fluid levels, pressures, valve and switch positions, battery charge levels, pressures, general cleanliness, and that functional components and emergency equipment are present and operational. When the equipment is not in use, no inspections are required.

[d] When equipment needs to be inspected while handling waste (i.e., during waste unloading or transfer operations), general cleanliness and functional components will be inspected to detect any problem that may harm human health or the environment. The inspection will verify that emergency equipment is present.

[e] Inspection of RH TRU mixed waste equipment and areas in the RH Complex applies only after RH TRU mixed waste receipt begins.

[f] The inspection/maintenance activities associated with these pieces of equipment are performed when the RH Complex is empty of RH TRU mixed waste. If contamination is present, a radiation work permit may be needed.

[g] For the Hot Cell and Transfer Cell, if RH TRU mixed waste is present, camera inspections will be performed in lieu of physical inspection.

[h] The integrity of the floor coating will be inspected weekly if RH TRU mixed waste is present.

[i] “Preoperational” signifies that inspections are required prior to the first use in a calendar day. For an area, preoperational inspection includes: area is clean and free of obstructions (for emergency equipment); adequate aisle space; emergency and communications equipment is readily available, properly located and sign-posted, visible, and operational. For equipment, this includes: checking fluid levels, pressures, valve and switch positions, battery charge levels, pressures, general cleanliness, and that functional components and emergency equipment are present and operational. When the equipment is not in use, no inspections are required.

[~~J~~j] Responsible organizations refers to the organization that owns the equipment. Preventive Maintenance (PM) procedures are conducted by either mine maintenance or surface operations maintenance personnel and Instrument Calibration (IC) procedures are conducted by instrument and calibration maintenance personnel.

[k] Inspection will be performed after 250 evolutions (actual and training emplacements), if such usage occurs prior to the semi-annual inspection.

[l] Inspections ~~and PM’s~~ are not required for equipment that is out of service.

[m] In the RH Bay of the WHB Unit, a minimum aisle space of 44 inches between loaded casks in maintained. For other locations within the RH Complex, sufficient aisle space is maintained to assure that emergency equipment can be assessed or moved to the necessary locations.

~~Table E-2~~
~~Monitoring Schedule~~

~~System/Equipment Name~~	~~Responsible Organization~~	~~Monitoring Frequency~~	~~Purpose~~
~~Geomechanical~~ [b]	~~Geotechnical Engineering~~	~~Monthly~~	~~To evaluate the geotechnical performance of the underground facility and to detect ground conditions that could affect operational safety~~
~~Central Monitoring System~~	~~Facility Operations~~	~~System Dependent~~	~~Monitor and provide status for the following facility parameters:~~ ~~Electrical Power Status~~ [d] ~~Fire Alarm System~~ [e] ~~Ventilation System Status~~ [f] ~~Meteorological Data System~~ [g] ~~Facility Systems (compressors~~ [g]~~, pumps~~ [h]~~, water tank levels~~ [i]~~, waste hoists~~ [j]~~)~~

[b] ~~Equipment is listed as Underground-Geomechanical Instrumentation System (GIS) in Table E-1.~~

[d] ~~Equipment listed as Backup Power Supply Diesel Generator in Table E-1.~~

[e] ~~Equipment listed as Fire Detection and Alarm System in Table E-1.~~

[f] ~~Equipment listed as Ventilation Exhaust in Table E-1.~~

[g] ~~Not RCRA equipment.~~

[h] ~~Equipment listed as Fire Pumps in Table E-1.~~

[i] ~~Equipment listed as Water Tank Level in Table E-1.~~

[j] ~~Equipment listed as Waste Hoist in Table E-1.~~

ATTACHMENT F

FACILITY PERSONNEL PERMIT TRAINING PROGRAM

ATTACHMENT F

FACILITY PERSONNEL PERMIT TRAINING PROGRAM

TABLE OF CONTENTS

ATTACHMENT F

FACILITY PERSONNEL PERMIT TRAINING PROGRAM

F-0 Introduction

This attachment describes the *Facility Personnel Permit Training Program* for the Waste Isolation Pilot Plant (**WIPP**) facility in accordance with the requirements of the Resource Conservation and Recovery Act (**RCRA**) and the New Mexico Hazardous Waste Act as described in 20.4.1.500 New Mexico Administrative Code (**NMAC**) (incorporating Title 40 of the Code of Federal Regulations (**CFR**) §264.16), and 20.4.1.900 NMAC (incorporating 40 CFR §270.14(b)(12)).

The primary objective of the *Facility Personnel Permit Training Program* is to prepare facility personnel to operate and maintain the WIPP facility in a safe and environmentally sound manner in compliance with 20.4.1.500 NMAC (incorporating 40 CFR §264.16). To achieve this objective, the program provides WIPP facility employees with training relevant to their positions.

Waste Isolation Pilot Plant~~WIPP~~ facility employees, including those not directly involved in transuranic (**TRU**) mixed waste handling activities or emergency response, receives an introduction to the RCRA regulations and emergency preparedness in their General Employee Training (**GET**) class. General Employee Training emphasizes that WIPP facility personnel and site visitors are required to comply with directions from emergency personnel and alarm system notifications and to follow instructions concerning emergency equipment, shutdown procedures, signage, and emergency evacuation routes and exits. In this way employees at the WIPP facility are given, at a minimum, a basic understanding of the regulatory requirements and emergency procedures. This ensures that facility employees know how to respond effectively to emergencies through familiarization with emergency procedures, emergency equipment, and emergency systems. Facility ~~Employees~~ employees in TRU mixed waste management or emergency response positions receive additional classroom and on-the-job training designed specifically to teach them how to perform their duties safely and in conformance with regulatory requirements of 20.4.1.500 NMAC (incorporating 40 CFR Part 264). ~~TRU~~ Transuranic mixed waste management personnel receive the required training before being allowed to work unsupervised, and emergency response personnel receive appropriate training before being called upon to respond to actual emergencies.

The training requirements of the *Facility Personnel Permit Training Program* are implemented via the WIPP Training Program and apply to appropriate facility personnel of the U.S. Department of Energy (**DOE**) and contractors, subcontractors, and bargaining-unit members who;

- Regularly work at the facility that may come in contact with and/or manage TRU mixed waste, or
- Oversee the operations of the facility that may come in contact with and/or manage TRU mixed waste, or
- Supervise individuals who may come in contact with and/or manage TRU mixed waste, or
- Provide emergency response capabilities.

This *Facility Personnel Permit Training Program* describes the introductory and continuing training provided to personnel at the WIPP facility, with emphasis on those facility personnel and their supervisors whose jobs are such that their actions or failure to act could result in a spill or release, or the immediate threat of a spill or release of TRU mixed waste.

This *Facility Personnel Permit Training Program* does not apply to facility employees who manage site-generated hazardous waste, low-level waste, universal waste, or other forms of hazardous waste that are not categorized as TRU mixed waste.

F-1 Outline of the Facility Personnel Permit Training Program

Employee training for the purpose of TRU mixed waste management and emergency response at the WIPP facility is the overall responsibility of the Management and Operating Contractor ~~(**MOC**)~~ Project Manager, with responsibility for implementation delegated to Technical Training. Technical Training is managed by the Technical Training Manager. The Technical Training Manager (or designee) has the responsibility for directing the *Facility Personnel Permit Training Program*. The list of job titles in Table F-1 ~~presents~~ identifies the jobs at the WIPP facility that include ~~the personnel with identified~~ responsibilities for TRU mixed waste management and emergency response.

F-1a Facility Personnel Permit Training Program Design

In developing the *WIPP Training Program*, Technical Training has used a modified version of the Systematic Approach to Training (**SAT**) which has five distinct phases to develop training programs. These phases are:

- Analysis
- Design
- Development
- Implementation
- Evaluation

Technical Training utilizes guidance provided within the DOE Handbooks, “Training Program Handbook: A Systematic Approach to Training (DOE-HDBK-1078-94),” and “Alternative Systematic Approaches to Training (DOE-HDBK-1074-95)” to direct these five phases.

Technical Training ensures that Permit-required training is conducted by qualified instructors as indicated in the *WIPP Training Program*.

Cognizant line managers provide significant input on training requirements for ~~the~~ WIPP facility personnel to qualified instructors who develop the following, as required:

- Classroom Instruction
- Required reading, structured self-study, eLearning, computer-~~ ~~based training
- On-the-Job Training

Upon completion of the specific classroom, ~~computer based~~computer-based training, eLearning or structured self-study technical training courses, trainees must successfully complete written (includes in person examinations, computer, and web based training examinations) or oral examinations to demonstrate competency.

Technical training documentation and records are maintained by Technical Training located at the WIPP facility. Documents and records required by 20.4.1.500 NMAC (incorporating 40 CFR §264.16(d)(1), (2), (3), and (4) are maintained in WIPP facility files and include the following:

- Job titles for positions related to TRU mixed waste management and emergency response and names of the employee filling those positions
- Written job descriptions for the applicable positions
- Written description of the type and amount of introductory and continuing training given for each applicable position
- Records documentation that the training or job experience required has been given to or completed by facility personnel include as appropriate:
    - Course Attendance
    - Completed Qualification Cards
    - Off-Site Training Documentation
    - Training or job experience given and completed for each position

Documentation is maintained which ~~included~~ includes records of training qualifications, and course attendance. The documentation is used to identify course refresher and requalification dates. Training records on current personnel are kept in the Technical Training files until facility closure. Technical training records on former employees are kept by Technical Training for at least three years from the date of employment termination from the WIPP facility. Training documentation for emergency response training received by personnel called out in the *RCRA Contingency Plan* (Permit Attachment D) is also maintained by Technical Training.

F-1b Job Title/Job Description

Facility personnel who are involved in TRU mixed waste management and emergency response activities receive the same core RCRA training. A list of TRU mixed waste management and emergency response job titles and position descriptions is provided in Table F-1. An up-to-date list of personnel assigned to these positions is maintained in WIPP facility files by the Permittees in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.16(d)(1)). The core TRU mixed waste management and emergency response training courses are indicated in Table F-2. Any changes to the Facility Personnel Permit Training Program specified training course materials (contained in WIPP facility files) that affect the Table F-2 training course content will be evaluated to determine if a permit modification is required, as specified in 20.4.1.900 NMAC (incorporating 40 CFR §270.42 The job titles listed in Tables F-1 include:

- Emergency Coordinator
- TRU Mixed Waste Worker
- TRU Mixed Waste Worker Supervisor
- Inspector
- RCRA Training Director
- Emergency Responder

F-1b(1) Training Content

To ensure that facility personnel are knowledgeable in responding effectively to emergency situations, every employee, regardless of whether they hold a position in TRU mixed waste management or emergency response, receives GET and the annual GET refresher training on topics relevant to the management of TRU mixed waste and emergency response that include:

- Emergency Preparedness and Response
- RCRA (including the Permit and the RCRA Contingency Plan)
- Fire Protection
- Safety Signage

Training course updates are identified by periodically reviewing the Table F-2 Permit-required training courses to ensure the content remains consistent with applicable Federal and State regulations. This review will be performed in accordance with the *WIPP Training Program* and the review will be documented in the WIPP facility files.

To facilitate identification of changes to Table F-2 Permit-required training courses, changes to training course materials, which will be maintained in the WIPP facility files, will have revision numbers and a change history summary. This training course information will be available for NMED inspection upon request.

F-1b(2) Training Frequency

TRU mixed waste management and emergency response courses are offered at a frequency that ensures new hires or transfers can receive ~~relevant~~ Permit-specified training within six months of assuming their new position ~~(although some emergency response training may require longer time periods to complete certifications)~~. Annual refresher training is required for each Permit course. Employees do not work unsupervised in TRU mixed waste management positions until they have completed the Permit-required initial training. In cases where an employee’s annual refresher training has lapsed, that employee cannot work unsupervised until the initial training has been repeated. The cognizant manager notifies the Human Resources Department who notifies the training staff when any employee is transferred into or out of a position associated with TRU mixed waste management or emergency response.

F-1b(3) Training Techniques

A variety of instructional techniques are used at the WIPP facility depending on the subject matter and the techniques that best suit the learning objectives. Many courses may include a combination of classroom, on-the-job training, computer-based training, eLearning, self-paced study, laboratory work, and/or comprehensive examinations. Most equipment operation courses include hands-on practical instruction.

Written examinations (includes in person examinations, computer, and web based training examinations) are used as a technique to test and document the knowledge level of individuals participating in classroom training courses. The length and content of each exam varies according to its objective. If individuals fail a written examination, in accordance with WIPP training procedures, they are disqualified from working unsupervised for the role or task associated with the failed training until the training course examination has been successfully completed.

On-the-job training at the WIPP facility follows a prescribed set of standards specific to the job to be performed. Typically, to become qualified to operate a piece of equipment or system, employees must be able to demonstrate the location and purpose of specified controls and gauges, describe proper startup and shutdown procedures, describe specific safety features and limitations of the equipment, and, in some cases, perform maintenance functions. They must also demonstrate the ability to operate the equipment or system. On-the-job training may also be function specific, such as performing a specific administrative function that is regulated. The terms “on-the-job-training,” “on-the-job-evaluation,” and “job performance measures” are considered equivalent with respect to training courses or qualification cards in accordance with DOE-HDBK-1074-95.

In addition to on-the-job training, some positions require the trainee to attend an oral board. The oral board is given upon completion of on-the-job training and prior to operating any equipment unsupervised. In the oral board, the trainee is quizzed on knowledge learned in on-the-job training. The purpose of the oral board is to determine if the trainee fully understands and can apply the knowledge learned in the training process.

Individuals who provide evidence of equivalency for specific requirements or prerequisites identified in the Table F-2 Permit-required training courses may be granted an exception from further training to those requirements in accordance with the *WIPP Training Program*. Requests for exceptions/equivalences are made and evaluated in accordance with the *WIPP Training Program*. Training exceptions/equivalences must be approved by the RCRA Training Director with concurrence of the Environmental Compliance Manager or his/her designee. Each exception/equivalency request is evaluated per specific criteria, such as 1) completion of previous training (transcripts, training completion records), 2) previous experience (résumé~~resume~~) that demonstrates the application of knowledge and/or skills presented by course objectives, and 3) satisfactory completion of an examination having equivalent course objectives. Each exception/equivalency will be granted in writing and documented in the individual’s training record.

F-1c Technical Training Manager (RCRA Training Director)

The Technical Training Manager (or designee) directs the *Facility Personnel Permit Training Program,* implemented via the *WIPP Training Program*, and is responsible for establishing technical training requirements in cooperation with the line managers. Specifically, this includes analysis, design, development, implementation, and evaluation of technical training. The Technical Training Manager (or designee) is trained in hazardous waste management procedures. The Technical Training Manager (or designee) is also required to be knowledgeable of the applicable regulations, orders, guidelines, and the specific training process employed at the WIPP facility.

The name and qualifications of the current Technical Training Manager are documented in WIPP facility files.

F-1d Relevance of Training to Job Position

The *WIPP Training Program* provides employees and their supervisors with training relevant to their positions. The SAT process mentioned in Section F-1a is a systematic method for determining the proper training for each TRU mixed waste management position. It compels managers and training staff to look critically at each position and determine the necessary training program for each employee to perform their work in a manner that protects human health and the environment and complies with the Permit.

Several training topics are considered relevant for all WIPP facility personnel. The basic philosophy at the WIPP facility is that, as a RCRA-regulated facility, facility personnel must understand the basic regulatory requirements under which the WIPP facility must operate as well as emergency actions required of facility personnel. Therefore, ~~all~~ WIPP facility personnel receive an introduction to the RCRA during their GET.

Beyond these universal topics, training is designed and implemented relevant to the specific job functions being performed. For example, employees who operate key pieces of equipment necessary to manage contact-handled (**CH**) or remote-handled (**RH**) TRU mixed waste (e.g., forklifts, hoists, bridge cranes, cask transfer cars) must be trained to perform their duties in a way that ensures the WIPP facility is operated in compliance with the Permit. These employees receive on-the-job training and demonstrate the ability to operate the equipment, as appropriate, and must at a minimum be able to respond effectively to emergencies that might arise while performing their duties. Emergency response personnel receive training, commensurate with their duties, that ensures their familiarity with emergency procedures, emergency equipment, and emergency systems including, but not limited to:

- Procedures for using and inspecting facility emergency equipment:
- Communications and alarm systems; and
- Response to fires or explosions.

As there are no automatic waste feed systems at the WIPP facility, training on parameters for waste feed cut-off systems is not required. Similarly, as there is no potential for groundwater contamination incidents at the WIPP facility, training for responding to such incidents is not required.

F-2 Implementation of Facility Personnel Permit Training Program

The *WIPP Training Program* has been formulated to implement the requirements of this *Facility Personnel Permit Training Program*, thereby ensuring TRU mixed waste management and emergency response personnel employed at the facility receive the training necessary to comply with the requirements of 20.4.1.500 NMAC (incorporating 40 CFR Part 264.16).

Newly hired employees, whose job positions are listed in Table F-2, receive the indicated training within six months of their date of hire or their transfer to a new position pursuant to 20.4.1.500 NMAC (incorporating 40 CFR §264.16(b). Personnel do not work unsupervised in TRU mixed waste management or emergency response positions until they successfully complete the Permit-indicated training requirements. ~~(Note that some emergency responder certifications may take more than six months to complete.)~~ TRU mixed waste management and emergency response personnel attend annual refresher courses that review the initial training received and document knowledge transfer. Per the *WIPP Training Program*, annual Permit refresher training is to be completed within 30 calendar days of an employee's training anniversary date. If an employee's annual refresher training has lapsed, they do not work unsupervised in TRU mixed waste management or emergency response positions until they have successfully repeated the Permit-required initial training.

Records relating to the *Facility Personnel Permit Training Program* for TRU mixed waste management and emergency response personnel are maintained by WIPP Technical Training as personally identifiable information. These records are located at the WIPP facility and include a roster of employees in hazardous waste management positions; a list of courses required for each position; course descriptions; documentation when each employee has received and completed appropriate training. Training records of current personnel are kept by Technical Training until closure of the WIPP facility. Records of former employees are kept by Technical Training for at least three years from the date the employee last worked at the facility.

F-3 References

Nuclear Waste Partnership LLC, “WIPP Training Program,” WP 14-TR.01~~, Rev. 19-FRI, 2017~~

Nuclear Waste Partnership LLC, “WIPP Fire Department Training Plan,” WP 12-FP.04~~, Rev. 2, 2016~~

U.S. Department of Energy, “Training Program Handbook: A Systematic Approach to Training (DOE-HDBK-1078- 94)”

U.S. Department of Energy, “Alternative Systematic Approaches to Training (DOE-HDBK-1074 95)”

TABLES

TABLE F-1
TRU MIXED WASTE MANAGEMENT AND EMERGENCY RESPONSE JOB TITLES AND DESCRIPTIONS

JOB TITLE	POSITION DESCRIPTION
TRU Mixed Waste Worker	Responsible for or involved in the surface processing, transport, and underground emplacement of ~~contact-handled (~~CH~~)~~ and ~~remote-handled (~~RH~~)~~ ~~transuranic (~~TRU~~)~~ mixed waste. May come into contact with TRU mixed waste while carrying out job duties, actions or failure to act could result in a spill or release of TRU mixed waste at the WIPP facility, and job is important for operating the facility safely and in compliance with the hazardous waste regulations. Depending upon the TRU Mixed Waste Worker's specific job position, this may involve one or more of the following: • Operating waste handling equipment and support systems to unload, handle, and emplace TRU mixed waste into the repository • Performing spot decontamination of shipping casks, waste containers, and waste handling equipment • Performing waste container overpacking operations • Conducting routine inspections of incoming shipping containers for contamination and damage • Conducting routine contamination surveys during waste handling activities • Operating the Waste Shaft Hoist • Loading and unloading of the Waste Shaft Conveyance above and below ground • Managing and dispositioning of waste resulting from releases of TRU mixed waste or TRU mixed waste constituents • Cleaning and restoring emergency response equipment after a release of TRU mixed waste or TRU mixed waste constituents and prior to resumption of normal operations
TRU Mixed Waste Worker Supervisor	Supervisors of TRU Mixed Waste Workers are directly responsible for day-to-day operations related to TRU mixed waste. Depending upon the TRU Mixed Waste Worker Supervisor's specific job position, job duties may involve one or more of the following: • Overseeing TRU mixed waste management activities performed by TRU Mixed Waste Workers • Coordinating and directing the daily operation and maintenance of the Waste Shaft Hoist and Waste Shaft
Emergency Responder	Emergency responders provide expertise and support to the Incident Command. Depending upon the Emergency Responder's specific job position, job duties may involve one or more of the following: • Responding to fires, explosions, or emergencies involving releases of TRU mixed waste or TRU mixed waste constituents • Performing technical rescue operations • Performing emergency medical response • Operating emergency vehicles and equipment • Establishing conditions at the incident scene • Managing incident operations, personnel, and resources • Ensuring that fires, explosions, and releases of TRU mixed waste do not occur, recur, or spread to other hazardous waste at the facility by stopping processes and operations, collecting and containing released TRU mixed waste, and removing or isolating containers, as applicable

JOB TITLE	**POSITION DESCRIPTION**
	• Performing decontamination of contaminated personnel and providing oversight to emergency medical response personnel, if injured person is contaminated • Conducting contamination surveys, establishing hot lines/cold zones, and performing decontamination following a release of TRU mixed waste or TRU mixed waste constituents • Overpacking or plugging/patching of waste containers associated with release of TRU mixed waste or TRU mixed waste constituents • Performing containerization of released TRU mixed waste or TRU mixed waste constituents • Terminating field emergency response
Emergency Coordinator	In the event of a fire, explosion, release of TRU mixed waste or TRU mixed waste constituents that could threaten human health or the environment, the Emergency Coordinator is responsible for carrying out the implementation of the *RCRA Contingency Plan*. Emergency Coordinators ensure emergency responders have current and specific information to properly address the incident and minimize hazards to human health and the environment. Emergency Coordinators implement measures and procedures to ensure the safety of personnel, such as ensuring that alarms have been activated, personnel have been accounted for, and evacuation of personnel has occurred, if necessary. Upon implementation of the *RCRA Contingency Plan*, depending upon the Emergency Coordinator's specific job position, the job duties may involve one or more of the following: • Providing notification to emergency response personnel • Ensuring that alarms have been activated, personnel have been accounted for, any injuries have been attended to, and evacuation of personnel has occurred, if necessary • Restricting personnel not needed for response activities from the scene of the incident and curtailing nonessential activities in the area • Identifying released material and assessing the extent of the emergency • Assessing any hazards to human health or the environment associated with a fire, explosion, or release of TRU mixed waste or TRU mixed waste constituents • Notifying appropriate State and local agencies with designated response roles if their help is needed • Ensuring that fires, explosions, and releases do not occur, recur, or spread to other hazardous waste at the facility by taking measures such as stopping processes and operations, collecting and containing released waste, and removing or isolating containers • Documenting the implementation of the *RCRA Contingency Plan* • Ensuring immediate notification to the New Mexico Environment Department is provided for incidents requiring implementation of the *RCRA Contingency Plan* • Making post-assessment notifications if it has been determined that the incident could threaten human health or the environment outside the facility • Providing for treating, storing, or disposing of recovered waste, contaminated soil or surface water, or any other material that results from a release, fire, or explosion at the facility • Ensuring that no waste that may be incompatible with the released material is treated, stored, or disposed of until cleanup procedures are completed • Ensuring that emergency equipment listed in the *RCRA Contingency Plan* is cleaned and fit for its intended use before operations are resumed

JOB TITLE	POSITION DESCRIPTION
Inspector	Responsible for routine inspection and maintenance (including repairing and replacement, as appropriate) of equipment instrumental in preventing, detecting, or responding to environmental or human health hazards, such as monitoring equipment, safety and emergency equipment, and operating or structural equipment. Inspections are performed at the facility to detect malfunctions, deterioration, operator errors, and discharges that may cause or lead to releases of TRU mixed waste or TRU mixed waste constituents to the environment or that could be a threat to human health. Depending on the Inspector's specific job position, job duties may involve one or more of the following: • Performing functional and operational checks of waste handling equipment and support systems as well as conducting waste container storage inspections • Conducting routine inspections of emergency response equipment and vehicles, on site • Performing routine inspections of the hoisting equipment for the Air Intake Shaft, Salt Handling Shaft, and Waste Shaft • Conducting routine inspections and testing of facility fire suppression and detection systems • Inspecting and testing of communication systems, site notification system, the public address system, and alarm systems for proper function • Performing routine inspections of the backup power supply diesel generators • Performing routine inspections of the eye wash and shower equipment • Performing routine inspections of the underground geomechanical instrumentation system • Performing routine inspections of the central uninterruptible power supply • Performing routine inspections of the fire water storage tank • Performing routine inspections of the ventilation exhaust fans
RCRA Training Director	Responsible for directing the hazardous waste management training at the WIPP facility. To meet the 20.4.1.500 NMAC (incorporating 40 CFR §264.16(a)(2)) requirements, the RCRA Training Director must be a person trained in hazardous waste management procedures.

Table F-2
PERMIT-REQUIRED TRAINING COURSES

Course	TRU Mixed Waste Worker	TRU Mixed Waste Worker Supervisor	Inspector	Emergency Responder	Emergency Coordinator	RCRA Training Director
General Employee Training – WIPP facility employees must be escorted at the WIPP facility until this course has been completed. Course content contains information on RCRA, the Permit, the WIPP *RCRA Contingency Plan*, emergency preparedness, emergency response and evacuation procedures, fire protection, and safety signage. There is an annual refresher required for this course.	X	X	X	X	X	X
RCRA Regulations/Hazardous Waste Facility Permit Overview – This course includes an overview of 40 CFR Parts 260-282; *New Mexico Hazardous Waste Act* (Title 20 of the NMAC, Part 4.1); protocol for facility and waste handling equipment inspections; overview of communication systems; overview of security systems; overview of *RCRA Contingency Plan*; overview of WIPP emergency equipment use, inspection, and repair; overview of training requirements; overview of Permit recordkeeping requirements; overview of NMED facility inspections; and consequences of Permit noncompliance. This course also provides an overview of the screening process (for procedures, facility configuration changes, training program changes, etc.) to ensure compliance with the Permit, along with an overview of the Permit modification process. There is an annual refresher required for this course.	X	X	X	X	X	X

Course	TRU Mixed Waste Worker	TRU Mixed Waste Worker Supervisor	Inspector	Emergency Responder	Emergency Coordinator	RCRA Training Director
Hazardous Waste Worker – This course addresses regulatory requirements for personnel who manage hazardous waste, including an in-depth review of the Hazard Communication Standard, principles of toxicology, hazard identification, and an overview of personal protective equipment for work activities associated with TRU mixed waste management. It also prepares emergency response personnel for hazardous waste handling, containment, and decontamination. There is an annual refresher required for this course.	X	X		X		X
Hazardous Waste Responder – Employees must complete Hazardous Waste Worker training before taking this course. Upon successful completion of the course and its prerequisites, a trainee will be able to respond to emergencies involving TRU mixed waste. Course curriculum includes an overview of the regulatory requirements, incident evaluation, overview of response operations, maintaining safety during an emergency response, and an overview of the Incident Command System at the WIPP facility. There is an annual refresher required for this course.				X		
Hazardous Waste Worker Supervisor – This course addresses manager and/or supervisor responsibilities for TRU mixed waste management. It addresses individual and corporate liability under applicable hazardous waste regulations. Course discusses impacts that decisions made during emergency situations may have, some with serious legal and safety consequences directly impacting the entities involved. There is an annual refresher required for this course.		X				

Course	TRU Mixed Waste Worker	TRU Mixed Waste Worker Supervisor	Inspector	Emergency Responder	Emergency Coordinator	RCRA Training Director
Permit Inspections/Recordkeeping – These technical work documents are under the purview of the responsible organization identified in Table E-1 of Permit Attachment E, *Inspection Schedule, Process and Forms*. This course addresses protocols for conducting Permit-specified inspections to detect malfunctions, deterioration, operator errors, and discharges; completion of inspection records; Permit-specified inspection frequencies; and corrective actions, including notifications and establishment of compensatory measures. This course also addresses review of the completed inspection record for completeness and accuracy; and the Permit-specified recordkeeping requirements. There is an annual refresher required for this course.			X			
RCRA Contingency Plan – This course provides an in-depth review of the WIPP *RCRA Contingency Plan* addressing when the Plan is to be implemented, appropriate emergency response actions, required notifications, evacuation plan details, and post-emergency RCRA-required activities. This course also addresses where copies of the Plan are required to be located and when the Plan must be amended. There is an annual refresher required for this course.					X	

ATTACHMENT G

CLOSURE PLAN

ATTACHMENT G

CLOSURE PLAN

TABLE OF CONTENTS

LIST OF TABLES

~~LIST OF FIGURES~~

ATTACHMENT G

CLOSURE PLAN

Introduction

This Permit Attachment contains the Closure Plan that describes the activities necessary to close the Waste Isolation Pilot Plant (**WIPP**) individual units and facility. Since the current plans for operations extend over several decades, the Permittees will periodically reapply for an operating permit in accordance with 20.4.1.900 New Mexico Administrative Code (**NMAC**) (incorporating Title 40 of the Code of Federal Regulations (**CFR**) §270.10(h)). Consequently, this Closure Plan describes several types of closures. The first type is panel closure, which involves constructing closures for~~in~~ each of the underground hazardous waste disposal units (**HWDUs**) after they are filled. The second type is partial closure, which can be less than the entire facility and, therefore, less than an entire unit as described herein for the Waste Handling Building (**WHB**) Container Storage Unit (**WHB Unit**), the Parking Area Container Storage Unit (**PAU**), or Permit-related surface equipment, structures and contaminated soils. The third type of closure is final facility closure at the end of the Disposal Phase, which will entail "clean" closure of ~~all~~ remaining surface storage units and construction of shaft seal systems for each shaft. Finally, in the event a new permit is not issued prior to expiration of an existing permit, a modification to this Closure Plan will be sought to perform contingency closure. Contingency closure defers the final closure of waste management facilities such as the ~~Waste Handling Building Container Storage Unit (~~WHB Unit~~)~~, the conveyances, the shafts, and the haulage ways because these will be needed to continue operations with non-mixed Transuranic (**TRU**) waste.

The hazardous waste management units (**HWMUs**) addressed in this Closure Plan include the ~~aboveground HWMU in the~~ WHB Unit, the PAU~~parking area HWMU~~, and Panels 1 through 8, Panel 11, and Panel 12, each consisting of seven rooms. In addition, this Closure Plan includes closures for Panels 9 and 10.

This plan was submitted to the New Mexico Environment Department (**NMED**) in accordance with 20.4.1.900 NMAC (incorporating 40 CFR §270.14(b)(13)). Closure at the panel level will include the construction of barriers that will contribute to limiting the emission of hazardous waste constituents from the panel into the mine ventilation air stream below levels that meet environmental performance standards. The Post-Closure Plan (Permit Attachment H) includes the implementation of institutional controls to limit access and groundwater monitoring to assess disposal system performance. Until final closure is complete and has been certified in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.115), a copy of the approved Closure Plan and ~~all~~ approved revisions will be on file at the WIPP facility and will be available to the Secretary of the NMED in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.112(a)(2))~~or the U.S. Environmental Protection Agency (**EPA**) Region VI Administrator~~ upon request.

This Closure Plan uses the terms Disposal Phase, facility closure period, and post-closure care period. The Disposal Phase began with the first waste emplacement in March 1999 and extends until the facility reaches its maximum capacity as defined in Section G-1c. The facility closure period is the 10-year period that begins once the final waste has been emplaced in the underground. The post-closure care period extends for 30-years after completion of facility closure period.

G-1 Closure Plan

This Closure Plan is prepared in accordance with the requirements of 20.4.1.500 NMAC (incorporating 40 CFR Part ~~§~~264, Subparts G, I, and X), Closure and Post-Closure, Use and Management of Containers, and Miscellaneous Units. The WIPP underground HWDUs, shown on Figure M-43~~G-1~~, will be closed under this Closure Plan to meet the performance standards in 20.4.1.500 NMAC (incorporating 40 CFR §264.601). The WIPP surface facilities, including the WHB~~Waste Handling Building Container Storage~~ Unit and the PAU~~Parking Area Container Storage Unit~~, will be closed in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.178). The Permittees may perform partial closure of the WHB Unit, PAU HWMUs, or Permit-related surface equipment, structures and contaminated soils prior to final facility closure and certification. For final facility closure, this plan also includes closure and sealing of the facility shafts in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.601).

Following completion of waste emplacement in each underground HWDU, the HWDU will be closed. The Permittees will notify the NMED of the closure of each underground HWDU as specified in the schedule in Figure M-61~~G-2~~. For the purpose of this Closure Plan, panel closure is defined as the process of rendering underground HWDUs in the repository inactive and closed according to the facility Closure Plan. The Post-Closure Plan (Permit Attachment H) addresses requirements for future monitoring that are deemed necessary for the post-closure period, prior to final facility closure.

For the purposes of this Closure Plan, final facility closure is defined as closure that will occur when ~~all~~ permitted HWDUs are filled or have achieved their maximum capacities as outlined in Permit Part 4, Table 4.1.1, or when the WIPP facility achieves its capacity of 6.2 million cubic feet (ft^3) (175,564 cubic meters (m^3)) of Land Withdrawal Act (**LWA**)TRU waste volume. At final facility closure, the surface container storage areas will be closed~~, and equipment that can be decontaminated and used at other facilities will be cleaned and sent off site~~. Equipment that cannot be decontaminated plus any derived waste resulting from decontamination will be placed in the last open underground HWDU. In addition, shafts and boreholes which lie within the WIPP Site Boundary and penetrate the Salado Formation (**Salado**) will be plugged and sealed, and surface and subsurface facilities and equipment will be decontaminated, if necessary, and removed and dispositioned appropriately or, alternatively, disposed in the last open underground HWDU as derived waste. Final facility closure will be completed to demonstrate compliance with the Closure Performance Standards contained in 20.4.1.500 NMAC (incorporating 40 CFR §264.111, 178, and 601).

In the event the Permittees fail to obtain an extension of the hazardous waste permit in accordance with 20.4.1.900 NMAC (incorporating 40 CFR §270.51) or fail to obtain a new permit in accordance with 20.4.1.900 NMAC (incorporating 40 CFR §270.10(h)), the Permittees will seek a modification to this Closure Plan in accordance with 20.4.1.900 NMAC (incorporating 40 CFR §270.42) to accommodate a contingency closure. Under contingency closure, storage units will undergo clean closure in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.178); waste handling equipment, shafts, and haulage ways will be inspected for hazardous waste residues (using, among other techniques, radiological surveys to indicate potential hazardous waste releases as described in Permit Attachment G3) and decontaminated as necessary; and underground HWDUs that contain radioactive mixed waste will be closed in accordance with the panel closure design described in this Closure Plan. Final facility closure, however, will be redefined and a time extension for final closure will be requested. A copy of this Closure Plan will be maintained by the Permittees at the WIPP facility and at the U.S. Department of Energy (**DOE**) Carlsbad Field Office. The primary contact person at the WIPP facility is:

Manager, Carlsbad Field Office
U.S. Department of Energy
Waste Isolation Pilot Plant
P. O. Box 3090
Carlsbad, New Mexico 88221-3090
(575) 234-7300

G-1a Closure Performance Standard

The closure performance standard specified in 20.4.1.500 NMAC (incorporating 40 CFR §264.111), states that the closure shall be performed in a manner that minimizes the need for further maintenance; that minimizes, controls, or eliminates the escape of hazardous waste; and that conforms to the closure requirements of §264.178 and §264.601. These standards are discussed in the following paragraphs.

G-1a(1) Container Storage Units

Final or partial closure of the permitted container storage units (the WHB~~Waste Handling Building~~ Unit and PAU~~Parking Area Unit~~) will be accomplished by removing ~~all~~ waste and waste residues. Indication of waste contamination will be based, among other techniques, on the use of radiological surveys as described in Permit Attachment G3. Radiological surveys use very sensitive radiation detection equipment to indicate if there has been a potential release of TRU mixed waste, including hazardous waste components, from a container. This allows the Permittees to indicate potential releases that are not detectable from visible evidence such as stains or discoloration. Visual inspection and operating records will also be used to identify areas where decontamination is necessary. Contaminated surfaces will be decontaminated until radioactivity is below DOE-established radiological protection limits[1]. Once surfaces are determined to be free of radioactive waste constituents, they will be sampled for hazardous waste contamination. Hazardous waste decontamination, if needed, will be conducted in accordance with the requirements of the Permit and the standards in 20.4.1.500 NMAC (incorporating 40 CFR Part 264). These surface decontamination activities will ensure the removal of waste residues to levels protective of human health and the environment. ~~The facility is expected to require no decontamination at closure because any waste spilled or released during operations will be contained and removed immediately.~~ Solid waste management units listed in Attachment K, Table K-4 will be subject to closure.

Once the container storage units are ~~decontaminated and~~ certified by the Permittees to be clean, no further maintenance is required. The facilities and equipment in these units will be available~~reused~~ for other purposes~~ as needed~~. If portions of the facilities or equipment in these units, which require decontamination, cannot be decontaminated, these portions will be

---

[1] Title 10 CFR Part 835.

removed, and the resultant wastes will be managed consistent with radiological control procedures pursuant to 10 CFR Part 835.

G-1a(2) Miscellaneous Unit

Post-closure migration of hazardous waste or hazardous waste constituents to ground or surface waters or to the atmosphere, above levels that will harm human health or the environment, will not occur due to facility engineering and the geological isolation of the unit. The engineering aspects of closure are centered on the use of panel closures on each of the underground HWDUs and final facility seals placed in the shafts. The design of the panel closure system is based on the criteria that the closure system for closed underground HWDUs will prevent migration of hazardous waste constituents in the air pathway in concentrations above health-based levels beyond the WIPP land withdrawal boundary during the Disposal Phase~~35 year operational~~ and facility closure period.

Consistent with the definitions in 20.4.1.101 NMAC (incorporating 40 CFR §260.10), the process of panel closure is considered partial closure because it is a process of rendering a part of the repository inactive and closed according to the approved underground HWDU partial closure plan. Panel closure will be complete when the panel closure system is emplaced and operational~~, when that underground HWDU and related equipment and structures have been decontaminated (if necessary),~~ and when the NMED has been notified of the closure.

Shaft seals are designed to provide effective barriers to the inward migration of ground~~-~~water and the outward migration of gas and contaminated brine over two discrete time periods. Several components become effective immediately and are expected to function for 100 years. Other components become effective more slowly~~,~~ but provide permanent isolation of the waste. The final shaft seal design is specified in Permit Attachment G2.

The facility will be finally closed to minimize the need for continued maintenance. Protection of human health and the environment includes, but is not limited to:

- Prevention of any releases that may have adverse effects on human health or the environment due to the migration of waste constituents in the groundwater or in the subsurface environment [20.4.1.500 NMAC, incorporating 40 CFR §264.601(a)].

- Prevention of any releases that may have adverse effects on human health or environment due to migration of waste constituents in surface water, in wetlands, or on the soil surface [20.4.1.500 NMAC, incorporating 40 CFR §264.601(b)].

- Prevention of any release that may have adverse effects on human health or the environment due to migration of waste constituents in the air [20.4.1.500 NMAC, incorporating 40 CFR §264.601(c)].

As part of final facility closure, surface recontouring and reclamation will establish a stable vegetative cover, and further surface maintenance will not be necessary to protect human health and the environment. Prior to cessation of active controls, monuments will be emplaced to serve as long-term site markers to discourage activities that would penetrate the facility or impair the ability of the salt formation to isolate the waste from the surface environment for at least 10,000 years. The Federal government will maintain administrative responsibility for the repository site in perpetuity and will limit future use of the area.

If, during panel or final facility closure activities, unexpected events require modification of this Closure Plan to demonstrate compliance with closure performance standards, a Closure Plan amendment will be submitted in accordance with 20.4.1.900 NMAC (incorporating 40 CFR §270.42).

G-1a(3) Post-Closure Care

The post-closure care period will begin after completion of the first panel closure and will continue for 30 years after final facility closure. The post-closure care period may be shortened or lengthened at the discretion of the NMED~~regulatory agency~~ based on evidence that human health and the environment are being protected or that they are at risk. During the post-closure care period, the WIPP facility shall be maintained in a manner that complies with the environmental performance standards in 20.4.1.500 NMAC (incorporating 40 CFR §264.601). Post-closure activities are described in Permit Attachment H.

G-1b Requirements

The Permit specifies a sequential process for the closure of individual HWMUs at the WIPP facility. Each underground HWDU will undergo panel closure when waste emplacement in that HWDU~~panel~~ is complete. Following waste emplacement in each underground HWDU, construction-side ventilation will be terminated, ~~and~~ waste-disposal-side ventilation will be established in the next underground HWDU to be used, and the underground HWDU containing the waste will be closed. The Permittees will notify the NMED of the closure of each of the underground HWDUs as they are sequentially filled on a HWDU-by-HWDU basis. The HWMUs in the WHB and in the parking area will be closed as part of final facility closure of the WIPP facility.

The Permittees will notify the Secretary of the NMED in writing at least 60 days prior to the date on which closure activities are scheduled to begin.

G-1c Maximum Waste Inventory

The maximum waste inventory (maximum capacity) for the permitted HWDUs is established in Permit Part 4, Table 4.1.1. During the Disposal Phase, and in~~In~~ accordance with the LWA, the WIPP facility will receive no more than 6.2 million ft^3 (175,564 m^3) of LWA TRU waste volume, which may include up to 250,000 ft^3 (7,079 m^3) of remote-handled (**RH**) TRU ~~mixed~~ waste. Excavations are mined as permitted when needed during operations to maintain a reserve of disposal areas. The amount of waste placed in each room is limited by structural and physical considerations of equipment and design. Transuranic mixed waste volumes include waste received from off-site generator locations as well as derived waste from disposal and decontamination operations. For closure planning purposes, a maximum achievable volume of ~~685,100 ft^3 (19,400 m^3) of~~ TRU mixed waste per ~~panel~~ HWDU is ~~used~~listed in Permit Part 4, Table 4.1.1. ~~This equates to 662,150 ft^3 (18,750 m^3) of contact-handled (**CH**) TRU mixed waste and 22,950 ft^3 (650 m^3) of RH TRU mixed waste per panel.~~

The maximum extent of operations during the term of this permit ~~is expected to be~~includes Panels 1 through ~~10~~ 8, and Panels 10-12;~~as shown on Figure G-1,~~ the WHB ~~Container Storage~~ Unit;~~,~~ and the PAU~~Parking Area Container Storage Unit~~. Note that ~~panels~~ Panel 9 will not be used for TRU mixed waste disposal and Panel 10 is~~are~~ not authorized for waste emplacement under this permit. If other waste management units are permitted during the Disposal Phase, this Closure Plan will be revised to include the additional waste management units. The design basis for a panel assumes that it takes about 30 months to fill the HWDU and initiate panel closure (DOE, 1997). However, it is anticipated that Panel 7, Panel 8, and Panel 10 (if authorized in the future for TRU mixed waste disposal) will take longer than 30 months to fill due to the reduction in available ventilation capability, ground conditions in Panel 10 and associated remediation efforts, and radiological contamination in Panel 10. These assumptions have been used in preparing the closure schedule in Table G-1. At any given time during disposal operations, it is possible that multiple rooms may be receiving TRU mixed waste for disposal at the same time. Underground HWDUs in which disposal has been completed (i.e., in which CH and RH TRU mixed waste emplacement activities have ceased) will undergo panel closure.

G-1d Schedule for Closure

For the purpose of establishing a schedule for closure, the final waste disposal will mark the end of the Disposal Phase and will occur when permitted HWDUs are filled or have achieved their maximum capacities as outlined in Permit Part 4, Table 4.1.1, or when the WIPP facility achieves its capacity of 6.2 million cubic feet (ft^3) (175,564 cubic meters (m^3)) of LWA TRU waste volume. The Permittees also assume closure will take 10 years~~an operating and closure period of no more than 35 years (25 years for disposal operations and 10 years for closure) is assumed~~. ~~This operating period~~ The Disposal Phase may be extended or shortened, within the authorized capacities, depending on a number of factors, including the rate of waste approved for shipment to the WIPP facility and the schedules of TRU mixed waste generator sites, and future decommissioning activities.

G-1d(1) Schedule for Panel Closure

The anticipated schedule for the closure of the underground HWDUs is shown in Figure M-61~~G-2~~. Underground HWDUs should be ready for closure according to the schedule in Table G-1. Table G-1 shows actual dates for completed activities and future dates based on the facility design parameters discussed in Section G-1c. These future~~Future~~ dates are estimates for planning and permitting purposes. Actual dates may vary depending on the availability of waste from the generator sites.

In the schedule in Figure M-61~~G-2~~, notification of intent to close occurs 30 days before placing the final waste in an HWDU~~ panel~~. Once an HWDU~~ panel~~ is full, the Permittees will initially block ventilation through the HWDU~~panel~~ as described in Permit Attachment A2, Section A2-2a(3) "Subsurface Structures," and then will assess the closure area for ground conditions and contamination so that a definitive schedule and closure location can be determined. If as the result of this assessment the Permittees determine that a panel closure cannot be emplaced in accordance with the schedule in this Closure Plan, a modification will be submitted requesting an extension to the time for closure.

G-1d(2) Schedule for Final Facility Closure

~~The Disposal Phase for the WIPP facility is expected to require a period of 25 years beginning with the first receipt of TRU waste at the WIPP facility and followed by a period ranging from 7 to 10 years for decontamination, decommissioning, and final closure. The Disposal Phase may therefore extend until 2024, and the latest expected year of final closure of the WIPP facility (i.e., date of final closure certification) would be 2034.~~ If, as is currently projected, the WIPP facility is dismantled at closure, ~~all~~ surface ~~and subsurface~~ facilities (except the hot cell portion of the WHB, which will remain as an artifact of the Permanent Marker System [**PMS**]) will be disassembled and either salvaged or disposed in accordance with applicable standards. Subsurface facilities and equipment will be disassembled and disposed or salvaged to the extent practicable based on underground mining practice. In addition, asphalt and crushed caliche that was used for paving will be removed, and the area will be recontoured and revegetated in accordance with a land management plan. A detailed closure schedule will be submitted in writing to the Secretary of the NMED, along with the notification of closure. Throughout the closure period, ~~all~~ necessary steps will be taken to prevent threats to human health and the environment in compliance with ~~all~~ applicable Resource Conservation and Recovery Act (**RCRA**) permit requirements. Figure M-62~~G-3~~ presents an estimate of a final facility closure schedule~~ based on 84 months to implement final closure~~.

The schedule for final facility closure is considered to be a best estimate because closure of the facility is driven by policies and practices established for the decontamination, if necessary, and decommissioning of radioactively contaminated facilities. These required activities include extensive radiological contamination surveys and hazardous constituent surveys using, among other techniques, radiological surveys to indicate potential hazardous waste releases. Both types of surveys will be performed at the ~~all~~ areas of the WIPP site where hazardous waste were managed, as appropriate. These surveys, along with historical radiological survey records, will provide the basis for determining the disposition~~release~~ of structures, equipment, and components ~~for~~(i.e., disposal or decontamination for release off-~~-~~site). Specifications will be developed for each structure to be removed. A cost benefit analysis may~~will~~ be needed to evaluate decontamination options if extensive decontamination is necessary. Individual equipment surveys, structure surveys, and debris surveys may~~will~~ be required prior to disposition. Size-reduction techniques may be required to dispose of mixed or radioactive waste at the WIPP site. Current DOE policy requires the preparation of a final decontamination~~decommissioning~~ and decommissioning~~decontamination~~ (**D&D**) plan immediately prior to final facility closure. In this way, the specific conditions of the facility at the time D&D is initiated will be addressed. Section G-1e(2~~3~~) provides a more detailed discussion of final facility closure activities.

Figure M-62~~G-3~~ shows the schedule for the final facility closure consisting of decontamination, as needed, of the TRU waste-handling equipment, and of the aboveground equipment and facilities, including closure of surface HWMUs; decontamination of the shaft and haulage ways (if needed); disposal of decontamination derived wastes in the last open underground HWDU; and subsequent closure of this underground HWDU. Subsequent activities will include installation of repository shaft seals.

~~An overall~~ A schedule for final facility closure, showing anticipated durations for~~currently scheduled dates for the start and end of~~ final facility closure activities, is shown in Table G-2. This schedule is based on notification of the intent to close as the initial activity, 60 days prior to the final facility closure start date. ~~The dates assume a startup date of March 1999 and continued permitting of the WIPP facility until it is filled.~~ Schedule details for panel closures are shown on Table G-1.

G-1d(3) Extension for Closure Time

As indicated by the closure schedule presented in Figure M-62~~G-3~~, the activities necessary to perform facility closure of the WIPP facility may require more than 180 days to complete because of additional stringent requirements for managing radioactive materials. Therefore, the

Permit provides an extension of the 180-day final closure requirement in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.113). During the extended closure period, the Permittees will continue to demonstrate compliance with applicable permit requirements and will take the ~~all~~ steps necessary to prevent threats to human health and the environment as a result of TRU mixed waste management at the WIPP facility including all of the applicable measures in Permit Part 2.10, ~~(~~*Preparedness and Prevention*~~)~~.

In addition, according to the schedules in Figure M-62~~G-3~~, the final derived wastes that are generated as the result of decontamination activities will not be disposed of for 16 months after the initiation of final facility closure. In accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.113(a)), the Permit provides an extension of the 90-day limit to dispose of final derived waste resulting from the closure process. This provision is necessitated by the fact that the radioactive nature of the derived waste makes placement in the WIPP repository the best disposition, and the removal of these wastes will, by necessity, take longer than 90 days in accordance with the closure schedules. During this extended period of time, the Permittees will take the ~~all~~ steps necessary to prevent threats to human health and the environment, including compliance with ~~all~~ applicable permit requirements. These steps include ~~all of~~ the applicable preparedness and prevention measures in Permit Part 2, Section 2.10, ~~(~~*Preparedness and Prevention*~~)~~.

Finally, in the event the hazardous waste permit is not renewed as assumed in the schedule, the Permittees will submit a modification to the Closure Plan to implement a contingency closure that will allow the Permittees to continue to operate for the disposal of non-mixed TRU waste. This modification will include a request for an extension of the time for final facility closure. This modified Closure Plan will be submitted to the NMED for approval.

G-1d(4) Amendment of the Closure Plan

If it becomes necessary to amend the Closure Plan for the WIPP facility, the Permittees will submit~~, in accordance with 20.4.1.900 NMAC (incorporating 40 CFR §270.42),~~ a written notification of or request for a permit modification in accordance with 20.4.1.900 NMAC (incorporating 40 CFR §270.42). This notification of, or request for, a permit modification will describe~~describing~~ any change in operation or facility design that affects the Closure Plan. The written notification of, or request for, a permit modification will include a copy of the amended Closure Plan for approval by the NMED. The Permittees will submit a written notification of, or request for, a permit modification to authorize a change in the approved plan, if:

- There are changes in operating plans or in the waste management unit facility design that affect the Closure Plan
- There is a change in the expected year of closure
- Unexpected events occur during panel or final facility closure that require modification of the approved Closure Plan
- Changes in State or Federal laws affect the Closure Plan
- Permittees fail to obtain permits for continued operations as discussed above

The Permittees will submit a written request for a permit modification with a copy of the amended Closure Plan at least 60 days prior to the proposed change in facility design or operation or within 60 days of the occurrence of an unexpected event that affects the Closure Plan. If the unexpected event occurs during final closure, the permit modification will be requested within 30 days of the occurrence. If the Secretary of the NMED requests a modification of the Closure Plan, a plan modified in accordance with the request will be submitted within 60 days of notification or within 30 days, if the change in facility condition occurs during final closure.

G-1e Closure Activities

Closure activities include those instituted for panel closure (i.e., closure of filled underground HWDUs), contingency closure (i.e., closure of surface HWMUs and decontamination of other waste handling areas), and final facility closure (i.e., closure of surface HWMUs, D&D of surface facilities and the areas surrounding the WHB, and placement of repository shaft seals). Panel closure systems will be emplaced to separate areas of the facility and to isolate panels. Permit Attachments G1 and G2 provide panel closure system and shaft seal designs, respectively. Closure~~All closure~~ activities will meet the applicable quality assurance (**QA**)/quality control (**QC**) program standards in place at the WIPP facility. Facility monitoring procedures in place during operations will remain in place through final closure, as applicable.

G-1e(1) Panel Closure

Following completion of waste emplacement in each underground HWDU, the HWDU will be closed. A WIPP Panel Closure (**WPC**) will be emplaced in the panel access drifts, in accordance with the design in Permit Attachment G1 and the schedule in Figure M-61~~G-2~~ and Table G-1. Alternatively, panels may be closed simultaneously by placing panel closures in the north-south mains (E-300, E-140, W-30, and W-170), as shown in Figure M-43~~G-1~~. ~~If this alternative is used to close Panels 3, 4, 5, and 6, then Panel 9 will not be used for TRU mixed waste disposal.~~ The panel closure system is designed to meet the following requirements that were established by the DOE for the design to comply with 20.4.1.500 NMAC (incorporating 40 CFR §264.601(a)):

- the panel closure system shall contribute to meeting the closure performance standards in Permit Part 6, Section 6.10.1 by mitigating the migration of volatile organic compounds (**VOCs**) from closed panels

- the panel closure system shall consider potential flow of VOCs through the disturbed rock zone (**DRZ**) in addition to flow through closure components

- the panel closure system shall perform its intended functions under loads generated by creep closure of the tunnels

- the panel closure system shall perform its intended function under the conditions of a postulated thermal runaway involving nitrate salt bearing waste (Golder, 2016)

- the nominal operational life of the closure system is 35 years, however, the inspection and maintenance, if needed, of accessible bulkheads can continue until the initiation of final facility closure

- the panel closure system may require minimal maintenance per 20.4.1.500 NMAC (incorporating 40 CFR 264.111)
- the panel closure system shall address the expected ground conditions in the waste disposal area
- the panel closure system shall be built of substantial construction and non-combustible material except for flexible flashing used to accommodate salt movement
- the design and construction shall follow conventional mining practices
- structural analysis shall use data acquired from the WIPP underground
- materials shall be compatible with their emplacement environment and function
- treatment of surfaces in the closure areas shall be considered in the design
- a QA/QC program shall verify material properties and construction
- construction of the panel closure system shall consider shaft and underground access and services for materials handling

The closure performance standard for air emissions from the WIPP facility is one excess cancer death in one million and a hazard index (**HI**) of 1 for a member of the public living outside the WIPP Site Boundary as specified in Permit Part 6, Section 6.10.1. Releases shall be below these limits for the facility to remain in compliance with standards to protect human health and the environment. The panel closure design has been shown, through analysis, to meet these standards, if emplaced in accordance with the specifications in Permit Attachment G1. Compliance will be demonstrated by the Repository VOC Monitoring Program (**RVMP**) in Permit Attachment N. Compliance with the standards established for the RVMP constitutes compliance with the closure standards in Permit Part 6, Table 6.10.1.

The design basis for this closure is such that the migration of hazardous waste constituents from closed panels during the operational and closure period would result in concentrations well below health-based standards. The source term used as the design basis included the average concentrations of VOCs from CH waste containers as measured in headspace gases through November 2010. The VOCs are assumed to have been released by diffusion through the container vents and are removed from the closed room by air leakage that occurs due to ventilation-related pressure differentials.

~~Figures G-4, G-4a, and G-5 show diagrams~~Diagrams of the panel closure design, the substantial barrier, and installation envelopes are depicted in Permit Attachment G1, Appendix G1-B, Figure M-63, and Figure M-42. Permit Attachment G1 provides the detailed design and the design analysis for the panel closure system. The Permittees shall use bulkheads as specified in Attachment G1 for the closure of filled panels. A run-of-mine (**ROM**) salt component will be included in the closure for Panel 9 and Panel 10. The substantial barrier in Figure M-63~~G-4a~~ will be installed in Panels 7 and 8.

~~G-1e(2) Prerequisite Activities for Panel 6 Final Closure~~

~~The NMED-approved WIPP Nitrate Salt Bearing Waste Container Isolation Plan (DOE, 2015) provides for performing prerequisite activities associated with ground control, equipment readiness, work control authorization, and ventilation prior to construction of the final closure in Panel 6. These activities are considered closure activities and will be completed in accordance with the WIPP Nitrate Salt Bearing Waste Container Isolation Plan (DOE, 2015).~~

G-1e(2~~3~~) Decontamination and Decommissioning

Decontamination is defined as those activities which are performed to remove contamination from surfaces and equipment that are not intended to be disposed of at the WIPP facility. The policy at the WIPP facility will be to decontaminate as many areas as possible or to fix the contaminants to the surface so they are not easily removable, consistent with radiological protection policy. Decontamination or fixing are part of closure activities and are a necessary activity in the clean closure of the surface container management units. Decontamination or fixing determinations are based upon radiological surveys.

Decommissioning is the process of removing equipment, facilities, or surface areas from further use and closing the facility. Decommissioning is part of final facility closure only and will involve the removal of equipment, buildings, closure of the shafts, and establishing active and passive institutional controls for the facility. Passive institutional controls are not included in the Permit.

The objective of D&D activities at the WIPP facility is to return the surface to as close to the preconstruction condition as reasonably possible, while protecting the health and safety of the public and the environment. Major activities required to accomplish this objective include, but are not limited to the following:

1. Review of operational records for historical information on releases
2. Visual examination of surface structures for evidence of spills or releases
3. Performance of site contamination surveys
4. Decontamination, if necessary, of usable equipment, materials, and structures including surface facilities and areas surrounding the WHB.
5. Disposal of equipment/materials that cannot be decontaminated but that meet the treatment, storage, and disposal facility waste acceptance criteria (**TSDF-WAC**) in an underground HWDU
6. Emplacement of panel closure system in the last HWDU
7. Emplacement of shaft seals[2]

---

[2] For the purposes of planning, the conclusion of shaft sealing is used by the DOE as the end of closure activities and the beginning of the Post-Closure Care Period.

8. Regrading the surface to approximately original contours

9. Initiation of active controls

This Closure Plan will be amended prior to the initiation of final closure activities to specify the methods to be used.

G-1e(2)(a) Hazards Survey~~Health and Safety~~

Before final closure activities begin, radiation protection personnel will conduct a hazards survey of the unit(s) being closed. A release of radionuclides could also indicate a release of hazardous constituents. If radionuclides are not detected, sampling for hazardous constituents will still be performed if there is documentation or visible evidence that a spill or release has occurred. The purpose of the hazards survey will be to identify potential contamination concerns that may present hazards to workers during the closure activities and to specify any control measures necessary to reduce worker risk. This survey will provide the information necessary for the health physics personnel to identify worker qualifications, personal protective equipment (**PPE**), safety awareness, work permits, exposure control programs, and emergency coordination that will be required to perform closure related activities.

G-1e(2~~3~~)(b~~a~~) Determine the Extent of Contamination

The first activities performed as part of decontamination include those needed to determine the extent of any contamination that needs to be removed or fixed prior to decommissioning a facility. This includes activities 1 to 3 above and, as can be seen by the schedules in Figures M-61~~G-2~~ and M-62~~G-3~~ (Items B and C), these surveys are anticipated to take 10 months to perform, including obtaining the results of any sample analyses. The process of identifying areas that require decontamination or fixing include three sources of information. First, operating records will be reviewed to determine where contamination has previously been found as the result of historical releases and spills. Even though releases and spills in the above ground storage units will have been cleaned up at the time of occurrence, newer equipment and technology may allow further cleaning. Second, surfaces of facilities and structures will be examined visually for evidence of spills or releases. Finally, extensive detailed contamination surveys will be performed to document the level of cleanliness for surface structures and equipment that are subject to decontamination. If equipment or areas are identified as contaminated, the Permittees will notify NMED as specified in Permit Part 1, and a plan and procedure(s) will be developed and implemented to address decontamination-related questions, including:

- Should the component be decontaminated or disposed of as waste?
- What is the most cost-effective method of decontaminating the component?
- Will the decontamination procedures adequately contain the contamination?

Radiological and hazardous constituent surveys will be used in determining the presence of hazardous waste and hazardous waste residues in areas where spills or releases have occurred. Radiological surveys are described in Permit Attachment G3. For contamination that is cleaned up, once cleanup of the radioactivity has been completed, the surface will be sampled for the hazardous constituents associated with the EPA Hazardous Waste Numbers specified in Permit Attachment B to determine that they, too, have been cleaned up. Sampling and analysis protocols will be consistent with EPA's document SW-846 (EPA, 2015~~1996~~).

G-1e(2~~3~~)(c~~b~~) Decontamination Activities

Once the extent of contamination is known, radiological control activities (e.g., decontamination, ~~or~~ fixing) ~~activities~~ will be planned and performed. Consistent with radiological control procedures pursuant to 10 CFR Part 835, decontamination activities will be performed, as necessary. Hazardous waste decontamination, if needed, will be conducted in accordance with the requirements of the Permit and the standards in 20.4.1.500 NMAC (incorporating 40 CFR Part 264). Radiological control and the control of hazardous waste residues are the primary criteria used in the design of decontamination activities. Radiological control procedures require that careful planning and execution be used in decontamination activities to prevent the exposure of workers beyond applicable standards and to prevent the further spread of contamination. Careful control of entry, cleanup, and ventilation are vital components of radiological control activities~~decontamination~~. The level of care mandated by DOE orders and occupational protection requirements results in closure activities that will exceed the 180 days allowed in 20.4.1.500 NMAC (incorporating 40 CFR §264.113(b)). Decontamination activities are included as item 4 above and are shown on the schedule~~s~~ for ~~contingency closure and~~ final facility closure (Figure~~s G-2 and~~ M-62~~G-3~~) as Activities~~activities~~ D, E, and F. These activities are anticipated to have a duration of 20 months for both contingency closure and for final facility closure. The result of these activities is the clean closure of the surface container management units. Under contingency closure, the other areas that have been decontaminated will not be closed. Instead they will remain in use for continued waste management activities involving non-mixed waste. Under final facility closure, other areas that are decontaminated are eligible for closure.

The operating philosophy of the WIPP Project, which is described as “Start Clean – Stay Clean,” is intended to minimize the~~will provide for minimum~~ need for decontamination at closure. However, the need for decontamination techniques may arise. Decontamination activities are managed consistent with radiological control procedures pursuant to 10 CFR Part 835, which includes the as-low-as-reasonably-achievable (**ALARA**) principle. The ALARA principle is an approach/philosophy to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. It is assumed that the process of localized surface decontamination will remove the hazardous waste constituents along with the radioactive waste constituents.

Decontamination activities will be coordinated with closure activities so that areas that have been decontaminated will not be recontaminated. ~~All waste~~Waste resulting from decontamination activities will be surveyed and analyzed for the presence of radioactive contamination and a determination of the hazardous constituents associated with the EPA Hazardous Waste Numbers specified in Part A of the Permit Application~~Permit Attachment B~~. The waste will be characterized as non-radioactive/non-hazardous, hazardous, mixed, or radioactive and will be packaged and handled appropriately. Mixed and radioactive waste, classified as TRU mixed waste, will be managed in accordance with the applicable Permit requirements. Derived mixed waste collected during decontamination activities that are generated before repository shafts have been sealed will be emplaced in the facility, if appropriate, or will be managed together with decontamination derived waste collected after the underground is closed. This waste will be classified and shipped off site to an appropriate, permitted facility for treatment, if necessary, and for disposal.

Removal of Hazardous Waste Residues

Because of the type of waste management activities that will occur at the WIPP facility, waste residues that may be encountered during the operation of the facility and at closure may include derived waste. Derived wastes result from the management of the waste containers or may be collected as part of the closure activities (such as those during which wipes were used to sample the containers and equipment for potential radioactive contamination or those involving solidified decontamination solutions, the handling of equipment designated for disposal, and the handling of residues collected as a result of spill cleanup). Derived wastes collected during the operation and closure of the WIPP facility will be identified and managed as TRU mixed wastes. These wastes will be disposed in an~~the~~ active underground HWDU. Decontamination and decommissioning derived wastes and equipment designated for disposal will be placed in an~~the last~~ underground HWDU ~~panel~~ before closure of that unit.

Surface Container Storage Units

The procedures employed for waste receipt at the WIPP facility minimize the likelihood for any waste spillage to occur on the surface outside the WHB. TRU mixed waste is shipped to the WIPP facility in approved shipping containers (i.e., ~~Contact-Handled~~CH or ~~Remote-Handled~~RH Packages) that are not opened until they are inside the WHB. Therefore, it is unlikely that soil in the Parking Area Unit or elsewhere in the vicinity of the WHB will become contaminated with TRU mixed waste constituents as a result of TRU mixed waste management activities. An evaluation of the soils in the vicinity of the WHB will only be necessary if an event resulting in a release of hazardous waste has occurred outside the WHB.

The “Start Clean—Stay Clean” operating philosophy of the WIPP Project will minimize the need for decontamination of the WHB during decommissioning and closure. Procedures for opening shipping containers in the WHB limit the opportunity for waste spillage.

Should the need for decontamination of the WHB arise, the following methods may be employed, as appropriate, for the hazardous constituent/contaminant type and extent:

- Chemical cleaning (e.g., water, mild detergent cleanser, and polyvinyl alcohol)
- Nonchemical cleaning (e.g., sandblasting, grinding, high-pressure water spray, scabbler pistons and needle scalers, ice-blast technology, dry-ice blasting)
- Removal of contaminated components such as pipe and ductwork

Waste generated as a result of WHB decontamination activities will be managed as derived waste in accordance with applicable Permit requirements and will be emplaced in the last open underground HWDU for disposal.

~~Waste Handling~~ Contaminated Underground Equipment

The ~~waste~~ Waste ~~shaft~~ Shaft conveyance, ~~and~~ associated waste handling equipment, and underground support equipment (e.g., mining equipment, carts) that has become contaminated with hazardous waste constituents associated with TRU mixed waste will be decontaminated ~~to background~~ or characterized and dispositioned~~be~~ (i.e., disposed of as derived waste) as part of both contingency and final facility closure. Procedures for detection and sampling will be as described above. Equipment cleanup will be as above using chemical or nonchemical techniques.

Personnel Decontamination

Personal protective equipment ~~(PPE)~~ worn by personnel performing closure activities in areas determined to be contaminated will be disposed of appropriately. Disposable PPE used in such areas will be placed into containers and managed as TRU mixed waste. Non-disposable PPE will be decontaminated, if possible. Non-disposable PPE that cannot be decontaminated will be managed as TRU mixed waste.

In accordance with DOE policy, TRU mixed waste PPE will be considered to be contaminated with all of the hazardous waste constituents contained in the containers that have been managed within the unit being closed. Wastes collected as a result of closure activities and that may be contaminated with radioactive and hazardous constituents will be considered TRU mixed wastes. These wastes will be managed as derived wastes and disposed of in the final open underground HWDU, as described in Permit Attachment A2. Such waste, collected as the result of closure of the WIPP facility, will be disposed of in the final open underground HWDU.

Cleanup Criteria

Radiological decontamination will be managed consistent with radiological control procedures, or to ~~less than or equal~~ whatever levels that may be established by DOE[3] at the time of cleanup.

Hazardous waste decontamination will be conducted in accordance with standards in 20.4.1.500 NMAC (incorporating 40 CFR Part ~~§~~264) or as incorporated into the Permit.

Final Contamination Sampling and Quality Assurance

Verification samples will be analyzed by a~~an approved~~ laboratory that has been qualified by the DOE according to a written program with strict criteria. The QA requirements of EPA/SW-846, “Test Methods for Evaluating Solid Waste” (EPA, 2015~~1996~~), will be met for hazardous constituent sampling and analyses.

Quality Assurance/Quality Control

Because decisions about closure activities may be based, in part, on analyses of samples of potentially contaminated surfaces and media, a program to ensure reliability of analytical data is essential. Data reliability will be ensured by following a QA/QC program that mandates adequate precision and accuracy of laboratory analyses. Field documentation will be used to document the conditions under which each sample is collected. The documented QA/QC program in place at the WIPP facility will meet applicable RCRA QA requirements.

Field blanks and duplicate samples will be collected in the field to determine potential errors introduced in the data from sample collection and handling activities. To determine the potential for cross-contamination, rinsate blanks (consisting of rinsate from decontaminated sampling equipment) will be collected and analyzed in accordance with applicable EPA guidance. ~~At least~~

---

[3] Title 10 CFR Part 835

~~one rinsate blank will be collected for every 20 field samples. Duplicate samples will be collected at a frequency of one duplicate sample for every ten field samples. In no case will less than one rinsate blank or duplicate sample be collected for a field-sampling effort. These blank and duplicate samples will be identified and treated as separate samples.~~ Acceptance criteria for QA/QC hazardous constituent sample analyses will adhere to the most recent version of EPA SW-846 or other applicable EPA guidance.

G-1e(2~~3~~)(d~~c~~) Dismantling

G-1e(2~~3~~)(d~~c~~)(1) Dismantling During Final Closure

Final facility closure will include dismantling of structures on the surface and in the underground. These are items 6 and 7 above and are represented as Activity G in the final facility closure schedule in Figure M-62~~G-3~~. During dismantling, priority will be given to contaminated structures and equipment that cannot be decontaminated to assure these are properly disposed of in the remaining open underground HWDU in a timely manner. All such facilities and equipment are expected to be removed and disposed of 16 months after the initiation of closure. Dismantling of the balance of the facility, including those structures and equipment that are not included in the application and are not used for TRU mixed waste management, is anticipated to take an additional 66 months. The~~It should be noted that the~~ placement of D&D waste into the final underground HWDU may, by necessity, involve the placement of uncontainerized bulk materials such as concrete components, building framing, structural members, disassembled or partially disassembled equipment, or containerized materials in non-standard waste boxes. Such placement will only occur if it can be shown that it is protective of human health and the environment and will be~~all items are~~ described in an amendment to the Closure Plan. Identification of bulk items is not possible at this time since their size and quantity will depend on the extent of non-removable contamination.

G-1e(2~~3~~)(d~~c~~)(2) Dismantling of Permit-Related Surface Equipment, Structures, and Contaminated Soils During Partial Closure

Partial closure may include~~includes~~ dismantling of Permit-related structures and/or equipment and removal of contaminated soils on the surface prior to final closure. During dismantling, priority will be given to structures and equipment contaminated with hazardous waste or hazardous waste constituents that cannot be decontaminated due to the presence of radioactivity to ensure these are properly disposed of at the WIPP facility or at another designated disposal facility in a timely manner. It should be noted that the placement of D&D waste into a WIPP HWDU may, by necessity, involve the placement of uncontainerized bulk materials such as concrete components, building framing, structural members, disassembled or partially disassembled equipment, or containerized materials in non-standard waste boxes. Such placement will only occur if it can be shown that it is protective of human health and the environment and items are described in the operating record. Identification of bulk items is not possible at this time since their size and quantity will depend on the extent of non-removable contamination.

G-1e(2~~3~~)(e~~d~~) Closure of Open Underground HWDU

The closure of the final underground HWDU is shown by Activity H in Figure M-62~~G-3~~. This closure will be consistent with the description in Section G-1e(1) and the design in Permit

Attachment G1. Detailed closure schedules for underground HWDUs are given in Figure M-61~~G-2~~ and Table G-1.

G-1e(2~~3~~)(f~~e~~) Final Facility Closure

Final facility closure includes several activities designed to assure both the short-term isolation of the waste and the long-term integrity of the disposal system. These include the placement of plugs in boreholes that penetrate the salt and the placement of the repository sealing system. In addition, the surface will be returned to as near its original condition as practicable~~,~~ and will be readied for the construction of markers and monuments that will provide permanent marking of the repository location and contents.

Figure M-43~~G-6~~ identifies where three existing boreholes overlie the proximate area of the repository footprint. Of these identified boreholes in Figure M-43~~G-6~~, all but ERDA-9 are terminated hundreds of feet above the repository horizon. Only ERDA-9, which is accounted for in long-term performance modeling, is drilled through the repository horizon, near the WIPP facility excavations.

To mitigate the potential for migration beyond the repository horizon, the DOE has specified that borehole seals be designed to limit the volume of water that could be introduced to the repository from the overlying water-bearing zones and to limit the volume of contaminated brine released from the repository to the surface or water-bearing zones.

Borehole plugging activities have been underway since the 1970s, from the early days of the development of the WIPP facility. Early in the exploratory phase of the project, a number of boreholes were sunk in Lea and Eddy counties. After the WIPP site was situated in its current location, an evaluation of ~~all~~ vertical penetrations was made by Christensen and Peterson (1981).

As an initial criterion, any borehole that connects a fluid-producing zone with the repository horizon becomes a plugging candidate.

Grout plugging procedures are routinely performed in standard oil-field operations; however, quantitative measurements of plug performance are rarely obtained. The Bell Canyon Test reported by Christensen and Peterson (1981) was a field test demonstration of the use of cementitious plugging materials and modification of existing industrial emplacement techniques to suit repository plugging requirements. Cement emplacement technology was found to be “generally adequate to satisfy repository plugging requirements.” Christensen and Peterson (1981) also report “that grouts can be effective in sealing boreholes, if proper care is exercised in matching physical properties of the local rock with grout mixtures. Further, the reduction in fluid flow provided by even limited length plugs is far in excess of that required by bounding safety assessments for the WIPP.” The governing regulations for plugging and/or abandonment of boreholes are summarized in Table G-3.

The proposed repository sealing system design will prevent water from entering the repository and will prevent gases or brines from migrating out of the repository. The proposed design includes the following subsystems and associated principal functions:

- Near-surface: to prevent subsidence at and around the shafts

- Rustler Formation: to prevent subsidence at and around the shafts and to ensure compliance with federal and New Mexico groundwater protection requirements

- Salado: to prevent transporting hazardous waste constituents beyond the point of compliance specified in Permit Part 5

The repository sealing system will consist of natural and engineered barriers within the WIPP repository that will withstand forces expected to be present because of rock creep, hydraulic pressure, and probable collapses in the repository and will meet the closure requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.601 and §264.111). Permit Attachment G2 presents the final repository sealing system design.

Once shaft sealing is completed, the Permittees will consider closure complete and will provide the NMED with a certification of such within 60 days.

G-1e(2~~3~~)(g~~f~~) Final Contouring and Revegetation

In the preparation of its Final Environmental Impact Statement (DOE, 1980), the DOE committed to restore the site to as near to its original condition as is practicable. This involves removal of access roads, unneeded utilities, fences, and any other structures built by the DOE to support WIPP operations. Provisions would be left for active post-closure controls of the site and for the installation of long-term markers and monuments for the purpose of permanently marking the location of the repository and waste. Permit Attachment H, Section H-1a(1) discusses the active and long-term controls proposed for the WIPP facility. Installation of borehole seals are anticipated to take 12 months, shaft seals 52 months, and final surface contouring 8 months.

G-1e(2~~3~~)(h~~g~~) Closure, Monuments, and Records

A record of the WIPP facility~~Project~~ shall be listed in the public domain in accordance with the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.116). Active access controls will be employed for at least the first 100 years after final facility closure. In addition, a passive control system consisting of monuments or markers will be erected at the site to inform future generations of the location of the WIPP repository (see “Permanent Marker Conceptual Design Report” [DOE, ~~1995~~1996]).

This Permit requires only a 30-year post-closure period. This is the maximum post-closure time frame allowed in an initial Permit for any facility, as specified in 20.4.1.500 NMAC (incorporating 40 CFR §264.117(a)). The Secretary of the NMED may shorten or extend the post-closure care period at any time in the future prior to completion of the original post-closure period (30 years after the completion of construction of the shaft seals). The Permanent Marker Conceptual Design Report and other provisions during the first 100 years after closure are addressed under another federal regulatory program.

Closure of the WIPP facility will contribute to the following:

- Prevention of the intrusion of fluids into the repository by sealing the shafts
- Prevention of human intrusion after closure
- Minimization of future physical and environmental surveillance

Detailed records shall be filed with local, state, and federal government agencies to ensure that the location of the WIPP facility is easily determined and that appropriate notifications and restrictions are given to anyone who applies to drill in the area. This information, together with land survey data, will be on record with the U.S. Geological Survey and other agencies. The federal government will maintain permanent administrative authority over those aspects of land management assigned by law. Details of post-closure activities are in Permit Attachment H.

G-1e(3~~4~~) Performance of the Closed Facility

20.4.1.500 NMAC (incorporating 40 CFR §264.601) requires that a miscellaneous unit be closed in a manner that protects human health and the environment. The RCRA Part B permit application addressed the expected performance of the closed facility during the 30-year post closure period. Groundwater monitoring will provide information on the performance of the closed facility during the post-closure care period, as specified in Permit Attachment H, Section H-1a(2) (Monitoring)~~ of Permit Attachment H~~.

The principal barriers to the movement of hazardous constituents from the facility or the movement of waters into the facility are the halite of the Salado (natural barrier) and the repository seals (engineered barrier). Data and calculations that support this discussion are~~were~~ presented in Renewal Application Addendum N1 (DOE, 2020)~~the permit application~~. The majority of the calculations performed for the repository are focused on long-term performance and making predictions of performance over the first 300-years of the 10,000-~~-~~year~~s~~ performance assessment. In the short term (300 years), the repository is reaching a steady state configuration where the hypothetical brine inflow rate is affected by the increasing pressure in the repository due to gas generation and creep closure. These three phenomena are related in the numerical modeling performed to support the permit application. The modeling parameters, assumptions and methodology are~~were~~ described in detail in Renewal Application Addendum N1 (DOE, 2020)~~the permit application~~.

G-2 Notices Required for Disposal Facilities

G-2a Certification of Closure

Within 60 days after completion of closure activities for a HWMU (i.e., for each storage unit and each disposal unit), the Permittees will submit to the Secretary of the NMED a certification that the unit (and, after completion of final closure, the facility) has been closed in accordance with the specifications of this Closure Plan. The certification will be signed by the Permittees and by an independent New Mexico registered professional engineer. Documentation supporting the independent registered engineer's certification will be furnished to the Secretary of the NMED with the certification.

G-2b Survey Plat

Within 60 days of completion of closure activities for each underground HWDU, and no later than the submission of the certification of closure of each underground HWDU, the Permittees will submit to the Secretary of the NMED a survey plat indicating the location and dimensions of hazardous waste disposal units with respect to permanently surveyed benchmarks. The plat will be prepared and certified by a professional land surveyor and will contain a prominently displayed note that states the Permittees' obligation to restrict disturbance of the hazardous waste disposal unit. In addition, the land records in the Eddy County Courthouse, Carlsbad, New Mexico, will be updated through filing of the final survey plats.

References

Christensen, C. L., and Peterson, E. W. 1981. “Field-Test Programs of Borehole Plugs in Southeastern New Mexico.” In *The Technology of High-Level Nuclear Waste Disposal Advances in the Science and Engineering of the Management of High-Level Nuclear Wastes*, P. L. Hofman and J. J. Breslin, eds., SAND79-1634C, DOE/TIC-4621, Vol. 1, pp. 354–369. Technical Information Center of the U.S. Department of Energy, Oak Ridge, TN.

DOE, see U.S. Department of Energy

EPA, see U.S. Environmental Protection Agency

Golder Associates Inc. (Golder),~~.~~ 2016,~~.~~ Design Report – WIPP Panel Closure report number 0632213 R1 Rev 1, Lakewood, Colorado, October 2016.

U.S. Department of Energy, 1980, “Final Environmental Impact Statement, Waste Isolation Pilot Plant,” DOE/EIS 0026, U.S. Department of Energy, Washington, D.C.

U.S. Department of Energy, 1997, Resource Conservation and Recovery Act Part B Permit Application, Waste Isolation Pilot Plant (WIPP), Carlsbad, New Mexico, Revision 6.5, 1997, Chapters D and I.

~~U.S. Department of Energy, 1995, “Permanent Marker Conceptual Design Report,” from Appendix PMR of the *Draft Compliance Certification Application*, Draft-DOE/CAO-2056, U.S. Department of Energy, Carlsbad, NM.~~U.S. Department of Energy, 1996, “Passive Institutional Controls Conceptual Design Report,” from Appendix PIC of the Compliance Certification Application, DOE/CAO 1996-2184, U.S. Department of Energy, Carlsbad, NM.

U.S. Department of Energy, 2020, WIPP Hazardous Waste Facility Permit Renewal Application, Carlsbad, New Mexico, March 2020.

~~U.S. Department of Energy, 2015, “WIPP Nitrate Salt Bearing Waste Container Isolation Plan, Revision 2, Waste Isolation Pilot Plant Hazardous Waste Facility Permit Number: NM4890139088-TSDF,” May 29, 2015, U.S. Department of Energy, Carlsbad, NM.~~

U.S. Environmental Protection Agency, 2015~~1996~~, “Test Methods for Evaluating Solid Waste,” SW-846, U.S. Environmental Protection Agency, Washington, D.C.

TABLES

Table G-1
Anticipated Earliest Closure Dates for the Underground HWDUs

HWDU	Operations Start	Operations End	Closure Start[a]	Closure End[b]
PANEL 1	3/99*	3/03*	3/03*	5/20*
PANEL 2	3/03*	10/05*	10/05*	5/20*
PANEL 3	4/05*	2/07*	2/07*	8/19*
PANEL 4	1/07*	5/09*	5/09*	8/19*
PANEL 5	3/09*	7/11*	7/11*	8/19*
PANEL 6	3/11*	1/14*	1/14*	8/19*
PANEL 7	9/13*	5/22~~7/21~~	6/22~~8/21~~	12/22~~1/22~~
PANEL 8	5/22~~7/21~~	8/25~~8/24~~	9/25~~9/24~~	3/26~~2/25~~
PANEL 9**	N/A	N/A	N/A	N/A
PANEL 10	8/25~~1/28~~	9/30	10/30	3/31~~SEE NOTE 1~~
PANEL 11	8/25	7/28	8/28	2/29
PANEL 12	7/28	6/31	7/31	1/32

* Actual month and year

** Panel 9 was not used for TRU mixed waste disposal. Closures for Panels 3, 4, 5 and 6 were placed in the north-south mains (E-300, E-140, W-30 and W-170), as shown in Figure G-1, pursuant to Section G-1e(1).

[a] The point of closure start is defined as 60 days following notification to the NMED of closure.

[b] The point of closure end is defined as 180 days following placement of final waste in the panel.

~~NOTE 1: The time to close these areas may be extended depending on the nature and extent of the disturbed rock zone. The excavations that constitute these panels will have been opened for as many as 40 years so that the preparation for closure may take longer than the time allotted in Figure G-2. If this extension is needed, it will be requested as an amendment to the Closure Plan.~~

NOTE 2: For the purposes of preparing the closure schedule, the “Operations Start” date for each additional HWDU is the same as the “Operations End” date of the immediately prior HWDU. The “Operations End” date for each additional HWDU is 30 months after the “Operations Start” date. The “Closure Start” date for each additional HWDU is 1 month after the “Operations End” date. The “Closure End” date for each additional HWDU is 6 months after the “Operations End” date.

N/A--Not Applicable

Table G-2
Anticipated Overall Schedule for Final Facility Closure Activities

Activity	Final Facility Closure Durations	
	Start Month	~~Stop~~Duration
Notify NMED of Intent to Close WIPP (or to Implement Contingency Closure)	Month -2~~October 2030~~	N/A
Perform Contamination Surveys in both Surface Storage Areas	Month 0~~October 2030~~	6 Months~~April 2031~~
Sample Analysis	Month 2~~December 2030~~	8 Months~~July 2031~~
Decontamination as Necessary of both Surface Storage Areas	Month 8~~June 2031~~	8 Months~~January 2032~~
Final Contamination Surveys of both Surface Storage Areas	Month 16~~February 2032~~	8 Months~~September 2032~~
Sample Analysis	Month 20~~June 2032~~	8 Months~~January 2033~~
Prepare and Submit Container Management Unit Closure Certification	Month 28~~February 2033~~	4 Months~~May 2033~~
Dispose of Closure-Derived Waste	Month 2~~November 2030~~	14 Months~~January 2032~~
Closure of Open Underground HWDU panel	Month 16~~February 2032~~*	8 Months~~September 2032~~
Install Borehole Seals	Month 24~~October 2032~~	12 Months~~September 2033~~
Install Repository Seals	Month 32~~June 2033~~	52 Months~~September 2037~~
Recontour and Revegetate	Month 84~~October 2037~~	8 Months~~ May 2038~~
Prepare and Submit Final (Contingency) Closure Certification	Month 84~~October 2037~~	2 Months~~May 2038~~
Post-closure Monitoring	Month 86~~July 2038~~	Up to 30 Years~~N/A~~

N/A--Not Applicable

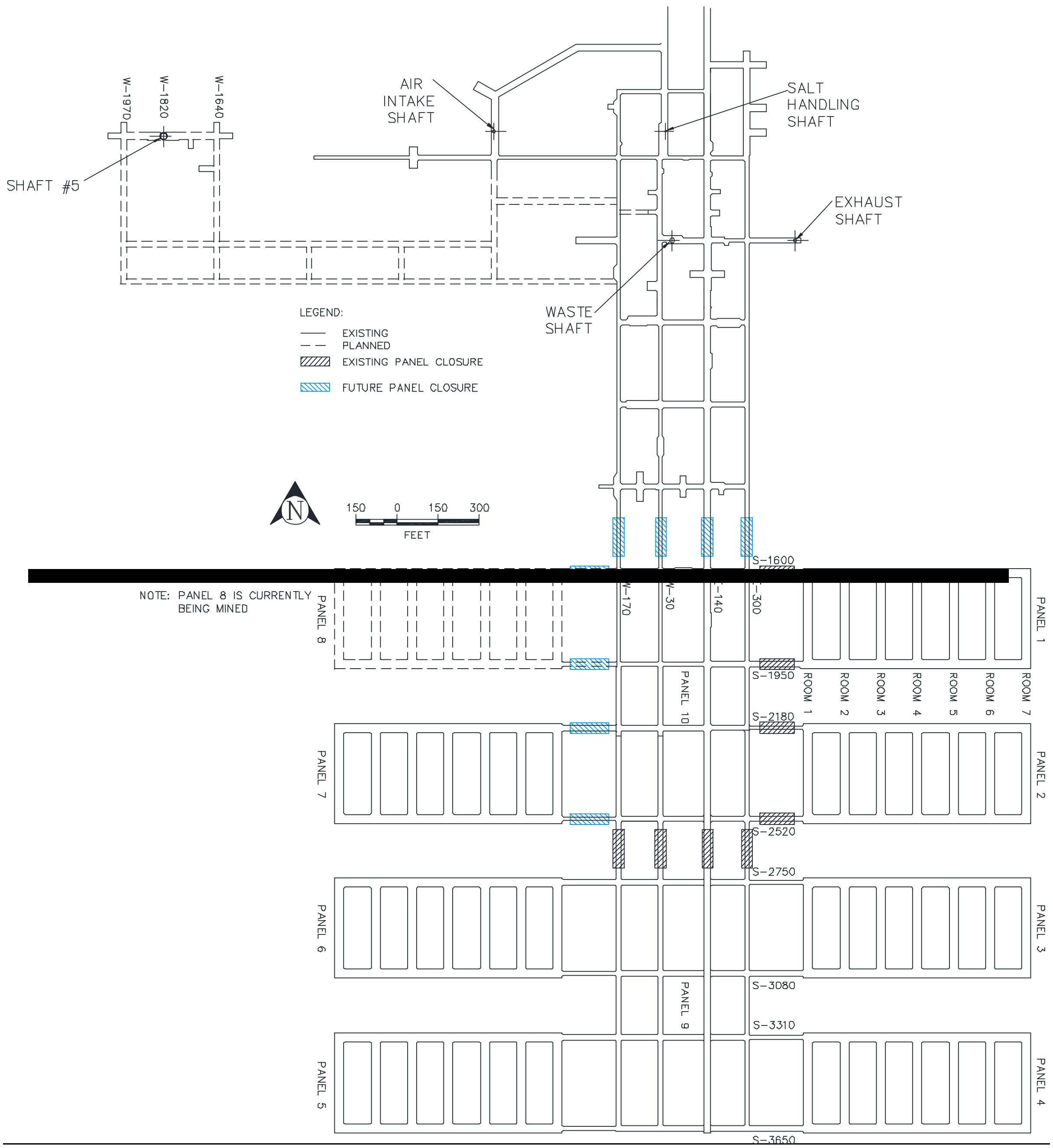
Refer to Figure~~s~~ M-62~~G-3~~ and Permit Attachment G1, Appendix G1-B~~G-4~~ for precise activity titles.

~~*This assumes the final waste is placed in this unit in January 2032 and notification of closure for this HWDU is submitted to the NMED in December 2031.~~

Table G-3
Governing Regulations for Borehole Abandonment

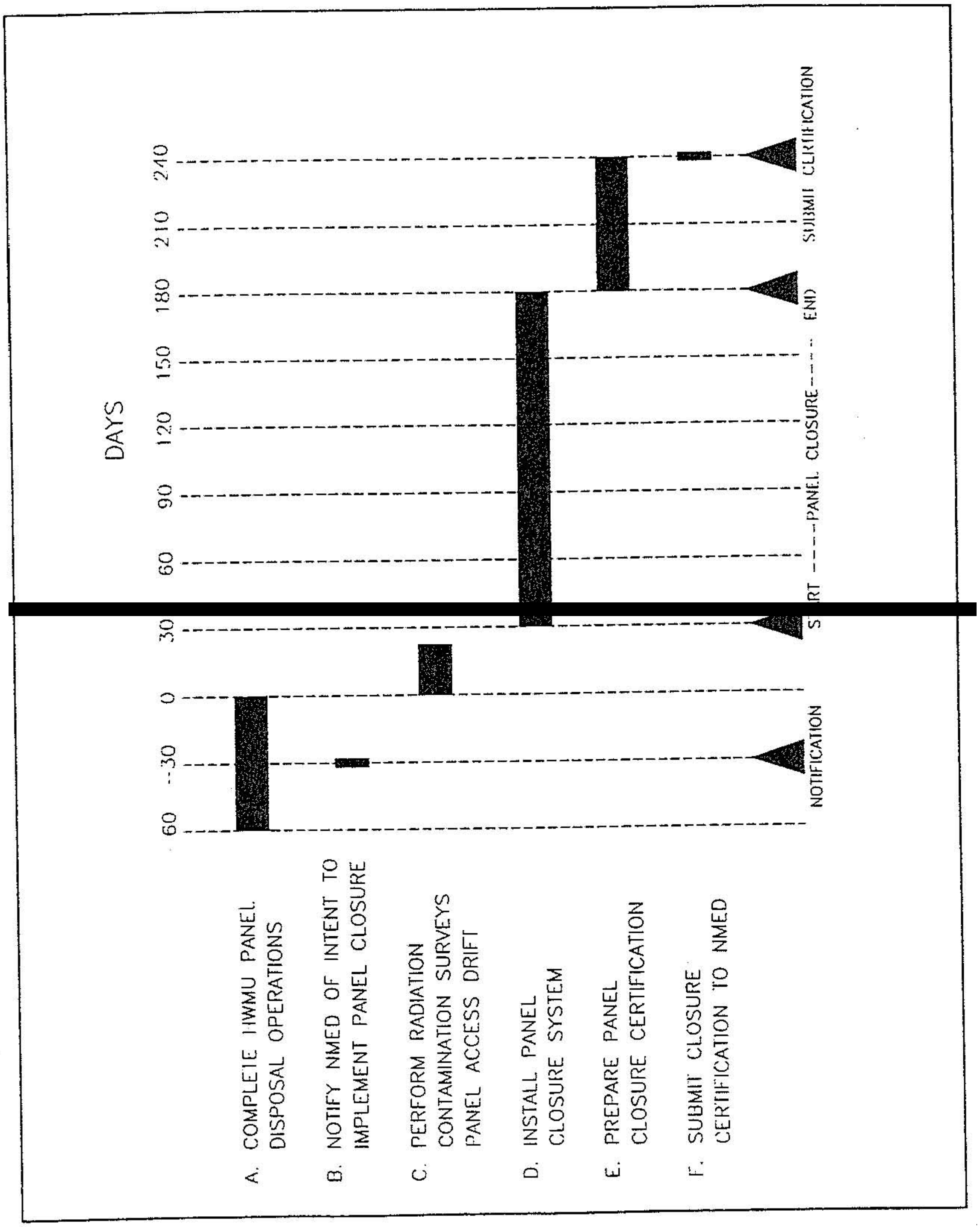
Federal or State Land	Type of Well or Borehole	Governing Regulation	Summary of Requirements
Both	Groundwater Surveillance	State and Federal regulation in effect at time of abandonment	Monitor wells no longer in use shall be plugged in such a manner as to preclude migration of surface runoff or groundwater along the length of the well. Where possible, this shall be accomplished by removing the well casing and pumping expanding cement from the bottom to the top of the well. If the casing cannot be removed, the casing shall be ripped or perforated along its entire length if possible, and grouted. Filling with bentonite pellets from the bottom to the top is an acceptable alternative to pressure grouting.
Federal	Oil and Gas Wells	43 CFR Part 3160, §§ 3162.3-4	The operator shall promptly plug and abandon, in accordance with a plan first approved in writing or prescribed by the authorized officer.
Federal	Potash	43 CFR Part 3590, § 3593.1	(b) Surface boreholes for development or holes for prospecting shall be abandoned to the satisfaction of the authorizing officer by cementing and/or casing or by other methods approved in advance by the authorized officer. The holes shall also be abandoned in a manner to protect the surface and not endanger any present or future underground operation, any deposit of oil, gas, or other mineral substances, or any aquifer.
State	Oil and Gas Well Outside the Oil-Potash Area	State of New Mexico, Oil Conservation Division, Rule 202 (eff. 3-1-91)	B. Plugging (1) Prior to abandonment, the well shall be plugged in a manner to permanently confine all oil, gas, and water in the separate strata where they were originally found. This can be accomplished by using mud-laden fluid, cement, and plugs singly or in combination as approved by the Division on the notice of intention to plug. (2) The exact location of plugged and abandoned wells shall be marked by the operator with a steel marker not less than four inches (4") in diameter, set in cement, and extending at least four feet (4') above mean ground level. The metal of the marker shall be permanently engraved, welded, or stamped with the operator name, lease name, and well number and location, including unit letter, section, township, and range.
State	Oil and Gas Wells Inside the Oil-Potash Area	State of New Mexico, Oil Conservation Division, Order No. R-111-P (eff. 4-21-88)	F. Plugging and Abandonment of Wells (1) All existing and future wells that are drilled within the potash area, shall be plugged in accordance with the general rules established by the Division. A solid cement plug shall be provided through the salt section and any water-bearing horizon to prevent liquids or gases from entering the hole above or below the salt selection. It shall have suitable proportions—but no greater than three (3) percent of calcium chloride by weight—of cement considered to be the desired mixture when possible.

~~FIGURES~~

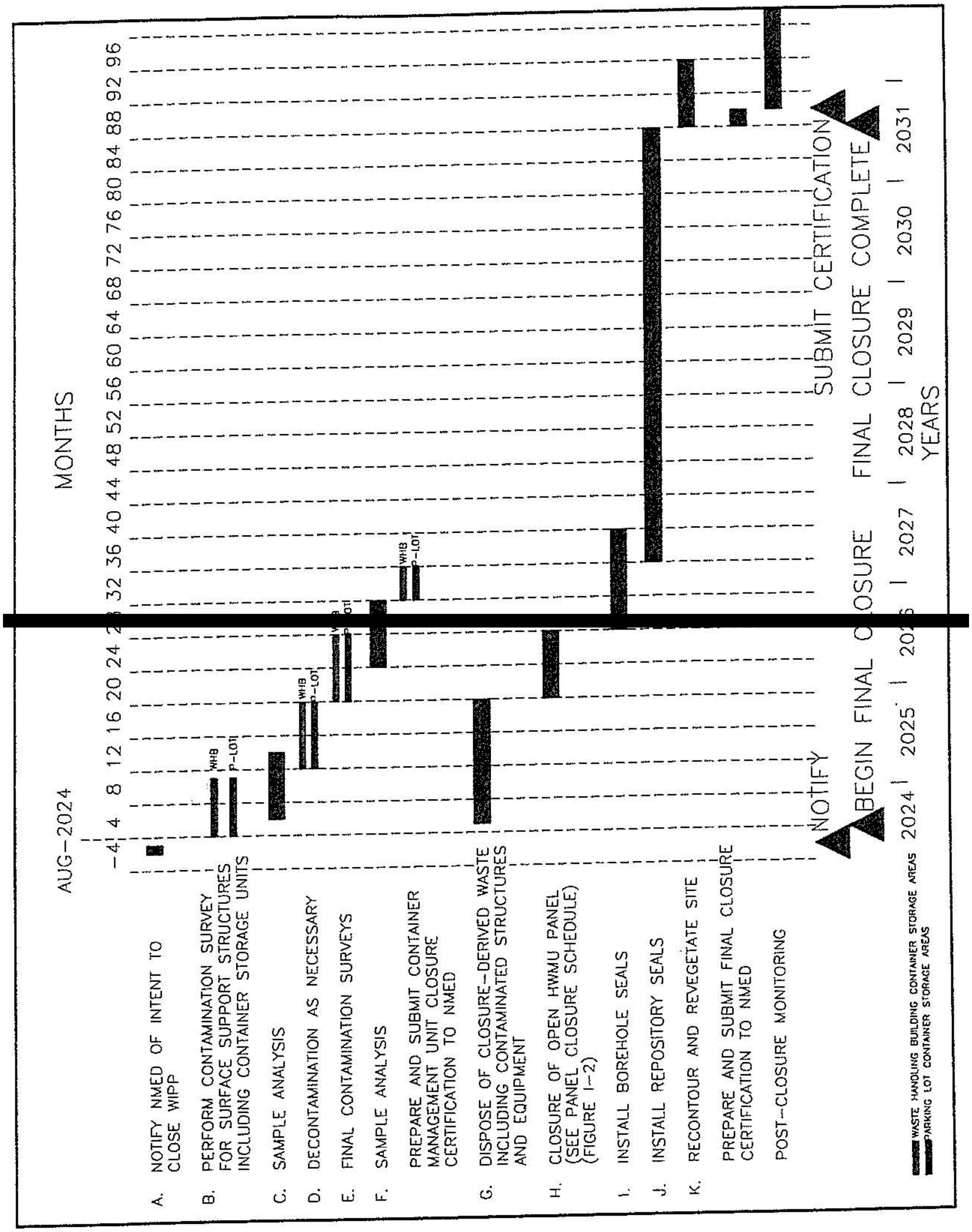


[redacted]

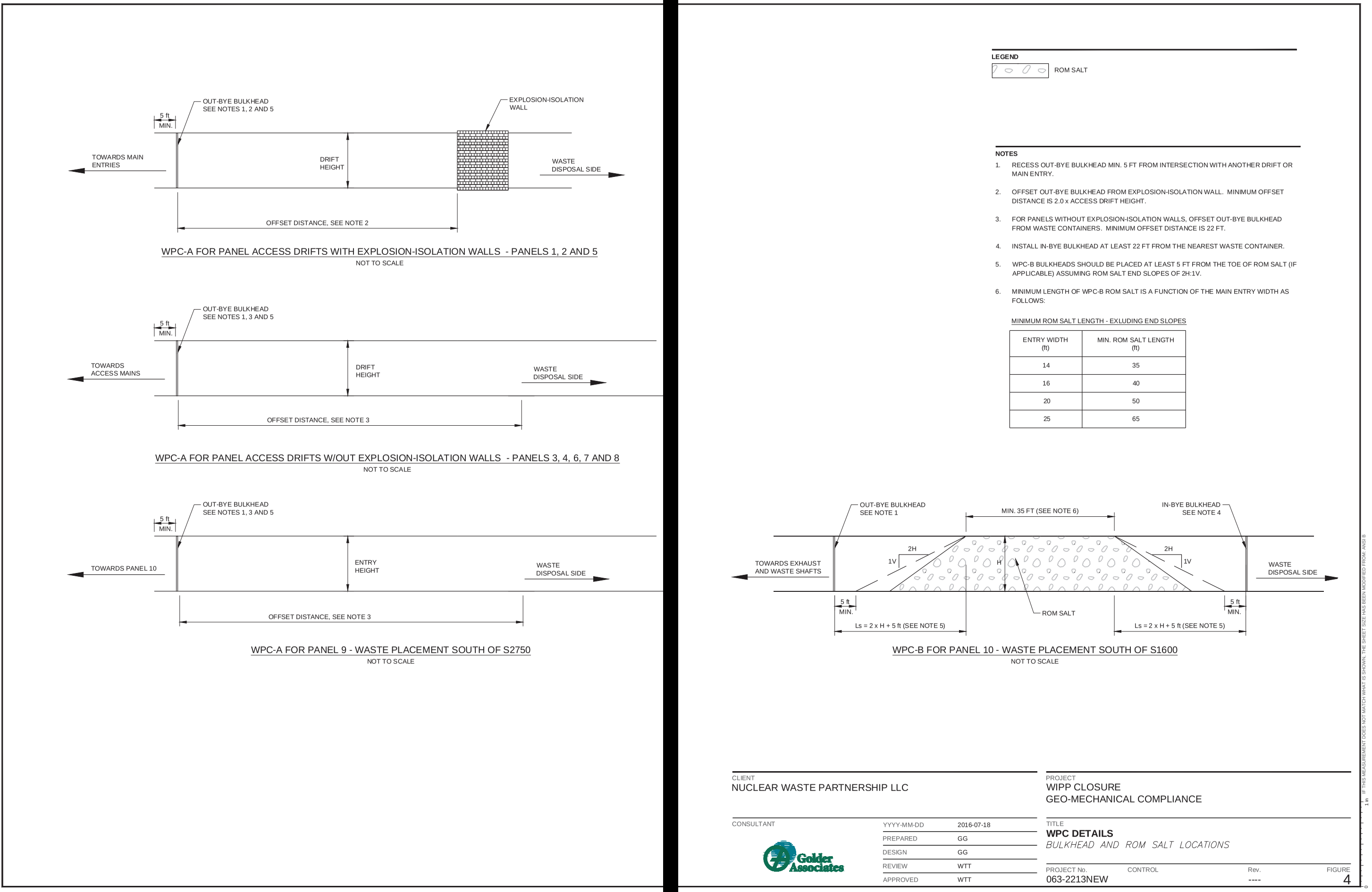
~~Figure G-1~~
~~Location of Underground HWDUs and Anticipated Closure Locations~~



~~**Figure G-2**~~
~~**WIPP Panel Closure Schedule**~~



~~Figure G-3~~
~~WIPP Facility Final Closure 84-Month Schedule~~



NOTES

1. RECESS OUT-BYE BULKHEAD MIN. 5 FT FROM INTERSECTION WITH ANOTHER DRIFT OR MAIN ENTRY.
2. OFFSET OUT-BYE BULKHEAD FROM EXPLOSION-ISOLATION WALL. MINIMUM OFFSET DISTANCE IS 2.0 x ACCESS DRIFT HEIGHT.
3. FOR PANELS WITHOUT EXPLOSION-ISOLATION WALLS, OFFSET OUT-BYE BULKHEAD FROM WASTE CONTAINERS. MINIMUM OFFSET DISTANCE IS 22 FT.
4. INSTALL IN-BYE BULKHEAD AT LEAST 22 FT FROM THE NEAREST WASTE CONTAINER.
5. WPC-B BULKHEADS SHOULD BE PLACED AT LEAST 5 FT FROM THE TOE OF ROM SALT (IF APPLICABLE) ASSUMING ROM SALT END SLOPES OF 2H:1V.
6. MINIMUM LENGTH OF WPC-B ROM SALT IS A FUNCTION OF THE MAIN ENTRY WIDTH AS FOLLOWS:

MINIMUM ROM SALT LENGTH - EXLUDING END SLOPES

ENTRY WIDTH (ft)	MIN. ROM SALT LENGTH (ft)
14	35
16	40
20	50
25	65

CLIENT
NUCLEAR WASTE PARTNERSHIP LLC

CONSULTANT
Golder Associates

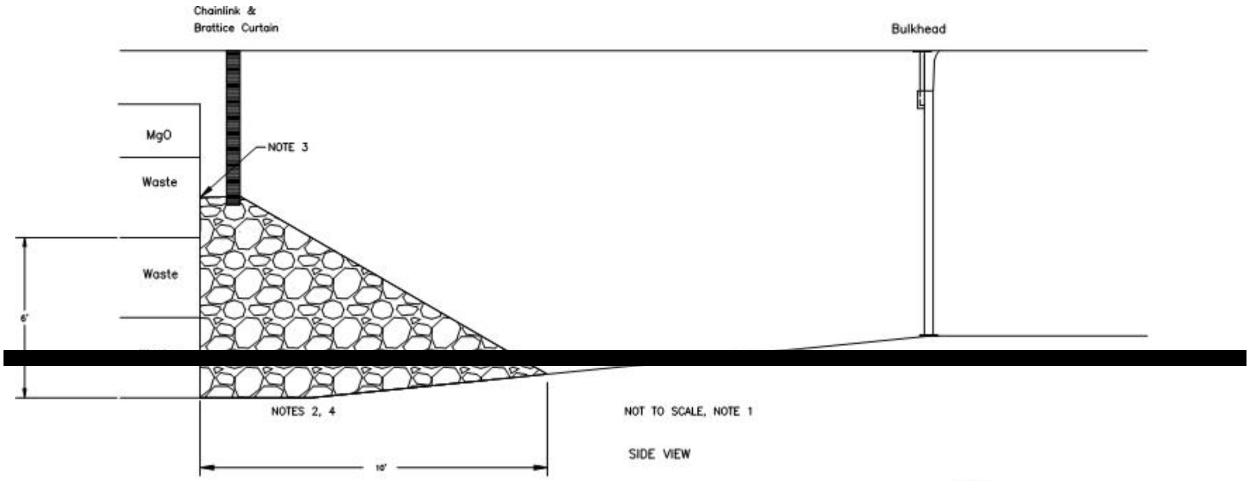
YYYY-MM-DD	2016-07-18
PREPARED	GG
DESIGN	GG
REVIEW	WTT
APPROVED	WTT

PROJECT
WIPP CLOSURE
GEO-MECHANICAL COMPLIANCE

TITLE
WPC DETAILS
BULKHEAD AND ROM SALT LOCATIONS

PROJECT No.	CONTROL	Rev.	FIGURE
063-2213NEW		----	4

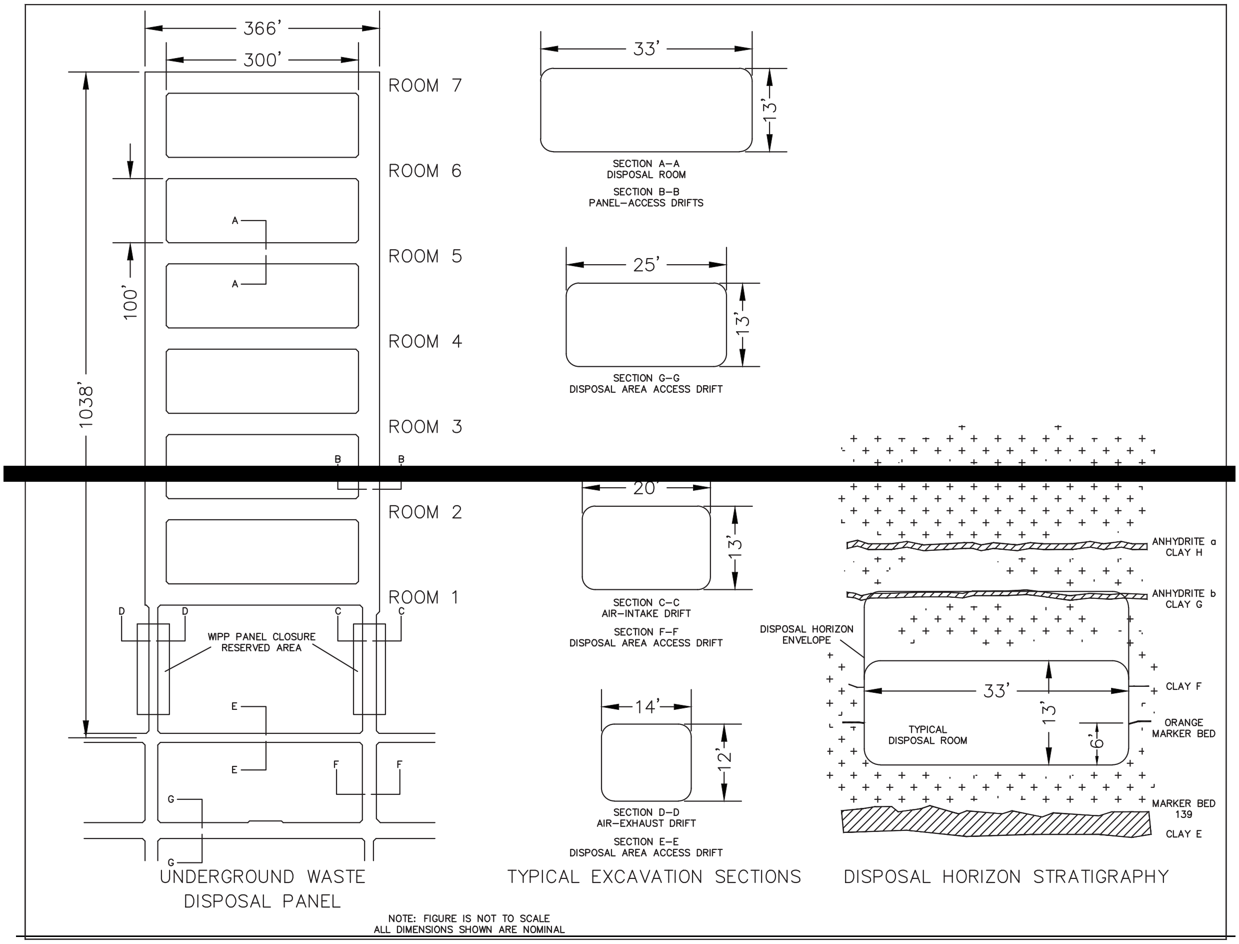
~~Figure G-4~~
~~Bulkhead and ROM Salt Locations~~



NOTES

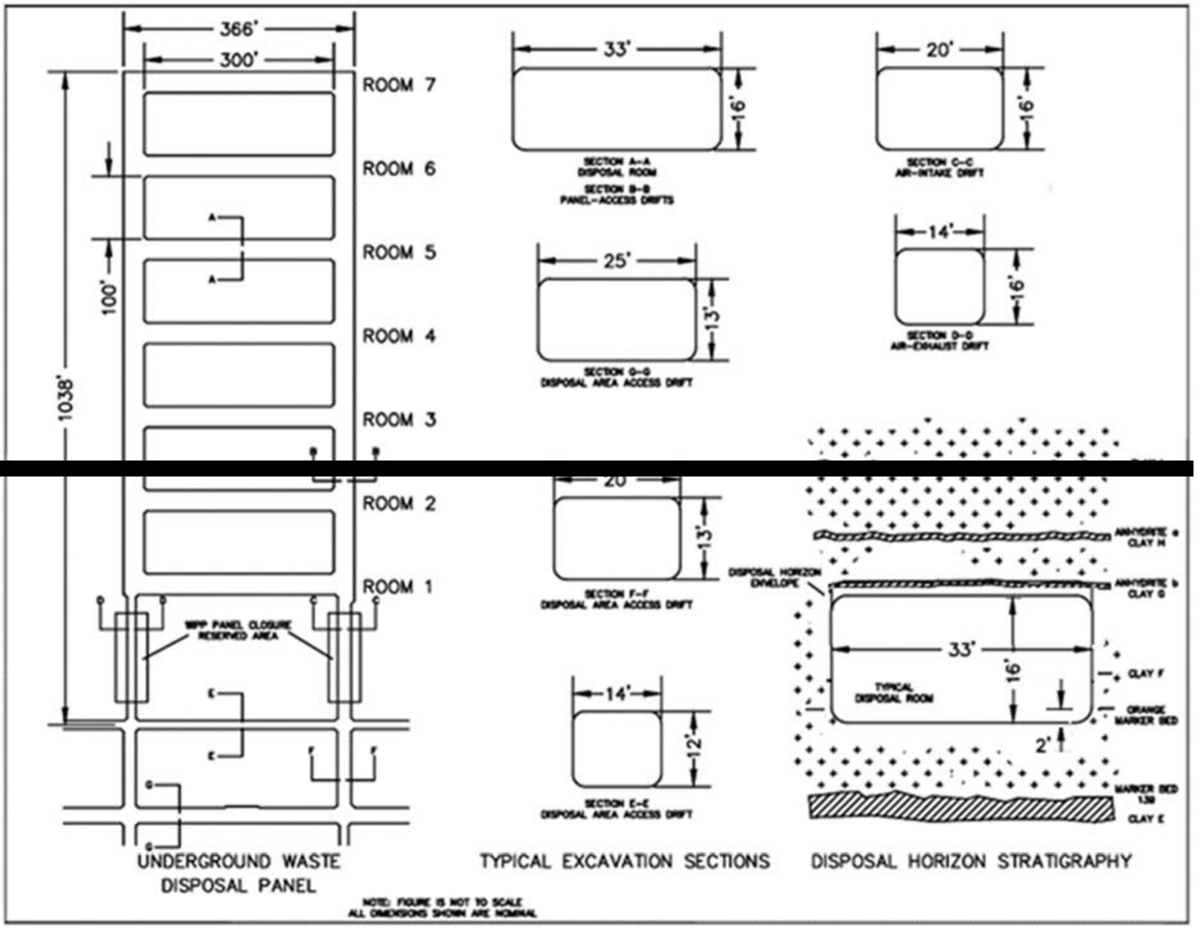
1. CONFIGURATION AND PLACEMENT OF THE SUBSTANTIAL BARRIER AND THE BULKHEAD DICTATED BY AS-FOUND (FIELD) CONDITIONS, AS DESIGNATED BY THE COGNIZANT ENGINEER.
2. SUBSTANTIAL BARRIER MATERIAL WILL CONSIST OF RUN-OF-MINE SALT OR OTHER SUITABLE NON-FLAMMABLE MATERIAL AS DESIGNATED BY THE COGNIZANT ENGINEER.
3. SUBSTANTIAL BARRIER MATERIAL SHOULD BE AGAINST THE WASTE FACE. THE HEIGHT OF THE SUBSTANTIAL BARRIER NEAR THE WASTE WILL BE AT LEAST EQUAL TO THE HEIGHT OF THE BOTTOM OF THE TOP ROW OF WASTE.
4. DIMENSIONS INDICATED ARE MINIMUMS. THE HEIGHT OF THE SUBSTANTIAL BARRIER IS MEASURED AT THE WASTE FACE. THE LENGTH OF THE SUBSTANTIAL BARRIER IS MEASURED FROM THE BOTTOM OF THE WASTE FACE TO THE TOE OF THE SUBSTANTIAL BARRIER MATERIAL.

~~Figure G-4a~~
~~Typical Substantial Barrier and Bulkhead~~



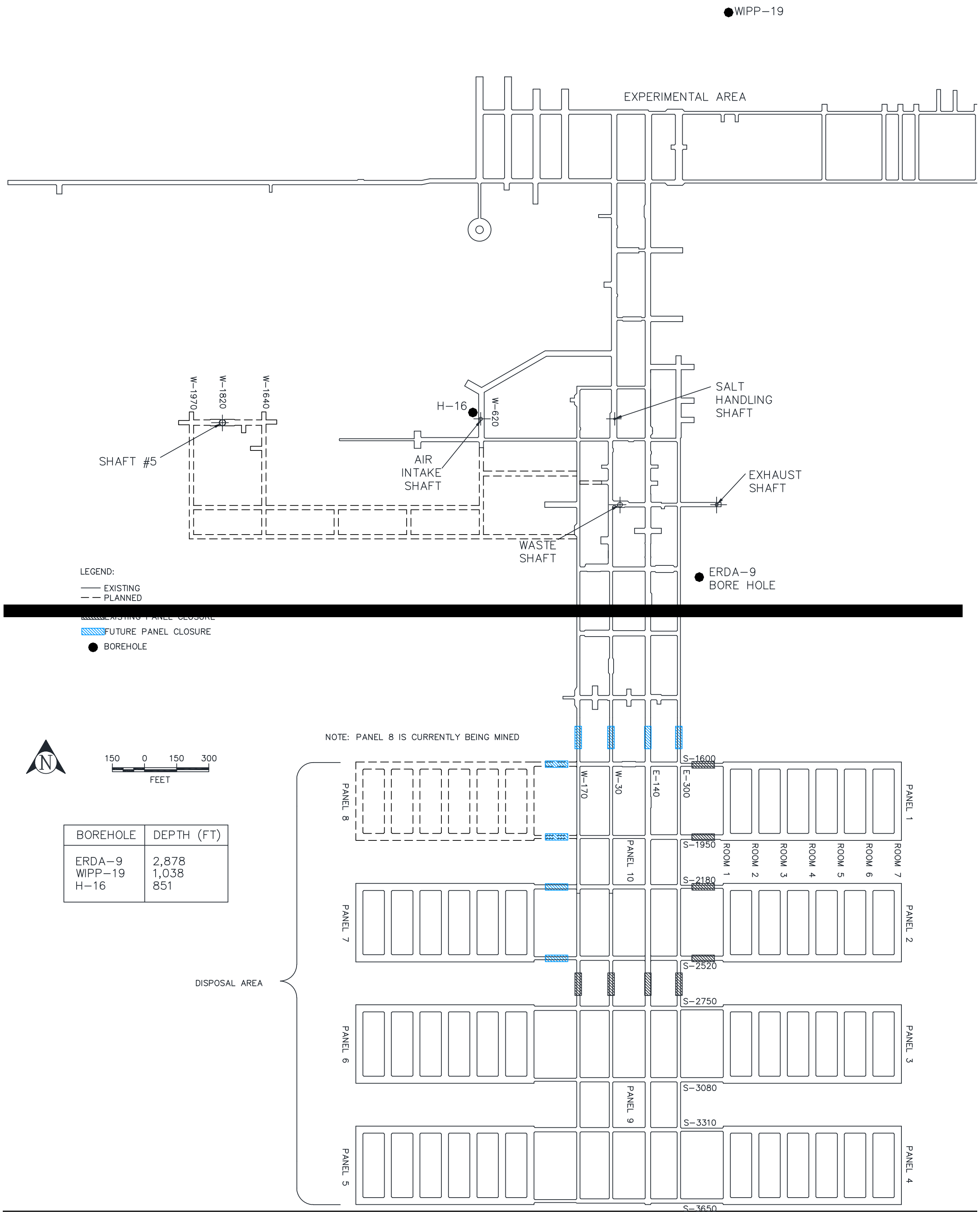
[redacted]

~~Figure G-5a~~
~~Typical Disposal Panel Dimensions for Panels 1-7~~



[redacted]

~~**Figure G-5b**~~
~~**Typical Disposal Panel Dimensions for Panel 8**~~



[redacted]

BOREHOLE	DEPTH (FT)
ERDA–9	2,878
WIPP–19	1,038
H–16	851

~~**Figure G-6**~~
~~**Approximate Locations of Boreholes in Relation to the WIPP Underground**~~

ATTACHMENT G1

WIPP PANEL CLOSURE DESIGN DESCRIPTION AND SPECIFICATIONS

Adapted from the October 2016 Design Report – WIPP Panel Closure

ATTACHMENT G1

WIPP PANEL CLOSURE DESIGN DESCRIPTION AND SPECIFICATIONS

TABLE OF CONTENTS

LIST OF TABLES

~~LIST OF FIGURES~~

LIST OF APPENDICES

LIST OF ABBREVIATIONS/ACRONYMS

Permit	WIPP Hazardous Waste Facility Permit
~~RCRA~~	~~Resource Conservation and Recovery Act~~
ROM	run-of-mine
~~VOC~~	~~volatile organic compound~~
WIPP	Waste Isolation Pilot Plant
WPC	WIPP Panel Closure

ATTACHMENT G1

WIPP PANEL CLOSURE DESIGN DESCRIPTION AND SPECIFICATIONS

G1-1 Introduction

An important aspect of repository operations at the Waste Isolation Pilot Plant (**WIPP**) facility is the closure of waste disposal panels, also referred to as Hazardous Waste Disposal Units ~~(**HWDUs**)~~, under the Resource Conservation and Recovery Act ~~(**RCRA**)~~. Each of Panels 1 through 8, 11, and 12 consists of a panel air-intake drift, a panel air-exhaust drift, and seven rooms. Panel~~s 9 and~~ 10 consists of the main entries (North to South) and cross entries (East to West). The closure of individual panels shall meet the closure requirements described in Attachment G and shall be built in accordance with the specifications in this attachment. This attachment describes the panel closure design and presents the applicable specifications and requirements for fabrication, installation, and maintenance of the WIPP Panel Closure (**WPC**).

The design discussed in this attachment is based on the Design Report, prepared by Golder Associates (Golder, 2016). Calculations demonstrating compliance with the volatile organic compounds ~~(**VOC**)~~ emission standards are included with the Design Report. Calculations addressing the performance of the WPC under the geometries in the access drifts and main entries, including an assessment of the required length of the run-of-mine (**ROM**) salt component, are also included in the Design Report. The specifications for standard steel bulkheads and ROM salt are included as Attachment G1 Appendix G1-A *Technical Specifications* and Attachment G1 Appendix G1-B *Drawings*.

G1-2 WPC Description

The WPC consists of WPC-A and WPC-B. The WPC-A is the design for Panels 1 through 8, 11, and 12. They shall be closed using out-bye bulkheads in the panel intake and exhaust drifts. The WPC-A with ROM salt is also installed in Panel 9 in the main entries between S-2750 and S-2520 as the closures for Panels 3 through 6. The WPC-B is the closure design for Panel 10. It consists of a combination of in-bye and out-bye bulkheads and a length of ROM salt placed in the main entries north of S-1600. The WPC locations are depicted in Permit Attachment G1, Appendix G1-B~~Figure G1-1~~.

G1-2a Permit Design Requirements

The applicable design requirements are provided in Permit Attachment G, Section G-1e(1). The WPC meets these design requirements as documented in the Design Report.

G1-2b Design Component Descriptions

The following subsections present a description of the WPC components. Individual specifications address shaft and underground access and materials handling, construction quality control, treatment of surfaces in the closure areas, and applicable design and construction standards.

The WPC-A consists of a standard steel bulkhead in the panel access drifts~~ for Panels 1 through 8~~, near the intersection with the main entries or relocated to the main north-south drifts as determined by the geotechnical engineer. This bulkhead is referred to as the closure/out-bye bulkhead and it will be maintained for as long as it is accessible. Additional ventilation barriers may remain in the panels as part of the operational controls prior to WPC installation. These ventilation barriers include steel bulkheads, brattice cloth and chain link, as well as concrete block walls in Panels 1, 2, and 5. These ventilation barriers are not part of the WPC design and will not impact the WPC-A bulkheads nor will they impede construction and maintenance of closure bulkheads. WPC-A with ROM salt has been ~~will also be~~ emplaced in the main entries between Panels 9 and 10 (between S-2520 and S-2750).

The WPC-B design for the closure installed in the main entries north of Panel 10 (north of S-1600) consists of ROM salt between in-bye and out-bye bulkheads as shown in Permit Attachment G1, Appendix G1-B~~Figure G1-2~~.

G1-2b(1) Steel Bulkhead

A bulkhead (shown in Permit Attachment G1, Appendix G1-B~~Figure G1-3~~) serves to close panels by blocking ventilation to the intake and exhaust access drifts of the panel and preventing personnel access. This use of a bulkhead is a standard practice and the closure bulkhead shall be constructed as a typical WIPP facility bulkhead. The bulkhead will consist of a steel member frame covered with sheet metal. Telescoping tubular steel or functionally equivalent material shall be used to bolt the bulkhead to the floor and roof. Flexible flashing material such as a rubber conveyor belt (or other appropriate material) will be attached to the steel frame and the salt as a gasket, thereby providing an effective yet flexible blockage to ventilation air. The steel bulkheads will be maintained for as long as they are accessible to workers. In this regard, accessible bulkheads will be repaired, renovated, or replaced as required. Permit Attachment E, Table E-1 provides the schedule for inspecting panel closure bulkheads.

G1-2b(2) ROM Salt

Run-of-mine salt material from mining operations will be used in the main entries north of Panel 10. The salt will be emplaced to a specified design length based on geomechanical calculations described in detail in the Design Report.

G1-3 Constructability

The WPC-A and WPC-B can be constructed using available technologies for the construction of bulkheads. The use of bulkheads is a standard practice at the WIPP facility and the closure bulkheads will be constructed as typical WIPP facility bulkheads. Run-of-mine salt is available from mining operations in sufficient quantities. The construction methods and materials required for the ROM salt placement north of Panel 10 will use available technologies as discussed in the Design Report.

Conventional WIPP facility mining practices will be used for the WPC construction. Work packages will be prepared for the fabrication and installation of steel bulkheads and will list the materials used, the equipment used, special precautions, and limitations. Each work package will address location-specific prerequisites for installing the closure components, will contain the bulkhead specifications, as appropriate, and the location where the closure components are to be installed. Details on the conventional mining practices and work package preparation are discussed in the Design Report and, further construction details are given in the technical specifications included in Attachment G1, Appendix G1-A.

G1-4 Technical Specifications

The technical specifications are included in Attachment G1, Appendix G1-A, and are listed in Table G1-1.

G1-5 Drawings

The drawings are included in Attachment G1, Appendix G1-B and are listed in Table G1-2.

G1-6 References

Golder Associates Inc. (Golder),~~:~~ 2016,~~:~~ Design Report – WIPP Panel Closure report number 0632213 R1 Rev 1, Lakewood, Colorado, October 2016.

TABLES

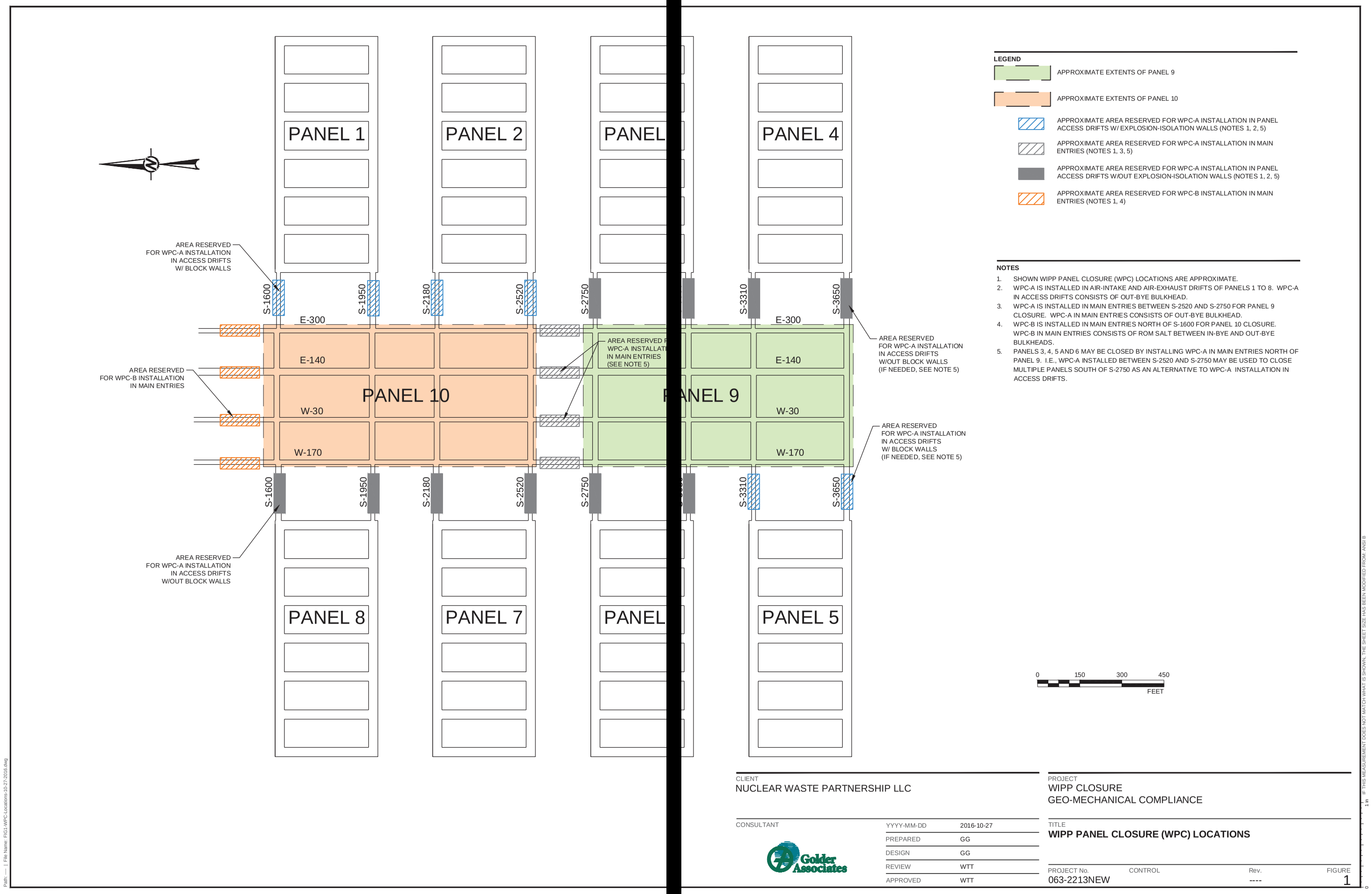
Table G1-1
WIPP Panel Closure Technical Specifications

Division 1 – General Requirements	
Section 01010	**Summary of Work**
Section 01090	Reference Standards
Section 01400	Contractor Quality Control
Section 01600	Material and Equipment
Division 2 – Site Work	
Section 02010	Mobilization and Demobilization
Section 02222	Excavation
Division 3 – WPC Components	
Section 03100	Run-of-Mine Salt
Section 03200	Steel Bulkheads

Table G1-2
WIPP Panel Closure Drawings

Drawing Number	Title
262-001	WIPP Panel Closure (WPC) Title Sheet
262-002	WPC Locations
262-003	Typical Panel Layout and Mined Entry Cross-Sections
262-004	WPC Details – Bulkhead and ROM Salt Locations
262-005	WPC Details – Bulkhead Front-View and Attachment Detail

~~FIGURES~~



[redacted]

LEGEND

🟩	APPROXIMATE EXTENTS OF PANEL 9
🟧	APPROXIMATE EXTENTS OF PANEL 10
▨	APPROXIMATE AREA RESERVED FOR WPC-A INSTALLATION IN PANEL ACCESS DRIFTS W/ EXPLOSION-ISOLATION WALLS (NOTES 1, 2, 5)
▨	APPROXIMATE AREA RESERVED FOR WPC-A INSTALLATION IN MAIN ENTRIES (NOTES 1, 3, 5)
■	APPROXIMATE AREA RESERVED FOR WPC-A INSTALLATION IN PANEL ACCESS DRIFTS W/OUT EXPLOSION-ISOLATION WALLS (NOTES 1, 2, 5)
▨	APPROXIMATE AREA RESERVED FOR WPC-B INSTALLATION IN MAIN ENTRIES (NOTES 1, 4)

NOTES

1. SHOWN WIPP PANEL CLOSURE (WPC) LOCATIONS ARE APPROXIMATE.
2. WPC-A IS INSTALLED IN AIR-INTAKE AND AIR-EXHAUST DRIFTS OF PANELS 1 TO 8. WPC-A IN ACCESS DRIFTS CONSISTS OF OUT-BYE BULKHEAD.
3. WPC-A IS INSTALLED IN MAIN ENTRIES BETWEEN S-2520 AND S-2750 FOR PANEL 9 CLOSURE. WPC-A IN MAIN ENTRIES CONSISTS OF OUT-BYE BULKHEAD.
4. WPC-B IS INSTALLED IN MAIN ENTRIES NORTH OF S-1600 FOR PANEL 10 CLOSURE. WPC-B IN MAIN ENTRIES CONSISTS OF ROM SALT BETWEEN IN-BYE AND OUT-BYE BULKHEADS.
5. PANELS 3, 4, 5 AND 6 MAY BE CLOSED BY INSTALLING WPC-A IN MAIN ENTRIES NORTH OF PANEL 9. I.E., WPC-A INSTALLED BETWEEN S-2520 AND S-2750 MAY BE USED TO CLOSE MULTIPLE PANELS SOUTH OF S-2750 AS AN ALTERNATIVE TO WPC-A INSTALLATION IN ACCESS DRIFTS.

CLIENT
NUCLEAR WASTE PARTNERSHIP LLC

CONSULTANT

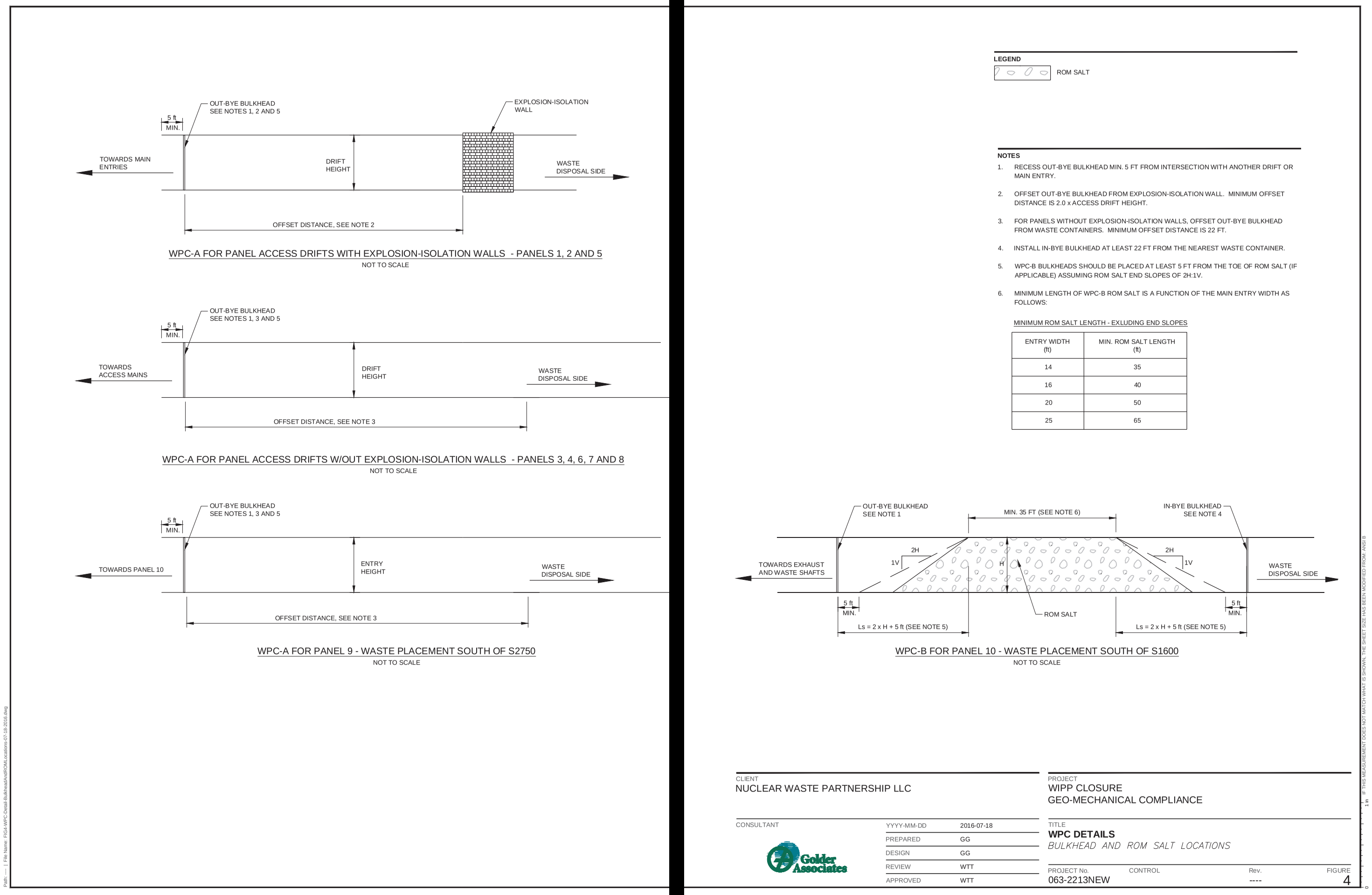
YYYY-MM-DD	2016-10-27
PREPARED	GG
DESIGN	GG
REVIEW	WTT
APPROVED	WTT

PROJECT
WIPP CLOSURE
GEO-MECHANICAL COMPLIANCE

TITLE
WIPP PANEL CLOSURE (WPC) LOCATIONS

PROJECT No.	CONTROL	Rev.	FIGURE
063-2213NEW		----	1

~~**Figure G1-1**~~
~~**WPC Locations**~~



NOTES

1. RECESS OUT-BYE BULKHEAD MIN. 5 FT FROM INTERSECTION WITH ANOTHER DRIFT OR MAIN ENTRY.
2. OFFSET OUT-BYE BULKHEAD FROM EXPLOSION-ISOLATION WALL. MINIMUM OFFSET DISTANCE IS 2.0 x ACCESS DRIFT HEIGHT.
3. FOR PANELS WITHOUT EXPLOSION-ISOLATION WALLS, OFFSET OUT-BYE BULKHEAD FROM WASTE CONTAINERS. MINIMUM OFFSET DISTANCE IS 22 FT.
4. INSTALL IN-BYE BULKHEAD AT LEAST 22 FT FROM THE NEAREST WASTE CONTAINER.
5. WPC-B BULKHEADS SHOULD BE PLACED AT LEAST 5 FT FROM THE TOE OF ROM SALT (IF APPLICABLE) ASSUMING ROM SALT END SLOPES OF 2H:1V.
6. MINIMUM LENGTH OF WPC-B ROM SALT IS A FUNCTION OF THE MAIN ENTRY WIDTH AS FOLLOWS:

MINIMUM ROM SALT LENGTH - EXLUDING END SLOPES

ENTRY WIDTH (ft)	MIN. ROM SALT LENGTH (ft)
14	35
16	40
20	50
25	65

CLIENT
NUCLEAR WASTE PARTNERSHIP LLC

CONSULTANT

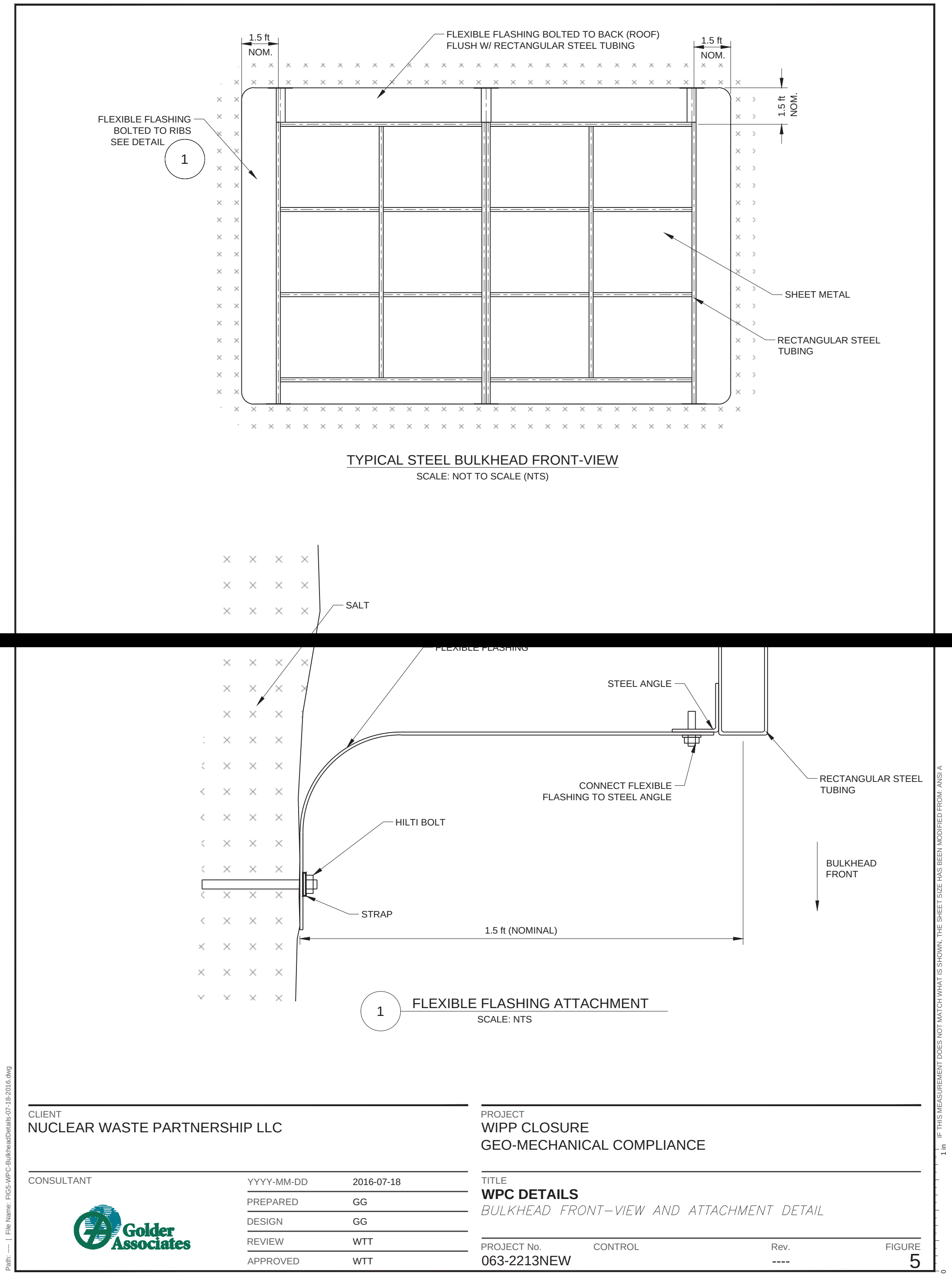
YYYY-MM-DD	2016-07-18
PREPARED	GG
DESIGN	GG
REVIEW	WTT
APPROVED	WTT

PROJECT
WIPP CLOSURE
GEO-MECHANICAL COMPLIANCE

TITLE
WPC DETAILS
BULKHEAD AND ROM SALT LOCATIONS

PROJECT No.	CONTROL	Rev.	FIGURE
063-2213NEW		----	4

~~**Figure G1-2**~~
~~**WPC Details – Bulkhead and Run-of-Mine Salt Locations**~~



[redacted]

~~**Figure G1-3**~~
~~**WPC Details – Bulkhead Front-View and Attachment Detail**~~

ATTACHMENT G1
APPENDIX G1-A

TECHNICAL SPECIFICATIONS

WIPP PANEL CLOSURE
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

ATTACHMENT G1
APPENDIX G1-A

TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

LIST OF TABLES

DIVISION 1 – GENERAL REQUIREMENTS

Section 01010 – Summary of Work

Part 1 – General

1.1 Scope

This section includes the following:

- Scope of Work
- Definitions and Abbreviations
- List of Drawings
- Work by Others
- Contractors Use of Site
- Contractors Use of Facilities
- Work Sequence
- Work Plan
- Health and Safety Plan (**HASP**)
- Contractor Quality Control Plan (**CQCP**)
- Submittals

1.2 Scope of Work

The contractor shall furnish all labor, materials, equipment, and tools to construct Waste Isolation Pilot Plant (**WIPP**) Panel Closure (**WPC**), including the WPC-A for Panels 1 through 9, and the WPC-B to the north of Panel 10. Each WPC-A in each of Panels 1-9 consists of a single steel bulkhead while the WPC-B north of Panel 10 will include dual bulkheads with run-of-mine (**ROM**) salt installed between. Run-of-mine salt will also be used as part of the Panel 9 closure. Nuclear Waste Partnership LLC (**NWP**) may elect to perform any portion or all of the work herein. Details are as follows:

- Install WPC-A in the air-intake and the air-exhaust drifts of Panel 1, 2, and 5 with the explosion-isolation walls (block walls), as shown on the drawings and described in these specifications. The WPC-A consists of an out-bye steel bulkhead. Alternatively, install WPC-A in the main entries and cross-drifts in order to close multiple panels simultaneously based on the direction of the geotechnical engineer.

- Install WPC-A in the air-intake and the air-exhaust drifts of Panel 3, 4, 6, 7, and 8 without the explosion-isolation walls (block walls), as shown on the drawings and described in these specifications. The WPC-A consists of an out-bye steel bulkhead. Alternatively, install WPC A in the main entries ~~access mains~~ and cross-drifts in order to close multiple panels simultaneously based on the direction of the geotechnical engineer.

- Install WPC-A in the main entries between Panels 9 and 10, as shown on the drawings and described in these specifications. The WPC-A consists of an out-bye steel bulkhead. Run-of-mine salt will also be used as part of the Panel 9 closure.

- Install WPC-B in the main entries north of Panel 10, as shown on the drawings and described in these specifications. The WPC-B consists of an in-bye and an out-bye steel bulkhead with ROM salt installed between.

Unless otherwise agreed by NWP, the contractor shall use NWP supplied equipment underground. Such use shall be coordinated with NWP and may include the use of NWP qualified operators.

The scope of work shall include but not necessarily be limited to the following units of work:

- Develop work plan, HASP, and CQCP, and submit for approval

- Prepare and submit any other plans requiring approval

- Mobilize to site

- Coordinate construction with WIPP operations

- Perform the following operations for the air-intake drift and the air-exhaust drift that do not contain block walls (Panels 3, 4, 6, 7, and 8):

    - Prepare the surfaces for the out-bye steel bulkhead placement
    - Construct the out-bye steel bulkhead
    - Clean up construction areas in underground and above ground
    - Submit required record documents
    - Demobilize from site

- Perform the following operations for the air-intake drift and the air-exhaust drift with block walls (Panels 1, 2, and 5):

    - Prepare the surfaces for the out-bye steel bulkhead placement
    - Construct the out-bye steel bulkhead
    - Clean up construction areas in underground and above ground
    - Submit required record documents
    - Demobilize from site

- Perform the following operations for the main entries between Panels 9 and 10:

    - Prepare the surfaces for the ROM salt placement
    - Place ROM salt material in multiple layers
    - Prepare the surfaces for the out-bye steel bulkhead placement
    - Construct the out-bye steel bulkhead
    - Clean up construction areas in underground and above ground
    - Submit required record documents
    - Demobilize from site

- Perform the following operations for the main entries north of Panel 10:

    - Prepare the surfaces for the in-bye steel bulkhead placement
    - Construct the in-bye steel bulkhead
    - Prepare the surfaces for the ROM salt placement
    - Place ROM salt material in multiple layers
    - Prepare surfaces for the out-bye steel bulkhead placement
    - Construct the out-bye steel bulkhead

- Clean up construction areas in underground and above ground
- Submit required record documents
- Demobilize from site

1.3 Definitions and Abbreviations

Definitions

Block wall – Existing mortared concrete block wall adjacent to the panel waste disposal area as shown in the drawings; also known as explosion-isolation wall

Creep – Viscoplastic deformation of salt under deviatoric stress

Partial closure – The process of rendering a part of the hazardous waste management unit in the underground repository inactive and closed according to approved facility closure plans

Run-of-mine ~~(**ROM**)~~ salt – A salt backfill obtained from mining operations and emplaced in an uncompacted state

Volatile organic compound (**VOC**) – Any VOC with Hazardous Waste Facility Permit emission limits

Nuclear Waste Partnership LLC (**NWP**) – the construction management authority

Abbreviations/Acronyms

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
CQCP	Contractor Quality Control Plan
DOE	U.S. Department of Energy
DWG	drawing
EPA	U.S. Environmental Protection Agency
HASP	Health and Safety Plan
JHA	Job Hazard Analysis
LHD	load haul dump
LLC	Limited Liability Corporation
MSHA	U.S. Mine Safety and Health Administration
NWP	Nuclear Waste Partnership LLC
ROM	Run-of-mine
USACE	U.S. Army Corps of Engineers
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant
WPC	WIPP Panel Closure

1.4 List of Drawings

The following drawings were prepared as a part of the WPC design report (Attachment G1, Appendix G1-B, Drawings):

DWG 262-001	WIPP Panel Closure (**WPC**) Title Sheet
DWG 262-002	WPC Locations
DWG 262-003	Typical Panel Layout and Mined Entry Cross-Sections
DWG 262-004	WPC Details – Bulkhead and ROM Salt Locations
DWG 262-005	WPC Details – Bulkhead Front-View and Attachment Detail

1.5 Work by Others

Survey

All survey work to locate, control, confirm, and complete the work will be performed by NWP. All survey work for record purposes will be performed by NWP. NWP may elect to perform certain portions or all of the work. The work performed by the NWP will be defined prior to the contract. Unless otherwise agreed by NWP, the contractor shall use underground equipment furnished by NWP for construction of the steel bulkheads and placement of ROM salt. Underground mining personnel who are qualified for the operation of such underground construction equipment may be made available to the contractor. The use of NWP equipment shall be coordinated with NWP.

1.6 Contractor's Use of Site

Site Conditions

The WIPP site is located near Carlsbad in southeastern New Mexico, as shown on the drawings. The underground arrangements and location of the WIPP waste disposal panels are shown on the drawings. The work is to construct steel bulkheads in the air-intake drifts, air-exhaust drifts, and main access drifts between Panels 9 and 10 after cessation of the disposal phase in the specific panel. The work may include installation of steel bulkheads at alternative locations. Alternative locations will be specified by the NWP geotechnical engineer prior to installation activities. Dual bulkheads will be emplaced in the main entries north of Panel 10 after cessation of all disposal activities, and ROM salt placed between these bulkheads at a length to be specified by NWP. Run-of-mine salt will also be used as part of the Panel 9 closure. The waste disposal panels are located approximately 2,150 feet (655 meters) below the ground surface. The contractor shall visit the site, and become familiar with the site and site conditions, prior to preparing a bid proposal.

Contractor's Use of Site

Areas at the ground surface will be designated for the contractor's use in assembling and storing ~~his~~ equipment and materials. The contractor shall utilize only those areas so designated.

Limited space within the underground area will be designated for the contractor's use for storage of material and setup of equipment.

1.7 Contractor's Use of Facilities

Existing facilities at the site available for use by the contractor are:

- Waste shaft conveyance
- Salt skip hoist
- 460-volt AC, 3-phase power
- Water (underground, at waste shaft only) (above ground, at a location designated by NWP)

Additional information on mobilization and demobilization to these facilities is presented in Section 02010.

1.8 Work Sequence

Work sequence shall be as shown on the drawings and as directed by NWP. NWP will designate the order in which panels are to be closed.

1.9 Work Plans

The contractor shall prepare work plans fully describing the proposed fabrication, installation, and construction for each WIPP panel closure. The work plan shall define proposed materials, equipment, and construction methods. The work plan shall state supporting processes, procedures, materials safety data sheets, and regulations by reference. The work plans shall address precautions related to the Job Hazards Check List. The work plan shall address limitations such as hold and witness points. The work plans shall address prerequisites for work. NWP shall approve the work plan and no work shall be performed prior to approval of the work plan.

1.10 Health and Safety Plan (HASP)

The contractor shall obtain, review, and agree to applicable portions of the existing WIPP Safety Manual, WP 12-1. The contractor shall prepare a project-specific HASP taking into account applicable sections of the WIPP Safety Manual. Personnel performing work shall be qualified to work underground. Personnel operating heavy construction equipment shall be qualified to operate such equipment. The contractor shall also perform a Job Hazard Analysis (**JHA**) in accordance with WP 12-1. NWP shall approve the HASP and JHA and no work shall be performed prior to approval of the HASP and JHA.

1.11 Contractor Quality Control Plan (CQCP)

The contractor shall prepare a CQCP identifying all personnel and procedures necessary to produce an end product that complies with the contract requirements. The CQCP shall comply with applicable NWP requirements, including operator training and qualification; and Section 01400, Contractor Quality Control, of this specification. NWP shall approve the CQCP and no work shall be performed prior to approval of the CQCP.

1.12 Submittals

Submittals shall be in accordance with NWP submittal procedures and as required by the individual specifications.

Part 2 – Products

Not used.

Part 3 – Execution

Not Used.

END OF SECTION

Section 01090 – Reference Standards

Part 1 – General

1.1 Scope

This section includes the following:

- Provision of Reference Standards at Site
- Acronyms used in Contract Documents for Reference Standards

1.2 Quality Assurance

For products or workmanship specified by association, trade, or Federal Standards, the contractor shall comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

Conform to reference by date of issue current on the date of the owner-contractor agreement.

The contractor shall obtain, at the contractor's own expense, a copy of the standards referenced in the individual specification sections and shall maintain that copy at the job site until completion and acceptance of the work.

Should specified reference standards conflict with the contract documents, the contractor shall request clarification from Nuclear Waste Partnership LLC (**NWP**) before proceeding.

1.3 Schedule of References

Various publications referenced in other sections of the specifications establish requirements for the work. These references are identified by document number and title. The addresses of the organizations responsible for these publications are listed below.

ANSI	American National Standards Institute 25 West 43rd Street New York, New York 10036 Ph: 212-642-4900 Fax: 212-398-0023
ASTM	ASTM International 100 Barr Harbor Drive P.O. Box C700 West Conshohocken, Pennsylvania 19428-2959 Ph: 610-832-9585 Fax: 610-832-9555

CFR	Code of Federal Regulations Government Printing Office 732 North Capital Street, NW Washington, District of Columbia 20401-0001 Ph: 202-512-1800 Fax: 202 512-2104
EPA	Environmental Protection Agency 1445 Ross Avenue, Suite 1200 Dallas, Texas 75202-2733 Ph: 214-665-2200
FTM-STD	Federal Test Method Standards Standardization Documents Order Desk, Building 4D 700 Robbins Avenue Philadelphia, Pennsylvania 19111-5094 Ph: 215-697-2179 Fax: 215-697-2978
NIST	National Institute of Standards and Technology 100 Bureau Drive, Stop 1000 Gaithersburg, Maryland 20899-1000 Ph: 301-975-6478 Fax: 301-975-8295
NTIS	National Technical Information Service U.S. Department of Commerce 5301 Shawnee Road Alexandria, Virginia 22312 Ph: 703-605-6000 Fax: 703-605-6900

Part 2 – Products

Not used.

Part 3 – Execution

Not used.

END OF SECTION

Section 01400 – Contractor Quality Control

Part 1 – General

1.1 Scope

This section includes the following:

- Contractor Quality Control Plan (**CQCP**)
- Reference Standards
- Quality Assurance
- Tolerances
- Testing Services
- Inspection Services
- Submittals

1.2 Related Sections

- 01090 – Reference Standards
- 01600 – Material and Equipment
- 02222 – Excavation
- 03100 – Run-of-Mine Salt

1.3 Contractor Quality Control Plan (CQCP)

The contractor shall prepare a CQCP describing the methods to be used to verify the performance of the engineered components of the Waste Isolation Pilot Plant (**WIPP**) Panel Closure (**WPC**). The quality control plan for the run-of-mine (**ROM**) salt shall detail the methods the contractor proposes to meet the minimum requirements, and the standard quality control test methods to be used to verify compliance with minimum requirements. Equipment methods employed shall be traceable to standard quality control tests as approved in the CQCP. No work shall be performed prior to Nuclear Waste Partnership LLC (**NWP**) approval of the CQCP.

1.4 References and Standards

Refer to individual specification sections for standards referenced therein, and to Section 01090, Reference Standards, for general listing. Additional standards will be identified in the CQCP.

Standards referenced in this section are as follows:

ASTM E 329-01b	Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E 543-02	Standard Practice for Agencies Performing Nondestructive Testing

1.5 Quality Assurance

The contractor shall:

- Monitor suppliers, manufacturers, products, services, site conditions, and workmanship to produce work of specified quality
- Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship
- Perform work with qualified persons to produce required and specified quality

1.6 Tolerances

The contractor shall:

- Monitor excavation, fabrication, and tolerances to produce acceptable work. The contractor shall not permit tolerances to accumulate.

1.7 Testing Services

Unless otherwise agreed by NWP, the contractor shall employ an independent firm qualified to perform the testing services and other services specified in the individual specification sections, and as may otherwise be required by NWP. Testing and source quality control may occur on or off the project site.

The testing laboratory, if used, shall comply with applicable sections of the reference standards and shall be authorized to operate in the State of New Mexico.

Testing equipment shall be calibrated at reasonable intervals traceable either to the standards from the National Institute of Standards and Technology or to accepted values of natural physical constants.

1.8 Inspection Services

The contractor may employ an independent firm to perform inspection services as a supplement to the contractor’s quality control as specified in the individual specification sections, and as may be required by NWP. Inspection may occur on or off the project site.

The inspection firm shall comply with applicable sections of the reference standards.

1.9 Submittals

The contractor shall submit a CQCP as described herein.

Prior to start of work, if a testing laboratory is used, the contractor shall submit for approval the testing laboratory name, address, telephone number, and name of responsible officer of the firm, as well as a copy of the testing laboratory compliance with the referenced American Society for Testing and Materials (**ASTM**) standards, and a copy of the report of laboratory facilities inspection made by Materials Reference Laboratory of National Institute of Standards and Technology with memorandum of remedies of any deficiencies reported by the inspection.

The contractor shall submit the names and qualifications of personnel proposed to perform the required inspections, along with their individual qualifications and certifications. Once approved by NWP, these personnel shall be available as may be required to promptly and efficiently complete the work.

Part 2 – Products

Not used.

Part 3 – Execution

3.1 General

The contractor is responsible for quality control and shall establish and maintain an effective quality control system. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the contract requirements. The quality control system shall cover construction operations, both on site and off site, and shall be keyed to the proposed construction sequence. The project superintendent will be held responsible for the quality of work on the job. The project superintendent in this context is the individual with the responsibility for the overall management of the project, including quality and production.

3.2 Contractor Quality Control Plan

3.2.1 General

The contractor shall supply, not later than 30 days after receipt of notice to proceed, the CQCP, which implements the requirements of the Contract. The CQCP shall identify personnel, procedures, control, instructions, tests, records, and forms to be used. Construction shall not begin until the CQCP is approved by NWP.

3.2.2 Content of the CQCP

The CQCP shall cover construction operations, both on site and off site, including work by subcontractors, fabricators, suppliers, and purchasing agents and shall include, as a minimum, the following items:

- A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the Contractor Quality Control (**CQC**) staff shall implement the control system for all aspects of the work specified.

- The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function.

- A description of CQCP responsibilities and a delegation of authority to adequately perform the functions described in the CQCP, including authority to stop work.

- Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, off-site fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with NWP submittal procedures.

- Control, verification, and acceptance testing procedures as may be necessary to ensure that the work is completed to the requirements of the drawings and specifications.

- Procedures for tracking deficiencies from identification, through acceptable corrective action, to verification that identified deficiencies have been corrected.

- Reporting procedures, including proposed reporting formulas.

3.2.3 Acceptance of Plan

Acceptance of the contractor's plan is conditional. NWP reserves the right to require the contractor to make changes in the CQCP and operations, including removal of personnel, if necessary, to obtain the quality specified.

3.2.4 Notification of Changes

After acceptance of the CQCP, the contractor shall notify NWP in writing of any proposed change. Proposed changes are subject to acceptance by NWP.

3.3 Tests

3.3.1 Testing Procedure

The contractor shall perform specified or required tests to verify that control measures are adequate to complete the work to contract requirements. Upon request, the contractor shall furnish, at the contractor's own expense, duplicate samples of test specimens for testing by NWP. The contractor shall perform, as necessary, the following activities and permanently record the results:

- Verify that testing procedures comply with contract requirements.

- Verify that facilities and testing equipment are available and comply with testing standards.

- Check test instrument calibration data against certified standards.

- Verify that recording forms and test identification control number system, including the test documentation requirements, have been prepared.

- Record the results of tests taken, both passing and failing. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test will be given. If approved by NWP, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an offsite or commercial test facility will be provided directly to NWP.

- The contractor may elect to develop an equipment specification with construction parameters based upon test results of a test section of ROM salt. The equipment specification based upon construction parameters shall be traceable to standard test results identified in the CQCP. Specification paragraph reference, location where construction parameters were taken, and the sequential control number identifying the construction parameters will be given. If approved by NWP, actual construction parameter reports may be submitted later with a reference to the recording of construction parameters, location, time, and date taken.

3.4 Testing Laboratory

The testing laboratory, if used, shall provide qualified personnel to perform specified sampling and testing of products in accordance with specified standards, and the requirements of contract documents.

Reports indicating results of tests, and compliance or noncompliance with the contract documents will be submitted in accordance with NWP submittal procedures. Testing by an independent firm does not relieve the contractor of the responsibility to perform the work to the contract requirements.

3.5 Inspection Services

The inspection firm shall provide qualified personnel to perform specified inspection of products in accordance with specified standards.

Reports indicating results of the inspection and compliance or noncompliance with the contract documents will be submitted in accordance with NWP submittal procedures.

Inspection by the independent firm does not relieve the contractor of the responsibility to perform the work to the contract requirements.

3.6 Completion Inspection

3.6.1 Pre-Final Inspection

At appropriate times and at the completion of the work, the contractor shall conduct an inspection of the work and develop a “punch list” of items that do not conform to the drawings and specifications. The contractor shall then notify NWP that the work is ready for inspection. NWP will perform this inspection to verify that the work is satisfactory and appropriately complete. A “final punch list” will be developed as a result of this inspection. The contractor shall ensure that the items on this list are corrected and notify NWP so that a final inspection can be scheduled. Any items noted on the final inspection shall be corrected in a timely manner. These inspections and any deficiency corrections required by this paragraph will be accomplished within the time slated for completion of the entire work.

3.6.2 Final Acceptance Inspection

The final acceptance inspection will be formally scheduled by NWP based upon notice from the contractor. This notice will be given to NWP at least 14 days prior to the final acceptance inspection. The contractor shall assure that the specific items previously identified as unacceptable, along with the remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection.

3.7 Documentation

The contractor shall maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers and shall be on an acceptable form approved by NWP.

3.8 Notification of Noncompliance

NWP will notify the contractor of any noncompliance with the foregoing requirements. The contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the contractor at the worksite, shall be deemed sufficient for the purpose of notification. If the contractor fails or refuses to comply promptly, NWP may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the contractor.

END OF SECTION

Section 01600 – Material and Equipment

Part 1 – General

1.1 Scope

This section includes the following:

- Equipment
- Products
- Transportation and Handling
- Storage and Protection
- Substitutions

1.2 Related Sections

- 01010 – Summary of Work
- 01400 – Contractor Quality Control
- 02010 – Mobilization and Demobilization
- 02222 – Excavation
- 03100 – Run-of-Mine Salt

1.3 Equipment

The contractor shall specify proposed equipment in the work plan. Power equipment for use underground shall be either electrical or diesel-engine driven. All diesel-engine equipment shall be certified for use underground at the Waste Isolation Pilot Plant (**WIPP**) site.

1.4 Products

The contractor shall specify in the work plan, or in subsequently required submittals, the proposed products including, but not limited to steel bulkheads and run-of-mine (**ROM**) salt. The proposed products shall be supported by laboratory test results as required by the specifications. Products shall be subject to approval by Nuclear Waste Partnership LLC (**NWP**).

1.5 Transportation and Handling

The contractor shall:

- Transport and handle products in accordance with manufacturer’s instructions.

- Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

- Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.6 Storage and Protection

The contractor shall:

- Store and protect products in accordance with manufacturers' instructions.
- Store with seals and labels intact and legible.
- Store sensitive products in weather-tight, climate-controlled enclosures in an environment favorable to product.
- Provide ventilation to prevent condensation and degradation of products.
- Store loose granular materials (other than ROM salt) on solid flat surfaces in a well-drained area and prevent mixing with foreign matter.
- Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- Arrange storage of products to permit access for inspection and periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.7 Substitutions

1.7.1 Equipment Substitutions

The contractor may substitute equipment for that proposed in the work plan subject to NWP approval.

1.7.2 Product Substitutions

The contractor may not substitute products after the proposed products have been approved by NWP unless he can demonstrate that the supplier/source of that product no longer exists in which case he shall submit alternate products with lab test results to NWP for approval.

Part 2 – Products

Not used.

Part 3 – Execution

Not used.

END OF SECTION

DIVISION 2 – SITE WORK

Section 02010 – Mobilization and Demobilization

Part 1 – General

1.1 Scope

This section includes the following:

- Mobilization of Equipment and Facilities to Site
- Use of Site
- Use of Existing Facilities
- Demobilization of Equipment and Facilities
- Site Cleanup

1.2 Related Sections

- 01010 – Summary of Work
- 01600 – Material and Equipment

Part 2 – Products

Not used.

Part 3 – Execution

3.1 Mobilization of Equipment and Facilities to Site

Upon authorization to proceed, the contractor shall mobilize the contractor’s equipment and facilities to the jobsite. Equipment and facilities shall be as specified and as defined in the contractor’s work plan.

Nuclear Waste Partnership LLC (**NWP**) will provide utilities at designated locations. The contractor shall be responsible for hookups and tie-ins required for contractor operations.

The contractor shall be responsible for providing its~~his~~ own office, storage, and sanitary facilities.

Areas will be designated for the contractor’s use in the underground area near the Waste Isolation Pilot Plant (**WIPP**) Panel Closure (**WPC**) installation. These areas are limited.

3.2 Use of Site

The contractor shall use only those areas specifically designated for use by NWP. The contractor shall limit on-site travel to the specific routes required for performance of work, and designated by NWP.

3.3 Use of Existing Facilities

Existing facilities available for use by the contractor are as follows:

- Waste shaft conveyance
- Salt skip hoist
- 460-volt AC, 3-phase power
- Water underground at waste shaft only
- Water on surface at location designated by NWP

The contractor shall arrange for use of the facilities with NWP and coordinate contractor actions and requirements with ongoing NWP operations.

Use of water in the underground will be restricted. No washout or cleanup will be permitted in the underground except as designated by NWP. Aboveground washout or cleanup of equipment will be allowed in the areas designated by NWP.

The contractor is cautioned to be aware of the physical dimensions of the waste conveyance and the air lock.

The contractor shall be responsible for any damage incurred by the existing site facilities as a result of contractor operations. Any damage shall be reported immediately to NWP and repaired at the contractor's cost.

3.4 Demobilization of Equipment and Facilities

At completion of work, the contractor shall demobilize contractor equipment and facilities from the job site. Contractor's equipment and materials shall be removed and disturbed areas restored. Utilities shall be removed to their connection points unless otherwise directed by NWP. Any equipment that becomes radiologically contaminated will be managed in accordance with NWP radiological protection policies.

3.5 Site Cleanup

At conclusion of the work, the contractor shall remove trash, waste, debris, excess construction materials, and restore the affected areas to their prior condition, to the satisfaction of NWP. A final inspection will be conducted by NWP and the contractor before final payment is approved. Any trash, waste, debris, excess construction materials that become radiologically contaminated will be managed in accordance with NWP radiological protection policies.

END OF SECTION

Section 02222 – Excavation

Part 1 – General

1.1 Scope

This section includes the following:

- Excavation for Surface Preparation and Leveling of Areas for Steel Bulkhead and ROM Salt Placement

- Disposing of Excavated Materials

- Field Measurements and Survey

1.2 Related Sections

- 01010 – Summary of Work
- 01600 – Material and Equipment

1.3 Reference Documents

Krieg, R.D., 1984. Reference Stratigraphy and Rock Properties for the Waste Isolation Pilot Plant, SAND83-1908, Sandia National Laboratories, Albuquerque, New Mexico.

1.4 Field Measurements and Survey

Survey required for performance of the work will be provided by Nuclear Waste Partnership LLC (**NWP**).

Part 2 – Products

Not used.

Part 3 – Execution

3.1 Excavation for Surface Preparation and Leveling of Areas for Steel Bulkhead and ROM Salt Placement

The contractor shall inspect the areas designated for placement of the Waste Isolation Pilot Plant (**WIPP**) Panel Closure (**WPC**) components (run-of-mine (**ROM**) salt and steel bulkheads) and remove any loose material. If loose material is found, the contractor shall excavate and prepare the surface by removing loose material and cleaning rock surfaces. The surface preparation of the floor shall produce a surface suitable for anchoring the steel bulkhead base components and for placing the first layer of ROM salt (as applicable). Excavation may be performed by either mechanical or manual means. Use of explosives is prohibited.

3.2 Disposing of Excavated Materials

The contractor shall dispose of excavated materials as directed by NWP. No excavated materials from radiologically controlled areas will be disposed of without prior approval of NWP.

3.3 Field Measurements and Survey

Survey required for performance of the work will be provided by NWP. The contractor shall protect survey control points, benchmarks, etc., from damage~~ by his operations~~. NWP will verify that the contractor has excavated to the required lines and grades. No salt shall be emplaced until approved by NWP.

END OF SECTION

DIVISION 3 – WPC COMPONENTS

SECTION 03100 – Run-of-Mine Salt

Part 1 – General

1.1 Scope

This section includes the following:

- Salt Placement

1.2 Related Sections

- 01010 – Summary of Work
- 01400 – Contractor Quality Control
- 01600 – Material and Equipment

1.3 Submittals for Review and Approval

The salt emplacement method, dust control plan and other safety-related material shall be approved by Nuclear Waste Partnership LLC (**NWP**).

1.4 Quality Assurance

The contractor shall perform the work in accordance with the Contractor Quality Control Plan (**CQCP**).

Part 2 – Products

2.1 Salt Material

The salt is run-of-mine (**ROM**) salt and requires no grading or compaction. The salt shall be free of foreign organic material.

Part 3 – Execution

3.1 General

The contractor shall furnish labor, material, equipment, and tools to handle and place the salt.

The contractor shall use underground equipment and underground mine personnel as required in Part 1.5, Work by Others in Section 01010, Summary of Work. NWP will supply ROM salt. The contractor shall make suitable arrangements for transporting and placing the ROM salt.

3.2 Installation

Run-of-mine salt shall be transported to the Waste Isolation Pilot Plant (**WIPP**) Panel Closure (**WPC**)-A installation area north of Panel 9 prior to installation of the outbye bulkhead and to the WPC-B installation area north of Panel 10 after the construction of the in-bye steel bulkhead. Run-of-mine salt from any underground excavation is useable as long as it is free of foreign organic matter. The ROM salt is not required to achieve a specified density.

Salt may be emplaced in layers to facilitate the construction. The ROM salt is emplaced in layers to achieve minimum lengths shown in Table 1. The lengths reported in Table 1 do not include sloped ends of the ROM salt plug. Extents of the ROM salt emplacement are designated in the drawings.

There shall be no gap left between ROM salt and roof or sidewalls. Hand placement or push plates can be used to fill the voids if necessary. The approximate lengths and slope inclines are specified in the drawings. Emplacement of the ROM salt at natural angle of repose is acceptable.

Table 1 Minimum ROM Salt Lengths

Entry Width (feet)	Minimum ROM Salt Length[1] (feet)
14	35
16	40
20	50
25	65

Note:

1. Reported ROM length dimensions do not include end slopes of the ROM salt plug.

3.3 Field Quality Control

The contractor shall provide a Quality Control Inspector to inspect the emplacement of salt.

END OF SECTION

SECTION 03200 – Steel Bulkheads

Part 1 – General

1.1 Scope

This section includes the following:

- Steel Bulkhead Installation

1.2 Related Sections

- 01010 – Summary of Work
- 01400 – Contractor Quality Control
- 01600 – Material and Equipment

1.3 Submittals for Review and Approval

The method of installation, construction equipment, and construction materials shall be approved by Nuclear Waste Partnership LLC (**NWP**).

1.4 Quality Assurance

The contractor shall perform the work in accordance with the Contractor Quality Control Plan (**CQCP**).

Part 2 – Products

2.1 Bulkhead Material

Construction material, including steel profiles, sheet metal, flexible flashing, and connectors/bolts shall be approved by NWP prior to construction.

Part 3 – Execution

3.1 General

The contractor shall furnish all labor, material, equipment, and tools to install steel bulkheads at the locations specified in the drawings. The contractor shall use underground equipment and underground mine personnel as required in Part 1.5, Work by Others, in Section 01010, Summary of Work.

3.2 Fabrication

Bulkheads will be fabricated on the surface or in the underground in a location designated by NWP.

3.3 Installation

In-bye steel and out-bye steel bulkheads shall be installed in the designated WPC areas approved by the NWP as specified in the drawings. The contractor shall not commence installation activities without prior inspection of the ground conditions as documented in the Health and Safety Plan (**HASP**) per Section 01010 of these specifications and without prior approval by NWP.

3.4 Field Quality Control

The contractor shall provide a Quality Control Inspector to inspect the steel bulkhead installation if requested by NWP prior to contract.

3.5 Product Acceptance

The contractor shall arrange for the pre-final inspection and final product inspection as described in Part 3.6, Section 01400, of these specifications. The resolution of noncompliance issues will be conducted as described in Part 3.8, Section 01400, of these specifications.

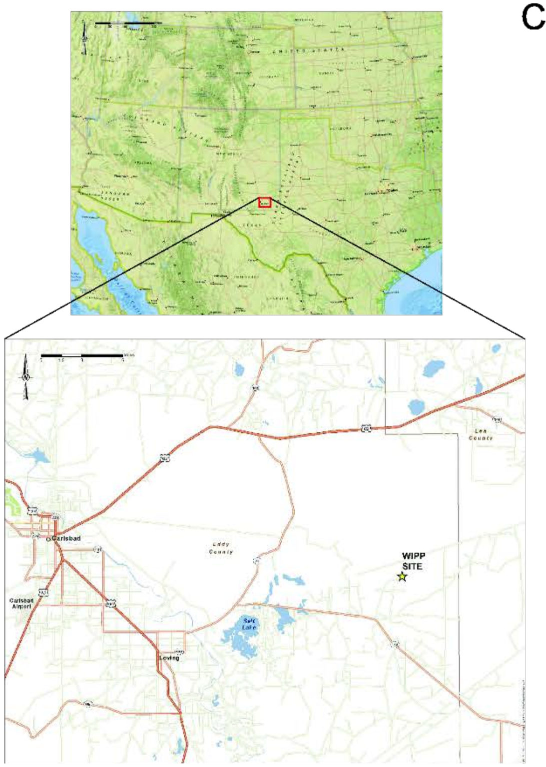
END OF SECTION

ATTACHMENT G1
APPENDIX G1-B

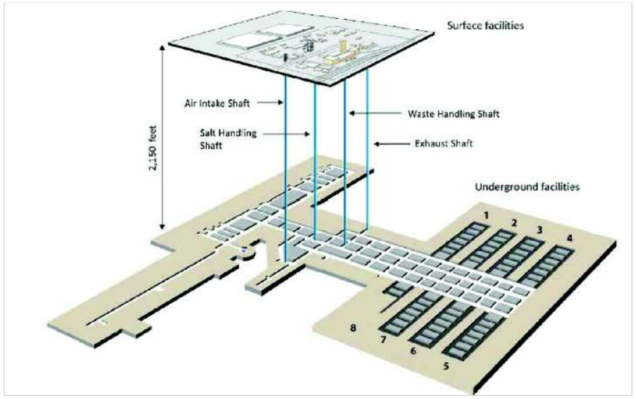
DRAWINGS

WIPP PANEL CLOSURE
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

WIPP PANEL CLOSURE
CARLSBAD, NEW MEXICO



INDEX OF DRAWINGS	
DRAWING NO.	TITLE
262-001	WIPP PANEL CLOSURE (WPC) TITLE SHEET
262-002	WPC LOCATIONS
262-003	TYPICAL PANEL LAYOUT AND MINED ENTRY CROSS-SECTIONS
262-004	WPC DETAILS - BULKHEAD AND ROM SALT LOCATIONS
262-005	WPC DETAILS - BULKHEAD FRONT-VIEW AND ATTACHMENT DETAIL



A2016-07-18ISSUED FOR CLIENT REVIEW GG KJC WTTWTT

REV. YYYY-MM-DD DESCRIPTION DESIGNED PREPAREDREVIEWEDAPPROVED

CLIENT
NUCLEAR WASTE PARTNERSHIP LLC

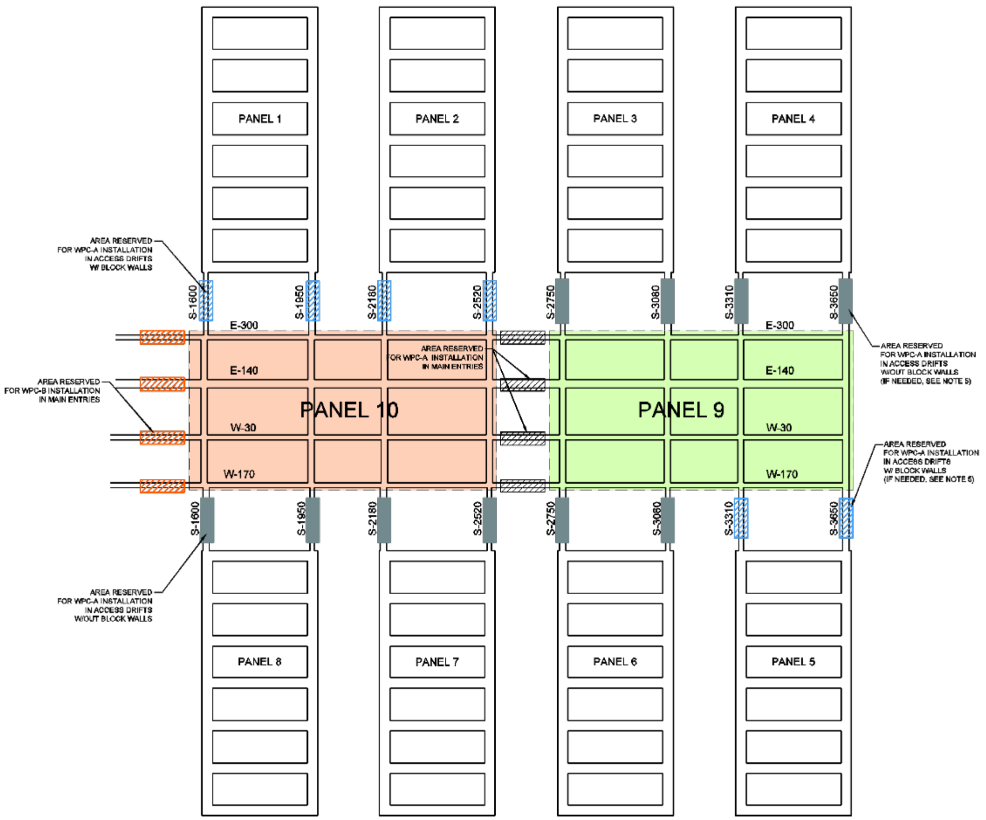
CONSULTANT
Golder Associates

DENVER OFFICE
44 UNION BLVD, STE 300
LAKEWOOD, COLORADO 80228
USA
[1] (303) +980 0540
www.golder.com

PROJECT
WIPP CLOSURE
GEO-MECHANICAL COMPLIANCE

TITLE
WIPP PANEL CLOSURE (WPC) TITLE SHEET

PROJECT NO. 063-2213NEW
REV. A
DRAWING 262-001



LEGEND

🟩	APPROXIMATE EXTENTS OF PANEL 9
🟧	APPROXIMATE EXTENTS OF PANEL 10
▨	APPROXIMATE AREA RESERVED FOR WPC-A INSTALLATION IN PANEL ACCESS DRIFTS W/ EXPLOSION-ISOLATION WALLS (NOTES 1, 2, 5)
▨	APPROXIMATE AREA RESERVED FOR WPC-A INSTALLATION IN MAIN ENTRIES (NOTES 1, 3, 5)
■	APPROXIMATE AREA RESERVED FOR WPC-A INSTALLATION IN PANEL ACCESS DRIFTS W/OUT EXPLOSION-ISOLATION WALLS (NOTES 1, 2, 5)
▨	APPROXIMATE AREA RESERVED FOR WPC-B INSTALLATION IN MAIN ENTRIES (NOTES 1, 4)

NOTES

1. SHOWN WIPP PANEL CLOSURE (WPC) LOCATIONS ARE APPROXIMATE.
2. WPC-A IS INSTALLED IN AIR-INTAKE AND AIR-EXHAUST DRIFTS OF PANELS 1 TO 8. WPC-A IN ACCESS DRIFTS CONSISTS OF OUT-BYE BULKHEAD.
3. WPC-A IS INSTALLED IN MAIN ENTRIES BETWEEN S-2520 AND S-2750 FOR PANEL 9 CLOSURE. WPC-A IN MAIN ENTRIES CONSISTS OF OUT-BYE BULKHEAD.
4. WPC-B IS INSTALLED IN MAIN ENTRIES NORTH OF S-1600 FOR PANEL 10 CLOSURE. WPC-B IN MAIN ENTRIES CONSISTS OF ROM SALT BETWEEN IN-BYE AND OUT-BYE BULKHEADS.
5. PANELS 3, 4, 5 AND 6 MAY BE CLOSED BY INSTALLING WPC-A IN MAIN ENTRIES NORTH OF PANEL 9. I.E., WPC-A INSTALLED BETWEEN S-2520 AND S-2750 MAY BE USED TO CLOSE MULTIPLE PANELS SOUTH OF S-2750 AS AN ALTERNATIVE TO WPC-A INSTALLATION IN ACCESS DRIFTS.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-10-27	ISSUED FOR CLIENT REVIEW	GG	GG	WTT	WTT

CLIENT
NUCLEAR WASTE PARTNERSHIP LLC

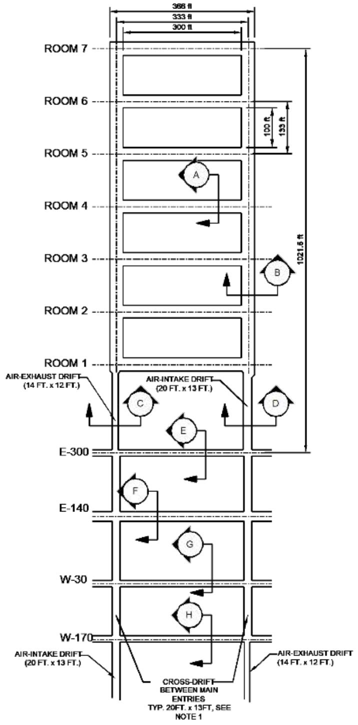
CONSULTANT
Golder Associates

DENVER OFFICE
44 UNION BLVD, STE 300
LAKEWOOD, COLORADO 80228
USA
[1] (303) +980 0540
www.golder.com

PROJECT
WIPP CLOSURE
GEO-MECHANICAL COMPLIANCE

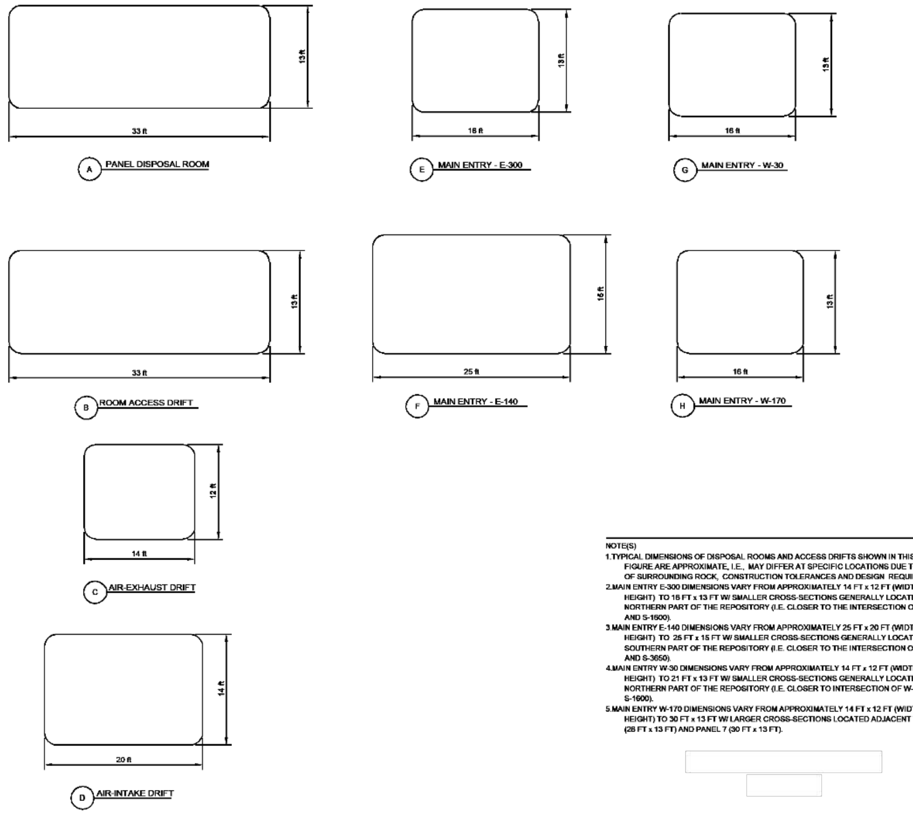
TITLE
WPC LOCATIONS

PROJECT NO. 063-2213NEW
REV. A
DRAWING 262-002



TYPICAL PANEL LAYOUT AND MINED ENTRY LOCATIONS - PLAN-VIEW

SCALE: AS SHOWN



NOTE(S)

1. TYPICAL DIMENSIONS OF DISPOSAL ROOMS AND ACCESS DRIFTS SHOWN IN THIS FIGURE ARE APPROXIMATE, I.E., MAY DIFFER AT SPECIFIC LOCATIONS DUE TO CREEP OF SURROUNDING ROCK, CONSTRUCTION TOLERANCES AND DESIGN REQUIREMENTS.
2. MAIN ENTRY E-300 DIMENSIONS VARY FROM APPROXIMATELY 14 FT x 12 FT (WIDTH x HEIGHT) TO 16 FT x 13 FT W/ SMALLER CROSS-SECTIONS GENERALLY LOCATED IN THE NORTHERN PART OF THE REPOSITORY (I.E. CLOSER TO THE INTERSECTION OF E-300 AND S-1600).
3. MAIN ENTRY E-140 DIMENSIONS VARY FROM APPROXIMATELY 25 FT x 20 FT (WIDTH x HEIGHT) TO 25 FT x 15 FT W/ SMALLER CROSS-SECTIONS GENERALLY LOCATED IN THE SOUTHERN PART OF THE REPOSITORY (I.E. CLOSER TO THE INTERSECTION OF E-140 AND S-3650).
4. MAIN ENTRY W-30 DIMENSIONS VARY FROM APPROXIMATELY 14 FT x 12 FT (WIDTH x HEIGHT) TO 21 FT x 13 FT W/ SMALLER CROSS-SECTIONS GENERALLY LOCATED IN THE NORTHERN PART OF THE REPOSITORY (I.E. CLOSER TO INTERSECTION OF W-30 AND S-1600).
5. MAIN ENTRY W-170 DIMENSIONS VARY FROM APPROXIMATELY 14 FT x 12 FT (WIDTH x HEIGHT) TO 30 FT x 13 FT W/ LARGER CROSS-SECTIONS LOCATED ADJACENT TO PANEL 6 (26 FT x 13 FT) AND PANEL 7 (30 FT x 13 FT).

A 2016-07-18 ISSUED FOR CLIENT REVIEW GG WT TWT GG

REV. DATE DESCRIPTION DESIGNED PREPARED REVIEWED APPROVED

CLIENT
NUCLEAR WASTE PARTNERSHIP LLC

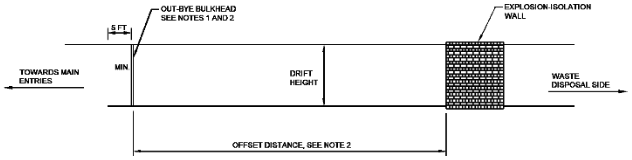
CONSULTANT
Golder Associates

DENVER OFFICE
44 UNION BLVD, STE 300
LAKEWOOD, COLORADO 80228
USA
[1] (303) +980 0540
www.golder.com

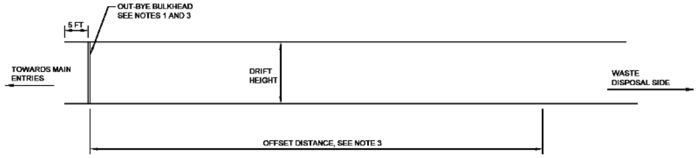
PROJECT
WIPP CLOSURE
GEO-MECHANICAL COMPLIANCE

TITLE
TYPICAL PANEL LAYOUT AND MINED ENTRY CROSS-SECTIONS

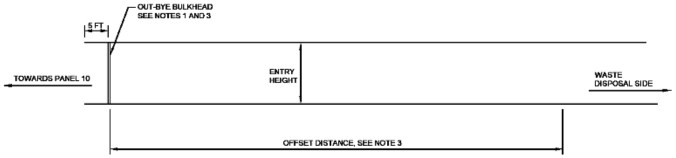
PROJECT NO. 063-2213NEW
REV. A
DRAWING 262-003



WPC-A FOR PANEL ACCESS DRIFTS WITH EXPLOSION-ISOLATION WALLS - PANELS 1, 2 AND 5
NOT TO SCALE



WPC-A FOR PANEL ACCESS DRIFTS W/OUT EXPLOSION-ISOLATION WALLS - PANELS 3, 4, 6, 7 AND 8
NOT TO SCALE



WPC-A FOR PANEL 9 - WASTE PLACEMENT SOUTH OF S-2750
NOT TO SCALE

LEGEND

▨ ROM SALT

NOTES

1.RECESS OUT-BYE BULKHEAD MIN. 5 FT FROM INTERSECTION WITH ANOTHER DRIFT OR MAIN ENTRY.

2.OFFSET OUT-BYE BULKHEAD FROM EXPLOSION-ISOLATION WALL. MINIMUM OFFSET DISTANCE IS 2.0 x ACCESS DRIFT HEIGHT.

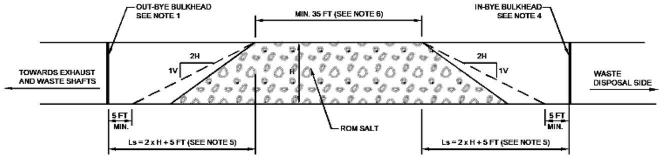
3.FOR PANELS WITHOUT EXPLOSION-ISOLATION WALLS, OFFSET OUT-BYE BULKHEAD FROM WASTE CONTAINERS. MINIMUM OFFSET DISTANCE IS 22 FT.

4.INSTALL IN-BYE BULKHEAD AT LEAST 22 FT FROM THE NEAREST WASTE CONTAINER.

5.ALL WPC-B BULKHEADS SHOULD BE PLACED AT LEAST 5 FT FROM THE TOE OF ROM SALT ASSUMING ROM SALT END SLOPES OF 2H:1V.

6.MINIMUM LENGTH OF WPC-B ROM SALT IS A FUNCTION OF THE MAIN ENTRY WIDTH AS FOLLOWS:

MINIMUM ROM SALT LENGTH - EXCLUDING END SLOPES	
ENTRY WIDTH (FT)	MIN. ROM SALT LENGTH (FT)
1435	
1640	
2050	
2585	



WPC-B FOR PANEL 10 - WASTE PLACEMENT SOUTH OF S-1600
NOT TO SCALE

A2016-07-18ISSUED FOR CLIENT REVIEW GGWTTWTT KJC
REV.DESCRIPTIONDATE DESIGNED PREPAREDREVIEWEDAPPROVED

CLIENT
NUCLEAR WASTE PARTNERSHIP LLC

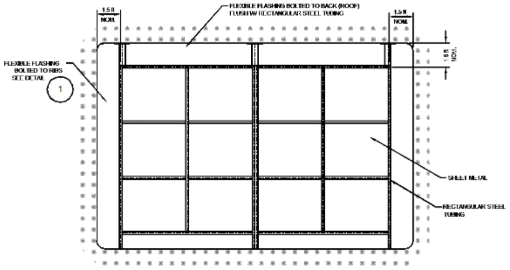
CONSULTANT

DENVER OFFICE
44 UNION BLVD, STE 300
LAKEWOOD, COLORADO 80228
USA
[1] (303) +980 0540
www.golder.com

PROJECT
WIPP CLOSURE
GEO-MECHANICAL COMPLIANCE

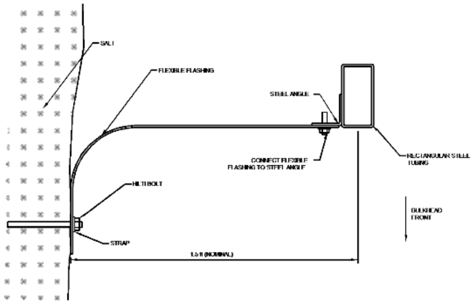
TITLE
WPC DETAILS - BULKHEAD AND ROM SALT LOCATIONS

PROJECT NO.REV. DRAWING
063-2213NEW A 262-004



TYPICAL STEEL BULKHEAD FRONT-VIEW

SCALE: NOT TO SCALE (NTS)



1 FLEXIBLE FLASHING ATTACHMENT

SCALE: NOT TO SCALE (NTS)

A	2016-07-18	ISSUED FOR CLIENT REVIEW	GG	WT	TWT	KJC
REV.	DATE	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED

CLIENT
NUCLEAR WASTE PARTNERSHIP LLC

CONSULTANT
Golder Associates

DENVER OFFICE
44 UNION BLVD, STE 300
LAKEWOOD, COLORADO 80228
USA
[1] (303) +980 0540
www.golder.com

PROJECT
WIPP CLOSURE
GEO-MECHANICAL COMPLIANCE

TITLE
WPC DETAILS - BULKHEAD FRONT-VIEW AND
ATTACHMENT DETAIL

PROJECT NO. 063-2213NEW
REV. A
DRAWING 262-005

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

0 1 in

ATTACHMENT G2

WASTE ISOLATION PILOT PLANT
SHAFT SEALING SYSTEM COMPLIANCE
SUBMITTAL DESIGN REPORT

ATTACHMENT G2

WASTE ISOLATION PILOT PLANT SHAFT SEALING SYSTEM COMPLIANCE SUBMITTAL DESIGN REPORT

ADAPTED FROM:

SAND96-1326/1
DISTRIBUTION UNLIMITED
RELEASE CATEGORY UC-721
PRINTED AUGUST 1996

WASTE ISOLATION PILOT PLANT SHAFT SEALING SYSTEM COMPLIANCE SUBMITTAL DESIGN REPORT

VOLUME 1 OF 2: MAIN REPORT
APPENDICES A AND B

REPOSITORY ISOLATION SYSTEMS DEPARTMENT
SANDIA NATIONAL LABORATORIES
ALBUQUERQUE, NM 87185

Abstract

This report describes a shaft sealing system design for the Waste Isolation Pilot Plant (WIPP), a proposed nuclear waste repository in bedded salt. The system is designed to limit entry of water and release of contaminants through the four existing shafts after the WIPP is decommissioned. The design approach applies redundancy to functional elements and specifies multiple, common, low-permeability materials to reduce uncertainty in performance. The system comprises 13 elements that completely fill the shafts with engineered materials possessing high density and low permeability. Laboratory and field measurements of component properties and performance provide the basis for the design and related evaluations. Hydrologic, mechanical, thermal, and physical features of the system are evaluated in a series of calculations. These evaluations indicate that the design guidance is addressed by effectively limiting transport of fluids within the shafts, thereby limiting transport of hazardous material to regulatory boundaries. Additionally, the use or adaptation of existing technologies for placement of the seal components combined with the use of available, common materials assure that the design can be constructed.

This report was modified to make it a part of the RCRA Facility Permit issued by the New Mexico Environment Department (NMED). The modifications included removal of Appendices C and D from the original document. Although they were important to demonstrate compliance with the performance standards in the hazardous waste regulations, they do not provide plans or procedures that will be implemented under the authority of the Permit. Appendices A, B and E are retained as Attachments to the Permit (Attachments G2-A, G2-B and G2-E). The Figures in this report, which were interspersed in the text in the original document, have been moved to a common section following the References.

Acknowledgments

The work presented in this document represents the combined effort of a number of individuals at Sandia National Laboratories, Parsons Brinckerhoff (under contract AG-4909), INTERA (under contract AG-4910), RE/SPEC (under contract AG-4911), and Tech Reps. The Sandian responsible for the preparation of each section of the report and the lead individual(s) at firms under contract to Sandia that provided technical expertise are recognized below.

Section	Author(s)
Executive Summary	F. D. Hansen, Sandia
Section 1, Introduction	J. R. Tillerson, Sandia
Section 2, Site Geologic, Hydrologic, & Geochemical Setting	A. W. Dennis and S. J. Lambert, Sandia
Section 3, Design Guidance	A. W. Dennis, Sandia
Section 4, Design Description	A. W. Dennis, Sandia
Section 5, Material Specifications	F. D. Hansen, Sandia
Section 6, Construction Techniques	E. H. Ahrens, Sandia
Section 7, Structural Analyses of Shaft Seals	L. D. Hurtado, Sandia; M. C. Loken and L.L. Van Sambeek, RE/SPEC
Section 8, Hydrologic Evaluation of the Shaft Seal System	M. K. Knowles, Sandia; V.A. Kelley, INTERA
Section 9, Conclusions	J. R. Tillerson and A. W. Dennis, Sandia
Appendix A, Material Specifications	F. D. Hansen, Sandia
Appendix B, Shaft Sealing Construction Procedures	E. H. Ahrens, Sandia, with the assistance of Parsons Brinckerhoff Construction and Scheduling staff
Appendix C, Fluid Flow Analyses	M. K. Knowles, Sandia; V.A. Kelley, INTERA
Appendix D, Structural Analyses	L. D. Hurtado, Sandia; M. C. Loken and L. L. Van Sambeek, RE/SPEC

Appendix E, Design Drawings	A. W. Dennis, Sandia; C. D. Mann, Parsons Brinckerhoff, with the assistance of the Parsons Brinckerhoff Design staff

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

T. P. Peterson and S. B. Kmetz, Tech Reps, served as technical editors of this document.

TABLE OF CONTENTS

* Appendices C and D are not included in the facility Permit.

*FIGURES

*NOTE: All Figures are attached following References

TABLES

ACRONYMS

AIS	Air Intake Shaft
AMM	asphalt mastic mix
CFR	Code of Federal Regulations
DOE	Department of Energy
DRZ	disturbed rock zone
EPA	Environmental Protection Agency
HMAC	hot mix asphalt concrete
MDCF	Multimechanism Deformation Coupled Fracture
MD	Munson-Dawson
NMED	New Mexico Environment Department
NMVP	No Migration Variance Petition
PA	performance assessment
PTM	Plug Test Matrix
QA	quality assurance
SMC	Salado Mass Concrete
SPVD	Site Preliminary Design Validation
SSSPT	Small Scale Seal Performance Test
SWCF	Sandia WIPP Central Files
TRU	transuranic
WIPP	Waste Isolation Pilot Plant

Executive Summary

Introduction

This report documents a shaft seal system design developed as part of a submittal to the Environmental Protection Agency (**EPA**) and the New Mexico Environment Department (**NMED**) that will demonstrate regulatory compliance of the Waste Isolation Pilot Plant (**WIPP**) for disposal of transuranic waste. The shaft seal system limits entry of water into the repository and restricts the release of contaminants. Shaft seals address fluid transport paths through the opening itself, along the interface between the seal material and the host rock, and within the disturbed rock surrounding the opening. The entire shaft seal system is described in this Permit Attachment and its three appendices, which include seal material specifications, construction methods, rock mechanics analyses, fluid flow evaluations, and the design drawings. The design represents a culmination of several years of effort that has most recently focused on providing to the EPA and NMED a viable shaft seal system design. Sections of this report and the appendices explore function and performance of the WIPP shaft seal system and provide well documented assurance that such a shaft seal system could be constructed using available materials and methods. The purpose of the shaft seal system is to limit fluid flow within four existing shafts after the repository is decommissioned. Such a seal system would not be implemented for several decades, but to establish that regulatory compliance can be achieved at that future date, a shaft seal system has been designed that exhibits excellent durability and performance and is constructable using existing technology. The design approach is conservative, applying redundancy to functional elements and specifying various common, low-permeability materials to reduce uncertainty in performance. It is recognized that changes in the design described here will occur before construction and that this design is not the only possible combination of materials and construction strategies that would adequately limit fluid flow within the shafts.

Site Setting

One of the U.S. Department of Energy’s (**DOE’s**) site selection criteria is a favorable geologic setting which minimizes fluid flow as a transport mechanism. Groundwater hydrology in the proximity of the WIPP site is characterized by geologic strata with low transmissivity and low hydrologic gradients, both very positive features with regard to sealing shafts. For purposes of performance evaluations, hydrological analyses divide lithologies and requirements into the Rustler Formation (and overlying strata) and the Salado Formation, comprised mostly of salt. The principal design concern is fluid transport phenomena of seal materials and lithologies within the Salado Formation. The rock mechanics setting is an important consideration in terms of system performance. Rock properties affect hydrologic response of the shaft seal system. The stratigraphic section contains lithologies that exhibit brittle and ductile behavior. A zone of rock around the shafts is disturbed owing to the creation of the opening. The disturbed rock zone (**DRZ**) is an important design consideration because it possesses higher permeability than intact rock. Host rock response and its potential to fracture, flow, and heal around WIPP shaft openings are relevant to the performance of the shaft seal system.

Design Guidance

Use of both engineered and natural barriers to isolate wastes from the accessible environment is required by 20.4.1.500 NMAC (incorporating 40 CFR §§264.111 and 264.601) and 40 CFR §191.14(d). The use of engineered barriers to prevent or substantially delay movement of water, hazardous constituents, or radionuclides toward the accessible environment is required by 20.4.1.500 NMAC (incorporating 40 CFR §§264.111 and 264.601) and 40 CFR §194.44. Hazardous constituent release performance standards are specified in Permit Part 5 and 20.4.1.500 NMAC (incorporating 40 CFR §§264.111(b), 264.601(a), and 264 Subpart F). Radionuclide release limits are specified in 40 CFR §191 for the entire repository system (EPA, 1996a; 1996b). Design guidance for the shaft seal system addresses the need for the WIPP to comply with system requirements and to follow accepted engineering practices using demonstrated technology. Design guidance is categorized below:

- limit hazardous constituents reaching regulatory boundaries,
- restrict groundwater flow through the sealing system,
- use materials possessing mechanical and chemical compatibility,
- protect against structural failure of system components,
- limit subsidence and prevent accidental entry, and
- utilize available construction methods and materials.

Discussions of the design presented in the text of this report and the details presented in the appendices respond to these qualitative design guidelines. The shaft seal system design was completed under a Quality Assurance program that includes review by independent, qualified experts to assure the best possible information is provided to the DOE on selection of engineered barriers (40 CFR §194.27). Technical reviewers examined the complete design including conceptual, mathematical, and numerical models and computer codes (40 CFR §194.26). The design reduces the impact of uncertainty associated with any particular element by using multiple sealing system components and by using components constructed from different materials.

Design Description

The shaft sealing system comprises 13 elements that completely fill the shaft with engineered materials possessing high density and low permeability. Salado Formation components provide the primary regulatory barrier by limiting fluid transport along the shaft during and beyond the 10,000-year regulatory period. Components within the Rustler Formation limit commingling between brine-bearing members, as required by state regulations. Components from the Rustler to the surface fill the shaft with common materials of high density, consistent with good engineering practice. A synopsis of each component is given below.

Shaft Station Monolith. At the bottom of each shaft a salt-saturated concrete monolith supports the local roof. A salt-saturated concrete, called Salado Mass Concrete (**SMC**), is specified and is placed using a conventional slickline construction procedure where the concrete is batched at the surface. SMC has been tailored to match site conditions. The salt-handling shaft and the waste-handling shaft have sumps which also will be filled with salt-saturated concrete as part of the monolith.

Clay Columns. A sodium bentonite is used for three compacted clay components in the Salado and Rustler Formations. Although alternative construction specifications are viable, labor-intensive placement of compressed blocks is specified because of proven performance. Clay columns effectively limit brine movement from the time they are placed to beyond the 10,000-year regulatory period. Stiffness of the clay is sufficient to promote healing of fractures in the surrounding rock salt near the bottom of the shafts, thus removing the proximal DRZ as a potential pathway. The Rustler clay column limits brine communication between the Magenta and Culebra Members of the Rustler Formation.

Concrete-Asphalt Waterstop Components. Concrete-asphalt waterstop components comprise three elements: an upper concrete plug, a central asphalt waterstop, and a lower concrete plug. Three such components are located within the Salado Formation. These concrete-asphalt waterstop components provide independent shaft cross-section and DRZ seals that limit fluid transport, either downward or upward. Concrete fills irregularities in the shaft wall, while use of the salt-saturated concrete assures good bonding with salt. Salt creep against the rigid concrete components establishes a compressive stress state and promotes early healing of the salt DRZ surrounding the concrete plugs. The asphalt intersects the shaft cross section and the DRZ.

Compacted Salt Column. Each shaft seal includes a column of compacted WIPP salt with 1.5 percent weight water added to the natural material. Construction demonstrations have shown that mine-run WIPP salt can be dynamically compacted to a density equivalent to approximately 90% of the average density of intact Salado salt. The remaining void space is removed through consolidation caused by creep closure. The salt column becomes less permeable as density increases. The location of the compacted salt column near the bottom of the shaft assures the fastest achievable consolidation of the compacted salt column after closure of the repository. Analyses indicate that the salt column becomes an effective long-term barrier in under 100 years.

Asphalt Column. An asphalt-aggregate mixture is specified for the asphalt column, which bridges the Rustler/Salado contact and provides a seal essentially impermeable to brine for the shaft cross-section and the shaft wall interface. All asphalt is placed with a heated slickline.

Concrete Plugs. A concrete plug is located just above the asphalt column and keyed into the surrounding rock. Mass concrete is separated from the cooling asphalt column with a layer of fibercrete, which permits work to begin on the overlying clay column before the asphalt has completely cooled. Another concrete plug is located near the surface, extending downward from the top of the Dewey Lake Redbeds.

Earthen Fill. The upper shaft is filled with locally available earthen fill. Most of the fill is dynamically compacted (the same method used to construct the salt column) to a density approximating the surrounding lithologies. The uppermost earthen fill is compacted with a sheepsfoot roller or vibratory plate compactor.

Structural Analysis

Structural issues pertaining to the shaft seal system have been evaluated. Mechanical, thermal, physical, and hydrological features of the system are included in a broad suite of structural calculations. Conventional structural mechanics applications would normally calculate load on system elements and compare the loads to failure criteria. Several such conventional calculations have been performed and show that the seal elements exist in a favorable, compressive stress state that is low in comparison to the strength of the seal materials. Thermal analyses have been performed to examine the effects of concrete heat of hydration and heat transfer for asphalt elements. Coupling between damaged rock and fluid flow and between the density and permeability of the consolidating salt column is evaluated within the scope of structural calculations. The appendices provide descriptions of various structural calculations conducted as part of the design study. The purpose of each calculation varies; however, the calculations generally address one or more of the following concerns: (1) stability of the component, (2) influences of the component on hydrological properties of the seal and surrounding rock, or (3) construction methods. Stability calculations address:

- potential for thermal cracking of concrete;
- structural loads on seal components resulting from salt creep, gravity, swelling clay, dynamic compaction, or possible repository-generated gas pressures.

Structural calculations defining input conditions to hydrological calculations include:

- spatial extent of the DRZ within the Salado Formation salt beds as a function of depth, time, and seal material;
- fracturing and DRZ development within Salado Formation interbeds;
- shaft-closure induced consolidation of compacted salt columns; and
- impact of pore pressures on salt consolidation.

Construction analyses examine:

- placement and structural performance of asphalt waterstops, and
- potential subsidence reduction through backfilling the shaft station areas.

Structural calculations model shaft features including representation of the host rock and its damaged zone as well as the seal materials themselves. Two important structural calculations discussed below are unique to shaft seal applications.

DRZ Behavior. The development and subsequent healing of a DRZ that forms in the rock mass surrounding the WIPP shafts is a significant concern in the seal design. It is well known that a DRZ will develop in rock salt adjacent to the shaft upon excavation. Placement of rigid components in the shaft promotes healing within the salt DRZ as seal elements restrain inward creep and reduce the stress difference. Two computer models to calculate development and extent of the salt DRZ are used. The first model uses a ratio of stress invariants to predict fracture; the second approach uses a damage stress criterion. The temporal and spatial extent of the DRZ along the entire shaft length is evaluated. Several analyses are performed to examine DRZ behavior of the rock salt surrounding the shaft. The time-dependent DRZ development and subsequent healing in the Salado salt surrounding each of the four seal materials are considered. All seal materials below a depth of about 300 m provide sufficient rigidity to heal the DRZ, a phenomenon that occurs quickly around rigid components near the shaft bottom. An extensive calculation is made of construction effects on the DRZ during placement of the asphalt-concrete waterstops. The time-dependent development of the DRZ within anhydrite and polyhalite interbeds of the Salado Formation is calculated. For all interbeds, the factor of safety against shear or tensile fracturing increases with depth into the rock surrounding the shaft wall. These results indicate that a continuous DRZ will not develop in nonsalt Salado rocks. Rock mechanics analysis also determines which of the near surface lithologies fracture in the proximity of the shaft. Results from these rock mechanics analyses are used as input conditions for the fluid-flow analyses.

Compacted Salt Behavior. Unique application of crushed salt as a seal component required development of a constitutive model for salt reconsolidation. The model developed includes a nonlinear elastic component and a creep consolidation component. The nonlinear elastic modulus is density-dependent, based on laboratory test data performed on WIPP crushed salt. Creep consolidation behavior of crushed salt is based on three candidate models whose parameters are obtained from model fitting to hydrostatic and shear consolidation test data gathered for WIPP crushed salt. The model for consolidating crushed salt is used to predict permeability of the salt column. The seal system prevents fluid transport to the consolidating salt column to ensure that pore pressure does not unacceptably inhibit the reconsolidation process. Calculations made to estimate fractional density of the crushed salt seal as a function of time, depth, and pore pressure show consolidation time increases as pore pressure increases, as expected. At a constant pore pressure of one atmosphere, compacted salt will increase from its initial fractional density of 90% to 96% within 40, 80, and 120 years after placement at the bottom, middle, and top of the salt component, respectively. At a fractional density of 96%, the permeability of reconsolidating salt is approximately 10^{-18} m^2. A pore pressure of 2 MPa increases times required to achieve a fractional density of 96% to 92 years, 205 years, and 560 years at the bottom, middle, and top of the crushed salt column, respectively. A pore pressure of 4 MPa would effectively prevent reconsolidation of the crushed salt within 1,000 years. Fluid flow calculations show only minimal transport of fluids to the salt column, so pore pressure equilibrium in the consolidating salt does not occur before low permeabilities (~10^{-18} m^2) are achieved.

Hydrologic Evaluations

The ability of the shaft seal system to satisfy design guidance is determined by the performance of the actual seal components within the physical setting in which they are constructed. Important elements of the physical setting are hydraulic gradients of the region, properties of the lithologic units surrounding a given seal component, and potential gas generation within the repository. Hydrologic evaluations focus on processes that could result in fluid flow through the shaft seal system and the ability of the seal system to limit any such flow. Transport of radiological or hazardous constituents will be limited if the carrier fluids are similarly limited. Physical processes that could impact seal system performance have been incorporated into four models. These models evaluate: (1) downward migration of groundwater from the Rustler Formation, (2) gas migration and reconsolidation of the crushed salt seal component, (3) upward migration of brines from the repository, and (4) flow between water-bearing zones in the Rustler Formation.

Downward Migration of Rustler Groundwater. The shaft seal system is designed to limit groundwater flowing into and through the shaft sealing system. The principal source of groundwater to the seal system is the Culebra Member of the Rustler Formation. No significant sources of groundwater exist within the Salado Formation; however, brine seepage has been noted at a number of the marker beds and is included in the models. Downward migration of Rustler groundwater is limited to ensure that liquid saturation of the compacted salt column does not impact the consolidation process and to limit quantities of brine reaching the repository horizon. Consolidation of the compacted salt column will be most rapid immediately following seal construction. Simulations conducted for the 200-year period following closure demonstrate that, during this initial period, downward migration of Rustler groundwater is insufficient to impact the consolidation process. Rock mechanics analyses show that this period encompasses the reconsolidation process. Lateral migration of brine through the marker beds is quantified in the analysis and shown to be inconsequential. At steady-state, the flow rate is most dependent on permeability of the system. Potential flow paths within the seal system consist of the seal material, an interface with the surrounding rock, and the host rock DRZ. Low permeability is specified for the engineered materials, and construction methods ensure a tight interface. Thus the flow path most likely to impact performance is the DRZ. Effects of the DRZ and sensitivity of the seal system performance to both engineered and host rock barriers show that the DRZ is successfully mitigated by the proposed design.

Gas Migration and Salt Column Consolidation. A multi-phase flow model of the lower seal system evaluates the performance of components extending from the middle concrete-asphalt waterstop located at the top of the salt column to the repository horizon for 200 years following closure. During this time period, the principal fluid sources to the model consist of potential gas generated by the waste and lateral brine migration within the Salado Formation. The predicted downward migration of a small quantity of Rustler groundwater (discussed above) is included in this analysis. Effects of gas generation are evaluated for three different repository repressurization scenarios, which simulate pressures as high as 14 MPa. Model results predict that high repository pressures do not produce appreciable differences in the volume of gas migration over the 200-year simulation period. Relatively low gas flow is a result of the low permeability and rapid healing of the DRZ around the lower concrete-asphalt waterstop.

Upward Migration of Brine. The Salado Formation is overpressurized with respect to the measured heads in the Rustler, and upward migration of contaminated brines could occur through an inadequately sealed shaft. Results from the model discussed above demonstrate that the crushed salt seal will reconsolidate to a very low permeability within 100 years following repository closure. Structural results show that the DRZ surrounding the long-term clay and crushed salt seal components will completely heal within the first several decades. Model calculations predict that very little brine flows from the repository to the Rustler/Salado contact.

Intra-Rustler Flow. Based on head differences between the various members of the Rustler Formation, nonhydrostatic conditions exist within the Rustler Formation. Therefore, the potential exists for vertical flow within water-bearing strata within the Rustler. The two units with the greatest transmissivity within the Rustler are the Culebra and the Magenta dolomites, which have the greatest potential for interflow. The relatively low undisturbed permeabilities of the mudstone and anhydrite units separating the Culebra and the Magenta naturally limit crossflow. However, the construction and subsequent closure of the shaft provide a potentially permeable vertical conduit connecting water-bearing units. The primary motivation for limiting formation crossflow within the Rustler is to prevent mixing of formation waters within the Rustler, as required by State of New Mexico statute. Commonly, such an undertaking would limit migration of higher dissolved solids (high-density) groundwater into lower dissolved solids groundwater. In the vicinity of the WIPP site, the Culebra has a higher density groundwater than the Magenta, and the potential for fluid migration between the two most transmissive units is from the unit with the lower total dissolved solids to the unit with the higher dissolved solids. This calculation shows that potential flow rates between the Culebra and the Magenta are insignificant. Under expected conditions, intra-Rustler flow is expected to be of such a limited quantity that (1) it will not affect either the hydraulic or chemical regime within the Culebra or the Magenta and (2) it will not be detrimental to the seal system itself.

Concluding Remarks

The principal conclusion is that an effective, implementable shaft seal system has been designed for the WIPP. Design guidance is addressed by limiting any transport of fluids within the shaft, thereby limiting transport of hazardous material to regulatory boundaries. The application or adaptation of existing technologies for placement of seal components combined with the use of available, common materials provide confidence that the design can be constructed. The structural setting for seal elements is compressive, with shear stresses well below the strength of seal materials. Because of the favorable hydrologic regime coupled with the low intrinsic permeability of seal materials, long-term stability of the shaft seal system is expected. Credibility of these conclusions is bolstered by the basic design approach of using multiple components to perform each sealing function and by using extensive lengths within the shafts to effect a sealing system. The shaft seal system adequately meets design requirements and can be constructed.

1. Introduction

1.1 Purpose of Compliance Submittal Design Report

This report documents the detailed design of the shaft sealing system for the Waste Isolation Pilot Plant (**WIPP**). The design documented in this report builds on the concepts and preliminary evaluations presented in the Sealing System Design Report issued in 1995 (DOE, 1995). The report contains a detailed description of the design and associated construction procedures, material specifications, analyses of structural and fluid flow performance, and design drawings. The design documented in this report forms the basis for the shaft sealing system which will be constructed under the authority of the hazardous waste facility Permit issued by NMED and as required by 20.4.1.500 NMAC (incorporating 40 CFR §§264.111(b) and 264.601(a)).

1.2 WIPP Description

The WIPP is designed as a full-scale, mined geological repository for the safe management, storage, and disposal of transuranic (**TRU**) radioactive wastes and TRU mixed wastes generated by US government defense programs. The facility is located near Carlsbad, New Mexico, in the southeastern portion of the state. The underground facility (Figure G2-1) consists of a series of shafts, drifts, panels, and disposal rooms. Four shafts, ranging in diameter from 3.5 to 6.1 m, connect the disposal horizon to the surface. Sealing of these four shafts is the focus of this report.

The disposal horizon is at a depth of approximately 655 m in bedded halite within the Salado Formation. The Salado is a sequence of bedded evaporites approximately 600 m thick that were deposited during the Permian Period, which ended about 225 million years ago. Salado salt has been identified as a good geologic medium to host a nuclear waste repository because of several favorable characteristics. The characteristics present at the WIPP site include very low permeability, vertical and lateral stratigraphic extent, tectonic stability, and the ability of salt to creep and ultimately entomb material placed in excavated openings. Creep closure also plays an important role in the shaft sealing strategy.

The WIPP facility must be determined to be in compliance with applicable regulations prior to the disposal of waste. After the facility meets the regulatory requirements, disposal rooms will be filled with containers holding TRU wastes of various forms. Wastes placed in the drifts and disposal rooms will be at least 150 m from the shafts. Regulatory requirements include use of both engineered and natural barriers to limit migration of hazardous constituents from the repository to the accessible environment. The shaft seals are part of the engineered barriers.

1.3 Performance Objective for WIPP Shaft Seal System

Each of the four shafts from the surface to the underground repository must be sealed to limit hazardous material release to the accessible environment and to limit groundwater flow into the repository. Although the seals will be permanent, the regulatory period applicable to the repository system analyses is 10,000 years.

1.4 Sealing System Design Development Process

This report presents a conservative approach to shaft sealing system design. Shaft sealing system performance plays a crucial role in meeting regulatory radionuclide and hazardous constituents release requirements. Although all engineering materials have uncertainties in properties, a combination of available, low-permeability materials can provide an effective sealing system. To reduce the impact of system uncertainties and to provide a high level of assurance of compliance, numerous components are used in this sealing system. Components in this design include long columns of clay, densely compacted crushed salt, a waterstop of asphaltic material sandwiched between massive low-permeability concrete plugs, a column of asphalt, and a column of earthen fill. Different materials perform identical functions within the design, thereby adding confidence in the system performance through redundancy.

The design is based on common materials and construction methods that utilize available technologies. When choosing materials, emphasis was given to permeability characteristics and mechanical properties of seal materials. However, the system is also chemically and physically compatible with the host formations, enhancing long-term performance.

Recent laboratory experiments, construction demonstrations, and field test results have been added to the broad and credible database and have supported advances in modeling capability. Results from a series of multi-year, in situ, small-scale seal performance tests show that bentonite and concrete seals maintain very low permeabilities and show no deleterious effects in the WIPP environment. A large-scale dynamic compaction demonstration established that crushed salt can be successfully compacted. Laboratory tests show that compacted crushed salt consolidates through creep closure of the shaft from initial conditions achieved in dynamic compaction to a dense salt mass with regions where permeability approaches that of in situ salt. These technological advances have allowed more credible analysis of the shaft sealing system.

The design was developed through an interactive process involving a design team consisting of technical specialists in the design and construction of underground facilities, materials behavior, rock mechanics analysis, and fluid flow analysis. The design team included specialists drawn from the staff of Sandia National Laboratories, Parsons Brinckerhoff Quade and Douglas, Inc. (contract number AG-4909), INTERA, Inc. (contract number AG-4910), and RE/SPEC Inc. (contract number AG-4911), with management by Sandia National Laboratories. The contractors developed a quality assurance program consistent with the Sandia National Laboratories Quality Assurance Program Description for the WIPP project. All three contractors received quality assurance support visits and were audited through the Sandia National Laboratories audit and assessment program. Quality assurance (**QA**) documentation is maintained in the Sandia National Laboratories WIPP Central Files. Access to project files for each contractor can be accomplished using the contract numbers specified above. In addition to the contractor support, technical input was obtained from consultants in various technical specialty areas.

Formal preliminary and final design reviews have been conducted on the technical information documented in the report. In addition, technical, management, and QA reviews have been performed on this report. Documentation is in the WIPP Central File.

It is recognized that additional information, such as on specific seal material or formation characteristics, on the sensitivity of system performance to component properties, on placement effectiveness, and on long-term performance, could be used to simplify the design and perhaps reduce the length or number of components. Such design optimization and associated simplifications are left to future research that may be used to update the compliance evaluations completed between now and the time of actual seal emplacement.

1.5 Organization of Document

This report contains an Executive Summary, 10 sections, and 5 appendices. The body of the report does not generally contain detailed backup information; this information is incorporated by reference or in the appendices.

The Executive Summary is a synopsis of the design and the supporting discussions related to seal materials, construction procedures, structural analyses, and fluid flow analyses. Introductory material in Section 1 sets the stage for and provides a “road map” to the remainder of the report.

Site characteristics that detail the setting into which the seals would be placed are documented in Section 2. These characteristics include the WIPP geology and stratigraphy for both the region and the shafts as well as a brief discussion of rock mechanics considerations of the site that impact the sealing system. Regional and local characteristics of the hydrologic and geochemical settings are also briefly discussed.

Section 3 presents the design guidance used for development of the shaft sealing system design. Seal-related guidance from applicable regulations is briefly described. The design guidance is then provided along with the design approach used to implement the guidance. The guidance forms the basis both for the design and for evaluations of the sealing system presented in other sections.

The shaft sealing system is documented in Section 4; detailed drawings for the design are provided in Appendix G2-E. The seal components, their design, and their functions are discussed for the Salado, the Rustler, and the overlying formations.

The sealing materials are described briefly in Section 5, with more detail provided in the materials specifications (Appendix G2-A). The materials used in the various seal components are discussed along with the reasons they are expected to function as intended. Material properties including permeability, strength, and mechanical constitutive response are given for each material. Brief discussions of expected compatibility, performance, construction techniques, and other characteristics relevant to the WIPP setting are also given.

Section 6 contains a brief description of the construction techniques proposed for use. General site and sealing preparation activities are discussed, including construction of a multi-deck stage for use throughout the placement of the components. Construction procedures to be used for the various types of components are then summarized based on the more detailed discussions provided in Appendix G2-B.

Section 7 summarizes structural analyses performed to assess the ability of the shaft sealing system to function in accordance with the design guidance provided in Section 3 and to provide input to hydrological calculations. The methods and computer programs, the models used to simulate the behavior of the seal materials and surrounding salt, and the results of the analyses are discussed. Particular emphasis is placed on the evaluations of the behavior of the disturbed rock zone. Details of the structural analyses are presented in Appendix D of *Waste Isolation Pilot Plant Shaft Sealing System Compliance Submittal Design Report ("Compliance Submittal Design Report")* (Sandia, 1996). Section 8 summarizes fluid flow analyses performed to assess the ability of the shaft sealing system to function in accordance with the design guidance provided in Section 3. Hydrologic evaluations are focused on processes that could result in fluid flow through the shaft seal system and the ability of the seal system to limit such flow. Processes evaluated are downward migration of groundwater from the overlying formation, gas migration and reconsolidation of the crushed salt component, upward migration of brines from the repository, and flow between water-bearing zones in the overlying formation. Hydrologic models are described and the results are discussed as they relate to satisfying the design guidance, with extensive reference to Appendix C of the Compliance Submittal Design Report (Sandia, 1996) that documents details of the flow analyses. Conclusions drawn about the performance of the WIPP shaft sealing system are described in Section 9. The principal conclusion that an effective, implementable design has been presented is based on the presentations in the previous sections. A reference list that documents principal references used in developing this design is then provided.

The three appendices that follow provide details related to the following subjects:

Appendix G2-A — Material Specification
Appendix G2-B — Shaft Sealing Construction Procedures
Appendix G2-E — Design Drawings (separate volume)

1.6 Systems of Measurement

Two systems of measurement are used in this document and its appendices. Both the System International d'Unites (SI) and English Gravitational (*fps* units) system are used. This usage corresponds to common practice in the United States, where SI units are used for scientific studies and *fps* units are used for facility design, construction materials, codes, and standards. Dual dimensioning is used in the design description and other areas where this use will aid the reader.

2. Site Geologic, Hydrologic, and Geochemical Setting

The site characteristics relevant to the sealing system are discussed in this section. The location and geologic setting of the WIPP are discussed first to provide background. The geology and stratigraphy, which affect the shafts, are then discussed. The hydrologic and geochemical settings, which influence the seals, are described last.

2.1 Introduction

The WIPP site is located in an area of semiarid rangeland in southeastern New Mexico. The nearest major population center is Carlsbad, 42 km west of the WIPP. Two smaller communities, Loving and Malaga, are about 33 km to the southwest. Population density close to the WIPP is very low: fewer than 30 permanent residents live within a 16-km radius.

2.2 Site Geologic Setting

Geologically the WIPP is located in the Delaware Basin, an elongated depression that extends from just north of Carlsbad southward into Texas. The Delaware Basin is bounded by the Capitan Reef (see Figure G2-2). The basin covers over 33,000 km^2 and is filled with sedimentary rocks to depths of 7,300 m (Hills, 1984). Rock units of the Delaware Basin (representing the Permian System through the Quaternary System) are listed in Figure G2-3.

Minimal tectonic activity has occurred in the region since the Permian Period (Powers et al., 1978). Faulting during the late Tertiary Period formed the Guadalupe and Delaware Mountains along the western edge of the basin. The most recent igneous activity in the area occurred during the mid-Tertiary Period about 35 million years ago and is evidenced by a dike in the subsurface 16 km northwest of the WIPP. Major volcanic activity last occurred more than 1 billion years ago during Precambrian time (Powers et al., 1978). None of these processes affected the Salado Formation at the WIPP. Therefore, seismic-related design criteria are not included in the current seal systems design guidelines.

2.2.1 Regional WIPP Geology and Stratigraphy

The Delaware Basin began forming with crustal subsidence during the Pennsylvanian Period approximately 300 million years ago. Relatively rapid subsidence over a period of about 14 million years resulted in the deposition of a sequence of deep-water sandstones, shales, and limestones rimmed by shallow-water limestone reefs such as the Capitan Reef (see Figure G2-2). Subsidence slowed during the late Permian Period. Evaporite deposits of the Castile Formation and the Salado Formation (which hosts the WIPP underground workings) filled the basin and extended over the reef margins. The evaporites, carbonates, and clastic rocks of the Rustler Formation and the Dewey Lake Redbeds were deposited above the Salado Formation near the end of the Permian Period. The Santa Rosa and Gatuña Formations were deposited after the close of the Permian Period.

From the surface downward to the repository horizon the stratigraphic units are the Quaternary surface sand sediments, Gatuña Formation, Santa Rosa Formation, Dewey Lake Redbeds, Rustler Formation, and Salado Formation. Three principal stratigraphic units (the Dewey Lake Redbeds, the Rustler Formation, and the Salado Formation) comprise all but the upper 15 to 30 m (50 to 100 ft) of the geologic section above the WIPP facility.

The Dewey Lake Redbeds consist of alternating layers of reddish-brown, fine-grained sandstone and siltstone cemented with calcite and gypsum (Vine, 1963). The Rustler Formation lies below the Dewey Lake Redbeds; this formation, the youngest of the Late Permian evaporite sequence, includes units that provide potential pathways for radionuclide migration from the WIPP. The five units of the Rustler, from youngest to oldest, are: (1) the Forty-niner Member, (2) the Magenta Dolomite Member, (3) the Tamarisk Member, (4) the Culebra Dolomite Member, and (5) an unnamed lower member.

The 250-million-year-old Salado Formation lies below the Rustler Formation. This unit is about 600 m thick and consists of three informal members. From youngest to oldest, they are: (1) an upper member (unnamed) composed of reddish-orange to brown halite interbedded with polyhalite, anhydrite, and sandstone, (2) a middle member (the McNutt Potash Zone) composed of reddish-orange and brown halite with deposits of sylvite and langbeinite; and (3) a lower member (unnamed) composed of mostly halite with lesser amounts of anhydrite, polyhalite, and glauberite, with some layers of fine clastic material. These lithologic layers are nearly horizontal at the WIPP, with a regional dip of less than one degree. The WIPP repository is located in the unnamed lower member of the Salado Formation, approximately 655 m (2150 ft) below the ground surface.

2.2.2 Local WIPP Stratigraphy

The generalized stratigraphy of the WIPP site, with the location of the repository, is shown in Figure G2-4. To establish the geologic framework required for the design of the WIPP facility shaft sealing system, an evaluation was performed to assess the geologic conditions existing in and between the shafts, where the individual shaft sealing systems will eventually be emplaced (DOE, 1995: Appendix G2-A). The study evaluated shaft stratigraphy, regional groundwater occurrence, brine occurrence in the exposed Salado Formation section, and the consistency between recorded data and actual field data.

Four shafts connect the WIPP underground workings to the surface, the (1) Air Intake Shaft (**AIS**), (2) Exhaust Shaft, (3) Salt Handling Shaft, and (4) Waste Shaft. Stratigraphic correlation and evaluation of the unit contacts show that lithologic units occur at approximately the same levels in all four shaft locations. Some stratigraphic contact elevations vary because of regional structure and stratigraphic thinning and thickening of units. However, the majority of the stratigraphic contacts used to date are suitable for engineering design reference because they intersect all four shafts.

2.2.3 Rock Mechanics Setting

The WIPP stratigraphy includes rock types that exhibit both brittle and ductile behaviors. The majority of the stratigraphy intercepted by the shafts consists of the Salado Formation, which is predominantly halite. The primary mechanical behavior of halitic rocks is creep. Except near free surfaces (such as the shaft wall), the salt rocks will remain tight and undisturbed despite the long-term creep deformation they sustain. The other rock types within the Salado Formation are anhydrites and polyhalites. These two rock types are typically brittle, stiff, and exhibit high strength in laboratory tests. The structural strength of particular anhydritic rock layers, however, depends on the thickness of the layers, which range from thin (<1 m) to fairly thick (10 m or more). Brittle failure of these noncreeping rocks can occur as they restrain, or attempt to restrain, the creep of the salt above and below the stiff layer. Although thick layers can resist the induced stresses, thin layers are fractured in tension by the salt creep. Because the deformation in the bounding salt is time dependent, the damage in the brittle rock is also time dependent.

Above the Salado Formation, the Rustler Formation stratigraphy consists of relatively strong limestones and siltstones. The shaft excavation is the only significant disturbance to these rocks. Any subsurface subsidence (deformation) or loading induced by the presence of the repository are negligible in a rock mechanics sense.

Regardless of rock type, the shafts create a disturbed zone in the surrounding rock. Microfracturing will occur in the rock adjacent to the shaft wall, where confining stresses are low or nonexistent. The extent of the zone depends on the rock strength and the prevailing stress state, which is depth dependent. In the salt rocks, microfracturing occurs to form the disturbed zone both at the time of excavation and later as dilatant creep deformations occur. In the brittle rocks, the disturbance occurs at the time of excavation and does not worsen with time. The extent of disturbed zones in the salt and brittle rocks can be calculated, as will be described in Section 7 and Appendix D in the Compliance Submittal Design Report (Sandia, 1996).

Preventing the salt surrounding the shafts from creeping causes reintroduction of stresses that reverse the damage process and cause healing (Van Sambeek et al., 1993). The seal system design relies on this principle for sealing the disturbed zone in salt. In the brittle rocks, grouting of the damage is a viable means of reducing the interconnected fractures that increase the permeability of the rock.

2.3 Site Hydrologic Setting

The WIPP shafts penetrate approximately 655 m (2150 ft) of sediments and rocks. From a hydrogeologic perspective, relevant information includes the permeability of the water-bearing units, the thickness of the water-bearing units, and the observed vertical pressure (head) gradients expected to exist after shaft construction and ambient pressure recovery. This section will discuss these three aspects of the site hydrogeology. The geochemistry of the pore fluids adjacent to the shaft system is also important hydrogeologic information and will be provided in Section 2.4.

2.3.1 Hydrostratigraphy

The WIPP shafts penetrate Quaternary surface sediments, the Gatuña Formation, the Santa Rosa Formation, the Dewey Lake Redbeds, the Rustler Formation, and the Salado Formation. The Rustler Formation contains the only laterally-persistent water-bearing units in the WIPP vicinity. As a result, flow-field characterization, regional flow-modeling, and performance assessment off-site release scenarios focus on the Rustler Formation. The hydrogeology of the stratigraphic units in contact with the upper portion of the AIS sealing system is fairly well known from detailed hydraulic testing of the Rustler Formation at well H-16 located 17 m from the AIS (Beauheim, 1987). The H-16 borehole was drilled in July and August 1987 to monitor the hydraulic responses of the Rustler members to the drilling and construction of the AIS. During the drilling of H-16, each member of the Rustler Formation was cored. In addition, detailed drill-stem, pulse, and slug hydraulic tests were performed in H-16 on the members of the Rustler. Through the detailed testing program at H-16, the permeability of each of the Rustler members was estimated. Detailed mapping of the AIS by Holt and Powers (1990) and other investigators provided information on the location of wet zones and weeps within the Salado Formation. This information will be summarized below. The reader, unless particularly interested in this subject, should proceed to Section 2.3.2.

Water-bearing zones have been observed in units above the Rustler Formation in the WIPP site vicinity. However, drilling in the Dewey Lake Redbeds has not identified any continuous saturated units at the WIPP site. Water-bearing units within stratigraphic intervals above the Rustler are typically perched saturated zones of very low yield. Thin perched groundwater intervals have been encountered in WIPP wells H-1, H-2, and H-3 (Mercer and Orr, 1979). The only Dewey Lake Redbed wells that have sufficient yields for watering livestock are the James Ranch wells, the Pocket well, and the Fairfield well (Brinster, 1991). These wells are located to the south of the WIPP and are not in the immediate vicinity of the WIPP shafts.

The Dewey Lake Redbeds overlie the Rustler Formation. The Rustler is composed of five members defined by lithology. These are, in ascending order, the unnamed lower member, the Culebra dolomite, the Tamarisk, the Magenta dolomite, and the Forty-niner (see Figure G2-4). Of these five members, the unnamed lower member, the Culebra, and the Magenta are the most transmissive units in the Rustler. The Tamarisk and the Forty-niner are aquitards within the Rustler and have very low permeabilities relative to the three members listed above.

To the east of the shafts in Nash Draw, the Rustler/Salado contact has been observed to be permeable and water-bearing. This contact unit has been referred to as the “brine aquifer” (Mercer, 1983). The brine aquifer is not reported to exist in the vicinity of the shafts. The hydraulic conductivity of the Rustler/Salado contact in the vicinity of the shafts is reported to be approximately 4×10^{-11} m/s, which is equivalent to a permeability of 6×10^{-18} m^2 using reference brine fluid properties (Brinster, 1991). The unnamed lower member was hydraulic tested at well H-16 in close proximity to the AIS. The maximum permeability of the unnamed lower member was interpreted to be 2.2×10^{-18} m^2 and was attributed to the unnamed lower member claystone by Beauheim (1987), which correlates to the transition and bioturbated clastic zones of Holt and Powers (1990).

The Culebra Dolomite Member is the most transmissive member of the Rustler Formation in the vicinity of the WIPP site and is the most transmissive saturated unit in contact with the shaft sealing system. The Culebra is an argillaceous dolomicrite which contains secondary porosity in the form of abundant vugs and fractures. The permeability of the Culebra varies greatly in the vicinity of the WIPP and is controlled by the condition of the secondary porosity (fractures). The permeability of the Culebra in the vicinity of the shafts is approximately 2.1×10^{-14} m^2.

The Tamarisk Member is composed primarily of massive, lithified anhydrite, including anhydrite 2, mudstone 3, and anhydrite 3. Testing of the Tamarisk at H-16 was unsuccessful. The estimated transmissivity of the Tamarisk at H-16 is one to two orders of magnitude lower than the least-transmissive unit successfully tested at H-16, which results in a permeability range from 4.6×10^{-20} to 4.6×10^{-19} m^2. Anhydrites in the Rustler have an approximate permeability of 1×10^{-19} m^2. The permeability of mudstone 3 is 1.5×10^{-19} m^2 (Brinster, 1991).

The Magenta is a dolomite that is typically less permeable than the Culebra. The Magenta Dolomite Member overlies the Tamarisk Member. The Magenta is an indurated, gypsiferous, arenaceous, dolomite that Holt and Powers (1990) classify as a dolarenite. The dolomite grains are primarily composed of silt to fine sand-sized clasts. Wavy to lenticular bedding and ripple cross laminae are prevalent through most of the Magenta. Holt and Powers (1990) estimate that inflow to the shaft from the Magenta during shaft mapping was less than 1 gal/min. The Magenta has a permeability of approximately 1.5 × 10^{-15} m^2 (Saulnier and Avis, 1988).

The Forty-niner Member is divided into three informal lithologic units. The lowest unit is anhydrite 4, a laminated anhydrite having a gradational contact with the underlying Magenta. Mudstone 4 overlies anhydrite 4 and is composed of multiple units containing mudstones, siltstones, and very fine sandstones. Anhydrite 5 is the uppermost informal lithologic unit of the Forty-niner Member. The permeability of mudstone 4, determined from the pressure responses in the Forty-niner interval of H-16 to the drilling of the AIS, is 3.9 × 10^{-16} m^2 (referred to as the Forty-niner claystone by Avis and Saulnier, 1990).

The Salado Formation is a very low permeability formation that is composed of bedded halite, polyhalite, anhydrite, and mudstones. Inflows in the shafts have been observed over select intervals during shaft mapping, but flows are below the threshold of quantification. In some cases these weeps are individual, lithologically distinct marker beds, and in some cases they are not. Directly observable brine flow from the Salado Formation into excavated openings is a short-lived process. Table G2-1 lists the brine seepage intervals identified by Holt and Powers (1990) during their detailed mapping of the AIS. Seepage could be indicated by a wet rockface or by the presence of precipitate from brine evaporation on the shaft rockface. The zones listed in Table G2-1 make up less than 10% of the Salado section that is intersected by the WIPP shafts.

Table G2-1
Salado Brine Seepage Intervals(1)

Stratigraphic Unit	Lithology	Thickness (m)
Marker Bed 103	Anhydrite	5.0
Marker Bed 109	Anhydrite	7.7
Vaca Triste	Mudstone	2.4
Zone A	Halite	2.9
Marker Bed 121	Polyhalite	0.5
Union Anhydrite	Anhydrite	2.3
Marker Bed 124	Anhydrite	2.7
Zone B	Halite	0.9
Zone C	Halite	2.7
Zone D	Halite	3.2
Zone E	Halite	0.6
Zone F	Halite	0.9
Zone G	Halite	0.6
Zone H	Halite	1.8
Marker Bed 129	Polyhalite	0.5
Zone I	Halite	1.7
Zone J	Halite	1.2

(1) After US DOE, 1995.

To gain perspective into the important stratigraphic units from a hydrogeologic view, the permeability and thickness of the units adjacent to the shafts can be compared. Table G2-2 lists the lithologic units in the Rustler and the Salado Formations with their best estimate permeabilities and their thickness as determined from the AIS mapping. The stratigraphy of the units overlying the Rustler is not considered in Table G2-2 because these units are typically not saturated in the vicinity of the WIPP shafts. The overlying sediments account for approximately 25% of the stratigraphy column adjacent to the shafts.

Because permeability varies over several orders of magnitude, the log of the permeability is also listed to simplify comparison between units. Table G2-2 shows that by far the two most transmissive zones occur in the Rustler Formation; these are the Culebra and Magenta dolomites. These units are relatively thin when compared to the combined Rustler and Salado thickness adjacent to the shafts (3% of Rustler and Salado combined thickness). The Magenta and the Culebra are the only two units that are known to possess permeabilities higher than 1×10^{-18} m^2.

Table G2-2
Permeability and Thickness of Hydrostratigraphic Units in Contact with Seals

Formation	**Member/Lithology**	**Undisturbed Permeability (m^2)**	**Thickness (m)**
Rustler	Anhydrite(1)	1.0×10^{-19}	46.7
Rustler	Mudstone 4	3.9×10^{-16}	4.4
Rustler	Magenta	1.5×10^{-15}	7.8
Rustler	Mudstone 3	1.5×10^{-19}	2.9
Rustler	Culebra	2.1×10^{-14}	8.9
Rustler	Transition/ Bioturbated Clastics	2.2×10^{-18}	18.7
Salado	Halite	1.0×10^{-21}	356.6
Salado	Polyhalite	3.0×10^{-21}	10.9
Salado	Anhydrite	1.0×10^{-19}	28.2

(1) Anhydrite 5, Anhydrite 4, Anhydrite 3, and Anhydrite 2

The vast majority (97%) of the rocks adjacent to the shaft in the Rustler and the Salado Formations are low permeability ($<1 \times 10^{-18}$ m^2). The conclusion that can be drawn from reviewing Table G2-2 is that the shafts are located hydrogeologically in a low permeability, low groundwater flow regime. Inflow measurements have historically been made at the shafts, and observable flow is attributed to leakage from the Rustler Formation.

Flow modeling of the Culebra has demonstrated that depressurization has occurred as a result of the sinking of the shafts at the site. Maximum estimated head drawdown in the Culebra at the centroid of the shafts was estimated by Haug et al. (1987) to be 33 m in the mid-1980s. This drawdown in the permeable units intersected by the shafts is expected because the shafts act as long-term constant pressure (atmospheric) sinks. Measurements of fluid flow into the WIPP shafts when they were unlined show a range from a maximum of 0.11 L/s (3,469 m^3/yr) measured in the Salt Handling Shaft on September 13, 1981 to a minimum of 0.008 L/s (252 m^3/yr) measured at the Waste Handling Shaft on August 6, 1987 (LaVenue et al., 1990).

The following summary of shaft inflow rates from the Rustler is based on a review of LaVenue et al. (1990) and Cauffman et al. (1990). Shortly after excavation and prior to grouting and liner installation, the inflow into the Salt Handling Shaft was 0.11 L/s (3,469 m^3/yr). The average flow rate measured after shaft lining for the period from mid-1982 through October 1992 was 0.027 L/s (851 m^3/yr). The average flow rate into the Waste Handling Shaft during the time when the shaft was open and unlined was about 0.027 L/s (851 m^3/yr). Between the first and second grouting events (July 1984 to November 1987) the average inflow rate was 0.016 L/s (505 m^3/yr). No estimates were found after the second grouting. Inflow to the pilot holes for the Exhaust Shaft averaged 0.028 L/s (883 m^3/yr). In December 1984 a liner plate was grouted across the Culebra. After this time, a single measurement of inflow from the Culebra was 0.022 L/s (694 m^3/yr). After liner plate installation, three separate grouting events occurred at the Culebra. No measurable flow was reported after the third grouting event in the summer of 1987. Flow into the AIS when it was unlined and draining averaged 0.044 L/s (1,388 m^3/yr). Since the Rustler has been lined, flow into the AIS has been negligible.

The majority of the flow represented by these shaft measurements originates from the Rustler. This is clearly evident by the fact that lining of the WIPP shafts was found to be unnecessary in the Salado Formation below the Rustler/Salado contact. When the liners were installed, flow rates diminished greatly. Under sealed conditions, hydraulic gradients in rocks adjacent to the shaft will diminish as the far-field pressures approach ambient conditions. The low-permeability materials sealing the shaft combined with the reduction in lateral hydraulic gradients will likely result in flow rates into the shaft that are several orders of magnitude less than observed under open shaft or lined shaft conditions.

2.3.2 Observed Vertical Gradients

Hydraulic heads within the Rustler and between the Rustler and Salado Formations are not in hydrostatic equilibrium. Mercer (1983) recognized that heads at the Rustler Salado transition (referred to as the brine aquifer and not present in the vicinity of the WIPP shafts) indicate an upward hydraulic gradient from that zone to the Culebra. Later, with the availability of more head measurements within the Salado and Rustler members, Beauheim (1987) provided additional insight into the potential direction of vertical fluid movement within the Rustler. He reported that the hydraulic data indicate an upward gradient from the Salado to the Rustler.

Formation pressures in the Salado Formation have been decreased in the near vicinity of the WIPP underground facility. The highest, and thought to be least disturbed, estimated formation fluid pressure from hydraulic testing is 12.55 MPa estimated from interpretation of testing within borehole SCP01 in Marker Bed 139 (**MB139**) just below the underground facility horizon (Beauheim et al., 1993). The fresh-water head within MB139, based on the estimated static formation pressure of 12.55 MPa, is 1,663.6 m (5,458 ft) above mean sea level (**msl**).

Hydraulic heads in the Rustler have also been impacted by the presence of the WIPP shafts. Impacts in the Culebra were significant in the 1980s with a large drawdown cone extending away from the shafts in the Culebra (Haug et al., 1987). The undisturbed head of the Rustler Salado contact in the vicinity of the AIS is estimated to be about 936.0 m (3,071 ft) msl (Brinster, 1991). The undisturbed head in the Culebra is estimated to be approximately 926.9 m (3,041 ft) msl in the vicinity of the AIS (LaVenue et al., 1990). The undisturbed head in the Magenta is estimated to be approximately 960.1 m (3,150 ft) msl (Brinster, 1991).

The disturbed and undisturbed heads in the Rustler are summarized in Table G2-3. Also included is the freshwater head of MB139 based on hydraulic testing in the WIPP underground. Consistent with the vertical flow directions proposed by previous investigators, estimated vertical gradients in the vicinity of the AIS before the shafts were drilled indicate a hydraulic gradient from the Magenta to the Culebra and from the Rustler/Salado contact to the Culebra. There is also the potential for flow from the Salado Formation to the Rustler Formation.

Table G2-3
Freshwater Head Estimates in the Vicinity of the Air Intake Shaft

	Freshwater Head (m asl)		
Hydrologic Unit	**Undisturbed**	**Disturbed**	**Reference**
Magenta Member	960.1[1]	948.8[2] (H-16)	Brinster (1991) Beauheim (1987)
Culebra Member	926.9[1]	915.0[2] (H-16)	LaVenue et al. (1990) Beauheim (1987)
Lower Unnamed Member	—	953.4[2] (H-16)	Beauheim (1987)
Rustler/Salado Contact	936.0 - 940.0[1]	—	Brinster (1991)
Salado MB139	1,663.6[2]	—	Beauheim et al. (1993)

[1] Estimated from a contoured head surface plot based principally on well data collected prior to shaft construction.

[2] Measured through hydraulic testing and/or long-term monitoring.

2.4 Site Geochemical Setting

2.4.1 Regional and Local Geochemistry in Rustler Formation and Shallower Units

The Rustler Formation, overlying the Salado Formation, consists of interbedded anhydrite/gypsum, mudstone/siltstone, halite east of the WIPP site, and two layers of dolomite. Principal occurrences of NaCl/$MgSO_4$ brackish to briny groundwater in the Rustler at the WIPP site and to the north, west, and south are found (1) at the lower member near its contact with the underlying Salado and (2) in the two dolomite members having a variable fracture-induced secondary porosity. The mineralogy of the Rustler Formation is summarized in Table G2-4.

The five members of the Rustler Formation are described as follows: (1) The Forty-niner Member is similar in lithology to the other non-dolomitic units but contains halite east of the WIPP site. (2) The Magenta Member is another variably fractured dolomite/sulfate unit containing sporadic occurrences of groundwater near and west of the WIPP site. (3) The Tamarisk Member is dominantly anhydrite (locally altered to gypsum) with subordinate fine-grained clastics, containing halite to the east of the WIPP site. (4) The Culebra Dolomite Member is dominantly dolomite with subordinate anhydrite and/or gypsum, having a variable fracture-induced secondary porosity containing regionally continuous occurrences of groundwater at the WIPP site and to the north, west, and south. (5) An unnamed lower member consists of sandstone, siltstone, mudstone, claystone, and anhydrite locally altered to gypsum, and containing halite under most of the WIPP site and occurrences of brine at its base, mostly west of the WIPP site.

Table G2-4
Chemical Formulas, Distributions, and Relative Abundance of Minerals in the Rustler and Salado Formations (after Lambert, 1992)

Mineral	Formula	Occurrence/Abundance
Amesite	$(Mg_4Al_2)(Si_2Al_2)O_{10}(OH)_8$	S, R
Anhydrite	$CaSO_4$	SSS, RRR
Calcite	$CaCO_3$	S, RR
Carnallite	$KMgCl_3\cdot 6H_2O$	SS†
Chlorite	$(Mg,Al,Fe)_{12}(Si,Al)_8O_{20}\ (OH)_{16}$	S‡, R‡
Corrensite	Mixed-layer chlorite/smectite	S‡, R‡
Dolomite	$CaMg(CO_3)_2$	RR
Feldspar	$(K,Na,Ca)(Si,Al)_4O_8$	S‡, R‡
Glauberite	$Na2Ca(SO_4)_2$	S
Gypsum	$CaSO_4\cdot 2H_2O$	S, RRR
Halite	$NaCl$	SSS, RRR
Illite	$K_{1-1.5}Al_4(Si_{7-6.5}Al_{1-1.5}O_{20})(OH)_4$	S‡, R‡
Kainite	$KMgClSO_4\cdot 3H_2O$	SS†
Kieserite	$MgSO_4\cdot H_2O$	SS†
Langbeinite	$K_2Mg_2(SO_4)_3$	S*
Magnesite	$MgCO_3$	S, R
Polyhalite	$K_2Ca_2Mg(SO_4)_4\cdot 2H_2O$	SS, R
Pyrite	FeS_2	S, R
Quartz	SiO_2	S‡, R‡
Serpentine	$Mg_3Si_2O_5(OH)_4$	S‡, R‡
Smectite	$(Ca_{1/2},Na)_{0.7}(Al,Mg,Fe)_4(Si,Al)_8O_{20}(OH)_4\cdot nH_2O$	S‡, R‡
Sylvite	KCl	SS*

Key to Occurrence/Abundance notations:

S = Salado Formation; R = Rustler Formation; 3× = abundant, 2× = common, 1× = rare or accessory; * = potash-ore mineral (never near surface); † = potash-zone non-ore mineral; ‡ = in claystone interbeds.

The Dewey Lake Redbeds, overlying the Rustler Formation, are the uppermost Permian unit; they consist of siltstones and claystones locally transected by concordant and discordant fractures that may contain gypsum. The Dewey Lake Redbeds contain sporadic occurrences of groundwater that may be locally perched, mostly in the area south of the WIPP site. The Triassic Dockum Group (undivided) rests on the Dewey Lake Redbeds in the eastern half of the WIPP site and thickens eastward; it is a locally important source of groundwater for agricultural and domestic use.

The Gatuña Formation, overlying the Dewey Lake Redbeds, occurs locally as channel and alluvial pond deposits (sands, gravels, and boulder conglomerates). The pedogenic Mescalero caliche is commonly developed on top of the Gatuña Formation and on many other erosionally truncated rock types. Surficial dune sand, which may be intermittently damp, covers virtually all outcrops at and near the WIPP site. Siliceous alluvial deposits southwest of the WIPP site also contain potable water. The geochemistry of groundwater found in the Rustler Formation and Dewey Lake Redbeds is summarized in Table G2-5.

Table G2-5
Major Solutes in Selected Representative Groundwater from the Rustler Formation and Dewey Lake Redbeds, in mg/L (after Lambert, 1992)

Well	Date	Zone	Ca	Mg	Na	K	SO_4	Cl
WIPP-30	July 1980	R/S	955	2770	121,000	2180	7390	192,000
WIPP-29	July 1980	R/S	1080	2320	36,100	1480	12,000	58,000
H-5B	June 1981	Cul	1710	2140	52,400	1290	7360	89,500
H-9B	November 1985	Cul	590	37	146	7	1900	194
H-2A	April 1986	Cul	743	167	3570	94	2980	5310
P-17	March 1986	Cul	1620	1460	28,300	782	6020	48,200
WIPP-29	December 1985	Cul	413	6500	94,900	23,300	20,000	179,000
H-3B1	July 1985	Mag	1000	292	1520	35	2310	3360
H-4C	November 1986	Mag	651	411	7110	85	7100	8460
Ranch	June 1986	DL	420	202	200	4	1100	418

Key to Zone:

R/S = “basal brine aquifer” near the contact between the Rustler and Salado Formations; Cul = Culebra Member, Rustler Formation; Mag = Magenta Member, Rustler Formation; DL = Dewey Lake Redbeds.

2.4.2 Regional and Local Geochemistry in the Salado Formation

The Salado Formation consists dominantly of halite, interrupted at intervals of meters to tens of meters by beds of anhydrite, polyhalite, mudstone, and local potash mineralization (sylvite or langbeinite, with or without accessory carnallite, kieserite, kainite and glauberite, all in a halite matrix). Some uniquely identifiable non-halite units, 0.1 to 10 m thick, have been numbered from the top down (100 to 144) for convenience as marker beds to facilitate cross-basinal stratigraphic correlation. The WIPP facility was excavated just above Marker Bed 139 in the Salado Formation at a depth of about 655 m.

Although the most common Delaware Basin evaporite mineral is halite, the presence of less soluble interbeds (dominantly anhydrite, polyhalite, and claystone) and more soluble admixtures (e.g. sylvite, glauberite, kainite) has resulted in chemical and physical properties significantly different from those of pure NaCl. Under differential stress produced near excavations, brittle interbeds (anhydrite, polyhalite, magnesite, dolomite) may fracture, whereas under a similar stress regime pure NaCl would undergo plastic deformation. Fracturing of these interbeds has locally enhanced the permeability, allowing otherwise nonporous rock to carry groundwater (e.g., the fractured polyhalitic anhydrite of Marker Bed 139 under the floor of the WIPP excavations).

Groundwater in evaporites represents the exposure of chemical precipitates to fluids that may be agents (as in the case of dissolution) or consequences of postdepositional alteration of the evaporites (as in the cases of dehydration of gypsum and diagenetic dewatering of other minerals). Early in the geological studies of the WIPP site, groundwater occurrences that could be hydrologically characterized were identified.

Since the beginning of conventional mining in the Delaware Basin, relatively short-lived seeps (pools on the floor, efflorescences on the walls, and stalactitic deposits on the ceiling) have been known to occur in the Salado Formation where excavations have penetrated. These brine occurrences are commonly associated with the non-halitic interbeds whose porosity is governed either by fracturing (as in brittle beds) or mineralogical discontinuities (as in “clay” seams).

The geochemistry of brines encountered in the Salado Formation is summarized in Table G2-6. The relative abundance of minerals was summarized in Table G2-4.

Table G2-6
Variations in Major Solutes in Brines from the Salado Formation, in mg/L (after Lambert, 1992)

Source of Brine	Date	Ca	Mg	K	Na	Cl	SO_4
Room G Seep	Sep-87	278	14800	15800	99000	188000	29500
	Nov-87	300	18700	15400	97100	190000	32000
	Feb-88	260	18200	17100	94100	186000	36200
	Mar-88	280	17000	16200	92100	187000	34800
	Jul-88	292	13000	14800	96600	188000	29300
	Sep-88	273	14700	13700	86500	185000	28000
	Apr-91	240	14400	12900	95000	189000	28000
	Jul-91	239	14100	13100	93000	190000	27700
	Oct-91	252	14700	14100	95000	189000	27100
Marker Bed 139 (under repository)		300	18900	14800	67700	155900	14700
		300	17100	15600	72700	158900	13400
		300	17600	15800	71600	182200	14700
Room J		230	17700	13500	63600	167000	15100
		210	27400	22400	56400	168000	19600
		220	17900	15600	73400	165000	9300
		250	22200	18300	63000	165000	31100
		190	31000	19900	46800	170000	24600
		100	35400	27800	40200	173000	30000
		270	18900	14500	59900	166000	16200
		280	20200	17000	70400	165000	10600
Room Q		279	31500	22600	68000	205000	19400
		288	31100	24100	68000	203000	19200
		257	34000	26300	63000	205000	23500
AIS Sump (accumulation in bottom of sump)	Jul-88	960	1040	1720	118000	187000	6170
	May-89	900	500	600	83100	122700	7700
	May-89	1000	800	1100	82400	114200	8800
McNutt Potash Zone							
Duval mine		640	55400	30000	27500	236500	3650
Miss. Chem. mine		200	44200	45800	43600	226200	12050

3. Design Guidance

3.1 Introduction

The WIPP is subject to regulatory requirements contained in applicable portions of the New Mexico Hazardous Waste Act, specifically 20.4.1.500 NMAC and .900 (incorporating 40 CFR §264 and §270), and requirements contained in 40 CFR §191 and 40 CFR §194. The use of both engineered and natural barriers to isolate wastes from the accessible environment is required by 20.4.1.500 NMAC (incorporating 40 CFR §§264.111 and 264.601) and 40 CFR §191.14(d). The use of engineered barriers to prevent or substantially delay the movement of water, hazardous constituents, or radionuclides toward the accessible environment is required by 20.4.1.500 NMAC (incorporating 40 CFR §§264.111 and 264.601) and 40 CFR §194.44. Hazardous constituent release performance standards are specified in Permit Part 5 and 20.4.1.500 NMAC (incorporating 40 CFR §§264.111(b), 264.601(a), and 264 Subpart F). Quantitative requirements for potential releases of radioactive materials from the repository system are specified in 40 CFR §191. The regulations impose quantitative release requirements on the total repository system, not on individual subsystems of the repository system, for example, the shaft sealing subsystem.

3.2 Design Guidance and Design Approach

The guidance described for the design of the shaft sealing system addresses the need for the WIPP to comply with system requirements and to follow accepted engineering practices using demonstrated technology. The design guidance addresses the need to limit:

1. radiological or other hazardous constituents reaching the regulatory boundaries,
2. groundwater flow into and through the sealing system,
3. chemical and mechanical incompatibility,
4. structural failure of system components,
5. subsidence and accidental entry, and
6. development of new construction technologies and/or materials.

For each element of design guidance, a design approach has been developed. Table G2-7 contains qualitative design guidance and the design approach used to implement it.

Table G2-7
Shaft Sealing System Design Guidance

Qualitative Design Guidance	Design Approach
The shaft sealing system shall limit:	*The shaft sealing system shall be designed to meet the qualitative design guidance in the following ways:*
1. the migration of radiological or other hazardous constituents from the repository horizon to the regulatory boundary during the 10,000-year regulatory period following closure;	1. In the absence of human intrusion, brine migrating from the repository horizon to the Rustler Formation must pass through a low permeability sealing system.
2. groundwater flowing into and through the shaft sealing system;	2. In the absence of human intrusion, groundwater migrating from the Rustler Formation to the repository horizon must pass through a low permeability sealing system.
3. chemical and mechanical incompatibility of seal materials with the seal environment;	3. Brine contact with seal elements is limited and materials possess acceptable mechanical properties.
4. the possibility for structural failure of individual components of the sealing system;	4. State of stress from forces expected from rock creep and other mechanical loads is favorable for seal materials.
5. subsidence of the ground surface in the vicinity of the shafts and the possibility of accidental entry after sealing;	5. The shaft is completely filled with low-porosity materials, and construction equipment would be needed to gain entry.
6. the need to develop new technologies or materials for construction of the shaft sealing system.	6. Construction of the shaft sealing system is feasible using available technologies and materials.

4. Design Description

4.1 Introduction

The design presented in this section was developed based on (1) the design guidance outlined in Section 3.0, (2) past design experience, and (3) a desire to reduce uncertainties associated with the performance of the WIPP sealing system. The WIPP shaft sealing system design has evolved over the past decade from the initial concepts presented by Stormont (1984) to the design concepts presented in this document. The past designs are:

- the plugging and sealing program for the WIPP (Stormont, 1984),
- the initial reference seal system design (Nowak et al., 1990),
- the seal design alternative study (Van Sambeek et al., 1993),
- the WIPP sealing system design (DOE, 1995).

The present design changes were implemented to take advantage of knowledge gained from small-scale seals tests conducted at the WIPP (Knowles and Howard, 1996), advances in the ability to predict the time-dependent mechanical behavior of compacted salt rock (Callahan et al., 1996), large-scale dynamic salt compaction tests and associated laboratory determination of the permeability of compacted salt samples (Hansen and Ahrens, 1996; Brodsky et al., 1996), field tests to measure the permeability of the DRZ surrounding the WIPP AIS (Dale and Hurtado, 1996), and around seals (Knowles et al., 1996). A summary paper (Hansen et al., 1996) describing the design has been prepared.

The shaft sealing system is composed of seals within the Salado Formation, the Rustler Formation, and the Dewey Lake Redbeds and overlying units. All components of the sealing system are designed to meet Items 3, 4, and 6 of the Design Guidance (Table G2-7.); that is, all sealing system components are designed to be chemically and mechanically compatible with the seal environment, structurally adequate, and constructable using currently available technology and materials. The seals in the Salado Formation are also designed to meet Items 1 and 2 of the Design Guidance. These seals will limit fluid migration upward from the repository to the Rustler Formation and downward from the Rustler Formation to the repository. Migration of brine upward and downward is discussed in Sections 8.5 and 8.4 respectively. The seals in the Rustler Formation are designed to meet Item 2 in addition to Items 3, 4, and 6 of the Design Guidance. The seals in the Rustler Formation limit migration of Rustler brines into the shaft cross-section and also limit cross-flow between the Culebra and Magenta members. The principal function of the seals in the Dewey Lake Redbeds and overlying units is to meet Item 5 of the Design Guidance, that is, to limit subsidence of the ground surface in the vicinity of the shafts and to prevent accidental entry after repository closure. Entry of water (surface water and any groundwater that might be present in the Dewey Lake Redbeds and overlying units) into the sealing system is limited by restraining subsidence and by placing high density fill in the shafts.

4.2 Existing Shafts

The WIPP underground facilities are accessed by four shafts commonly referred to as the Waste, Air Intake, Exhaust, and Salt Handling Shafts. These shafts were constructed between 1981 and 1988. All four shafts are lined from the surface to just below the contact of the Rustler and Salado Formations. The lined portion of the shafts terminates in a substantial concrete structure called the “key,” which is located in the uppermost portion of the Salado Formation.

Drawings showing the configuration of the existing shafts are included in Appendix G2-E and listed below in Table G2-8. Table G2-9 contains a summary of information describing the existing shafts.

The upper portions of the WIPP shafts are lined. The Waste, Air Intake, and Exhaust shafts have concrete linings; the Salt Handling Shaft has a steel lining with grout backing. In addition, during shaft construction, steel liner plates, wire mesh, and pressure grouting were used to stabilize portions of the shaft walls in the Rustler Formation and overlying units. Seepage of groundwater into the lined portions of the shafts has been observed. This seepage was expected; in fact, the shaft keys (massive concrete structures located at the base of each shaft liner) were designed to collect the seepage and transport it through a piping system to collection points at the repository horizon. In general, the seepage originates in the Magenta and Culebra members of the Rustler Formation and in the interface zone between the Rustler and Salado formations. It flows along the interface between the shaft liner and the shaft wall and through the DRZ immediately adjacent to the shaft wall. In those cases where seepage through the liner occurred, it happened where the liner offered lower resistance to flow than the interface and DRZ, for example, at construction joints. Maintenance grouting, in selected areas of the WIPP shafts, has been utilized to reduce seepage.

Table G2-8
Drawings Showing Configuration of Existing WIPP Shafts (Drawings are in Appendix G2-E)

Shaft	Drawing Title	Sheet Number of Drawing SNL-007
Waste	Near-Surface/Rustler Formation Waste Shaft Stratigraphy & As-Built Elements	2 of 28
Waste	Salado Formation Waste Shaft Stratigraphy & As-Built Elements	3 of 28
AIS	Near-Surface/Rustler Formation Air Intake Shaft Stratigraphy & As-Built Elements	7 of 28
AIS	Salado Formation Air Intake Shaft Stratigraphy & As-Built Elements	8 of 28
Exhaust	Near-Surface/Rustler Formation Exhaust Shaft Stratigraphy & As-Built Elements	12 of 28
Exhaust	Salado Formation Exhaust Shaft Stratigraphy & As-Built Elements	13 of 28
Salt Handling	Near-Surface/Rustler Formation Salt Handling Shaft Stratigraphy & As-Built Elements	17 of 28
Salt Handling	Salado Formation Salt Handling Shaft Stratigraphy & As-Built Elements	18 of 28

Table G2-9
Summary of Information Describing Existing WIPP Shafts

	Shafts			
	Salt Handling	**Waste**	**Air Intake**	**Exhaust**
A. Construction Method				
i. Sinking method	Blind bored	Initial 6′ pilot hole slashed by drill & blast (smooth wall blasting)	Raise bored	Initial 6′ pilot hole slashed by drill & blast (smooth wall blasting)
ii. Dates of shaft sinking	7/81-10/81	Drilled 12/81-2/82 Slashed 10/83-6/84	12/87-8/88	9/83-11/84
iii. Ground treatment in water-bearing zone	Grout behind steel liner during construction	Grouted 1984 & 1988	Grouted 1993	Grouted 1985, 1986, & 1987
iv. Sump construction	Drill & blast	Drill & blast	No sump	No sump
B. Upper Portion of Shaft *				
i. Type of liner	Steel	Concrete	Concrete	Concrete
ii. Lining diameter (ID)	10′-0″	19′-0″	18′-0″/16′-7″	14′-0″
iii. Excavated diameter	11′-10″	20′-8″ to 22′-4″	20′-3″	15′-8″ to 16′-8″
iv. Installed depth of liner	838.5′	812′	816′	846′
C. Key Portion of Shaft *				
i. Construction material	Reinf. conc. w/chem. seals	Reinf. concrete w/chem. seals	Reinf. concrete w/chem. seals	Reinf. concrete w/chem. seals
ii. Liner diameter (ID)	10′-0″	19′-0″	16′-7″	14′-0″
iii. Excavated diameter	15′-0″ to 18′-0″	27′-6″ to 31′-0″	29′-3″ to 35′-3″	21′-0″ to 26′-0″
iv. Depth-top of Key	844′	836′	834′	846′
v. Depth-bottom of Key	883′	900′	897′	910′
vi. Dow Seal #1 depth	846′ to 848′	846′ to 849′	839′ to 842′	853′ to 856′
vii. Dow Seal #2 depth	853′ to 856′	856′ to 859′	854′ to 857′	867′ to 870′
viii. Dow Seal #3 depth	868 to 891′	NA	NA	NA
ix. Top of salt (Rustler/Salado contact)	851′	843′	841′	853′

	Shafts			
	Salt Handling	**Waste**	**Air Intake**	**Exhaust**
D. Lower Shaft (Unlined) *				
i. Type of support	Unlined	Chain link mesh	Unlined	Chain link mesh
ii. Excavated diameter	11′-10″	20′-0″	20′-3″	15′-0″
iii. Depth-top of “unlined”	882′	900′	904′	913′
iv. Depth-bottom of “unlined”	2144′	2142′	2128′	2148′
E. Station *				
i. Type of support	Wire mesh		Wire mesh	Wire mesh
ii. Principal dimensions	21H × 31W	12H × 30W	25H × 36W	12H × 23W
iii. Depth-top of station	2144′	2142′	2128′	2148′
iv. Depth-floor of station	2162′	2160′	2150′	2160′
F. Sump *				
Depth-top of sump	2162′	2160′	No sump	No sump
Depth-bottom of sump	2272′	2286′		
G. Shaft Duty	Construction hoisting of excavated salt; personnel hoisting; for intake (fresh) air; in some cases, unfiltered exhaust shaft to ventilate areas of the underground that do not need filtration	Hoisting shaft for lowering waste containers; personnel hoisting until waste receipt	Ventilation shaft for intake (fresh) air; personnel hoisting	Exhaust air ventilation shaft

*This information is from the MOC drawings identified on Sheets 2, 3, 7, 8, 12, 13, 17, and 18 of Drawing SNL-007 (see Appendix G2-E).

4.3 Sealing System Design Description

This section describes the shaft sealing system design, components, and functions. The shaft sealing system consists of three essentially independent parts:

1. The seals in the Salado Formation provide the primary regulatory barrier. They will limit fluid flow into and out of the repository throughout the 10,000-year regulatory period.

2. The seals in the Rustler Formation will limit flow from the water-bearing members of the Rustler Formation and limit commingling of Magenta and Culebra groundwaters.

3. The seals in the Dewey Lake Redbeds and the near-surface units will limit infiltration of surface water and preclude accidental entry through the shaft openings.

The same sealing system is used in all four shafts. Therefore an understanding of the sealing system for one shaft is sufficient to understand the sealing system in all shafts. Only minor differences exist in the lengths of the components, and the component diameters differ to accommodate the existing shaft diameters.

The shaft liner will be removed in four locations in each shaft. All of these locations are within the Rustler Formation. Additionally, the upper portion of each shaft key will be eliminated. The portion of the shaft key that will be eliminated spans the Rustler/Salado interface and extends into the Salado Formation. The shaft liner removal locations are

1. from 10 ft above the Magenta Member to the base of the Magenta (removal distances vary from 34–39 ft because of different member thickness at shaft locations),

2. for a distance of 10 ft in the anhydrite of the Tamarisk Member,

3. through the full height of the Culebra (17–24 ft), and

4. from the top anhydrite unit in the unnamed lower member to the top of the key (67–85 ft).

Additionally, the concrete will be removed from the top of the key to the bottom of the key's lower chemical seal ring (23 to 29 ft). Drawing SNL-007, Sheets 4, 9, 14, and 19 in Appendix G2-E show shaft liner removal plans, and Sheet 23 shows key removal plans.

The decision to abandon portions of the shaft lining and key in place is based on two factors. First, no improvements in the performance of the sealing system associated with removal of these isolated sections of concrete have been identified. Second, because the keys are thick and heavily reinforced, their removal would be costly and time consuming. No technical problems are associated with the removal of this concrete; thus, if necessary, its removal can be incorporated in any future design.

The DRZ will be pressure grouted throughout the liner and key removal areas and for a distance of 10 ft above and below all liner removal areas. The pressure grouting will stabilize the DRZ during liner removal and shaft sealing operations. The grouting will also control groundwater seepage during and after liner removal. The pressure grouting of the DRZ has not been assigned a sealing function beyond the construction period. It is likely that this grout will seal the DRZ for an extended period of time. However, past experience with grout in the mining and tunneling industries demonstrates that groundwater eventually opens alternative pathways through the media and reestablishes seepage patterns (maintenance grouting is common in both mines and tunnels). Therefore, post-closure sealing of the DRZ in the Rustler Formation has not been assumed in the design.

The compacted clay sealing material (bentonite) will seal the shaft cross-section in the Rustler Formation. In those areas where the shaft liner has been removed, the compacted clay will confine the vertical movement of groundwater in the Rustler to the DRZ. Sealing the shaft DRZ is accomplished in the Salado Formation. It is achieved initially through the interruption of the halite DRZ by concrete-asphalt waterstops and on a long-term basis through the natural process of healing the halite DRZ. The properties of the compacted clay are discussed in Section 5.3.2. The concrete-asphalt waterstops and DRZ healing in the Salado are discussed in Sections 7.6.1 and 7.5.2 respectively.

Reduction of the uncertainty associated with long-term performance is addressed by replacing the upper and lower Salado Formation salt columns used in some of the earlier designs with compacted clay columns and by adding asphalt sealing components in the Salado Formation. Use of disparate materials for sealing components reduces the uncertainty associated with a common-mode failure.

The compacted salt column provides a seal with an initial permeability several orders of magnitude higher than the clay or asphalt columns; however, its long-term properties will approach those of the host rock. The permeability of the compacted salt, after consolidation, will be several orders of magnitude lower than that of the clay and comparable to that of the asphalt. The clay provides seals of known low permeability at emplacement, and asphalt provides an independent low permeability seal of the shaft cross-section and the shaft wall interface at the time of installation. Sealing of the DRZ in the Rustler Formation during the construction period is accomplished by grouting, and initial sealing of the DRZ in the Salado Formation is accomplished by three concrete-asphalt waterstops.

In the following sections, each component of each of the three shaft segments is identified by name and component number (see Figure G2-5 for nomenclature). Associated drawings in Appendix G2-E are also identified. Drawings showing the overall system configurations for each shaft are listed in Table G2-10.

4.3.1 Salado Seals

The seals placed in the Salado Formation are composed of (1) consolidated salt, clay, and asphalt components that will function for very long periods, exceeding the 10,000-year regulatory period; and (2) salt saturated concrete components that will function for extended periods. The specific components that comprise the Salado seals are described below.

4.3.1.1 Compacted Salt Column

The compacted salt column (Component 10 in Figure G2-5, and shown in Drawing SNL-007, Sheet 25) will be constructed of crushed salt taken from the Salado Formation. The length of the salt column varies from 170 to 172 m (556 to 564 ft) in the four shafts. The compacted salt column is sized to allow the column and concrete-asphalt waterstops at either end to be placed between the Vaca Triste Unit and Marker Bed 136. The salt will be placed and compacted to a density approaching 90% of the average density of intact Salado salt. The effects of creep closure will cause this density to increase with time, further reducing permeability.

The salt column will offer limited resistance to fluid migration immediately after emplacement, but it will become less permeable as creep closure further compacts the salt. Salt creep increases rapidly with depth; therefore, at any time, creep closure of the shaft will be greater at greater depth. The location and initial compaction density of the compacted salt column were chosen to assure consolidation of the compacted salt column in the 100 years following repository closure. The state of salt consolidation, results of analyses predicting the creep closure of the shaft, consolidation and healing of the compacted salt, and healing of the DRZ surrounding the compacted salt column are presented in Sections 7.5 and 8.4 of this document. These results indicate that the salt column will become an effective long-term barrier within 100 years.

Table G2-10
Drawings Showing the Sealing System for Each Shaft (Drawings are in Appendix G2-E)

Shaft	Drawing Title	Sheet Number of Drawing SNL 007
Waste	Near-Surface/Rustler Formation Waste Shaft Stratigraphy & Sealing Subsystem Profile	4 of 28
Waste	Salado Formation Waste Shaft Stratigraphy & Sealing Subsystem Profile	5 of 28
AIS	Near-Surface/Rustler Formation Air Intake Shaft Stratigraphy & Sealing Subsystem Profile	9 of 28
AIS	Salado Formation Air Intake Shaft Stratigraphy & Sealing Subsystem Profile	10 of 28
Exhaust	Near-Surface/Rustler Formation Exhaust Shaft Stratigraphy & Sealing Subsystem Profile	14 of 28
Exhaust	Salado Formation Exhaust Shaft Stratigraphy & Sealing Subsystem Profile	15 of 28
Salt Handling	Near-Surface/Rustler Formation Salt Handling Shaft Stratigraphy & Sealing Subsystem Profile	19 of 28
Salt Handling	Salado Formation Salt Handling Shaft Stratigraphy & Sealing Subsystem Profile	20 of 28

4.3.1.2 Upper and Lower Salado Compacted Clay Columns

The upper and lower Salado compacted clay columns (Components 8 and 12 respectively in Figure G2-5) are shown in detail on Drawing SNL-007, Sheet 24. A commercial well-sealing grade sodium bentonite will be used to construct the upper and lower Salado clay columns. These clay columns will effectively limit fluid movement from the time they are placed and will provide an effective barrier to fluid migration throughout the 10,000-year regulatory period and thereafter. The upper clay column ranges in length from 102 to 107 m (335 to 351 ft), and the lower clay column ranges in length from 29 to 33 m (94 to 107 ft) in the four shafts. The locations for the upper and lower clay columns were selected based on the need to limit fluid migration into the compacting salt column. The lower clay column stiffness is sufficient to promote early healing of the DRZ, thus removing the DRZ as a potential pathway for fluids (Appendix D in the Compliance Submittal Design Report (Sandia, 1996), Section 5.2.1).

4.3.1.3 Upper, Middle, and Lower Concrete-Asphalt Waterstops

The upper, middle, and lower concrete-asphalt waterstops (Components 7, 9, and 11 respectively in Figure G2-5) are identical and are composed of three elements: an upper concrete plug, a central asphalt waterstop, and a lower concrete plug. These components are also shown on Drawing SNL-007, Sheet 22. The concrete specified is a specially developed salt-saturated concrete called Salado Mass Concrete (**SMC**). In all cases the component's overall design length is 15 m (50 ft).

The upper and lower concrete plugs of the concrete-asphalt waterstop are identical. They fill the shaft cross-section and have a design length of 7 m (23 ft). The plugs are keyed into the shaft wall to provide positive support for the plug and overlying sealing materials. The interface between the concrete plugs and the surrounding formation will be pressure grouted. The upper plug in each component will support dynamic compaction of the overlying sealing material if compaction is specified. Dynamic compaction of the salt column is discussed in Section 6.

The asphalt waterstop is located between the upper and lower concrete plugs. In all cases a kerf extending one shaft radius beyond the shaft wall is cut in the surrounding salt to contain the waterstop. The kerf is 0.3 m (1 ft) high at its edge and 0.6 m (2 ft) high at the shaft wall. The kerf, which cuts through the existing shaft DRZ, will result in the formation of a new DRZ along its perimeter. This new DRZ will heal shortly after construction of the waterstop, and thereafter the waterstop will provide a very low permeability barrier to fluid migration through the DRZ. The formation and healing of the DRZ around the waterstop are addressed in Section 7.6.1. The asphalt fill for the waterstop extends two feet above the top of the kerf to assure complete filling of the kerf. The construction procedure used assures that shrinkage of the asphalt from cooling will not result in the creation of voids within the kerf and will minimize the size of any void below the upper plug.

Concrete-asphalt waterstops are placed at the top of the upper clay column, the top of the compacted salt column, and the top of the lower clay column. The concrete-asphalt waterstops provide independent seals of the shaft cross-section and the DRZ. The SMC plugs (and grout) will fill irregularities in the shaft wall, bond to the shaft wall, and seal the interface. Salt creep against the rigid concrete components will place a compressive load on the salt and promote early healing of the salt DRZ surrounding the SMC plugs. The asphalt waterstop will seal the shaft cross-section and the DRZ.

The position of the concrete components was first determined by the location of the salt and clay columns. The components were then moved upward or downward from their initial design location to assure the components were located in regions where halite was predominant. This positioning, coupled with variations in stratigraphy, is responsible for the variations in the lengths of the salt and clay columns.

4.3.1.4 Asphalt Column

An asphalt-aggregate mixture is specified for the asphalt column (Component 6 in Figure G2-5). This column is 42 to 44 m (138 to 143 ft) in length in the four shafts, as shown in Drawing SNL-007, Sheet 23. The asphalt column is located above the upper concrete-asphalt waterstop; it extends approximately 5 m (16 ft) above the Rustler/Salado interface. A 6-m (20-ft) long concrete plug (part of the Rustler seals) is located just above the asphalt column.

The existing shaft linings will be removed from a point well above the top of the asphalt column to the top of the shaft keys. The concrete shaft keys will be removed to a point just below the lowest chemical seal ring in each key. The asphalt column is located at the top of the Salado Formation and provides an essentially impermeable seal for the shaft cross section and along the shaft wall interface. The length of the asphalt column will decrease slightly as the column cools. The procedure for placing the flowable asphalt-aggregate mixture is described in Section 6.

4.3.1.5 Shaft Station Monolith

A shaft station monolith (Component 13) is located at the base of the each shaft. Because the configurations of each shaft differ, drawings of the shaft station monoliths for each shaft were prepared. These drawings are identified in Table G2-11. The shaft station monoliths will be constructed with SMC. The monoliths function to support the shaft wall and adjacent drift roof, thus preventing damage to the seal system as the access drift closes from natural processes.

Table G2-11
Drawings Showing the Shaft Station Monoliths (Drawings are in Appendix G2-E)

Shaft	Drawing Title	Sheet Number of Drawing SNL-007
Waste	Waste Shaft Shaft Station Monolith	6 of 28
AIS	Air Intake Shaft Shaft Station Monolith	11 of 28
Exhaust	Exhaust Shaft Shaft Station Monolith	16 of 28
Salt Handling	Salt Handling Shaft Shaft Station Monolith	21 of 28

4.3.2 Rustler Seals

The seals in the Rustler Formation are composed of the Rustler compacted clay column and a concrete plug. The concrete plug rests on top of the asphalt column of the Salado seals. The clay column extends from the concrete plug through most of the Rustler Formation and terminates above the Rustler’s highest water-bearing zone in the Forty-niner Member.

4.3.2.1 Rustler Compacted Clay Column

The Rustler compacted clay column (Component 4 in Figure G2-5) is shown on Drawing SNL-007, Sheet 27 for each of the four shafts. A commercial well-sealing-grade sodium bentonite will be used to construct the Rustler clay column, which will effectively limit fluid movement from the time of placement and provide an effective barrier to fluid migration throughout the 10,000-year regulatory period and thereafter. Design length of the Rustler clay column is about 71 m (234 to 235 ft) in the four shafts.

The location for the Rustler clay columns was selected to limit fluid migration into the shaft cross-section and along the shaft wall interface and to limit mixing of Culebra and Magenta waters. The clay column extends from above the Magenta Member to below the Culebra

Member of the Rustler Formation. The Magenta and Culebra are the water-bearing units of the Rustler. The members above the Magenta (the Forty-niner), between the Magenta and Culebra (the Tamarisk), and below the Culebra (the unnamed lower member) are aquitards in the vicinity of the WIPP shafts.

4.3.2.2 Rustler Concrete Plug

The Rustler concrete plug (Component 5 in Figure G2-5) is constructed of SMC. The plugs for the four shafts are shown on Drawing SNL-007, Sheet 26. The plug is 6 m (20 ft) long and will fill the shaft cross-section. The plug is placed directly on top of the asphalt column of the Salado seals. The plug will be keyed into the surrounding rock and grouted. The plug permits work to begin on the overlying clay column before the asphalt has completely cooled. The option of constructing the overlying clay columns using dynamic compaction (present planning calls for construction using compressed clay blocks) is also maintained by keying the plug into the surrounding rock.

4.3.3 Near-Surface Seals

The near-surface region is composed of dune sand, the Mescalero caliche, the Gatuña Formation, the Santa Rosa Formation, and the Dewey Lake Redbeds. This region extends from the ground surface to the top of the Rustler Formation—a distance of about 160 m (525 ft). All but about 15 m (50 ft) of this distance is composed of the Dewey Lake Redbeds Formation. The near-surface seals are composed of two earthen fill columns and a concrete plug. The upper earthen fill column (Component 1) extends from the shaft collar through the surficial deposits downward to the top of the Dewey Lake Redbeds. The concrete plug (Component 2) is placed in the top portion of the Dewey Lake Redbeds, and the lower earthen fill column (Component 3) extends from the concrete plug into the Rustler Formation. These components are shown on Drawing SNL-007, Sheet 28.

This seal will limit the amount of surface water entering the shafts and will limit the potential for any future groundwater migration into the shafts. The near surface seals will also completely close the shafts and prevent accidental entry and excessive subsidence in the vicinity of the shafts. As discussed in Section 4.3.2, the existing shaft linings will be abandoned in place throughout the near-surface region.

4.3.3.1 Near-Surface Upper Compacted Earthen Fill

This component (Component 1 in Figure G2-5) will be constructed using locally available fill. The fill will be compacted to a density near that of the surrounding material to inhibit the migration of surface waters into the shaft cross-section. The length of this column varies from 17 to 28 m (56 to 92 ft) in the four shafts. In all cases, this portion of the WIPP sealing system may be modified as required to facilitate decommissioning of the WIPP surface facilities.

4.3.3.2 Near-Surface Concrete Plug

Current plans call for an SMC plug (Component 2 in Figure G2-5). However, freshwater concrete may be used if found to be desirable at a future time, and if approved by NMED through the Permit modification process specified in 20.4.1.900 NMAC (incorporating 40 CFR §270.42). The plug extends 12 m (40 ft) downward from the top of the Dewey Lake Redbeds. It is placed inside the existing shaft lining, and the interface is grouted.

4.3.3.3 Near-Surface Lower Compacted Earthen Fill

This component (Component 3 in Figure G2-5) will be constructed using locally available fill, which will be placed using dynamic compaction (the same method used to construct the salt column). The fill will be compacted to a density equal to or greater than the surrounding materials to inhibit the migration of surface waters into the shaft cross-section. The length of this column varies from 136 to 148 m (447 to 486 ft) in the four shafts.

5. Material Specification

Appendix G2-A provides a body of technical information for each of the WIPP shaft seal materials. The materials specification characterizes each seal material, establishes the adequacy of its function, states briefly the method of component placement, and quantifies expected characteristics (particularly permeability) pertinent to a WIPP-specific shaft seal design. The goal of the materials specifications is to substantiate why materials used in this seal system design will limit fluid flow within the shafts and thereby limit releases of hazardous constituents from the WIPP site at the regulatory boundary.

This section summarizes materials characteristics for shaft seal system components designed for the WIPP. The shaft seal system will not be constructed for decades; however, if it were to be constructed in the near term, materials specified could be placed in the shaft and meet performance specifications using current materials and construction techniques. Construction methods are described in Appendix G2-B. Materials specifications and construction specifications are not to be construed as the only materials or methods that would suffice to seal the shafts effectively. Undoubtedly, the design will be modified, perhaps simplified, and construction alternatives may prove to be advantageous during the years before seal construction proceeds. Nonetheless, a materials specification is necessary to establish a frame of reference for shaft seal design and analysis, to guide construction specifications, and to provide a basis for seal material parameters.

Design detail and other characteristics of the geologic, hydrologic, and chemical setting are provided in the text, appendices, and references. The four shafts will be entirely filled with dense materials possessing low permeability and other desirable engineering and economic attributes. Seal materials include concrete, clay, asphalt, and compacted salt. Other construction and fill materials include cementitious grout and earthen fill. Concrete, clay, and asphalt are common construction materials used extensively in sealing applications. Their descriptions, drawn from literature and site-specific references, are given in Appendix G2-A. Compaction and natural reconsolidation of crushed salt are uniquely applied here. Therefore, crushed salt specification includes discussion of constitutive behavior and sealing performance, specific to WIPP applications. Cementitious grout is also specified in some detail. Only rudimentary discussion of earthen fill is given here and in Appendices A and B. Specifications for each material are discussed in the following order:

- functions,
- material characteristics,
- construction,
- performance requirements,
- verification methods.

Seal system components are materials possessing high durability and compatibility with the host rock. The system contains functional redundancy and uses differing materials to reduce uncertainty in performance. All materials used in the shaft seal system are expected to maintain their integrity for very long periods. Some sealing components reduce fluid flow soon after placement while other components are designed to function well beyond the regulatory period.

5.1 Longevity

A major environmental advantage of the WIPP locale is an overall lack of groundwater to seal against. Even though very little regional water is present in the geologic setting, the seal system reflects great concern for groundwater's potential influence on the shaft seal system. If the hydrologic system sustained considerable fluid flow, brine geochemistry could impact engineered materials. Brine would not chemically change the compacted salt column, but mechanical effects of pore pressure are of concern to reconsolidation. The geochemical setting, as further discussed in Section 2.4, will have little influence on concrete, asphalt, and clay shaft seal materials. Each material is durable because the potential for degradation or alteration is very low.

Materials used to form the shaft seals are the same as those identified in the scientific and engineering literature as appropriate for sealing deep geologic repositories for radioactive wastes. Durability or longevity of seal components is a primary concern for any long-term isolation system. Issues of possible degradation have been studied throughout the international community and within waste isolation programs in the USA. Specific degradation studies are not detailed in this document because longevity is one of the over-riding attributes of the materials selected and degradation is not perceived to be likely. However, it is acknowledged here that microbial degradation, seal material interaction, mineral transformation, such as silicification of bentonite, and effects of a thermal pulse from asphalt or hydrating concrete are areas of continuing investigations.

Among longevity concerns, degradation of concrete is the most recognized. At this stage of the design, it is established that only small volumes of brine ever reach the concrete elements (see Section C4 of the Compliance Submittal Design Report (Sandia, 1996)). Further analysis concerned with borehole plugging using cementitious materials shows that at least 100 pore volumes of brine in an open system would be needed to begin degradation processes. In a closed system, such as the hydrologic setting in the WIPP shafts, phase transformations create a degradation product of increased volume. Net volume increase owing to phase transformation in the absence of mass transport would decrease rather than increase permeability of concrete seal elements.

Asphalt has existed for thousands of years as natural seeps. Longevity studies specific to DOE's Hanford site have utilized asphalt artifacts buried in ancient ceremonies to assess long-term stability (Wing and Gee, 1994). Asphalt used as a seal component deep in the shaft will inhabit a benign environment, devoid of ultraviolet light or an oxidizing atmosphere. Additional assurance against possible microbial degradation in asphalt elements is provided with addition of lime. For these reasons, it is believed that asphalt components will possess their design characteristics well beyond the regulatory period.

Natural bentonite is a stable material that generally will not change significantly over a period of ten thousand years. Bentonitic clays have been widely used in field and laboratory experiments concerned with radioactive waste disposal. As noted by Gray (1993), three internal mechanisms, illitization, silicification and charge change, could affect sealing properties of bentonite. Illitization and silicification are thermally driven processes and, following discussion by Gray (1993), are not possible in the environment or time-frame of concern at the WIPP. The naturally occurring Wyoming bentonite which is the specified material for the WIPP shaft seal is well over a million years old. It is, therefore, highly unlikely that the metamorphism of bentonite enters as a design concern.

5.2 Materials

5.2.1 Mass Concrete

Concrete has low permeability and is widely used for hydraulic applications. The specification for mass concrete presents a special design mixture of a salt-saturated concrete called Salado Mass Concrete (**SMC**). Performance of SMC and similar salt-saturated mixtures has been established through analogous industrial applications and in laboratory and field testing. The documentation substantiates adequacy of SMC for concrete applications within the WIPP shafts.

The function of the concrete is to provide durable components with small void volume, adequate structural compressive strength, and low permeability. SMC is used as massive plugs, a monolith at the base of each shaft, and in tandem with asphalt waterstops. Concrete is a rigid material that will support overlying seal components while promoting natural healing processes within the salt DRZ. Concrete is one of the redundant components that protects the reconsolidating salt column. The salt column will achieve low permeabilities in fewer than 100 years, and concrete will no longer be needed at that time. However, concrete will continue to provide good sealing characteristics for a very long time.

Salt-saturated concrete contains sufficient salt as an aggregate to saturate hydration water with respect to NaCl. Salt-saturated concrete is required for all uses within the Salado Formation because fresh water concrete would dissolve part of the host rock. The concrete specified for the shaft seal system has been tailored for the service environment and includes all the engineering properties of high quality concrete, as described in Appendix G2-A. Among these are low heat of hydration, high compressive strength, and low permeability. Because SMC provides material characteristics of high-performance concrete, it will likely be the concrete of choice for all seal applications at the WIPP.

Construction involves surface preparation and slickline placement. A batching and mixing operation on the surface will produce a wet mixture having low initial temperatures. Placement uses a tremie line, where the fresh concrete exits the slickline below the surface level of the concrete being placed. Placed in this manner, the SMC will have low porosity (about 5%) with or without vibration. Tremie line placement is a standard construction method in mining operations.

Specifications of concrete properties include mixture proportions and characteristics before and after hydration. SMC strength is much greater than required for shaft seal elements, and the state of stress within the shafts is compressional with little shear stress developing. Volume stability of the SMC is also excellent; this, combined with salt-saturation, assures a good bond with the salt. Permeability of SMC is very low, consistent with most concrete (Pfeifle et al., 1996). Because of a favorable state of stress and isothermal conditions, the SMC will remain intact. Because little brine is available to alter concrete elements, minimal degradation is possible. These favorable attributes combine to assure concrete elements within the Salado will remain structurally sound and possess very low permeability (between 2×10^{-21} and 1×10^{-17} m^2) for exceedingly long periods. A permeability distribution function and associated discussion are given in Appendix G2-A.

Standard ASTM specifications are made for the green and hydrated concrete properties. Quality control and a history of successful use in both civil construction and mining applications assure proper placement and performance.

5.2.2 Compacted Clay

Compacted clays are commonly proposed as primary sealing materials for nuclear waste repositories and have been extensively investigated against rigorous performance requirements. Advantages of clays for sealing purposes include low permeability, demonstrated longevity in many types of natural environments, deformability, sorptive capacity, and demonstrated successful utilization in practice for a variety of sealing purposes.

Compacted clay as a shaft sealing component functions as a barrier to brine flow and possibly to gas flow (see alternative construction methods in Appendix G2-B). Compacted bentonitic clay can generate swelling pressure and clays have sufficient rigidity to promote healing of any DRZ in the salt. Wetted swelling clay will seal fractures as it expands into available space and will ensure tightness between the clay seal component and the shaft walls.

The Rustler and Salado compacted clay columns are specified to be constructed of dense sodium bentonite blocks. An extensive experimental data base exists for the permeability of sodium bentonites under a variety of conditions. Many other properties of sodium bentonite, such as strength, stiffness, and chemical stability, are established. Bentonitic clays heal when fractured and can penetrate small fractures or irregularities in the host rock. Further, bentonite is stable in the seal environment. These properties, noted by international waste isolation programs, make bentonite a widely accepted seal material.

From the bottom clay component to the top earthen fill, different methods will be used to place clay materials in the shaft. Seal performance within the Salado Formation is far more important to regulatory compliance of the seal system than is performance of clay and earthen fill in the overlying formations. Therefore, more time and effort will be expended on placement of Salado clay components. Three potential construction methods could be used to place clay in the shaft, as discussed in Appendix G2-B: compacted blocks, vibratory roller, and dynamic compaction. Construction of Salado clay components specifies block assembly.

Required sealing performance of compacted clay elements varies with location. For example, Component 4 provides separation of water-bearing zones, while the lowest clay column (Component 12) limits fluid flow to the reconsolidating salt column. If liquid saturation in the clay column of 85% can be achieved, it would serve as a gas barrier. In addition, compacted clay seal components promote healing of the salt DRZ. To achieve low permeabilities, the dry density of the emplaced bentonite should be about 1.8 g/cm^3. A permeability distribution function for performance assessment and the logic for its selection are given in Appendix G2-A.

Verification of specified properties such as density, moisture content, permeability, or strength of compacted clay seals can be determined by direct measurement during construction. However, indirect methods are preferred because certain measurements, such as permeability, are likely to be time consuming and invasive. Methods used to verify the quality of emplaced seals will include quality of block production and field measurements of density.

5.2.3 Asphalt

Asphalt is used to prevent water migration down the shaft in two ways: as an asphalt column near the Rustler/Salado contact and as a “waterstop” sandwiched between concrete plugs at three locations within the Salado Formation. Asphalt components of the WIPP seal design add assurance that minimal transport of brine down the sealed shaft will occur.

Asphalt is a widely used construction material because of its many desirable engineering properties. Asphalt is a strong cement, readily adhesive, highly waterproof, and durable. Furthermore, it is a plastic substance that is readily mixed with mineral aggregates. A range of viscosity is achievable for asphalt mixtures. It is highly resistant to most acids, salts, and alkalis. These properties are well suited to the requirements of the WIPP shaft seal system.

Construction of the seal components containing asphalt can be accomplished using a slickline process where low-viscosity heated material is effectively pumped into the shaft. The technology to apply the asphalt in this manner is available as described in the construction procedures in Appendix G2-B.

The asphalt components are required to endure for about 100 years and limit brine flow down the shaft to the compacted salt component. Since asphalt will not be subjected to ultraviolet light or an oxidizing environment, it is expected to provide an effective seal for centuries. Air voids less than 2% ensure low permeability. The permeability of the massive asphalt column is expected to have an upper limit 1×10^{-18} m^2.

Sufficient construction practice and laboratory testing information is available to assure performance of the asphalt component. Laboratory validation tests to optimize viscosity may be desirable before final installation specifications are prepared. In general, verification tests would add quantitative documentation to expected performance values and have direct application to WIPP.

5.2.4 Compacted Salt Column

A reconsolidated column of natural WIPP salt will seal the shafts permanently. If salt reconsolidation is unimpeded by fluid pore pressures, the material will eventually achieve extremely low permeabilities approaching those of the native Salado Formation. Recent developments in support of the WIPP shaft seal system have produced confirming experimental results, constitutive material models, and construction methods that substantiate use of a salt column to create a low permeability seal component. Reuse of salt excavated in the process of creating the underground openings has been advocated since its initial proposal in the 1950s. Replacing the natural material in its original setting ensures physical, chemical, and mechanical compatibility with the host formation.

The function of the compacted and reconsolidated salt column is to limit transmission of fluids into or out of the repository for the statutory period of 10,000 years. The functional period starts within a hundred years and lasts essentially forever. After a period of consolidation, the salt column will almost completely retard gas or brine migration within the former shaft opening. A completely consolidated salt column will achieve flow properties indistinguishable from natural Salado salt.

The salt component is composed of crushed Salado salt with additional small amounts of water. The total water content of the crushed salt will be adjusted to 1.5 wt% before it is tamped into place. Field and laboratory tests have verified that natural salt can be compacted to significant fractional density ($\rho \geq 0.9$) with addition of these moderate amounts of water.

Dynamic compaction is the specified construction procedure to tamp crushed salt in the shaft. Deep dynamic compaction provides great energy to the crushed salt, is easy to apply, and has an effective depth of compactive influence greater than lift thickness. Dynamic compaction is relatively straightforward and requires a minimal work force in the shaft. Compaction itself will follow procedures developed in a large-scale compaction demonstration, as outlined in Appendix G2-B.

Numerical models of the shaft provide density of the compacted salt column as a function of depth and time. Many calculations comparing models for consolidation of crushed salt were performed to quantify performance of the salt column, as discussed in Appendix D of the Compliance Submittal Design Report (Sandia, 1996) and the references (Callahan et al., 1996; Brodsky et al., 1996). From the density-permeability relationship of reconsolidating crushed salt, permeability of the compacted salt seal component is calculated. In general, results show that the bottom of the salt column consolidates rapidly, achieving permeability of 1×10^{-19} m^2 in about 50 years. By 100 years, the middle of the salt column reaches similar permeability.

Results of the large-scale dynamic compaction demonstration suggest that deep dynamic compaction will produce a sufficiently dense starting material. As with other seal components, testing of the material in situ will be difficult and probably not optimal to ensure quality of the seal element. This is particularly apparent for the compacted salt component because the compactive effort produces a finely powdered layer on the top of each lift. It was demonstrated (Hansen and Ahrens, 1996) that the fine powder is very densely compacted upon tamping the superincumbent lifts. The best means to ensure that the crushed salt element is placed properly is to establish performance through verification of quality assurance/quality control procedures. If crushed salt is placed with a reasonable uniformity of water and compacted with sufficient energy, long-term performance can be assured.

5.2.5 Cementitious Grout

Cementitious grouting is specified for all concrete members. Grouting is also used in advance of liner removal to stabilize the ground and to limit water inflow during shaft seal construction. Cementitious grout is specified because of its proven performance, nontoxicity, and previous use at the WIPP.

The function of grout is to stabilize the surrounding rock before existing concrete liners are removed. Grout will fill fractures within adjacent lithologies, thereby adding strength and reducing permeability and, hence, water inflow during shaft seal construction. Grout around concrete members of the concrete asphalt waterstop will be employed in an attempt to tighten the interface and fill microcracks in the DRZ. Efficacy of grouting will be determined during construction.

An ultrafine cementitious grout has been specifically developed for use at the WIPP (Ahrens and Onofrei, 1996). This grout consists of Type 5 portland cement, pumice as a pozzolanic material, and superplasticizer. The average particle size is approximately 2 microns. The ultrafine grout is mixed in a colloidal grout mixer, with a water to components ratio (**W:C**) of 0.6:1.

Drilling and grouting sequences provided in Appendix G2-B follow standard procedures. Grout will be mixed on the surface and transported by slickline to the middle deck on the multi-deck stage (galloway). Grout pressures are specified below lithostatic to prevent hydrofracturing.

Performance of grout is not a consideration for compliance issues. Grouting of concrete elements is an added assurance to tighten interfaces. Grouting is used to facilitate construction by stabilizing any loose rock behind the concrete liner.

No verification of the effectiveness of grouting is currently specified. If injection around concrete plugs is possible, an evaluation of quantities and significance of grouting will be made during construction. Procedural specifications will include measurements of fineness and determination of rheology in keeping with processes established during the WIPP demonstration grouting (Ahrens et al., 1996).

5.2.6 Earthen Fill

A brief description of the earthen fill is provided in Appendix G2-A, and construction is summarized in Appendix G2-B. Compacted fill can be obtained from local borrow pits, or material excavated during shaft construction can be returned to the shaft. There are minimal design requirements for earthen fill and none that are related to WIPP regulatory performance.

5.3 Concluding Remarks

Materials specifications in Appendix G2-A provide descriptions of seal materials along with reasoning on their expected reliability in the WIPP setting. The specification follows a framework that states the function of the seal component, a description of the material, and a summary of construction techniques. The performance requirements for each material are detailed. Materials chosen for use in the shaft seal system have several common desirable attributes: low permeability, high density, compatibility, longevity, low cost, constructability, availability, and supporting documentation.

6. Construction Techniques

Construction of the shaft sealing system is feasible. The described procedures utilize currently available technology, equipment, and materials to satisfy shaft sealing system design guidance. Although alternative methods are possible, those described satisfy the design guidance requirements listed in Table G2-7 and detailed in the appendices. Construction feasibility is established by reference to comparable equipment and activities in the mining, petroleum, and food industries and test results obtained at the WIPP. Equipment and procedures for emplacement of sealing materials are described below.

6.1 Multi-Deck Stage

A multi-deck stage (Figures G2-6 and G2-7) consisting of three vertically connected decks will be the conveyance utilized during the shaft sealing operation. Detailed sketches of the multi-deck stage appear in Appendix G2-E. The stage facilitates installation and removal of utilities and provides a working platform for the various sealing operations. A polar crane attached to the lower deck provides the mechanism required for dynamic compaction and excavation of the shaft walls. Additionally, the header at the bottom of the slickline is supported by a reinforced steel shelf, which is securely bolted to the shaft wall during emplacement of sealing materials. The multi-deck stage can be securely locked in place in the shaft whenever desired (e.g., during dynamic compaction, excavation of the salt walls of the shaft, grouting, liner removal, etc.). The multi-deck stage is equipped with floodlights, remotely aimed closed-circuit television, fold-out floor extensions, a jib crane, and range-finding devices. Similar stages are commonly employed in shaft sinking operations.

The polar crane can be configured for dynamic compaction (Figure G2-6) or for excavation of salt (Figure G2-7); a man cage or bucket can be lowered through the stage to the working surface below. Controlled manually or by computer, the crane and its trolley utilize a geared track drive. The crane can swiftly position the tamper (required for dynamic compaction) in the drop positions required (Figure G2-8) or accommodate the undercutter required for excavation of the shaft walls. The crane incorporates a hoist on the trolley and an electromagnet, enabling it to position, hoist, and drop the tamper. A production rate of one drop every two minutes during dynamic compaction is possible.

6.2 Salado Mass Concrete (Shaft Station Monolith and Shaft Plugs)

Salado Mass Concrete, described in Appendix G2-A, will be mixed on surface at 20ºC and transferred to emplacement depth through a slickline (i.e., a steel pipe fastened to the shaft wall and used for the transfer of sealing materials from surface to the fill horizon) minimizing air entrainment and ensuring negligible segregation. Existing sumps will be filled to the elevation of the floor of the repository horizon, and emplacement of the shaft station monolith is designed to eliminate voids at the top (back) of the workings.

When excavating salt for waterstops or plugs in the Salado Formation, an undercutter attached to the trolley of the polar crane will be forced into the shaft wall by a combination of geared trolley and undercutter drives. Full circumferential cuts will be accomplished utilizing the torque developed by the geared polar crane drive.

The undercutter proposed is a modified version of those currently in use in salt and coal mines, where their performance is proven. Such modifications and applications have been judged feasible by the manufacturer.

The concrete-salt interface and DRZ around concrete plugs in the Salado Formation (and the one at the base of the Rustler Formation) will be grouted with ultrafine grout. Injection holes will be collared in the top of the plug and drilled downward at 45º below horizontal. The holes will be drilled in a “spin” pattern describing a downward opening cone designed to intercept both vertical and horizontal fractures (Figure G2-9). The holes will be stage grouted (i.e., primary holes will be drilled and grouted, one at a time). Secondary holes will then be drilled and grouted, one at a time, on either side of primaries that accepted grout.

6.3 Compacted Clay Columns (Salado and Rustler Formations)

Cubic blocks of sodium bentonite, 20.8 cm on the edge and weighing approximately 18 kg, will be precompacted on surface to a density between 1.8 and 2.0 gm/cm^3 and emplaced manually. The blocks will be transferred from surface on the man cage. Block surfaces will be moistened with a fine spray of potable water, and the blocks will be manually placed so that all surfaces are in contact. Peripheral blocks will be trimmed to fit irregularities in the shaft wall, and remaining voids will be filled with a thick mortar of sodium bentonite and potable water. Such blocks have been produced at the WIPP and used in the construction of 0.9-m-diameter seals, where they performed effectively (Knowles and Howard, 1996). Alternatives, which may be considered in future design evaluations, are discussed in Appendix G2-B.

6.4 Asphalt Waterstops and Asphaltic Mix Columns

Neat asphalt is selected for the asphalt waterstops, and an asphaltic mastic mix (**AMM**) consisting of neat asphalt, fine silica sand, and hydrated lime will be the sealing material for the columns. Both will be fluid at emplacement temperature and remotely emplaced. Neat asphalt (or AMM, prepared in a pug mill near the shaft collar) will be heated to 180°C and transferred to emplacement depth via an impedance-heated, insulated tremie line (steel pipe) suspended from slips (pipe holding device) at the collar of the shaft.

This method of line heating is common practice in the mining and petroleum industries. This method lowers the viscosity of the asphalt so that it can be pumped easily. Remote emplacement by tremie line eliminates safety hazards associated with the high temperature and gas produced by the hot asphalt. Fluidity ensures that the material will flow readily and completely fill the excavations and shaft. Slight vertical shrinkage will result from cooling (calculations in Appendix D of the Compliance Submittal Design Report (Sandia, 1996)), but the material will maintain contact with the shaft walls and the excavation for the waterstop. Vertical shrinkage will be counteracted by the emplacement of additional material.

6.5 Compacted WIPP Salt

Dynamic compaction of mine-run WIPP salt has been demonstrated (Ahrens and Hansen, 1995). The surface demonstration produced salt compacted to 90% of in-place rock salt density, with a statistically averaged permeability of 1.65×10^{-15} m^2. Additional laboratory consolidation of this material at 5 MPa confining pressure (simulating creep closure of the salt) resulted in increased compaction and lower permeability (Brodsky, 1994). Dynamic compaction was selected because it is simple, robust, proven, has excellent depth of compaction, and is applicable to the vertical WIPP shafts.

The compactive effect expanded laterally and downward in the demonstration, and observation during excavation of the compacted salt revealed that the lateral compactive effect will fill irregularities in the shaft walls. Additionally, the depth of compaction, which was greater than that of the three lifts of salt compacted, resulted in the bottom lift being additionally compacted during compaction of the two overlying lifts. This cumulative effect will occur in the shafts.

Construction of the salt column will proceed in the following manner:

- Crushed and screened salt will be transferred to the fill elevation via slickline. Use of slicklines is common in the mining industry, where they are used to transfer backfill materials or concrete to depths far greater than those required at the WIPP. Potable water will be added via a fine spray during emplacement at the fill surface to adjust the moisture content to 1.5 ±0.3 wt%, accomplished by electronically coordinating the weight of the water with that of the salt exiting the hose.

- Dynamic compaction will then be used to compact the salt by dropping the tamper in specific, pre-selected positions such as those shown in Figure G2-8.

6.6 Grouting of Shaft Walls and Removal of Liners

The procedure listed below is a common mining practice which will be followed at each elevation where liner removal is specified. If a steel liner is present, it will be cut into manageable pieces and hoisted to the surface for disposal, prior to initiation of grouting.

Upward opening cones of diamond drill holes will be drilled into the shaft walls in a spin pattern (Figure G2-10) to a depth ensuring complete penetration of the Disturbed Rock Zone (**DRZ**) surrounding the shaft. For safety reasons, no major work will be done from the top deck; all sealing activities will be conducted from the bottom deck. The ends of the holes will be 3 m apart, and the fans will be 3 m apart vertically, covering the interval from 3 m below to 3 m above the interval of liner removal. Tests at the WIPP demonstrated that the ultrafine cementitious grout penetrated more than 2 m from the injection holes(Ahrens et al., 1996).

Injection holes will be drilled and grouted one at a time, as is the practice in stage grouting. Primary holes are grouted first, followed by the grouting of secondary holes on either side of primaries that accepted grout. Ultrafine grout will be injected below lithostatic pressure to avoid hydrofracturing the rock, proceeding from the bottom fan upward. Grout will be mixed on surface and transferred to depth via the slickline.

Radial, horizontal holes will then be drilled on a 0.3-m grid, covering the interval to be removed. These will be drilled to a depth sufficient to just penetrate the concrete liner. A chipping hammer will be used to break a hole through the liner at the bottom of the interval. This hole, approximately 0.3 m in diameter, will serve as “free face,” to which the liner can be broken. Hydraulically-actuated steel wedges will then be used in the pre-drilled holes to break out the liner in manageable pieces, beginning adjacent to the hole and proceeding upward. Broken concrete will be allowed to fall to the fill surface, where it will be gathered and hoisted to the surface for disposal. Chemical seal rings will be removed as encountered.

6.7 Earthen Fill

Local soil, screened to produce a maximum particle dimension of approximately 15 mm, will be the seal material. This material will be transferred to the fill surface via the slickline and emplaced in the same manner as the salt. After adjusting the moisture content of the earthen fill below the concrete plug in the Dewey Lake Redbeds to achieve maximum compaction, the fill will be dynamically compacted, achieving a permeability as low as that of the enclosing formation.

The portion of the earthen fill above the plug will be compacted with a vibratory-impact sheepsfoot roller, a vibratory sheepsfoot roller, or a walk-behind vibratory plate compactor, because of insufficient height for dynamic compaction.

6.8 Schedule

For discussion purposes, it has been assumed that the shafts will be sealed two at a time. This results in the four shafts being sealed in approximately six and a half years. The schedules presented in Appendix G2-B are based on this logic. Sealing the shafts sequentially would require approximately eleven and a half years.

7. Structural Analyses of Shaft Seals

7.1 Introduction

The shaft seal system was designed in accordance with design guidance described in Section 3.2. To be successful, seal system components must exhibit desired structural behavior. The desired structural behavior can be as simple as providing sufficient strength to resist imposed loads. In other cases, structural behavior is critical to achieving desired hydrological properties. For example, permeability of compacted salt depends on the consolidation induced by shaft closure resulting from salt creep. In this example, results from structural analyses feed directly into fluid-flow calculations, which are described in Section 8, because structural behavior affects both time-dependent permeabilities of the compacted salt and pore pressures within the compacted salt. In other structural considerations, thermal effects are analyzed as they affect the constructability and schedule for the seal system. Thus a series of analyses, loosely termed structural analyses, were performed to accomplish three purposes:

1. to determine loads imposed on components and to assess both structural stability based on the strength of the component and mechanical interaction between components;

2. to estimate the influence of structural behavior of seal materials and surrounding rock on hydrological properties; and

3. to provide structural and thermal related information on construction issues.

For the most part, structural analyses rely on information and design details presented in the Design Description (Section 4), the Design Drawings (Appendix G2-E), and Material Specification (Section 5 and Appendix G2-A). Some analyses are generic, and calculation input and subsequent results are general in nature.

7.2 Analysis Methods

Finite-element modeling was the primary numerical modeling technique used to evaluate structural performance of the shaft seals and surrounding rock mass. Well documented finite-element computer programs, SPECTROM-32 and SPECTROM-41, were used in structural and thermal modeling, respectively. The computer program SALT_SUBSID was used in the subsidence modeling over the backfilled shaft-pillar area. Specific details of these computer programs as they relate to structural calculations are listed in Appendix D of the Compliance Submittal Design Report (Sandia, 1996), Section D2.

7.3 Models of Shaft Seals Features

Structural calculations require material models to characterize the behavior of (1) each seal material (concrete, crushed salt, compacted clay, and asphalt); (2) the intact rock lithologies in the near-surface, Rustler, and Salado formations; and (3) any DRZ within the surrounding rock. A general description of the material models used in characterizing each of these materials and features is given below. Details of the models and specific values of model parameters are given in Appendix D in the Compliance Submittal Design Report (Sandia, 1996), Section D3.

7.3.1 Seal Material Models

The SMC thermal properties required for the structural analyses (thermal conductivity, density, specific heat, and volumetric heat generation rate) were obtained from SMC test data. Concrete was assumed to behave as a viscoelastic material, based on experimental data, and the elastic modulus of SMC was modeled as age-dependent. Strength properties of SMC were specified in the design (see Appendix G2-A).

For crushed salt, the deformational model included a nonlinear elastic component and a creep consolidation component. The nonlinear elastic modulus was assumed to be density-dependent, based on laboratory test data performed on WIPP crushed salt. Creep consolidation behavior of crushed salt was based on three candidate models whose parameters were obtained from model fitting to hydrostatic and shear consolidation test data performed on WIPP crushed salt. Creep consolidation models include functional dependencies on density, mean stress, stress difference, temperature, grain size, and moisture content.

Compacted clay was assumed to behave according to a nonlinear elastic model in which shear stiffness is negligible, and asphalt was assumed to behave as a weak elastic material. Thermal properties of asphalt were taken from literature.

7.3.2 Intact Rock Lithologies

Salado salt was assumed to be argillaceous salt that is governed by the Multimechanism Deformation Coupled Fracture (**MDCF**) model, which is an extension of the Munson-Dawson (**M-D**) creep model. A temperature-dependent thermal conductivity was necessary.

Salado interbeds were assumed to behave elastically. Their material strength was assumed to be described by a Drucker-Prager yield function, consistent with values used in previous WIPP analyses.

Deformational behavior of the near-surface and Rustler Formation rock types was assumed to be time-invariant, and their strength was assumed to be described by a Coulomb criterion, consistent with literature values.

7.3.3 Disturbed Rock Zone Models

Two different models were used to evaluate the development and extent of the DRZ within intact salt. The first approach used ratios of time-dependent stress invariants to quantify the potential for damage or healing to occur. The second approach used the damage stress criterion according to the MDCF model for WIPP salt.

7.4 Structural Analyses of Shaft Seal Components

7.4.1 Salado Mass Concrete Seals

Five analyses related to structural performance of SMC seals were performed, including (1) a thermal analysis, (2) a structural analysis, (3) a thermal stress analysis, (4) a dynamic compaction analysis, and (5) an analysis of the effects of clay swelling pressure. This section presents these analyses and evaluates the results in terms of the performance of the SMC seal.

Details of these calculations are given in Appendix D in the Compliance Submittal Design Report (Sandia, 1996), Section D4.

7.4.1.1 Thermal Analysis of Concrete Seals

The objective of this calculation was to determine expected temperatures within (and surrounding) an SMC emplacement resulting from its heat of hydration. Results indicate that the concrete component temperature increases from ambient (27°C) to a maximum of 53°C at 0.02 year after emplacement. The maximum temperature in the surrounding salt is 38°C at approximately the same time. The thermal gradient within the concrete is approximately 1.5°C/m. Most of the higher temperatures are contained within the concrete. At a radial distance of 2 m into the surrounding salt, the temperature rise is less than 1°C. These conditions are favorable for proper performance of the SMC components. A 26°C temperature rise and a 1.5°C/m temperature gradient are not large enough to cause thermal cracking as the concrete cools (Andersen et al., 1992).

7.4.1.2 Structural Analysis of Concrete Seals

The objectives of this calculation were to determine (1) expected stresses within the concrete components caused by restrained creep of the surrounding salt and (2) expected stresses in the concrete component from weight of overlying seal material.

In the upper concrete-asphalt waterstop, radial stresses increase (compression is positive) from zero at time of emplacement (t = 0) to 2.5 MPa at t = 50 years. Similarly, radial stresses in the middle concrete component range from 3.5 to 4.5 MPa at 50 years after emplacement. In the lower concrete-asphalt waterstop, radial stresses range from 4.5 to 5.5 MPa at t = 50 years. All the calculated stresses are well below the unconfined compressive strength of the concrete (30 MPa).

The upper, middle, and lower concrete-asphalt waterstops are located at depths of 300, 420, and 610 m, respectively. When performing these calculations, it was assumed that each concrete component must support the weight of the overlying materials between it and the next concrete component above it. Using an average overburden density of 0.02 MPa/m, stresses induced by the overlying material are significantly less than the strength of the concrete. The structural integrity of concrete components will not be compromised by either induced radial stress or imposed vertical stress.

7.4.1.3 Thermal Stress Analysis of Concrete Seals

The objectives of this calculation were (1) to determine thermal stresses in concrete components from the heat of hydration and (2) to determine thermal impact on the creep of the surrounding salt.

Thermoelastic stresses in the concrete were calculated based on a maximum temperature increase of 26°C and assuming a fully confined condition. Results of this calculation indicate that short-term compressive thermal stresses in the concrete will be less than 9.2 MPa. The temperature rise in the surrounding salt is insignificant in terms of producing either detrimental or beneficial effects. Based on these results, the structural integrity of concrete components will not be compromised by thermoelastic stresses caused by heat of hydration.

7.4.1.4 Effect of Dynamic Compaction on Concrete Seals

The objective of this calculation was to determine a required thickness of seal layers above concrete components to reduce the impact of dynamic compaction. Compaction depths for crushed salt and clay layers are 2.8 m and 2.2 m, respectively. Layers 3.7-m thick for crushed salt and 3-m thick for clay are to be emplaced before compaction begins, thus providing a layer about 30% thicker than the calculated compaction depths.

7.4.1.5 Effect of Clay Swelling Pressures on Concrete Seals

The objective of this calculation was to determine the increased stresses within concrete components as a result of clay swelling pressures. Test measurements on confined bentonite at an emplaced density of 1.8 g/cm^3 indicate that anticipated swelling pressures are on the order of 3.5 MPa. In order to fracture the salt surrounding the clay, the swelling pressures must exceed the lithostatic rock stress in the salt, which ranges from nominally 8.3 MPa at the upper clay seal to 14.4 MPa at the lower clay seal. The design strength of the concrete (31.0 MPa) is significantly greater than the swelling pressure of 3.5 MPa. Even in the unlikely event that the clay swelled to lithostatic pressures, the resulting state of stress in the concrete seal would lie well below any failure surface. Furthermore, the compressive tangential stress in the salt along the shaft wall, even after stress relaxation from creep, is always larger than lithostatic. Hence, radial fracturing from clay swelling pressure is not expected.

7.4.2 Crushed Salt Seals

Two analyses related to structural performance of crushed salt seals were performed, including (1) a structural analysis and (2) an analysis to determine effects of pore pressure on consolidation of crushed salt seals. This section presents the results of these analyses and evaluates the results in terms of performance of crushed salt seals. Details of these analyses are given in Appendix D in the Compliance Submittal Design Report (Sandia, 1996), Section D4.

7.4.2.1 Structural Analysis of Compacted Salt Seal

The objectives of this calculation were (1) to determine the fractional density of the crushed salt seal as a function of time and depth and, using these results, (2) to determine permeability of the crushed salt as a function of time and depth.

Results indicate that compacted salt will increase from its emplaced fractional density of 90% to a density of 95% approximately 40, 80, and 120 years after emplacement at the bottom, middle, and top of the shaft seal, respectively. Using the modified Sjaardema-Krieg creep consolidation model, the times required to fully reconsolidate the crushed salt to 100% fractional density are 70 years, 140 years, and 325 years at the bottom, middle, and top of the salt column, respectively. Based on these results, the desired fractional densities (hence, permeability) can be achieved over a substantial length of the compacted salt seal in the range of 50 to 100 years.

7.4.2.2 Pore Pressure Effects on Reconsolidation of Crushed Salt Seals

The objective of this calculation was to determine the effect of pore pressure on the reconsolidation of the crushed salt seal. Fractional densities of the crushed salt seal were calculated using the modified Sjaardema-Krieg consolidation model for a range of pore pressures (0, 2, and 4 MPa). Results indicate that times required to consolidate the crushed salt increase as the pore pressure increases, as expected. For example, for a pore pressure of 2 MPa, the times required to achieve a fractional density of 96% are about 90 years, 205 years, and 560 years at the bottom, middle, and top of the crushed salt column, respectively. A pore pressure of 4 MPa would effectively prevent reconsolidation of the crushed salt within a reasonable period (<1,000 years). The results of this calculation were used in the fluid flow calculations, and the impact of these pore pressures on the permeability of the crushed salt seal is described in Section 8 and Appendix C of the Compliance Submittal Design Report (Sandia, 1996).

7.4.3 Compacted Clay Seals

One analysis was performed to determine the structural response of compacted clay seals. The objective of this calculation was to determine stresses in the upper Salado compacted clay component and the lower Salado compacted clay component as a result of creep of the surrounding salt. Details of this calculation are given in Appendix D in the Compliance Submittal Design Report (Sandia, 1996), Section D4. Results of this calculation indicate that after 50 years the compressive stresses in the upper Salado compacted clay component are about 0.7 MPa, not including the effects of swelling pressures. Similarly, after 50 years the stresses in the lower Salado compacted clay component are approximately 2.6 MPa. Based on these results, the compacted clay component will provide some restraint to the creep of salt and induce a back (radial) stress in the clay seal, which will promote healing of the DRZ in the surrounding intact salt (see discussion about DRZ in Section 7.5.1).

7.4.4 Asphalt Seals

Three analyses were performed related to structural performance of the asphalt seals, including (1) a thermal analysis, (2) a structural analysis, and (3) a shrinkage analysis. This section presents the results of these analyses and evaluates the results in terms of the performance of the asphalt seal. Details of these analyses are given in Appendix D of the Compliance Submittal Design Report (Sandia, 1996), Section D4.

7.4.4.1 Thermal Analysis

The objectives of this calculation were (1) to determine temperature histories within the asphalt seal and the surrounding salt and (2) to determine effects of the length of the waterstop.

Results indicate that the center of the asphalt column will cool from its emplaced temperature of 180°C to 83°C, 49°C, 31°C, and 26°C at times 0.1 year, 0.2 year, 0.5 year, and 1.0 year, respectively. Similarly, the asphalt/salt interface temperatures at corresponding times are 47°C, 38°C, 29°C, and 26°C. The time required for a waterstop to cool is significantly less than that required to cool the asphalt column. Based on these results, about 40 days are required for asphalt to cool to an acceptable working environment temperature. The thermal impact on enhanced creep rate of the surrounding salt is considered to be negligible.

7.4.4.2 Structural Analysis

The objective of this analysis was to calculate pressures in asphalt that result from restrained creep of the surrounding salt and to evaluate stresses induced on the concrete seal component by such pressurization.

Results indicate that pressures in the waterstops after 100 years are 1.8 MPa, 2.5 MPa, and 3.2 MPa for the upper, middle, and lower waterstops, respectively. Based on these results, the structural integrity of concrete components will not be compromised by imposed pressures, and the rock surrounding the asphalt will not be fractured by the pressure. The pressure from asphalt is enough to initiate healing of the DRZ surrounding the waterstop.

7.4.4.3 Shrinkage Analysis

The objective of this analysis was to calculate shrinkage of the asphalt column as it cools from its emplaced temperature to an acceptable working environment temperature. Results of this analysis indicate that the 42-m asphalt column will shrink 0.9 m in height as the asphalt cools from its emplaced temperature of 180°C to 38°C.

7.5 Disturbed Rock Zone Considerations

7.5.1 General Discussion of DRZ

Microfracturing leading to a DRZ occurs within salt whenever excavations are made. Laboratory and field measurements show that a DRZ has enhanced permeability. The body of evidence strongly suggests that induced fracturing is reversible and healed when deviatoric stress states created by the opening are reduced. Rigid seal components in the shaft provide a restraint to salt creep closure, thereby inducing healing stress states in the salt. A more detailed discussion of the DRZ is included in Appendix D in the Compliance Submittal Design Report (Sandia, 1996).

7.5.2 Structural Analyses

Three analyses were performed to determine the behavior of the DRZ in the rock mass surrounding the shaft. The first analysis considered time-dependent DRZ development and subsequent healing of intact Salado salt surrounding each of the four seal materials. The second analysis considered time-dependent development of the DRZ within anhydrite and polyhalite interbeds within the Salado Formation. The last analysis considered time-independent DRZ development within the near-surface and Rustler formations. These analyses are discussed below and given in more detail in Appendix D of the Compliance Submittal Design Report (Sandia, 1996), Section D5. Results from these analyses were used as input conditions for the fluid flow analysis presented in Section 8 and Appendix C of the Compliance Submittal Design Report (Sandia, 1996).

7.5.2.1 Salado Salt

The objective of this calculation was to determine time-dependent extent of the DRZ in salt, assuming no pore pressure effects, for each of the four shaft seal materials (i.e., concrete, crushed salt, compacted clay, and asphalt. The seal materials below a depth of about 300 m provide sufficient rigidity to heal the DRZ within 100 years. Asphalt, modeled as a weak elastic material, will not create a stress state capable of healing the DRZ because it is located high in the Salado.

7.5.2.2 Salado Anhydrite Beds

The objective of this calculation was to determine the extent of the DRZ within the Salado anhydrite and polyhalite interbeds as a result of creep of surrounding salt.

For all interbeds, the factor of safety against failure (shear or tensile fracturing) increases with depth into the rock surrounding the shaft wall. These results indicate that, with the exception of Marker Bed 117 (**MB117**), the factor of safety is greater than 1 (no DRZ will develop) for all interbeds. For MB117, the potential for fracturing is localized to within 1 m of the shaft wall.

7.5.2.3 Near-Surface and Rustler Formations

The objective of this calculation was to determine the extent of the DRZ surrounding the shafts in the near-surface and Rustler formations.

Rock types in near-surface and Rustler formations are anhydrite, dolomite, and mudstone. These rock types exhibit time-independent behavior. Results indicate that no DRZ will develop in anhydrite and dolomite (depths between 165 and 213 m). For mudstone layers, the radial extent of the DRZ increases with depth, reaching a maximum of 2.6 shaft radii at a depth of 223 m.

7.6 Other Analyses

This section discusses two structural analyses performed in support of design concerns, namely (1) the asphalt waterstops constructability and (2) benefits from shaft station backfilling. Analyses performed in support of these efforts are discussed below and given in more detail in Appendix D of the Compliance Submittal Design Report (Sandia, 1996), Section D6.

7.6.1 Asphalt Waterstops

The DRZ is a major contributor to fluid flows through a low permeability shaft seal system, regardless of the materials emplaced within the shaft. Therefore, to increase the confidence in the overall shaft seal, low permeability layers (termed radial waterstops) were included to intersect the DRZ surrounding the shaft. These waterstops are emplaced to alter the flow direction either inward toward the shaft seal or outward toward intact salt. Asphalt-filled waterstops will be effective soon after emplacement. The objectives of these structural calculations were to evaluate performance of the waterstops in terms of (1) intersecting the DRZ around the shaft, (2) inducing a new DRZ because of special excavation, and (3) promoting healing of the DRZ.

Results indicate that the DRZ from the shaft extends to a radial distance of less than one shaft radius (3.04 m). Waterstop excavation extends the DRZ radially to about 1.4 shaft radii (4.3 m). However, this extension is localized within the span of the concrete component and extends minimally past the waterstop edge. The DRZ extent reduced rapidly after the concrete and asphalt restrained creep of the surrounding salt. After 20 years, the spatial extent of the DRZ is localized near the asphalt-concrete interface, extending spatially into the salt at a distance of less than 2 m. Based on these results, construction of waterstops is possible without substantially increasing the DRZ. Furthermore, the waterstop extends well beyond the maximum extent of the DRZ surrounding the shaft and effectively blocks this flow path (within 2 years after emplacement), albeit over only a short length of the flow path.

7.6.2 Shaft Pillar Backfilling

The objective of this calculation was to assess potential benefits from backfilling a portion of the shaft pillar to reduce subsurface subsidence and thereby decrease the potential for inducing fractures along the shaft wall. The calculated subsidence without backfilling is less than one foot, due to the relatively low extraction ratio at the WIPP. Based on the results of this analysis, backfilling portions of the shaft pillar would result in only 10% to 20% reduction in surface subsidence. This reduction in subsidence from backfilling is not considered enough to warrant backfilling the shaft pillar area. The shaft seals within the Salado are outside the angle-of-draw for any horizontal displacements caused by the subsidence over the waste panels. Moreover, horizontal strains caused by subsidence induced by closures within the shaft pillar are compressive in nature and insignificant in magnitude to induce fracturing along the shaft wall.

8. Hydrologic Evaluation of the Shaft Seal System

8.1 Introduction

The design guidance in Section 3 presented the rationale for sealing the shaft seal system with low permeability materials, but it did not provide specific performance measures for the seal system. This section compares the hydrologic behavior of the system to several performance measures that are directly related to the ability of the seal system to limit liquid and gas flows through the seal system. The hydrologic evaluation is focused on the processes that could result in fluid flow through the shaft seal system and the ability of the seal system to limit any such flow. Transport of radiological or hazardous constituents will be limited if the carrier fluids are similarly limited.

The hydrologic performance models are fully described in Appendix C of the Compliance Submittal Design Report (Sandia, 1996). The analyses presented are deterministic. Quantitative values for those parameters that are considered uncertain and that may significantly impact the primary performance measures have been varied, and the results are presented in Appendix C the Compliance Submittal Design Report (Sandia, 1996). This section summarizes the seal system performance analyses and discusses results within the context of the design guidance of Section 3. The results demonstrate that (1) fluid flows will be limited within the shaft seal system and (2) uncertainty in the conceptual models and parameters for the seal system are mitigated by redundancy in component function and materials.

8.2 Performance Models

The physical processes that could impact seal system performance are presented in detail in Appendix C of the Compliance Submittal Design Report (Sandia, 1996). These processes have been incorporated into four performance models. These models evaluate (1) downward migration of groundwater from the Rustler Formation, (2) gas migration and consolidation of the crushed salt seal component, (3) upward migration of brines from the repository, and (4) flow between water-bearing zones in the Rustler Formation. The first three are analyzed using numerical models of the Air Intake Shaft (**AIS**) seal system and the finite-difference codes SWIFT II and TOUGH28W. These codes are extensively used and well documented within the scientific community. A complete description of the models is provided in Appendix C of the Compliance Submittal Design Report (Sandia, 1996). The fourth performance model uses a simple, analytical solution for fluid flow. Results from the analyses are summarized in the following sections and evaluated in terms of the design guidance presented in Section 3.

Material properties and conceptual models that may significantly impact seal system performance have been identified, and uncertainty in properties and models have been addressed through variation of model parameters. These parameters include (1) the effective permeability of the DRZ, (2) those describing salt column consolidation and the relationship between compacted salt density and permeability, and (3) repository gas pressure applied at the base of the shaft seal system.

8.3 Downward Migration of Rustler Groundwater

The shaft seal system is designed to limit groundwater flowing into and through the shaft sealing system (see Section 3). The principal source of groundwater to the seal system is the Culebra Member of the Rustler Formation. The Magenta Member of this formation is also considered a groundwater source, albeit a less significant source than the Culebra. No significant sources of groundwater exist within the Salado Formation; however, brine seepage has been noted at a number of the marker beds. The modeling includes the marker beds, as discussed in Appendix C of the Compliance Submittal Design Report (Sandia, 1996). Downward migration of Rustler groundwater must be limited so that liquid saturation of the compacted salt column salt column does not impact the consolidation process and to ensure that significant quantities of brine do not reach the repository horizon. Because it is clear that limitation of liquid flow into the salt column necessarily limits liquid flow to the repository, the volumetric flux of liquid into and through the salt column were selected as performance measures for this model.

Consolidation of the compacted salt column salt column will be most rapid immediately following seal construction. Simulations were conducted for the 200-year period following closure to demonstrate that, during this initial period, downward migration of Rustler groundwater will be insufficient to impact the consolidation process. Lateral migration of brine through the marker beds is also quantified in the analysis and shown to be nondetrimental to the function of the salt column.

8.3.1 Analysis Method

Seal materials will not, in general, be fully saturated with liquid at the time of construction. The host rock surrounding the shafts will also be partially desaturated at the time of seal construction. The analysis presented in this section assumes a fully saturated system. The effects of partial saturation of the shaft seal system are favorable in terms of system performance, as will be discussed in Section 8.3.2.

Seal material and host rock properties used in the analyses are discussed in Appendix C of the Compliance Submittal Design Report (Sandia, 1996), Section C3. Appendix G2-A contains a detailed discussion of seal material properties. A simple perspective on the effects of material and host rock properties may be obtained from Darcy’s Law. At steady-state, the flow rate in a fully saturated system depends directly on the system permeability. The seal system consists of the component material and host rock DRZ. Low permeability is specified for the engineered materials; thus the system component most likely to impact performance is the DRZ. Rock mechanics calculations presented in Appendix D of the Compliance Submittal Design Report (Sandia, 1996) predict that the DRZ in the Salado Formation will not be vertically continuous because of the intermittent layers of stiff anhydrites (marker beds). Asphalt waterstops are included in the design to minimize DRZ impacts. The effects of the marker beds and the asphalt waterstops on limiting downward migration are explicitly simulated through variation of the permeability of the layers of Salado DRZ.

Initial, upper, and lateral boundary conditions for the performance model are consistent with field measurements for the physical system. At the base of the shaft a constant atmospheric pressure is assumed.

8.3.2 Summary of Results

The initial pore volumes in the filled repository and the AIS salt column are approximately 460,000 m^3 and 250 m^3, respectively. The performance model predicts a maximum cumulative flow of less than 5 m^3 through the sealed shafts for the 200 years following closure. If the marker beds have a disturbed zone immediately surrounding the shaft, the maximum flow is less than 10 m^3 during the same period. Assuming the asphalt waterstops are not effective in interrupting the vertical DRZ, the volumetric flow increases but is still less than 30 m^3 for the 200 years following closure. These volumes are less than 1/100 of 1% of the pore volume in the repository and less than 20% of the initial pore volume of the salt column.

Two additional features of the model predictions should also be considered. The first of these is that flow rates fall from less than 1 m^3 / year in the first five years to negligible values within 10 years of seal construction. Therefore most of the cumulative flow occurs within a few years following closure. The second feature is the model prediction that the system returns to nearly ambient undisturbed pressures within two years. The repressurization occurs quickly within the model due to the assumption of a fully saturated flow regime because of brine incompressibility. As will be discussed in Section 8.4, the pore pressure in the compacted salt column is a critical variable in the analysis. The pressure profiles predicted by the model are an artifact of the assumption of full liquid saturation and do not apply to the pore pressure analysis of the salt column.

The magnitude of brine flow that can reach the repository through a sealed shaft is minimal and will not impact repository performance. The flow that reaches the salt column must be assessed with regard to the probable impacts on the consolidation process. Although the volume of flow to the salt column is a small percentage of the available pore volume, the saturation state and fluid pore pressure of this component are the variables of significance. These issues cannot be addressed by a fully saturated model. Instead it is necessary to include these findings in a multi-phase model that includes the salt column. This is the topic of Section 8.4.

The results of the fully saturated model will over-predict the flow rates through the sealed shaft. This analysis does not take credit for the time required for the system to resaturate, nor does it take credit for the sorptive capabilities of the clay components. The principal source of groundwater to the system is the Rustler Formation. The upper clay component is located below the Rustler and above the salt column and will be emplaced at a liquid saturation state of approximately 80%. Bentonite clays exhibit strong hydrophilic characteristics, and it is expected that the upper clay component will have these same characteristics. As a result, it is possible that a significant amount of the minimal Rustler groundwater that reaches the clay column will be absorbed and retained by this seal component. Although this effect is not directly included in the present analysis, the installation of a partially saturated clay component provides assurance that the flow rates predicted by the model are maximum values.

8.4 Gas Migration and Consolidation of Compacted Salt Column

The seal system is designed to limit the flow of gas from the disposal system through the sealed shafts. Migration of gas could impact performance if this migration substantially increases the fluid pore pressure of the compacted salt column. The initial pore pressure of the salt column will be approximately atmospheric. The sealed system will interact with the adjacent desaturated host rock as well as the far-field formation. Natural pressurization will occur as the system returns to an equilibrium state. This pressurization, coupled with seepage of brine through the marker beds, will also result in increasing fluid pore pressure within the compacted salt column. The analysis presented in this section addresses the issue of fluid pore pressure in the compacted salt column resulting from the effects of gas generation at the repository horizon and natural repressurization from the surrounding formation. A brief discussion on the impedance to gas flow afforded by the lower compacted clay column is also presented.

8.4.1 Analysis Method

A multi-phase flow model of the lower seal system was developed to evaluate the performance of components extending from the middle SMC component to the repository horizon. Rock mechanics calculations presented in Section 7 and Appendix D of the Compliance Submittal Design Report (Sandia, 1996) predict that the compacted salt column will consolidate for a period of approximately 400 years if the fluid-filled pores of the column do not produce a backstress. Within the physical setting of the compacted salt column, three processes have been identified which may result in a significant increase in pore pressure: groundwater flow from the Rustler Formation, gas migration from the repository, and natural fluid flow and repressurization from the Salado Formation. The first two processes were incorporated into the model as initial and boundary conditions, respectively. The third process was captured in all simulations through modeling of the lithologies surrounding the shaft. Simulations were conducted for 200 years following closure to evaluate any effects these processes might have on the salt column during this initial period.

As discussed in Section 8.3.1, the host rock DRZ is an important consideration in seal system performance. A vertically continuous DRZ could exist in both the Rustler and Salado Formations. Concrete-asphalt waterstops are included in the design to add assurance that a DRZ will not adversely impact seal performance. The significance of a continuous DRZ and waterstops will be evaluated based on results of the performance model.

A detailed description of the model grid, assumptions, and parameters is presented in Appendix C of the Compliance Submittal Design Report (Sandia, 1996).

8.4.2 Summary of Results

The consolidation process is a function of both time and depth. The resultant permeability of the compacted salt column will similarly vary. To simplify the evaluation, an effective permeability of the salt component was calculated. This permeability is calculated by analogy to electrical circuit theory. The permeability of each model layer is equated to a resistor in a series of resistors. The equivalent resistance (i.e., permeability) of a homogeneous column of identical length is derived in this manner. Figure G2-11 illustrates this process.

Results of the performance model simulations are summarized in Table G2-12. The effective permeabilities were calculated by the model assuming that, as the salt consolidated, permeability was reduced pursuant to the best-fit line through the experimental data (Appendix G2-A, Figure G2A-7). From Table G2-12 it is clear that, for all simulated conditions, the salt column consolidates to very low values in 200 years. Differences in the effective permeability because of increased repository gas pressure and a vertically continuous DRZ were negligible. The DRZ around concrete components is predicted to heal (Appendix D of the Compliance Submittal Design Report (Sandia, 1996)) within 25 years. If the asphalt waterstops do not function as intended, the DRZ in this region will still heal in 25 years, as compared to 2 years for effective waterstops. The effective permeability of the compacted salt column increases by about a factor of two for this condition. However, the resultant permeability is sufficiently low that the compacted salt columns will comprise permanent effective seals within the WIPP shafts.

Table G2-12
Summary of Results from Performance Model

Repository Pressure	Rustler Flow (m^3)	Continuous DRZ (Yes/No)	Concrete-Asphalt Waterstop Healing Time (Years)	Effective Permeability at 200 Years (m^2)
7 MPa in 100 Years	0	No	2	3.3×10^{-20}
14 MPa in 200 Years	0	No	2	3.3×10^{-20}
7 MPa in 100 Years	2.7	Yes	2	3.4×10^{-20}
7 MPa in 100 Years	17.2	Yes	25	6.0×10^{-20}

The relationship between the fractional density (i.e., consolidation state) of the compacted salt column and permeability is uncertain, as discussed in Appendix G2-A. Lines drawn through the experimental data (Figure A-7) provide a means to quantify this uncertainty but do not capture the actual physical process of consolidation. As observed through microscopy, consolidation is dominated by pressure solution and redeposition, a mechanism of mass movement facilitated by the presence of moisture on grain boundaries (Hansen and Ahrens, 1996). As this process continues, the connected porosity and hence permeability of the composite mass will reduce at a rate that has not been characterized by the data collected in WIPP experiments. The results of the multi-phase performance model presented in Table G2-12 used a best-fit line through the data. Additional simulations were conducted using a line that represents a 95% certainty that the permeability is less than or equal to values taken from this line. Model simulations that used the 95% line are not considered representative of the consolidation process. However, these results provide an estimation of the significance that this uncertainty may have on the seal system performance.

Figure G2-12 depicts the effective permeability of the salt column as a function of time using the 95% line. The consolidation process, and hence permeability reduction, essentially stopped at 75 years for this simulation. Although the model predicts that the fractional density at the base of the salt column will reach approximately 97% of the density of intact halite, the permeability remains several orders of magnitude higher than that of the surrounding host rock. As a result, repressurization occurs rapidly throughout the vertical extent of the compacted salt column, and consolidation ceases. Laboratory experiments have shown that permeability to brine should decrease to levels of 10^{-18} to 10^{-20} m^2 at the fractional densities predicted by the performance model. The transport of brine within the consolidating salt will reduce the permeability even further (Brodsky et al., 1995). The predicted permeability of 10^{-16} m^2 is still sufficiently low that brine migration would be limited (DOE, 1995). However, the results of this analysis are more valuable in terms of demonstrating the coupled nature of the mechanical and hydrological behavior of consolidating crushed salt.

A final consideration within this performance model relates to the lower compacted clay column. This clay column is included in the design to provide a barrier to both gas and brine migration from the repository horizon. The ability of the clay to prevent gas migration will depend upon its liquid saturation state (Section 5 and Appendix G2-A). The lower clay component has an initial liquid saturation of about 80%, and portions of the column achieve brine saturations of nearly 100% during the 200 year simulation period. If the clay component performs as designed, gas migration through this component should be minimal. An examination of the model gas saturations indicates that, for all runs, gas flow occurs primarily through the DRZ prior to healing. These model predictions are consistent with field demonstrations that brine-saturated bentonite seals will prevent gas flow at differential pressures of up to 4 MPa (Knowles and Howard, 1996).

8.5 Upward Migration of Brine

The performance model discussed in Section 8.3 was modified to simulate undisturbed equilibrium pressures. As discussed in Appendix C of the Compliance Submittal Design Report (Sandia, 1996), the Salado Formation is overpressurized with respect to the measured heads in the Rustler, and upward migration of contaminated brines could occur through an inadequately sealed shaft. Sections 8.3 and 8.4 demonstrated that the compacted salt column will consolidate to a low permeability following repository closure. Appendix D of the Compliance Submittal Design Report (Sandia, 1996) and Section 7 show that the DRZ surrounding the long-term clay and crushed salt seal components will completely heal within the first several decades. As a result, upward migration at the base of the Salado salt is predicted to be approximately 1 m^3 over the regulatory period. At the Rustler/Salado contact, a total of approximately 20 m^3 migrates through the sealed AIS over the regulatory period. The only brine sources between these two depths are the marker beds. It can therefore be concluded that most of the brine flow reaching the Rustler/Salado contact originates in marker beds above the repository horizon. The seal system effectively limits the flow of brine and gas from the repository through the sealed shafts throughout the regulatory period.

8.6 Intra-Rustler Flow

The potential exists for vertical flow within water-bearing strata of the Rustler Formation. Flow rates were estimated using a closed form solution of the steady-state saturated flow equation (Darcy’s Law). The significance of the calculated flow rates can be assessed in terms of the width of the hydraulic disturbance (i.e., plume half-width) generated in the recipient flow field. The plume half-width was calculated to be minimal for all expected conditions (Compliance Submittal Design Report (Sandia, 1996), Section C7). Intra-Rustler flow is therefore concluded to be of such a limited quantity that (1) it will not affect either the hydraulic or chemical regime in the Rustler and (2) it will not be detrimental to the seal system.

9. Conclusions

The principal conclusion drawn from discussions in the previous sections and details provided in the appendices is that an effective, implementable design has been documented for the WIPP shaft sealing system. Specifically, the six elements of the Design Guidance, Table G2-12, are implemented in the design in the following manner:

1. The shaft sealing system shall limit the migration of radiological or other hazardous constituents from the repository horizon to the regulatory boundary during the 10,000-year regulatory period following closure.

   Based on the analysis presented in Section 8.5, it was determined that this shaft sealing system effectively limits the migration of radiological or other hazardous constituents from the repository horizon to the regulatory boundary during the 10,000-year regulatory period following closure.

2. The shaft sealing system shall limit groundwater flowing into and through the shaft sealing system.

   The combination of the seal components in the Salado Formation, the Rustler Formation, and above the Rustler combine to produce a robust system. Based on analysis presented in Section 8.3, it was concluded that the magnitude of brine flow that can reach the repository through the sealed shaft is minimal and will not impact repository performance.

3. The shaft sealing system shall limit chemical and mechanical incompatibility of seal materials with the seal environment.

   The sealing system components are constructed of materials possessing high durability and compatibility with the host rock. Engineered materials including salt-saturated concrete, bentonite, clays, and asphalt are expected to retain their design properties over the regulatory period.

4. The shaft sealing system shall limit the possibility for structural failure of individual components of the sealing system.

   Analysis of components has determined that: (a) the structural integrity of concrete components will not be compromised by induced radial stress, imposed vertical stress, temperature gradients, dynamic compaction of overlying materials, or swelling pressure associated with bentonite (Section 7.4.1); (b) the thermal impact of asphalt on the creep rate of the salt surrounding the asphalt waterstops is negligible (Section 7.4.4); and (c) the pressure from the asphalt element of the concrete-asphalt waterstops is sufficient to initiate healing of the surrounding DRZ within two years of emplacement (Section 7.6.1). The potential for structural failure of sealing components is minimized by the favorable compressive stress state that will exist in the sealed WIPP shafts.

5. The shaft sealing system shall limit subsidence of the ground surface in the vicinity of the shafts and the possibility of accidental entry after sealing.

The use of high density sealing materials that completely fill the shafts eliminates the potential for shaft wall collapse, eliminates the possibility of accidental entry after closure, and assures that local surface depressions will not occur at shaft locations.

6. The shaft sealing system shall limit the need to develop new technologies or materials for construction of the shaft sealing system.

   The shaft sealing system utilizes existing construction technologies (identified in Section 6) and materials (identified in Section 5).

The design guidance can be summarized as focusing on two principal questions: Can you build it, and will it work? The use or adaptation of existing technologies for the placement of the seal components combined with the use of available, common materials assure that the design can be constructed. Performance of the sealing system has been demonstrated in the hydrologic analyses that show very limited flows of gas or brine, in structural analyses that assure acceptable stress and deformation conditions, and in the use of low permeability materials that will function well in the environment in which they are placed. Confidence in these conclusions is bolstered by the basic design approach of using multiple components to perform each intended sealing function and by using extensive lengths within the shafts to effect a sealing system. Additional confidence is added by the results of field and lab tests in the WIPP environment that support the data base for the seal materials.

10. References

Ahrens, E. H., and F. D. Hansen. 1995. *Large-Scale Dynamic Compaction Demonstration Using WIPP Salt: Fielding and Preliminary Results*. SAND95-1941. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the Sandia WIPP Central Files, Sandia National Laboratories, Albuquerque, NM [SWCF] as WPO31104.)

Ahrens, E. H., and M. Onofrei. 1996. “Ultrafine Cement Grout for Sealing Underground Nuclear Waste Repositories,” *2nd North American Rock Mechanics Symposium (NARMS 96), Montreal, Quebec, June 19-21, 1996*. SAND96-0195C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO31251.)

Ahrens, E. H., T. F. Dale, and R. S. Van Pelt. 1996. *Data Report on the Waste Isolation Pilot Plant Small-Scale Seal Performance Test, Series F Grouting Experiment*. SAND93-1000. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO37355.)

Andersen, P. J., M.E. Andersen, and D. Whiting. 1992. *A Guide to Evaluating Thermal Effects in Concrete Pavements*. SHRP-C/FR-92-101. Washington, DC: Strategic Highway Research Program, National Research Council. (Copy on file in the SWCF.)

Avis, J.D., and G. J. Saulnier, Jr. 1990. *Analysis of the Fluid-Pressure Responses of the Rustler Formation at H-16 to the Construction of the Air-Intake Shaft at the Waste Isolation Pilot Plant (WIPP) Site*. SAND89-7067. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO24168.)

Bachman, G. O. 1987. *Karst in Evaporites in Southeastern New Mexico*. SAND86-7078. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO24006.)

Beauheim, R. L. 1987. *Interpretations of Single-Well Hydraulic Tests Conducted at and Near the Waste Isolation Pilot Plant (WIPP) Site*, *1983-1987*. SAND87-0039. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO27679.)

Beauheim, R. L., R. M. Roberts, T. F. Dale, M.D. Fort, and W. A. Stensrud. 1993. *Hydraulic Testing of Salado Formation Evaporites at the Waste Isolation Pilot Plant Site: Second Interpretive Report*. SAND92-0533. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO23378.)

Brinster, K.F. 1991. *Preliminary Geohydrologic Conceptual Model of the Los Medaños Region Near the Waste Isolation Pilot Plant for the Purpose of Performance Assessment*. SAND89-7147. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO27781.)

Brodsky, N. S. 1994. *Hydrostatic and Shear Consolidation Tests with Permeability Measurements on Waste Isolation Pilot Plant Crushed Salt*. SAND93-7058. Albuquerque, NM: Sandia National Laboratories.

Brodsky, N. S., D. H. Zeuch, and D. J. Holcomb. 1995. “Consolidation and Permeability of Crushed WIPP Salt in Hydrostatic and Triaxial Compression,” *Rock Mechanics Proceedings of the 35th U.S. Symposium, University of Nevada, Reno, NV, June 5-7, 1995*. Eds. J. J. K.

Daemen and R.A. Schultz. Brookfield, VT: A. A. Balkema. 497-502. (Copy on file in the SWCF as WPO22432.)

Brodsky, N. S., F. D. Hansen, and T. W. Pfeifle. 1996. “Properties of Dynamically Compacted WIPP Salt,” *4th International Conference on the Mechanical Behavior of Salt, Montreal, Quebec, June 17-18, 1996*. SAND96-0838C. Albuquerque, NM: Sandia National Laboratories. (Copy on file at the Technical Library, Sandia National Laboratories, Albuquerque, NM.)

Callahan, G. D., M. C. Loken, L. D. Hurtado, and F. D. Hansen. 1996. “Evaluation of Constitutive Models for Crushed Salt,” *4th International Conference on the Mechanical Behavior of Salt, Montreal, Quebec, June 17-18, 1996*. SAND96-0791C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO36449.)

Cauffman, T. L., A.M. LaVenue, and J.P. McCord. 1990. *Ground-Water Flow Modeling of the Culebra Dolomite. Volume II: Data Base*. SAND89-7068/2. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO10551.)

Dale, T., and L. D. Hurtado. 1996. “WIPP Air-Intake Shaft Disturbed-Rock Zone Study,” *4th International Conference on the Mechanical Behavior of Salt, Montreal, Quebec, June 17-18, 1996*. SAND96-1327C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF.)

DOE (U.S. Department of Energy). 1995. *Waste Isolation Pilot Plant Sealing System Design Report*. DOE/WIPP-95-3117. Carlsbad, NM: U.S. Department of Energy, Waste Isolation Pilot Plant. (Copy on file in the SWCF as WPO29062.)

EPA (Environmental Protection Agency). 1996a. *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant’s Compliance with the 40 CFR Part 191 Disposal Regulations. Response to Comments Document for 40 CFR Part 194*. EPA 402-R-96-001. Washington, DC: U.S. Environmental Protection Agency, Office of Radiation and Indoor Air. (Copy on file in the Nuclear Waste Management Library, Sandia National Laboratories, Albuquerque, NM.)

EPA (Environmental Protection Agency). 1996b. *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant’s Compliance with the 40 CFR Part 191 Disposal Regulations. Background Information Document for 40 CFR Part 194*. EPA 402-R-96-002. Washington, DC: U.S. Environmental Protection Agency, Office of Radiation and Indoor Air. (Copy on file in the Nuclear Waste Management Library, Sandia National Laboratories, Albuquerque, NM.)

Gray, M. N. 1993. *OECD/NEA International Stripa Project. Overview Volume III: Engineered Barriers*. Stockholm, Sweden: SKB, Swedish Nuclear Fuel and Waste Management Company. (Copy on file in the Nuclear Waste Management Library, Sandia National Laboratories, Albuquerque, NM as TD898.2 .G73 1993.)

Hansen, F. D., and E. H. Ahrens. 1996. “Large-Scale Dynamic Compaction of Natural Salt,” *4th International Conference on the Mechanical Behavior of Salt, Montreal, Quebec, June 17-18, 1996*. SAND96-0792C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO39544.)

Hansen, F. D., E. H. Ahrens, A. W. Dennis, L. D. Hurtado, M. K. Knowles, J. R. Tillerson, T. W. Thompson, and D. Galbraith. 1996. "A Shaft Seal System for the Waste Isolation Pilot Plant," *Proceedings of SPECTRUM '96, Nuclear and Hazardous Waste Management, International Topical Meeting, American Nuclear Society/Department of Energy Conference, Seattle, WA, August 18-23, 1996.* SAND96-1100C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO39369.)

Haug, A., V.A. Kelley, A.M. LaVenue, and J. F. Pickens. 1987*. Modeling of Ground-Water Flow in the Culebra Dolomite at the Waste Isolation Pilot Plant (WIPP) Site: Interim Report*. SAND86-7167. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO28486.)

Hills, J. M. 1984. "Sedimentation, Tectonism, and Hydrocarbon Generation in [the] Delaware Basin, West Texas and Southeastern New Mexico," *American Association of Petroleum Geologists Bulletin*. Vol. 68, no. 3, 250-267. (Copy on file in the SWCF.)

Holt, R. M., and D. W. Powers. 1990. *Geologic Mapping of the Air Intake Shaft at the Waste Isolation Pilot Plant*. DOE-WIPP 90-051. Carlsbad, NM: Westinghouse Electric Corporation for U.S. Department of Energy. (Copy on file in the Nuclear Waste Management Library, Sandia National Laboratories, Albuquerque, NM.)

Knowles, M. K., and C. L. Howard. 1996. "Field and Laboratory Testing of Seal Materials Proposed for the Waste Isolation Pilot Plant," *Proceedings of the Waste Management 1996 Symposium, Tucson, AZ, February 25-29, 1996*. SAND95-2082C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO30945.)

Knowles, M. K., D. Borns, J. Fredrich, D. Holcomb, R. Price, D. Zeuch, T. Dale, and R. S. Van Pelt. 1996. "Testing the Disturbed Zone Around a Rigid Inclusion in Salt," *4th Conference on the Mechanical Behavior of Salt*, *Montreal, Quebec, June 17-18, 1996*. SAND95-1151C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF.)

Lambert, S. J. 1992. "Geochemistry of the Waste Isolation Pilot Plant (WIPP) Site, Southeastern New Mexico, U.S.A.," *Applied Geochemistry*. Vol. 7, no. 6, 513-531. (Copy on file in the SWCF as WPO26361.)

LaVenue, A.M., T. L. Cauffman, and J. F. Pickens. 1990. *Ground-Water Flow Modeling of the Culebra Dolomite. Volume I: Model Calibration.* SAND89-7068/1. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO24085.)

Mercer, J. W. 1983. *Geohydrology of the Proposed Waste Isolation Pilot Plant Site, Los Medaños Area, Southeastern New Mexico*. Water-Resources Investigations Report 83-4016. Albuquerque, NM: U.S. Geological Survey, Water Resources Division. (Copy on file in the Nuclear Waste Management Library, Sandia National Laboratories, Albuquerque, NM.) (Copy on file in the SWCF.)

Mercer, J. W., and B. R. Orr. 1979. *Interim Data Report on the Geohydrology of the Proposed Waste Isolation Pilot Plant Site, Southeast New Mexico*. Water-Resources Investigations Report 79-98. Albuquerque, NM: U.S. Geological Survey, Water Resources Division. (Copy on file in the SWCF.)

Nowak, E. J., J. R. Tillerson, and T. M. Torres. 1990. *Initial Reference Seal System Design: Waste Isolation Pilot Plant*. SAND90-0355. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO23981.)

Pfeifle, T. W., F. D. Hansen, and M. K. Knowles. 1996. “Salt-Saturated Concrete Strength and Permeability,” *4th Materials Engineering Conference, ASCE Materials Engineering Division, Washington, DC, November 11-18, 1996.* Albuquerque, NM: Sandia National Laboratories.)

Powers, D. W., S. J. Lambert, S-E. Shaffer, L. R. Hill, and W. D. Weart, eds. 1978. *Geological Characterization Report Waste Isolation Plant (WIPP) Site, Southeastern New Mexico*. SAND78-1596. Albuquerque, NM: Sandia National Laboratories. Vols. I-II. (Copy on file in the SWCF as WPO5448, WPO26829-26830.)

Sandia (Repository Isolation Systems Department 6121). 1996. *Waste Isolation Pilot Plant Shaft Sealing System Compliance Submittal Design Report.* SAND96-1326/1&2. Albuquerque, NM: Sandia National Laboratories.

Saulnier, G. J., Jr., and J.D. Avis. 1988. *Interpretation of Hydraulic Tests Conducted in the Waste-Handling Shaft at the Waste Isolation Pilot Plant (WIPP) Site*. SAND88-7001. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO24164.)

Stormont, J.C. 1984. *Plugging and Sealing Program for the Waste Isolation Pilot Plant (WIPP)*. SAND84-1057. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO24698.)

Van Sambeek, L.L., D. D. Luo, M.S. Lin, W. Ostrowski, and D. Oyenuga. 1993. *Seal Design Alternatives Study.* SAND92-7340. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO23445.)

Vine, J.D. 1963. *Surface Geology of the Nash Draw Quadrangle, Eddy County, New Mexico*. Geological Survey Bulletin 1141-B. Washington, DC: U.S. Government Printing Office. (Copy on file in the SWCF as WPO39558.)

Wing, N. R., and G. W. Gee. 1994. “Quest for the Perfect Cap,” *Civil Engineering*. Vol. 64, no. 10, 38-41. (Copy on file in the SWCF as WPO21158.)

FIGURES

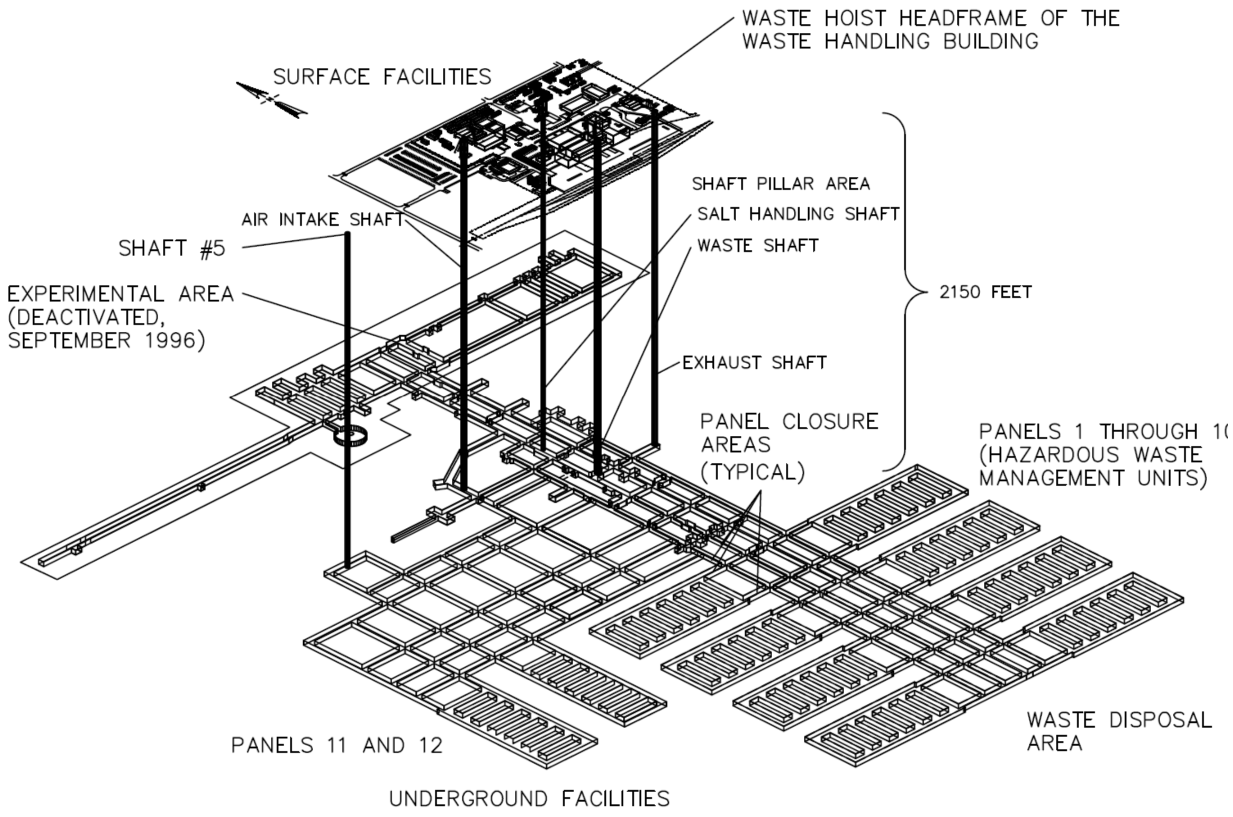


Figure G2-1
View of the WIPP Underground Facility

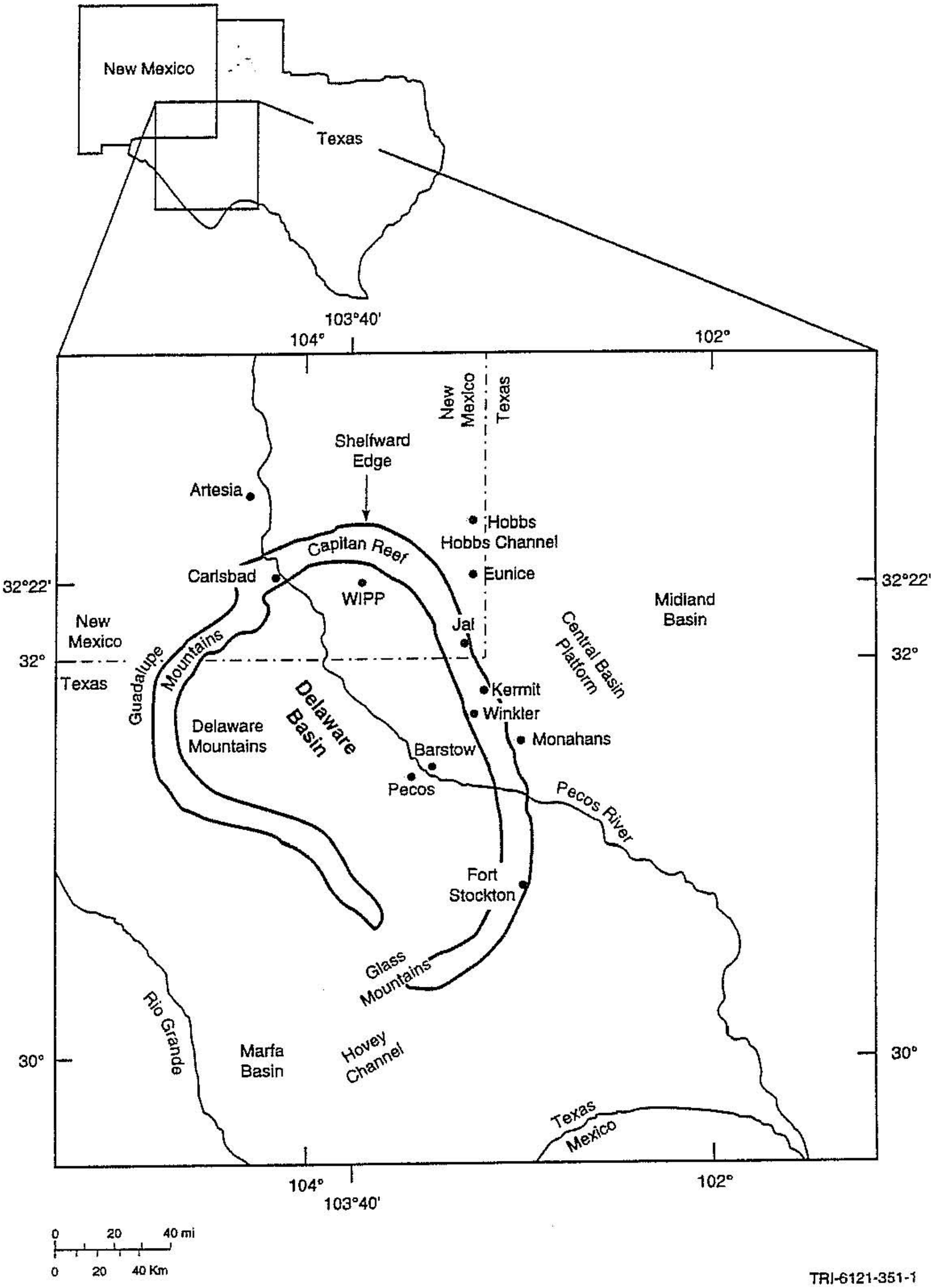
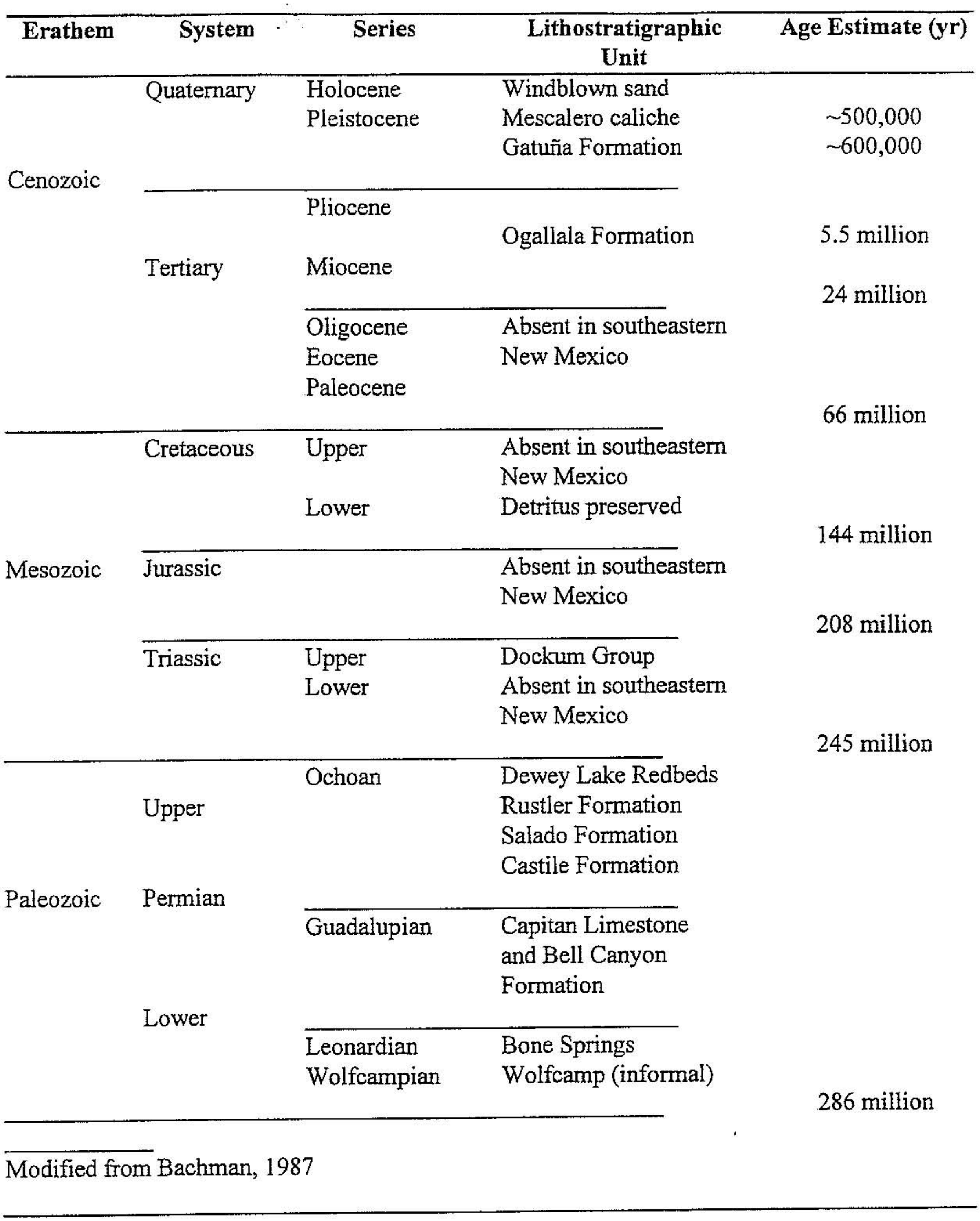


Figure G2-2
Location of the WIPP in the Delaware Basin



Erathem	System	Series	Lithostratigraphic Unit	Age Estimate (yr)
Cenozoic	Quaternary	Holocene Pleistocene	Windblown sand Mescalero caliche Gatuña Formation	~500,000 ~600,000
	Tertiary	Pliocene Miocene	Ogallala Formation	5.5 million 24 million
		Oligocene Eocene Paleocene	Absent in southeastern New Mexico	66 million
Mesozoic	Cretaceous	Upper Lower	Absent in southeastern New Mexico Detritus preserved	144 million
	Jurassic		Absent in southeastern New Mexico	208 million
	Triassic	Upper Lower	Dockum Group Absent in southeastern New Mexico	245 million
Paleozoic	Upper	Ochoan	Dewey Lake Redbeds Rustler Formation Salado Formation Castile Formation	
	Permian	Guadalupian	Capitan Limestone and Bell Canyon Formation	
	Lower	Leonardian Wolfcampian	Bone Springs Wolfcamp (informal)	286 million

Modified from Bachman, 1987

Figure G2-3
Chart Showing Major Stratigraphic Divisions, Southeastern New Mexico

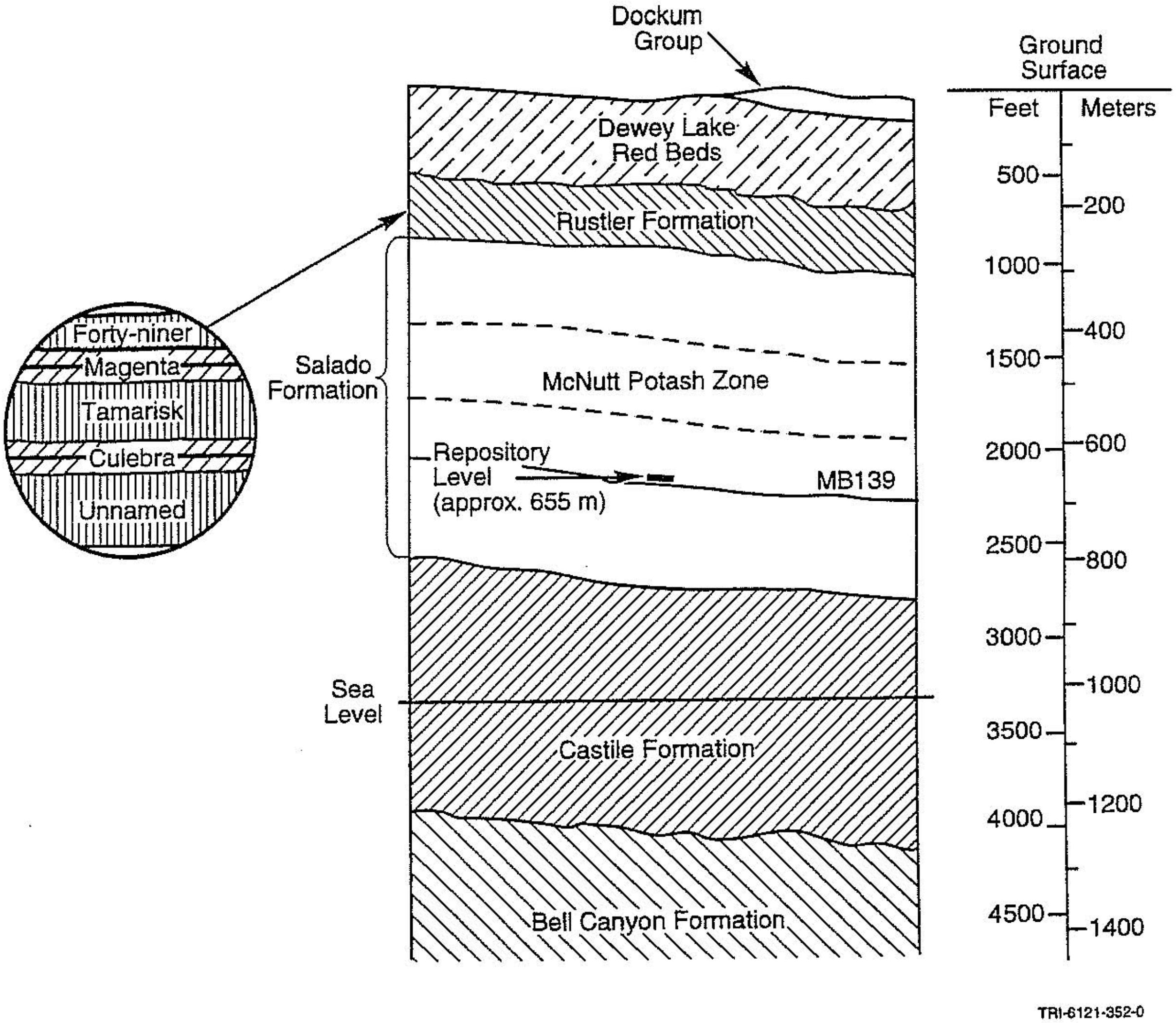


Figure G2-4
Generalized Stratigraphy of the WIPP Site Showing Repository Level

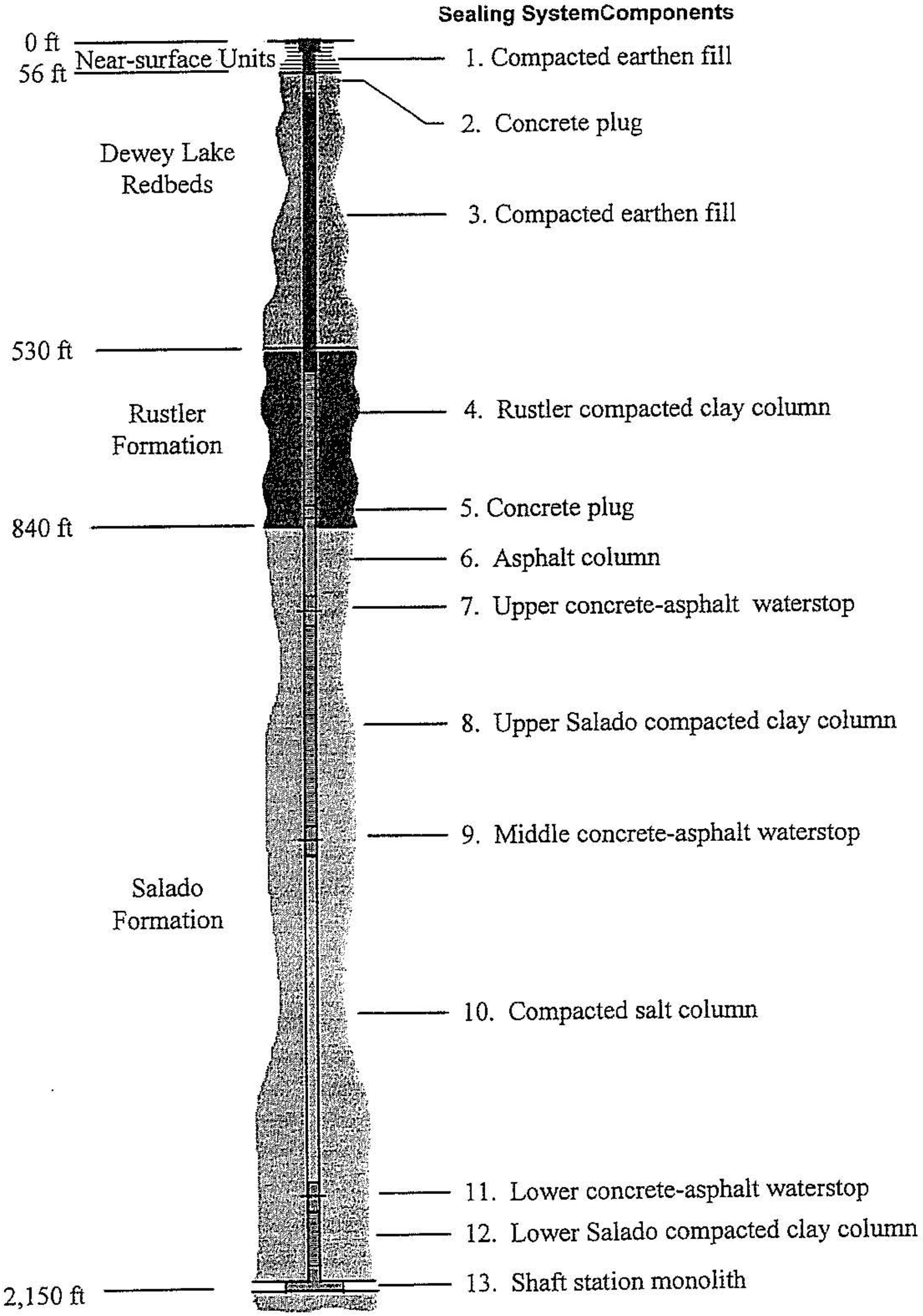


Figure G2-5
Arrangement of the Air Intake Shaft Sealing System

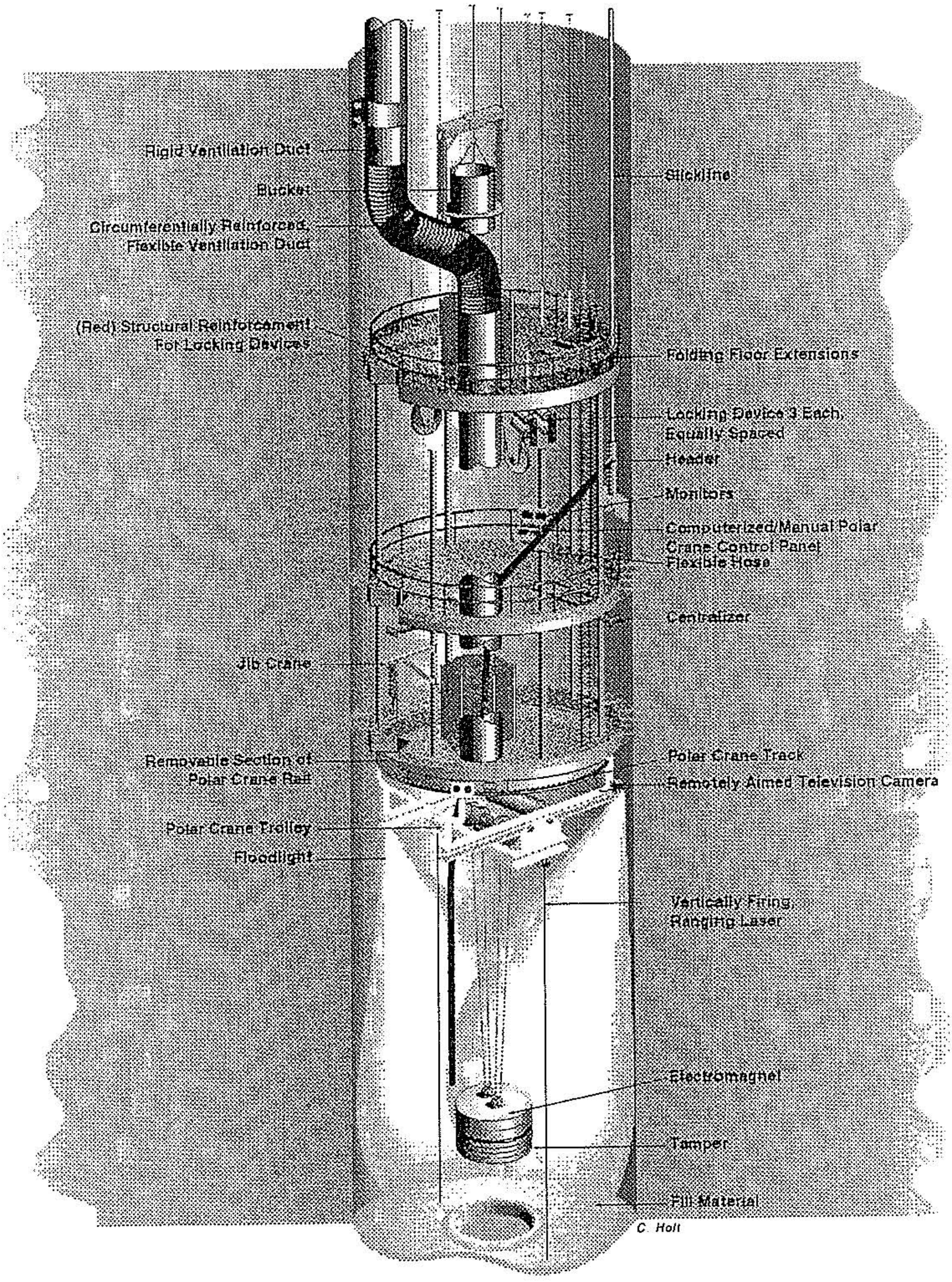


Figure G2-6
Multi-deck Stage Illustrating Dynamic Compaction

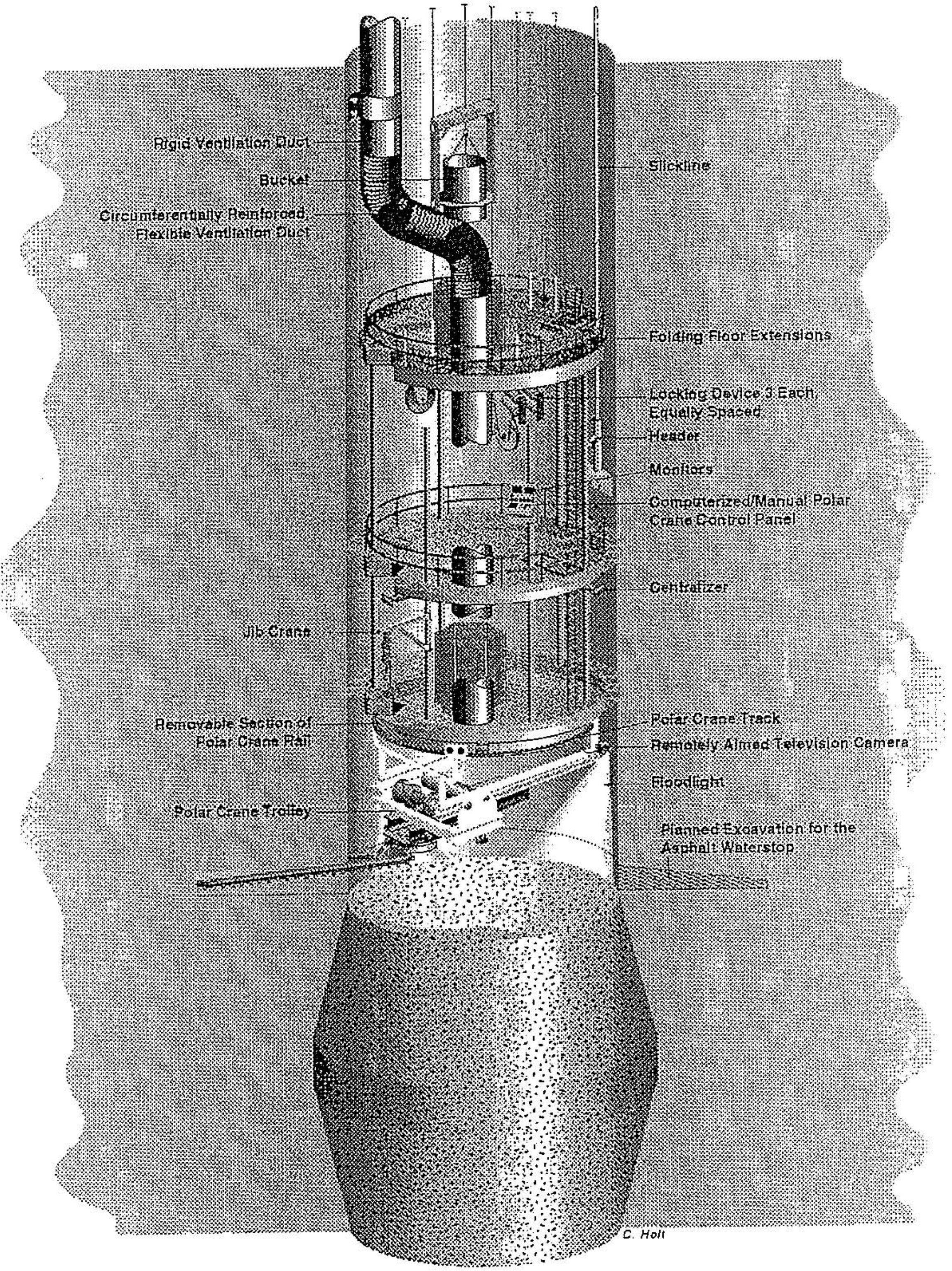
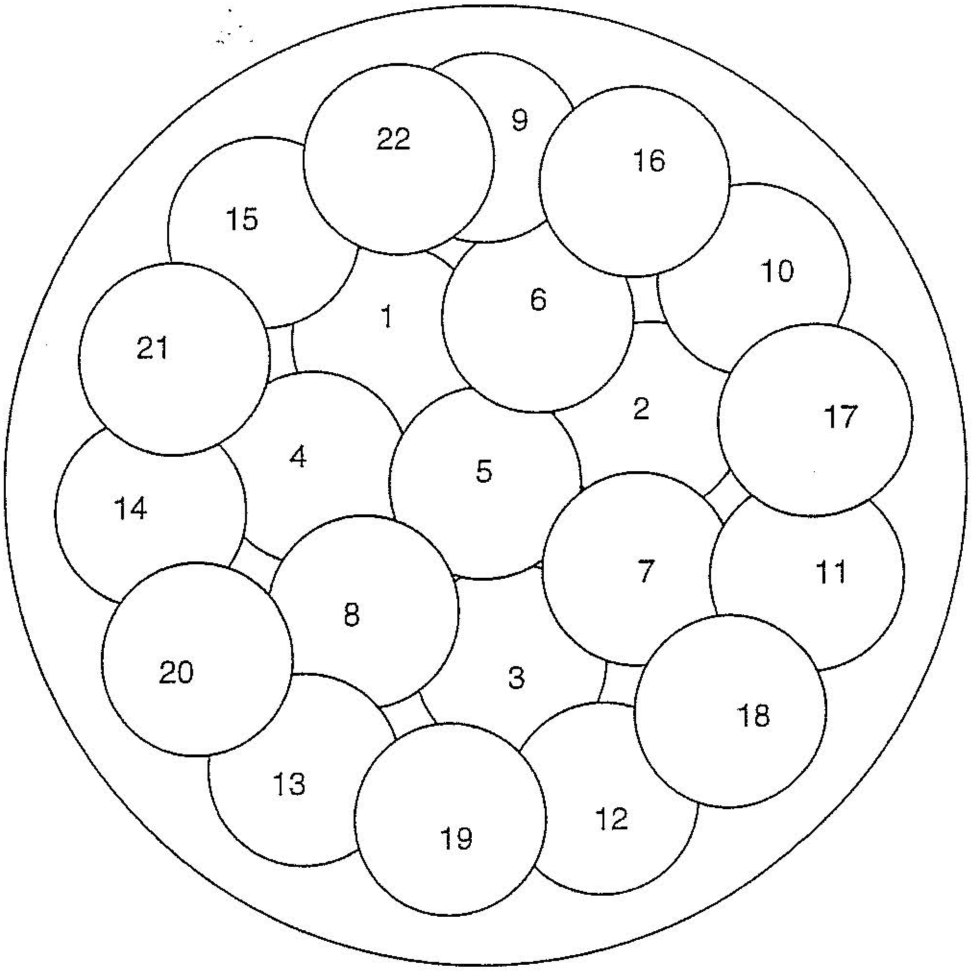


Figure G2-7
Multi-deck Stage Illustrating Excavation for Asphalt Waterstop



Scale: 1" = 4'

TRI-6121-376-0

Figure G2-8
Drop Pattern for 6-m-Diameter Shaft Using a 1.2-m-Diameter Tamper

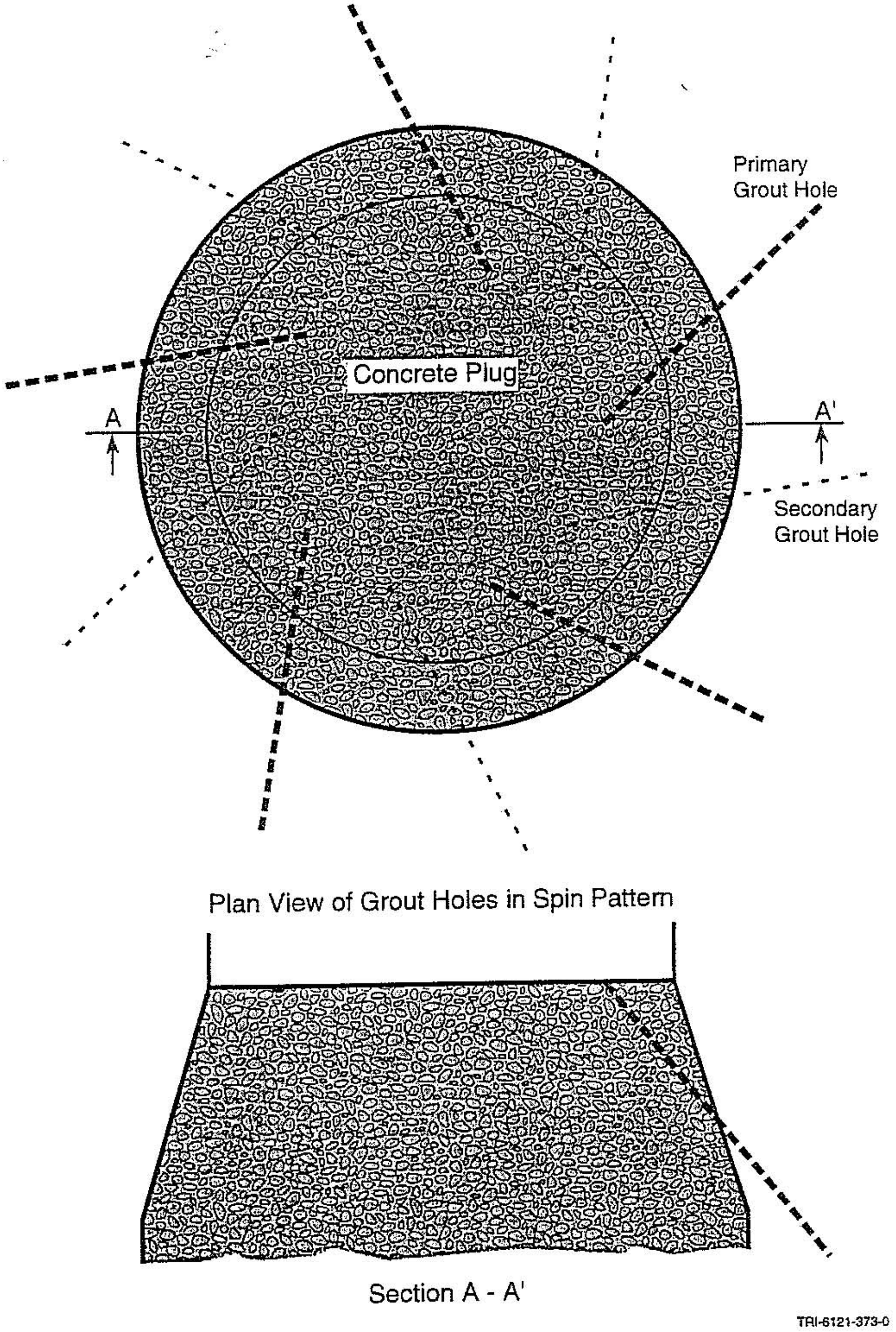
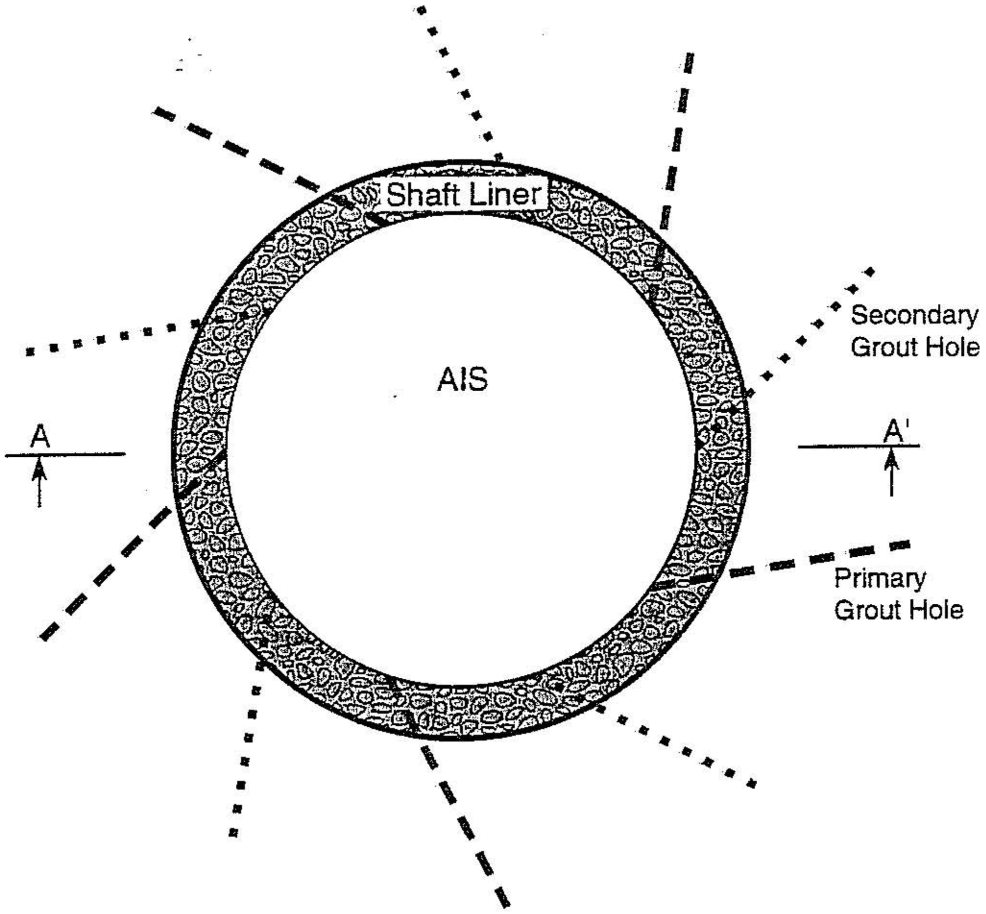


Figure G2-9
Plan and Section Views of Downward Spin Pattern of Grout Holes



Plan View of Grout Holes in Spin Pattern

Section A - A'

TRI-6121-374-0

Figure G2-10
Plan and Section Views of Upward Spin Pattern of Grout Holes

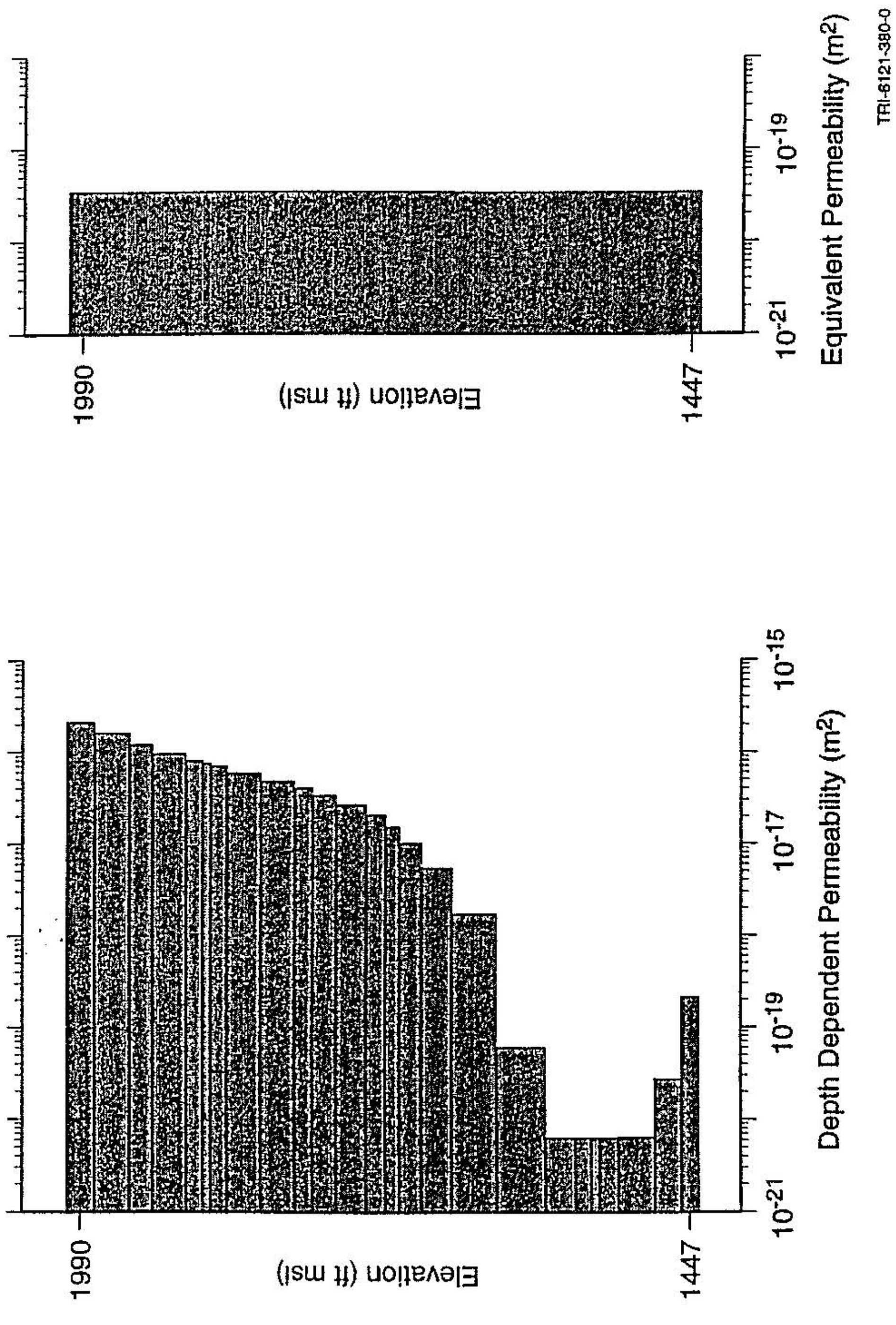


Figure G2-11
Example of Calculation of an Effective Salt Column Permeability from the Depth-Dependent Permeability at a Point in Time

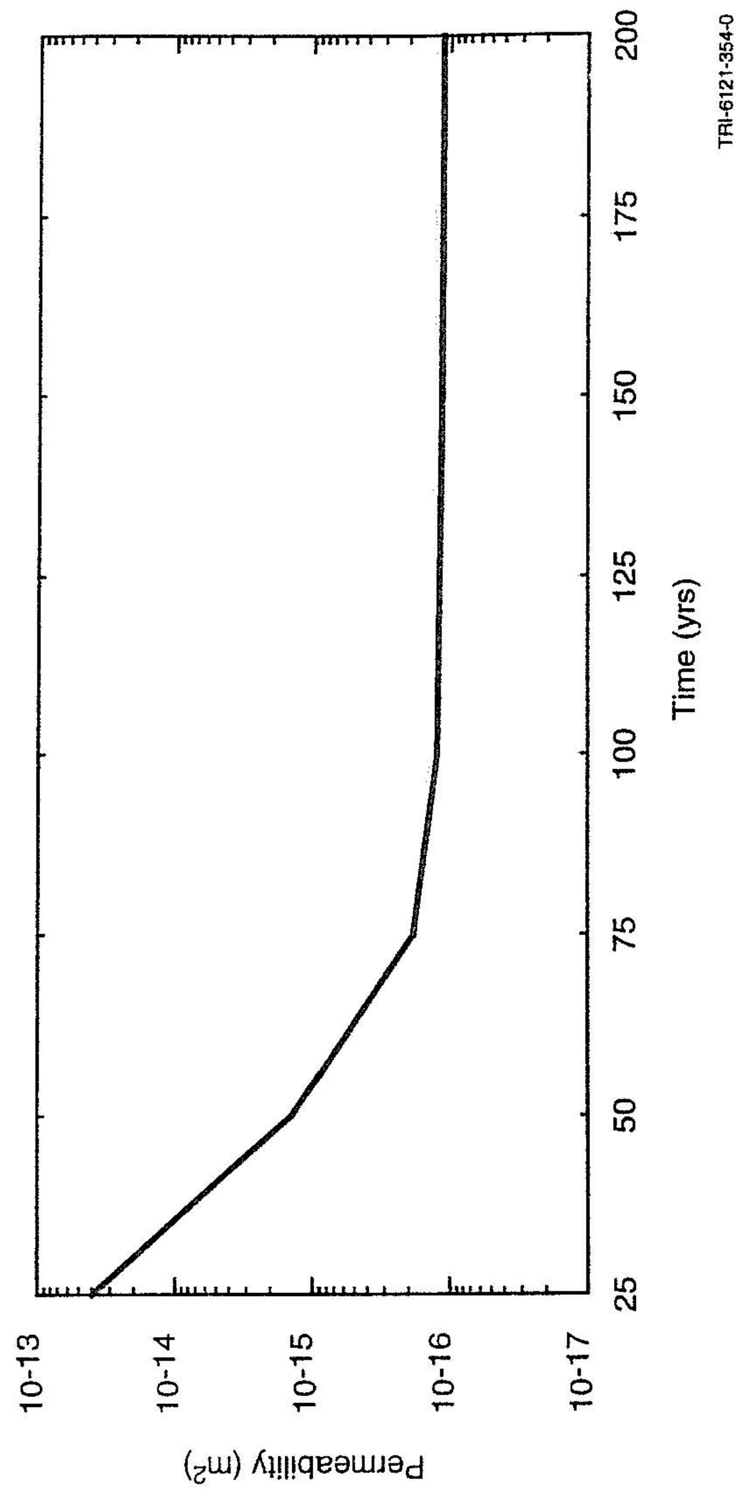


Figure G2-12
Effective Permeability of the Compacted Salt Column using the 95% Certainty Line

1

ATTACHMENT G2
APPENDIX A

MATERIAL SPECIFICATION

SHAFT SEALING SYSTEM
COMPLIANCE SUBMITTAL DESIGN REPORT

ATTACHMENT G2
APPENDIX A

MATERIAL SPECIFICATION

SHAFT SEALING SYSTEM
COMPLIANCE SUBMITTAL DESIGN REPORT

Appendix A Abstract

This appendix specifies material characteristics for shaft seal system components designed for the Waste Isolation Pilot Plant. The shaft seal system will not be constructed for decades; however, if it were to be constructed in the near term, materials specified here could be placed in the shaft and meet performance specifications. A material specification is necessary today to establish a frame of reference for design and analysis activities and to provide a basis for seal material parameters. This document was used by three integrated working groups: (1) the architect/engineer for development of construction methods and supporting infrastructure, (2) fluid flow and structural analysis personnel for evaluation of seal system adequacy, and (3) technical staff to develop probability distribution functions for use in performance assessment. The architect/engineers provide design drawings, construction methods and schedules as appendices to the final shaft seal system design report, called the *Compliance Submittal Design Report* (Permit Attachment G2). Similarly, analyses of structural aspects of the design and fluid flow calculations comprise other appendices to the final design report (not included in this Permit Attachment). These products together are produced to demonstrate the adequacy of the shaft seal system to independent reviewers, regulators, and stakeholders. It is recognized that actual placement of shaft seals is many years in the future, so design, planned construction method, and components will almost certainly change between now and the time that detailed construction specifications are prepared for the bidding process. Specifications provided here are likely to guide future work between now and the time of construction, perhaps benefiting from optimization studies, technological advancements, or experimental demonstrations.

TABLE OF CONTENTS

FIGURES

TABLES

A1. INTRODUCTION

This appendix provides a body of technical information for each of the WIPP shaft seal system materials identified in the text of the *Compliance Submittal Design Report* (Permit Attachment G2). This material specification characterizes each seal material, establishes why it will function adequately, states briefly how each component will be placed, and quantifies expected characteristics, particularly permeability, pertinent to a WIPP-specific shaft seal design. Each material is first described from an engineering viewpoint, then appropriate properties are summarized in tables and figures which emphasize permeability parameter distribution functions used in performance calculations. Materials are discussed beyond limits normally found in conventional construction specifications. Descriptive elements focus on stringent shaft seal system requirements that are vital to regulatory compliance demonstration. Information normally contained in an engineering *performance specification* is included because more than one construction method, or even a completely different material, may function adequately. Content that would eventually be included contractually in *specifications for materials* or *specifications for workmanship* are not included in detail. The goal of these specifications is to substantiate why materials used in this seal system design will limit fluid flow and thereby adequately limit releases of hazardous constituents from the WIPP site at the point of compliance defined in Permit Part 5 and limit releases of radionuclides at the regulatory boundary.

Figure G2A-1 is a schematic drawing of the proposed WIPP shaft sealing system. Design detail and other characteristics of the geologic, hydrologic and chemical setting are provided in the main body of Permit Attachment G2, other appendices, and references. The four shafts will be entirely filled with dense materials possessing low permeability and other desirable engineering and economic attributes. Seal materials include concrete, clay, asphalt, and compacted salt. Other construction and fill materials include cementitious grout and earthen fill. The level of detail included for each material, and the emphasis of detail, vary among the materials. Concrete, clay, and asphalt are common construction materials used extensively in hydrologic applications. Their descriptions will be rather complete, and performance expectations will be drawn from the literature and site-specific references. Portland cement concrete is the most common structural material being proposed for the WIPP shaft seal system and its use has a long history. Considerable specific detail is provided for concrete because it is salt-saturated. Clay is used extensively in the seal system. Clay is often specified in industry as a construction material, and bentonitic clay has been widely specified as a low permeability liner for hazardous waste sites. Therefore, a considerable body of information is available for clay materials, particularly bentonite. Asphalt is a widely used paving and waterproofing material, so its specification here reflects industry practice. It has been used to seal shaft linings as a filler between the concrete and the surrounding rock, but has not been used as a full shaft seal component. Compaction and natural reconsolidation of crushed salt are uniquely applied here. Therefore, the crushed salt specification provides additional information on its constitutive behavior and sealing performance. Cementitious grout is also specified in some detail because it has been developed and tested for WIPP-specific applications and similar international waste programs. Earthen fill will be given only cursory specifications here because it has little impact on the shaft seal performance and placement to nominal standards is easily attained.

Discussion of each material is divided into sections, which are described in the annotated bullets below:

Functions

A general summary of functions of specific seal components is presented. Each seal component must function within a natural setting, so design considerations embrace naturally occurring characteristics of the surrounding rock.

Material Characteristics

Constitution of the seal material is described and key physical, chemical, mechanical, hydrological, and thermal features are discussed.

Construction

A brief mention is made regarding construction, which is more thoroughly treated in Appendix B of the *Compliance Submittal Design Report* (Permit Attachment G2, Appendix B). Construction, as discussed in this section, is primarily concerned with proper placement of materials. A viable construction procedure that will attain placement specifications is identified, but such a specification does not preclude other potential methods from use when the seal system is eventually constructed.

Performance Requirements

Regulations to which the WIPP must comply do not provide quantitative specifications applicable to seal design. Performance of the WIPP repository is judged against performance standards for miscellaneous units specified in 20.4.1.500 NMAC (incorporating 40 CFR §264.601) for releases of hazardous constituents at the point of compliance defined in Permit Part 5. Performance is also judged against potential releases of radionuclides at the regulatory boundary, which is a probabilistic calculation. To this end, probability distribution functions for permeabilities (referred to as PDFs) of each material have been derived for performance assessment of the WIPP system and are included within this subsection on performance requirements.

Verification Methods

It must be assured that seal materials placed in the shaft meet specifications. Both design and selection of materials reflect this principal concern. Assurance is provided by quality control procedures, quality assurance protocol, real-time testing, demonstrations of technology before construction, and personnel training. Materials and construction procedures are kept relatively simple, which creates robustness within the overall system. In addition, elements of the seal system often are extensive in length, and construction will require years to complete. If atypical placement of materials is detected, corrections can be implemented without impacting performance. These specifications limit in situ testing of seal material as it is constructed although, if it is later determined to be desirable, certain in situ tests can be amended in construction specifications. Invasive testing has the potential to compromise the material, add cost, and create logistic and safety problems. Conventional specifications are made for property testing and quality control.

References

These specifications draw on a wealth of information available for each material. Reference to literature values, existing data, anecdotal information, similar applications, laboratory and field testing, and other applicable supportive documentation is made.

A1.1 Sealing Strategy

The shaft seal system design is an integral part of compliance with 20.4.1.500 NMAC (incorporating 40 CFR §264) and 40 CFR §191. The EPA has also promulgated 40 CFR §194, entitled "Criteria for the Certification and Re-certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191," to which this design and these specifications are responsive. Other seal design requirements, such as State of New Mexico regulations, apply to stratigraphy above the Salado.

Compliance of the site with 20.4.1.500 NMAC (incorporating 40 CFR §264) and 40 CFR §191 will be determined in part by the ability of the seal system to limit migration of hazardous constituents to the point of compliance defined in Permit Part 5, and migration of radionuclides to the regulatory boundary. Both natural and engineered barriers may combine to form the isolation system, with the shaft seal system forming an engineered barrier in a natural setting. Seal system materials possess high durability and compatibility with the host rock. All materials used in the shaft seal system are expected to maintain their integrity for very long periods. The system contains functional redundancy and uses differing materials to reduce uncertainty in performance. Some sealing components are used to retard fluid flow soon after placement, while other components are designed to function well beyond the regulatory period. International programs engaged in research and demonstration of sealant technology provide significant information on longevity of materials similar to those proposed for this shaft seal system (Gray, 1993). When this information is applied to the setting and context of the WIPP, there is strong evidence that the materials specified will maintain their positive attributes for defensibly long periods.

A1.2 Longevity

Longevity of materials is considered within the site geologic and hydrologic setting as summarized in the main body of this report (Permit Attachment G2) and described in the Seal System Design Report (DOE, 1995). A major environmental advantage of the WIPP locality is an overall lack of groundwater to seal against. In terms of sealing the WIPP site, the stratigraphy can be conveniently divided into the Salado Formation and the superincumbent formations comprising primarily the Rustler Formation and the Dewey Lake Redbeds. The Salado Formation, composed mainly of evaporite sequences dominated by halite, is nearly impermeable. Transmissivity of engineering importance in the Salado Formation is lateral along anhydrite interbeds, basal clays, and fractured zones near underground openings. Neither the Dewey Lake Redbeds nor the Rustler Formation contains regionally productive sources of water, although seepage near the surface in the Exhaust Shaft has been observed. Permeability of materials placed in the Salado below the contact with the Rustler, and their effects on the surrounding disturbed rock zone, are the primary engineering properties of concern. Even though very little regional water is present in the geologic setting, the seal system reflects great concern for groundwater's potential influence on materials comprising the shaft seal system.

Shaft seal materials have been selected in part because of their exceptional durability. However, it is recognized that brine chemistry *could* impact engineered materials if conditions permitted. Highly concentrated saline solutions can, under severe circumstances, affect performance of cementitious materials and clay. Concrete has been shown to degrade under certain conditions, and clays can be more transmissive to brine than to potable water. Asphalt and compacted salt are essentially chemically inert to brine. Although stable in naturally occurring seeps such as those in the Santa Barbara Channel (California), asphalt can degrade when subjected to ultraviolet light or through microbial activity. Brine would not chemically change the compacted salt column, but mechanical effects of pore pressure are of concern to reconsolidation. Mechanical influences of brine on the reconsolidating salt column are discussed in Sections 7 and 8 of the main report (Permit Attachment G2), which summarize Appendices D and C, respectively (Appendices C and D are not included in the Permit, but are contained in *Waste Isolation Pilot Plant Shaft Sealing System Compliance Submittal Design Report (“Compliance Submittal Design Report”)* (Sandia, 1996)).

Because of limited volumes of brine, low hydraulic gradients, and low permeability materials, the geochemical setting will have little influence on shaft seal materials. Each material is durable, though the potential exists for degradation or alteration under extreme conditions. For example, the three major components of portland cement concrete, portlandite ($Ca\ (OH)_2$,) calcium-aluminate-hydrate (CAH) and calcium-silicate-hydrate (CSH), are not thermodynamically compatible with WIPP brines. If large quantities of high ionic strength brine were available and transport of mass was possible, degradation of cementitious phases would certainly occur. Such a localized phenomenon was observed on a construction joint in the liner of the Waste Handling Shaft at the WIPP site. Within the shaft seal system, however, the hydrologic setting does not support such a scenario. Locally brine will undoubtedly contact the surface of mass placements of concrete. A low hydrologic gradient will limit mass transport, although degradation of paste constituents is expected where brine contacts concrete.

Among longevity concerns, degradation of concrete is the most recognized. At this stage of the design, it is established that only small volumes of brine ever reach the concrete elements (see Section 8). Further analysis concerned with borehole plugging using cementitious materials shows that at least 100 pore volumes of brine in an open system would be needed to begin degradation processes. In a closed system, such as the hydrologic setting in the WIPP shafts, phase transformations create a degradation product of increased volume. Net volume increase owing to phase transformation in the absence of mass transport would decrease rather than increase permeability of concrete seal elements.

Mechanical and chemical stability of clays, in this case the emphasis is on bentonitic clay, is particularly favorable in the WIPP geochemical and hydrological environment. A compendium of recent work associated with the Stripa project in Sweden (Gray, 1993) provides field-scale testing results, supportive laboratory experimental data, and thermodynamic modeling that lead to a conclusion that negligible transformation of the bentonite structure will occur over the regulatory period of the WIPP. In fact, very little brine penetration into clay components is expected, based on intermediate-scale experiments at WIPP. Any wetting of bentonite will result in development of swelling pressure, a favorable situation that would accelerate return to a uniform stress state within the clay component.

Natural bentonite is a stable material that generally will not change significantly over a period of ten thousand years. Bentonitic clays have been widely used in field and laboratory experiments concerned with radioactive waste disposal. As noted by Gray (1993), three internal mechanisms, illitization, silicification and charge change, could affect sealing properties of bentonite. Illitization and silicification are thermally driven processes and, following discussion by Gray (1993), are not possible in the environment or time-frame of concern at the WIPP. The naturally occurring Wyoming bentonite which is the specified material for the WIPP shaft seal is well over a million years old. It is, therefore, highly unlikely that metamorphism of bentonite enters as a design concern.

Asphalt has existed for thousands of years as natural seeps. Longevity studies specific to DOE's Hanford site have utilized asphalt artifacts buried in ancient ceremonies to assess long-term stability (Wing and Gee, 1994). Asphalt used as a seal component deep in the shaft will inhabit a benign environment, devoid of ultraviolet light or an oxidizing atmosphere. Additional assurance against possible microbial degradation in asphalt elements is mitigated with addition of lime. For these reasons, it is thought that design characteristics of asphalt components will endure well beyond the regulatory period.

Materials being used to form the shaft seals are the same as those being suggested in the scientific and engineering literature as appropriate for sealing deep geologic repositories for radioactive wastes. This fact was noted during independent technical review. Durability or longevity of seal components is a primary concern for any long-term isolation system. Issues of possible degradation have been studied throughout the international community and within waste isolation programs in the USA. Specific degradation studies are not detailed in this document because longevity is one of the over-riding attributes of the materials selected and degradation is not perceived to be likely. However, it is acknowledged here that microbial degradation, seal material interaction, mineral transformation, such as silicification of bentonite, and effects of a thermal pulse from asphalt or hydrating concrete remain areas of continued study.

A2. MATERIAL SPECIFICATIONS

The WIPP shaft seal system plays an important role in meeting regulatory requirements such as 20.4.1.500 NMAC (incorporating 40 CFR §§264.111 and 264.601) and 40 CFR 191. A combination of available, durable materials which can be emplaced with low permeability is proposed as the seal system. Components include mass concrete, asphalt waterstops sandwiched between concrete plugs, a column of asphalt, long columns of compacted clay, and a column of compacted crushed WIPP salt. The design is based on common materials and construction technologies that could be implemented using today's technology. In choosing materials, emphasis was given to permeability characteristics and mechanical properties. The function, constitution, construction, performance, and verification of each material are given in the following sections.

A2.1 Mass Concrete

Concrete has exceptionally low permeability and is widely used for hydraulic applications such as water storage tanks, water and sewer systems, and massive dams. Salt-saturated concrete has been used successfully as a seal material in potash and salt mining applications. Upon hydration, unfractured concrete is nearly impermeable, having a permeability less than 10^{-20} m^2. In addition, concrete is a primary structural material used for compression members in countless applications. Use of concrete as a shaft seal component takes advantage of its many attributes and the extensive documentation of its use.

This specification for mass concrete will discuss a special design mixture of a salt-saturated concrete called Salado Mass Concrete or SMC (Wakeley et al., 1995). Performance of SMC and similar salt-saturated mixtures is established and will be completely adequate for concrete applications within the WIPP shafts. Because concrete is such a widely used material, it has been written into specifications many times. Therefore, the specification for SMC contains recognized standard practices, established test methods, quality controls, and other details that are not available at a similar level for other seal materials. Use of salt-saturated concrete, especially SMC, is backed by extensive laboratory and field studies that establish performance characteristics far exceeding requirements of the WIPP shaft seal system.

A2.1.1 Functions

The function of the concrete is to provide a durable component with small void volume, adequate structural compressive strength, and low permeability. Concrete components appear within the shaft seal system at the very bottom, the very top, and several locations in between where they provide a massive plug that fills the opening and a tight interface between the plug and host rock. In addition, concrete is a rigid material that will support overlying seal components while promoting natural healing processes within the salt disturbed rock zone (the DRZ is discussed further in Appendix D of the Compliance Submittal Design Report (Sandia, 1996)).

Concrete is one of the redundant components that protects the reconsolidating salt column. Since the salt column will achieve low permeabilities in fewer than 100 years (see Section 2.4.4 of this specification), concrete would no longer be needed after that time. For purposes of performance assessment calculations, a change in concrete permeability to degraded values is “allowed” to occur. However, concrete within the Salado Formation is likely to endure throughout the regulatory period with sustained engineering properties.

All concrete sealing elements, with the exception of a possible concrete cap, are unreinforced. In conventional civil engineering design, reinforcement is used to resist tensile stresses since concrete is weak in tension and reinforcement bar (rebar) balances tensile stresses in the steel with compressive stresses in concrete. However, concrete has exceptional compressive strength, and all the states of stress within the shaft will be dominated by compressive stress. Mass concrete, by definition, is related to any volume of concrete where heat of hydration is a design concern. SMC is tailored to minimize heat of hydration and overall differential temperature. An analysis of hydration heat distribution is included in Appendix D of the Compliance Submittal Design Report (Sandia, 1996). Boundary conditions are favorable for reducing any possible thermally induced tensile cracking during the hydration process.

A2.1.2 Material Characteristics

Salt-saturated concrete contains sufficient salt as an aggregate to saturate hydration water with respect to NaCl. Salt-saturated concrete is required for all uses within the Salado Formation because fresh water concrete would dissolve part of the host rock. Dissolution would cause a poor bond and perhaps a more porous interface, at least initially.

Dry materials for SMC include cementitious materials, fine and coarse aggregates, and sodium chloride. Concrete mixture proportions of materials for one cubic yard of concrete appear in Table A-1.

Table A-1
Concrete Mixture Proportions

Material	lb/yd^3
Portland cement	278
Class F fly ash	207
Expansive cement	134
Fine aggregate	1292
Coarse aggregate	1592
Sodium chloride	88
Water	225

kg/m^3 = (lb/yd^3) * (0.59). Water: Cement Ratio is weight of water divided by all cementitious materials.

Table A-2 is a summary of standard specifications for concrete materials. Further discussion of each specification is presented in subsequent text, where additional specifications pertinent to particular concrete components are also given.

Table A-2
Standard Specifications for Concrete Materials

Material	Applicable Standard Tests and Specifications	Comments
Class H oilwell cement	American Petroleum Institute Specification 10	Chemical composition determined according to ASTM C 114
Class F fly ash	ASTM C 618, Standard Specification for Fly Ash	Composition and properties determined according to ASTM C 311
Expansive cement	Similar to ASTM C 845	Composition determined according to ASTM C 114
Salt	ASTM E 534, Chemical Analysis of Sodium Chloride	Batched as dry ingredient, not as an admixture
Coarse and fine aggregates	ASTM C 33, Standard Specification for Concrete Aggregates; ASTM C 294 and C 295 also applied	Moisture content determined by ASTM C 566

Portland cement shall conform to American Petroleum Institute (API) Specification 10 Class G or Class H. Additional requirements for the cement are that the fineness as determined according to ASTM C 204 shall not exceed 300 m^2/kg, and the cement must meet the requirement in ASTM C 150 for moderate heat of hydration.

Fly Ash shall conform to ASTM C 618, Class F, with the additional requirement that the percentage of Ca cannot exceed 10 %.

Expansive cement for shrinkage-compensation shall have properties so that, when used with portland cement, the resulting blend is shrinkage compensating by the mechanism described in ASTM C 845 for Type K cement. Additional requirements for chemical composition of the shrinkage compensating cement appear in Table A-3.

Table A-3
Chemical Composition of Expansive Cement

Chemical composition	Weight %
Magnesium oxide, max	1.0
Calcium oxide, min	38.0
Sulfur trioxide, max	28.0
Aluminum trioxide (AL_2O_3), min	7.0
Silicon dioxide, min	7.0
Insoluble residue, max	1.0
Loss on ignition, max	12.0

Sodium Chloride shall be of a technical grade consisting of a minimum of 99.0 % sodium chloride as determined according to ASTM E 534, and shall have a maximum particle size of 600 µm.

Aggregate proportions are reported here on saturated surface-dry basis. Specific gravity of coarse and fine aggregates used in these proportions were 2.55 and 2.58, respectively. Absorptions used in calculations were 2.25 (coarse) and 0.63 (fine) % by mass. Concrete mixture proportions will be adjusted to accommodate variations in the materials selected, especially differences in specific gravity and absorptions of aggregates. Fine aggregate shall consist of natural silica sand. Coarse aggregate shall consist of gravel. The quantity of flat and elongated particles in the separate size groups of coarse aggregates, as determined by ASTM D 4791, using a value of 3 for width-thickness ratio and length-width ratio, shall not exceed 25 % in any size group. Moisture in the fine and coarse aggregate shall not exceed 0.1 % when determined in accordance with ASTM C 566. Aggregates shall meet the requirements listed in Table A-4.

A2.1.3 Construction

Construction techniques include surface preparation of mass concrete and slickline (a drop pipe from the surface) placement at depth within the shaft. A batching and mixing operation on the surface will produce a wet mixture having initial temperatures not exceeding 20°C. Placement uses a tremie line, where the fresh concrete exits the slickline below the surface level of the concrete being placed. This procedure will minimize entrained air. Placement requires no vibration and, except for the large concrete monolith at the base of each shaft, no form work. No special curing is required for the concrete because its natural environment ensures retention of humidity and excellent hydration conditions. It is desired that each concrete pour be continuous, with the complete volume of each component placed without construction joints. However, no perceivable reduction in performance is anticipated if, for any reason, concrete placement is interrupted. A free face or cold joint could allow lateral flow but would remain perpendicular to flow down the shaft. Further discussion of concrete construction is presented in Permit Attachment G2, Appendix B.

Table A-4
Requirements for Salado Mass Concrete Aggregates

Property	Fine Aggregate	Coarse Aggregate
Specific Gravity (ASTM C 127, ASTM C 128)	2.65, max	2.80, max
Absorption (ASTM C 127, ASTM C 128)	1.5 percent, max	3.5 percent, max
Clay Lumps and Friable Particles (ASTM C 142)	3.0 percent, max	3.0 percent, max
Material Finer than 75-µm (No. 200) Sieve (ASTM C 117)	3.0 percent, max	1.0 percent, max
Organic Impurities (ASTM C 40)	No. 3, max	N/A
L.A. Abrasion (ASTM C 131, ASTM C 535)	N/A	50 percent, max
Petrographic Examination (ASTM C 295)	Carbonate mineral aggregates shall not be used	Carbonate rock aggregates shall not be used
Coal and Lignite, less than 2.00 specific gravity (ASTM C 123)	0.5 percent, max	0.5 percent, max

A2.1.4 Performance Requirements

Specifications of concrete properties include characteristics in the green state as well as the hardened state. Properties of hydrated concrete include conventional mechanical properties and projections of permeabilities over hundreds of years, a topic discussed at the end of this section. Table A-5 summarizes target properties for SMC. Attainment of these characteristics has been demonstrated (Wakeley et al., 1995). SMC has a strength of about 40 MPa at 28 days and continues to gain strength after that time, as is typical of hydrating cementitious materials. Concrete strength is naturally much greater than required for shaft seal elements because the state of stress within the shafts is compressional with little shear stress developing. In addition, compressive strength of SMC increases as confining pressure increases (Pfeifle et al., 1996). Volume stability of the SMC is also excellent, which assures a good bond with the salt.

Thermal and constitutive models for the SMC are described in Appendix D of the Compliance Submittal Design Report (Sandia, 1996). Thermal properties are fit to laboratory data and used to calculate heat distribution during hydration. An isothermal creep law and an increasing modulus are used to represent the concrete in structural calculations. The resistance established by concrete to inward creep of the Salado Formation accelerates healing of microcracks in the salt. The state of stress impinging on concrete elements within the Salado Formation will approach a lithostatic condition.

Table A-5
Target Properties for Salado Mass Concrete

Property	Comment
Initial slump 10 ± 1.0 in. Slump at 2 hr 8 ± 1.5 in.	ASTM C 143, high slump needed for pumping and placement
Initial temperature ≤ 20°C	ASTM C 1064, using ice as part of mixing water
Air content ≤ 2.0%	ASTM C 231 (Type B meter), tight microstructure and higher strength
Self-leveling	Restrictions on underground placement may preclude vibration
No separately batched admixtures	Simple and reproducible operations
Adiabatic temperature rise ≤ 16°C at 28 days	To reduce thermally induced cracking
30 MPa (4500 psi) compressive strength	ASTM C 39, at 180 days after placement
Volume stability	ASTM C 157, length change between +0.05 and -0.02% through 180 days

Permeability of SMC is very low, consistent with most concretes. Owing to a favorable state of stress and isothermal conditions, the SMC will remain intact. Because little brine is available to alter concrete elements, minimal degradation is possible. Resistance to phase changes of salt-saturated concretes and mortars within the WIPP setting has been excellent. These favorable attributes combine to assure concrete elements within the Salado will remain structurally sound and possess very low permeability for exceedingly long periods.

Permeabilities of SMC and other salt-saturated concretes have been measured in Small-Scale Seal Performance Tests (SSSPT) and Plug Test Matrix (PTM) at the WIPP for a decade and are corroborated by laboratory measurements (e.g., Knowles and Howard, 1996; Pfeifle et al., 1996). From these tests, values and ranges of concrete permeability have been developed. For performance assessments calculations, permeability of SMC seal components is treated as a random variable defined by a log triangular distribution with a best estimator of 1.78×10^{-19} m^2 and lower and upper limits of 2.0×10^{-21} and 1.0×10^{-17} m^2, respectively.

The probability distribution function is shown in Figure G2A-2. Further, it is recognized that concrete function is required for only a relatively short-term period as salt reconsolidates. Concrete is expected to function adequately beyond its design life. For calculational expediency, a higher, very conservative permeability of 1.0×10^{-14} is assigned to concrete after 400 years. This abrupt change in permeability does not imply degradation, but rather reflects system redundancy and the fact that concrete is no longer relied on as a seal component.

A2.1.5 Verification Methods

The concrete supplier shall perform the inspection and tests described below (Tables A-6 and A-7) and, based on the results of these inspections and tests, shall take appropriate action. The laboratory performing verification tests shall be on-site and shall conform with ASTM C 1077. Individuals who sample and test concrete or the constituents of concrete as required in this specification shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Laboratory Testing Technicians, Grade I. The Buyer will inspect the laboratory, equipment, and test procedures for conformance with ASTM C 1077 prior to start of dry materials batching operations and prior to restarting operations.

A2.1.5.1 Fine Aggregate

(*A) Grading*. Dry materials will be sampled while the batch plant is operating; there shall be a sieve analysis and fineness modulus determination in accordance with ASTM C 136.

(B) Fineness Modulus Control Chart. Results for fineness modulus shall be grouped in sets of three consecutive tests, and the average and range of each group shall be plotted on a control chart. The upper and lower control limits for average shall be drawn 0.10 units above and below the target fineness modulus, and the upper control limit for range shall be 0.20 units above the target fineness modulus.

Table A-6
Test Methods Used for Measuring Concrete Properties During and After Mixing

Property	Test Method	Title
Slump	ASTM C 143	Slump of Portland Cement Concrete
Unit weight	ASTM C 138	Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
Air content	ASTM C 231	Air Content of Freshly Mixed Concrete by the Pressure Method
Mixture temperature	ASTM C 1064	Temperature of Freshly Mixed Concrete

Table A-7
Test Methods Used for Measuring Properties of Hardened Concrete

Property	Test Method	Title
Compressive strength	ASTM C 39	Compressive Strength of Cylindrical Concrete Specimens
Modulus of elasticity	ASTM C 469	Static Modulus of Elasticity and Poisson’s Ratio of Concrete in Compression
Volume stability	ASTM C 157	Length Change of Hardened Cement Mortar and Concrete

(C) Corrective Action for Fine Aggregate Grading. When the amount passing any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure for any sieve, the fact shall be immediately reported to the Buyer. Whenever a point on the fineness modulus control chart, either for average or range, is beyond one of the control limits, the frequency of testing shall be doubled. If two consecutive points are beyond the control limits, the process shall be stopped and stock discarded if necessary.

(D) Moisture Content Testing. There shall be at least two tests for moisture content in accordance with ASTM C 566 during each 8-hour period of dry materials batch plant operation.

(E) Moisture Content Corrective Action. Whenever the moisture content of fine aggregate exceeds 0.1 % by weight, the fine aggregate shall be immediately resampled and retested. If there is another failure the batching shall be stopped.

A2.1.5.2 Coarse Aggregate

(A) Grading. Coarse aggregate shall be analyzed in accordance with ASTM C 136.

(B) Corrective Action for Grading. When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Buyer. Where two consecutive averages of five tests are outside specification limits, the dry materials batch plant operation shall be stopped, and immediate steps shall be taken to correct the grading.

(C) Moisture Content Testing. There shall be at least two tests for moisture content in accordance with ASTM C 566 during each 8-hour period of dry materials batch plant operation.

(D) Moisture Content Corrective Action. Whenever the moisture content of coarse aggregate exceed 0.1 % by weight, the coarse aggregate shall be immediately resampled and retested. If there is another failure, batching shall be stopped.

A2.1.5.3 Batch-Plant Control

The measurement of all constituent materials including cementitious materials, each size of aggregate, and granular sodium chloride shall be continuously controlled. The aggregate batch weights shall be adjusted as necessary to compensate for their nonsaturated surface-dry condition.

A2.1.5.4 Concrete Products

Concrete products will be tested during preparation and after curing as summarized in Tables A-6 and A-7 for preparation and hydrated concrete, respectively.

A2.2 Compacted Clay

Compacted clays are commonly proposed as primary sealing materials for nuclear waste repositories and have been extensively investigated (e.g., Gray, 1993). Compacted clay as a shaft sealing component provides a barrier to brine and possibly to gas flow into or out of the repository and supports the shaft with a high density material to minimize subsidence. In the event that brine does contact the compacted clay columns, bentonitic clay can generate a beneficial swelling pressure. Swelling would increase internal supporting pressure on the shaft wall and accelerate healing of any disturbed rock zone. Wetted, swelling clay will seal fractures as it expands into available space and will ensure tightness between the clay seal component and the shaft walls.

A2.2.1 Functions

In general, clay is used to prevent fluid flow either down or up the shaft. In addition, clay will stabilize the shaft opening and provide a backstress within the Salado Formation that will enhance healing of microfractures in the disturbed rock. Bentonitic clays are specified for Components 4, 8, and 12. In addition to limiting brine migration down the shafts, a primary function of a compacted clay seal through the Rustler Formation (Component 4) is to provide separation of water bearing units. The primary function of the upper Salado clay column (Component 8) is to limit groundwater flow down the shaft, thereby adding assurance that the reconsolidating salt column is protected. The lower Salado compacted clay column (Component 12) will act as a barrier to brine and possibly to gas flow (see construction alternatives in Appendix B) soon after placement and remain a barrier throughout the regulatory period.

A2.2.2 Material Characteristics

The Rustler and Salado compacted clay columns will be constructed of a commercial well-sealing grade sodium bentonite blocks compacted to between 1.8 and 2.0 g/cm^3. An extensive experimental data base exists for the permeability of sodium bentonites under a variety of conditions. Many other properties of sodium bentonite, such as strength, stiffness, and chemical stability also have been thoroughly investigated. Advantages of clays for sealing purposes include low permeability, demonstrated longevity in many types of natural environments, deformability, sorptive capacity, and demonstrated successful utilization in practice for a variety of sealing purposes.

A variety of clays could be considered for WIPP sealing purposes. For WIPP, as for most if not all nuclear waste repository projects, bentonite has been and continues to be a prime candidate as the clay sealing material. Bentonite clay is chosen here because of its overwhelming positive sealing characteristics. Bentonite is a highly plastic swelling clay material (e.g., Mitchell, 1993), consisting predominantly of smectite minerals (e.g., IAEA, 1990). Montmorillonite, the predominant smectite mineral in most bentonites, has the typical plate-like structure characteristic of most clay minerals.

The composition of a typical commercially available sodium bentonite (e.g. Volclay, granular sodium bentonite) contains over 90% montmorillonite and small portions of feldspar, biotite, selenite, etc. A typical sodium bentonite has the chemical composition summarized in Table A-8 (American Colloid Company, 1995). This chemical composition is close to that reported for MX-80 which was used successfully in the Stripa experiments (Gray, 1993). Sodium bentonite has a tri-layer expanding mineral structure of approximately $(Al\ Fe_{1.67}\ Mg_{0.33})\ Si_4O_{10}\ (OH_2)\ Na^+Ca^{++}_{0.33}$. Specific gravity of the sodium bentonite is about 2.5. The dry bulk density of granular bentonite is about 1.04 g/cm^3.

Densely compacted bentonite (of the order of 1.75 g/cm^3), when confined, can generate a swelling pressure up to 20 MPa when permeated by water (IAEA, 1990). The magnitude of the swelling pressure generated depends on the chemistry of the permeating water. Laboratory and field measurements suggest that the bentonite specified for shaft seal materials in the Salado may achieve swell pressures of 3 to 4 MPa, and likely substantially less. Swelling pressure in the bentonite column is not expected to be appreciable because little contact with brine fluids is conceivable. Further considerations of potential swelling of bentonite within the Rustler Formation may be appropriate, however.

Table A-8
Representative Bentonite Composition.

Chemical Compound	Weight %
SiO_2	63.0
Al_2O_3	21.1
Fe_2O_3	3.0
FeO	0.4
MgO	2.7
Na_2O	2.6
CaO	0.7
H_2O	5.6
Trace Elements	0.7

Mixtures of bentonite and water can range in rheological characteristics from a virtually Newtonian fluid to a stiff solid, depending on water content. Bentonite can form stiff seals at low moisture content, and can penetrate fractures and cracks when it has a higher water content. Under the latter conditions it can fill void space in the seal itself and disturbed rock zones. Bentonite with dry density of 1.75 g/cm^3 has a cohesion of 5-50 kPa, and a friction angle of 5 to 15° (IAEA, 1990). At density greater than 1.6-1.7 g/cm^3, swelling pressure of bentonite is less affected by the salinity of groundwater providing better chemical and physical stabilities.

A2.2.3 Construction

Seal performance within the Salado Formation is far more important to regulatory compliance than is performance of earthen fill in the overlying formations. Three potential construction methods might be used to place clay in the shaft, as discussed in Appendix B. Construction of bentonite clay components specifies block assembly procedures demonstrated successfully at the WIPP site (Knowles and Howard, 1996) and in a considerable body of work by Roland Pusch (see summary in Gray, 1993). To achieve low permeabilities, dry density of the bentonite blocks should be about 2.0 g/cm^3, although a range of densities is discussed in Section 2.2.4. A high density of clay components is also desirable to carry the weight of overlying seal material effectively and to minimize subsidence.

Placement of clay in the shaft is one area of construction that might be made more cost and time effective through optimization studies. An option to construct clay columns using dynamic compaction will likely prove to be efficient, so it is specified for earthen fill in the Dewey Lake Redbeds (as discussed later) and may prove to be an acceptable placement method for other components. Dynamic compaction would use equipment developed for placement of crushed salt. The Canadian nuclear waste program has conducted extensive testing, both in situ and in large scale laboratory compaction of clay-based barrier materials with dynamic hydraulically powered impact hammers (e.g., Kjartanson et al, 1992). The Swedish program similarly has investigated field compaction of bentonite-based tunnel backfill by means of plate vibrators (e.g., Nilsson, 1985). Both studies demonstrated the feasibility of in situ compaction of bentonite-based materials to a high density. Near surface, conventional compaction methods will be used because insufficient space remains for dynamic compaction using the multi-deck work stage.

A2.2.4 Performance Requirements

The proven characteristics of bentonite assure attainment of very low permeability seals. It is recognized that the local environment contributes to the behavior of compacted clay components. Long-term material stability is a highly desired sealing attribute. Clay components located in brine environments will have to resist cation exchange and material structure alteration. Clay is geochemically mature, reducing likelihood of alteration and imbibition of brine is limited to isolated areas. Compacted clay is designed to withstand possible pressure gradients and to resist erosion and channeling that could conceivably lead to groundwater flow through the seal. Compacted clay seal components support the shaft walls and promote healing of the salt DRZ. Volume expansion or swelling would accelerate healing in the salt. A barrier to gas flow could be constructed if moisture content of approximately 85% of saturation could be achieved.

Permeability of bentonite is inversely correlated to dry density. Figure G2A-3 plots bentonite permeability as a function of reported sample density for sodium bentonite samples. The permeability ranges from approximately 1×10^{-21} to 1×10^{-17} m^2. In all cases, the data in Figure G2A-3 are representative of low ionic strength permeant waters. Data provided in this figure are limited to sodium bentonite and bentonite/sand mixtures with clay content greater than or equal to 50 %. Cheung et al. (1987) report that in bentonite/sand mixtures, sand acts as an inert fraction which does not alter the permeability of the mixture from that of a 100 % bentonite sample at the same equivalent dry density. Also included in Figure G2A-3 are the three point estimates of permeability at dry densities of 1.4, 1.8, and 2.1 g/cm^3 provided by Jaak Daemen of the University of Nevada, Reno, who is actively engaged in WIPP-specific bentonite testing.

A series of in situ tests (SSSPTs) that evaluated compacted bentonite as a sealing material at the WIPP site corroborate data shown in Figure G2A-3. Test Series D tested two 100 % bentonite seals in vertical boreholes within the Salado Formation at the repository horizon. The diameter of each seal was 0.91 m, and the length of each seal was 0.91 m. Cores of the two bentonite seals had initial dry densities of 1.8 and 2.0 g/cm^3. Pressure differentials of 0.72 and 0.32 MPa were maintained across the bentonite seals with a brine reservoir on the upstream (bottom) of the seals for several years.

Over the course of the seal test, no visible brine was observed at the downstream end of the seals. Upon decommissioning the SSSPT, brine penetration was found to be only 15 cm. Determination of the absolute permeability of the bentonite seal was not precise; however, a bounding calculation of 1×10^{-19} m^2 was made by Knowles and Howard (1996).

Beginning with a specified dry density of 1.8 to 2.0 g/cm^3 and Figure G2A-3, a distribution function for clay permeability was developed and is provided in Figure G2A-4. Parameter distribution reflects some conservative assumptions pertaining to WIPP seal applications. The following provide rationale behind the distribution presented in Figure G2A-4.

1. A practical minimum for the distribution can be specified at 1×10^{-21} m^2.

2. If effective dry density of the bentonite emplaced in the seals only varies from 1.8 to 2.0 g/cm^3, then a maximum expected permeability can be extrapolated from Figure G2A-3 as 1×10^{-19} m^2.

3. Uncertainty exists in being able to place massive columns of bentonite to design specifications. To address this uncertainty in a conservative manner, it is assumed that the compacted clay be placed at a dry density as low as 1.6 g/cm^3. At 1.6 g/cm^3, the maximum permeability for the clay would be approximately 5×10^{-19} m^2. Therefore, neglecting salinity effects, a range of permeability from 1×10^{-21} to 5×10^{-19} m^2 with a best estimate of less than 1×10^{-19} m^2 could be reasonably defined (assuming a best estimate emplacement density of 1.8 g/cm^3). It could be argued, based on Figure G2A-3, that a best estimate could be as low as 2×10^{-20}m^2.

Salinity increases bentonite permeability; however, these effects are greatly reduced at the densities specified for the shaft seal. At seawater salinity, Pusch et al. (1989) report the effects on permeability could be as much as a factor of 5 (one-half order of magnitude). To account for salinity effects in a conservative manner, the maximum permeability is increased from 5×10^{-19} to 5×10^{-18} m^2. The best estimate permeability is increased by one-half order of magnitude to 5×10^{-19} m^2. The lower limit is held at 1×10^{-21} m^2. Because salinity effects are greatest at lower densities, the maximum is adjusted one full order of magnitude while the best estimate (assumed to reside at a density of 1.8 g/cm^3) is adjusted one-half of an order.

The four arguments presented above give rise to the permeability cumulative frequency distribution plotted in Figure G2A-4, which summarizes the performance specification for bentonite columns.

A2.2.5 Verification Methods

Verification of specified properties such as density, moisture content or strength of compacted clay seals can be determined by direct access during construction. However, indirect methods are preferred because certain measurements, such as permeability, are likely to be time consuming and invasive. Methods used to verify the quality of emplaced seals will include quality of block production and field measurements of density. As a minimum, standard quality control procedures recommended for compaction operations will be implemented including visual observation, in situ density measurements, and moisture content measurements. Visual observation accompanied by detailed record keeping will assure design procedures are being followed. In situ testing will confirm design objectives are accomplished in the field.

Density measurements of compacted clay shall follow standard procedures such as ASTM D 1556, D 2167, and D 2922. The moisture content of clay blocks shall be calculated based on the water added during mixing and can be confirmed by following ASTM Standard procedures D 2216 and D 3017. It is probable that verification procedures will require modifications to be applicable within the shaft. As a minimum, laboratory testing to certify the above referenced quality control measures will be performed to assure that the field measurements provide reliable results.

A2.3 Asphalt Components

Asphalt is used to prevent water migration down the shaft in two ways: an asphalt column bridging the Rustler/Salado contact and a “waterstop” sandwiched between concrete plugs at three locations within the Salado Formation, two above the salt column and one below the salt column. An asphalt mastic mix (AMM) that contains aggregate is specified for the column while the specification for the waterstop layer is pure asphalt.

Asphalt is a widely used construction material with many desirable properties. Asphalt is a strong cement, is readily adhesive, highly waterproof, and durable. Furthermore, it is a plastic substance that provides controlled flexibility to mixtures of mineral aggregates with which it is usually combined. It is highly resistant to most acids, salts, and alkalis. A number of asphalts and asphalt mixes are available that cover a wide range of viscoelastic properties which allows the properties of the mixture to be designed for a wide range of requirements for each application. These properties are well suited to the requirements of the WIPP shaft seal system.

A2.3.1 Functions

The generic purpose of asphalt seal components above the salt column is to eliminate water migration downward. The asphalt waterstops above the salt column are designed to intersect the DRZ and limit fluid flow. Asphalt is not the lone component preventing flow of brine downward; it functions in tandem with concrete and a compacted clay column. Waterstop Component # 11 located below the salt column would naturally limit upward flow of brine or gas. Concrete abutting the asphalt waterstops provides a rigid element that creates a backstress upon the inward creeping salt, promoting healing within the DRZ. Asphalt is included in the WIPP shaft seal system to reduce uncertainty of system performance by providing redundancy of function while using an alternative material type. The combination of shaft seal components restricts fluid flow up or down to allow time for the salt column to reconsolidate and form a natural fluid-tight seal.

The physical and thermal attributes of asphalt combine to reduce fluid flow processes. The placement fluidity permits asphalt to flow into uneven interstices or fractures along the shaft wall. Asphalt will self-level into a nearly voidless mass. As it cools, the asphalt will eventually cease flowing. The elevated temperature and thermal mass of the asphalt will enhance creep deformation of the salt and promote healing of the DRZ surrounding the shaft. Asphalt adheres tightly to most materials, eliminating flow along the interface between the seal material and the surrounding rock.

A2.3.2 Material Characteristics

The asphalt column specified for the WIPP seal system is an AMM commonly used for hydraulic structures. The AMM is a mixture of asphalt, sand, and hydrated lime. The asphalt content of AMM is higher than those used in typical hot mix asphalt concrete (pavements). High asphalt contents (10-20% by weight) and fine, well-graded aggregate (sand and mineral fillers) are used to obtain a near voidless mix. A low void content ensures a material with extremely low water permeability because there are a minimum number of connected pathways for brine migration.

A number of different asphaltic construction materials, including hot mix asphalt concrete (HMAC), neat asphalt, and AMMs, were evaluated for use in the WIPP seal design. HMAC was eliminated because of construction difficulty that might have led to questionable performance. An AMM is selected as a preferred alternative for the asphalt columns because it has economic and performance advantages over the other asphaltic options. Aggregate and mineral fines in the AMM increase rigidity and strength of the asphalt seal component, thereby enhancing the potential to heal the DRZ and reducing shrinkage relative to neat asphalt.

Viscosity of the AMM is an important physical property affecting construction and performance. The AMM is designed to have low enough viscosity to be pumpable at application temperatures and able to flow readily into voids. High viscosity of the AMM at operating temperatures prevents long-term flow, although none is expected. Hydrated lime is included in the mix design to increase the stability of the material, decrease moisture susceptibility, and act as an anti-microbial agent. Table A-9 details the mix design specifications for the AMM.

The asphalt used in the waterstop is AR-4000, a graded asphalt of intermediate viscosity. The waterstop uses pure, or neat, asphalt because it is a relatively small volume when compared to the column.

A2.3.3 Construction

Construction of asphalt seal components can be accomplished using a slickline process where the molten material is effectively pumped into the shaft. The AMM will be mixed at ground level in a pug mill at approximately 180°C. At this temperature the material is readily pourable. The AMM will be slicklined and placed using a heated and insulated tremie line. The AMM will easily flow into irregularities in the surface of the shaft or open fractures until the AMM cools. After cooling, flow into surface irregularities in the shaft and DRZ will slow considerably because of the sand and mineral filler components in the AMM and the temperature dependence of the viscosity of the asphalt. AMM requires no compaction in construction. Neat asphalt will be placed in a similar fashion.

The technology to pump AMM is available as described in the construction procedures in Appendix B. One potential problem with this method of construction is ensuring that the slickline remains heated throughout the construction phase. Impedance heating (a current construction technique) can be used to ensure the pipe remains at temperatures sufficient to promote flow. The lower section (say 10 m) of the pipe may not need to be heated, and it may not be desirable to heat it as it is routinely immersed in the molten asphalt during construction to minimize air entrainment. Construction using large volumes of hot asphalt would be facilitated by placement in sections. After several meters of asphalt are placed, the slickline would be retracted by two lengths of pipe and pumping resumed. Once installed, the asphalt components will cool; the column will require several months to approach ambient conditions. Calculations of cooling times and plots of isotherms for the asphalt column are given in Appendix D of the Compliance Submittal Design Report (Sandia, 1996). It should be noted that a thermal pulse into the surrounding rock salt could produce positive rock mechanics conditions. Fractures will heal much faster owing to thermally activated dislocation motion and diffusion. Salt itself will creep inward at a much greater rate as well.

Table A-9
Asphalt Component Specifications

AMM Composition:	20 wt% asphalt (AR-4000 graded asphalt) 70 wt% aggregate (silicate sand) 10 wt% hydrated lime	
Aggregate (% passing by weight)		
US Sieve Size		Specification Limits
2.36 mm	(No. 8)	100
1.18 mm	(No. 16)	90
600	(No. 30)	55-75
300	(No. 50)	35-50
150	(No. 100)	15-30
75	(No. 200)	5-15
Mineral Filler: Hydrated Lime Chemical Composition:		
Total active lime content (% by weight)		min. 90.0%
Unhydrated lime weight (% by weight CaO)		max. 5.0%
Free water (% by weight H_2O)		max. 4.0%
Residue Analysis:		
Residue retained on No. 6 sieve		max. 0.1%
Residue retained on No. 30 sieve		max. 3.0%

A2.3.4 Performance Requirements

Asphalt components are required to endure for about 100 years as an interim seal while the compacted salt component reconsolidates to create a very low permeability seal component. Since asphalt will not be subjected to ultraviolet light or an oxidizing environment, it is expected to provide an effective brine seal for several centuries. Air voids should be less than 2% to ensure low permeability. Asphalt mixtures do not become measurably permeable to water until voids approach 8% (Brown, 1990).

At Hanford, experiments are ongoing on the development of a passive surface barrier designed to isolate wastes (in this case to prevent downward flux of water and upward flux of gases) for 1000 years with no maintenance. The surface barrier uses asphalt as one of many horizontal components because low-air-void, high-asphalt-content materials are noted for low permeability and improved mechanically stable compositions. The design objective of this asphalt concrete was to limit infiltration to 1.6×10^{-9} cm/s (1.6×10^{-11} m/s, or for fresh water, an intrinsic permeability of 1.6×10^{-18} m^2). The asphalt component of the barrier is composed of a 15 cm layer of asphaltic concrete overlain with a 5-mm layer of fluid-applied asphalt. The reported hydraulic conductivity of the asphalt concrete is estimated to be 1×10^{-9} m/s (equivalent to an intrinsic permeability of approximately 1×10^{-16} m^2 assuming fresh water). Myers and Duranceau (1994) report that the hydraulic conductivity of fluid-applied asphalt is estimated to be 1.0×10^{-11} to 1.0×10^{-10} cm/s (equivalent to an intrinsic permeability of approximately 1.0×10^{-20} to 1.0×10^{-19} m^2 assuming fresh water).

Consideration of published values results in a lowest practical permeability of 1×10^{-21} m^2. The upper limit of the asphalt seal permeability is assumed to be 1×10^{-18} m^2. Intrinsic permeability of the asphalt column is defined as a log triangular distributed parameter, with a best estimate value of 1×10^{-20} m^2 , a minimum value of 1×10^{-21} m^2, and a maximum value of 1×10^{-18} m^2, as shown in Figure G2A-5. It is recognized that the halite DRZ in the uppermost portion of the Salado Formation is not likely to heal because creep of salt is relatively slow.

These values are used in performance assessment of regulatory compliance analyses and in fluid flow calculations (Appendix C of the Compliance Submittal Design Report (Sandia, 1996)) pertaining to seal system functional evaluation. Other calculations pertaining to rock mechanics and structural considerations of asphalt elements are discussed in Appendix D of the Compliance Submittal Design Report (Sandia, 1996).

A2.3.5 Verification Methods

Viscosity of the AMM must be low enough for easy delivery through a heated slickline. Sufficient text book information is available to assure performance of the asphalt component; however, laboratory validation tests may be desirable before installation. There are no plans to test asphalt components after they are placed. With that in mind, some general tests identified below would add quantitative documentation to expected performance values and have direct application to WIPP. The types and objectives of the verification tests are:

Mix Design. A standard mix design which evaluates a combination of asphalt and aggregate mixtures would quantify density, air voids, viscosity, and permeability. Although the specified mixture will function adequately, studies could optimize the mix design.

Viscoelastic Properties at Service Temperatures. Viscoelastic properties over the range of expected service temperatures would refine the rheological model.

Accelerated Aging Analysis. Asphalt longevity issues could be further addressed by using the approach detailed in PNL-Report 9336 (Freeman and Romine, 1994).

Brine Susceptibility Analysis. The presumed inert nature of the asphalt mix can be demonstrated through exposure to groundwater brine solutions found in the Salado Formation. Potential for degradation will be characterized by monitoring the presence of asphalt degradation products in WIPP brine or brine simulant as a function of time. Effects on hydraulic conductivity can be measured during these experiments.

A2.4 Compacted Salt Column

A reconstituted salt column has been proposed as a primary means to isolate for several decades those repositories containing hazardous materials situated in evaporite sequences. Reuse of salt excavated in the process of creating the underground openings has been advocated since the initial proposal by the NAS in the 1950s. Replacing the natural material to its original setting ensures physical, chemical, and mechanical compatibility with the host formation. Recent developments in support of the WIPP shaft seal system have produced confirming experimental results, constitutive material laws, and construction methods that substantiate use of a salt column for a low permeability, perfectly compatible seal component.

Numerical models of the shaft and seal system have been used to provide information on the mechanical processes that affect potential pathways and overall performance of the seal system. Several of these types of analyses are developed in Appendix D of the Compliance Submittal Design Report (Sandia, 1996). Simulations of the excavated shaft and the compacted salt seal element behavior after placement show that as time passes, the host salt creeps inward, the compacted salt is loaded by the host formation and consolidates, and a back pressure is developed along the shaft wall. The back pressure imparted to the host formation by the compacted salt promotes healing of any microcracks in the host rock. As compacted salt consolidates, density and stiffness increase and permeability decreases.

A2.4.1 Functions

The function of the compacted and reconsolidated salt column is to limit transmission of fluids into or out of the repository for the statutory period of 10,000 years. The functional period starts within a hundred years and lasts essentially forever. After a period of consolidation, the salt column will almost completely retard gas or brine migration within the former shaft opening. A completely consolidated salt column will achieve flow properties indistinguishable from natural Salado salt.

A2.4.2 Material Characteristics

The salt component comprises crushed Salado salt with addition of small amounts of water. No admixtures other than water are needed to meet design specifications. Natural Salado salt (also called WIPP salt) is typical of most salts in the Permian Basin: it has an overall composition approaching 90-95 % halite with minor clays, carbonate, anhydrite, and other halite minerals. Secondary minerals and other impurities are of little consequence to construction or performance of the compacted salt column as long as the halite content is approximately 90 %.

The total water content of the crushed salt should be approximately 1.5 wt% as it is tamped into place. Field and laboratory testing verified that natural salt can be compacted to significant density ($\rho \geq 0.9$) with addition of these modest amounts of water. In situ WIPP salt contains approximately 0.5 wt% water. After it is mined, transported, and stored, some of the connate water is lost to evaporation and dehydration. Water content of the bulk material that would be used for compaction in the shaft is normally quite small, on the order of 0.25 wt%, as measured during compaction demonstrations (Hansen and Ahrens, 1996). Measurements of water content of the salt will be necessary periodically during construction to calibrate the proper amount of water to be added to the salt as it is placed.

Water added to the salt will be sprayed in a fine mist onto the crushed salt as it is cast in each lift. Methods similar to those used in the large-scale compaction demonstration will be developed such that the spray visibly wets the salt grain surfaces. General uniformity of spray is desired. The water has no special chemical requirements for purity. It can be of high quality (drinkable) but need not be potable. Brackish water would suffice because water of any quality would become brackish upon application to the salt.

The mined salt will be crushed and screened to a nominal maximum diameter of 5 mm. Gradation of particles smaller than 5 mm is not of concern because the crushing process will create relatively few fines compared to the act of dynamic compaction. Based on preliminary large-scale demonstrations, excellent compaction was achieved without optimization of particle sizes. It is evident from results of the large compaction demonstration coupled with laboratory studies that initial density can be increased and permeability decreased beyond existing favorable results. Further demonstrations of techniques, including crushing and addition of water may be undertaken in ensuing years between compliance certification and beginning of seal placement.

A2.4.3 Construction

Dynamic compaction is the specified procedure to tamp crushed salt in the shaft. Other techniques of compaction have potential, but their application has not been demonstrated. Deep dynamic compaction provides the greatest energy input to the crushed salt, is easy to apply, and has an effective depth of compactive influence far greater than lift thickness. Dynamic compaction is relatively straightforward and requires a minimal work force. If the number of drops remains constant, diameter and weight of the tamper increases in proportion to the diameter of the shaft. The weight of the tamper is a factor in design of the infrastructure supporting the hoisting apparatus. Larger, heavier tampers require equally stout staging. The construction method outlined in Appendix B balances these opposing criteria. Compaction itself will follow the successful procedure developed in the large-scale compaction demonstration (Hansen and Ahrens, 1996).

Transport of crushed salt to the working level can be accomplished by dropping it down a slickline. As noted, additional water will be sprayed onto the crushed salt at the bottom of the shaft as it is placed. Lift heights of approximately 2 m are specified, though greater depths could be compacted effectively using dynamic compaction. Uneven piles of salt can be hand leveled.

A2.4.4 Performance Requirements

Compacted crushed salt is a unique seal material because it consolidates naturally as the host formation creeps inward. As the crushed salt consolidates, void space diminishes, density increases, and permeability decreases. Thus, sealing effectiveness of the compacted salt column will improve with time. Laboratory testing over the last decade has shown that pulverized salt specimens can be compressed to high densities and low permeabilities (Brodsky et al., 1996). In addition, consolidated crushed salt uniquely guarantees chemical and mechanical compatibility with the host salt formation. Therefore, crushed salt will provide a seal that will function essentially forever once the consolidation process is completed. Primary performance results of these analyses include plots of fractional density as a function of depth and time for the crushed salt column and permeability distribution functions that will be used for performance assessment calculations. These performance results are summarized near the end of this section, following a limited background discussion.

To predict performance, a constitutive model for crushed salt is required. To this end, a technical evaluation of potential crushed salt constitutive models was completed (Callahan et al., 1996). Ten potential crushed salt constitutive models were identified in a literature search to describe the phenomenological and micromechanical processes governing consolidation of crushed salt. Three of the ten potential models were selected for rigorous comparisons to a specially developed, although somewhat limited, database. The database contained data from hydrostatic and shear consolidation laboratory experiments. The experiments provide deformation (strain) data as a function of time under constant stress conditions. Based on volumetric strain measurements from experiments, change in crushed salt density and porosity are known. In some experiments, permeability was also measured, which provides a relationship between density and permeability of crushed salt. Models were fit to the experimental database to determine material parameter values and the model that best represents experimental data.

Modeling has been used to predict consolidating salt density as a function of time and position in the shaft. Position or depth of the calculation is important because creep rates of intact salt and crushed salt are strong functions of stress difference. Analyses made use of a “pineapple” slice structural model at the top (430 m), middle (515 m), and bottom (600 m) of the compacted salt column. Initial fractional density of the compacted crushed salt was 0.90 (1944 kg m^{-3}). The structural model, constitutive material models, boundary conditions, etc. are described in Appendix D of the Compliance Submittal Design Report (Sandia, 1996). Modeling results coupled with laboratory-determined relationships between density and permeability were used to develop distribution functions for permeability of the compacted crushed salt column for centuries after seal emplacement.

Analyses used reference engineering values for parameters in the constitutive models (e.g., the creep model for intact salt and consolidation models for crushed salt). Some uncertainty associated with model parameters exists in these constitutive models. Consolidating salt density was quantified by predicting density at specific times using parameter variations. Many of these types of calculations comparing three models for consolidation of crushed salt were performed to quantify performance of the salt column, and the reader is referred to Appendix D of the Compliance Submittal Design Report (Sandia, 1996) for more detail.

Predictions of fractional density as a function of time and depth are shown in Figure G2A-6. Performance calculations of the seal system require quantification of the resultant salt permeability. The permeability can be derived from the experimental data presented in Figure G2A-7. This plot depicts probabilistic lines through the experimental data. From these lines, distribution functions can be derived. Permeability of the compacted salt column is treated as a transient random variable defined by a log triangular distribution. Distribution functions were provided for 0, 50, 100, 200, and 400 years after seal emplacement, assuming that fluids in the salt column pores spaces would not produce a backstress. The resultant cumulative frequency distribution for seal permeability at the seal mid-height is shown in Figure G2A-8. This method predicts permeabilities ranging from 1×10^{-23} m^2 to 1×10^{-16} m^2. Because crushed salt consolidation will be affected by both mechanical and hydrological processes, detailed calculations were performed. These calculations are presented in Appendices C and D.

Numerical models of the shaft provide density of the compacted salt column as a function of depth and time. From the density-permeability relationship, permeability of the compacted salt seal component can be calculated. Similarly, the extent of the disturbed rock zone around the shaft is provided by numerical models. From field measurements of the halite DRZ, permeability of the DRZ is known as a function of depth and time. These spatial and temporal permeability values provide information required to assess the potential for brine and gas movement in and around the consolidating salt column.

A2.4.5 Verification Methods

Results of the large-scale dynamic compaction demonstration suggest that deep dynamic compaction will produce a dense starting material, and laboratory work and modeling show that compacted salt will reconsolidate within several decades to an essentially impermeable mass. As with other seal components, testing of the material in situ will be difficult and probably not the best way to ensure quality of the seal element. This is particularly apparent for the compacted salt component because the compactive effort produces a finely powdered layer on the top of each lift. It turns out that the fine powder compacts into a very dense material when the next lift is compacted. The best way to ensure that the crushed salt element functions properly is to establish performance through QA/QC procedures. If crushed salt is placed with a reasonable uniformity of water and is compacted with sufficient energy, long-term performance can be assured.

Periodic measurements of the water content of loose salt as it is placed in lifts will be used for verification and quality control. Thickness of lifts will be controlled. Energy imparted to each lift will be documented by logging drop patterns and drop height. If deemed necessary, visual inspection of the tamped salt can be made by human access. The powder layer can be shoveled aside and hardness of underlying material can be qualitatively determined or tested. Overall geometric measurements made from the original surface of each lift could be used to approximate compacted density.

A2.5 Cementitious Grout

Cementitious grouting is specified for all concrete members in response to external review suggestions. Grouting is also used in advance of liner removal to stabilize the ground. Cementitious grout is specified because of its proven performance, nontoxicity, and previous use at the WIPP.

A2.5.1 Functions

The function of grout is to stabilize the surrounding rock before existing concrete liners are removed. Grout will fill fractures within adjacent lithologies, thereby adding strength and reducing permeability. Grout around concrete members of the concrete asphalt waterstop will be employed in an attempt to tighten the interface and fill microcracks in the DRZ. Efficacy of grouting will be determined during construction. In addition, reduction of local permeability will further limit groundwater influx into the shaft during construction. Concrete plugs are planned for specific elevations in the lined portion of each shaft. The formation behind the concrete liner will be grouted from approximately 3 m below to 3 m above the plug positions to ensure stability of any loose rock.

A2.5.2 Material Characteristics

The grout developed for use in the shaft seal system has the following characteristics:

- no water separation upon hydration,
- low permeability paste,
- fine particle size,
- low hydrational heat,
- no measurable agglomeration subsequent to mixing,
- two hours of injectability subsequent to mixing,
- short set time,
- high compressive strength, and
- competitive cost.

A cementitious grout developed by Ahrens and coworkers (Ahrens et al., 1996) is specified for application in the shaft seal design. This grout consists of portland cement, pumice as a pozollanic material, and superplasticizer in the proportions listed in Table A-10. The ultrafine grout is mixed in a colloidal grout mixer, with a water to components ratio (W:C) of 0.6:1. Grout has been produced with 90 % of the particles smaller than 5 microns and an average particle size of 2 microns. The extremely small particle size enables the grout to penetrate fractures with apertures as small as 6 microns.

Table A-10
Ultrafine Grout Mix Specification

Component	Weight Percent (wt%)
Type 5 portland cement	45
Pumice	55
Superplasticizer	1.5

A2.5.3 Construction

Grout holes will be drilled in a spin pattern that extends from 3 m below to 3 m above that portion of the lining to be removed. The drilling and grouting sequence will be defined in the workmanship specifications prior to construction. Grout will be mixed on surface and transferred to the work deck via the slick line. Maximum injection pressure will be lithostatic, less 50 psig. It is estimated that four holes can be drilled and grouted per shift.

A2.5.4 Performance Requirements

Performance of grout is not a consideration for compliance issues. Grouting is used to facilitate construction by stabilizing any loose rock behind the concrete liner. If the country rock is fractured, grouting will reduce the permeability of the DRZ significantly. Application at the WIPP demonstrated permeability reduction in an anhydrite marker bed of two to three orders of magnitude (Ahrens et al., 1996). Reduction of local permeability adds to longevity of the grout itself and reduces the possibility of brine contacting seal elements. Because grout does not influence compliance issues, a model for it is not used and has not been developed. General performance achievements are:

- filled fractures as small as 6 microns,
- no water separation upon hydration,
- no evidence of halite dissolution,
- no measurable agglomeration subsequent to mixing,
- one hour of injectability,
- initial Vicat needle set in 2.5 hours,
- compressive strength 40 MPa at 28 days, and
- competitive cost.

A2.5.5 Verification Methods

No verification of the effectiveness of grouting is currently specified. If injection around concrete plugs is possible, an evaluation of quantities and significance of grouting will be made during construction. Procedural specifications will include measurements of fineness and determination of rheology in keeping with processes established during the WIPP demonstration grouting (Ahrens et al., 1996).

A2.6 Earthen Fill

Compacted earthen fill comprise approximately 150 m of shaft fill in the Dewey Lake Redbeds and near surface stratigraphy.

A2.6.1 Functions

There are minimal performance requirements imposed for Components 1 and 3 and none that affect regulatory compliance of the site. Specifications for Components 1 and 3 are general: fill the shaft with relatively dense material to reduce subsidence.

A2.6.2 Material Characteristics

Fill can utilize material that was excavated during shaft sinking and stored at the WIPP site, or a borrow pit may be excavated to secure fill material. The bulk fill material may include bentonite additive, if deemed appropriate.

A2.6.3 Construction

Dynamic compaction is specified for the clay column in the Dewey Lake Formation because of its perceived expediency. Vibratory compaction will be used near surface when there is no longer space for the three stage construction deck.

A2.6.4 Performance Requirements

Care will be taken to compact the earthen fill with an energy of twice Modified Proctor energy, which has been shown to produce a dense, uniform fill.

A2.6.6 Verification

Materials placed will be documented, with density measurements as appropriate.

A3. CONCLUDING REMARKS

Material specifications in this appendix provide descriptions of seal materials along with reasoning about why they are expected to function well in the WIPP setting. The specification follows a framework that states the function of the seal component, a description of the material, and a summary of construction techniques that could be implemented without resorting to extensive development efforts. Discussion of performance requirements for each material is the most detailed section because design of the seal system requires analysis of performance to ascertain compliance with regulations. Successful design of the shaft seal system is demonstrated by an evaluation of how well the design performs, rather than by comparison with a predetermined quantity.

Materials chosen for use in the shaft seal system have several common desirable attributes: low permeability, availability, high density, longevity, low cost, constructability, and supporting documentation. Functional redundancy using different materials provides an economically and technologically feasible shaft seal system that limits fluid transport.

A4. REFERENCES

Ahrens, E.H., T.F. Dale, and R.S. Van Pelt. 1996. *Data Report on the Waste Isolation Pilot Plant Small-Scale Seal Performance Test, Series F Grouting Experiment*. SAND93-1000. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the Sandia WIPP Central Files, Sandia National Laboratories, Albuquerque, NM [SWCF] as WPO37355.)

American Colloid Company. 1995. "Technical Data Sheet. Volclay GPG 30." Arlington Heights, IL: Industrial Chemical Division, American Colloid Company. 1 p. (Copy on file in the SWCF as WPO39636.)

American Petroleum Institute. 1990. "Specification for Materials and Testing for Well Cements." API Specification 10. 5th ed. Washington, DC: American Petroleum Institute. (Available from American Petroleum Institute, 1220 L St. NW, Washington, DC 20005, 202/682-8375.)

ASTM C 33 - 93. "Specification for Concrete Aggregates," *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 39 - 94. "Test Method for Compressive Strength of Cylindrical Concrete Specimens," *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 40 - 92. "Test Method for Organic Impurities in Fine Aggregates for Concrete," *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 114 - 94. "Test Methods for Chemical Analysis of Hydraulic Cement," *Annual Book of ASTM Standards, Volume 04.01, Cement; Lime; Gypsum*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 117 - 95. "Test Method for Material Finer Than 75-:m (No. 200) Sieve in Mineral Aggregates by Washing," *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 123 - 94. "Test Method for Lightweight Pieces in Aggregate," *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 127 - 88 (1993). "Test Method for Specific Gravity and Absorption of Coarse Aggregate," *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 128 - 93. “Test Method for Specific Gravity and Absorption of Fine Aggregate,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 131 - 89. “Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 136 - 95a. “Test Method for Sieve Analysis of Fine and Coarse Aggregates,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 138 - 92. “Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 142 - 78 (1990). “Test Method for Clay Lumps and Friable Particles in Aggregates,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 143 - 90a. “Test Method for Slump of Hydraulic Cement Concrete,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 150 - 95. “Specification for Portland Cement,” *Annual Book of ASTM Standards, Volume 04.01, Cement; Lime; Gypsum*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 157 - 93. “Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 204 - 94a. “Test Method for Fineness of Hydraulic Cement by Air Permeability Apparatus,” *Annual Book of ASTM Standards, Volume 04.01, Cement; Lime; Gypsum*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 231 - 91b. “Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 294 - 86 (1991). “Descriptive Nomenclature for Constituents of Natural Mineral Aggregates,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 295 - 90. “Guide for Petrographic Examination of Aggregates for Concrete,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 311 - 94b. “Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 469 - 94. “Test Method for Static Modulus of Elasticity and Poisson’s Ratio of Concrete in Compression,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 534 - 94. “Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form,” *Annual Book of ASTM Standards, Volume 04.06, Thermal Insulation; Environmental Acoustics*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 535 - 89. “Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 566 - 95. “Test Method for Total Moisture Content of Aggregate by Drying,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 618 - 95. “Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 845 - 90. “Specification for Expansive Hydraulic Cement,” *Annual Book of ASTM Standards, Volume 04.01, Cement; Lime; Gypsum*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 1064 - 86 (1993). “Test Method for Temperature of Freshly Mixed Portland Cement Concrete,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM C 1077 - 95a. “Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation,” *Annual Book of ASTM Standards, Volume 04.02, Concrete and Aggregates*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM D 1556 - 90. “Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method,” *Annual Book of ASTM Standards, Volume 04.08, Soil and Rock*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM D 2167 - 94. “Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method,” *Annual Book of ASTM Standards, Volume 04.08, Soil and Rock*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM D 2216 - 92. “Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock,” *Annual Book of ASTM Standards, Volume 04.08, Soil and Rock.* Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM D 2922 - 91. “Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth),” *Annual Book of ASTM Standards, Volume 04.08, Soil and Rock*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM D 3017 - 88 (1993). “Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth),” *Annual Book of ASTM Standards, Volume 04.08, Soil and Rock*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM D 4791 - 95. “Test Method for Flat or Elongated Particles in Coarse Aggregate,” *Annual Book of ASTM Standards, Volume 04.03, Road and Paving Materials; Pavement Management Technologies*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

ASTM E 534 - 91. “Test Methods for Chemical Analysis of Sodium Chloride,” *Annual Book of ASTM Standards, Volume 15.05, Engine Coolants; Halogenated Organic Solvents; Industrial Chemicals*. Philadelphia, PA: American Society for Testing and Materials. (Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187, 215/299-5400.)

Brodsky, N.S., F.D. Hansen, and T.W. Pfeifle. 1996. “Properties of Dynamically Compacted WIPP Salt,” *4th International Conference on the Mechanical Behavior of Salt, Montreal,* *Quebec, June 17-18, 1996*. SAND96-0838C. Albuquerque, NM: Sandia National Laboratories. (Copy on file at the Technical Library, Sandia National Laboratories, Albuquerque, NM.)

Brown, E.R. 1990. "Density of Asphalt Concrete--How Much is Needed?," *Transportation Research Record No. 1282*. Washington, DC: Transportation Research Board. 27-32. (Copy on file in the SWCF.)

Callahan, G.D., M.C. Loken, L.D. Hurtado, and F.D. Hansen. 1996. "Evaluation of Constitutive Models for Crushed Salt," *4th International Conference on the Mechanical Behavior of Salt, Montreal, Quebec, June 17-18, 1996*. SAND96-0791C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO36449.)

Cheung, S.C.H., M.N. Gray, and D.A. Dixon. 1987. "Hydraulic and Ionic Diffusion Properties of Bentonite-Sand Buffer Materials," *Coupled Processes Associated with Nuclear Waste Repositories, Proceedings of the International Symposium on Coupled Processes Affecting the Performance of a Nuclear Waste Repository, Berkeley, CA, September 18-20, 1985*. Ed. C-F. Tsang. Orlando, FL: Academic Press, Inc. 383-407. (Copy on file in the SWCF.)

CRD-C 38 - 73. "Method of Test for Temperature Rise in Concrete," *Handbook for Concrete and Cement*. Vicksburg, MS: U.S. Army Corps of Engineers, Waterways Experiment Station. (Copy on file in the SWCF as WPO39656.)

DOE (U.S. Department of Energy). 1995. *Waste Isolation Pilot Plant Sealing System Design Report*. DOE/WIPP-95-3117. Carlsbad, NM: U.S. Department of Energy, Waste Isolation Pilot Plant. (Copy on file in the SWCF as WPO29062.)

EPA (Environmental Protection Agency). 1996a. *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations. Response to Comments Document for 40 CFR Part 194*. EPA 402-R-96-001. Washington, DC: Environmental Protection Agency, Office of Radiation and Indoor Air. (Copy on file in the Nuclear Waste Management Library, Sandia National Laboratories, Albuquerque, NM.)

EPA (Environmental Protection Agency). 1996b. *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations. Background Information Document for 40 CFR Part 194*. EPA 402-R-96-002. Washington, DC: Environmental Protection Agency, Office of Radiation and Indoor Air. (Copy on file in the Nuclear Waste Management Library, Sandia National Laboratories, Albuquerque, NM.)

Freeman, H.D., and R.A. Romine. 1994. *Hanford Permanent Isolation Barrier Program: Asphalt Technology Test Plan*. PNL-9336. Richland, WA: Pacific Northwest Laboratories. (Copy available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA, 22161, 703/487-4650. Order number: DE94013454.)

Gray, M.N. 1993. *OECD/NEA International Stripa Project. Overview Volume III: Engineered Barriers*. Stockholm, Sweden: SKB, Swedish Nuclear Fuel and Waste Management Company. (Copy on file in the Nuclear Waste Management Library, Sandia National Laboratories, Albuquerque, NM as TD898.2 .G73 1993.)

Hansen, F.D., and E.H. Ahrens. 1996. “Large-Scale Dynamic Compaction of Natural Salt,” *4th International Conference on the Mechanical Behavior of Salt, Montreal, Quebec, June 17-18, 1996*. SAND96-0792C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO39544.)

IAEA (International Atomic Energy Agency). 1990*. Sealing of Underground Repositories for Radioactive Wastes*. STI/DOC/10/319. Technical Reports Series No. 319. Vienna, Austria: International Atomic Energy Agency; Lanham, MD: Unipub. (Copies on file at the Technical Library, Sandia National Laboratories, Albuquerque, NM and at Centennial Science and Engineering Library, University of New Mexico, Albuquerque, NM.)

Kjartanson, B.H., N.A. Chandler, A.W.L. Wan, C.L. Kohle, and P.J. Roach. 1992. “Use of a Method Specification for In Situ Compaction of Clay-Based Barrier Materials*,” High Level Radioactive Waste Management, Proceedings of the Third International Conference, Las Vegas, NV, April 12-16, 1992*. La Grange Park, IL: American Nuclear Society, Inc.; New York, NY: American Society of Civil Engineers. Vol. 1, 1129-1136. (Copy on file in the SWCF.)

Knowles, M.K., and C.L. Howard. 1996. “Field and Laboratory Testing of Seal Materials Proposed for the Waste Isolation Pilot Plant,” *Proceedings of the Waste Management 1996 Symposium, Tucson, AZ, February 25-29, 1996*. SAND95-2082C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO30945.)

Mitchell, J.K. 1993. *Fundamentals of Soil Behavior*. 2nd ed. New York, NY: John Wiley & Sons, Inc.

Myers, D.R., and D.A. Duranceau. 1994. *Prototype Hanford Surface Barrier: Design Basis Document*. BHI-00007, Rev. 00. Richland, WA: Bechtel Hanford, Inc. for the U.S. Department of Energy, Office of Environmental Restoration and Waste Management. (Copy on file at the Nuclear Waste Management Library, Sandia National Laboratories, Albuquerque, NM.)

Nilsson, J. 1985. “Field Compaction of Bentonite-Based Backfilling,” *Engineering Geology*. Vol. 21, no. 3-4, 367-376. (Copy on file in the SWCF.)

Onofrei, M., M.N. Gray, W.E. Coons, and S.R. Alcorn. 1992. “High Performance Cement-Based Grouts for Use in a Nuclear Waste Disposal Facility,” *Waste Management*. Vol. 12, no. 2/3, 133-154. (Copy on file in the SWCF.)

Pfeifle, T.W., F.D. Hansen, and M.K. Knowles. 1996. “Salt-Saturated Concrete Strength and Permeability,” *4th Materials Engineering Conference, ASCE Materials Engineering Division, Washington, DC, November 11-18, 1996.* Albuquerque, NM: Sandia National Laboratories.)

Pusch, R. 1982. “Mineral-Water Interactions and Their Influence on the Physical Behavior of Highly Compacted Na Bentonite,” *Canadian Geotechnical Journal*. Vol. 19, no. 3, 381-387. (Copy on file in the SWCF.)

Pusch, R., and L. Börgesson. 1989. “Bentonite Sealing of Rock Excavations,” *Sealing of Radioactive Waste Repositories, Proceedings of an NEA/CEC Workshop, Braunschweig, Germany, May 22-25, 1989*. EUR 12298. Paris: Organisation for Economic Co-Operation and Development. 297-308. (Copy on file in the SWCF.)

Pusch, R., M. Gray, F. Huertas, M. Jorda, A. Barbreau, and R. Andre-Jehan. 1989. “Sealing of Radioactive Waste Repositories in Crystalline Rock,” *Sealing of Radioactive Waste Repositories, Proceedings of an NEA/CEC Workshop, Braunschweig, Germany, May 22-25, 1989*. EUR 12298. Paris: Organisation for Economic Co-Operation and Development. 214-228. (Copy on file in the SWCF.)

Sandia (Repository Isolation Systems Department 6121). 1996. *Waste Isolation Pilot Plant Shaft Sealing System Compliance Submittal Design Report.* SAND96-1326/1&2. Albuquerque, NM: Sandia National Laboratories.

Wakeley, L.D., P.T. Harrington, and F.D. Hansen. 1995. *Variability in Properties of Salado Mass Concrete*. SAND94-1495. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO22744.)

Wing, N.R., and G.W. Gee. 1994. “Quest for the Perfect Cap,” *Civil Engineering*. Vol. 64, no. 10, 38-41. (Copy on file in the SWCF as WPO21158.)

FIGURES

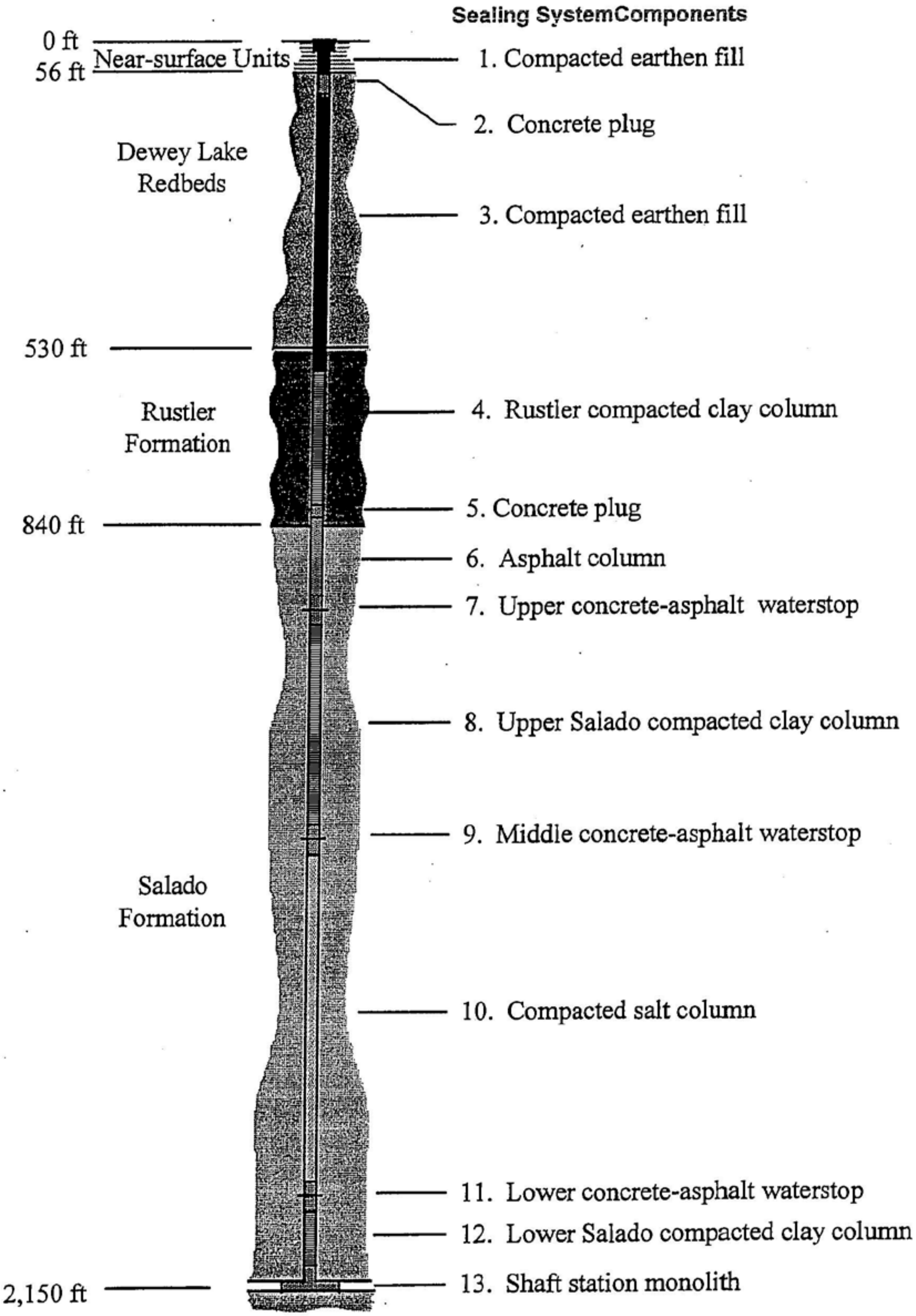


Figure G2A-1
Schematic of the WIPP Shaft Seal Design

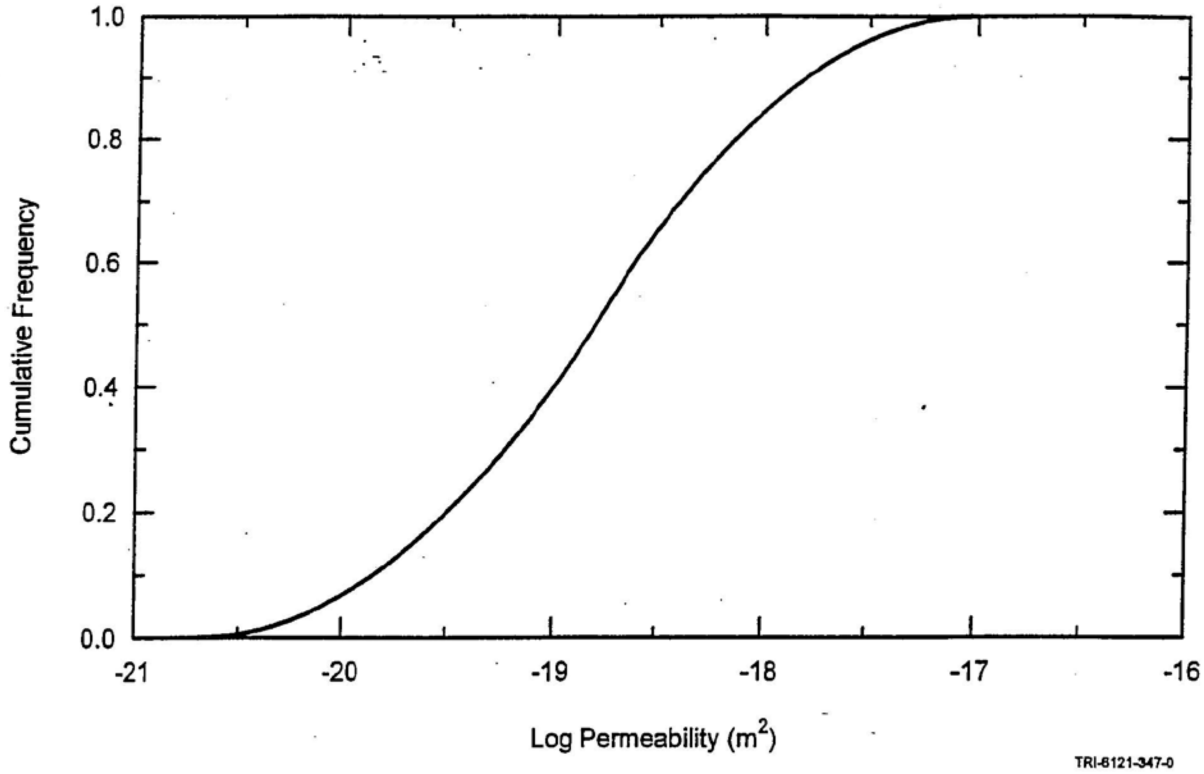


Figure G2A-2
Cumulative Distribution Function for SMC

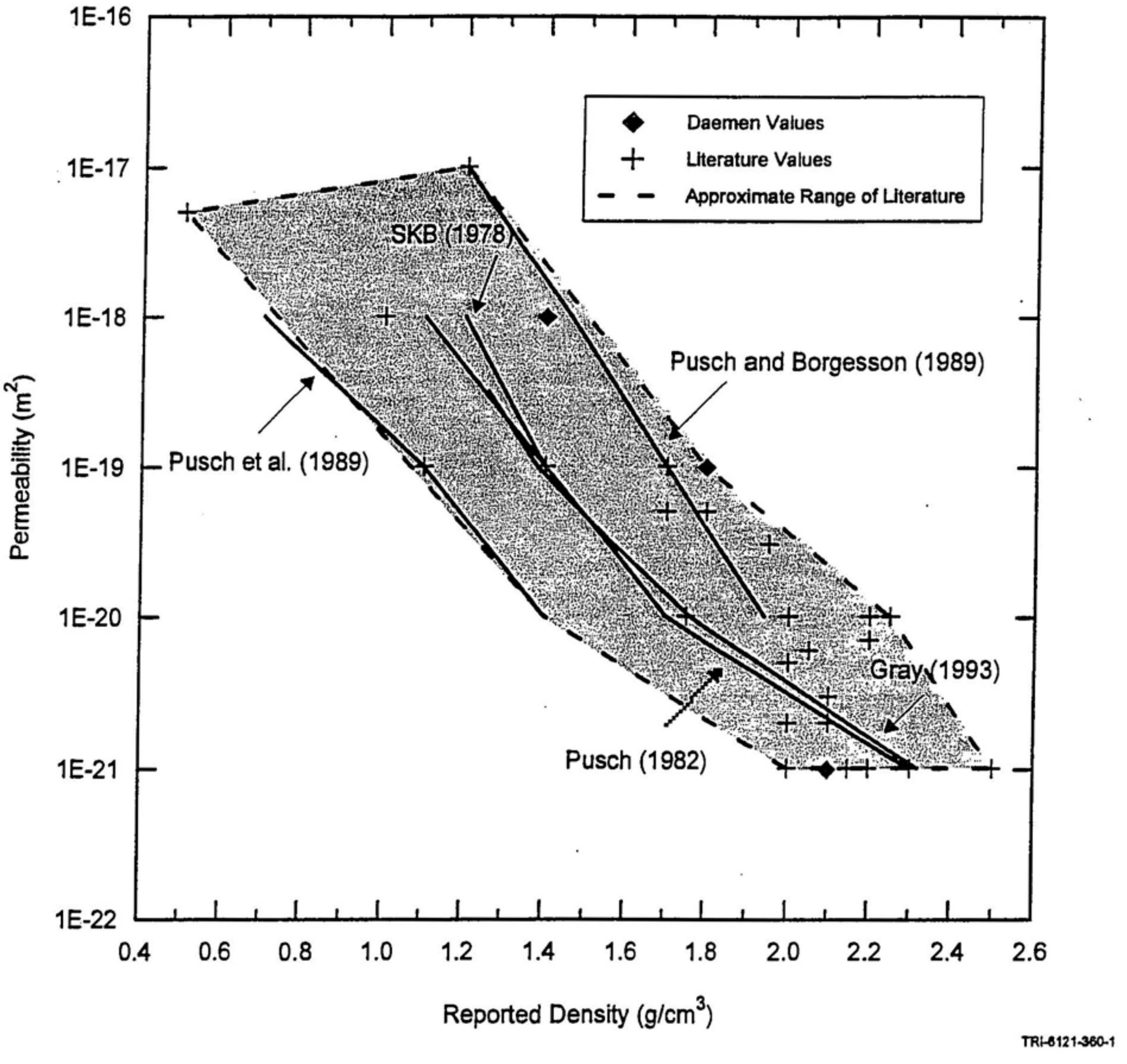


Figure G2A-3
Sodium Bentonite Permeability Versus Density

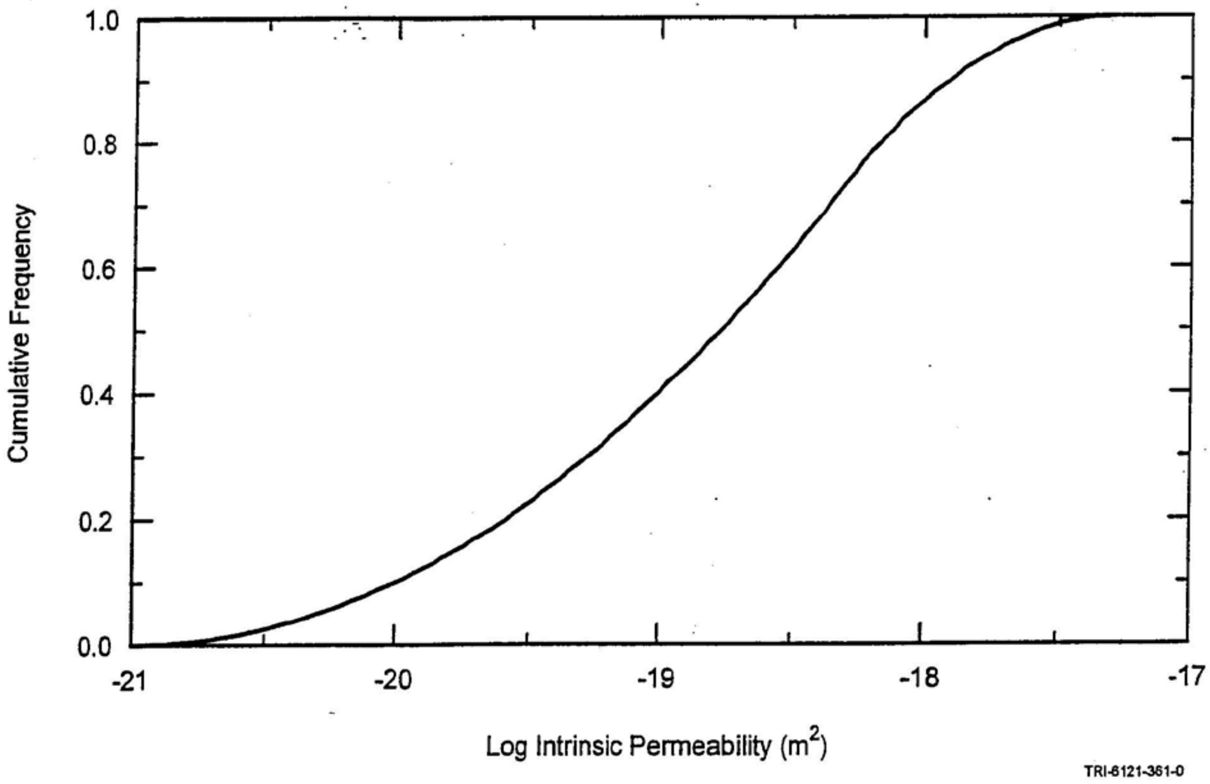


Figure G2A-4
Cumulative Frequency Distribution for Compacted Bentonite

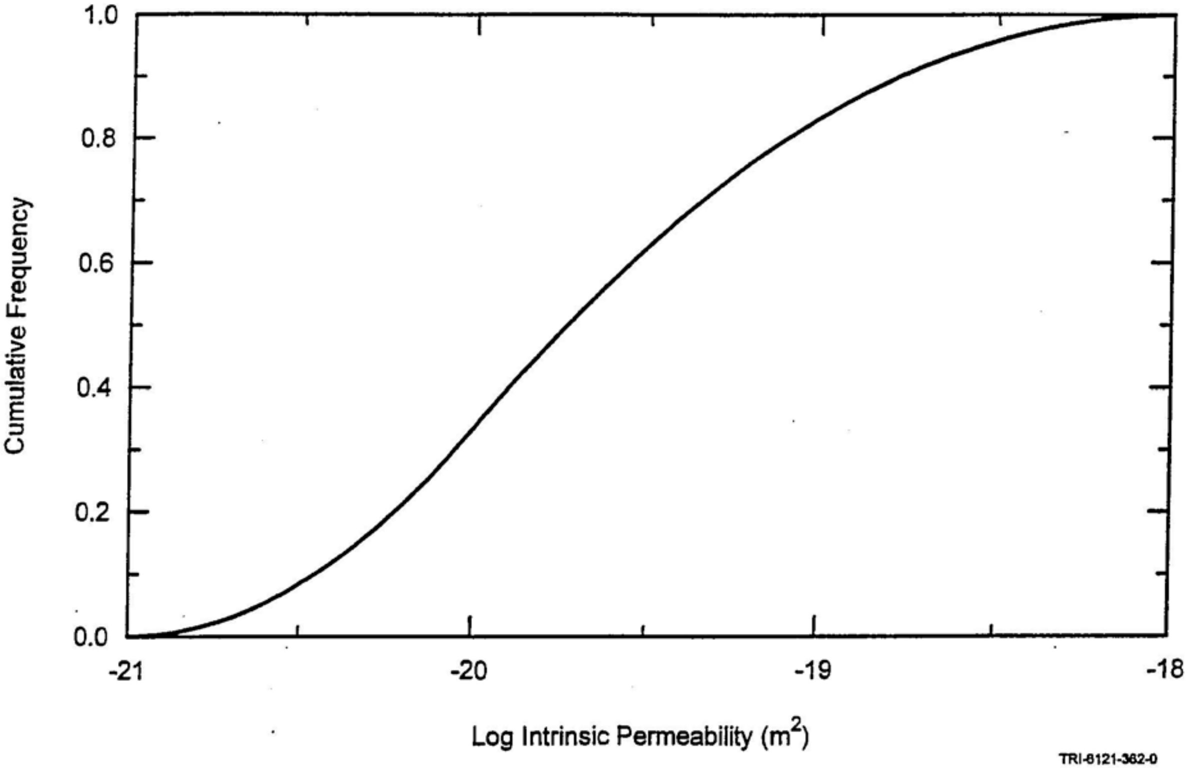


Figure G2A-5
Asphalt Permeability Cumulative Frequency Distribution Function

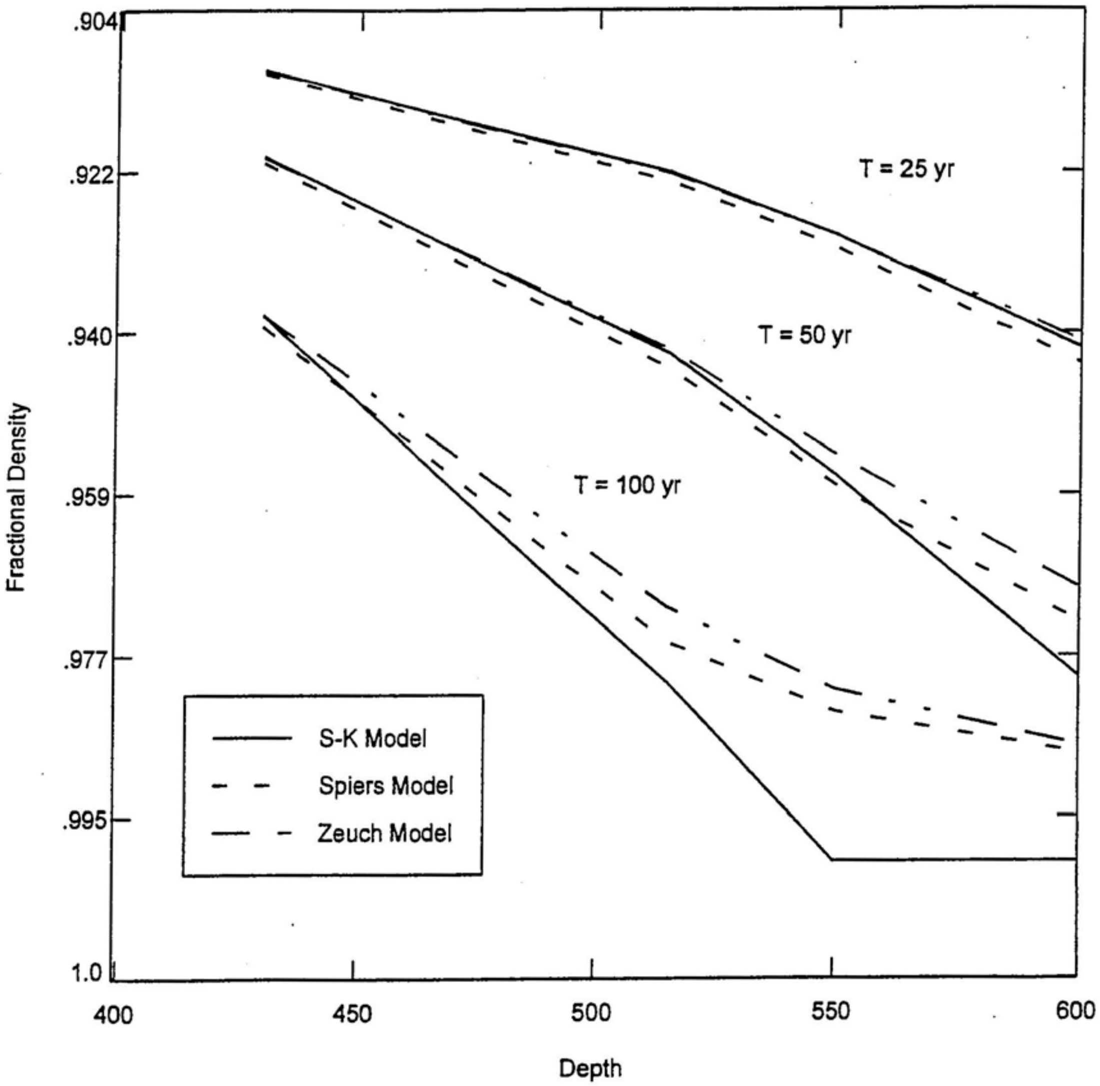


Figure G2A-6
Fractional Density of the Consolidating Salt Column

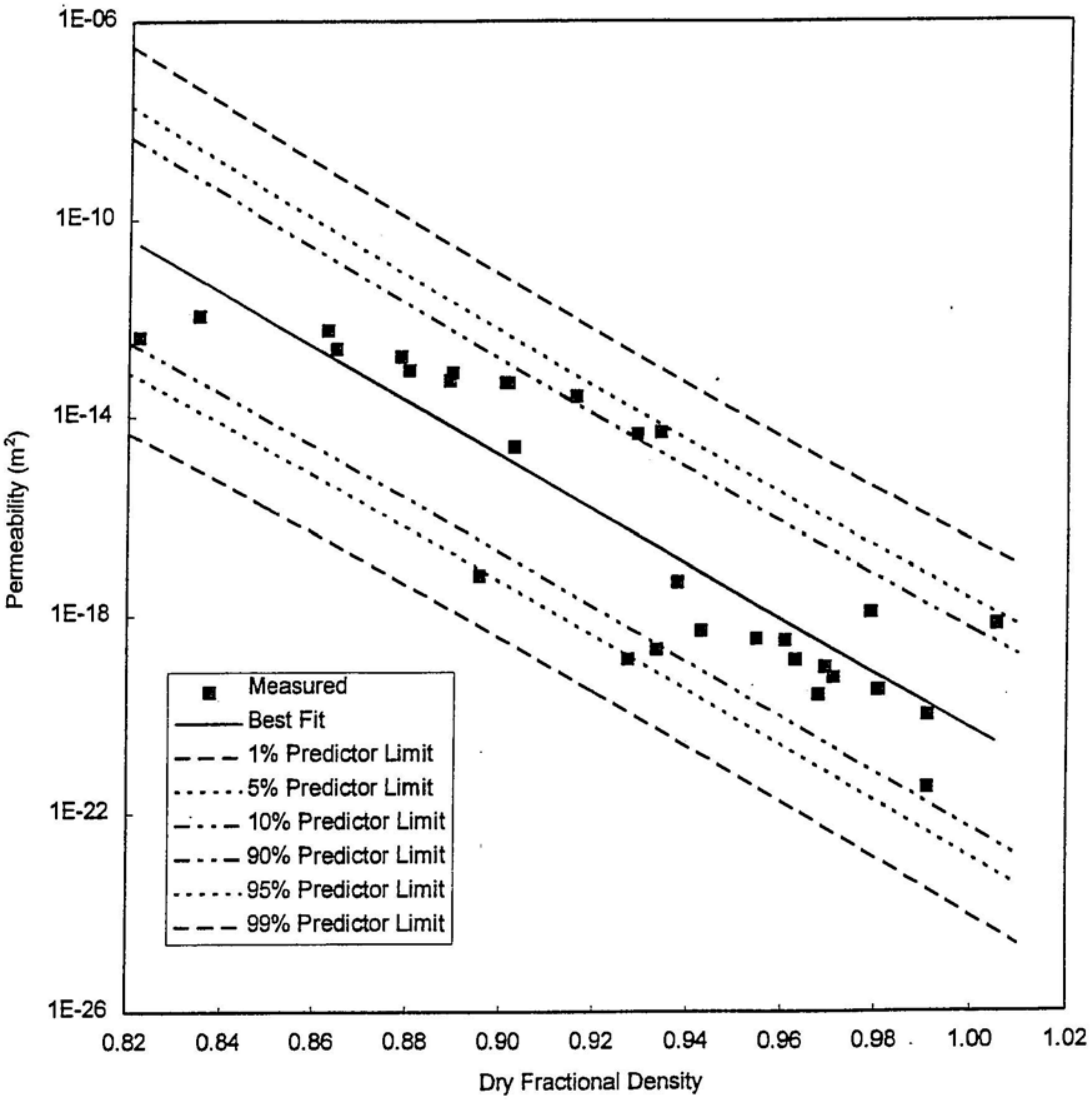


Figure G2A-7
Permeability of Consolidated Crushed Salt as a Function of Fractional Density

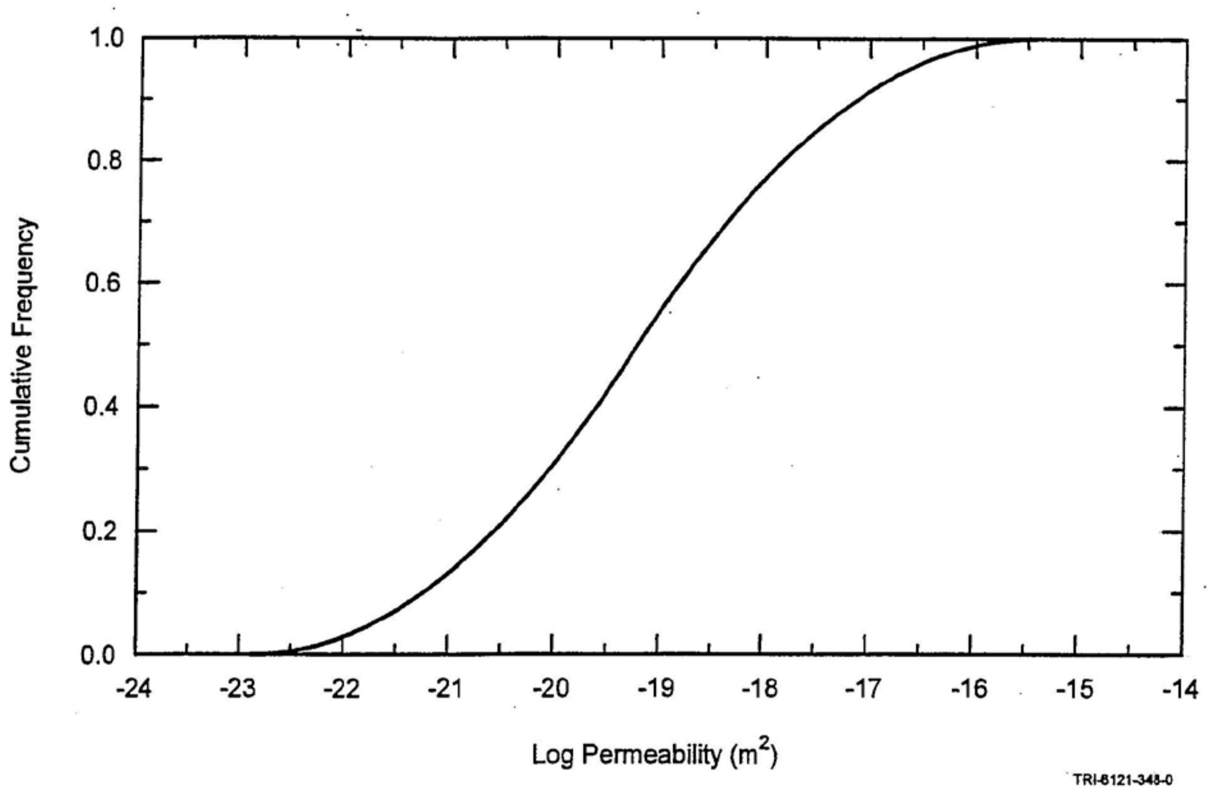


Figure G2A-8
Compacted Salt Column Permeability Cumulative Frequency Distribution Function at Seal Midpoint 100 Years Following Closure

ATTACHMENT G2
APPENDIX B

SHAFT SEALING CONSTRUCTION PROCEDURES

SHAFT SEALING SYSTEM
COMPLIANCE SUBMITTAL DESIGN REPORT

ATTACHMENT G2
APPENDIX B

SHAFT SEALING CONSTRUCTION PROCEDURES

SHAFT SEALING SYSTEM COMPLIANCE SUBMITTAL DESIGN REPORT

Appendix B Abstract

This appendix describes equipment and procedures used to construct the shaft seals as specified in Permit Attachment G2. Existing or reasonably modified construction equipment is specified, standard mining practices are applied, and a general schedule is provided at the end of this appendix. This appendix describes the following activities:

- pre-sealing activities for the sub-surface and surface,
- construction and operation of a multi-deck stage,
- installation of special concrete (sumps, shaft station monoliths, and concrete plugs),
- installation of compacted clay columns,
- emplacement and dynamic compaction of WIPP salt,
- installation of neat asphalt and asphaltic mastic mix,
- grouting of concrete plugs and the country rock behind existing shaft liners,
- removal of portions of the existing shaft liners, and
- emplacement of compacted earthen fill.

TABLE OF CONTENTS

FIGURES

B1. Introduction

This appendix describes construction specifications for placement of shaft seal materials. Flexibility is incorporated in construction specifications to facilitate placement of several different material types. Engineering materials used to seal the full length of the shaft include earthen fill, compacted clay, tamped crushed salt, asphalt, concrete, and a combination of concrete and asphalt in concrete-asphalt waterstops. Appendix A of Permit Attachment G2 provides details of the materials. A full-length shaft seal of this type has never before been constructed; however, application of available technology and equipment, standard construction practices, and common materials provides confidence that the system can be placed to satisfy the design requirements.

A primary feature of the construction specification is development of a work platform from which seal materials are placed. Although the proposed multi-deck stage (galloway) proposed here is engineered specifically for shaft sealing operations, it is similar to stages used for construction of shafts. Inherently flexible, the multi-deck stage facilitates several construction methods required for the various materials specified for the shaft seal system. It provides an assembly of a slickline and header for transport of flowable materials from the surface to the placement horizon. A crane device is attached to the base of the stage to facilitate compaction, and an avenue through the stage provides a means to transport bulk material. It is understood that procedures specified here may change during the tens of years preceding construction as a result of equipment development, additional testing, or design changes. Further, it is acknowledged that the construction methods specified are not the only methods that could place the seal materials successfully.

A few assumptions are made for purposes of evaluating construction activities. These assumptions are not binding, but are included to assist discussion of general operational scenarios. For example, four multi-deck stages are specified, one for each shaft. This specification is based on shaft-sinking experience, which indicates that because of the wear encountered, it is advisable to replace rather than rebuild stages. However, much of the equipment on the multi-deck stage is reused. For scheduling purposes, it is assumed that sealing operations are conducted in two of the four shafts simultaneously. The Air Intake and Exhaust Shafts are sealed first, and the Waste and Salt Handling Shafts are sealed last. With this approach, shaft sealing will require about six and a half years, excluding related work undertaken by the WIPP Management and Operating Contractor (**MOC**). Sealing the shafts sequentially would require approximately eleven and a half years. To facilitate discussion of scheduling and responsibilities, it is assumed that sealing operations will be conducted by a contractor other than the MOC.

Years from now, when actual construction begins, it is probable that alternatives may be favored. Therefore, construction procedures note alternative methods in recognition that changes are likely and that the construction strategy is sufficiently robust to accommodate alternatives. This appendix contains both general and very specific information. It begins with a discussion of general mobilization in Section 2. Details of the multi-deck construction stage are provided in Section 3. Section 4 contains descriptions of the construction activities. Information presented here is supplemented by several engineering drawings and sketches contained in Permit Attachment G2, Appendix E. The topical information and the level of provided detail substantiate the theory that reliable shaft seal construction is possible using available technology and materials.

B2. Project Mobilization

The duty descriptions that follow are for discussion purposes. The discussions do not presuppose contractual arrangements, but simply identify tasks necessary for shaft seal construction.

B2.1 Subsurface

Prior to initiation of sealing activities, the MOC will remove installations and equipment on the repository level. A determination of items removed will be made before construction begins. Such removal would include, but is not limited to, gates and fences at the shaft; equipment such as winches, ventilation fans, pipelines; and communication and power cables. Additionally, the following items will be removed from the shafts:

- cables, counterweights, and sheaves;
- existing waterlines; and
- electrical cables not required for sealing operations.

The following equipment will be stored near the shaft on the repository level by the Sealing Contractor prior to initiation of sealing activities:

- a concrete header, hopper, and pump;
- a concrete pump line to distribute concrete; and
- an auxiliary mine fan and sufficient flexible ventilation tubing to reach work areas required for installation of the shaft station concrete monolith.

The subsurface will be prepared adequately for placement of the shaft station monolith. Determination of other preparatory requirements may be necessary at the time of construction.

B2.2 Surface

The MOC will remove surface facilities such as headframes, hoists, and buildings to provide clear space for the Sealing Contractor. Utilities required for sealing activities (e.g., air compressors, water, electrical power and communication lines) will be preserved. The Sealing Contractor will establish a site office and facilities required to support the construction crews, including a change house, lamp room, warehouse, maintenance shop, and security provisions. Locations will be selected and foundations constructed for headframes, multi-deck stage winches, man/equipment hoist, and exhaust fan. A drawing in Permit Attachment G2, Appendix E (Sketch E-4) depicts a typical headframe and associated surface facilities. The hoist and winches will be enclosed in suitable buildings; utilities and ventilation ducting will be extended to the shaft collar. The large ventilation fan located near the collar is designed to exhaust air through the rigid ventilation duct, resulting in the movement of fresh air down the shaft. Air flow will be sufficient to support eight workers to the depth of the repository level. The following facilities will be procured and positioned near the shaft collar:

- a concrete batch plant capable of weighing, batching, and mixing the concrete to design specifications;

- a crushing and screening plant to process WIPP salt and local soil;
- an insulated and heated pug mill, asphalt pump, asphalt storage tank, and other auxiliary equipment; and
- pads, silos, and structures to protect sealing materials from the weather.

The Sealing Contractor will construct a temporary structural steel bulkhead over the shaft at the surface. The bulkhead will be sufficiently strong to support the weight of the multi-deck stage, which will be constructed on it. When the multi-deck stage is completed, the headframe will be erected. The headframe (depicted in Permit Attachment G2, Appendix E, Sketch E-3) will be built around the multi-deck stage, and a mobile crane will be required during fabrication. When the headframe is completed, cables for hoisting and lowering the multi-deck stage will be installed. Cables will run from the three winches, over the sheaves in the headframe, down and under the sheaves on the multi-deck stage, and up to anchors in the headframe. The headframe will be sufficiently high to permit the multi-deck stage to be hoisted until the lowest component is 3.05 m (10 ft) above surface. This will facilitate slinging equipment below the multi-deck stage and lowering it to the work surface, as well as activities required at the collar during asphalt emplacement.

The multi-deck stage will be lowered to clear the collar, allowing the installation of compressed-air-activated steel shaft collar doors, which will serve as a safety device, permitting safe access to the man cage and bucket, while preventing objects from falling down the shaft. Following installation of these doors, workers will utilize the multi-deck stage to traverse the shaft from the collar to the repository horizon, inspecting it for safety hazards and making any necessary repairs. After this inspection, the multi-deck stage will return to the surface.

B2.3 Installation of Utilities

In preparation for placement of shaft seal materials, requisite utilities will be outfitted for operations. The multi-deck stage will descend from the collar to the repository horizon. As added assurance against unwanted water, a gathering system similar to the one currently in place at the bottom of the concrete liner will be installed and moved upward as seal emplacement proceeds. Water collected will be hoisted to the surface for disposal. Additionally, any significant inflow will be located and minimized by grouting. After installation of the water gathering system, the following utilities will be installed from surface to the repository horizon by securely fastening them to the shaft wall:

- 5.1-cm steel waterline with automatic shut-off valves every 60 m;
- 10.2-cm steel compressed-air line;
- power, signal, and communications cables;
- 15.2 cm steel slickline and header; and
- a rigid, cylindrical, ventilation duct, which would range from 107 cm in diameter in the three largest shafts to 91 cm in diameter in the Salt Handling Shaft.

B3. Multi-Deck Stage

The multi-deck stage (galloway) provides a work platform from which all sealing operations except placement of asphalt are conducted. The concept of using a multi-deck stage is derived from similar equipment commonly employed during shaft sinking operations. Plan and section views of conceptual multi-deck stages are shown in Permit Attachment G2, Appendix E, Sketches E-1 and E-2. The construction decks specified here are modified from typical shaft sinking configurations in two important ways to facilitate construction. Conceptual illustrations of these two modifications are displayed in Figures G2B-1 and G2B-2. Figure G2B-1 illustrates the multi-deck performing dynamic compaction of salt. Figure G2B-2 illustrates the multi-deck stage configured for excavation of the kerf required for the asphalt waterstop in Salado salt.

A device called a polar crane mounted below the lower deck can be configured for either dynamic compaction or salt excavation. The crane can rotate 360º horizontally by actuating its geared track drive. Its maximum rotational speed will be approximately two revolutions per minute. The crane can be controlled manually or by computer (computerized control will swiftly position the tamper in the numerous drop positions required for dynamic compaction). When excavation for the concrete-asphalt waterstops is required, the tamper, electromagnet, and cable used for dynamic compaction will be removed, and a custom salt undercutter will be mounted on the polar crane trolley. Geared drives on the crane, trolley, and undercutter will supply the force required for excavation. In addition to the special features noted above and shown in Figures G2B-1 and G2B-2, the multi-deck stage has the following equipment and capabilities:

- Maximum hoisting/lowering speed is approximately 4.6 m (15 ft) per minute.

- A cable, electromagnet, and tamper will be attached to the polar crane during dynamic compaction. The cylindrical tamper consists of A-36 carbon steel plates bolted together with high-tensile-strength steel bolts. It is hoisted and dropped by the polar crane using the electromagnet. The tamper will be mechanically secured to the polar crane before personnel are allowed under it.

- Range-finding lasers will facilitate the accurate positioning of the multi-deck stage above the work surface and allow the operator to determine when the surface is sufficiently level. The distance indicated by each laser will be displayed on a monitor at the crane control station.

- Flood lights and remotely controlled closed-circuit television equipment will enable the crane operator to view operations below the multi-deck stage on a monitor.

- Fold-out floor extensions that accommodate the variance in shaft diameter between the unlined and lined portions of the shaft will be provided for safety.

- A cutout in each deck, combined with a removable section of the polar crane track, will permit stage movement without removal of the rigid ventilation duct (which is fastened to the shaft wall).

The multi-deck stage is equipped with many of the features found on conventional shaft sinking stages, such as:

- three independent hoisting/lowering cables,
- man and material conveyances capable of passing through the multi-deck stage and accessing the working surface below,
- a jib crane that can be used to service the working surface below,
- removable safety screens and railings, and
- centering devices.

Three sets of double locking devices are provided to secure the multi-deck stage to the shaft wall. A suitable factor of safety for these locking devices is judged to be 4. The area of the grips securing the deck is calculated from static principles:

$$FS = \mu(Co)(A)/W \tag{B-1}$$

where:

FS = factor of safety
μ = steel/salt friction coefficient = 0.15 (see Table 20.1 in McClintock and Aragon, 1966; and Van Sambeek, 1988)
Co = compressive strength of WIPP salt, which varies from 172 kg/cm^2 to 262 kg/cm^2 (Van Sambeek, 1988)
W = total vertical weight
A = total gripper pad surface area.

Manipulating the equation to solve for required area, applying a factor of safety of 4, selecting the heaviest work stage (753,832 kg) and the minimum compressive strength value for salt (assuming that the locking pressure equals the minimum compressive strength of salt), the following gripper surface area (A) is:

> A = 4(753,832 kg)/0.15(172 kg/cm^2) = 11,416.5 cm^2, and each of the six gripper pads would be 1902.8 cm^2.

As designed, each gripper pad area is 2167.2 cm^2, resulting in a factor of safety (FS) of 4.56. Additionally, although tension in the hoisting cables is relaxed while the multi-deck stage is in the locked configuration, the cables are still available to hold the work-deck, should the locking devices fail.

B4. Placement of Sealing Materials

Construction activities include placement of materials in three basic ways: (1) by slickline (e.g., concrete and asphalt), (2) by compaction (e.g., salt and earthen fill), and (3) by physical placement (e.g., clay blocks). Materials will be placed at various elevations using identical procedures. Because placement procedures generally are identical regardless of elevation, they will be described only once. Where differences occur, they will be identified and described. In general, placement of shaft seal elements is described from bottom to top.

B4.1 Concrete

Concrete is used as a seal material for several different components, such as the existing sumps in the Salt Handling Shaft and the Waste Shaft, the shaft station monoliths, concrete plugs, and concrete-asphalt waterstops. Existing sumps are shown in Permit Attachment G2, Appendix E, Drawings SNL-007, Sheets 6 and 21. Shaft station monoliths are shown in Drawings SNL-007, Sheets 6, 11, 16, and 21. Concrete plugs are depicted on Drawings SNL-007, Sheets 4, 5, 9, 10, 14, 15, 19, and 20. Lower, middle, and upper concrete-asphalt waterstops are shown in Drawing SNL-007, Sheet 22. Construction material for all concrete members will be Salado Mass Concrete (SMC).

As specified, all SMC will be mixed on surface to produce a product possessing the characteristics defined in Permit Attachment G2, Appendix A. Concrete will be transferred to its placement location within the shaft via slickline and header. The slickline (shown in Figure G2B-1) is a steel pipe fastened to the shaft wall. Vertical drops as great as 656 m to the repository horizon are required. Such concrete transport and construction are common in mining applications. For example, a large copper mine in Arizona is placing concrete at a depth of 797 m using this procedure. A header attached to the bottom of the slickline is designed to absorb kinetic energy generated by the falling material. The header, a steel pipe slightly larger in diameter than the slickline and made of thicker steel, diverts the flow 45°, absorbing most of the impact. Because the drop generates considerable force, the header will be securely supported by a reinforced steel shelf bolted to the shaft wall. A flexible hose, in sections approximately 3 m long and joined by quick-connect fittings, will be attached to the header.

B4.1.1 Shaft Station Monolith

Construction of the shaft station monoliths is preceded by filling two existing sumps with SMC. Initially, sufficient hose will be used to convey the concrete to the bottom of the sump. The discharge will remain below the concrete surface during placement to minimize air entrainment. Sections of hose will be withdrawn and removed as the SMC rises to the floor of the repository horizon in a continuous pour. Subsequent to filling the sump, arrangements will be made to place the concrete monolith.

A small mine fan will be located above the rigid suction-duct inlet to ensure a fresh air base. Masonry block forms will be constructed at the extremities of the shaft station monolith in the drifts leading from the station. Temporary forms, partially filling the opening, will be erected at the shafts to facilitate the placement of the outermost concrete. These temporary forms will permit access necessary to ensure adequate concrete placement. SMC will be transported via the slickline to the header, which will discharge into a hopper feeding the concrete pump, and the pump will be attached to the pumpcrete line. The pumpcrete line, suspended in cable slings near the back of the drifts, will be extended to the outer forms. A flexible hose, attached to the end of the pumpcrete line, will be used by workers to direct emplacement. The pumpcrete line will be withdrawn as emplacement proceeds toward the shaft.

When the concrete has reached the top of the temporary forms, they will be extended to seal the openings completely, and two 5-cm-diameter polyvinyl chloride (PVC) pipes will be incorporated in the upper portion of each form. Both pipes will be situated in a vertical plane oriented on the long axis of the heading and inclined away from the station at approximately 70° to the horizontal. The upper end of the top pipe will extend to just below the back, and the upper end of the lower pipe will be located just below that of the top pipe. SMC will be injected through the lower pipe until return is obtained from the upper pipe, ensuring that the heading has been filled to the back. The header will then be moved to a position in the shaft above the designed elevation at the top of the shaft station monolith and supported by a bracket bolted to the shaft wall. After the outer concrete has achieved stability, the temporary interior forms may be removed. Equipment no longer required will be slung below the multi-deck stage and hoisted to surface for storage and later use. The station and shaft will be filled to design elevation with concrete via the slickline, header, and flexible hose. The slickline is cleaned with spherical, neoprene swabs ("pigs") that are pumped through the slickline, header, and hose.

B4.1.2 Concrete-Asphalt Waterstops

Lower, middle, and upper concrete-asphalt waterstops in a given shaft are identical and consist of two SMC sections separated by an asphalt waterstop. Before the bottom member of the lower concrete component is placed, the multi-deck stage will be raised into the headframe; the polar crane will be mounted below the lower deck; and the salt undercutter will be mounted on the crane trolley. The multi-deck stage will then return to the elevation of the concrete component. Two undercutter bars will be used to make the necessary excavations for upper, middle, and lower asphalt-concrete waterstops and the concrete plug above the Salado Formation. Notches for the plugs will be excavated using a short, rigid cutter bar (length less than half the radius). The kerf for the asphalt waterstop will be excavated using a long cutter bar that can excavate the walls to a depth of one shaft radius. These operations will be conducted as required as seal placement proceeds upward.

The lower concrete member (and all subsequent concrete entities) will be placed via the slickline, header, and flexible hose, using the procedure outlined for the shaft station monolith. Construction of vertical shaft seals provides the ideal situation for minimizing interface permeability between the rock and seal materials. Concrete will flow under its own weight to provide intimate contact. A tight cohesive interface was demonstrated for concrete in the small-scale seal performance tests (SSSPTs). The SSSPT concrete plugs were nearly impermeable without grouting. However, interface grouting is usually performed in similar construction, and it will be done here in the appropriate locations.

B4.1.3 Concrete Plugs

An SMC plug, keyed into the shaft wall, is situated a few meters above the upper Salado contact in the Rustler Formation. A final SMC plug is located a few meters below surface in the Dewey Lake Redbeds. This plug is emplaced within the existing shaft liner using the same construction technique employed for the concrete-asphalt waterstops.

B4.2 Clay

B4.2.1 Salado and Rustler Compacted Clay Column

Blocks of sodium bentonite clay, precompacted to a density of 1.8 to 2.0 g/cm^3, will be the sealing material. This density has been achieved at the WIPP using a compaction pressure of 492.2 kg/cm^2 in a machine designed to produce adobe blocks (Knowles and Howard, 1996). Blocks are envisioned as cubes, 20.8 cm on the edge, weighing approximately 18 kg, a reasonable weight for workers to handle. The bentonite blocks will be compacted at the WIPP in a new custom block-compacting machine and will be stored in controlled humidity to prevent desiccation cracking. Blocks will be transported from surface in the man cage, which will be sized to fit through the circular “bucket hole” in the multi-deck stage. The conveyance will be stacked with blocks to a height of approximately 1.8 m.

Installation will consist of manually stacking individual blocks so that all interfaces are in contact. Block surfaces will be moistened with a spray of potable water as the blocks are placed to initiate a minor amount of swelling, which will ensure a tight fit and a decrease in permeability. Peripheral blocks will be trimmed to fit irregularities in the shaft wall and placed as close to the wall as possible. Trimmed material will be manually removed with a vacuum. Dry bentonite will be manually tamped into remaining voids in each layer of blocks. This procedure will be repeated throughout the clay column. The multi-deck stage will, in all cases, be raised and utilities removed to the surface as emplacement of sealing materials proceeds upward.

Dynamic compaction construction is an alternative method of clay emplacement that could be considered in the detailed design. Dynamic compaction materials being considered are:

- sodium bentonite/fine silica sand, and
- highly compressed bentonite pellets.

Boonsinsuk et al. (1991) developed and tested a dynamic (drop hammer) method for a relatively large diameter (0.5-m) hole, simulated with a steel cylinder, that gave very good results on 1 : 1 dry mass mixtures of sodium bentonite and sand, at a moisture content of 17% to 19%. The alternatives have the advantages of simplifying emplacement.

B4.3 Asphalt

Asphalt, produced as a distillate of petroleum, is selected as the seal material because of its longevity, extremely low permeability, history of successful use as a shaft lining material, and its ability to heal if deformed. Shielded from ultraviolet radiation and mixed with hydrated lime to inhibit microbial degradation, the longevity of the asphalt will be great. Emplaced by tremie line at the temperature specified, the material will be fluid and self-leveling, ensuring complete contact with the salt.

Construction of an asphalt column using heated asphalt will introduce heat to the surrounding salt. The thermal shock and heat dissipation through the salt has not been studied in detail. Performance of the asphalt column may be enhanced by the introduction of the heat that results from acceleration of creep and healing of microfractures. If, upon further study, the thermomechanical effects are deemed undesirable or if an alternative construction method is preferred at a later date, asphalt can readily be placed as blocks. Asphalt can “cold flow” to fill gaps, or the seams between blocks can be filled with low-viscosity material.

B4.3.1 Concrete-Asphalt Waterstops

Electrically insulated, steel grated flooring will be constructed over the shaft at the surface. A second, similar flooring will be built in the shaft 3 m below the first. These floors will be used only during the emplacement of asphalt and asphaltic mastic mix (AMM) and will be removed at all other times. A 12.7-cm ID/14-cm OD, 4130 steel pipe (tremie line) in 3-m lengths will be electrically equipped for impedance heating, then insulated and suspended in the shaft from slips (pipe holding devices) situated on the upper floor. The tremie line cross-sectional area is smallest at the shoulder of the top thread, where tensional yield is 50,000 kg; the line weight is 20.8 kg/m. Heavier weights are routinely suspended in this manner in the petroleum and mining industries.

Neat, AR-4000-graded petroleum-based asphalt cement will be the sealing material for asphalt waterstops. Neat asphalt from the refinery will be delivered to the WIPP at approximately 80°C in conventional, insulated refinery trucks and pumped into a heated and insulated storage tank located near the shaft. The multi-deck stage will be hoisted into the headframe and mechanically secured for safety. Asphalt, heated to 180°C ±5°, will be pumped down the shaft to the fill elevation through the heated tremie line. Viscosity of the neat asphalt for the waterstops will be sufficiently low to allow limited penetration of the DRZ. Installation of asphalt in each of the concrete-waterstops is identical.

As the pipe is lowered, workers on the lower deck will attach the wiring required for heating circuits and apply insulation. Workers on the top deck will install flanged and electrically insulated couplings as required (the opening in the slip bowl will be large enough to permit the passage of these couplings). Properly equipping and lowering the pipe should progress at the rate of one section every 10 minutes. The lower asphalt waterstop requires approximately 607 m of pipe for a casing weight of 12,700 kg. Additionally, electrical wire and insulation will weigh about 7250 kg for a total equipped tremie line weight of 20,000 kg. Therefore, the safety factor for the tremie line is 50,000 kg/20,000 kg, or 2.5.

To minimize air entrainment, the lower end of the tremie line will be immersed as much as 1 m during hot asphalt emplacement. Therefore, the lower 3 m of casing will be left bare (to simplify cleaning when emplacement has been completed).

Initially the tremie line will be lowered until it contacts the concrete plug (immediately underlying the excavation for the waterstop) and then raised approximately 0.3 m. Asphalt emplacement will proceed as follows:

- The impedance heating system will be energized, heating the tremie line to 180°C ±5°, and the asphalt in the storage tank will be heated to approximately 180°C ±5°.

- Heated, neat asphalt will be pumped down the tremie line at a rate approximating 13 L/min. This low rate will ensure that the asphalt flows across the plug from the insertion point, completely filling the excavation and shaft to the design elevation.

- The tremie line will be raised 3 m and cleaned by pumping a neoprene swab through it with air pressure. Impedance heating will be stopped, and the line will be allowed to cool. When cool, the line will be hoisted, stripped, cleaned, disassembled, and stored for future use.

Sealing operations will be suspended until the air temperature at the top of the asphalt has fallen to approximately 50°C for the comfort of the workers when they resume activity at the fill horizon. Temperature will be determined by lowering a remotely read thermometer to an elevation approximately 3 m above the asphalt at the center of the shaft. The temperature of the asphalt at the center of the shaft will be 50°C in about a month, but active ventilation should permit work to resume in about two weeks (see calculations in Appendix D of *Waste Isolation*

Pilot Plant Shaft Sealing System Compliance Submittal Design Report (“Compliance Submittal Design Report”) (Sandia, 1996)).

When sufficient cooling has occurred, workers will descend in the multi-deck stage and cover the hot asphalt with an insulating and structural material such as fiber-reinforced shotcrete, as illustrated in Figure G2B-3. To accomplish this, they will spray cementitious shotcrete containing fibrillated polypropylene fibers (for added tensional strength), attaining a minimum thickness of approximately 0.6 m.

B4.3.2 Asphaltic Mastic Mix Column

Asphaltic mastic mix (AMM) for the column will be prepared on surface in a pug mill. Viscosity of the AMM can be tailored to provide desired properties such as limited migration into large fractures.

- AMM will be prepared by mixing the ingredients in the pug mill, which has been heated to 180°C ±5°. The mix will be pumped from the pug mill through the tremie line to the emplacement depth. AMM is self-leveling at this temperature, and its hydrostatic head will ensure intimate contact with the shaft walls.

- Pumping rate will be approximately 200 L/min for efficiency, because of the larger volume (approximately 1,224,700 L in the Air Intake Shaft). To facilitate efficient emplacement and avoid air entrainment, the tremie line will not be shortened until the mix has filled 6 vertical meters of the shaft. Back pressure (approximately 0.84 kg/cm^2) resulting from 6 m of AMM above the discharge point will be easily overcome from surface by the hydraulic head.

After 6 vertical meters of AMM have been placed:

- Impedance heating current will be turned off and locked out (the hot line will drain completely).

- To prevent excessive back pressure resulting from AMM above the insertion point, the line will be disconnected from the pump and hoisted hot. Two sections will be stripped, removed, cleaned with a “pig,” and stacked near the shaft.

- Electrical feed will be adjusted (because of the decreased resistance of the shortened line).

- The tremie line will be reconnected to the pump.

- The impedance heating system will be energized.

- When the temperature of the line has stabilized at 180ºC ±5º, pumping will resume.

This procedure will be followed until the entire column, including the volume computed to counteract 0.9 m of vertical shrinkage (calculations in Appendix D of the Compliance Submittal Design Report (Sandia, 1996)), has been placed. The line will be disconnected from the pump and cleaned by pumping “pigs” through it with air pressure. It will then be hoisted, stripped, removed in 3-m sections, and stacked on surface for reuse.

Sealing operations will be suspended following removal of the tremie line, and ventilation will be continuous to speed cooling. The column will shrink vertically but maintain contact with the shaft walls as it cools. When the air temperature at 3 m above the asphalt has cooled sufficiently, workers will descend on the multi-deck stage and cover the hot asphalt with fibercrete as described for the concrete-asphalt waterstop (Permit Attachment G2, Appendix B, Section B4.3.1) and illustrated in Figure G2B-3.

Note: Near the top of the Salado Formation, portions of the concrete liner key, chemical seal rings, and concrete and steel shaft liners will be removed. Liner removal will occur before emplacement of AMM. For safety, exposed rock will be secured with horizontal, radial rock bolts and cyclone steel mesh. A range-finding device, fastened to the shaft wall approximately 3 m above the proposed top of the asphaltic column, will indicate when the hot AMM reaches the desired elevation. A remotely read thermometer, affixed to the shaft wall approximately 2 m above the proposed top of the column, will show when the air temperature has fallen sufficiently to resume operations. The intake of the rigid ventilation duct will be positioned approximately 3 m above the proposed top of the column, and ventilation will be continuous throughout emplacement and cooling of the asphaltic column. After the multi-deck stage has been hoisted into the headframe and mechanically secured for safety, emplacement of AMM will proceed.

B4.4 Compacted Salt Column

Crushed, mine-run salt, dynamically compacted against intact Salado salt, is the major long-term shaft seal element. As-mined WIPP salt will be crushed and screened to a maximum particle dimension of 5 mm. The salt will be transferred from surface to the fill elevation via the slickline and header. A flexible hose attached to the header will be used to emplace the salt, and a calculated weight of water will be added. After the salt has been nominally leveled, it will be dynamically compacted. Dynamic compaction consists of compacting material by dropping a tamper on it and delivering a specified amount of energy. The application of three times Modified Procter Energy (MPE) to each lift (one MPE equals 2,700,000 Joules/m^3) will result in compacting the salt to 90% of the density of in-place rock salt.

Approximately 170 vertical meters of salt will be dynamically compacted. Dynamic compaction was validated in a large-scale demonstration at Sandia National Laboratories during 1995. As-mined WIPP salt was dynamically compacted to 90% density of in-place rock salt in a cylindrical steel chamber simulating the Salt Handling Shaft (Ahrens and Hansen, 1995). Depth of compaction is greater than that achieved by most other methods, allowing the emplacement of thicker lifts. For example, dropping the 4.69 metric ton tamper 18 m (as specified below) results in a compaction depth of approximately 4.6 m, allowing emplacement of lifts 1.5-m high. Most other compaction methods are limited to lifts of 0.3 m or less. Lift thickness will be increased and drop height decreased for the initial lift above the concrete plug at the base of the salt column to ensure that the concrete is not damaged. Drop height for the second and third lifts will be decreased as well. Although the tamper impact is thereby reduced, three MPE will be delivered to the entire salt column.

If lifts are 1.5-m thick, the third lift below the surface will receive additional densification during compaction of overlying lifts, and this phenomenon will proceed up the shaft. Construction will begin by hoisting the multi-deck stage to the surface and attaching the cable, electromagnet, and tamper to the hoist on the polar crane. The multi-deck assembly will be lowered to the placement elevation, and moisture content of the crushed and screened salt will be calibrated. Then the salt will be conveyed at a measured rate via a weighbelt conveyor to a vibratorequipped hopper overlying the 15.2-cm ID slickline. The salt will pass down the slickline and exit a flexible hose connected to the header. A worker will direct the discharge so that the upper surface of the lift is nominally level and suitable for dynamic compaction. A second worker will add potable water, in the form of a fine spray, to the salt as it exits the hose. Water volume will be electronically controlled and coordinated with the weight of the salt to achieve the desired moisture content.

The initial lift above the SMC will be 4.6 m, and drop height will be 6 m. This increased lift thickness and reduced drop height are specified to protect the underlying SMC plug from damage and/or displacement from tamper impact. Compaction depth for a drop height of 6 m is approximately 3.7 m. Ultimately, the tamper will be dropped six times in each position, resulting in a total of 132 drops per lift in the larger shafts. The drop pattern is shown in Figure G2B-4. A salt lift 1.5 m high will then be placed and leveled. Following compaction of the initial lift, the multi-deck stage will be positioned so the base of the hoisted tamper is 10 m above the surface of the salt.

The multi-deck stage will then be secured to the shaft walls by activating hydraulically powered locking devices. Hydraulic pressure will be maintained on these units when they are in the locked position; in addition, a mechanical pawl and ratchet on each pair will prevent loosening. The safety factor for the locking devices has been calculated to be approximately 4.5. After locking, tension in the hoisting cables will be relaxed, and centering rams will be activated to level the decks. Prior to positioning the stage, tension will be applied to the hoisting cables; the centering rams will be retracted; and the locking devices will be disengaged.

The work deck will be hoisted until the base of the retracted tamper is 23 m above the surface of the salt, where it will be locked into position and leveled as described above. This procedure, repeated throughout the salt column, allows emplacement and compaction of three lifts (1.5-m thick) per multi-deck stage move. Depth of compaction for a drop height of 18 m is approximately 4.6 m. Therefore the third lift below the fill surface will receive a total of 9 MPE (274,560 m kg/m^3), matching the energy applied in the successful, large-scale demonstration.

The compactive effect expands laterally as it proceeds downward from the base of the tamper and will effectively compact the salt into irregularities in the shaft wall, as demonstrated in the large-scale demonstration. Although other techniques could be used, dynamic compaction was selected because it is simple, can be used in the WIPP shafts, and has been demonstrated (Hansen and Ahrens, 1996).

The tamper will be dropped from the hoisted position by turning off the power to the electromagnet. Immediately upon release, the crane operator will “chase” the tamper by lowering the electromagnet at twice hoisting speed; the magnet will engage the tamper, allowing it to be hoisted for the subsequent drop. Initially, the tamper will be dropped in positions that avoid impact craters caused by preceding drops. The surface will then be leveled manually and the tamper dropped in positions omitted during the previous drop series.

Experience gained during the large-scale salt compaction demonstration indicated that a considerable volume of dust is generated during the emplacement of the salt, but not during dynamic compaction. However, because the intake of the rigid vent duct is below the multi-deck stage, workers below the stage will wear respirators during emplacement. They will be the only workers affected by dust during dynamic compaction.

The Air Intake Shaft will require 22 drop positions (Figure G2B-4). Application of one MPE requires six drops in each position, for a total of 132 drops per lift. Three MPE, a total of 396 drops per lift, will be applied to all salt. After each compaction cycle, the salt surface will be leveled manually and the tamper will be dropped in positions omitted in the preceding drop series. Two lifts, each 1.8 m high, will then be sequentially placed, leveled, and compacted with two MPE, using a 6-m drop height.

Dynamic compaction ensures a tight interface. Salt compacted during the large-scale dynamic compaction demonstration adhered so tenaciously to the smooth interior walls of the steel compaction chamber that grinders with stiff wire wheels were required for its removal.

B4.5 Grout

Ultrafine sulfate-resistant cementitious grout (Ahrens et al., 1996) is selected as the sealing material. Specifically developed for use at the WIPP, and successfully demonstrated in an in situ test, the hardened grout has a permeability of 1×10^{-21} m^2. It has the ability to penetrate fractures smaller than 6 microns and is being used for the following purposes:

- to seal many of the microfractures in the DRZ and ensure a tight interface between SMC and the enclosing rock, and
- to solidify fractured rock behind existing concrete shaft liners, prior to removal of the liner (for worker safety).

The interface between concrete plugs in the Salado Formation (and one in the Rustler Formation, a short distance above the Salado) will be grouted. A 45º downward-opening cone of reverse circulation diamond drill holes will be collared in the top of the plugs, drilled in a spin pattern (see Figure G2B-5), and stage grouted with ultrafine cementitious grout at 3.5 kg/cm^2 below lithostatic pressure. Stage grouting consists of:

- drilling and grouting primary holes, one at a time;
- drilling and grouting secondary holes, one at a time, on either side of the primary holes that accepted grout; and
- (if necessary) drilling and grouting tertiary holes on either side of secondary holes that accepted grout.

Note: For safety, all liner removal tasks will be accomplished from the bottom deck. In areas where the steel liner is removed, it will be cut into manageable pieces with a cutting torch and hoisted to the surface for disposal. Mechanical methods will be employed to clean and roughen the existing concrete shaft liner before placing the Dewey Lake SMC plug in the shafts.

The work sequence will start 3 m below the lower elevation of liner removal. A 45° upward-opening cone of grout injection holes, drilled in a “spin” pattern (Figure G2B-6), will be drilled to a depth subtending one shaft radius on a horizontal plane. These holes will be stage grouted as described in Section 4.5. Noncoring, reverse circulation, diamond drill equipment will be used to avoid plugging fractures with fine-grained diamond drill cuttings. Ultrafine cementitious grout will be mixed on the surface, transferred via the slickline to the upper deck of the multi-deck stage, and injected at 3.5 kg/cm^2 gage below lithostatic pressure to avoid hydrofracturing the rock.

Grout will be transferred in batches, and after each transfer, a “pig” will be pumped through the slickline and header to clean them. Grouting will proceed upward from the lowest fan to the highest. Recent studies conducted in the Air Intake Shaft (Dale and Hurtado, 1996) show that this hole depth exceeds that required for complete penetration of the Disturbed Rock Zone (DRZ). Maximum horizontal spacing at the ends of the holes will be 3 m.

The multi-deck stage will then be raised 3 m and a second fan, identical to the first, will be drilled and grouted. This procedure will continue, with grout fans 3 m apart vertically, until the highest fan, located 3 m above the highest point of liner removal, has been drilled and grouted. Ultrafine cementitious grout was observed to penetrate more than 2 m in the underground grouting experiment conducted at the WIPP in Room L-3 (Ahrens and Onofrei, 1996).

When grouting is completed, the multi-deck stage will be lowered to the bottom of the liner removal section and a hole will be made through the concrete liner. This hole, approximately 30 cm in diameter, will serve as “free-face” to which the liner will be broken. Similar establishment and utilization of free face is a common practice in hard rock mining (e.g., the central drill hole in a series drilled into the rock to be blasted is left empty and used as free-face to which explosives in adjacent holes break the rock). Radial, horizontal percussion holes will be drilled on a 30-cm grid (or less, if required), covering the liner to be removed. Hydraulic wedges, activated in these holes, will then break out the liner, starting adjacent to the free face and progressing away from it, from the bottom up. Broken fragments of the concrete liner will fall to the fill surface below.

A mucking “claw,” suspended from the trolley of the polar crane, will collect the broken concrete and place it in the bucket for removal to the surface. As many as three buckets can be used to speed this work.

B4.6 Compacted Earthen Fill

Local soil, screened to a maximum particle dimension of 13 mm, will be placed and compacted to inhibit the migration of surficial water into the shaft cross section. Such movement is further decreased by a 12-m high SMC plug at the top of the Dewey Lake Redbeds.

B4.6.1 Lower Section

Emplacement of the compacted earthen fill will proceed as follows:

- Moisture content of the screened soil will be determined.

- The soil will then be transferred via the slickline, header, and flexible hose from surface to the fill elevation. The moisture content optimal for compaction will be achieved using the same procedure as described for compacted salt (Permit Attachment G2, Appendix B, Section B4.4). The soil will be emplaced in lifts 1.2 m high (depth of compaction is approximately 3.7 m) and dynamically compacted using a drop height of 18.3 m.

- The fill will be dynamically compacted until its hydraulic conductivity to water is nominally equivalent to that of the surrounding formation.

This procedure will continue until the lower section has been emplaced and compacted. Care will be exercised at the top of the column to ensure that all soil receives sufficient compaction.

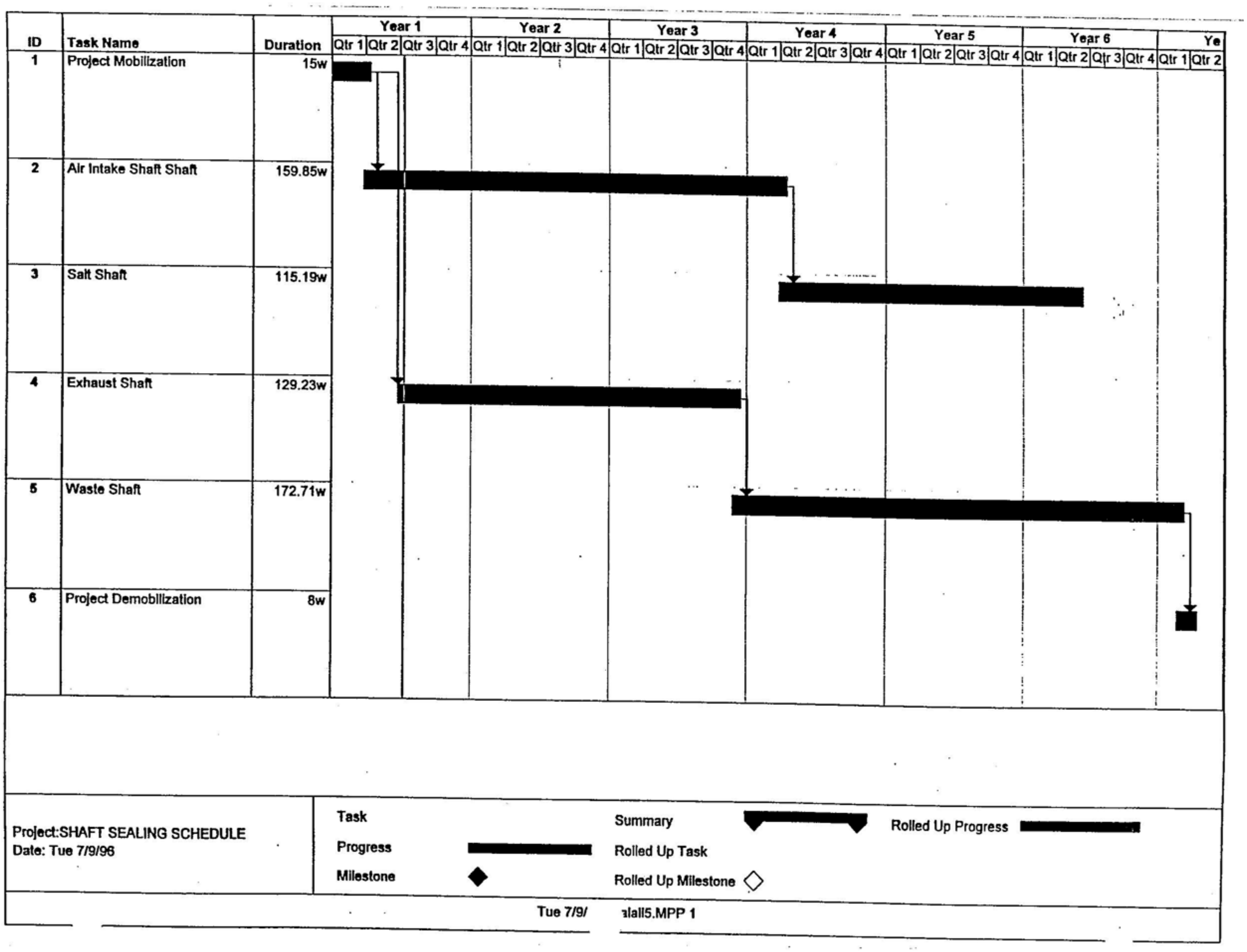
B4.6.2 Upper Section

The upper section contains insufficient room to employ dynamic compaction. Therefore the screened soil, emplaced as described above, will be compacted by vibratory-impact sheepsfoot roller, vibratory sheepsfoot roller, or a walk-behind vibratory-plate compactor. Because of the limited compaction depth of this equipment, lifts will be 0.3 m high. The top of the fill will be coordinated with the MOC to accommodate plans for decommissioning surface facilities and placing markers.

B4.7 Schedule

Preliminary construction schedules are included on the following pages. The first schedule is a concise outline of the total construction schedule. It is followed by individual schedules for each shaft. The first schedule in each shaft series is a truncated schedule showing the major milestones. The truncated schedules are followed by detailed construction schedules for each shaft. These schedules indicate that it will take approximately six and a half years to complete the shaft sealing operations, assuming two shafts are simultaneously sealed.

SEALING SCHEDULE - ALL SHAFTS



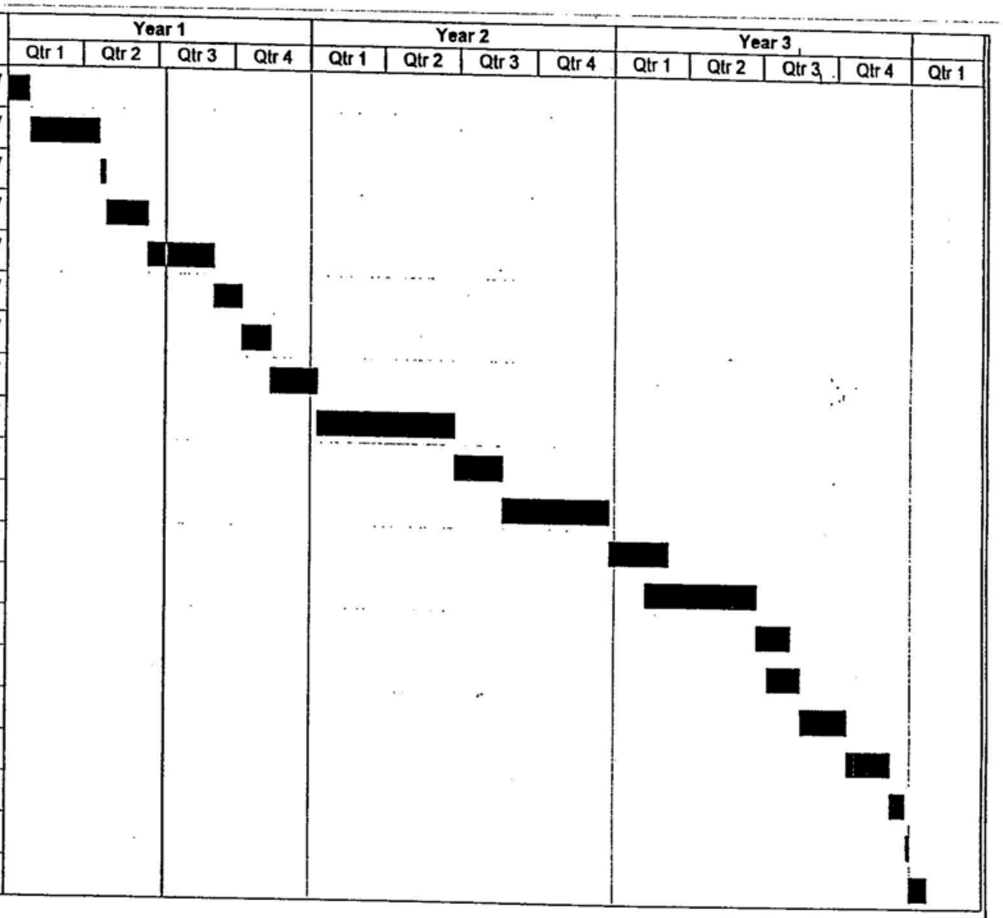
ID	Task Name	Duration
1	Project Mobilization	15w
2	Air Intake Shaft Shaft	159.85w
3	Salt Shaft	115.19w
4	Exhaust Shaft	129.23w
5	Waste Shaft	172.71w
6	Project Demobilization	8w

Project:SHAFT SEALING SCHEDULE
Date: Tue 7/9/96

Tue 7/9/ alall5.MPP 1

SEALING SCHEDULE - AIR INTAKE SHAFT

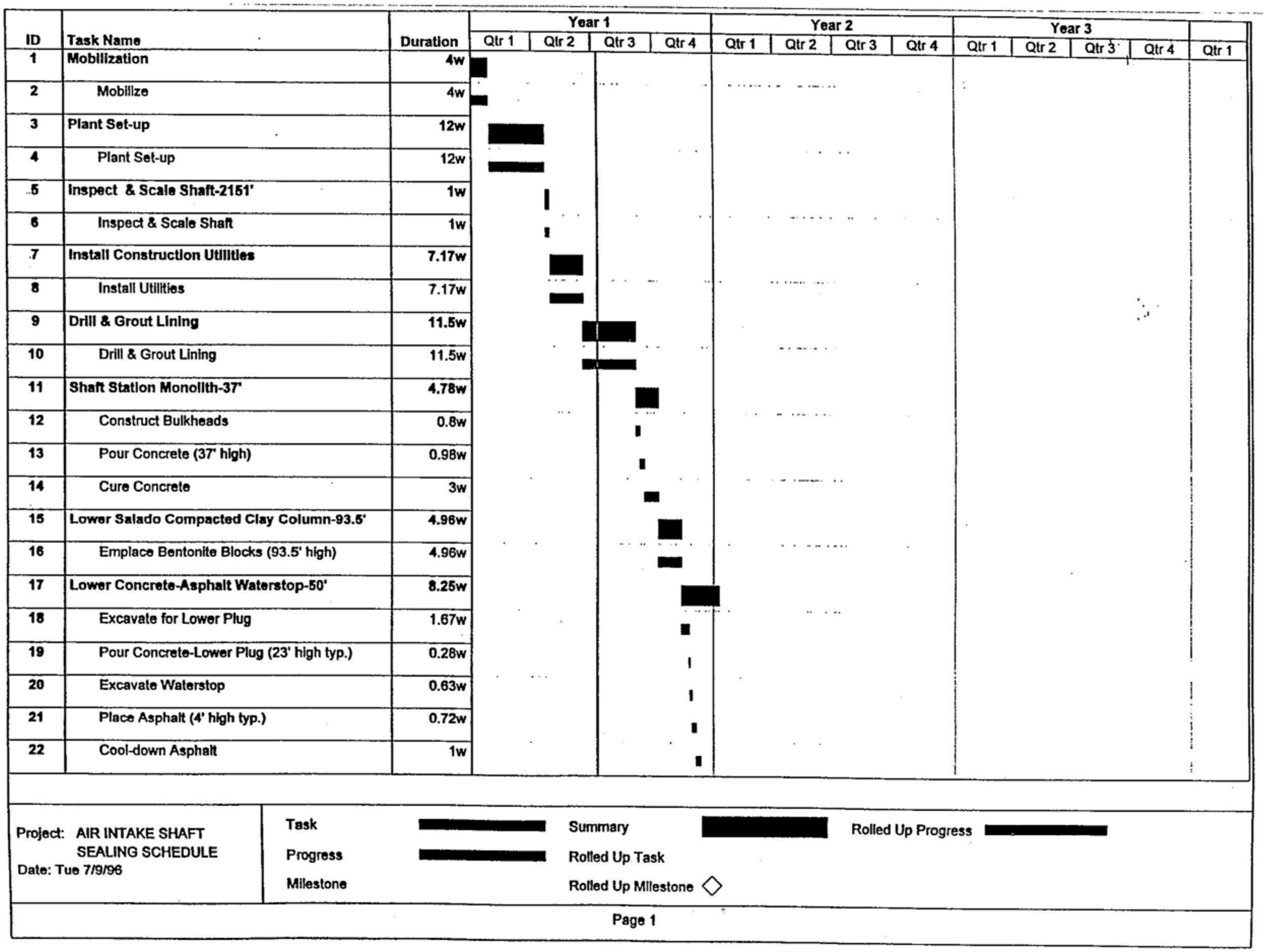
ID	Task Name	Duration
1	Mobilization	4w
3	Plant Set-up	12w
5	Inspect & Scale Shaft-2151'	1w
7	Install Construction Utilities	7.17w
9	Drill & Grout Lining	11.5w
11	Shaft Station Monolith-37'	4.78w
15	Lower Salado Compacted Clay Column-93.5'	4.96w
17	Lower Concrete-Asphalt Waterstop-50'	8.25w
26	Compacted Salt Column-563.5'	23.58w
28	Middle Concrete-Asphalt Waterstop-50'	8.25w
37	Upper Salado Compacted Clay Column-344'	18.24w
39	Upper Concrete-Asphalt Waterstop-50'	10.25w
48	Asphalt Column-138.3'	19.41w
56	Concrete Plug-20'	5.99w
61	Remove Concrete Shaft Lining	5.71w
63	Rustler Compacted Clay Column-234.7'	8.36w
65	Compacted Earthen Fill-473'	7.59w
67	Concrete Plug-40'	2.98w
71	Compacted Earthen Fill-57'	0.65w
73	Demobilization	3.2w



Project: AIR INTAKE SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

Task	▬	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task			
Milestone		Rolled Up Milestone	◇		

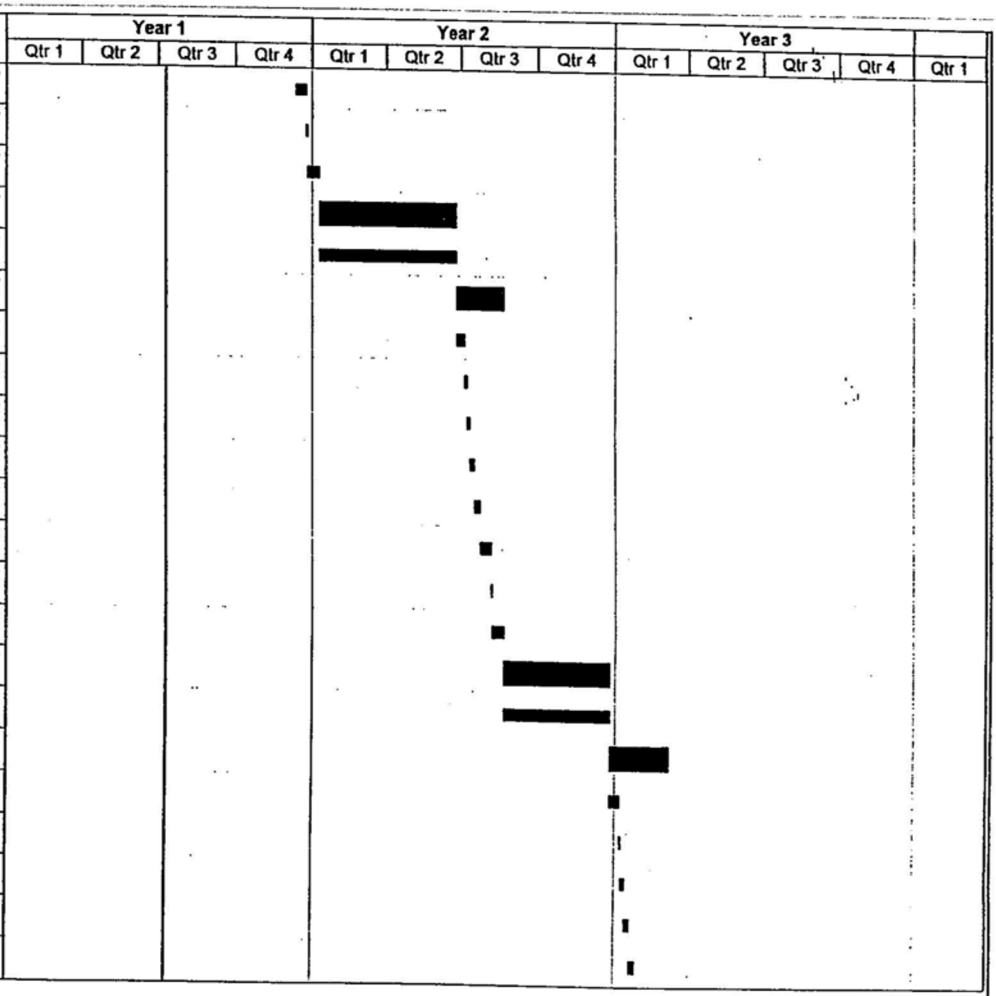
ge 1



ID	Task Name	Duration
1	**Mobilization**	**4w**
2	Mobilize	4w
3	**Plant Set-up**	**12w**
4	Plant Set-up	12w
5	**Inspect & Scale Shaft-2151'**	**1w**
6	Inspect & Scale Shaft	1w
7	**Install Construction Utilities**	**7.17w**
8	Install Utilities	7.17w
9	**Drill & Grout Lining**	**11.5w**
10	Drill & Grout Lining	11.5w
11	**Shaft Station Monolith-37'**	**4.78w**
12	Construct Bulkheads	0.8w
13	Pour Concrete (37' high)	0.98w
14	Cure Concrete	3w
15	**Lower Salado Compacted Clay Column-93.5'**	**4.96w**
16	Emplace Bentonite Blocks (93.5' high)	4.96w
17	**Lower Concrete-Asphalt Waterstop-50'**	**8.25w**
18	Excavate for Lower Plug	1.67w
19	Pour Concrete-Lower Plug (23' high typ.)	0.28w
20	Excavate Waterstop	0.63w
21	Place Asphalt (4' high typ.)	0.72w
22	Cool-down Asphalt	1w

Project: AIR INTAKE SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

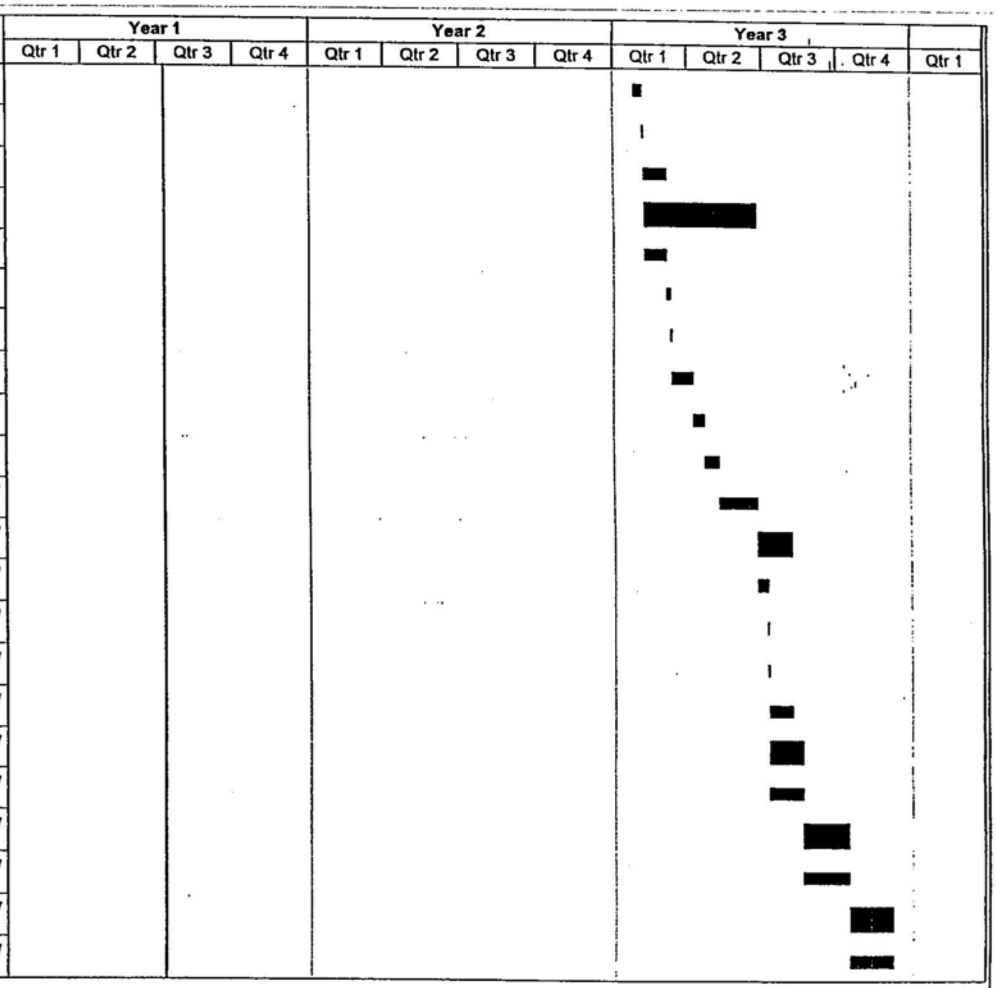
ID	Task Name	Duration
23	Excavate for Upper Plug	1.67w
24	Pour Concrete-Upper Plug (23' high typ.)	0.28w
25	Cure Concrete	2w
26	**Compacted Salt Column-563.5'**	**23.58w**
27	Emplace & Compact Crushed/Screened Salt	23.58w
28	**Middle Concrete-Asphalt Waterstop-50'**	**8.25w**
29	Excavate for Lower Plug	1.67w
30	Pour Concrete-Lower Plug	0.28w
31	Excavate Waterstop	0.63w
32	Place Asphalt	0.72w
33	Cool-down Asphalt	1w
34	Excavate for Upper Plug	1.67w
35	Pour Concrete-Upper Plug	0.28w
36	Cure Concrete	2w
37	**Upper Salado Compacted Clay Column-344'**	**18.24w**
38	Emplace Bentonite Blocks	18.24w
39	**Upper Concrete-Asphalt Waterstop-50'**	**10.25w**
40	Excavate for Lower Plug	1.67w
41	Pour Concrete-Lower Plug	0.28w
42	Excavate Waterstop	0.63w
43	Place Asphalt	0.72w
44	Cool-down Asphalt	1w



Project: AIR INTAKE SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

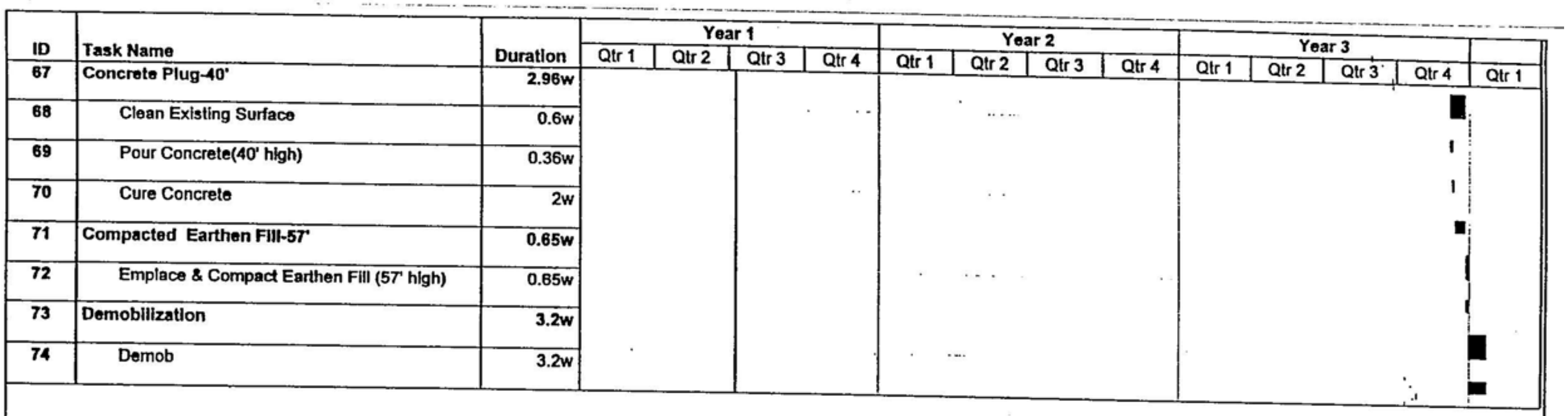
Task	▬	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task			
Milestone		Rolled Up Milestone	◇		

ID	Task Name	Duration
45	Excavate for Upper Plug	1.67w
46	Pour Concrete-Upper Plug	0.28w
47	Cure Concrete	4w
48	**Asphalt Column-138.3'**	**19.41w**
49	Remove Lining in Key	3.76w
50	Remove Chemical Seal Rings	0.6w
51	Mobilize to Emplace Asphalt	0.3w
52	Asphalt in Salt Section	3.62w
53	Asphalt in Lower Lined Section	1.93w
54	Complete Asphalt Emplacement	2.77w
55	Cool-down Asphalt	6.43w
56	**Concrete Plug-20'**	**5.99w**
57	Remove Concrete Lining & Rock	1.65w
58	Remove Liner Plate	0.13w
59	Pour Concrete(20' high)	0.21w
60	Cure Concrete	4w
61	**Remove Concrete Shaft Lining**	**5.71w**
62	Remove 86' of lining--4 zones	5.71w
63	**Rustler Compacted Clay Column-234.7'**	**8.36w**
64	Emplace & Compact Bentonite(234.7' high)	8.36w
65	**Compacted Earthen Fill-473'**	**7.59w**
66	Emplace & Compact Earthen Fill(473' high)	7.59w



Project: AIR INTAKE SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

Task ▬
Progress ▬
Milestone
Summary ▬
Rolled Up Task
Rolled Up Milestone ◇
Rolled Up Progress ▬



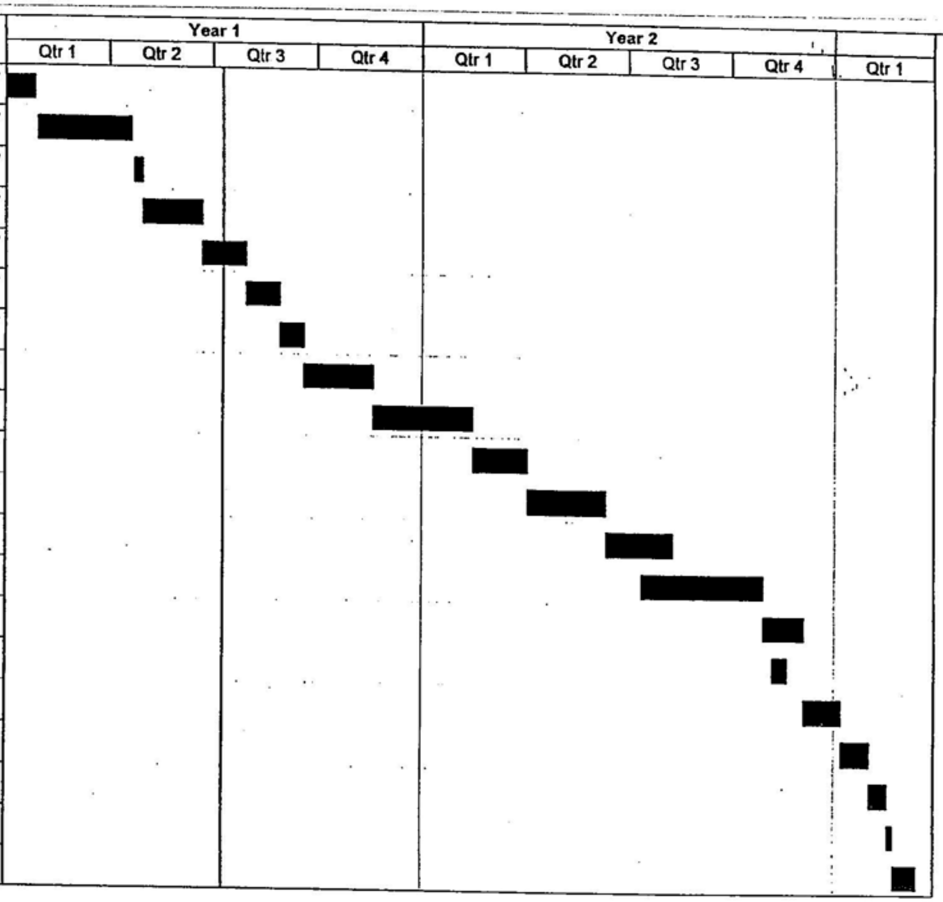
ID	Task Name	Duration
67	**Concrete Plug-40'**	**2.96w**
68	Clean Existing Surface	0.6w
69	Pour Concrete(40' high)	0.36w
70	Cure Concrete	2w
71	**Compacted Earthen Fill-57'**	**0.65w**
72	Emplace & Compact Earthen Fill (57' high)	0.65w
73	**Demobilization**	**3.2w**
74	Demob	3.2w

Project: AIR INTAKE SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

Task	▬	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task			
Milestone		Rolled Up Milestone	◇		

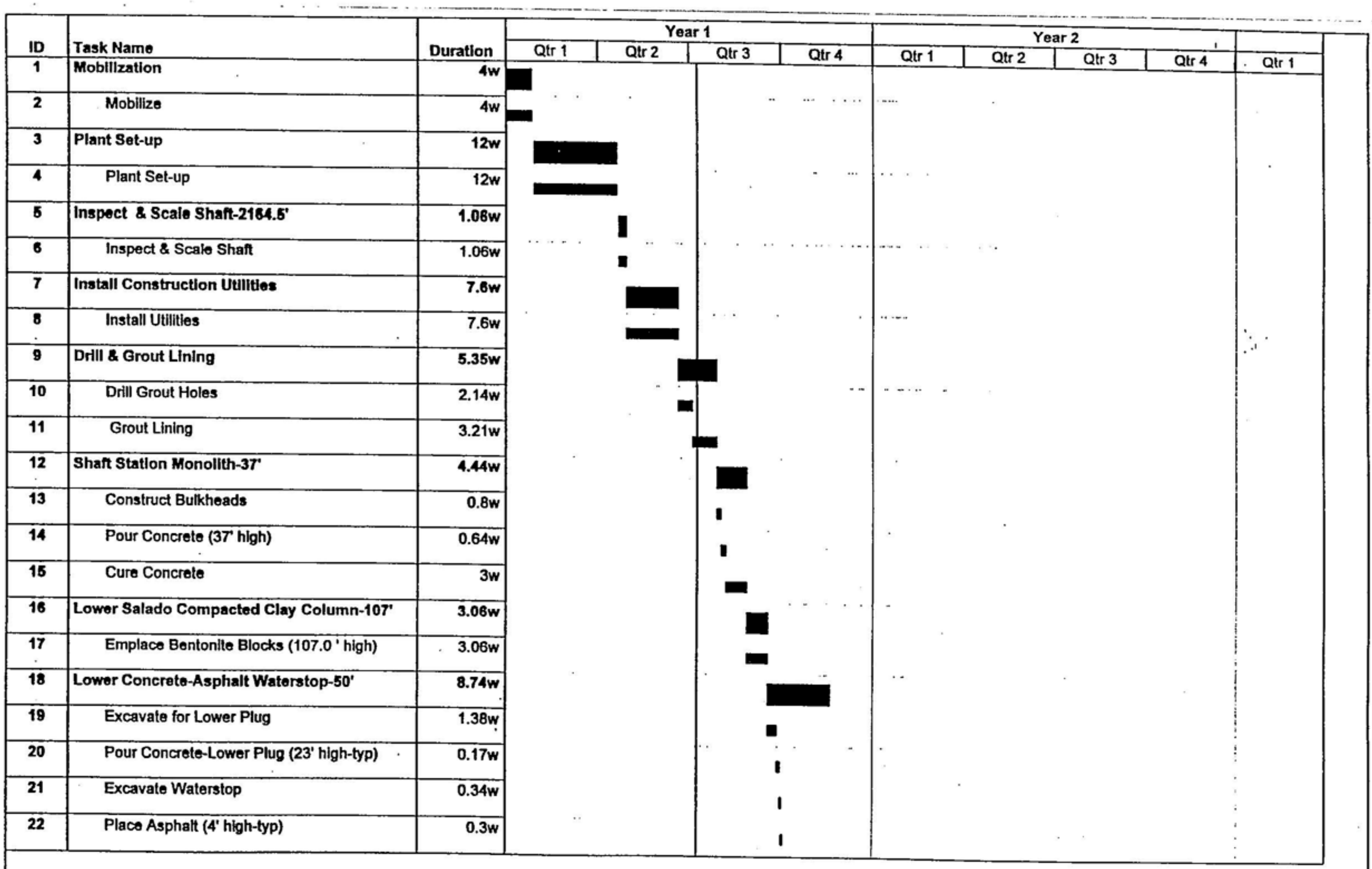
SEALING SCHEDULE - SALT HANDLING SHAFT

ID	Task Name	Duration
1	Mobilization	4w
3	Plant Set-up	12w
5	Inspect & Scale Shaft-2164.5'	1.06w
7	Install Construction Utilities	7.6w
9	Drill & Grout Lining	5.35w
12	Shaft Station Monolith-37'	4.44w
16	Lower Salado Compacted Clay Column-107'	3.06w
18	Lower Concrete-Asphalt Waterstop-50'	8.74w
27	Compacted Salt Column-560'	12.67w
29	Middle Concrete-Asphalt Waterstop-50'	6.74w
38	Upper Salado Compacted Clay Column-335'	9.58w
40	Upper Concrete-Asphalt Waterstop-50'	8.74w
49	Asphalt Column-140'	15.33w
57	Concrete Plug-20'	5.32w
61	Remove Concrete Shaft Lining	1.9w
63	Rustler Compacted Clay Column-234'	4.81w
65	Compacted Earthen Fill-449'	3.65w
67	Concrete Plug-40'	2.45w
71	Compacted Earthen Fill-92.5'	0.65w
73	Demobilization	3w



Project: SALT HANDLING SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

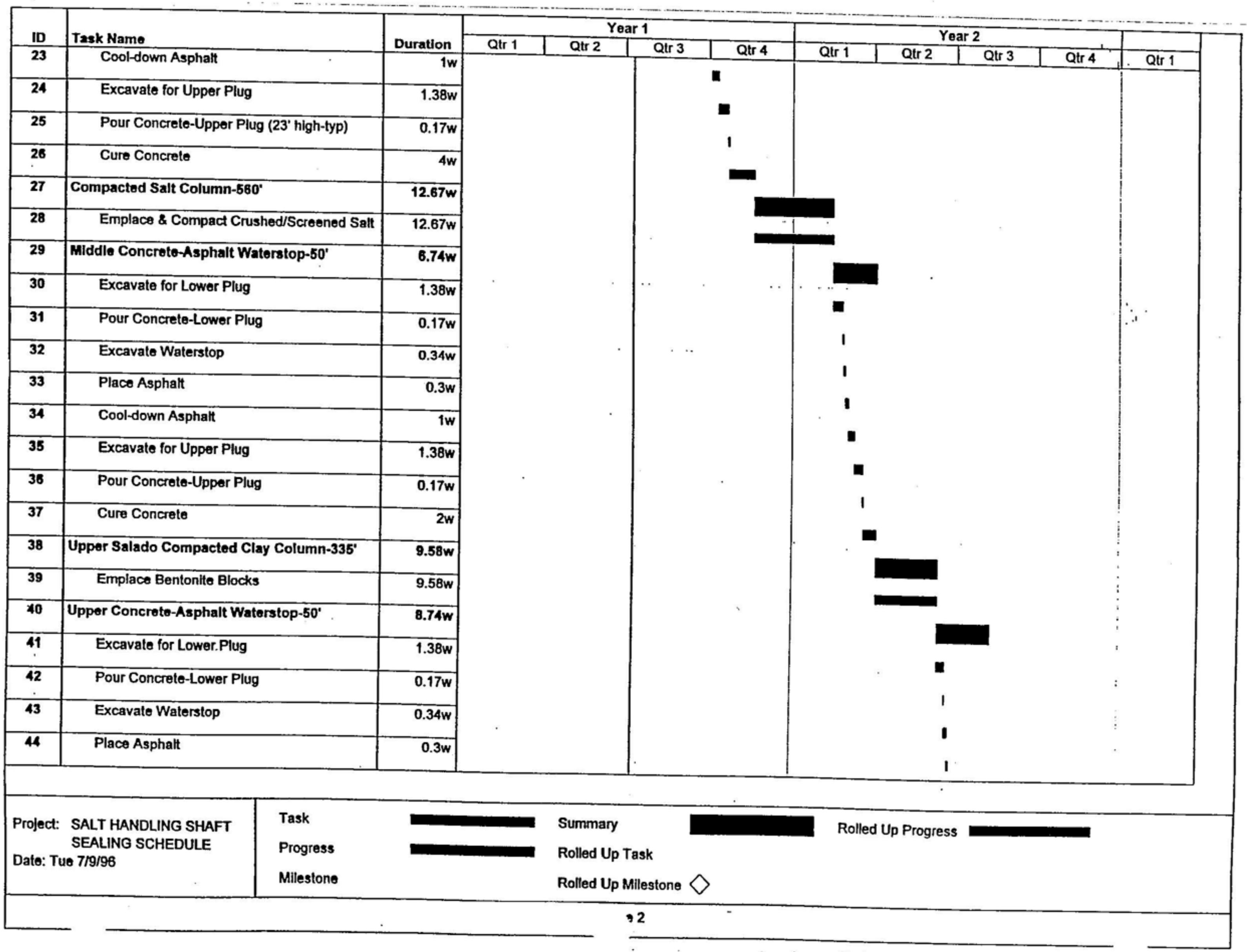
Task	▬	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task			
Milestone		Rolled Up Milestone	◇		



ID	Task Name	Duration
1	**Mobilization**	**4w**
2	Mobilize	4w
3	**Plant Set-up**	**12w**
4	Plant Set-up	12w
5	**Inspect & Scale Shaft-2164.5'**	**1.06w**
6	Inspect & Scale Shaft	1.06w
7	**Install Construction Utilities**	**7.6w**
8	Install Utilities	7.6w
9	**Drill & Grout Lining**	**5.35w**
10	Drill Grout Holes	2.14w
11	Grout Lining	3.21w
12	**Shaft Station Monolith-37'**	**4.44w**
13	Construct Bulkheads	0.8w
14	Pour Concrete (37' high)	0.64w
15	Cure Concrete	3w
16	**Lower Salado Compacted Clay Column-107'**	**3.06w**
17	Emplace Bentonite Blocks (107.0 ' high)	3.06w
18	**Lower Concrete-Asphalt Waterstop-50'**	**8.74w**
19	Excavate for Lower Plug	1.38w
20	Pour Concrete-Lower Plug (23' high-typ)	0.17w
21	Excavate Waterstop	0.34w
22	Place Asphalt (4' high-typ)	0.3w

Project: SALT HANDLING SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

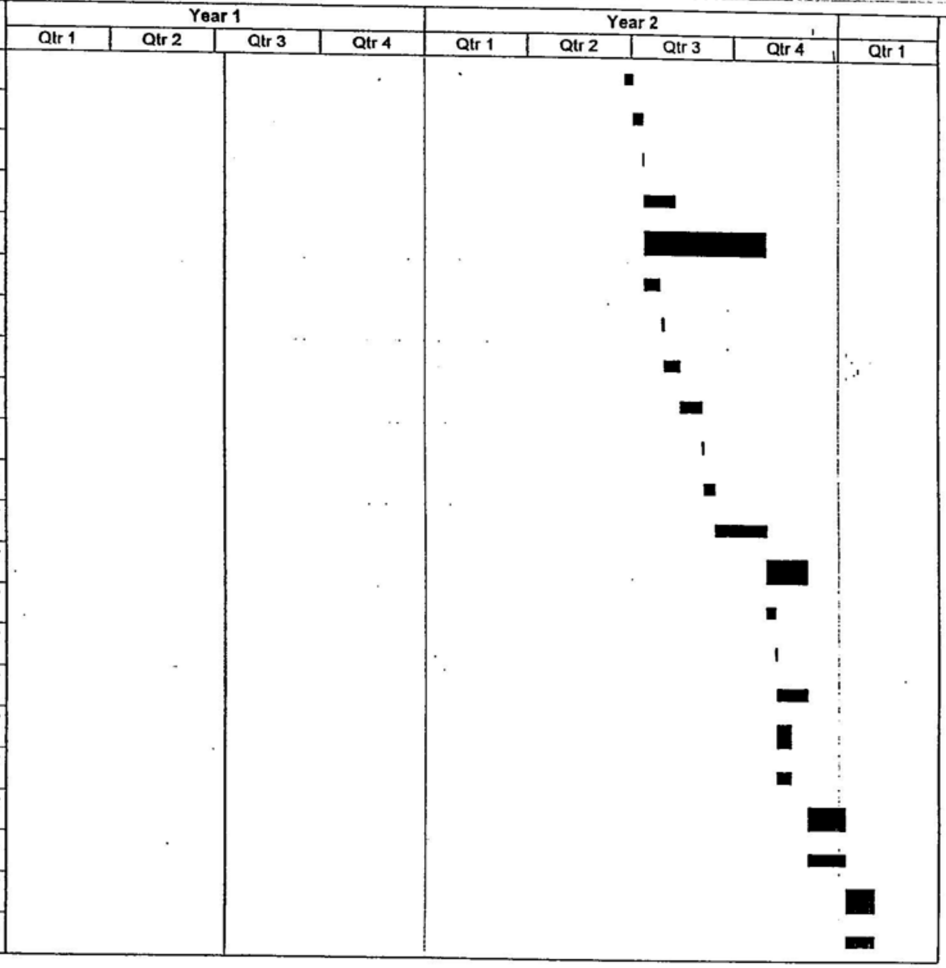
Task	▬	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task			
Milestone		Rolled Up Milestone	◇		



ID	Task Name	Duration
23	Cool-down Asphalt	1w
24	Excavate for Upper Plug	1.38w
25	Pour Concrete-Upper Plug (23' high-typ)	0.17w
26	Cure Concrete	4w
27	**Compacted Salt Column-560'**	**12.67w**
28	Emplace & Compact Crushed/Screened Salt	12.67w
29	**Middle Concrete-Asphalt Waterstop-50'**	**6.74w**
30	Excavate for Lower Plug	1.38w
31	Pour Concrete-Lower Plug	0.17w
32	Excavate Waterstop	0.34w
33	Place Asphalt	0.3w
34	Cool-down Asphalt	1w
35	Excavate for Upper Plug	1.38w
36	Pour Concrete-Upper Plug	0.17w
37	Cure Concrete	2w
38	**Upper Salado Compacted Clay Column-335'**	**9.58w**
39	Emplace Bentonite Blocks	9.58w
40	**Upper Concrete-Asphalt Waterstop-50'**	**8.74w**
41	Excavate for Lower Plug	1.38w
42	Pour Concrete-Lower Plug	0.17w
43	Excavate Waterstop	0.34w
44	Place Asphalt	0.3w

Project: SALT HANDLING SHAFT SEALING SCHEDULE
Date: Tue 7/9/96

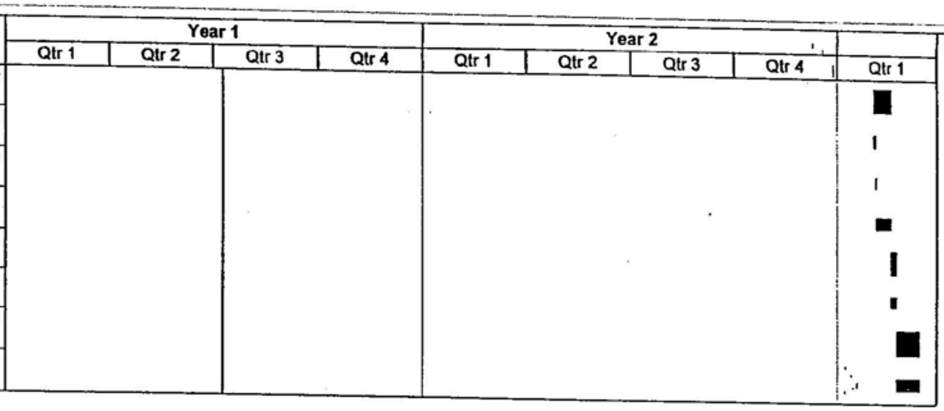
ID	Task Name	Duration
45	Cool-down Asphalt	1w
46	Excavate for Upper Plug	1.38w
47	Pour Concrete-Upper Plug	0.17w
48	Cure Concrete	4w
49	**Asphalt Column-140'**	**15.33w**
50	Remove Lining in Key	2.02w
51	Remove Chemical Seal Rings	0.4w
52	Mobilize to emplace asphalt	2w
53	Asphalt in Salt Section	2.73w
54	Asphalt in Lower Lined Section	0.25w
55	Complete Asphalt Emplacement	1.5w
56	Cool-down Asphalt	6.43w
57	**Concrete Plug-20'**	**5.32w**
58	Remove Concrete Lining & Rock	1.11w
59	Pour Concrete (20' high)	0.21w
60	Cure Concrete	4w
61	**Remove Concrete Shaft Lining**	**1.9w**
62	Remove 72' of lining--4 zones	1.9w
63	**Rustler Compacted Clay Column-234'**	**4.81w**
64	Emplace & Compact Bentonite (234' high)	4.81w
65	**Compacted Earthen Fill-449'**	**3.65w**
66	Emplace & Compact Earthen Fill (449' high)	3.65w



Project: SALT HANDLING SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

Task	■	Summary	■	Rolled Up Progress	■
Progress	■	Rolled Up Task			
Milestone		Rolled Up Milestone	◇		

ID	Task Name	Duration
67	**Concrete Plug-40'**	**2.45w**
68	Clean Existing Surface	0.34w
69	Pour Concrete	0.11w
70	Cure Concrete	2w
71	**Compacted Earthen Fill-92.5'**	**0.65w**
72	Emplace & Compact Earthen Fill (92.5'high)	0.65w
73	**Demobilization**	**3w**
74	Demob	3w

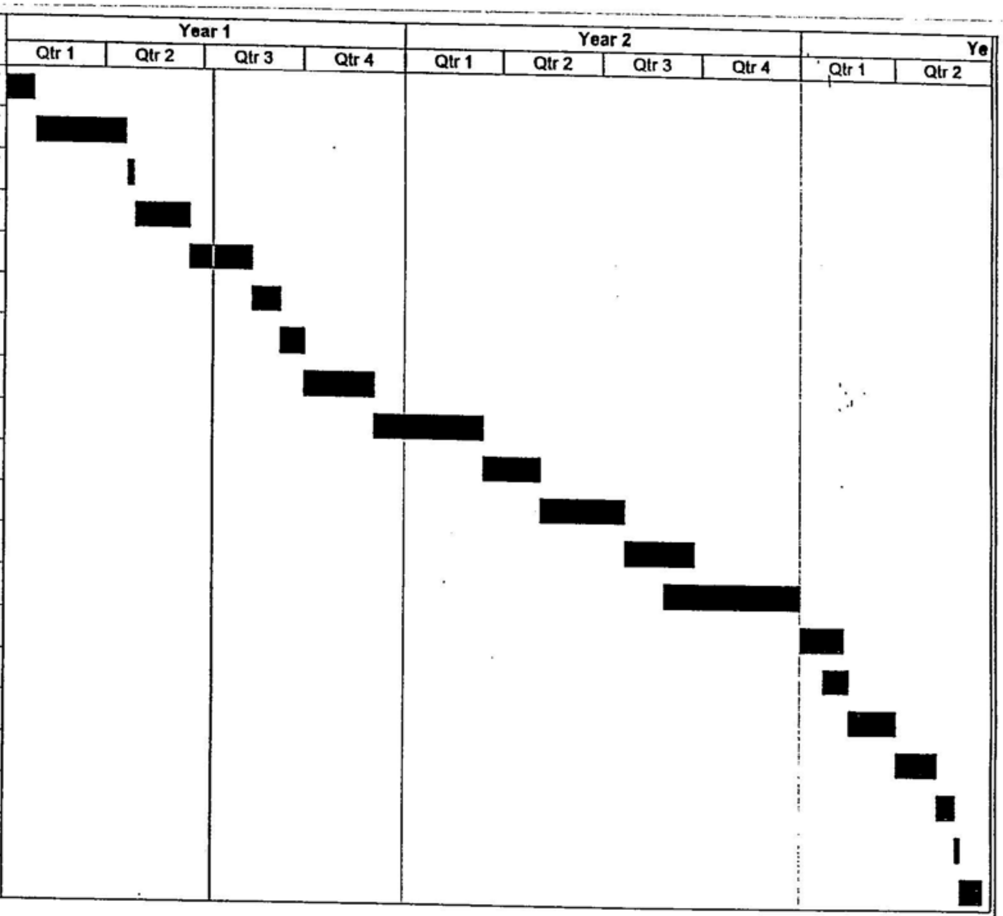


Project: SALT HANDLING SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

Task	▬	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task			
Milestone		Rolled Up Milestone ◇			

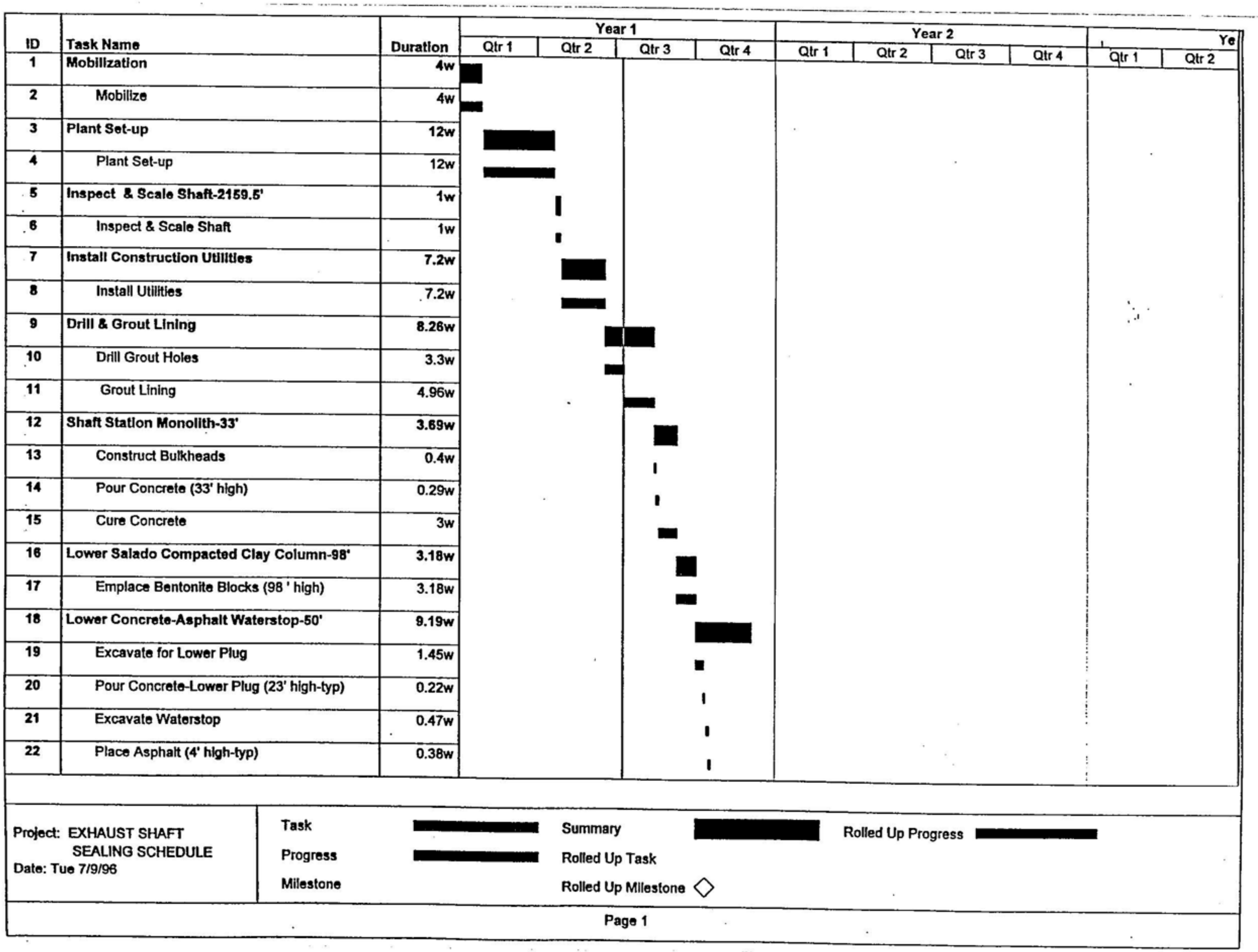
SEALING SCHEDULE - EXHAUST SHAFT

ID	Task Name	Duration
1	Mobilization	4w
3	Plant Set-up	12w
5	Inspect & Scale Shaft-2159.5'	1w
7	Install Construction Utilities	7.2w
9	Drill & Grout Lining	8.26w
12	Shaft Station Monolith-33'	3.69w
16	Lower Salado Compacted Clay Column-98'	3.18w
18	Lower Concrete-Asphalt Waterstop-50'	9.19w
27	Compacted Salt Column-559'	14.37w
29	Middle Concrete-Asphalt Waterstop-50'	7.19w
38	Upper Salado Compacted Clay Column-340'	11.01w
40	Upper Concrete-Asphalt Waterstop-50'	9.19w
49	Asphalt Column-142.5'	18.43w
57	Concrete Plug-20'	5.87w
61	Remove Concrete Shaft Lining	3.23w
63	Rustler Compacted Clay Column-234.5'	6.62w
65	Compacted Earthen Fill-486.4'	5.44w
67	Concrete Plug-40'	2.69w
71	Compacted Earthen Fill-56.1'	0.44w
73	Demobilization	3w



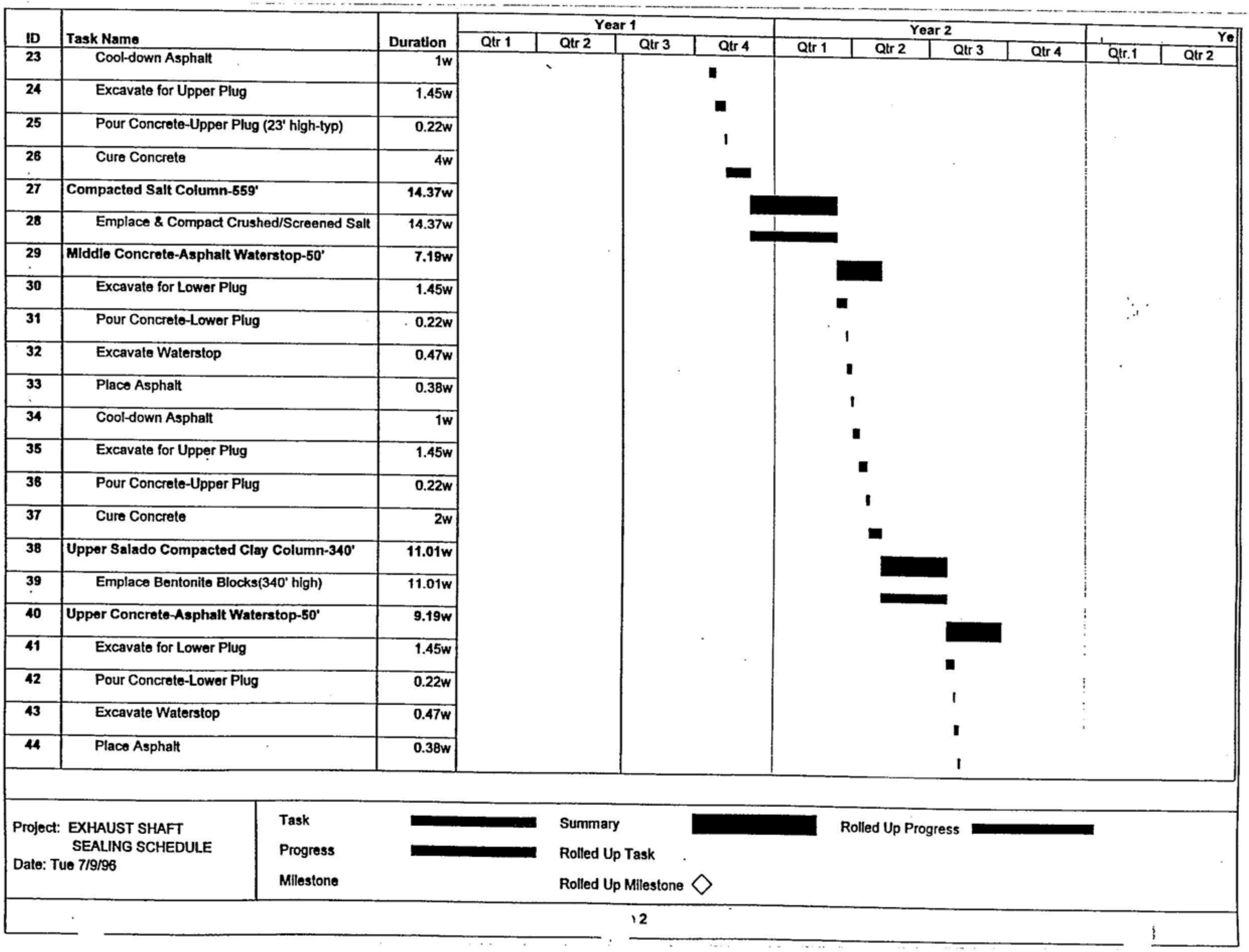
Project: EXHAUST SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

Task	▬	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task			
Milestone		Rolled Up Milestone	◇		



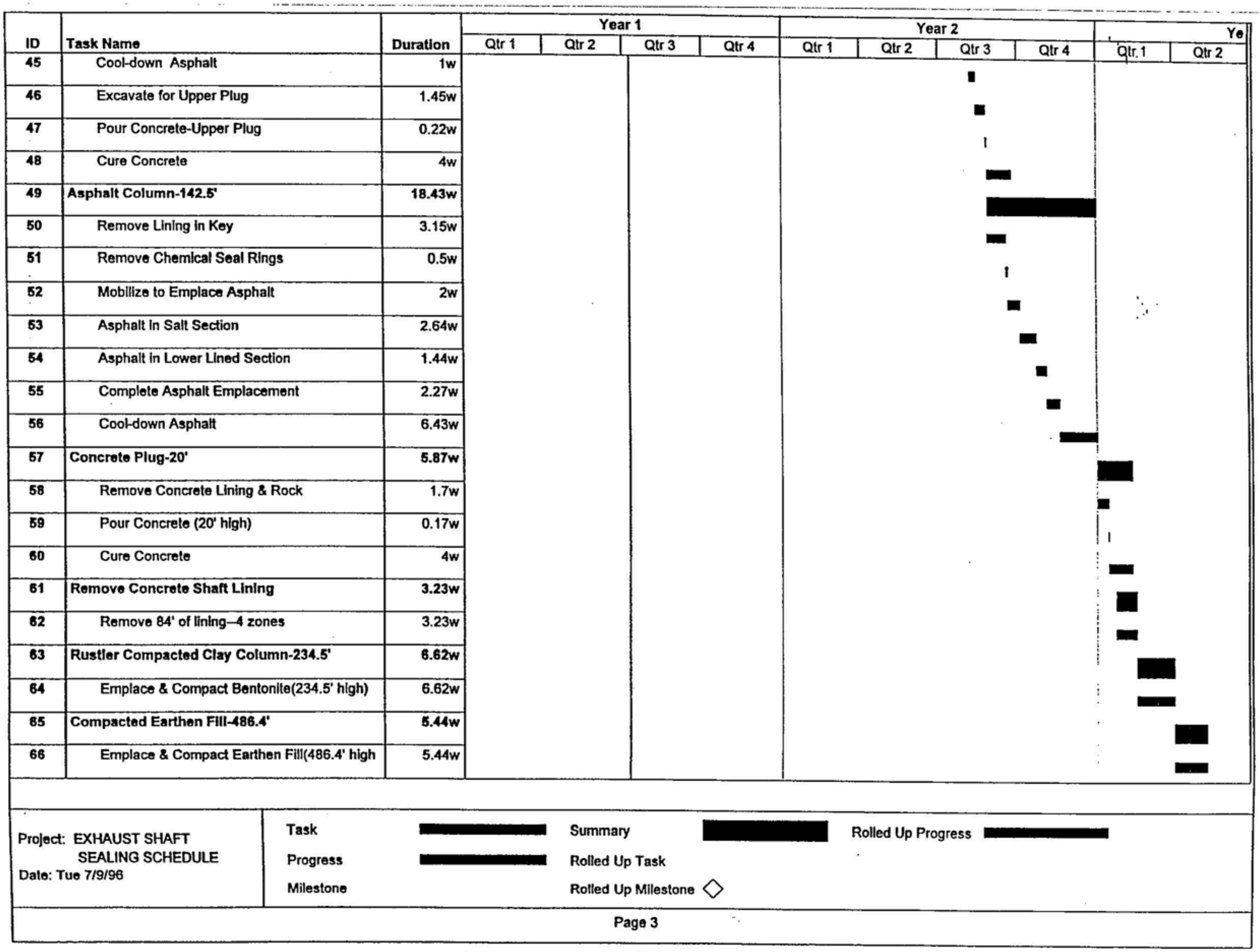
ID	Task Name	Duration
1	**Mobilization**	4w
2	Mobilize	4w
3	**Plant Set-up**	12w
4	Plant Set-up	12w
5	**Inspect & Scale Shaft-2159.5'**	1w
6	Inspect & Scale Shaft	1w
7	**Install Construction Utilities**	7.2w
8	Install Utilities	7.2w
9	**Drill & Grout Lining**	8.26w
10	Drill Grout Holes	3.3w
11	Grout Lining	4.96w
12	**Shaft Station Monolith-33'**	3.69w
13	Construct Bulkheads	0.4w
14	Pour Concrete (33' high)	0.29w
15	Cure Concrete	3w
16	**Lower Salado Compacted Clay Column-98'**	3.18w
17	Emplace Bentonite Blocks (98 ' high)	3.18w
18	**Lower Concrete-Asphalt Waterstop-50'**	9.19w
19	Excavate for Lower Plug	1.45w
20	Pour Concrete-Lower Plug (23' high-typ)	0.22w
21	Excavate Waterstop	0.47w
22	Place Asphalt (4' high-typ)	0.38w

Project: EXHAUST SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96



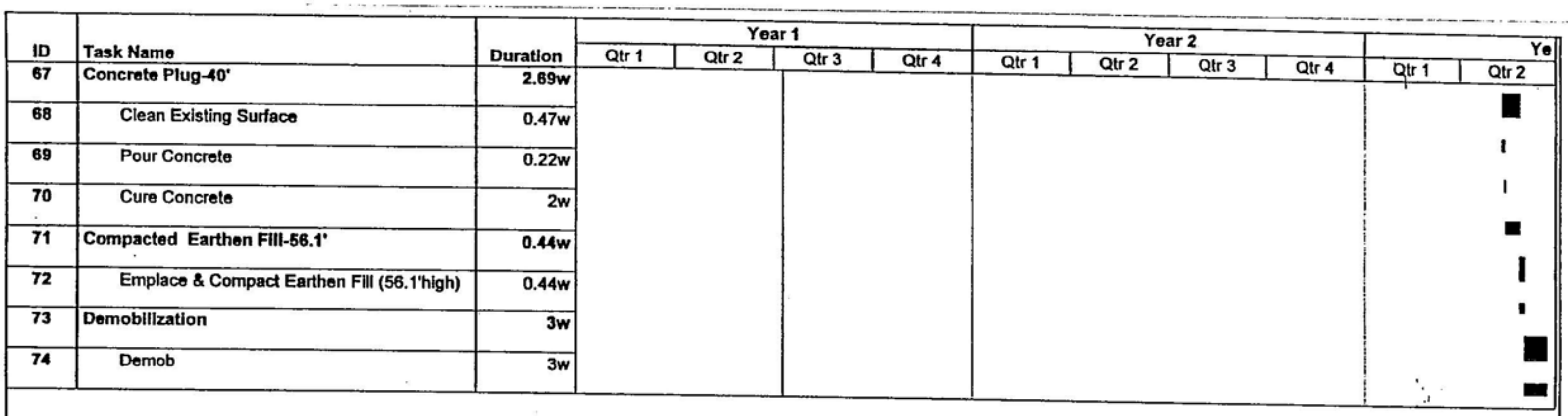
ID	Task Name	Duration
23	Cool-down Asphalt	1w
24	Excavate for Upper Plug	1.45w
25	Pour Concrete-Upper Plug (23' high-typ)	0.22w
26	Cure Concrete	4w
27	**Compacted Salt Column-559'**	**14.37w**
28	Emplace & Compact Crushed/Screened Salt	14.37w
29	**Middle Concrete-Asphalt Waterstop-50'**	**7.19w**
30	Excavate for Lower Plug	1.45w
31	Pour Concrete-Lower Plug	0.22w
32	Excavate Waterstop	0.47w
33	Place Asphalt	0.38w
34	Cool-down Asphalt	1w
35	Excavate for Upper Plug	1.45w
36	Pour Concrete-Upper Plug	0.22w
37	Cure Concrete	2w
38	**Upper Salado Compacted Clay Column-340'**	**11.01w**
39	Emplace Bentonite Blocks(340' high)	11.01w
40	**Upper Concrete-Asphalt Waterstop-50'**	**9.19w**
41	Excavate for Lower Plug	1.45w
42	Pour Concrete-Lower Plug	0.22w
43	Excavate Waterstop	0.47w
44	Place Asphalt	0.38w

Project: EXHAUST SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96



ID	Task Name	Duration
45	Cool-down Asphalt	1w
46	Excavate for Upper Plug	1.45w
47	Pour Concrete-Upper Plug	0.22w
48	Cure Concrete	4w
49	**Asphalt Column-142.5'**	**18.43w**
50	Remove Lining in Key	3.15w
51	Remove Chemical Seal Rings	0.5w
52	Mobilize to Emplace Asphalt	2w
53	Asphalt in Salt Section	2.64w
54	Asphalt in Lower Lined Section	1.44w
55	Complete Asphalt Emplacement	2.27w
56	Cool-down Asphalt	6.43w
57	**Concrete Plug-20'**	**5.87w**
58	Remove Concrete Lining & Rock	1.7w
59	Pour Concrete (20' high)	0.17w
60	Cure Concrete	4w
61	**Remove Concrete Shaft Lining**	**3.23w**
62	Remove 84' of lining—4 zones	3.23w
63	**Rustler Compacted Clay Column-234.5'**	**6.62w**
64	Emplace & Compact Bentonite(234.5' high)	6.62w
65	**Compacted Earthen Fill-486.4'**	**5.44w**
66	Emplace & Compact Earthen Fill(486.4' high	5.44w

Project: EXHAUST SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96



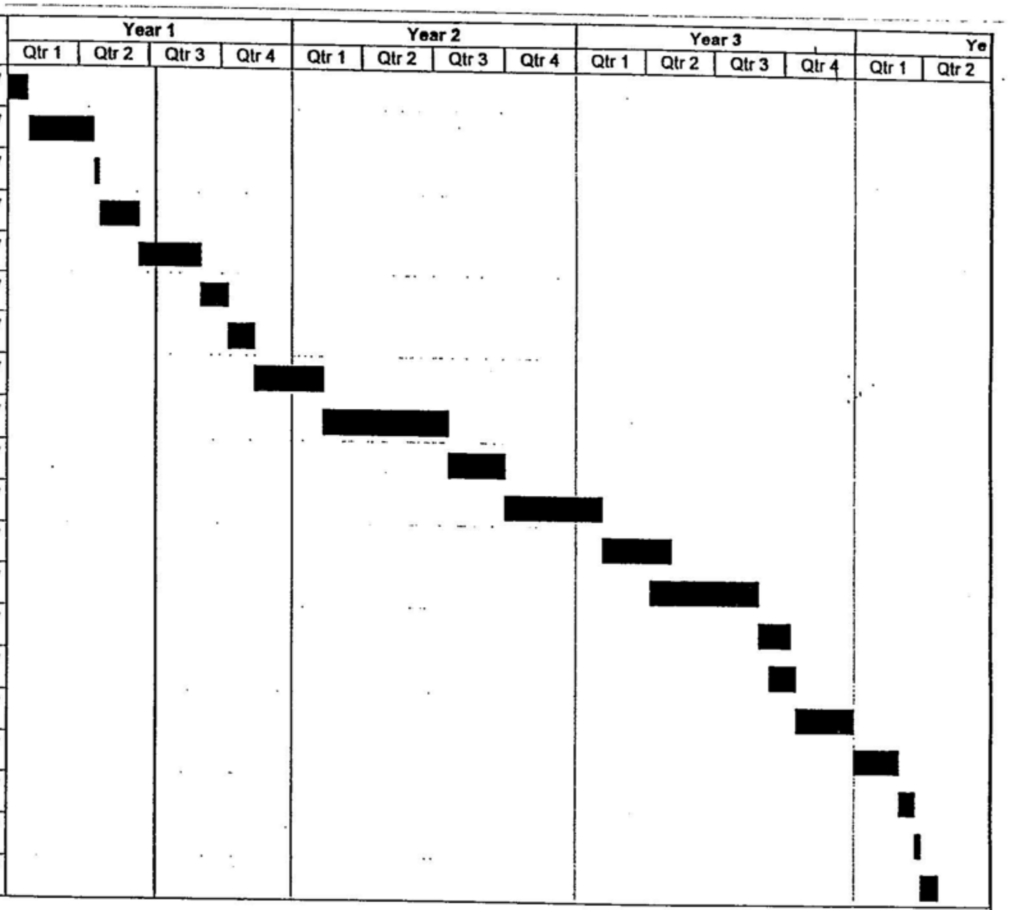
ID	Task Name	Duration
67	**Concrete Plug-40'**	**2.69w**
68	Clean Existing Surface	0.47w
69	Pour Concrete	0.22w
70	Cure Concrete	2w
71	**Compacted Earthen Fill-56.1'**	**0.44w**
72	Emplace & Compact Earthen Fill (56.1'high)	0.44w
73	**Demobilization**	**3w**
74	Demob	3w

Project: EXHAUST SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

Task	▬	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task			
Milestone		Rolled Up Milestone	◇		

SEALING SCHEDULE - WASTE SHAFT

ID	Task Name	Duration
1	Mobilization	4w
3	Plant Set-up	12w
5	Inspect & Scale Shaft-2159.5'	1w
7	Install Construction Utilities	7.2w
9	Drill & Grout Lining	11.21w
12	Shaft Station Monolith-37'	5.17w
16	Lower Salado Compacted Clay Column-96'	5.01w
18	Lower Concrete-Asphalt Waterstop-50'	12.57w
27	Compacted Salt Column-555.5'	22.87w
29	Middle Concrete-Asphalt Waterstop-50'	10.57w
38	Upper Salado Compacted Clay Column-351.5'	17.86w
40	Upper Concrete-Asphalt Waterstop-50'	12.57w
49	Asphalt Column-142.3'	20.71w
57	Concrete Plug-20'	5.98w
61	Remove Concrete Shaft Lining	5.07w
63	Rustler Compacted Clay Column-234.7'	10.99w
65	Compacted Earthen Fill-447'	8.25w
67	Concrete Plug-40'	3.04w
71	Compacted Earthen Fill-61.5'	1.14w
73	Demobilization	3.5w

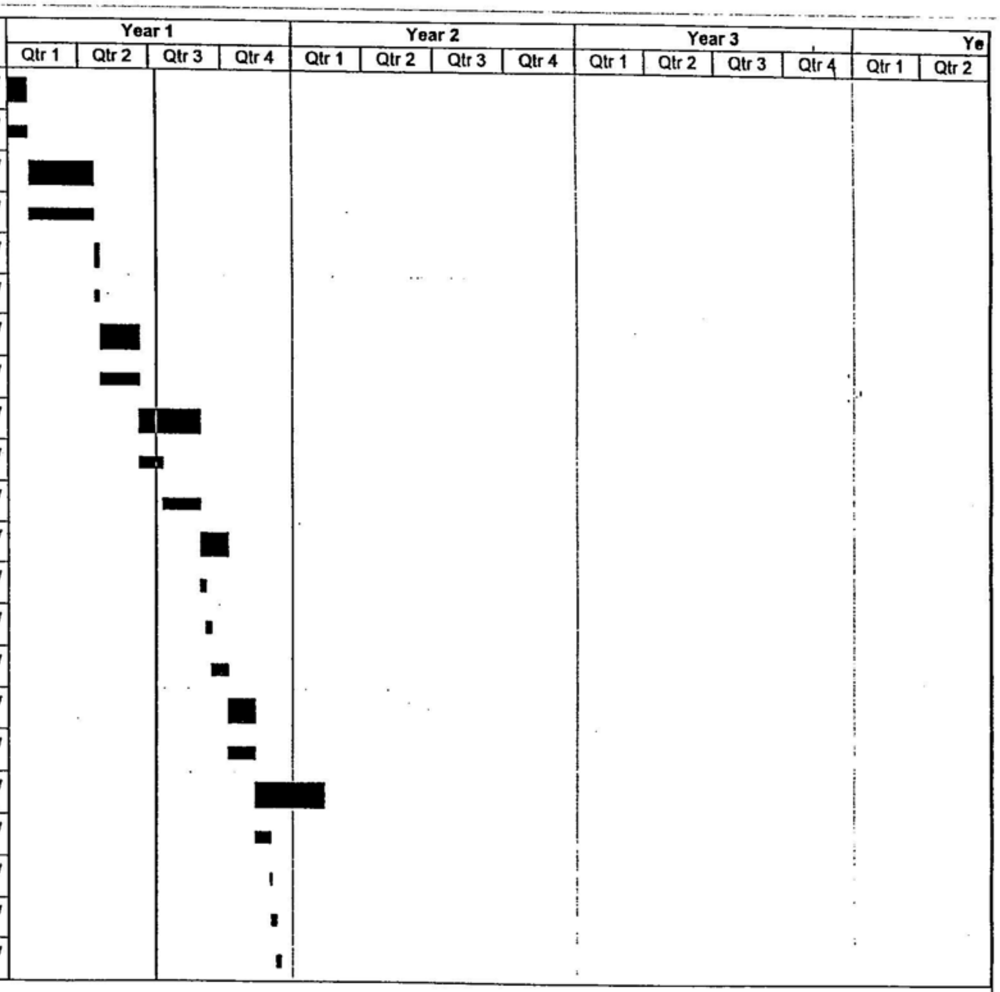


Project: WASTE HANDLING SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

Task ■
Progress ■
Milestone
Summary ■
Rolled Up Task
Rolled Up Milestone ◇
Rolled Up Progress ■

1

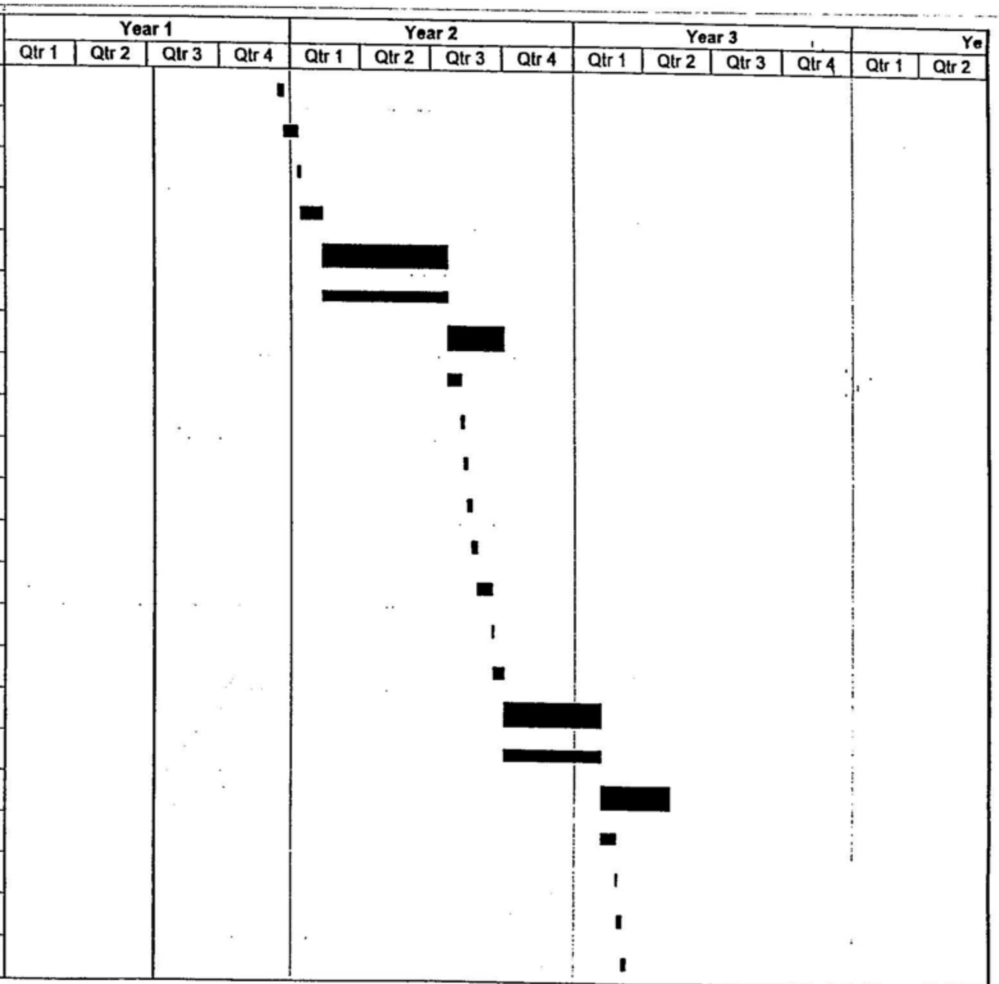
ID	Task Name	Duration
1	**Mobilization**	**4w**
2	Mobilize	4w
3	**Plant Set-up**	**12w**
4	Plant Set-up	12w
5	**Inspect & Scale Shaft-2159.5'**	**1w**
6	Inspect & Scale Shaft	1w
7	**Install Construction Utilities**	**7.2w**
8	Install Utilities	7.2w
9	**Drill & Grout Lining**	**11.21w**
10	Drill Grout Holes	4.48w
11	Grout Lining	6.73w
12	**Shaft Station Monolith-37'**	**5.17w**
13	Construct Bulkheads	1w
14	Pour Concrete (37' high)	1.17w
15	Cure Concrete	3w
16	**Lower Salado Compacted Clay Column-96'**	**5.01w**
17	Emplace Bentonite Blocks (96 ' high)	5.01w
18	**Lower Concrete-Asphalt Waterstop-50'**	**12.57w**
19	Excavate for Lower Plug	2.72w
20	Pour Concrete-Lower Plug (23' high-typ)	0.27w
21	Excavate Waterstop	0.84w
22	Place Asphalt (4' high-typ)	0.75w



Project: WASTE HANDLING SHAFT SEALING SCHEDULE
Date: Tue 7/9/96

Task	▬	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task			
Milestone		Rolled Up Milestone	◇		

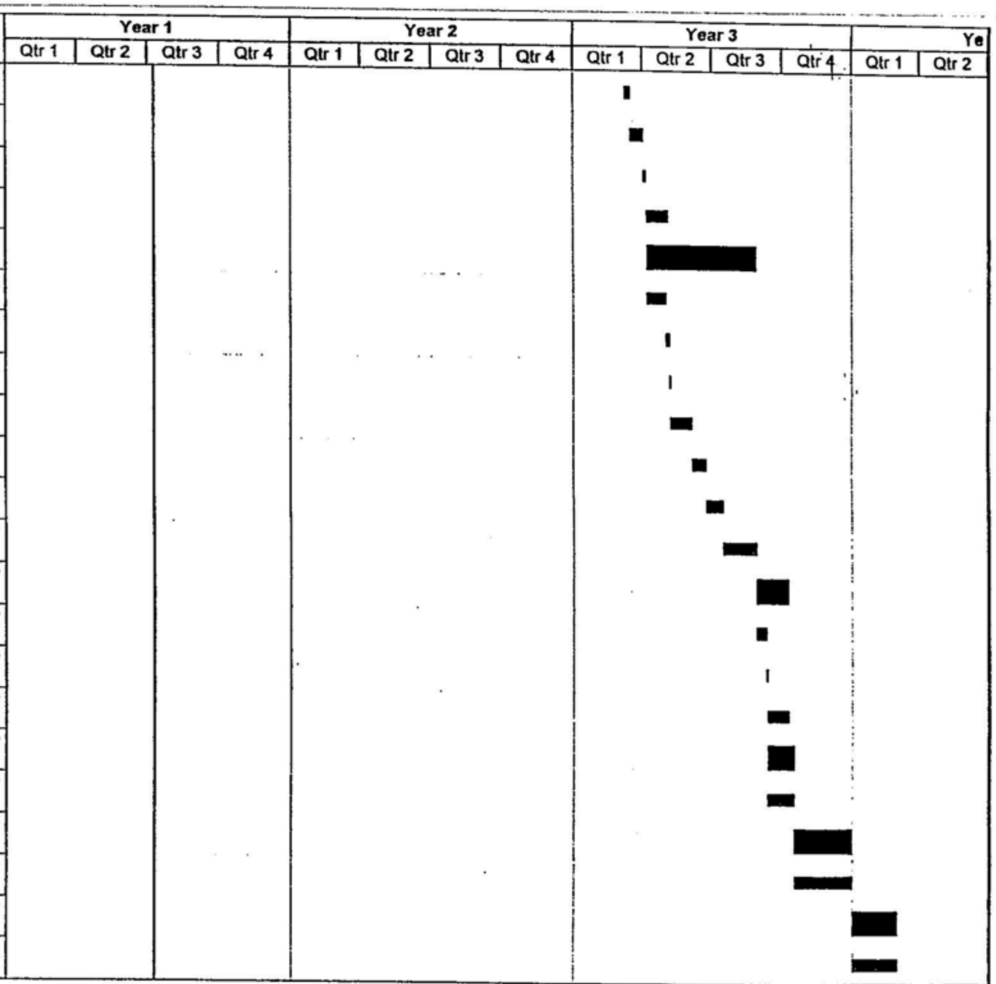
ID	Task Name	Duration
23	Cool-down Asphalt	1w
24	Excavate for Upper Plug	2.72w
25	Pour Concrete-Upper Plug (23' high-typ)	0.27w
26	Cure Concrete	4w
27	**Compacted Salt Column-555.5'**	**22.87w**
28	Emplace & Compact Crushed/Screened Salt	22.87w
29	**Middle Concrete-Asphalt Waterstop-50'**	**10.57w**
30	Excavate for Lower Plug	2.72w
31	Pour Concrete-Lower Plug	0.27w
32	Excavate Waterstop	0.84w
33	Place Asphalt	0.75w
34	Cool-down Asphalt	1w
35	Excavate for Upper Plug	2.72w
36	Pour Concrete-Upper Plug	0.27w
37	Cure Concrete	2w
38	**Upper Salado Compacted Clay Column-351.5'**	**17.86w**
39	Emplace Bentonite Blocks(351.5' high)	17.86w
40	**Upper Concrete-Asphalt Waterstop-50'**	**12.57w**
41	Excavate for Lower Plug	2.72w
42	Pour Concrete-Lower Plug	0.27w
43	Excavate Waterstop	0.84w
44	Place Asphalt	0.75w



Project: WASTE HANDLING SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

Task	▬	Summary	▬	Rolled Up Progress	▬
Progress	▬	Rolled Up Task			
Milestone		Rolled Up Milestone	◇		

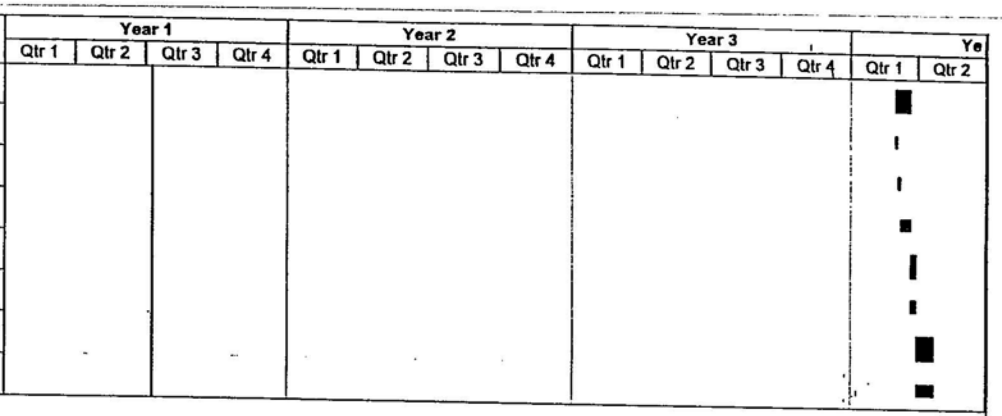
ID	Task Name	Duration
45	Cool-down Asphalt	1w
46	Excavate for Upper Plug	2.72w
47	Pour Concrete-Upper Plug	0.27w
48	Cure Concrete	4w
49	**Asphalt Column-142.3'**	**20.71w**
50	Remove Lining in Key	3.8w
51	Remove Chemical Seal Rings	0.6w
52	Mobilize to emplace asphalt	0.3w
53	Asphalt in Salt Section	4.01w
54	Asphalt in Lower Lined Section	2.33w
55	Complete Asphalt Emplacement	3.24w
56	Cool-down Asphalt	6.43w
57	**Concrete Plug-20'**	**5.98w**
58	Remove Concrete Lining & Rock	1.73w
59	Pour Concrete (20' high)	0.25w
60	Cure Concrete	4w
61	**Remove Concrete Shaft Lining**	**5.07w**
62	Remove 84' of lining–4 zones	5.07w
63	**Rustler Compacted Clay Column-234.7'**	**10.99w**
64	Emplace & Compact Bentonite (234.7' high)	10.99w
65	**Compacted Earthen Fill-447'**	**8.25w**
66	Emplace & Compact Earthen Fill (447' high)	8.25w



Project: WASTE HANDLING SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

Task	▬	Summary	■	Rolled Up Progress	▬
Progress	▬	Rolled Up Task			
Milestone		Rolled Up Milestone	◇		

ID	Task Name	Duration
67	**Concrete Plug-40'**	**3.04w**
68	Clean Existing Surface	0.64w
69	Pour Concrete	0.4w
70	Cure Concrete	2w
71	**Compacted Earthen Fill-61.5'**	**1.14w**
72	Emplace & Compact Earthen Fill (61.5' high)	1.14w
73	**Demobilization**	**3.5w**
74	Demob	3.5w



Project: WASTE HANDLING SHAFT
SEALING SCHEDULE
Date: Tue 7/9/96

Task ▬
Progress ▬
Milestone
Summary ▬
Rolled Up Task
Rolled Up Milestone ◇
Rolled Up Progress ▬

B5. References

Ahrens, E.H., and F.D. Hansen. 1995. *Large-Scale Dynamic Compaction Demonstration Using WIPP Salt: Fielding and Preliminary Results*. SAND95-1941. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the Sandia WIPP Central Files, Sandia National Laboratories, Albuquerque, NM [SWCF] as WPO31104.)

Ahrens, E.H., and M. Onofrei. 1996. "Ultrafine Cement Grout for Sealing Underground Nuclear Waste Repositories," *2nd North American Rock Mechanics Symposium (NARMS 96), Montreal, Quebec, June 19-21, 1996*. SAND96-0195C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO31251.)

Ahrens, E.H., T.F. Dale, and R.S. Van Pelt. 1996. *Data Report on the Waste Isolation Pilot Plant Small-Scale Seal Performance Test, Series F Grouting Experiment*. SAND93-1000. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO37355.)

Boonsinsuk, P., B.C. Pulles, B.H. Kjartanson, and D.A. Dixon. 1991. "Prediction of Compactive Effort for a Bentonite-Sand Mixture," *44th Canadian Geotechnical Conference*, *Preprint Volume, Calgary, Alberta, September 29-October 2, 1991.* Paper No. 64. Waterloo, Ontario: Canadian Geotechnical Society. Pt. 2, 64/1 through 64/12. (Copy on file in the SWCF.)

Dale, T., and L.D. Hurtado. 1996. "WIPP Air-Intake Shaft Disturbed-Rock Zone Study," *4th International Conference on the Mechanical Behavior of Salt, Montreal, Quebec, June 17-18, 1996*. SAND96-1327C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF.)

Hansen, F.D., and E.H. Ahrens. 1996. "Large-Scale Dynamic Compaction of Natural Salt," *4th International Conference on the Mechanical Behavior of Salt, Montreal, Quebec, June 17-18, 1996*. SAND96-0792C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO39544.)

Knowles, M.K., and C.L. Howard. 1996. "Field and Laboratory Testing of Seal Materials Proposed for the Waste Isolation Pilot Plant," *Proceedings of the Waste Management 1996 Symposium, Tucson, AZ, February 25-29, 1996*. SAND95-2082C. Albuquerque, NM: Sandia National Laboratories. (Copy on file in the SWCF as WPO30945.)

McClintock, F.A., and A.S. Aragon. 1996. *Mechanical Behavior of Materials*. Reading MA: Addison-Wesley.

Sandia (Repository Isolation Systems Department 6121). 1996. *Waste Isolation Pilot Plant Shaft Sealing System Compliance Submittal Design Report.* SAND96-1326/1&2. Albuquerque, NM: Sandia National Laboratories.

Van Sambeek, L.L. 1988. *Considerations for the Use of Quarried Salt Blocks in Seal Components at the WIPP*. Topical Report RSI-0340. Rapid City, SD: RE/SPEC Inc. (Copy on file in the SWCF as WPO9233.)

FIGURES

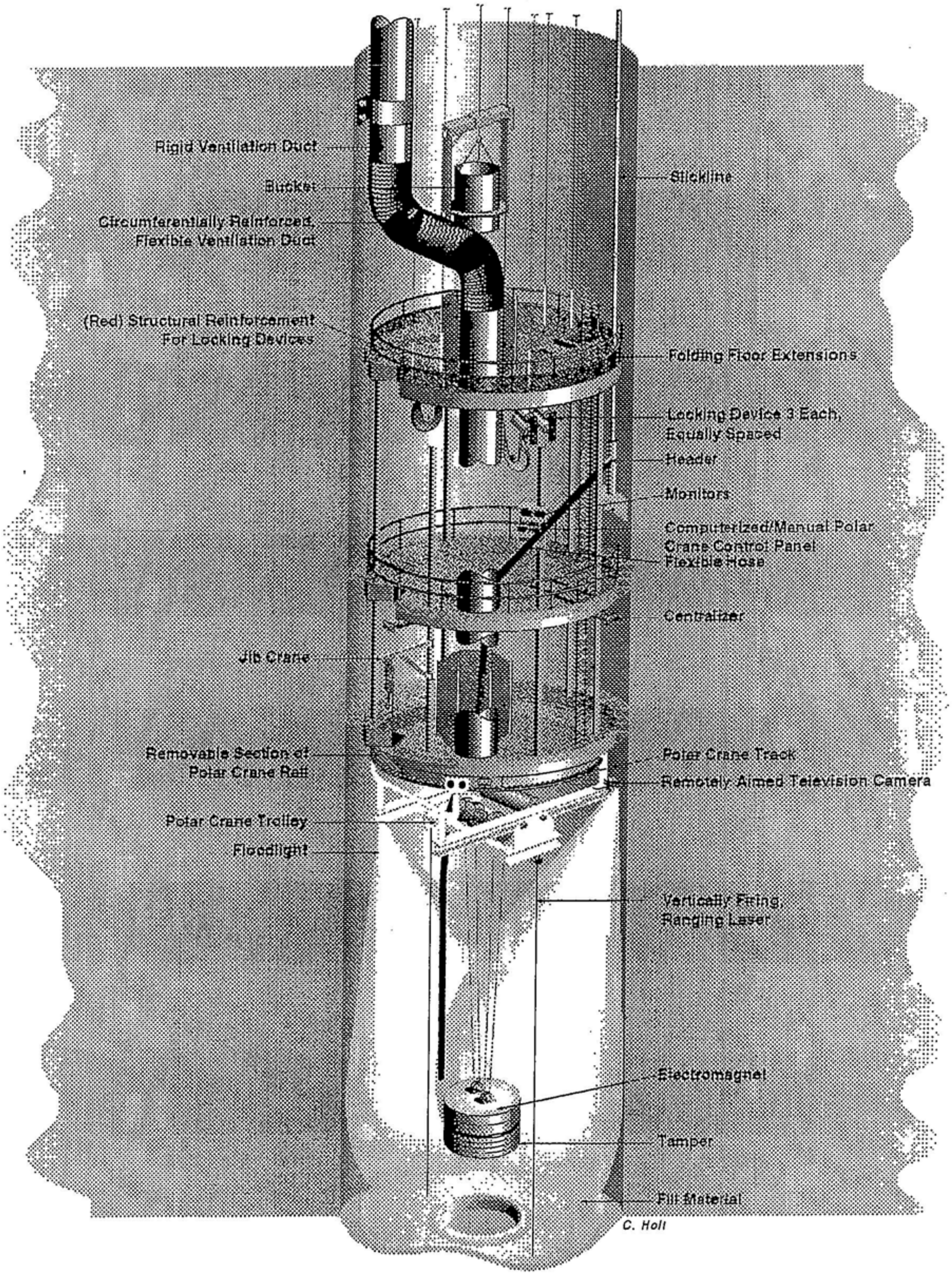


Figure G2B-1
Multi-Deck Stage Illustrating Dynamic Compaction

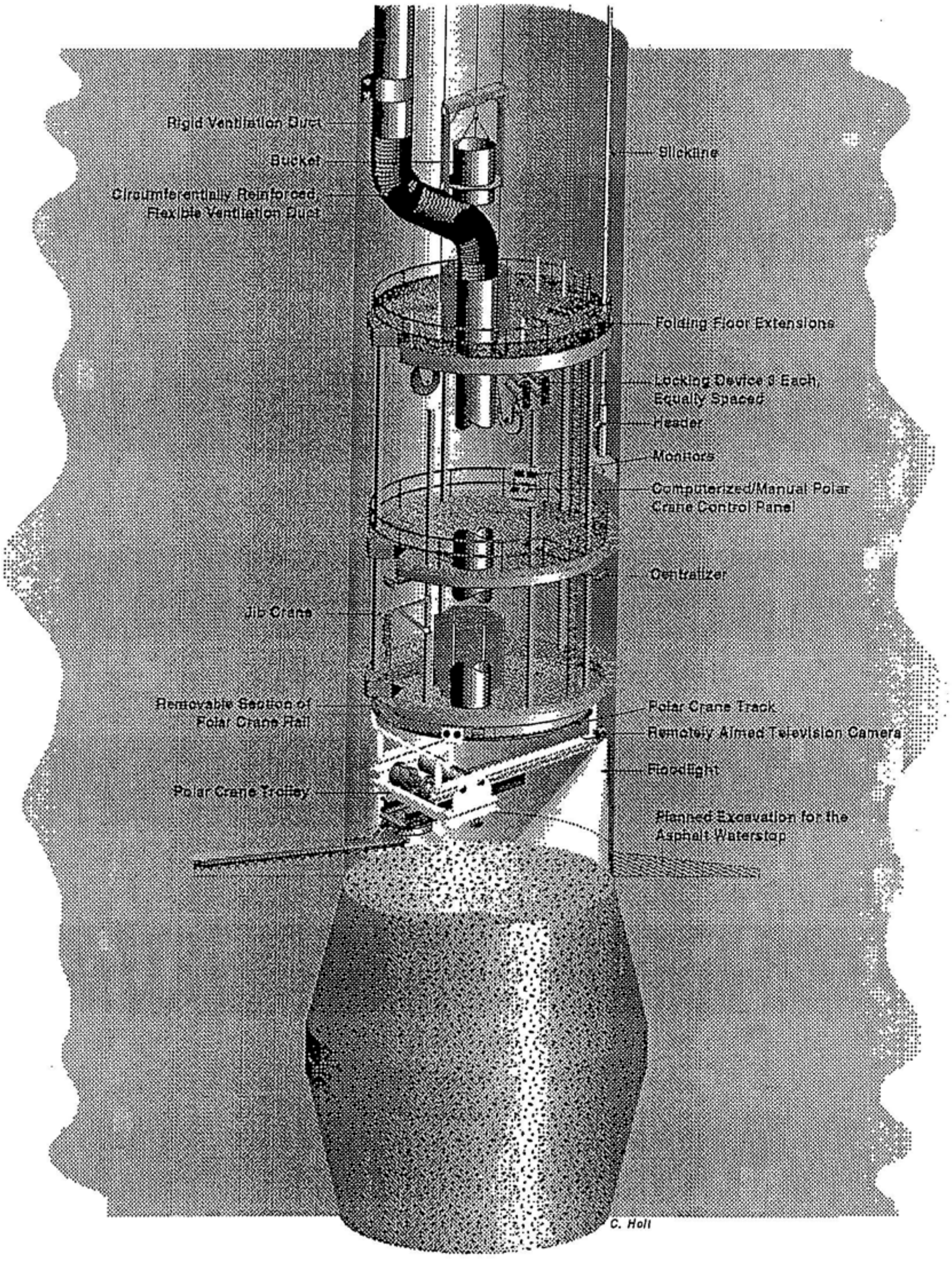
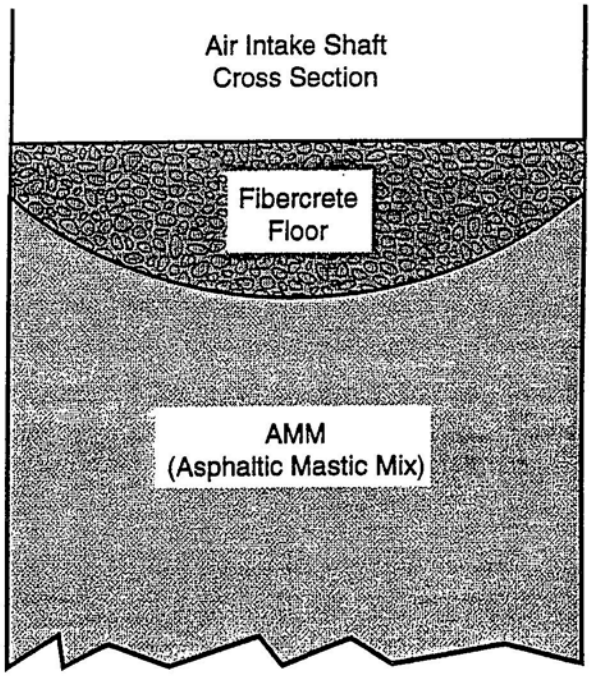
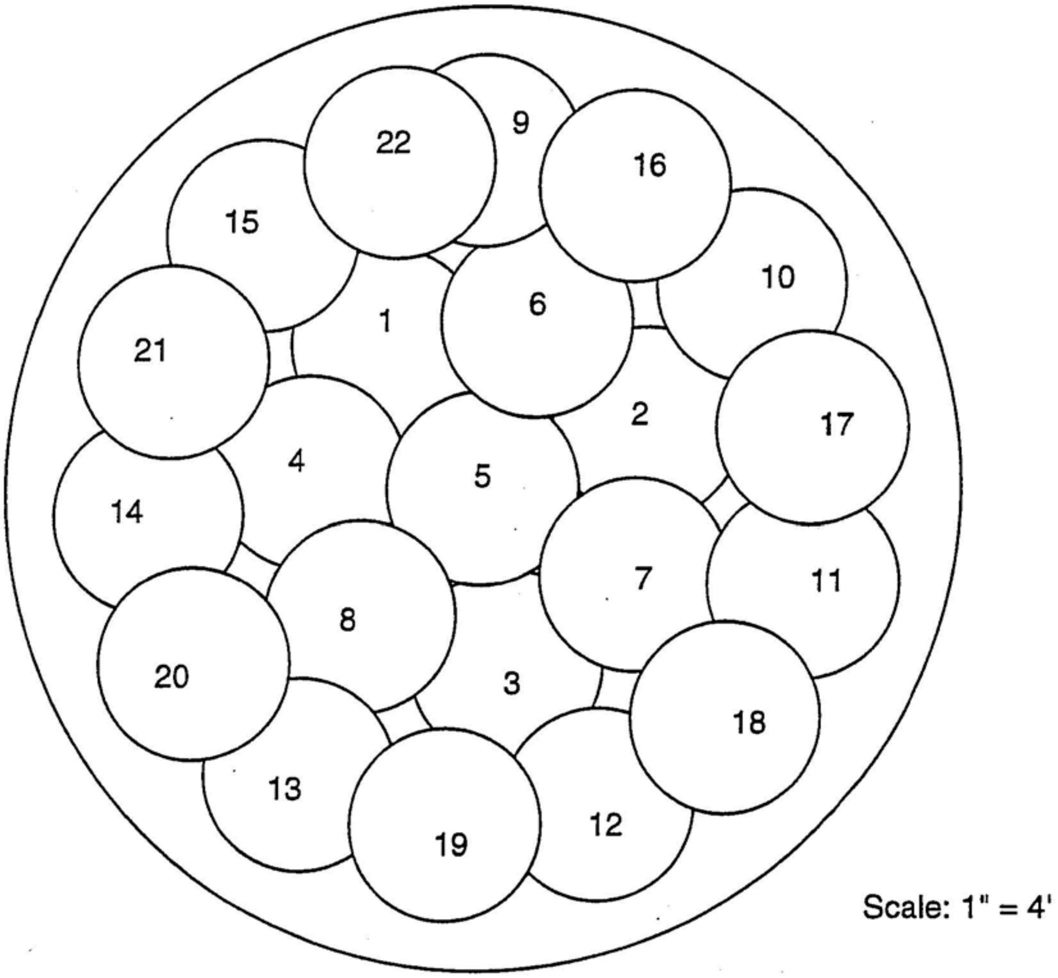


Figure G2B-2
Multi-Deck Stage Illustrating Excavation for Asphalt Waterstop



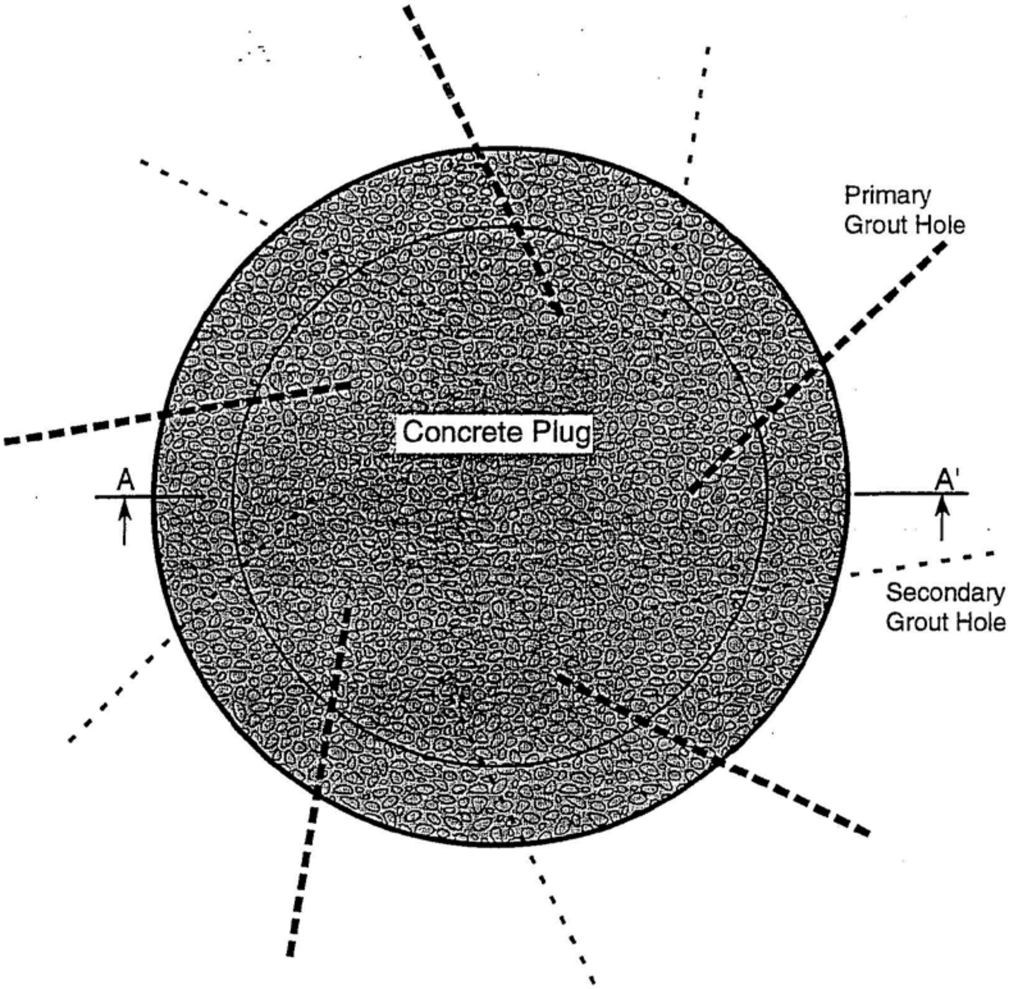
TRI-6121-375-0

Figure G2B-3
Typical Fibercrete at Top of Asphalt

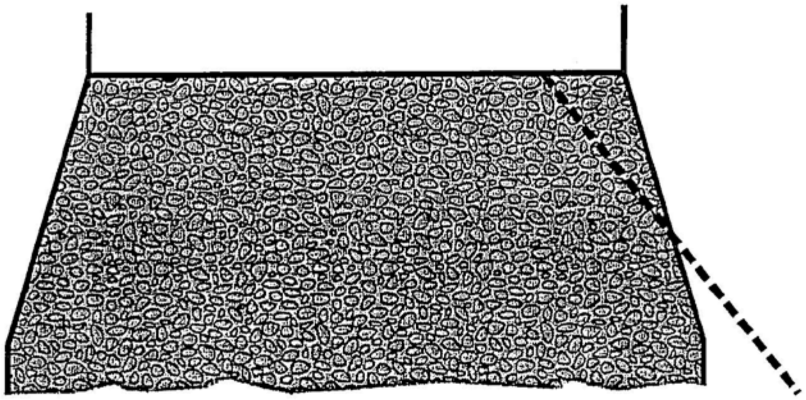


TRI-6121-376-0

Figure G2B-4
Drop Pattern for 6-m-Diameter Shaft Using a 1.2-m-Diameter Tamper



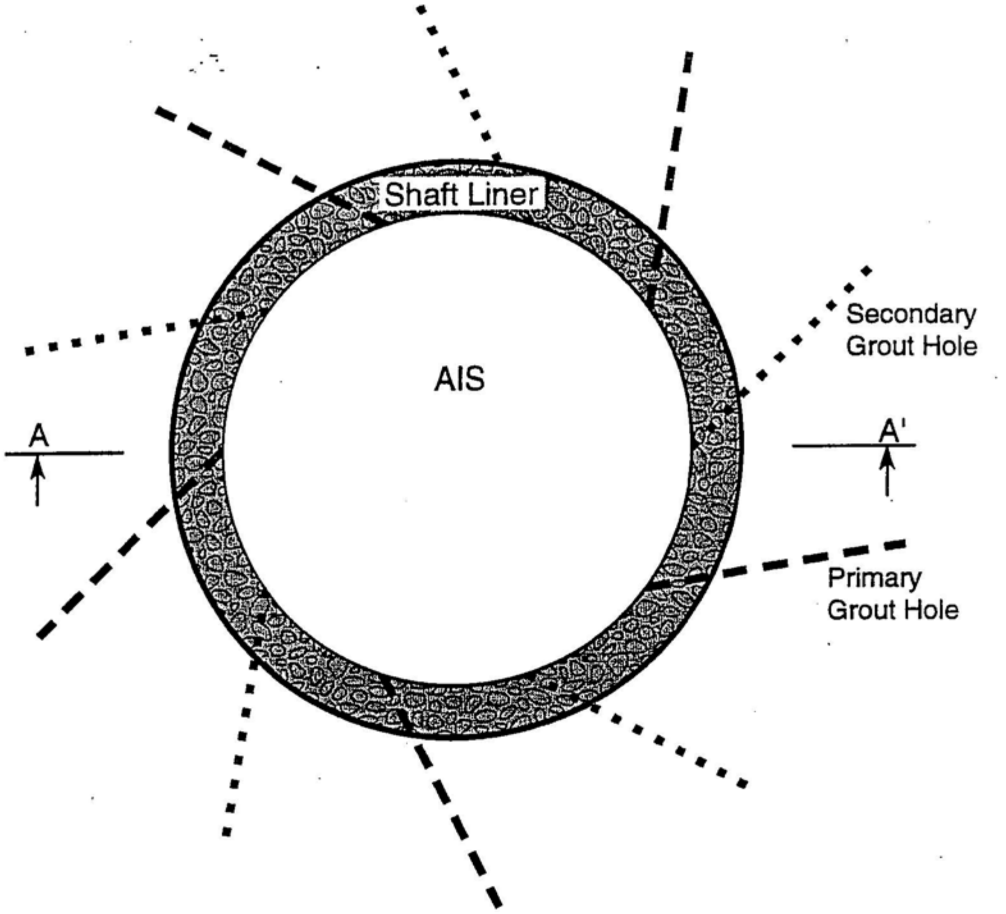
Plan View of Grout Holes in Spin Pattern



Section A - A'

TRI-6121-373-0

Figure G2B-5
Plan and Section Views of Downward Spin Pattern of Grout Holes



Plan View of Grout Holes in Spin Pattern

Section A - A'

TRI-6121-374-0

Figure G2B-6
Plan and Section Views of Upward Spin Pattern of Grout Holes

ATTACHMENT G2
APPENDIX E

DESIGN DRAWINGS

SHAFT SEALING SYSTEM
COMPLIANCE SUBMITTAL DESIGN REPORT

SAND96-1326/2
Unlimited Release
Printed August 1996

Distribution
Category UC-721

Waste Isolation Pilot Plant
Shaft Sealing System
Compliance Submittal Design Report

Volume 2 of 2:
Appendix E

Repository Isolation Systems Department
Sandia National Laboratories
Albuquerque, NM 87185

ABSTRACT

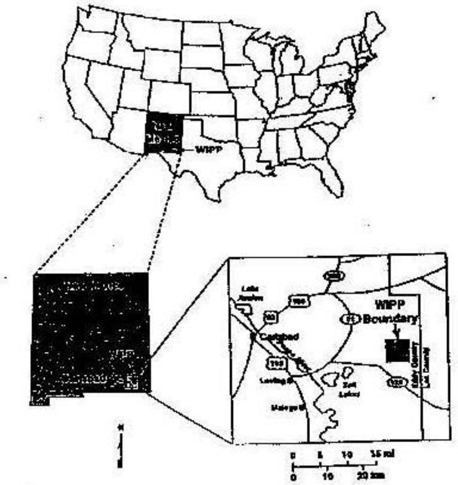
This is the second volume of a two-volume report describing a shaft sealing system design for the Waste Isolation Pilot Plant. This appendix contains detailed drawings of the shaft sealing system and its components.

WASTE ISOLATION PILOT PLANT

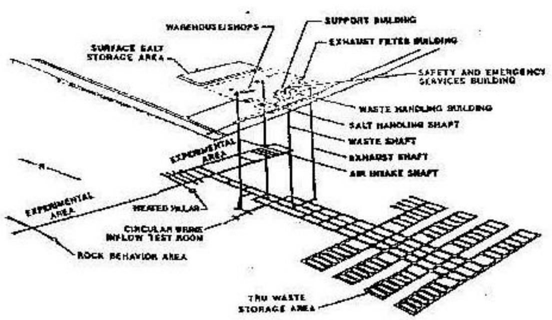
CARLSBAD, NM

SHAFT SEALING SYSTEM DESIGN

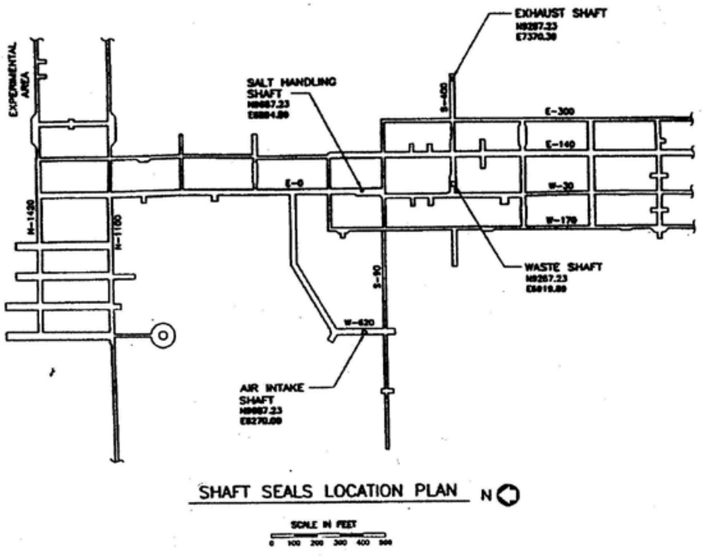
DESIGN DRAWINGS



WIPP LAYOUT



DRAWING NUMBER	TITLE
SNL-007 1 OF 28	WIPP SHAFT SEALING SYSTEM SHAFT LOCATION PLAN, ABBREVIATIONS, GENERAL NOTES AND LEGEND
SNL-007 2 OF 28	WIPP SHAFT SEALING SYSTEM NEAR-SURFACE/RUSTLER FORMATIONS WASTE SHAFT STRATIGRAPHY & AS-BUILT ELEMENTS
SNL-007 3 OF 28	WIPP SHAFT SEALING SYSTEM SALADO FORMATION WASTE SHAFT STRATIGRAPHY & AS-BUILT ELEMENTS
SNL-007 4 OF 28	WIPP SHAFT SEALING SYSTEM NEAR-SURFACE/RUSTLER FORMATIONS WASTE SHAFT STRATIGRAPHY & SEALING SUBSYSTEM PROFILE
SNL-007 5 OF 28	WIPP SHAFT SEALING SYSTEM SALADO FORMATION WASTE SHAFT STRATIGRAPHY & SEALING SUBSYSTEM PROFILE
SNL-007 6 OF 28	WIPP SHAFT SEALING SYSTEM WASTE SHAFT SHAFT STATION MONOLITH
SNL-007 7 OF 28	WIPP SHAFT SEALING SYSTEM NEAR-SURFACE/RUSTLER FORMATIONS AIR INTAKE SHAFT STRATIGRAPHY & AS-BUILT ELEMENTS
SNL-007 8 OF 28	WIPP SHAFT SEALING SYSTEM SALADO FORMATION AIR INTAKE SHAFT STRATIGRAPHY & AS-BUILT ELEMENTS
SNL-007 9 OF 28	WIPP SHAFT SEALING SYSTEM NEAR-SURFACE/RUSTLER FORMATIONS AIR INTAKE SHAFT STRATIGRAPHY & SEALING SUBSYSTEM PROFILE
SNL-007 10 OF 28	WIPP SHAFT SEALING SYSTEM SALADO FORMATION AIR INTAKE SHAFT STRATIGRAPHY & SEALING SUBSYSTEM PROFILE
SNL-007 11 OF 28	WIPP SHAFT SEALING SYSTEM AIR INTAKE SHAFT SHAFT STATION MONOLITH
SNL-007 12 OF 28	WIPP SHAFT SEALING SYSTEM NEAR-SURFACE/RUSTLER FORMATIONS EXHAUST SHAFT STRATIGRAPHY & AS-BUILT ELEMENTS
SNL-007 13 OF 28	WIPP SHAFT SEALING SYSTEM SALADO FORMATION EXHAUST SHAFT STRATIGRAPHY & AS-BUILT ELEMENTS
SNL-007 14 OF 28	WIPP SHAFT SEALING SYSTEM NEAR-SURFACE/RUSTLER FORMATIONS EXHAUST SHAFT STRATIGRAPHY & SEALING SUBSYSTEM PROFILE
SNL-007 15 OF 28	WIPP SHAFT SEALING SYSTEM SALADO FORMATION EXHAUST SHAFT STRATIGRAPHY & SEALING SUBSYSTEM PROFILE
SNL-007 16 OF 28	WIPP SHAFT SEALING SYSTEM EXHAUST SHAFT SHAFT STATION MONOLITH
SNL-007 17 OF 28	WIPP SHAFT SEALING SYSTEM NEAR-SURFACE/RUSTLER FORMATIONS SALT HANDLING SHAFT STRATIGRAPHY & AS-BUILT ELEMENTS
SNL-007 18 OF 28	WIPP SHAFT SEALING SYSTEM SALADO FORMATION SALT HANDLING SHAFT STRATIGRAPHY & AS-BUILT ELEMENTS
SNL-007 19 OF 28	WIPP SHAFT SEALING SYSTEM NEAR-SURFACE/RUSTLER FORMATIONS SALT HANDLING SHAFT STRATIGRAPHY & SEALING SUBSYSTEM PROFILE
SNL-007 20 OF 28	WIPP SHAFT SEALING SYSTEM SALADO FORMATION SALT HANDLING SHAFT STRATIGRAPHY & SEALING SUBSYSTEM PROFILE
SNL-007 21 OF 28	WIPP SHAFT SEALING SYSTEM SALT HANDLING SHAFT SHAFT STATION MONOLITH
SNL-007 22 OF 28	WIPP SHAFT SEALING SYSTEM CONCRETE-ASPHALT WATERSTOP IN SALADO FORMATION
SNL-007 23 OF 28	WIPP SHAFT SEALING SYSTEM ASPHALT COLUMN
SNL-007 24 OF 28	WIPP SHAFT SEALING SYSTEM UPPER AND LOWER SALADO COMPACTED CLAY COLUMNS
SNL-007 25 OF 28	WIPP SHAFT SEALING SYSTEM COMPACTED SALT COLUMN
SNL-007 26 OF 28	WIPP SHAFT SEALING SYSTEM CONCRETE PLUG
SNL-007 27 OF 28	WIPP SHAFT SEALING SYSTEM RUSTLER COMPACTED CLAY COLUMN
SNL-007 28 OF 28	WIPP SHAFT SEALING SYSTEM COMPACTED EARTHEN FILL AND CONCRETE PLUG

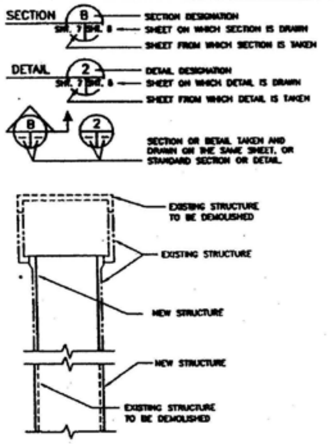


SHAFT SEALS LOCATION PLAN

GENERAL NOTES:

1. THE DRIFT NUMBERING SYSTEM (E-300, S-400, ETC.) IS BASED ON THE DIRECTION AND NOMINAL DISTANCE IN FEET THE DRIFT IS FROM THE SALT HANDLING SHAFT'S DESIGNATED CENTERLINE LOCATION OF N-000, E-000. THE WIPP PLANT COORDINATE SYSTEM CENTERLINE LOCATION FOR THE SALT HANDLING SHAFT IS N9987.23, AND E8894.80. THE PLANT COORDINATE SYSTEM IS DESCRIBED IN WESTINGHOUSE DRAWING NO. 51-W-100-W, UNDERGROUND EXCAVATIONS, DATED 6/15/92.
2. THE AS-BUILT DIMENSIONS AND DEPTHS AND/OR ELEVATIONS SHOWN IN THESE DRAWINGS ARE NOMINAL IN THAT DIMENSIONS MAY CHANGE DUE TO LOCAL VARIANCE OF THE STRATIFICATION, OPERATIONAL MODIFICATIONS MADE TO SUIT THE CREEP CLOSURE OF THE HALITE, AND OTHER OPERATIONAL REQUIREMENTS. THEREFORE THE AS-BUILT DIMENSIONS AND THE PERTINENT ELEVATIONS FOR SITING THE SEALING SYSTEM SHALL BE VERIFIED BY FIELD SURVEYING AND EXPLORATORY CORE DRILLING DURING SITE PREPARATION FOR THE FINAL CONSTRUCTION.
3. DRAWING NUMBERS:
   FOR CLARITY ON DETAIL AND SECTION DESIGNATIONS, AND NOTES, ONLY THE SHEET NUMBER IS SHOWN.

LEGEND FOR PROPOSED SHAFT SEALING SYSTEM:



ABBREVIATIONS:

℄	CENTERLINE
ANH.	ANHYDRITE
CMP	CORRUGATED METAL PLATE
CONC.	CONCRETE
DOE	DEPARTMENT OF ENERGY
DWG.	DRAWING
E	EAST
EL.	ELEVATION
EXIST.	EXISTING
FT.	FOOT, FEET
HT.	HEIGHT
I.D.	INSIDE DIAMETER
IN.	INCHES
MB	MARKER BED
MIN.	MINIMUM
MSL	MEAN SEA LEVEL
N	NORTH
NO.	NUMBER
R	RADIUS
S	SOUTH
SHT.	SHEET NUMBER
SMC	SALADO MASS CONCRETE
TYP.	TYPICAL
USGS	UNITED STATES GEOLOGICAL SURVEY
W	WEST
WID	WESTINGHOUSE WASTE ISOLATION DIVISION
WIPP	WASTE ISOLATION PILOT PLANT

E-4

ALBERT W. DENNIS
5971

Albert W. Dennis
9-2-96

REV.	DATE	DESCRIPTION	BY	CK.	APP
0	9/2/96	ISSUED FOR RECORDS PACKAGE			

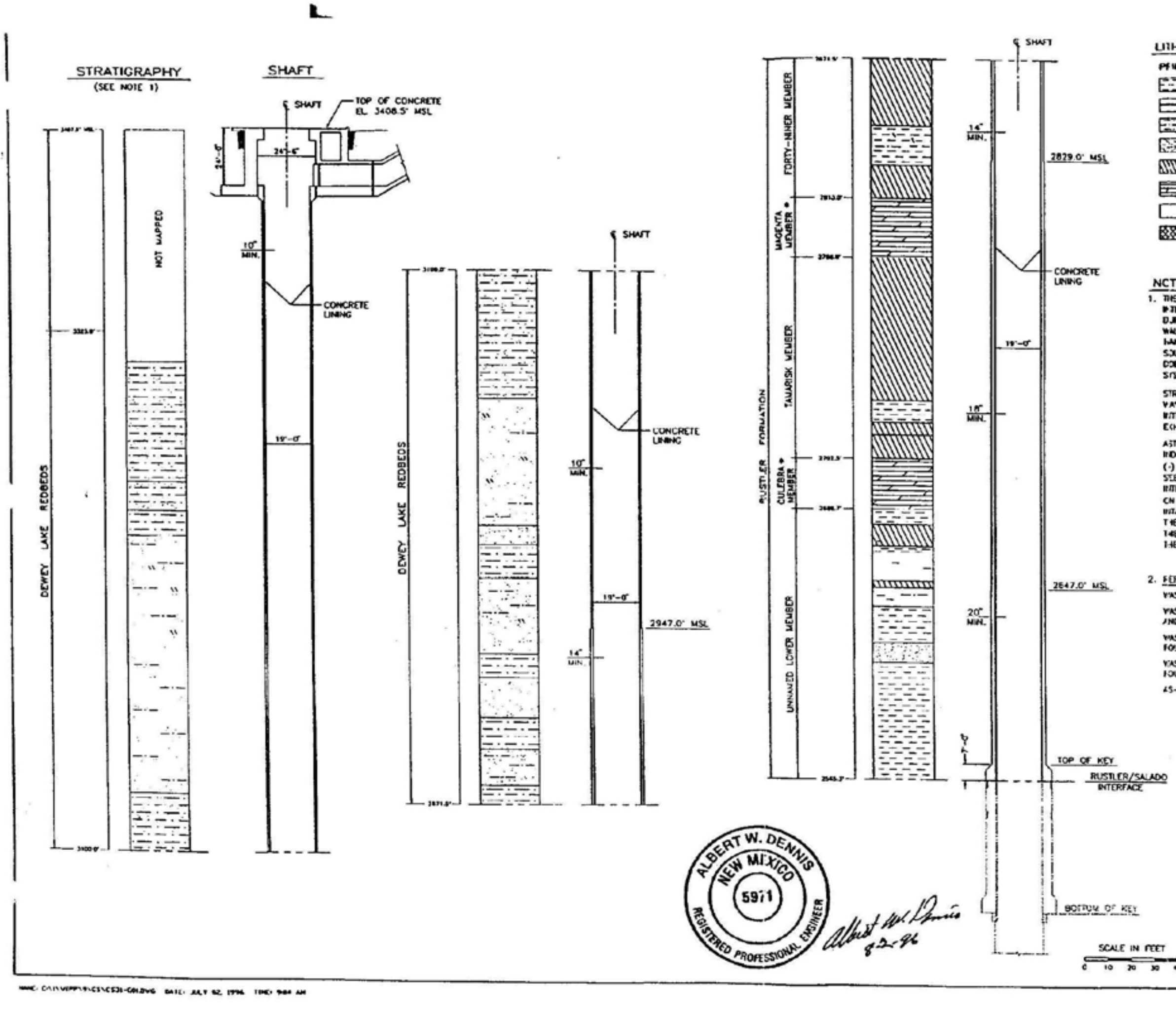
SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT
CONTRACT NO. AC-4089
WIPP SHAFT SEALING SYSTEM
SHAFT LOCATION PLAN, ABBREVIATIONS, GENERAL NOTES AND LEGEND

	NAME	DATE
BY		
CK.		
APP.		
APP.		
APP.		

PARSONS BRINCKERHOFF ENERGY SERVICES, INC	SCALE:	SIZE	SNL DWG. NO	SHEET NO.
		B	SNL-007	1 OF 28

[illegible] DATE: JULY 02, 1996 TIME: 9:42 AM

Shaft Location Plan, Abbreviations, General Notes and Legend Sheet 1 of 28



ALBERT W. DENNIS
5971

Albert W. Dennis
8-2-96

LITHOLOGY:

PRIMARY ROCK/SEDIMENT TYPES		SECONDARY CONSTITUENTS	
▤	MUDSTONE/CLAYSTONE	_ _	ARGILLACEOUS
▤	CLAYSTONE BED	·-·-	SILTY
▨	SILTSTONE	⁘	SANDY
▨	SANDSTONE	\\\\\\\\	SULFATIC
▨	ANHYDRITE/GYPSUM	⊥	DOLOMITIC
▤	DOLOMITE	⊥	CALCAREOUS
☐	HALITE	+ +	HALITIC
▩	POLYHALITE	x x x	POLYHALITIC

NOTES:

1. THE STRATIGRAPHY AND GROUNDWATER BRINE SEEPAGE/WEEP INTERVALS ARE BASED ON THE LITHOLOGIC INFORMATION COMPILED DURING THE GEOLOGIC MAPPING OF THE WASTE HANDLING SHAFT WALLS, WTSD-TME 038, "GEOTECHNICAL ACTIVITIES IN THE WASTE HANDLING SHAFT WASTE ISOLATION PILOT PLANT (WIPP) PROJECT SOUTHEASTERN NEW MEXICO," 1984, AND APPENDIX A OF REPORT DOE/WIPP-95-3117, "WASTE ISOLATION PILOT PLANT SEALING SYSTEM DESIGN REPORT," 1995.

   STRATIGRAPHIC CONTACT AT THE TOP OF THE DEWEY LAKE REDBEDS WAS NOT RECORDED DURING MAPPING. ELEVATION SHOWN IS INTERPRETED FROM RECORDINGS OF THE SALT HANDLING AND EXHAUST SHAFTS.

   ASTERISK (*) WITHIN THE RUSTLER AND SUPRA RUSTLER FORMATIONS INDICATE GROUNDWATER OBSERVED DURING SHAFT MAPPING. ASTERISK (*) WITHIN THE SALADO FORMATION INDICATES A POTENTIAL BRINE SEEPAGE/WEEP INTERVAL. THESE POTENTIAL BRINE SEEPAGE/WEEP INTERVALS, LOCATED ABOVE THE SHAFT STATION LEVEL, ARE BASED ON OBSERVED INTERVALS OF BRINE SEEPAGE/WEEPS IN THE AIR INTAKE SHAFT THAT HAVE BEEN PROJECTED TO THE WASTE SHAFT. THE MAPPING OF THE WASTE SHAFT (HOLT & POWERS, 1984/WTSD-TME-038) DID NOT INDICATE OBSERVED SEEPAGE INTERVALS WITHIN THE SALADO FORMATION.

2. REFERENCE AS-BUILT DRAWINGS FROM WID:

WASTE SHAFT 311 SHAFT DEVELOPMENT SECTIONS	31-R-001-010
WASTE SHAFT 311 SHAFT LINING & KEY SECTIONS AND DETAILS	31-R-002-010
WASTE HANDLING BUILDING 411 HOIST TOWER FOUNDATION PLANS, ELEVATIONS, 76'-0" & 89'-0"	41-D-016-014
WASTE HANDLING BUILDING 411 HOIST TOWER FOUNDATION SECTIONS	41-D-018-014
AS-BUILT FOR WASTE SHAFT COLLAR	OCL A-001

E-5

REV.	DATE	DESCRIPTION	BY	CK.	APP.
0	8/2/96	ISSUED FOR RECORDS PACKAGE			

SANDIA NATIONAL LABORATORIES

WIPP A/E SUPPORT — CONTRACT NO. AC-4808

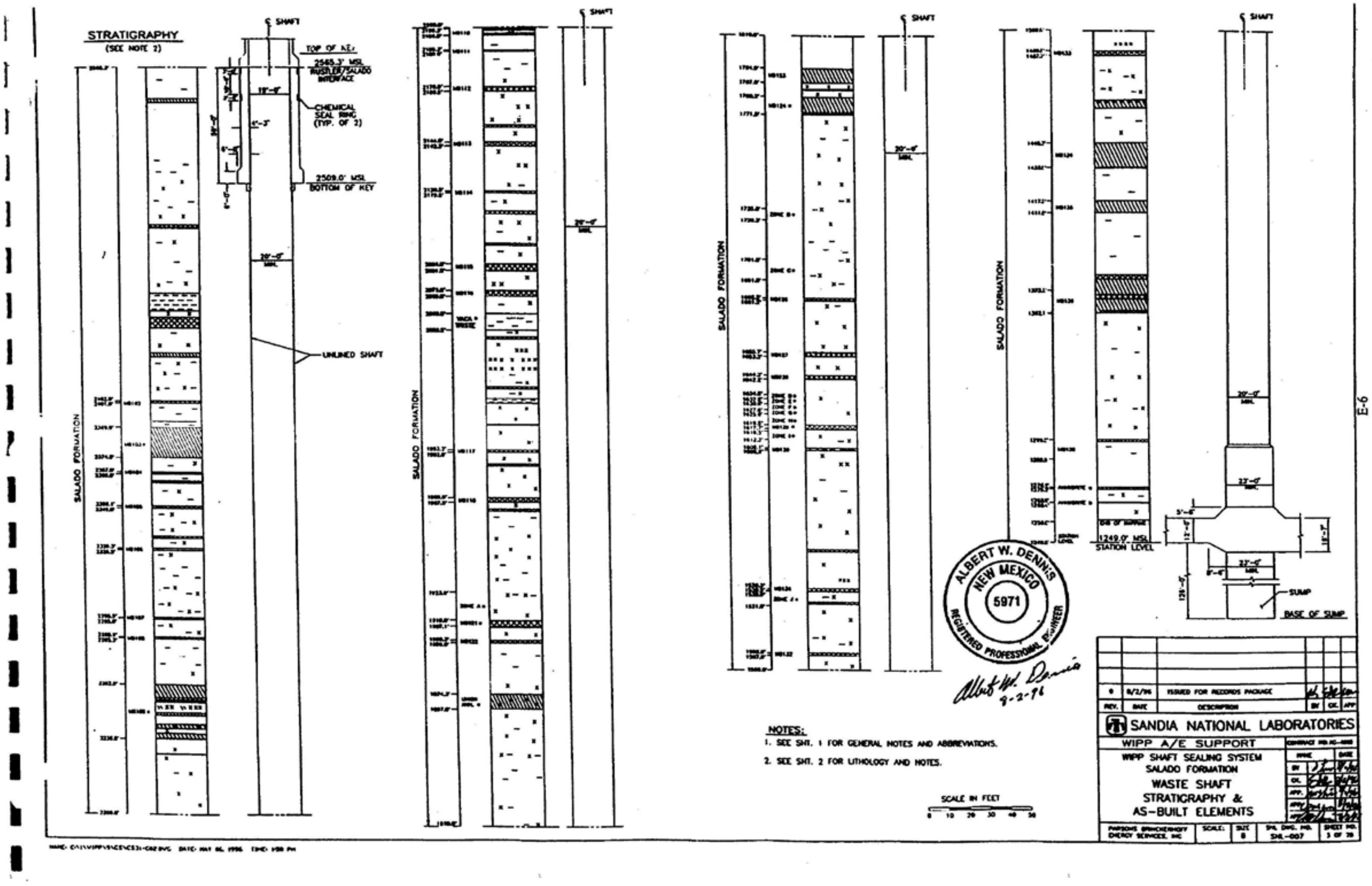
WIPP SHAFT SEALING SYSTEM
NEAR-SURFACE/RUSTLER FORMATIONS
WASTE SHAFT
STRATIGRAPHY &
AS-BUILT ELEMENTS

	NAME	DATE
BY		
CK.		
APP.		
APP.		
APP.		

PARSONS BRINCKERHOFF ENERGY SERVICES, INC	SCALE:	SIZE B	SNL DWG. NO. SNL-007	SHEET NO. 2 OF 28

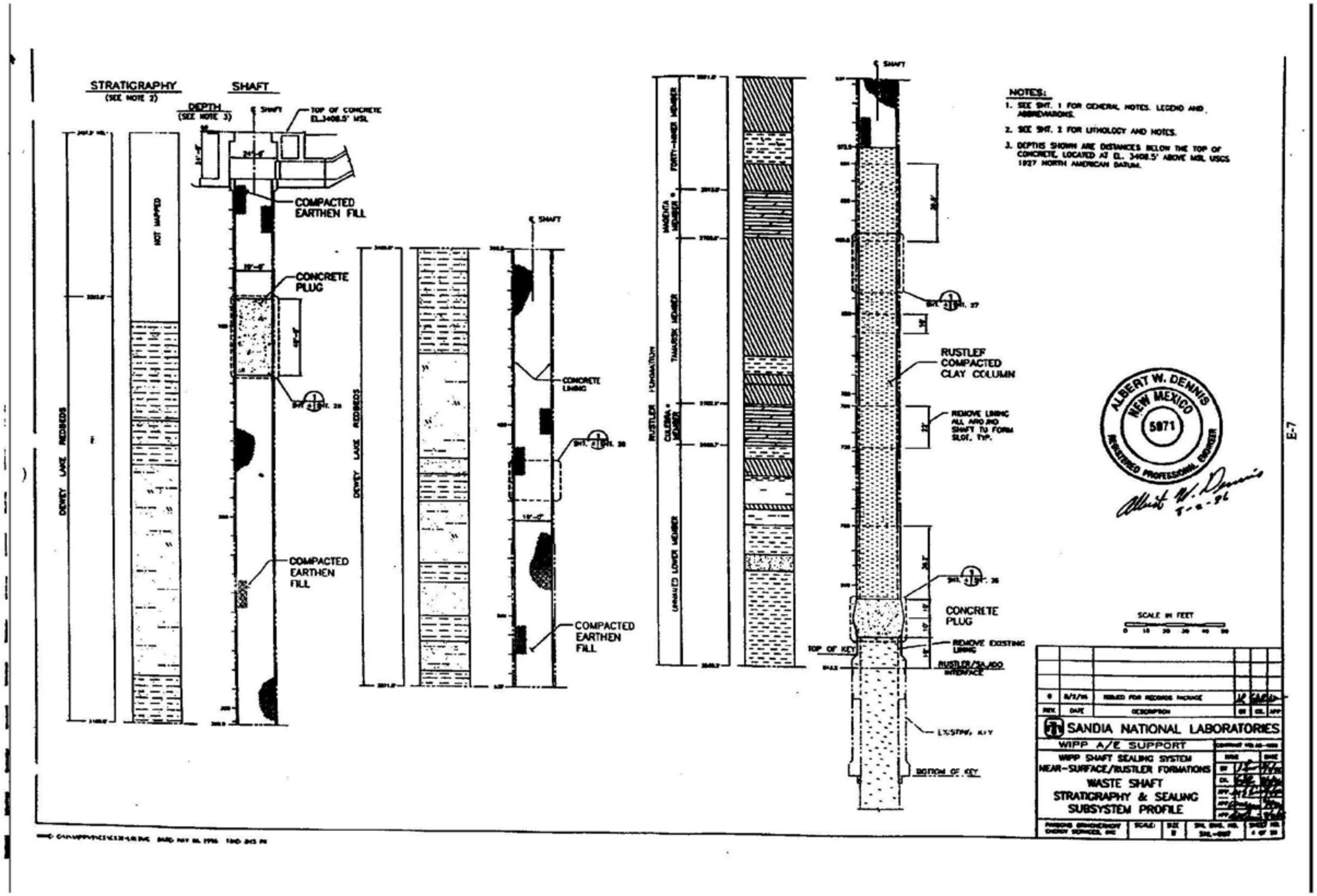
Near-Surface/Rustler Formations Waste Shaft Stratigraphy and AS-Built Elements

Sheet 2 of 28



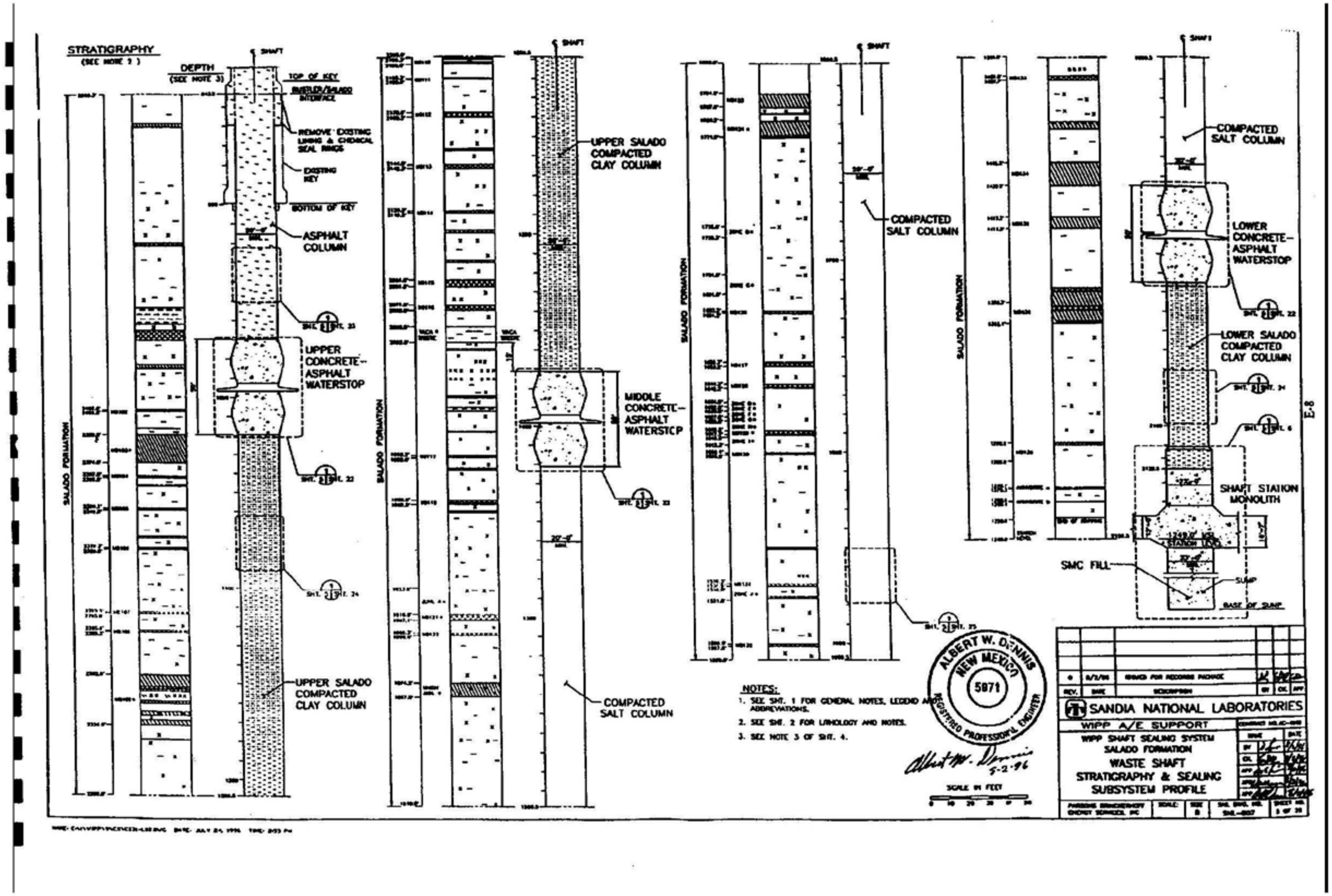
Salado Formation Waste Shaft Stratigraphy and AS-Built Elements

Sheet 3 of 28



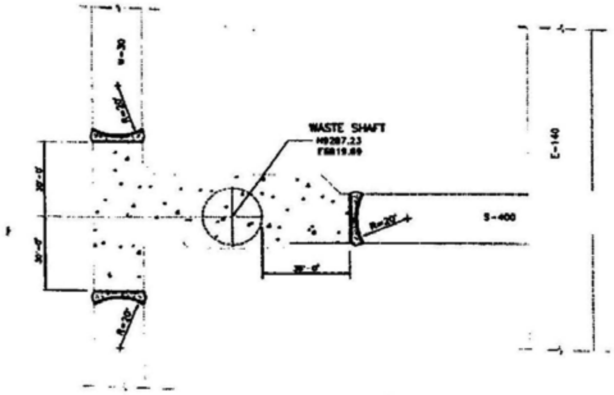
Near-Surface/Rustler Formations Waste Shaft Stratigraphy and Sealing Subsystem Profile

Sheet 4 of 28



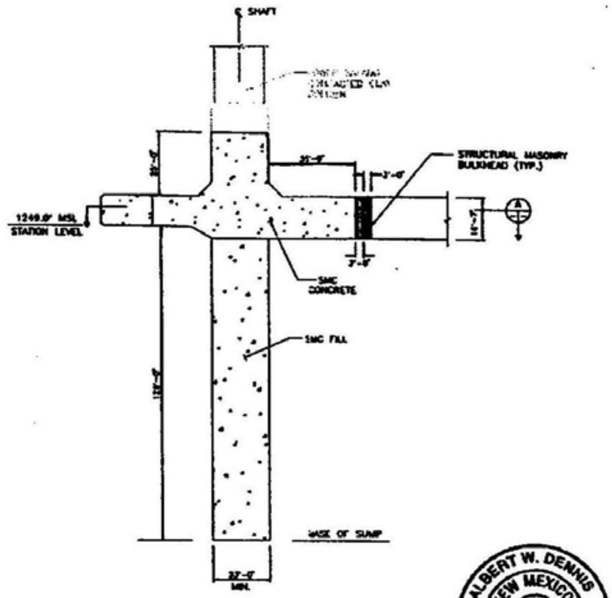
NOTES:
1. SEE SHT. 1 FOR GENERAL NOTES, LEGEND AND ABBREVATIONS.
2. SEE SHT. 2 FOR LITHOLOGY AND NOTES.
3. SEE NOTE 3 OF SHT. 4.

Salado Formation Waste Shaft Stratigraphy and Sealing Subsystem Profile Sheet 5 of 28



SECTION A

N



DETAIL 1

SHT. 5 SHT 6

E-9

ALBERT W. DENNIS
5971

Albert W. Dennis
8-2-96

NOTES:

1. SEE SHT. 1 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.

SCALE IN FEET
0 10 20 30 40 50

REV.	DATE	DESCRIPTION	BY	CK.	APP.
0	6/2/96	ISSUED FOR RECORDS PACKAGE			

SANDIA NATIONAL LABORATORIES

WIPP A/E SUPPORT

WIPP SHAFT SEALING SYSTEM

WASTE SHAFT
SHAFT STATION MONOLITH

PARSONS BRINCKERHOFF ENERGY SERVICES, INC.

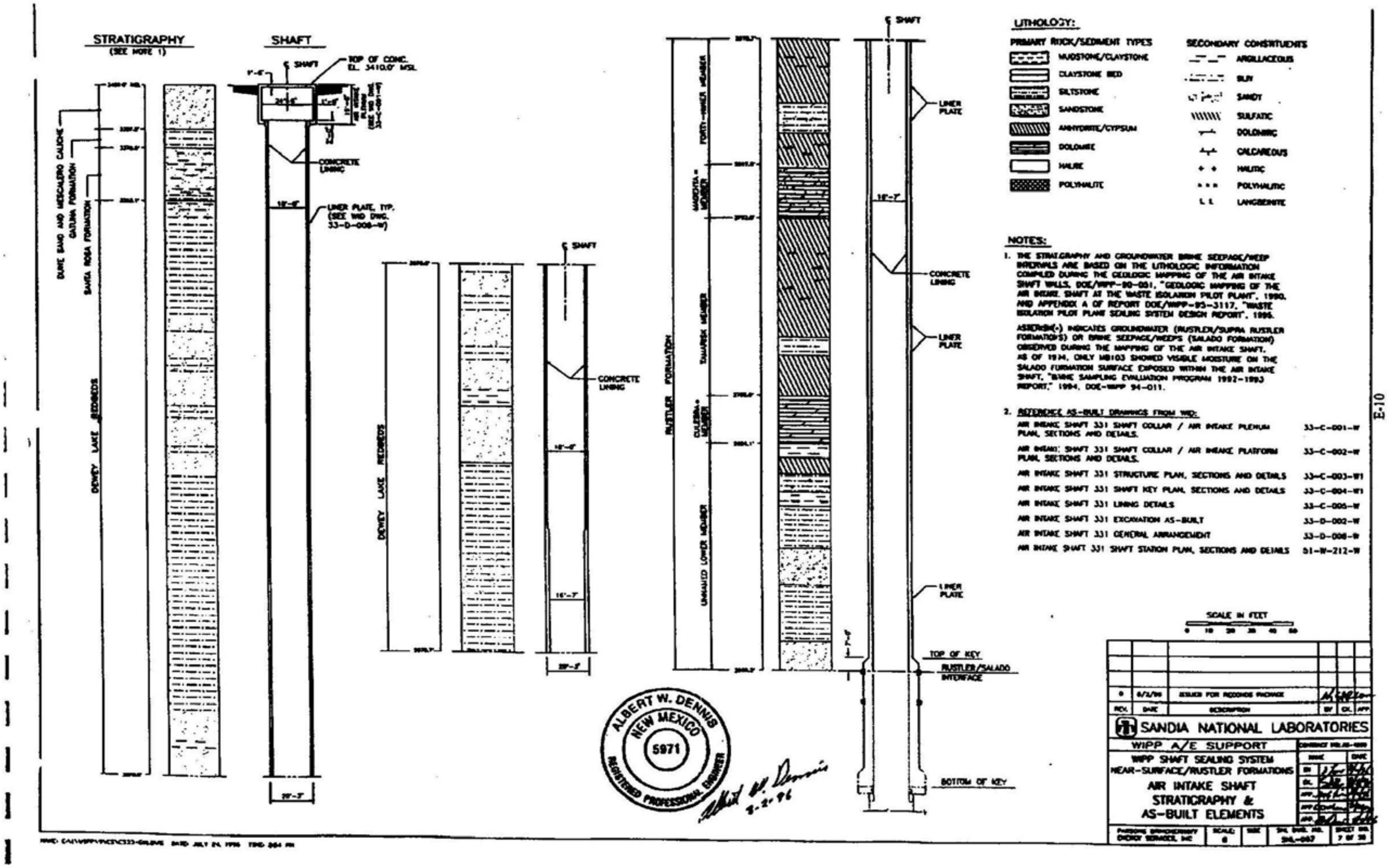
SNL DWG. NO. SNL-007

SHEET NO. 6 of 28

[illegible]

Waste Shaft Station Monolith

Sheet 6 of 28



LITHOLOGY:

PRIMARY ROCK/SEDIMENT TYPES		SECONDARY CONSTITUENTS	
▤	MUDSTONE/CLAYSTONE	_ ‾ _ ‾	ARGILLACEOUS
▭	CLAYSTONE BED	·-·-·	SILTY
▤	SILTSTONE	∴	SANDY
▦	SANDSTONE	\\\\\\\\	SULFATIC
▨	ANHYDRITE/GYPSUM	┬	DOLOMITIC
▤	DOLOMITE	┴┬	CALCAREOUS
▭	HALITE	+ +	HALITIC
▩	POLYHALITE	• • •	POLYHALITIC
		L L	LANGBEINITE

NOTES:

1. THE STRATIGRAPHY AND GROUNDWATER BRINE SEEPAGE/WEEP INTERVALS ARE BASED ON THE LITHOLOGIC INFORMATION COMPILED DURING THE GEOLOGIC MAPPING OF THE AIR INTAKE SHAFT WALLS, DOE/WIPP-90-001, "GEOLOGIC MAPPING OF THE AIR INTAKE SHAFT AT THE WASTE ISOLATION PILOT PLANT", 1990, AND APPENDIX A OF REPORT DOE/WIPP-95-3117, "WASTE ISOLATION PILOT PLANT SEALING SYSTEM DESIGN REPORT", 1995.

   ASTERISK(*) INDICATES GROUNDWATER (RUSTLER/SUPRA RUSTLER FORMATIONS) OR BRINE SEEPAGE/WEEPS (SALADO FORMATION) OBSERVED DURING THE MAPPING OF THE AIR INTAKE SHAFT. AS OF 1994, ONLY MB103 SHOWED VISIBLE MOISTURE ON THE SALADO FORMATION SURFACE EXPOSED WITHIN THE AIR INTAKE SHAFT, "BRINE SAMPLING EVALUATION PROGRAM 1992-1993 REPORT," 1994, DOE-WIPP 94-011.

2. REFERENCE AS-BUILT DRAWINGS FROM WID:

AIR INTAKE SHAFT 331 SHAFT COLLAR / AIR INTAKE PLENUM PLAN, SECTIONS AND DETAILS	33-C-001-W
AIR INTAKE SHAFT 331 SHAFT COLLAR / AIR INTAKE PLATFORM PLAN, SECTIONS AND DETAILS	33-C-002-W
AIR INTAKE SHAFT 331 STRUCTURE PLAN, SECTIONS AND DETAILS	33-C-003-W1
AIR INTAKE SHAFT 331 SHAFT KEY PLAN, SECTIONS AND DETAILS	33-C-004-W1
AIR INTAKE SHAFT 331 LINING DETAILS	33-C-005-W
AIR INTAKE SHAFT 331 EXCAVATION AS-BUILT	33-D-002-W
AIR INTAKE SHAFT 331 GENERAL ARRANGEMENT	33-D-008-W
AIR INTAKE SHAFT 331 SHAFT STATION PLAN, SECTIONS AND DETAILS	51-W-212-W

ALBERT W. DENNIS
5971

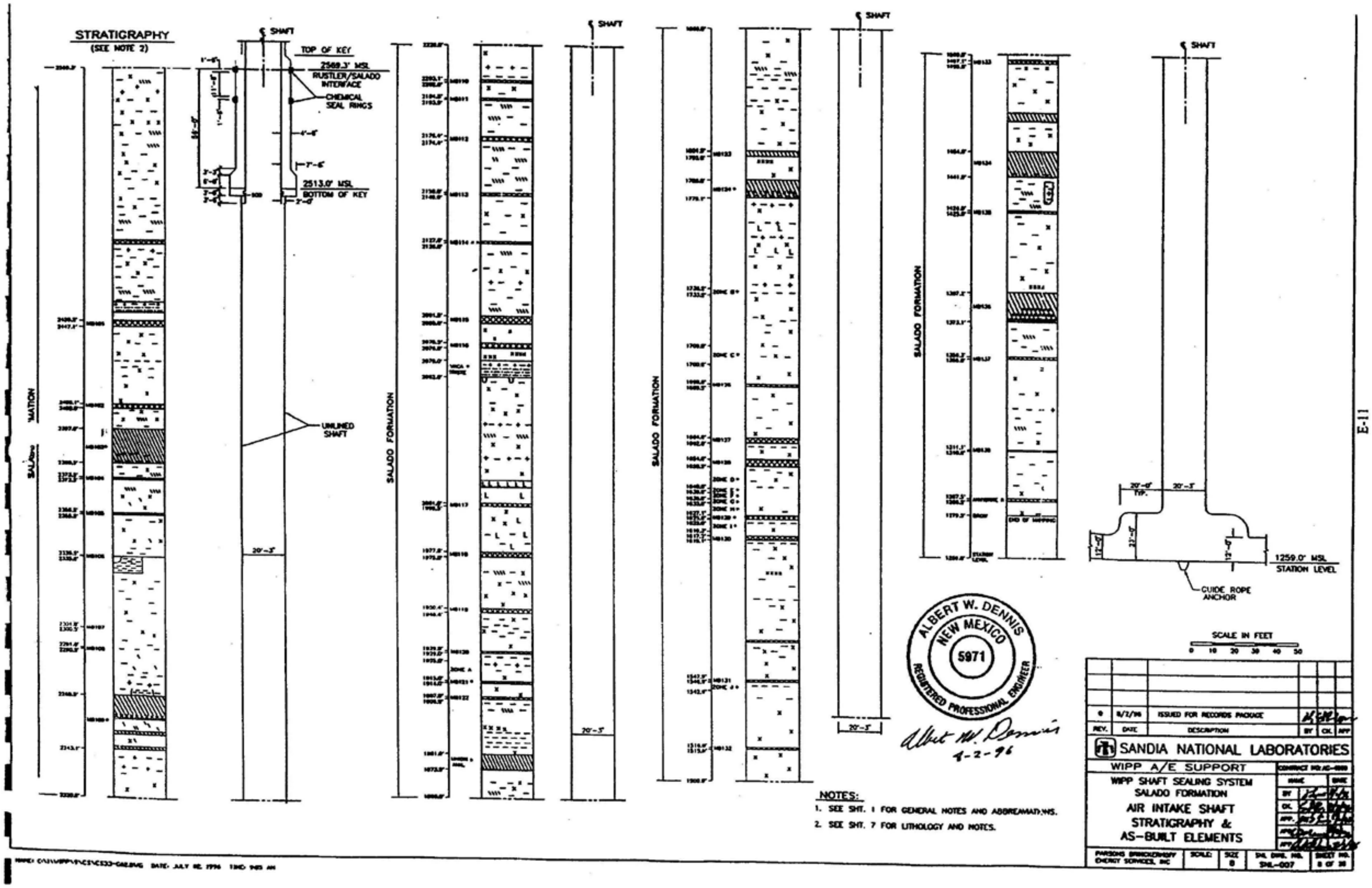
Albert W. Dennis
2-2-96

REV.	DATE	DESCRIPTION	BY	CK.	APP
0	6/2/96	ISSUED FOR RECORDS PACKAGE			

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

PARSONS BRINCKERHOFF ENERGY SERVICES, INC | SCALE: | SIZE | SH. DWG. NO. 96-067 | SHEET NO. 7 OF 28

Near-Surface / Rustler Formations Air Intake Shaft Stratigraphy and AS-Built Elements   Sheet 7 of 28



ALBERT W. DENNIS
5971

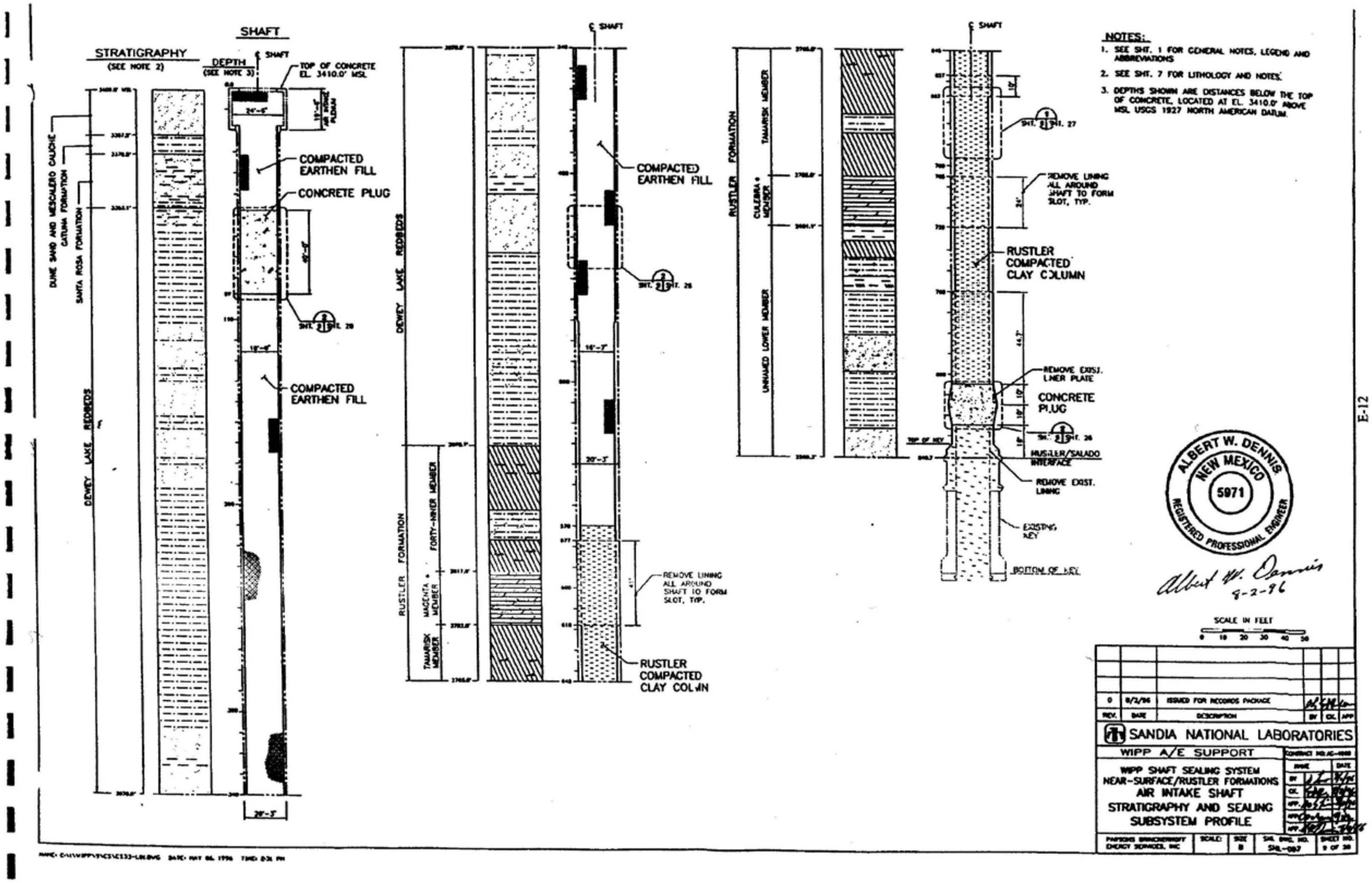
Albert W. Dennis
4-2-96

NOTES:
1. SEE SHT. 1 FOR GENERAL NOTES AND ABBREVIATIONS.
2. SEE SHT. 7 FOR LITHOLOGY AND NOTES.

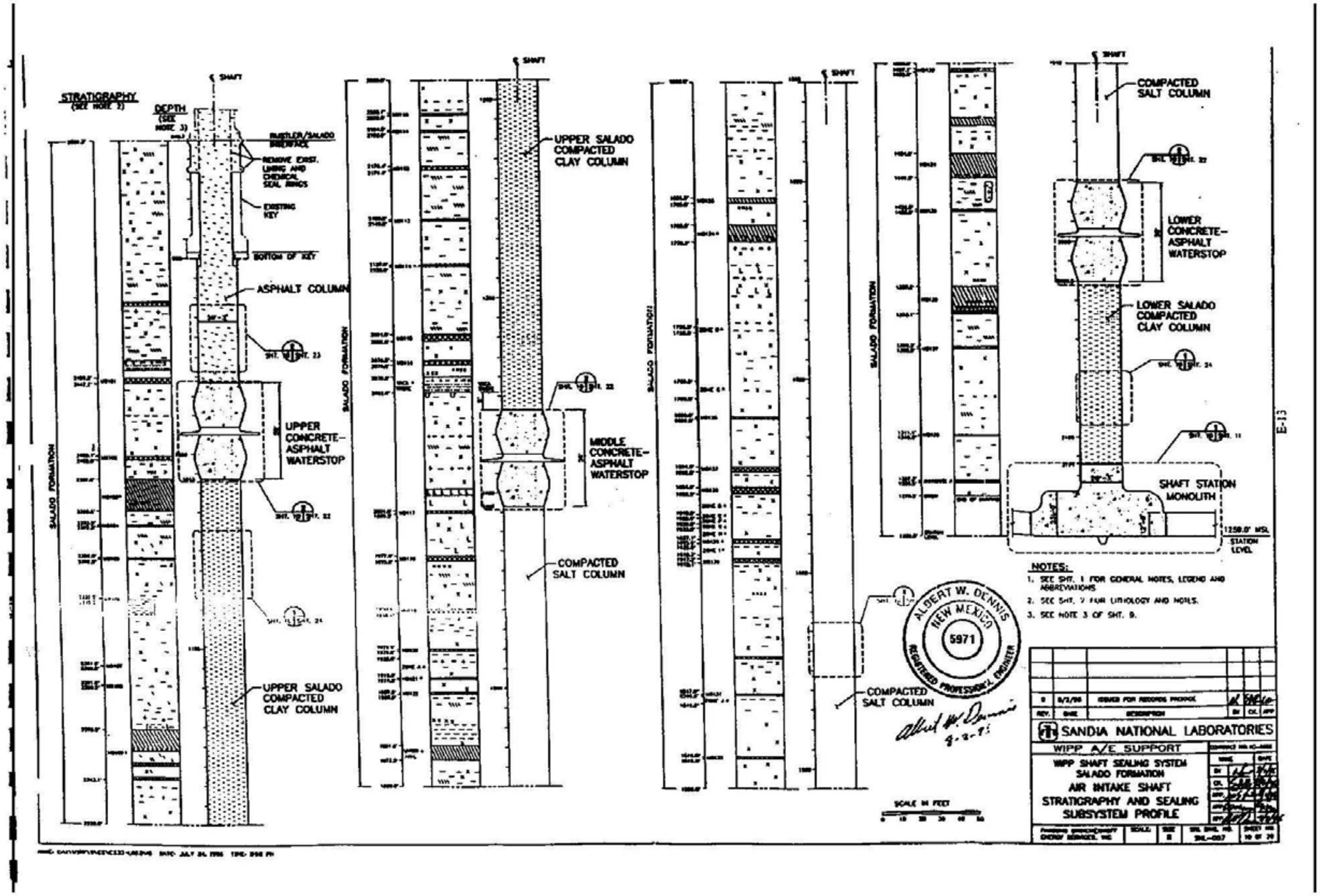
REV.	DATE	DESCRIPTION	BY	CK.	APP
0	8/2/96	ISSUED FOR RECORDS PACKAGE			

SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT
WIPP SHAFT SEALING SYSTEM
SALADO FORMATION
AIR INTAKE SHAFT
STRATIGRAPHY &
AS-BUILT ELEMENTS
PARSONS BRINCKERHOFF ENERGY SERVICES, INC
SIZE B
SNL DWG. NO. SNL-007
SHEET NO. 8 OF 28

Salado Formation Air Intake Shaft Stratigraphy and AS-Built Elements Sheet 8 of 28



Near-Surface / Rustler Formations Air Intake Shaft Stratigraphy and Sealing Subsytem Profile Sheet 9 of 28



NOTES:

1. SEE SHT. 1 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.
2. SEE SHT. 7 FOR LITHOLOGY AND NOTES.
3. SEE NOTE 3 OF SHT. 9.

ALBERT W. DENNIS
5971

Albert W. Dennis
8-2-96

REV.	DATE	DESCRIPTION	BY	CK.	APP.
0	8/2/96	ISSUED FOR RECORDS PACKAGE			

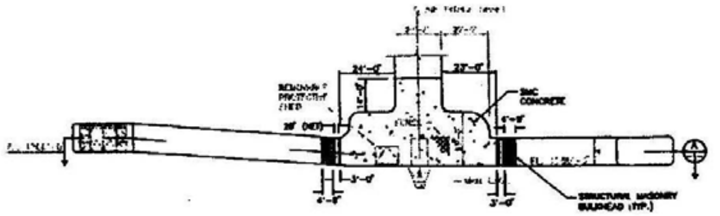
SANDIA NATIONAL LABORATORIES

WIPP A/E SUPPORT

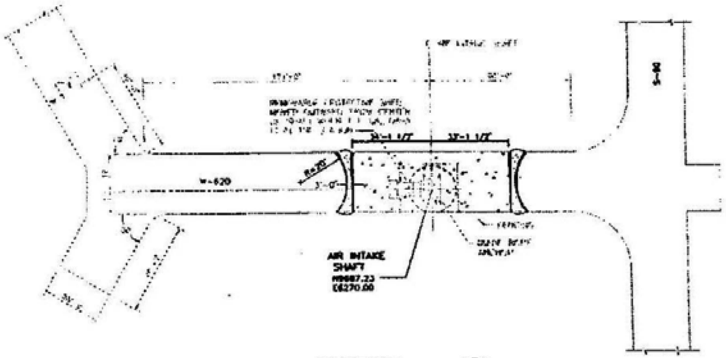
WIPP SHAFT SEALING SYSTEM
SALADO FORMATION
AIR INTAKE SHAFT
STRATIGRAPHY AND SEALING
SUBSYSTEM PROFILE

SHEET 10 OF 28

Salado Formation Air Intake Shaft Stratigraphy and Sealing Subsytem Profile Sheet 10 of 28



DETAIL 1 SHT. 10 SHT. 11



SECTION A

N

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

ALBERT W. DENNIS
5971

A. W. Dennis
9-2-96

SCALE IN FEET
0 10 20 30 40 50

0	6/2/96	ISSUED FOR RECORDS PACKAGE			
REV.	DATE	DESCRIPTION	BY	CK.	APP

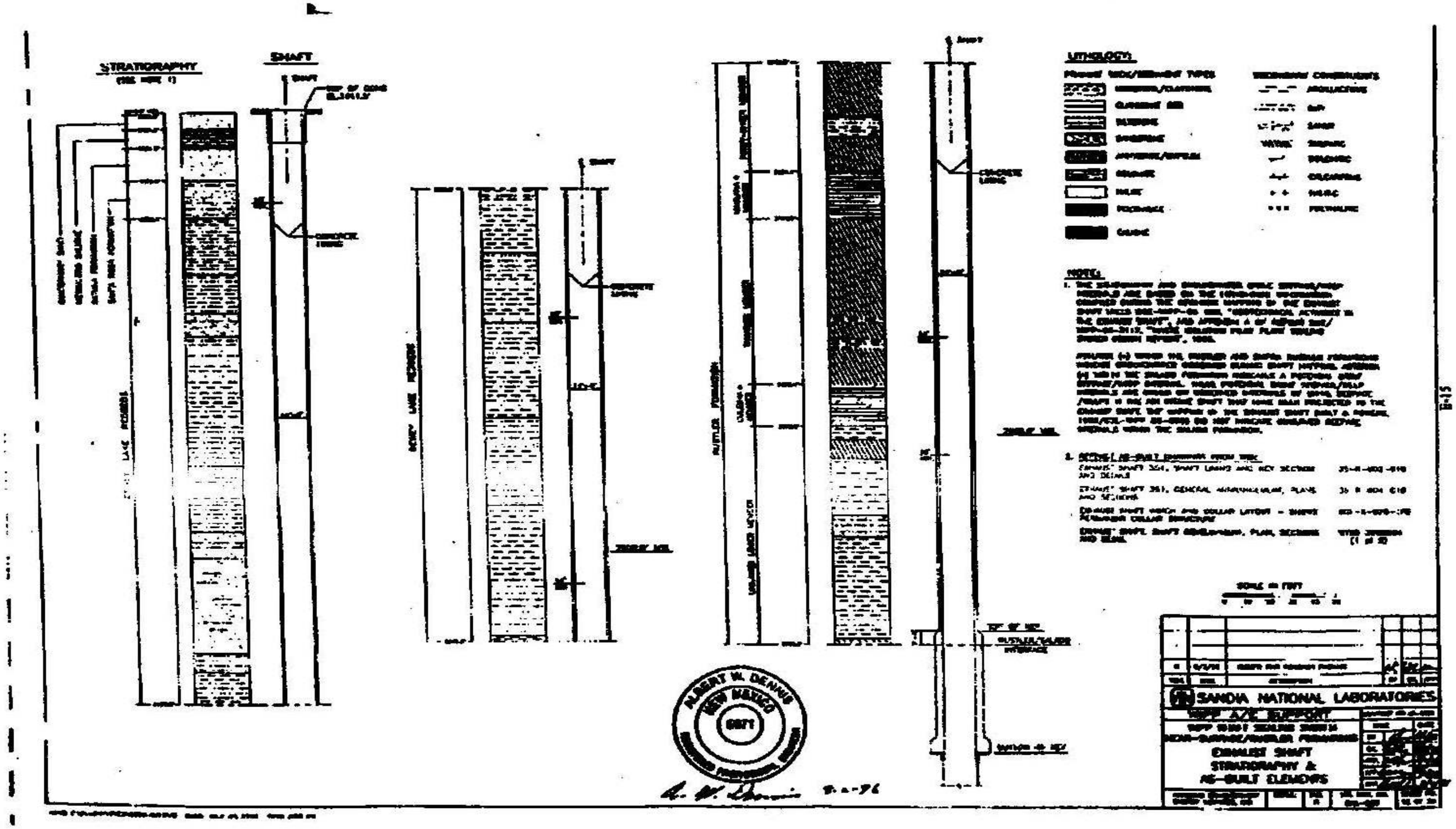
SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT
WIPP SHAFT SEALING SYSTEM
AIR INTAKE SHAFT
SHAFT STATION MONOLITH

PARSONS BRINCKERHOFF ENERGY SERVICES, INC
SCALE
SIZE B
SNL DWG. NO. SNL-007
SHEET NO. 11 OF 28

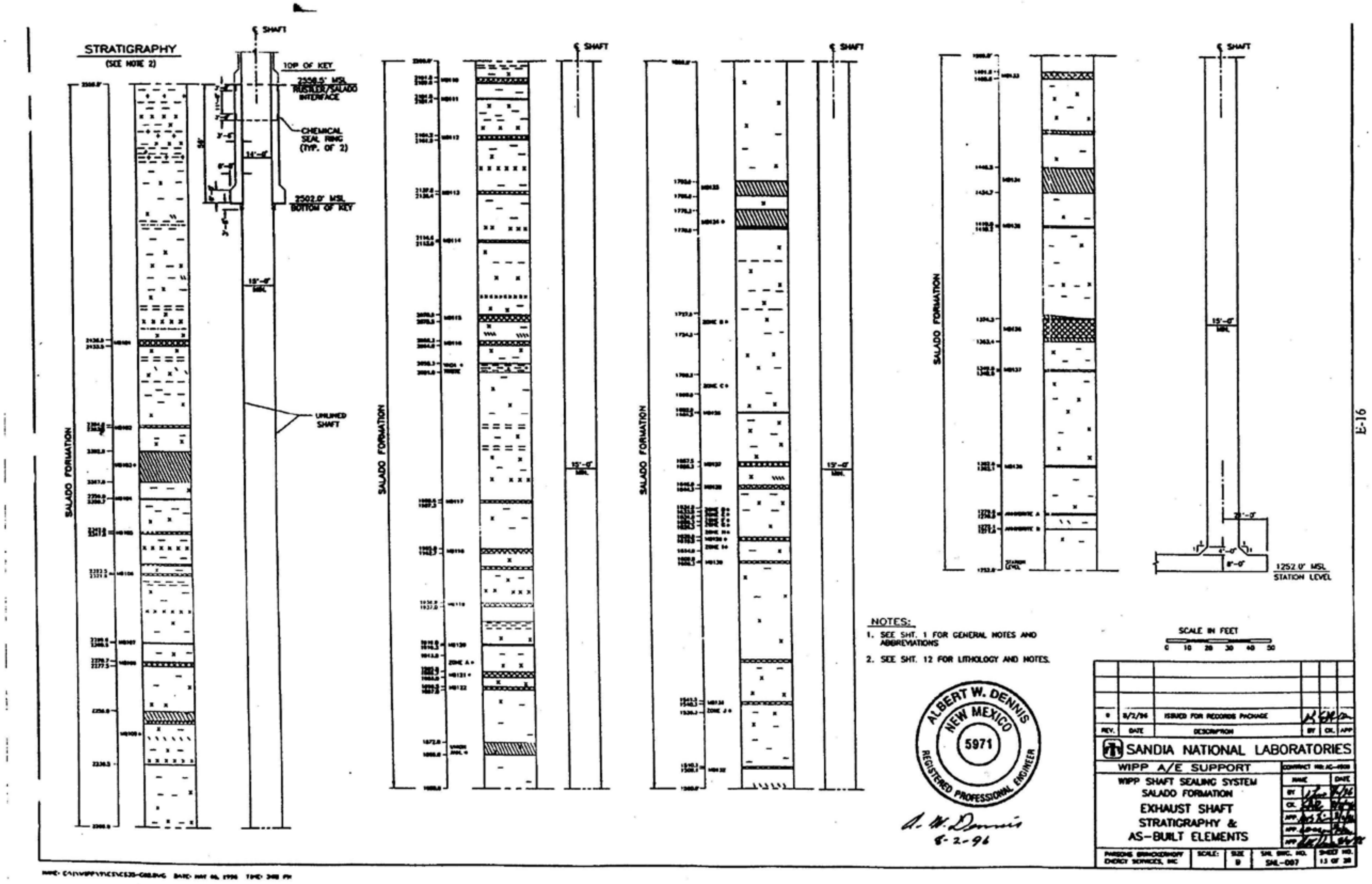
E-14

Air Intake Shaft Station Monolith

Sheet 11 of 28

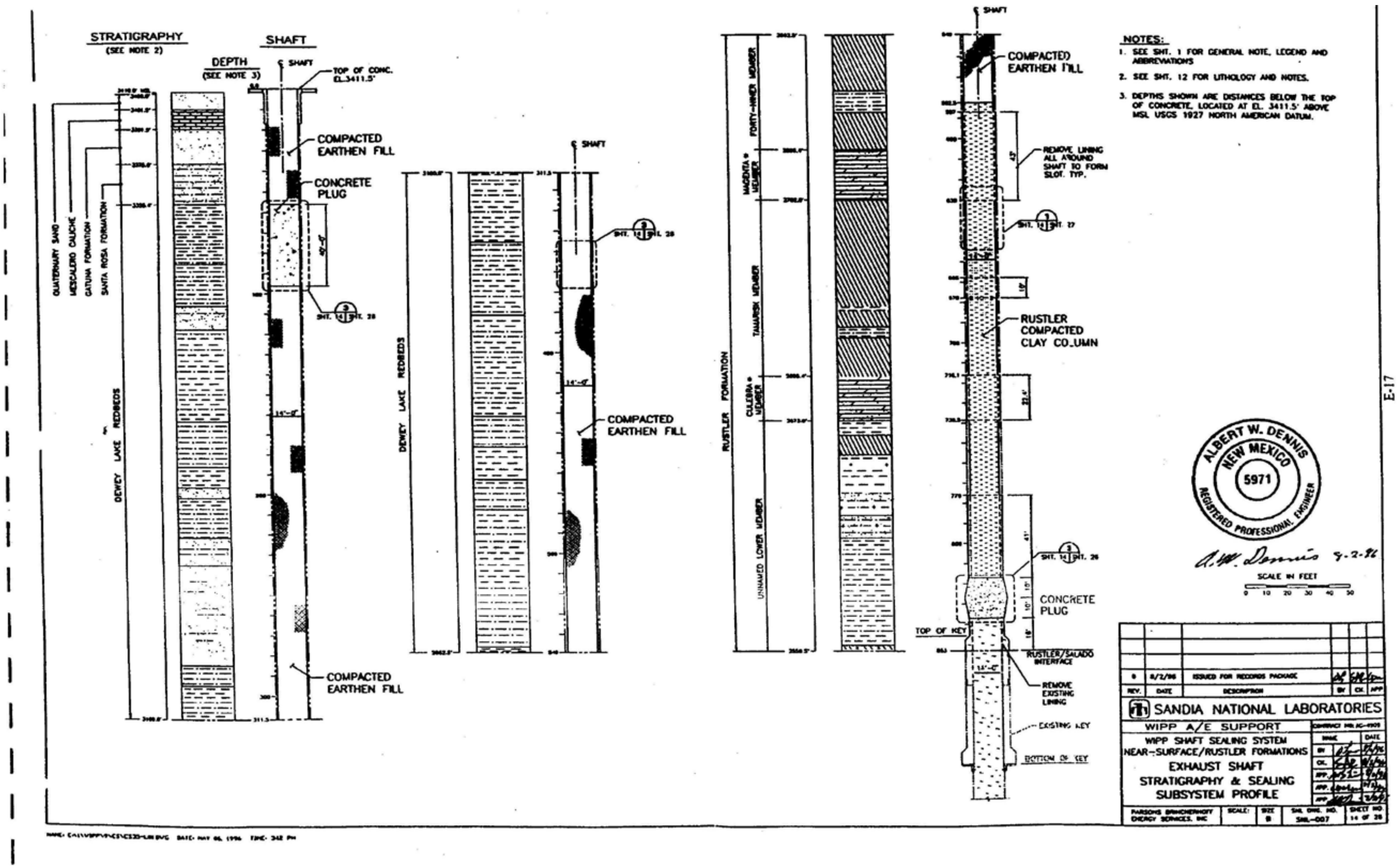


Near-Surface / Rustler Formations Exhaust Shaft Stratigraphy and AS-Built Elements Sheet 12 of 28



Salado Formation Exhaust Shaft Stratigraphy and AS-Built Elements

Sheet 13 of 28



NOTES:

1. SEE SHT. 1 FOR GENERAL NOTE, LEGEND AND ABBREVIATIONS
2. SEE SHT. 12 FOR LITHOLOGY AND NOTES.
3. DEPTHS SHOWN ARE DISTANCES BELOW THE TOP OF CONCRETE, LOCATED AT EL. 3411.5' ABOVE MSL USGS 1927 NORTH AMERICAN DATUM.

ALBERT W. DENNIS 5971

A.W. Dennis 9-2-96

REV.	DATE	DESCRIPTION	BY	CK.	APP
0	8/2/96	ISSUED FOR RECORDS PACKAGE			

SANDIA NATIONAL LABORATORIES

WIPP A/E SUPPORT

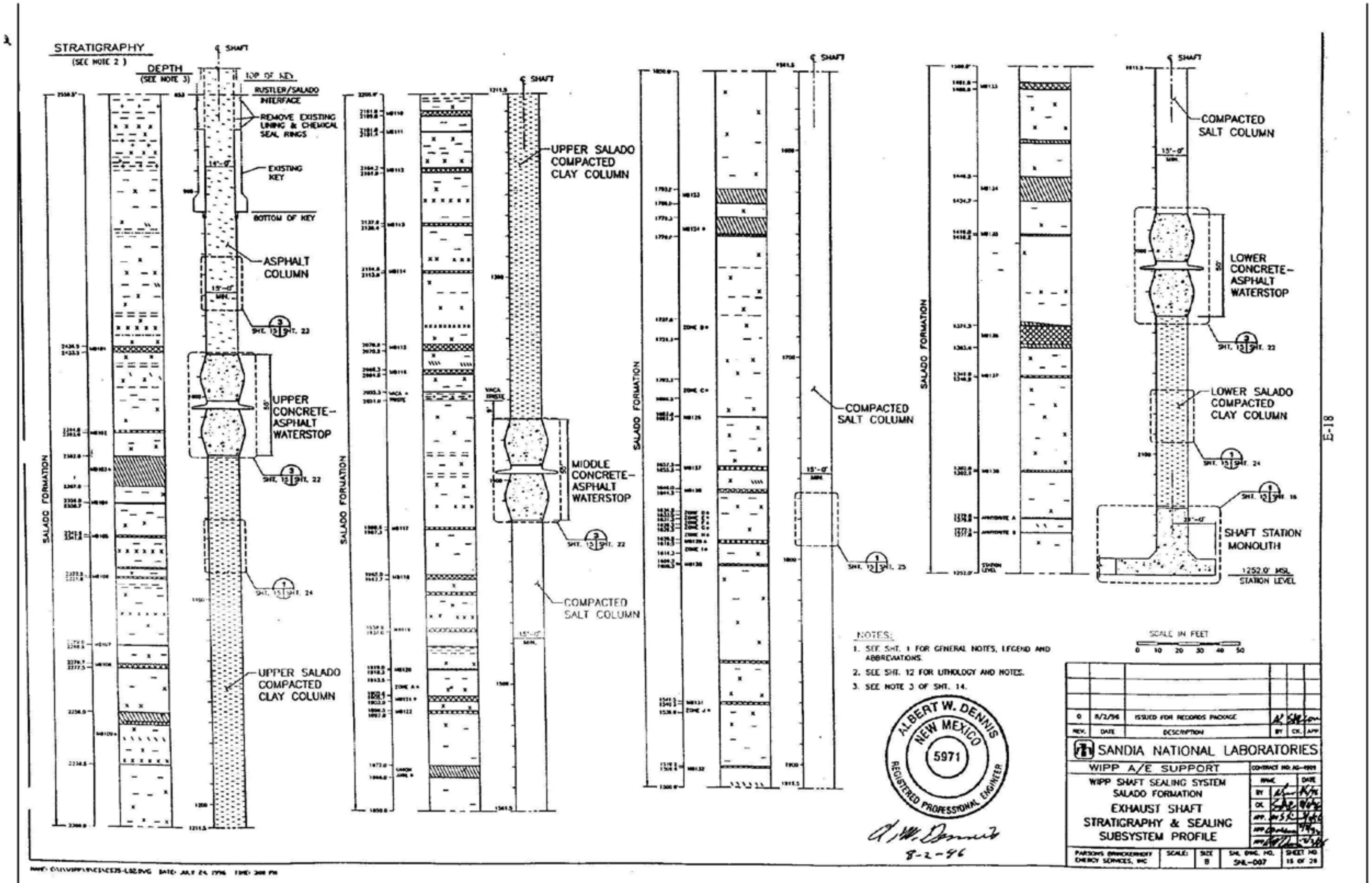
WIPP SHAFT SEALING SYSTEM
NEAR-SURFACE/RUSTLER FORMATIONS
EXHAUST SHAFT
STRATIGRAPHY & SEALING
SUBSYSTEM PROFILE

PARSONS BRINCKERHOFF ENERGY SERVICES, INC

SNL DWG. NO. SNL-007

SHEET NO. 14 OF 28

Near-Surface / Rustler Formations Exhaust Shaft Stratigraphy and Sealing Subsystem Profile Sheet 14 of 28



NOTES:

1. SEE SHT. 1 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.
2. SEE SHT. 12 FOR LITHOLOGY AND NOTES.
3. SEE NOTE 3 OF SHT. 14.

ALBERT W. DENNIS
NEW MEXICO
5971
REGISTERED PROFESSIONAL ENGINEER

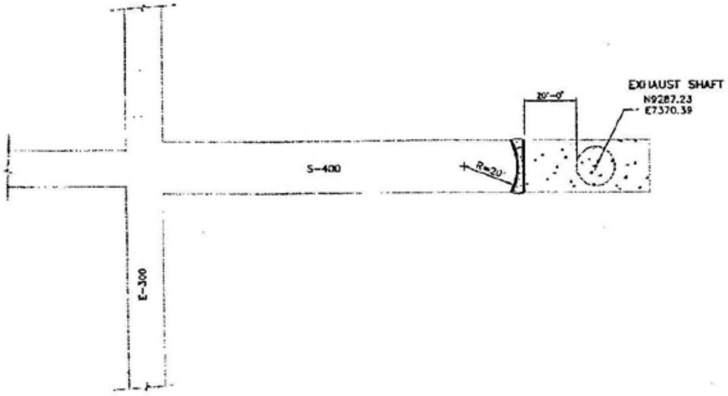
A. W. Dennis
8-2-96

REV.	DATE	DESCRIPTION	BY	CK.	APP
0	8/2/96	ISSUED FOR RECORDS PACKAGE			

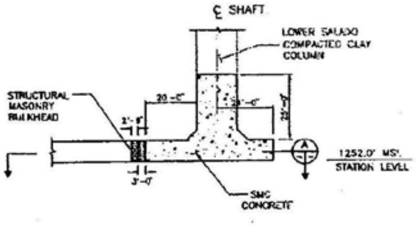
SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT
CONTRACT NO. AG-4909
WIPP SHAFT SEALING SYSTEM
SALADO FORMATION
EXHAUST SHAFT
STRATIGRAPHY & SEALING
SUBSYSTEM PROFILE
PARSONS BRINCKERHOFF ENERGY SERVICES, INC
SCALE:
SIZE B
SNL DWG. NO. SNL-007
SHEET NO 15 OF 28

Salado Formation Exhaust Shaft Stratigraphy and Sealing Subsystem Profile

Sheet 15 of 28



SECTION (A)



DETAIL (1) SHT. 15 SHT. 16

NOTES:

1. SEE SHT. 1 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.

ALBERT W. DENNIS 5971

A.W. Dennis 8-2-96

0	8/2/95	ISSUED FOR RECORDS PACKAGE			
REV.	DATE	DESCRIPTION	BY	CK.	APP

SANDIA NATIONAL LABORATORIES

WIPP A/E SUPPORT

WIPP SHAFT SEALING SYSTEM

CONTRACT NO: AG-4909

	NAME	DATE
BY		8/1/96

Exhaust Shaft Station Monolith

Sheet 16 of 28

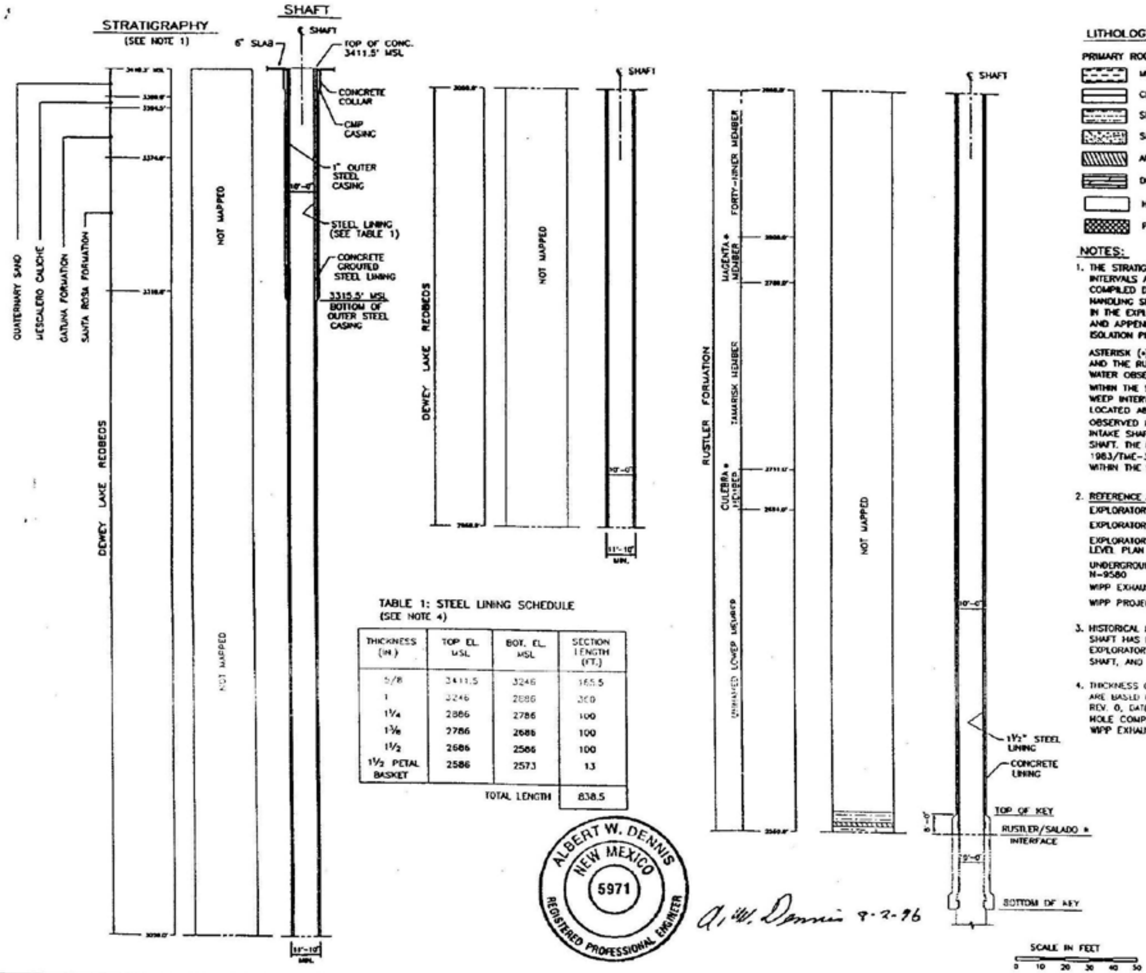


TABLE 1: STEEL LINING SCHEDULE
(SEE NOTE 4)

THICKNESS (IN.)	TOP EL. MSL	BOT. EL. MSL	SECTION LENGTH (FT.)
5/8	3411.5	3246	165.5
1	3246	2886	360
1¼	2886	2786	100
1⅜	2786	2686	100
1½	2686	2586	100
1½ PETAL BASKET	2586	2573	13
		TOTAL LENGTH	838.5

ALBERT W. DENNIS 5971

A. W. Dennis 8-2-96

LITHOLOGY:

PRIMARY ROCK/SEDIMENT TYPES		SECONDARY CONSTITUENTS	
▤	MUDSTONE/CLAYSTONE	–‾ –‾	ARGILLACEOUS
☰	CLAYSTONE BED	·–·–	SILTY
▤	SILTSTONE	⁘	SANDY
▨	SANDSTONE	\\\\\\\\	SULFATIC
▨	ANHYDRITE/GYPSUM	┴	DOLOMITIC
☰	DOLOMITE	┴┬┴	CALCAREOUS
☐	HALITE	+ +	HALITIC
▩	POLYHALITE	x x x	POLYHALITIC

NOTES:

1. THE STRATIGRAPHY AND GROUNDWATER BRINE SEEPAGE/WEEP INTERVALS ARE BASED ON THE LITHOLOGIC INFORMATION COMPILED DURING THE GEOLOGIC MAPPING OF THE SALT HANDLING SHAFT WALLS. TME 3178: "GEOTECHNICAL ACTIVITIES IN THE EXPLORATORY SHAFT-SELECTION OF THE FACILITY INTERVAL"; AND APPENDIX A OF REPORT DOE/WIPP-95-3117, "WASTE ISOLATION PILOT PLANT SEALING SYSTEM DESIGN REPORT", 1995.

   ASTERISK (*) WITHIN THE RUSTLER AND SUPRA RUSTLER FORMATIONS AND THE RUSTLER/SALADO FORMATION CONTACT INDICATES GROUNDWATER OBSERVED PRIOR TO SHAFT LINING INSTALLATION. ASTERISK (*) WITHIN THE SALADO FORMATION INDICATES A POTENTIAL BRINE SEEPAGE/WEEP INTERVAL. THESE POTENTIAL BRINE SEEPAGE/WEEP INTERVALS, LOCATED ABOVE THE SHAFT STATION LEVEL, ARE BASED ON OBSERVED INTERVALS OF BRINE SEEPAGE/WEEPS IN THE AIR INTAKE SHAFT THAT HAVE BEEN PROJECTED TO THE SALT HANDLING SHAFT. THE MAPPING OF THE SALT HANDLING SHAFT (JAROLIMEK ET AL., 1983/TME-3178) DID NOT INDICATE OBSERVED SEEPAGE INTERVALS WITHIN THE SALADO FORMATION.

2. REFERENCE AS-BUILT DRAWINGS FROM WID:

EXPLORATORY SHAFT KEY SHAFT STATION LOCATION, SECTIONS	37-R-010
EXPLORATORY SHAFT KEY, SECTIONS AND DETAILS	37-R-012
EXPLORATORY SHAFT STATION DEVELOPMENT – EXPERIMENTAL LEVEL PLAN AND SECTIONS	37-R-019
UNDERGROUND BASE PLAN E-0 DRIFT FROM N-9900 TO N-9580	51-W-126-W5
WIPP EXHAUST SHAFT 120" I.D. CASING x 834"	FS-M3259-01
WIPP PROJECT 120" I.D. CASING LINER HOLE COMPLEX	FS M3259-02

3. HISTORICAL NOTE: SINCE ITS CONSTRUCTION, THE SALT HANDLING SHAFT HAS BEEN REFERRED TO AS THE EXHAUST SHAFT, THE EXPLORATORY SHAFT, THE CONSTRUCTION AND SALT HANDLING SHAFT, AND THE SALT HANDLING SHAFT.

4. THICKNESS OF STEEL LINING VARIES, LINING TYPE AND LENGTH ARE BASED ON FENIX AND SCISSON AS-BUILT DWGS. M3259-02, REV. 0, DATED 11/30/79, WIPP PROJECT 120" I.D. CASING LINER HOLE COMPLEX, AND M3259-01, REV. 1, DATED 10/13/80, WIPP EXHAUST SHAFT 120" I.D. CASING x 834".

REV.	DATE	DESCRIPTION	BY	CK.	APP
0	8/2/96	ISSUED FOR RECORDS PACKAGE			

SANDIA NATIONAL LABORATORIES

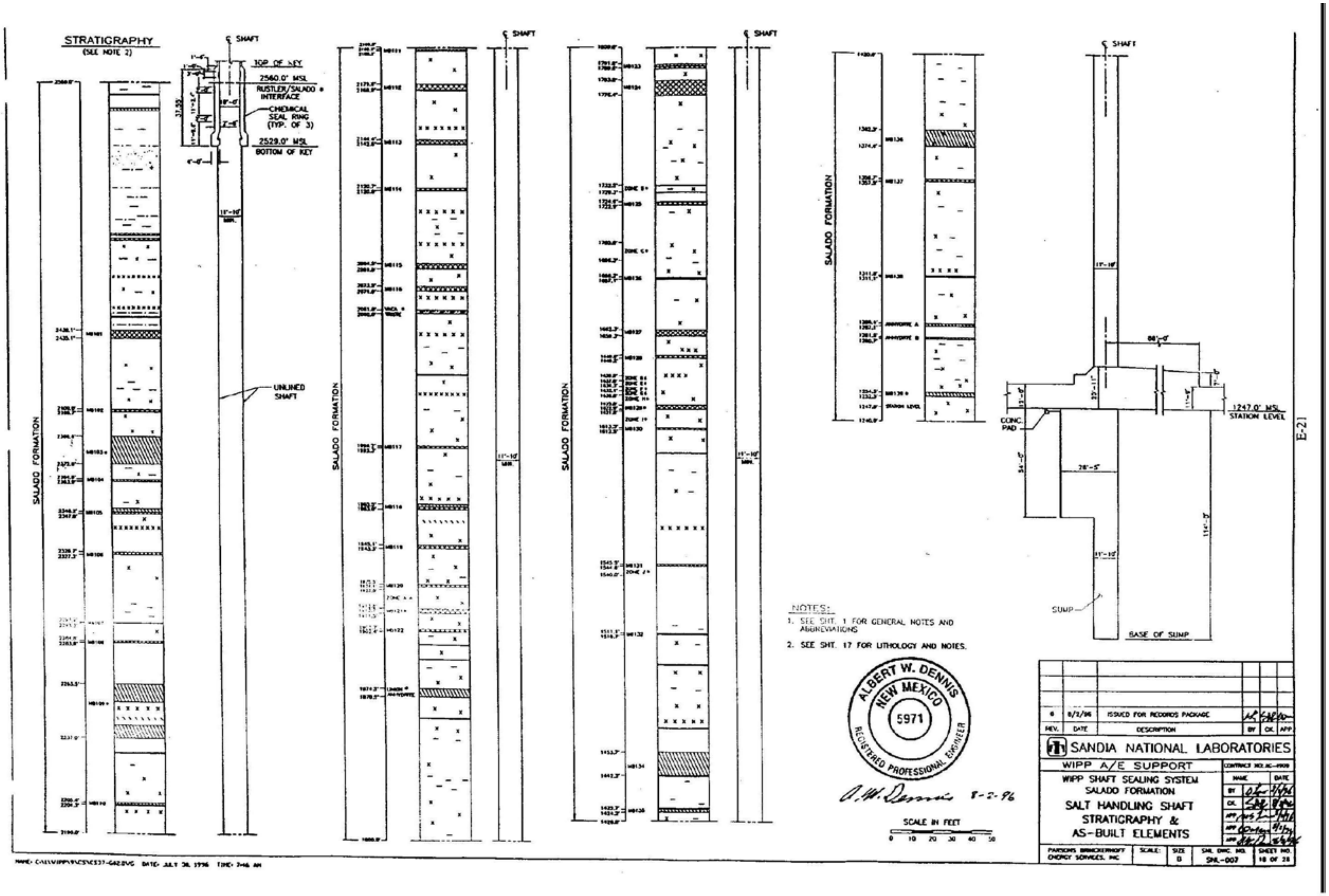
WIPP A/E SUPPORT — CONTRACT NO: AC-4931

WIPP SHAFT SEALING SYSTEM
NEAR-SURFACE/RUSTLER FORMATIONS
SALT HANDLING SHAFT
STRATIGRAPHY &
AS-BUILT ELEMENTS

	NAME	DATE
BY		
CK.		
APP.		
APP.		
APP.		

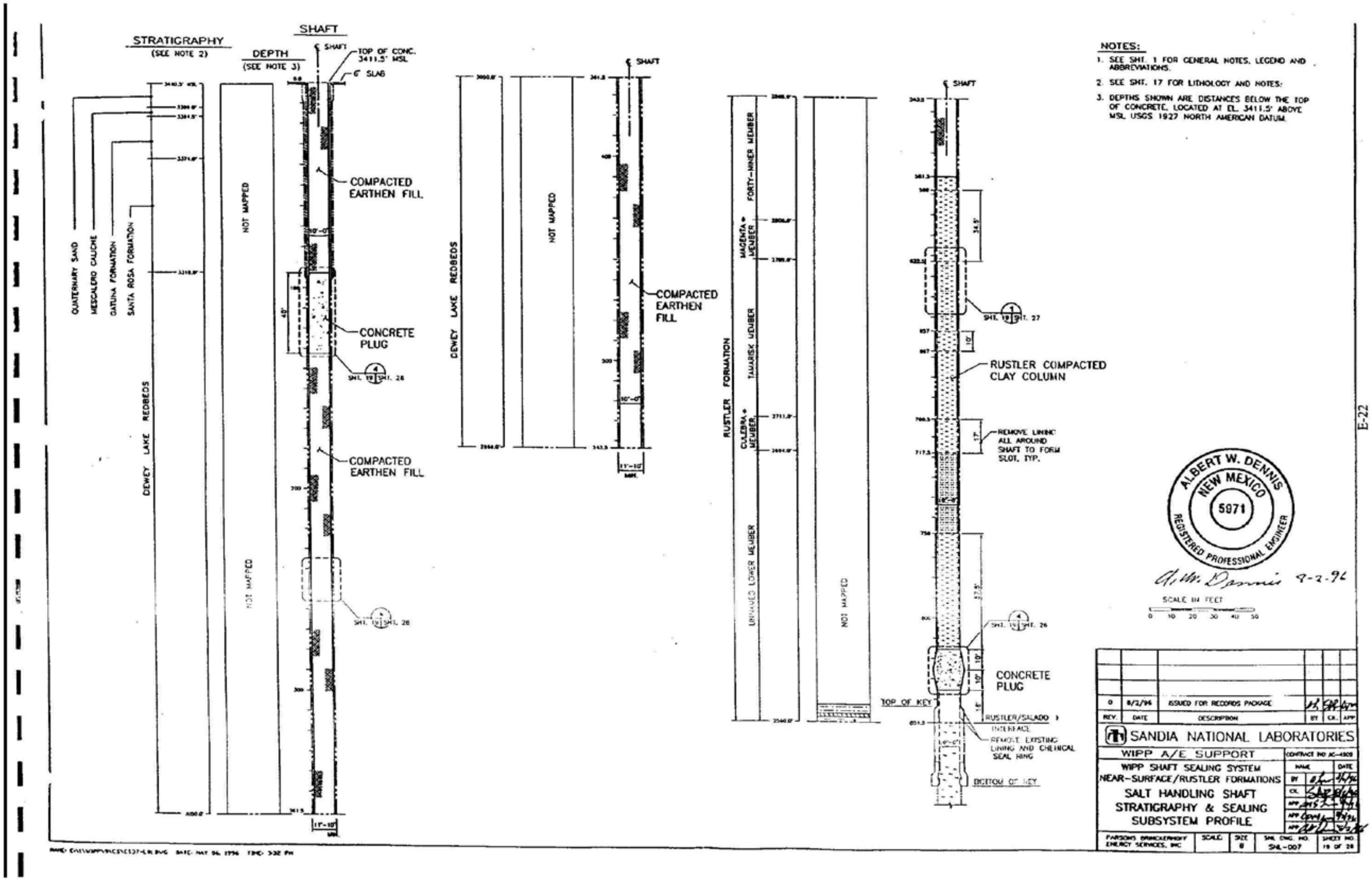
PARSONS BRINCKERHOFF ENERGY SERVICES, INC	SCALE:	SIZE B	SNL DWG. NO. SNL-007	SHEET NO. 17 OF 39

Near-Surface / Rustler Formations Salt Handling Shaft Stratigraphy and AS-Built Elements Sheet 17of 28



Salado Formation Salt Handling Shaft Stratigraphy and AS-Built Elements

Sheet 18 of 28



NOTES:

1. SEE SHT. 1 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.
2. SEE SHT. 17 FOR LITHOLOGY AND NOTES:
3. DEPTHS SHOWN ARE DISTANCES BELOW THE TOP OF CONCRETE, LOCATED AT EL. 3411.5' ABOVE MSL USGS 1927 NORTH AMERICAN DATUM.

ALBERT W. DENNIS 5971

A.W. Dennis 9-2-96

REV.	DATE	DESCRIPTION	BY	CK.	APP
0	9/2/96	ISSUED FOR RECORDS PACKAGE			

SANDIA NATIONAL LABORATORIES

WIPP A/E SUPPORT

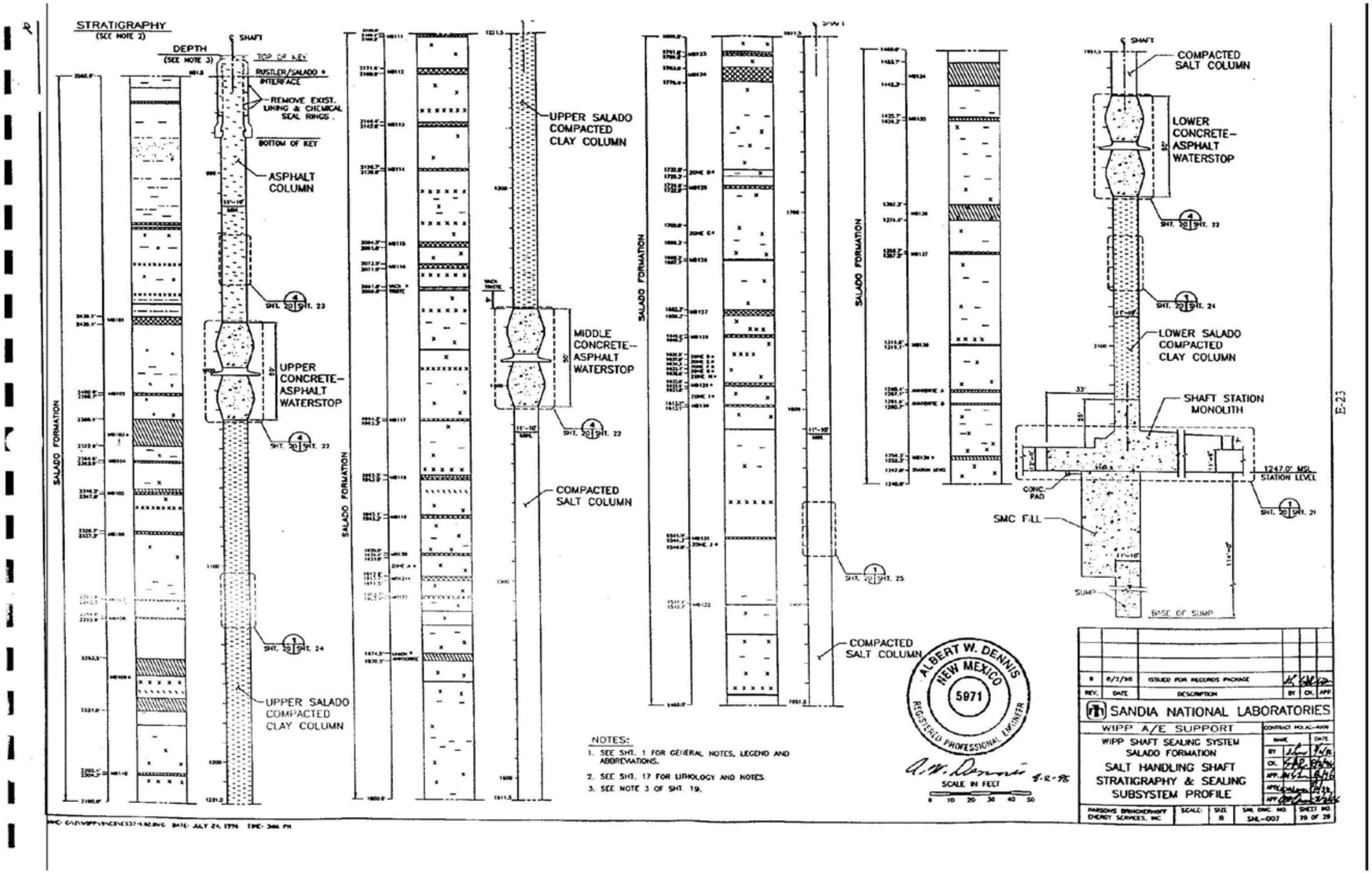
CONTRACT NO AC-4909

WIPP SHAFT SEALING SYSTEM
NEAR-SURFACE/RUSTLER FORMATIONS
SALT HANDLING SHAFT
STRATIGRAPHY & SEALING
SUBSYSTEM PROFILE

PARSONS BRINCKERHOFF ENERGY SERVICES, INC

SCALE	SIZE	SNL DWG. NO.	SHEET NO.
	B	SNL-007	19 OF 28

Near-Surface / Rustler Formations Salt Handling Shaft Stratigraphy and Sealing Subsystem Profile Sheet 19 of 28



NOTES:
1. SEE SHT. 1 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.
2. SEE SHT. 17 FOR LITHOLOGY AND NOTES.
3. SEE NOTE 3 OF SHT. 19.

ALBERT W. DENNIS
NEW MEXICO
5971
REGISTERED PROFESSIONAL ENGINEER

A.W. Dennis 8-2-96

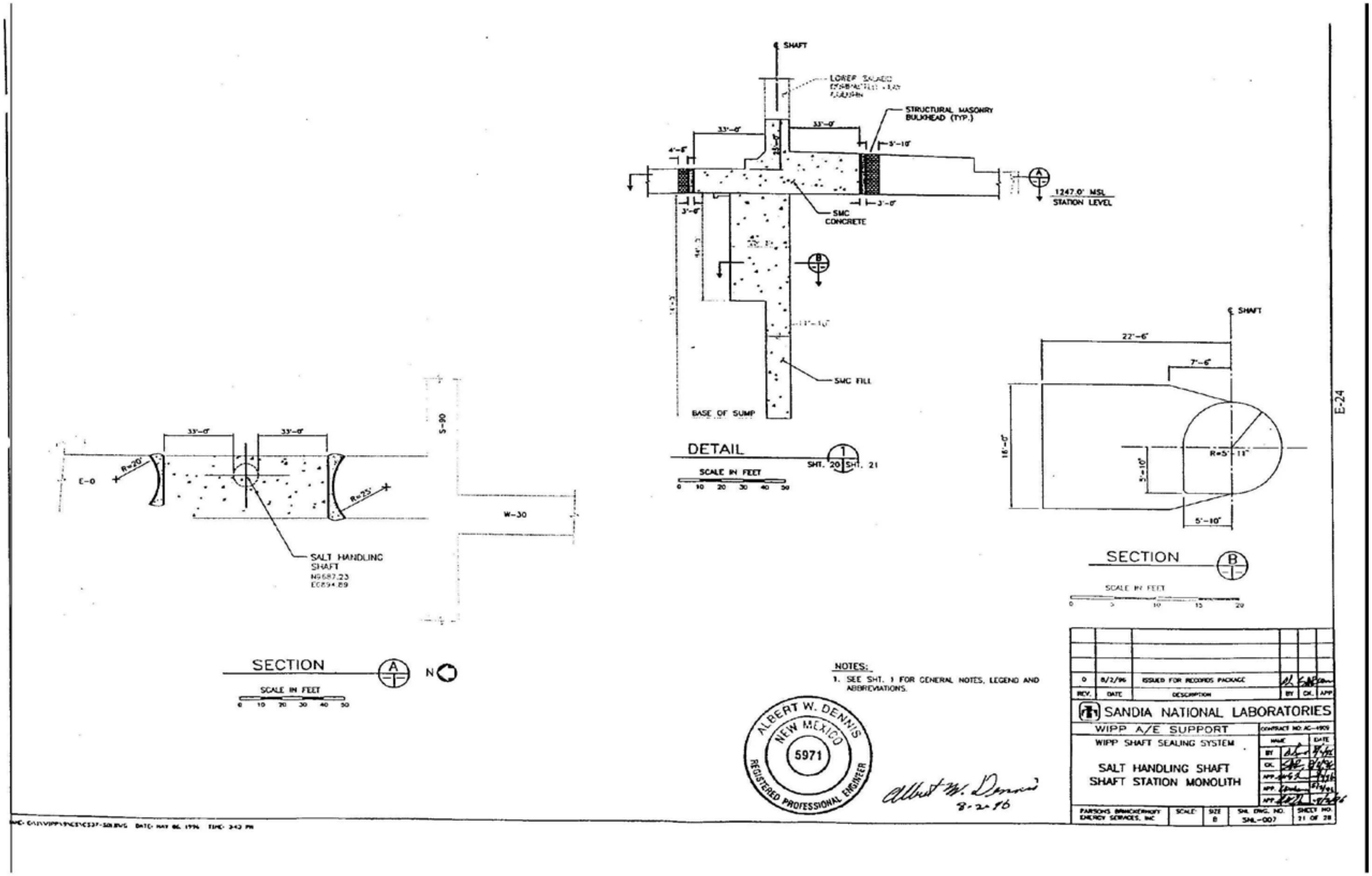
REV.	DATE	DESCRIPTION	BY	CK.	APP
0	8/7/96	ISSUED FOR RECORDS PACKAGE			

SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT
CONTRACT NO. AC-4009
WIPP SHAFT SEALING SYSTEM
SALADO FORMATION
SALT HANDLING SHAFT
STRATIGRAPHY & SEALING
SUBSYSTEM PROFILE

PARSONS BRINCKERHOFF ENERGY SERVICES, INC | SCALE: | SIZE B | SNL DWG. NO. SNL-007 | SHEET NO. 20 OF 28

Salado Formation Salt Handling Shaft Stratigraphy and Sealing Subsystem Profile

Sheet 20 of 28



NOTES:

1. SEE SHT. 1 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.

ALBERT W. DENNIS 5971

Albert W. Dennis
8-2-96

REV.	DATE	DESCRIPTION	BY	CK.	APP
0	8/2/96	ISSUED FOR RECORDS PACKAGE			

SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT
CONTRACT NO: AC-4909
WIPP SHAFT SEALING SYSTEM
SALT HANDLING SHAFT
SHAFT STATION MONOLITH

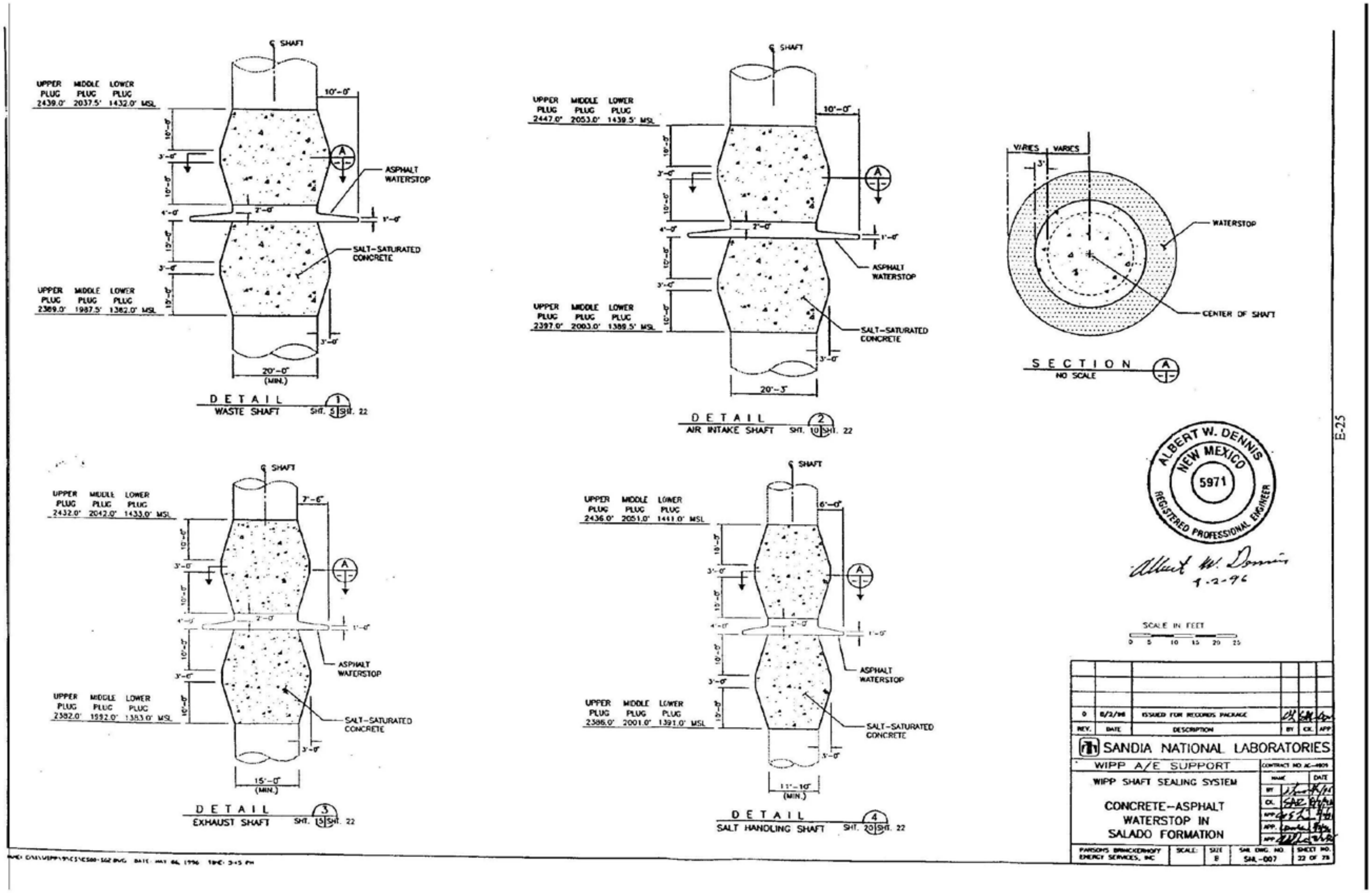
	NAME	DATE
BY		
CK.		
APP.		
APP.		8/2/96
APP.		

PARSONS BRINCKERHOFF ENERGY SERVICES, INC	SCALE:	SIZE B	SNL DWG. NO. SNL-007	SHEET NO. 21 OF 28

DATE: MAY 06, 1996 TIME: 3:43 PM

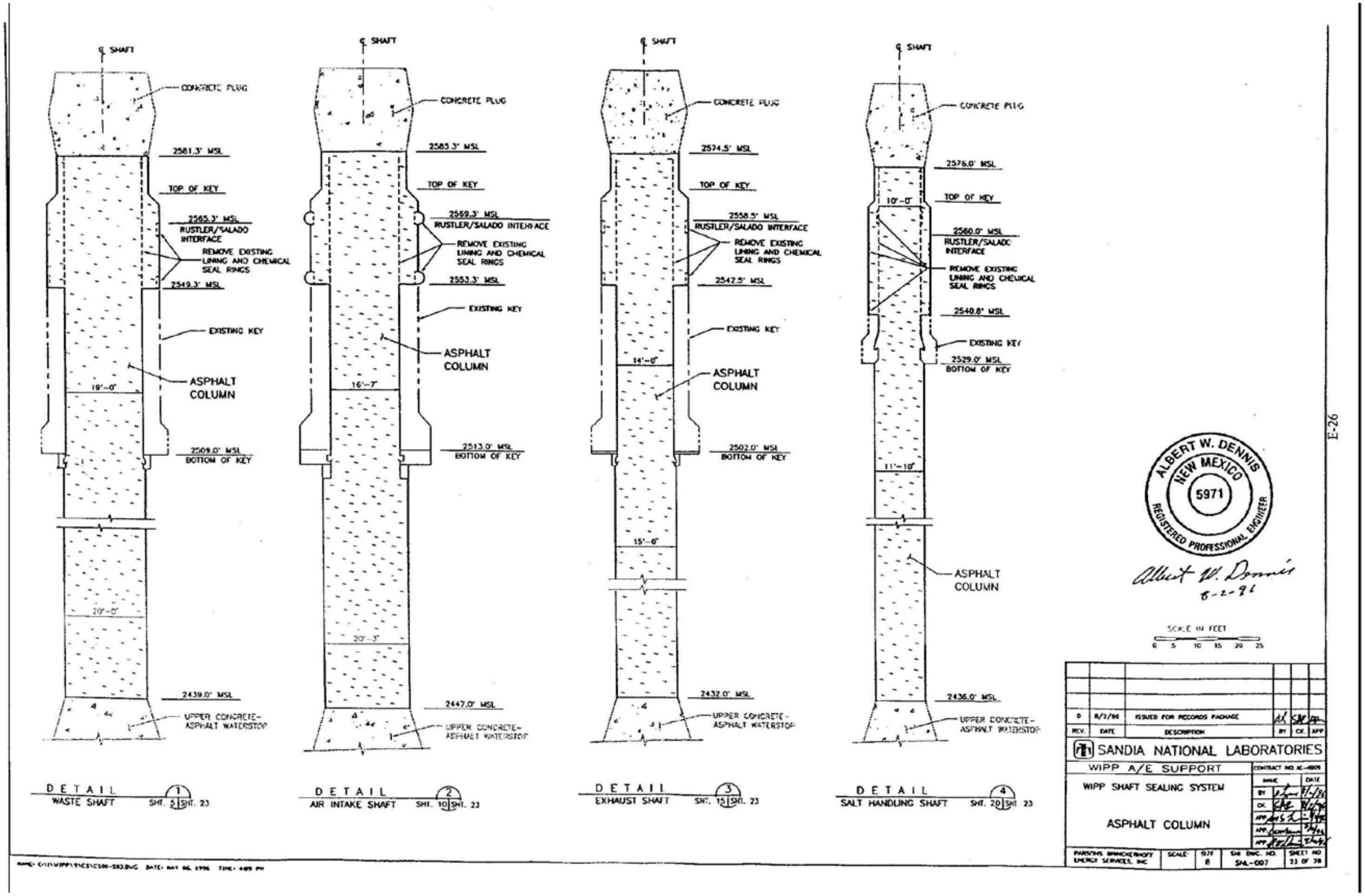
Salt Handling Shaft Shaft Station Monolith

Sheet 21 of 28



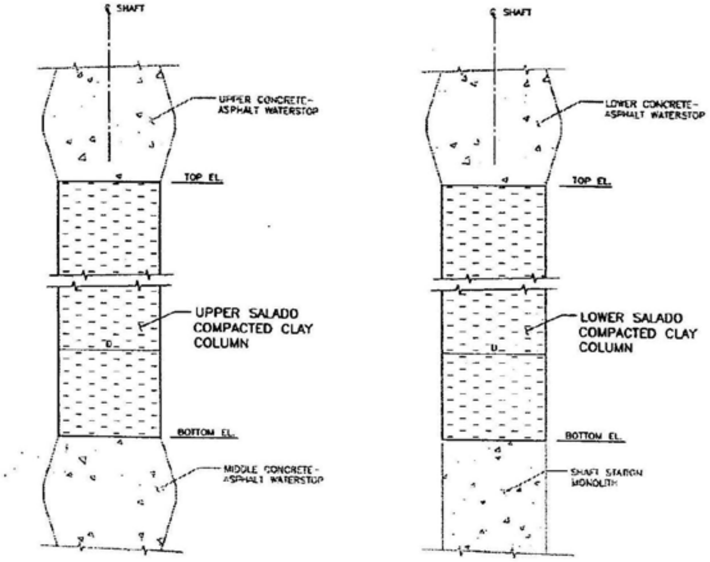
Concrete-Asphalt Water Stop in Salado Formation

Sheet 22 of 28



Asphalt Column

Sheet 23 of 28



DETAIL ①
SEE TABLE 1 FOR DETAILS
NO SCALE

SHT. 5 | SHT. 24
SHT. 10
SHT. 15
SHT. 20

TABLE 1

SHAFT	NOMINAL SHAFT DIAMETER D	UPPER SALADO COMPACTED CLAY COLUMN			LOWER SALADO COMPACTED CLAY COLUMN		
		TOP EL. (FT. MSL)	BOTTOM EL. (FT. MSL)	TOTAL HT. (FT.)	TOP EL. (FT. MSL)	BOTTOM EL. (FT. MSL)	TOTAL HT. (FT.)
WASTE	20'-0"	2389.0	2037.5	351.5	1382.0	1286.0	96.0
AIR INTAKE	20'-3"	2397.0	2053.0	344.0	1389.5	1296.0	93.5
EXHAUST	15'-0"	2382.0	2042.0	340.0	1383.0	1285.0	98.0
SALT HANDLING	11'-10"	2386.0	2051.0	335.0	1391.0	1284.0	107.0

ALBERT W. DENNIS
5971

Albert W. Dennis
9-2-96

REV.	DATE	DESCRIPTION	BY	CK.	APP.
0	8/2/96	ISSUED FOR RECORDS PACKAGE			

SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT
CONTRACT NO. AG-4909
WIPP SHAFT SEALING SYSTEM

UPPER AND LOWER SALADO
COMPACTED CLAY COLUMNS

NAME | DATE
BY
CK.
APP.
APP.
APP.

PARSONS BRINCKERHOFF ENERGY SERVICES, INC
SCALE:
SIZE B
SNL DWG. NO. SNL-007
SHEET NO. 24 OF 28

NAME: C:\WIPP\SNL\C500-S24.DWG DATE: MAY 06, 1996 TIME: 4:42 PM

Upper and Lower Salado Compacted Clay Columns

Sheet 24 of 28

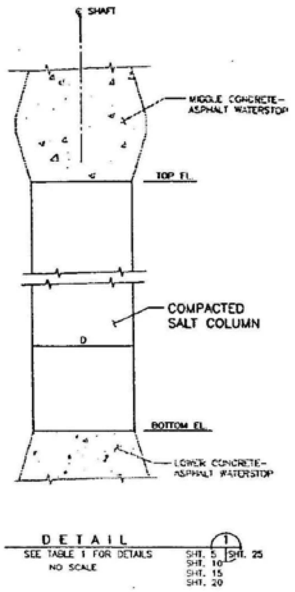


TABLE 1

SHAFT	NOMINAL SHAFT DIAMETER D	COMPACTED SALT COLUMN		
		TOP EL. (FT. MSL)	BOTTOM EL. (FT. MSL)	TOTAL HT. (FT.)
WASTE	20'–0"	1987.5	1432.0	555.5
AIR INTAKE	20'–3"	2003.0	1439.5	563.5
EXHAUST	15'–0"	1992.0	1433.0	559.0
SALT HANDLING	11'–10"	2001.0	1441.0	560.0

ALBERT W. DENNIS
5971

Albert W. Dennis
8-2-96

REV.	DATE	DESCRIPTION	BY	CK.	APP
0	8/2/96	ISSUED FOR RECORDS PACKAGE			

SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT
CONTRACT NO. AG-4909
WIPP SHAFT SEALING SYSTEM

COMPACTED
SALT COLUMN

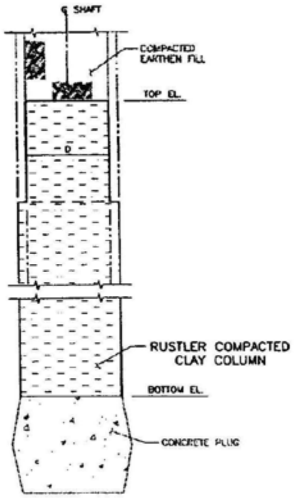
PARSONS BRINCKERHOFF ENERGY SERVICES, INC
SCALE:
SIZE B
SNL DWG. NO. SNL-007
SHEET NO 25 OF 28

Compacted Salt Column

Sheet 25 of 28

WIPP Shaft Sealing System Concrete Plug

Drawing SNL 007 26 of 28 not currently available. Drawing is not displayed in the Permit.



DETAIL 1
SEE TABLE 1 FOR DETAILS
NO SCALE
SHT. 4
SHT. 9
SHT. 14
SHT. 19
SHT. 27

TABLE 1

SHAFT	NOMINAL SHAFT DIAMETER D	RUSTLER COMPACTED CLAY COLUMN		
		TOP EL. (FT. MSL)	BOTTOM EL. (FT. MSL)	TOTAL HT. (FT.)
WASTE	19'–0"	2836.0	2601.3	234.7
AIR INTAKE	16'–7"	2840.0	2605.3	234.7
EXHAUST	14'–0"	2829.0	2594.5	234.5
SALT HANDLING	10'–0"	2830.0	2596.0	234.0

ALBERT W. DENNIS
5971

Albert W. Dennis
8-2-96

0	8/2/96	ISSUED FOR RECORDS PACKAGE			
REV.	DATE	DESCRIPTION	BY	CK.	APP

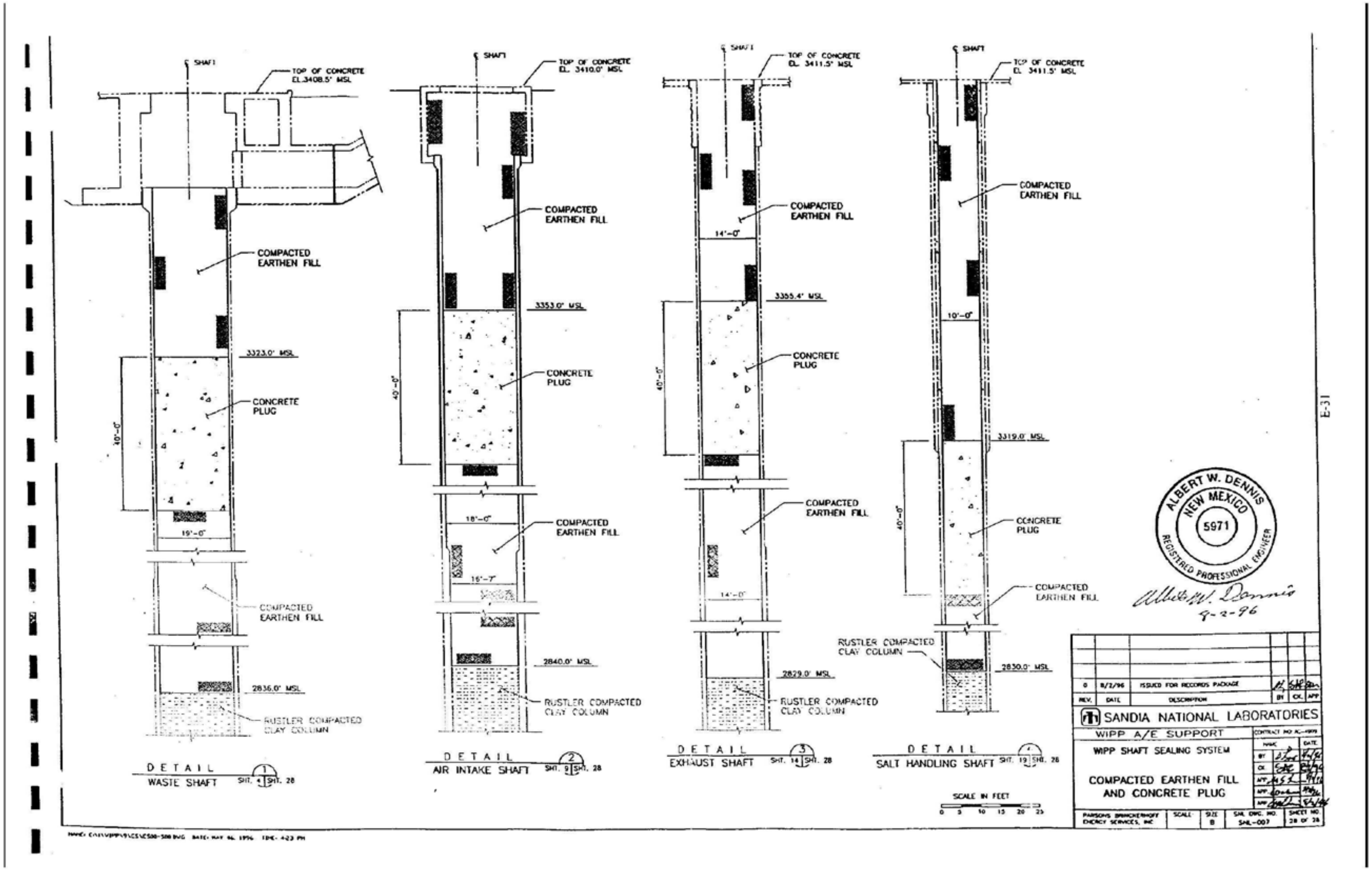
SANDIA NATIONAL LABORATORIES
WIPP A/E SUPPORT
CONTRACT NO: AC-4908
WIPP SHAFT SEALING SYSTEM

RUSTLER COMPACTED
CLAY COLUMN

NAME DATE
BY
CK.
APP.
APP.
APP.

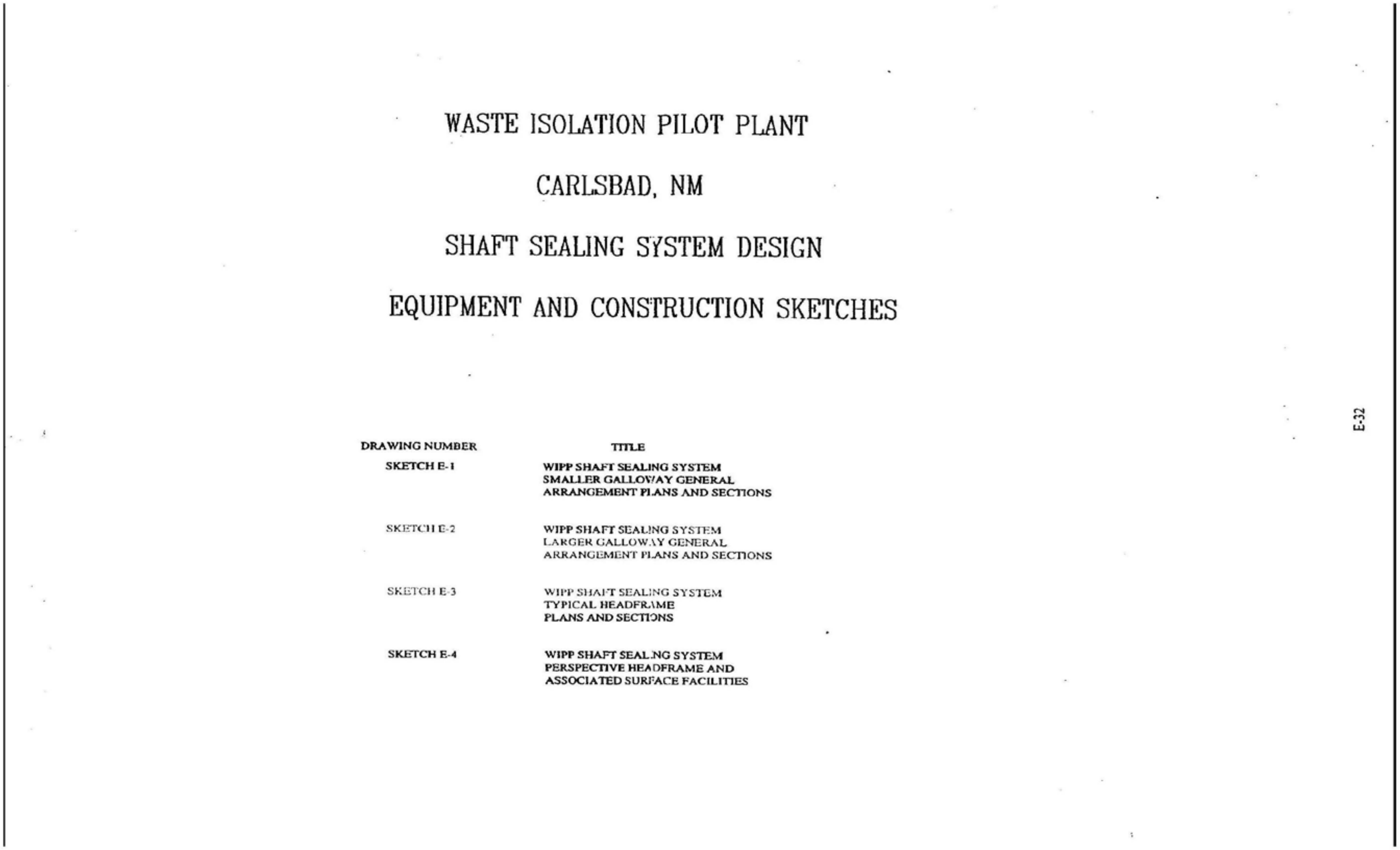
PARSONS BRINCKERHOFF ENERGY SERVICES, INC
SCALE:
SIZE B
SNL DWG. NO SNL-007
SHEET NO. 27 OF 28

NAME: [illegible] DATE: MAY 06, 1996 TIME: [illegible]



Compacted Earthen Fill and Concrete Plug

Sheet 28 of 28



WASTE ISOLATION PILOT PLANT

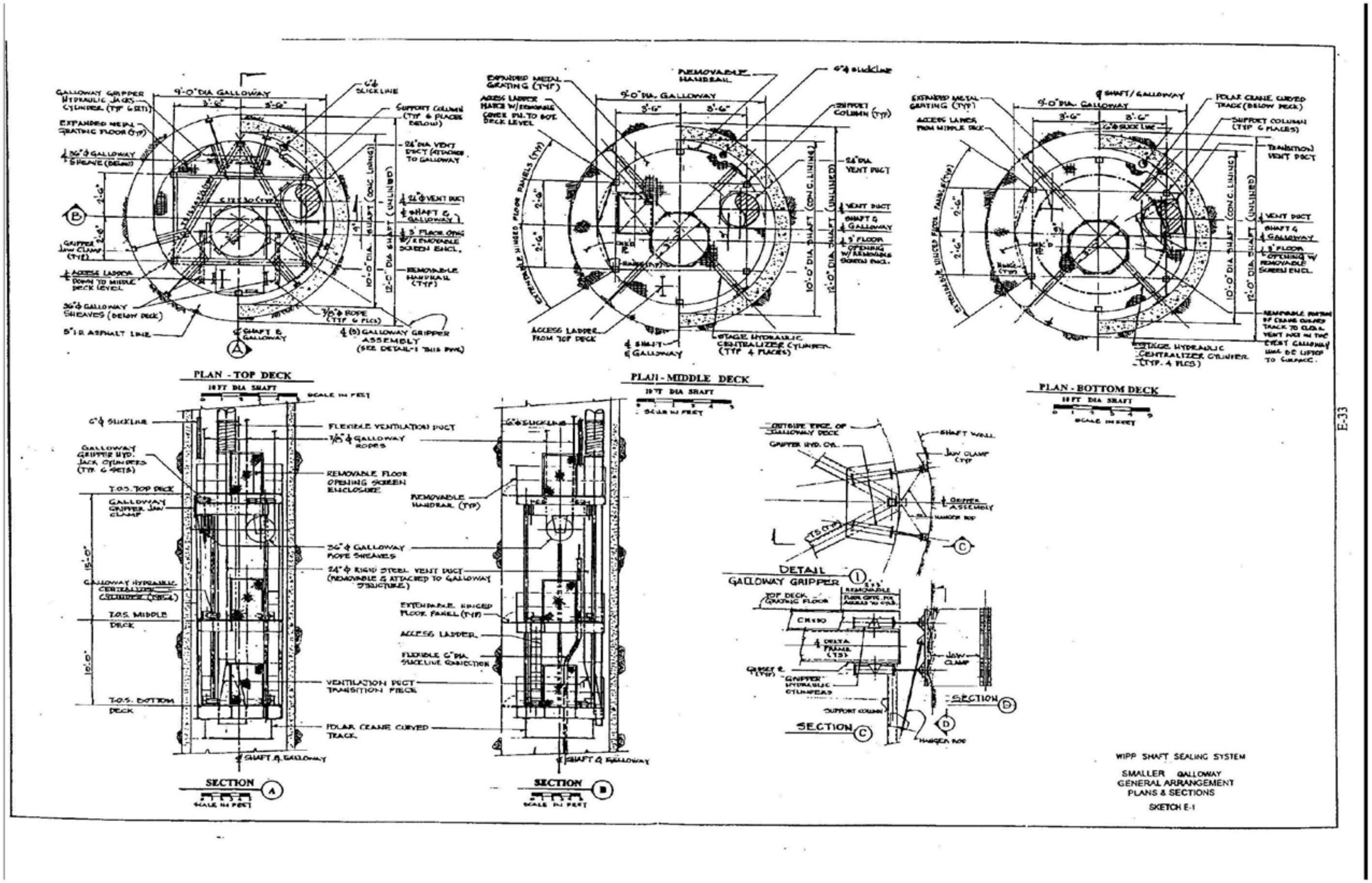
CARLSBAD, NM

SHAFT SEALING SYSTEM DESIGN

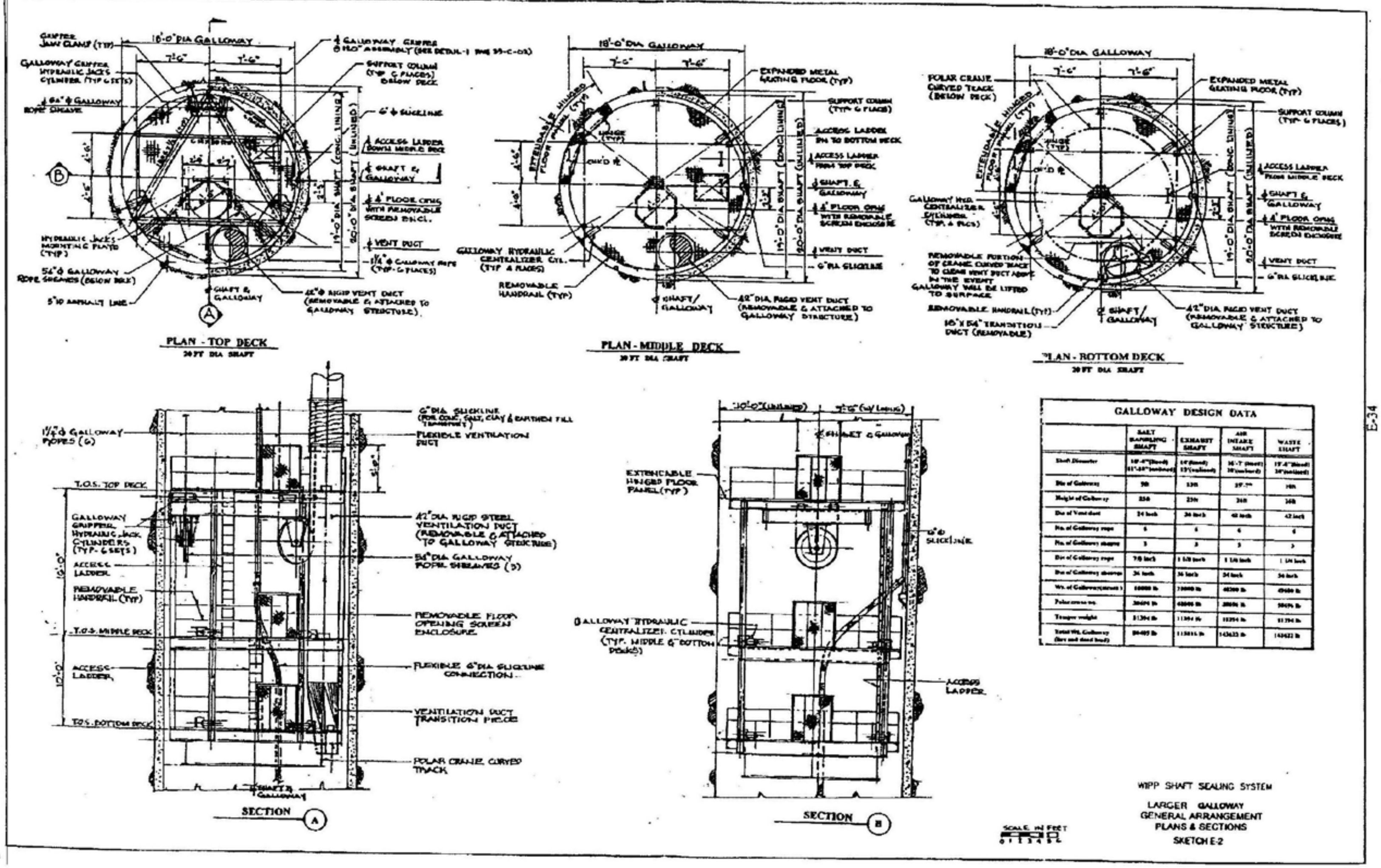
EQUIPMENT AND CONSTRUCTION SKETCHES

DRAWING NUMBER	TITLE
SKETCH E-1	WIPP SHAFT SEALING SYSTEM SMALLER GALLOWAY GENERAL ARRANGEMENT PLANS AND SECTIONS
SKETCH E-2	WIPP SHAFT SEALING SYSTEM LARGER GALLOWAY GENERAL ARRANGEMENT PLANS AND SECTIONS
SKETCH E-3	WIPP SHAFT SEALING SYSTEM TYPICAL HEADFRAME PLANS AND SECTIONS
SKETCH E-4	WIPP SHAFT SEALING SYSTEM PERSPECTIVE HEADFRAME AND ASSOCIATED SURFACE FACILITIES

List of Sketches



WIPP Shaft Sealing System Smaller Galloway Genral Arrangement Plans and Sections

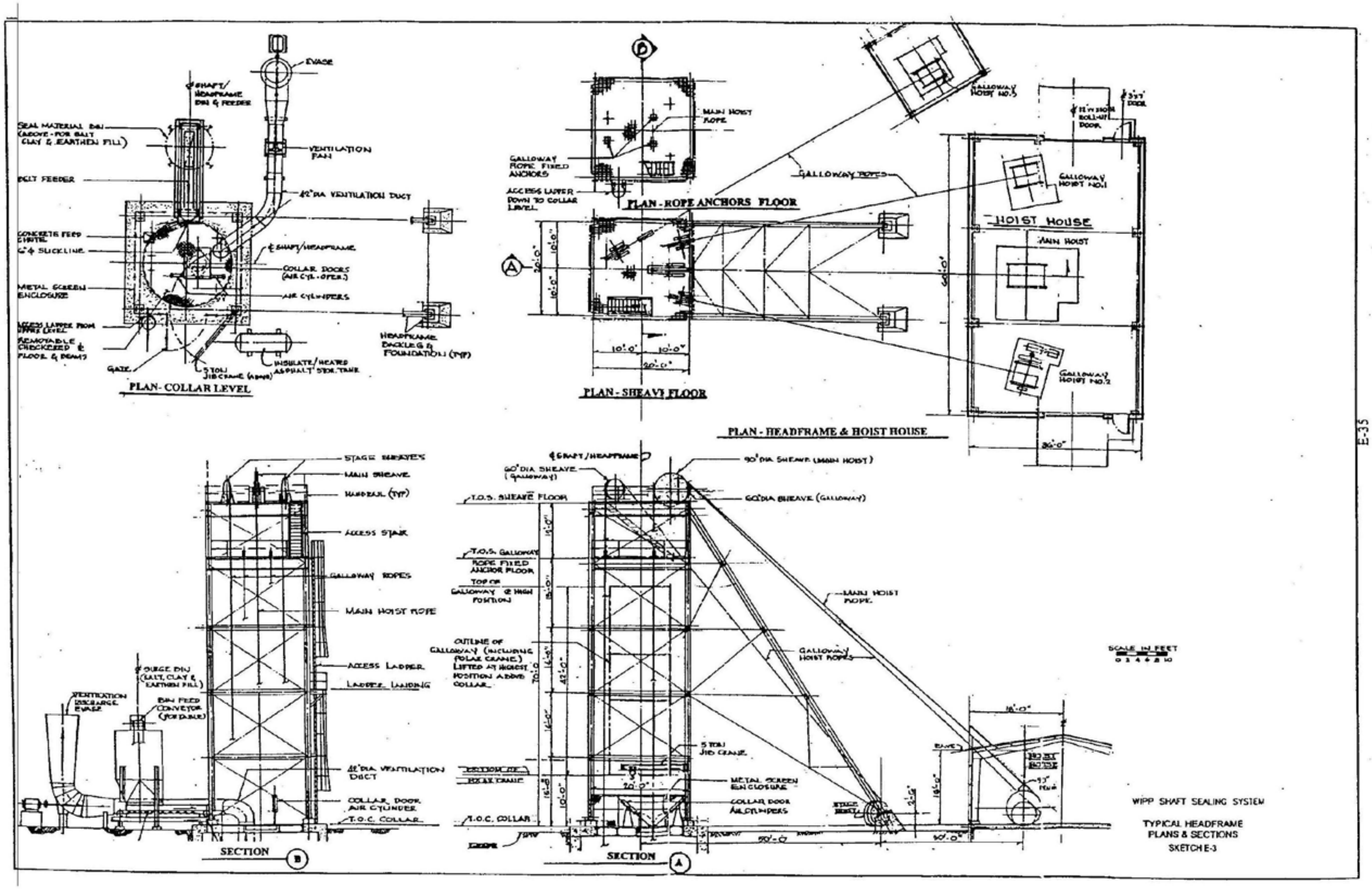


GALLOWAY DESIGN DATA

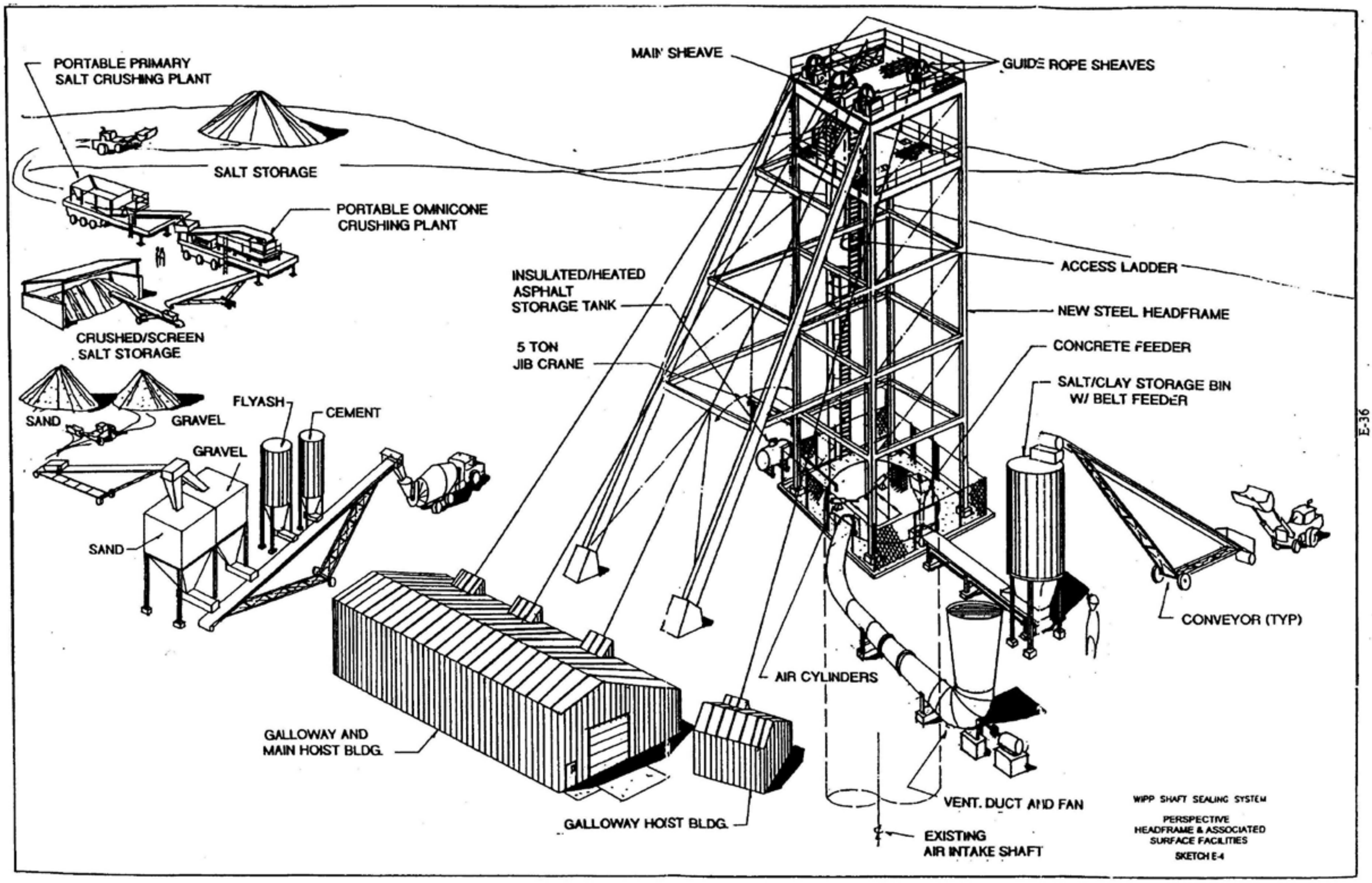
	SALT HANDLING SHAFT	EXHAUST SHAFT	AIR INTAKE SHAFT	WASTE SHAFT
Shaft Diameter	10'-4" (lined) 11'-10" (unlined)	14' (lined) 15' (unlined)	16'-7" (lined) 20' (unlined)	19'-4" (lined) 20' (unlined)
Dia of Galloway	9ft	13ft	15'-7"	18ft
Height of Galloway	25ft	23ft	36ft	36ft
Dia of Vent duct	24 inch	36 inch	48 inch	42 inch
No. of Galloway rope	6	6	6	6
No. of Galloway sheave	3	3	3	3
Dia of Galloway rope	7/8 inch	1 1/8 inch	1 1/4 inch	1 1/4 inch
Dia of Galloway sheave	24 inch	36 inch	54 inch	54 inch
Wt. of Galloway (structure)	40000 lb	70000 lb	46300 lb	49600 lb
Polar crane wt.	30694 lb	48000 lb	38806 lb	50696 lb
Tamper weight	11394 lb	11394 lb	11394 lb	11394 lb
Total Wt. Galloway (live and dead load)	80405 lb	115016 lb	143633 lb	143622 lb

WIPP Shaft Sealing System Larger Galloway General Arrangement Plans and Sections

]



WIPP Shaft Sealing System Typical Headframe Plans and Sections



WIPP Shaft Sealing System Typical Headframe and Associated Surface Faclities

WIPP
UC721 Distribution List

Federal Agencies

US Department of Energy (4)
Office of Civilian Radioactive Waste Mgmt.
Attn: Deputy Director, RW-2
    Acting Director, RW-10
        Office of Human Resources & Admin.
    Director, RW-30
        Office of Program Mgmt. & Integ.
    Director, RW-40
        Office of Waste Accept., Stor., & Tran.
Forrestal Building
Washington, DC 20585

Attn: Project Director (2)
Yucca Mountain Site Characterization Office
    Director, RW-3
    Office of Quality Assurance
101 Convention Center Drive, Suite #P-110
Las Vegas, NV 89109

US Department of Energy
Albuquerque Operations Office
Attn: National Atomic Museum Library
P.O. Box 5400
Albuquerque, NM 87185-5400

US Department of Energy
Research & Waste Management Division
Attn: Director
P.O. Box E
Oak Ridge, TN 37831

US Department of Energy (8)
Carlsbad Area Office
Attn: G. Dials
    D. Galbraith (3)
    M. Matthews
    M. McFadden
    R. Lark
    J. A. Mewhinney
P.O. Box 3090
Carlsbad, NM 88221-3090

US Department of Energy
Office of Environmental Restoration and
Waste Management
Attn: J. Lytle, EM-30
Forrestal Building
Washington, DC 20585-0002

US Department of Energy (3)
Office of Environmental Restoration and
Waste Management
Attn: M. Frei, EM-34, Trevion II
Washington, DC 20585-0002

US Department of Energy
Office of Environmental Restoration and
Waste Management
Attn: S. Schneider, EM-342, Trevion II
Washington, DC 20585-0002

US Department of Energy (2)
Office of Environment, Safety & Health
Attn: C. Borgstrom, EH-25
    R. Pelletier, EH-231
Washington, DC 20585

US Department of Energy (2)
Idaho Operations Office
Fuel Processing & Waste Mgmt. Division
785 DOE Place
Idaho Falls, ID 83402

US Environmental Protection Agency (2)
Radiation Protection Programs
Attn: M. Oge
ANR-460
Washington, DC 20460

Boards

Defense Nuclear Facilities Safety Board
Attn: D. Winters
625 Indiana Ave. NW, Suite 700
Washington, DC 20004

Nuclear Waste Technical Review Board (2)
Attn: Chairman
    S. J. S. Parry
1100 Wilson Blvd., Suite 910
Arlington, VA 22209-2297

State Agencies

Attorney General of New Mexico
P.O. Drawer 1508
Santa Fe, NM 87504-1508

Environmental Evaluation Group (3)
Attn: Library
7007 Wyoming NE, Suite F-2
Albuquerque, NM 87109

Metropolitan Water District of Southern Calif.
Attn: J. Narvaiz
P.O. Box 54153
Los Angeles, CA 90071-3123

NM Energy, Minerals, and Natural
Resources Department
Attn: Library
2040 S. Pacheco
Santa Fe, NM 87505

NM Environment Department (3)
Secretary of the Environment
Attn: Mark Weidler
1190 St. Francis Drive
Santa Fe, NM 87503-0968

NM Bureau of Mines & Mineral Resources
Socorro, NM 87801

NM Environment Department
WIPP Project Site
Attn: P. McCasland
P.O. Box 3090
Carlsbad, NM 88221

Laboratories/Corporations

Battelle Pacific Northwest Laboratories (2)
Attn: R. E. Westerman
    R. Romine, MS P8-38
P.O. Box 999
900 Battelle Blvd.
Richland, WA 99352

Brookhaven National Laboratory
Attn: P. D. Moskowitz
Environmental & Waste Technology
    Center
Building 830
Upton, NY 11973

Harnischfeger Corp.
Phonex Engineering Services
Attn: R. Luebke
2969 S. Chase Avenue
Milwaukee, WI 53207-6408

Ian Clelland
6656 N. Amdahl Dr.
Tucson, AZ 85704

INTERA, Inc.
Attn: G. A. Freeze
1650 University Blvd. NE, Suite 300
Albuquerque, NM 87102

INTERA, Inc. (6)
Attn: J. F. Pickens
    V. Kelley
    M. Reeves
    W. Statham
    J. Beach
    D. Fryar
    INTERA WIPP Library
6850 Austin Center Blvd., Suite 300
Austin, TX 78731

INTERA, Inc.
Attn: J. Lee, YMP PA Dept.
1261 Town Center Drive
Las Vegas, NV 89134

INTERA, Inc.
Attn: W. Stensrud
P.O. Box 2123
Carlsbad, NM 88221

Istasca Consulting Group, Inc.
Attn: John Tinucci
Thresher Square East
708 South Third Street, Suite 310
Minneapolis, MI 55415

Los Alamos National Laboratory
Attn: B. Erdal, INC-12
P.O. Box 1663
Los Alamos, NM 87544

Morton International, Morton Salt
Attn: H. W. Diamond
Morton International Building
100 N. Riverside Plaza,
Randolph Street at the River
Chicago, IL 60606-1597

Parsons Brinckerhoff Energy Services, Inc.
Attn: W. S. Roman
One Penn Plaza
New York, NY 10119

Parsons Brinckerhoff Energy Services, Inc. (2)
Attn: B. W. Lawerance
    C. D. Mann
    M. S. Lin
303 Second Street
Suite 850 North
San Francisco, CA 94107

Parsons Brinckerhoff International, Inc.
Attn: Mary Ann Novak
700 11th Street, NW, Suite 710
Washington, DC 20001

Phillips Mining, Geotechnical & Grouting
Attn: Stephen Phillips
8640 North Glenhurst Place
Tucson, AZ 85704

RE/SPEC, Inc. (5)
Attn: L. Van Sambeek (3)
    G. Callahan
    M. Loken
    J. Ratigan
    T. Pfeifle
3824 Jet Drive
P.O. Box 725
Rapid City, SD 57709

RE/SPEC, Inc
Attn: Angus Robb
4775 Indian School NE, Suite 300
Albuquerque, NM 87110-3927

Science Applications International Corp.
Attn: W. Thompson
15000 W. 6th Avenue, Suite 202
Golden, CO 80401

Tech Reps, Inc. (3)
Attn: J. Chapman (1)
    L. Robledo (2)
5000 Marble NE, Suite 222
Albuquerque, NM 87110

Westinghouse Electric Corporation (5)
Attn: Library
    J. Epstein
    J. Lee
    B. A. Howard
    R. Kehrman
P.O. Box 2078
Carlsbad, NM 88221

S. Cohen & Associates
Attn: Bill Thurber
1355 Beverly Road
McLean, VA 22101

National Academy of Sciences, WIPP Panel

Howard Adler
Oxyrase, Incorporated
7327 Oak Ridge Highway
Knoxville, TN 37931

Bob Andrews
Board of Radioactive Waste Management
GF456
2101 Constitution Ave.
Washington, DC 20418

Rodney C. Ewing
Department of Geology
University of New Mexico
Albuquerque, NM 87131

Charles Fairhurst
Department of Civil
and Mineral Engineering
University of Minnesota
500 Pillsbury Dr. SE
Minneapolis, MN 55455-0220

B. John Garrick
PLG Incorporated
4590 MacArthur Blvd., Suite 400
Newport Beach, CA 92660-2027

Leonard F. Konikow
US Geological Survey
431 National Center
Reston, VA 22092

Carl A. Anderson, Director
Board of Radioactive Waste Management
National Research Council
HA 456
2101 Constitution Ave. NW
Washington, DC 20418

Christopher G. Whipple
ICF Kaiser Engineers
1800 Harrison St., 7th Floor
Oakland, CA 94612-3430

John O. Blomeke
720 Clubhouse Way
Knoxville, TN 37909

Sue B. Clark
University of Georgia
Savannah River Ecology Lab
P.O. Drawer E
Aiken, SC 29802

Konrad B. Krauskopf
Department of Geology
Stanford University
Stanford, CA 94305-2115

Della Roy
Pennsylvania State University
217 Materials Research Lab
Hastings Road
University Park, PA 16802

David A. Waite
CH_2 M Hill
P.O. Box 91500
Bellevue, WA 98009-2050

Thomas A. Zordon
Zordan Associates, Inc.
3807 Edinburg Drive
Murrysville, PA 15668

Universities

Harvey Mudd College
Attn: M. Cardenas
Department of Engineering
Claremont, CA 91711

New Mexico State University
Waste-management Education & Research
Corporation.
Attn: R. Bhada
P.O. Box 3001
Las Cruces, NM 88003-8001

University of California
Department of Mechanical and Environmental
Engineering
Attn: E. Marschall
University of California
Santa Barbara, CA 93106

University of Nevada-Reno
Department of Mining Engineering
Mackay School of Mines
Attn: J. Daamen
Reno, NV 89557

University of New Mexico
Center for Radioactive Waste Management
Attn: W. Lutze
209 Faris Engineering Building
Albuquerque, NM 87131-1341

University of New Mexico
Department of Civil Engineering
Attn: J. C. Stormont
Albuquerque, NM 87131-1351

University of New Mexico
Geology Department
Attn: Library
141 Northrop Hall
Albuquerque, NM 87131

University of Washington
College of Ocean & Fishery Sciences
Attn: G. R. Heath
583 Henderson Hall, HN-15
Seattle, WA 98195

Libraries

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

Government Publications Department
Zimmerman Library
University of New Mexico
Albuquerque, NM 87131

New Mexico Junior College
Pannell Library
Attn: R. Hill
Lovington Highway
Hobbs, NM 88240

New Mexico State Library
Attn: N. McCallan
325 Don Gaspar
Santa Fe, NM 87503

New Mexico Tech
Martin Speere Memorial Library
Campus Street
Socorro, NM 87810

WIPP Public Reading Room
Carlsbad Public Library
101 S. Halagueno St.
Carlsbad, NM 88220

Foreign Addresses

Atomic Energy Canada Ltd. (5)
Whiteshell Laboratory
Attn: Neil Chandler
    Glenn McCrank
    B. Goodwin
    Malcolm Gray
    Maria Onefrei
Pinawa Manitoba, CANADA ROE 1L0

Francois Chenevier (2)
ANDRA
Route de Panorama Robert Schumann
B. P. 38
92266 Fontenay-aux-Roses, Cedex
FRANCE

Claude Sombret
Centre d'Etudes Nucleaires
de la Vallee Rhone
CEN/VALRHO
S.D.H.A.   B.P. 171
30205 Bagnols-Sur-Ceze, FRANCE

Commissariat a L'Energie Atomique
Attn: D. Alexandre
Centre d'Etudes de Cadarache
13108 Saint Paul Lez Durance Cedex
FRANCE

Bundesanstalt fur Geowissenschaften und
Rohstoffe (2)
Attn: M. Langer
          M. Wallner
Postfach 510 153
D-30631 Hannover, GERMANY

Bundesministerium fur Forschung und
Technologie
Postfach 200 706
5300 Bonn 2, GERMANY

Forschungszentrum Karlsruhe GmbH
Institut für Nukleare Entsorgungstechnik
Attn: E. Korthaus
Postfach 3640, D-76021 Karlsruhe
Bundesrepublic Deutchland
GERMANY

Gesellschaft fur Anlagen und Reaktorsicherheit
(GRS)
Attn: B. Baltes
Schwertnergasse 1
D-50667 Cologne, GERMANY

Grundbau Und Felsbau GmbH
Attn: W. Wittke
Henricistraße 50
52072 Aachen, GERMANY

Institut Für Gebirgsmechanik
Attn: W. Minkley
Friederikenstraße 60
04279 Leipzig, GERMANY

Institut Für Tieflagerung
Attn: K. Kuhn
Theodor-Heuss-Strasse 4
D-3300 Braunschweig, GERMANY
Shingo Tashiro
Japan Atomic Energy Research Institute
Tokai-Mura, Ibaraki-Ken, 319-11
JAPAN

Netherlands Energy Research Foundation ECN
Attn: J. Prij
3 Westerduinweg
P.O. Box 1
1755 ZG Petten
THE NETHERLANDS

Universiteit Utrecht
Department of Geology (HPT-lab)
Attn: C. J. Spiers
PO Box 80021
NL-3508 TA Utrech
Budapestlaan 4
THE NETHERLANDS

Svensk Karnbransleforsorjning AB
Attn: F. Karlsson
Project KBS (Karnbranslesakerhet)
Box 5864
S-102 48 Stockholm
SWEDEN

Nationale Genossenschaft fur die Lagerung
Radioaktiver Abfalle (2)
Attn: S. Vomvoris
       P. Zuidema
Hardstrasse 73
CH-5430 Wettingen
SWITZERLAND

AEA Technology
Attn: J. H. Rees
D5W/29 Culham Laboratory
Abington, Oxfordshire OX14 3DB
UNITED KINGDOM

AEA Technology
Attn: W. R. Rodwell
044/A31 Winfrith Technical Centre
Dorchester, Dorset DT2 8DH
UNITED KINGDOM

AEA Technology
Attn: J. E. Tinson
B4244 Harwell Laboratory
Didcot, Oxfordshire OX11 ORA
UNITED KINGDOM

Internal

MS	Org.	
0483	5165	R. E. Stinebaugh
0706	6113	J. K. Linn
1320	6719	E. J. Nowak
1322	6121	J. R. Tillerson (10)
1322	6121	E. H. Ahrens (2)
1322	6121	A. W. Dennis (10)
1322	6121	F. D. Hansen
1322	6121	L. D. Hurtado
1322	6121	M. K. Knowles
1324	6115	P. B. Davies
1325	6852	L. S. Costin
1325	6852	R. E. Finley
1328	6749	D. R. Anderson
1328	6741	H. N. Jow
1328	6849	M. F. Fewell
1328	6849	P. Vaughn
1335	6705	M. Chu
1341	6748	J. T. Holmes
1395	6800	L. Shephard
1395	6707	M. Marietta
1395	6841	V. H. Slaboszewicz
1330	6752	B. J. Pierson (2)
1330	6752	NWM Library (100)
9018	8523-2	Central Technical Files
0899	4414	Technical Library (5)
0619	12630	Review and Approval Desk, For DOE/OSTI (2)

ATTACHMENT G3

RADIOLOGICAL SURVEYS TO INDICATE POTENTIAL HAZARDOUS WASTE RELEASES

ATTACHMENT G3

RADIOLOGICAL SURVEYS TO INDICATE POTENTIAL HAZARDOUS WASTE RELEASES

TABLE OF CONTENTS

LIST OF TABLES

ATTACHMENT G3

RADIOLOGICAL SURVEYS TO INDICATE POTENTIAL HAZARDOUS WASTE RELEASES

G3-1 Purpose

Within the Resource Conservation and Recovery Act (**RCRA**) Permit for the Waste Isolation Pilot Plant (**WIPP**), detection of radiological contamination on surfaces ~~monitoring~~ is used to indicate~~determine~~ whether a potential release of hazardous constituents has occurred. This method is used in addition to the visual examinations and container inspections mandated by the Permit~~RCRA~~.

G3-2 Definition

This Permit Attachment describes the principle of co-detection. Co-detection is defined as the process of identifying hazardous waste releases from containers of transuranic (**TRU**) mixed waste by~~procedures for~~ performing radiological surveys on surfaces and assuming~~to indicate~~ the release~~potential for hazardous waste releases from containers by virtue of detection~~ of a radioactive constituent indicates the concurrent release of a hazardous waste constituent~~release~~. Co-detection does not apply to the gaseous~~These procedures assume the potential co-release of hazardous and radioactive materials and applies to all releases except the~~ release of volatile organic compounds (**VOC**) from ~~transuranic (~~TRU~~)~~ mixed waste containers nor does it apply to the detection of radioactive constituents in water. Radiological surveys are used to indicate the potential presence or absence of hazardous waste constituents based on the presence or absence of radioactive constituents~~radioactivity~~ on surfaces. Radiological surveys do not provide an~~any~~ assessment with regard to the concentrations of hazardous waste constituents, since these surveys do not actually detect hazardous waste constituents.

G3-3 Discussion

Radiological surveys provide the Permittees~~WIPP facility~~ with a very sensitive method of indicating the potential spill or release of ~~non-VOC~~ hazardous waste constituents through the use of surface sampling (swipes) and radioactivity counting. This approach depends on the nature of the hazardous waste portion of the TRU mixed waste, the nature of the TRU mixed waste, and the nature of the spill~~s~~ or release. The sections below discuss each of these factors.

G3-3a Nature of the Hazardous Waste Portion of TRU Mixed Waste

The hazardous waste constituents in~~Based on the waste codes listed in the Part A (Permit Attachment B) and discussed in the WIPP Waste Analysis Plan (Permit Attachment C), the hazardous waste constituents in WIPP~~ TRU mixed waste are~~consist~~ mainly U.S. Environmental Protection Agency (**EPA**)~~of EPA~~ F-coded solvents and metals that exhibit the toxicity characteristic. The TRU mixed wastes that are to be shipped to the WIPP facility for disposal have been placed into waste categories based on their physical and chemical properties. Waste category information is summarized in Table G3-1 with emphasis on the process that generated the waste. The waste generating processes can be described in five general categories:

1. Wastes (such as combustible waste) that result from cleaning and decontamination activities in which items such as towels and rags become contaminated simultaneously with hazardous and radioactive constituents~~ and radioactivity~~. In these cases, the hazardous constituent and the radioactive constituent are intimately mixed, both on the rag or towel used for cleaning and as residuals on the surface of the object being cleaned. These waste forms are not homogeneous in nature; however, they are generated in a fashion that distributes~~ensures that~~ the hazardous and radioactive contaminants ~~coexist~~ throughout the waste matrix.

2. Wastes generated when materials that contain metals that ~~are believed to~~ exhibit the toxicity characteristic become contaminated with radioactive constituents~~radioactivity~~ as the result of plutonium operations (leaded rubber, some glass, and metal waste are typical examples). These materials may also become contaminated with solvents during decontamination or plutonium recovery activities.

3. A class of processes where objects that are not metals are used in plutonium processes and become contaminated with radioactive constituents~~radioactivity~~. They are subsequently cleaned with solvents to recover plutonium. Surfaces of these objects (such as graphite, filters, and glass) may be~~are~~ contaminated with both radioactive constituents and hazardous constituents.

4. Waste generating processes involving foundry operations where impurities are removed from plutonium. These impurities may result in the deposition of toxicity characteristic metals on the surfaces of objects, such as firebrick, ceramic crucibles, pyrochemical salts, and graphite, which are contaminated with residual quantities of radioactive constituents~~radioactivity~~.

5. In all of the process waste categories in the second half of ~~the attached table~~Table G3-1, the hazardous constituent and the radioactive constituents~~radioactivity~~ are physically mixed together as a result of the treatment process. In these wastes, the spill or release of ~~any portion of~~ the waste matrix may~~will~~ involve both the hazardous waste and the radioactive waste components, because the treatment process generates a relatively homogeneous waste form.

~~Some waste forms only contain radioactive contamination on the surface, because they are not the result of a treatment process or are not porous in form. These include glass, leaded rubber, metals, graphite, ceramics, firebricks, and plastics. In theory, a hazardous waste release could occur if the interiors of these materials became exposed and were involved in a release or spill. Such an occurrence is not likely during operations, because no activities are planned or anticipated that would result in the breaking of these materials to expose fresh surfaces.~~

Based on the information in the attached table and the discussion above, hazardous constituent releases could potentially occur in either~~only one~~ of two forms: 1) VOCs or ~~and~~ 2) particulate resulting from the ~~catastrophic~~ failure of the confinement capability of a container. Mechanisms that can initiate releases in these forms are discussed subsequently. Regardless of how the release occurs, the nature of the waste and the processes that generated it is such that the radioactive and hazardous components are assumed to be intimately mixed;~~. A~~ a release of one without the other is not likely, except for releases of VOCs from containers.

G3-3b Nature of the TRU Mixed Waste

TRU mixed waste is defined as transuranic waste which is also a hazardous waste. The processes responsible for the radioactive constituents~~radioactivity~~ in the waste are, for the most part, the same processes responsible for making it a hazardous waste. Therefore, the TRU mixed waste forms are described in terms of both radioactive and hazardous~~classes of~~ waste ~~(radioactive and hazardous)~~. The ~~Permit~~ Treatment, Storage, and Disposal Facility Waste Acceptance Criteria (**TSDF-WAC**) ~~in Permit Part 2~~ places limits on the characteristics of the waste that can be shipped to the WIPP facility based on ~~the characteristics of~~ the waste form. According to the TSDF-WAC, certain waste forms with specific characteristics are not allowed at the WIPP facility. Waste with liquid in excess of the TSDF-WAC limits is one waste form that is not allowed. Other limitations include, but are not limited to, a prohibition on pyrophoric materials, corrosive materials, ignitable waste, and compressed gases. Furthermore, payload containers of TRU waste must contain 100 nanocuries or more of transuranic elements per gram of waste, which means that the radioactive component of the waste will always be present within the waste in significant concentrations. The TSDF-WAC limitations and restrictions are provided to ensure that any waste form received at the WIPP facility is stable and can be managed safely.

One benefit of waste form restrictions, such as no liquid in excess of the TSDF-WAC limits, is that they limit the kinds of releases that could occur to those that would be readily detectable through visual inspection (i.e., large objects that fall out of ruptured containers) or through the use of radiological detection ~~radiation monitoring~~ either locally or within the adjacent area to detect materials that have escaped from containers.

G3-3c Nature of the Releases

The WIPP facility personnel will handle only sealed containers of TRU mixed waste and derived waste. The practice of handling sealed containers minimizes the opportunity for releases or spills. For the purposes of safety analysis (DOE 2018~~1997~~) [1], it was assumed that releases and spills during operations occur by either of two mechanisms: 1) surface contamination and 2) accidents.

Radioactive materials releases resulting from unique and representative hazard evaluation events are~~Surface contamination is~~ documented in the WIPP Documented Safety Analysis (**DSA**)~~Safety Analysis Report (**SAR**)~~ (DOE 2018~~1997~~). Surface contamination of a waste container is considered to be a~~the only~~ credible source of contamination external to the containers during normal operations. Surface contamination is assumed to be caused by waste management activities at the generator site that result in the contamination of the outside of a waste container. Contamination would most likely be particulates (dirt or dust) that would be deposited during generator-site handling/loading activities. This contamination may not be detected by visible inspections. Surface contamination is detected~~monitored~~ ~~upon~~ after arrival at the WIPP facility through the use of swipes and radiation ~~monitoring~~ surveying equipment, as specified in radiological control procedures pursuant to 10 CFR Part 835. Surveying for radioactive constituents allows for the detection of contamination that may not be visible on the surface of the container.~~WIPP Procedure WP 12-HP1100, "Radiological Surveys" (DOE, 1995). WP 12-HP1100 is a technical procedure that provides specific methods and guidance for~~

---

[1] DOE 2018, Waste Isolation Pilot Plant Documented Safety Analysis, DOE/WIPP 07-3372, REV. 6a, February 2018.

~~performing surface contamination and dose rate surveys of items, equipment, and areas, but does not cover the monitoring of personnel. Detection using radioactivity is very sensitive and allows for the detection of contamination that may not be visible on the surface of the container.~~ This exceeds the capability required by the RCRA, which is generally limited to inspections that detect only visible evidence of spills or leaks. RCRA-required inspections are specified in Permit Attachment E~~Part 3~~.

Releases due to accidents are modeled in the WIPP DSA~~SAR~~. ~~Significant accidents within the waste handling process are assumed to result in the release of radioactive contaminants and VOCs. Radioactive~~ For the purposes of co-detection, releases are detectable using surface-contamination detection~~sampling (swipe)~~ techniques.

G3-4 Application of Radiological Surveys

Radiological surveys apply to many situations calling for ~~sampling or monitoring~~ surveying to indicate the potential for ~~nonvolatile~~ releases. This includes initial sampling for surface radiological contamination upon receipt, sampling for contamination during waste handling activities, sampling for contamination during decommissioning, sampling for contamination during packaging for off-site shipment, and sampling to demonstrate the effectiveness of decontamination activities that follow a release or spill and retrieval. ~~Radiation monitoring and sampling are~~Radiological surveying is mandated by DOE Orders and provide an immediate indication of a radiological release or spill, even when ~~they~~ there are ~~not~~ no visibly detectable indications. A release or spill involving hazardous constituents ~~(except VOCs)~~ will also likely involve a release or spill of ~~radioactivity~~radioactive constituents, based on the processes that generated the waste and the physical form of the waste. These processes mixed the hazardous and radioactive components, as described in Table G3-1, to the extent that detection of the radioactive component can indicate the potential that the hazardous component is also present on a contaminated surface. Radiological surveys to indicate the potential for hazardous waste releases will be performed as specified in the following sections.

G3-4a TRU Mixed Waste Processing

Tables G3-2, G3-2a, and G3-3 specify the various steps in the process of receiving and disposing containers of CH TRU mixed waste, including RH TRU mixed waste in shielded containers and RH TRU mixed waste, respectively, where radiological surveys will be performed by the Permittees in accordance with radiological control procedures pursuant to 10 CFR Part 835. ~~WIPP Procedure WP 12-HP1100 provides the detailed description of methods and equipment used when performing surface contamination surveys, dose rate surveys, and large area wipes.~~

G3-4b TRU Mixed Waste Releases

The RCRA Contingency Plan (Permit Attachment D) specifies actions required by the Permittees in the event of spills or leaking or punctured containers of CH and RH TRU mixed waste. Following completion of decontamination efforts, the Permittees will perform hazardous material sampling to confirm the removal of hazardous waste constituents from contaminated surfaces.

G3-4c Decontamination Activities at Closure

The Closure Plan (Permit Attachment G, Section G-1e(2)) specifies decontamination activities required by the Permittees at closure. Following completion of decontamination efforts, the Permittees will perform hazardous material sampling to confirm removal of hazardous waste constituents from contaminated surfaces.

TABLES

Table G3-1

Summary of Waste Generation Processes and Waste Forms

Waste Category	Hazardous Waste Codes	Description of Processes	Description of Waste Forms
Combustibles	F001, F002, F003, D008, D019	Cloth and paper wipes are used to clean parts and wash down gloveboxes. Wood and plastic parts are removed from gloveboxes after they are cleaned. Lead may occur as shielding tape or as minor noncombustible waste in this category.	Materials such as metals may retain traces of organics left on surfaces that were cleaned. Waste may remain on the cloth and paper that was used for cleaning or for wiping up spills.
Graphite		Graphite molds, which may contain impurities of metals, are scraped and cleaned with solvents to remove the recoverable plutonium.	Surfaces may retain residual solvents. Lead may be used as shielding or may be an impurity in the graphite.
Filters	F001, F002	Filters are used to capture radioactive particulate in air streams associated with numerous plutonium operations and to filter particulate from aqueous streams.	Filter media may retain organic solvents that were present in the air or liquid streams.
Benelex® and Plexiglas®	F001, F002, D008	Materials are used in gloveboxes as neutron absorbers. The glovebox assembly often includes leaded glass. All surfaces may be wiped down with solvents to remove residual plutonium.	Surfaces may retain residual solvents from wiping operations. Leaded glass may also be present.
Firebrick and Ceramic Crucibles	F001, F002, F005, D006, D007, D008	Firebrick is used to line plutonium processing furnaces. Ceramic crucibles are used in plutonium analytical laboratories. Both may contain metals as surface contaminants.	Metals deposited during plutonium refining or analytical operations could remain as residuals on surfaces. Surfaces may retain residual solvents.
Leaded Rubber	D008	Leaded rubber includes lead oxide impregnated materials such as gloves and aprons.	The leaded rubber could potentially exhibit the toxicity characteristic.
Metal	F001, F002, D008	Metals range from large pieces removed from equipment and structures to nuts, bolts, wire, and small parts. Many times, metal parts will be cleaned with solvents to remove residual plutonium.	Solvents may exist on the surfaces of metal parts. The metals themselves potentially exhibit the toxicity characteristic.
Glass	F001, F002, D006, D007, D008, D009	Glass includes Raschig rings removed from processing tanks, leaded glass removed from gloveboxes, and miscellaneous laboratory glassware.	Solvents may exist as residuals on glass surfaces and in empty containers. The leader glass may exhibit the toxicity characteristic.
Inorganic Wastewater Treatment Sludge	F001-F003, D006-D009, P015	Sludge is vacuum filtered and stabilized with cement or other appropriate sorbent prior to packaging.	Traces of solvents and heavy metals may be contained in the treated sludge which is in the form of a solid dry monolith, highly viscous gel-like material, or dry crumbly solid.

Waste Category	Hazardous Waste Codes	Description of Processes	Description of Waste Forms
Organic Liquid and Sludge	F001, F003	Organic liquids such as oils, solvents, and lathe coolants are immobilized through the use of various solidification agents or sorbent materials.	Solvents and metals may be present within the matrix of the solids created through the immobilization process.
Solidified Liquid	F001, F003, D006, D008	Liquids that are not compatible with the primary treatment processes and have to be batched. Typically these liquids are solidified with portland or magnesium cement.	Solvents and metals may be present within the matrix of the solids created through the immobilization process.
Inorganic Process Solids and Soil	F001, F002, F003, D008	Solids that cannot be reprocessed or process residues from tanks, firebrick fines, ash, grit, salts, metal oxides, and filter sludge. Typically solidified with portland or gypsum-based cements.	Solvents and metals may be present within the matrix of the solids created through the immobilization process.
Pyrochemical Salts	D007	Molten salt is used to purify plutonium and americium. After the radioactive metals are removed, the salt is discarded.	Residual metals may exist in the salt depending on impurities in the feedstock.
Cation and Anion Exchange Resins	D008	Plutonium is sorbed on resins and is eluted and precipitated.	Feed solutions may contain traces of solvents or metals depending on the preceding process.

Table G3-2
Radiological Surveys During CH TRU Mixed Waste Processing (TRUPACT-II/HalfPACT)

Step in CH TRU Mixed Waste Processing	**Surface Contamination Survey**	**Dose Rate Survey**	**Large Area Wipes** [a]
Exterior of CH package after arrival at the WIPP facility	X	X	
CH~~Contact Handled~~ p~~P~~ackage o~~O~~uter c~~C~~onfinement a~~A~~ssembly (**OCA**) lid interior and top of i~~I~~nner c~~C~~ontainment v~~V~~essel (**ICV**) lid	X		X
CH~~Contact Handled~~ p~~P~~ackage quick connect and vent port	X		
As ICV lid is raised		X	
ICV lid interior and top of payload	X		X
Payload assembly, guide tubes, standard waste box (**SWB**) and ten-drum overpack (**TDOP**) connecting devices	X		
As payload assembly is raised, including bottom of payload	X	X	
After placement of payload on facility pallet	X	X	X

[a] Surface contamination surveys of CH~~Contact Handled~~ p~~P~~ackages are performed in accordance with radiological control procedures pursuant to 10 CFR Part 835~~Procedure WP 12-HP1100, which stipulates that all such work be performed under a Radiation Work Permit (**RWP**). The RWP will only stipulate large area wipes when necessary and not as a routine measure.~~

Table G3-2a
Radiological Surveys During CH TRU Mixed Waste Processing (TRUPACT-III)

Step in CH TRU Mixed Waste Processing	Surface Contamination Survey	Dose Rate Survey	Large Area Wipes [a]
Exterior of TRUPACT-III ~~on~~ after arrival at the WIPP facility	X	X	
Interior of o~~O~~verpack c~~C~~over and exterior of c~~C~~ontainment l~~L~~id	X	X	X
TRUPACT-III v~~V~~ent p~~P~~ort t~~T~~ool a~~A~~ssembly quick connect	X		
Interior of c~~C~~ontainment l~~L~~id and front of SLB2	X	X	X
As SLB2 is removed from TRUPACT-III		X	
After placement of SLB2 on facility pallet	X		X

[a] Surface contamination surveys of CH~~Contact Handled~~ p~~P~~ackages are performed in accordance with radiological control procedures pursuant to 10 CFR Part 835~~Procedure WP 12-HP1100, which stipulates that all such work be performed under an RWP~~. ~~The RWP will only stipulate large area wipes when necessary and not as a routine measure.~~

Table G3-3
Radiological Surveys During RH TRU Mixed Waste Processing

Step in RH TRU Mixed Waste Processing	Surface Contamination Survey	Dose Rate Survey
Exterior of cask ~~on~~ after arrival at the WIPP facility	X	X
~~During~~ After removal of impact limiters on RH-TRU 72-B cask	X	X
During removal of outer lid closure from RH-TRU 72-B cask	X	X
During removal of inner lid closure from RH-TRU 72-B cask	X	
During removal of upper impact limiter on the CNS 10-160B cask	~~X~~	X
After removal of upper impact limiter on the CNS 10-160B cask	X	X
After removal of the CNS 10-160B cask from the lower impact limiter	X	X
After transfer of the CNS 10-160B cask lid into the Hot Cell	X	
~~During~~ After transfer of waste drum carriages into the Hot Cell	X	
During transfer of waste into the facility canister in the Hot Cell	X	
During transfer of the waste canister from the RH-TRU 72-B cask to the facility cask	X	
Interior of shipping cask inside the RH Bay after unloading of waste canister or drums	X	
Exterior of shield plug subsequent to final canister emplacement		X
Interior of facility cask after completion of waste emplacement	X	

ATTACHMENT H

POST-CLOSURE PLAN

ATTACHMENT H

POST-CLOSURE PLAN

TABLE OF CONTENTS

ATTACHMENT H

POST-CLOSURE PLAN

Introduction

This ~~Permit~~ Attachment contains the Post-Closure Plan, which describes activities required to maintain the Waste Isolation Pilot Plant (**WIPP**) facility after completion of final facility closure. Since the current plans for operations extend over several decades, the Permittees will periodically reapply for an operating permit in accordance with 20.4.1.900 New Mexico Administrative Code (**NMAC**) (incorporating Title 40 of the Code of Federal Regulations (**CFR**) §270.10(h)).

This plan was submitted to the New Mexico Environment Department (**NMED**) in accordance with 20.4.1.900 NMAC (incorporating 40 CFR §270.14(b)(13))~~ and the U.S. Environmental Protection Agency (**EPA**)~~. The Post-Closure Plan includes the implementation of institutional controls to limit access and groundwater monitoring to assess disposal system performance. Until final facility closure is complete and has been certified in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.115), a copy of the approved Post-Closure Plan and all approved revisions will be on file at the WIPP facility and will be available to the Secretary of the NMED ~~or the EPA Region VI Administrator~~ upon request.

H-1 Post-Closure Plan

The post-closure care period begins after completion of closure of the first underground hazardous waste disposal unit (**HWDU**) and continues for 30 years after final closure of the facility. The post-closure care period may be shortened or lengthened by the Secretary of the NMED, based on evidence that human health and the environment are being protected or are at risk. During the post-closure period, the WIPP facility shall be maintained in a manner that complies with the environmental performance standards applicable to the facility. During this period, the Permittees will employ active institutional controls as necessary.

This post-closure plan focuses on activities following final facility closure. However, some discussion of post-closure following panel closure is warranted since some panel closures will occur long before final facility closure. As discussed in Attachment G (Closure Plan), Section G-1e(1), panel closures have been designed to require minimum post-closure maintenance. The Permittees have defined a post-closure care program for closed panels that has three aspects. These are routine inspection of the openings in the vicinity of the closures and bulkheads used as part of the closures, coupled with ~~the sampling of ventilation air for harmful constituents~~repair or replacement of bulkheads that no longer serve their purpose as panel closures;~~,~~ the sampling of ventilation air for harmful constituents; and a Repository Volatile Organic Compound Monitoring Program (**RVMP**). The rules of the Mine Safety and Health Administration as well as Permit Attachment E (Inspection Schedule, Process and Forms) drive the implementation of the first two programs. These rules require that underground mines monitor air quality to assure good breathing air whenever personnel are underground and that mine operators provide safe ground conditions for personnel in areas that require access. Routine monitoring of the openings in the access ways to panels will be continued and these openings will be maintained for as long as access into them is needed. This includes continued reading of installed geomechanical instrumentation, sounding the areas, visual inspection and maintenance activities as required and as described in Permit Attachment A2. In addition, ~~all~~ areas in the underground that are occupied by personnel are checked prior to each day's work activities for accumulations of harmful gases. Action levels for increasing ventilation to areas that show high levels of harmful gases are specified as described in standard operating procedures on file at the WIPP facility.

~~These m~~Monitoring programs will be carried out during the period between the closure of the first panel and the initiation of final facility closure for the underground facility. The Permittees have prepared a ~~Volatile Organic Compound Monitoring Plan (~~~~**VOCMP**~~RVMP~~)~~ which ~~will be~~has been implemented to confirm that the annual average concentration of volatile organic compounds (**VOCs**) in the air emissions from the underground HWDUs do not exceed the VOC action levels (10^{-5} for carcinogens and ~~HI~~hazard index >1 for non-carcinogens) listed in Permit Part 4, Section 4.6.2.3. The ~~VOCMP~~ RVMP is provided in Attachment N. The ~~VOCMP~~ RVMP includes monitoring design, sampling and analysis procedures and quality assurance objectives. This plan is required to demonstrate compliance with 20.4.1.500 and .900 NMAC (incorporating 40 CFR §264.602 and §270.23(a)(2)).

The Permittees will operate in accordance with the ~~VOCMP~~ RVMP until after certification of the closure of the last underground HWDU.

~~The VOCMP uses~~ ~~**EPA**~~ ~~Compendium Method TO-15. The Permittees have had success with TO-15 at the WIPP if care is taken in placing the sampler to avoid high dust and if stringent cleaning requirements are imposed for the clean canisters. This is necessary because of the extremely low concentrations that are being monitored.~~

The ~~VOCMP~~ RVMP ~~will be~~is implemented under a Quality Assurance Plan that conforms to the document entitled "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations." Quality Assurance criteria required for the target analytes are presented in Table N-2 in Permit Attachment N. ~~Definitions of these criteria are given in Permit Attachment N along with a discussion of other requirements of the Quality Assurance Program, including sample handling, calibration, analytical procedures, data reduction, validation and reporting, performance and system audits, preventive maintenance, and corrective actions.~~

H-1a Post-Closure Plan after Final Facility Closure

A number of regulations deal with the period of time that begins once the WIPP facility has undergone final facility closure and decommissioning. Under 40 CFR Part 191, the period consists of an active control period and a passive control period; only 100 years of the active control period can be used in performance assessment. The Land Withdrawal Act (LWA) of 1992 requires that the U.S. Department of Energy (**DOE**) prepare and submit a post-decommissioning land management plan. The New Mexico hazardous waste regulations at 20.4.1.500 NMAC (incorporating 40 CFR §264.117) ~~requires~~requires post-closure care, including monitoring, security, and control of property use. Because of the numerous regulations, the Permittees have prepared a single strategy for post-closure management of the WIPP site. This strategy consists of three elements: 1) active controls, 2) monitoring, and 3) passive controls. Only the first and second elements occur within the post-closure period covered by this permit.

H-1a(1) Active Institutional Controls

Once a facility is decommissioned, positive actions (referred to as “active institutional controls”) will be taken to assure proper maintenance and monitoring. The EPA, in 40 CFR §191.14(a) has specified that active controls will be maintained for as long as practicable and that no more than 100 years of active institutional control can be assumed in predictions of long-term performance. This assumption assures that future protection and control does not rely on positive actions by future generations.

The Permittees’ active institutional control program has a primary objective of addressing ~~all~~ applicable requirements, including restoring the WIPP site as nearly as possible to its original condition, and thereby equalizing any preference over other areas for development by humans in the future. Restoration of the WIPP site includes any necessary remedial actions or cleanup of releases resulting from decommissioning. In addition, as part of the active institutional control program implemented under 40 CFR §194.14(a), the Permittees will implement monitoring systems suitable for assessing disposal system performance if such monitoring is feasible.

The Permittees will implement the active institutional control program as described in more detail below:

Identification of Active Institutional Control Measures

A detailed explanation of the active institutional controls selected by the Permittees as part of this first step is provided in Permit Attachment H1 (WIPP Active Institutional Controls). This is the Permittees’ reference design for active institutional controls. The reference design will be reviewed periodically and updated by the Permittees as appropriate during WIPP disposal operations. The ongoing review and evaluation ensure that the active institutional controls implemented are appropriate for the conditions that may exist at that time. The Permittees will review the reference design prior to implementation and all affected regulatory agencies will be consulted as part of this review. If updating the reference design proposes any changes in the Post-Closure Plan as described in this permit, the Permittees shall apply for a permit modification to include those changes, or submit the reference design and revised Post-Closure Plan as part of a routine permit renewal application, as required by 20.4.1.500 NMAC (incorporating 40 CFR §264.118(d)).

As part of the active institutional controls program, the Permittees have developed a set of active institutional controls which will be implemented. These are as follows:

- A fence line shall be established to control access to the repository’s footprint area (the waste disposal area projected to the surface). A standard wire fence shall be erected along the perimeter of the repository surface footprint. The fence shall have gates placed approximately midway along each of the four sides.

- An unpaved roadway along the perimeter of the barbed wire fence shall be constructed to provide ready vehicle access to any point around the fenced perimeter, to facilitate inspection and maintenance of the fence line, and to permit visual observation of the repository footprint to the extent permitted by the lay of the land. This roadway shall connect to the paved south access road.

- To ensure visual notification, the fence line shall be posted with signs having as a minimum, a legend reading “Danger—Unauthorized Personnel Keep Out” and a warning against entering the area without specific permission of the Permittees.

- Contractual arrangements shall be developed to ensure that periodic inspection and necessary corrective maintenance is conducted on the fence line, its associated warning signs, and the roadway. The Permittees will maintain control over all contractual work and will maintain, in the operating record, the results of all inspections and maintenance activities.

- Through direct Permittee staffing support and/or contractual arrangements, procedures shall be established to provide routine periodic patrols and surveillances of the protected area by personnel trained in security surveillance and investigation.

- Mitigating actions will be taken to address any abnormal conditions[1] identified during periodic surveillance and inspections.

- Reports of activities associated with the post-disposal active access controls shall be prepared in accordance with regulatory requirements for submittal to the appropriate regulatory and legislative authority.

Details on meeting these criteria are found in Permit Attachment H1.

Preparation of a Post-Decommissioning Land Management Plan

Section 13(b) of the LWA requires the DOE to prepare and submit a plan for managing the land withdrawal area after decommissioning the WIPP facility. This plan will include a description of both the active and passive institutional controls that will be imposed after decommissioning is complete. This plan will be prepared in consultation with the Department of Interior and the state of New Mexico. If the land management plan proposes any changes in the Post-Closure Plan as described in this permit, the Permittees shall apply for a permit modification to include those changes, or submit the land management plan and revised Post-Closure Plan as part of a routine permit renewal application, as required by 20.4.1.500 NMAC (incorporating 40 CFR §264.118(d)).

Preparation of the Active Institutional Control Plan

An active institutional control plan will be initiated prior to actual plant ~~closure, and~~closure and will contain ~~all~~ the information needed to implement the active and passive institutional controls for the WIPP facility. Active institutional control planning will be based on the reference design and will take into account the most current information regarding the facility and its vicinity and will make use of state-of-the-art materials and techniques. This plan will include acceptable radiological decontamination levels pursuant to 10 CFR Part 835, sampling and analysis plans, and QA/QC specifications. If ~~such future plan~~the Active Institutional Controls Plan contains provisions different from those in this Post-Closure Plan or Permit Attachment H1 (Active

---

[1] “Abnormal conditions” include any natural or human-caused conditions which could affect the integrity of ~~Active~~ active ~~Institutional~~ institutional controls required by the Permit or which could affect compliance of the WIPP facility with applicable RCRA standards.

Institutional Controls), the Permittees shall submit a request for modification of the Post-Closure Plan and the WIPP Permit. The changes must be approved and made part of the revised Permit before the changes are implemented, in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.118(d)).

Implementation of Active Institutional Control Measures

Most of the active institutional control measures, such as long-term site monitoring and site remedial actions, will be implemented simultaneously with facility closure. However, it may be possible to implement some measures earlier. For example, salt disposal may begin prior to final plant closure. Reclamation and restoration of unused disturbed surface areas has already begun. Guarding and maintenance activities, which are already in place, could evolve into an appropriate type of post-closure activity, subject to appropriate modifications of the Permit.

H-1a(2) Monitoring

Post-closure groundwater monitoring will involve a continuation of the monitoring plan in Permit Attachment L as described in Permit Part 5. The sampling frequency may be changed to a frequency of every two years after final facility closure is complete by modification of the Permit as approved by the Secretary of the NMED in accordance with 20.4.1.901.B NMAC (incorporating 40 CFR §270.42). In addition, the final target analyte list specified in Permit Attachment L may be changed by permit modification based on final TRU mixed waste volume.

H-2 Notices Required for Disposal Facilities

H-2a Post-Closure Certification

Within 60 days of completion of the post-closure care period after final facility closure, the Permittees will submit to the Secretary of the NMED, via registered mail, a certification that post-closure care was performed in accordance with the specifications of the approved post-closure plan. The certification will be signed by the Permittees and by an independent New Mexico registered professional engineer. Documentation supporting the independent registered engineer’s certification and a copy of the certification will be furnished to the Secretary of the NMED.

H-2b Post-Closure Notices

Within 60 days after certification of closure of each underground HWDU or final facility closure, the Permittees will submit to the Secretary of the NMED, and to the Eddy County government or other applicable local government agencies, a record of the type, location, and quantity of hazardous wastes disposed of in each underground HWDU as required in 20.4.1.500 NMAC (incorporating 40 CFR §264.119).

ATTACHMENT H1

ACTIVE INSTITUTIONAL CONTROLS DURING POST-CLOSURE

ATTACHMENT H1

ACTIVE INSTITUTIONAL CONTROLS DURING POST-CLOSURE

TABLE OF CONTENTS

~~LIST OF FIGURES~~

ACRONYMS

CH	contact-handled
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
LWA	Land Withdrawal Act
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
SWB	standard waste box
TRU	transuranic
WIPP	Waste Isolation Pilot Plant

ATTACHMENT H1

ACTIVE INSTITUTIONAL CONTROLS DURING POST-CLOSURE

Introduction

Under the requirements of 20.4.1.500 New Mexico Administrative Code (**NMAC**) (incorporating Title 40 of the Code of Federal Regulations (**CFR**) §264.118(b), the following activities identified as active institutional controls during post-closure are incorporated into the Post-Closure Plan.

The post-closure requirements of this permit include 20.4.1.500 NMAC, incorporating:

- 40 CFR §264.117(a)(1), which requires that

  "Post-closure care for each hazardous waste management unit subject to the requirements of §264.117 through 264.120 must begin after completion of closure of the unit and continue for 30 years after that date…"

- 40 CFR §264.601, which requires that

  "A miscellaneous unit must be…maintained and closed in a manner that will ensure protection of human health and the environment…"

- and 40 CFR §264.603, which requires that

  "A miscellaneous unit that is a disposal unit must be maintained in a manner that complies with §264.601 during the post-closure care period."

The containment requirements for a disposal system for transuranic (**TRU**) radioactive wastes are defined in Title 40 CFR §191.13 (U.S. Environmental Protection Agency [**EPA**] 1993). ~~40 CFR §191.14 is titled Assurance Requirements.~~ With regard to the active institutional control~~s~~ aspects of the Assurance Requirements, 40 CFR §191.14 states the following:

> "To provide the confidence needed for long-term compliance with the requirements of §191.13, disposal of spent fuel or high-level or transuranic wastes shall be conducted in accordance with the following provisions… (a) Active institutional controls over disposal sites should be maintained for as long a period of time as is practicable after disposal; however, performance assessments that assess isolation of the wastes from the accessible environment shall not consider any contribution from active institutional controls for more than 100 years after disposal… "

40 CFR §191.12 states the following:

> "Active institutional controls mean:
> 1) controlling access to a disposal site by any means other than passive institutional controls,
> 2) performing maintenance operations or remedial actions at a site,
> 3) controlling or cleaning up releases from a site, or

4) monitoring parameters related to disposal system performance."

Purpose: This ~~Permit~~ Attachment describes the design of a system that the Permittees will implement for compliance with the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264.118(b)) and 40 CFR §191.14(a) to control access to the Waste Isolation Pilot Plant (**WIPP**) disposal site and implement maintenance and remedial actions pertaining to the site access controls. In addition, this ~~Permit~~ Attachment addresses the scheduling process for control of inspection, maintenance, and periodic reporting related to long-term monitoring. Long-term monitoring addresses the monitoring of disposal system performance, as required by 40 CFR §191.14(b), and environmental monitoring, in accordance with ~~this~~ the Permit and the Consultation and Cooperation Agreement between the U.S. Department of Energy (**DOE**) and the state of New Mexico. The scheduling process will also address evaluation of testing activities related to the permanent marker system design contained within the passive institutional controls (not required by ~~this permit~~the Permit).

Implementation of active institutional controls at the WIPP site will commence when final facility closure is achieved, as specified in Permit Part 6 and Permit Attachment G. Implementation of active institutional controls marks the transition from the active life of the facility (which ends upon certification of closure) to the post-closure care period, as specified in 20.4.1.500 NMAC (incorporating 40 CFR ~~§~~Part 264, Subpart G). The Permittees will continue the imposition of active institutional controls under this Permit until the New Mexico Environment Department (**NMED**) approves the post-closure certification specified in Permit Part 7 and Permit Attachment H.

Decommissioning activities include decontamination and site restoration. The decontamination effort will be completed prior to sealing of the shafts to allow disposal of ~~all~~ derived waste (radioactive and/or mixed waste derived from TRU/TRU-mixed waste received at the WIPP facility) into the repository. The implementation of active institutional controls upon certification of facility closure will prevent human intrusion into the repository. The Permittees' restoration efforts will return the land disturbed by the WIPP activities to a stable ecological state that will assimilate with the surrounding undisturbed ecosystem. Necessary exceptions to returning the site to its full pre-WIPP condition include measurements associated with long-term monitoring.

Scope: The active institutional control requirements include a means of controlling access to the site of the repository's surface footprint (the repository area projected to the surface) and maintenance, including corrective actions, for access control system components. Active control of access to the site will be exercised by the Permittees for the duration of the post-closure care period. Although the Permittees are only required to maintain active institutional controls until approval of the post-closure certification by the NMED, the Permittees will continue active institutional controls for at least 100 years after final facility closure to satisfy other regulatory requirements. Control of access will prevent intrusion into the disposed waste by deep drilling or mining for natural resources. This ~~Permit~~ Attachment also specifies a process for scheduling activities related to the long-term monitoring of the repository. Some of the activities supporting the monitoring programs will be initiated during the active life of the facility to establish databases. These activities are planned to continue beyond closure through the time after removal of the site structures and return of the land disturbed by the WIPP activities to a stable ecological state that will assimilate with the surrounding undisturbed ecosystem. Long-term monitoring requirements will be necessarily integrated with efforts toward returning the land to a stable ecological state.

Background: The WIPP facility was ~~sited and designed~~authorized by Congress as a research and development facility to demonstrate the safe disposal of radioactive wastes. The wastes are derived from DOE defense-related activities. Specifically, the mission of the WIPP ~~project~~ Project is to ~~conduct research, demonstration, and siting studies relevant to the~~facilitate ~~permanent~~ disposal of TRU wastes. Most of these wastes ~~will be~~are contaminated with hazardous constituents, making them mixed wastes.

The WIPP Land Withdrawal Act (**LWA**) addresses the disposal phase of the WIPP ~~project~~Project, the period following closure of the site, and the removal of the surface facilities. The LWA set aside 10,240 acres (4,144 hectares) located in Eddy County, 26 miles (42 kilometers) east of Carlsbad, New Mexico, as the WIPP site. A 277-acre (112-hectare) portion within the 10,240 acres (4,144 hectares) is bounded by a barbed wire fence. This fenced area contains the surface facilities and the mined salt piles for the WIPP ~~site~~facility. Figure M-44~~H1-1~~ is a cutaway illustrating the spatial relationship of the surface facilities and the underground repository.

~~Upon receipt~~After receiving ~~of~~ the necessary certifications and permits from the EPA and the ~~New Mexico Environment Department~~NMED, the Permittees ~~will begin~~began disposal of contact-handled (**CH**) and remote-handled (**RH**) TRU and TRU mixed waste in the WIPP facility. ~~This waste emplacement and disposal phase~~ The Disposal Phase will continue until the initiation of final facility closure when the Hazardous Waste Disposal Units~~HWDUs~~ have received the final volume of waste or when the 6.2 million cubic feet (**ft^3**) (175,588 cubic meters (**m^3**)) of LWA TRU waste volume has been reached, and as long as the Permittees comply with the requirements of the Permit. At that time, final facility closure will be initiated as described in Renewal Permit Attachment G.~~For the purposes of this Permit Attachment, this time period is assumed to be 25 years.~~ The waste will be shipped from DOE facilities across the country in specially designed transportation containers certified by the Nuclear Regulatory Commission. The transportation routes from these facilities to the WIPP facility have been predetermined. The CH and RH TRU mixed waste will be packaged in ~~55-gallon (208-liter), 85-gallon (322-liter), 100-gallon (379-liter) steel drums, standard waste boxes (**SWBs**), ten drum overpacks (**TDOPs**), and/or standard large box 2s (**SLB2s**). An SWB is a steel container having a free volume of 66.3 cubic feet (1.88 cubic meters). Figure H1-2 shows the general arrangement of a seven-pack of drums and an SWB as received in a Contact-Handled Package.~~approved containers as listed in Permit Part 3, Section 3.3.1 and described in Permit Attachment A1 ~~RH TRU mixed waste inside a Remote-Handled Package is contained in one or more of the allowable containers described in Permit Attachment A1. Some RH TRU mixed waste may arrive in shielded containers as described in Permit Attachment A1~~.

Upon receipt and inspection of the waste containers in the ~~waste handling building~~Waste Handling Building Container Storage Unit, the containers will be moved into the repository 2,150 feet (655 meters) below the surface. The containers will then be transported to a disposal room. (See Figure M-44~~H1-1~~ for room and panel arrangement.) ~~The initial seven disposal rooms are in Panel 1. Panel 1 is the first of eight panels planned to be excavated. Special supports and ground control corrective actions have been implemented in Panel 1 to ensure its stability.~~ Upon filling an entire panel, that panel will be closed to isolate it from the rest of the repository and the ventilation system. During the period of time it takes to fill a given panel, an additional panel will be excavated. Sequential excavation of ~~Panels 2 through 8~~panels will ensure that these individual panels remain stable during the entire time a panel is being filled with waste. Ground control maintenance and evaluation with appropriate corrective action will be required to ensure that ~~Panels 9 and 10 (~~ventilation and access drifts in the repository~~)~~ remain stable.

Decontamination of the WIPP facility will commence with a detailed radiation survey of the entire site. ~~Contaminated~~Radiological contaminated areas and equipment will be evaluated and decontaminated~~ in accordance with applicable requirements~~ consistent with radiological control procedures pursuant to 10 CFR Part 835. Hazardous waste decontamination, if needed, will be conducted in accordance with standard 20.4.1.500 NMAC (incorporating 40 CFR Part 264) or as prescribed by the Permit. Where decontamination efforts identify areas that meet clean closure standards for permitted container storage units and are below radiological ~~release criteria~~control limits pursuant to 10 CFR Part 835, routine dismantling and salvaging practices will determine the disposition of the material or equipment involved. Material and equipment that do not meet these standards and criteria will be emplaced in the ~~access entries~~final open disposal area ~~(Panels 9 and/or 10)~~. Upon completion of emplacement of the contaminated facility material, the entries will be ~~closed~~closed, and the repository shafts will be sealed. Final ~~repository~~ facility closure includes sealing the shafts leading to the repository. Figure M-64~~H1-3~~ illustrates the shaft sealing arrangement. Certification of closure will end disposal operations and initiate the post-closure care period for implementation of active institutional controls.

H1.1 Active Institutional Controls

Active institutional controls during post-closure consist of three elements:

- controlling access to a disposal site,
- performing maintenance operations or remedial actions at a site, and
- controlling or cleaning up releases from a site.

The LWA has removed the WIPP site from public use as a site for mining and other types of mineral resource extraction. Since any type of exploration activity would require authorization, the issuance of approval to intrude upon the repository is precluded by the LWA. The existence of the LWA as law permits meeting the requirements of the first element above by implementing low technology barriers. These barriers include a posted fence and active surveillance at a frequency that denies sufficient time for an individual or organization to intrude into the repository undetected using today’s drilling technology. Maintenance and remedial actions at the WIPP site will be conducted by the Permittees at the time of implementing the access controls for the site. The control or cleanup of releases from the site will be conducted as part of the operational program prior to sealing of the shafts. This is necessary to ensure that ~~all~~ derived waste is disposed of within the repository prior to shaft sealing.

The Permittees shall maintain the access controls. This requirement includes the maintenance and corrective actions necessary to ensure that the fence and patrol requirements (surveillance) are met. The active institutional controls to be implemented by the Permittees after final closure are the following:

1. A fence line will be established to control access to the repository footprint area on the surface. A standard four-strand (three barbed and one unbarbed, in accordance with the Bureau of Land Management specifications) wire fence will be erected along the perimeter of the repository surface footprint. To provide access to the repository footprint during construction of the berm (which may be built in multiple sections simultaneously),

the fence will have gates placed approximately midway along ~~each of the four side~~selected legs of the fenced area~~s~~. ~~these~~ These gates will remain locked with access controlled by the Permittees. The ~~western~~ gates will be ~~20 feet (6 meters) wide. The remaining three gates will each be 16 feet (4.9 meters) wide.~~wide enough to accommodate the equipment that will be used to build the berm. Additional fencing will be constructed where appropriate for remote locations that are used for disposal system monitoring. Such fences will meet the same construction specifications as the repository footprint perimeter fence.

2. Unpaved roadways 16 feet (4.9 meters) wide will be established along the perimeter of the barbed wire fence as well as along the WIPP site boundary. These roadways will be constructed so as to provide ready vehicle access to any point around the fenced perimeter and the site boundary. These roadways will facilitate inspection and maintenance of the fenceline and will allow visual observation of the repository footprint and the site boundary to the extent permitted by the lay of the land. These roadways will connect to the paved south access road. Roads to remote sites will also be constructed and maintained where appropriate.

3. The fence line will be posted with signs having, as a minimum, a legend reading “Danger—Unauthorized Personnel Keep Out” (20.4.1.500 NMAC (incorporating 40 CFR §264.14[c])) and warning against entering the area without specific permission of the Permittees. The legend must be written in English and Spanish. The signs must be legible from a distance of at least 25 feet (7.6 meters). The size of the visual warning and the spacing of the warning signs will be sufficiently large and close to ensure that one or more of the signs can be seen from any approach prior to an individual actually making contact with the fence line. In no case will the spacing be greater than 300 feet (91.5 meters).

4. The Permittees will ensure that periodic inspection and expedited corrective maintenance are conducted on the fence line, its associated warning signs, and roadways.

5. The Permittees will provide for routine periodic patrols and surveillance of ~~all~~ areas controlled by or under the authority of the Permittees by personnel trained in security surveillance and investigation.

6. The Permittees will implement the periodic monitoring requirements of the long-term monitoring system.

7. The Permittees will submit a Permit modification request for any proposed modifications to the active institutional controls appropriate for access control, as specified in 20.4.1.900 NMAC (incorporating 40 CFR §270.42).

8. The Permittees will immediately take appropriate action to address abnormal conditions identified during periodic surveillance and inspections. Abnormal conditions include any natural or human-caused conditions which would affect the integrity of the active institutional controls.

9. Reports addressing activities associated with the performance of the active access controls after final closure will be prepared periodically according to applicable

requirements by the Permittees for submittal to the appropriate regulatory and legislative authorities.

H1.1.1 Repository Footprint Fencing

~~Access to an area~~The fenced area will be composed of two adjoining rectangular areas (See Figure M-65). One rectangular area will be approximately 2,780 feet by 2,360 feet (875 meters by 720 meters), covering the area over Panels 1-8. The second (adjoining) rectangular area will be approximately 1,040 feet by 1,210 feet (317 meters by 369 meters) covering the area over Panels 11 and 12. The fenced area will be controlled by a four-strand barbed wire fence. ~~A single gate~~Gates will be included as needed along ~~each~~ the sides of the fence for access. These gates will remain locked with access controlled by the Permittees. Around the perimeter of the fence, an unpaved roadway 16 feet (4.9 meters) wide will be cut to allow for patrolling of the perimeter. Figure M-65~~H1-4~~ is an illustration of the fence line in relation to the repository footprint. Patrolling of the perimeter is based upon the need to ensure that no mining or well drilling activity is initiated that could threaten the integrity of the repository.

Fencing off an area larger than the disposal area footprint would not significantly reduce the risk of intrusion but would interfere with cattle grazing~~ established prior to the LWA. The LWA states that the Secretary of Energy can allow grazing to continue where it was established prior to enactment of the LWA~~. Based upon current drilling technologies, discussions with local well drilling organizations, and observation of well drilling activities in the WIPP vicinity, it typically requires at least two to three days for a driller to set up a deep drilling rig and commence actual drilling operations. Attaining the 2,150-foot (655-meter) depth that would approach the repository horizon takes at least another week to 10 days. Based upon current drilling practices, patrolling the fenced area two to three times weekly would identify any ~~potential~~ drilling activity well before any breach of the repository could occur. Therefore, the perimeter fence will be patrolled three times weekly after final closure.

Construction of access control systems using higher technology than described is not required. Likewise, continuous surveillance whether human or electronic is not required.

H1.1.2 Surveillance Monitoring

The Permittees will conduct periodic surveillance of the site and the repository footprint during the post-closure period. Unpaved roadways around the WIPP site boundary and around the repository footprint will facilitate such surveillance. Contractual arrangements with a local organization such as the Eddy County Sheriff's Department may be established which would provide some distinct advantages. Among the advantages are the following:

- deputies are trained in patrol and surveillance activities,
- deputies are authorized to arrest members of the general public who are found to be violating trespassing laws,
- the liability associated with apprehension, attempted apprehension, or circumstances arising from attempts would remain with the Sheriff's Department, and
- the general area to be patrolled is already a part of the Sheriff's area of responsibility.

Surveillance will consist of drive-by patrolling around the fenced perimeter a minimum of ~~three~~ two times per week (weather and road conditions permitting). In the course of the patrol, particular note will be taken of the fence and sign integrity. In addition, the locked condition of each gate will be checked to ensure that gate integrity is maintained and there is no evidence of tampering. Surveillance will also include visual observation of the entire enclosed area for any signs of human activity. Additionally, surveillance patrols will be conducted around the site boundary's perimeter for signs of unauthorized human activities. A routine summary of each month's surveillance activity will be prepared documenting the date and time of each patrol and any unusual circumstances that may have been observed. This surveillance routine will continue throughout the post-closure care period.

H1.1.3 Maintenance and Remedial Actions

Anticipated maintenance and remedial action issues during the post-closure care period are minimal and should encompass such issues as

- fence and road maintenance,
- repair of any damage that occurs,
- response to evidence of potential erection of drilling equipment, and
- response to unauthorized entry into prohibited areas.

The Permittees will provide maintenance services within a reasonable time after the need is identified during routine patrolling activity. Any observed vandalism or unauthorized entry will be ~~investigated~~investigated, and action will be taken as the circumstances warrant.

H1.1.4 Control and Clean-up of Releases

The decontamination process and disposal of the derived waste will be completed prior to sealing the shafts and final facility closure. With the location of the WIPP repository at 2,150 feet (655 meters) below the surface and with panels closed and shafts sealed, the potential for releases of radioactive material or hazardous constituents following the sealing of the shafts is precluded. There will be no credible pathway for releases from the repository other than human intrusion. Routine patrols in accordance with access control requirements will preclude human intrusion into the repository during the post-closure period.

H1.1.5 Groundwater Monitoring

Groundwater monitoring is the only monitoring program required by the Permit that will be conducted throughout the post-closure care period. The post-closure groundwater monitoring requirements are specified in Permit Part 7 and Permit Attachment L.

H1.2 Additional Post-Closure Activities

With the certification of closure of the WIPP facility and return of the land disturbed by the WIPP activities to a stable ecological state that will assimilate with the surrounding undisturbed ecosystem, continuous occupancy of the site for operational and security purposes will cease. Any additional activities will be imposed through the Post-Closure Care Permit issued by the NMED after certification of closure.

H1.3 Quality Assurance

The quality assurance and quality control plan will be applied to the procurement of materials for and the erection of the fencelines enclosing the repository footprint. In particular, quality control inspection of the placement and tensioning of the barbed wire and chain link fabric will be applied and utilized to provide reasonable assurance that the fencing structures will function during the post-closure care period with normal maintenance.

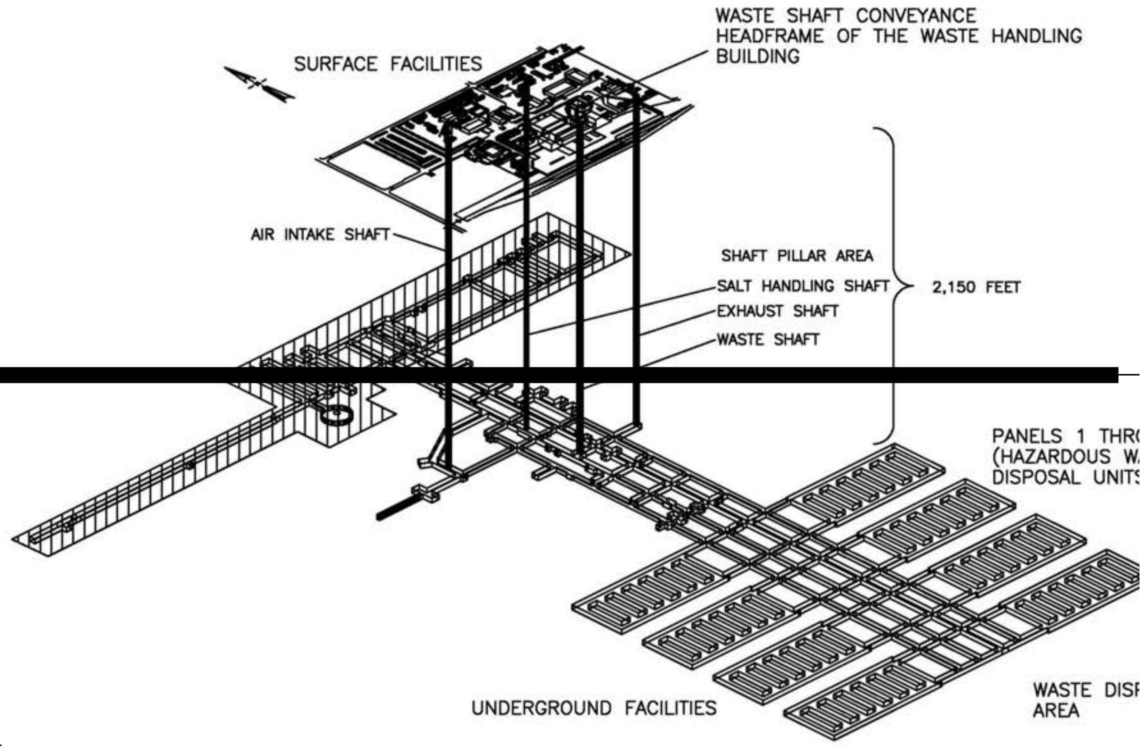
Quality assurance and quality control will also be applied to the sampling and analyses supporting the environmental monitoring program. Contractors collecting samples and laboratories conducting analyses for the Permittees shall be qualified in accordance with guidelines prescribed in the most current edition of the Permittees' quality assurance program document at the time that the contracts are awarded.

References

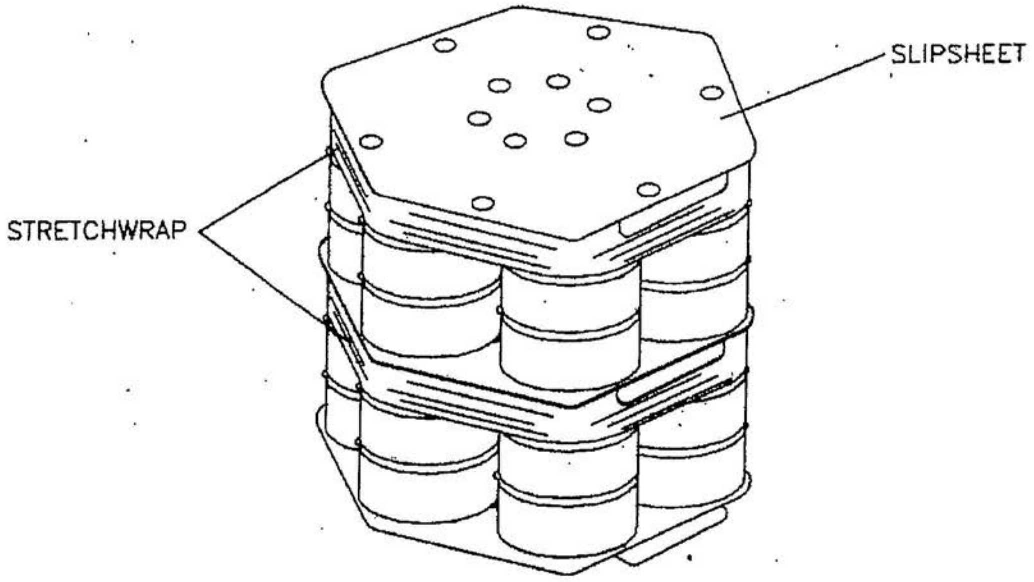
EPA (U.S. Environmental Protection Agency). 1993. 40 CFR Part 191 Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste; Final Rule. *Federal Register*, Vol. 58, No. 242, pp. 66398-66416, December 20, 1993. Office of Radiation and Indoor Air, Washington, D.C.

U.S. Congress. 1992. Waste Isolation Pilot Plant Land Withdrawal Act as amended. Public Law 102-579, 106 Stat. 4777, October 1992. 102nd Congress, Washington, D.C.

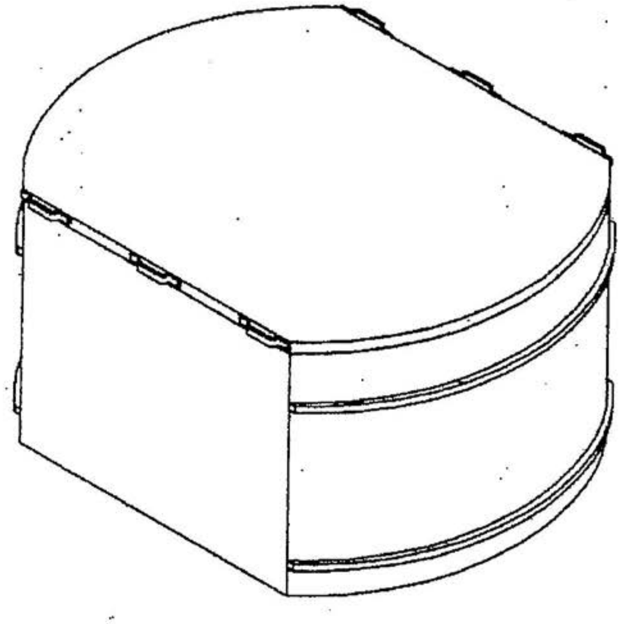
~~FIGURES~~



~~**Figure H1-1**~~
~~**Spatial View of WIPP Surface and Underground Facilities**~~

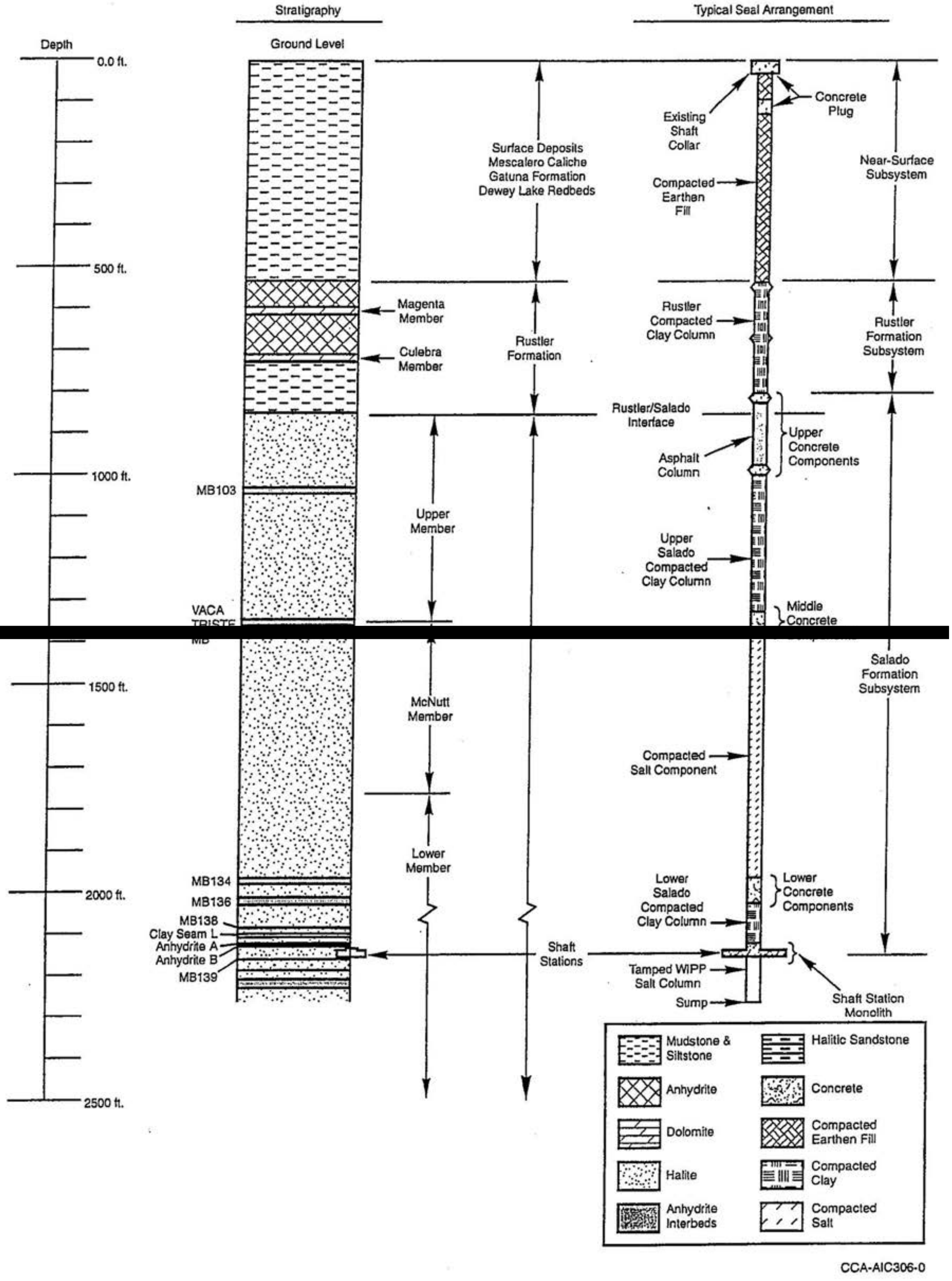


SEVEN–PACKS

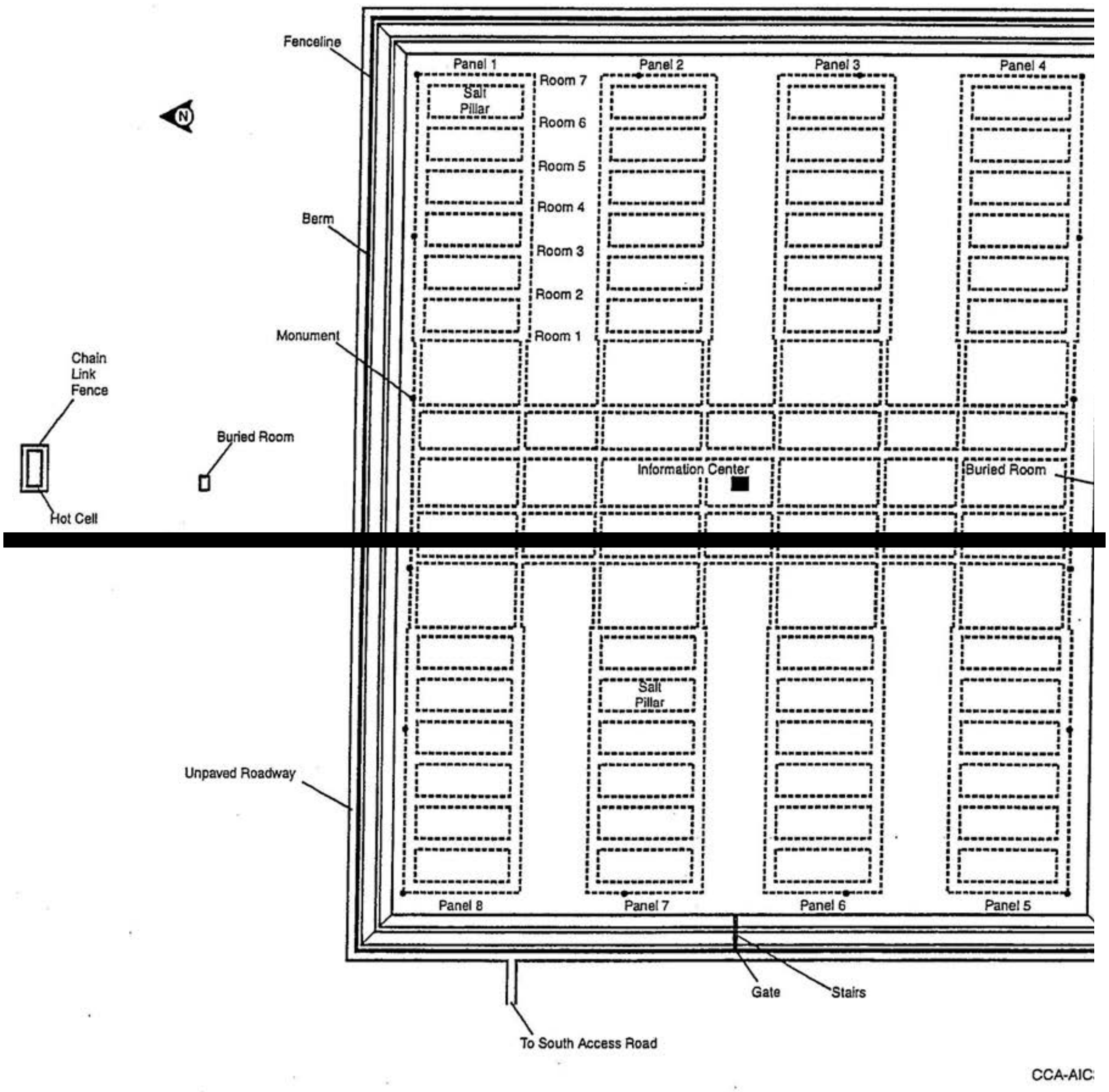


STANDARD WASTE BOX

~~**Figure H1-2**~~
~~**Standard Waste Box and Seven-Pack Configuration**~~



~~Figure H1-3~~
~~Typical Shaft Sealing System~~



~~Figure H1-4~~
~~Perimeter Fenceline and Roadway~~

ATTACHMENT I

(RESERVED FOR PERMIT ATTACHMENT I, COMPLIANCE SCHEDULE)

ATTACHMENT J

(RESERVED FOR PERMIT ATTACHMENT J, HAZARDOUS WASTE MANAGEMENT UNIT TABLES)

ATTACHMENT K

(RESERVED FOR PERMIT ATTACHMENT K, SOLID WASTE MANAGEMENT UNIT (SWMU) AND AREA OF CONCERN (AOC) TABLES)

ATTACHMENT L

WIPP GROUNDWATER DETECTION MONITORING PROGRAM PLAN

ATTACHMENT L

WIPP GROUNDWATER DETECTION MONITORING PROGRAM PLAN

TABLE OF CONTENTS

LIST OF TABLES

~~LIST OF FIGURES~~

LIST OF ABBREVIATIONS/ACRONYMS/UNITS

Bell Canyon	Bell Canyon Formation
bgs	below ground surface
Castile	Castile Formation
cm	centimeter(s)
Culebra	Culebra Member of the Rustler Formation
CofC/RFA	chain of custody/request for analysis
°C	degree(s) Celsius
%C	percent completeness
Dewey Lake	Dewey Lake Redbeds Formation
DI	deionized
DMP	Detection Monitoring Program
DMW	Detection Monitoring Well
DOE	U.S. Department of Energy
DQO	data quality objectives
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
ft^2	square foot (square feet)
ft^2/d	square feet per day
g/cm^3	gram(s) per cubic centimeter
HWDU	hazardous waste disposal unit(s)
km	kilometer(s)
km^2	square kilometer(s)
L	liter(s)
lb/in.^{2}	pound(s) per square inch
LCS	laboratory control samples
LCSD	lab control sample duplicate
Los Medaños	Los Medaños Member of the Rustler Formation
LWA	Land Withdrawal Act
m	meter(s)
M&DC	monitoring and data collection
m^2	square meter(s)
Magenta	Magenta Member of the Rustler Formation
mg/L	milligram(s) per liter
mi	mile(s)
mi^2	square mile(s)
mL	milliliter(s)
molal	moles per kilogram
MOC	Management and Operating Contractor
MPa	megapascal(s)
m/s	meters per second
m^2	square meters

m^2/s	square meters per second
mV	millivolt(s)
NIST	National Institute for Standards and Technology
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
QA	~~Quality~~ quality ~~Assurance~~assurance
QA/QC	quality assurance/quality control
QAO	Quality Assurance Objective
QC	quality control
PABC	Performance Assessment Baseline Calculation
RCRA	Resource Conservation and Recovery Act
RPD	relative percent difference
Rustler	Rustler Formation
%R	percent recovery
Salado	Salado Formation
SAP	Sampling and Analysis Plans
SC	specific conductance
SOP	~~Standard~~ standard ~~Operating~~ operating ~~Procedure~~procedure
TDS	total dissolved solids
TOC	total organic carbon
TRU	transuranic
TSDF	treatment, storage, and disposal facilities
UTLV	upper tolerance limit value
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant
WLMP	WIPP Groundwater Level Monitoring Program
µg/L	microgram(s) per liter
µm	micrometers

ATTACHMENT L

WIPP GROUNDWATER DETECTION MONITORING PROGRAM PLAN

L-1 Introduction

The Waste Isolation Pilot Plant (**WIPP**) facility is subject to regulation under Title 20 of the New Mexico Administrative Code (**NMAC**), Chapter 4, Part 1~~, Subpart V~~ (20.4.1.500 NMAC). As required by 20.4.1.500 NMAC (incorporating 40 CFR §264.601), the Permittees shall demonstrate that the environmental performance standards for a miscellaneous unit, which are applied to the hazardous waste disposal units (**HWDUs**) in the underground, will be met.

The WIPP facility is located in Eddy County in southeastern New Mexico (Figure ~~L-1~~M-57), within the Pecos Valley section of the southern Great Plains physiographic province. The facility is 26 miles (mi) (42 kilometers [km]) east of Carlsbad, New Mexico, in an area known as Los Medaños (the dunes). Los Medaños is a relatively flat, sparsely inhabited plateau with little water and limited land uses.

The WIPP facility (Figure ~~L-2~~M-66) consists of 16 sections of ~~F~~federal land in Township 22 South, Range 31 East. The 16 sections of ~~F~~federal land were withdrawn from the application of public land laws by the WIPP Land Withdrawal Act (**LWA**), Public Law 102-579. The WIPP LWA transferred the responsibility for the administration of the 16 sections from the Department of Interior, Bureau of Land Management, to the U.S. Department of Energy (**DOE**). This law specified that mining and drilling for purposes other than support of the WIPP project are prohibited within this ~~16 ~~16-section area with the exception of Section 31. Oil and gas drilling activities are restricted in Section 31 from the surface down to 6,000 feet.

The WIPP facility includes a mined geologic repository for the disposal of transuranic (**TRU**) mixed waste. The disposal horizon is located 2,150 feet (ft) (655 meters [m]) below the land surface in the bedded salt of the Salado Formation (**Salado**). At the WIPP facility, water-bearing units occur both above and below the disposal horizon. Groundwater monitoring of the uppermost aquifer below the facility is not required because the water-bearing unit, which is ~~(~~the Bell Canyon Formation (**Bell Canyon**)~~)~~, is not considered a credible pathway for a release from the repository. This is because the repository horizon and water-bearing sandstones of the Bell Canyon are separated by over 2,000 ft (610 m) of very low-permeability evaporite sediments (Amended Renewal Application Addendum L1 (DOE, 2009)). No natural credible pathway has been established for contaminant transport to water-bearing zones below the repository horizon, as there is no hydrologic communication between the repository and underlying water-bearing zones. The U.S. Environmental Protection Agency (**EPA**) concluded in 1990 that natural vertical communication does not exist based on review of numerous studies (EPA, 1990). Furthermore, drilling boreholes for groundwater monitoring through the Salado and the Castile Formation (**Castile**) into the Bell Canyon would compromise the isolation properties of the repository medium.

Groundwater monitoring at the WIPP facility focuses on the Culebra Member (**Culebra**) of the Rustler Formation (**Rustler**) because it represents the most significant hydrologic contaminant migration pathway to the accessible environment. The Culebra is the most ~~significant~~ transmissive water-bearing unit lying above the repository. Groundwater movement in the

Culebra, ~~using~~ based-on results from the basin-scale groundwater model, is discussed in detail in Amended Renewal Application Addendum L1, Section L1-2a, (DOE, 2009).

This monitoring plan addresses requirements for sample collection, Culebra groundwater surface elevation monitoring, Culebra groundwater flow direction and rate determination, data management, and reporting of Culebra groundwater monitoring data. It also identifies indicator parameters and hazardous constituents selected to assess Culebra groundwater quality for the WIPP ~~g~~Groundwater ~~d~~Detection ~~m~~Monitoring ~~p~~Program (**DMP**). Because quality assurance is an integral component of the groundwater sampling, analysis, and reporting process, quality assurance/quality control (**QA/QC**) elements and associated data acceptance criteria are included in this plan.

Procedures are required for each aspect of the Culebra groundwater monitoring and sampling processes, including Culebra groundwater surface elevation measurement, Culebra groundwater flow direction and rate determination, sampling equipment installation and operation, field water-quality measurements, and sample collection. Instructions for performing field activities that will be conducted in conjunction with this DMP are provided in the WIPP Standard Operating Procedures (**SOPs**) (see Table L-3), which are maintained in facility files and which comply with the applicable requirements of 20.4.1.500 NMAC (incorporating 40 CFR § 264.97 (d)). ~~Procedures are required for each aspect of the Culebra groundwater sampling process, including Culebra groundwater surface elevation measurement, Culebra groundwater flow direction and rate determination, sampling equipment installation and operation, field water-quality measurements, and sample collection.~~ Data required by this plan will be collected by qualified personnel in accordance with SOPs (Table L-3).

L-1a Geologic and Hydrologic Characteristics

L-1a(1) Geology

The WIPP facility is situated within the Delaware Basin bounded to the north and east by the Capitan Reef, which is part of the larger Permian Basin, located in western Texas and southeastern New Mexico~~the south-central region of North America~~. Three major evaporite-bearing formations were deposited in the Delaware Basin (see Figures ~~L-3~~M-67 and ~~L-4~~M-68 and Amended Renewal Application Addendum L1, Section L1-1 (DOE, 2009) for more detail):

- The Castile, which consists of interbedded anhydrites and halite. Its upper boundary is at a depth of about 2,825 ft (861 m) below ground surface (**bgs**), and its thickness at the WIPP facility is 1,250 ft (381 m).

- The ~~repository is located in the~~ Salado, which is the host formation of the repository and overlies the Castile and resulted from prolonged desiccation that produced predominantly halite, with some carbonates, anhydrites, and clay seams. Its upper boundary is at a depth of about 850 ft (259 m) bgs, and it is about 2,000 ft (610 m) thick in the repository area.

- The Rustler, ~~Formation~~which was deposited in a lagoonal environment during a major freshening of the basin and consists of carbonates, anhydrites, and halites. Its beds consist of clay and anhydrite and contain small amounts of brine. The Rustler’s upper boundary is about 500 ft (152 m) bgs, and it ranges up to 350 ft (107 m) in thickness in the repository area.

These evaporite-bearing formations lie between two other formations significant to the geology and hydrology of the WIPP facility. The Dewey Lake Redbeds Formation (**Dewey Lake**) overlying the Rustler is dominated by nonmarine sediments and consists almost entirely of mudstone, claystone, siltstone, and interbedded sandstone (see Amended Renewal Application Addendum L1, Section L1-1c(6) (DOE, 2009)). This formation forms a 500-ft~~-~~ (152-m) thick barrier of fine-grained sediments that retard the downward percolation of water into the evaporite units below. The Bell Canyon is the first water-bearing unit below the repository (see Amended Renewal Application Addendum L1, Section L1-1c(2) (DOE, 2009)) and is confined above by the thick evaporite deposits of the Castile. It consists of 1,200 ft (366 m) of interbedded sandstone, shale, and siltstone.

The Salado was selected to host the WIPP repository for several reasons. First, it is regionally extensive, underlying an area of more than 36,000 square mi (**mi^2**) (93,240 square kilometers [**km^2**]). Second, its permeability is extremely low. Third, salt behaves mechanically in a plastic manner under pressure (the lithostatic pressure at the disposal horizon is approximately 2,200 pounds per square inch [**lb/in.^{2}**] or 14.9 megapascals [**MPa**]) and eventually deforms to fill any opening (referred to as creep). Fourth, any fluid remaining in small fractures or openings is saturated with salt, is incapable of further salt dissolution, and has probably remained in place since deposition. Finally, the Salado lies between the Rustler and the Castile (Figure ~~L-4~~M-68), both of which contain very low-~~-~~permeability layers that help confine and isolate waste within and keep water outside of the WIPP repository (see Amended Renewal Application Addendum L1, Section L1-1c(5) and L1-1c(3) (DOE, 2009)).

L-1a(2) Groundwater Hydrology

The general hydrogeology of the area surrounding the WIPP facility is described in this section starting with the first geologic unit below the Salado. Addendum L1, Section L1-2a of ~~the~~ Amended Renewal Application (DOE, 2009) provides more detailed discussions of the local and regional hydrogeology. Relevant hydrological parameters for the various rock units, above the Salado at the WIPP facility are summarized in Table L-1.

L-1a(2)(i) The Castile

The Castile is a basin-filling evaporite sequence of sediments surrounded by the Capitan Reef. The Castile represents a major regional groundwater aquitard that effectively prevents upward migration of water from the underlying Bell Canyon. Fluid present in the Castile is very restricted because evaporites do not readily maintain pore space, solution channels, or open fractures at depth. Drill-stem tests conducted in the Castile during construction of the WIPP facility determined its permeability to be lower than detection limits; however, the hydraulic conductivity has been conservatively estimated to be less than 10^{-8} ~~ft~~feet (**ft**) per day or ~~(~~3.5 × 10^{-}~~^{9}~~^{14} meters per second (**m/s**)~~ per day~~. A description of the Castile brine reservoirs outside the WIPP facility area is provided in Addendum L1, Section L1-2a(2)(b) of ~~the~~ Amended Renewal Application (DOE, 2009).

L-1a(2)(ii) The Salado

The Salado is an evaporite sequence that filled the remainder of the Delaware Basin and lapped extensively over the Capitan Reef and the back-reef sediments beyond. The Salado consists of approximately 2,000 ft (610 m) of bedded halite, with interbeds or seams of anhydrite, clay, and polyhalite. It acts hydrologically as a regional confining bed. The porosity of the Salado is very low and naturally interconnected pores are probably nonexistent in halite at the depth of the disposal horizon. Fluids associated with the Salado occur mainly as very small fluid inclusions in the halite crystals and also occur between crystal boundaries (interstitial fluid) of the massive crystalline salt formation; fluids also occur in clay seams and anhydrite beds. Permeabilities measured from the surface in the area of the WIPP facility range from 0.01 to 25 microdarcys~~microdarcies~~ (9.9 x 10^{-17} square meters [**m^2**]). The most reliable value, 0.3 microdarcy (3.0 x 10^{-19} m^2), was obtained from well DOE-2. The results of permeability testing at the disposal horizon are within the range of 0.001 to 0.01 microdarcy (9.9 x 10^{-22} to 9.9 x 10^{-21} m^2).

L-1a(2)(iii) The Rustler

The Rustler has been the subject of extensive characterization activities because it contains the most transmissive hydrologic units overlying the Salado. Within the Rustler, five members have been identified. Of these, the Culebra is the most transmissive and has been the focus of most of the Rustler hydrologic studies.

The Culebra is the first continuous water-bearing zone above the Salado and is up to approximately 30 ft (9 m) thick. Water in the Culebra is usually present in fractures and is confined by overlying gypsum or anhydrite and underlying clay and anhydrite beds. The hydraulic gradient within the Culebra in the area of the WIPP facility is approximately 20 ft per mi (3.8 m per km) and becomes much flatter south and southwest of the site (Figure ~~L-5~~M-69). Culebra transmissivities in the Nash Draw range up to 1,250 square ft (**ft^2**) per day (**ft^2/d**) (1.3 x 10^{-3} m^2 per second (**m^2/s**)~~116 square m [m^2]) per day~~; closer to the WIPP facility, they are as low as 0.007 to 74 ft^2/d (~~0.000065~~7.5 x 10^{-9} to 8.0 x 10^{-5}~~7.0~~ m^2/s)~~ per day~~.

The two primary types of field tests that are being used to characterize the flow and transport characteristics of the Culebra are hydraulic tests and tracer tests.

The hydraulic tests consist of pump, injection, and slug testing of wells across the study area (see Amended Renewal Application Addendum L1, Section L1-2a(3)(a)(ii) (DOE, 2009)). The most detailed hydraulic test data exist for the WIPP hydropads (e.g., H-19). The hydropads generally comprise a network of three or more wells located within a few tens of meters of each other. Long-term pumping tests have been conducted at hydropads H-3, H-11, and H-19 and at well WIPP-13 (see Amended Renewal Application Addendum L1, Section L1-2a(3)(a)(ii) (DOE, 2009)). These pumping tests provided transient pressure data both at the hydropad and over a much larger area. Tests often included use of automated data-acquisition systems, providing high-resolution (in both space and time) data sets. In addition to long-term pumping tests, slug tests and short-term pumping tests have been conducted at individual wells to provide pressure data that can be used to interpret the transmissivity at that well (see Amended Renewal Application Addendum L1, Section L1-2a(3)(a)(ii) (DOE, 2009)). Detailed cross-hole hydraulic testing has been conducted at the H-19 hydropad (see Amended Renewal Application Addendum L1, Section L1-2a(3)(a)(ii) (DOE, 2009)).

Pressure data ~~are~~ were collected during hydraulic tests for estimation of hydrologic characteristics such as transmissivity, permeability, and storativity. The pressure data from long-term pumping tests and the interpreted transmissivity values for individual wells ~~are~~ were used to develop the conceptual model for incorporation into~~in calibration of~~ flow models. Some of the hydraulic test data and interpretations are also important for the interpretation of transport characteristics. For instance, the permeability values interpreted from the hydraulic tests at a given hydropad ~~are~~ were needed for interpretations of tracer test data at that hydropad.

There is strong evidence that the permeability of the Culebra varies spatially and varies sufficiently that it cannot be characterized with a uniform value or range over the region ~~of interest to~~that affects the WIPP facility. The transmissivity of the Culebra varies spatially over ten orders of magnitude from east to west in the vicinity of the WIPP facility. Transmissivities have been calculated at 1×10^{-7} ft^2/d~~square feet per day~~ (1×10^{-13} m^2/s~~square meters per second~~) at well SNL-15 east of the WIPP site to 1×10^{3} ft^2/d~~square feet per day~~ (1×10^{-3} m^2/s~~square meters per second~~) at well H-7 in Nash Draw (see Amended Renewal Application Addendum L1, Section L1-2a(3)(a)(ii) (DOE, 2009)).

Transmissivity variations in the Culebra are believed to be controlled by the relative abundance of open fractures (secondary porosity) rather than by primary porosity (i.e.~~that is~~, depositional) ~~features~~ of the unit (Roberts, 2007).~~ Lateral variations in depositional environments were small within the mapped region, and primary features of the Culebra show little map-scale spatial variability, according to Holt and Powers, 1988. Direct measurements of the density of open fractures are not available from core samples because of incomplete recovery and fracturing during drilling, but observation of the relatively unfractured exposures in the WIPP shafts suggests that the density of open fractures in the Culebra decreases to the east.~~ Holt and Powers (1988) examined available Culebra cores at and near the WIPP site and integrated observations with shaft mapping at the site. These cores were not all complete through the Culebra. Culebra thickness varies somewhat in the site area. The Culebra varies vertically, but Holt and Powers (1988) described consistent sedimentary features across the area. The Culebra did not reveal facies changes over the site and surrounding area that indicate changes in depositional environments.

Holt (1997) described transport processes through the Culebra, concluding that at the regional scale the Culebra will behave as a double-porosity unit. Fractures were related to depth and dissolution of underlying Salado halite by Holt (Holt and Yarbrough, 2002; Powers et al., 2003). It was also noted by Holt (1997) that halite bounding the Culebra (especially to the east of the WIPP site) was likely to further decrease the porosity of the Culebra. Culebra core from monitor well SNL-15 (Powers et al., 2006) provided evidence of halite filling Culebra porosity where halite beds overlie and underlie the dolomite (Holt and Powers, 2010). Gypsum precipitated in porosity in some areas of the Culebra may further decrease porosity (Beauheim and Holt, 1990). The Culebra conceptual model was revised based on the relationship of transmissivity to the three factors of overburden thickness, dissolution of salt from below the Culebra, and the presence of halite below and above the Culebra (Holt et al., 2005).

Geochemical and radioisotope characteristics of the Culebra have been studied. There is considerable variation in groundwater geochemistry in the Culebra. The variation has been described in terms of different hydrogeochemical facies that can be mapped in the Culebra. A halite-rich hydrogeochemical facies exists in the region of the WIPP site and to the east, approximately corresponding to the regions in which halite exists in units above and below the Culebra, and in which a large portion of the Culebra fractures are gypsum filled. An anhydrite-rich hydrogeochemical facies exists west and south of the WIPP site, where there is relatively less halite in adjacent strata and where there are fewer gypsum-filled fractures. ~~Radiogenic isotopic~~Isotopic signatures suggest that the age of the groundwater in the Culebra is on the order of 10,000 years or more (see Amended Renewal Application Addendum L1 (DOE, 2009)).

More recent data indicate Krypton-81 model ages on the order of 130,000 years for high-transmissivity zones of the Culebra (Sturchio et al., 2014)

The radiogenic ages of the Culebra groundwater and the geochemical differences provide information potentially relevant to the groundwater flow directions and groundwater interaction with other units and are important constraints on conceptual models of groundwater flow (see Renewal Application Addendum L1, Section L1-4b (DOE, 2020).

The Permittees have proposed a conceptualization of groundwater flow that explains observed geochemical facies and groundwater flow patterns. The conceptualization, referred to as the basin-scale groundwater model, offers a ~~three~~ three-dimensional approach to treatment of Supra-Salado rock units, and assumes vertical leakage (albeit very slow) between rock units of the Rustler exists (where a hydraulic head is present).

Flow in the Culebra is considered transient. The model assumes that the groundwater system is dynamic and is responding to climate~~the~~ drying ~~of climate~~ that has persisted~~occurred~~ since the late Pleistocene period. The Permittees assumed that recharge rates during the late Pleistocene period were sufficient to maintain the water table near land surface, but has since dropped significantly. Therefore, the impact of local topography on groundwater flow was greater during wetter periods, with discharge from the Rustler in the vicinity of the WIPP facility to the west toward Nash Draw; flow is currently dominated by more regional topographic effects during drier times, with flow in the Rustler from the vicinity of the WIPP facility towards the Balmorhea-Loving Trough to the south.

Using data from 22 wells, Siegel et al.~~, Robinson, and Myers~~ (1991) originally defined four hydrochemical zones~~facies~~ (A, B, C, and D) for Culebra groundwater based primarily on ionic strength and major constituents. With the data ~~now~~ available from 59 wells, Domski and Beauheim (2008) defined transitional A/C and B/C facies, as well as a new ~~facies~~ Zone E for high-moles per kilogram (molal) Na-Mg Cl brines. These hydrochemical zones/facies include the following:

- Zone B - Dilute (ionic strength ≤0.1 molal) $CaSO_4$-rich groundwater, from southern high-transmissivity area. Mg/Ca molar ratio 0.32 to 0.52.
- ~~Zone~~ Facies B/C - Ionic strength 0.18 to 0.29 molal, Mg/Ca molar ratio 0.4 to 0.6.
- Zone C - Variable composition waters, ionic strength 0.3 to 1.0 molal, Mg/Ca molar ratio 0.4 to 1.1.
- ~~Zone~~ Facies A/C - Ionic strength 1.1 to 1.6 molal, Mg/Ca molar ratio 0.5 to 1.2.
- Zone A - Ionic strength >1.66 molal, up to 5.3 molal, Mg/Ca molar ratio 1.2 to 2.4.
- Zone D - Defined based on inferred contamination related to potash refining operations. Ionic strength 3 molal, K/Na weight ratios of ~0.2.
- Zone E - Wells east of the mudstone-halite margins, ionic strength 6.4 to 8.6 molal, Mg/Ca molar ratio 4.1 to 6.6.

The low-ionic-strength (≤0.1 molal) ~~facies~~ Zone B waters contain more sulfate than chloride, and are found southwest and south of the WIPP site within and down the Culebra hydraulic gradient from the southernmost closed catchment basins, mapped by Powers (2006), in the southwest arm of Nash Draw. These waters reflect relatively recent recharge through gypsum karst overlying the Culebra. However, with total dissolved solids (**TDS**) concentrations in excess of 3,000 mg/L, the ~~facies~~ Zone B waters do not represent modern-day precipitation rapidly reaching the Culebra. They must have residence times in the Rustler sulfate units of thousands of years before reaching the Culebra.

The higher-ionic-strength (0.3-1 molal) ~~facies~~ Zone C brines have differing compositions, representing meteoric waters that have dissolved $CaSO_4$, overprinted with mixing and localized processes. ~~Facies~~ Zone A brines (ionic strength 1.6 - 5.3 molal) are high in NaCl and are clustered along the extent of halite in the middle of the Tamarisk Member of the Rustler Formation. ~~Facies~~ Zone A represents old waters (long flow paths) that have dissolved halite and/or connate brine, or a mixture of the two from ~~facies~~ Zone E. The ~~facies~~ Zone D brines, as identified by Siegel et al.~~, Robinson, and Myers~~ (1991), are high-ionic-strength solutions found in western Nash Draw with high K/Na ratios representing waters contaminated with effluent from potash refining operations. Similar water is found at shallow depth (<36 ft (11 m)) in the upper Dewey Lake at SNL-1, just south of the Intrepid East tailings pile. The newly defined ~~facies~~ Zone E waters are very high ionic strength (6.4 - 8.6 molal) NaCl brines with high Mg/Ca ratios. The ~~facies~~ Zone E brines are found east of the WIPP site, where Rustler halite is present above and below the Culebra, and halite cements are present in the Culebra. They represent primitive brines present since deposition of the Culebra and immediately overlying strata.

In a previous (earlier) conceptual model, the geochemistry of Culebra groundwater was not correlated with flow direction. It was assumed the Zone~~Previously, the Permittees and others believed the geochemistry of Culebra groundwater was inconsistent with flow directions. This was based on the premise that facies~~ C water must transform to Zone~~facies~~ B water (e.g.,, become “fresher”), which is inconsistent with the observed flow direction. It is now believed that the observed geochemistry and flow directions can be explained with different recharge areas and Culebra travel paths (Amended Renewal Application Addendum L1 (DOE, 2009) and Renewal Application Addendum L1 (DOE, 2020)).

Head distribution in the Culebra (see Amended Renewal Application Addendum L1 (DOE, 2009) and Renewal Application Addendum L1 (DOE, 2020)) is now consistent with basin-scale groundwater basin modeling results indicating that the generalized groundwater flow direction in the Culebra is currently north to south. However, the fractured nature of the Culebra, coupled with variable fluid densities, can cause localized flow patterns to differ from general flow patterns.

Groundwater levels in the Culebra in the region around the WIPP facility have been measured in numerous wells. Water-level rises have been observed and are attributed to causes discussed in ~~the~~ Amended Renewal Application Addendum L1, Section L1-2a(3)(a)(ii) (DOE, 2009) and Renewal Application Addendum L1, Section L1-4d (DOE, 2020). The extent of changes in water ~~-~~levels ~~rise~~ observed at a particular well depends on several factors, but the proximity of the observation point to the cause of the water-level change appears to be a primary factor. Water level decreases have been observed due to athropogenic causes, such as pumping water wells by a local rancher and well pumping from the oil and gas industry for hydraulic fracking (Thomas et al., 2017)

Hydrological investigations conducted from 2003 through 2007 provided new information, some of it confirming long-held assumptions and some offering new insight into the hydrological system around the WIPP site. A Culebra monitoring network optimization study was completed by McKenna (2004) and updated by Kuhlman (2010) to identify locations where new Culebra monitoring wells would be of greatest value and to identify wells that could be removed from the network with little loss of information.

As discussed in Amended Renewal Application Addendum L1, Section L1-2a(3)(a)(ii) (DOE, 2009) and Renewal Application Addendum L1 (DOE, 2020), extensive hydrological testing has been performed in the new wells. This testing has involved both short-term single-~~-~~well tests, which provide information on local transmissivity and heterogeneity, and long-term (19 to 32 days) pumping tests that have created observable responses in wells up to 5.9 mi (9.5 km) away.

Inferences about vertical flow directions in the Culebra have been made from well data collected by the Permittees. Beauheim (1987) reported flow directions towards the Culebra from both the underlying Los Medaños Member (**Los Medaños**) of the Rustler and the overlying Magenta Member (**Magenta**) of the Rustler across the WIPP site, indicating that the Culebra acts as a drain for the units around it. This is consistent with results of basin-scale groundwater modeling.

Use of water from the Culebra in the WIPP facility area is quite limited because of its varying yields and high salinity. The Culebra is not used for water supply in the immediate WIPP facility vicinity. Its nearest use is approximately 7 mi (11 km) southwest of the WIPP facility, where salinity is low enough to allow its use for livestock watering.

L-2 General Regulatory Requirements

Because geologic repositories such as the WIPP facility are defined under the Resource Conservation and Recovery Act (**RCRA**) as land disposal facilities and as miscellaneous units, the groundwater monitoring requirements of 20.4.1.500 NMAC (incorporating 40 CFR §§264.600 through 264.603) shall be addressed. The requirements of 20.4.1.500 NMAC (incorporating 40 CFR §§264.90 through 264.101) apply to miscellaneous unit treatment, storage, and disposal facilities (**TSDF**) only if groundwater monitoring is needed to satisfy 20.4.1.500 NMAC (incorporating 40 CFR §§264.601 through 264.603) environmental performance standards.

The New Mexico Environment Department (**NMED**) has concluded that groundwater monitoring in accordance with 20.4.1.500 NMAC (incorporating 40 CFR ~~§~~Part 264, Subpart F) at the WIPP facility is necessary to meet the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §§264.601 through 264.603).

L-3 WIPP Detection Monitoring Program (DMP)—Overview

L-3a Scope

This DMP plan governs groundwater sampling events conducted to meet the applicable requirements of 20.4.1.500 NMAC (incorporating 40 CFR Part 264 Subpart F), and ensures that such data are gathered in accordance with these and other applicable requirements. Analytical results collected during the DMP are compared to the baseline established in ~~this~~ Permit Part 5, Table 5.6, to determine whether or not a release has occurred.

There are two separate components of the Groundwater Monitoring Program, the ~~Detection Monitoring Program (~~DMP~~)~~ and the Water Level Monitoring Program (WLMP). The first component consists of a network of six Detection Monitoring Wells (DMWs). The DMWs (WQSP 1-6) were constructed to be consistent with the specifications provided in the Groundwater Monitoring Technical Enforcement Guidance Document and constitute the RCRA groundwater monitoring network specified in the DMP (Figure M-69). The DMWs were used to establish background groundwater quality in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §§ 264.97 and 264.98~~-~~(f)). The second component of the Culebra Groundwater Monitoring Program is the WLMP, which is used to determine the groundwater surface elevation and flow direction. Table L-4 is a list of the wells used in the WLMP. The list of wells is subject to change due to plugging and abandonment and drilling of new wells.

L-3b Current WIPP DMP

Wells WQSP-1, WQSP-2, and WQSP-3 are located ~~directly~~ upgradient (north) of the WIPP shaft area.

WQSP-4, WQSP-5, and WQSP-6 are located downgradient (south) of the WIPP shaft area. All three Culebra downgradient wells (WQSP-4, -5, and -6) were sited to be located generally in the flow path of contaminants that might be released from the shaft area in the Culebra. Well WQSP-4 was also specifically located to monitor the zone of higher transmissivity, which may represent a faster flow path away from the WIPP shaft area to the LWA boundary (Amended Renewal Application Addendum L1, Section L1-2a(3)(a)(ii) (DOE, 2009)).

The compliance point is defined in 20.4.1.500 NMAC (incorporating 40 CFR §264.95) as the vertical plane immediately downgradient of the hazardous waste management unit area (i.e., at the downgradient footprint of the WIPP repository). Permit Part 5 specifies the point of compliance as "the vertical surface located at the hydraulically downgradient limit of the Underground HWDUs that extends to the Culebra Member of the Rustler Formation." Wells WQSP-4, 5, and 6 are situated to demonstrate that during the operating life of the facility (including closure), there will be no releases of hazardous waste constituents that may have an adverse effect on human health and the environment due to the migration of waste constituents in the groundwater or subsurface environment ~~release of contaminants to the general public will not occur~~.

Transport modeling suggests that travel times from the Waste Handling Shaft to the LWA boundary could be on the order of thousands of years. This assumes conditions where hazardous constituents migrate from the sealed repository (post closure) to the Culebra via the sealed shafts.

Potentiometric surfaces and groundwater flow directions defined for the Culebra prior to large-scale pumping in the WIPP facility area and the excavation of WIPP facility shafts suggests that flow was generally to the south-southeast from the waste disposal and shaft areas (Mercer, 1983; Davies, 1989). Potentiometric surface maps of the Culebra adjusted for density differences show very similar characteristics. Water levels used to determine~~The wells used for measuring~~ the potentiometric surface of the Culebra are measured monthly and listed in Table L-4.

L-3b(1) Detection Monitoring Well Construction Specification

Diagrams of the six DMP wells are shown in Figures ~~L-7~~M-71 through ~~L-12~~M-76. Detailed descriptions of geology and construction methods ~~may be~~are found in DOE (1995).

The six DMP Culebra wells were drilled between September 13 and October 16, 1994. The total depth of each well is shown in Table L-5. The wells were drilled through the Culebra into the Los Medaños as shown in Table L-5. The wells were drilled to the top of the Culebra using compressed air as the drilling fluid and a 9⅞-in. drill bit. The wells were then cored using a 5¼-in. core bit to cut 4-in. (0.1-m) diameter core to total depth. See Table L-5 for the drilling and coring intervals for each well. After coring, DMP wells were reamed to 9⅞ -in. (0.3 m) in diameter to total depth. After reaming, wells were cased from the surface to total depth with 5-in. (0.1-m) (0.28-in. [0.7-centimeter (**cm**)] wall) blank fiberglass casing with in-line 5-in.- (0.1-m) diameter fiberglass 0.02-in. (0.1-cm) slotted screen across the Culebra interval as shown in Table L-5 . The annulus between the borehole wall and the casing/screen is packed from total depth to surface with ~~sand and with~~ 8/16 Brady gravel, followed by sand, bentonite, and cement as indicated in Table L-5.

L-4 Monitoring Program Description

The WIPP DMP has been designed to meet the groundwater monitoring requirements of 20.4.1.500 NMAC (incorporating 40 CFR §§264.90 through 264.101). The following sections of the monitoring plan specify the components of the DMP.

L-4a Monitoring Frequency

Groundwater surface elevations ~~will be~~are monitored in each of the six DMWs on a monthly basis. The groundwater surface elevation in each DMW ~~will also be~~are measured prior to each annual sampling event. The groundwater surface elevation measurements in the WLMP wells are ~~will~~ also ~~be~~ monitored on a monthly basis when accessible. The characteristics of the DMW (sampling frequency, location) ~~will be~~are evaluated ~~if~~ for significant changes ~~are observed~~ in the groundwater flow direction or gradient.

L-4b Analytical Parameters and Hazardous Constituents

The parameters listed in Permit Part 5, Table 5.4.a, and hazardous constituents listed in Permit Part 5, Table 5.4.b, are measured as part of the DMP.

Additional hazardous constituents may be identified through changes to the list of hazardous waste numbers authorized for disposal at the WIPP facility. If hazardous constituents are identified, these will be added to Permit Part 5, Table 5.4.b, unless the Permittees provide justification for their omission (e.g. hazardous constituent not in 40 CFR ~~§~~Part 264, Appendix IX), and this omission is approved by the NMED.

L-4c Groundwater Surface Elevation Measurement, Sample Collection and Laboratory Analysis

Groundwater surface elevations will be measured in each DMW prior to groundwater sample collection. ~~Groundwater will be extracted using serial and final sampling methods. Serial samples~~Data will be collected until groundwater field indicator parameters stabilize or three well bore volumes, whichever occurs first, after which the final sample for complete analysis will be collected. Final samples will then be analyzed for the parameters and constituents in Permit Part 5, Tables 5.4.a and 5.4.b.

L-4c(1) Groundwater Surface Elevation Monitoring Methodology

The ~~WIPP groundwater level monitoring program (**WLMP**)~~ WLMP activities are conducted in accordance with the WIPP facility SOPs listed in Table L-3.

Groundwater surface elevation measurements will be taken monthly at each of the six DMWs and prior to the annual sampling event. Additionally, groundwater surface elevation measurements will be taken monthly in the other Culebra wells as listed in Table L-4, when accessible. Well locations are shown in Figure ~~L-14~~M-77. If a cumulative groundwater surface elevation change of more than 2 feet is detected in any DMP well over the course of one year ~~which~~ ,and the change in elevation is not attributable to site tests or natural stabilization of the site hydrologic system, the Permittees will notify the NMED in writing and discuss the origin of the changes in the Annual Culebra Groundwater Report specified in Permit Part 5. Abnormal, unexplained changes in groundwater surface elevation will be evaluated to determine if they indicate changes in site recharge/discharge, which could affect the assumptions regarding DMW placement and constitute new information as specified in 20.4.1.900 NMAC (incorporating 40 CFR §270.41(a)(2)).

Groundwater surface elevation monitoring will continue through the post-closure care period specified in Permit Part 7. The Permittees may temporarily increase the frequency of monitoring to effectively document naturally occurring or artificial perturbations that may be imposed on the hydrologic systems at any point in time. This will be conducted in selected key wells by increasing the frequency of the manual groundwater surface elevation measurements or by monitoring water pressures with the aid of electronic pressure transducers and remote data-logging systems. The Permittees will include such additional data in the reports specified in Section L-5c.

Interpretation of groundwater surface elevation measurements and corresponding fluctuations over time is complicated at the WIPP facility by spatial variation in fluid density. To monitor the hydraulic gradients of the hydrologic flow systems accurately, actual groundwater surface elevation measurements will be monitored at the frequencies specified in Table L-2, and the Culebra groundwater densities, ~~of the fluids~~ in the wells listed in Table L-4, will be calculated ~~measured~~ annually. The fluid density calculated for~~measured at~~ well H-19b0 will be used to correct for freshwater head for the other wells on H-19 pad (H-19b2, H-19b3, H-19b4, H-19b5, H-19b6, and H-19b7).

Measured Culebra water surface elevation data can be converted to equivalent freshwater head from knowledge of the density of the borehole fluid, using the following formula.

$$p = \rho\gamma\cancel{y}h$$

where

p = freshwater head (length of freshwater head)
γ~~y~~ = average specific gravity of the borehole fluid (unitless ratio of borehole fluid density to density of fresh water)

ρ~~p~~ = freshwater density (mass/volume)
h = fluid column height above the datum (length)

~~If the freshwater density is assumed to be 1.000 gram per cubic centimeter (g/cm^3), then the equivalent freshwater head is equal to the fluid column height times the average borehole fluid specific gravity.~~

Density calculations~~measurements~~ are performed ~~made~~ annually. Density for the DMWs will be expressed as specific gravity as measured in the field during sampling events using a hydrometer. Freshwater head for other Culebra wells will be calculated as described above from fluid density measurements obtained using pressure transducers.

L-4c(1)(i) Field Methods and Data Collection Requirements

To obtain an accurate groundwater surface elevation measurement, a calibrated water-level measuring device will be lowered into a test well and the depth to water recorded from a known reference point. An SOP will be used when making water-level measurements for this program. The SOP will specify the methods to be used in obtaining groundwater-level measurements, and provide general instructions including prerequisites, safety precautions, performance frequency, quality assurance, data management, and records.

L-4c(1)(ii) Groundwater Surface Elevation Records and Document Control

~~Incoming~~ Groundwater surface elevation measurement data will be processed in a manner that ensures data integrity. The data management process for groundwater surface elevation measurement~~s~~ data will begin with completion of the field data sheets. Date, time, tape measurement, unique equipment identification number, ~~calibration due date,~~ initial of the field personnel, and equipment/comments will be recorded on the field data sheets. If, for some unexpected reason, a measurement is not possible (e.g., a test is under way that blocks entry to the well bore), then a notation as to why the measurement was not taken will be recorded in the comment column. Personnel will also use the comment column to report any security observations (~~i.e.~~e.g., well lock missing, casing damage).

Data recorded on the field data sheets and submitted by field personnel will be subject to applicable SOPs (see Table L-3). These procedures specify the processes for administering and managing such data. The data will be entered onto a computerized work sheet. The work sheet program calculates groundwater surface elevation in both feet and meters relative to the top of the casing and also relative to mean sea level. The work sheet program adjusts groundwater surface elevations to equivalent freshwater heads.

A check print will be made of the work sheet printout. The check print will be used to verify that data taken in the field ~~was~~ were properly reported on the database printout. A minimum of 10 percent of the spreadsheet calculations will be randomly verified on the check print to ensure that calculations are being performed correctly. If errors are found, the work sheet will be corrected. Groundwater surface elevation data and equivalent freshwater heads for the Culebra wells in Table L-4 will be transmitted to the NMED by May 31 and November 30. Semi-annual groundwater reports will also include annotated hydrographs and trend analysis.

L-4c(2) Groundwater Sampling

L-4c(2)(i) Groundwater Pumping and Sampling Systems

The groundwater pumping and sampling systems used to collect a groundwater sample from the six DMWs will provide continuous and adequate production of water so that a representative groundwater sample can be obtained.

The type of pumping and sampling system to be used in a well depends primarily on the aquifer characteristics of the Culebra and well construction. The DMWs are individually equipped with dedicated submersible pumping assemblies. Each well has a ~~specific type of~~ submersible pump~~,~~ matched to the ability of the well to yield water during pumping. The down-hole submersible pumps are controlled by a variable electronic flow controller to match the production capacity of the formation at ~~each~~ the well.

As recommended in the "RCRA Ground-Water Monitoring Technical Enforcement Guidance Document" (EPA, 1986) the wells will be purged no more than three well bore volumes or until field indicator parameters have stabilized, whichever comes first. Well purging will be performed in accordance with an SOP in conjunction with ~~serial sampling~~field parameter analysis to determine when the groundwater chemistry stabilizes and is therefore representative of undisturbed groundwater.

The DMWs are cased and screened through the production interval with materials (fiberglass-reinforced plastic) that do not yield contamination to the aquifer or allow the production interval to collapse under stress ~~(high epoxy fiberglass)~~. An electric, submersible pump installation without the use of a packer is used in this instance. The largest amount of discharge from the submersible pump takes place from a discharge pipe. In addition to this main discharge pipe, a dedicated sample line running parallel to the discharge pipe is used. The sampling line is manufactured from a chemically inert material. Cumulative flow is measured using a totalizing flow meter. Flow from the discharge pipe is routed to a discharge tank for disposal.

The dedicated sampling line is used to collect the water sample that will undergo analysis. By using a dedicated sample line, the water will not be contaminated by the metal discharge pipe. The sample line will branch from the main discharge pipe a few inches above the pump. Flow from the sample line will be routed into the sample collection area. Flow through the sample collection line is regulated by a flow-control valve. The sample line is insulated at the surface to minimize temperature fluctuations.

L-4c(2)(ii) ~~Serial Samples~~Field Parameter Analysis

~~Serial sampling~~Field parameter analysis is the ~~collection~~ measurement of data from temperature, specific conductivity, and pH meters installed in a flow-through cell for~~of sequential samples for~~ the purpose of determining when the groundwater chemistry stabilizes and is therefore representative of undisturbed groundwater. The Permittees' SOP for ~~serial sampling~~field parameter analysis will provide criteria for determining when a final sample should be taken. Each DMW will be purged ~~to no than more~~ three well bore volumes, or until field parameters stabilize, whichever occurs first. Well stabilization occurs when the field-analyzed parameters are within ± 5% ~~of~~ for three consecutive measurements. A well bore volume is defined as the volume of water from static water level to the bottom of the well sump. ~~Serial samples will be analyzed in the mobile filed laboratory for field indicator parameters.~~ The

Permittees will provide an explanation of why the sample was collected when field indicator parameters were not stabilized and place that explanation in the WIPP facility Operating Record.

~~Serial samples~~Field parameters will be ~~collected and~~ analyzed to detect and monitor the chemical variation of the groundwater as a function of the volume of water pumped. Once ~~serial sampling~~data collection begins, the duration~~frequency~~ at which ~~serial samples~~field parameters are ~~collected and~~ analyzed will be left to the discretion of the Permittees~~, but will be performed a minimum of three times during a sampling round~~.

The Permittees will use appropriate field methods to identify stabilization of the following field indicator parameters: pH, temperature, specific conductance **(SC)**, and specific gravity.

The three field indicator parameters of temperature, ~~specific conductance~~SC, and pH will be determined by either an “in-line” technique, using a self-contained flow cell, or an “off-line” technique, in which the samples will be collected from a sample line at atmospheric pressure. ~~Specific conductance and specific gravity samples will be collected from the sample line at atmospheric pressure.~~ Because of the lack of sophisticated weights and measures equipment available for field density assessments, field density evaluations will be expressed in terms of specific gravity, which is a unitless measure. Density is expressed as unit weight per unit volume.

New polyethylene containers, that are certified clean by the laboratory, will be used to collect the ~~serial~~ final samples from the sample line.

~~Serial samples collected in laboratory-certified clean containers do not require rinsing prior to sample collection. Unfiltered groundwater will be used when determining temperature, pH, specific conductance, and specific gravity. Sample bottles will be properly identified and labeled.~~

~~Samples collected will immediately be analyzed for pH and specific conductance (SC) as these parameters are most sensitive to changes in ambient temperature. Temperature, pH, and specific conductance, when not measured in a flow cell, will be measured at the approximate time of serial sample collection. These samples will be collected from the unfiltered sample line.~~

~~Upon completion of the collection of the last serial sample suite, the serial sample bottles accrued throughout the duration of the pumping of the well will be discarded. No serial sample bottles will be reused for sampling purposes of any sort. However, serial samples may be stored for a period of time depending upon the need. Standard Operating Procedures (see Table L-3) defines the protocols for the collection of final and serial samples and analysis.~~

L-4c(2)(iii) Final Samples

The final sample will be collected once the measured field indicator parameters have stabilized (refer to Section L-4(c)(2)(ii)). ~~A serial sample~~Collected data will ~~also~~ be ~~collected and~~ analyzed for each day of pumping until final sampling. This is to ensure that samples collected for laboratory analysis are still representative of stable conditions. Sample preservation, handling, and transportation methods will maintain the integrity and representativeness of the final samples.

Prior to collecting the final samples, the collection team shall consider the analyses to be performed so that proper shipping or storage containers can be assembled. Table L-6 presents the sample containers, volumes, and holding times for laboratory samples collected as part of the DMP.

The monitoring system will use dedicated pumping systems and sample collection lines from the sampled formation to the well head.

Sample integrity will be ensured through appropriate decontamination procedures. Laboratory glassware will be washed after each use with a solution of nonphosphorus detergent and deionized (**DI**) water and rinsed in DI water. Sample containers will be new, certified clean containers that will be discarded after one use. Groundwater surface elevation measurement devices will be rinsed with fresh water after each use. Non-dedicated sample collection manifold assemblies will be rinsed in accordance with SOPs after each use. The exposed ends will be capped off during storage. Prior to the next use of the sampling manifold, it will be rinsed a second time with DI water~~ and a rinsate blank sample will be collected to verify cleanliness~~.

Water samples will be collected at atmospheric pressure using either the filtered or unfiltered sampling lines. Detailed protocols, in the form of SOPs (see Table L-3) define how final samples will be collected in a consistent and repeatable fashion for analyses.

Final samples will be collected in the appropriate type of container for the specific analysis to be performed. The samples will be collected in new and unused glass and plastic containers (refer to Table L-6). For each parameter analyzed, a sufficient volume of sample will be collected to satisfy the volume requirements of the analytical laboratory (as specified by laboratory SOPs). This includes an additional volume of sample water necessary for maintaining quality control standards. ~~All final~~Final samples will be treated, handled, and preserved as required for the specific type of analysis to be performed. Details about sample containers, preservation, and volumes required for individual types of analyses are found in the applicable SOPs generated, approved, and maintained by the contract analytical laboratory.

Final samples will be sent to the analytical laboratories and analyzed for parameters and hazardous constituents specified in Permit Part 5, Tables 5.4.a and 5.4.b.

Duplicates of the final sample will be provided to WIPP Project oversight agencies when requested.

Wastes resulting from the sampling and field analysis of groundwater are disposed of in accordance with the WIPP SOPs (see Table L-3).

L-4c(2)(iv) Sample Preservation, Tracking, Packaging, and Transportation

Many of the chemical constituents measured by the DMP are not chemically stable and require preservation and special handling techniques. Samples requiring acidification will be treated as requested by the analytical laboratory.

The analytical laboratory receiving the samples will prescribe the type and amount of preservative, the container material type, the required sample volumes that shall be collected, and the shipping requirements. This information will be recorded on the Final Sample Checklist for use by field personnel when final samples are being collected. The Permittees will follow the

EPA “RCRA Ground-Water Monitoring Technical Enforcement Guidance Document,” Table 4-1 (EPA, 1986), when laboratory SOPs do not specify sample container, volume, or preservation requirements. ~~WIPP~~ Waste Isolation Pilot Plant SOPs (see Table L-3) provide instructions to ensure proper sample preservation and shipping.

The sample tracking system at the WIPP facility uses uniquely numbered chain of custody / request for analysis (**CofC/RFA**) forms. The primary consideration for storage or transportation is that samples shall be analyzed within the prescribed holding times for the analytes of interest. WIPP SOPs (see Table L-3) provide instructions to ensure proper sample tracking protocol.

L-4c(2)(v) Sample Documentation and Custody

To ensure the integrity of samples from the time of collection through reporting date, sample collection, handling, and custody shall be documented. Sample custody and documentation procedures for sampling and analysis activities are detailed in WIPP facility SOPs (see Table L-3).

Standardized forms used to document samples will include sample identification numbers, sample labels, custody tape, the sample tracking data, and CofC/RFA form. ~~An example form is shown in Figure L-13.~~

Sample Numbers and Labels

A unique sample identification number will be assigned to each sample sent to the laboratory for analysis. The sample identification numbers will be used to track the sample from the time of collection through data reporting. Every sample container sent to the laboratory for analysis will be identified with a label affixed to it. Sample label information will be completed in indelible ink and will contain the following information: sample identification number with sample matrix type; sample location; analysis requested; time and date of collection; preservative(s), if any; and the sampler’s name or initials.

Custody Seals

Custody seals or custody tape will be used to detect unauthorized sample tampering from collection through analysis. For example, custody seals that are adhesive-backed strips are destroyed when removed or when the container is opened. The seal will be dated, initialed, and affixed to the sample container in such a manner that it is necessary to break the seal to open the container. Seals will be affixed to sample containers in the field immediately after collection. Upon receipt at the laboratory, the laboratory custodian will inspect the seal for integrity; a broken seal will invalidate the sample.

Sample Identification and Tracking

Sample tracking information will be completed for each sample collected. The sample tracking information includes the following information: CofC/RFA form number; date sample(s) were sent to the lab; laboratory name; acknowledgment of receipt or comments; well name and round number. Sample codes will indicate the well location; the geologic formation where the water was collected from, the sampling round number; and the sample number. The code is broken down as follows:

WQ6[1]C[2]R2[3]N1[4]

[1] Well identification (e.g., WQSP-6 in this case)
[2] Geologic formation (e.g., the Culebra in this case)
[3] Sample round no. (Round 2)
[4] Sample no. (N1)

To distinguish duplicate samples from other samples, a “D” is added as the last digit to signify a duplicate. Sample tracking information will be completed in the field by the sampling team.

Sample tracking is monitored and documented with the CofC/RFA form and the shipping airbill. Both of these documents are included in the data packets. Receipt at the analytical laboratory may be monitored, if necessary, via the shipper’s website tracking application. Samples are considered complete when a copy of the original CofC/RFA form is merged with the Field-~~-~~Lab copy of the same document.

Chain of Custody and Request for Analysis

A CofC/RFA form will be completed during or immediately following sample collection and will accompany the sample through analysis and disposal. The CofC/RFA form will be signed and dated each time the sample custody is transferred. A sample will be considered to be in a person’s custody if: the sample is in his/her physical possession; the sample is in his/her unobstructed view; and/or the sample is placed, by the last person in possession of it, in a secured area with restricted access. During shipment, the carrier’s air bill number serves as custody verification. Upon receipt of the samples at the analytical laboratory, the laboratory sample custodian acknowledges possession of the samples by signing and dating the CofC/RFA form. The completed original (top page) of the CofC/RFA will be returned to the Permittees with the laboratory analytical report and becomes part of the permanent record of the sampling event. The CofC/RFA form also contains specific instructions to the analytical laboratory for sample analysis, potential hazards, and disposal instructions.

L-4c(3) Laboratory Analysis

Analysis of samples will be performed using methods selected to be consistent with EPA recommended procedures in SW-~~-~~846 (EPA, 2015~~1996~~). Additional detail on analytical techniques and methods will be given in laboratory SOPs. In Permit Part 5, Tables 5.4.a and 5.4.b presents the analytical parameters and hazardous constituents for the WIPP DMP.

The Permittees will establish the criteria for laboratory selection, including the stipulation that the laboratory follow the procedures specified in SW-~~-~~846 and that the laboratory follow EPA protocols unless alternate methods or protocols are approved by the NMED. The analytical laboratory shall demonstrate, through laboratory SOPs that it will follow appropriate EPA SW-~~-~~846 requirements and the requirements specified by the EPA protocols unless alternate methods or protocols are approved by the NMED. The analytical laboratory shall also provide documentation to the Permittees describing the sensitivity of laboratory instrumentation. This documentation will be retained in the WIPP facility Operating Record. Instrumentation sensitivity needs to be considered because of regulatory requirements governing constituent concentrations in groundwater and the complexity of brines associated with the Culebra groundwater.

The laboratory will maintain documentation of sample handling and custody, analytical results, and internal ~~quality control (**QC**)~~QC data. Additionally, the laboratory will analyze QC samples in accordance with this plan and its own internal QC program for indicators of analytical accuracy and precision. Data generated outside of laboratory acceptance limits will trigger an evaluation and, if appropriate, corrective action as directed by the Permittees. The laboratory will report the results of the environmental sample and QC sample analyses and any necessary corrective actions that were performed. In the event that more than one analytical laboratory is used (e.g., for different analyses), each one will have the responsibilities specified above. A copy of the laboratory SOPs will be maintained in WIPP facility files. The Permittees will provide the NMED with an initial set of applicable laboratory SOPs for information purposes~~,~~ and provide the NMED with ~~any~~ updated SOPs ~~on an annual basis by January 31~~upon request.

Data validation will be performed and reported in the Annual Culebra Groundwater Report and will be maintained in the WIPP facility Operating Record.

L-4d Calibration

L-4d(1) Sampling and Groundwater Elevation Monitoring Equipment Calibration

The equipment used to collect data for this DMP will be calibrated in accordance with SOPs. The Permittees will be responsible for calibrating needed equipment on schedule and for maintaining current calibration records for each piece of equipment.

L-4d(2) Groundwater Surface Elevation Monitoring Equipment Calibration Requirements

The equipment used in taking groundwater surface elevation measurements will be maintained in accordance with WIPP facility SOPs (see Table L-3). The Permittees will be responsible for ensuring equipment is calibrated on schedule in accordance with SOPs. The Permittees will also be responsible for maintaining copies of records of the most recent calibration for each piece of equipment.

L-4e Statistical Analysis of Laboratory Analytical Data

Analytical data collected as part of the DMP will be evaluated using appropriate statistical techniques. The following specifies the statistical analysis to be performed by the Permittees.

L-4e(1) Temporal and Spatial Analysis

Temporal and spatial analyses of the data were completed as part of establishing the water quality baseline (Crawley and Nagy, 1998; IT, 2000). As a result, the Permittees determined to evaluate changes relative to baseline on an individual location basis and to report the concentrations of constituents as a time series, either in tabular form or as time plots. No particular seasonal variations have been noted in the concentrations of groundwater samples collected during the spring and autumn; therefore, continuing temporal analysis is not required.

The analytical results for constituents will be reported as time series, either in tabular form or as time plots or both, and compared to the 95th percentile values or reporting limits identified in Permit Part 5, Table 5.6.

L-4e(2) Distributions and Descriptive Statistics

Techniques were established to compare detection monitoring data generated during the baseline studies. A 95th upper tolerance limit value (**UTLV**) or 95th percentile was determined from those data sets where target analytes were measured at concentrations above the method detection limits. The UTLV is provided for normal or lognormal distributions and a 95th percentile confidence interval is provided for data sets that are nonparametric or have greater than 15 percent non-detects. For analytes with only a few detects (greater than 95 percent non-detects), an accurate 95th percentile cannot be calculated. For these analytes, the maximum detected concentration is used as the baseline value. For the analytes that are non-detect in all the samples, the method reporting limit was used as the baseline value.

L-4e(3) Action Levels

Using baseline distributions, actions levels were identified in accordance with methodologies described in the baseline documents. Action levels are based on the 95th percentile or reporting limits identified in the baseline. If the groundwater concentration of a constituent identified in Permit Part 5, Table 5.6, is found to exceed an action level, a test for outliers is performed in accordance with the methodologies specified in “Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities” (EPA, 2009).

L-4e(4) Comparisons and Reporting

Prior to TRU mixed waste receipt, measurements were made ~~of each~~to establish a background concentration for each groundwater quality hazardous constituent specified in Permit Part 5, Table ~~L-~~5.4.b, at each DMW~~every detection monitoring well~~. These measurements were made during each of the ten background sampling events (with the exception of trans-1,2-dichloroethylene and vanadium that were added after TRU mixed waste disposal began). These measurements serve as a statistical baseline (Permit Part 5, Table 5.6) that is used for evaluating the significance of the results of subsequent sampling events during detection monitoring. Time-trend control charts with associated screening values for each hazardous constituent are used for this evaluation. The Permittees will compare the results from groundwater hazardous constituents of ongoing annual groundwater sample analysis to these baseline values in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.97(h)(4)). If the comparisons show that a constituent statistically exceeds the baseline of the DMWs (as defined in 20.4.1.500 NMAC (incorporating 40 CFR §264.98(f))), the well shall be resampled and an analysis performed as soon as possible, in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.98(g)(3)). The results of the statistical comparison will be reported annually to the NMED in the Annual Culebra Groundwater Report by November 30, as required under 20.4.1.500 NMAC (incorporating 40 CFR §264.98(g)).

L-5 Reporting

L-5a Laboratory Data Reports

Laboratory data will be provided in electronic and hard copy reports to the Permittees and will contain the following information for each analytical report:

- A brief narrative summarizing laboratory analyses performed, date of issue, deviations from the analytical method, technical problems affecting data quality, laboratory quality checks, corrective actions (if any), and the project manager's signature approving issuance of the data report.

- Header information for each analytical data summary sheet including: sample number and corresponding laboratory identification number; sample matrix; date of collection, receipt, preparation and analysis; and analyst's name.

- Parameter and hazardous constituents, analytical results, reporting units, reporting limit, analytical method used.

- Results of QC sample analyses for all concurrently analyzed QC samples.

~~All analytical~~Analytical results will be provided to the NMED as specified in the Permit Part 5.

L-5b Statistical Analysis and Reporting of Results

Analytical results for hazardous constituents from annual groundwater sampling activities will be compared and interpreted by the Permittees through generation of statistical analyses as specified in Section L-4e. The Permittees will perform statistical analyses; the results will be included in the Annual Culebra Groundwater Report in summary form, and will also be provided to the NMED as specified in Permit Part 5.

L-5c Semi-Annual Groundwater Surface Elevation Report and Annual Culebra Groundwater Report

Data collected from this DMP will be reported to the NMED as specified in Permit Part 5 in the Annual Culebra Groundwater Report. The report will include ~~all applicable~~ information that may affect the comparison of background groundwater quality and groundwater surface elevation data through time. This information will include but is not limited to:

- DMW and WLMP well configuration changes that may have occurred from the time of the last measurement (i.e., plug installation and removal, packer removal and reinstallation, or both; and the type and quantity of fluids that may have been introduced into the test wells).

- Pumping activities that may have taken place since publication of the last annual report (i.e., related to groundwater quality sampling, hydraulic testing, and shaft installation or grouting) that may have taken place since the last annual groundwater report.

- A discussion of the origins of abnormal unexpected changes in the groundwater surface elevation, which ~~is~~ are not attributable to site tests or natural stabilization of the site hydrologic system that exceeds 2 ft in a DMP well over the course of the period covered by the Annual Culebra Groundwater Report (this may indicate changes in recharge/discharge which would affect the assumptions regarding DMP well placement and constitute new information as specified in 20.4.1.900 NMAC (incorporating 40 CFR §270.41(a)(2)).

- The results of the annual measurements of densities.

- Annotated hydrographs.

- Groundwater flow rate and direction.
- Potentiometric surface map generated using the following steps:
  - Examine hydrographs to identify month having the largest number of Culebra water levels available with the fewest wells affected by pumping or other anthropogenic events.
  - Convert water levels from subject month to equivalent freshwater heads using fluid densities appropriate to the date.
  - Fit trend surface through freshwater heads.
  - Extrapolate the trend surface to the boundaries of the model domain used for the current Performance Assessment Baseline Calculations (**PABCs**) and define initial fixed-head boundary conditions based on the trend surface.
  - Using the ensemble-average Culebra transmissivity field used for the current PABC, optimize the model boundary heads to improve the fit of the model to the freshwater heads at the wells using optimization software interactively with MODFLOW.
  - Run MODFLOW with optimal boundary conditions fit.
  - Contour MODFLOW head results on WIPP site.
  - Compute particle path and travel time from the Waste Handling Shaft to the LWA Boundary.
  - Data analysis that will accompany the potentiometric surface map will include:
    - ▪ Measured versus modeled scatter plot diagram
    - ▪ Frequency of modeled head residuals
    - ▪ Modeled residual freshwater head at each well
    - ▪ Explanations for modeled misfit residuals greater than 16.4 feet (5 meters).
- Semi-annual groundwater surface elevation results will be reported as specified in Permit Part 5, ~~Condition~~ Section 5.10.2.2.

The DMP data used in generating the Annual Culebra Groundwater Report will be maintained as part of the WIPP facility Operating Record and will be provided to the NMED for review as specified in the permit.

L-6 Records Management

Records generated during groundwater sampling and water level monitoring will be maintained in either project files at the Permittees facility or the Operating Record. Project files will include, but are not limited to:

- Sampling and Analysis Plans (**SAPs**)
- SOPs
- Field Data Entry Sheets
- CofC/RFA forms
- Analytical Laboratory Data Reports
- Variance Logs and Nonconformance Reports
- Corrective Action Reports.

Detection Monitoring Program monitoring, testing, and analytical data and WLMP data will be maintained in the WIPP facility Operating Record.

L-7 Quality Assurance Requirements

Quality Assurance ~~(**QA**)~~ requirements specific to the DMP are presented in this section.

L-7a Data Quality Objectives and Quality Assurance Objectives

L-7a(1) Data Quality Objectives

Data Quality Objectives (DQOs) are qualitative and quantitative statements that specify the quality of data required to support project decisions. DQOs have been established to ensure that the data collected will be of a sufficient and known quality for their intended uses. The overall DQOs for this DMP are shown in the following sections.

L-7a(1)(i) Detection Monitoring Program

Collect accurate and defensible data of known quality that will be sufficient to assess the concentrations of constituents in the groundwater underlying the WIPP facility.

L-7a(1)(ii) Water Level Monitoring Program

Collect accurate and defensible data of known quality that will be sufficient to assess the groundwater flow direction and rate at the WIPP facility.

L-7a(2) Quality Assurance Objectives

Quality Assurance Objectives (**QAOs**) for measurement data have been specified in terms of accuracy, precision, completeness, representativeness, and comparability.

L-7a(2)(i) Accuracy

Accuracy is the closeness of agreement between a measurement and an accepted reference value. When applied to a set of observed values, accuracy is a combination of a random component and a common systematic error (bias) component. Measurements for accuracy will include analysis of calibration standards, laboratory control samples, matrix spike samples, and surrogate spike recoveries. The bias component of accuracy is expressed as percent recovery (%R). Percent recovery is expressed as follows:

$$\%R = \frac{(measured\ sample\ concentration)}{true\ concentration} \times 100$$

L-7a(2)(i)(A) Accuracy Objectives for Field Measurements

Field measurements will include pH, ~~Specific Conductance (~~SC~~)~~, temperature, specific gravity, and static groundwater surface elevation. Field measurement accuracy will be determined using calibration standards. Thermometers used for field measurements will be calibrated to the National Institute for Standards and Technology (**NIST**) traceable standard on an annual basis to ensure accuracy. Accuracy of groundwater surface elevation measurements will be checked before each measurement period by verifying calibration of the device within the specified schedule. ~~WIPP~~ Waste Isolation Pilot Plant document WP 13-1 outlines the basic requirements for field equipment use and calibration. ~~WIPP~~ Waste Isolation Pilot Plant facility SOPs contains instructions that outline protocols for maintaining current calibration of groundwater surface elevation measurement instrumentation.

L-7a(2)(i)(B) Accuracy Objectives for Laboratory Measurements

Analytical system accuracy will be quantified using the following laboratory accuracy QC checks: calibration standards, laboratory control samples (**LCS**), laboratory blanks, matrix and surrogate spike recoveries. Single LCSs and matrix spike and surrogate spike sample analyses will be expressed as %R. Laboratory analytical accuracy is parameter dependent and will be prescribed in the laboratory SOP.

L-7a(2)(ii) Precision

Precision is the agreement among a set of replicate measurements without assumption or knowledge of the true value. Precision data will be derived from duplicate field and laboratory measurements. Precision will be expressed as relative percent difference (**RPD**), which is calculated as follows:

~~$RPD = \frac{|(measured\ \ value\ \ sample\ 1 - measured\ \ value\ \ sample\ 2)|}{average\ \ of\ \ measured\ \ samples\ 1+2} \times 100$~~ $RPD = \left(\frac{|V_1 - V_2|}{\frac{V_1 + V_2}{2}}\right) \times 100$

Where

RPD = relative percent difference
V_1 = sample 1 measured value
V_2 = sample 2 measured value

L-7a(2)(ii)(A) Precision Objectives for Field Measurements

Specific conductance, pH, and temperature will be measured during well purging~~ and after sampling~~. ~~SC~~Specific conductance measurements will be precise to ±10% pH to 0.10 standard unit, specific gravity to 0.01 by hydrometer and temperature to 0.10 degrees Celsius (°C). Water-level measurements will be precise to ± 0.01 ft. The precision of water density measurements, ~~when measured in the field~~calculated using down~~-~~-hole pressure-transducer data~~instrumentation~~, will be determined on a well-by-well basis and will result in no more than a ± 2 ft of error in the derived fresh-water head.

L-7a(2)(ii)(B) Precision Objectives for Laboratory Measurements

Precision of laboratory analyses will be determined by analyzing an LCS and a lab control sample duplicate (**LCSD**) or by analyzing one of the field samples in duplicate depending on the requirements of the particular standard method. The precision is measured as the RPD of the recoveries for the spiked LCS/LCSD pair or the RPD of the duplicate sample analysis results. Laboratory analytical precision is also parameter dependent and will be prescribed in laboratory SOPs.

L-7a(2)(iii) Contamination

In addition to measurements of precision and bias, QC checks for contamination will be performed. QC samples including trip blanks, field blanks, and method blanks will be analyzed to assess and document contamination attributable to sample collection equipment, sample handling and shipping, and laboratory reagents and glassware. Trip blanks will be used to assess volatile organic compound (**VOC**) sample contamination during shipment and handling and will be collected and analyzed at a frequency of ~~1~~one sample per sample shipment. Field blanks will be used to assess field sample collection methods and will be collected and analyzed at a minimum frequency of one sample per 20 samples (five percent of the samples collected). Method blanks will be used to assess contamination resulting from the analytical process and will be analyzed at a minimum frequency of one sample per 20 samples, or five percent of the samples collected. Evaluation of sample blanks will be performed following U.S. EPA “National Functional Guidelines for Organic Data Review” (EPA, 1999) and “National Functional Guidelines for Evaluating Inorganics Analyses” (EPA, 2004). Only method blanks will be analyzed via wet chemistry methods. The criteria for evaluating method blanks will be established as follows: If method blank results exceed method reporting limits, then that value will become the detection limit for the sample batch. Detection of analytes of interest in method blank samples may be used to disqualify some samples, requiring resampling and additional analyses on a case-by-case basis.

L-7a(2)(iv) Completeness

Completeness (%C) is a measure of the amount of usable valid data resulting from a data collection activity, given the sample design and analysis. Completeness (%C) may be affected by unexpected conditions that may occur during the data collection process.

Occurrences that reduce the amount of data collected include sample container breakage during sample shipment or in the laboratory and data generated while the laboratory was operating outside prescribed QC limits. All attempts will be made to minimize data loss and to recover lost data whenever possible. The completeness objective for analysis of Permit Part 5,

Table 5.4.a parameters will be 90 percent and 100 percent analysis of Permit Part 5, Table 5.4.b hazardous constituents. If the completeness objective for Permit Part 5, Table 5.4.b hazardous constituents is not met, the Permittees will determine the need for resampling on a case-by-case basis. Numerical expression of the completeness (**%C**) of data is as follows:

$$\%C = \frac{number\ of\ \ accepted\ samples}{total\ number\ of\ \ samples\ collected} \times 100$$

L-7a(2)(v) Representativeness

Representativeness is the degree to which sample analyses accurately and precisely represent the media they are intended to represent. Data representativeness for this DMP will be accomplished through implementing approved sampling procedures and the use of validated analytical methods. Sampling procedures will be designed to minimize factors affecting the integrity of the samples. Groundwater samples will only be collected after well purging criteria have been met. The analytical methods selected will be those that will most accurately and precisely represent the true concentration of analytes of interest.

For water levels and density, representativeness is a qualitative term that describes the extent to which a sampling design adequately reflects the environmental conditions of a site. The SOPs for measurement ensure that samples are representative of site conditions.

L-7a(2)(vi) Comparability

Comparability is the extent to which one data set can be compared to another. Comparability will be achieved through reporting data in consistent units and collection and analysis of samples using consistent methodology. Aqueous samples will consistently be reported in units of measures dictated by the analytical method. Units of measure include:

- Milligrams per liter (mg/L) for alkalinity, inorganic compounds and metals and
- Micrograms per liter (µg/L) for VOCs and semivolatile organic compounds (**SVOC**s).

Culebra groundwater surface elevation measurements will be expressed as equivalent freshwater elevation in feet above mean sea level.

L-7b Design Control

The approved design for the DMP is specified in this ~~Permit~~Attachment. Modifications to the DMP will be processed in accordance with 20.4.1.900 NMAC (incorporating 40 CFR §§ 270.42).

L-7c Instructions, Procedures, and Drawings

The preparation and use of instructions and procedures at the WIPP facility are outlined in the WIPP facility document WP 13-1 (see Table L-3). Activities performed for the DMP that may affect groundwater data quality will be performed in accordance with approved procedures which comply with the Permit.

L-7d Document Control

Permittees will ensure that the latest approved versions of WIPP facility SOPs will be used in performing groundwater monitoring functions and that obsolete materials will be adequately identified or removed from work areas.

L-7e Inspection and Surveillance

Inspection and surveillance activities will be conducted as outlined in WIPP document WP 13-1 (see Table L-3). The Permittees will be responsible for performing the applicable WIPP facility SOPs.

L-7f Control of Monitoring and Data Collection Equipment

WIPP document WP 13-1 (see Table L-3) outlines the basic requirements for control and calibrating monitoring and data collection (**M&DC**) equipment. M&DC equipment shall be properly controlled, calibrated, and maintained according to WIPP facility SOPs (see Table L-3) to ensure continued accuracy of groundwater monitoring data. Results of calibrations, maintenance, and repair will be documented. Calibration records will identify the reference standard and the relationship to national standards or nationally accepted measurement systems. Records will be maintained to track uses of M&DC equipment. If M&DC equipment is found to be out of tolerance, the equipment will be tagged and removed from service until corrections have been made~~and it will not be used until corrections are made~~.

L-7g Control of Nonconforming Conditions

In accordance with WP 13-1 (see Table L-3), equipment that does not conform to specified requirements will be controlled to prevent use. The disposition of defective items will be documented on records traceable to the affected items. Prior to final disposition, faulty items will be tagged and segregated. Repaired equipment will be subject to the original acceptance inspections and tests prior to use.

L-7h Corrective Action

Requirements for the development and implementation of a system to determine, document, and initiate appropriate corrective actions after encountering conditions adverse to quality at the WIPP facility are outlined in WIPP document WP 13-1 (see Table L-3). Conditions adverse to acceptable quality will be documented and reported in accordance with corrective action procedures and corrected as soon as practical. Immediate action will be taken to control work performed under conditions adverse to acceptable quality and its results to prevent quality degradation.

L-7i Quality Assurance Records

~~WIPP document~~Standard operating procedure WP 13-1 (see Table L-3) outlines the policy that will be used at the WIPP facility regarding identification, preparation, collection, storage, maintenance, disposition, and permanent storage of QA records.

Records to be generated in the DMP will be specified by procedure. Quality Assurance (**QA**) and RCRA ~~operating~~ Operating ~~records~~ Records will be identified. This will be the basis for the labeling of records as “QA” or “RCRA ~~operating~~ Operating ~~record~~Record” on the Environmental Monitoring Records Inventory and Disposition Schedule.

L-8 References

Beauheim, R.L., 1986. “Hydraulic-Test Interpretations for Well DOE-2 at the Waste Isolation Pilot Plant (WIPP) Site,” *SAND86-1364*, Sandia National Laboratories/New Mexico, Albuquerque, New Mexico.

Beauheim, R.L., 1987. “Analysis of Pumping Tests at the Culebra Dolomite Conducted at the H-3 Hydropad at the Waste Isolation Pilot Plant (WIPP) Site,” *SAND86-2311*, Sandia National Laboratories/New Mexico, Albuquerque, New Mexico.

Beauheim, R.L., and Holt, R.M., 1990. “Hydrogeology of the WIPP Site,” in Powers, D.W., Holt, R.M., Beauheim, R.L., and Rempe, N., eds., Geological and Hydrological Studies of Evaporites in the Northern Delaware Basin for the Waste Isolation Pilot Plant (WIPP): Guidebook 14, Geological Society of America (Dallas Geological Society), p. 131-179, Dallas, Texas.

Corbet, T.F., and P.M. Knupp, 1996. “The Role of Regional Groundwater Flow in the Hydrogeology of the Culebra Member of the Rustler Formation at the Waste Isolation Pilot Plant (WIPP), Southeastern New Mexico,” *SAND96-2133*, Sandia National Laboratories/New Mexico, Albuquerque, New Mexico.

Crawley, M. and M. Nagy, 1998. “WIPP RCRA Background Groundwater Quality Baseline Report,” DOE/WIPP-98-2285.

Davies, P.B., 1989. “Variable-Density Ground-Water Flow and Paleohydrology in the Waste Isolation Pilot Plant (WIPP) Region, Southeastern New Mexico,” U.S. Geological Survey Open-File Report 88-490, Albuquerque, New Mexico.

DOE, see U.S. Department of Energy.

Domenico, P.A., and F.W. Schwartz, 1990. “Physical and Chemical Hydrogeology,” New York: John Wiley & Sons, Textbook.

Domski, P.S., and R.L. Beauheim. 2008. “Evaluation of Culebra Brine Chemistry,”~~.~~ AP-125,~~.~~ ERMS ~~549336~~549443,~~.~~ Carlsbad, NM: Sandia National Laboratories. ~~(In development)~~

Domski, P.S., D.T. Upton, and R.L. Beauheim, 1996. “Hydraulic Testing Around Room Q: Evaluation of the Effects of Mining on the Hydraulic Properties of Salado Evaporites,” *SAND96-0435*, Sandia National Laboratories/New Mexico, Albuquerque, New Mexico.

Earlough, E.C., Jr., 1977. “Advances in Well Test Analysis,”: Society of Petroleum Engineers of AIME, Textbook, Dallas, Texas.

EPA, see U.S. Environmental Protection Agency.

Holt, R.M., 1997. “Conceptual Model for Transport Processes in the Culebra Dolomite Member, Rustler Formation”: SAND97-1094, Sandia National Laboratories. Albuquerque, New Mexico.

Holt, R.M., and D.W. Powers, 1988. “Facies Variability and Post-Deposition Alteration Within the Rustler Formation in the Vicinity of the Waste Isolation Pilot Plant, Southeastern New Mexico,” *DOE-WIPP-88-04*, U.S. Department of Energy, Carlsbad, New Mexico.

Holt, R.M., Beauheim, R.L., and Powers, D.W., 2005. “Predicting Fractured Zones in the Culebra Dolomite,” in Faybishenko, B, Witherspoon, P.A., and Gale, J., eds., Dynamics of Fluids and Transport in Fractured Rock: AGU Geophysical Monograph Series, v. 162, p. 103-116. Sandia National Laboratories. Carlsbad, New Mexico.

Holt, R.M., and Powers, D.W., 2010. “Evaluation of halite dissolution at a radioactive waste disposal site,” Andrews County, TX: Geological Society of America Bulletin, v. 122, p. 1989-2004, DOI: 10.1130/B30052.1.

Holt, R.M., and Yarbrough, 2002. “Analysis Report, Task 2 of AP 088, Estimating Base Transmissitivity Fields”: ERMS 523889, Sandia National Laboratories, Carlsbad, NM.

IT Corporation, “2000 Addendum 1 Waste Isolation Pilot Plant RCRA Background Groundwater Quality Baseline Update Report,~~.~~” Albuquerque, New Mexico.

Kuhlman, K.L. 2010. “Analysis Report, AP-111 Revision 1, Culebra Water Level Monitoring Network Design,”~~.~~ ERMS 554054. Carlsbad, NM: Sandia National Laboratories.

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

Mercer, J.W., 1983. “Geohydrology of the Proposed Waste Isolation Pilot Plant Site, Los Medaños Area, Southeastern New Mexico,” U.S. Geological Survey, Water Resources Investigations 83-4016, 113 pp.

Powers, D. W. 2006. “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., Holt, R.M., Beauheim, R.L., and McKenna, S.A., 2003. “Geological Factors Related to the Transmissivity of the Culebra Dolomite Member, Permian Rustler Formation, Delaware Basin, Southeastern New Mexico,” in Johnson, K.S., and Neal, J.T., eds., Evaporite karst and engineering/environmental problems in the United States: Oklahoma Geological Survey Circular 109, p. 211-218.

Powers, D.W., Holt, R.M., Beauheim, R.L., and Richardson, R.G., 2006. “Advances in Depositional Models of the Permian Rustler Formation, Southeastern New Mexico,” in Caves & Karst of Southeastern New Mexico, L. Land and others, eds., NM Geological Society Fifty-seventh Annual Field Conference Guidebook, p. 267-276.

Roberts, R. M. 2007. “Analysis of Culebra Hydraulic Tests Performed Between June 2006 and September 2007,”~~.~~ ERMS 547418,~~.~~ Carlsbad, NM: Sandia National Laboratories.

Siegel, M.D., K. L. Robinson, and J. Myers. 1991. “Solute Relationships in Groundwaters from the Culebra Dolomite and Related Rocks in the Waste Isolation Pilot Plant Area, Southeastern New Mexico,” SAND88-0196.

Sturchio, N.C., K.L. Kuhlman, Yokochi, R., Probst, P.C., Jiang, W., Lu, Z.T., Mueller, P., Jiang, W., and Yang, G.M. 2014. Krypton-81 in groundwater of the Culebra Dolomite near the Waste Isolation Pilot Plant, New Mexico. Contam. Hydrol 160:12-20.

Thomas MA, K.L. Kuhlman, and A.L. Ward. 2017. “Anthropogenic influences on groundwater in the vicinity of a long-lived radioactive waste repository,” Hydrol Process 27 31:2637-2647.

U.S. Department of Energy (DOE), 1995. “Basic Data Report for WQSP-1 through WQSP-6A,” DOE/WIPP-95-2154.

U.S. Department of Energy (DOE), 2009.~~,~~ “WIPP Hazardous Waste Facility Permit Amended Renewal Application,” Carlsbad, New Mexico.

U.S. Department of Energy (DOE), 2020. “WIPP Hazardous Waste Facility Permit Renewal Application,” Carlsbad, New Mexico.

U.S. Environmental Protection Agency (EPA), 2009. “Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Unified Guidance,” U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1999. “National Functional Guidelines for Organic Data Review,” U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1990. “Background Documentation for the U.S. Environmental Protection Agency’s Proposed Decision on the No-Migration Variance for U.S. Department of Energy’s Waste Isolation Pilot Plant,” U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 2004. “Functional Guidelines for Evaluating Inorganics Analyses,” U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1986. “RCRA Ground-Water Monitoring Technical Enforcement Guidance Document,” U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), ~~1996~~2015. “Test Methods for Evaluating Solid Waste,” *SW-846*, ~~third ed.,~~ Office of Solid Waste and Emergency Response, Washington, D.C.

TABLES

Table L-1
Hydrological Parameters for Rock Units above the Salado at the WIPP Site

Unit		Hydraulic Conductivity	Storage	Thickness	Hydraulic Gradient
Santa Rosa		2×10^{-8} to 2×10^{-6} m/s (1) (2)		0 to 91 m	0.001 (5)
Dewey Lake		10^{-8} m/s	Specific storage 1×10^{-5} (1/m) (2)	152 m	0.001 (5)
Rustler	Forty-niner	1×10^{-13} to 1×10^{-11} m/s (anhydrite) 1×10^{-9} m/s (mudstone) (2)	Specific storage 1×10^{-5} (1/m) (2)	13 to 23 m	NA (6)
	Magenta	$1 \times 10^{-8.5}$ to $1 \times 10^{-6.5}$ m/s (2)	Specific storage 1×10^{-5} (1/m) (2)	7 to 8.5 m	3 to 6
	Tamarisk	1×10^{-13} to 1×10^{-11} m/s (anhydrite) 1×10^{-9} m/s (mudstone) (2)	Specific storage 1×10^{-5} (1/m) (2)	26 to 56 m	NA (6)
	Culebra	$1 \times 10^{-7.5}$ to $1 \times 10^{-5.5}$ m/s (2)	Specific storage 1×10^{-5} (1/m) (2)	4 to 11.6 m	0.003 to 0.007 (5)
	Los Medaños	6×10^{-15} to 1×10^{-13} m/s 1.5×10^{-11} to 1.2×10^{-11} m/s (basal interval)	Specific storage 1×10^{-5} (1/m) (2)	29 to 38 m	NA (6)

Matrix characteristics relevant to fluid flow include values used in this table such as permeability, hydraulic conductivity, gradient, etc.)

Table Notes:

(1) The Santa Rosa Formation is not present in the western portion of the WIPP site. It was combined with the Dewey Lake ~~Red Beds~~ in three-dimensional regional groundwater flow modeling (Corbet and Knupp, 1996), and the range of values entered here are those used in that study for the Dewey Lake/Triassic hydrostratigraphic unit.

(2) Values or ranges of values given for these entries are the values used in three-dimensional regional groundwater flow modeling (Corbet and Knupp, 1996). Values are estimated based on literature values for similar rock types, adjusted to be consistent with site-specific data where available. Ranges of values include spatial variation over the WIPP site and differences in values used in different simulations to test model sensitivity to the parameter.

(3) Hydraulic gradient is a dimensionless term describing change in the elevation of hydraulic head divided by change in horizontal distance. Values given in these entries are determined from potentiometric surfaces. The range of values given for the Culebra reflects the highest and lowest gradients observed within the WIPP site boundary. Values for the Dewey Lake and Santa Rosa are assumed to be the same as the gradient determined from the water table. Note that the Santa Rosa Formation is absent or above the water table in most of the controlled area, and that the concept of a horizontal hydraulic gradient is not meaningful for these regions.

(4) Flow in units of very low hydraulic conductivity is slow, and primarily vertical. The concept of a horizontal hydraulic gradient is not applicable.

Sources: Beauheim~~,~~ (1986); Domenico and Schwartz~~,~~ (1990); Domski, Upton, and Beauheim~~,~~ (1996); Earlough~~,~~ (1977).

Table L-2
WIPP Groundwater Detection Monitoring Program Sample Collection and Groundwater Surface Elevation Measurement Frequency

Installation	Frequency
Groundwater Quality Sampling	
DMWs	Annually
Groundwater Surface Elevation Monitoring	
DMWs	Monthly and prior to sampling events
WLMP Wells (see Table L-4)	Monthly

Table L-3
Standard Operating Procedures Applicable to the DMP

Number	Title/Description
WP 02-EM1010	Field Parameter Measurements and Final Sample Collection: This procedure provides general instructions necessary to perform field analyses of serial samples in support of the DMP. Serial samples are collected and analyzed at the field laboratory for field indicators. Serial sample results help determine if pumped groundwater is representative of undisturbed groundwater within the formation. This procedure also describes the steps for collecting groundwater samples from the DMWs near the WIPP facility. Samples are collected and analyzed at the Field Laboratory until stabilization of the field parameters occurs. Final samples for Resource Conservation and Recovery Act (RCRA) analyses are collected and analyzed by a contract laboratory.
WP 02-EM1014	Groundwater Level Measurement: This document describes the method used for groundwater level measurements in support of groundwater monitoring at the WIPP facility using a portable electronic water-level probe.
WP 02-EM1026	Water Level Data Handling and Reporting: This procedure provides instructions on handling water level data. Data are collected and recorded on field forms in accordance with WP 02-EM1014. This procedure is initiated when wells in the water surveillance program have been measured for a given month.
WP 02-EM3001	Administrative Processes for Environmental Monitoring and Hydrology Programs: This procedure provides the administrative guidance environmental monitoring personnel use to maintain quality control associated with environmental monitoring sampling and reporting activities. This administrative procedure does not pertain to volatile organic compound (VOC) monitoring, with the exception of Section 5.0 which pertains to the regulatory reporting review process.
WP 02-EM3003	Data Validation and Verification of RCRA Constituents: This procedure provides instructions on performing verification and validation of laboratory data containing the analytical results of groundwater monitoring samples. This procedure is applied only to the non-radiological analyses results for compliance data associated with the detection monitoring samples. The data reviewed for this procedure includes general chemistry parameters and RCRA constituents.
WP-02-RC.01	Hazardous and Universal Waste Management Plan: This plan describes the responsibilities and handling requirements for hazardous and universal wastes generated at the WIPP facility. It is meant to ensure that these wastes are properly handled, accumulated, and transported to an approved Treatment, Storage, Disposal Facility (TSDF) in accordance with applicable state and federal regulations, U.S. Department of Energy (DOE) Orders, and Management and Operating Contractor (MOC) policies and procedures. This plan implements applicable sections of 20.4.1.100-1102 New Mexico Administrative Code (NMAC), *Hazardous Waste Management* (incorporating 40 *Code of Federal Regulations* [CFR] Parts 260-268 and 273).
WP 10-AD3029	Calibration and Control of Monitoring and Data Collection Equipment: This procedure provides direction for the control and calibration of Monitoring and Data Collection (M&DC) equipment at the WIPP facility, and ensures traceability to ~~NIST (~~National Institute of Standards and Technology~~)~~ **(NIST)** standards, international standards, or intrinsic standards. This procedure also establishes requirements and responsibilities for identifying recall equipment, and for obtaining calibration services for WIPP facility M&DC equipment.
WP 13-1	Management and Operating Contractor Quality Assurance Program Description: This document establishes the minimum quality requirements for MOC personnel and guidance for the development and implementation of ~~QA~~ quality assurance programs by MOC organizations.

Table L-4
List of Culebra Wells in the WLMP, Current as of January 2022

WELL ID	WELL ID	WELL ID
AEC-7R	IMC-461	SNL-15
C-2737	SNL-1	SNL-16
H-4bR	SNL-2	SNL-17
H-5bR	SNL-3	SNL-18
H-6bR	SNL-5	SNL-19
H-9bR	SNL-6	WQSP-1
H-10cR	SNL-8	WQSP-2
H-11b4R	SNL-9	WQSP-3
H-12R	SNL-10	WQSP-4
H-15R	SNL-12	WQSP-5
H-16	SNL-13	WQSP-6
H-19 pad*	SNL-14	WIPP-11R

*The water level for the H-19b0 well on the H-19 pad is measured monthly; the fluid density measured annually at well H-19b0 will be used to correct for freshwater head for the other wells on the H-19 pad (H-19b2, H-19b3, H-19b4, H-19b5, H-19b6, and H-19b7).

Table L-5
Details of Construction for the Six Culebra Detection Monitoring Wells

NAME (Figure)	**DATE DRILLED**	**TOTAL DEPTH feet (meters) bgs**	**DEPTH INTO LOS MEDAÑOS feet (meters)**	**DRILLING DEPTHS feet (meters) bgs**		**CASING feet (meters) bgs**		**PACKING feet (meters) bgs**		**CULEBRA INTERVAL feet (meters) bgs**
				WITH AIR	**CORING**	**DEPTH FOR 5 in. CASING**	**INTERVAL FOR SLOTTED SCREEN**	**SAND PACK INTERVAL**	**BRADY GRAVEL PACK INTERVAL**	
WQSP-1 Figure ~~L-7~~M-71	September 13 through 16, 1994	737 (225)	15 (5)	696 (212)	696 to 737 (212 to 225)	737 (~~225~~225)	702 to 727 (214 to ~~222~~222)	640 to 651 (195 to 198)	651 to 737 (198 to 225)	699 to 722 (213 to 220)
WQSP-2 Figure ~~L-8~~M-72	September 6 through 12, 1994	846 (258)	12 (4)	800 (244)	800 to 846 (244 to 258)	846 (258)	811 to 836 (247 to 255)	790 to 793 (241 to 242)	793 to 846 (242 to 258)	810.1 to 833.7 (247 to 254)
WQSP-3 Figure ~~L-9~~M-73	October 20 through 26, 1994	880 (268)	10 (3)	833 (254)	833 to 880 (254 to 268)	880 (268)	844 to 869 (257 to 265)	827 to 830 (252 to 253)	830 to 880 (253 to 268)	844 to 870 (257 to 265)
WQSP-4 Figure ~~L-10~~M-74	October 5 through 10, 1994,	800 (244)	9 (3)	740 (226)	740 to 798 (226 to 243)	800 (244)	764 to 789 (233 to 240)	752 to 755 (229 to 230)	755 to 800 (230 to 244)	766 to 790.8 (233 to 241)
WQSP-5 Figure ~~L-11~~M-75	October 12 through 18, 1994,	681 (208)	7 (2)	648 (198)	648 to 676 (198 to 206)	681 (208)	646 to 671 (197 to 205)	623 to 626 (190 to 191)	626 to 681 (191 to 208)	648 to 674.4 (198 to 205)
WQSP-6 Figure ~~L-12~~M-76	September 26 through October 3, 1994	616.6 (188)	10 (3)	568 (173)	568 to 617 (173 to 188)	617 (188)	581 to 606 (177 to 185)	567 to 570 (173 to 174)	570 to 616.6 (174 to 188)	582 to 606.9 (177 to 185)

Table L-6
Analytical Parameter and Sample Requirements

(10) PARAMETERS	(12) NO. OF BOTTLES	(13) VOLUME	(14) TYPE	(15) ACID WASH	(16) SAMPLE FILTER	(17) PRESERVATIVE	(18) HOLDING TIME
Indicator~~[1]~~ Parameters: • pH • SC • TOC	- - 4	25 ~~ml[2]~~mL[1] 100 ~~ml[2]~~mL[1] 15 ~~ml[2]~~mL[1]	Glass Glass Glass	Field determined Field determined yes	No No No	Field determined Field determined HCl	None None 28 ~~days[2]~~days[1]
General Chemistry	1	1 ~~Liter~~L	Plastic	Yes	No	HNO_3, pH<2	not specified in DMP
Phenolics	1	1 ~~Liter~~L	Amber Glass	Yes	No	H_2SO_4, pH<2	not specified in DMP
Metals/Cations	2	1 ~~Liter~~L	Plastic	Yes	No	HNO_3, pH<2	6 ~~months[2]~~, ~~[3]~~[1,2]
VOC	4	40 ~~ml~~mL	Glass	No	No	HCL, ~~ph~~pH<2	14 ~~days[2]~~days[1]
VOC (~~Purgable~~Purgeable)	2	40 ~~ml~~mL	Glass	No	No	HCL, ~~ph~~pH<2	14 ~~days[2]~~days[1]
VOC (Non-~~Purgable~~Purgeable)	2	40 ~~ml~~mL	Glass	No	No	HCL, ~~ph~~pH<2	14 ~~days[2]~~days[1]
~~BN/As~~Semi-VOC	1	~~½ Gallon~~1 L	Amber Glass	Yes	No	None	14 days[1]
TCLP	1	1 ~~Liter~~L	Plastic	Yes	No	HNO_3, pH<2	7 ~~days[2]~~days[1]
Cyanide (Total)	1	1 ~~Liter~~L	Plastic	Yes	No	NaOH, pH>12	14 ~~days[2]~~days[1]
Sulfide	1	250 ~~ml~~mL	Amber Glass	Yes	No	NaOH + Zn Acetate	28 ~~days[2]~~days[1]
Radionuclides	1	1 Gallon	Plastic Cube	Yes	Yes	HNO_3, pH<2	6 ~~months[2]~~months[1]

~~1 = RCRA Detection Monitoring Analytes~~

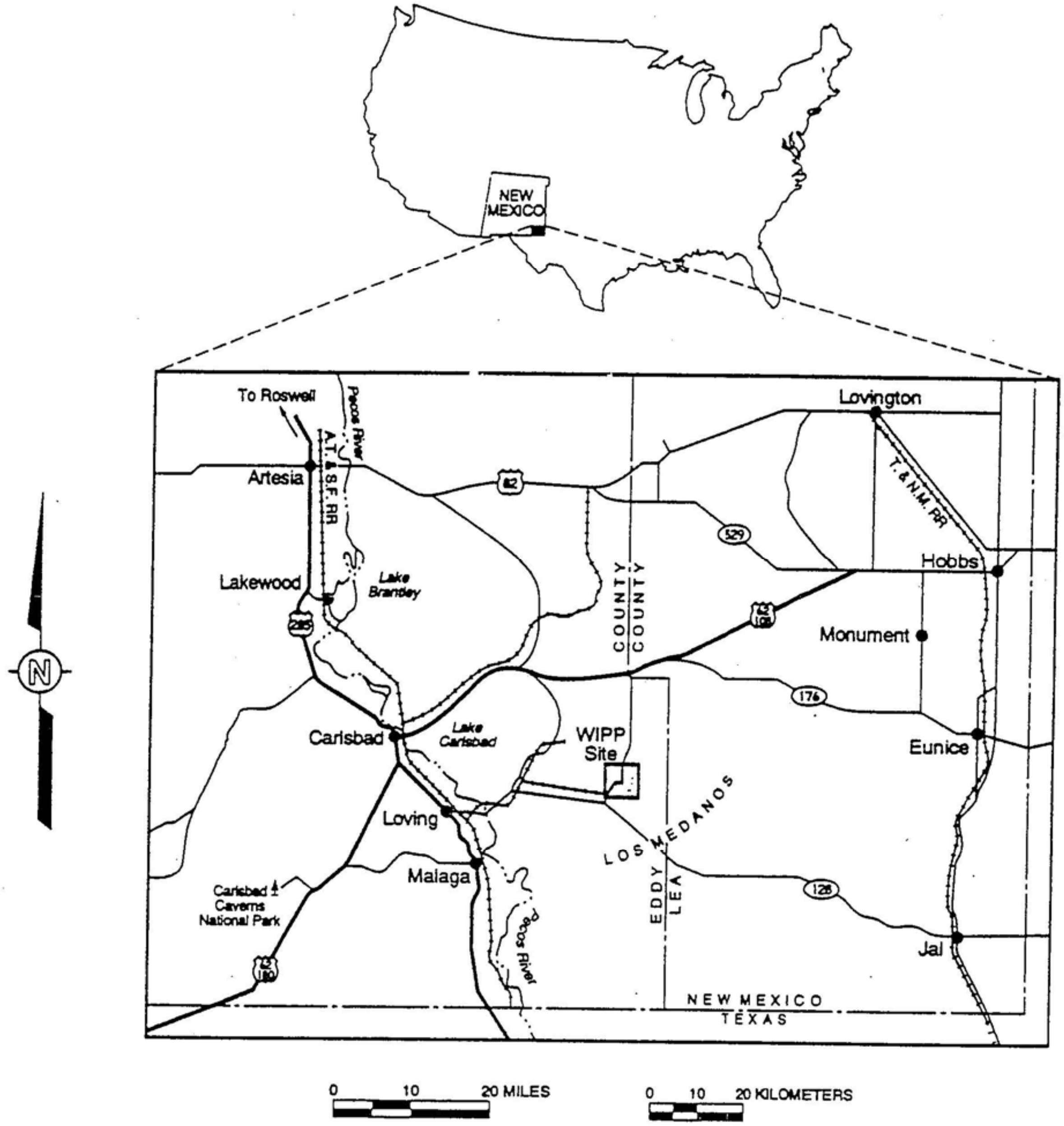
~~2~~1 = As specified in Table 4-1 of the RCRA TEGD

~~3~~2 = Reduced holding time of 1 week for WIPP-specific Divalent cation 2 samples noted in the GMD

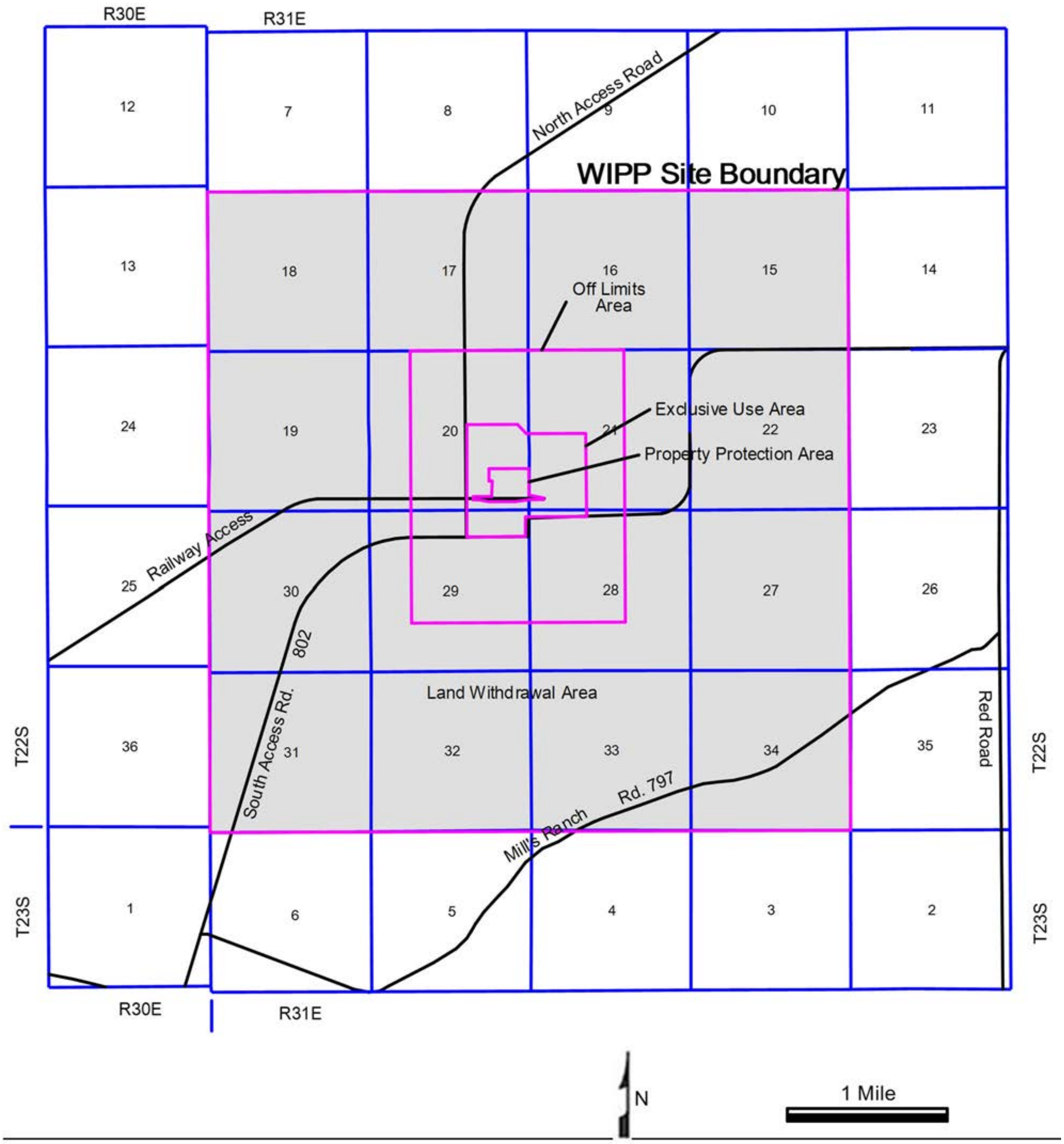
Note: Unless otherwise indicated, information in this table is from SOP WP 02-EM1010 and is provided as information only.

Note: Deviations from this table are allowed with prior approval by the NMED.

~~FIGURES~~



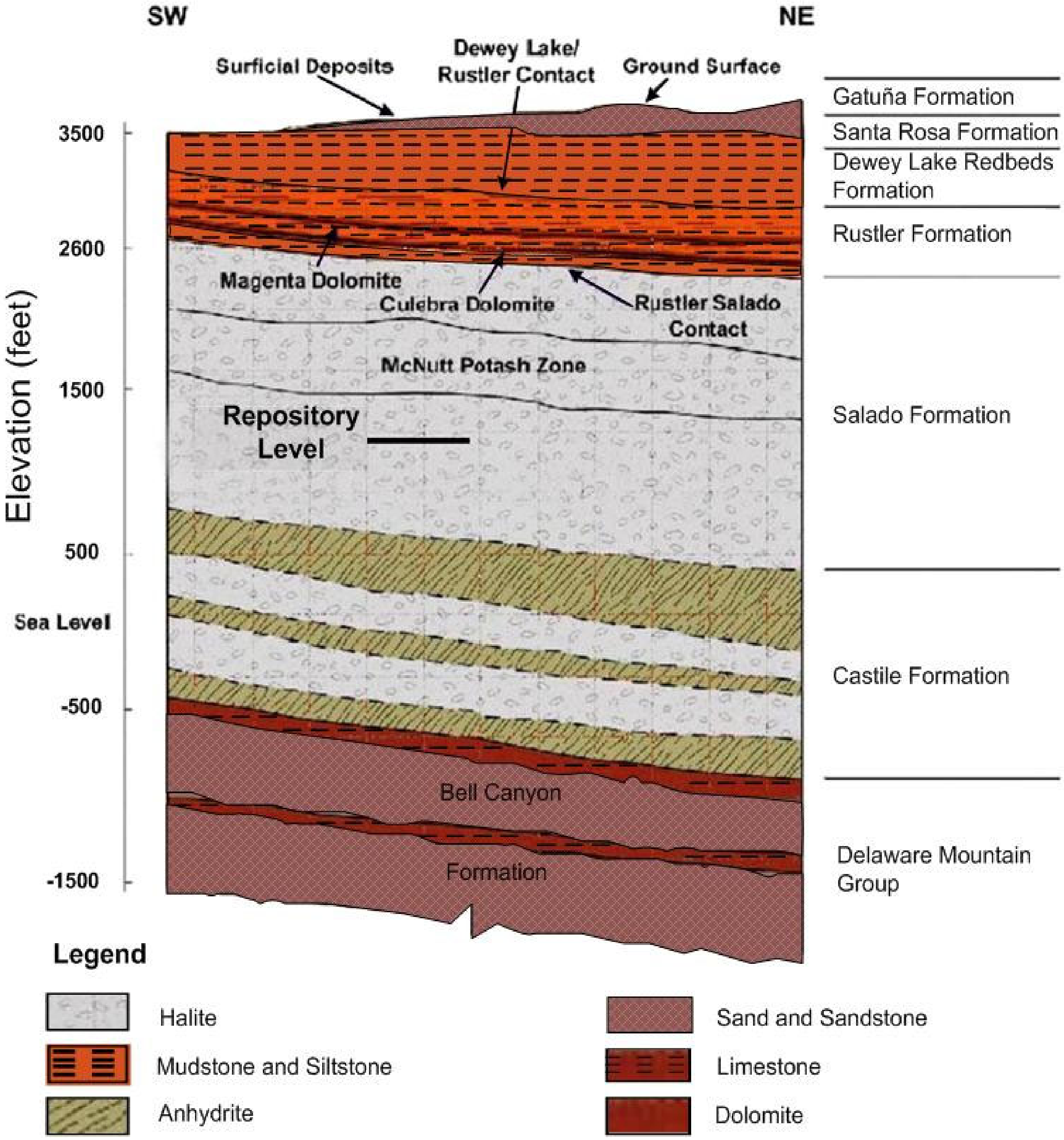
~~Figure L-1~~
~~General Location of the WIPP Facility~~



~~Figure L-2~~
~~WIPP Facility Boundaries Showing 16-square-Mile Land Withdrawal Boundary~~

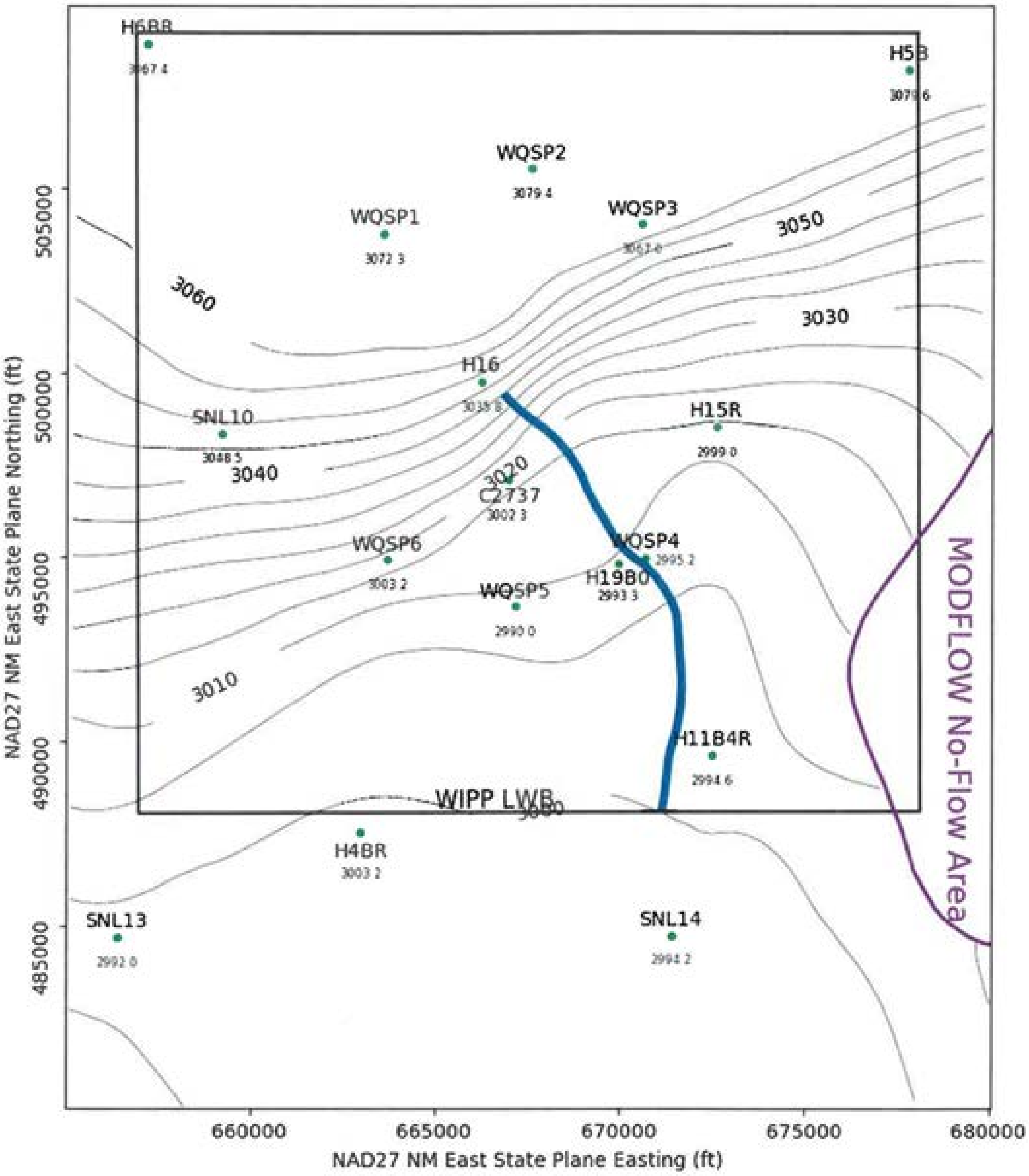
SYSTEM	SERIES	GROUP	FORMATION	MEMBER
RECENT	RECENT		SURFICIAL DEPOSITS	
QUATERNARY	PLEISTOCENE		MESCALERO CALICHE	
			GATUÑA	
TERTIARY	MID-PLIOCENE		OGALLALA	
TRIASSIC		DOCKUM	SANTA ROSA	
PERMIAN	OCHOAN		DEWEY LAKE	
			RUSTLER	Forty-niner
				Magenta
				Tamarisk
				Culebra
				Los Medaños
			SALADO	Upper
				McNutt Potash
				Lower
			CASTILE	
	GUADALUPIAN	DELAWARE MOUNTAIN	BELL CANYON	
			CHERRY CANYON	
			BRUSHY CANYON	

~~Figure L-3~~
~~Site Geologic Column~~



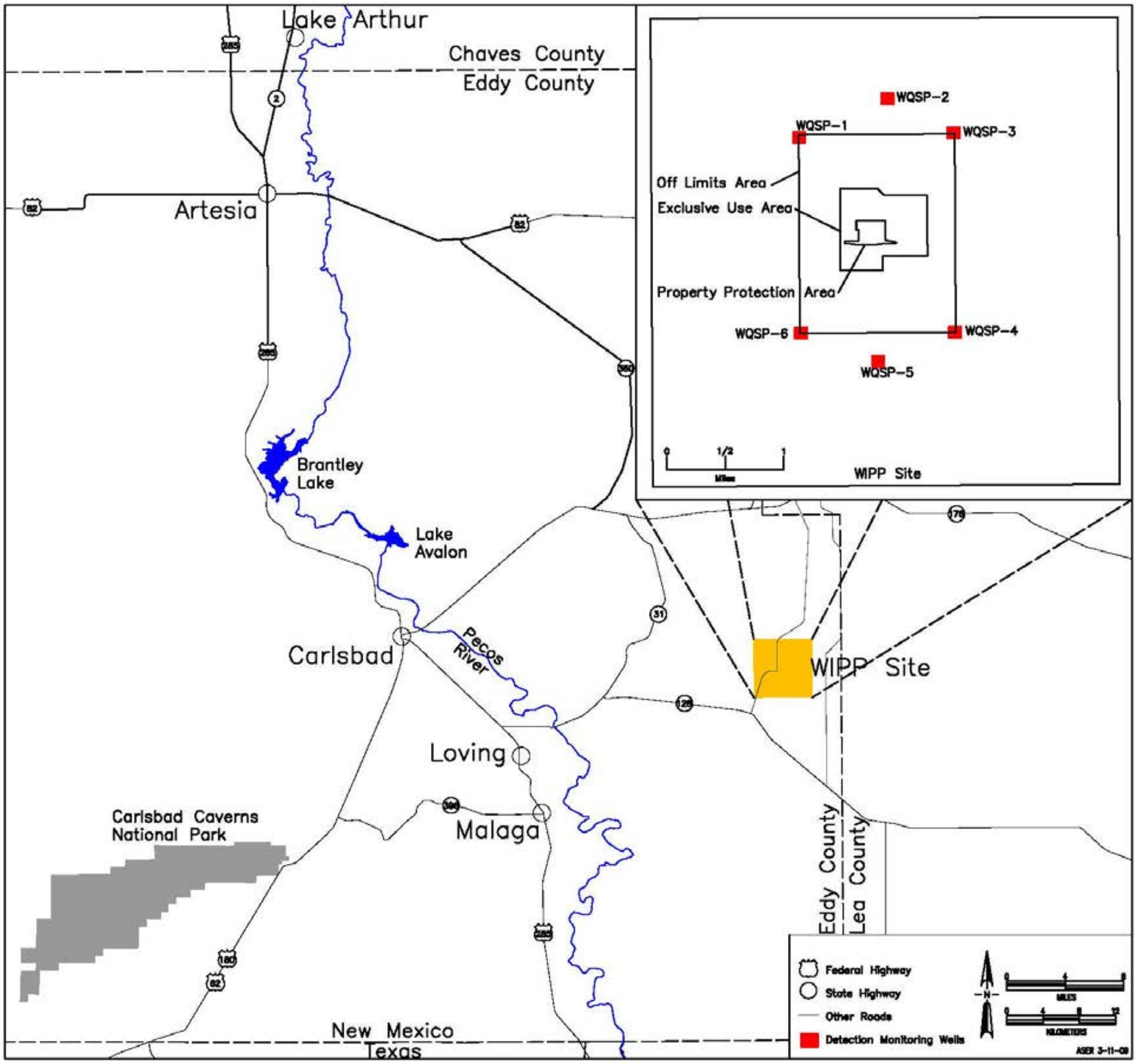
~~Figure L-4~~

~~Generalized Stratigraphic Cross Section above Bell Canyon Formation at WIPP Site~~

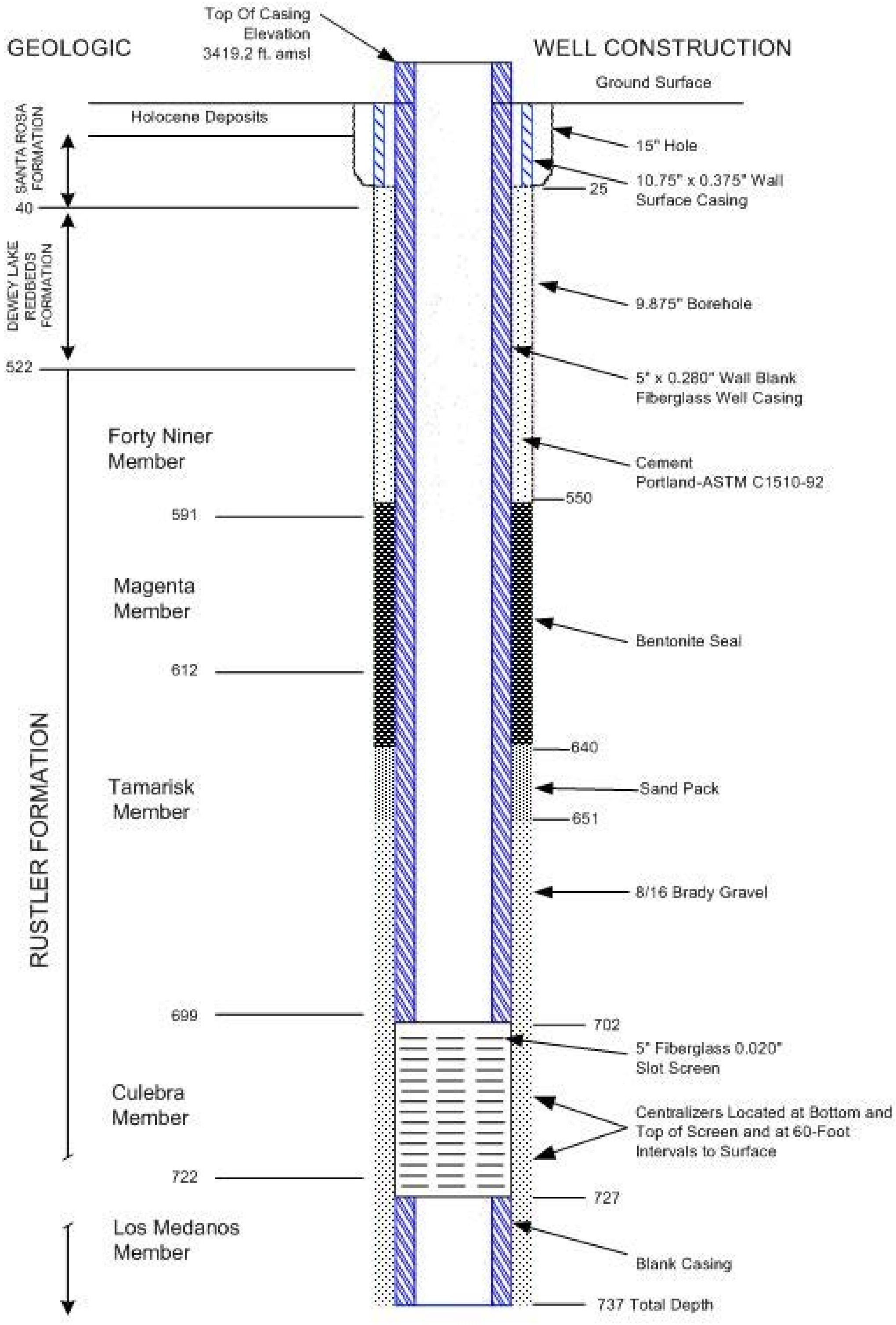


~~*Model generated September 2019 utilizing May 2018 freshwater head contours with observed heads (ft) listed at each well. Contours are at 5 ft intervals with the blue line particle track from the waste handling shaft to the WIPP Land Withdrawal Boundary. The purple line is a constant head boundary representing the Rustler halite margin.*~~

~~**Figure L-5**~~
~~**Culebra Freshwater-Head Potentiometric Surface**~~

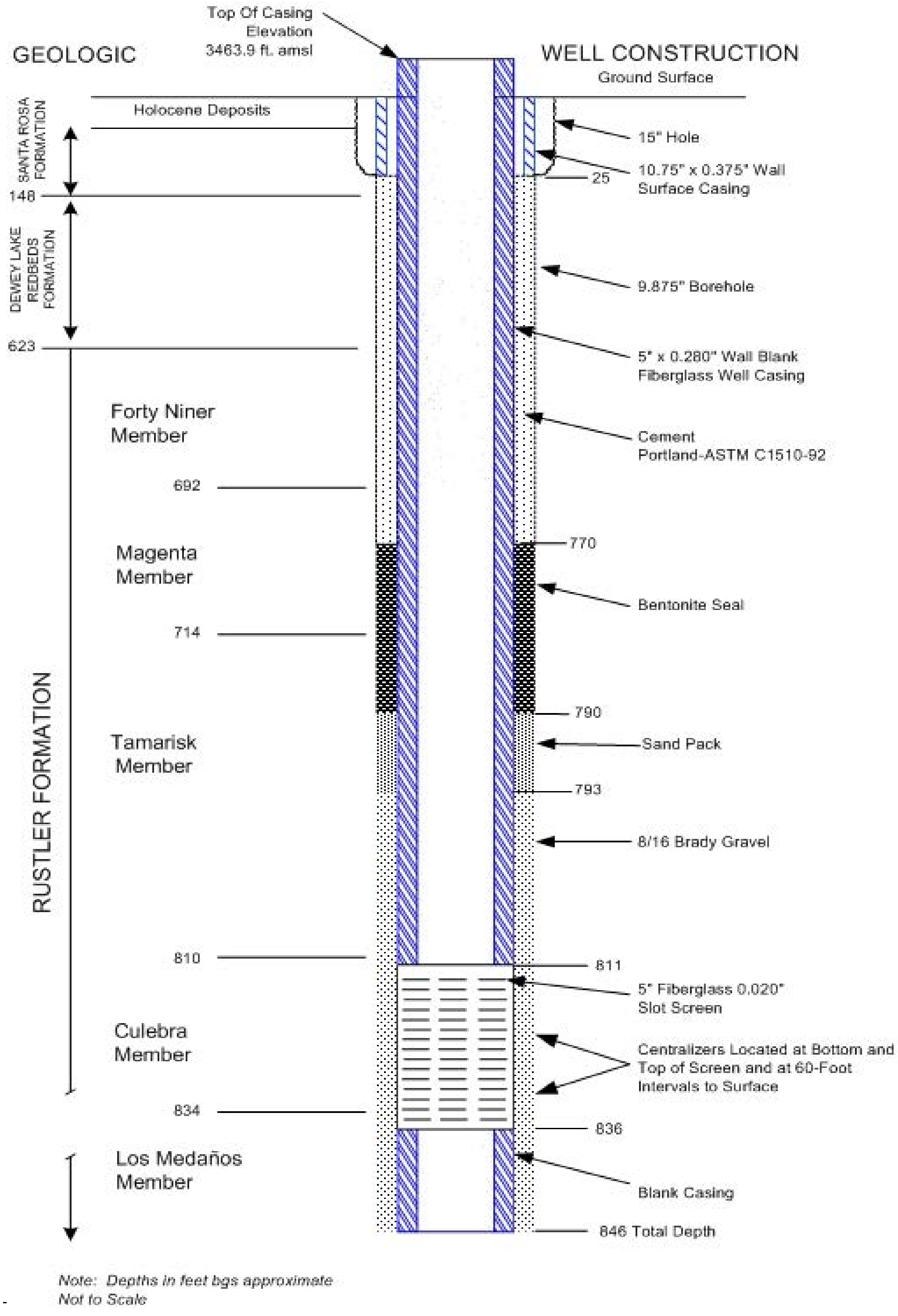


~~**Figure L-6**~~
~~**Detection Monitoring Well Locations**~~

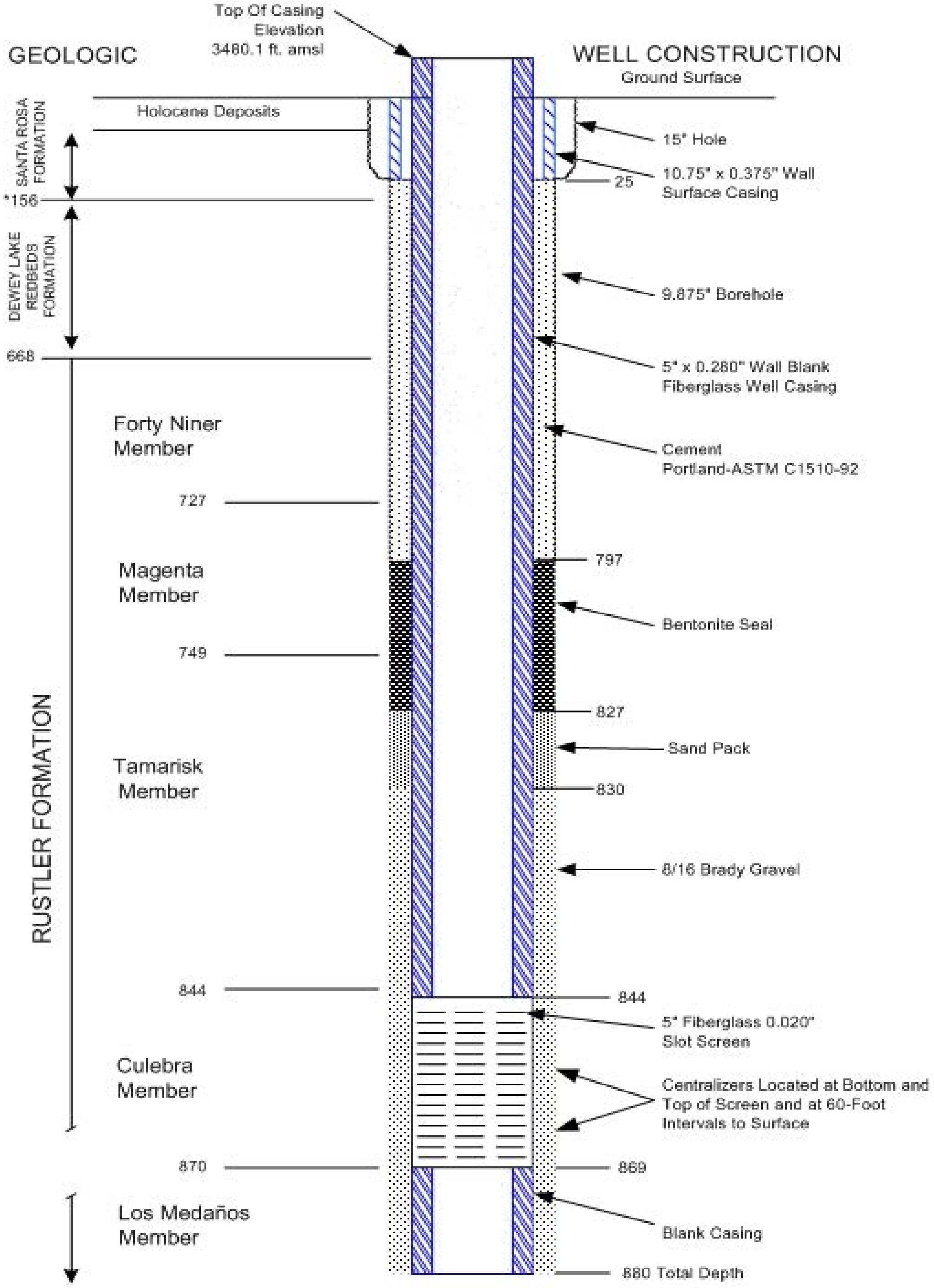


Note: Depths in feet bgs approximate
Not to Scale

~~Figure L-7~~
~~As-Built Configuration of Well WQSP-1~~



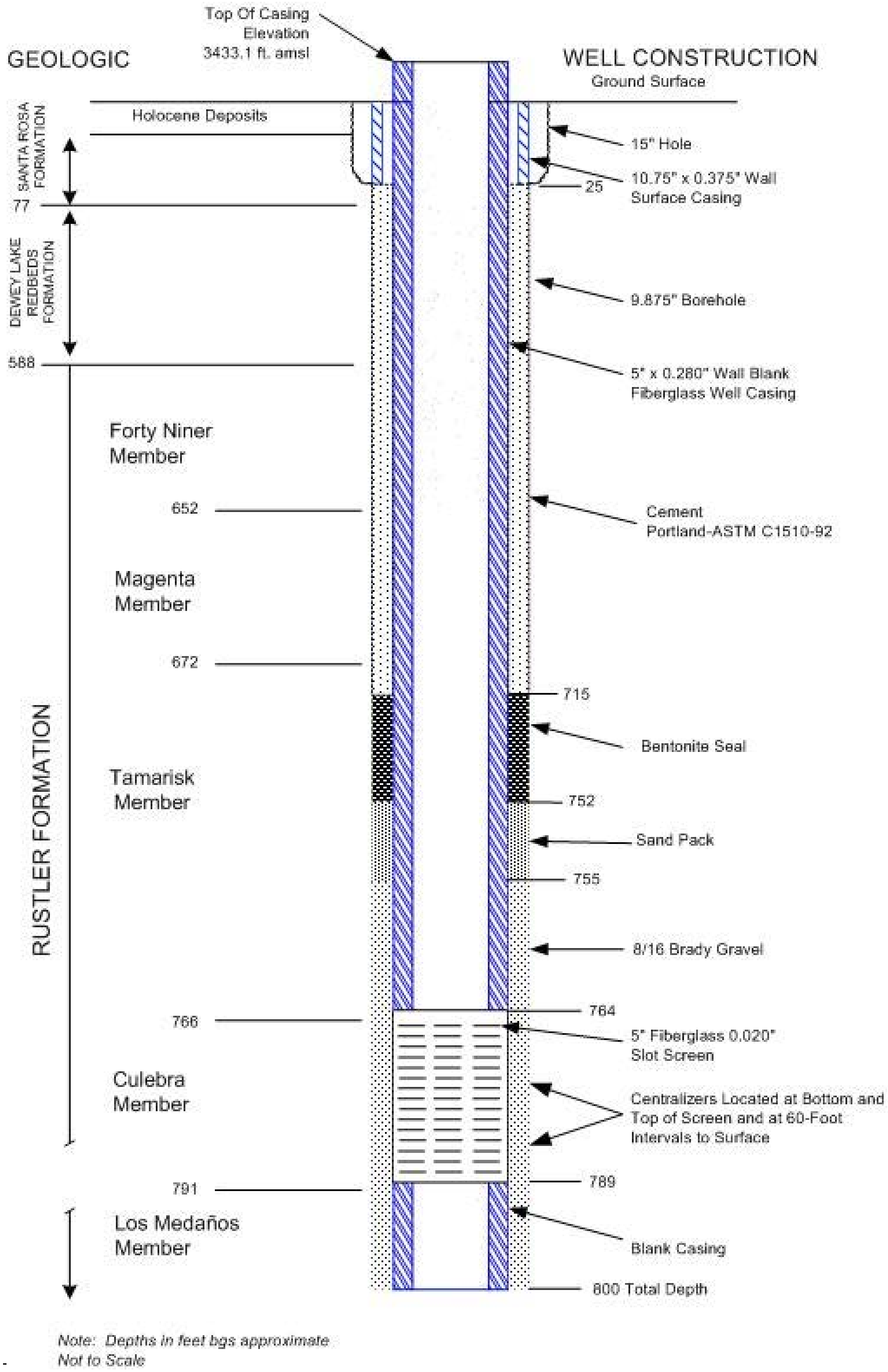
~~**Figure L-8**~~
~~**As-Built Configuration of Well WQSP-2**~~



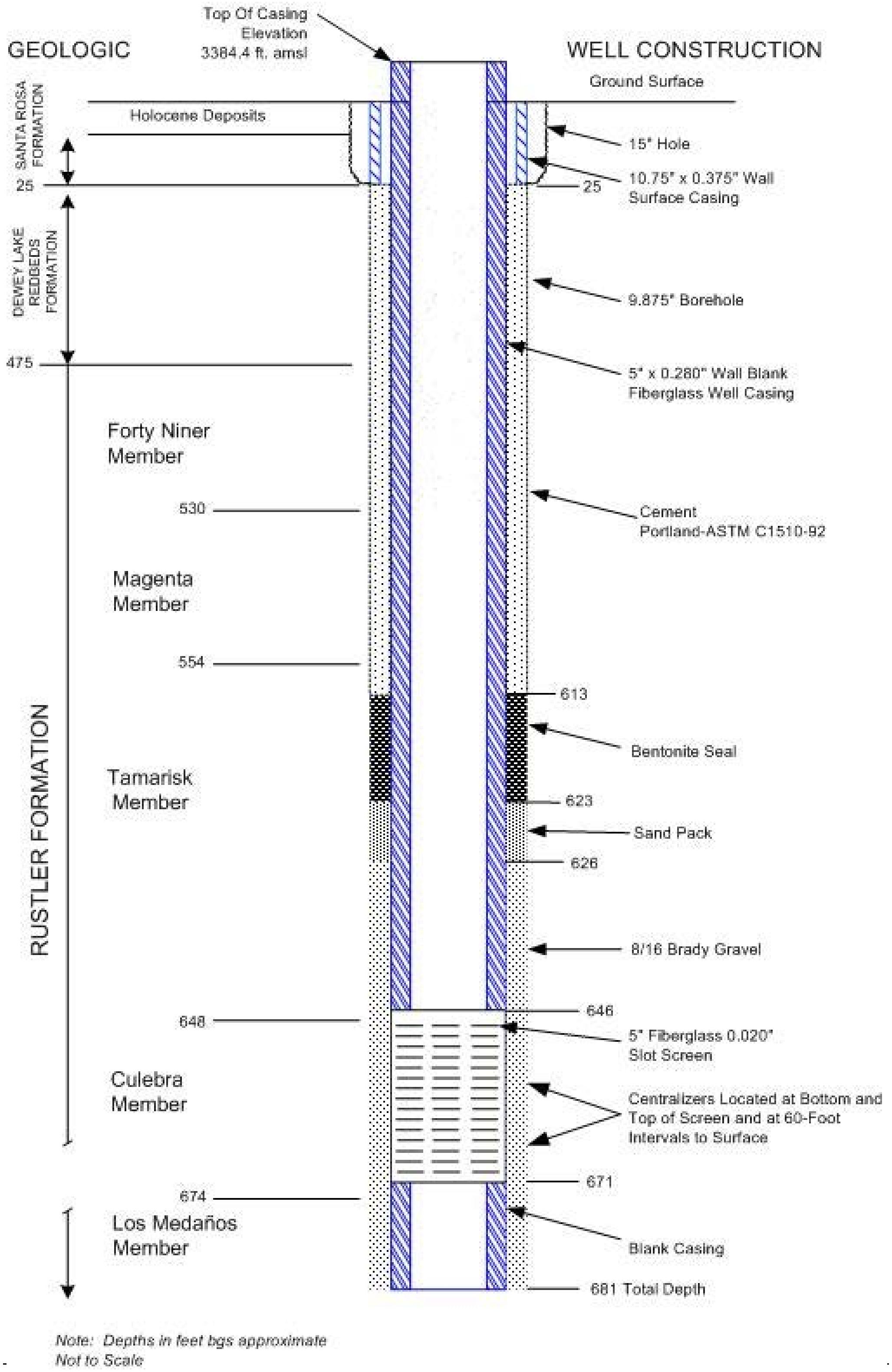
Note: Depths in feet bgs approximate
Not to Scale

**from DOE/WIPP-95-2154*

~~Figure L-9~~
~~As-Built Configuration of Well WQSP-3~~

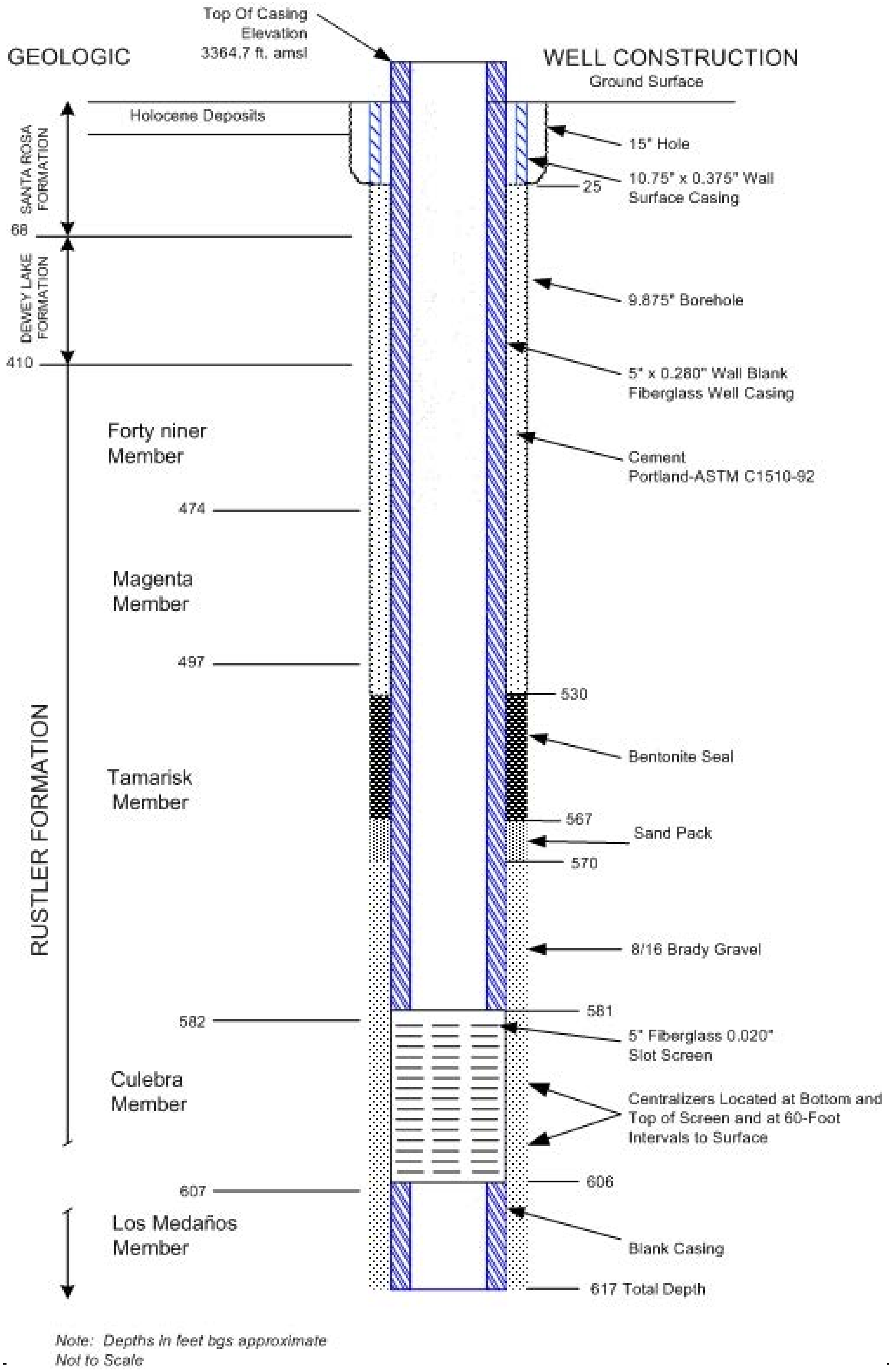


~~Figure L-10~~
~~As-Built Configuration of Well WQSP-4~~

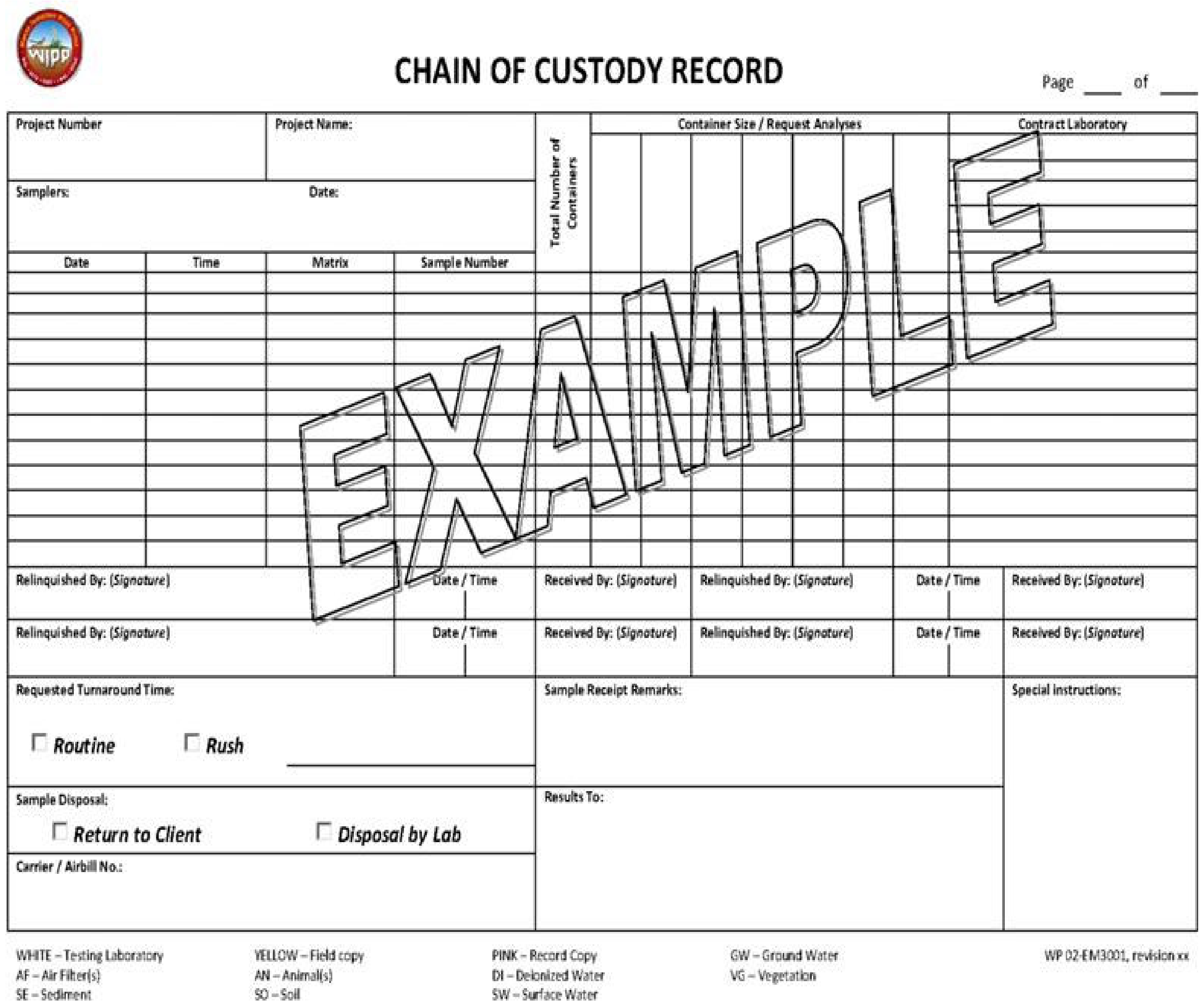


Note: Depths in feet bgs approximate
Not to Scale

~~Figure L-11~~
~~As-Built Configuration of Well WQSP-5~~



~~Figure L-12~~
~~As-Built Configuration of Well WQSP-6~~



CHAIN OF CUSTODY RECORD

Page ____ of ____

Project Number

Project Name:

Samplers:

Date:

Total Number of Containers

Container Size / Request Analyses

Contract Laboratory

Date	Time	Matrix	Sample Number

Relinquished By: (*Signature*) | Date / Time | Received By: (*Signature*) | Relinquished By: (*Signature*) | Date / Time | Received By: (*Signature*)

Relinquished By: (*Signature*) | Date / Time | Received By: (*Signature*) | Relinquished By: (*Signature*) | Date / Time | Received By: (*Signature*)

Requested Turnaround Time:

☐ *Routine* ☐ *Rush*

Sample Receipt Remarks:

Special Instructions:

Sample Disposal:

☐ *Return to Client* ☐ *Disposal by Lab*

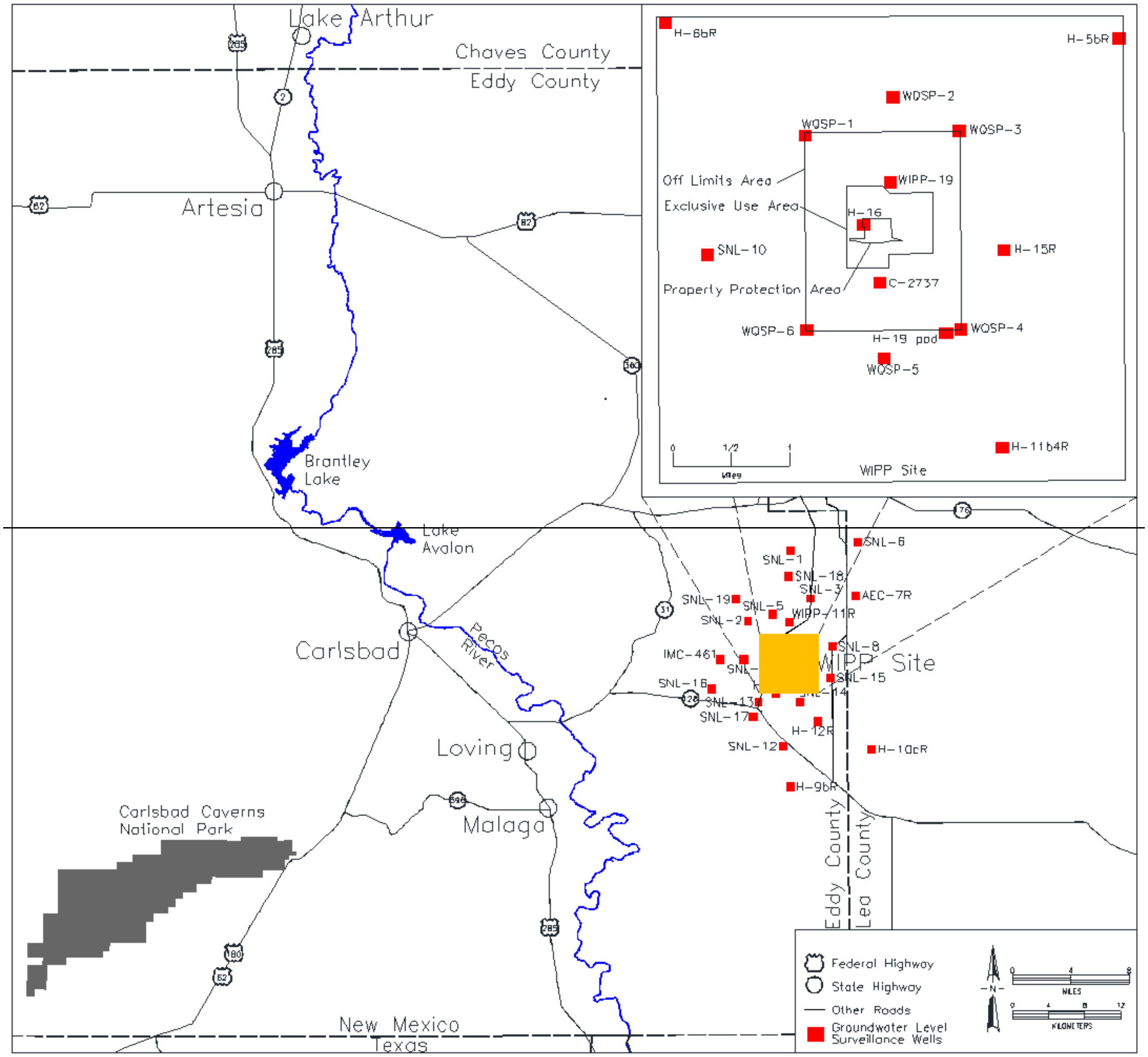
Results To:

Carrier / Airbill No.:

WHITE – Testing Laboratory	YELLOW – Field copy	PINK – Record Copy	GW – Ground Water	WP 02-EM3001, revision xx
AF – Air Filter(s)	AN – Animal(s)	DI – Deionized Water	VG – Vegetation	
SE – Sediment	SO – Soil	SW – Surface Water		

EXAMPLE

~~Figure L-13~~
~~Example Chain-of-Custody/Request for Analysis Form~~



~~**Figure L-14**~~
~~**Groundwater Level Surveillance Wells**~~
~~**(inset represents the groundwater surveillance wells in WIPP Land Withdrawal Area)**~~

ATTACHMENT M

FIGURES

DISCLAIMER

The figures presented in this attachment are illustrations and are for information purposes only. These figures are not to scale.

ATTACHMENT M

FIGURES

LIST OF FIGURES

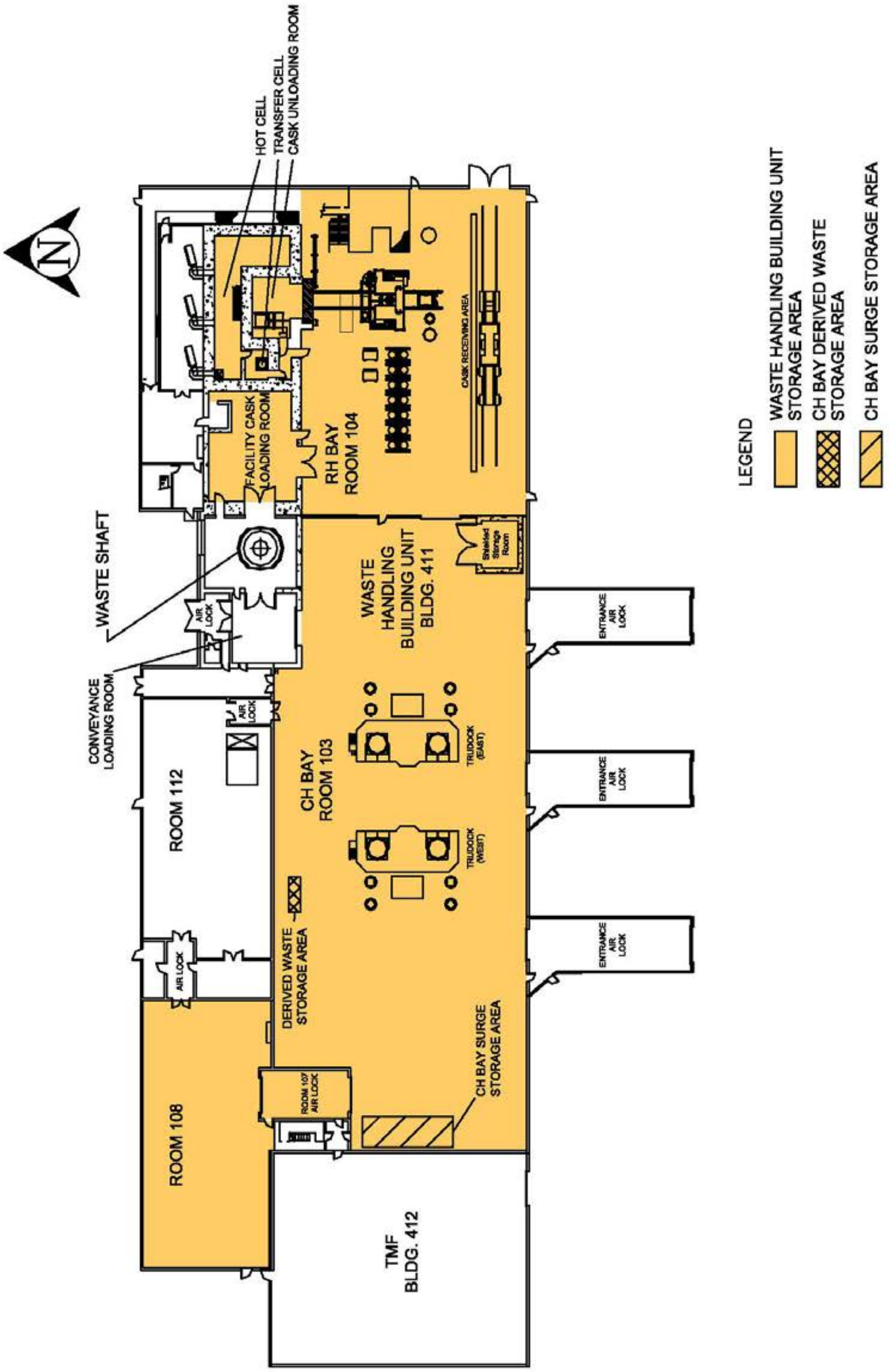


Figure M-1
Waste Handling Building Unit – TRU Mixed Waste Container Storage and Surge Areas

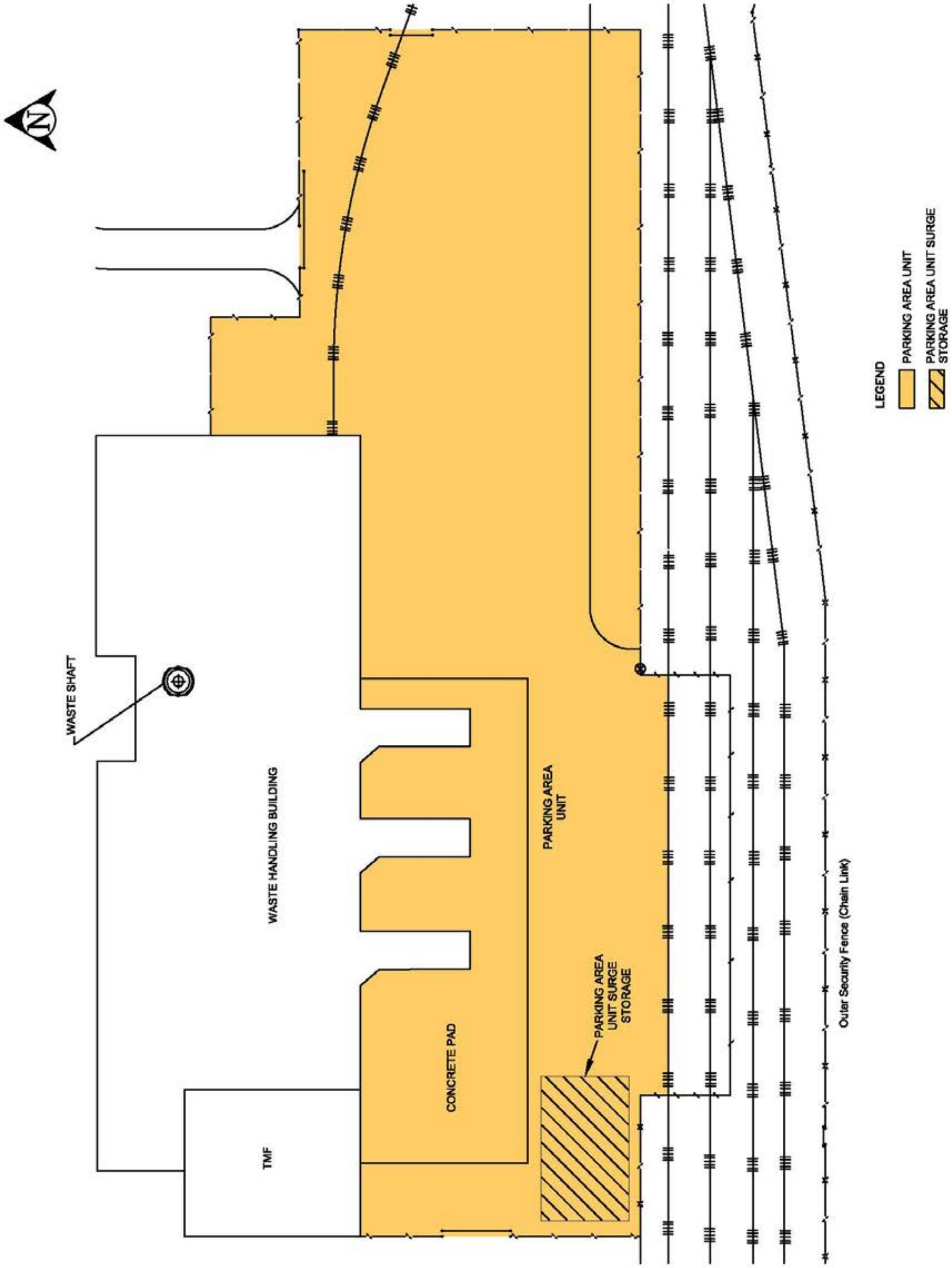


Figure M-2
Parking Area Unit – TRU Mixed Waste Container Storage and Surge Areas

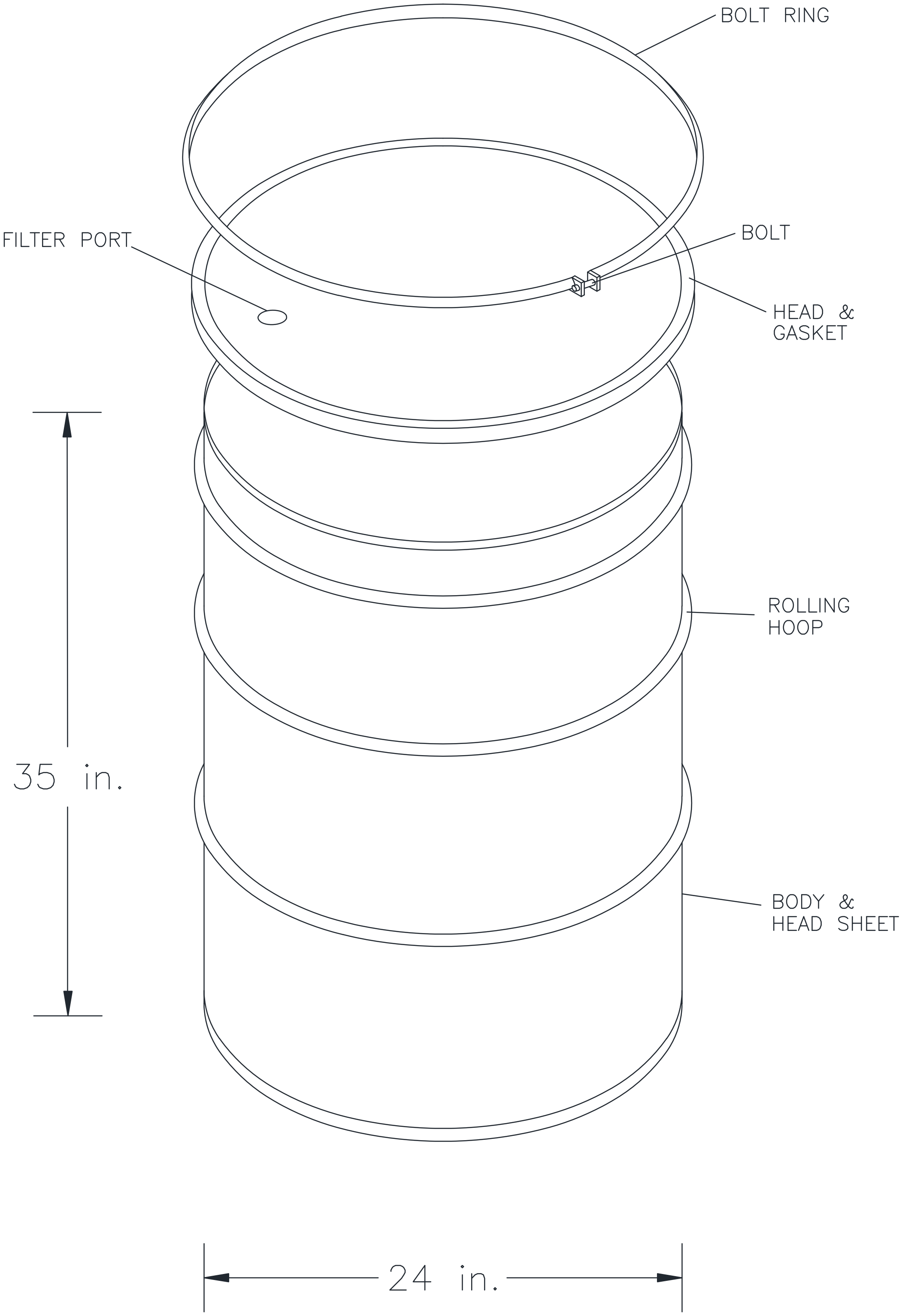


Figure M-3
Standard 55-Gallon Drum (Typical)

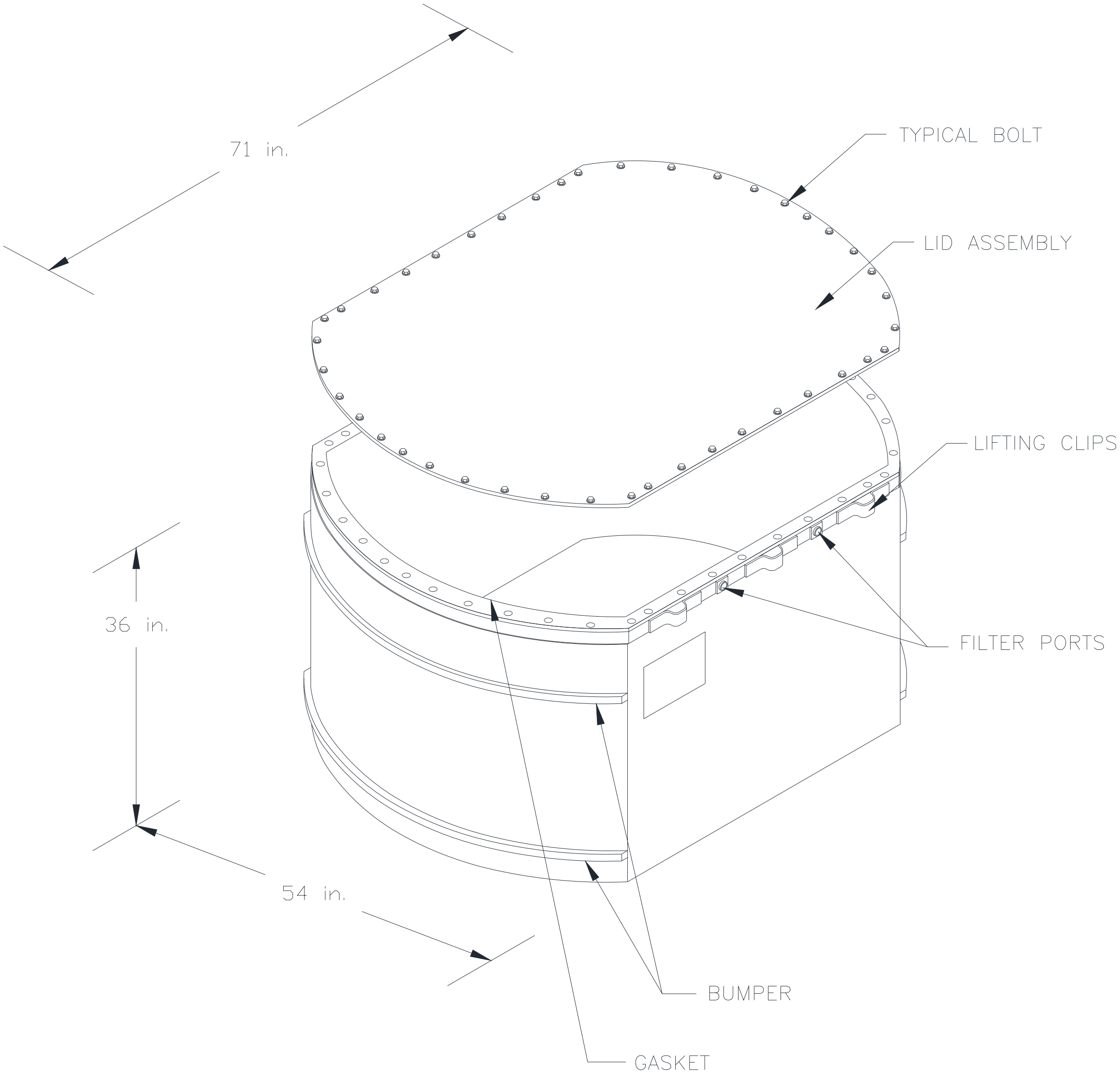


Figure M-4
Standard Waste Box

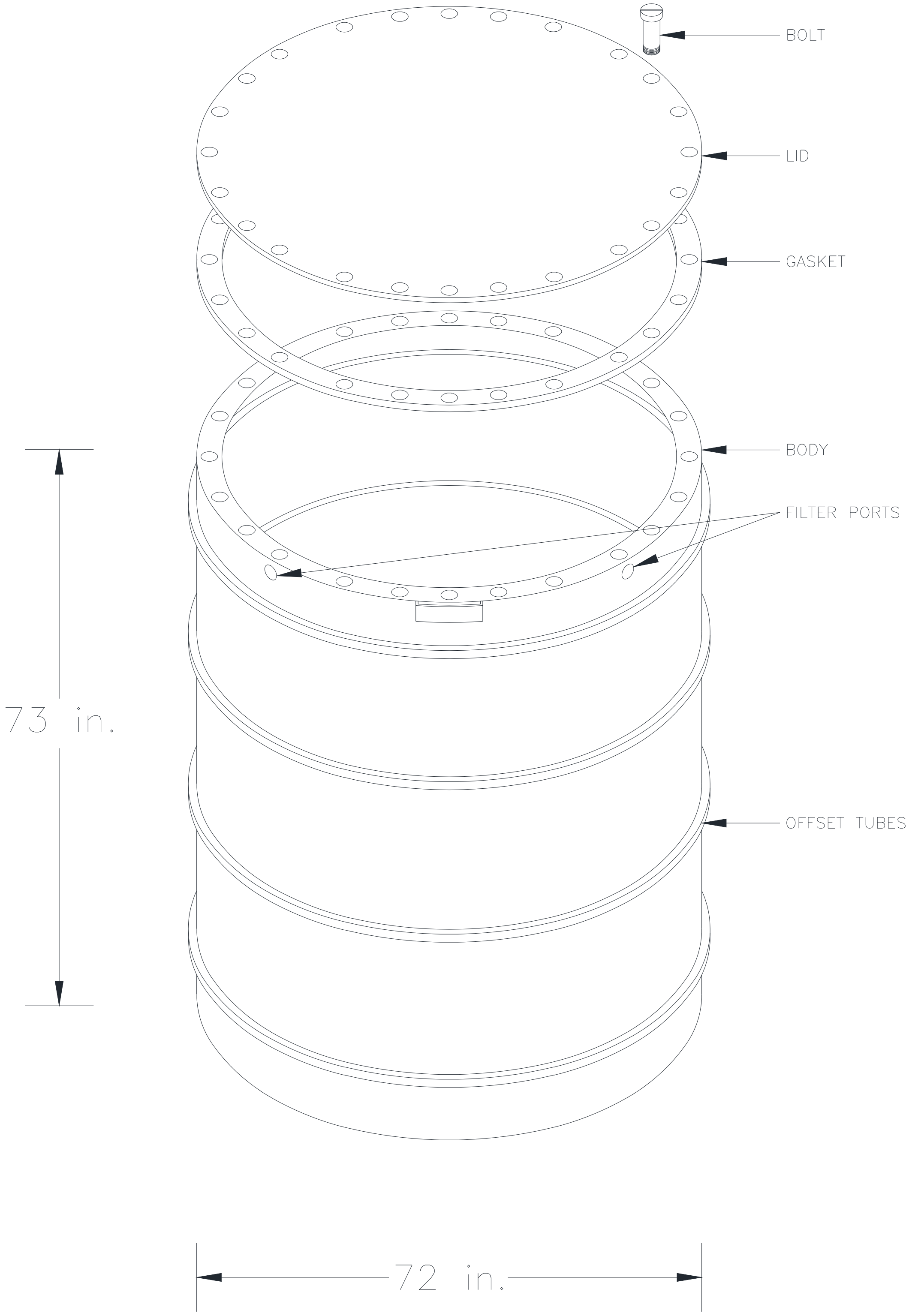


Figure M-5
Ten-Drum Overpack

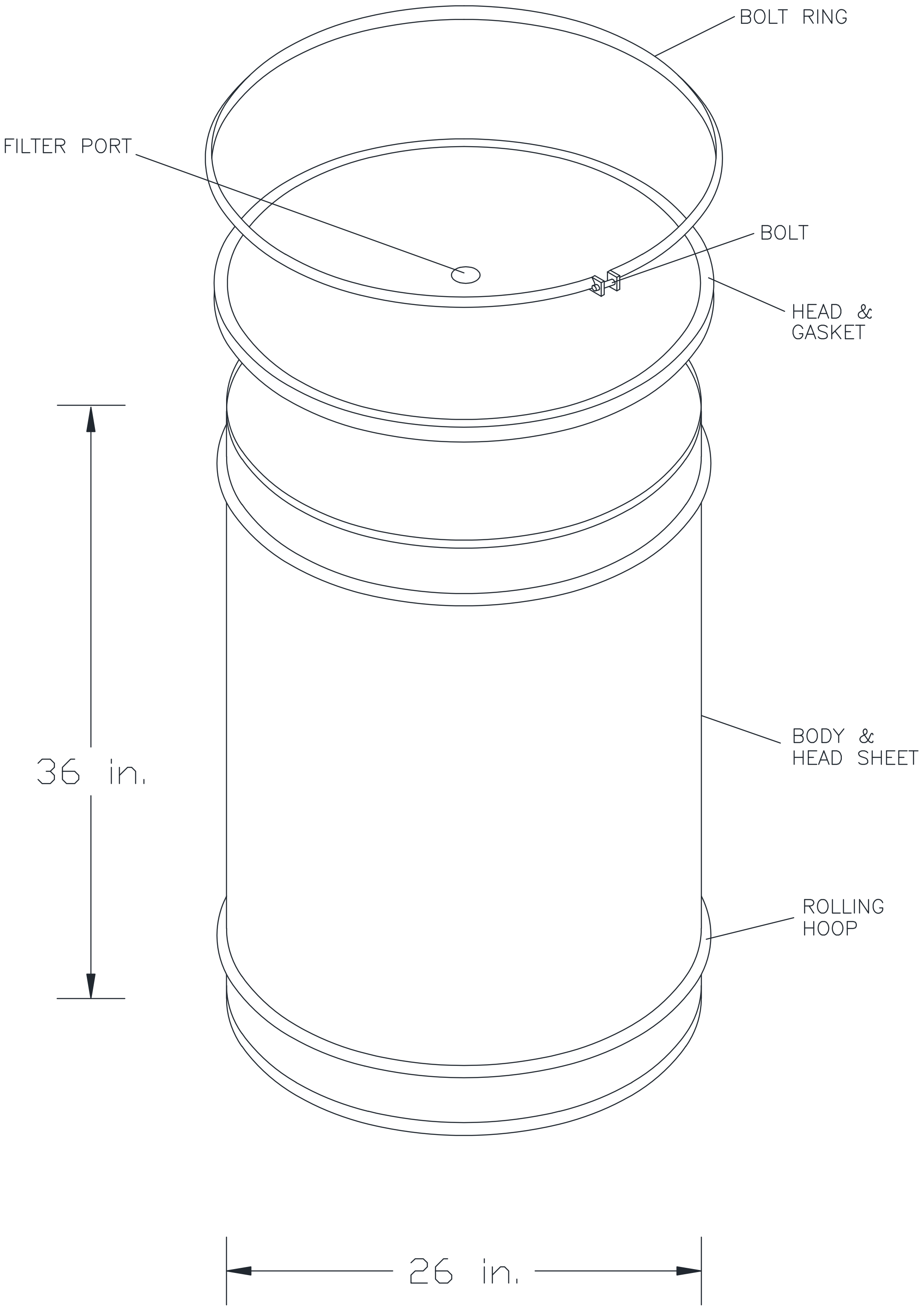


Figure M-6
85-Gallon Drum

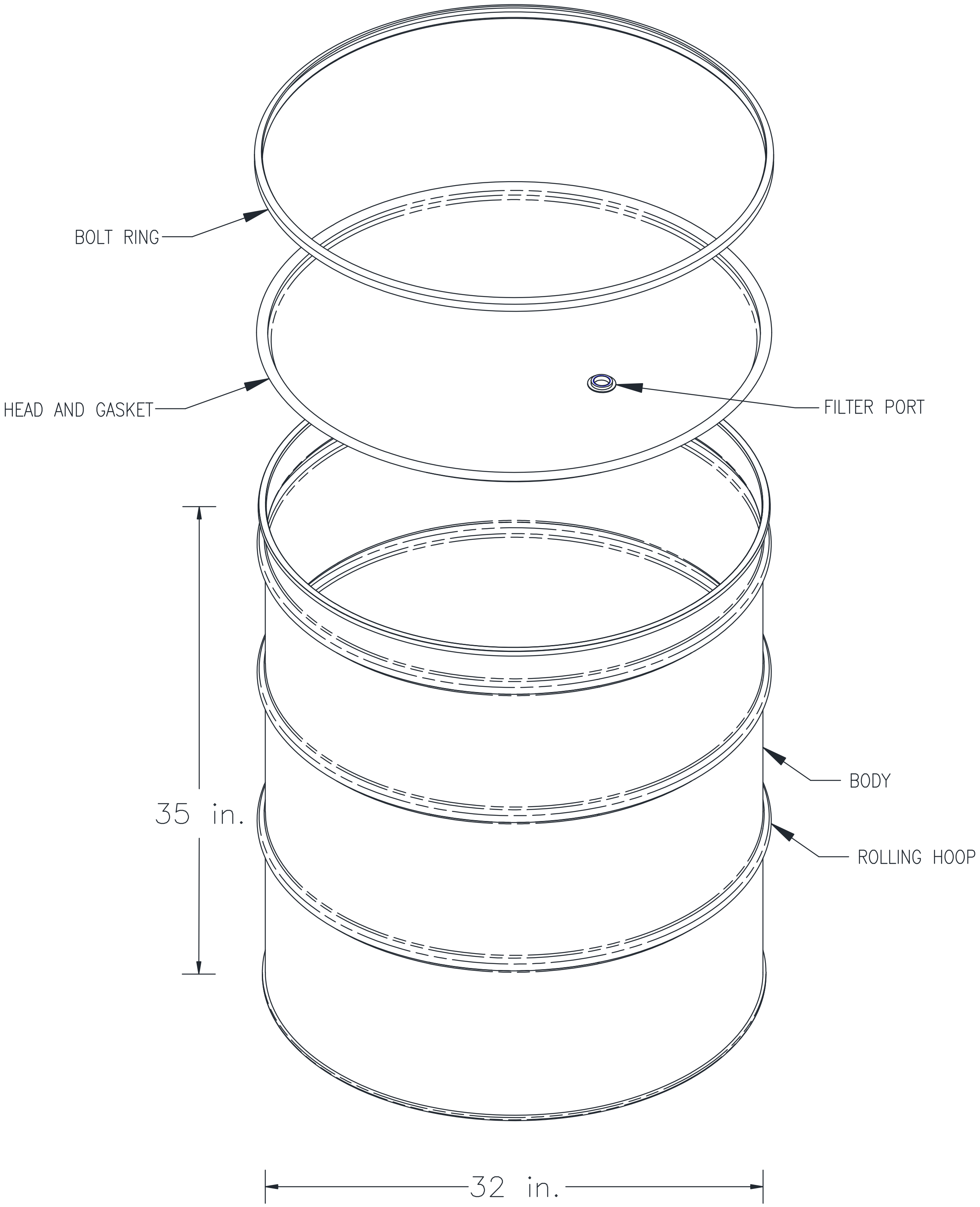


Figure M-7
100-Gallon Drum

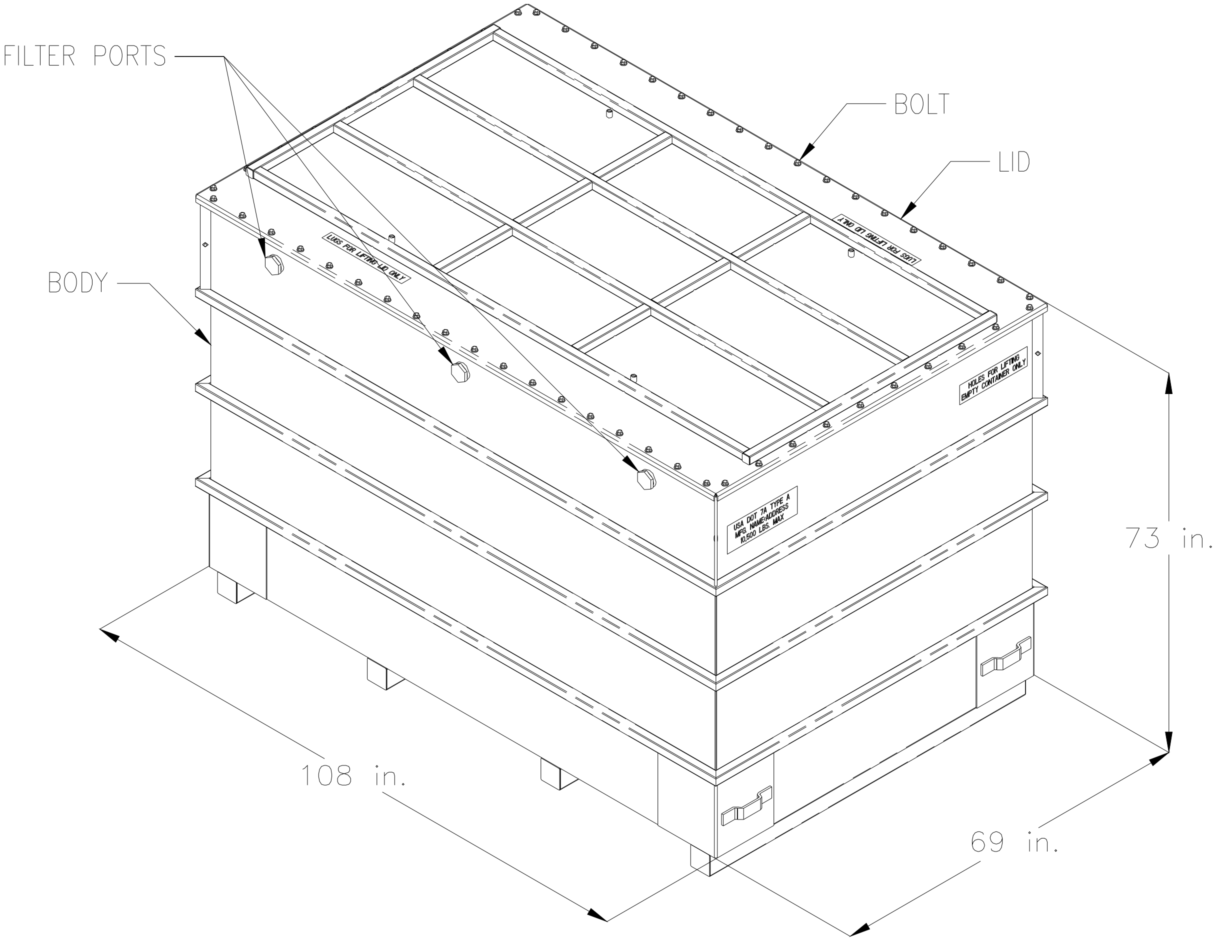


Figure M-8
Typical Standard Large Box 2

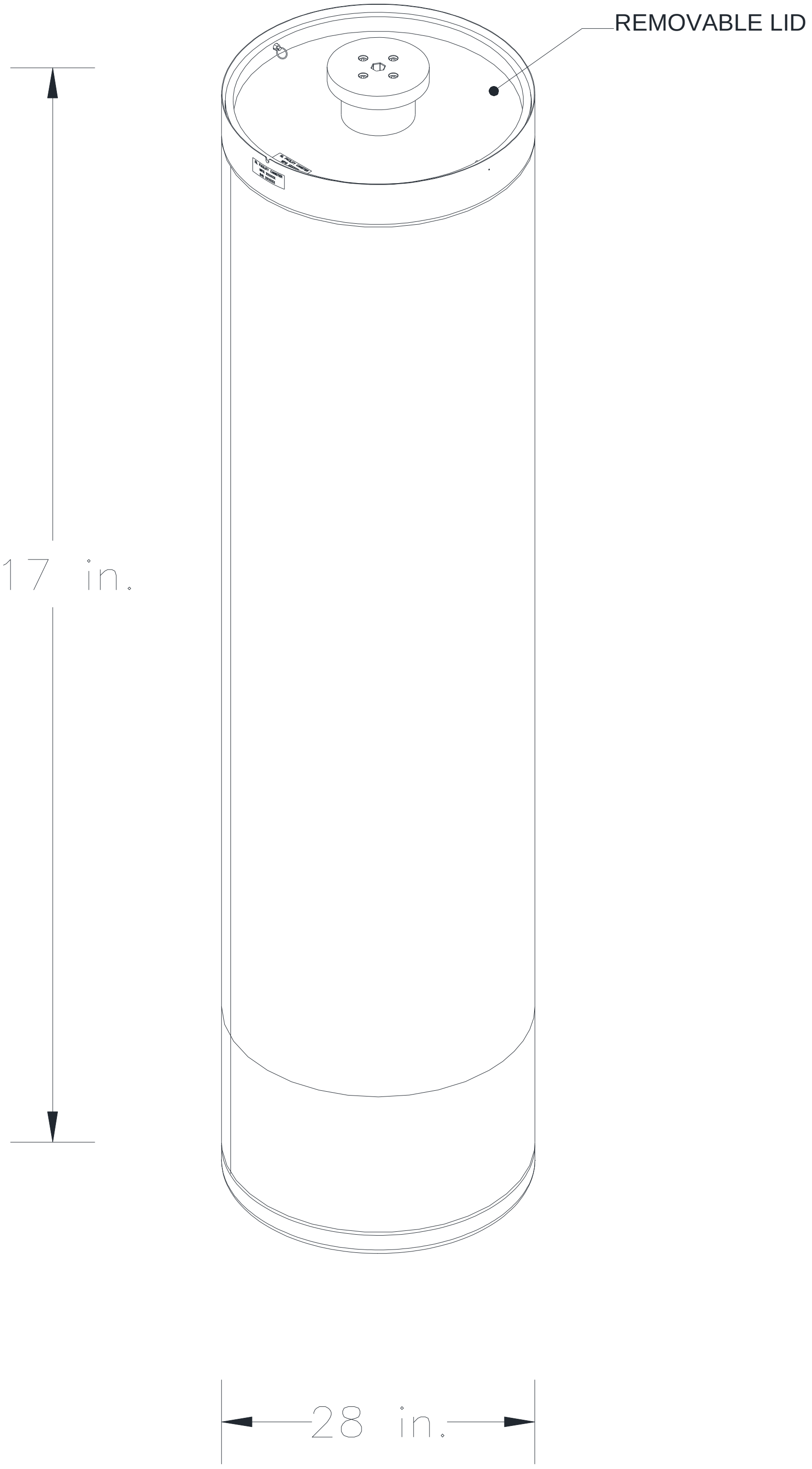


Figure M-9
Facility Canister Assembly

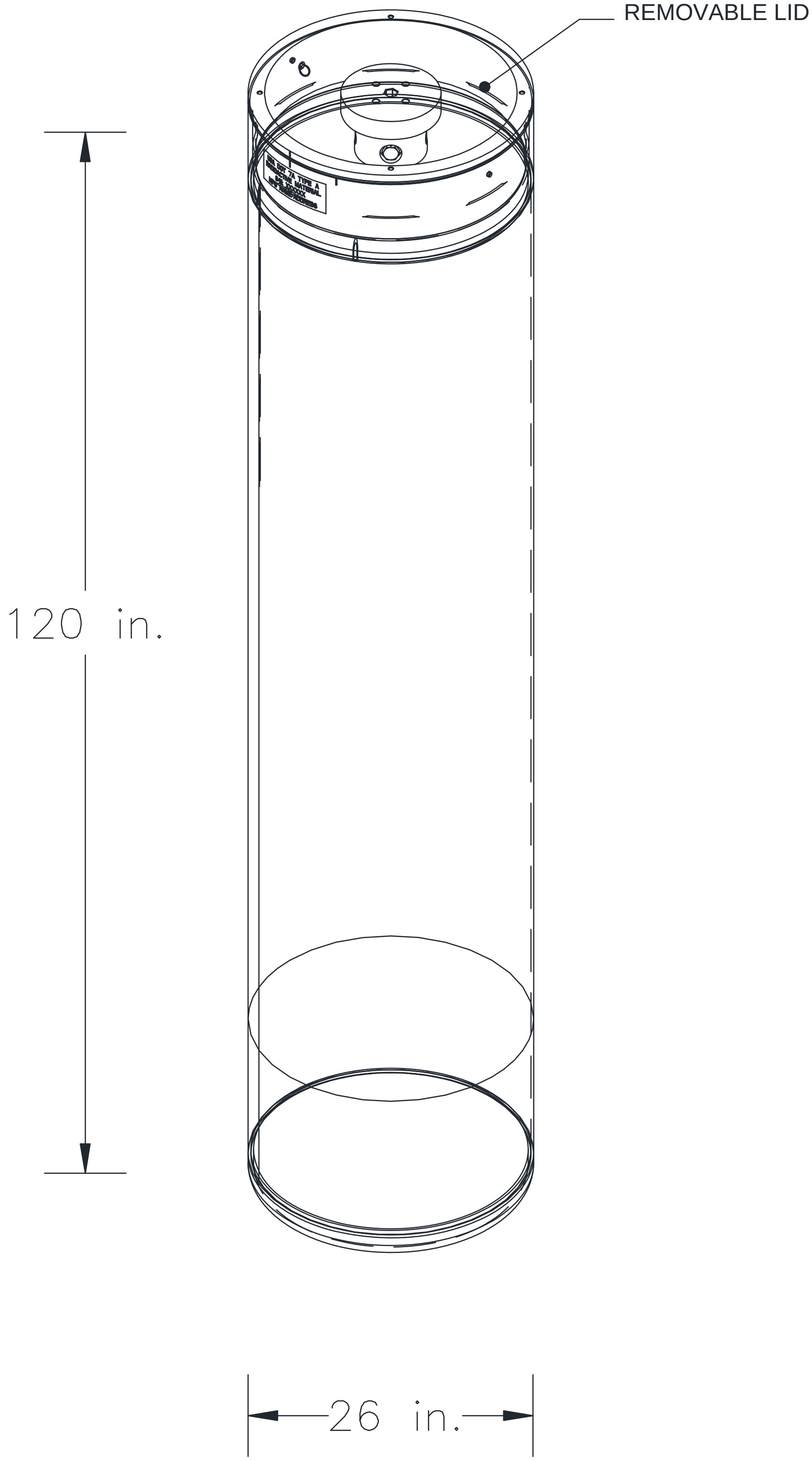


Figure M-10
RH-TRU 72-B Canister Assembly

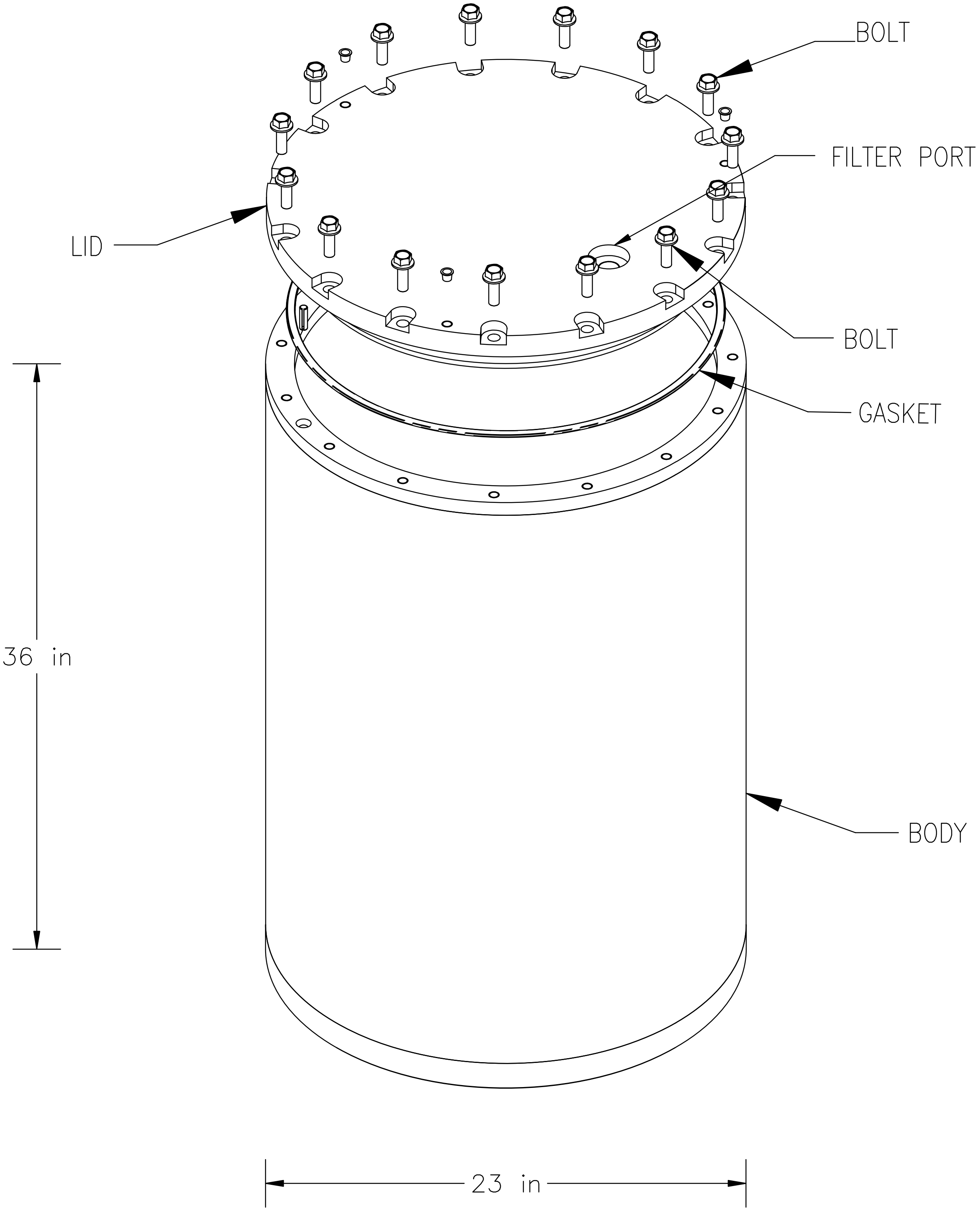


Figure M-11
Typical Shielded Container

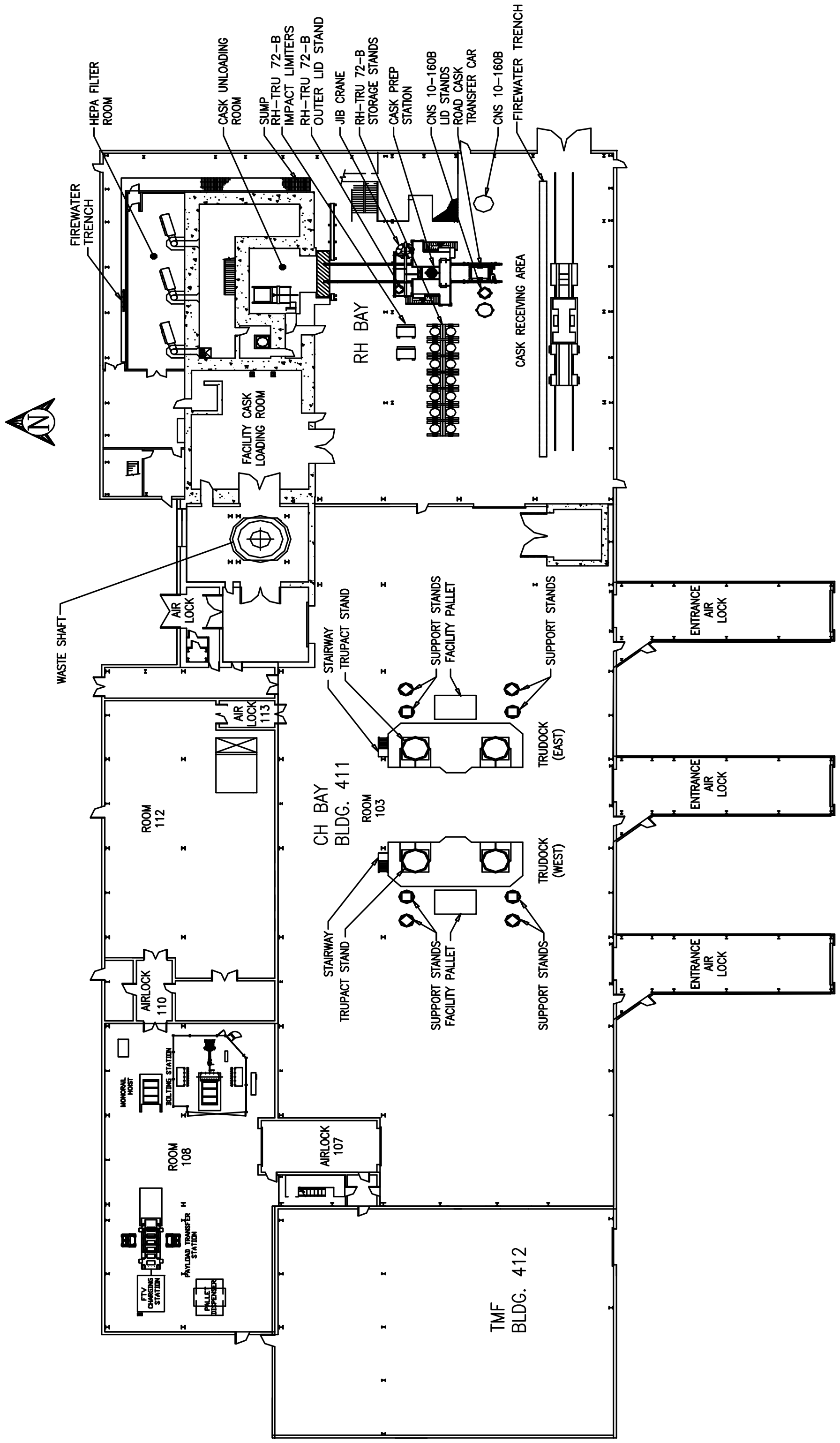


Figure M-12
Waste Handling Building Plan (Ground Floor)

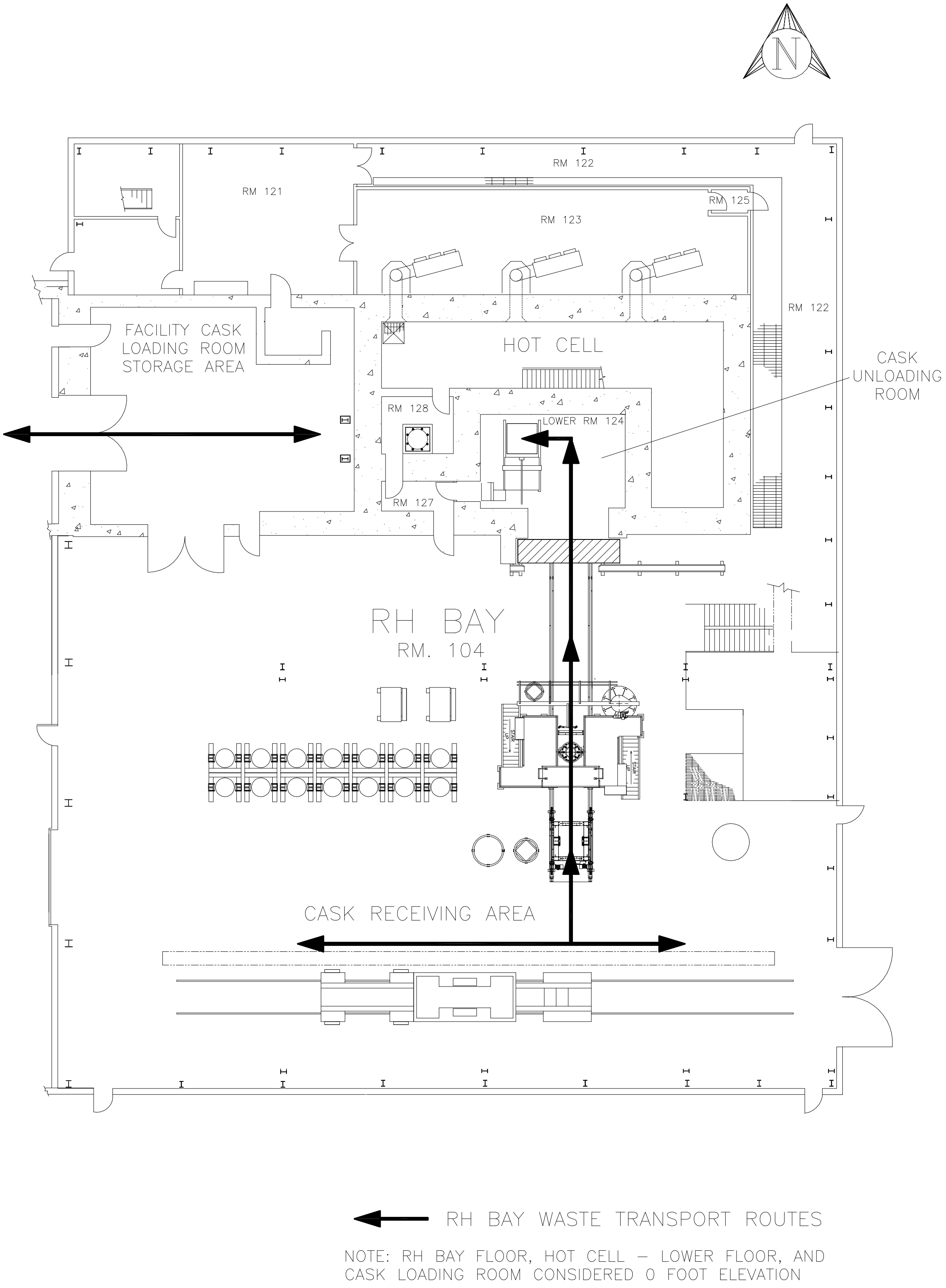


Figure M-13
RH Bay Ground Floor and Waste Transport Routes

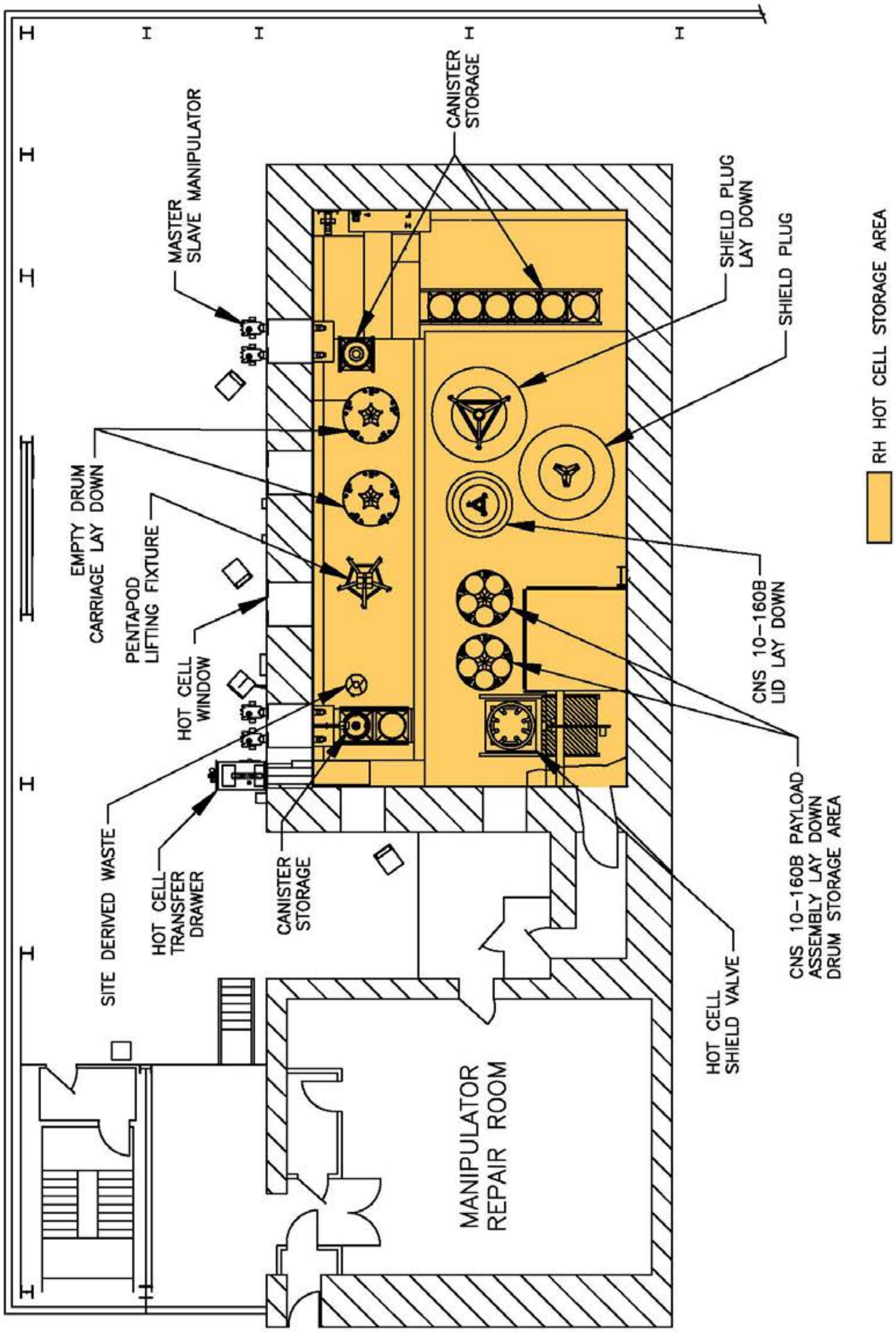


Figure M-14
RH Hot Cell Storage Area

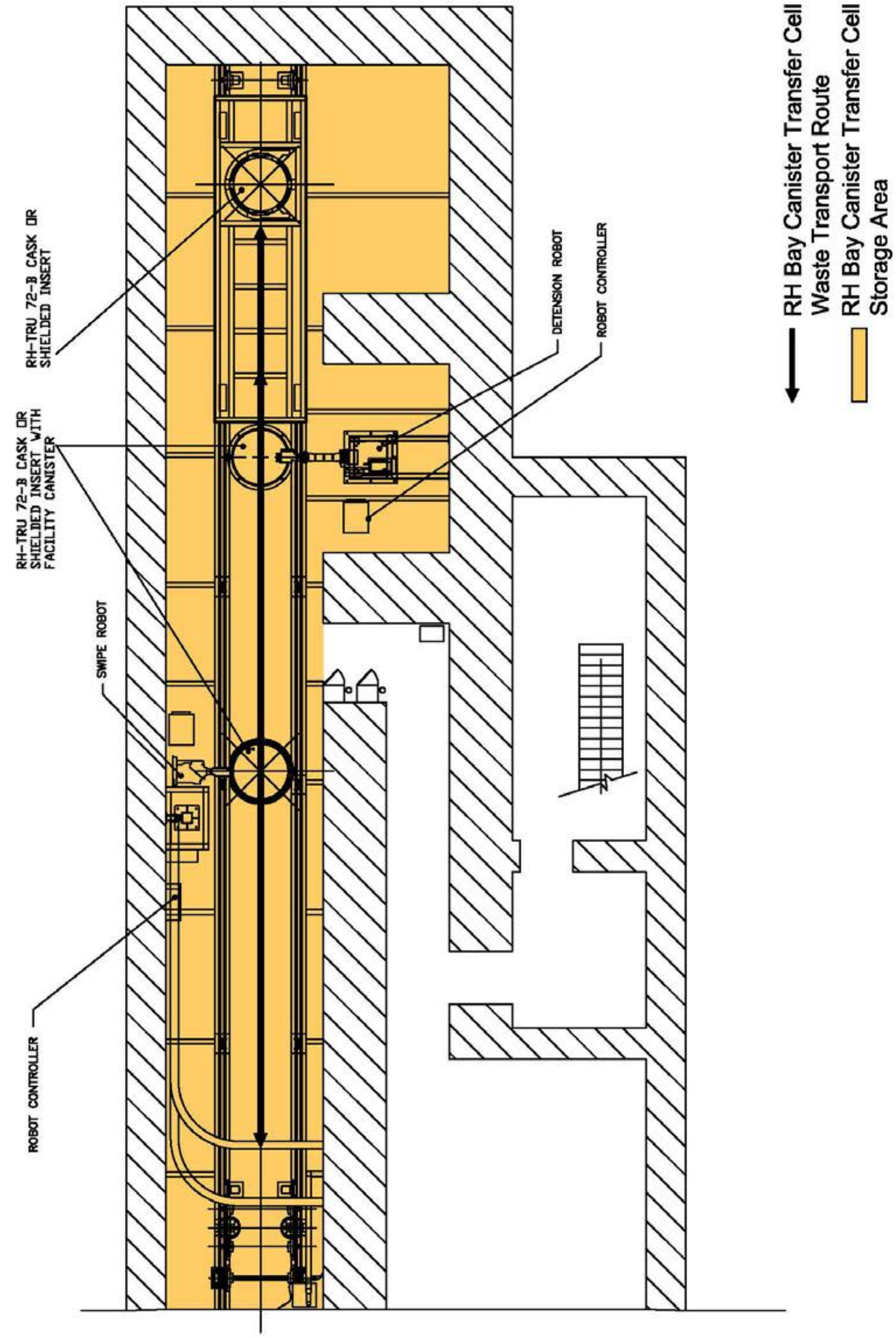


Figure M-15
RH Canister Transfer Cell Storage Area and Waste Transport Route

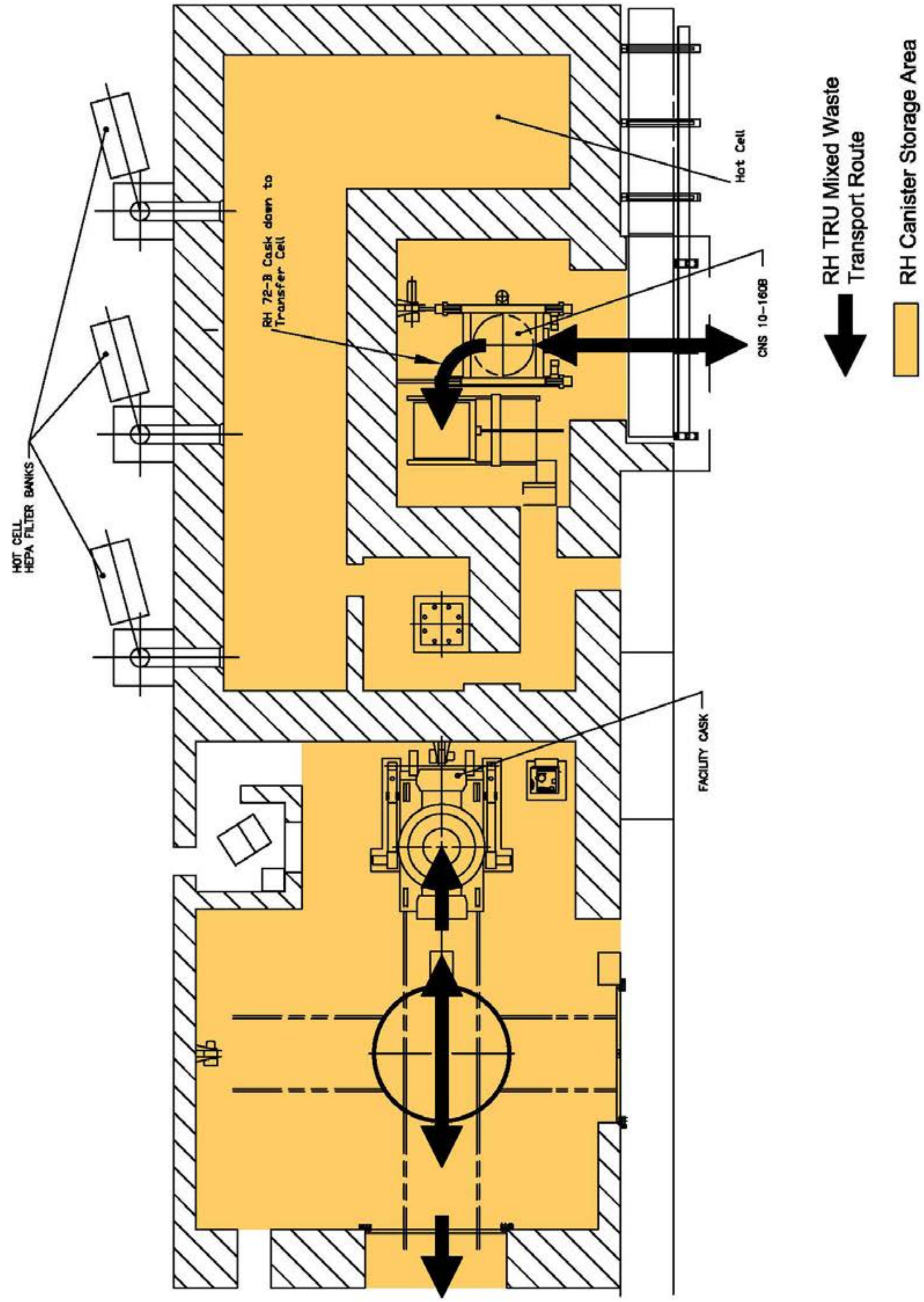


Figure M-16
RH Facility Cask Loading Room and Cask Unloading Storage Area and Waste Transport Route

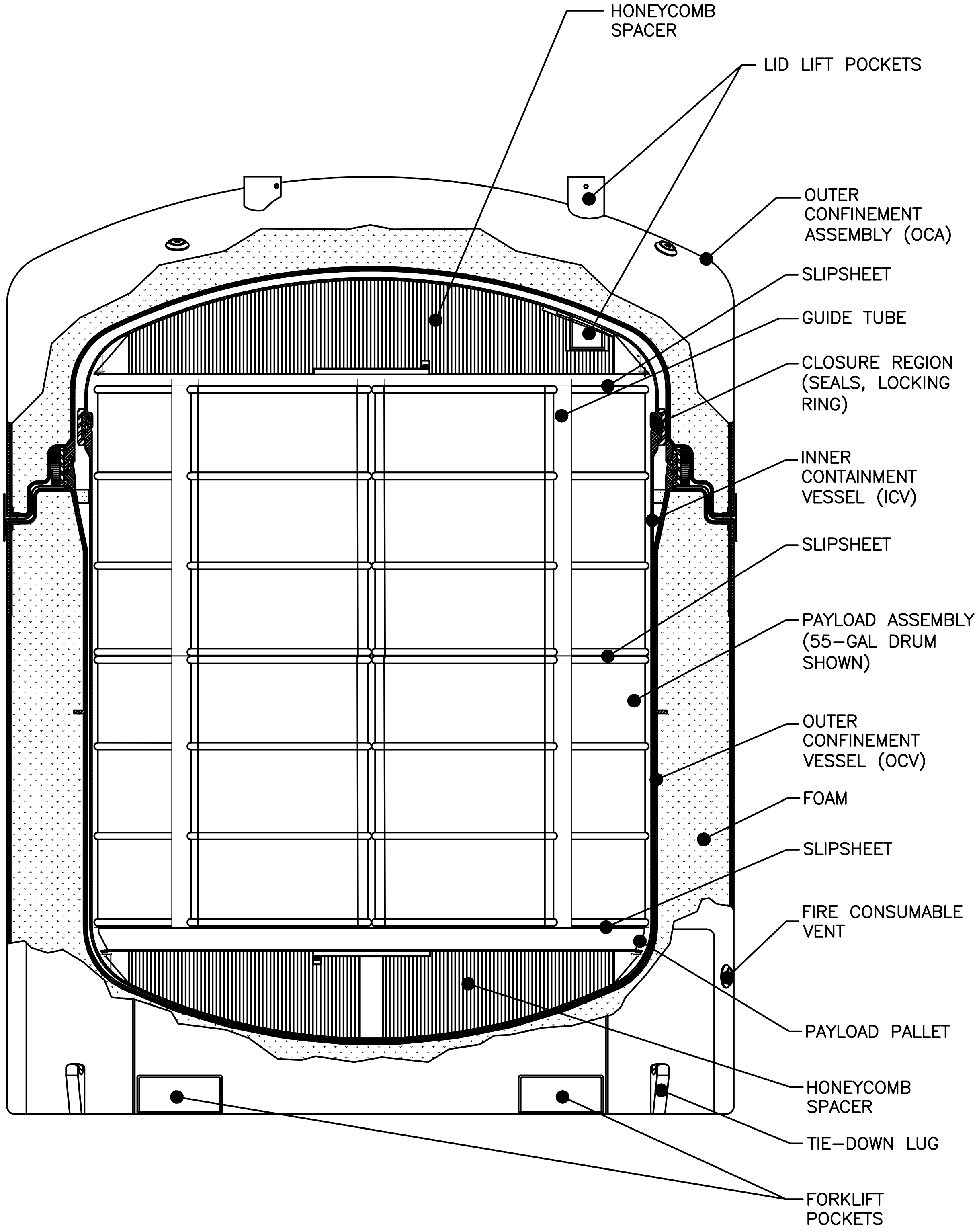


Figure M-17
TRUPACT-II Type B Shipping Container

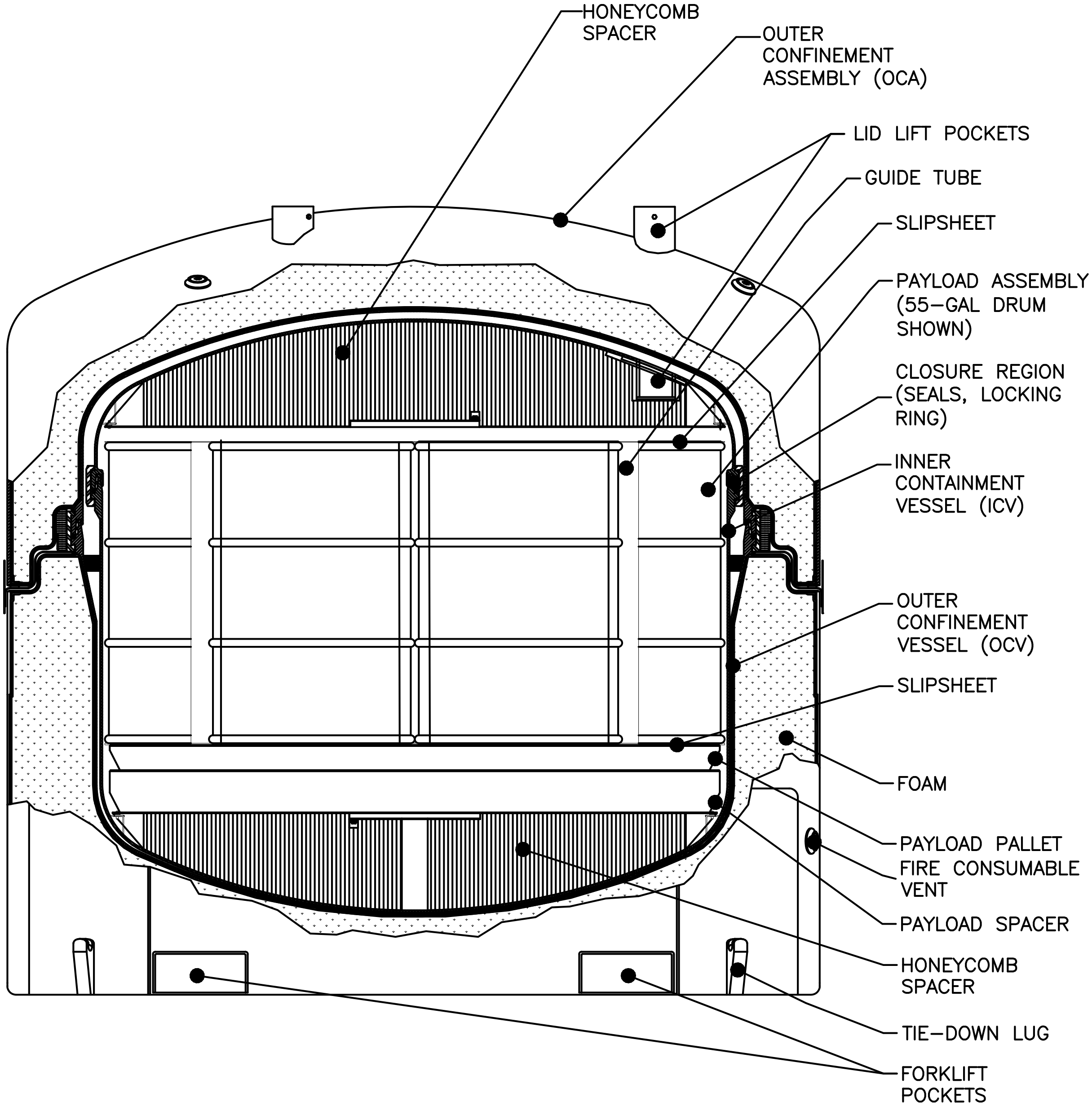


Figure M-18
Typical HalfPACT Type B Shipping Container

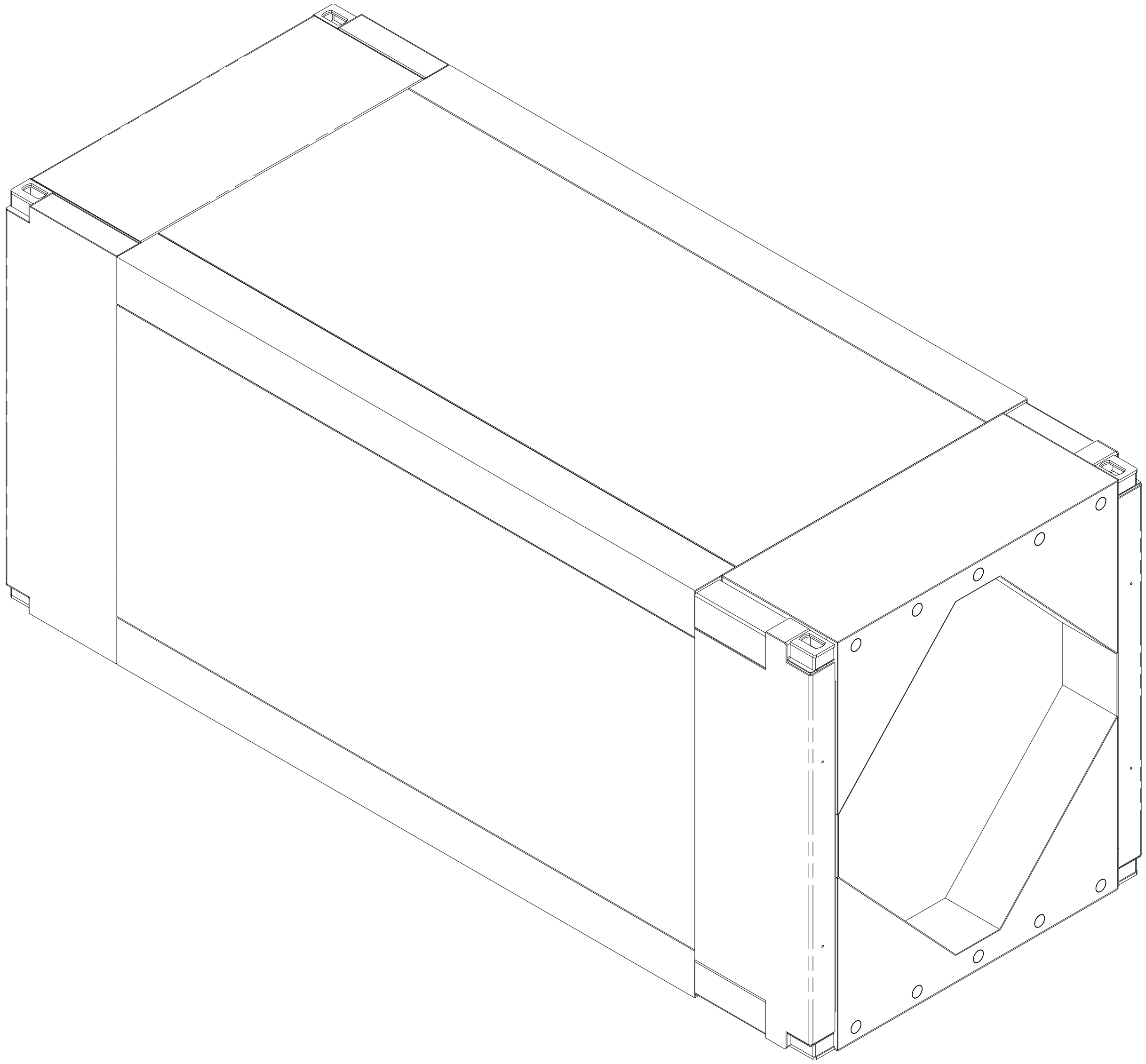


Figure M-19
Typical TRUPACT-III Type B Shipping Container

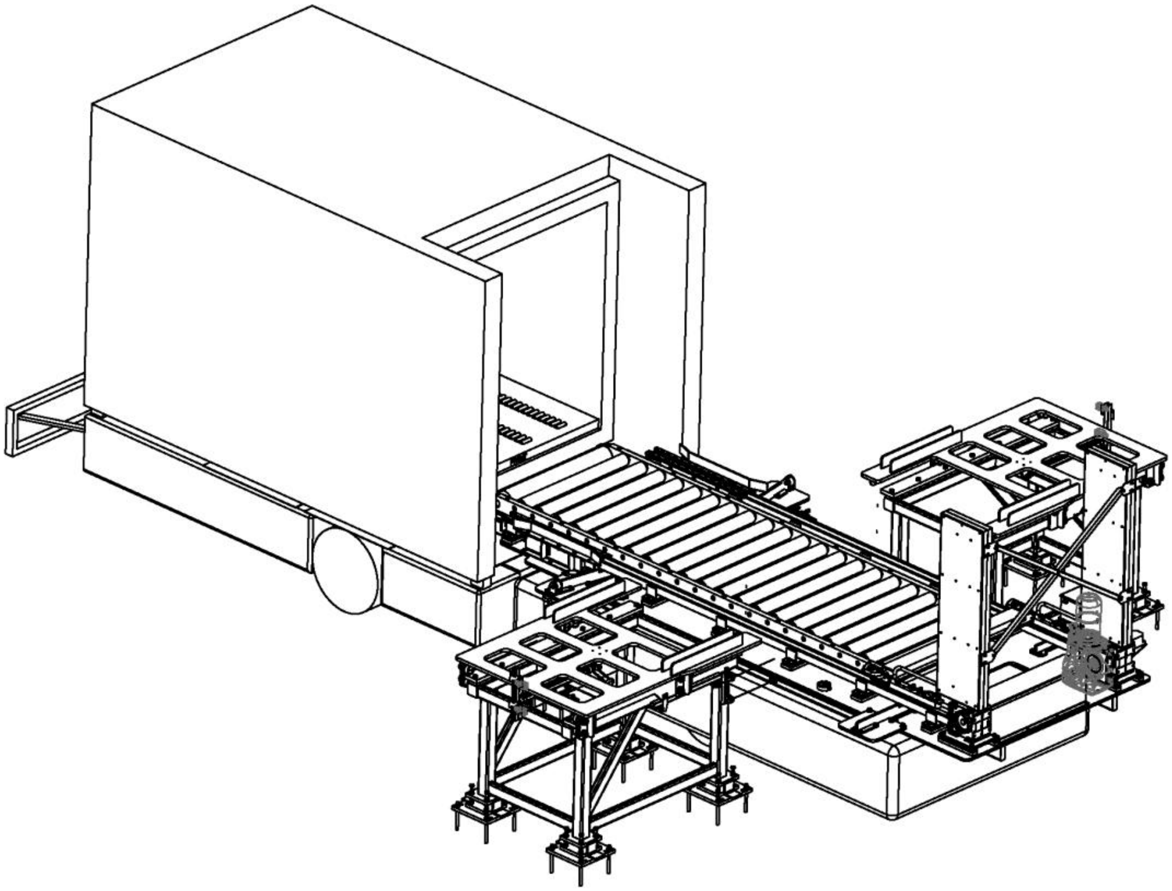


Figure M-20
Payload Transfer Station

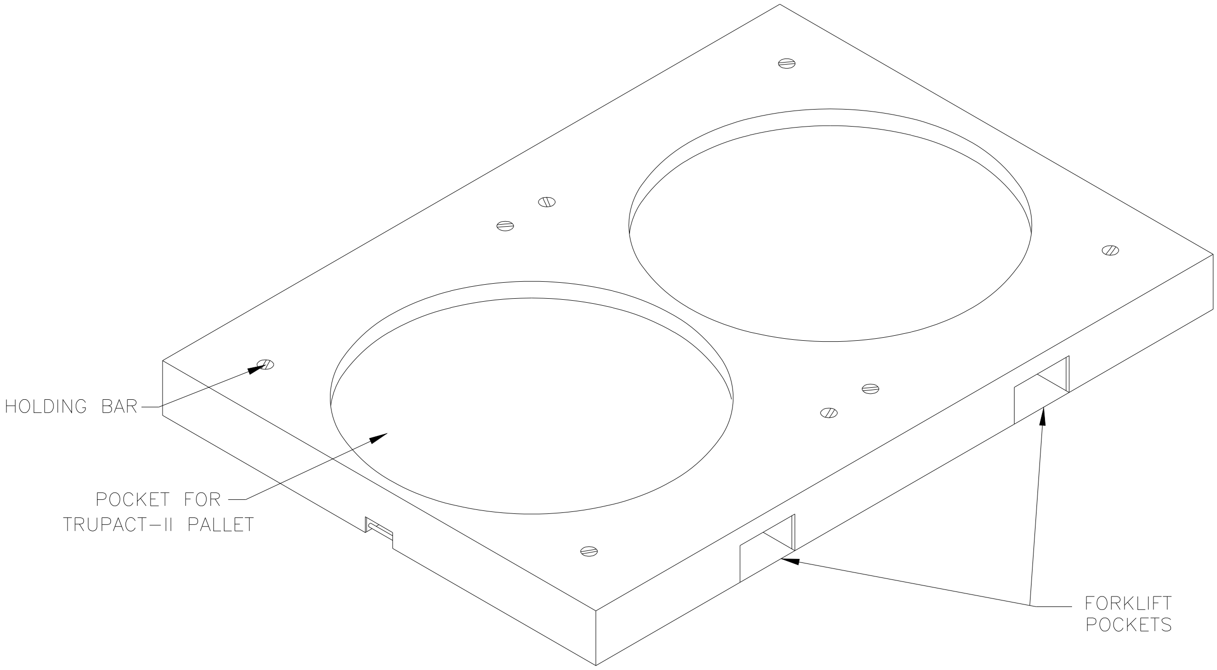


Figure M-21
Facility Pallet

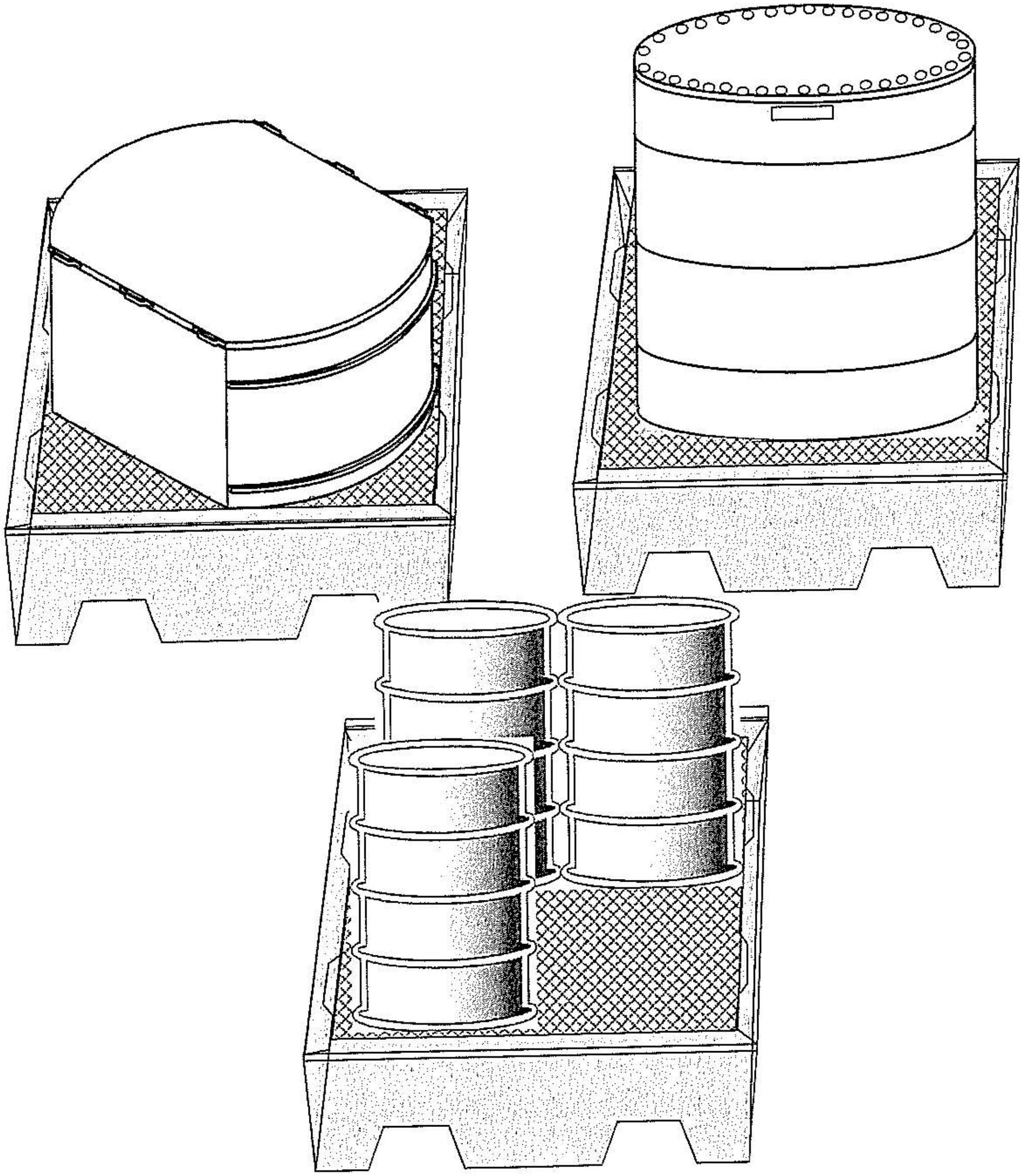


Figure M-22
Typical Containment Pallet

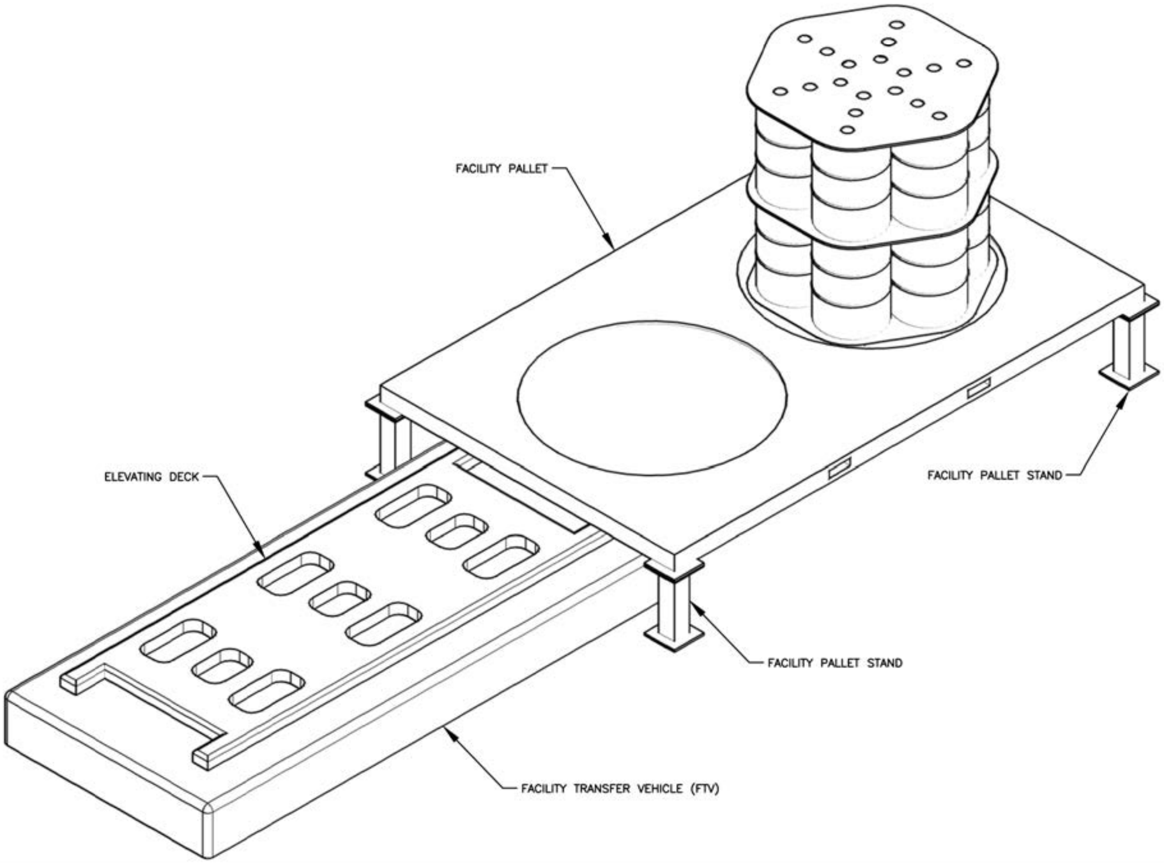


Figure M-23
Facility Transfer Vehicle, Facility Pallet, and Typical Pallet Stand

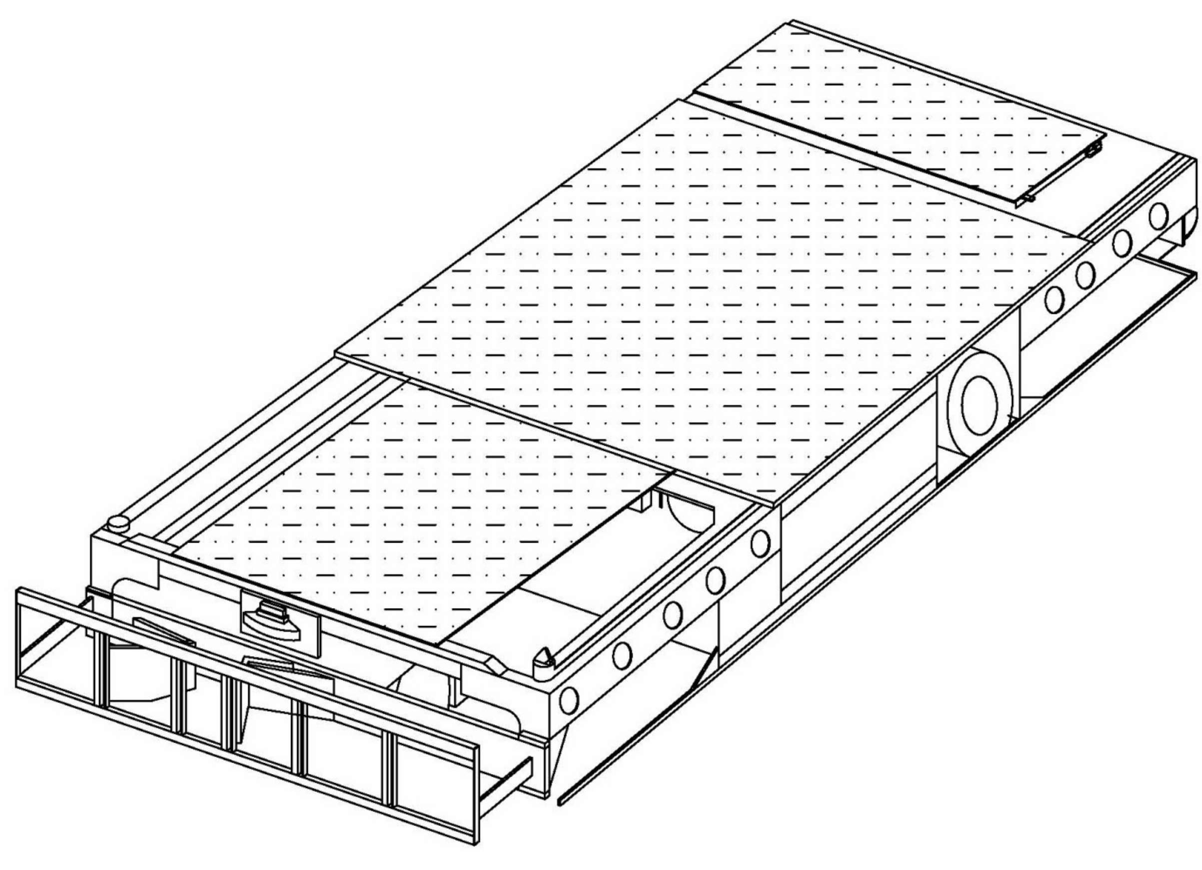


Figure M-24
Typical Yard Transfer Vehicle

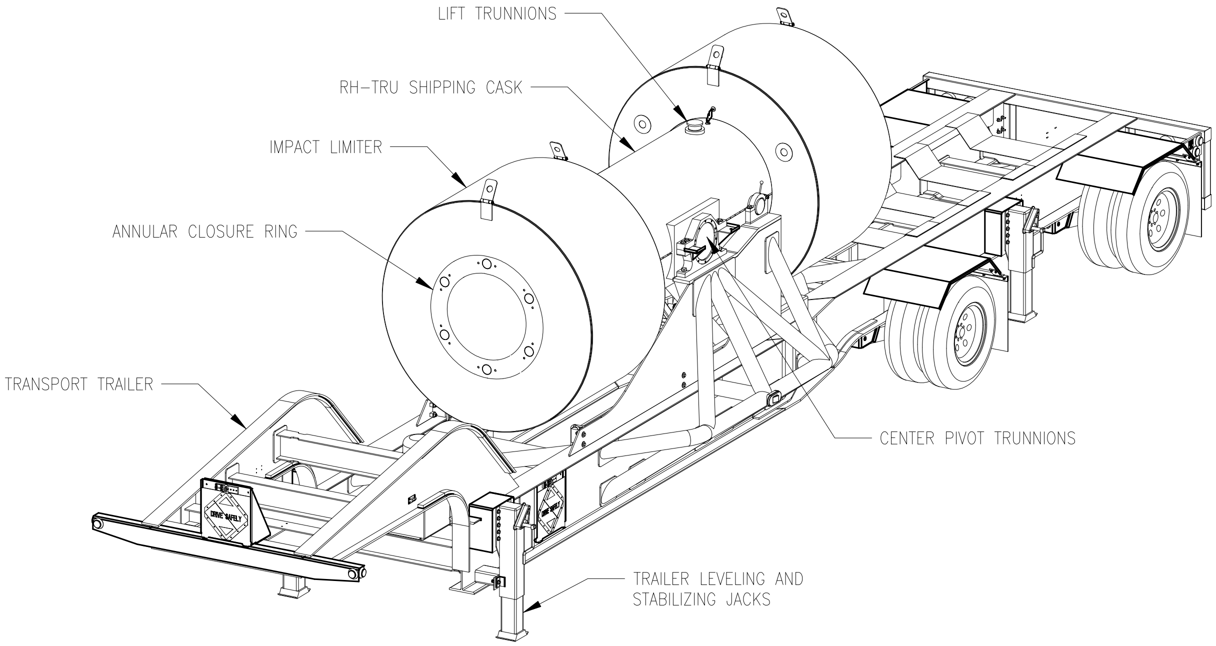


Figure M-25
RH TRU 72-B Shipping Cask on Trailer

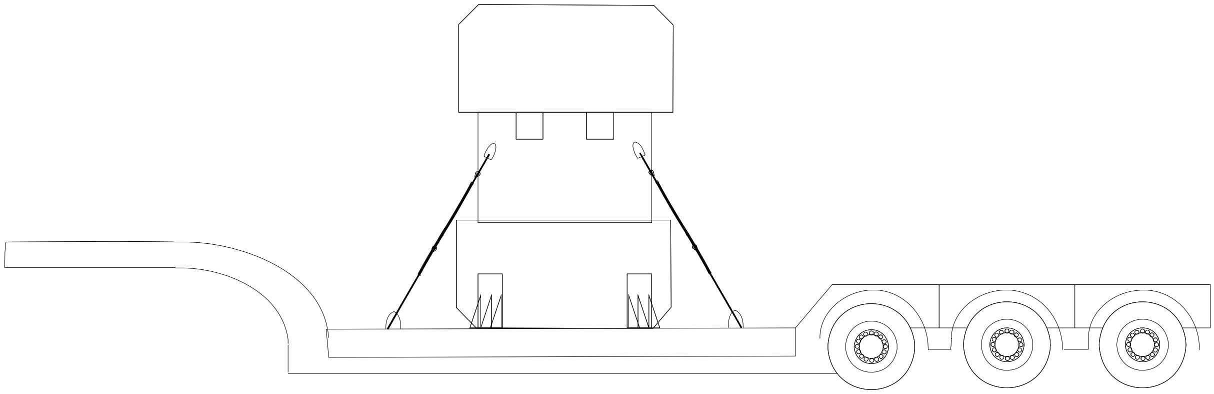


Figure M-26
CNS 10-160B Shipping Cask on Trailer

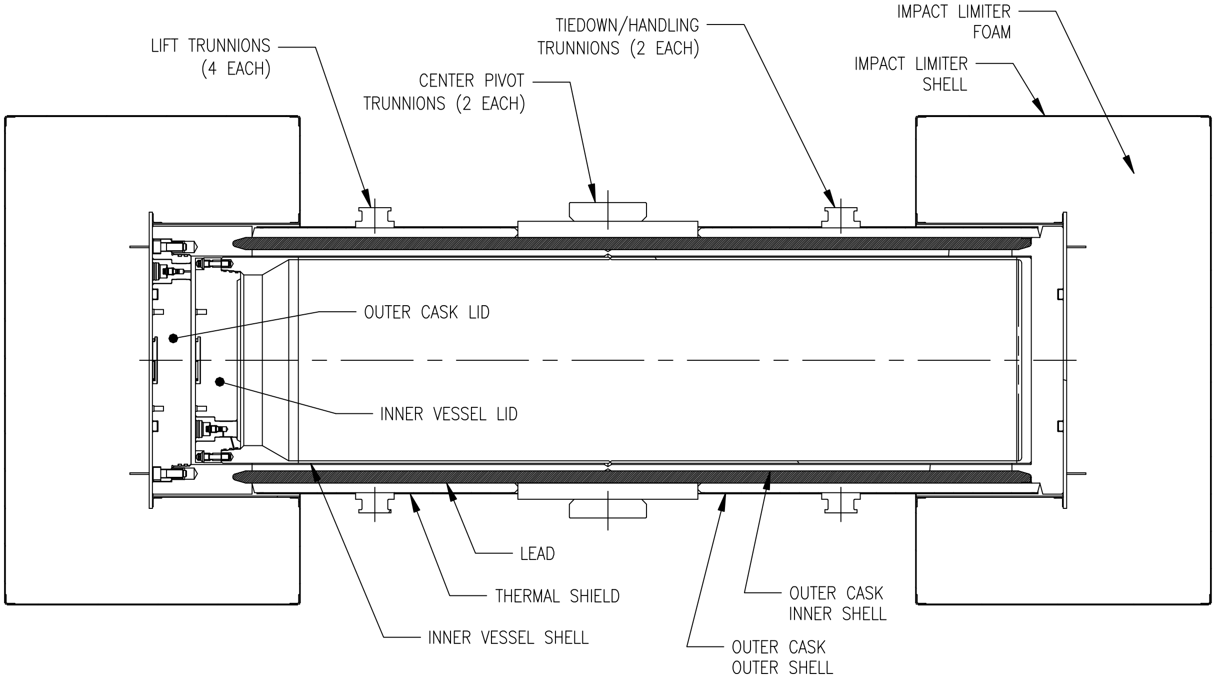


Figure M-27
RH-TRU 72-B Type B Shipping Cask

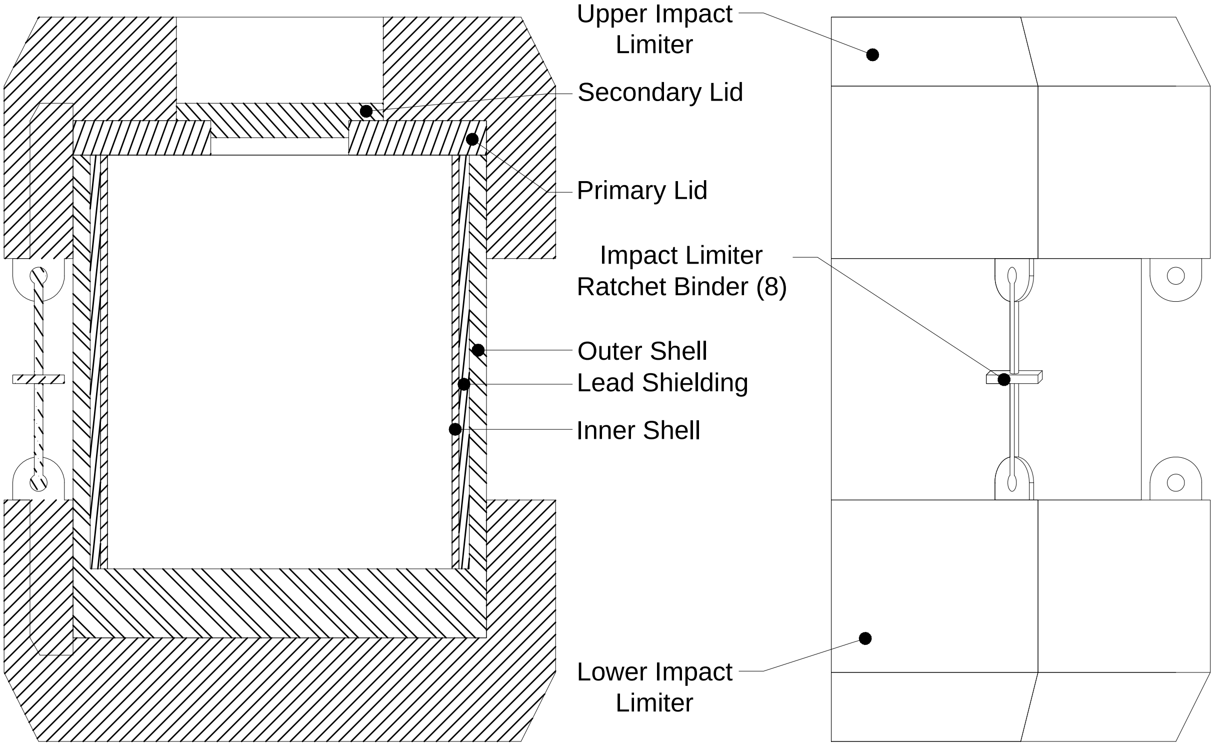


Figure M-28
CNS 10-160B Type B Shipping Cask

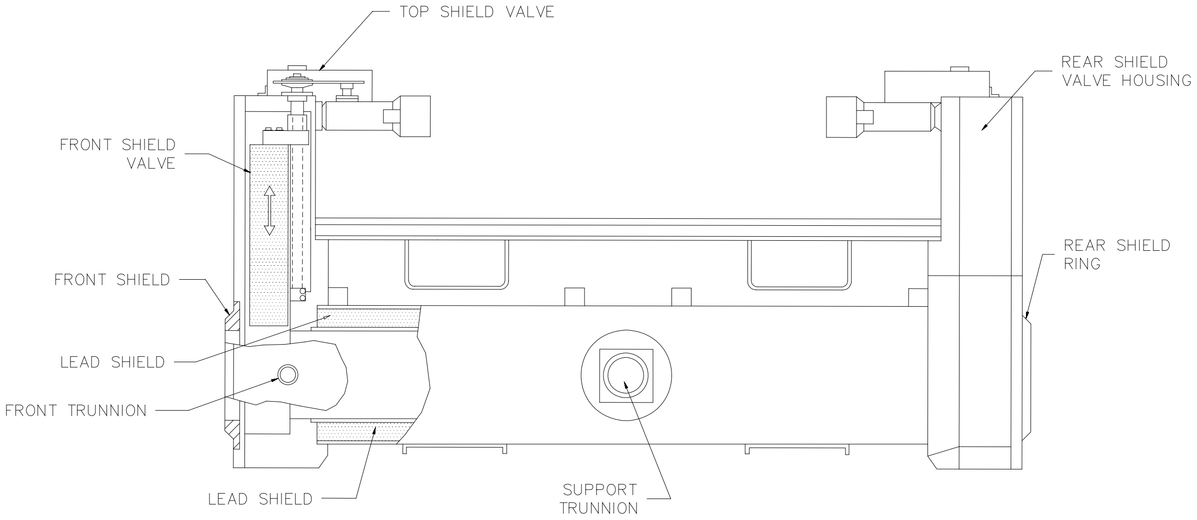


Figure M-29
RH Transuranic Waste Facility Cask and Light Weight Facility Cask

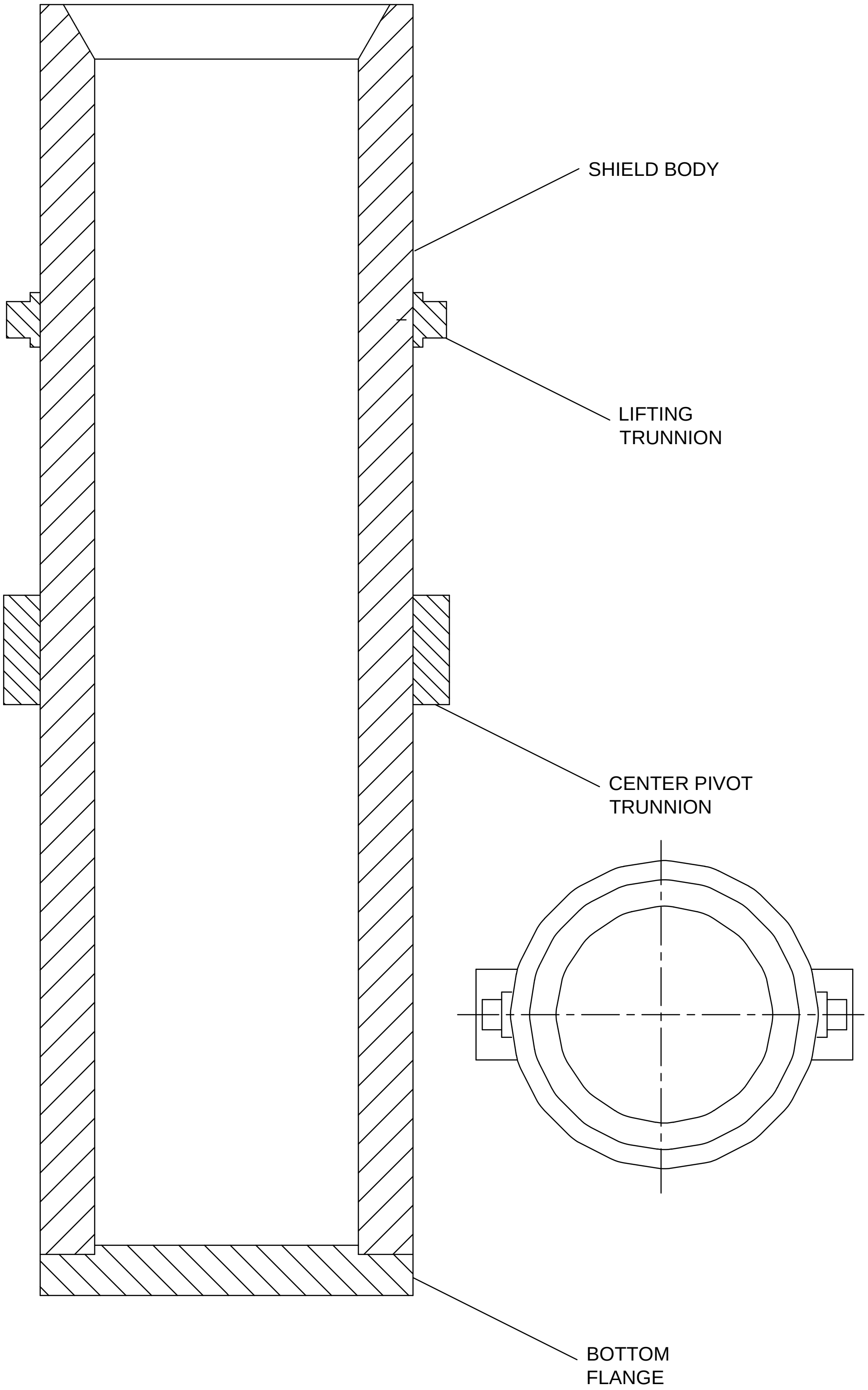


Figure M-30
RH Shielded Insert Assembly

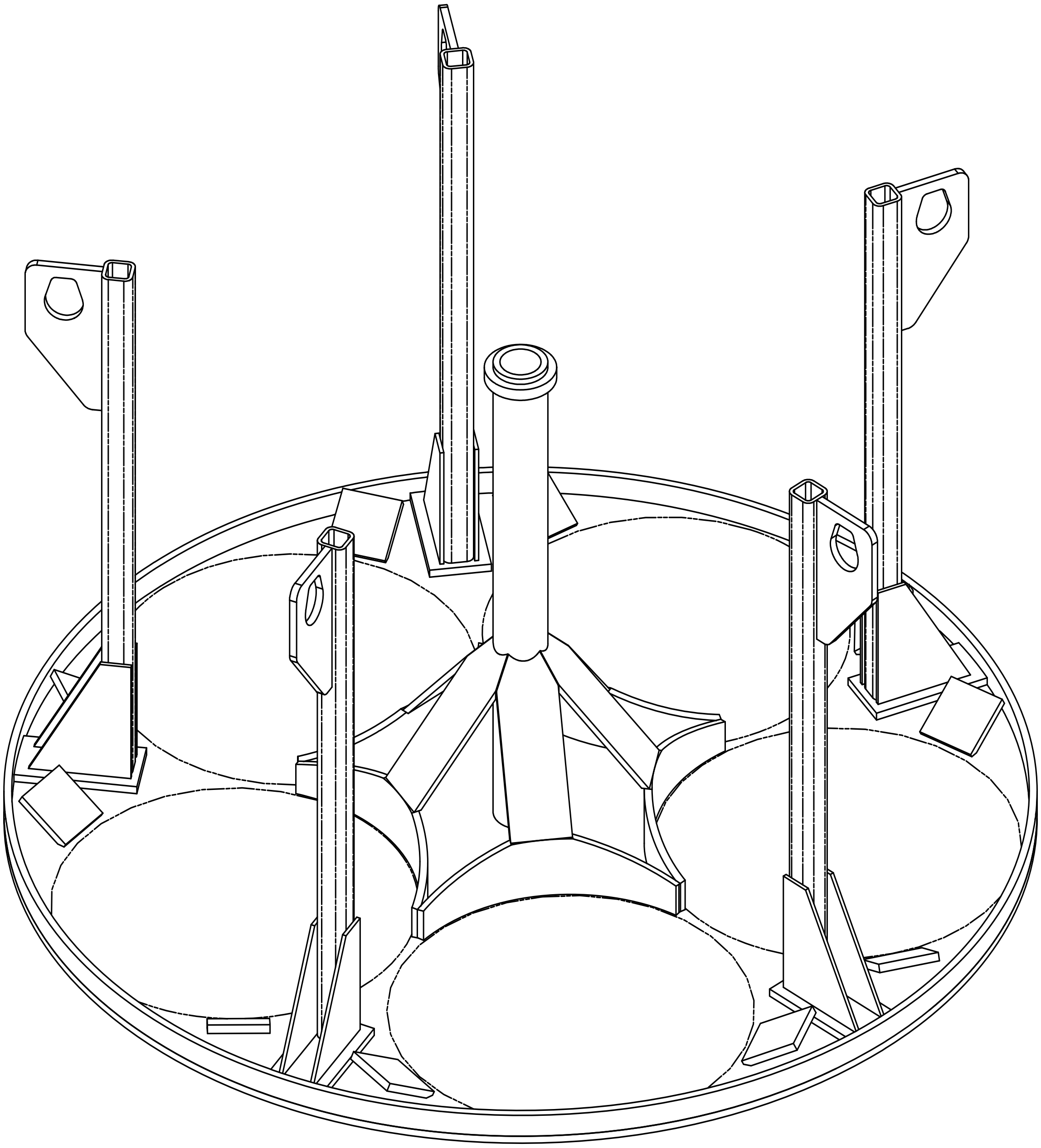


Figure M-31
CNS 10-160B Drum Carriage

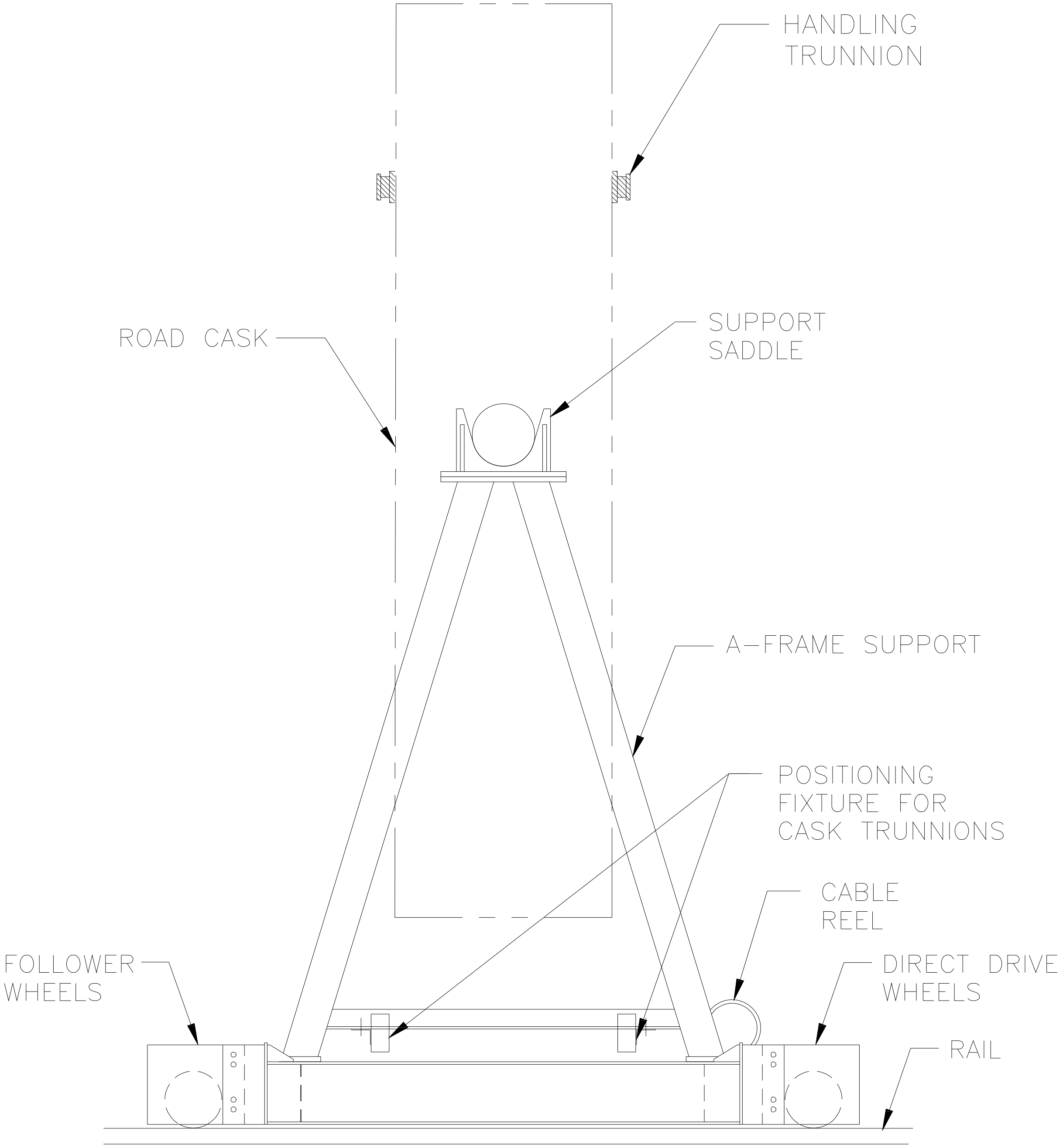


Figure M-32
RH-TRU 72-B Cask Transfer Car

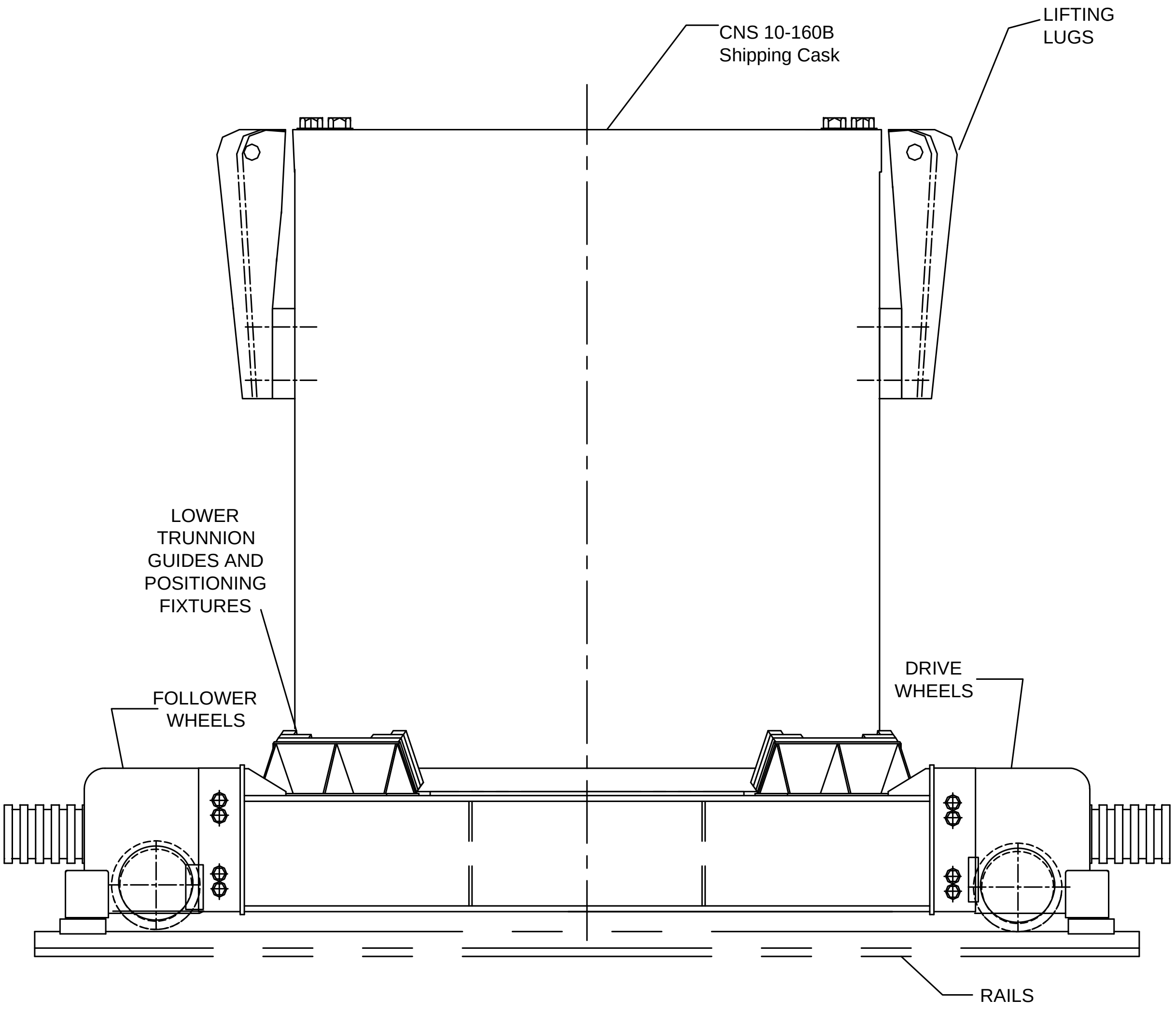


Figure M-33
CNS 10-160B Cask Transfer Car

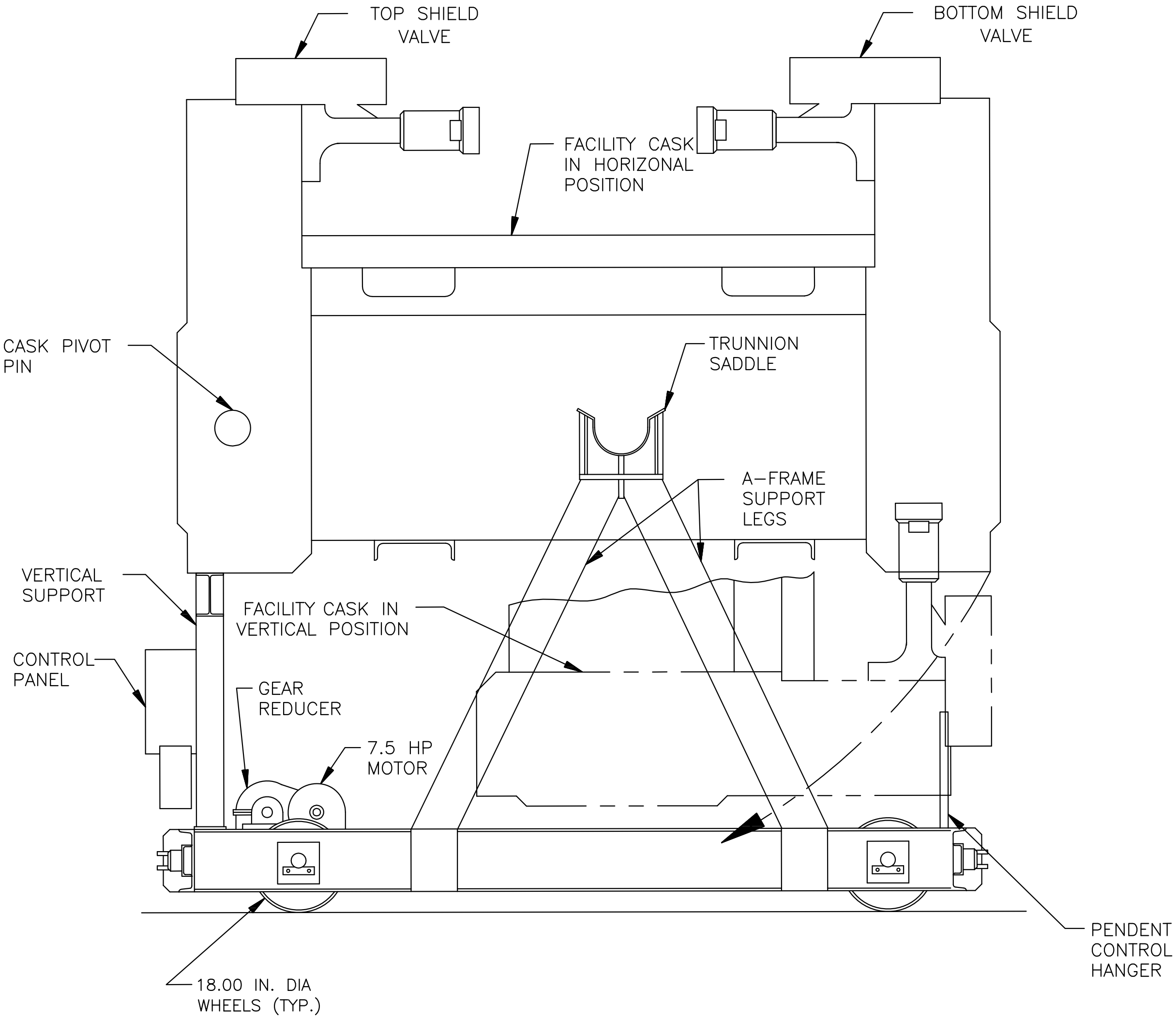


Figure M-34
RH Facility Cask Transfer Car (Side View)

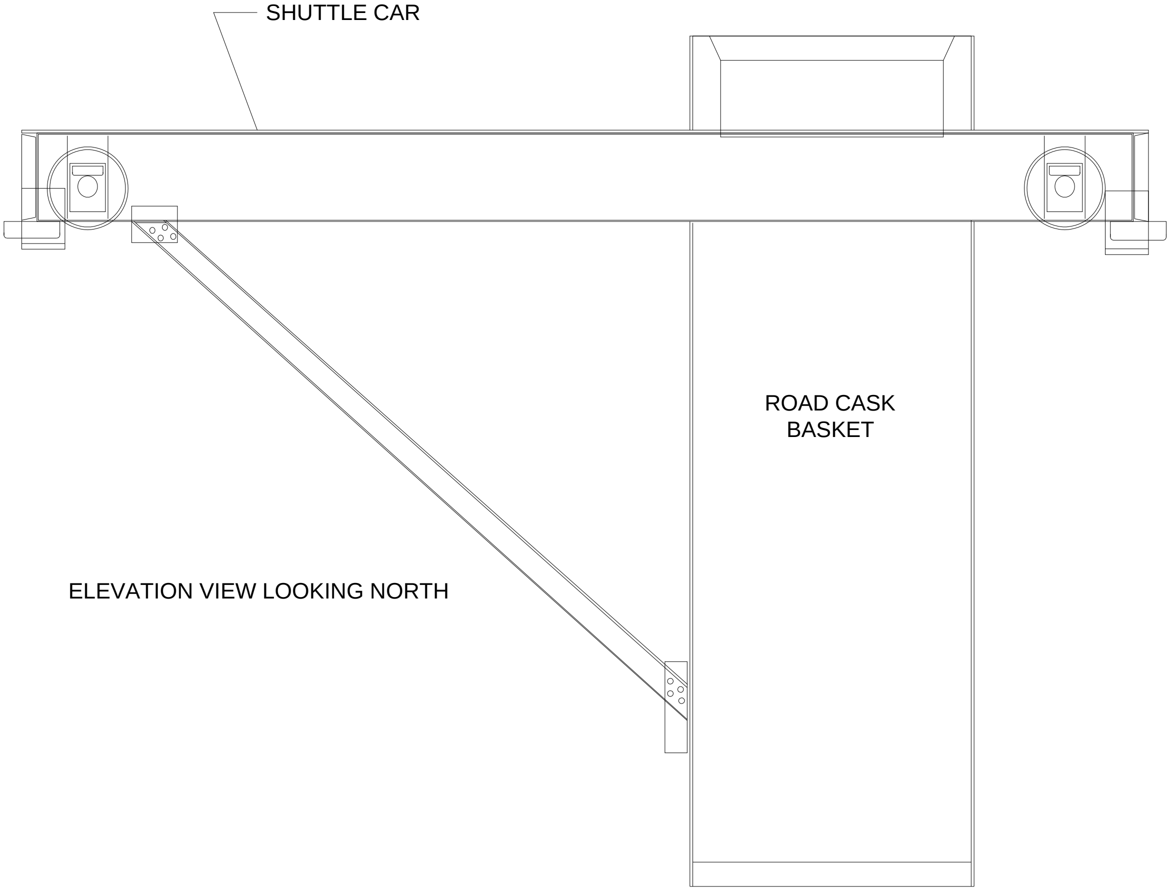
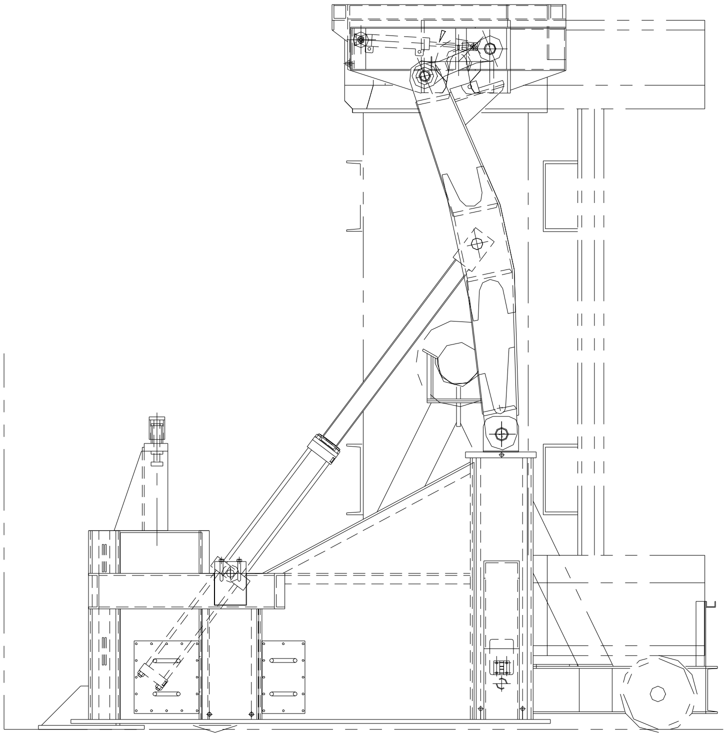
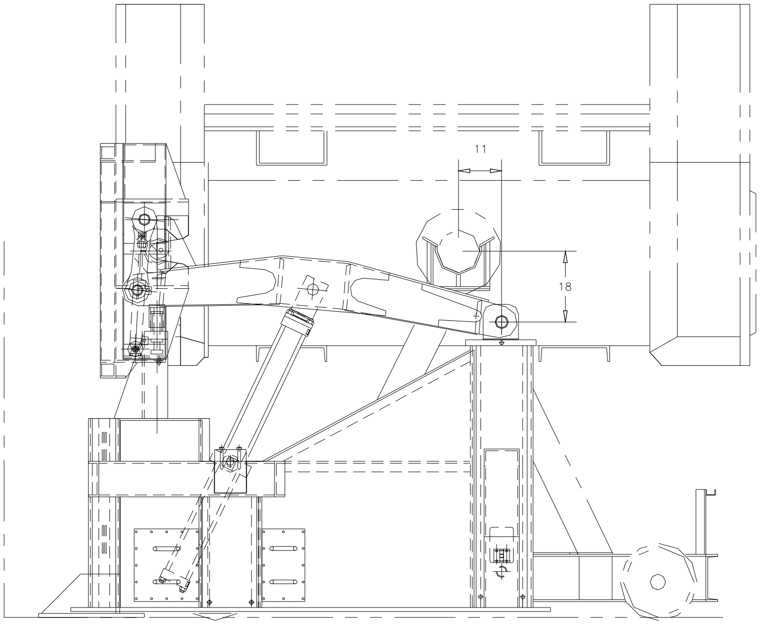


Figure M-35
Transfer Cell Shuttle Car



FRONT ELEVATION
CASK VERTICAL



FRONT ELEVATION
CASK HORIZONTAL

Figure M-36
Facility Cask Rotating Device

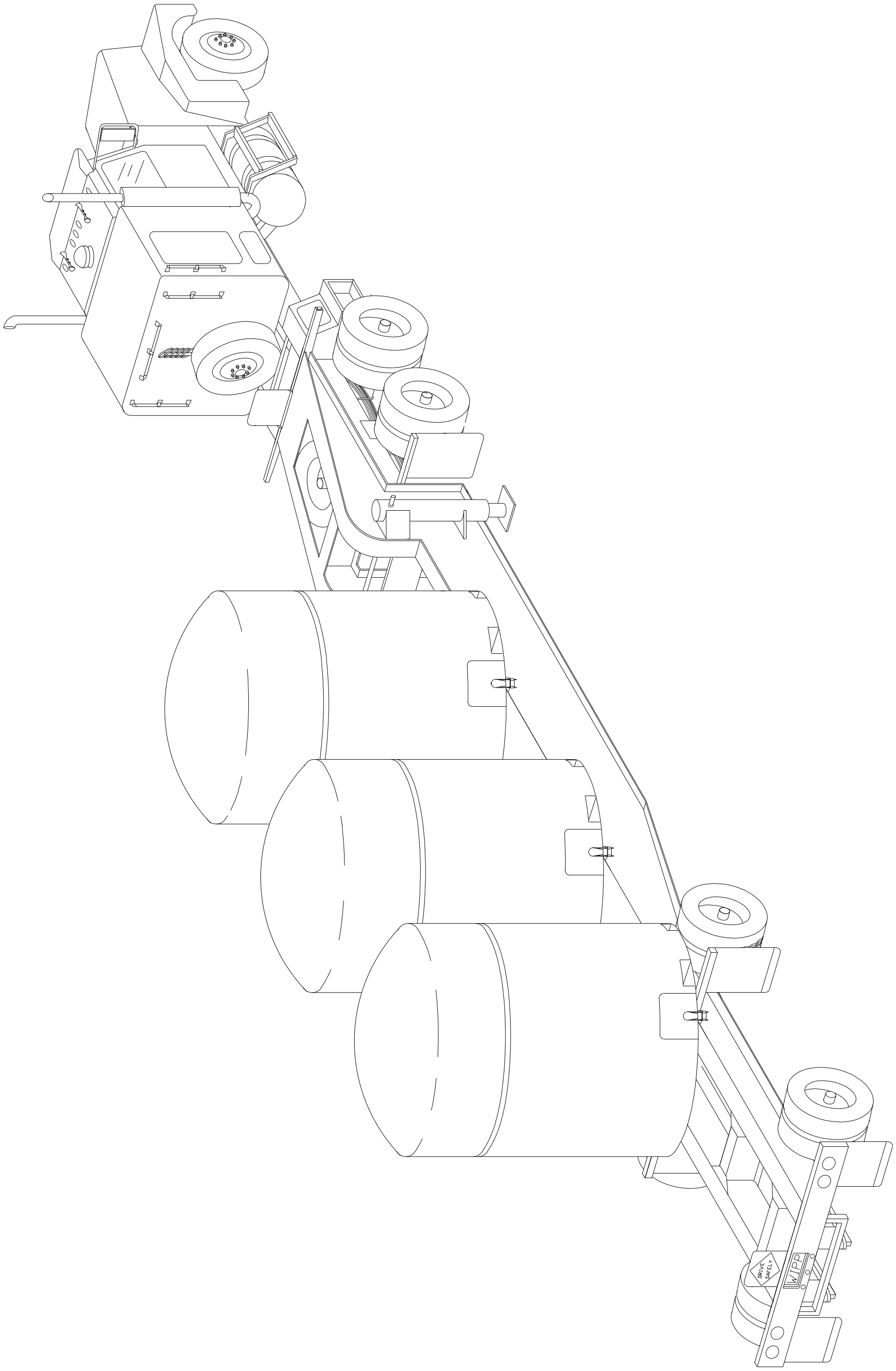


Figure M-37
TRUPACT-II Containers on Trailer

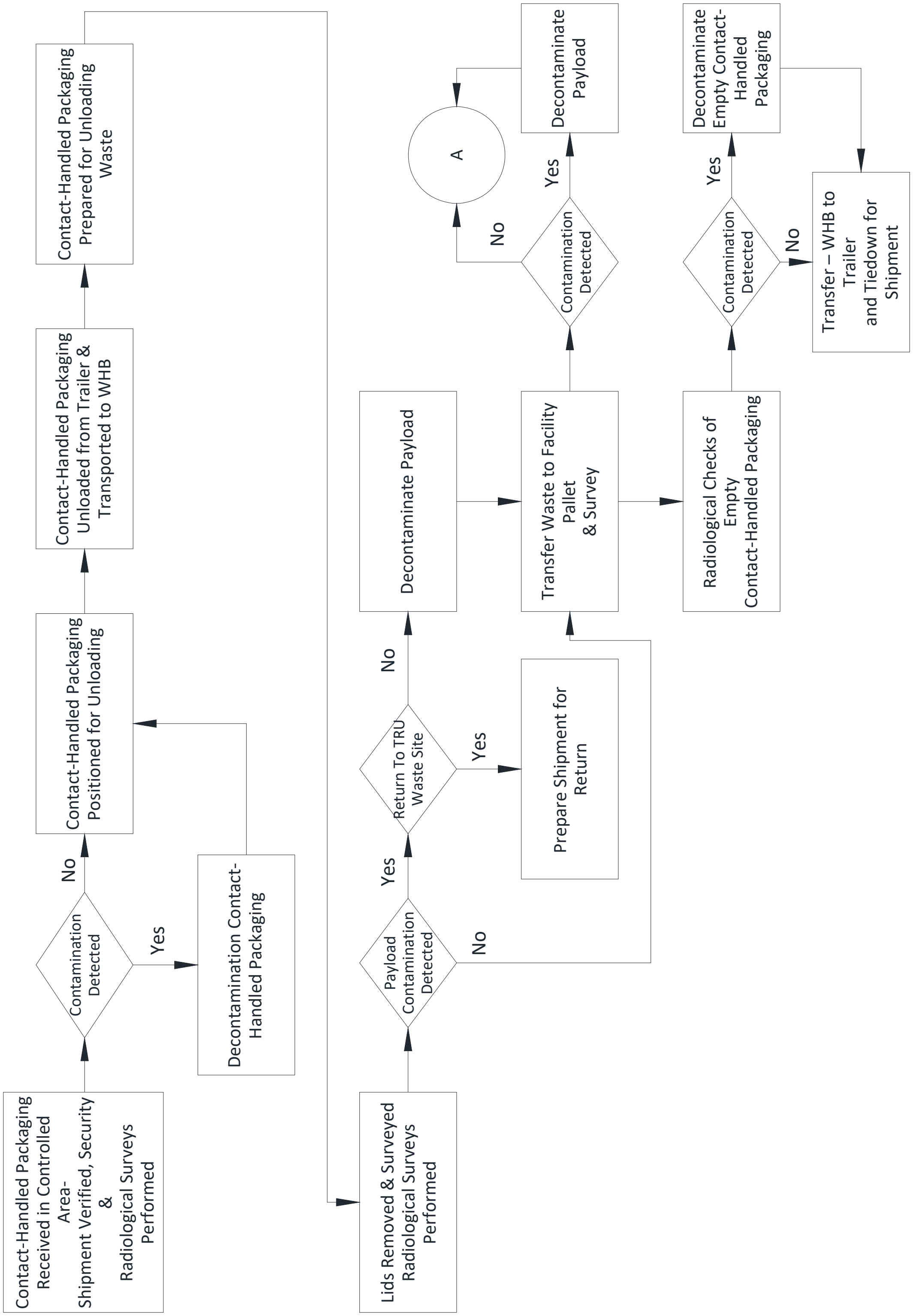


Figure M-38
WIPP Facility Surface and Underground CH Transuranic Mixed Waste Process Flow Diagram

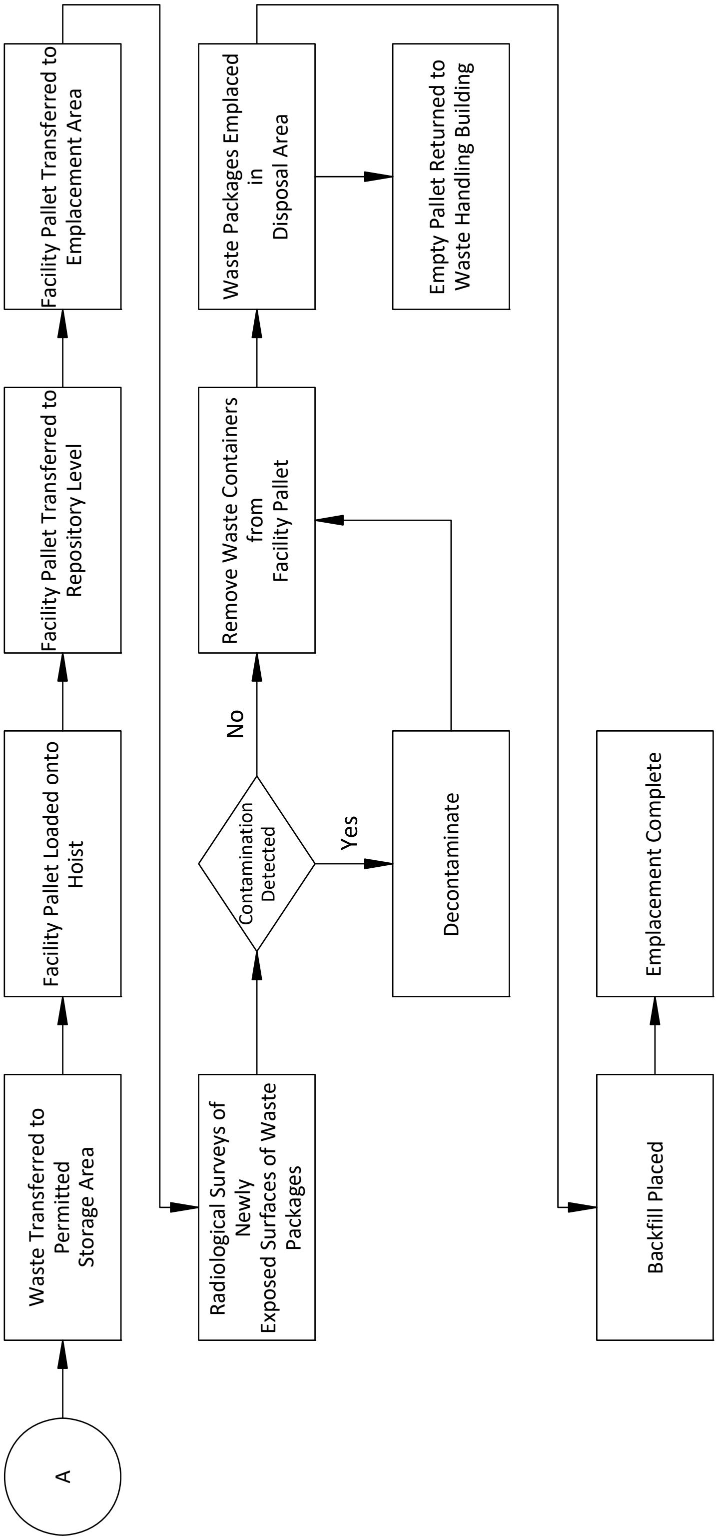
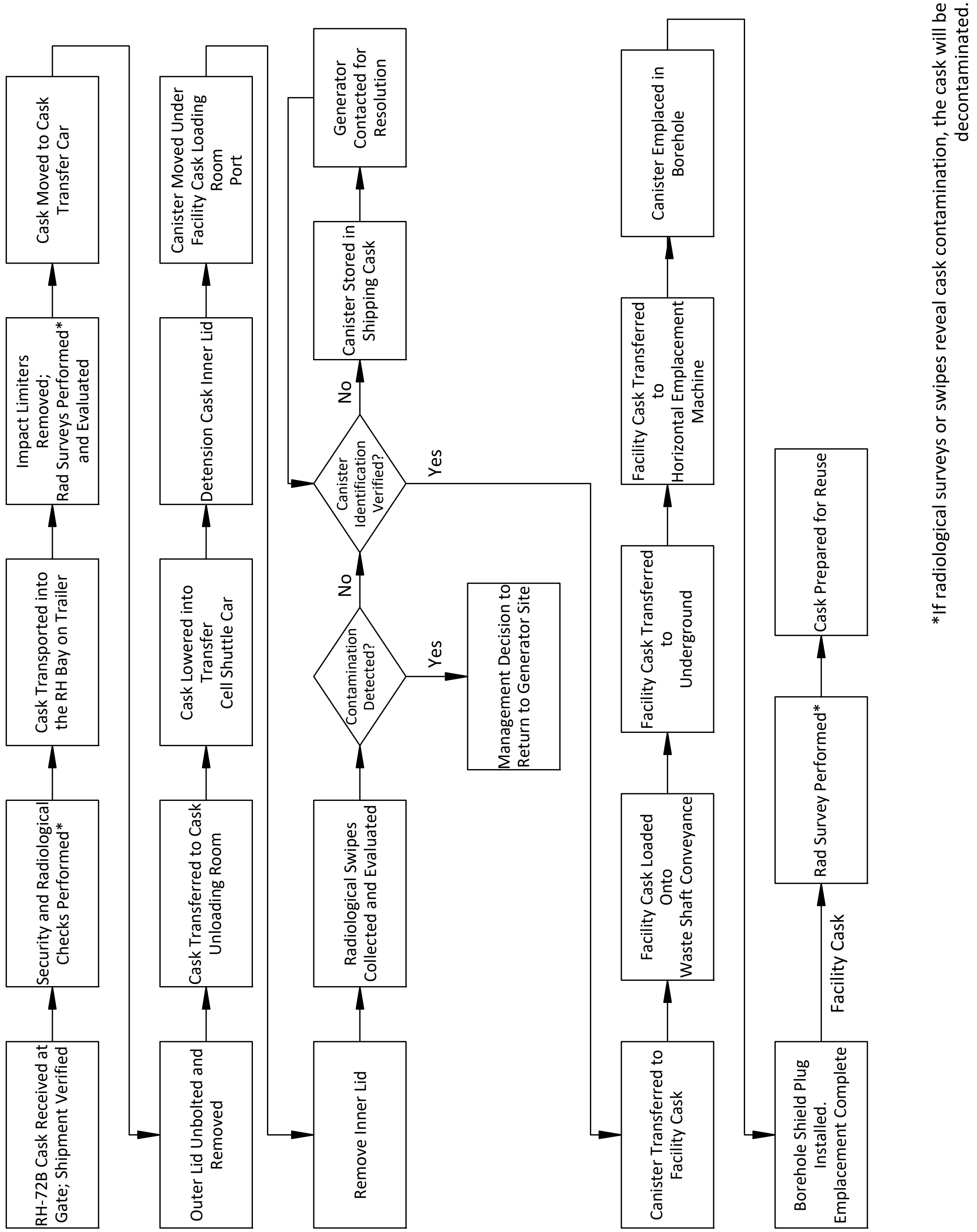
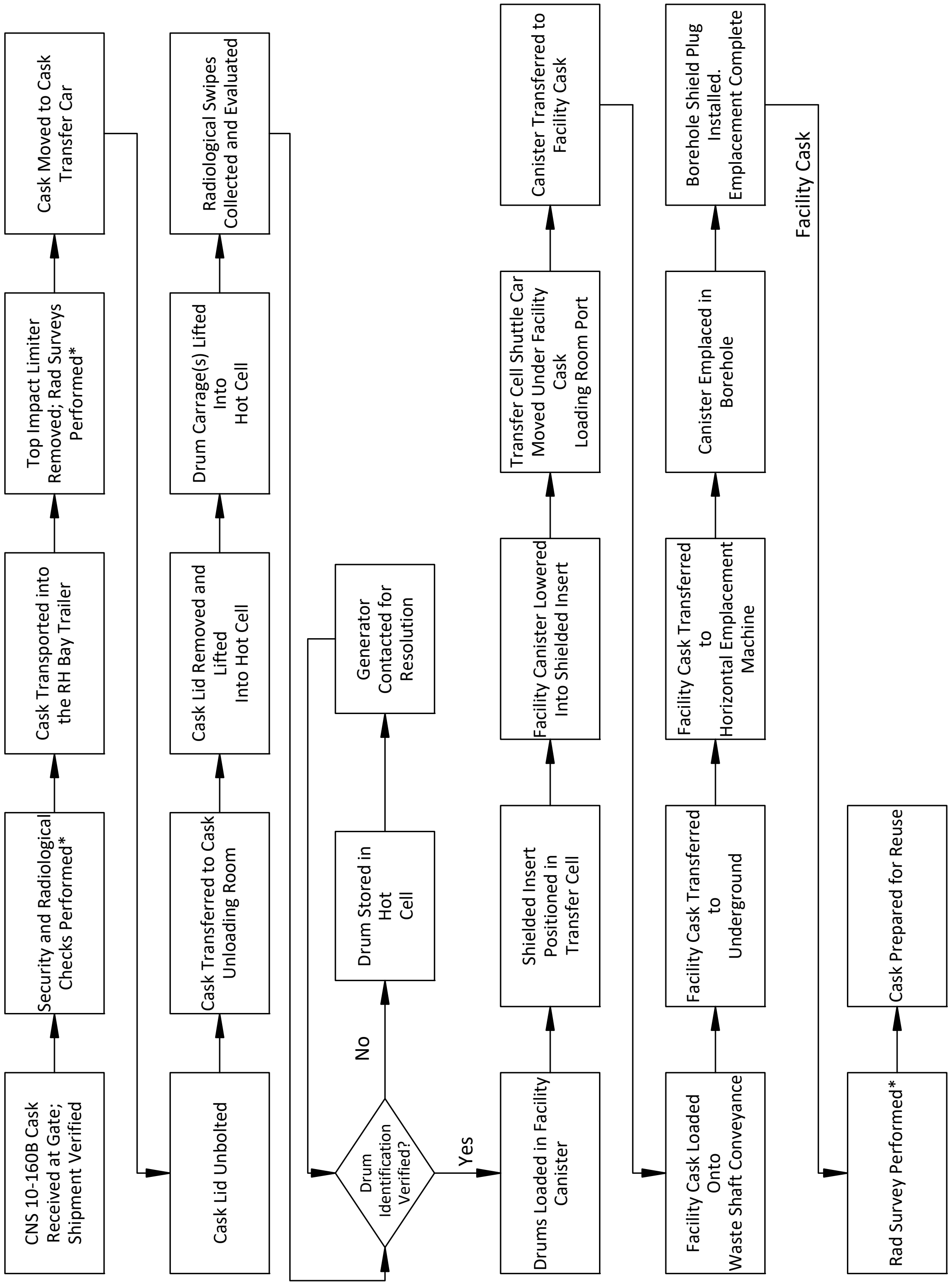


Figure M-39
WIPP Facility Surface and Underground CH Transuranic Mixed Waste Process Flow Diagram (Continued)



*If radiological surveys or swipes reveal cask contamination, the cask will be decontaminated.

Figure M-40
Surface and Underground RH Transuranic Mixed Waste Process Flow Diagram for RH-TRU 72-B Shipping Cask



*If radiological surveys or swipes reveal cask contamination, the cask will be decontaminated.

Figure M-41
Surface and Underground RH Transuranic Mixed Waste Process Flow Diagram for CNS 10-160B Shipping Cask

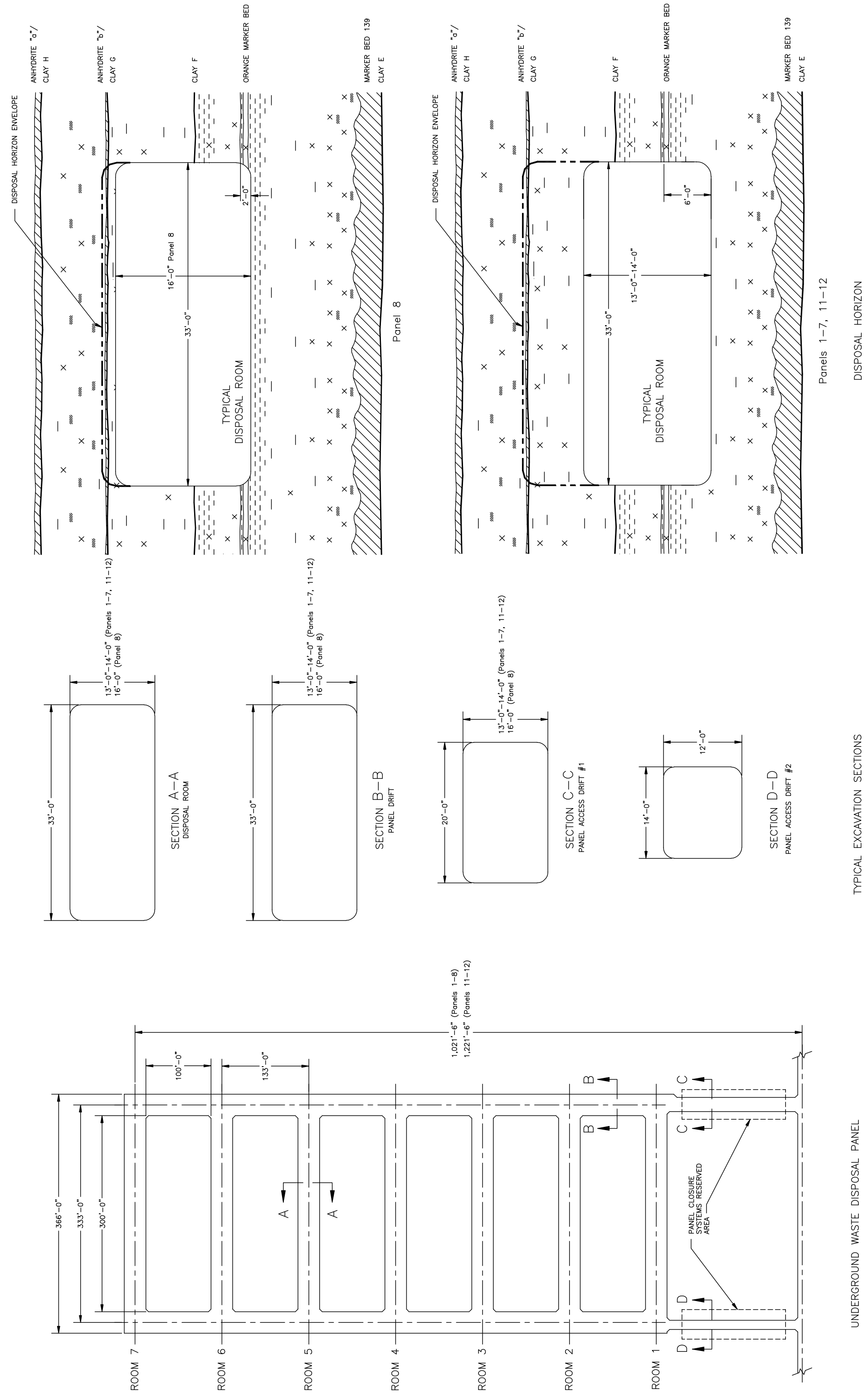
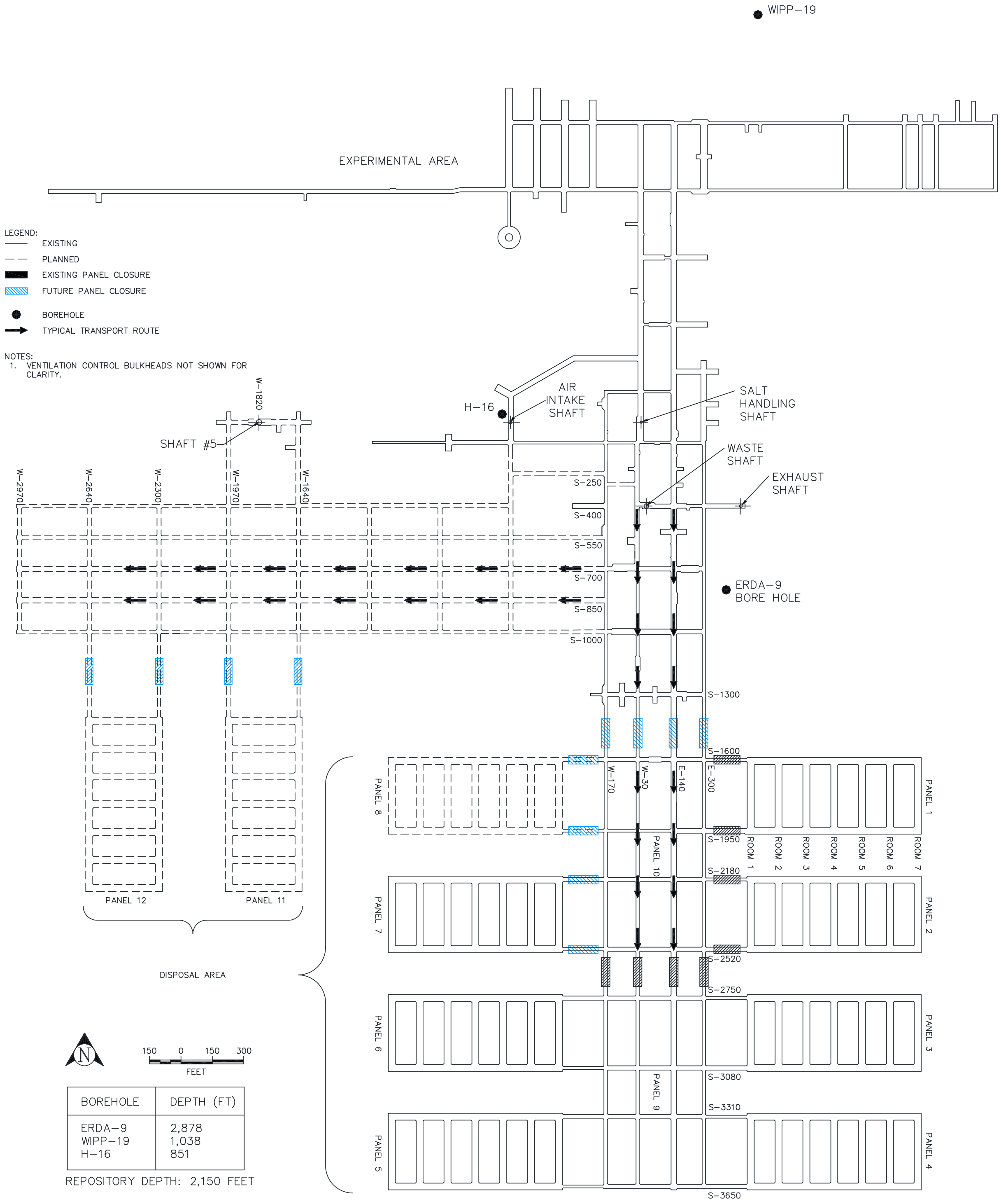


Figure M-42
Typical Disposal Panel



BOREHOLE	DEPTH (FT)
ERDA−9	2,878
WIPP−19	1,038
H−16	851

Figure M-43
Repository Horizon and Underground Waste Transport Routes

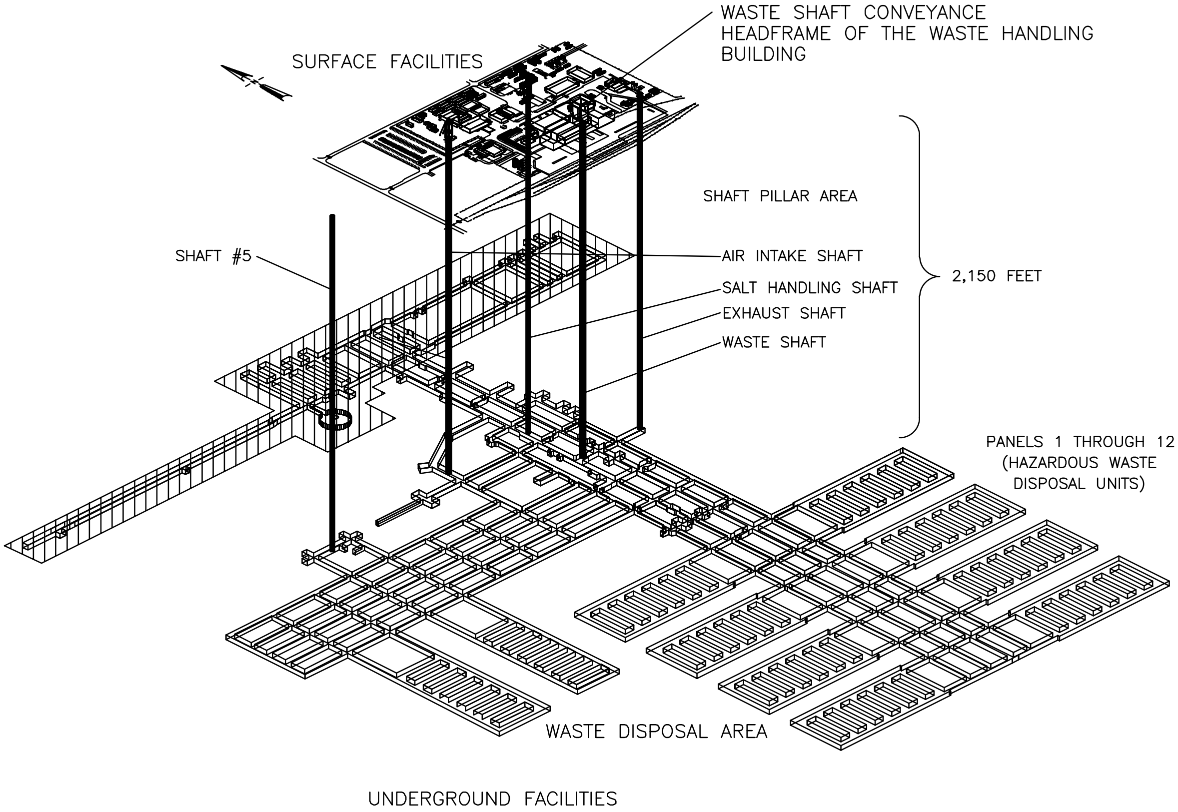


Figure M-44
Spatial View of the Miscellaneous Unit and Waste Handling Facility

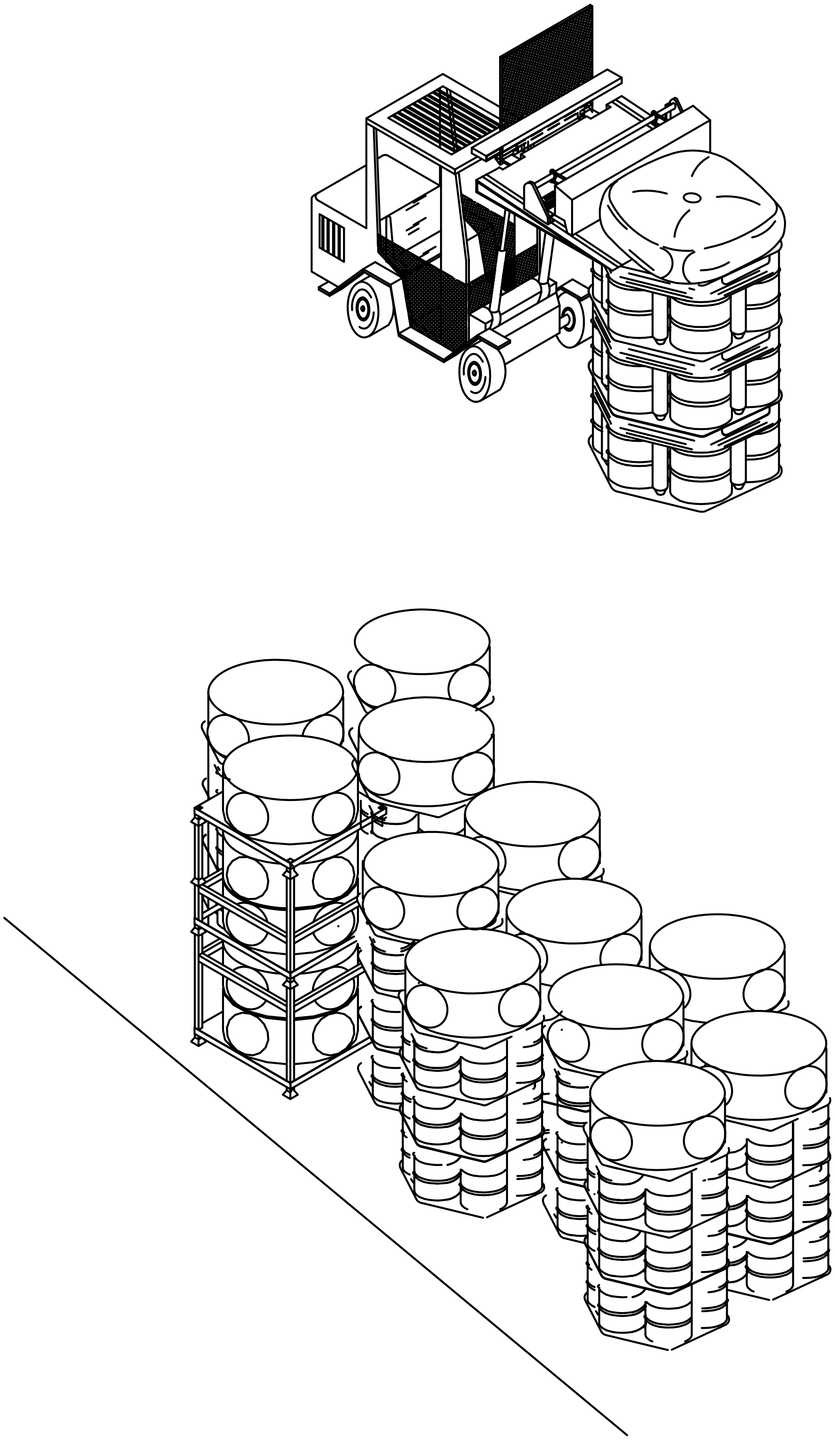


Figure M-45
Typical MgO Backfill Sacks Emplaced on Drum Stacks and Emplacement Configurations

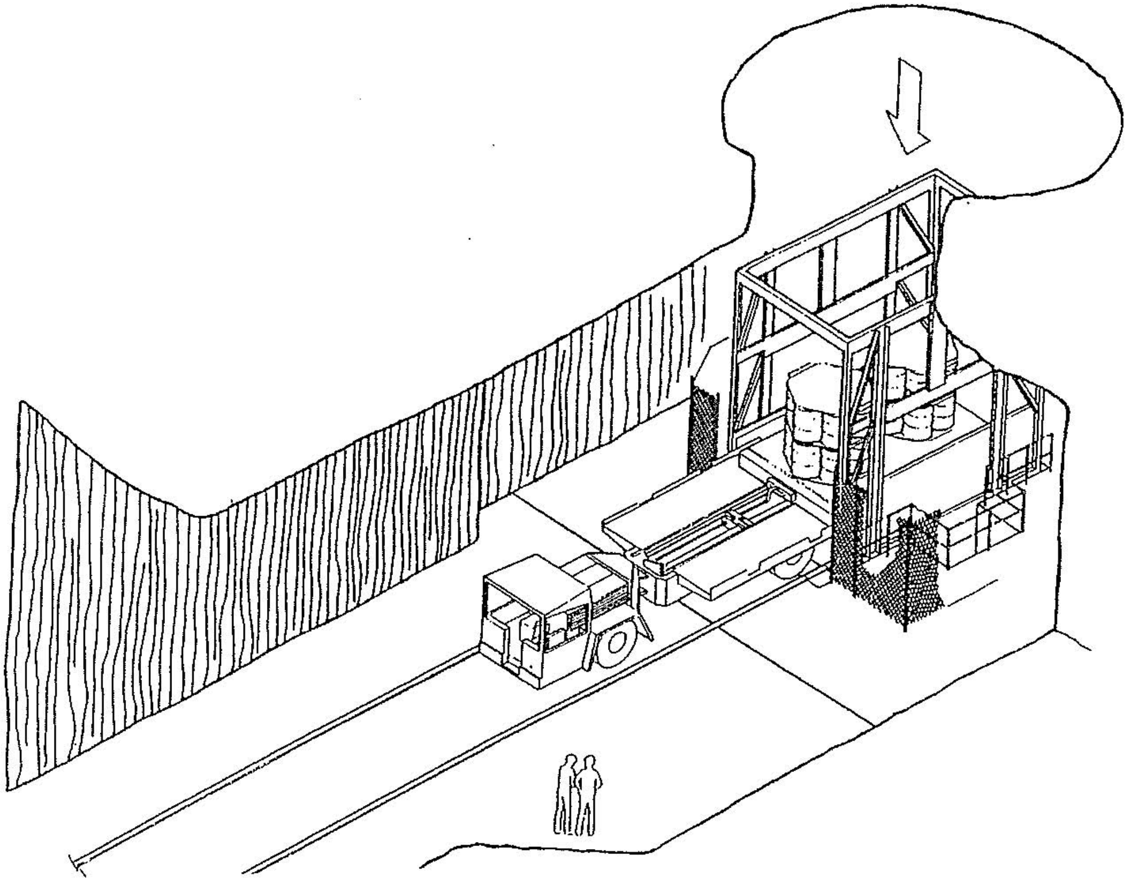
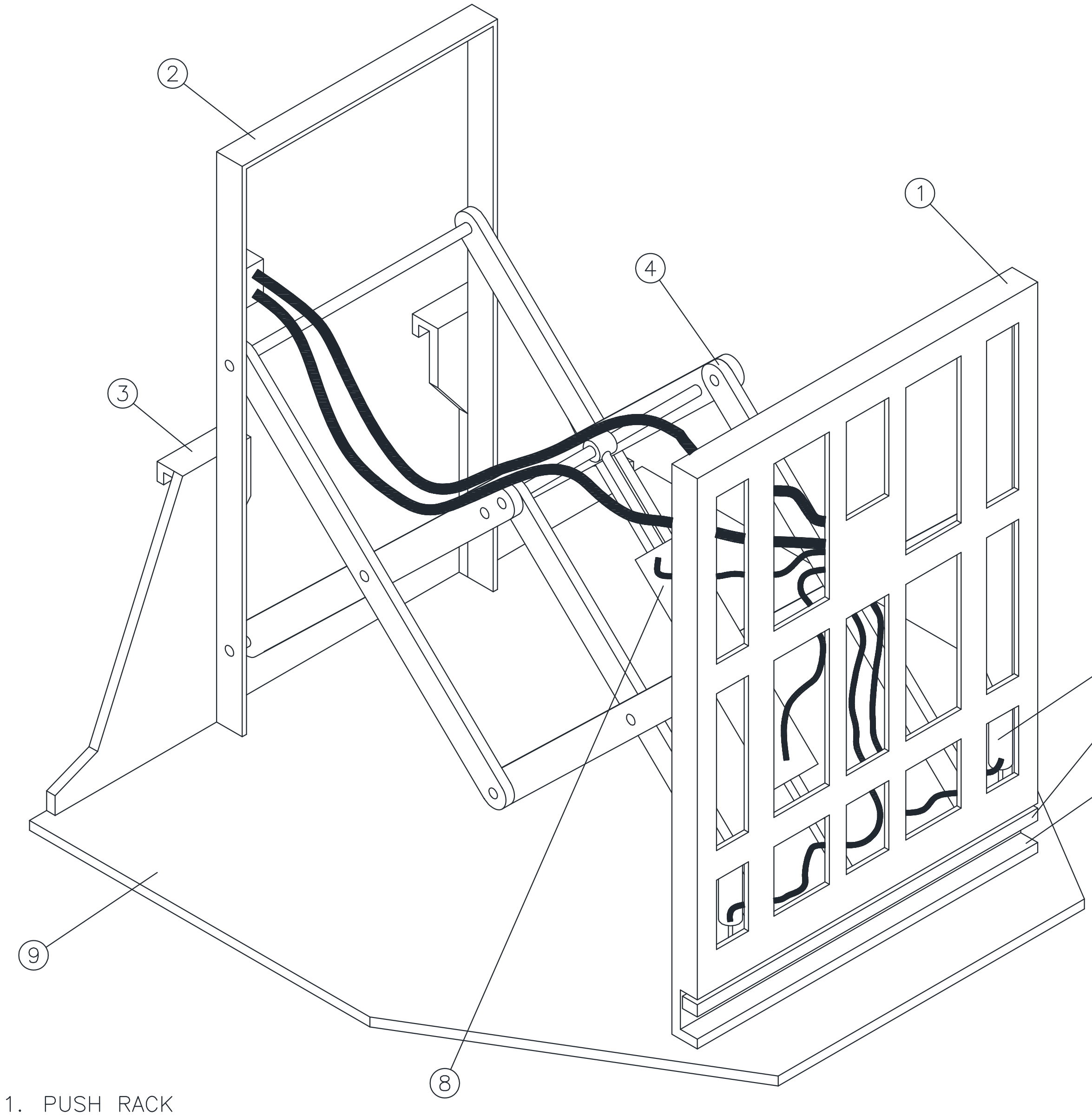
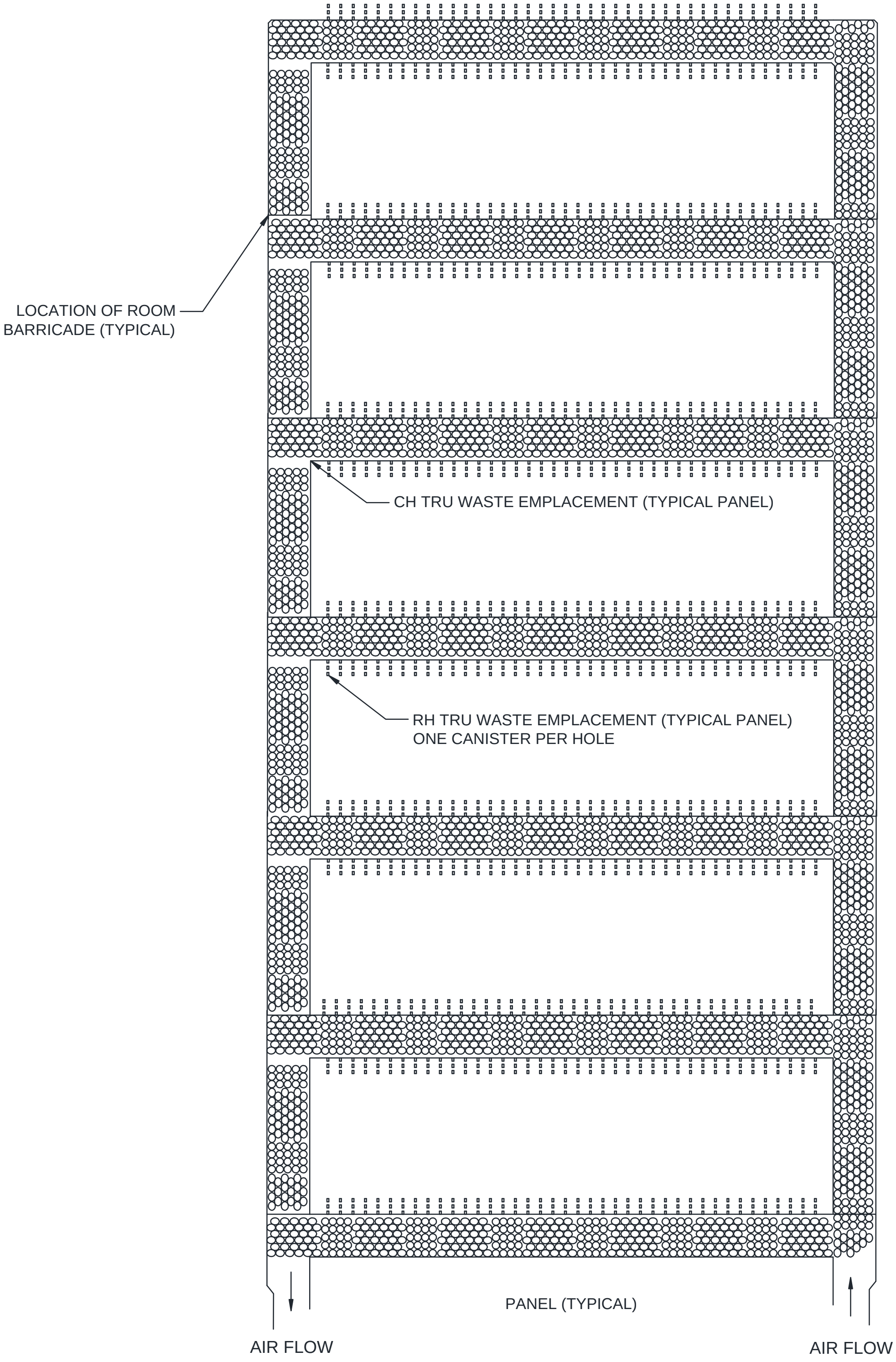


Figure M-46
Waste Transfer Cage to Transporter



1. PUSH RACK
2. BASE ASSEMBLY
3. UPPER RETAINER
4. LINKAGE ASSEMBLY
5. GRIPPER CYLINDER
6. GRIPPER BAR
7. GRIPPER JAW
8. PUSH CYLINDER
9 PLATFN

Figure M-47
Push-Pull Attachment to Forklift to Allow Handling of Waste Containers



NOTE: MgO will be emplaced as necessary

Figure M-48
Typical RH and CH TRU Mixed Waste Container Disposal Configuration

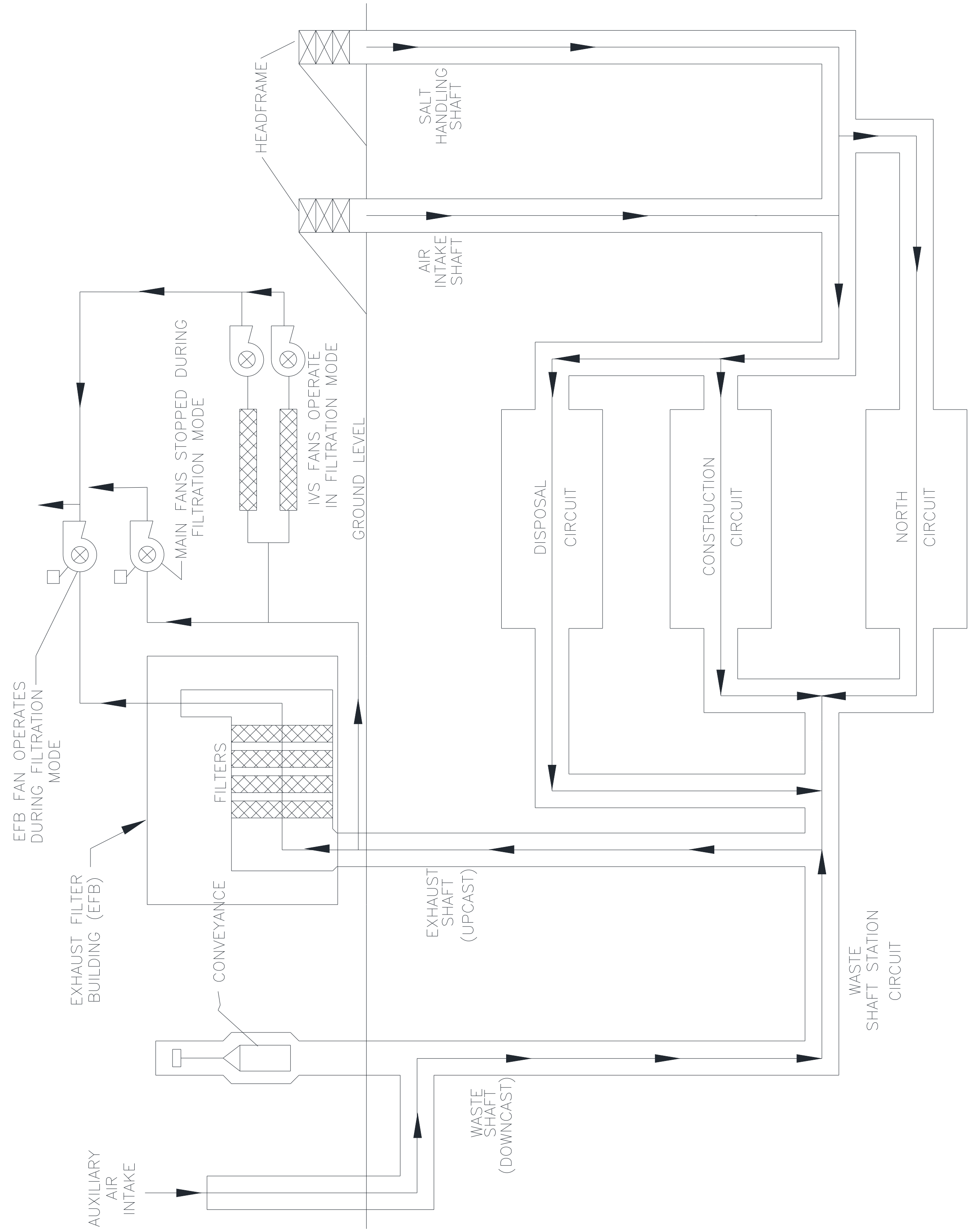


Figure M-49
Underground Ventilation System Airflow

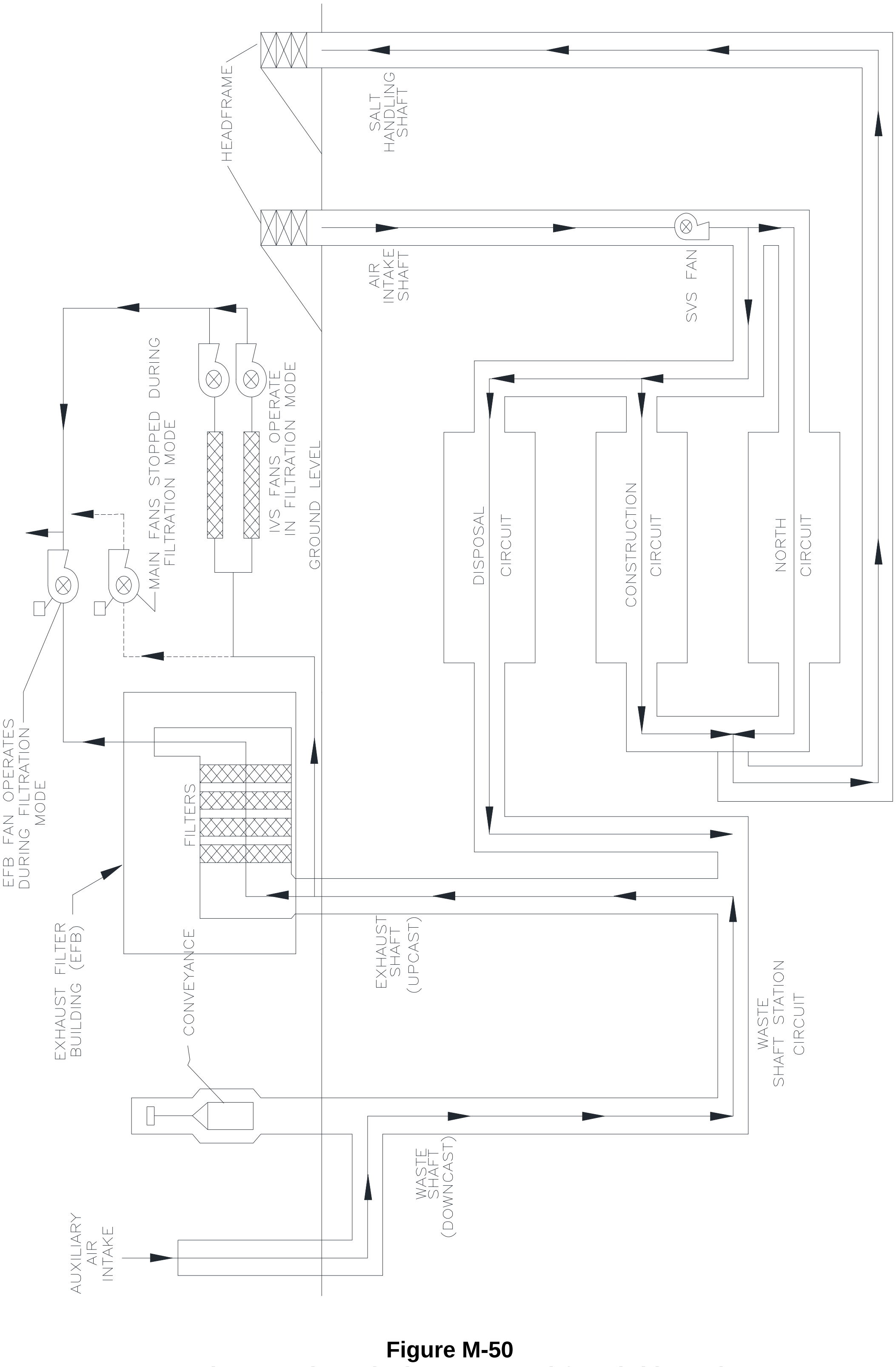


Figure M-50
Underground Ventilation System Airflow (with SVS)

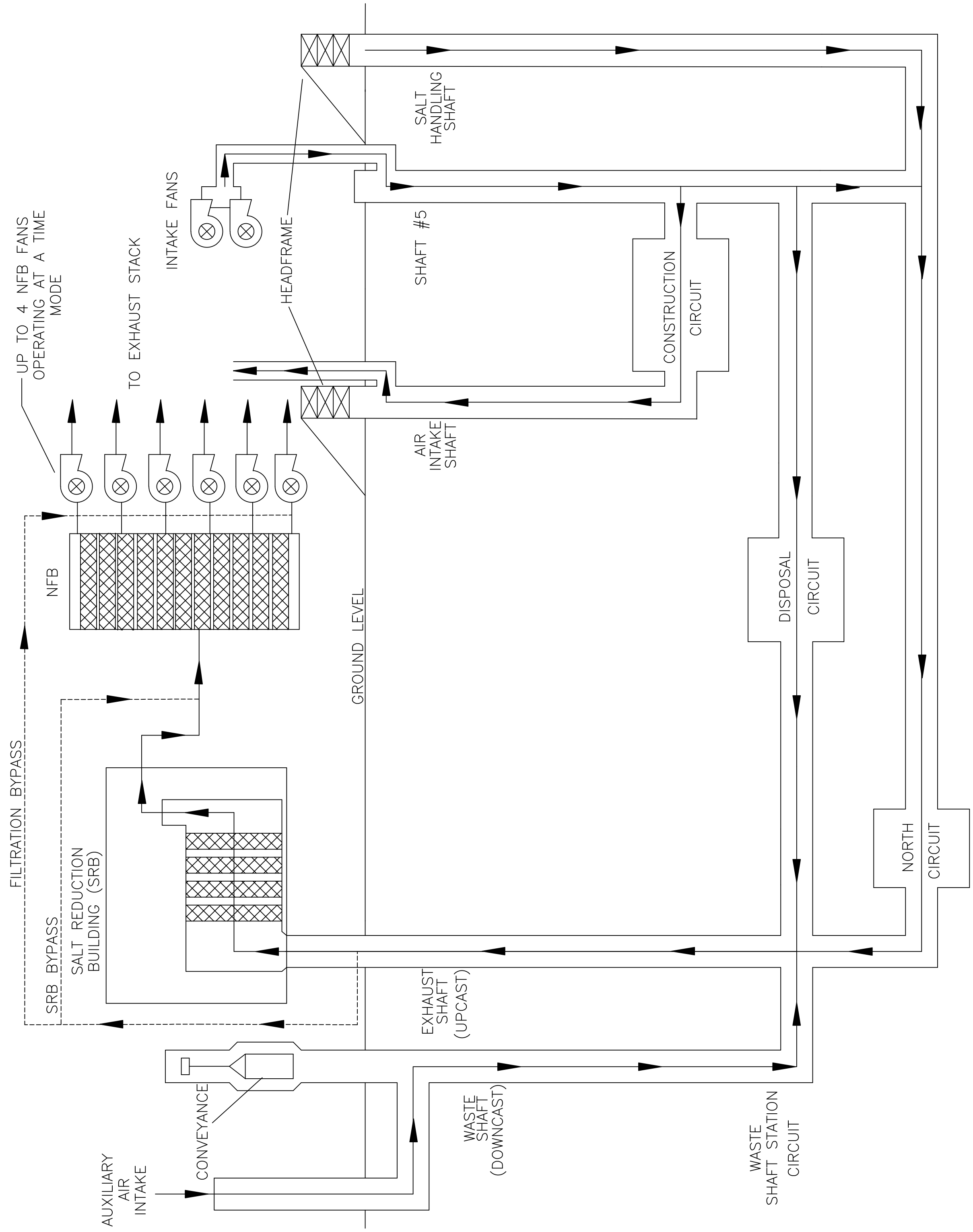


Figure M-51
Underground Ventilation System Airflow (with S#5)

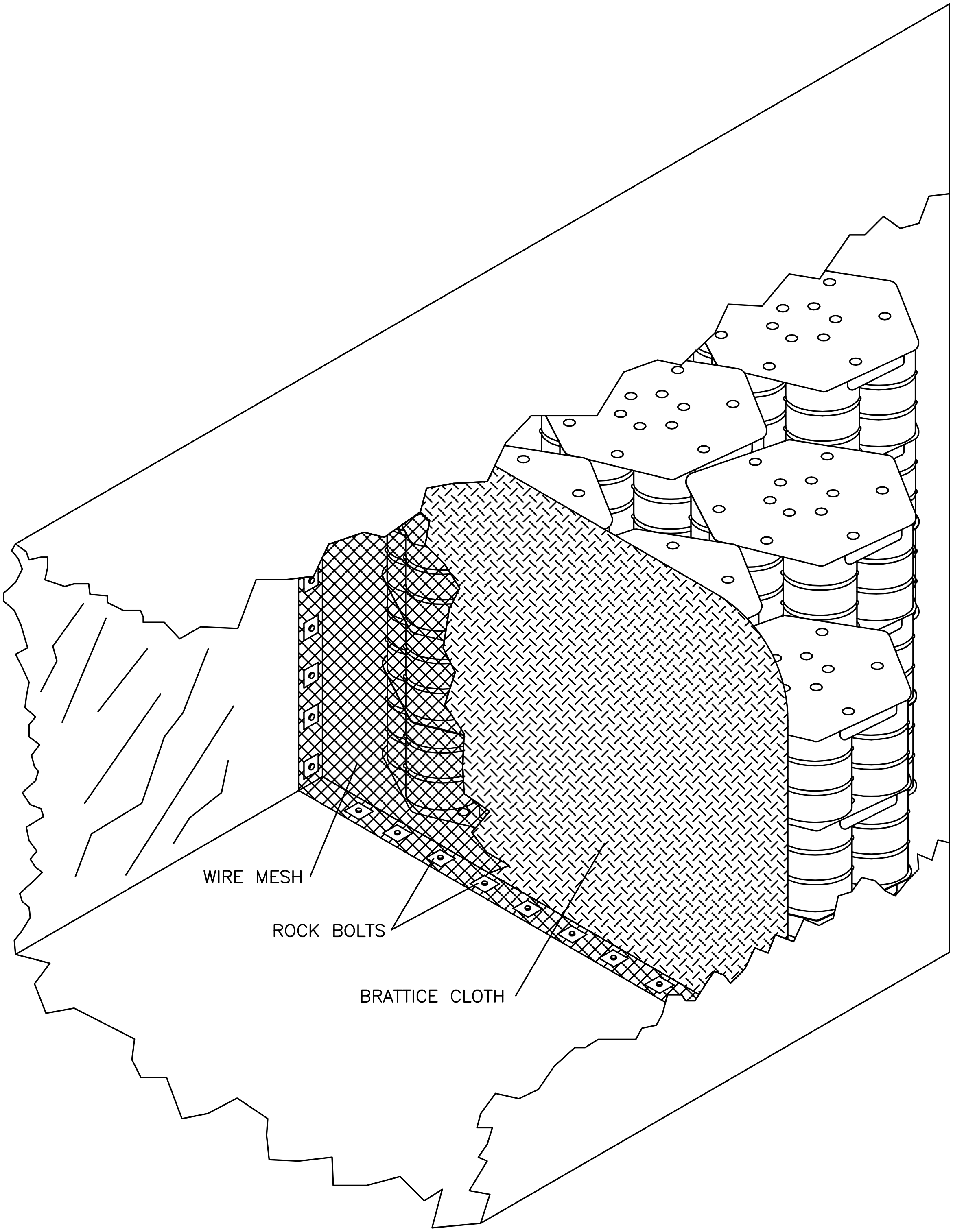


Figure M-52
Typical Room Barricade

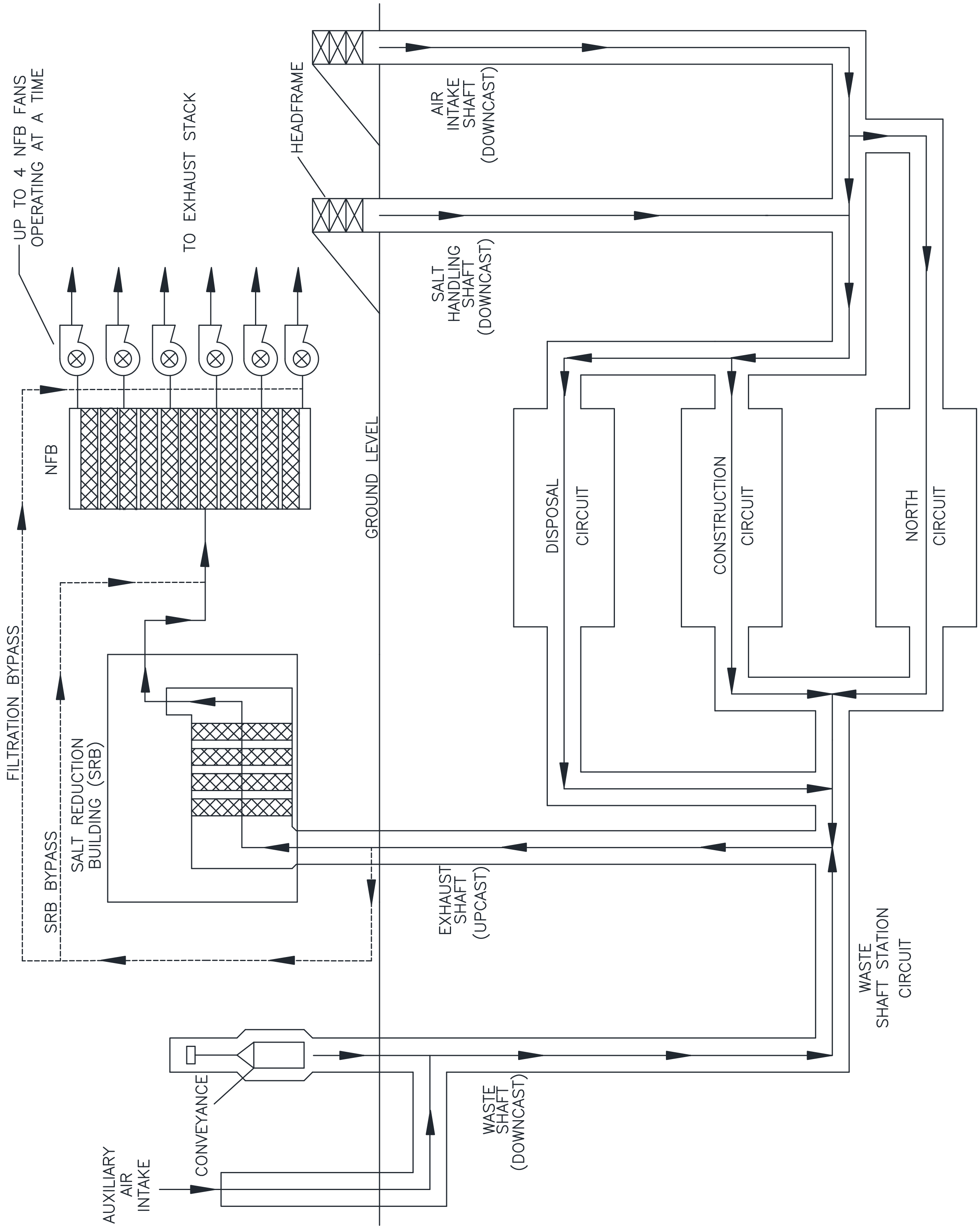


Figure M-53
Underground Ventilation System Airflow (with Building 416)

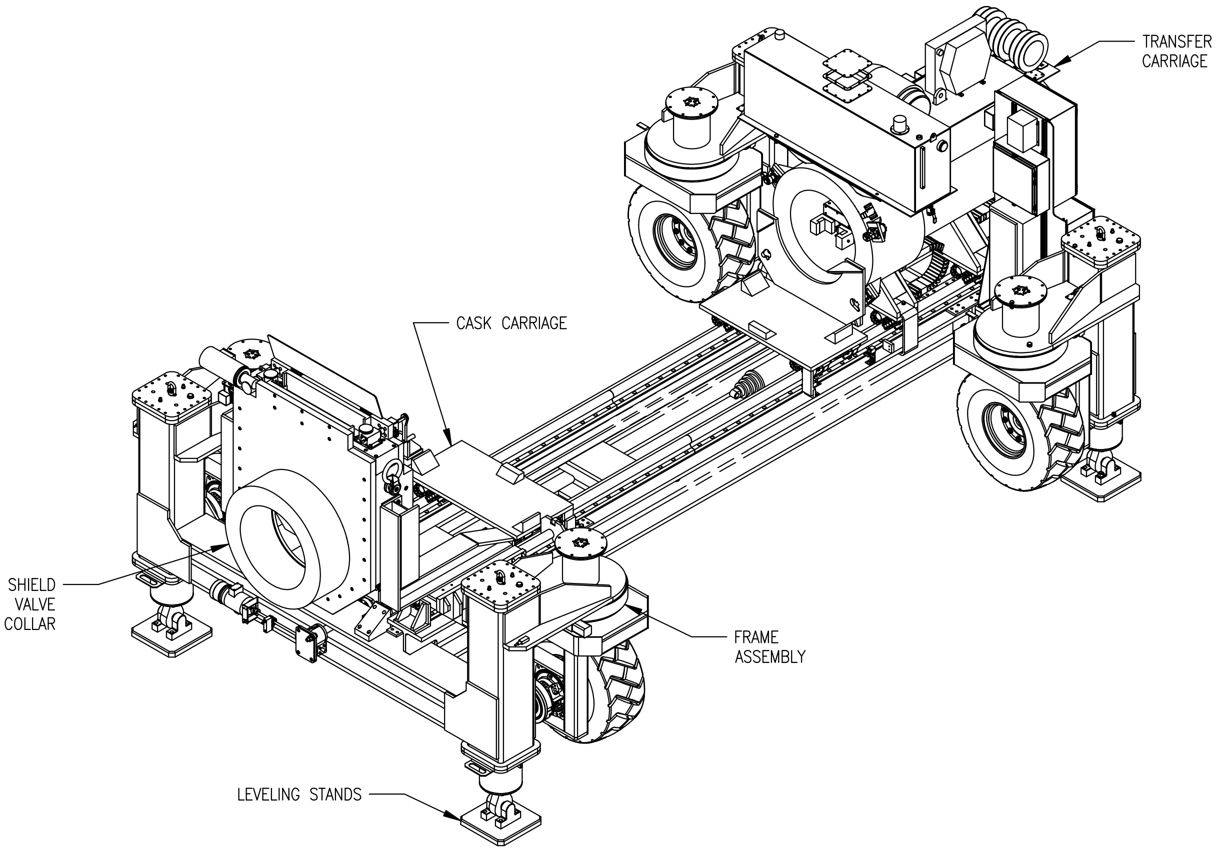


Figure M-54
Typical RH Emplacement Equipment

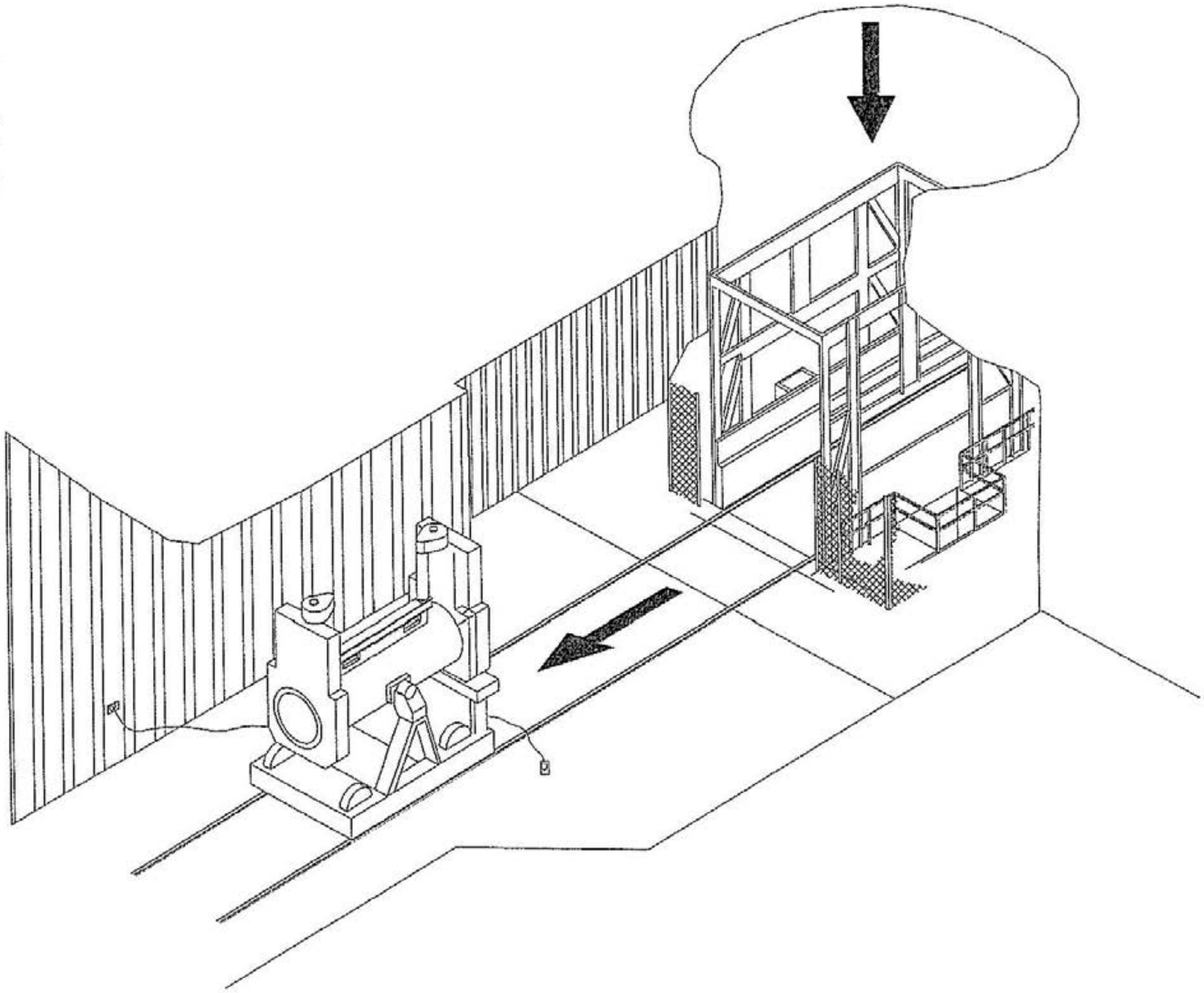


Figure M-55
RH TRU Waste Facility Cask Unloading from Waste Shaft Conveyance

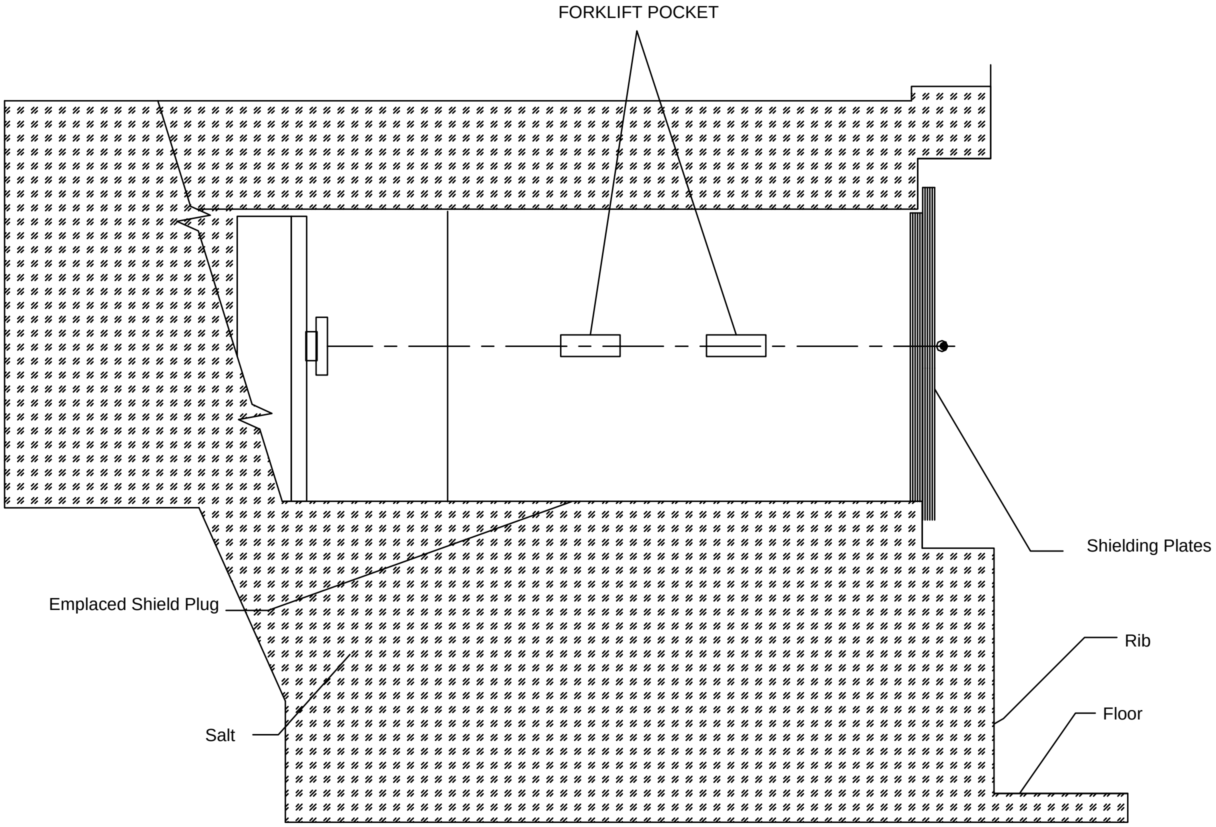


Figure M-56
Section of Borehole Showing the RH Shield Plug and Supplemental Shielding Plate(s)

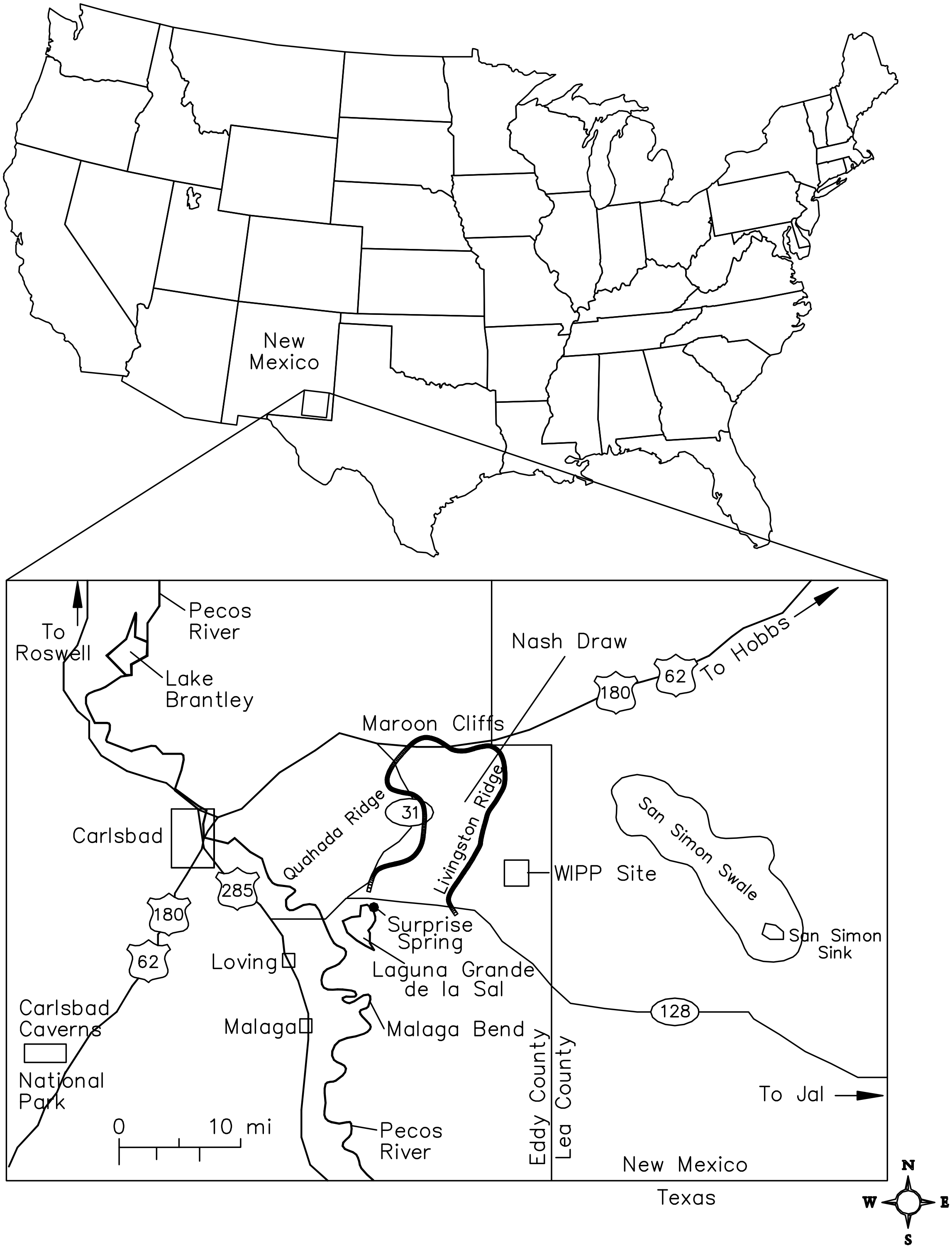
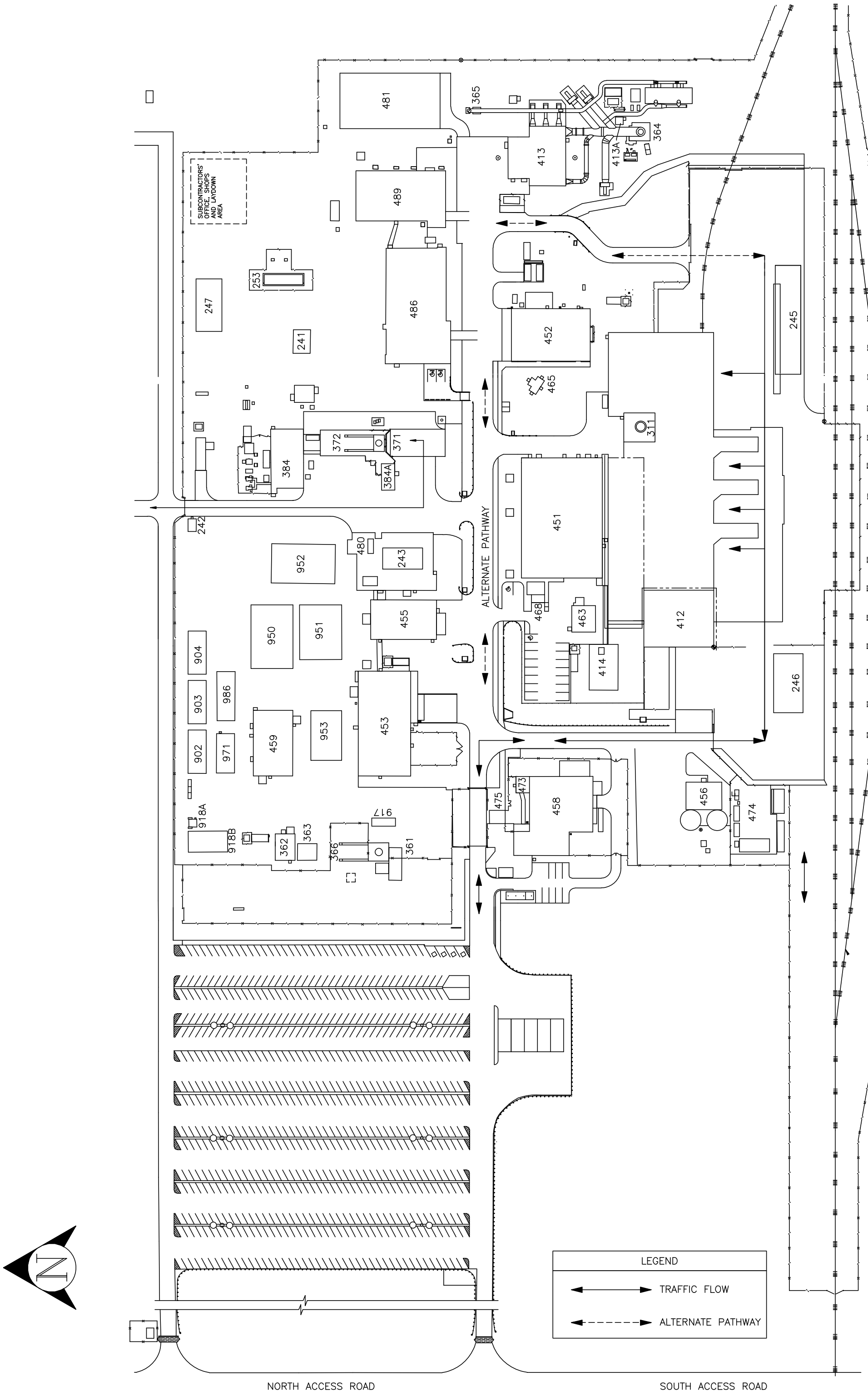
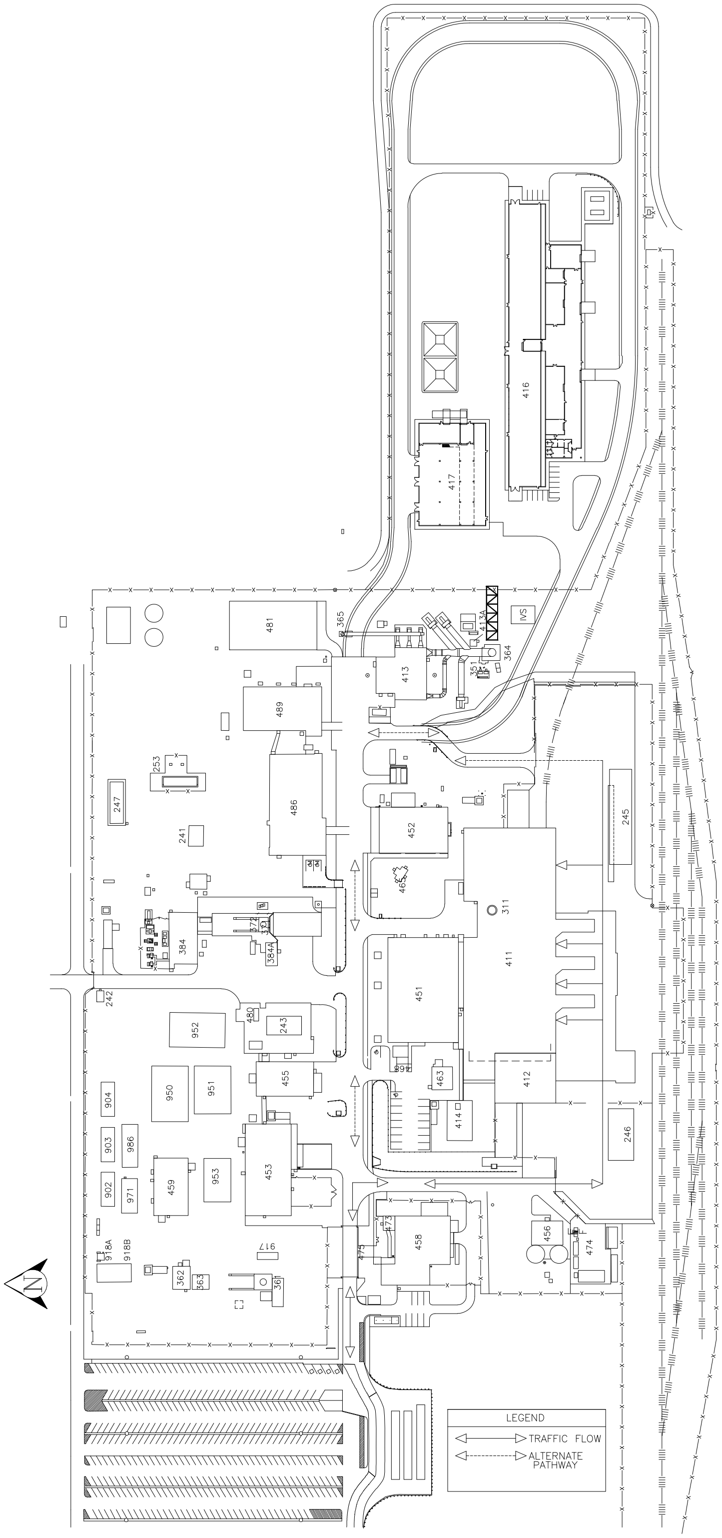


Figure M-57
General Location of the WIPP Facility



(see Figure D-1 for legend of the surface buildings)

Figure M-58
WIPP Traffic Flow Diagram



(see Figure D-1-NFB for legend of the surface buildings)

Figure M-59
WIPP Traffic Flow Diagram with Building 416

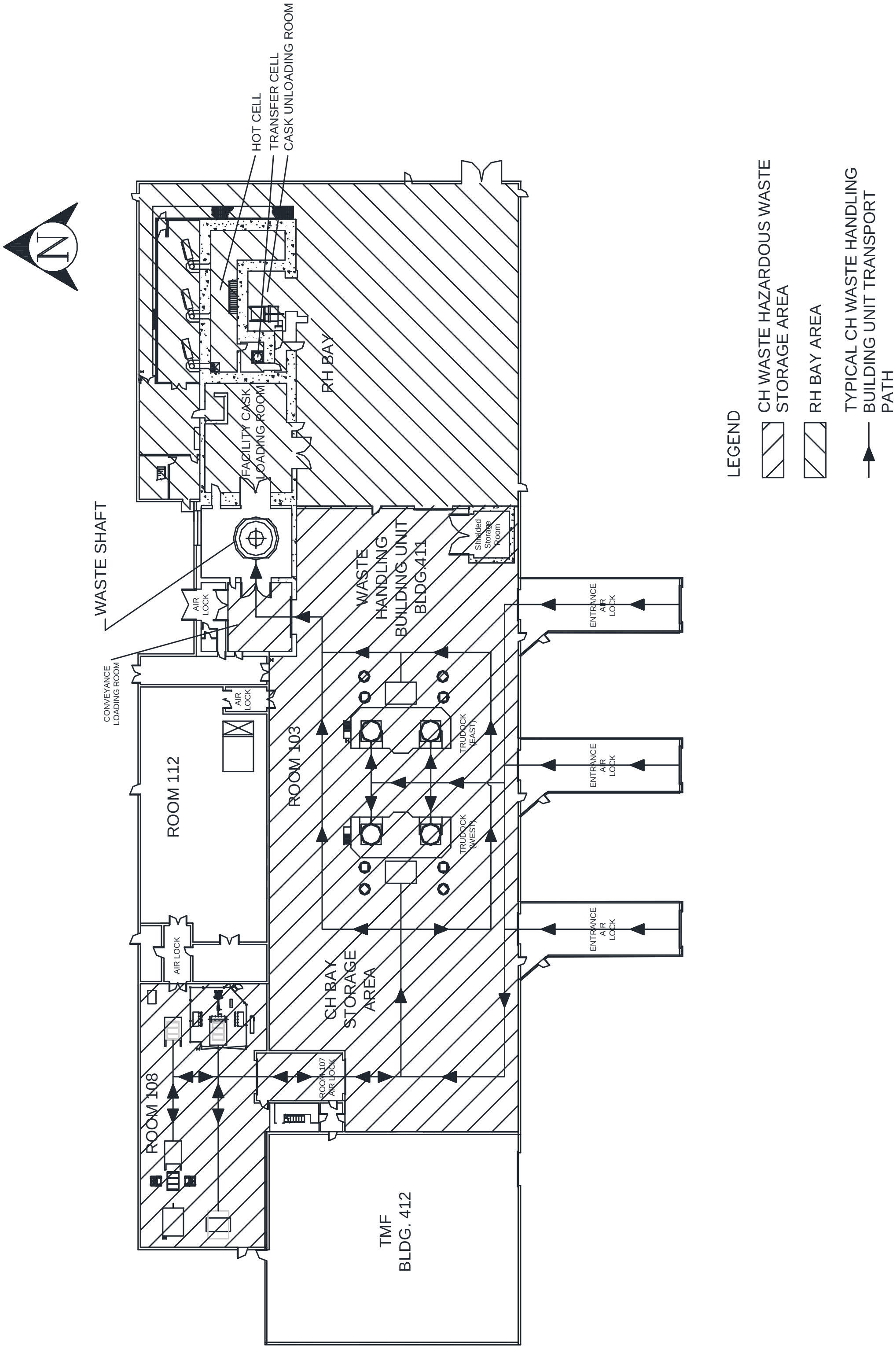


Figure M-60
Typical CH Mixed Waste Transport Routes in Waste Handling Building - Container Storage Unit

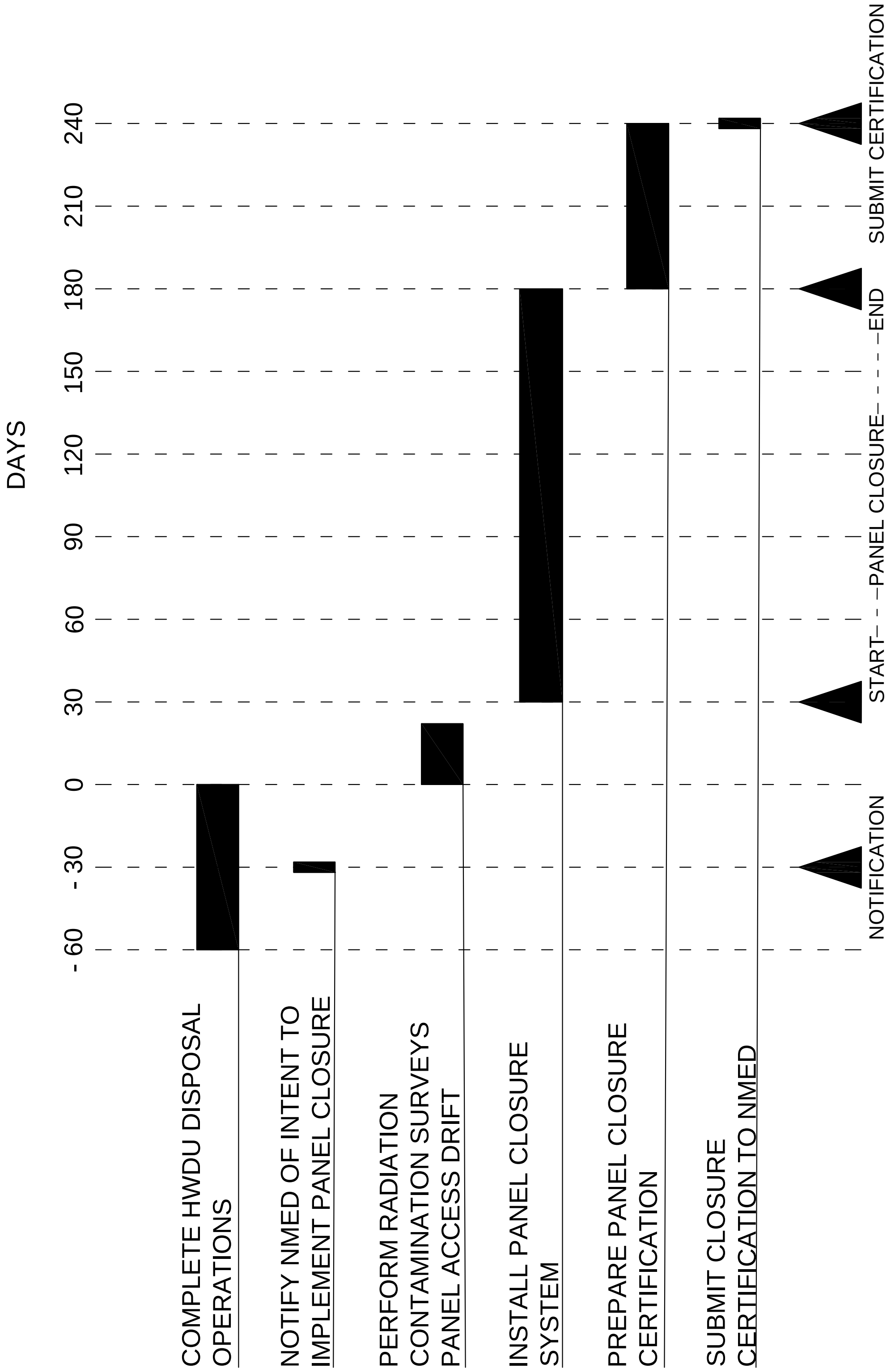


Figure M-61
WIPP Panel Closure Schedule

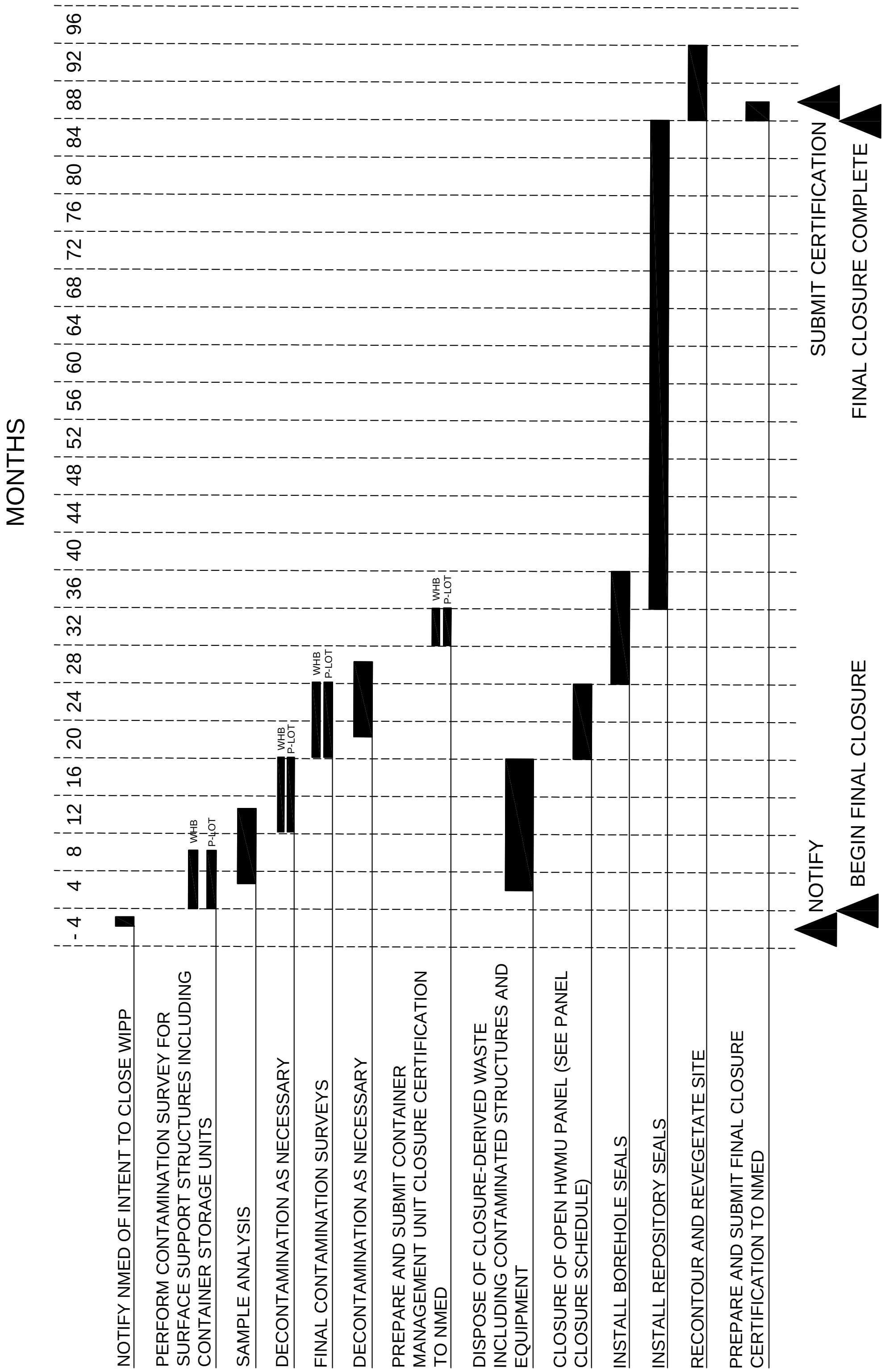
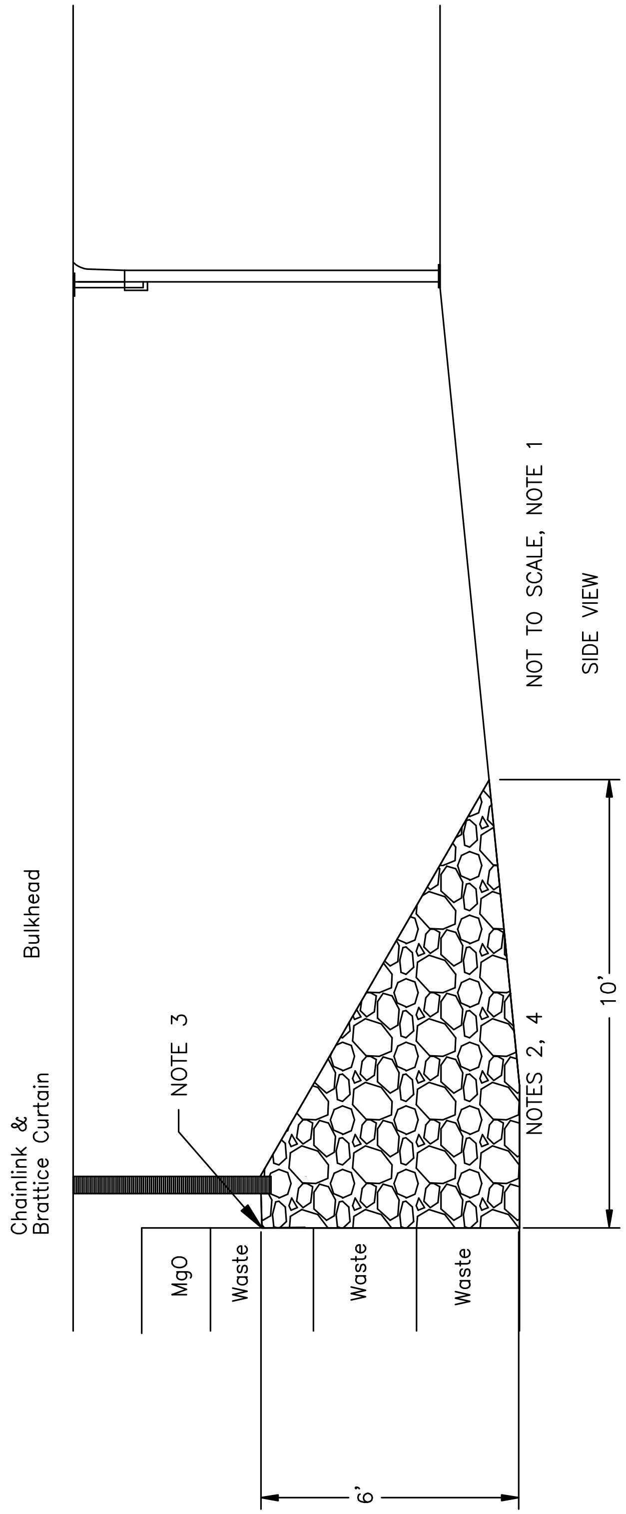


Figure M-62
WIPP Facility Final Closure 84-Month Schedule



NOTES

1. CONFIGURATION AND PLACEMENT OF THE SUBSTANTIAL BARRIER AND THE BULKHEAD DICTATED BY AS-FOUND (FIELD) CONDITIONS, AS DESIGNATED BY THE COGNIZANT ENGINEER.

2. SUBSTANTIAL BARRIER MATERIAL WILL CONSIST OF RUN-OF-MINE SALT OR OTHER SUITABLE NON-FLAMMABLE MATERIAL AS DESIGNATED BY THE COGNIZANT ENGINEER.

3. SUBSTANTIAL BARRIER MATERIAL SHOULD BE AGAINST THE WASTE FACE. THE HEIGHT OF THE SUBSTANTIAL BARRIER NEAR THE WASTE WILL BE AT LEAST EQUAL TO THE HEIGHT OF THE BOTTOM OF THE TOP ROW OF WASTE.

4. DIMENSIONS INDICATED ARE MINIMUMS. THE HEIGHT OF THE SUBSTANTIAL BARRIER IS MEASURED AT THE WASTE FACE. THE LENGTH OF THE SUBSTANTIAL BARRIER IS MEASURED FROM THE BOTTOM OF THE WASTE FACE TO THE TOE OF THE SUBSTANTIAL BARRIER MATERIAL.

Figure M-63
Typical Substantial Barrier and Bulkhead

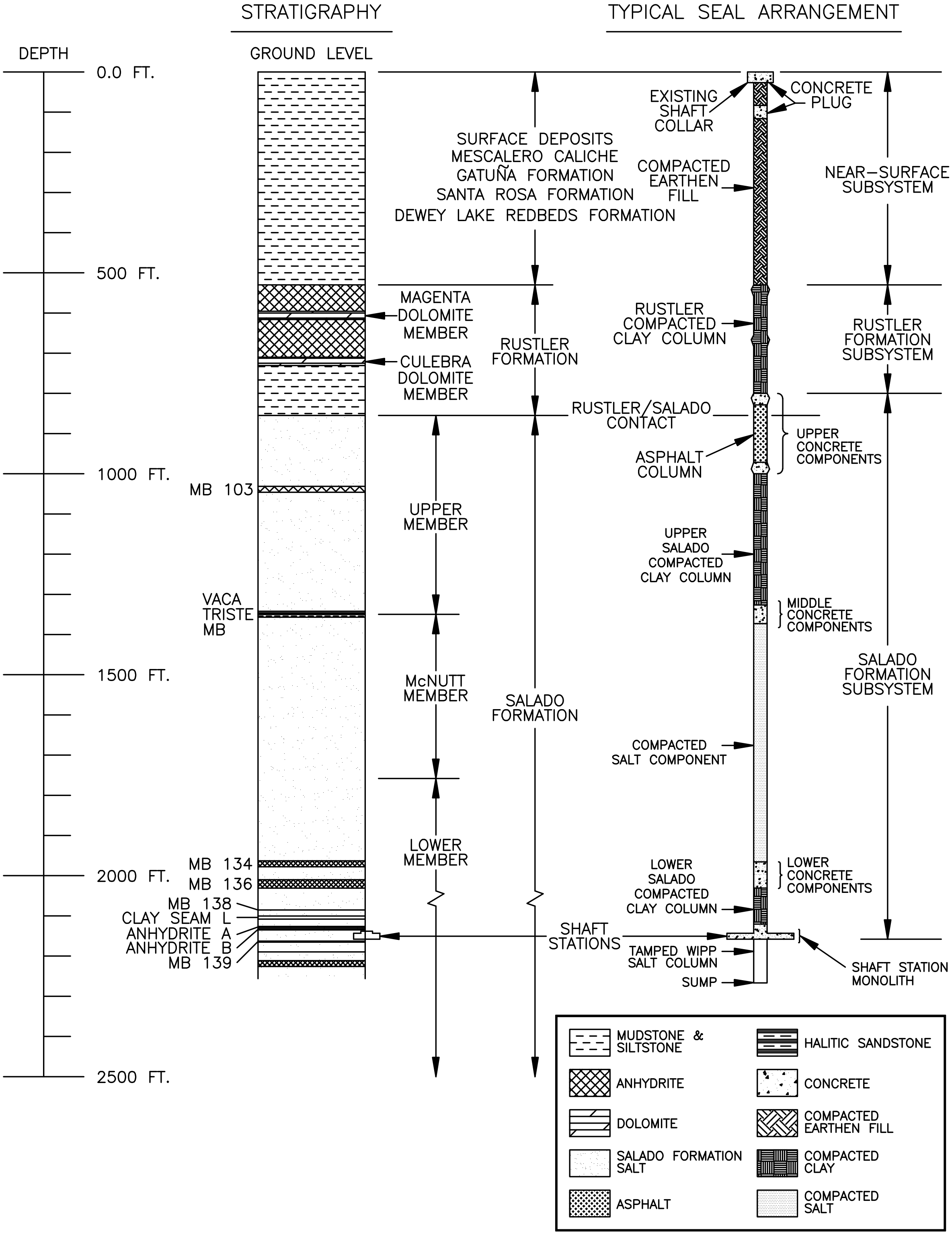


Figure M-64
Typical Shaft Sealing System

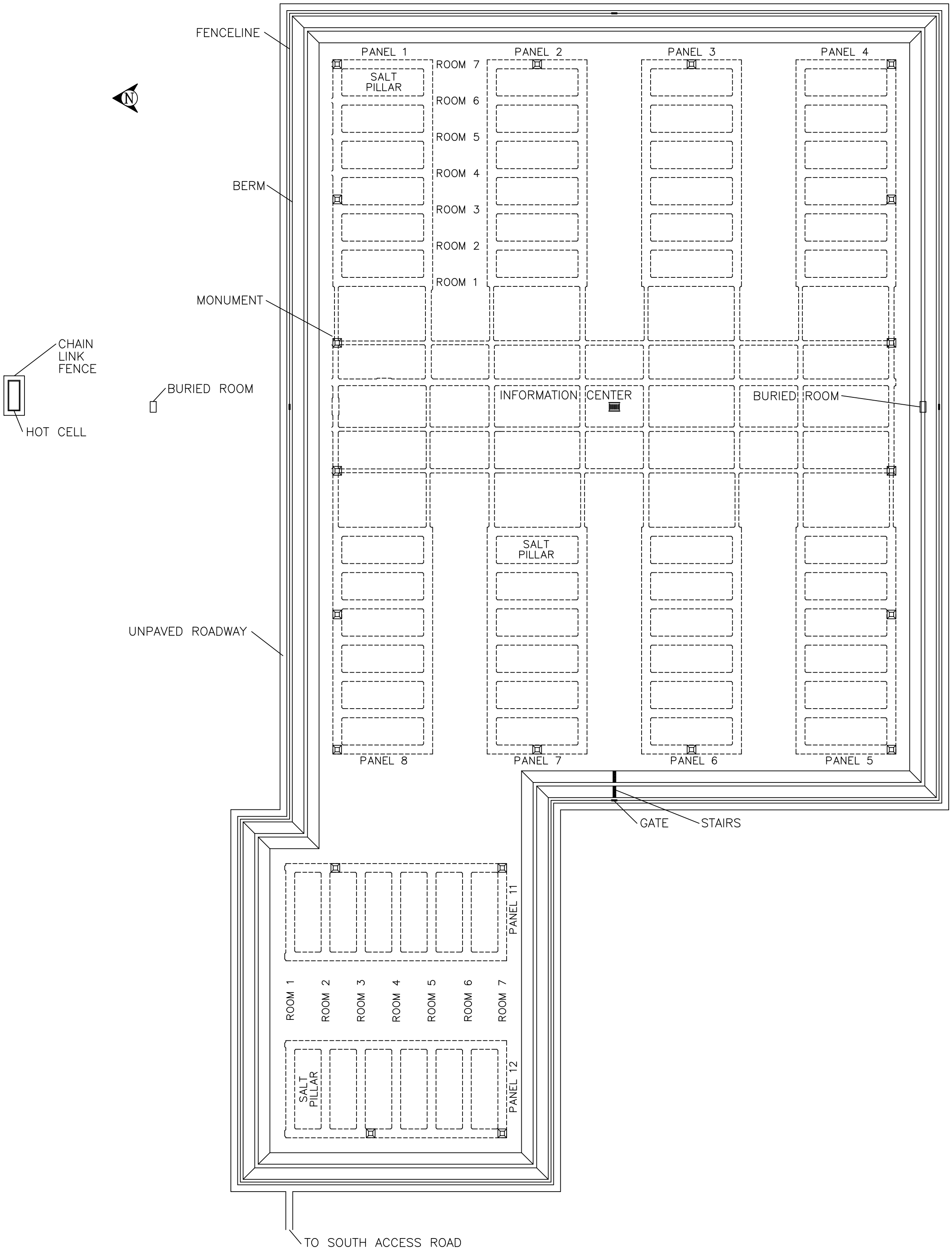


Figure M-65
Perimeter Fenceline and Roadway

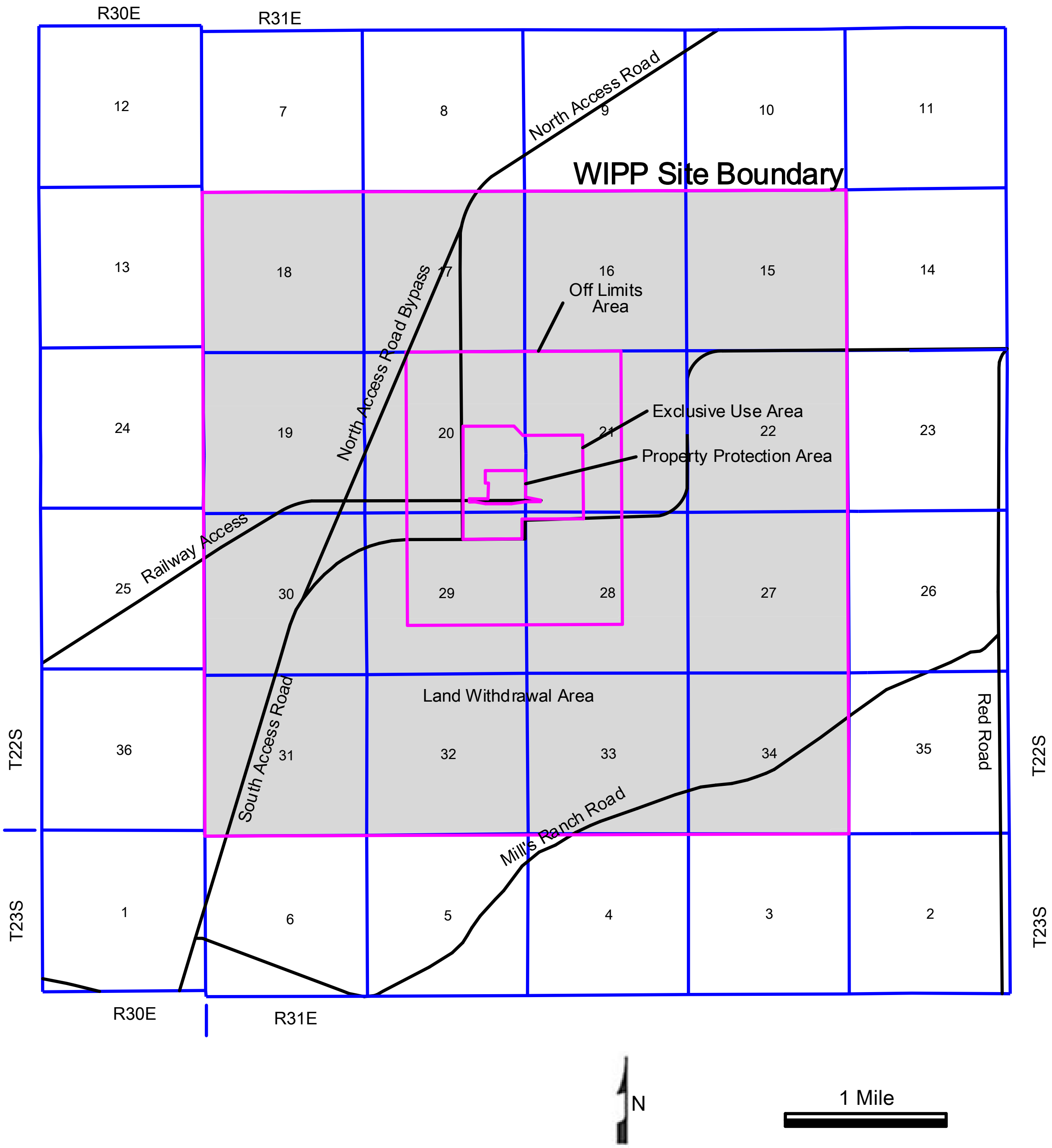


Figure M-66
WIPP Facility Boundaries Showing 16-square-Mile Land Withdrawal Boundary

SYSTEM	SERIES	GROUP	FORMATION	MEMBER
RECENT	RECENT		SURFICIAL DEPOSITS	
QUATERNARY	PLEISTOCENE		MESCALERO CALICHE	
			GATUÑA	
TERTIARY	MID-PLIOCENE		OGALLALA	
TRIASSIC		DOCKUM	SANTA ROSA	
PERMIAN	OCHOAN		DEWEY LAKE REDBEDS	
			RUSTLER	FORTY-NINER
				MAGENTA DOLOMITE
				TAMARISK
				CULEBRA DOLOMITE
				LOS MEDAÑOS
			SALADO	UPPER
				MCNUTT POTASH
				LOWER
			CASTILE	
	GUADALUPIAN	DELAWARE MOUNTAIN	BELL CANYON	
			CHERRY CANYON	
			BRUSHY CANYON	

Figure M-67
Site Geologic Column

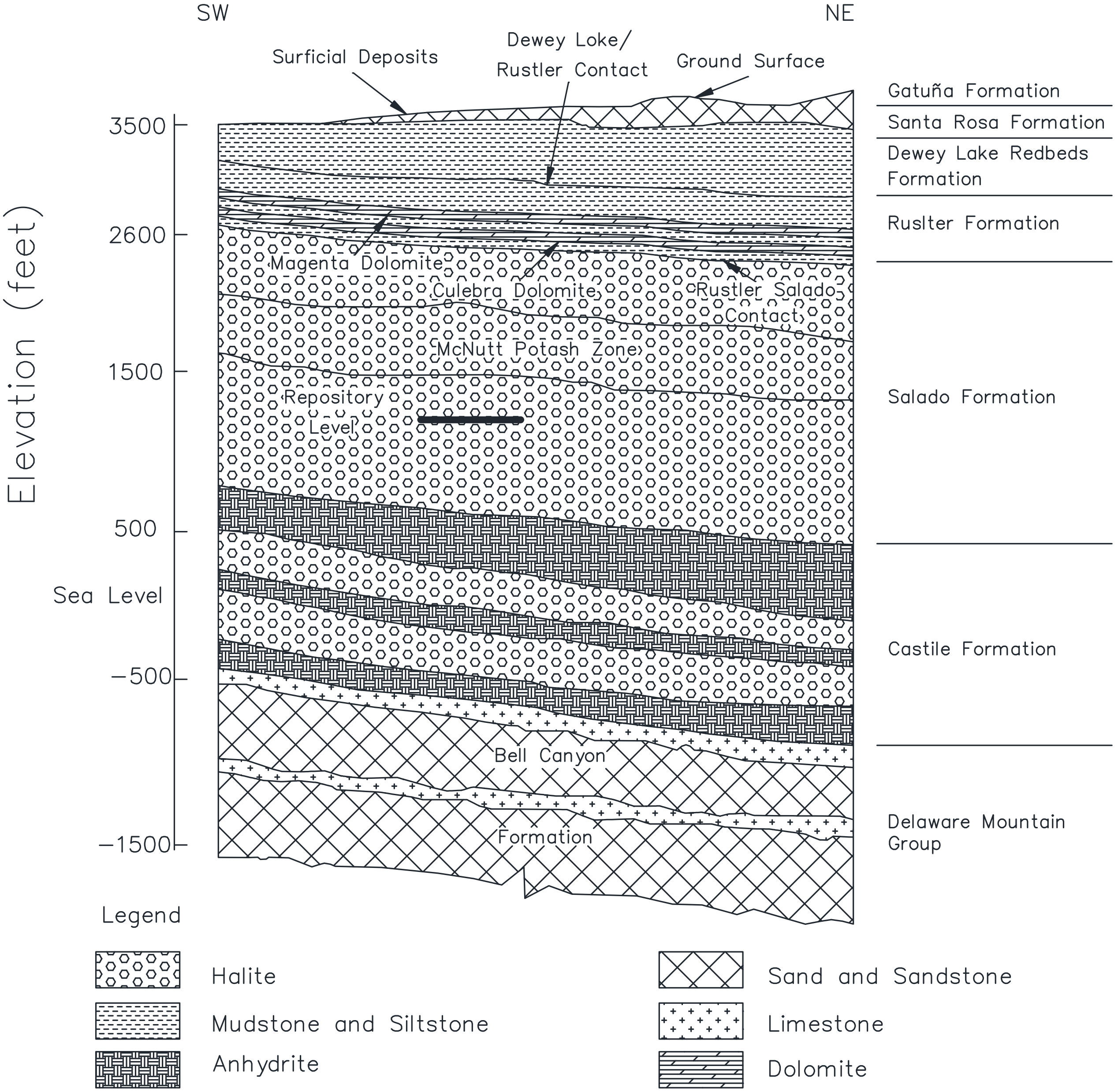
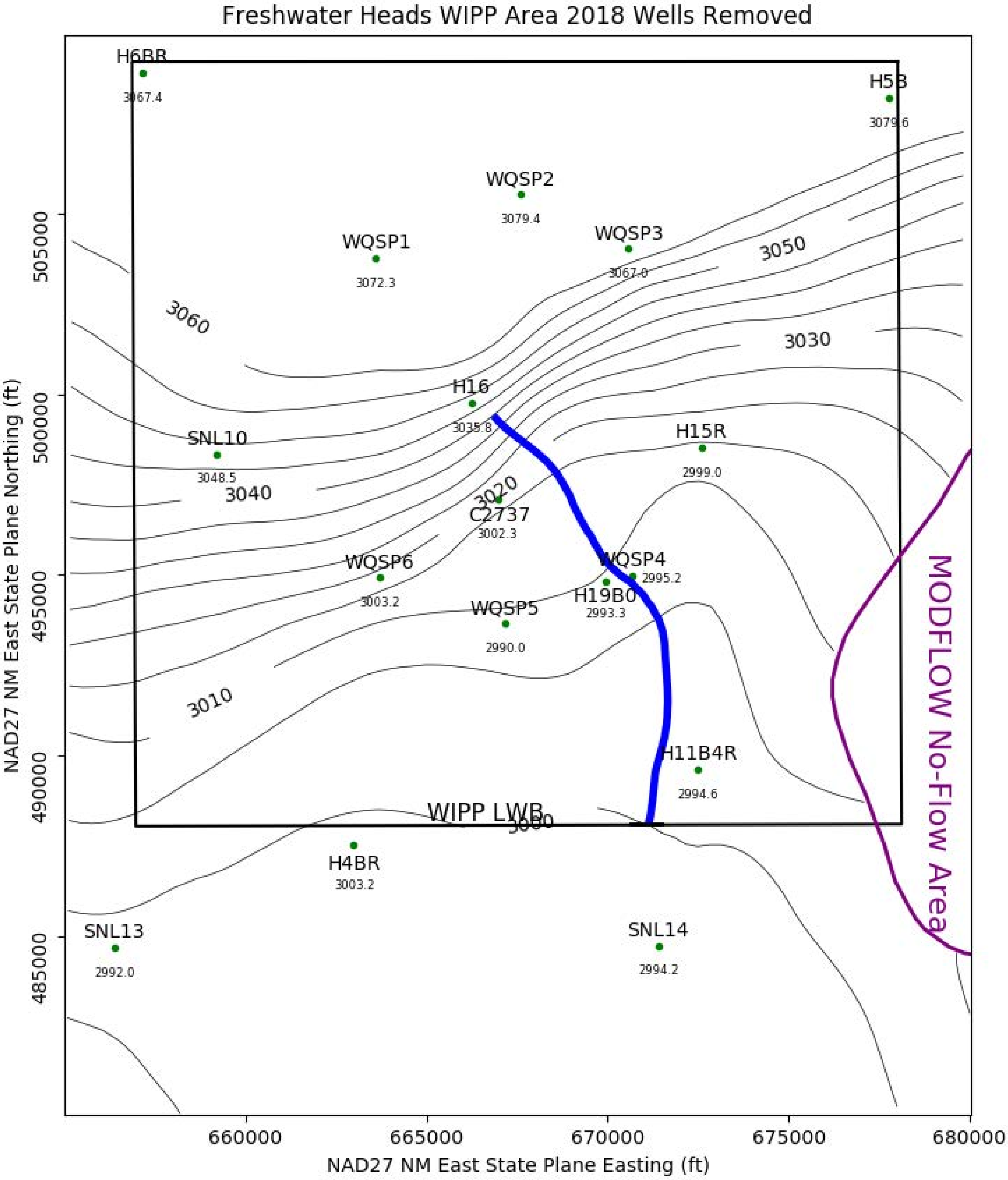


Figure M-68
Generalized Stratigraphic Cross Section above the Bell Canyon Formation at the WIPP Site



Model generated September 2019 utilizing May 2018 freshwater head contours with observed heads (ft) listed at each well. Contours are at 5 ft intervals with the blue line particle track from the waste handling shaft to the WIPP Land Withdrawal Boundary. The purple line is a constant head boundary representing the Rustler halite margin.

Figure M-69
Culebra Freshwater-Head Potentiometric Surface

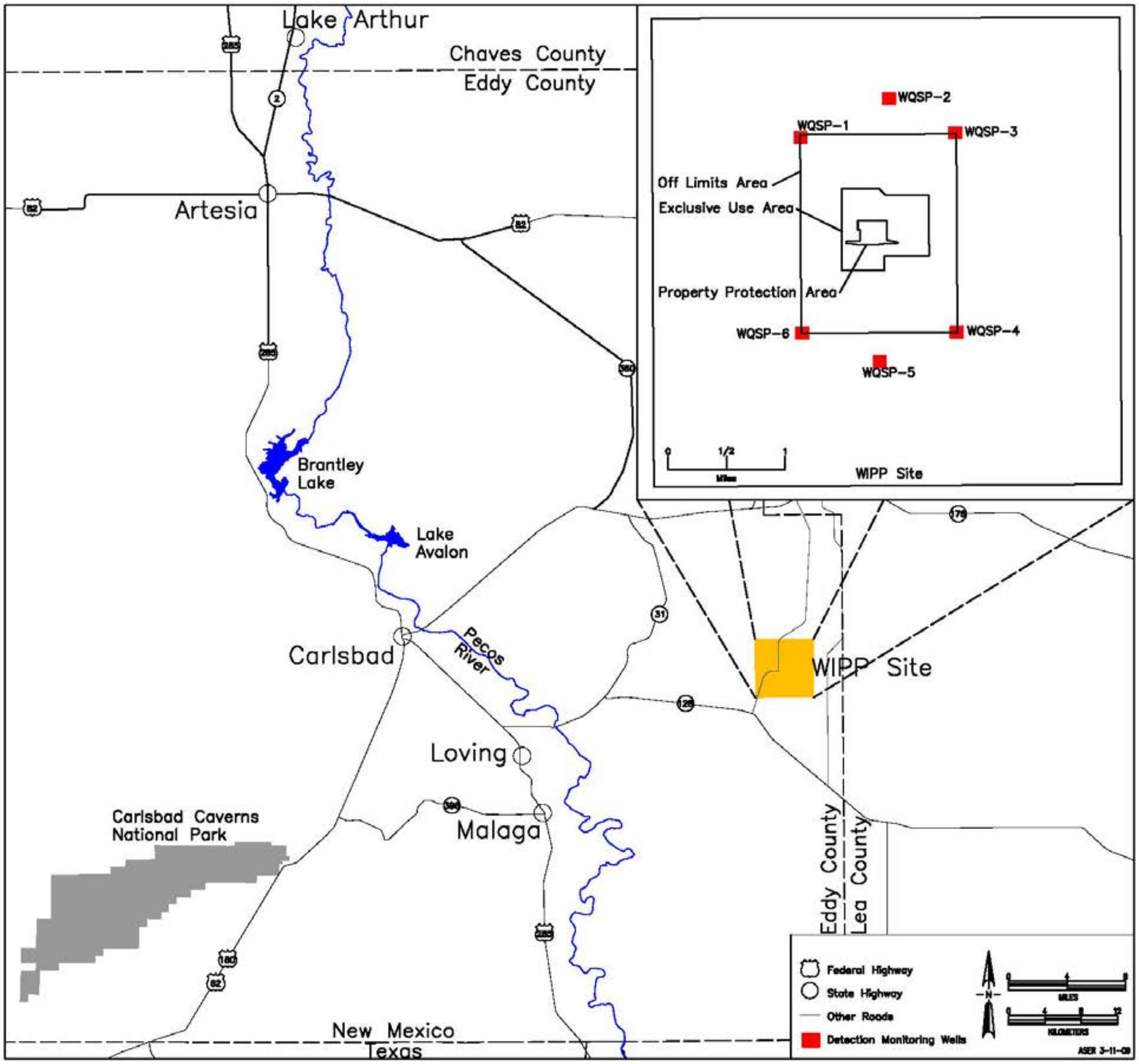
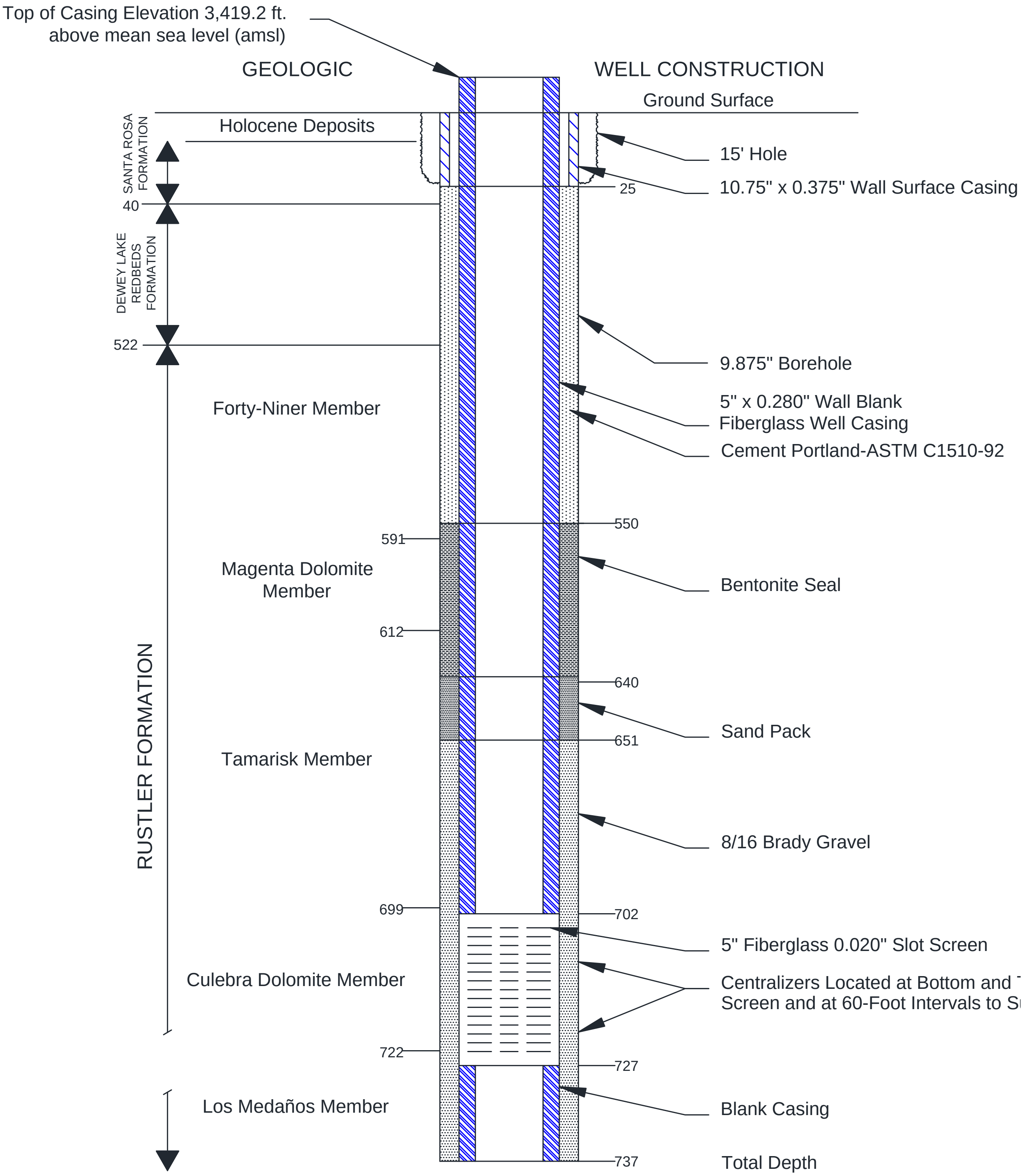


Figure M-70
Detection Monitoring Well Locations



Note: Depths in feet below ground surface (bgs) approximate.

Figure M-71
As-Built Configuration of Well WQSP-1

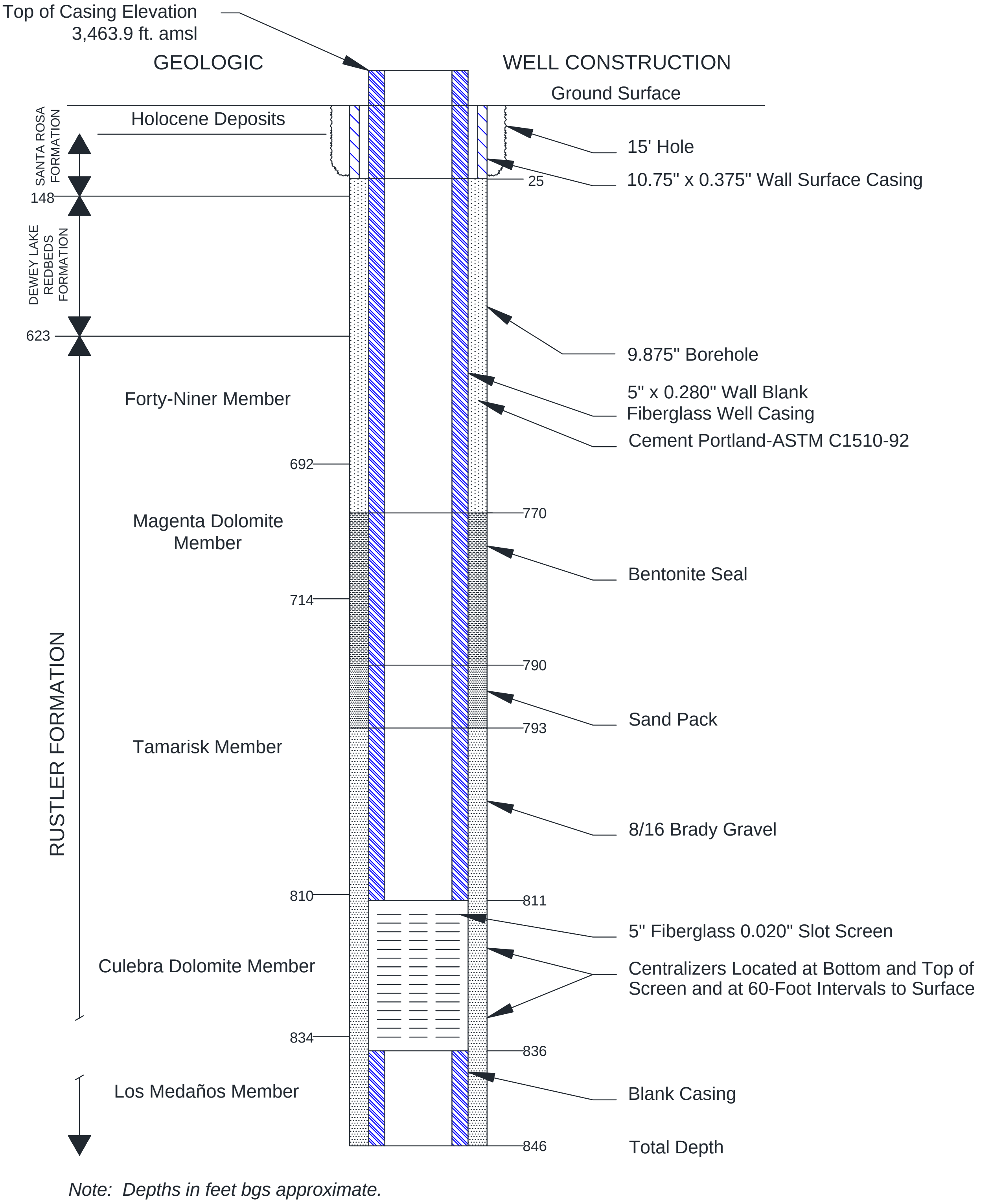
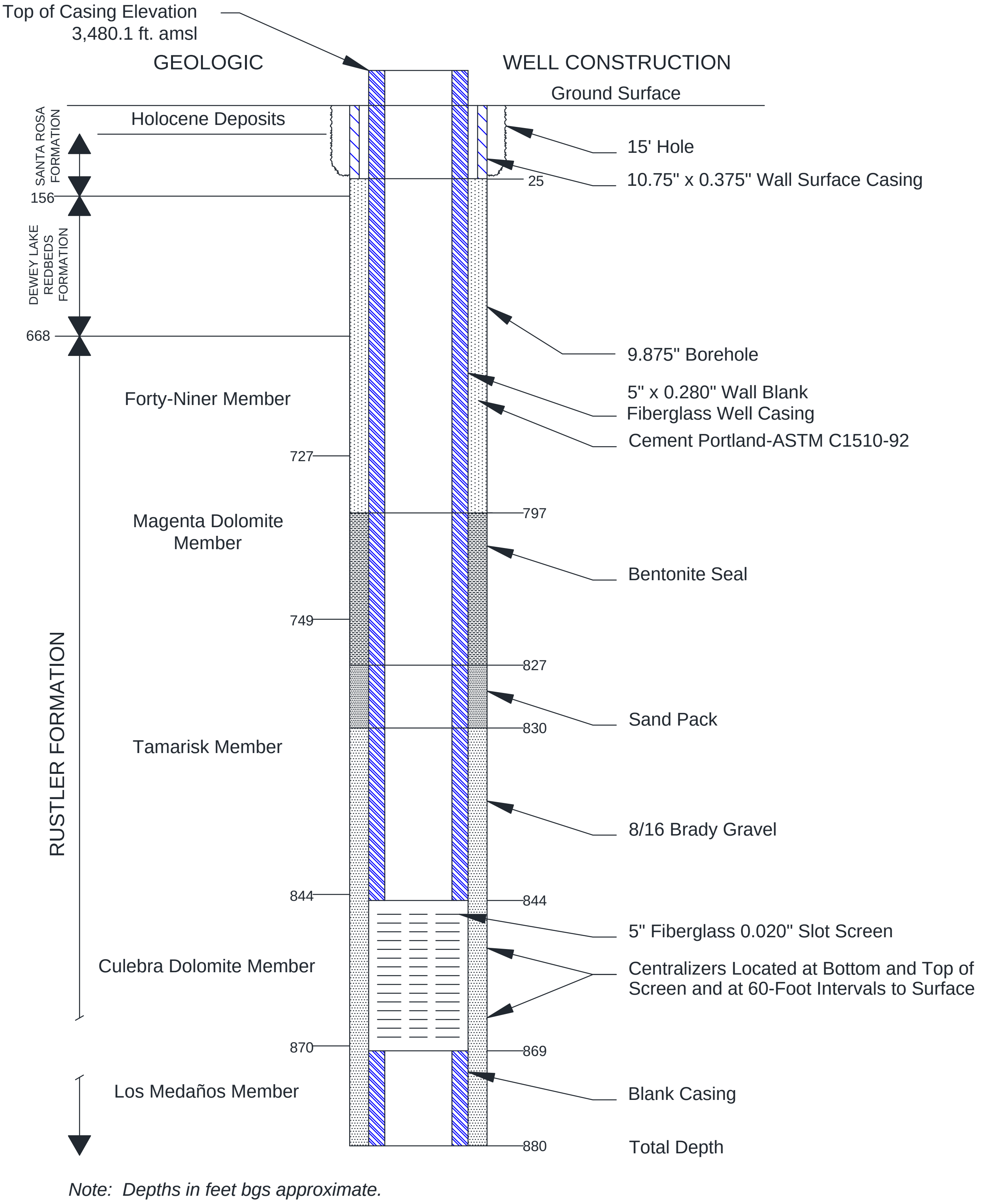
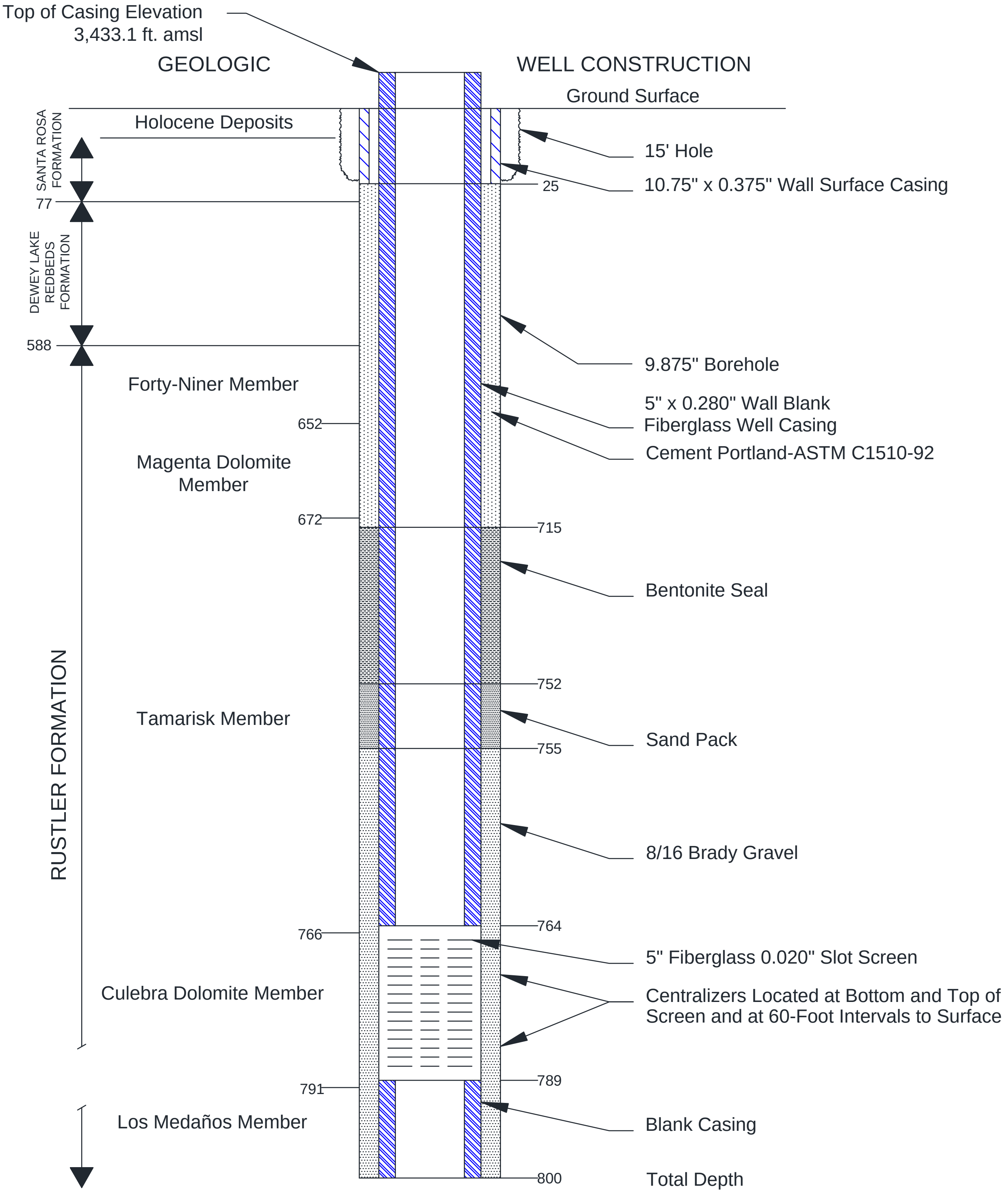


Figure M-72
As-Built Configuration of Well WQSP-2



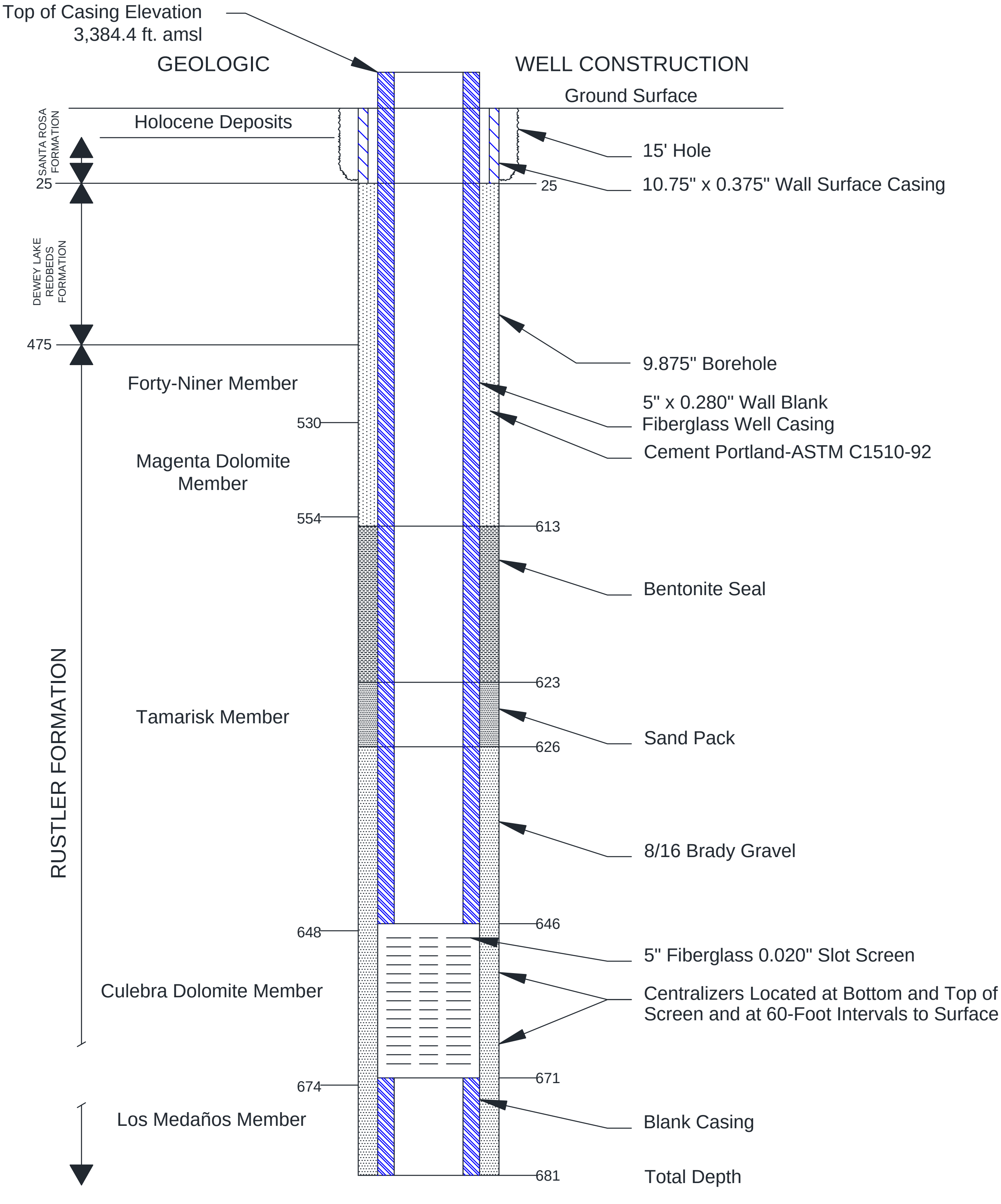
Note: Depths in feet bgs approximate.

Figure M-73
As-Built Configuration of Well WQSP-3



Note: Depths in feet bgs approximate.

Figure M-74
As-Built Configuration of Well WQSP-4



Note: Depths in feet bgs approximate.

Figure M-75
As-Built Configuration of Well WQSP-5

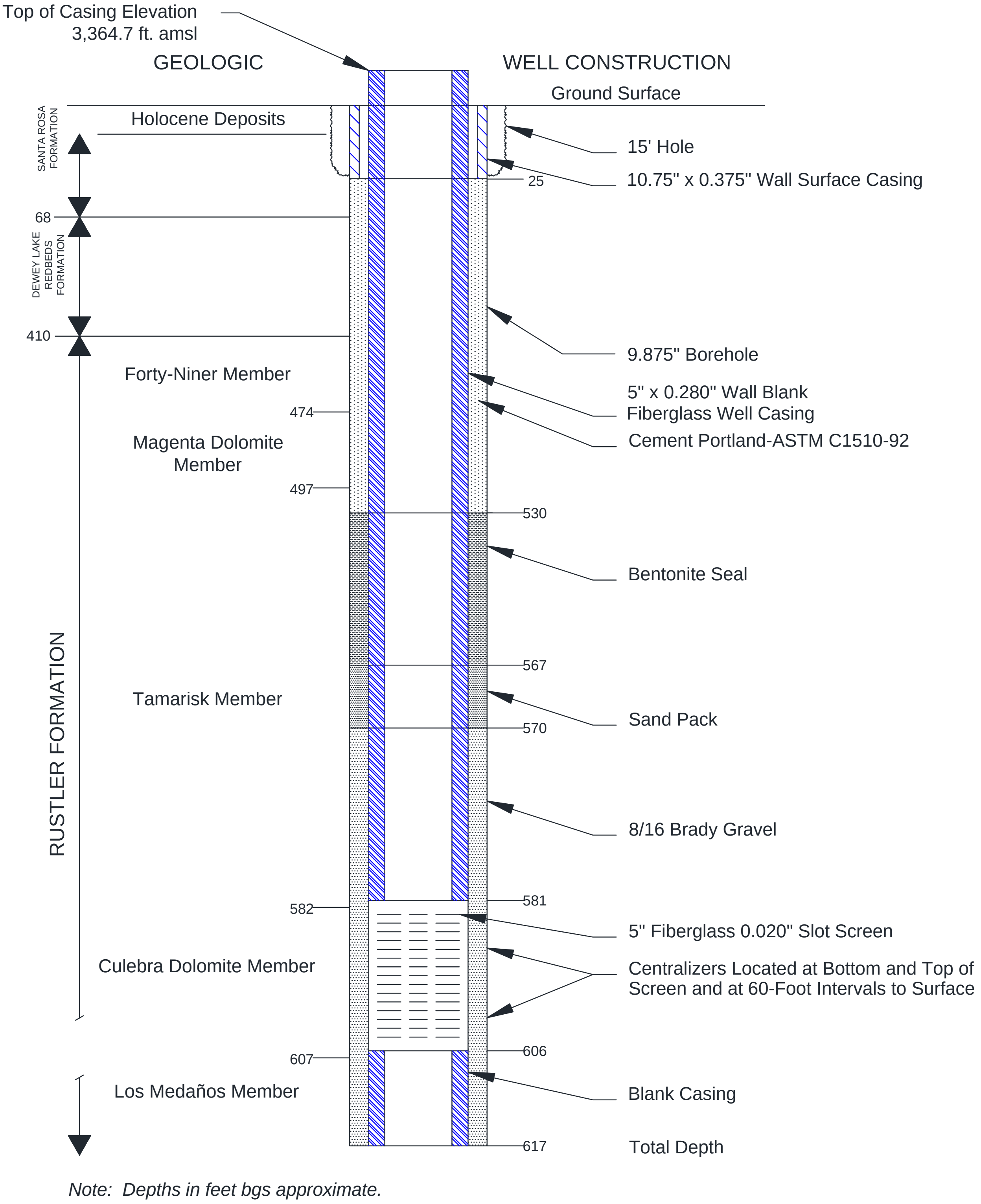


Figure M-76
As-Built Configuration of Well WQSP-6

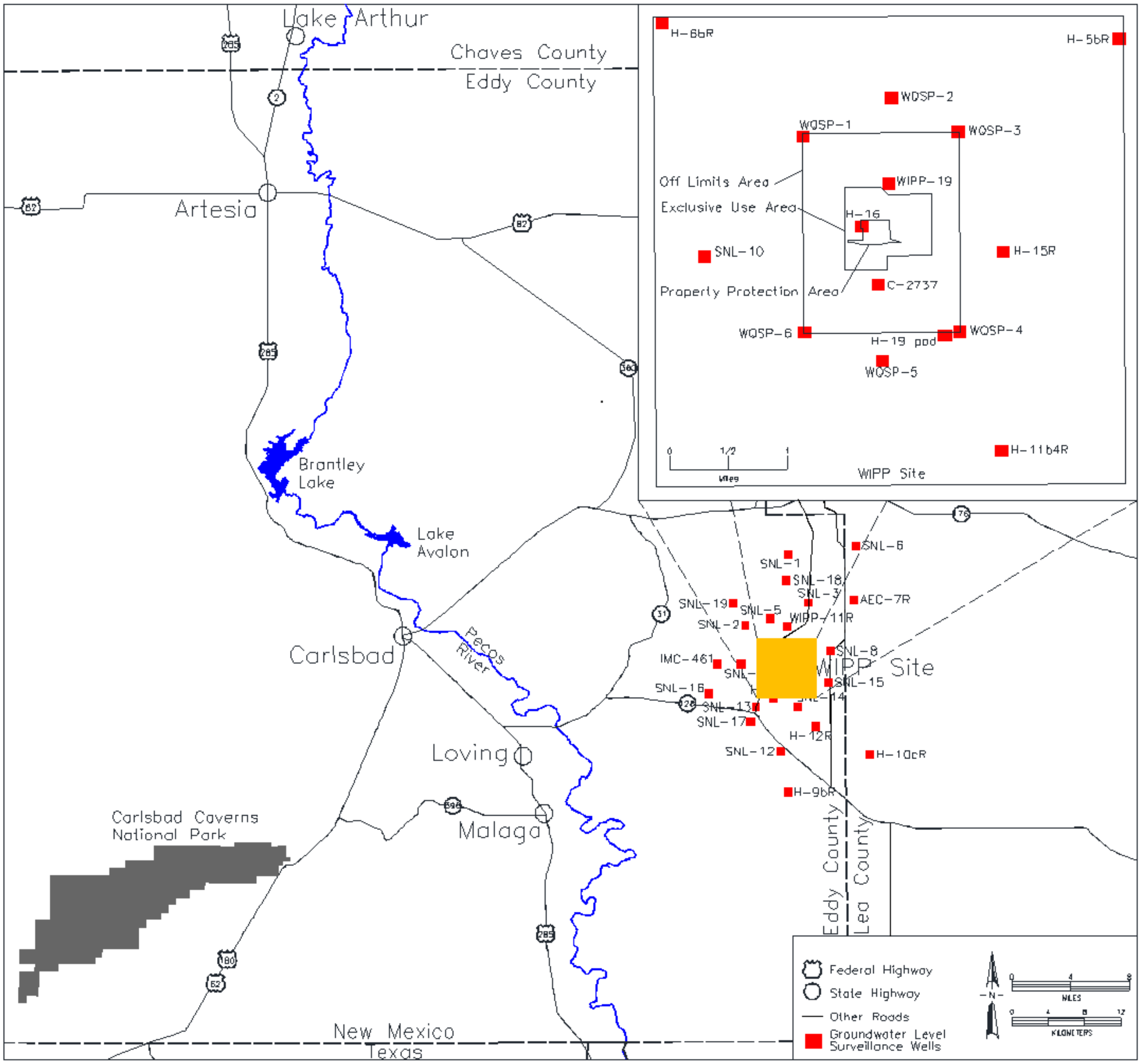
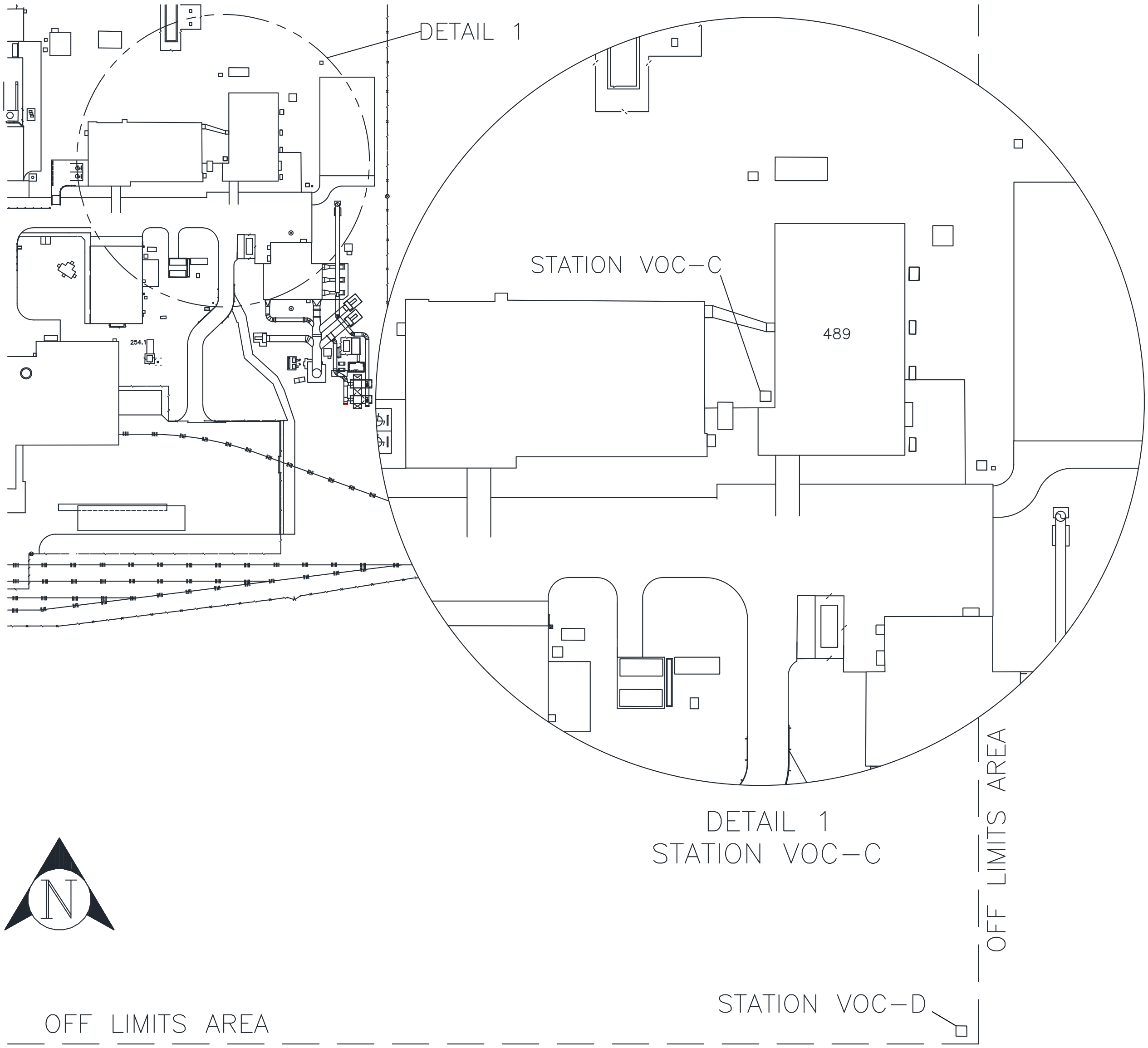


Figure M-77
Groundwater Level Surveillance Wells
(inset represents the Groundwater Level Surveillance Wells within the WIPP Land Withdrawal Area)



(see Figure D-1 and Figure D-1a for a detailed map and legend of the surface buildings)

Figure M-78
Repository VOC Monitoring Locations

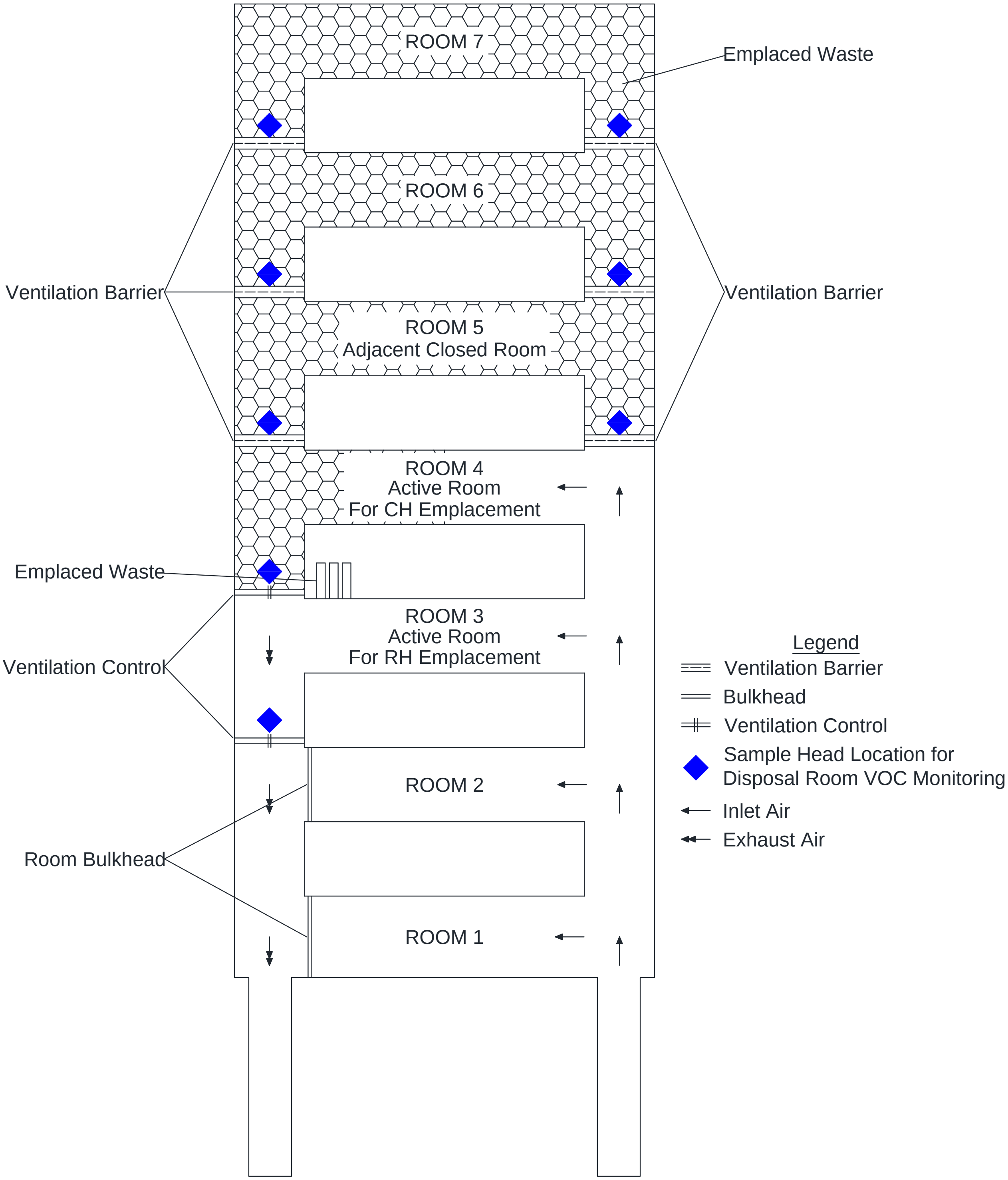


Figure M-79
Typical Disposal Room VOC Monitoring Locations

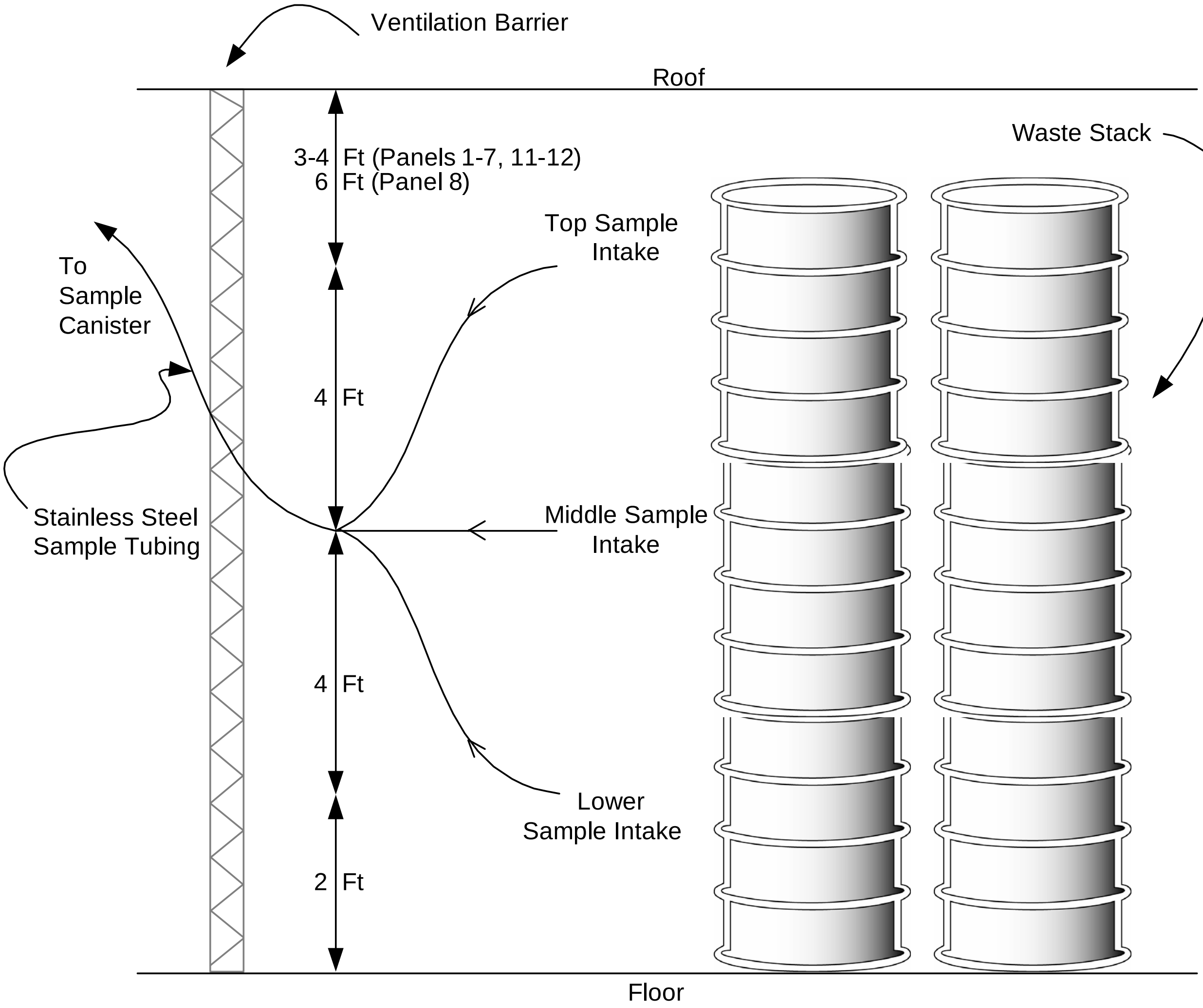
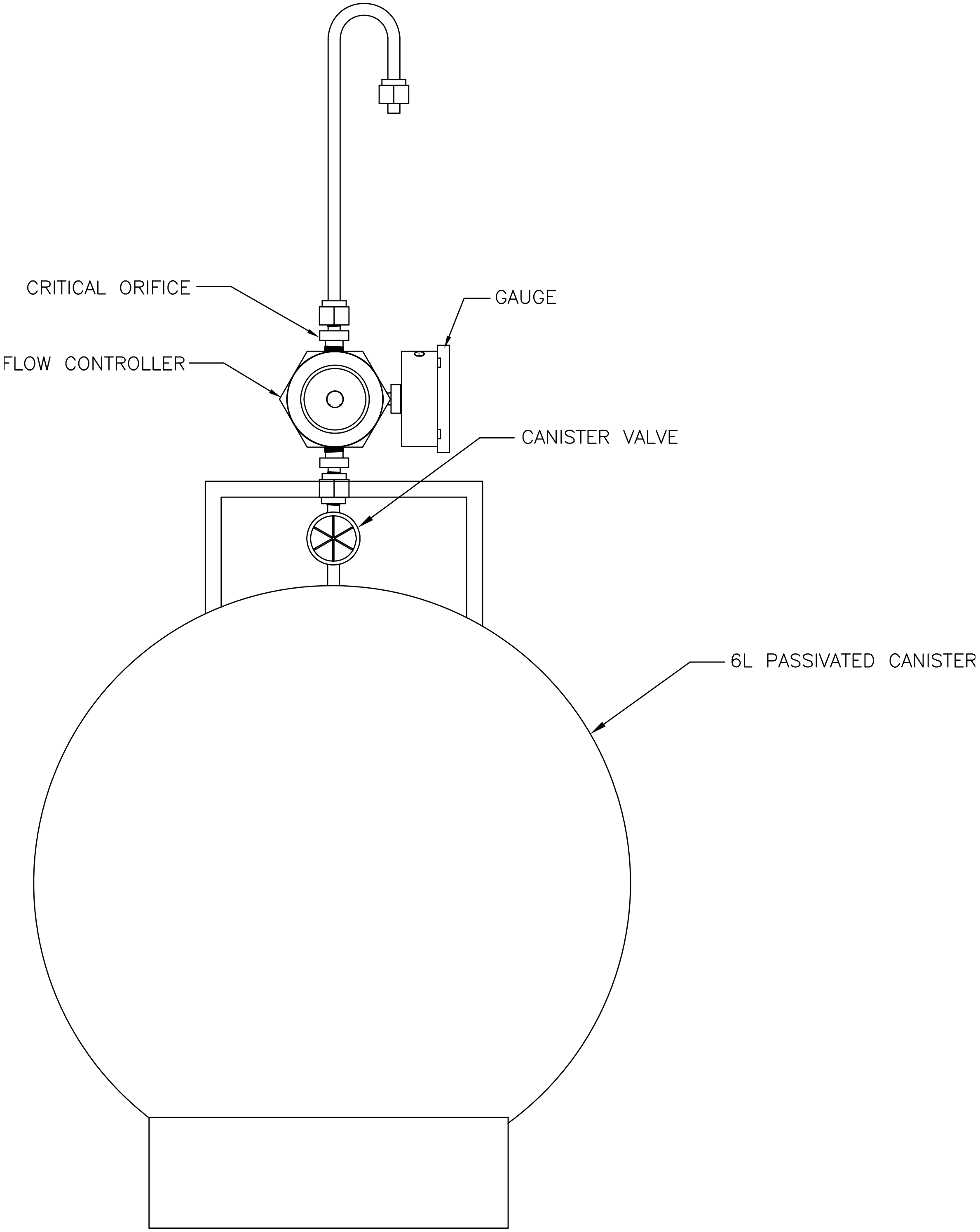
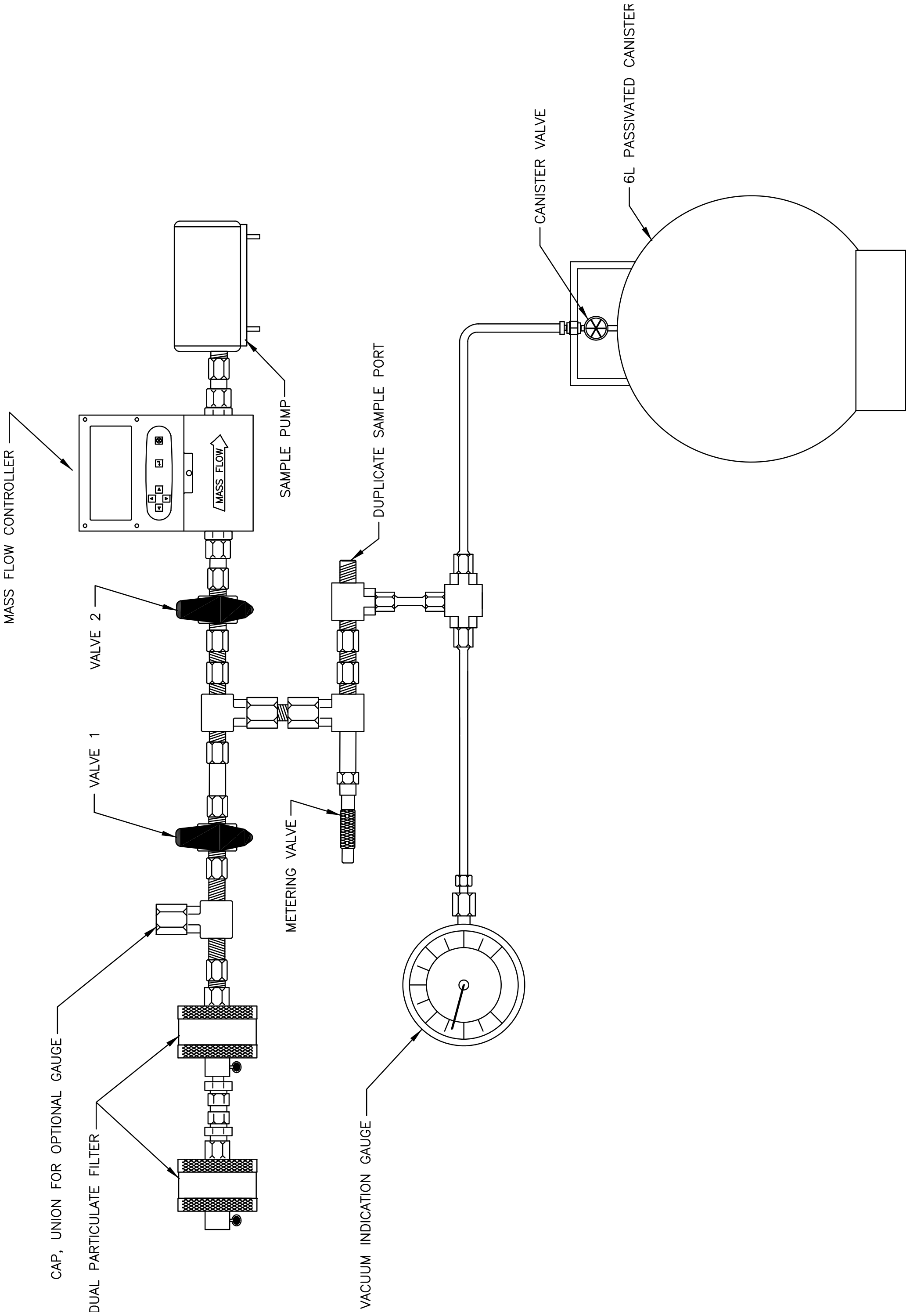


Figure M-80
Typical Disposal Room Sample Head Arrangement



TYPICAL PASSIVE AIR-SAMPLING KIT WITH CANISTER

Figure M-81
VOC Monitoring System Design



TYPICAL SUBATMOSPHERIC SAMPLING ASSEMBLY WITH CANISTER

Figure M-82
VOC Monitoring System Design (continued)

ATTACHMENT N

VOLATILE ORGANIC COMPOUND MONITORING PLAN

ATTACHMENT N

VOLATILE ORGANIC COMPOUND MONITORING PLAN

TABLE OF CONTENTS

LIST OF TABLES

~~LIST OF FIGURES~~

ACRONYMS, ABBREVIATIONS, AND UNITS

ARA	additional requested analyte
BS/BSD	blank spike/blank spike duplicate
CFR	Code of Federal Regulations
CH	contact~~Contact~~-handled
CRQL	contract-required quantitation limit
DOE	U.S. Department of Energy
DRVMP	Disposal Room VOC Monitoring Program
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ft	feet
GC/MS	gas chromatography/mass spectrometry
HI	hazard index
HWDU	Hazardous Waste Disposal Unit
IUR	inhalation unit risk
L	liter
LCS	laboratory control sample
LPEP	Laboratory Performance Evaluation Plan
m	meter
MDL	method detection limit
mm	millimeter
MOC	Management and Operating Contractor
MRL	method reporting limit
~~mtorr~~	~~millitorr~~
NIST	National Institute of Standards and Technology
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
PASK	passive air~~-~~-sampling kit
ppbv	parts per billion by volume
ppmv	parts per million by volume
PT	proficiency testing
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control

RfC	reference concentration
RH	remote-handled
RPD	relative percent difference
RVMP	Repository VOC Monitoring Program
SOP	standard operating procedure
TIC	tentatively identified compound
TRU	transuranic
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant

ATTACHMENT N

VOLATILE ORGANIC COMPOUND MONITORING PLAN

N-1 Introduction

~~This Permit~~ Attachment N describes the monitoring plan for volatile organic compound (**VOC**) emissions from transuranic (**TRU**) mixed waste that may be entrained in the exhaust air from the U.S. Department of Energy (**DOE**) Waste Isolation Pilot Plant (**WIPP**) Underground Hazardous Waste Disposal Units (**HWDUs**) during the disposal phase at the facility. The purpose of VOC monitoring is to ensure compliance with the VOC action levels and limits specified in Permit Part 4. This VOC monitoring plan consists of two programs: (1) the Repository VOC Monitoring Program (**RVMP**), which assesses compliance with the action levels in Permit Part 4, Section 4.6.2.3; and (2) the Disposal Room VOC Monitoring Program (**DRVMP**) ~~(includes ongoing disposal room VOC monitoring)~~, which assesses compliance with the disposal room action levels and limits in Permit Part 4, Tables 4.4.1, 4.4.2, 4.6.3.2, and 4.6.3.3. This plan includes the monitoring design, a description of sampling and analysis procedures, quality assurance (**QA**) objectives, and reporting activities.

N-1a Background

The ~~Underground~~ underground HWDUs are located 2,150 feet (ft) (655 meters [m]) below ground surface at the WIPP facility~~, in the WIPP underground~~. ~~As defined for this Permit, an~~ An ~~Underground~~ underground HWDU is a single excavated panel consisting of seven rooms and two access drifts designated for disposal of contact-handled (**CH**) and remote-handled (**RH**) ~~transuranic (**TRU**)~~ TRU mixed waste. Each room in Panels 1-7 is approximately 300 ft (91 m) long, 33 ft (10 m) wide, and 13 ft (4 m) high. Each room in Panel 8 is approximately 300 ft (91 m) long, 33 ft (10 m) wide, and 16 ft (5 m) high. Access drifts connect the rooms and have the same cross section. The Permittees shall dispose of TRU mixed waste in ~~Underground~~ underground HWDUs designated as Panels 1 through 8, 11, and 12.

This plan addresses the following elements:

1. Rationale for the design of the VOC monitoring programs, based on:
    - Possible pathways from the WIPP underground HWDUs during the active life of the facility,
    - Demonstrating compliance with the disposal room limits by monitoring VOCs in underground disposal rooms,
    - Demonstrating compliance with the ambient air monitoring action levels by monitoring VOC emissions on the surface,
    - VOC sampling operations at the WIPP facility, and
    - Optimum locations for sampling.
2. Descriptions of the specific elements of the VOC monitoring programs, including:

- The type of monitoring conducted,
- Sampling locations,
- The monitoring interval,
- The specific hazardous constituents monitored,
- VOC monitoring schedule,
- Sampling equipment,
- Sampling and analytical techniques,
- Data recording/reporting procedures, and
- Notification and action levels for remedial action.

The technical basis for Disposal Room VOC Monitoring is discussed in detail in the Technical Evaluation Report for Room-Based VOC Monitoring (WRES, 2003).

N-1b Objectives of the Volatile Organic Compound Monitoring Plan

The CH and RH TRU mixed waste disposed in the WIPP ~~Underground~~ underground HWDUs contain VOCs which could be released from the WIPP underground facility during the disposal phase of the project. This Plan describes how:

- VOCs released from waste panels will be monitored to confirm that the running annual average risk to the non-waste surface worker due to VOCs in the air emissions from the ~~Underground~~ underground HWDUs do not exceed the action levels identified in Permit Part 4, Section 4.6.2.3~~.~~ and calculated from measured VOC concentrations using risk factors identified in Table 4.6.2.3. Appropriate remedial action, as specified in Permit Section 4.6.2.4, will be taken if the action levels in Permit Part 4, Section 4.6.2.3 are reached.

- The VOCs released from waste containers in disposal rooms will be monitored to confirm that the concentration of VOCs in the air of closed and active rooms in active panels do not exceed the VOC disposal room limits identified in Permit Part 4, Table 4.4.1 or Table 4.4.2, as appropriate. Remedial action, as specified in Permit Part 4, Section 4.6.3.3, will be taken if the original sample results are greater than or equal to the action levels in Permit Part 4, Table 4.6.3.2 or Table 4.6.3.3, as appropriate.

N-2 Target Volatile Organic Compounds

The target VOCs for repository monitoring (Station VOC-C and VOC-D) and disposal room monitoring are presented in Table N-1.

These target VOCs were selected because together they represent approximately 99 percent of the carcinogenic risk due to air emissions of VOCs.

N-3 Monitoring Design

Detailed design features of this plan are presented in this section. This plan uses available sampling and analysis techniques to measure VOC concentrations in air. Subatmospheric sample collection units are used in the Repository and Disposal Room VOC Monitoring Programs. These sample collection units are described in greater detail in Section N-4a(2).

N-3a Sampling Locations

Air samples will be collected at the WIPP facility to quantify airborne VOC concentrations as described in the following sections.

N-3a(1) Sampling Locations for Repository VOC Monitoring

Mine ventilation air, which could potentially be impacted by VOC emissions from the ~~Underground~~ underground HWDUs identified as Panels 1 through 8, 11, and 12, will exit the underground through the Exhaust Shaft. Building 489 has been identified as the location of the maximum non-waste surface worker exposure. Air samples will be collected from Station VOC-C located at the west air intake for Building 489 (Figure M-78~~N-1~~) to quantify VOCs in the ambient air. Background VOCs will be measured by sampling from Station VOC-D located at groundwater pad WQSP-4 (Figure M-78~~N-1~~). This pad is located approximately one mile southeast (upwind based on the predominant wind direction) of the Exhaust Shaft within the WIPP facility boundary.

N-3a(2) Sampling Locations for Disposal Room VOC Monitoring

For purposes of compliance with Section 310 of Public Law 108-447, the ~~VOC~~ monitoring of airborne VOCs in underground disposal rooms in which waste ~~has been~~ is emplaced will be performed as follows (Figures M-79 and M-80):

1. ~~A sample~~ Sample heads will be installed, prior to the certification of a Panel, in ~~inside~~ the ~~disposal room behind the~~ exhaust ~~drift bulkhead and at the inlet side of the disposal room.~~ and inlet sides of each disposal room, with the exception of Room 1. An inlet sample head will not be installed in Room 1 because panel closure will commence once Room 1 is filled.

2. Sampling at the exhaust side location is initiated when TRU mixed waste ~~will be~~ is emplaced in the active disposal room. Sampling is initiated at the inlet location when the active disposal room is filled.

~~3. When the active disposal room is filled, another sample head will be installed to the inlet of the filled active disposal room. (Figure N-3 and N-4)~~

~~4. The exhaust drift bulkhead will be removed and re-installed in the next disposal room so disposal activities may proceed.~~

~~5. A ventilation barrier will be installed where the bulkhead was located in the active disposal room's exhaust drift. Another ventilation barrier will be installed in the active disposal room's air inlet drift, thereby closing that active disposal room.~~

~~6~~3. ~~Monitoring of VOCs will continue in the now closed disposal room.~~ Monitoring of VOCs will occur in the active disposal room and ~~all~~ the closed disposal rooms in which waste has been emplaced until commencement of panel closure activities (i.e., completion of ventilation barriers in Room 1).

~~This sequence for installing sample locations will proceed in the remaining disposal rooms until the inlet air ventilation barrier is installed in Room 1. An inlet sampler will not be installed in Room 1 because disposal room sampling proceeds to the next panel.~~

N-3b Analytes to Be Monitored

The VOCs that have been identified for repository and disposal room VOC monitoring are listed in Table N-1. The analysis will focus on routine detection and quantification of these target analytes in collected samples. As part of the analytical evaluations, the presence of other compounds (i.e., non-target VOCs) will also be monitored. Some non-target VOCs may be included on the laboratory's target analyte list as additional requested analytes (**ARAs**) to gain a better understanding of potential concentrations and associated risk. The analytical laboratory will be directed to calibrate for ARAs, when necessary. The analytical laboratory will also be directed to classify and report other non-target VOCs as tentatively identified compounds (**TICs**) when tentative identification can be made. The evaluation of TICs in original samples will include those concentrations that are ≥10 percent of the relative internal standard. The evaluation of ARAs only includes concentrations that are greater than or equal to the MRLs listed in Table N-2.

Non-target VOCs classified as ARAs or TICs meet the following criteria: (1) are listed in Appendix VIII of 40 Code of Federal Regulations (**CFR**) Part 261 (incorporated by reference in 20.4.1.200 New Mexico Administrative Code (**NMAC**)), and (2) are detected in 10 percent or more of any original VOC monitoring samples collected over a 12-month timeframe. Non-target VOCs will be added, as applicable, to the analytical laboratory target analyte list for both the repository and disposal room VOC monitoring programs, unless the Permittees can justify their exclusion. Non-target VOCs reported as "unknown" by the analytical laboratory are not evaluated due to indeterminate identifications.

Information regarding additional~~Additional~~ requested analytes and TICs detected in the repository and disposal room VOC monitoring programs will be placed in the WIPP Operating Record and reported to the New Mexico Environment Department (**NMED**) in the Semi-Annual VOC Monitoring Report as specified in Permit Part 4, Section 4.6.2.2. As applicable, the Permittees will also report the justification for exclusion of the ARA or TIC from the target analyte list (e.g., the compound does not contribute to more than one percent of the risk; the compound persists in the background samples at similar concentrations). If new targets are required, the Permittees will submit the appropriate permit modification annually (in October) to update Table 4.6.2.3 to include the new analyte and associated recommended U.S. Environmental Protection Agency (**EPA**) risk values for the inhalation unit risk (**IUR**) and reference concentration (**RfC**). Added compounds will be included in the risk assessment described in Section N-3e(1).

N-3c Sampling and Analysis Methods

~~The VOC monitoring programs include a comprehensive VOC monitoring program established at the facility; equipment, training, and documentation are already in place.~~

The sampling methods used for VOC monitoring are based on the concepts contained in the EPA Compendium Method TO-15 (EPA, 1999). The TO-15 sampling concept uses 6-liter passivated stainless-steel canisters to collect integrated air samples at each sample location. This conceptual method will be used as a reference for collecting the samples at the WIPP facility. The samples will be analyzed using gas chromatography/mass spectrometry (**GC/MS**) under an established QA/quality control (**QC**) program. Laboratory analytical procedures have been developed based on the concepts contained in both TO-15 and SW-846 Method 8260~~B~~. Section N-5 contains additional QA/QC information for this project.

The TO-15 method is an EPA-recognized sampling concept for VOC sampling and speciation. It can be used to provide subatmospheric samples, integrated samples, or grab samples, as well as compound quantitation for a broad range of concentrations. This sampling technique is also viable for use while analyzing the sample using other EPA methods such as SW-846 Method 8260~~B~~.

For subatmospheric sampling, air is collected in an initially evacuated passivated canister. When the canister is opened to the atmosphere, the differential pressure causes the sample to flow into the canister. Flow rate and duration are regulated with a flow-restrictive inlet and flow controller. The air will pass through a particulate filter to prevent sample and equipment contamination. Passivated sampling equipment components are used to inhibit adsorption of compounds on the surfaces of the equipment. The required Method Reporting Limit (**MRL**) for the RVMP is 0.2 parts per billion by volume (**ppbv**) in SCAN mode and 0.1 ppbv in SIM mode. Consequently, low concentrations can be measured. The required MRL for DRVMP is 500 ppbv (0.5 parts per million by volume (**ppmv**)) to allow for reliable quantitation. The MRL is a function of instrument performance, sample preparation, sample dilution, and ~~all~~ steps involved in the sample analysis process. The DRVMP will employ sample collection units that will provide a subatmospheric sample within a short duration (less than 1 hour). Passivated sampling lines will be installed in the disposal room as described in Section N-3a(2) and maintained (to the degree possible) after the room is closed, until the panel associated with the room is closed. The independent lines will run from the sample inlet point to a sampling manifold located in an area accessible to sampling personnel.

N-3d Sampling Schedule

The Permittees will perform sampling on the following schedule in accordance with standard operating procedures.

N-3d(1) Sampling Schedule for Repository VOC Monitoring

Routine collection of a 24-hour time-integrated sample will be conducted two times per week. The RVMP sampling will continue until the certified closure of the last ~~Underground~~ underground HWDU.

N-3d(2) Sampling Schedule for Disposal Room VOC Monitoring

The disposal room sampling in open panels will occur once every two weeks, unless the need to increase the frequency to weekly occurs in accordance with Permit Section 4.6.3.3.

~~Beginning with Panel 3, disposal room sampling in filled panels will occur monthly until final panel closure unless an explosion-isolation wall is installed. The Permittees will sample VOCs in Room 1 of each filled panel.~~

N-3e Data Evaluation and Reporting

N-3e(1) Data Evaluation and Reporting for Repository VOC Monitoring

When the Permittees receive laboratory analytical data from an air~~-~~-sampling event, the data will be validated as specified in Section N-5d. After obtaining validated data from an original surface VOC monitoring sample obtained during an ~~air sampling~~air-sampling event, the data will be evaluated to determine whether the VOC emissions from the ~~Underground~~ underground HWDUs exceed the action levels in Permit Part 4, Section 4.6.2.3. The values are calculated in terms of excess cancer risk for compounds believed to be carcinogenic and in terms of a hazard index (**HI**) for non-carcinogens using the following steps~~as follows~~:

Step 1: Calculate the carcinogenic risk (risk due to exposure to target) for the non-waste surface worker (for each target VOC) using the following equation:

$$R_{VOCj} = \frac{Conc_{VOCj} \times EF \times ED \times IUR_{VOCj} \times 1000}{AT} \qquad \text{(N-1)}$$

Where:

R_{VOCj} *= Risk due to exposure to target* VOC_j

$Conc_{VOC_j}$ *= Concentration target* VOC_j *at the receptor (milligram per cubic meter (**mg/m³**)), calculated as the concentration at VOC-C (mg/m³) – the concentration at VOC-D (mg/m³)*

EF = Exposure frequency (hours/year) = 1,920 hours per year

ED = Exposure duration, years = 10 years

IUR_{VOCj} *= Inhalation unit risk factor from Table 4.6.2.3 (microgram per cubic meter (**µg/m³**))*$^{-1}$

AT = Averaging time for carcinogens, = 613,200 hours based on 70 years

1,000 = µg/mg

Step 2: Calculate the~~The~~ total carcinogenic risk. This is~~ then~~ the sum of the risk due to each carcinogenic target VOC:

~~$Total\ Carcinogen\ ic\ Risk = \sum_{j=1}^{m} R_{VOC_j}$~~ $Total\ Carcinogenic\ Risk = \sum_{j=1}^{m} R_{VOC_j}$ (N-2)

Where:

Total Risk must be less than 10^{-5}

m = the number of carcinogenic target VOCs

Step 3: Calculate ~~The formula for calculating~~ the non-carcinogenic hazard index ~~is similar~~:

$$HI_{VOC_j} = \frac{Conc_{VOC_j} \times EF \times ED}{AT \times RfC_{VOC_j}} \qquad \text{(N-3)}$$

Where:

HI_{VOC_j} *= Hazard Index for exposure to target* VOC_j

$Conc_{VOC_j}$ *= Concentration target* VOC_j *at the receptor (mg/m*^{3}*), calculated as the concentration at VOC-C (mg/m*^{3}*) – the concentration at VOC-D (mg/m*^{3}*)*

EF = Exposure frequency (hours/year) = 1,920 hours per year

ED = Exposure duration, years = 10 years

RfC_{VOC_j} *= Reference concentration from Table 4.6.2.3 (mg/m*^{3}*)*

AT = Averaging time for non-carcinogens, = 87,600 hours, based on exposure duration

Step 4: Calculate the~~The~~ total hazard. This is the sum of the hazard index due to each non-carcinogenic target VOC:

$$\text{Total Hazard Index} = \sum_{j=1}^{m} HI_{VOC_j} \qquad \text{(N-4)}$$

Where:

Hazard Index must be less than or equal to 1.0

m = the number of non-carcinogenic target VOCs

The total carcinogenic risk (Equation N-2) and the total HI (Equation N-4) calculated from the surface VOC concentrations for each sampling event will be compared directly to the action levels in Permit Part 4, Section 4.6.2.3. This will establish whether the combined effect of~~any of~~ the concentrations of VOCs in the emissions from the ~~Underground~~ underground HWDUs exceeded the risk and HI action levels at the time of the sampling.

As specified in Permit Part 4, the Permittees shall notify the Secretary in writing, within seven calendar days of obtaining validated analytical results, whenever the risk or HI exceeds the action levels specified in Permit Part 4, Section 4.6.2.3.

The surface VOC concentrations for each target VOC that is calculated for each sampling event will then be averaged with the surface VOC concentrations calculated for the air-~~-~~sampling events conducted during the previous 12 months. This will be considered the running annual average concentration for each target VOC. The running annual average risk and HI will be compared to action levels specified in Permit Part 4, Section 4.6.2.3. When a VOC is added to the target analyte list, the running annual average concentration will be calculated using all available data.

As specified in Permit Part 4, the Permittees shall notify the Secretary in writing, within seven calendar days of obtaining validated analytical results, whenever the running annual average risk or HI (calculated after each sampling event) exceeds the action levels specified in Permit Part 4, Section 4.6.2.3.

The Permittees will maintain a database with the VOC air-sampling data and the results will be reported to the Secretary as specified in Permit Part 4.

N-3e(2) Data Evaluation and Reporting for Disposal Room VOC Monitoring

When the Permittees receive laboratory analytical data from an air-sampling event, the data will be validated as specified in Section N-5d. The validated data will be evaluated to determine whether the VOC concentrations in the air of any closed room, the active open room, or the immediately adjacent closed room exceeded the ~~Action Levels~~ action levels for DRVMP specified in Permit Part 4, Table 4.6.3.2 or Table 4.6.3.3, as appropriate.

The Permittees shall notify the Secretary in writing, within seven calendar days of obtaining validated analytical results, whenever the concentration of any VOC specified in Permit Part 4, Table 4.4.1 or Table 4.4.2 exceeds the action levels specified in Permit Part 4, Table 4.6.3.2 or Table 4.6.3.3, respectively.

The Permittees shall submit to the Secretary the Semi-Annual VOC Monitoring Report specified in Permit Section 4.6.2.2 that also includes results from disposal room VOC monitoring.

N-4 Sampling and Analysis Procedures

This section describes the equipment and procedures that will be implemented during sample collection and analysis activities for VOCs at the WIPP facility.

N-4a Sampling Equipment

The sampling equipment that will be used includes: 6-liter (L) stainless-steel passivated canisters, passive air-sampling kits (**PASKs**), subatmospheric sampling assemblies, passivated stainless-steel tubing, and one or more in-line filters. A discussion of each of these items is presented below.

N-4a(1) Sample Canisters

Six-liter, stainless-steel canisters with passivated interior surfaces will be used to collect and store all ambient air and disposal room samples for VOC analyses collected as part of the monitoring processes. These canisters will be cleaned and certified (batch certification acceptable for disposal room monitoring) prior to their use, in a manner similar to that described by Compendium Method TO-15. The canisters will be certified clean to below the required reporting limits for the VOC analytical method for the target VOCs. The vacuum of certified clean canisters will be verified as adequate upon initiation of a sample cycle as described in standard operating procedures (**SOPs**). The sample canisters are initially evacuated at the analytical laboratory to <0.05 millimeter of mercury (**mm Hg**) (50 millitorr).

N-4a(2) Sample Collection Units

The sample collection unit for surface VOC samples is a commercially available PASK comprised of components that regulate the rate and duration of air flow into a sample canister. It can be operated either manually, using canister valves, or unattended, using a programmable timer.

The sample collection unit for disposal room VOC monitoring is a subatmospheric sampling assembly that regulates the rate and duration of air flow into a sample canister. The subatmospheric sampling assembly also allows for purging of sample lines to ensure that a representative sample is collected.

Sample collection units will use passivated components for the sample flow path. When sample canisters installed on sample collection units are opened to the atmosphere, the differential pressure causes the sample to flow into the canister at a regulated rate. By the end of each sampling period, the canisters will be near atmospheric pressure. Detailed instructions on sample collection will be given in SOPs. A conceptual diagram of the VOC sample collection units are provided in Figures M-81 and M-82~~N-2~~.

N-4a(3) Sample Tubing

The tubing used as a sample path is comprised of passivated stainless-steel to prevent the inner walls from absorbing sample constituents and/or contaminants when they are pulled from the sample point to the sample collection unit.

N-4b Sample Collection

Sample collection for VOCs at the WIPP facility will be conducted in accordance with written SOPs that are kept on file at the facility. These SOPs will specify the steps necessary to ensure the collection of samples that are of acceptable quality to meet the applicable data quality objectives in Section N-5.

Repository VOC samples will be 24~~-~~-hour time-integrated samples for each sampling event. Alternative sampling durations may be defined for assessment purposes and to meet the data quality objectives. The selection of sampling days will be specified in SOPs and will be alternated from week-to-week in order to avoid potential bias created by plant operations.

Sample flow for the PASK will be set using an in-line mass flow ~~controller~~meter. The flow ~~controllers~~ meters are initially factory-calibrated and specify a typical accuracy of better than 10 percent full scale. Additionally, each air flow ~~controller~~ meter is calibrated at a manufacturer-specified frequency using a National Institute of Standards and Technology (**NIST**) primary flow standard.

To verify the matrix similarity and assess field~~-~~-sampling precision, field duplicate samples will be collected (two canisters filled simultaneously) for each VOC monitoring program at an overall frequency of at least ~~5~~five percent (see Section N-5a).

Prior to collecting the active open disposal room and closed room samples, the sample lines are purged to ensure that the air collected is not air that has been stagnant in the tubing. This is important in regard to the disposal room sample because of the long lengths of tubing associated with these samples.

N-4c Sample Management

Field~~-~~-sampling data sheets will be used to document the sampler conditions under which each sample is collected. These data sheets have been developed specifically for VOC monitoring at the WIPP facility. The individuals assigned to collect the specific samples will be required to fill in all of the appropriate sample data and to maintain this record in sample logbooks. The program team leader will review these forms for each sampling event.

All sample containers will be marked with identification at the time of collection of the sample. A Request-for-Analysis Form will be completed to identify the sample canister number(s), sample type and type of analysis requested.

All samples will be maintained, and shipped if necessary, at ambient temperatures. Collected samples will be transported in appropriate containers. Prior to leaving the underground for analysis, sample containers may undergo radiological screening, which will ensure that contaminated samples or equipment will not be transported to the surface. Samples will not be accepted by the receiving laboratory personnel unless they are properly labeled and sealed to ensure a tamper-free shipment.

An important component of the sampling program is a demonstration that collected samples were obtained from the locations stated and that they reached the laboratory without alteration. To satisfy this requirement, evidence of collection, shipment, laboratory receipt, and custody will be documented with a completed Chain-of-Custody Form. Chain-of-custody procedures will be followed closely, and additional requirements imposed by the laboratory for sample analysis will be included as necessary.

Individuals collecting samples will be responsible for the initiation of custody procedures. The chain of custody will include documentation as to the canister certification, location of sampling event, time, date, and the name of the individual handling the samples. Deviations from procedure will be considered variances. Variances must be preapproved by the program manager and recorded in the project files. Unintentional deviations, sampler malfunctions, and other problems are nonconformances. Nonconformances must be documented and recorded in the project files. All field logbooks/data sheets must be incorporated into the Permittees'~~WIPP's~~ records management program.

N-4d Maintenance of Sample Collection Units

Periodic maintenance for sample collection units and associated equipment will be performed as needed. This maintenance may include cleaning, replacement of damaged or malfunctioning parts, and leak testing. Additionally, complete spare sample collection units will be maintained on-site to minimize downtime because of equipment malfunction.

N-4e Analytical Procedures

Analytical procedures used in the analysis of VOC samples from canisters are based on concepts contained in Compendium Method TO-15 (EPA, 1999) and in SW-846 Method 8260~~B~~ (EPA, 2015~~1996~~).

Analysis of samples will be performed by a certified laboratory. Methods will be specified in procurement documents and will be selected to be consistent with Compendium Method TO-15 (EPA, 1999) or EPA recommended procedures in SW-846 (EPA, 2015~~1996~~). Additional detail on analytical techniques and methods will be given in laboratory SOPs.

The Permittees will establish the criteria for laboratory selection, including the stipulation that the laboratory follow the procedures specified in the appropriate Air Compendium or SW-846 method and that the laboratory follow EPA protocols. The selected laboratory shall demonstrate, through laboratory SOPs, that it will follow appropriate EPA SW-846 requirements and the requirements specified by the EPA Air Compendium protocols. The laboratory shall also provide documentation to the Permittees describing the sensitivity of laboratory instrumentation. This documentation will be retained in the facility ~~operating~~ Operating ~~record~~ Record and will be available for review upon request by NMED.

The SOPs for the laboratory currently under contract will be maintained in the ~~operating~~ Operating ~~record~~ Record by the Permittees. The Permittees will provide NMED with an initial set of applicable laboratory SOPs for information purposes, and provide NMED with ~~any~~ updated SOPs ~~on an annual basis by January 31~~upon request.

Data validation will be performed by the Permittees. Copies of the data validation report will be kept on file in the ~~operating~~ Operating ~~record~~ Record for review upon request by NMED.

N-5 Quality Assurance

The QA activities for the VOC monitoring programs will be conducted in accordance with the documents: *EPA Guidance for Quality Assurance Project Plans QA/G-5* (EPA, 2002) and the *EPA Requirements for Preparing Quality Assurance Project Plans, QA/R-5* (EPA, 2001). The QA criteria for the VOC monitoring programs are listed in Table N-2. This section addresses the methods to be used to evaluate the components of the measurement system and how this evaluation will be used to assess data quality. The QA limits for the sampling procedures and laboratory analysis shall be in accordance with the limits set forth in the specific EPA Method referenced in standard operating procedures employed by either the Permittees or the laboratory. The Permittees standard operating procedures will be in the facility Operating Record and available for review by NMED ~~at anytime~~upon request. The laboratory standard operating procedures will also be in the facility Operating Record and will be supplied to the NMED as indicated in Section N-4e.

N-5a Quality Assurance Objectives for the Measurement of Precision, Accuracy, Sensitivity, and Completeness

QA objectives for this plan will be defined in terms of the following data quality parameters.

Precision. For the duration of this program, precision will be defined and evaluated by the RPD values calculated between field duplicate samples and between laboratory duplicate samples.

$$RPD = \left(\frac{(A - B)}{(A + B)/2} \right) * 100 \quad RPD = \frac{(A-B)}{(A+B)/2} \times 100 \qquad \text{(N-5)}$$

Where

A = Original sample result

B = Duplicate sample result

Accuracy. Analytical accuracy will be defined and evaluated through the use of analytical standards. Because recovery standards cannot reliably be added to the sampling stream, overall system accuracy will be based on analytical instrument performance evaluation criteria. These criteria will include performance verification for instrument calibrations, laboratory control samples, sample surrogate recoveries (when required by method or laboratory SOPs), and sample internal standard areas. Use of the appropriate criteria as determined by the analytical method performed, will constitute the verification of accuracy for target analyte quantitation (i.e., quantitative accuracy). Evaluation of standard ion abundance criteria for bromofluorobenzene~~BFB~~ will be used to evaluate the accuracy of the analytical system in the identification of targeted analytes, as well as the evaluation of unknown contaminants (i.e., qualitative accuracy).

Sensitivity. Sensitivity will be defined by the required MRLs for the program. Attainment of required MRLs will be verified by the performance of statistical method detection limit (**MDL**) studies in accordance with 40 ~~*Code of Federal Regulations* §~~ CFR Part 136. The MDL represents the minimum concentration that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. An MDL study will be performed by the program analytical laboratory prior to sampling and analysis, and annually thereafter.

Completeness. Completeness will be defined as the percentage of the ratio of the number of valid sample results received (i.e., those which meet data quality objectives) versus the total number of samples collected. Completeness may be affected, for example, by sample loss or destruction during shipping, by laboratory sample handling errors, or by rejection of analytical data during data validation.

N-5a(1) Evaluation of Laboratory Precision

Laboratory sample duplicates and blank spike/blank spike duplicates (**BS/BSD**) will be used to evaluate laboratory precision. QA objectives for laboratory precision are listed in Table N-2~~,~~ and are based on precision criteria proposed by the EPA for canister sampling programs (EPA, 1991). These values will be appropriate for the evaluation of samples with little or no matrix effects. Because of the potentially high level of salt-type aerosols in the WIPP underground environment, the analytical precision achieved for WIPP samples may vary with respect to the EPA criteria. RPDs for BS/BSD analyses will be tracked through the use of control charts. RPDs obtained for laboratory sample duplicates will be compared to those obtained for BS/BSDs to ascertain any sample matrix effects on analytical precision. BS/BSDs and laboratory sample duplicates will be analyzed at a frequency of 10 percent, or one per analytical lot, whichever is more frequent.

N-5a(2) Evaluation of Field Precision

Field duplicate samples will be collected at a frequency of at least ~~5~~five percent for the RVMP and at least ~~5~~five percent for the DRVMP. The data quality objective for field precision is 35 percent for each set of field duplicate samples.

N-5a(3) Evaluation of Laboratory Accuracy

Quantitative analytical accuracy will be evaluated through performance criteria on the basis of (1) relative response factors generated during instrument calibration, (2) analysis of laboratory control samples (**LCS**), and (3) recovery of internal standard compounds. The criteria for the initial calibration (~~5~~five-point calibration) is $\leq$ 30 percent relative standard deviation for target analytes. After the successful completion of the ~~5~~five-point calibration, it is sufficient to analyze only a midpoint standard for every 24 hours of operation. The midpoint standard will pass a 30 percent difference acceptance criterion for each target compound before sample analysis may begin.

A blank spike or LCS is an internal QC sample generated by the analytical laboratory by spiking a standard air matrix (humid zero air) with a known amount of a certified reference gas. The reference gas will contain the target VOCs at known concentrations. Percent recoveries for the target VOCs will be calculated for each LCS relative to the reference concentrations. Objectives for percent recovery are listed in Table N-2~~,~~ and are based on accuracy criteria proposed by the EPA for canister sampling programs (EPA, 1991). ~~LCSs~~Laboratory control samples will be analyzed at a frequency of 10 percent, or one per analytical lot, whichever is more frequent.

Internal standards will be introduced into each sample analyzed~~,~~ and will be monitored as a verification of stable instrument performance. In the absence of any unusual interferences, areas should not change by more than 40 percent over a 24-hour period. Deviations larger than 40 percent are an indication of a potential instrument malfunction. If an internal standard area in a given sample changes by more than 40 percent, the sample will be reanalyzed. If the 40 percent criterion is not achieved during the reanalysis, the instrument will undergo a performance check and the midpoint standard will be reanalyzed to verify proper operation. Response and recovery of internal standards will also be compared between samples, LCSs, and calibration standards to identify any matrix effects on analytical accuracy.

N-5a(4) Evaluation of Sensitivity

The presence of aerosol salts in underground locations may affect the MDL of the samples collected in those areas. The sample inlet of these sample collection units will be protected sufficiently from the underground environment to minimize salt aerosol interference. Up to two filters, inert to VOCs, will be installed in the sample flow path to minimize particulate interference.

The MDL for each of the target VOCs will be evaluated by the analytical laboratories before sampling begins. The initial and annual MDL evaluation will be performed in accordance with 40 ~~*Code of Federal Regulations* §~~CFR Part 136, and with EPA/530-SW-90-021, as revised and retitled, “Project Quality Assurance and Quality Control” (Chapter 1 of SW-846) (2015~~1996~~).

N-5a(5) Completeness

The expected completeness for this program is greater than or equal to 95 percent. Data completeness will be tracked monthly.

N-5b Sample Handling and Custody Procedures

Sample packaging, shipping, and custody procedures are addressed in Section N-4c.

N-5c Calibration Procedures and Frequency

Calibration procedures and frequencies for analytical instrumentation are listed in Section N-4e.

N-5d Data Reduction, Validation, and Reporting

Field-sampling data sheets will ~~contain documentation of all pertinent data for the sampling and will~~ at a minimum include the following; sample identification, sample location, sample collection date, initial vacuum, ending vacuum, collection start and collection stop time~~,~~ and flow rate ~~and ambient temperature~~.

Data validation procedures will include at a minimum, a check of all field data sheets for completeness and correctness. Sample custody and analysis records will be reviewed by the analytical laboratory QA officer and the analytical laboratory supervisor at a frequency of at least 10 percent.

Electronic Data Deliverables (**EDDs**) are provided by the laboratory prior to receipt of ~~hard~~ certified copy data packages. Electronic Data Deliverables~~EDDs~~ will be evaluated within five calendar days of receipt to determine if VOC concentrations are at or above action levels in Permit Part 4, Section 4.6.3.2 for disposal room VOC monitoring data, or the action levels specified in Permit Part 4, Section 4.6.2.3 for repository monitoring data. If the EDD indicates that VOC concentrations are at or above these action levels or concentrations, the ~~hard~~ certified copy data package will be validated within five calendar days as opposed to the 14 calendar day time frame.

Data will be reported as specified in Section N-3(e) and Permit Part 4.

Acceptable data for this VOC monitoring plan will meet stated precision and accuracy criteria. The QA objectives for precision, accuracy, and completeness as shown in Table N-2 can be achieved when established methods of analyses are used as proposed in this plan and standard sample matrices are being assessed.

N-5e Performance and System Audits

The Permittees will evaluate whether the monitoring systems and analytical methods are functioning properly through performance and system audits. The assessment period will be determined by the Permittees. System audits will initially address start-up functions for each phase of the project. These audits will consist of on-site evaluation of materials and equipment, review of certifications for canisters and measurement and test equipment, review of laboratory qualification and operation and, at the request of the QA officer, an on-site audit of the laboratory facilities. The function of the system audit is to verify that the requirements in this plan have been met prior to initiating the program. System audits will be performed at or shortly after the initiation of the VOC monitoring programs and on an annual basis thereafter.

Performance audits will be accomplished as necessary through the evaluation of analytical QC data by performing periodic site audits throughout the duration of the project, and through the introduction of third-party audit cylinders (laboratory blinds) into the analytical sampling stream. Performance audits will also include a surveillance/review of data associated with canister certifications and measurement and test equipment, a project-specific technical audit of field operations, and a laboratory performance audit. Field logs, logbooks, and data sheets, as applicable will be reviewed during data validation. Blind-audit canisters will be introduced once during the sampling period. Details concerning scheduling, personnel, and data quality evaluation are addressed in the QAPjP.

~~By May 1, 2016 the Permittees shall develop and implement a RVMP Laboratory Performance Evaluation Plan (**LPEP**) that has been reviewed and approved by the Secretary prior to use, for Repository VOC ambient monitoring. In addition to the timely submittal of validated data packages under this LPEP to the Secretary, the results shall also be reported annually in the October Semi- Annual VOC Monitoring Report. The second contract laboratory performing the performance evaluation to be used for comparison to the primary contract laboratory shall use the required MRLs as required in Table N-2, which are defined to be equivalent to the CRQLs. Any contract laboratory involved in this program shall have a site specific quality assurance project plan and an associated QA/QC program that are acceptable and aligned with EPA guidance. The LPEP shall, at a minimum, include the following sections:~~

1. ~~Table of Contents~~
2. ~~Introduction~~
3. ~~Background~~
4. ~~Scope/Objectives: this section shall include comparative testing of subatmospheric sampling containers, the field background canisters, and a test of the cleanliness of the canister less than the SIM mode MRL in Table N-2.~~
5. ~~Laboratory Specific SOPs~~
6. ~~Sampling Methodologies~~
7. ~~Analytical Methodologies~~
8. ~~Quality Assurance Requirements~~
9. ~~Schedules~~
10. ~~Reporting: data packages shall contain all applicable sections found in the document "*Statement-of-Work for the Analysis of Air Toxics from Superfund Sites*" (EPA 1990), Exhibit B, Section 2, "*Reporting Requirements and Order of Data Deliverables*" and as approved by the Secretary.~~

~~As an alternative to the LPEP, the Permittees will notify the Secretary of their intention to require the contract laboratory to participate in proficiency testing.~~ The Permittees ~~will then, within 90 days, submit to the NMED for approval, a proposal for proficiency testing. If the Permittees are unable to develop a proficiency testing plan that is acceptable to the NMED, then the Permittees will prepare and submit the LPEP~~have implemented a proficiency testing (**PT**) plan. The ~~proposal for proficiency testing will~~PT plan includes the following, as applicable:

- Specific analytical method(s),
- Schedule for proficiency testing implementation, and

- Provision for the periodic reporting of proficiency testing results and corrective actions, if any.

Results of ~~proficiency testing~~ PT will be reported in the Semi-Annual VOC Monitoring Report as specified in Permit Part 4, Section 4.6.2.2.

N-5f Preventive Maintenance

Maintenance of sample collection units is described briefly in Section N-4d Maintenance of analytical equipment will be addressed in the analytical laboratory SOP.

N-5g Corrective Actions

If the required completeness of valid data (95 percent) is not maintained, corrective action may be required. Corrective action for field~~-~~-sampling activities may include recertification and cleaning of sample collection units, reanalysis of samples, additional training of personnel, modification to field and laboratory procedures, and recalibration of measurement and test equipment.

Laboratory corrective actions may be required to maintain data quality. The laboratory continuing calibration criteria indicate the relative response factor for the midpoint standard will be less than 30 percent different from the mean relative response factor for the initial calibration. Differences greater than 30 percent will require recalibration of the instrument before samples can be analyzed. If the internal standard areas in a sample change by more than 40 percent, the sample will be reanalyzed. If the 40 percent criterion is not achieved during the reanalysis, the instrument will undergo a performance check and the midpoint standard will be reanalyzed to verify proper operation. Deviations larger than 40 percent may indicate instrument malfunction.

The laboratory results for samples, duplicate analyses, LCSs, and blanks should routinely be within the QC limits. If results exceed control limits, the reason for the nonconformances and appropriate corrective action must be identified and implemented.

N-5h Records Management

The VOC ~~Monitoring Programs~~ monitoring programs will require administration of record files (both laboratory and field data collection files). The records control systems will provide adequate control and retention for program-related information. Records administration, including QA records, will be conducted in accordance with applicable DOE, MOC, and WIPP Project requirements.

Unless otherwise specified, VOC monitoring plan records will be retained as lifetime records. Temporary and permanent storage of QA records will occur in facilities that prevent damage from temperature, fire, moisture, pressure, excessive light, and electromagnetic fields. Access to stored VOC Monitoring Program QA Records will be controlled and documented to prevent unauthorized use or alteration of completed records.

Revisions to completed records (i.e., as a result of audits or data validation procedures) may be made only with the approval of the responsible program manager and in accordance with applicable QA procedures. Records of project activities will be maintained at the WIPP site. Documentation will be available for inspection by internal and external auditors.

~~N-6 Sampling and Analysis Procedures for Disposal Room VOC Monitoring in Filled Panels~~

~~Disposal room VOC samples in filled panels will be collected using the subatmospheric pressure grab sampling technique described in Compendium Method TO-15 (EPA, 1999). This method uses an evacuated passivated canister (or equivalent) that is under vacuum (0.05 mm Hg) to draw the air sample from the sample lines into the canister. The sample lines will be purged prior to sampling to ensure that a representative sample is collected. The passivation of tubing and canisters used for VOC sampling effectively seals the inner walls and prevents compounds from being retained on the surfaces of the equipment. By the end of each sampling period, the canisters will be near atmospheric pressure.~~

~~The analytical procedures for disposal room VOC monitoring in filled panels are the same as specified in Section N-4e.~~

N-~~7~~6 References

40 CFR Part 136, "*Guidelines Establishing Test Procedures for the Analysis of Pollutants*."

Section 310 of Public Law 108-447 of the *Consolidated Appropriations Act of 2005.*

U.S. Environmental Protection Agency, 1991. Contract Laboratory Program, *Volatile Organics Analysis of Ambient Air in Canisters (Draft)*, EPA540/R-94-085, December 1991, Washington, D.C.

~~U.S. Environmental Protection Agency. 1996. SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. Third Edition. Office of Solid Waste and Emergency Response, Washington, D.C.~~

U.S. Environmental Protection Agency. 1*999 Compendium Method TO-15: Determination of Volatile Organic Compounds (VOCs) In Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)*, EPA 625/R-96/010b. Center for Environmental Research Information, Office of Research and Development, Cincinnati, OH, January 1999.

U.S. Environmental Protection Agency. 2001. *EPA Requirements for Quality Assurance Project Plans, QA/R-5*, EPA 240/B-01/003, March 2001, Washington, D.C.

U.S. Environmental Protection Agency. 2002. *Guidance for Quality Assurance Project Plans*, QA/G-5*,* EPA 240/R-02/009, December 2002, Washington, D.C.

U.S. Environmental Protection Agency. 2015. SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. Office of Solid Waste and Emergency Response, Washington, D.C.

Washington Regulatory and Environmental Services, 2003. *Technical Evaluation Report for WIPP Room-Based VOC Monitoring*.

TABLES

Table N-1

Target Analytes and Methods for Repository VOC (Station VOC-C and VOC-D) Monitoring and Disposal ~~VOC~~ Room VOC Monitoring

Target Analyte	EPA Standard Analytical Method
Carbon tetrachloride	EPA TO-15[a] EPA 8260~~B~~[b]
Chlorobenzene	
Chloroform	
1,1-Dichloroethylene	
1,2-Dichloroethane	
Methylene chloride	
1,1,2,2--Tetrachloroethane	
Toluene	
1,1,1--Trichloroethane	
Trichloroethylene	

[a] U.S. Environmental Protection Agency, 1999, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air- Second Edition, http://www.epa.gov/ttn/amtic/airtox.html

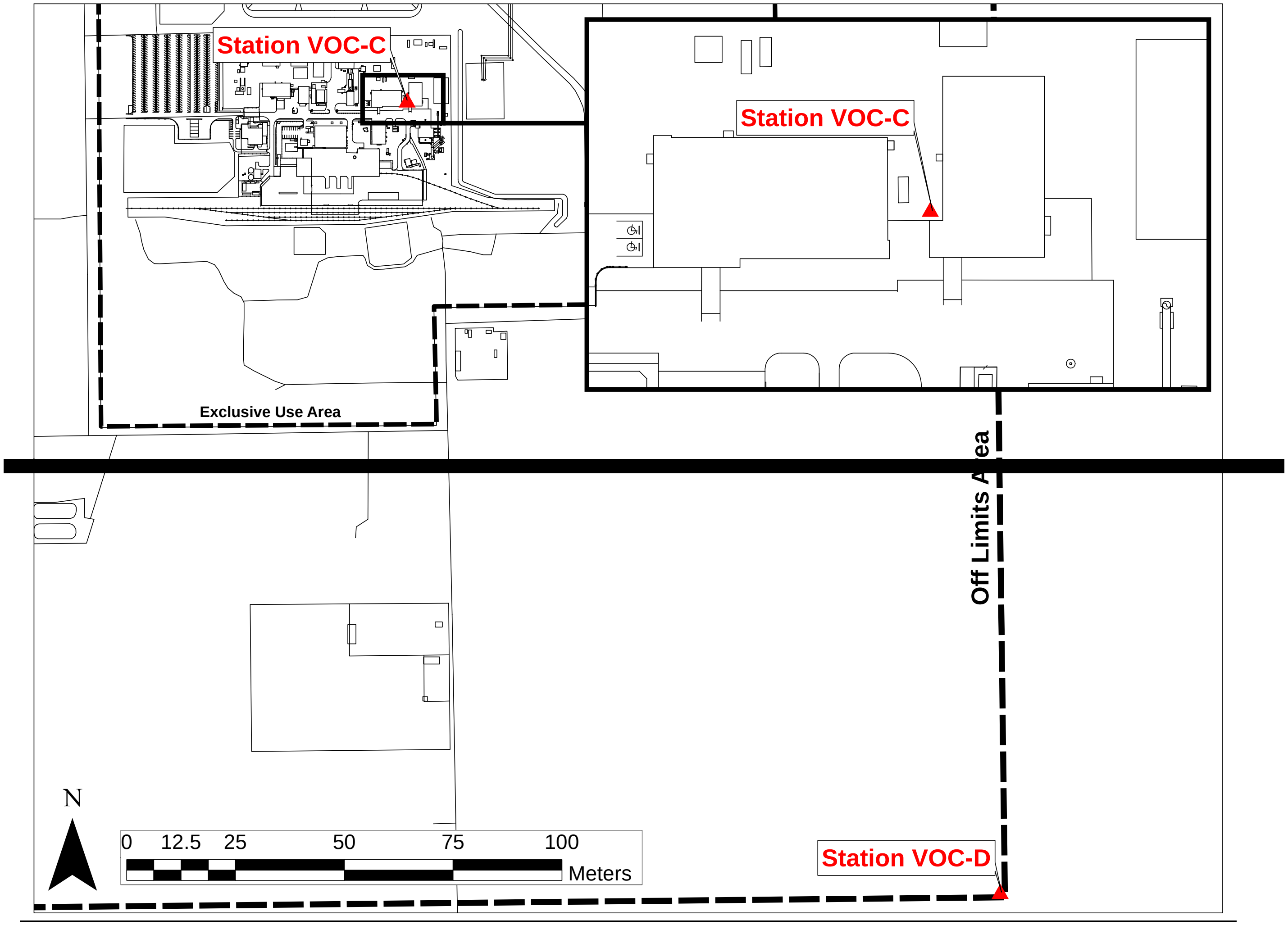
[b] U.S. Environmental Protection Agency, SW-846 Test Methods for Evaluation Solid Wastes, Chemical and Physical Methods, ~~http://www.epa.gov/epaoswer/hazwaste/test/main.htm~~https://www.epa.gov/hw-sw846/sw-846-compendium

Table N-2
Quality Assurance Objectives for Accuracy, Precision, Sensitivity, and Completeness

Target Analyte	Accuracy (Percent Recovery)	Precision (RPD)		Required Repository Surface Monitoring MRL for SCAN Mode (ppbv)	Required Repository Surface Monitoring MRL for SIM Mode (ppbv)	Required Disposal Room MRL (ppbv)	Complete-ness (Percent)
		Laboratory	Field				
Carbon tetrachloride	60 to 140	25	35	0.2	0.1	500	95
Chlorobenzene	60 to 140	25	35	0.2	0.1	500	95
Chloroform	60 to 140	25	35	0.2	0.1	500	95
1,1-Dichloroethylene	60 to 140	25	35	0.2	0.1	500	95
1,2-Dichloroethane	60 to 140	25	35	0.2	0.1	500	95
Methylene chloride	60 to 140	25	35	0.2	0.1	500	95
1,1,2,2-Tetrachloroethane	60 to 140	25	35	0.2	0.1	500	95
Toluene	60 to 140	25	35	0.2	0.1	500	95
1,1,1-Trichloroethane	60 to 140	25	35	0.2	0.1	500	95
Trichloroethylene	60 to 140	25	35	0.2	0.1	500	95

MRL	maximum method reporting limit for undiluted samples
RPD	relative percent difference

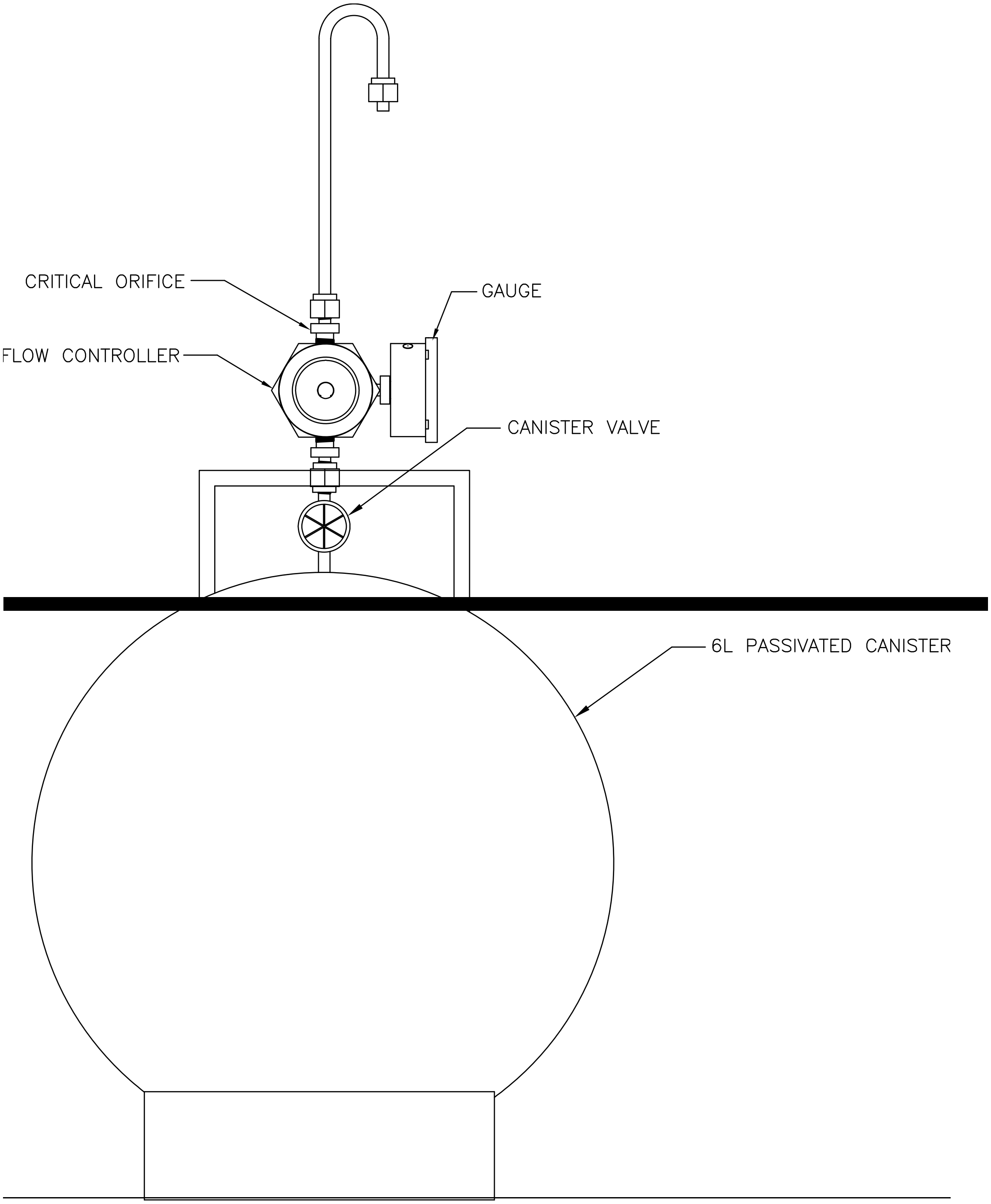
~~FIGURES~~



~~(see Figure D-1 and Figure D-1a for a detailed map and legend of the suface buildings)~~

~~Figure N-1~~
~~Repository VOC Monitoring Locations~~

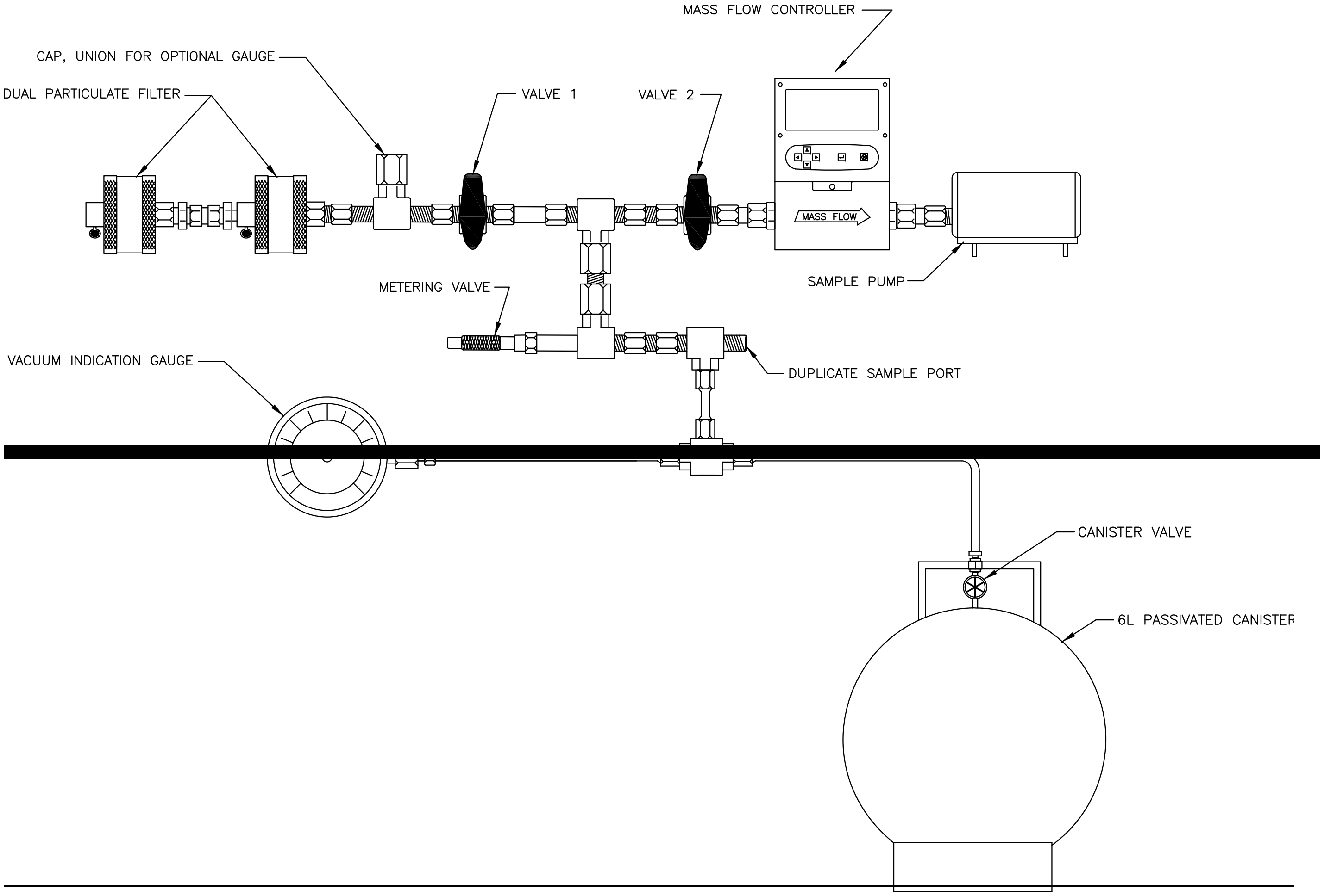
1



~~TYPICAL PASSIVE AIR SAMPLING KIT WITH CANISTER~~

~~**Figure N-2**~~
~~**VOC Monitoring System Design**~~

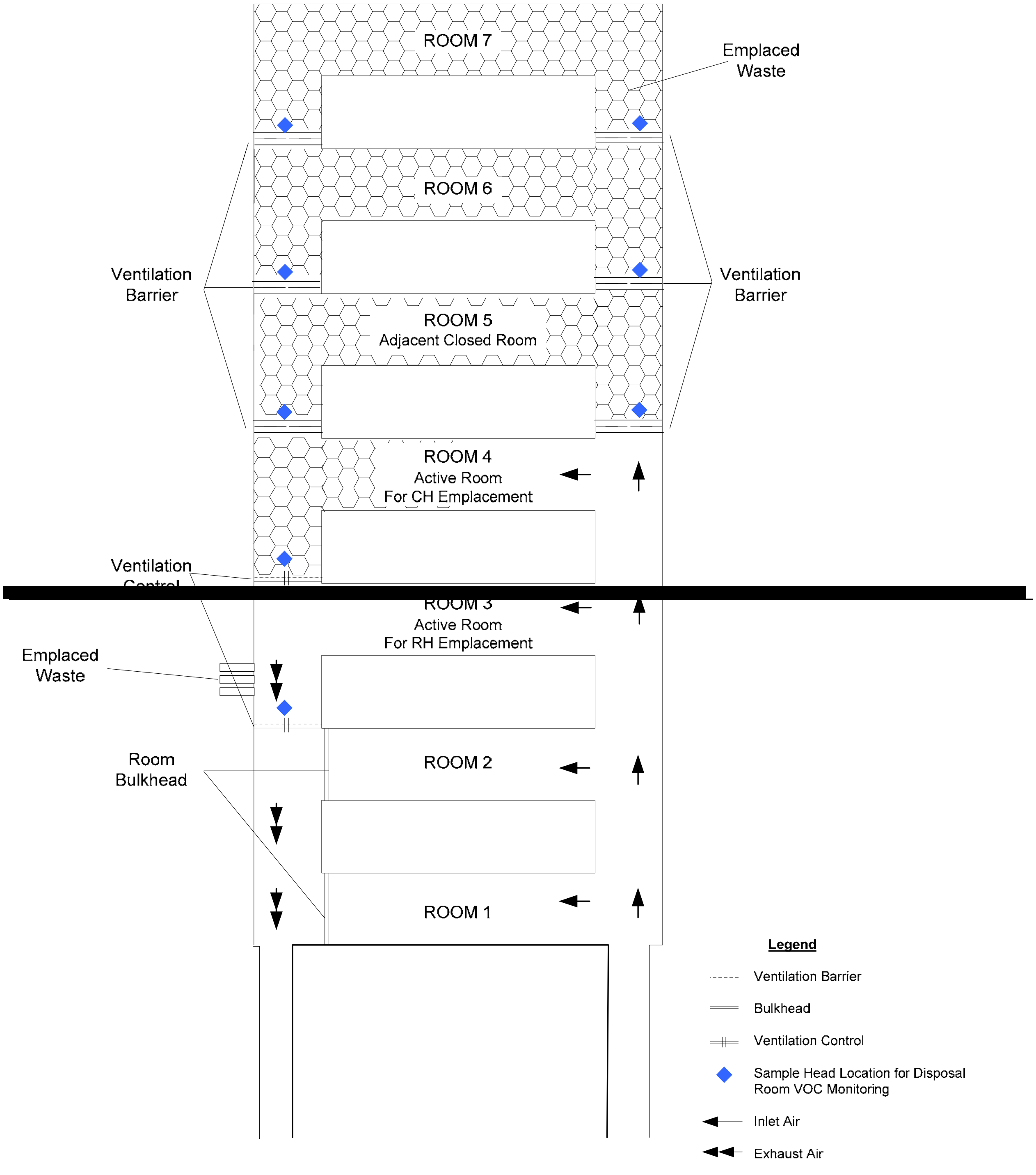
1



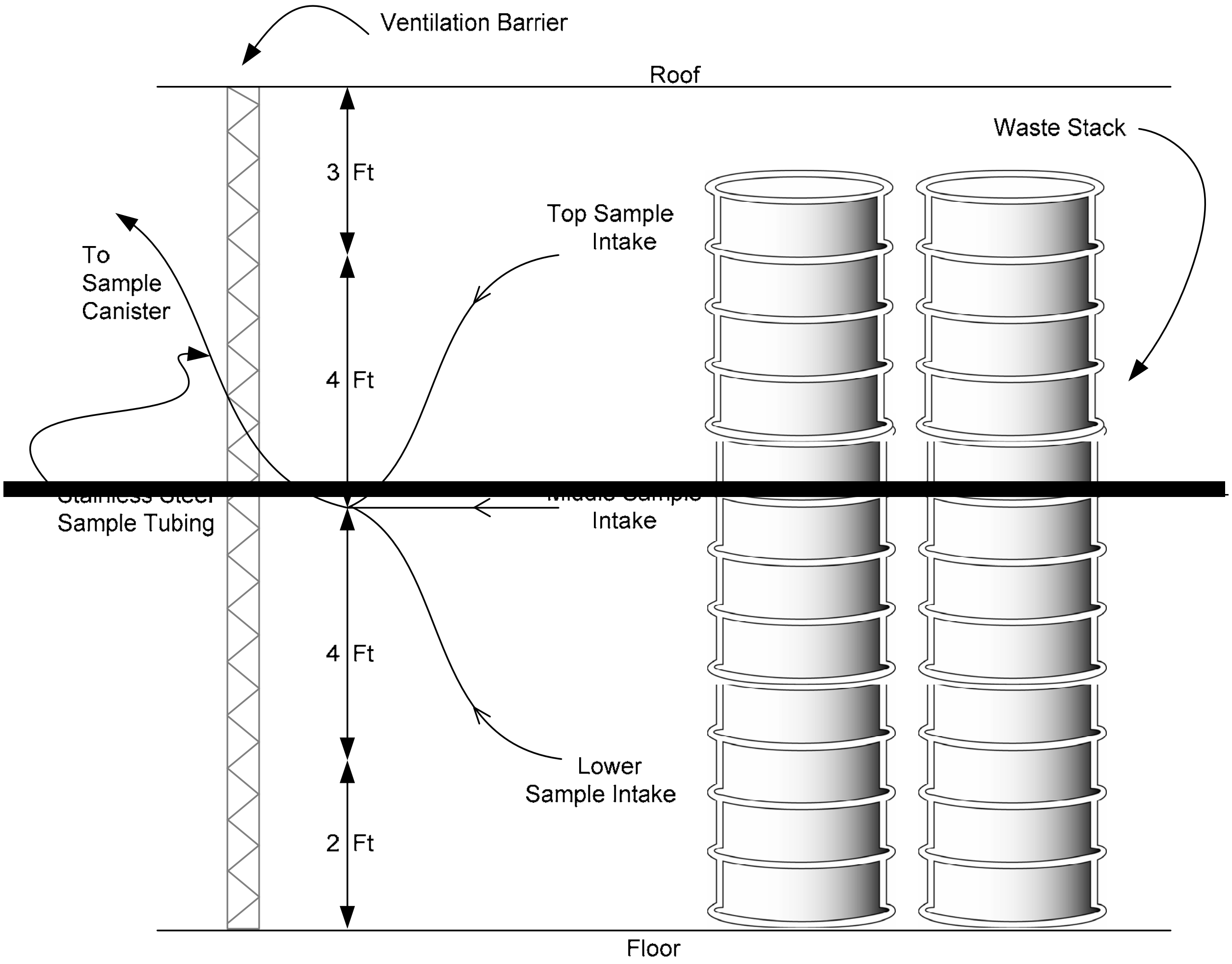
~~TYPICAL SUBATMOSPHERIC SAMPLING ASSEMBLY WITH CANISTER~~

~~Figure N-2~~
~~VOC Monitoring System Design (continued)~~

1

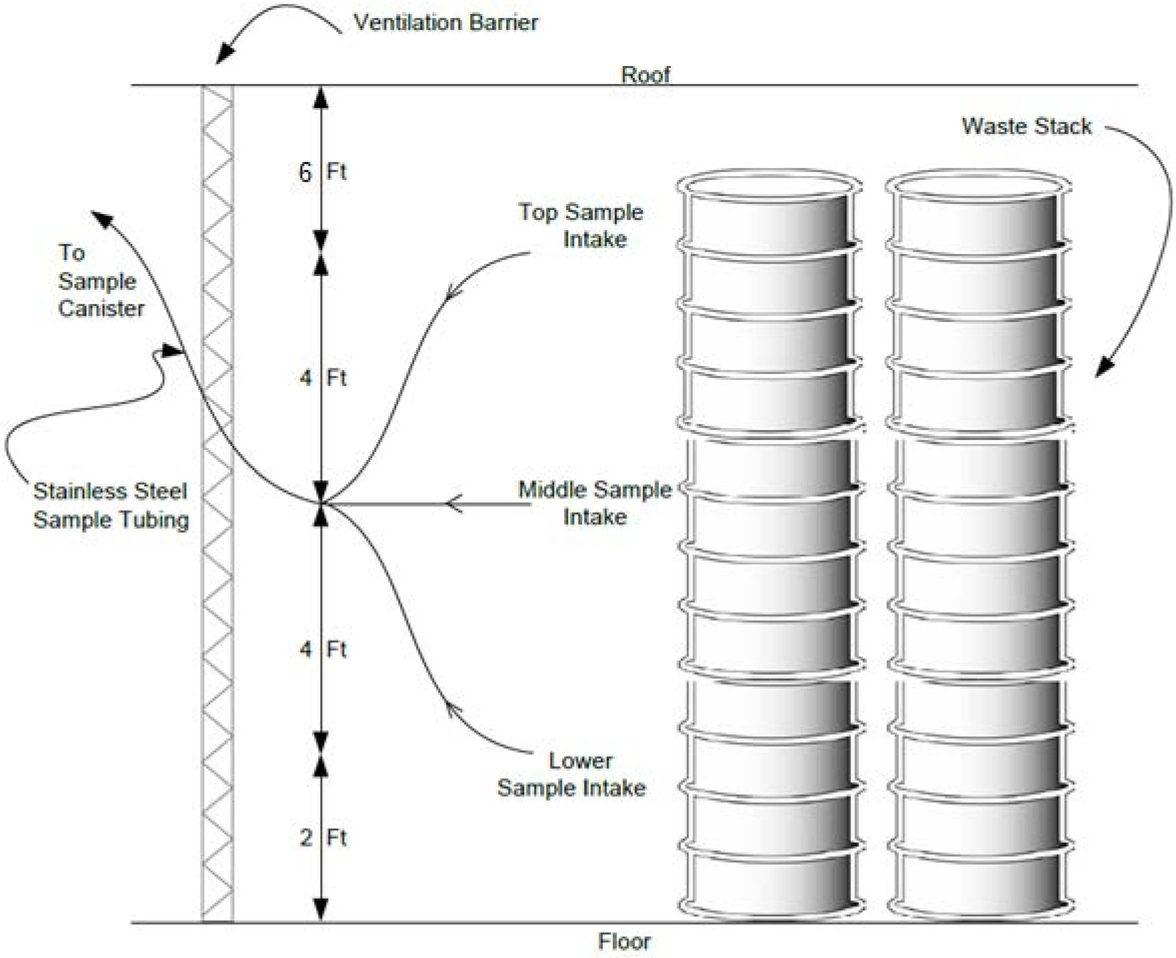

[redacted]

~~Figure N-3~~
~~Typical Disposal Room VOC Monitoring Locations~~



(not to scale, all measurements approximate)

~~Figure N-4a~~
~~Disposal Room Sample Head Arrangement for Panels 1-7~~



~~Figure N-4b~~
~~Disposal Room Sample Head Arrangement for Panel 8~~

1

ATTACHMENT O

WIPP MINE VENTILATION RATE MONITORING PLAN

ATTACHMENT O

WIPP MINE VENTILATION RATE MONITORING PLAN

TABLE OF CONTENTS

List of Tables

ATTACHMENT O

WIPP MINE VENTILATION RATE MONITORING PLAN

O-1 Definitions

Compliance with the mine ventilation requirements set forth in Permit Part 4 and Permit Attachment A2 requires the use and definition of the following terms:

Actual cubic feet per minute (acfm): The volume of air passing a fixed point in an excavation, normally determined as the product of the cross section of the excavation and the mean velocity of the air.

Standard cubic feet per minute (scfm): The actual cubic feet per minute passing a fixed point adjusted to standard conditions. In the Imperial measurement system, the standard condition for pressure is 14.7 pounds per square inch (**psi**) (sea level) and the standard condition for temperature is 492 degrees Rankine (freezing point of water or 32 degrees Fahrenheit). The greatest difference between acfm and scfm occurs in the summer when the pressure at the repository horizon is about 14.2 psi and the temperature is about 560 degrees Rankine (100 degrees Fahrenheit). Then

$$1 \text{ scfm} \times (560/492) \times (14.7/14.2) = 1.2 \text{ acfm}$$

A reasonably conservative conversion factor, therefore, is 1.2. Using this factor, 35,000 scfm is very nearly 35,000 x 1.2 or 42,000 acfm.

Restricted Access: If the required ventilation rate in an active disposal room when waste disposal is taking place cannot be achieved or cannot be supported due to operational needs, access is restricted by the use of barriers, signs and postings, or individuals stationed at the entrance to the active disposal room when ventilation rates are below 35,000 scfm unless measures as described in Section O-3b(1) are implemented. Note: As provided in Section O-3b(2) entry to restricted access active rooms for the purpose of establishing normal ventilation is allowed.

Shift: Those work shifts when there is normal access to the Waste Isolation Pilot Plant (**WIPP**) underground.

Worker: Anyone who has ~~normal~~ unescorted access to the WIPP underground.

O-2 Objective

The objective of this plan is to describe how the ventilation requirements in the Permit will be met. This plan achieves this objective and documents the process by which the Permittees demonstrate compliance with the ventilation requirements by:

- Maintaining a minimum of 35,000 scfm of air through the active rooms when waste disposal is taking place and when workers are present in the rooms

- If an active room ventilation rate of 35,000 scfm cannot be met, actions as described in Section O-3b(1) shall be taken during waste disposal operations when workers are present.

~~This plan contains the following elements: Objective; Design and Procedures; Equipment Calibration and Maintenance; Reporting and Record Keeping; Quality Assurance.~~

O-3 Design and Procedures

This section describes the three basic processes that make up the mine ventilation rate monitoring plan:

- Test and Balance, a periodic re-verification of the satisfactory performance of the entire underground ventilation system and associated components

- Monitoring of active disposal room(s) to ensure a minimum flow of 35,000 scfm whenever waste disposal is taking place and workers are present in the room

- If an active disposal room ventilation rate of 35,000 scfm cannot be met, actions as described in Section O-3b(1) shall be taken during waste disposal operations when workers are present.

O-3a Test and Balance

O-3a(1) Test and Balance Process

The WIPP underground ventilation system and the underground ventilation modes of operation are described in Permit Attachment A2, Section A2-2a(3). The Permittees shall verify underground ventilation system performance by conducting a periodic Test and Balance. The Test and Balance is a comprehensive series of measurements and adjustments designed to ensure that the system is operating within acceptable design parameters. The Test and Balance is an appropriate method of verifying system flow because it provides consistent results based on good engineering practices. The testing of underground ventilation systems is described in McPherson, 2009~~1993~~. Once completed, the Test and Balance data become the baseline for underground ventilation system operation until the next Test and Balance is performed.

The “Test” portion of the process shall involve measuring the pressure drop and air quantity of every underground entry excluding alcoves or other dead end drifts. In addition, the tests shall verify resistance curves for each of the main regulators, measure shaft resistance, and measure main fan pressure and quantity. This is done at the highest achievable airflow to facilitate accurate measurements. From these measurements the frictional resistance of the system is determined.

Pressure shall be measured using the gage and tube method, which measures the pressure drop between two points using a calibrated pressure recording device and pitot tubes. Pressure drops across the shafts shall be measured by either calibrated barometers at the top and bottom of shafts or the gage and tube method. Airflow shall be measured using a calibrated ~~vane~~ anemometer to take a full entry traverse between system junctions. Fan pressure shall be measured using a calibrated pressure recording device and pitot tube to determine both static and velocity pressure components.

Multiple measurements shall be taken at each field location to ensure accurate results. Consecutive field values must fall within ±5% to be acceptable. These data shall be verified during the testing process by checking that:

- the sum of airflows entering and leaving a junction is equal to zero; and,
- the sum of pressure drops around any closed loop is equal to zero.

Once the measurements are taken, data shall be used to calculate the resistance of every underground drift, as well as shafts and regulators using Atkinson's Square Law

$$P=R \times Q^2$$

where the pressure drop of an entry (P) is equal to a resistance (R) times the square of the quantity of air flowing (Q) through the circuit.

The "Balance" portion of the process shall involve adjusting the settings of the system fans and regulators to achieve the desired airflow distribution in all parts of the facility for each mode of operation. The system baseline settings for the current Balance shall be established from the previous Test and Balance. Adjustments shall then be made to account for changes in system resistance due to excavation, convergence due to salt creep, approved system modifications, or operational changes.

The Permittees shall use ~~a commercially available~~an appropriate ventilation simulator to process Test and Balance field data. The simulator uses the Hardy-Cross Iteration Method (McPherson, 2009~~1993~~) to reduce field data into a balanced ventilation network, including the appropriate regulator settings necessary to achieve proper airflow distribution for the various operating modes. Once balanced, the same simulator shall be used to evaluate changes such as future repository development and potential system modification before they are implemented.

The Test and Balance process culminates in a final report which is retained on site. Following receipt of the Test and Balance Report, the Permittees shall revise the WIPP surface and underground ventilation system procedures to incorporate any required changes to the ventilation system configuration. The Test and Balance data shall be used to adjust the operating range of fan controls, waste tower pressure, auxiliary air intake tunnel regulator settings, underground regulator settings, and door configurations. The model data and procedure changes shall be used to establish normal configuration settings to achieve the desired airflow in the underground. These settings shall then be modified by operations personnel throughout the year to compensate for system fluctuations caused by seasonal changes in psychrometric properties, and to meet specific operational needs. This ensures that the facility is operated at the design airflow rate for each ventilation mode.

O-3a(2) Test and Balance Schedule

The Test and Balance is generally conducted on a 12- to 18-month interval, but in no case shall the interval between consecutive Test and Balance performances exceed 18 months. This interval is sufficient to account for changes in the mine configuration since over this period the ventilated volume changes very little. ~~The quality and maintenance of ventilation control structures (e.g., bulkheads) is excellent, so leakage is small and relatively~~

~~constant.~~Maintenance of ventilation control structures (e.g., bulkheads) occurs periodically to ensure the ventilation structure performs as expected. Historic test and balance results confirm that changes between test and balances fall within anticipated values.

O-3b Active Room Minimum Airflow

O-3b(1) Verification of Active Room Minimum Airflow

Whenever workers are present, the Permittees shall verify the minimum airflow through active room(s) when waste disposal is taking place of 35,000 scfm at the start of each shift, any time there is an operational mode change, or if there is a change in the ventilation system configuration. If an active room ventilation rate of 35,000 scfm cannot be met, measures such as those described below shall be taken during waste disposal operations when workers are present.

Measures to allow waste emplacement in an active room when, under abnormal conditions, 35,000 scfm cannot be achieved will be prescribed in standard operating procedure(s) **(SOPs)** described in Section O-5c. These measures may include, but are not limited to, the following: the adjustment of the volatile organic compound (**VOC**) immediately dangerous to life or health ~~(**IDLH**)~~ based action levels in ~~the~~ Permit Part 4, Section 4.6.3.2 (these adjustments are directly proportional to the actual flow rate that is less than 35,000 scfm); or the use of personal protective equipment (**PPE**) as described in Occupational Safety and Health Administration (**OSHA**) Standard 29 ~~CFR~~Code of Federal Regulations (**CFR**) 1910.134.

Implementing measures taken at the WIPP facility regarding the 35,000 scfm ventilation rate and associated details (i.e., date, start time, end time, and reason) will be recorded in the Central Monitoring Room Operator's (**CMRO**) Log and reported to the New Mexico Environment Department (**NMED**) as required by Section O-5a.

O-3b(2) Measurement and Calculation of the Active Disposal Room Airflow

The Permittees shall measure the airflow rate and use the disposal room cross-sectional area to calculate the volume of air flowing through a disposal room. The measurement of airflow shall use a calibrated anemometer and a moving traverse (McPherson, 2009~~1993~~). Airflow measurements shall be collected at an appropriate location, chosen by the operator to minimize airflow disturbances, near the entrance of each active disposal room. The excavation dimensions at the measurement location are taken and the cross-sectional area is calculated. The flow rate is the product of the air velocity and the cross-section area. The value shall be entered on a log sheet and compared to the required minimum. The format and content of the log sheet may vary, but will always contain the following data and information as applicable:

- Date
- Time
- Ventilation flow rate reading
- If the required minimum ventilation rate was achieved
- If the room was restricted

- If Section O-3b(1) measures will be implemented (implementing procedure and revision number, if applicable)
- The reason for waste emplacement under 35,000 scfm ventilation rate, if applicable
- Signature

Working values are in acfm and the conversion to scfm is described in Section O-1 above. Measurements shall be collected, recorded, and verified by qualified operators.

The operator shall compare the recorded acfm value with the minimum acfm value provided at the top of the log sheet. During waste disposal operations, t~~T~~he airflow shall be re-checked and recorded whenever there is an operational mode change or a change in ventilation system configuration. Once the ventilation rate has been recorded and verified to be at least the required minimum, personnel access to the room is unrestricted in accordance with normal underground operating procedures. If the required ventilation rate cannot be achieved, or cannot be supported due to operational needs, access to the room shall be restricted. Those periods when active disposal room access is restricted shall be documented on the log sheet for that active disposal room. Entry to restricted access active rooms for the purpose of establishing normal ventilation or for emplacing waste under the conditions identified in Section O-3b(1) is allowed. Such entry shall be documented on the log sheet including a reference to the SOP used.

O-4 Equipment Calibration and Maintenance

The list of equipment used to conduct the Test and Balance and to determine the airflow through the active disposal room(s) is provided in Table O-1.

Equipment ~~used for the periodic Test and Balance, and daily verification of active disposal room flow rate~~ shall be calibrated, as appropriate, in accordance with ~~appropriate~~ WIPP facility calibration and data collection procedures. Work performed by subcontractors shall also be calibrated to an equivalent standard. Equipment shall be inspected before each use to ensure that it is functioning properly and that the equipment calibration is current. Maintenance of equipment shall be completed by qualified individuals or by qualified off-site service vendors.

~~Equipment used to conduct the Test and Balance, and to determine the airflow through the active disposal room(s) are provided in Table O-1.~~

O-5 Reporting and Recordkeeping

O-5a Reporting

The Permittees shall submit an annual report to NMED presenting the results of the data and analysis of the Mine Ventilation Rate Monitoring Plan. In the years that the Test and Balance is performed, the Permittees will provide a summary of the results in the annual report.

The Permittees shall evaluate compliance with the minimum ventilation rate for an active room specified in Permit Part 4, Section 4.5.3.2 on a monthly basis. The Permittees shall report to the Secretary in the annual report specified in Permit Part 4, Section 4.6.4.2 whenever the evaluation of the mine ventilation monitoring program data identifies that the ventilation rate specified in Permit Part 4, Section 4.5.3.2 has not been achieved. The Permittees will identify the implementing measures as described in Section O-3b(1) used to allow waste handling activities to proceed when the 35,000 scfm ventilation rate is not achieved. These implementing measures and associated details (i.e., date, start time, end time, and reason) will be reported to NMED in the annual Mine Ventilation Rate Monitoring Report required by this section.

The Permittees shall also notify NMED by e-mail within 15 calendar days of commencement of waste emplacement operations taking place below 35,000 scfm. The notification shall include the date, start time, end time, reason and implementing measure taken, as applicable. If the Permittees have not completed the waste emplacement activity by the time of this notification, a follow-up e-mail shall be provided within 15 calendar days to notify NMED of the end of the waste emplacement activity and other relevant information not previously provided.

O-5b Recordkeeping

The Permittees shall retain the following information in the Operating Record:

- The CMRO Log documenting the ventilation system operating mode.
- Active disposal room log sheet documenting the ventilation flow rate readings and applicable information listed in Section O-3b(2).

These records will be maintained in the facility Operating Record until closure of the WIPP facility.

O-5c Standard Operating Procedure Applicable to Abnormal Operating Conditions for Active Room Ventilation Flow Rate

The abnormal operating conditions procedure provides instructions necessary to evaluate VOC concentrations in an adjacent filled room prior to commencing waste emplacement operations in an active disposal room when workers are present at a reduced active room ventilation flow rate. Abnormal conditions that may prevent 35,000 scfm from being met, may include, but are not limited to, barometric pressure changes, maintenance activities, and equipment malfunctions. VOC data in the adjacent filled room are collected and analyzed in accordance with Permit Part 4, Section 4.6.3. Adjusted VOC action levels are prescribed at a maximum of 5,000 scfm increments (e.g., 30,000 scfm, 25,000 scfm, 20,000 scfm, 15,000 scfm, and 10,000 scfm) to provide a means of assessment. When the measured flow rates fall~~s~~ between the increment values in the SOP, the lower flow rate is used for determining the adjusted VOC action level. The validated VOC monitoring data are compared to the action levels prescribed in the standard operating procedure and a decision flow path is provided to the Facility Shift Manager, or designee, to determine applicable actions.

These actions include, but are not limited to, commencing waste emplacement operations at a reduced active room ventilation flow rate based on the adjusted VOC action levels, commencing waste emplacement operations at a reduced active room ventilation flow rate with the use of PPE as described in OSHA standard 29 CFR 1910.134, or restricting access to the active disposal room until the ventilation flow rate requirements of Permit Part 4, Section 4.5.3.2~~.~~ are met. As stated in the abnormal operating conditions procedure, implementing measures taken at the WIPP facility are recorded in the CMRO Log and reported to NMED as required by Section O-5a.

O-6 Quality Assurance

Quality assurance associated with the Mine Ventilation Rate Monitoring Plan shall comply with the requirements of the WIPP Quality Assurance Program Description (**QAPD**). The Permittees shall verify the qualification of personnel conducting ventilation flow measurements. The instrumentation used for monitoring active disposal rooms shall be calibrated in accordance with the applicable provisions of the WIPP procedures. The ventilation simulation software programs shall be controlled in accordance with the WIPP QAPD and WIPP computer software quality assurance plans.

Data generated by this plan, as well as records, and procedures to support this plan shall be maintained and managed in accordance with the WIPP QAPD. Nonconformance or conditions adverse to quality as identified in performance of this plan will be addressed and corrected as necessary in accordance with applicable WIPP Quality Assurance procedures.

O-7 References

McPherson, Malcolm J. 2009. *Subsurface Ventilation Engineering.* 2nd. Fresno, California: Mine Ventilation Services Inc.~~McPherson, M. J., 1993. *Subsurface Ventilation and Environmental Engineering*, Chapman & Hall, London, First Edition.~~

TABLES

Table O-1
Mine Ventilation Rate Testing Equipment

Equipment Used to Conduct Test	Ventilation Test Performed	
	Test and Balance	Active Disposal Room(s)
Calibrated Anemometer	X	X
Calibrated Differential Pressure Sensor	X	
Pitot Tubes	X	
Tubing	X	
Temperature Sensing Device	X	
Relative Humidity Sensor	X	
Calibrated Barometers	X	
Electronic Manometer	X	