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# EXECUTIVE SUMMARY
# ENVIRONMENTAL IMPACT STATEMENT

(DOE/EIS-0026)

# Waste Isolation Pilot Plant

October 1980

U.S. DEPARTMENT OF ENERGY

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U. S. DEPARTMENT OF ENERGY
ALBUQUERQUE, NEW MEXICO

## FOREWORD

The purpose of this document is to provide a summary of the environmental impact statement for the Waste Isolation Pilot Plant (WIPP) project. The Draft Environmental Impact Statement for the WIPP was published by the U.S. Department of Energy (DOE) in April 1979. This document was reviewed and commented on by members of the general public, private organizations, and governmental agencies. The Final Environmental Impact Statement was subsequently published in October, 1980.

This summary is designed to assist decision-makers and interested individuals in reviewing the material presented in the environmental impact statement for the WIPP project. To make this material widely available, this summary is published in both Spanish and English.

Additional, more detailed information concerning the environmental and safety consequences of the WIPP project is available in the Final Environmental Impact Statement. Written comments and public hearing comments on the Draft Environmental Impact Statement are available for review. Two other documents also prepared by the DOE or its contractors are the <u>WIPP Safety Analysis Report</u> and the <u>Geological Characterization Report</u>. These documents may be reviewed at public document sections of the public libraries and at reading rooms of the government offices listed below or by contacting the U.S. Department of Energy, Washington, D.C. 20545.

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# 1.0 BACKGROUND OF THE WIPP PROJECT

Large quantities of radioactive waste have been generated in U.S. defense programs. This waste includes both "high-level" and "transuranic" waste. High-level waste (HLW) is characterized by intense heat and penetrating radiation. Transuranic (TRU) waste is any solid radioactive waste, other than high-level waste, which is contaminated with certain radioactive elements to the extent that surface disposal is unsuitable. TRU waste is less radioactive than high-level waste and it produces little heat, but the isotopes it contains remain radioactive for very long periods of time. These radioactive wastes pose a potential hazard to human health and safety so that they must be permanently isolated from the environment in which we live. Defense wastes are currently stored in a manner which cannot assure long-term (more than 100-year) isolation. Much of the TRU waste is currently being stored or is planned to be stored above ground at the Idaho National Engineering Laboratory (INEL), near Idaho Falls, Idaho.

## 1.1 INTRODUCTION TO THE WIPP PROJECT AND ITS ENVIRONMENTAL IMPACT STATEMENT

During the last two decades, techniques for the disposal of radioactive waste have been studied through exploration, laboratory experiments, field tests and analyses. Those efforts led the Energy Research and Development Administration (ERDA), predecessor to the U. S. Department of Energy (DOE), to propose a repository for defense waste, the Waste Isolation Pilot Plant (WIPP).

As most recently defined by the authorizing legislation, the WIPP is a DOE project for providing a research-and-development facility to demonstrate the safe disposal of radioactive wastes resulting from national defense activities. The site investigated for the WIPP project, referred to as the Los Medanos site, is about 26 miles east of Carlsbad and 18 miles northeast of Loving, New Mexico (Figure 1-1). The legislation appropriating funds to the DOE for fiscal year 1980 prohibited spending funds for any purpose related to licensing of the WIPP by the Nuclear Regulatory Commission (NRC) or related to the disposal at the WIPP of non-defense-related radioactive waste. Furthermore, the fiscal year 1980 authorization act for DOE's national security and military programs defined WIPP so as to limit it to activities involving defense-related radioactive waste.

On February 12, 1980, President Carter sent a special message to the Congress establishing the Nation's first comprehensive radioactive waste management program. This statement resulted from recommendations of the Interagency Review Group (IRG) on Nuclear Waste Management (IRG, 1979). The President declared that all repositories for the permanent disposal of highly radioactive waste should be licensed by the NRC. He stated that an unlicensed facility for TRU waste alone would not provide useful experience relevant to either licensing or high-level waste disposal and, therefore, is an inefficient use of funds. The President directed the DOE to expand and diversify its geologic investigation program before selecting a specific site for repository development. He stated that the WIPP project should be cancelled.

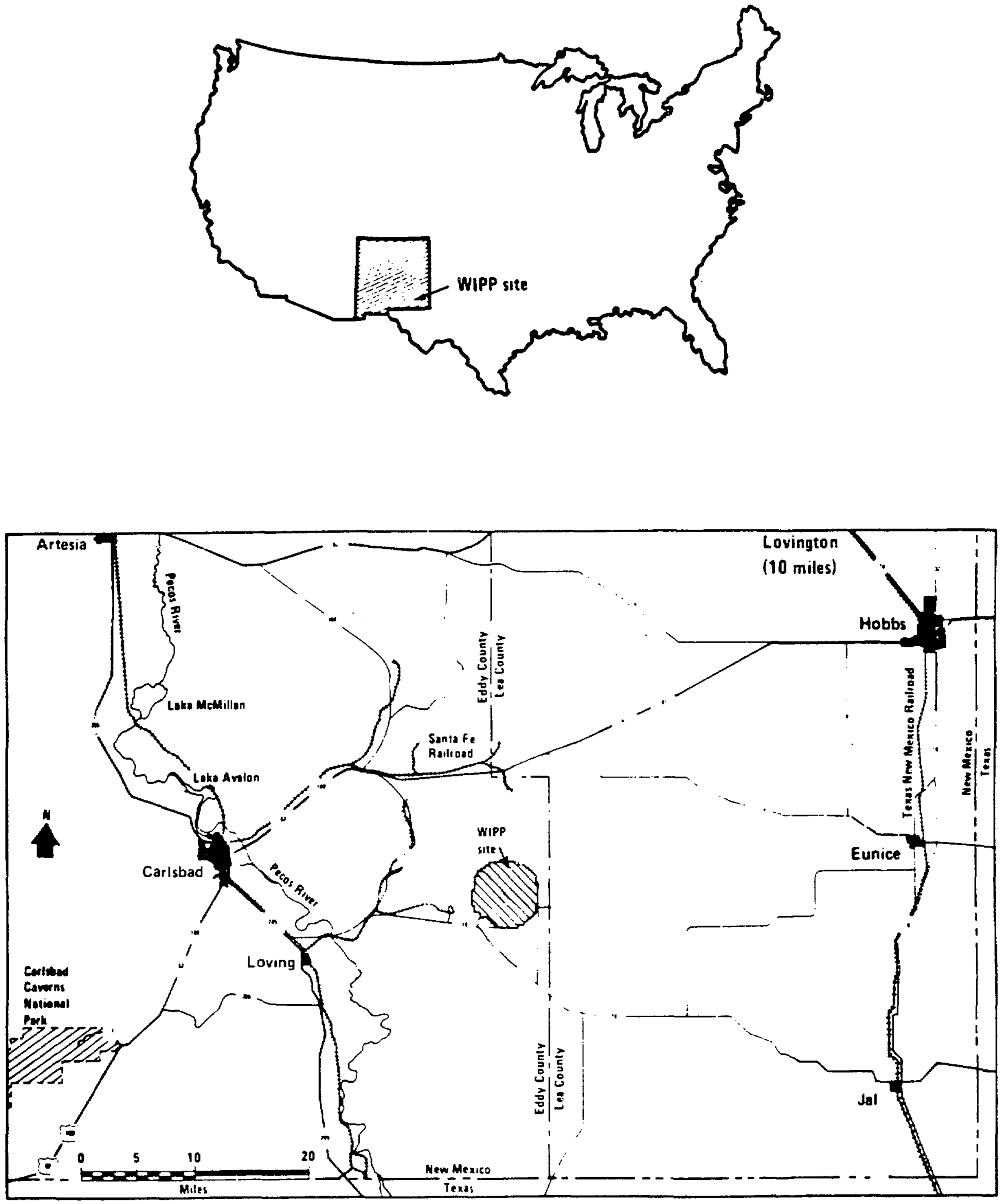


Figure 1-1. Location of the Los Medanos Site.

In accordance with the Impoundment Control Act of 1974, President Carter sent to the Congress on March 4, 1980, a proposal to rescind funds appropriated for the WIPP. Congress did not act on the proposal. Consequently the DOE is required to continue project activities.

The WIPP Final Environmental Impact Statement (FEIS) examines the impacts of the DOE preferred alternative, that is, to dispose of defense TRU waste in the first available commercial high-level repository, as well as the impacts of the authorized WIPP project and other alternative plans, and compares the impacts of the alternatives.

### 1.1.1 Decisions for Which the WIPP FEIS Provides Environmental Input

The WIPP FEIS, prepared in accordance with the requirements of the National Environmental Policy Act of 1969, provides information for the following decisions:

1. What should be the plan for the long-term management of the TRU waste stored at the INEL?

2. Whether a geologic repository for TRU waste should be a combined high-level waste/TRU waste repository or the authorized WIPP facility?

3. Whether the WIPP facility should be constructed and operated at the Los Medanos site?

4. If not, whether the Los Medanos site should be retained for future consideration as a possible combined high-level waste/TRU waste repository?

In the event the preferred alternative is selected, future decisions relative to qualification of the Los Medanos site for a high-level waste repository, qualification of other sites, site selection, and repository construction and operation will be the subject of future environmental documentation.

### 1.1.2 Contents of the WIPP FEIS

#### Retrieval of wastes from the INEL

Part of the DOE plan is the retrieval of waste stored at the INEL for offsite disposal. About 3.0 million cubic feet of TRU waste is either currently stored or is planned to be stored at the INEL through 1990. The WIPP environmental impact analysis includes an evaluation of the effects at INEL of retrieving this waste and the impacts of transporting it to a repository site. This is assumed to be the Los Medanos site for the purpose of analysis. Defense TRU waste generated between the years 1990 and 2003 would be shipped directly from the source of the waste to the WIPP or high-level waste repository.

Withdrawal of BLM land

If the preferred alternative is selected, the DOE would apply to the U.S. Department of the Interior, Bureau of Land Management (BLM) for the temporary withdrawal of the land at the Los Medanos site to complete the site characteriaztion program for a possible high-level waste repository. Land would be withdrawn permanently only if the Los Medãnos site were selected for a high-level waste repository after future environmental review.

If the WIPP is to be constructed as authorized, it would be necessary to transfer to the DOE about 17,200 acres of public lands currently controlled by the BLM. With the addition of 1760 acres of State lands, this acreage would compose the WIPP site. One of the purposes of the WIPP environmental impact statement is to examine the environmental consequences of the withdrawal of these lands.

WIPP construction and operation

In accordance with authorizing legislation, the DOE would proceed with activities leading to the construction of the WIPP at the Los Medanos site. As part of the continuing site-characterization program, two site-validation shafts and an in-situ experimentation facility would be constructed before the construction of the full repository. This program is referred to as "Site and Preliminary Design Validation" or "SPDV". These shafts and the underground experimental area would permit verification of site suitability and design-validation studies in making final design decisions. Although this program has been defined for the WIPP project, it could contribute to site characterization for a high-level waste repository.

The WIPP environmental impact statement describes the impacts of constructing, operating, and decommissioning the WIPP facility at the Los Medanos site. To provide a comprehensive picture of the environmental impacts of the WIPP, the statement also discusses the impacts of activities attendant to the operation of the WIPP but that would be incurred regardless of the location and design of the repository (e.g., impacts of waste transportation).

The WIPP environmental impact statement also specifically analyzes the environmental impacts of the SPDV program, which are included within the more extensive impacts of facility development. These effects are identified separately to allow evaluation of the impacts in the event that the site validation activities were conducted but full facility construction did not go forward.

## 1.2 HISTORY OF MANAGEMENT PROGRAMS LEADING TO CONSIDERATION OF THE LOS MEDANOS SITE

### 1.2.1 Early History of Waste-Management Programs

In 1957, a committee of the National Academy of Sciences (NAS/NRC, 1957) concluded that "the most promising method of disposal of high-level waste at the present time seems to be in salt deposits."

Salt was recommended for further study because of its thermal and physical properties. The existence of salt for hundreds of millions of years has demonstrated its isolation from groundwater and the geologic stability of its environs. Consequently, research was conducted for several years (1957 to 1961) on radioactive waste disposal in salt.

Studies indicated that the Permian basin, which includes the Delaware basin in eastern New Mexico and large areas in Kansas, west Texas, and Oklahoma, might be suitable for the disposal of radioactive waste. From 1963 to 1967, studies were conducted in a salt mine at Lyons, Kansas (Project Salt Vault) to evaluate the effects of radioactive waste and high temperatures upon Permian basin salts. In 1970, the Lyons site was conditionally endorsed as a location for a nuclear waste repository and in 1971 a conceptual design for the repository accommodating both high-level and TRU waste was completed. In 1972, however, the site was abandoned mainly because water used in nearby mining could not be traced and because there could be no assurance in that area that all old drill holes could be found and sealed. The rejection of the Lyons site led the U. S. Atomic Energy Commission (AEC) to seek sites elsewhere.

### 1.2.2 The Site-Selection Process

The site-selection process as applied to the WIPP project, has occurred in the four stages shown in Table 1.1. Each stage of the process narrows the acceptable choices more and more. This four-stage process has been used since 1972 in the search for acceptable sites.

Table 1.1 Site Selection as a Screening Process

| Stage | Function | Action | Decision |
|---|---|---|---|
| 1 | General information | Select disposal media; define geographic regions where they occur; consider their characteristics in terms of tentative selection criteria | Select one (or more) regions for further study |
| 2 | Regional studies | Identify potential study areas and apply selection criteria | Select most promising study areas and candidate sites for further study |
| 3 | Site studies | Conduct detailed field studies to characterize candidate site(s); determine details about how each site meets the selection criteria; determine site factors which are less than ideal | Proceed to step 4 or reject sites and select alternative candidate site or sites |

| | | | |
|---|---|---|---|
| 4 | Site analyses | Analyze site-specific characteristics and environmental impacts; determine risks of using each site | Accept or reject each site |

### 1.2.3 History of Site Selection for the WIPP

Stage 1 of the process

The first task in stage 1 of the selection process is to choose disposal media. A search for repository sites began in 1973 directed primarily toward sites in salt, although shale and limestone sites were also considered (ORNL, 1972).

The selection criteria listed in Table 1.2 (ORNL, 1973) were used in the second task of stage 1, evaluating the regions where salt occurs.

Table 1.2 ORNL Stage 1 Site Selection Criteria

| Characteristics | Requirement |
|---|---|
| Depth of salt | 1000 to 2500 feet |
| Thickness of salt | At least 200 feet |
| Lateral extent of salt | Sufficient to protect against dissolution |
| Tectonics | Low historical seismicity, no salt-flow structures nearby |
| Hydrology | Minimal groundwater |
| Mineral potential | Minimal |
| Existing boreholes | Minimal number |
| Population density | Low |
| Land availability | Federal land preferred |

Additional criteria added during the 1973 search included the requirement that there be no deep boreholes within two miles of the site, and that the available land area include three square miles and a two-mile-wide buffer zone.

Stage 2 of the process

From the bedded-salt regions surveyed in stage 1, eastern New Mexico was selected as the area in the United States best satisfying the site-selection guidelines. This area is well known geologically, it has flat salt beds at adequate depths, and little deep drilling for oil and gas has occurred.

Three locations in eastern New Mexico were examined in greater detail. Two of these areas were eliminated from the selection process and the Carlsbad potash area within the Delaware basin (Jones et al., 1973) was considered most desirable. The eventual site selected for further study, on the Eddy-Lea County line about 30 miles east of Carlsbad, avoided deep drill holes penetrating the salt.

Stage 3 of the process

Field investigations conducted in 1974 and 1975 were directed at confirming existing site information. However, these investigations found unexpected geologic structures due to the nearness of the site to a formation called the Capitan reef. Consequently, that site was given up.

In late 1975, the New Mexico portion of the Delaware basin was reexamined using the following criteria (Griswold, 1977):

1. The site should be at least six miles from the Capitan reef, a major aquifer in the region.

2. The repository site and its surrounding buffer zone should avoid the Known Potash District to avoid conflict with mineral resources.

3. No part of the central area should be closer than one mile to deep drill holes penetrating the evaporite strata into underlying rocks.

4. Known oil and gas sources should be avoided to avoid conflict with these resources.

5. The site should be at least one mile from the nearest salt dissolution front.

6. The salt beds should be nearly flat.

7. Salt of high purity should be available at depths between 1000 and 3000 feet.

8. The use of State and private land should be minimized.

These selection criteria were applied to eight sites and all but one were eliminated. Intensive studies have been conducted at the remaining one, the Los Medanos site, since 1975.

Stage 4 of the process

Work satisfying the stage 4 requirements of the site selection process for the Los Medanos site for the WIPP project include the Geological Characterization Report (Powers et al., 1978), the Safety Analysis Report (DOE, 1980b) and the Final Environmental Impact Statement (DOE, 1980a). These reports provide detailed safety and environmental analyses. Results of these studies indicate that the Los Medanos site may be a suitable location for accomplishing the WIPP mission.

### 1.2.4 The Continuing Site-Characterization Program

Along with the investigations in the Delaware basin, the DOE is continuing its site-characterization program for mined repositories for the disposal of commercially generated high-level waste, as part of the National Waste Terminal Storage (NWTS) program. Neither the WIPP project nor the Los Medanos site are included as part of the NWTS program, although if not developed for the WIPP project, the Los Medanos site would be available for further consideration as a high-level waste repository.

The NWTS program is, however, providing information on potential alternatives to the WIPP. The NWTS program has identified several locations of interest for repositories other than the Los Medanos site. Host rocks being studied are salt, crystalline rocks (basalt and granite), argillaceous rocks (shale), and tuff. No problems have been identified which would clearly preclude the use of these media for a repository. Although the WIPP site is the only site to have reached an advanced stage of characterization, the NWTS program will eventually take other sites to a similar stage.

## 1.3 DEFENSE WASTE TO BE DISPOSED OF OR STUDIED

### 1.3.1 Waste Sources and Volumes

The U.S. defense program has already generated large quantities of contact-handled transuranic (TRU) waste, which requires no shielding, and remotely handled TRU waste, which requires shielding to protect workers who handle it. TRU waste results from almost every industrial process involving transuranic materials, but mainly from the making of plutonium used in nuclear weapons.

The major producers of defense TRU waste have been the Rocky Flats Plant near Denver, the Hanford facilities near Richland, Washington, and the Los Alamos Scientific Laboratory in northern New Mexico. Most of the readily retrievable waste has been stored at the Idaho National Engineering Laboratory and at Hanford.

At the end of 1977, the accumulated volume of defense TRU waste amounted to 11 million cubic feet of material. Only 1.6 million cubic feet is readily retrievable. By the end of 1986, this volume is expected to be 13 million cubic feet, including 3.7 million cubic feet retrievably stored. About 30,000 cubic feet of remotely handled TRU waste from defense programs is now in storage. This volume is expected to grow to about 89,000 cubic feet by 1986. The authorized WIPP facility would be for the demonstration disposal of all of the readily retrievable waste expected to be stored at the INEL through 1990 plus all TRU waste produced by all U.S. defense facilities between 1990 and 2003.

An experimental program designed to study the behavior of high-level waste (HLW) in a repository would also be included in the authorized WIPP facility. The source of the high-level waste to be used in this experimental program is not yet defined. By the late 1980's, solid defense HLW may be available from the Savannah River Plant near Aiken, South Carolina. HLW used in the experimental program would produce high levels of heat and radiation. To speed up waste/salt interactions, some of the waste would be put in place without a surrounding container, and some would be ground into small particles before being emplaced. About 150 cubic feet of solidified HLW would be required for these research and development activities. All of the HLW used for experiments would be retrieved from the WIPP after completion of the research program. Any material contaminated during experiments would also be removed for disposal.

### 1.3.2 Waste Forms

TRU waste exists in a wide variety of physical forms, ranging from unprocessed general trash (e.g., absorbent papers, protective clothing, plastics, rubber, and wood) to decommissioned tools and glove boxes. Criteria have been developed which would govern the acceptance of TRU waste at the repository; these criteria constitute a detailed description of the characteristics of the waste. Features of waste controlled by the Waste Acceptance Criteria (WAC) include the combustibility, liquid content, gas generating potential, degree of immobilization and explosiveness of the waste. The design life and structure of the waste containers including weight, structure, dimensions, maximum radiation surface-dose rate, and thermal power are also mandated.

# 2.0 ALTERNATIVES AND THEIR ENVIRONMENTAL IMPACTS

This chapter discusses the development of the alternatives evaluated in the WIPP Environmental Impact Statement. The environmental impacts of these alternatives are evaluated and compared.

## 2.1 ALTERNATIVES FOR THE WIPP MISSION

### 2.1.1 Alternatives for TRU Waste Disposal

Three alternatives may be considered for the TRU-waste-disposal portion of the WIPP mission. They are: (1) no action; (2) a WIPP in southeastern New Mexico; and (3) delay. Delay could be delay in building at the Los Medanos site, delay for the sake of considering additional possible sites, or delay to eliminate the need for a separate TRU waste repository by allowing this waste to be disposed of in a high-level waste (HLW) repository. Delay could also be for various periods of time.

The "no action" alternative for TRU-waste disposal means retention at the Idaho National Engineering Laboratory (INEL) of the readily retrievable TRU waste expected to be there through 1990. This waste could be held in its present storage or placed in improved storage at the INEL for an indeterminate period of time. The possibility of geologic storage at the INEL has also been considered. However, this approach is technically unsuitable for the following reasons:

- There is no suitable geologic environment at the INEL. The INEL is on the Snake River Plain and is underlain by the very important Snake River aquifer.

- The only part of the INEL not located over the aquifer is not considered a promising site, because of unknown hydrologic characteristics. Existing mines in this area are troubled by groundwater and hydrologic connections with the aquifer are suspected.

Accordingly, the long-term management of this waste requires offsite disposal.

### 2.1.2 Alternatives for Research-and-Development Studies

Four alternatives might be considered for the research-and-development (R&D) portion of the WIPP mission: (1) no action (i.e., reliance on laboratory studies alone); (2) a facility devoted solely to R&D; (3) an R&D facility in the WIPP; and (4) an R&D facility in the first available high-level waste repository.

In order to advance knowledge about radioactive waste disposal, it is necessary to conduct full-scale experiments with wastes in an actual facility. Continued laboratory experiments are not believed to be a useful research and development alternative.

The development of a stand-alone full-scale experimental facility would greatly advance the state-of-the-art of future waste disposal. However, a pure R&D facility, unless it were located at a possible future repository site, would raise questions about the applicability of its results to a specific site. The value of the experiments alone would have to be traded against the high costs of buildings, shafts, and underground openings.

An R&D facility at the Los Medanos site would have the same uncertainty relative to the transferability of experimental results; on the other hand, its results would be quite helpful in future planning. The cost of colocating an R&D facility as part of the WIPP would represent only a small fraction of its total cost without an R&D facility.

The alternative of including an R&D facility in the first available high-level waste repository is not in conflict with the other action alternatives. Indeed, the arguments for including one in the WIPP also apply, with some changes, to an R&D facility in the first high-level waste repository.

## 2.2 ALTERNATIVE DISPOSAL METHODS

Five candidate methods for the disposal of TRU waste have been considered: disposal in conventionally mined geologic repositories, emplacement in deep ocean sediments, emplacement in very deep drill holes, transmutation, and ejection into space. Except for geologic disposal, none of these methods has been shown to be technically or economically feasible, and several years of research will be needed before any demonstration of their feasibility can begin.

### 2.2.1 Conventional Geologic Repositories

Mined by conventional techniques, a geologic repository would be located deep underground in an environment judged suitable for the long-term isolation of waste from man's environment. The successful outcome of a mined repository will be determined by the joint effects of the regional environment, future human activities, the physical and chemical properties of the chosen host rock, the physical and chemical form of the waste, and the engineering aspects of the repository.

### 2.2.2 Other Disposal Methods

Four alternate disposal methods to geologic disposal are described below:

- Emplacement in deep ocean sediments - Isolation in deep seabeds would involve implanting waste canisters into deep ocean sediments by free-fall penetration or other techniques. Sediments can be found which are thick, uniform, and stable, which have accumulated over millions of years, and which are in the process of becoming sedimentary rocks. There are engineering, safety-related, environmental, and international political uncertainties about this disposal method. However, the DOE concluded that only the limited relevant state of knowledge and experience keeps this method from being attractive at this time (DOE, 1979, p. 1-35).

- Emplacement in very deep drill holes - Waste canisters would be emplaced in a very deep (at least 25,000 feet) drill hole. This disposal concept would require technological developments not currently available, but it is believed this method is possible by the extension of existing technology. This method may compromise the integrity of the disposal medium and retrieval of waste may be impossible using this method.

- Transmutation - The transmutation of long-lived radionuclides into short-lived or stable ones could probably be carried out in a nuclear reactor. Spent-fuel reprocessing and plutonium recycling are necessary components of a transmutation scheme. The fission products from the transmutation, together with those resulting from power generation, would have to be separated and disposed of by some other, presumably geologic, method. Geologic disposal would, therefore, still be necessary but the time over which isolation of the wastes must be ensured would be shortened. Transmutation is not considered a workable alternative disposal method for TRU waste because the high volume of TRU waste and the relatively low radioactivity of this waste makes the process unnecessary. Transmutation might, however, be a promising alternative for long-term disposal of high-level waste.

- Ejection into space - This process calls for a space shuttle to launch waste into earth orbit. The waste package would then be docked and assembled with an unmanned orbital transfer vehicle and be ejected by it into an appropriate solar orbit. While there appears to be no fundamental scientific problem with space disposal, numerous technical and safety questions remain unresolved. For example, waste canisters must be designed to withstand the impact of a waste-carrying missile crashing to the ground after a faulty launch. This possibility, combined with the high volume and relatively low radioactivity of TRU waste, makes ejection into space an impractical alternative for the WIPP project.

## 2.3 GEOLOGIC DISPOSAL ALTERNATIVES

Three general classes of candidate geologic media for conventionally mined repositories are being considered for the disposal of radioactive wastes:

- Salt in bedded, anticlinal, and dome formations

- Igneous and volcanic rocks (granite, basalt, and tuff)

- Argillaceous rocks (shale)

The important charactersitic of a geologic medium is the long-term environmental impact of a repository built in it. The short-term impacts (i.e., those related to construction, operation, and transportation) are fundamentally the same regardless of the medium.

### 2.3.1 Salt

Rock salt has received most of the attention in waste-disposal studies over the past two decades. The original report of a committee established by the National Academy of Sciences (NAS/NRC, 1957) recommended that salt be evaluated as a disposal medium because of its thermal and physical properties and because the existence of a salt formation for hundreds of millions of years has demonstrated its stability and isolation from groundwater.

Extensive salt mining in many locations around the United States and abroad has resulted in a well-developed salt-mining technology (D'Appolonia Consulting Engineers, Inc., 1976). One particular advantage associated with salt mining is that, after shaft construction, explosives are not needed. Continuous-mining machines can be used to construct the disposal rooms and avoid shock-produced cracks.

The desirable intrinsic properties of the salt include a uniformly low permeability, a high thermal conductivity (this criterion is more important for heat-generating waste than for TRU waste) and a plasticity which enables fractures to heal themselves at feasible repository depths. However, like every other medium considered for disposal, salt presents some problems. These problems have been reviewed (OSTP, 1978; Hebel, et al., 1978) to identify several specific considerations which should be applied in locating and evaluating repository sites in salt.

Salt is the best understood of all candidate geologic media with respect to its possible use as a waste repository medium. The IRG has concluded (IRG Subgroup, 1978,) that "with appropriate selection of a site and appropriate hydrogeology and conservative engineering, salt could be an appropriate repository medium."

### 2.3.2 Other Media

Basalt, granite, and other crystalline igneous and volcanic rocks have been considered as geologic media for a repository. Crystalline rocks are attractive because of their strength and structural stability. The little water they contain lies largely in fractures. Because of these favorable natural conditions, it has been estimated that the waste containers stored in a crystalline-rock repository could maintain their integrity over hundreds of years. The design and the operating procedures for a crystalline-rock repository would be similar to those used in a salt repository, except drill-and-blast mining, rather than continuous miners, may be necessary.

Tuff, a rock produced by volcanoes, has also been considered as a geologic medium for a repository. The repository design concept is to locate the repository in a body of tuff of high density, low porosity and water content, and having the capacity to withstand high temperatures generated by the waste. Surrounding this rock would be another type of tuff with low density, high porosity, very low interstitial permeability, and very favorable sorptive properties for radionuclides. The combination of these two types of tuff is believed to produce a favorable media for waste disposal.

Shale and related rock types have a number of qualities that could make them attractive as media for the isolation of radioactive wastes. These properties include low permeability, plasticity, good sorptive characteristics, and low solubility in water. These rock types are abundant in thick masses throughout the midwestern and western United States.

## 2.4 INFLUENCE OF THE NWTS PROGRAM

No method other than emplacement in a mined geologic repository is feasible at present for the disposal of TRU waste. The National Waste Terminal Storage (NWTS) program is investigating other host media, and potential repository sites will be identified starting in 1985. Although these sites are being sought for the disposal of commercial high-level waste (HLW), they may also be suitable for the disposal of TRU waste.

The Presidential program recommends a system of repositories in a wide variety of geologic environments. In the next 5 years, the NWTS program is expected to characterize several sites and then recommend one site for HLW disposal. The earliest possible dates for completing the required studies and enviromental documentation needed to consider a possible site further are as follows:

| Geologic medium and location | Date |
|---|---|
| Bedded salt (other than Los Medanos) | 1985 |
| Dome salt (Gulf interior region) | 1983 |
| Basalt (Hanford) | 1984 |
| Nevada Test Site | 1985 |
| Other hard rock sites | 1985 |

Each of these sites will have been taken through the NWTS site exploration and characterization phase. Thus, a decision-maker in late 1985, for example, could probably consider several sites in the selection process.

## 2.5 FORMULATION OF ALTERNATIVES

The two parts of the WIPP mission--demonstration of the disposal of TRU waste and R&D studies for high-level waste--are complementary. However, a TRU waste repository could be built with or without a capability for R&D studies at very little difference in effort and cost. A stand-alone

R&D facility would itself be a major undertaking. Stand-alone R&D facilities in several media, including salt, are being considered in the NWTS program. For those reasons a stand-alone R&D facility for defense waste only is not included among the alternatives discussed here for the WIPP mission. All the remaining alternatives discussed in this document assume that an R&D facility is to be built in whatever repository alternative is chosen.

Thus, there are two choices left, each with several possible time scales: TRU waste can be disposed of in a repository dedicated to TRU waste alone or it can be put into a repository that is primarily a repository for high-level waste (high-level waste, being heat-producing, is more difficult to analyze and accomodate in design). The remaining alternatives, therefore, are the following:

- Alternative 2, the authorized alternative. A repository for the demonstration of the disposal of TRU waste and including an R&D facility for high-level waste is built now at the one presently available site, the Los Medanos site in southeastern New Mexico.

- Alternative 3, the preferred alternative. TRU waste is disposed of in the first available HLW repository. This repository is planned to be in operation in the 1997 to 2006 time period. The Los Medanos site would be considered for a HLW repository. New environmental impact statements would be required for site selection and repository construction.

- Alternative 4. The decision on where to build is delayed until at least 1984 when two or three sites in addition to Los Medanos should be available for consideration.

## 2.6 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

The environmental impact of each of the alternatives are summarized in this section. The information on alternative 2, the reference case for environmental comparisons, is expanded in Chapter 6 of this document. The costs and impacts of high-level waste repositories required for alternative 3, are taken mainly from the draft generic environmental impact statement on the management of commercially generated high-level waste (DOE, 1979). Alternative 3 is considered from two points of view: (1) the changes in impacts (usually increases) associated with expanding the high-level waste repository to include TRU waste and (2) the changes in impacts (usually decreases) in having one repository rather than two.

### 2.6.1 Alternative 1: No Action

TRU waste would be maintained at present storage sites and no impacts from TRU waste disposal at the Los Medanos site would occur. In the short term, the radiological consequences of no action are small. At the Idaho National Engineering Laboratory exposures to individuals of no more than 0.0000036 rem per year could be expected. However, in the long term, some natural events and human intrusion that might produce large exposures are probable. The Laboratory is at the edge of the Arco Volcanic Rift Zone, which has been active as recently as 10,500 years ago and is likely to be the scene of volcanic action in the future. Fifty-year radiation dose commitments to exposed persons from these types of events could be as large as 90 rem to the lung due to volcanic lava flow and 700 rem to the lung for human intrusion.

### 2.6.2 Alternative 2: The Authorized WIPP Project

The WIPP facility would be developed in two phases: (1) Site and Preliminary Design Validation (SPDV), in which two deep shafts and an underground experimental area were constructed; and (2) full construction in which the required surface and underground facilities and the remaining shafts were built. This initial phase is technically compatible with further characterization of the Los Medanos site for a facility under alternatives 3 and 4.

The physical impacts of the SPDV program would be similar to those which accompany any small mining project: locally increased noise levels, local degradation of air quality from dust, disturbance of vegetation and wildlife habitat, and increased soil erosion. None of these impacts is judged to be significant. Socioeconomic impacts of SPDV activities, either beneficial or adverse, would be minimal because of the small size and short duration of stay of the SPDV workforce. No radioactive materials would be used in the SPDV program so there would be no radiological consequences.

The physical impacts of developing the full WIPP facility would include the removal of 1072 acres of land from grazing and the denial of access to some subsurface minerals. Some of this land (37 acres) would be removed from grazing for a very long time because it would be sterilized by the salt stored on its surface. The important mineral reserve is langbeinite, a mineral used for fertilizer where chlorides cannot be used; access to an estimated 3 percent to 10 percent of the U.S. reserves of this mineral would be denied throughout the operating life of the WIPP, and strict controls on its removal would be enforced thereafter. Although langbeinite is useful, it is not essential to agriculture; similar minerals can be used in its place.

The authorized WIPP repository would cost about $500 million (1979 dollars) to design and build and $24 million a year to operate. Jobs created directly and indirectly would peak at about 2100 during construction and drop to 950 during operation.

Transportation accidents of extreme severity, though not expected to occur, were postulated to analyze the worst possible consequences of transporting waste to the WIPP. Such an accident postulated for the transportation of the experimental high-level waste could deliver a 50-year radiation dose commitment that might reach seven times the dose delivered by natural background radiation. For a postulated accident during the shipment of TRU waste, the maximally exposed individual could receive a dose 3.4 times that from background sources.

During operations, the most severe credible accident would be an underground fire in the contact-handled TRU waste area. The 50-year radiation dose commitment received by the maximally exposed individual would be about 0.0001 percent of the dose from natural background radiation; this dose would be delivered to the bone.

After the WIPP ceased operation and was closed, no release of radioactive material would be expected. Nevertheless, if someone were to drill directly into the emplaced TRU waste 100 years later, the geologist on the drill crew could be exposed to a whole-body dose of about 0.0015 rem. This dose is about 1.5 percent of the annual dose received from natural background radiation. Even if the worst imaginable release into groundwater did occur, the consequences would be very small: the radioactivity discharged into the Pecos River would deliver an annual bone dose of only 0.00003 rem to the person receiving the highest exposure; this is 0.03 percent of the dose received from natural background radiation.

### 2.6.3 Alternative 3: (The Preferred Alternative) Delay the Authorized WIPP Activities - Combine Them with the First Available High-Level Waste Repository

In this preferred alternative, there would be no separate defense waste disposal facility for TRU waste. The delay inherent in this alternative means that the TRU waste would remain longer in its present storage; leaving it there for a short time would entail no significant consequences, barring a natural catastrophe. Potential sites, in addition to Los Medanos, to be considered include sites in other bedded salt, salt domes, basalt, granite, shale, and tuff. This alternative is consistent with the program proposed by the President and that described by the DOE in the Waste Confidence Rulemaking of the NRC (DOE, 1980c). The impacts for a HLW repository in salt or basalt are analyzed in the environmental impact statement. A HLW repository in shale, granite, tuff, or other medium would entail different impacts, which can be accurately predicted only after further study of these media and the identification of specific sites.

Under alternative 3, the Los Medanos site would become a potential site for a commerical repository which would include the disposal of defense TRU waste. The Los Medanos site does not appear to be in conflict with the draft NWTS criteria for qualifying sites for commercial HLW disposal (ONWI, 1980). Moreover, although the analyses of environmental impacts have focused on the use of the site for the WIPP mission, these evaluations have not developed any information which would eliminate the Los Medanos site as a potential site for a HLW facility.

A site characterization program, which may or may not require sinking of a shaft to the repository horizon, would be required before a decision could be made on the suitability of the Los Medanos site for a commercial HLW repository. In general, the sinking of such a shaft would have impacts similar to those associated with the SPDV program described in alternative 2.

At the high-level waste repository, the land required may be increased by not more than 6 percent with the addition of TRU waste, but combining TRU and high-level waste repositories would decrease overall land use by about 15 percent. The quantity of mined rock would increase by 3 percent to 7 percent at the high-level waste site but remain basically unchanged overall.

By including a TRU waste repository, the construction and operating costs at the high-level waste site would be increased by 8 to 25 percent and 15 to 30 percent, respectively, but decreased in comparison to separate repositories. The number of workers at the high-level site would increase by 27 to 35 percent, but would decrease by 10 percent in comparison to separate repositories.

Transportation routes would vary depending upon the site selected for the combined repository. The consequences of individual accidents would remain essentially the same. There is no reason to expect any change in the probabilities of operational accidents.

In the long term, the anticipated release of radioactivity from all sites is the same: zero. Credible events or processes that might impair the integrity of the repository differ with the site, and analyses of the consequences of such breaches at sites other than the Los Medanos have not generally been performed. However, any such alternative site will be subjected to such analyses, and any site that appears to entail significant risks from long-term releases will be eliminated from further consideration.

### 2.6.4 Alternative 4: A Defense Waste Facility Built After the Consideration of Sites in Addition to Los Medanos

This alternative would basically be alternative 2 delayed. During the delay, the TRU waste would remain in its present storage, with no significant consequences. The quantity of defense TRU waste stored at the surface would increase by about 10 percent per year.

The physical impacts of this alternative would be essentially the same as those of alternative 2 with respect to land use, resources used, effluents, and mined-rock disposal. If the repository were constructed in the Gulf interior region or in the basalt at Hanford, the conflict with mineral resources potentially would be reduced. However, the salt in domes is in itself a resource.

Transportation routes would be longer to a salt-dome repository, and this would increase the probability of transportation accidents; the reverse would be true of a basalt repository. The consequences of an accident and the radiation doses delivered to individual person under normal transport conditions would remain basically unchanged, as the consequences are calculated under the assumption that the waste packaging alone provides the relied on containment.

Individual radiation exposures during plant operations (under both normal and postulated accident conditions) would not be expected to change; population exposures would be higher in the vicinity of salt-dome and basalt repositories because of higher population densities.

There would be no changes in the long-term consequences of a delayed defense waste facility if it were built at the Los Medanos Site.

Although the actual construction and operating costs of a delayed defense waste facility would not be expected to change drastically from those of alternative 2 (if the costs are calculated in constant dollars), the overall cost of alternative 4 would be significantly higher. These increased costs would include the cost of storing increasing quantities of TRU waste at the Idaho National Engineering Laboratory and other DOE sites and the cost of closing out and restarting the program. The cost of closing out the present effort is estimated to be about $3 million; starting the project up again, either at the Los Medanos site or elsewhere, could cost considerably more.

### 2.6.5 Conclusions

The alternative of no action (alternative 1) is unacceptable in the long-term because it leaves TRU waste exposed to possible volcanic action or human intrusion.

The remaining three alternatives are predicted to have impacts that are small both during operation and in the more distant future, but none of them is so clearly superior to the other that it can be selected on environmental grounds alone. Any of these three alternatives can be carried out in a safe and environmentally acceptable manner. Table 2.1 presents a comparison of the environmental impacts of these action alternatives.

Alternative 3 is the preferred alternative and is consistent with the comprehensive radioactive waste management program proposed by the President. Its predicted environmental impacts are generally small. It may deny access to some U.S. mineral resources depending upon the site selected.

Predicted impacts for alternative 2, the authorized alternative, are also generally small. The use of the Los Medanos site in southeastern New Mexico would deny access to 3 percent to 10 percent of the U.S. reserves of the mineral langbeinite for the operating life of the facility and require strict controls on its extraction thereafter. It is the alternative consistent with authorization and appropriation acts.

The radiological consequences of accidents during the transportation of high-level waste could be severe, but they would be similar regardless of when or where the repository is built. The probabilities and the overall population doses would change, but the radiation doses received by the maximally exposed individual would be the same.

Table 2.1 Comparison of Environmental Impacts of Alternatives

| | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|
| Basis for comparison to alternative 2 | | The changes in impacts caused by expansion of the HLW repository to accommodate TRU waste | The impacts of alternative 4 |
| Physical impacts | Withdrawal of about 1000 acres now used for grazing by about 16 cattle | Commitment of about 25 additional acres at HLW repository | Same amount of land withdrawn; current uses depend on site |
| | Sterilization of 37 acres by salt storage | Increase in stored-rock volume of up to 7% | Little difference in volume of mined-rock pile |
| | Denial of access to 3-10% of U.S. langebinite | Possible no conflict with mineral resources | Possible avoidance of conflict with mineral resources, depending on site |
| Socioeconomic impacts | Injection of $138 million into two-county economy; permanent population increase of 1000 | Increase in spending near HLW repository of up to 25% in construction and of up to 30% in operation; roughly 30% increase in workforce | Spending equal to WIPP spending or significantly higher, depending on site; little or no change in population from WIPP estimates |
| | Possible temporary housing shortage; need to increase community services several months earlier than without the project | Probably no significant increase in demands for services near HLW repository | Possible decreases in service demands, depending on site |
| Radiological impacts of transportation and operation | Normal transportation and operation: dose commitments much smaller than natural background doses | Little change on transportation routes to HLW repository and little additional impact from TRU waste | Transporatation: changes in routine doses range from 13% increase to 20% decrease, depending on site, no change in accident effects |

Table 2.1 Comparison of Environmental Impacts of Alternatives (continued)

| | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|
| | Accidents: extremely severe transportation accidents could produce dose commitments greater than three times natural background doses; accidents at plant contribute a fraction much below 1% | Little addition to impacts of repository operation | Operation: possible increase in routine and accidental population doses, depending on site |
| Long-term impacts | No release of radioactive material expected | No release expected at HLW repository | No release expected at repository site |
| | Hypothetical unlikely releases could produce doses or dose commitments amounting to a small fraction of natural background doses | Effects of hypothetical unlikely releases probably little different from those at WIPP; detailed modeling unavailable | Effects of hypothetical unlikely releases probably little different from those at WIPP; detailed modeling unavailable |
| Impacts of removing waste | (Impacts at retrieval site) | | |
| | Normal operation: dose commitments far below doses from natural background radiation | Same as alternative 2 except for increase in volume of stored waste during delay | Same as alternative 2 except for increase in volume of stored waste during delay |
| | Accidents: extremely severe accidents could produce dose commitments amounting to a small fraction of doses from natural background radiation | | |
| Impacts not exerted by alternative 2 | | No impacts at WIPP site or along parts of transportation routes that differ from WIPP routes | Changes in locations of impacts (see alternative 3) |
| | | Cost ($3.2 million) of closing WIPP project | Cost ($280 million) of closing and reopening project |

# 3.0 TRANSPORTATION OF WASTES TO THE WIPP FACILITY

## 3.1 REGULATIONS

### 3.1.1 Background

Three Federal agencies would be responsible for regulating the safety aspects of transporting radioactive materials to the WIPP: the Department of Transportation (DOT); the Nuclear Regulatory Commission (NRC); and the Department of Energy (DOE). The DOT is responsible for regulating safety in the transportation of all hazardous materials; its regulations apply to all shippers and carriers. The NRC is the regulator of the commercial nuclear industry. Specifically, it regulates the safety of certain commercial nuclear operations including the receipt, possession, use and transfer of nuclear materials. The DOE assures the protection of public health and safety by imposing standards similar to those of the DOT and the NRC on its transportation activities.

### 3.1.2 Packaging

The primary means for ensuring safety during the transport of radioactive material is proper packaging. Consequently, most of the radioactive material transport regulations are concerned with packaging standards.

Three aspects of packaging which would apply to WIPP shipments are governed by the regulations:

- Containment of the radioactive material, with allowance for heat dissipation;
- Shielding from the radiation emitted by the material; and
- Prevention of nuclear criticality in fissile materials.

### 3.1.3 Handling

During handling, the carrier of radioactive materials must perform special actions in addition to those required for other hazardous materials. Since the safety of radioactive material transport is primarily governed by packaging design, the carrier's special actions are largely limited to administrative actions such as documenting, certifying, and labeling. However, one important action is to ensure that established radiation limits are not exceeded in any shipment.

### 3.1.4 Routing

The DOT is establishing routing regulations for transportation of radioactive materials by public highway. Objectives are to reduce the risk of transporting radioactive waste and to identify the role of state and local governments in the routing of radioactive materials. The proposed regulations are based on the belief that reducing time in transit will decrease the overall transportation risks. The proposed regulations also allow states and local authorities to regulate routes provided their regulations are not inconsistent with those of the DOT.

#### 3.1.5 Vehicle Safety

No additional or special vehicle regulations are imposed on the carrier of radioactive materials beyond those required for a carrier of any other hazardous material. Vehicle safety is ensured by other Federal regulations which are not specific to vehicles carrying radioactive material.

## 3.2 TRANSPORTATION ELEMENTS

### 3.2.1 Containers

Proper packaging design is the foundation of safety in the shipment of radioactive materials.

Contact-handled TRU waste is shipped in polyethylene-lined drums or plywood boxes coated with fiberglass-reinforced polyester. These containers are then packed inside approved steel cargo containers designed to withstand accidents. Packagings (shipping containers) which can efficiently contain drums or boxes of contact-handled TRU waste are currently being developed for the WIPP project. These new package transporters called TRUPACTs will contain up to 48 55-gallon drums or eight boxes and are designed for rail transport. Another TRUPACT for truck transport is also being developed.

Two likely packaging configurations to be used for the shipment of remotely-handled TRU waste are: (1) disposable shielded packagings such as concrete-shielded drums; and (2) canisters placed in reusable shielded packagings similar to those used for high-level waste.

At present there are no shipping casks designed specifically for transporting canisters of high-level waste. There are, however, two conceptual cask designs. Each of these designs utilizes features to contain the radiation given off by the waste and keep the cask cool. Weights of these packagings would be 60 to 100 tons.

### 3.2.2 Vehicles

For the WIPP shipment, CH TRU wastes would be placed in the TRUPACT containers and handled like other cargo containers. Flatbed railcars would be used for rail transport of the TRUPACT containers. Flatbed trucks would be used to carry the TRUPACT containers over highways.

Similar rail and highway vehicles would be used in shipping casks containing the RH TRU waste. Because of the weight of high-level waste shipping casks, only rail transport of this material would appear feasible.

### 3.2.3 Routes

The TRU waste transported to the WIPP would come from the Idaho National Engineering Laboratory and, after 1990, other DOE facilities. The DOE would select the mode of transport to be used (rail or truck) and possibly the specific route to be used. Routes would be selected for safety and shortest transit time. Typical rail transportation routes to the WIPP from each TRU waste source are shown in Figure 3-1. The number of routes for truck carriers is more varied as shown in Figure 3-2.

Sources of the high-level waste that would be used in the WIPP experimental program are not presently defined. This waste would probably come from either Battelle Pacific Northwest Laboratories near Hanford or from the Savannah River Plant in South Carolina. If this waste came from Hanford the route would be the same as the route used for other waste forms. The route to be used if the waste comes from South Carolina is shown by a dashed line in Figure 3-1.

### 3.2.4 Emergency Procedures

The DOE would prepare an emergency preparedness plan for the WIPP. States are responsible for developing emergency preparedness plans for transportation accidents and the carrier is responsible for hazardous materials in transit and emergency response planning.

Immediately following an accident, the carrier is required to notify local law enforcement officials, the DOT and the carrier's own management. The accident scene is secured and any injured persons are attended by state and local police. The emergency response personnel of the state radiological health department then arrange for assistance in monitoring the accident scene. If evacuation of persons near the scene is required, action would be taken by local public-safety officials in accordance with prearranged plans.

The carrier is financially responsible for the clean-up phase of the emergency procedures. Typically, state and local police, and health and environmental departments will direct this operation.

Training of emergency-response personnel along transportation routes to the WIPP site would be offered by the DOE.

### 3.2.5 Security and Sabotage

The nuclear materials shipped to the WIPP would not present an attractive target because of the mass of the packaging and the relatively small radioactivity content of TRU wastes. The high-level waste shipments to the WIPP would be the most attractive targets for attack, however, only six or seven such shipments would occur throughout the lifetime of the WIPP.

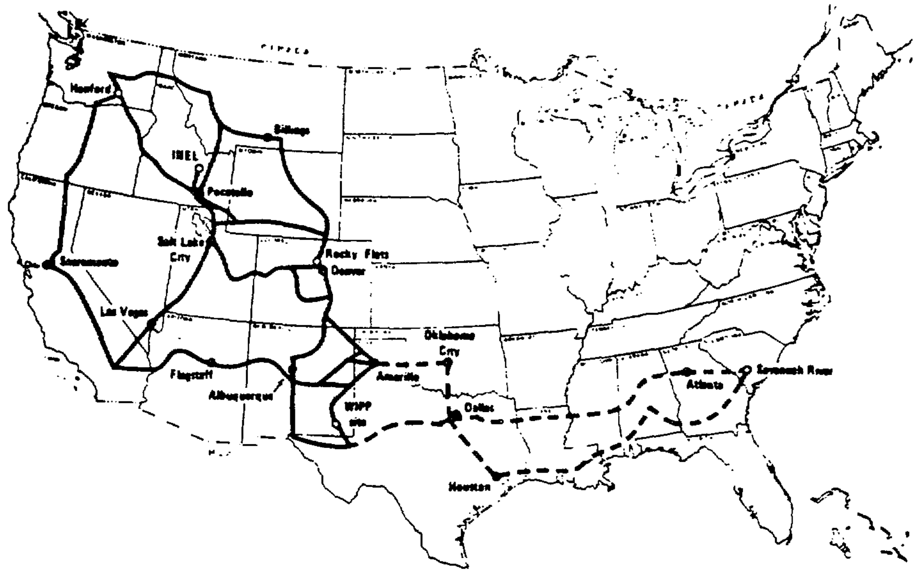


Figure 3-1. Typical Rail Transportation Routes from Principal Sources

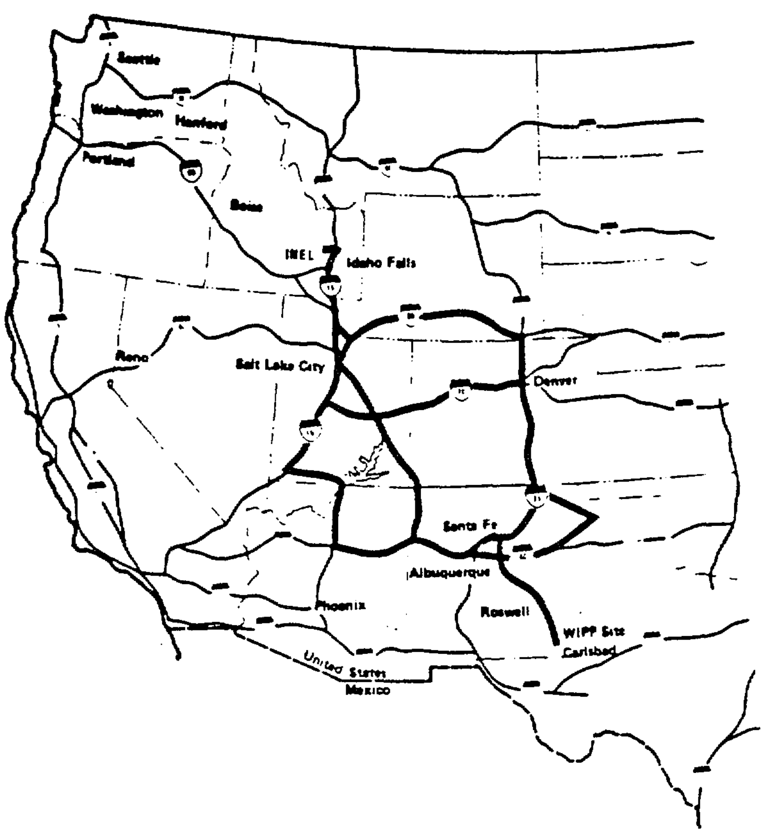


Figure 3-2.

Typical Truck Transportation Routes to the WIPP

Studies are currently being conducted to evaluate package response to terrorist attacks and to determine the characteristics of any released material. Were such an attack to occur, the results would be serious. Resulting whole body radiation doses to the exposed population could be about three times greater than that of the worst-case transportation accident with high-level waste and the bone dose could be 70 times greater.

### 3.2.6 Insurance

Congress passed the Price-Anderson Act in 1957 to insure parties against damage from a nuclear incident. Although the Act does not specifically address the operation of a nuclear-waste repository, provisions in the Act and its amendments resolve some of the questions which might arise.

The provisions of state and Federal law would appear to cover transportation accidents related to the WIPP. The Price-Anderson Act requires the NRC to submit, before August 1983, a report to Congress recommending repeal or modification of any provisions of the Act.

## 3.3 WASTE TRANSPORT ASSESSMENT

### 3.3.1 Volumes

There would be about 227 annual rail shipments of contact-handled TRU waste to the WIPP totalling approximately 290,000 cubic feet of waste. Truck shipments of contact-handled TRU waste would total about 232 annually, representing a volume of 100,000 cubic feet.

Rail shipments of remotely handled TRU waste would not exceed a total of 50 per year, totaling 9300 cubic feet. No more than about 80 annual truck shipments would be required (3300 cubic feet of remotely handled TRU waste).

A total of about 40 canisters of high-level waste would be transported to the WIPP in six shipments throughout the life of the facility.

### 3.3.2 Transport: Normal Conditions

In normal transport, the package of radioactive material would arrive at its destination without releasing its contents. Exposure of people to radiation would arise from the radiation emitted by the radioactive material inside the shipping containers. Population groups exposed to these low levels of radiation would include those who handle waste packages, people working in the vicinity of the packages, bystanders, passing motorists, and train passengers.

Estimates of radiation doses which would be received by these groups of people have been made. Comparisons were then made between these estimated doses and doses received from naturally occurring background radiation. During normal conditions the most exposed person would receive an additional 0.00015 rem annually. This compares with 0.1 rem background radiation dose a person would annually receive from natural sources. A person detained in a car for two hours while waiting for a stalled waste-hauling truck to move would receive an external dose of about 0.0016 rem. For all possible situations examined additional radiation exposure received by the public is negligible.

### 3.3.3 Transport: Accident Conditions

The likelihood of transportation accidents and the effects of accidents involving release of radioactive material have been studied. Five hypothetical accident scenarios were developed for this analysis and the likelihood of each was estimated. The most likely of these accidents has one chance in 40,000 in any given year; the least likely accident has one chance in 1,000,000 of occurring in any one year. The maximum whole-body radiation dose commitment received by a bystander from the most severe accident (a rail accident involving high-level waste for experiments) is 33 rem, which is almost seven times the 50-year natural-background dose (5 rem) he would receive to the whole body. The 50-year dose commitment to the bone from this accident would be 37 rem. A rescue worker, operating under the worst possible conditions after an accident, would receive a 50-year dose commitment of 50 rem to the bone, 8 rem to the lung and 44 rem to the whole body.

# 4.0 THE EXISTING ENVIRONMENT AT THE LOS MEDANOS SITE

The existing environment at the Los Medanos site is described in three sections: general description, geology, and hydrology. Emphasis is placed upon geology and hydrology because these are most important to the long-term integrity of a waste repository.

## 4.1 GENERAL DESCRIPTION

### 4.1.1 Biophysical Environment

The Los Medanos site is located in Eddy County, New Mexico, about 26 miles east of Carlsbad (Figure 1-1). The site is on a plateau east of the Pecos River, an area of rolling sand-covered hills and dunes. There is no site surface drainage connected with the Pecos River and rain generally soaks into the sand or evaporates directly.

#### Climate

The climate is semiarid, with generally mild temperatures, low precipitation and humidity, and a high evaporation rate. Winds are most commonly from the south to southeast and of moderate speeds. Temperatures are moderate throughout the year, although seasonal changes are distinct. Mean annual temperatures are near 60°F. Rainfall is light and unevenly distributed throughout the year, averaging about 12 inches. Winter is the season of least rainfall and approximately half of the yearly precipitation comes during intense summer thunderstorms. Climatic conditions relating to the dispersion of potential air pollutants have been extensively studied at the Los Medanos site.

#### Air quality and noise

The air quality in the region of the Los Medanos site meets State and Federal standards except locally near industries where excessive dust occurs.

The Los Medanos site is relatively remote from man-induced noise and the site area is generally quiet. Noise sources include animals, aircraft, wind, occasional road traffic and intermittent use of heavy equipment in the distance.

#### Background radiation

The observed background radiation in 1977 averaged 8 microroentgens per hour (Brewer and Metcalf, 1977). This radiation level means that the external whole-body radiation exposure of a person at the site is about 75 millirem per year. Naturally occurring, internally deposited isotopes would contribute an additional 20 millirem per year. This level of background radiation is about the average observed throughout the United States.

### Terrain and soils

The land surface at the Los Medanos site is a relatively flat plain covered by small, sporadic depressions and an abundance of sand ridges and dunes.

The site soils consist of sandy, deep soils from sand deposits eroded by wind. These soils are particularly sensitive to wind erosion in the spring. Water seeps quickly through the surface layer of soil but more slowly in the subsoil. The site soils are only suitable for grazing and wildlife habitat.

### Vegetation

The Los Medanos site lies within a transition region between Chihauhuan Desert (desert grassland) and the Southern Great Plains (short-grass prairie); it shares the floral characteristics of both. Vegetation at the site is not a true climax, at least in part because of past grazing management. Vegetation near the site center is a stabilized dune area supporting a shinnery oak, sand sagebrush and dune yucca association. Mesquite is not a prominent shrub here, although it is a frequent dominant elsewhere in the dune areas.

### Fauna

The semiarid climate makes water a limiting factor for the animals in the region. The amount and timing of rainfall greatly influence plant productivity and therefore the food supply available for wildlife and livestock. Significant fluctuations in the abundance and distribution of plants and wildlife are typical.

No endangered plant or animal species are known to occur within the site area. (Hart et al., 1980a and 1980b).

Thirty-nine mammal species representing five mammalian orders have been observed in a 72-square-mile study area at the Los Medanos site. Many species are restricted to specific habitats. The desert cottontail and the black-tailed jackrabbit are common in all habitats, as is the most frequently sighted predator, the coyote. Two big-game species, the mule deer and the pronghorn, are present.

Reptiles present in the area include the side-blotched lizard, the western box turtle, the western whiptail lizard and several species of snakes.

Amphibians are restricted by the availability of aquatic habitat. The green toad, the plain's spadefoot and the tiger salamander are common around stock tanks and ponds.

A total of 123 species of birds representing 37 families has been observed within the 72-square-mile study area. The densities of birds in the study area show considerable annual and seasonal variations. Common species at the site include scaled quail, mourning dove, loggerhead shrike, pyrrhuloxia, black-throated sparrow, and western meadowlark.

About 1000 species of insects have been collected in a 72-square-mile study area at the site. Vast colonies of subterranean termites are located across the study area.

Aquatic habitats within the site area are limited. Stock-watering ponds and tanks constitute the only permanent surface waters. At greater distances, seasonally wet, shallow, usually salty lakes (playas) and permanent salt lakes are found. The Pecos River, approximately 14 miles from the site, is the nearest permanent watercourse.

### 4.1.2 Sociocultural Environment

#### History and archaeological resources

The first inhabitants of the site region were American Indians. Spanish explorers passed through during the sixteenth century, but the area was used almost entirely by Indians until cattlemen began arriving around 1886. Trading posts appeared in the late nineteenth century and Carlsbad was founded in 1889. Potash, oil and gas development has occurred in the twentieth century, and the area population has increased eightfold in the last 50 years.

The region has not been considered a fruitful area for archaeological research because the wandering inhabitants left few traces that remain today. Surveys at the Los Medanos site found about eight archaeological sites per square mile. The evidence found at the sites was usually stone tools, fragments of pottery, or dark stains in soil where hearths were once located. The remains of at least one permanent structure was found on the site. The archaeological sites at the Los Medanos site are believed to be the remains of an eastward extension of the Jornada Branch of the Mogollon culture. Most of these sites are attributable to the A.D. 900 to 1300 period.

Thirty-three sites located in an archaeological survey of portions of the Los Medanos site were determined eligible for nomination to the National Register of Historic Places. This determination was made because the 33 sites constitute an archaeological district and investigation of these sites may significantly contribute to the understanding of the prehistory of the area.

#### Land use

The main uses of the land around the Los Medanos site are grazing, oil and gas production, and potash mining. Approximately six to nine cattle graze on each 640-acre section. The only agricultural land within 30 miles is irrigated farmland along the Pecos River, near Carlsbad and Loving.

Grazing rights at the Los Medanos site are owned by local ranchers. Potash mining and oil and gas development leases owned by various companies are located throughout the site.

## Population

Sixteen people live within ten miles of the Los Medanos site and approximately 102,245 persons live within 50 miles. Most of these people live in Artesia, Carlsbad and Loving in Eddy County, and Eunice, Hobbs, Jal and Lovington in Lea County.

## Housing

Housing is available but not abundant in the local communities of Carlsbad, Hobbs, and Loving. Mobile homes constitute approximately ten percent of the housing units within these communities.

## Economy

Basic industries of the region are mining, manufacturing and agriculture. Potash mining and processing and oil and natural gas production are the principal mining activities. Manufacturing activities include food processing, meat packing, chemical production, and metal parts fabrication. Agriculture accounts for less than four to five percent of the total personal income of the two-county area; primary products are cotton and livestock. Tourism, primarily attracted by Carlsbad Caverns National Park, also contributes to the economy of the area.

The per capita income in Lea and Eddy counties is higher than the statewide average and higher than the national average for counties which are not associated with major metropolitan areas.

## Transportation

Portions of New Mexico Highways 31 and 128 are within 10 miles of the site. These are both two-lane roads connecting communities in the region to larger, more distant U.S. highways. U.S. Route 62-180, the main route between Carlsbad and Hobbs is about 10 miles north of the site. Numerous dirt roads are maintained in the area for ranching, pipeline maintenance, and access to oil and gas drilling sites. There are no railroad tracks within five miles of the site and the nearest airstrip is 12 miles north of the site.

## Community services

Educational opportunities, health care facilities, and other community services available in the area communities are typical of those of other U.S. cities of their size.

## 4.2 GEOLOGY

### 4.2.1 Summary

A great deal of geologic research has been conducted to evaluate the suitability of the Los Medanos site for a radioactive waste repository. Important conclusions include the following:

- The Salado Formation (the 2000-foot-thick evaporite layer in which the wastes would be emplaced) is hydrologically isolated from other geologic strata.
- The Delaware basin in which the site is located is tectonically stable.
- Dissolution of bedded salt near the site is occurring but is advancing toward the potential repository horizon at an extremely slow rate.
- Mineral resources at the site are of economic interest.

### 4.2.2 Regional and Site Geology

The geologic history of southeastern New Mexico may be classed into three general phases. The first phase was a period (at least 500 million years long) of uplift and erosion of ancient rocks culminating with the area reduced to a nearly level plain. During the second phase, sediments accumulated when the area was submerged by an ancient sea. It was during this period that the salt of the Salado formation was deposited. Tectonic activity was important during this period, the close of which was marked by regional uplift and east-southeastward tilting. During the third and present phase the area has remained dry and tectonically stable. The present landscape was formed by surface erosion during this phase.

### 4.2.3 Seismology

Seismic studies have been conducted at the Los Medanos site to gather information on the consequences of ground motion on surface and underground structures and to evaluate the effects of faulting on the salt beds and/or shaft seals. A record of earthquakes in southern New Mexico (dating since 1923) and recent seismic studies indicate that the Los Medanos site is located in a zone expected to receive only minor damage to structures. An analysis of seismic risk indicates that the possibility of significant faulting at the site is extremely low.

### 4.2.4 Energy and Mineral Resources

Potential mineral resources at the Los Medanos site have been investigated. Of the mineral resources expected to occur beneath the site, five are of practical concern: the potassium salts sylvite and langbeinite, which occur in strata above the potential repository level, and the hydrocarbons, crude oil, natural gas and distillate (liquids associated with natural gas), which occur in strata below the possible repository level. Table 4.1 summarizes the energy and mineral resources at the Los Medanos site.

Table 4.1 Total Mineral Resources at the Los Medanos Site

| RESOURCE | QUANTITY | DEPTH (ft.) | RICHNESS |
|---|---|---|---|
| Sylvite ore[a] | 133.2 million tons | 1600 | 8% $K_2O$, 4-ft thickness |
| Langbeinite ore[a] | 351.2 million tons | 1800 | 3% $K_2O$, 4-ft thickness. |
| Crude oil[b] | 37.50 million bbl | 4000-20,000 | 31-46° API[c] |
| Natural gas[b] | 490.12 billion $ft^3$ | 4000-20,000 | 1100 Btu/$ft^3$ |
| Distillate[b] | 5.72 million bbl | 4000-20,000 | 53° API[c] |

[a]Low grade resource and better. Data from John, et al. (1978).
[b]Data from Foster (1974).
[c]The degrees API unit has been adopted by the American Petroleum Institute as a measure of the specific gravity of hydrocarbons.

The significance of these resources is discussed in Section 6.3.

## 4.3 HYDROLOGY

### 4.3.1 Regional Hydrology

The Los Medanos site lies within a region typified by aquifers of low productivity. There are no perennial streams or surface-water impoundments on the site, nor are there any wells yielding more than a few gallons per minute. The closest river, the Pecos, is perennial throughout the region with the exception of a few reaches where the flow percolates into the stream bed. The maximum historical flood height of the Pecos is 500 feet below the lowest elevation of the land surface at the Los Medanos site.

### 4.3.2 Local Groundwater Hydrology

Hydrologic testing at the Los Medanos site has been conducted to evaluate the water-bearing rock strata and the chemistry of water beneath the site. Geologic stability and groundwater-transport characteristics have been evaluated.

Some conclusions on the occurrence of fluids in the rock units at the site may be summarized as follows:

- There is no significant groundwater occurring in the rocks above the Rustler Formation.
- There are two water-bearing zones in the Rustler Formation: the Culebra dolomite and the Magenta dolomite (Figure 4.2).
- Groundwater flow within the Culebra dolomite is southeast changing to south-southwest. The water-carrying capacity of this zone is quite limited (transmissivities vary from 140 square feet per day to as little as 0.0001 square foot per day).
- Fluid movement within the Magenta dolomite at the site is to the southwest. The water-carrying capacity of this zone is quite limited (transmissivities vary from 0.01 to 2.0 square feet per day).
- Very low yields of brines were found along the Rustler-Salado contact, with transmissivities ranging from 0.1 to 0.00001 square foot per day.
- The potentiometric surface is higher in the Bell Canyon sands (below the potential repository horizon) than in the Rustler formation (above the potential repository horizon). Thus, if a hydraulic connection were made from the Bell Canyon Sands to the surface, water would move upward through the Salado (Figure 3-4).
- A boundary to shallow groundwater flow is located to the east of the WIPP site.
- Groundwater in the Santa Rosa sandstone flows southward towards the Pecos River.

### 4.3.3 Dissolution of Salts in the Permian Evaporites

The dissolution of salt may result in the formation of geologic features such as sinks, depressions, and breccia pipes (sites where surficial deposits have collapsed into voids formed by dissolution of salt in underlying layers).

The shallow-dissolution feature most relevant to a geologic waste repository is the dissolution within the Rustler formation and at the top of the Salado which produces a residue or leached zone. The "dissolution front" within any formation is the leading edge of dissolution where it is beginning to affect the formation. The location of the Rustler/Salado dissolution front and its rate of advancement are important in evaluating the long-term site integrity for waste disposal. Drilling at the Los Medanos site indicates that the dissolution front in the Salado formation, at its closest point, is one to two miles away. The average rate of vertical dissolution has been estimated to be 0.33 foot to 0.5 foot per 1000 years. Under anticipated climatic conditions the site will not be affected by these processes for at least one million years.

Deep dissolution phenomena are those which occur within the evaporite section or that may be initiated from below the evaporites. The major features of concern for the Los Medanos site are breccia pipes because the presence of these features could threaten the integrity of the repository. Geologic investigations in the region indicate that breccia pipes are restricted to the Capitan reef or back-reef area and are not present at the Los Medanos site. It is believed that deep dissolution will not affect the Los Medanos site for the next million years (Anderson, 1978).

# 5.0 CONSTRUCTION AND OPERATION OF THE WIPP FACILITY

## 5.1 SITE LOCATION AND DESCRIPTION

The Los Medanos site is in Eddy County in southeastern New Mexico, about 26 miles east of Carlsbad (Figure 1-1). The land area committed to the WIPP project would be 18,960 acres, an area approximately six miles in diameter, of which nearly 17,000 acres would be used to provide buffer zones around the mined repository.

The site would be divided into four control zones. Less control would be placed on surface and underground use at increasing distances from the center of the site, as follows:

- Control zone I, at the site center, would contain nearly all the surface facilities and occupy about 100 acres surrounded by a security fence.

- Control zone II, an area of about 1800 acres, would overlie the maximum potential area of underground development. Only drilling and mining carried out by the U. S. Department of Energy (DOE) or its contractors would be allowed within this zone.

- Control zone III would occupy an area of about 6200 acres; its outside diameter would be four miles. Drilling and mining within this zone might be permitted if the DOE determined that this activity would not threaten repository integrity.

- Control zone IV would have an outside diameter of six miles and an area of about 11,000 acres. Drilling and conventional mining might be permitted in this zone. However, solution mining would be prohibited.

The DOE would exercise no control or impose any restrictions on use of land outside control zone IV.

Total on-site rights-of-way for the WIPP facility would be 220 acres and total off-site rights-of-way would be 660 acres. Existing highway and rail facilities would be upgraded and extended as necessary to serve the facility.

## 5.2 FACILITY CONSTRUCTION

The development of the WIPP facility would occur in two distinct phases: (1) Site and Preliminary Design Validation (SPDV), in which two deep shafts and an underground experimental area are constructed; and (2) full construction, in which the required surface and underground facilities and the remaining shafts are built.

### 5.2.1 SPDV Phase

Two shafts would be excavated at the WIPP site for the SPDV program. A 12-foot-diameter shaft would be bored near the center of control zone I to provide the main access to the underground experimental area. This shaft would be equipped with a hoisting system to transport excavated salt, personnel and equipment to and from the underground experimental area. A 6-foot-diameter ventilation shaft would be bored 600 feet south of the larger shaft.

At the bottom of the 12-foot-diameter shaft, 2150 feet below the surface, conventional room and pillar horizontal excavation in the Salado formation would produce a network of underground cavities about ten acres in area. Experimental rooms occupying about eight acres would be provided during the SPDV. Salt from the underground experimental area would be transported from the larger shaft to a salt storage pile located immediately east of control zone I.

Once these underground rooms are in place, a series of experiments would be conducted without radioactive waste. These experiments would study the effects of brine inundation upon waste containers, corrosion of containers, salt response to heating, radionuclide migration, salt permeability, shaft sealing, waste retrievability and other repository phenomena. None of these experiments would involve introducing radioactive material into the facility.

### 5.2.2. Full Construction Phase

The layout of the surface and subsurface structures of the WIPP is shown in Figure 5-1. Surface facilities would include a waste-handling building for receiving and preparing radioactive waste for transfer underground, an underground personnel building to support underground operations, an administration building, a sewage treatment plant and a water supply system and other support facilities. In addition there would be a mined-rock (salt) pile, an evaporation pond for collecting salt pile runoff, a spoils disposal area, and a sanitary landfill.

The subsurface facilities would consist of four shafts to the underground area and a mined underground horizon for the disposal of contact-handled (CH) and remotely-handled (RH) TRU waste. The underground mine would be confined within a surface area of about 100 acres. The actual mined area would be approximately 25 acres. Another area of the mine (about 20 acres) would be used for conducting experiments with defense high-level wastes.

## 5.3 FACILITY OPERATION

Contact-handled (CH) TRU waste would be shipped to the WIPP by rail and truck. The waste would be packaged in specially designed containers which would be unloaded within the waste-handling building. A system of air-locks and air pressure controls would be employed to prevent radioactive contaminants from escaping during this operation. The CH waste containers would arrive in packages which would be removed, inspected, decontaminated if necessary, and reloaded into vehicles leaving the plant. The CH waste

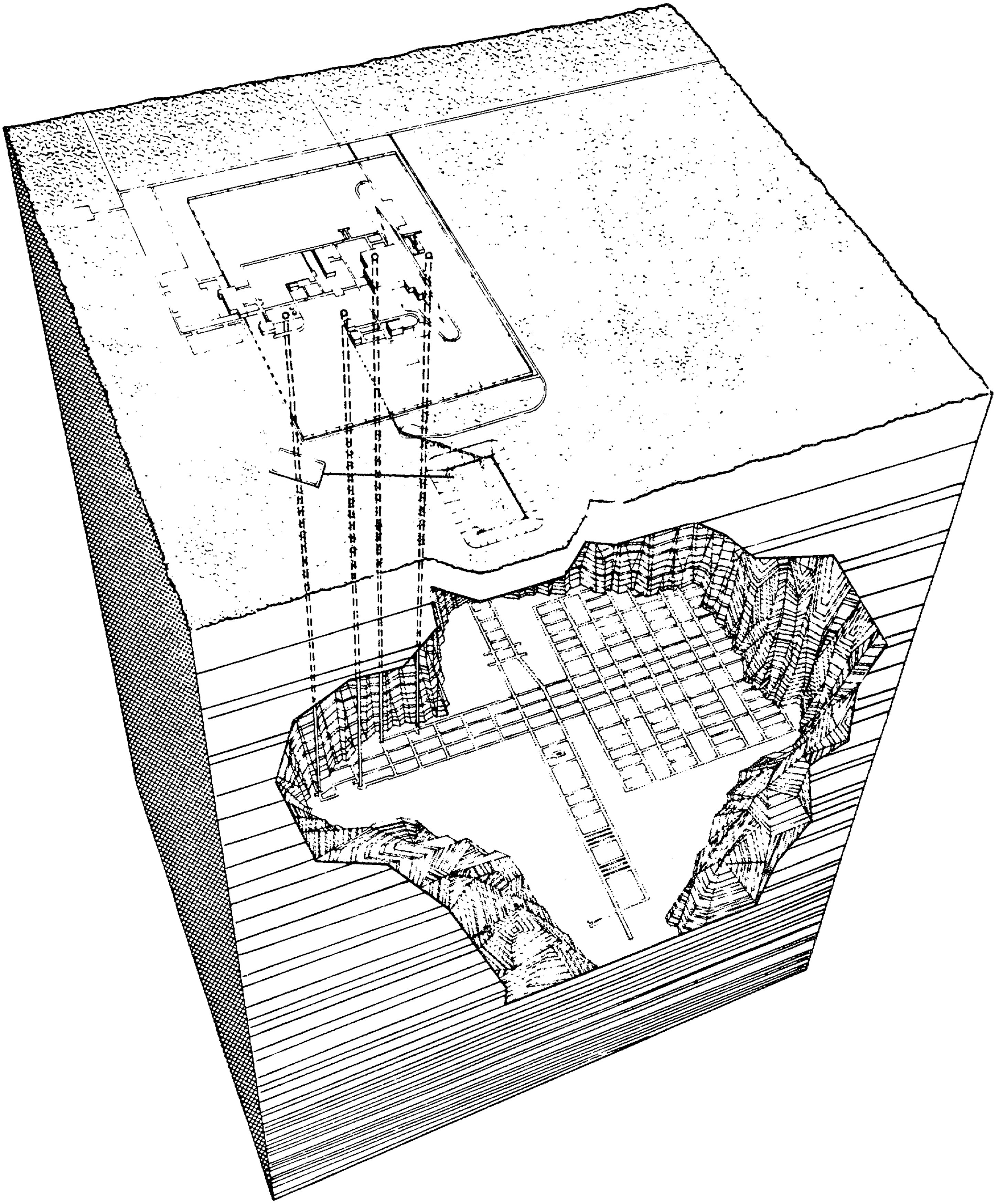

Figure 5-1. Surface and Subsurface Structures of the WIPP

containers would be moved to the inventory-and-preparation area and then to the underground waste-receiving station. At this station, the waste would be unloaded from the hoist cage and transported to the waste-disposal rooms. Each disposal room would be backfilled with salt to cover the emplaced waste.

Remotely handled (RH) TRU waste would arrive by rail or truck in special shipping casks. The shipping casks would be inspected and unloaded within the waste-handling building. The waste cask would be moved to the cask-preparation-and-decontamination area. RH waste would be handled from within a shielded cell and with remote-handling equipment. The RH waste canisters would be unloaded from their shipping casks and, after unloading, the shipping casks would be returned to the shipper for reuse. The waste canisters would be loaded into casks designed to transfer RH waste to the underground disposal area.

The cask holding the RH waste canister would be lowered in the hoist cage to the waste-receiving station where it would be removed from the hoist cage and lifted and transported to the waste-disposal area by a specially designed forklift. The RH waste canisters would be horizontally emplaced in steel-lined holes in the walls of major tunnels. These lined holes would then be capped with a steel shield plug.

## 5.4 EXPERIMENTAL AND DEVELOPMENTAL PROGRAMS

During the SPDV phase of the project, an underground area would be excavated for conducting nonradiological tests. The completed WIPP repository would include a testing facility for experiments on the interactions of defense high-level waste (HLW) with bedded salt. The small amount of HLW used in the experiments would be removed at the end of the program and would not produce any significant long-term residual effects on the WIPP repository. In addition, the WIPP would include several other underground activities which can be broadly characterized as development efforts. The development of storage and handling methods would be supported by demonstrations and by monitoring the structure of the repository.

The in-situ studies in the WIPP repository would be only a part of a larger program that includes laboratory investigations, studies in large blocks of salt, and the development of analytical models for predicting the behavior of a repository. Much of this extensive "pre-WIPP" program is underway, and most of it would have been completed before the facility would open.

The investigations in the WIPP repository would therefore be extensions of earlier studies. The WIPP studies would establish whether the results of earlier experiments are fully valid in an actual repository and would check previously developed analytical models. They would also serve as a useful demonstration of waste-disposal operations in salt.

## 5.5 PLANS FOR RETRIEVAL

An important aspect of the WIPP project would be the ability to remove emplaced waste from the plant if such retrieval becomes necessary or desirable in the future. The retrievability period for TRU waste would be 5 to 10 years after the decision on retrieval was made; that decision would be made up to 5 years after the first waste is emplaced. To permit access for retrievability the main tunnels would not be used for disposal during the retrievability period. Demonstrations of retrieval would be performed regularly to train workers and to refine and improve retrieval methods.

## 5.6 PLANS FOR DECOMMISSIONING

At the end of the WIPP operation, a decommissioning program would be carried out for the safe permanent disposition of both surface and underground facilities. The alternatives for decommissioning include mothballing, in-place entombment, decontamination and dismantling, and conversion to a new system. These alternatives are briefly described below:

- Mothballing - This option would consist of putting the plant into a state of protective storage for a few decades.
- Entombment - After removal of usable equipment, the mine would be filled with salt and the shafts and boreholes plugged.
- Decontamination and dismantling - The shaft and mine would be entombed as described above. Surface facilities would be decontaminated, dismantled, and the debris removed. The present plan for decommissioning uses this method.
- Conversion to a new system - It is possible that the plant could be put to another use after WIPP operations are completed.

If wastes were permanently emplaced and the repository was decommissioned as presently planned, administrative controls would be established to prevent deep drilling, mining or similar activities which might allow water into the disposal area. Written documentation of the WIPP would be maintained in public document depositories. Shaft locations would be permanently marked and durable warning monuments would be placed at the site.

## 5.7 EMERGENCY, SECURITY AND SAFEGUARDS

A comprehensive program would be established to respond to emergencies at the WIPP facility. Formal emergency plans and procedures to cope with radiation emergencies would be established.

Planning for emergencies at the site would be coordinated with local organizations such as law-enforcement agencies, fire companies and hospitals. Before activities begin at the WIPP, firm arrangements would be made with these organizations and others to ensure that additional support could be obtained if emergency assistance were required. An emergency plan would cover the requirements for notification of emergency preparedness organizations in New Mexico.

Several security measures would be utilized to protect against deliberate acts of damage or destruction and theft of radioactive material or plant equipment. This would include a central monitor-and-control system, an emergency response force, a controlled-access area, and various lighting, locking and alarm security systems.

# 6.0 ANALYSIS OF ENVIRONMENTAL IMPACTS OF THE AUTHORIZED WIPP PROJECT

## 6.1 IMPACTS ON THE BIOPHYSICAL ENVIRONMENT

### 6.1.1 Terrain and Soils

Adverse impacts on the terrain resulting from development of the WIPP facility would be minimal because the site is level to gently sloping. The greatest change in the terrain would result from the surface storage of mined materials.

Impacts on soils would result from grading and soil stockpiling. Increased wind and water erosion of salt stored on the surface would result in decreased soil productivity.

### 6.1.2 Water Resources

No waterborne discharges are planned during the construction of the SPDV or the full facilities. Surface runoff directly from the salt pile would be collected by a drainage ditch, where it would be allowed to evaporate and soak into the ground. No impact on groundwater would be expected. Sanitary waste discharges during normal WIPP operation would amount to about 25,000 gallons per day of treated effluent. Any effluent discharged would meet state water-quality standards and these effluents would not affect local surface and/or groundwater resources.

### 6.1.3 Air Quality

The construction of the SPDV and the full WIPP would have an adverse effect on local air quality, but construction-related emissions of air pollutants and dust would be short-lived. Emissions of carbon monoxide, hydrocarbons, nitrogen oxides, sulfur dioxide, and particulates would result from the operation of diesel-powered construction equipment. Fugitive dust would also be generated. In addition, some salt would become airborne from mine exhaust, salt hauling operations, and wind erosion of the salt pile. Most of the increases in air pollutants and dust emissions would occur during the early stages of construction.

Normal operation of the WIPP would result in emission of salt particles from the salt handling system and combustion products from the use of diesel fuel. There would be three major sources of emissions from the combustion of diesel fuel: the emergency-power systems, the surface handling equipment, and the underground handling equipment.

These emissions would not cause violations of Federal or State air quality standards or any noticeable impacts such as reduced visibility or damage to vegetation.

### 6.1.4 Noise

Construction of the SPDV and the full WIPP facilities would cause locally increased noise levels. Noise levels one mile from the site resulting from site clearing and excavation would be about 63 dBA. Building erection noise would result from working with steel building frames, concrete placement, crane operation, and diesel trucks. The overall noise level for building erection would be about five to seven dBA lower than that for site clearing. Shaft sinking would be the noisiest during the first 50 to 90 feet of drilling, but the noise levels generated would be less than those for clearing and excavation. Increased traffic in the area would also contribute to higher noise levels.

Noise produced during normal operation of the WIPP would come from the water pumphouse, the hoist house, the transformer and switchyard, mine construction exhaust and train movements. An overall level of 50 dBA could be expected 400 feet from the waste-handling building.

The increased noise levels would generally be insignificant except during early construction when the noise may disturb the nearest persons hearing the noise, the four permanent and/or 20 seasonal residents at the James Ranch.

### 6.1.5 Vegetation and Wildlife

Adverse impacts on biological resources would be slight for the following reasons:

1. No endangered species of plants or animals are known to inhabit the site or the vicinity of the site.

2. Water requirements for the site would be low.

3. The land contains soil types and vegetation associations which are common throughout the region.

Biological effects of construction would result from the removal of land from rangeland habitats. A total of 48 and 192 acres of vegetation from shinnery oak, senecio, sagebrush, yucca, mesquite, and broom snakeweed vegetation types would be cleared for SPDV development and full facility construction, respectively. All vegetation and wildlife within this area would be removed throughout the duration of the project.

Impacts are expected from the construction of rights-of-way. Some birds-of-prey deaths may be caused by electrocution on utility lines despite the fact that these lines would be designed in accordance with U. S. Department of Agriculture guidelines to minimize such effects (USDA-REA, no date). Although some negative effects (increased animal mortality, inhibition of animal movements) would be expected when the roads are built, roadways often have a positive effect on local plants and animals by increasing the diversity of habitats. Much of the land cleared along rights-of-way during construction would revert to natural vegetation. Although some of the removed plant species may remain absent from the rights-of-way for years, the impact would be minor because the removed species are very common in the region.

Because no areas would be cleared other than those during construction, the impacts to vegetation during operations would be primarily the result of continued use of cleared areas. Dispersion and deposition of salt and other mined rock particles from the storage pile would affect local vegetation adversely. However, these impacts would not be significant.

Operational noise would frighten resident wildlife species, but after a period of time some animals would become accustomed to this kind of noise and return to their original habitat. Other more sensitive species would have left the area as a result of construction activities.

New roads in the area would allow easier access for hunting and other outdoor activities. This improved access would lead to increased road traffic, and intermittent off-road excursions would disturb vegetation and wildlife. The people who move into the Carlsbad area to work at the facility could increase hunting pressure on wildlife in the area.

### 6.1.6 Routine Releases of Radioactivity

The operation of the facility would require handling of packages and canisters, some of which may be externally contaminated. No canister would be opened, but very small quantities of nuclides would be released as a result of routine handling. The releases would be held to levels as low as reasonably achievable.

Impacts from radionuclides released from the waste packages during normal operations would be small. The greatest individual 50-year dose commitment to offsite persons would be 0.0000065 rem to the bone.

## 6.2 IMPACTS ON THE SOCIOCULTURAL ENVIRONMENT

### 6.2.1 Population

Construction time for the WIPP would be 4.5 years and a maximum of 2250 new residents would be drawn to Eddy and Lea counties during this period. A decrease of about 1575 persons is expected during the two-year period following completion of construction. With the beginning of operations (seven years after construction start-up) 225 in-migrants are expected, with another 100 people following the next year. The ninth year after construction start-up should see a total drop in population of about 1250 people. The net change in population is expected to remain constant throughout operation at just over 1050.

Assuming that current patterns of place-of-residence choices would be followed by the new WIPP-attracted population, most population change would occur in Eddy County. Carlsbad is expected to receive the greatest share of the new residents (a peak change of 1900). Loving is expected to gain a maximum of only about 100 new residents and the maximum impact in Lea County is projected at 150 new residents during the peak of construction and fewer than 100 during operation. The following discussions assume this pattern of population influx.

### 6.2.2 Housing

Housing demand induced by the WIPP project would peak during the fourth year of construction at about 880 total housing units. This demand would decrease to 330 total units during the seventh year after construction start-up and thereafter remain stable.

The composition of housing demand would be expected to change as construction and operation began. During construction, there would likely be a large demand for mobile homes and multi-family units; during operation, 81 percent of the demand would be for single-family units.

The arrival of new residents, combined with the current tight mortgage-loan market, could cause a short-lived housing shortage in Carlsbad, Loving, and Hobbs during the early stage of WIPP construction. Other types of housing, such as mobile homes, could be used to cover this shortage. Five years after construction start-up an excess of housing units would be expected because of a lag between the end of WIPP construction and the beginning of operations.

### 6.2.3 Economic Activity

During construction of the WIPP, approximately \$291.5 million would be spent for labor, equipment, and other construction costs. Because certain expenditures would go to areas outside Eddy and Lea counties, and in some instances outside the State of New Mexico, only \$137.9 million would directly affect the economy of the two-county area. Indirect effects in the private sector would total an estimated \$112.4 million. The government sector (state, local, and indirectly affected Federal agencies) would receive about \$14.8 million in new activity. The greatest local economic impact (direct and indirect) during a single year would be about \$79.4 million during the third year of construction.

As construction ended and the facility became operational, the economic impact would change significantly. Some \$23.5 million would be spent annually for the operation phase; \$16.9 million would directly affect the economy of the area. The total local economic impact of the operation phase, both direct and indirect, would amount to almost \$33.0 million annually.

Both Eddy and Lea counties have experienced low unemployment rates in the past and would be expected to have reasonably low unemployment at the beginning of the WIPP project. The average number of construction and non-construction WIPP jobs would be approximately 920 during the third year of construction. Full operation of the WIPP would require approximately 440 employees and an additional 514 jobs would be supported indirectly.

### 6.2.4 Community Services and Facilities

#### Education

The principal effect of the WIPP upon the Carlsbad school system would be to accelerate the rate of increase in enrollment, with a 10 percent increase being reached by the fourth year after the start of construction. This accelerated rate of student-population growth, however, would not tax the capacity of the school system because of an excess of physical capacity. The WIPP project would likely require the hiring of additional teachers. Like Carlsbad, Loving currently has an excess of classroom space and the WIPP would not cause overcrowding.

Water supply and wastewater treatment

Carlsbad has sufficient water rights for the next several decades. The WIPP project would increase demand by as much as six percent during construction and two percent in subsequent years. The Loving water system should reach capacity in 1992 if the WIPP were constructed; without the WIPP the system capacity would be reached a year later.

A new sewage-treatment plant is being constructed in Carlsbad and the plant should be adequate to meet the needs of Carlsbad for the next several decades with or without the WIPP. The current demand on Loving's sewage-treatment plant utilizes approximately 60 percent of the plant's capacity. Population increases expected from the WIPP project would not be expected to increase demand beyond the plant's current capacity. However, because the present plant does not meet effluent standards of the New Mexico Water Quality Commission, any increase in population would aggravate effluent quality problems.

Electrical and natural gas service

The WIPP project would be expected to increase electricity use in the Carlsbad-Loving area by one percent during a nine-year construction and initial operation period. Generating capacity would be sufficient to meet the projected demand, however, new distribution substations would be required.

As a result of the WIPP, gas consumption in the Carlsbad area would be about 0.5 percent above baseline levels in 1987. The increase in the Loving area would be two percent in 1987. Gas company officials anticipate that the increased demand could be accommodated without difficulty.

Fire and police protection

To maintain current levels of fire protection in 1987, Carlsbad would need 36 full-time fire department employees under baseline conditions and 38 employees with the WIPP. To maintain current levels of fire protection in 1987, Loving will need to purchase one additional piece of major equipment. No new personnel would be needed, with or without the WIPP.

The WIPP facility would create the need for three more Carlsbad police employees by 1987, and the WIPP would change the times when additions to the Carlsbad Police Department and Eddy County Sheriff's department are needed. In Loving, the WIPP would not increase the number of police officers needed to maintain the current officers/residents ratio.

Health care

Current hospital facilities in Eddy and Lea Counties are adequate to meet any WIPP-induced demand through the 1980s. The WIPP would increase the demand for primary-care physicians by about one by 1987.

Traffic and transportation

Most of the streets in Carlsbad have traffic volumes below capacity and the WIPP would not be expected to cause congestion problems. In Hobbs, some intersections are expected to exceed capacity by 1987 and the WIPP project could add slightly to this problem.

Communications services and facilities

General Telephone of the Southwest is expanding installations in the area and anticipates no difficulty in meeting projected demand with or without the WIPP.

Solid waste management

The projected increase in the Carlsbad population indicates that two additional vehicles will be needed to collect refuse in 1987. With the WIPP three additional vehicles would be needed. No change in vehicle requirements would be expected in Loving and Hobbs with the WIPP. The land-fill facilities of these three communities are adequate to handle future needs for at least 20 years with or without the WIPP.

## 6.3 DENIAL OF MINERAL RESOURCES

Emplacement of radioactive waste in the WIPP repository could preclude for safety reasons the extraction of mineral resources from the geologic strata above or below the disposal level within control zones I, II and III. Any mining or drilling activities occurring within these zones would be under strict DOE control. Restricted development would be permitted within control zone IV.

In order to put the denial of these minerals in perspective, one needs to compare them with regional, national and world resources and reserves. Table 6.1 contains the elements for such a comparison. The data reveal that, except for langbeinite (for which there are synthetic substitutes), the total land commitment would have little effect on the regional availability of minerals and almost no national significance.

The in-place ore value of the potash reserves at the Los Medanos site is estimated at $6.26 million at 1977 average prices. This estimate is based on the assumption that sylvite resources at the site are economically recoverable. The gross value of the hydrocarbon reserves at the site is estimated to be greater than $146.4 million.

Since DOE controls would allow future drilling and mining within control zone IV of the type now practiced in the area, the impact of withdrawing mineral resources and reserves would be reduced from those indicated for the total site. Exploitation of control zone IV would recover a significant fraction of the minerals, i.e., 73 percent of the langbeinite reserves and 53 percent of the natural gas (Table 6.2).

Table 6.1. Significance of the Resources and Reserves at the WIPP Site

| Deposit | WIPP site | Region | United States | World |
|---|---|---|---|---|
| | RESOURCES[a] | | | |
| Sylvite (at lease grade) | | | | |
| Quantity, million tons ore | 88.5 | 4260 | 8500 | 850,000 |
| Percentage at WIPP site | | 2.1 | 1.0 | 0.010 |
| high grade | 54.0 | | | |
| low grade | 133.2 | | | |
| Langbeinite (at lease grade) | | | | |
| Quantity, million tons ore | 264.2 | 1140 | No estimate available | |
| Percentage at WIPP site | | 23 (21.5 as $K_2O$) | | |
| high grade | 77.6 | | | |
| low grade | 351.0 | | | |
| Crude oil | | | | |
| Quantity, million barrels | 37.50 | 1915 | 200,000 | Not available |
| Percentage at WIPP site | | 2.0 | 0.019 | |
| Natural gas | | | | |
| Quantity, billion cubic feet | 490 | 25,013 | 855,000 | Not available |
| Percentage at WIPP site | | 2.0 | 0.057 | |
| Distillate | | | | |
| Quantity, million barrels | 5.72 | 293 | Not available | |
| Percentage at WIPP site | | 2.0 | | |
| | RESERVES[b] | | | |
| Sylvite[c] | | | | |
| Quantity, million tons $K_2O$ | 3.66 | 106 | 206 | 11,206 |
| Percentage at WIPP site | | 3.4 | 1.8 | 0.033 |
| Langbeinite[d] | | | | |
| Quantity, million tons $K_2O$ | 0.92[d] | 9.3 | 9.3 | Not available |
| Percentage at WIPP site | | 10 | 10 | |
| Crude oil | | | | |
| Quantity, million barrels | Nil | 471.7 | 29,486 | 646,000 |
| Percentage at WIPP site | | 0 | 0 | 0 |
| Natural gas | | | | |
| Quantity, billion cubic feet | 44.62 | 3865 | 208,800 | 2,520,000 |
| Percentage at WIPP site | | 1.15 | 0.021 | 0.0018 |

Table 6.1. Significance of the Resources and Reserves at the WIPP Site (Cont.)

| Deposit | WIPP site | Region | United States | World |
|---|---|---|---|---|
| Distillate | | | | |
| Quantity, million barrels | 0.12 | 169.1 | 35,000 | Not available |
| Percentage at WIPP site | | 0.07 | 0.0003 | |

[a]Data sources: Hydrocarbons, Foster (1974) for the site and region; potash salts, John et al. (1978) for the site and region; Brobst and Pratt (1973) for U.S. oil and gas and the world resources of sylvite.

[b]Data sources: Hydrocarbons, SW&A (1979) for the site; American Petroleum Institute (1978) for the region, the United States and the world; potash salts, U.S. Bureau of Mines (USBM, 1977).

[c]The U.S. Bureau of Mines (USBM, 1977) does not consider any sylvite to be commercial today. However, one bed (mining unit A-1) of sylvite was marginal and has been added to the reserve list.

[d]Estimates from AIM, 1979. The USBM estimate for the WIPP site is 4.41 million tons $K_2O$ equivalent but no comparable USBM estimate is available for the entire district.

Table 6.2. The Effect of Allowing the Exploitation of Hydrocarbons and Potash in Control Zone IV

| Deposit | In total site | In inner zones (I, II, III) | Percentage of total recoverable in Zone IV |
|---|---|---|---|
| | RESOURCES | | |
| Sylvite,[a] million tons ore | 133.2 | 39.1 | 71 |
| Langbeinite,[a] million tons ore | 351.0 | 121.9 | 65 |
| Crude oil,[b] million barrels | 37.50 | 16.12 | 57 |
| Natural gas,[b] billion cubic feet | 490 | 211 | 57 |
| Distillate,[b] million barrels | 5.72 | 2.46 | 57 |
| | RESERVES | | |
| Sylvite,[c,d] million tons ore | 27.43 | Nil | 100 |
| Sylvite,[c,d] million tons $K_2O$ | 3.66 | Nil | 100 |
| Langbeinite,[c] million tons ore | 48.46 | 13.3 | 73 |
| Langbeinite,[c] million tons $K_2O$ | 4.41 | 1.21 | 73 |
| Crude oil, million barrels | --- | --- | --- |
| Natural gas,[e] billion cubic feet | 44.62 | 21.05 | 53 |
| Distillate, million barrels | 0.12 | 0.03 | 75 |

[a]Data from John et al. (1978, Table 4).

[b]Computed from data presented by Foster (1974) by proportion of area of zone IV to the total area of the site.

[c]Data from the U.S. Bureau of Mines (USBM, 1977, Table 5).
[d]Sylvite resource is considered subeconomic by USBM.
[e]Computed from data presented by SWA (1979), considering that only reserves under the inner three zones are precluded from development.

## 6.4 IMPACTS OF OPERATIONAL ACCIDENTS

### 6.4.1 Accidents Involving Radiation

To assess the environmental impacts of accidents that could release radioactive material, scenarios were postulated to model severe accidents. Each scenario was analyzed in detail to determine potential impacts to the general public. A typical scenario of an accident releasing the waste includes the following events:

1. A breach of the waste container.
2. Exposure of a portion of the waste to the air.
3. Suspension of the portion of the waste that is of respirable size in ventilation air.
4. Depletion or fallout of waste particles from the airstream when such processes are credible.
5. Release to the environment.
6. Dispersion of the airborne radioactivity to the site boundary and calculation of the resultant dose.

None of these accidents is likely to occur.

The dose commitments to individuals resulting from four of the accident scenarios for CH TRU waste are presented in Table 6.3. Since most of the exposure due to the CH TRU waste results from the direct inhalation of radionuclide particulates, the values in the tables are 50-year dose commitments. The greatest percentage of the dose commitments results from plutonium.

The CH TRU waste scenario involving an underground fire would have the greatest impact; nevertheless, the impact on the general public would be negligible. Should an underground fire occur, this person would receive a 0.0000044 rem 50-year dose commitment to the bone. During 50 years, however, natural background radiation will contribute a dose of 5 rem to the bone. The dose from the accident would be a small fraction of the naturally occurring background exposure. None of the hypothesized scenarios for CH TRU waste could result in a significant dose to the public.

The results of accidents involving RH TRU waste are also presented in Table 6.3. Judged by comparison with doses received from natural background radiation, the doses to the general public which would result from any of these accident scenarios are also very small.

Table 6.3 50-Year Dose Commitment Received by a Person Living at the Site Boundary

| Accident scenario | Dose commitments[a] (rem) Bone | Lung | Whole Body |
|---|---|---|---|
| CH Area | | | |
| Surface fire | 1.4-7[b] | 5.8-9 | 3.3-9 |
| Surface container failure | 7.7-9 | 2.0-10 | 1.9-10 |
| Hoist drop | 6.0-7 | 1.5-8 | 1.5-6 |
| Underground fire | 4.4-6 | 1.0-7 | 1.0-7 |
| RH Area | | | |
| Canister drop in transfer cell | 1.2-8 | 6.0-10 | 3.6-10 |
| Hoist drop | | | |
| RH TRU waste | 2.1-7 | 1.0-8 | 5.2-9 |
| Experimental HLW | 1.6-6 | 7.3-7 | 7.8-7 |
| Natural background[c] | 5.0 | 9.0 | 5.0 |
| 5-hour jet flight[d] | | | 2.5-3 |

[a]Dose equivalent commitments
[b]1.4-7 = 1.4 x $10^{-7}$=0.00000014
[c]Data from the National Council on Radiation Protection and Measurements (NCRP, 1975).
[d]Mid-latitudes at 38,000 feet.

### 6.4.2 Nonradiological Accidents

Accidents that could affect the environment without dispersing radionuclides would be releases of chemicals, fuels or other toxic materials as a result of chemical explosions, fire or structural damage. Precautions would be taken to ensure that all potentially hazardous materials kept at the site would be handled in such a way as to minimize environmental hazards and effects on the health and safety of the public.

### 6.4.3 Natural Events

#### Earthquakes

All buildings and systems essential for the safe handling of radioactive waste would be designed to withstand earthquake accelerations that may be expected to occur at the site during the operational life of the WIPP facility. Accordingly, earthquake-induced releases of radioactivity would be unlikely.

Strong earthquakes could damage other structures but failure of these structures and systems would not affect the buildings and systems designed to withstand earthquakes.

### Thunderstorms and tornadoes

Thunderstorms are not likely to cause serious safety problems for the WIPP. Surface structures essential to the safe handling of radioactive wastes would be designed to withstand tornado-force winds, tornado-driven missiles and sudden pressure changes.

### Range fires

There is a potential for range fires at the Los Medanos site because of the arid climate and desert vegetation. During operations, such a range fire would not cause extensive damage to the WIPP facilities because of the buffer afforded by clearing vegetation from control zone I and the fire protection systems employed at the site.

A range fire near the site, however, could release radionuclides accumulated biologically in vegetation as a result of previous routine releases of radioactivity. Accordingly, conservative analysis of the radiation dose consequences of such a fire was conducted. This analysis assumes that the range fire occurs after 25 years of normal operation. Results indicate that the radiation dose to the maximally exposed individual as a result of this occurrence would be a small fraction of doses from normal background radiation.

## 6.5 MITIGATION OF IMPACTS

Various design features and construction practices incorporated into the WIPP project would lessen the potential adverse environmental impacts attendant to such an activity. The DOE would obtain all applicable Federal and State permits and approvals dealing with environmental protection and many potential adverse consequences of the project would be avoided in complying with these regulations. Part of the design of the WIPP would include plans for environmental monitoring. This monitoring would allow the DOE and its contractors to be aware continuously of environmental conditions in the site area, and would alert them to any unexpected impacts. If such unanticipated consequences should be detected, appropriate action could be taken at that time to reduce the severity of any adverse impact.

### 6.5.1 Biophysical Environment

### Disturbed areas

Mitigating the impacts to disturbed areas would consist of two basic parts: (1) minimizing the area affected and associated impacts during construction and (2) restoring disturbed areas after completing the project. During construction, impacts to terrain and soils would be reduced by the control of wind and water erosion. Watering of all disturbed areas on an "as needed" basis would reduce the amount of soil lost by wind. Construction of perimeter ditches to intercept rainfall runoff would greatly reduce the amount of soil erosion by water. These ditches would be designed and constructed so that the water they carry will not cause excessive erosion in the channels.

Site traffic will be limited to designated roads and specific parking areas as much as practicable. Construction materials will be confined to specified laydown areas. Only areas in which facilities will be constructed and material laydown areas will be cleared of vegetation and graded. These measures will prevent indiscriminate disruption of the desert habitat by the construction workforce.

At the completion of construction, all areas disturbed by construction and not required for permanent facilities will be restored. All temporary buildings will be removed and these disturbed areas restored to their approximate undisturbed state.

Water pollution

During the early phases of construction, chemical toilets would be provided for sanitary waste that would be collected regularly and removed from the site for proper treatment and disposal. With completion of the sewage-treatment plant, trailers with restrooms and day tanks for storage would be used until the rest of the system is completed. The day tanks would be emptied at the sewage-treatment plant. After this time and during operations, sanitary-waste effluents would be treated to meet State of New Mexico standards. Where economically feasible, wastewater would be recycled to reduce consumption; for example, treated sanitary effluents would be employed for landscape irrigation and dust control at the site.

Air pollution

Construction-related air pollution would generally be limited to the immediate area of the site. The largest source of airborne pollutants would be the handling and transfer of soil, producing fugitive dust. To reduce this dust, permanent roadways would be paved and maintained. Other frequently traveled areas would be overlaid with gravel or caliche and watered as needed during working hours.

If a concrete batch plant were needed at the site during construction, dust from its operation would be controlled using best engineering practices. Combustion emissions from construction equipment would be controlled by the use of all applicable EPA emission controls. If burning of refuse at the site were necessary, it would be carried out in compliance with all applicable regulations.

During preparation of the mined-rock-storage area, disturbed surfaces would be sprayed with water to control dust. Covered conveyors would move the mined rock from the mine-shaft headframe to a stacker conveyor, on which the mined rock would be sprayed lightly with water during its trip to the storage pile. Separate ditches would channel natural drainage water around the pile and retain runoff from the pile itself.

Solid waste

During construction, litter would be controlled by the use of trash and scrap containers located throughout the site. The trash and scrap would be removed to an approved disposal area. Standard procedures for the landfill consist of excavation, disposal, and backfilling over the waste. The solid waste would be layered with fill dirt for insect and rodent control and sprinkled with water to reduce dust. A low-lying area would be selected to make the landfill unobtrusive, and natural drainage would be diverted around the site. Natural revegetation of the filled areas would be encouraged.

All lubricants and other chemicals used during construction would be stored in approved standard containers with precautions against accidental spills or leakage. All fuels would be stored in conformance with applicable codes. Waste chemicals and oil would be collected in approved and clearly marked standard containers. The containers would be stored separately from other waste and removed from the site for reprocessing or disposal in an acceptable manner.

Noise

The highest construction noise levels would occur in the daytime during site preparation and excavation. The impacts of noise would be reduced by using equipment which meet the EPA noise-emission guidelines and by maintaining and servicing equipment to ensure that excessive noise was minimized. Other mitigation measures for operating noise would include providing silencers for the diesel-generator exhaust and locating most pumps inside structures.

Radioactive effluents

The WIPP facility would be operated in accordance with DOE procedures to reduce to the lowest practicable level the amount of radioactive material released during normal and accident conditions. Retrieval of the wastes from the INEL and transport to the WIPP would also be performed in strict compliance with applicable rules and regulations of the DOE, the DOT, and others.

### 6.5.2 Sociocultural Environment

Several Federal laws could help governmental jurisdictions near the WIPP site deal with WIPP-induced sociocultural impacts. Among these are:

- The Education Act of 1956 which provides for assistance to local educational agencies in areas affected by Federal activity.

- The Small Business Act of 1959 which authorizes the Small Business Administration to make direct and guaranteed loans to small businesses that suffer economic injury as a result of displacement by a Federal facility.

The Federal "701" planning program of the Department of Housing and Urban Development and the Intergovernmental Personnel Program are designed to help communities in planning for rapid growth. Support from both of these programs may be available to the communities and counties in the area.

Transportation impacts

States have the authority, if not the responsibility to develop emergency-preparedness plans for transportation accidents involving potentially hazardous materials. Most states have emergency plans that are under development but are not yet completed. The DOE would work with potential carriers, state law-enforcement officials, and state radiological-health officials to develop the procedures to be followed after a transportation accident with radioactive waste.

The DOE would offer to train state and local police and emergency personnel in the proper procedures to be followed after a transportation accident. This training would be made available throughout the operating life of the WIPP facility.

Impacts to archaeological resources

Prior to start of construction of the facilities, the DOE would consult with the New Mexico Historic Preservation Officer and the Advisory Council on Historic Preservation to comply with the requirements of the National Historic Preservation Act, to identify any eligible properties in addition to those already known, to request a determination of effect and to implement consultation to mitigate or minimize any adverse effects.

### 6.5.3 Denial of Mineral Resources

Natural gas

The hydrocarbon resources beneath the Los Medanos site can be exploited by deviated drilling from outside control zone IV or by vertical and deviated drilling within control zone IV.

Potash

Potash reserves in Control Zone IV may be mined using techniques presently employed in the Carlsbad Potash District. The consequences of mining in control zones I, II and III are currently being evaluated.

### 6.5.4 Impacts of Operational Accidents

The emergency preparedness plan would be concerned with responding to accidents at the WIPP itself, both radiological and nonradiological. The circumstances would probably be more favorable than in the case of transportation accidents because equipment and trained people would be immediately available and monitoring and control could be started without delay. Also, there would not be large numbers of people or intensively used land nearby.

## 6.6 LONG-TERM EFFECTS OF THE REPOSITORY

During the long term, for thousands of years after the WIPP repository had ceased operation and been closed, no radioactive material would be expected to enter man's environment. Nevertheless, natural events or intrusions by people which could cause such a release were postulated to examine the potential consequences.

### 6.6.1 Effects Involving the Release of Radioactivity

An analysis of long-term effects of radioactivity releases to man's environment was conducted by estimating the consequences of a series of highly unlikely hypothetical events. After postulating mechanisms for the release of radionuclides from the burial medium, the study examined radionuclide transport through the surrounding geologic media and then through the biosphere. The amounts of radionuclides that might reach people along different pathways were estimated and the estimated concentrations were used to calculate the radiation doses that might result from the hypothetical releases.

The five senarios used in this analysis are listed below:

Scenario 1: A hydraulic communication connects the Rustler aquifer above the repository, the Bell Canyon aquifer of the Delaware Mountain Group below the repository and the repository.

Scenario 2: A hydraulic communication allows water to flow from the Rustler, through the repository, and back to the Rustler.

Scenario 3: A stagnant pool connects the Rustler aquifer with the repository. In contrast to scenarios 1 and 2, which involve flowing water, this communication permits radionuclide migration to the Rustler only by molecular diffusion.

Scenario 4: A hydraulic communication connects the Rustler aquifer with the repository; all the Rustler water normally moving above the repository flows through the repository and back to the Rustler. In contrast, scenarios 1 and 2 establish only a limited hydraulic connection.

Scenario 5: A drill shaft penetrates the repository and intercepts a nuclear-waste container and the radioactive material is brought to the surface.

The following conclusions were drawn from the analysis of the five scenarios:

1. The greatest consequences from a hydraulic communication scenario are for Scenario 4. Under the assumptions made for that scenario, the greatest 50-year whole-body and organ dose commitments are less than 0.02% of the 50-year whole-body dose commitment from natural background radiation at the WIPP site.

2. The consequences of a hydraulic communication scenario depend on the flow rate of water through the breached repository. A factor-of-4000 difference in the flow rates for the analyzed scenarios translates into a difference of two orders of magnitude in the maximum doses received by a person at Malaga Bend (the point on the Pecos River toward which groundwater from the WIPP site flows). The consequences of Scenario 3, which involves mass transport only by diffusion, are directly proportional to the area of the communication that connects the repository with the Rustler aquifer.

3. Under the assumptions made concerning plutonium adsorption coefficients, no plutonium enters the biosphere after 1000 years for Scenarios 1 through 4.

4. The 50-year dose commitment received though indirect pathways by a person living on a nearby farm 100 years after closure is conservatively estimated to be 0.00022 rem to the bone if a drill penetrates the contact-handled TRU waste and 0.00027 rem to the bone if it penetrates a canister of remotely handled TRU waste. These calculated dose commitments are upper bounds to the dose commitments that people might receive. The 100 year time period is cited simply to illustrate potential dose risks.

### 6.6.2 Effects Not Involving the Release of Radioactivity

The long-term effects of heat from emplaced waste may create buoyant forces that might lift the waste upward in the rock column. Although this effect may be significant in repositories for high-level waste, the waste emplaced in the WIPP repository would release little heat. Analyses predict no possibility that this effect could breach the repository.

The underground mined openings of the repository would eventually close because of the weight of overlying rock and the plasticity of the salt. This will result in surface subsidence which is estimated to affect a surface area of less than 1000 acres. Maximum surface subsidence would be about 1.6 feet. This would have little impact upon the ground surface because there is no integrated surface drainage to disturb.

### 6.6.3 Interactions Between the Waste and the Salt

Some of the unresolved technical issues in the analysis of waste disposal in bedded salt involve interactions between the waste and the salt.

Gas dispersion

Stored TRU waste might generate substantial amounts of gas. Two questions to be answered about this process are:

- How is the gas generated -- by what mechanisms, in what amounts and at what rates?

- After generation, how would the gas affect a repository?

Mechanisms identified so far for gas production from TRU waste are radiolysis, bacterial degradation, thermal decompositon and dewatering, and chemical corrosion.

This gas may disperse in at least one of three possible modes:

1. The medium is permeable enough to allow gases to move away from the repository without any significant pressure buildup.

2. The medium is impermeable, and gas accumulates until the medium fractures under the gas pressure.

3. The medium is impermeable, but the gas accumulation is sufficiently slow for the medium to flow plastically, adjusting the void volume; the pressure never becomes much more than the pressure of the surrounding rock and the medium remains intact.

Initial calculations indicate that there is little possibility of repository failure from gas generation and dispersion. This issue will be subject to further evaluation when data are available from the actual underground workings.

Brine migration

Experimental studies have shown that movements of naturally occurring brine inclusions through salt depend on temperature gradients and are credible only for sources with a substantial heat output. These effects would not be appreciable for TRU waste in the WIPP repository.

Canister corrosion

Waste canisters are not intended to be the major long-term barrier preventing radioactive materials from entering the biosphere. The burial medium is the most important barrier. Canisters are, however, resistant to corrosion and would act to hinder release of radionuclides.

Leaching

The movement of radioactive waste out of waste canisters is an important step in the release of radionuclides from the repository. If escape from the repository is to occur, leaching must take place before intruding water can mobilize the radionuclides. Leach rates are likely to be affected by interactions among the waste, canisters, backfill, and the salt, although the waste will tend to resist leaching. Analytical models are being formulated to predict leaching behavior over hundreds to thousands of years.

Stored energy

Research has been conducted to evaluate whether energy stored by radiation damage in the salt surrounding buried waste could be released and produce a serious thermal excursion or some other undesirable effect. Results indicate that the temperature requirement for sudden release (150°C) demands local energy inputs that are not available. No credible mechanism for catastrophic release of stored energy from radiation damage has been identified.

Nuclear criticality

The contact-handled TRU waste containers emplaced in the repository would contain amounts of fissile material ranging from several grams to as much as 350 grams. The fissile material would not form a critical mass because it would be widely dispersed. A nuclear criticality in the stored waste is not a credible threat.

Thermal effects on aquifers

Temperature increases in the water-bearing rocks above the WIPP resulting from heat released by wastes would be less than 0.3°C. The WIPP would not alter the water flow or induce cracking in aquifers.

## 6.7 EFFECTS OF REMOVING THE TRU WASTE STORED AT INEL

About 75 percent of the retrievable defense TRU waste stored in the United States is located at the Radioactive Waste Management Complex of the Idaho National Engineering Laboratory (INEL). Several operations would be involved in removing the waste and shipping it to the WIPP repository: retrieval; processing; and packaging and shipping.

The radiological effects of retrieving the stored waste would be limited because it is intended that the stored TRU waste be fully contained at the time of retrieval.

Nonradiological effects of retrieval would be those associated with a commitment of manpower and the use of resources. The resources used are significant but their use would not place any strain on either the local or national economy. The overall effect on land use would be to restore the area now used for waste storage to its once-vegetated state.

The radiological impact of processing operations would result from airborne radioactive effluents. One consequence of the airborne effluents would be the gradual buildup of released radioactivity in the environment. Both individual and population annual dose commitments from processing facilities would be several orders of magnitude lower than doses presently received from natural background radiation.

The nonradiological effects of waste processing would be limited to those associated with a commitment of manpower and the use of other resources.

The increment in particulate emissions from the construction and operation of any of the processing facilities would not be measurable, nor would it cause current limits to be exceeded.

The impact on local communities, particularly Idaho Falls, where two-thirds of the workforce would be expected to live, would probably be felt most in the schools, which are already operating near capacity because of recent growth in the area.

The waste processing plant would occupy a maximum of about 1.4 acres. Construction and operation would result in devegetation of this area which has already been disturbed and is no longer in its natural state.

Vehicular noise and emissions associated with on-site waste transfer would be small and isolated. The number of workers required for these activities would also be small. The Radioactive Waste Managaement Complex already has its own rail siding, and extending it would not involve significant effort nor use additional acreage outside the complex.

The effects in Idaho of retrieving, processing, and shipping the stored TRU waste would be minimal. The radiological impact of all of these operations as well as hypothetical accidents would be far smaller than the corresponding effects from natural background radiation. Nonradiological effects would be limited to relatively minor commitments of manpower and other resources.

# 7.0 INTERAGENCY COORDINATION AND PUBLIC PARTICIPATION

## 7.1 INTERAGENCY COORDINATION AND PERMITTING

The Federal Government and the State of New Mexico require that a number of permits, certifications, licenses, consultations, and other approvals related to potential environmental consequences of the authorized WIPP project, would be needed before construction could begin. A partial listing of these requirements follows:

### Federal Permits, Approvals and Consultations

- Historic preservation - No permits, certifications, or approvals per se are required, however, the U.S. Department of Energy (DOE) must provide an opportunity for comment and consultation by the Advisory Council on Historic Preservation as required by the Historic Preservation Act of 1966.

- Hazardous-waste disposal - Nonradioactive wastes which are hazardous to human health must be managed in accordance with the requirements of the Resource Conservation and Recovery Act of 1976. If the WIPP generates any such waste, the DOE must comply with the appropriate regulations.

- Endangered species - The Endangered Species Act, as amended, requires the DOE to consult with the Secretary of the Interior to ensure that construction of the WIPP would not jeopardize the continued existence of any endangered or threatened species.

- Rights-of-way - Most of the land at the Los Medanos site is currently under Bureau of Land Management (BLM) control. Thus the DOE must withdraw land from BLM control and it must acquire right-of-way permits from the BLM if the Los Medanos site is to be used.

- Water quality - The WIPP would not discharge water pollutants into "navigable waters" as defined in the Clean Water Act Amendments of 1977. Thus no permit will be required.

- Air quality - The WIPP would not qualify as a "major stationary source" of air pollutants as defined currently in the Clean Air Act and the DOE will therefore not be required to acquire a permit.

### State Permits, Approvals and Consultations

- Radiation protection - New Mexico state law has established a "Radioactive Waste Consultation Task Force" and a "Radioactive Waste Consultation Committee" to negotiate for the state with the Federal Government in areas relating to siting, licensing, and operation of Federal radioactive waste disposal facilities.

- Water quality - The DOE would be required to file a Notice of Intent to Discharge and Discharge Plan with the New Mexico Department of Health and Environment, Environmental Improvement Division.

- Air quality - New sources of air pollution are governed by New Mexico State regulations. A New Source Permit would be obtained by the DOE if it were demonstrated that the WIPP would emit air contaminants in excess of state standards.

- Endangered species - As with the Federal government, the DOE must consult with the State of New Mexico to ensure that construction of the WIPP will not jeopardize the continued existence of any endangered or threatened species.

## 7.2 PUBLIC PARTICIPATION

The decision-making process for the WIPP project has provided opportunities for public comment and public involvement. The Draft Environmental Impact Statement (DEIS) of April 1979 was made available to individuals and groups that requested an opportunity to comment on the statement. Notices of the availability of the statement were published in English and Spanish and special efforts were made to notify individuals and organizations who, by their demonstrated interest or activity, could be expected to be interested in the WIPP project.

## 7.3 PUBLIC AND AGENCY COMMENTS

Comments from the public, citizens interest groups and governmental agencies on the WIPP DEIS were obtained during seven days of public hearings and a 142-day written comment period. Ninety-three letters, several in excess of 50 pages, were received. Each testimony or letter was analyzed in detail and comments concerning specific issues were identified. Because of the voluminous response to the DEIS, all substantive comments were summarized or consolidated into 30 major issues with multiple subissues. A response to each of these issues was prepared by the DOE and incorporated in the Final Environmental Impact Statement (FEIS).

## ABBREVIATIONS AND ACRONYMS

| | | |
|---|---|---|
| AEC | - | U.S. Atomic Energy Commission |
| AIM | - | Agricultural and Industrial Minerals, Inc. |
| CH TRU | - | Contact-Handled Transuranic (Waste) |
| dBA | - | Decibel, A-Weighted Scale. |
| DEIS | - | Draft Environmental Impact Statement |
| DOE | - | U.S. Department of Energy |
| DOT | - | U.S. Department of Transportation |
| EPA | - | U.S. Environmental Protection Agency |
| ERDA | - | U.S. Energy Research and Development Administration |
| $^oF$ | - | Degrees Fahrenheit |
| FEIS | - | Final Environmental Impact Statement |
| HLW | - | High-Level Waste |
| INEL | - | Idaho National Engineering Laboratory |
| IRG | - | Interagency Review Group on Nuclear Waste Management |
| NAS/NRC | - | National Academy of Sciences-National Research Council |
| NCRP | - | National Council on Radiation Protection and Measurements |
| NRC | - | U.S. Nuclear Regulatory Commission |
| NWTS | - | National Waste Terminal Storage |
| ONWI | - | Office of Nuclear Waste Isolation |
| ORNL | - | Oak Ridge National Laboratory, Tennessee |
| OSTP | - | Office of Science and Technology Policy |
| R&D | - | Research and Development |
| RH TRU | - | Remotely Handled Transuranic Waste |
| SW&A | - | Sipes, Williamson & Associates (Petroleum Consultants) |
| SPDV | - | Site and Preliminary Design Validation |
| TRU | - | Transuranic |
| USBM | - | U.S. Bureau of Mines |
| USDA-REA | - | U.S. Department of Agriculture Rural Electrification Administration |
| WAC | - | Waste Acceptance Criteria |
| WIPP | - | Waste Isolation Pilot Plant |

## GLOSSARY

| | | |
|---|---|---|
| Aquifer | - | A body of rock that contains sufficient saturated permeable material to transmit groundwater and to yield significant quantities of groundwater to wells and springs. |
| Anticline | - | A fold of rocks whose core contains older rocks; it is convex upward. |
| Argillaceous rocks | - | Rocks containing appreciable amounts of clay. |
| Background radiation | - | Radiation in the human environment from naturally ocurring elements, from cosmic radiation, and from fallout. |
| Basalt | - | A dark igneous rock, usually formed as lava flows. |
| Baseline conditions | - | The existing conditions and trends of the human and natural environment in a potentially affected region, providing a reference by which effects of an action may be predicted. |
| Bedded salt | - | Consolidated layered salt separated from other layers by distinguishable planes of separation. |
| Bell Canyon formation | - | A sequence of rock strata which form a hydrologic unit of the Delaware Mountain Group. The formation is located below the potential repository level at the Los Medanos site. |
| Biomass | - | The total mass of organic material of a species per unit area or volume; the term is used in expressing population densites. |
| Biosphere | - | The portion of the earth inhabited by living organisms, including the land masses, oceans and atmosphere. |
| Caliche | - | A limy material commonly found in layers on or within the surface of stoney soils of arid and semiarid regions. It is composed largely of crusts of calcium carbonate (lime) as well as gravels, sands, silts and clays cemented together by the calcium carbonate. |
| Canister | - | As used in this document, a container for remotely handled waste or high-level waste, usually cylindrical. The waste would remain in this canister during and after burial in salt. A canister affords physical containment but not shielding, shielding is provided during shipment by a cask. |

Capitan reef - A buried horseshoe-shaped fossil limestone reef of Permian age which rings the Delaware basin except to the south.

Castile formation - A formation of Permian age evaporite rocks (interbedded halite and anhydrite) which immediately underlies the Salado formation at the Los Medanos site.

Chain reaction - A reaction that stimulates its own repetition. In a fission chain reaction, a fissionable nucleus absorbs a neutron and splits, releasing additional neutrons. A fission chain reaction is self-sustaining when the number of neutrons released equals or exceeds the number of neutrons lost by escape from the system or by non-fission absorption.

Climax community - The final and most stable of a series of biotic communities in a succession, remaining relatively unchanged as long as climate and physiographic factors remain constant (assuming no human interference).

Contact-handled waste - Radioactive waste that does not require shielding other than that provided by its container.

Critical mass - The smallest mass of fissionable material that will support a self-sustaining chain reaction. The critical mass depends on its shape and the nature of the surrounding material because these influence the ease with which neutrons can escape and the likelihood that they will be reflected back in the mass.

Crystalline rock - Rock designated as being either igneous or metamorphic, not sedimentary; rock consisting wholly of mineral crystals or fragments of crystals.

Culebra dolomite - A layer of dolomite within the Rustler formation which is locally water bearing in the area of the Los Medanos site.

Decibel - A unit of the loudness of sound. The A-weighted decibel scale reflects the human perception of sounds of varying frequencies.

Defense waste - Nuclear waste derived from the manufacture of nuclear weapons and the operation of military reactors. Associated activities such as the research conducted in the weapons laboratories also produce defense waste.

| | |
|---|---|
| Delaware basin | - An area in southeastern New Mexico and adjacent parts of Texas where thick layers of evaporites were deposited some 200 million years ago in an ancient sea. It is partially surrounded by the Capitan reef. |
| Dissolution | - The process whereby a space or cavity in or between rocks is formed by the dissolving of part of the rock material in water. |
| Dose equivalent commitment | - The total dose equivalent that results from an intake of radioactive material during all the time from the intake to death of the organism. For humans the dose equivalent is usually evaluated for a period of 50 years from the intake. |
| Dolomite | - A sedimentary rock consisting primarily of the mineral dolomite ($CaMg(CO_3)_2$). It is commonly found in association with limestone ($CaCO_3$). |
| Evaporites | - Sedimentary rocks composed primarily of minerals produced from a saline solution that became concentrated by evaporation of the solvent such as rock salt, sylvite, langbeinite, anhydrite, etc. |
| Fission | - The splitting of a heavy nucleus into two approximately equal parts, each the nucleus of a lighter element, accompanied by the release of a large amount of energy and generally one or more neutrons. Fission can occur spontaneously, but it usually follows the absorption of neutrons. |
| Fissionable | - Describes a nuclide that undergoes fission on absorption of a neutron of energy over some threshold energy. |
| Fugitive dust | - Soil particles entrained in air due to construction equipment, vehicles or wind erosion. |
| Glove box | - A sealed box in which workers, remaining outside and using gloves attached to and passing through openings in the box, can safely handle and work with radioactive materials. |

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| High-level waste | - Nuclear waste resulting from reprocessing of spent fuel. Unreprocessed fuel is also regarded as high-level waste. It is characterized by intense, penetrating radiation and by high heat-generation rates. Even in protective canisters, high-level waste must be handled remotely. |
| Langbeinite | - A mineral used by the fertilizer industry as a source of potassium sulfate. |
| Leaching | - The process of extracting a soluble component from a solid by the percolation of a solvent (in this report, water) through the solid. |
| Lithostatic load | - The vertical pressure at a point in the Earth's crust, equal to the pressure exerted by the weight of the overlying rock and/or soil. |
| Los Medanos | - Literally, "little sand bars" in Spanish. The geographic name for the area surrounding the site investigated for the WIPP project in southeastern New Mexico. |
| Millirem | - One thousandth of a rem (0.001 rem) |
| Permian basin | - A region in the central United States where, during Permian time, 280 to 225 million years ago, extensive beds of evaporites were deposited in a number of shallow sea basins. The Delaware basin is a part of the Permian basin. |
| Permeability | - A property of a mass of soil or rock defined in the study of groundwater hydraulics as the rate at which water can flow through that mass. It is measured in feet per day or equivalent units. It is equal to the hydraulic transmissivity divided by the thickness of the aquifer. |
| Rem | - "Roentgen equivalent man," a unit measuring ionizing effects of radiation doses which considers biological consequences of the dose. A single dose of 500 rem will result in approximately 50 percent mortality to the exposed population; 250 rem will cause severe radiation sickness and some mortalities. A dose of 100 rem will induce radiation sickness of many members of the exposed population. The health consequences of long-term, low-level exposures have not been determined with certainty. |
| Remotely handled waste | - Radioactive waste that requires shielding other than that provided by its container. |

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| Repository | - A facility for the storage or disposal of radioactive waste. |
| Retrievable | - Storage of radioactive waste in a manner designed for recovery without loss of control or release of radioactivity. |
| Rustler formation | - The formation of Permian age composed predominately of evaporites which immediately overlies the Saladc formation at the Los Medanos. |
| Salado formation | - The Permian age evaporite formation. A geologic waste repository at the Los Medanos site would be constructed within this formation. |
| Sylvite | - The mineral, potassium chloride, used as a fertilizer. |
| Tectonic activity | - Movement of the earth's crust such as uplift and subsidence and the associated folding, faulting, and seismicity. |
| Transmutation | - The transformation of one atom into another atom of a different element, occuring artifically by bombardment with neutrons or other nuclear particles. |
| Transuranic waste | - Radioactive waste containing greater than 10 nCi/gram of isotopes of atomic weight greater than uranium. |
| Tuff | - A compacted deposit of volcanic ash and dust that may contain appreciable amounts of clay or sand. |

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