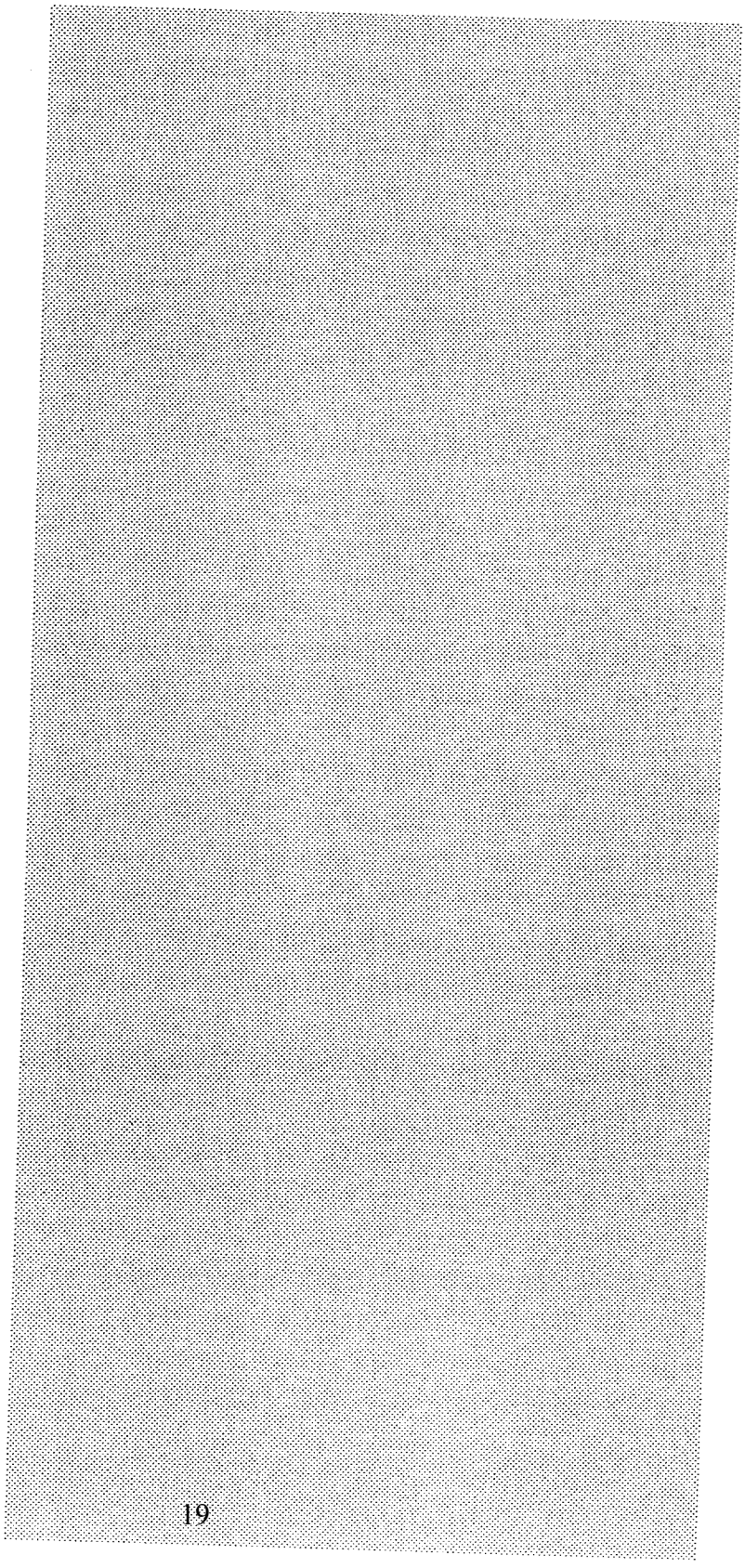
WIPP Facility



INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) is the principal facility for the disposal of our nation's transuranic (TRU) radioactive waste generated as a result of over 50 years of nuclear weapons research, development, and production. The selection of the WIPP site followed a lengthy search and extensive studies for the identification of a site for disposal of TRU wastes (NRC 1983, 1984). These efforts led to the selection of a 41 km^2 (16 mi^2) site, 26-miles (42-km) east of Carlsbad, NM. Following studies conducted of geological formations stable enough to contain wastes for thousands of years during the 1950s, the National Research Council (NRC 1957) identified deep geologic isolation in salt as a most desirable disposal mode for radioactive waste. Experiments conducted on salt mines revealed that there were no technical difficulties with waste disposal in salt (NRC 1984). The Carlsbad site was selected by the DOE because the deep salt beds located there are expected to provide the necessary stability for waste disposal. The site and the region surrounding it had been studied for many years, and mineral exploration of both potash and hydrocarbon deposits provided additional knowledge regarding the geology of the region. The U.S. Geological Survey and other agencies assisted DOE in identifying the New Mexico location for the repository. The salt deposit at this site, known as the Salado Formation, is a minimum of 2,000 ft (610 m) thick and located at a depth of 1,000-2,000 ft (305-610 m) (Fig. 1).

Salt allows significant deformation without fracturing. The Salado Formation is regionally extensive, and includes continuous beds of salt without complicated structures. The DOE identified the following four advantages of the site:

1. The salt deposit is in a stable geological area with little seismic activity, assuring the stability of a waste repository for thousands of years.
2. Salt deposits indicate the absence of flowing fresh water which could move waste to the surface. Water, if it had been or were present, would have dissolved the salt beds.
3. Salt is relatively easy to mine.
4. Rock salt exhibits a characteristic mechanical behavior, creep, that makes it an excellent host for waste isolation. In response to excavation-induced stress changes, salt slowly flows (or creeps), to close the mined openings. Creep closure starts immediately and continues until the salt has regained its original density and stress distribution. Salt formations tend to slowly and progressively fill mined areas and safely seal radioactive waste from the environment.

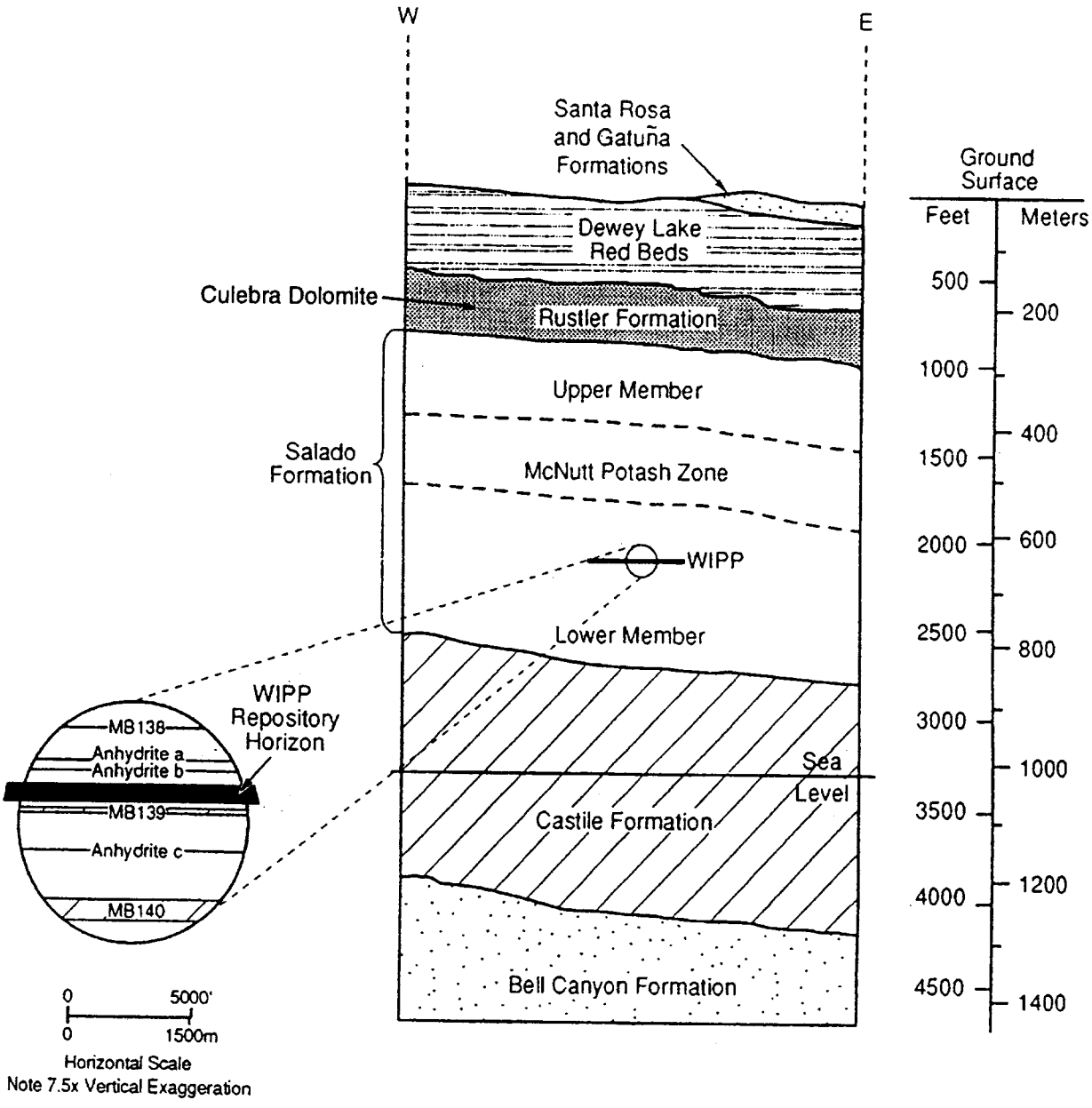


Fig. 1. WIPP Repository and local stratigraphy.

Geological data were collected from the WIPP site and surrounding area to evaluate its suitability as a radioactive waste repository. These data were collected principally by the DOE; the DOE's predecessor agencies; the U.S. Geological Survey; the New Mexico Bureau of Mines and Mineral Resources; and private organizations engaged in natural resource exploration and extraction. The DOE analyzed the data and has stated that the site is suitable for long-term isolation of radioactive waste.

The geology of the WIPP site has specific advantages identified by the DOE against potentially adverse environmental impacts. At the depth of the WIPP repository, the salt will slowly encapsulate the buried waste in the stable rock. Salt rock also shields radioactivity, providing a protection similar to that of concrete. Waste placed in the excavation at the WIPP is expected to be encapsulated and all waste-filled spaces closed over a period of 75-200 years. The waste disposal depth of 2,150 ft (650 m) is close enough to the surface to make access reasonable.

Subsequent to the investigation of the subsurface geology, the DOE selected the Salado Formation as the site of the WIPP repository for the following reasons:

1. The Salado halite units have low permeability to fluid flow, which impedes groundwater flow into and out of the repository;
2. It is regionally widespread;
3. It includes continuous halite beds without complicated structure;
4. It is deep with little potential for dissolution;
5. It is close enough to the surface that access is reasonable; and
6. It is largely free of mobile groundwater, as compared to existing mines and other potential repository sites.

Another of the favorable aspects of subsurface geology at the WIPP site is that the groundwater hydrology in the immediate proximity is characterized by geologic strata with low transmissivity and low hydrologic gradients.

SUBSURFACE GEOLOGY

The WIPP site is located in the northern portion of the Delaware Basin, a structural basin underlying present-day southeastern New Mexico and western Texas, and containing a thick sequence of sandstones, shales, carbonates, and evaporites. At the repository depth of 2,150 ft (650 m), the natural rock is of the Permian age. The

sediments accumulated during the Permian period represent the thickest portion of the sequence in the northern Delaware Basin and are divided into four series. From oldest to youngest, these series are: the Wolfcampian, Leonardian, Guadalupian, and Ochoan. As shown in Fig. 2, the Ochoan series is divided into four formations. From oldest to youngest, these formations are: Castile, Salado, Rustler, and Dewey Lake.

Salado formation

This massive bedded salt formation, predominately halite (sodium chloride), is thick and laterally extensive. The Salado formation is approximately 530 to 610 m (1,740 to 2,000 ft) thick in the WIPP site area, and the repository is located in the thickest part. The Salado formation is comprised of three members. From oldest to youngest, these are: Lower Member, McNutt Potash Member, and Upper Member. The WIPP repository is located in the Lower Member. The Salado formation contains many distinctive and laterally continuous layers composed mostly of anhydrite (a potassium-magnesium-calcium sulfate mineral). These layers have been designated by geologists as "marker beds" and numbered to designate vertical position within the Salado Formation.

Castile formation

This formation directly underlies the Salado Formation and comprises the base of the Ochoan Series (Fig. 2). It is found 244 m (800 ft) below the level of the repository. The Castile Formation near the WIPP typically contains three relatively thick anhydrite/carbonate units and two thick halite units. The thickness of the Castile varies regionally as well as locally beneath the WIPP, and there is considerable evidence from borehole data and geophysical surveys that the units of the Castile are deformed. The more brittle anhydrite units of the Castile are probably fractured, and the fracture zones are relatively permeable and act as zones for accumulation of brine originating in the Castile. The Castile is exposed at the surface over a considerable area along the western side of the Delaware Basin. In the eastern part of the basin, it is approximately 430 to 460 m (1,400 to 1,500 ft) thick. At the northern boundary of the WIPP, the Castile's thickness has been measured at 301 m (989 ft).

Bell Canyon formation

The Bell Canyon Formation underlies the Castle Formation and is the uppermost formation of the Guadalupian Series. Near the WIPP, the Bell Canyon is comprised

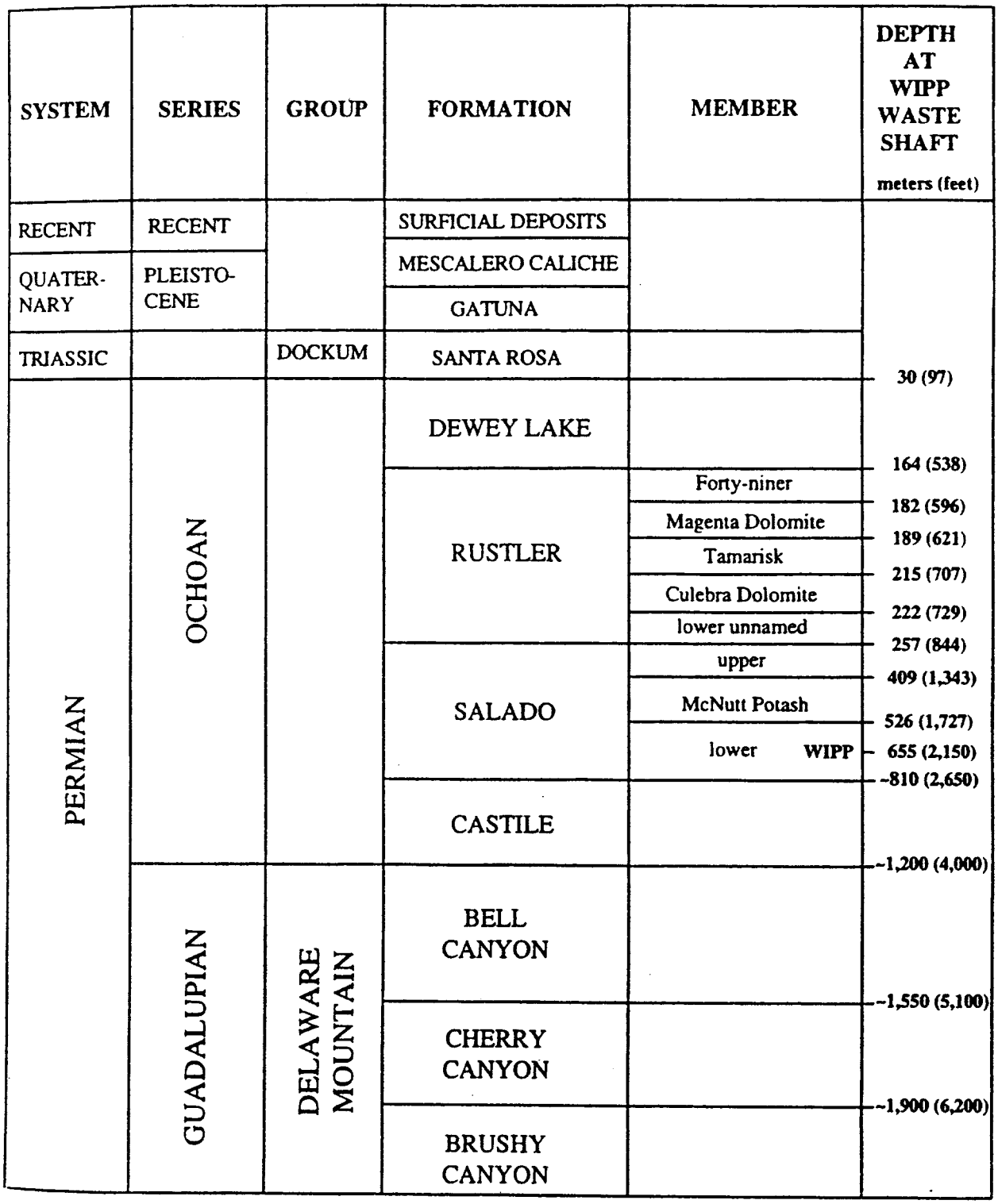


Fig. 2. Regional geologic column.

of a layered sequence of sandstones, shales, siltstones, and limestones approximately 300 m (1,000 ft) or more in thickness. It is the uppermost target of hydrocarbon exploration in the local area and is known from outcrops on the west side of the Delaware Basin and from oil and gas exploration boreholes.

Rustler formation

The Rustler Formation directly overlies the Salado Formation and contains five members (Fig. 2). From the base of the Rustler, these member are: Los Medanos Member (formerly referred to as the unnamed lower member), Culebra Member, Tamarisk Member, Magenta Member, and Forty-niner Member. The Culebra and Magenta Members are gypsum-bearing dolomites containing numerous cavities, fractures, and silty zones. The other three members contain various amounts of anhydrite, siltstone, claystone and halite. The Rustler is the youngest (uppermost) formation in the Delaware Basin that primarily contains evaporite deposits. In the WIPP region, the Rustler can be 152 m (500 ft) thick, although it ranges from 91 to 107 m (300 to 350 ft) thick within the WIPP boundary.

Dewey Lake formation

This formation overlies the Rustler Formation at the WIPP. Consisting largely of reddish-brown siltstones and claystones with lesser amounts of sandstone, the Dewey Lake Formation is about 30 to 170 m (100 to 560 ft) thick in the vicinity of the WIPP.

Santa Rosa formation

This formation of Triassic Age, also called the Dockum Group, overlies the Dewey Lake Formation. Characterized by the light reddish-brown sandstones and conglomerates, the Santa Rosa Formation is anywhere between thin to absent within the WIPP site boundaries, but is thicker to the east.

Gatuna formation

This formation overlies the Santa Rosa Formation and is somewhat similar in lithology and color, although the Gatuna is characterized by a wide range of

lithologies (coarse conglomerates to gypsum-bearing claystones). The Gatuna is Pleistocene in age, based on the 600,000-year old volcanic ash layer in the Upper Gatuna.

FACILITIES CONSTRUCTED AT THE WIPP

The major construction activities at the WIPP occurred between 1981 and 1990, and the facility accepted its first shipment of Transuranic (TRU) wastes in March 1999. Underground facilities were excavated 655 m (2,150 ft) beneath the surface of the land and include: four shafts; the waste disposal area; an experimental area (now closed); an equipment and maintenance area; and connecting tunnels. The DOE has also excavated the first and second of eight planned panels (designated as Panels 1 and 2) as shown in Fig. 3. Panel 1 has received wastes.

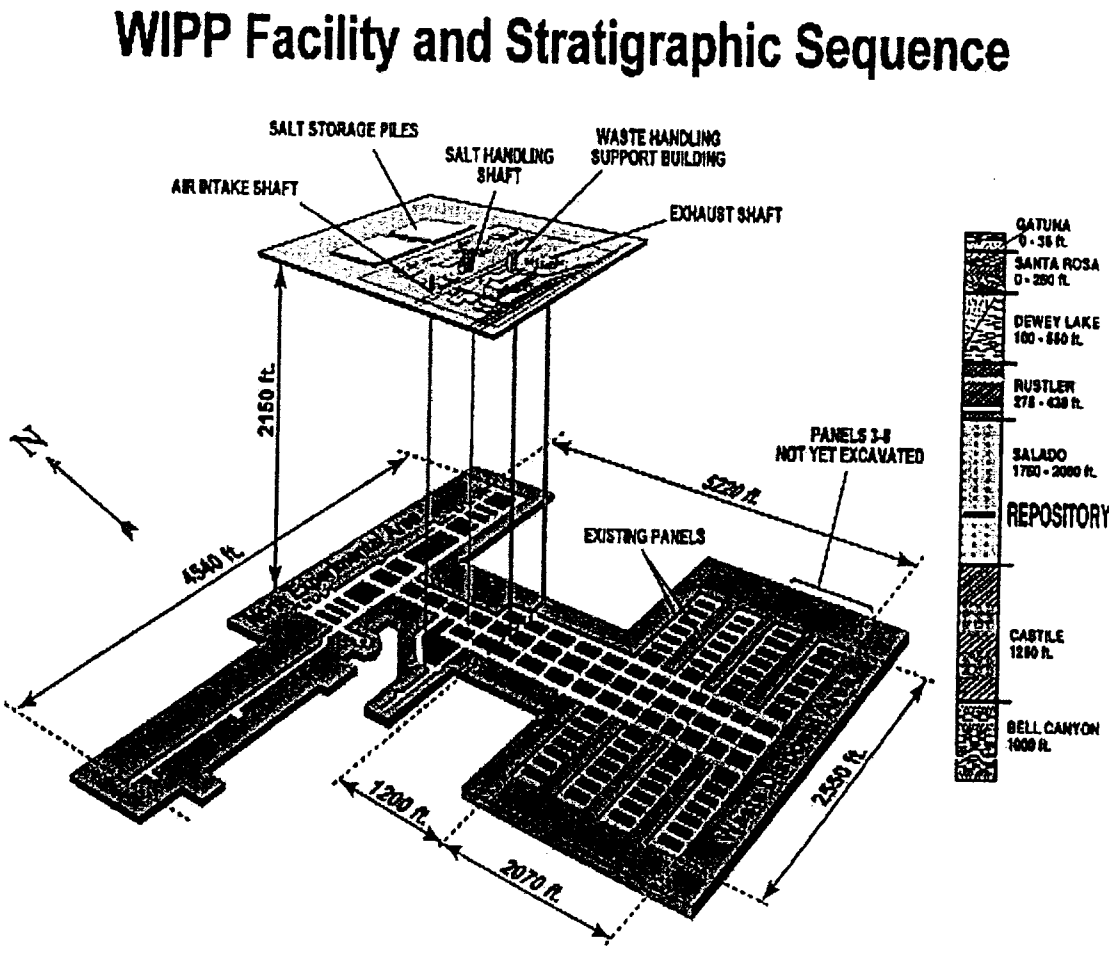


Fig. 3. WIPP facility and stratigraphic sequence.

Each panel is expected to take five years to mine, fill, and close. In addition, panel-equivalents 9 and 10 in Fig. 3 are located in the north-south mine access ways and are calculated to be required to complete the burial of the 1.75×10^5 m^3 (6.2×10^6 ft^3) of TRU waste permissible under the Land Withdrawal Act (LWA). All panels consist of seven waste disposal rooms, each about 91 m (300 ft) long, 10 m (33 ft) wide, and 4 m (13 ft) high. Pillars between rooms are 30 m (100 ft) wide.

A number of surface facilities have been constructed. The principal surface structure at the WIPP is the Waste Handling Building (WHB) where TRU wastes are unloaded from their transportation containers and transferred to the underground disposal area through the Waste Shaft. The WHB contains four functional areas: 1) the Contact Handled (CH) TRU waste handling area; 2) the Remote Handled (RH) TRU waste handling area; 3) the WHB support area; and 4) the Waste Shaft.

Other WIPP surface facilities include the hoist houses; Support Building; Guard and Security Building; Water Pump House; Transuranic Package Transporter, Model 2 (TRUPACT-II) Maintenance Facility; Training Building; office trailers; Exhaust Filter Building; warehouse and shops; Engineering Building; Core Storage Building; and the Safety and Emergency Services Building.

The underground support facilities include those needed to service and maintain equipment for excavation and disposal operations; monitor for contamination; and allow limited decontamination of personnel and equipment, if necessary. All underground facilities are inspected by the Mine Safety and Health Administration.

Waste Handling Building (WHB)–container storage unit

This building is the surface facility where TRU handling activities will take place. The WHB has a total area of approximately 84,000 ft^2 (7,804 m^2), of which 33,175 ft^2 (3,082 m^2) are designated for the waste handling and container storage of CH TRU mixed waste. The concrete floors are sealed with a coating that makes them impervious to the chemicals and facilitates decontamination if necessary.

The vehicles used to transport TRU mixed waste containers will be received through one of three air-lock entries to the CH Bay of the WHB Unit. The WHB heating, ventilation, and air conditioning 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 radioactive constituents 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.

The waste containers are visually inspected for physical damage (e.g., severe rusting, apparent structural defects, signs of pressurization) and leakage to ensure that they are in good condition prior to storage. Waste containers are also checked for external surface contamination. If a primary waste container is not in good condition, the DOE will overpack the container.

Parking area container storage unit–parking area unit

The parking area south of the WHB is to be used for storage of waste containers within sealed shipping containers awaiting unloading. The Parking Area Unit provides storage space for 12 loaded containers, corresponding to 1,591 ft^3 (45 m^3) of CH TRU mixed waste. Secondary containment and protection of the waste containers from standing liquid are provided by the transportation containers. Wastes placed in the Parking Area Unit will remain sealed in their TRUPACT-II transportation containers at all times while in this area.

CONTAINER MANAGEMENT PRACTICES

Containers are to be managed in a specified 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 contain radioactive waste, safety concerns require that containers be continuously vented to obviate the buildup of gases within the container. These gases could result from radiolysis, which is the breakdown of moisture by radiation. The vents are filtered to enable any potential generated gas to escape while particulate matter is retained. Derived waste containers are kept closed at all times unless waste is being added or removed.

Containers with residual liquids

Defense production facilities are prohibited from shipping liquid wastes in the containers sent to the WIPP. In no case is the total residual liquid allowed to equal or exceed 1% (by volume) of the waste container. Consequently, calculations made to determine the secondary containment as required by regulations are based on

10% of 1% of the volume of the containers, or 1% of the largest container, whichever is greater.

Description of containers

Waste containers are to be in good condition prior to shipment from the generator sites, i.e., containers will be of high integrity, intact, and free of surface contamination above established limits. This condition is to be verified upon receipt of the waste at WIPP. 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.

The volatile organic compounds (VOC) in the headspace of waste containers are limited to maximum allowable VOC room-averaged headspace concentration limits specified in the permit. There are no maximum allowable headspace gas concentration limits for individual containers, as some containers can exceed these values as long as container headspace averages in a disposal room do not.

Containers for CH TRU mixed waste will be either 55-gal (208-L) drums arranged singly in 7-packs; 85-gal (321-L) drums arranged singly in 4-packs; 100-gallon drums, arranged singly or as three-packs; ten-drum overpacks (TDOP) either as overpacks or direct-loaded; or standard waste boxes (SWBs). Following is a summary description for each container type.

Standard 55-gallon drums: These 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 ft^3 (0.208 m^3). One or more filtered vents (as described in Permit Section M1-1d(1)) is to be installed in the drum lid or body to prevent the escape of any radioactive particulate matter and to eliminate any potential for pressurization. Standard 55-gal (208-L) drums are constructed of mild steel and may also contain rigid, molded polyethylene (or other compatible material) liners.

Standard Waste Boxes (SWBs): One or more filtered vents are to be installed in the standard waste box lid or body to prevent the escape of any radioactive

particulate matter and to eliminate any potential of pressurization. SWBs have an internal volume of 66.3 ft^3 (1.88 m^3).

One hundred-gallon drums: A 100-gal (379-L) drum has a gross internal volume of 13.4 ft^3 (0.39 m^3). One or more filtered vents are installed in the drum lid or body to prevent the escape of any radioactive particulate matter and to eliminate potential pressurization. These drums are constructed of mild steel and may also contain rigid, molded polyethylene (or other compatible material) liners. These drums may be used as overpacks or may be direct-loaded.

Ten-Drum Overpack: The TDOP is a metal container, similar to a SWB, and is certified to be noncombustible. It is a welded-steel cylinder, approximately 74 in (1.9 m) high and 71 in. (1.8 m) in diameter with a gross internal capacity of 160 ft^3. The maximum loaded weight of a TDOP is limited to 6,700 lbs (3,040 kg). A bolted lid on one end is removable; sealing is accomplished by clamping a neoprene gasket between the lid and the body. Filter ports are located near the top of the TDOP. One or more filtered vents are installed in the ten-drum overpack lid or body to prevent the escape of any radioactive particulate matter and to eliminate any potential for pressurization. A TDOP may contain up to ten standard 55-gal (208-L) drums or one SWB. The TDOPs may be used to overpack drums or SWBs containing CH TRU mixed waste. The TDOP may also be direct-loaded with waste items that are too large to fit into the standard 55-gallon (208-L) drum; the 85-gallon drum; or the SWB.

Eighty-five gallon drums: The 85-gal (321-L) drum overpack is to be used primarily for overpacking contaminated 55-gal (208 L) drums at the WIPP facility. The 85-gal (321-L) drums may be direct-loaded with CH TRU-mixed waste and may be used to collect derived waste. One or more filtered vents are to be installed in the 85-gal (321-L) drum lid or body to prevent the escape of any radioactive particulate matter and to eliminate any potential of pressurization.

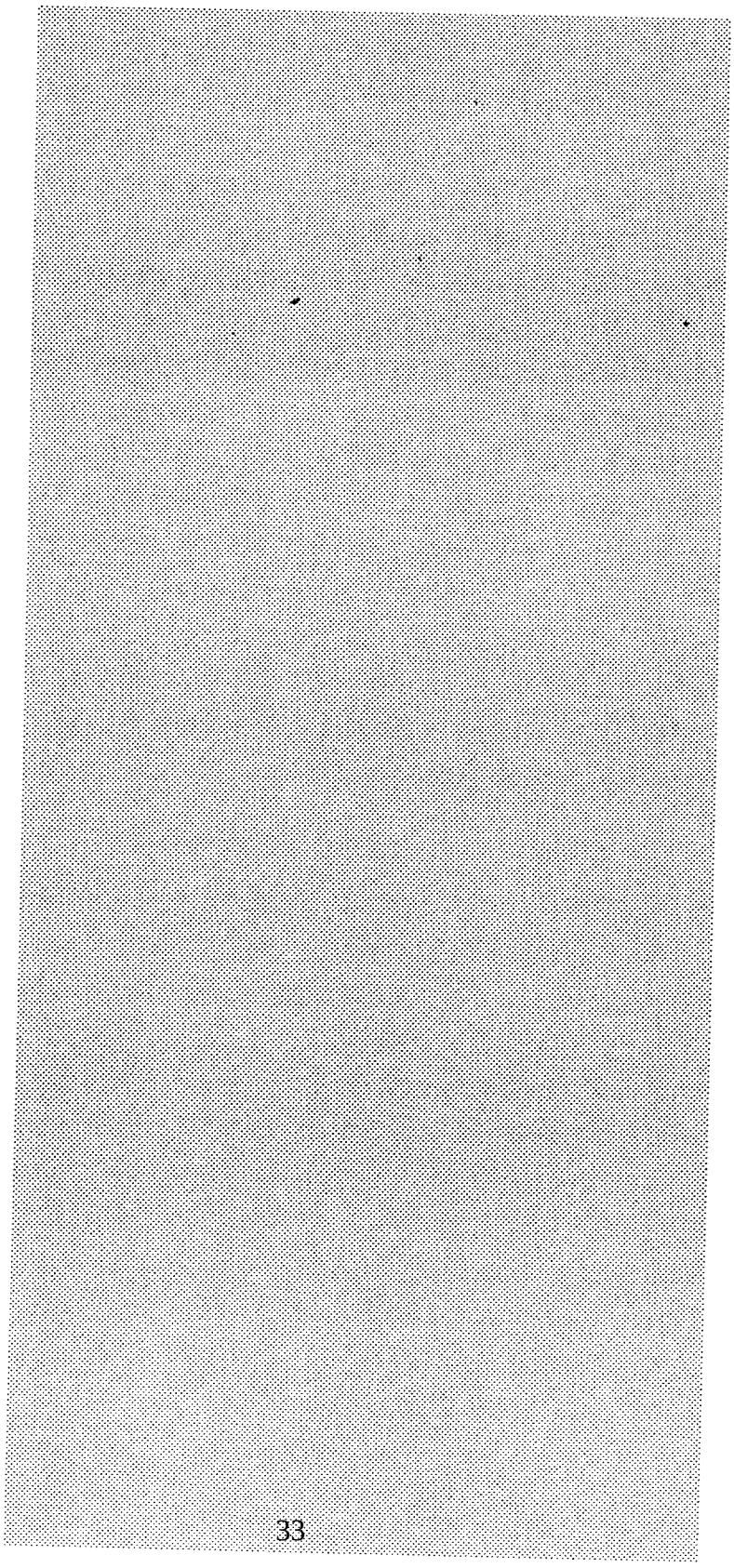
Container compatibility: All containers are made of steel, and some will contain rigid, molded polyethylene liners. Requirements to conduct compatibility studies include container materials to assure that containers are compatible with the waste.

WASTE PROCESSING STEPS AT THE WIPP

The handling and disposal of CH TRU wastes at the WIPP involves the following series of steps:

1. A waste shipment arrives at the WIPP by truck. Each truck is capable of carrying up to three TRU Packaging Transport Model IIs (TRUPACT-IIs).
2. After an initial security inspection, a radiological survey, and a shipping documentation review, the truck is parked near the WHB for additional inspection and radiological survey. A forklift is used to transfer each TRUPACT-II from the trailer, through an air lock, and into the WHB, where it is placed in an area called a TRUDOCK, which is used by workers to unload the waste from the TRUPACT IIs.
3. Radiological surveys are conducted to confirm that waste containers have not sustained damage during shipment or waste container removal.
4. At the TRUDOCK, an overhead crane is used to remove the waste containers from the TRUPACT-II and place them on a facility pallet.
5. A forklift moves the loaded facility pallet to the conveyance loading car at the waste handling shaft. The conveyance loading car is used to load the facility pallet onto the waste hoist.
6. The waste hoist descends 2,150 ft (705 m) to the WIPP repository.
7. An underground transporter pulls the loaded facility pallet off the hoist onto the trasporter bed and moves the waste to the appropriate disposal room where a forklift removes the waste containers from the facility pallet and places them in the disposal area. Containers may be stacked three high in the disposal area.
8. Bags of magnesium oxide are placed on top of the stack of containers to serve as backfill. The magnesium oxide will control the solubility of radionuclides and is an added measure of assurance for long-term repository performance.

Legal Requirements



INTRODUCTION

The Waste Isolation Pilot Plant project was authorized in 1979 (PL96-164) as a research and development activity to demonstrate the safe disposal of radioactive waste originating from the U.S. nuclear weapons program. This and several other laws and regulations have resulted in the construction and operation of WIPP as a unique facility for the disposal of transuranic (TRU) waste.

TRU waste is defined as a waste containing alpha-emitting isotopes of transuranic elements which emits more than 100 nCi/g of waste. The half-lives of the isotopes of these elements must be greater than 20 years (LWA 1992; EPA 1993).

Much of the TRU waste contains chemical constituents subject to the regulations of the Resource Conservation and Recovery Act (RCRA) and the New Mexico Hazardous Waste Act. TRU wastes that contain both chemical and radioactive waste are referred to as Mixed TRU. According to RCRA, WIPP is required to have a hazardous waste permit to receive waste containing hazardous waste constituents. The state of New Mexico has adopted the relevant RCRA regulations by reference and thus is authorized to issue hazardous waste permits. WIPP received a permit (NMED 1999) on October 27, 1999 for contact-handled (CH) waste, defined as having a surface radiation dose rate not greater than 200 mrem/h (2 mSv/h). TRU waste with a greater dose rate is defined as Remote Handled (RH) TRU Mixed Waste.

The enactment of the Land Withdrawal Act (LWA 1992) resulted in permanent withdrawal and transfer of the administration of federal land for the site from the U.S. Department of Interior to the DOE. This law mandated that the U.S. Environmental Protection Agency (EPA) certify the DOE's compliance with EPA's relevant, generally applicable environmental standards for radioactive materials. Subsequently, the EPA (1996a) issued the criteria to be used in certifying compliance. In response, the DOE provided the EPA with appropriate documents; models; and evaluations of the geology, hydrology, and climate as well as projected performance of the entire disposal system, including the mined repository, shaft seals, panel closures, borehole plugs, and mine backfill. Finally, the EPA (1998) certified that the WIPP met all of the criteria required for the disposal of TRU waste.

The LWA limited the amount and types of TRU wastes that can be emplaced at WIPP. The limits include the following:

1. The WIPP capacity is limited to 1.75×10^5 m^3 (6.2×10^6 ft^3) total TRU waste by volume.
2. No more than 5% (by volume) of RH-TRU waste may have a surface dose rate in excess of 100 rem/h (1 μSv/h).
3. No RH-TRU waste may have a surface dose rate in excess of 1,000 rem/h (10 Sv/h).
4. RH-TRU waste containers shall not exceed 23 Ci/L (851 GBq/L) maximum activity level averaged over the volume of the container.
5. The total radioactivity of RH-TRU waste shall not exceed 5.1 MCi (188.7 PBq).
6. Of the allowed waste disposal volume of 1.75×10^5 m^3 (6.2×10^6 ft^3), the Consultation and Cooperation Agreement with the State of New Mexico limits the volume of RH-TRU waste to 7,080 m^3 (250,000 ft^3).

The 41 km^2 (16 mi^2) area under DOE's jurisdiction at WIPP is deemed sufficient to ensure that at least 1.6 km (1 mi) of intact salt exists laterally between the waste disposal area and the accessible environment, and also to ensure that no permanent residences will be established in close proximity to the facility.

EPA'S CRITERIA FOR WIPP CERTIFICATION

Criteria for certification and recertification of WIPP were published in final form by the EPA (1996a). These criteria were detailed and contained specific requirements. In its regulations, EPA provided requirements not only for quality assurance and characterization but also specific requirements for expert judgement and peer review. The following are excerpts from EPA's regulations:

"§ 194.22 Quality assurance.

(a)(1) As soon as practicable after April 9, 1996, the Department shall adhere to a quality assurance program that implements the requirements of ASME NQA-1-1989 edition, ASME NQA-2a-1990 addenda, part 2.7, to ASME NQA-2-1989 edition, and ASME NQA-3-1989 edition (excluding Section 2.1 (b) and (c), and Section 17.1). (Incorporation by reference as specified in § 194.5.)
(2) Any compliance application shall include information which demonstrates that the quality assurance program required pursuant to paragraph (a)(1) of this section

has been established and executed for:
(i) Waste characterization activities and assumptions;
(ii) Environmental monitoring, monitoring of the performance of the disposal system, and sampling and analysis activities;
(iii) Field measurements of geologic factors, ground water, meteorologic, and topographic characteristics;
(iv) Computations, computer codes, models and methods used to demonstrate compliance with the disposal regulations in accordance with the provisions of this part;
(v) Procedures for implementation of expert judgment elicitation used to support applications for certification or re-certification of compliance;
(vi) Design of the disposal system and actions taken to ensure compliance with design specifications;
(vii) The collection of data and information used to support compliance application(s); and
(viii) Other systems, structures, components, and activities important to the containment of waste in the disposal system.
(b) Any compliance application shall include information which demonstrates that data and information collected prior to the implementation of the quality assurance program required pursuant to paragraph (a)(1) of this section have been qualified in accordance with an alternate methodology, approved by the Administrator or the Administrator's authorized representative, that employs one or more of the following methods: Peer review, conducted in a manner that is compatible with NUREG–1297, "Peer Review for High-Level Nuclear Waste Repositories," published February 1988 (incorporation by reference as specified in § 194.5); corroborating data; confirmatory testing; or a quality assurance program that is equivalent in effect to ASME NQA-1-1989 edition, ASME NQA-2a-1990 addenda, part 2.7, to ASME NQA-2-1989 edition, and ASME NQA-3-1989 edition (excluding Section 2.1 (b) and (c) and Section 17.1). (Incorporation by reference as specified in § 194.5.)
(c) Any compliance application shall provide, to the extent practicable, information which describes how all data used to support the compliance application have been assessed for their quality characteristics, including:
(1) Data accuracy, i.e., the degree to which data agree with an accepted reference or true value;
(2) Date prevision, i.e., a measure of the mutual agreement between comparable data gathered or developed under similar conditions expressed in terms of a standard deviation;

(3) Data representativeness, i.e., the degree to which data accurately and precisely represent a characteristic of a population, a parameter, variations at a sampling point, or environmental conditions;
(4) Data completeness, i.e., a measure of the amount of valid data obtained compared to the amount that was expected; and
(5) Data comparability, i.e., a measure of the confidence with which one data set can be compared to another.
(d) Any compliance application shall provide information which demonstrates how all data are qualified for use in the demonstration of compliance.
(e) The Administrator will verify appropriate execution of quality assurance programs through inspections, record reviews and record keeping requirements, which may include, but may not be limited to, surveillance, audits and management systems reviews."

"§ 194.24 Waste characterization.

(a) Any compliance application shall describe the chemical, radiological and physical composition of all existing waste proposed for disposal in the disposal system. To the extent practicable, any compliance application shall also describe the chemical, radiological and physical composition of to-be-generated waste proposed for disposal in the disposal system. These descriptions shall include a list of waste components and their approximate quantities in the waste. This list may be derived from process knowledge, current non-destructive examination/assay, or other information and methods.
(b) The Department shall submit in the compliance certification application the results of an analysis which substantiates:
(1) That all waste characteristics influencing containment of waste in the disposal system have been identified and assessed for their impact on disposal system performance. The characteristics to be analyzed shall include, but shall not be limited to: Solubility, formation of colloidal suspensions containing radionuclides; production of gas from the waste; shear strength compactability; and other waste-related inputs into the computer models that are used in the performance assessment.
(2) That all waste components influencing the waste characteristics identified in paragraph (b)(1) of this section have been identified and assessed for their impact on disposal system performance. The components to be analyzed shall include, but shall not be limited to: metals, cellulosics; chelating agents; water and other liquids; and activity in curies of each isotope of the radionuclides present.
(3) Any decision to exclude consideration of any waste characteristic or waste component because such characteristic or component is not expected to

significantly influence the containment of the waste in the disposal system.
(c) For each waste component identified and assessed pursuant to paragraph (b) of this section, the Department shall specify the limiting value (expressed as an upper or lower limit of mass, volume, curies, concentration, etc.), and the associated uncertainty (i.e., margin of error) for each limiting value, of the total inventory of such waste proposed for disposal in the disposal system. Any compliance application shall:
(1) Demonstrate that, for the total inventory of waste proposed for disposal in the disposal system, WIPP complies with the numeric requirements of § 194.34 and § 194.55 for the upper or lower limits (including the associated uncertainties), as appropriate, for each waste component identified in paragraph (b)(2) of this section, and for the plausible combinations of upper and lower limits of such waste components that would result in the greatest estimated release.
(2) Identify and describe the method(s) used to quantify the limits of waste components identified in paragraph (b)(2) of this section.
(3) Provide information which demonstrates that the use of process knowledge to quantify components in waste for disposal conforms with the quality assurance requirements found in § 194.22.
(4) Provide information which demonstrates that a system of controls has been and will continue to be implemented to confirm that the total amount of each waste component that will be emplaced in the disposal system will not exceed the upper limiting value or fall below the lower limiting value described in the introductory text of paragraph (c) of this section. The system of controls shall include, but shall not be limited to: Measurement; sampling; chain of custody records; record keeping systems; waste loading schemes used; and other documentation.
(5) Identify and describe such controls delineated in paragraph (c)(4) of this section and confirm that they are applied in accordance with the quality assurance requirements found in § 194.22.
(d) The Department shall include a waste loading scheme in any compliance application, or else performance assessments conducted pursuant to § 194.32 and compliance assessments conducted pursuant to § 194.54 shall assume random placement of waste in the disposal system.
(e) Waste may be emplaced in the disposal system only if the emplaced components of such waste will not cause:
(1) The total quantity of waste in the disposal system to exceed the upper limiting value, including the associated uncertainty, described in the introductory text to paragraph (c) of this section; or
(2) The total quantity of waste that will have been emplaced in the disposal system, prior to closure, to fall below the lower limiting value, including the associated uncertainty, described in the introductory text to paragraph (c) of this section.

(f) Waste emplacement shall conform to the assumed waste loading conditions, if any, used in performance assessments conducted pursuant to § 194.32 and compliance assessments conducted pursuant to § 194.54.
(g) The Department shall demonstrate in any compliance application that the total inventory of waste emplaced in the disposal system complies with the limitations on transuranic waste disposal described in the WIPP LWA.
(h) The Administrator will use inspections and records reviews, such as audits, to verify compliance with this section."

"§ 194.26 Expert judgment.

(a) Expert judgment, by an individual expert or panel of experts, may be used to support any compliance application, provided that expert judgment does not substitute for information that could reasonably be obtained through data collection or experimentation.
(b) Any compliance application shall:
(1) Identify any expert judgments used to support the application and shall identify experts (by name and employer) involved in any expert judgment elicitation processes used to support the application.
(2) Describe the process of eliciting expert judgment, and document the results of expert judgment elicitation processes and the reasoning behind those results. Documentation of interviews used to elicit judgments from experts, the questions or issues presented for elicitation of expert judgment, background information provided to experts, and deliberations and formal interactions among experts shall be provided. The opinions of all experts involved in each elicitation process shall be provided whether the opinions are used to support compliance applications or not.
(3) Provide documentation that the following restrictions and guidelines have been applied to any selection of individuals used to elicit expert judgments:
(i) Individuals who are members of the team of investigators requesting the judgment or the team of investigators who will use the judgment were not selected; and
(ii) Individuals who maintain, at any organizational level, a supervisory role or who are supervised by those who will utilize the judgment were not selected.
(4) Provide information which demonstrates that:
(i) The expertise of any individual involved in expert judgment elicitation comports with the level of knowledge required by the questions or issues presented to that individual; and
(ii) The expertise of any expert panel, as a whole, involved in expert judgment

elicitation comports with the level and variety of knowledge required by the questions or issues presented to that panel.
(5) Explain the relationship among the information and issues presented to experts prior to the elicitation process, the elicited judgment of any expert panel or individual, and the purpose for which the expert judgment is being used in compliance application(s).
(6) Provide documentation that the initial purpose for which expert judgment was intended, as presented to the expert panel, is consistent with the purpose for which this judgment was used in compliance application(s).
(7) Provide documentation that the following restrictions and guidelines have been applied in eliciting expert judgment:
(i) At least five individuals shall be used in any expert elicitation process, unless there is a lack of unavailability of experts and a documented rationale is provided that explains why fewer than five individuals were selected.
(ii) At least two-thirds of the experts involved in an elicitation shall consist of individuals who are not employed directly by the Department or by the Department's contractors, unless the Department can demonstrate and document that there is a lack or unavailability of qualified independent experts. If so demonstrated, at least one-third of the experts involved in an elicitation shall consist of individuals who are not employed directly by the Department or by the Department's contractors.
(c) The public shall be afforded a reasonable opportunity to present its scientific and technical views to expert panels as input to any expert elicitation process."

"§ 194.27 Peer review.

(a) Any compliance application shall include documentation of peer review that has been conducted, in a manner required by this section, for:
(1) Conceptual models selected and developed by the Department;
(2) Waste characterization analyses as required in § 194.24(b); and
(3) Engineered barrier evaluation as required in § 194.44.
(b) Peer review processes required in paragraph (a) of this section, and conducted subsequent to the promulgation of this part, shall be conducted in a manner that is compatible with NUREG-1297, "Peer Review for High-Level Nuclear Waste Repositories," published February 1988. (Incorporation by reference as specified in § 194.5.)
(c) Any compliance application shall:
(1) Include information that demonstrates that peer review processes required in paragraph (a) of this section, and conducted prior to the implementation of the

promulgation of this part, were conducted in accordance with an alternate process substantially equivalent in effect to NUREG-1297 and approved by the Administrator or the Administrator's authorized representative; and
(2) Document any peer review processes conducted in addition to those required pursuant to paragraph (a) of this section. Such documentation shall include formal requests, from the Department to outside review groups or individuals, to review or comment on any information used to support compliance applications, and the responses from such groups or individuals."

The packaging of waste at the originating sites; transport to the site; transport vehicles; and disposal of heat-generating waste are beyond the scope of this study and are not dealt with in this report.

The health and safety consequences of the postulated repository failure mechanisms appear to be so minimal that simplifications in design may be justified, and cost-effectiveness studies should be carried out to determine whether they would be acceptable. However, the probability and the consequences of potentially rapid flow of brine solutions containing radionuclides, through more permeable formations, have not been completely determined. Once these have been resolved, conventional safety considerations (e.g., number of shafts and packaging of waste for highway transport) might determine the optimum design.

Relaxation of the WIPP waste acceptance criteria (e.g., elimination of the incineration of some of the waste at the Process Experimental Pilot Plant (PREPP) facility and removal of the requirement for the use of steel-case overpack of the wooden boxes) may also have minimal consequences.

EPA'S CERTIFICATION DECISION

Subsequent to the publication of the EPA's regulations on criteria for WIPP certification, DOE undertook a major effort to comply with the EPA's requirements. The result was the decision by the EPA (1998) to certify that WIPP has met the EPA's criteria. However, this certification included certain limitations and requirements. Excerpts of the EPA's certification decision are as follows:

"The EPA finds that DOE has demonstrated that the WIPP will comply with EPA's radioactive waste disposal regulations at Subparts B and C of 40 CFR Part 191.

This decision allows the WIPP to begin accepting transuranic waste for disposal, provided that other applicable environmental regulations have been met and once a 30-day Congressionally-required waiting period has elapsed. EPA's decision is based on a thorough review of information submitted by DOE, independent technical analyses, and public comments. The EPA determined that DOE met all of the applicable requirements of the WIPP compliance criteria at 40 CFR Part 194. However, DOE must meet certain conditions in order to maintain a certification for the WIPP and before shipping waste for disposal at the WIPP."

"The EPA will continue to have a role at the WIPP after this certification becomes effective. As discussed above, DOE must submit periodic reports on any activities or conditions at the WIPP that differ significantly from the information contained in the most recent compliance application. The EPA may also, at any time, request additional information from DOE regarding the WIPP. The Agency will review such information as it is received to determine whether the certification must be modified, suspended, or revoked. Such action might be warranted if, for example, significant information contained in the most recent compliance application were no longer to remain true. The certification could be modified to alter the terms or conditions of certification—for example, to add a new condition, if necessary to address new or changed activities at the WIPP. The certification could be revoked if it becomes evident in the future that the WIPP cannot or will not comply with the disposal regulations. Either modification or revocation must be conducted by rule-making, in accordance with the WIPP compliance criteria (§§ 194.65-66). Suspension may be initiated at the Administrator's discretion, in order to promptly reverse or mitigate a potential threat to public health. For instance, a suspension would take effect if, during emplacement of waste, a release from the WIPP occurred in excess of EPA's containment limits."

"In addition to reviewing annual reports from DOE regarding activities at the WIPP, EPA periodically will evaluate the WIPP's continued compliance with the WIPP compliance criteria and disposal regulations. As directed by Congress, this "recertification" will occur every five years. For recertification, DOE must submit to EPA for review the information described in the WIPP compliance criteria (although, to the extent that information submitted in previous certification applications remains valid, it can be summarized and referenced rather than resubmitted) (§ 194.14). In accordance with the WIPP compliance criteria, documentation of continued compliance will be made available in EPA's dockets, and the public will be provided at least a 30-day period in which to submit comments. The EPA's decision on recertification will be announced in the *Federal Register* (§ 194.64)."

"Notices announcing EPA inspections or audits to evaluate implementation of quality assurance ("QA") and waste characterization requirements at generator facilities will be published in the *Federal Register*. The public will have the opportunity to submit written comments on the waste characterization and QA program plans submitted by DOE. As noted above, EPA's decisions on whether to approve waste generator QA program plans and waste characterization systems of controls—and thus, to allow shipment of specific waste streams for disposal at the WIPP—will be conveyed by a letter from EPA to DOE. A copy of the letter, as well as any EPA inspection or audit reports, will be placed in EPA's docket."

"Finally, the WIPP compliance criteria provide EPA the authority to conduct inspections of activities at the WIPP and at all off-site facilities which provide information included in certification applications. (§ 194.21) The Agency expects to conduct periodic inspections, both announced and unannounced, to verify the adequacy of information relevant to certification applications. The Agency may conduct its own laboratory tests, in parallel with those conducted by DOE. The Agency also may inspect any relevant records kept by DOE, including those records required to be generated in accordance with the compliance criteria. For example, EPA intends to conduct ongoing inspections or audits at the WIPP and at waste generator sites to ensure that approved quality assurance programs are being adequately maintained and documented. The EPA plans to place inspection reports in its docket for public examination."

BRIEF WIPP CHRONOLOGY

1957 National Research Council recommended salt as host rock, Identified areas to investigate, and Identified favorable siting criteria

1974 Atomic Energy Commission selected site near Carlsbad for exploratory work

1979 Congress authorized WIPP for research and development for safe disposal of defense-generated radioactive waste

1980 DOE issued Final Environmental Impact Statement (FEIS)

1981 DOE issued Record of Decision

1981 DOE began construction of WIPP Exploratory Shaft

1985 EPA issued 40 CFR 191--radioactive waste disposal standards applicable to WIPP

1986 EPA stated facilities must comply with Resource Conservation and Recovery Act (RCRA) for disposal of mixed (hazardous and radioactive) waste

1990 New Mexico was authorized by EPA to regulate mixed waste

1990 DOE issued first Supplemental Environmental Impact Statement (SEIS)

1991 DOE submitted Parts A and B of the RCRA Permit Application to New Mexico

1992 WIPP Land Withdrawal Act permanently segregates land for WIPP and gave EPA regulatory authority to certify WIPP compliance to 40 CFR 191.

1995 DOE submitted revised RCRA Permit Application to New Mexico Environment Department

1996 EPA issued 40 CFR 194, compliance criteria in February

1996 DOE submitted 84,000 page Compliance Certification Application to EPA

1998 DOE issued SEIS II in January

1998 EPA certified WIPP ready for disposal

1998 New Mexico Environment Department issued draft hazardous waste facility permit (HWFP) for disposal of transuranic mixed waste

1999 First shipment non-mixed waste in March

1999 New Mexico Environment Department issued Hazardous Waste Facility Permit

2000 First shipment of mixed waste in September