1.0 INTRODUCTION

The U.S. Department of Energy (DOE) is responsible for the disposition of transuranic (TRU) waste generated through national defense-related activities. Approximately 62,000 cubic meters of these wastes have been generated and are currently stored at government defense installations across the country. The Waste Isolation Pilot Plant (WIPP), located near Carlsbad, New Mexico, has been sited and constructed to meet the criteria established by the scientific and regulatory community for the safe disposal of TRU wastes. This Compliance Certification Application provides the DOE's demonstration of compliance for the WIPP with the long-term disposal regulations set forth in Title 40 of the Code of Federal Regulations (CFR) Part 191, Subparts B and C (U.S. Environmental Protection Agency [EPA] 1993). The information provided in this application has been structured in accordance with the criteria for certification issued by the EPA in February 1996 as 40 CFR Part 194, titled *Criteria for the Certification and Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations; Final Rule.*

In this application, the DOE documents how the favorable geological, hydrological, physical, chemical, and environmental characteristics of the site, along with engineered features of the facility, contribute to a reasonable expectation that compliance will be achieved for the 10,000-year regulatory period. Calculations provided in this application demonstrate that even under the stringent conditions dictated by the disposal standards and the certification criteria, the WIPP complies with the quantitative release limits, individual exposure standards, and groundwater protection standards. In addition, this application documents the measures that the DOE has taken, or intends to take at the time of facility closure, to provide further assurance that the quantitative limits will be met.

The activities that have led up to the preparation of this application began over 20 years ago with the selection of a site that best met the numerous siting criteria established for safe disposal of TRU waste. At that time, the DOE and its predecessor agencies sought a disposal location with certain favorable characteristics that were anticipated as desirable for long-term waste isolation. The WIPP site best met these criteria. For example, the site has favorable geological characteristics in that

- the host rock formation behaves plastically, thereby creeping closed to encapsulate buried waste;
- the effects of dissolution at the site were minimal and predictable;
- deformation of the rocks within the disposal system is low;
- excavation of the repository is relatively easy;
- future resource development is predictable and minimal; and
- the repository host rock is relatively uncomplicated lithologically and structurally.

Hydrologically, the site exhibits

- a host rock formation that contains little groundwater and transmits it poorly;
- a location where the effects of groundwater flow are minimal and predictable;
- an area where future groundwater use is low and where there are no permanent surface waters;
- an area where future groundwater use is unlikely; and
- a repository host rock that will not likely be affected by anticipated possible long-term climate changes within 10,000 years.

Finally, when selected, the WIPP site

- maximized the use of federal lands while avoiding existing drill holes, avoiding known oil and gas trends and minimizing the impacts on potash deposits;
- avoided natural areas, endangered species and critical habitats;
- has a climate that minimizes hydrological impacts; and
- is in a seismically stable area.

All of these favorable factors contribute to the demonstration of compliance and more than compensate for less favorable features such as nearby hydrocarbon production and potash mining. Furthermore, the favorable characteristics allow the WIPP to accommodate a broad spectrum of TRU waste characteristics, thereby allowing the DOE to meet its mandated mission of disposal of the nation's TRU waste inventory.

The efforts to prepare this final documentation of compliance began in 1992, when Congress passed the WIPP Land Withdrawal Act (LWA), in which it established several mandates. First, Congress required that the DOE demonstrate compliance to the final disposal standards codified in 40 CFR Part 191, Subparts B and C, prior to opening the WIPP for the disposal of TRU waste (EPA 1985, 1993). Second, Congress mandated that the DOE submit an application to the EPA seeking certification of the DOE's compliance demonstration. To facilitate the certification process, Congress mandated that the EPA issue certification criteria to judge the adequacy of the DOE's application. The EPA met this obligation in February 1996 with the issuance of 40 CFR Part 194. Following the issuance of 40 CFR Part 194, the EPA issued guidance for implementation. This guidance is the *Compliance Application Guidance for 40 CFR Part 194* (EPA 1996b).

The DOE has been working on its demonstration of compliance since the initial publication of the disposal standards in 1985. Initial work was aimed at identifying appropriate conceptual models for the features, events, and processes (FEPs) that could reasonably be expected to affect the disposal system.[1] The effect of the LWA was to focus the DOE's activities to meet specific criteria that the EPA has established for certification of compliance. This application is the result of those efforts and demonstrates that the WIPP meets the disposal standards of 40 CFR Part 191, Subparts B and C, under the conditions imposed by the standards and in accordance with the certification criteria.

The information presented in this application is the culmination of over 20 years of scientific work specifically dedicated to TRU waste isolation in the WIPP. Throughout this process, the DOE and its predecessor agencies have ensured that qualified individuals were available to address the technical questions surrounding the long-term performance of the disposal system. These experts have included members of the federal and state government agencies, several national laboratories, academia, and industry. In addition, the DOE has ensured ongoing technical oversight of the project through the services of the Environmental Evaluation Group (EEG), the National Academy of Sciences (NAS), and the New Mexico Governor's Consultation Task Force on Radioactive Waste. Frequent consultation with these organizations has served to identify important issues and their timely resolution. In addition, the DOE has involved the public in the decision-making process at key points throughout the compliance demonstration process. The DOE has maintained a documented Quality Assurance Program to ensure that objective evidence exists to support the quality of the work that has been performed for this assessment.

This chapter provides an overview of the application, including a summary of the regulatory basis for the application, a discussion of the DOE's purpose for the WIPP, a summary of the site selection process, a summary of the approach taken in this application to demonstrate long-term performance, and a summary of the contents of the remaining chapters.

1.1 Applicable Regulations

Several federal and state of New Mexico regulations apply specifically to the DOE's activities to open and operate the WIPP for the disposal of TRU waste. Compliance with these regulations is summarized in Appendix BECR. However, two of these regulations are the specific subject of this application. These are 40 CFR Part 191, *Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes,*[2] and 40 CFR Part 194, *Criteria for the Certification and*

[1] The EPA defines the disposal system as any combination of engineered and natural barriers that isolate spent nuclear fuel or radioactive waste after disposal (40 CFR § 191.12).

[2] The DOE uses the following convention in referencing regulations: General references are expressed as 40 CFR Part 191 or 40 CFR Part 191, Subpart B. Specific references to requirements within the regulations are shown as 40 CFR § 191.14(b). In addition, reference is made to the supplementary information provided in the preamble of the regulation. *Federal Register* citations for these references are shown as follows: 61 FR 5224.

Re-Certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations; Final Rule.

1.1.1 40 CFR Part 191

The EPA is responsible for developing environmental standards for the protection of the public and the environment from radioactivity. The statutory authority for establishing and implementing the regulatory standards applicable to the operation, closure, and long-term performance of the WIPP facility are found in the Atomic Energy Act of 1954, Reorganization Plan Number 3 of 1970, and in the Nuclear Waste Policy Act of 1982. The regulations affecting the radioactive waste disposal operations that will occur at the WIPP are found in 40 CFR Part 191.

Since the mid-1970s, the EPA has been developing guidance and standards for the management and disposal of radioactive waste. The EPA's final rule, 40 CFR Part 191, was first published on September 19, 1985. This standard was vacated and remanded to the EPA by a Federal Court of Appeals in 1987. The LWA of 1992 reinstated the 1985 disposal standard except for the aspects of the standard that were specifically questioned by the court (that is, 40 CFR § 191.15, Individual Protection Requirements, and 40 CFR § 191.16, Ground Water Protection Requirements). On December 20, 1993, the EPA promulgated, effective January 19, 1994, final disposal standards that corrected deficiencies associated with the individual and groundwater protection requirements.

40 CFR Part 191 Subparts B and C establish standards and measures of performance for the following aspects of a disposal system:

- isolation of radionuclides sufficient to meet the containment requirements of the disposal system.
- protection of individuals from radiation exposures for a period of 10,000 years,
- protection of groundwater from radioactive contamination for 10,000 years, and

To demonstrate that a disposal system will comply with 40 CFR Part 191, the DOE must show a reasonable expectation that each performance measure will be satisfied.

In addition to numeric standards, the qualitative assurance standards set out in 40 CFR § 191.14 were promulgated in order to provide the confidence needed for long-term compliance with the containment requirements in 40 CFR § 191.13. They include (1) active and passive institutional controls to preclude or mitigate the potential for human disturbance of the repository for an extended period of time, (2) the concept of multiple (natural and engineered) barriers, and (3) other measures taken to enhance confidence in the disposal system performance.

The DOE has demonstrated that the WIPP complies with the disposal standards in 40 CFR Part 191. This demonstration is documented in this application. The location in this application of compliance demonstrations for each of the requirements in 40 CFR Part 191 is shown under the Regulatory Cross Reference tab in this application. The final complementary cumulative distribution function (CCDF), which is the measure of compliance for containment, is shown in Figure 1-1. Based on this CCDF, the DOE has a reasonable expectation that the disposal system will perform in compliance with the containment requirements of 40 CFR Part 191.

1.1.2 40 CFR Part 194

As mentioned above, the EPA was mandated by the LWA to issue criteria for evaluating the DOE's compliance demonstration. The EPA met this mandate on February 9, 1996 with the publication of 40 CFR Part 194. In the summary of the rule, the EPA states that by this rule it is

> promulgating criteria for determining if the Waste Isolation Pilot Plant (WIPP) will comply with EPA's environmental radiation protection standards for the disposal of radioactive waste. If the Administrator of EPA determines that the WIPP will comply with the standards for disposal, then the Administrator will issue to the Secretary of Energy a certification of compliance which will allow the emplacement of transuranic waste in the WIPP to begin, provided that all other statutory requirements have been met. If a certification is issued, EPA will also use this final rule to determine if the WIPP has remained in compliance with EPA's environmental radiation protection standards, once every five years after the initial receipt of waste for disposal at the WIPP. (61 FR 5224)

The EPA states that "[w]ith today's rulemaking, the Agency establishes criteria by which to judge whether the WIPP is in compliance with the 'disposal regulations' and sets forth procedural requirements for this determination." To this end, the rule contains four subparts.

- Subpart A establishes provisions related to the structure of the 40 CFR Part 194, including purpose, scope and applicability; definitions; substitution of alternative provisions for those promulgated in the final rule; and procedures that shall be followed in communications and written reports submitted by the Secretary of Energy to the Administrator of the EPA.

- Subpart B sets forth requirements for the format and content of compliance applications.

- Subpart C establishes the requirements that apply to the performance assessments and compliance assessments that will be used to demonstrate compliance with the numerical requirements of the disposal regulations.

- Subpart D establishes procedures that the EPA will use to involve the public in the decisions on certification and recertification and requires the EPA to publish notices of its actions in the *Federal Register*.

The DOE has met all of the criteria established by the EPA in 40 CFR Part 194. The documentation for demonstrating compliance as defined in the criteria in 40 CFR Part 194 are contained in this application. A crosswalk relating the criteria to the various sections of the application can be found under the Regulatory Cross Reference tab in this application. The location of the principal information required by the certification criteria is shown in Table 1-1.

1.1.3 Other Regulations

In addition to 40 CFR Part 191, one other regulation applies to the WIPP during the period following closure of the facility. This is a regulation issued pursuant to the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA). The RCRA regulates the hazardous waste component of TRU waste.[3] The DOE has implemented compliance programs for the RCRA that complement the disposal standards. Details of the RCRA compliance program can be found in Appendix BECR.

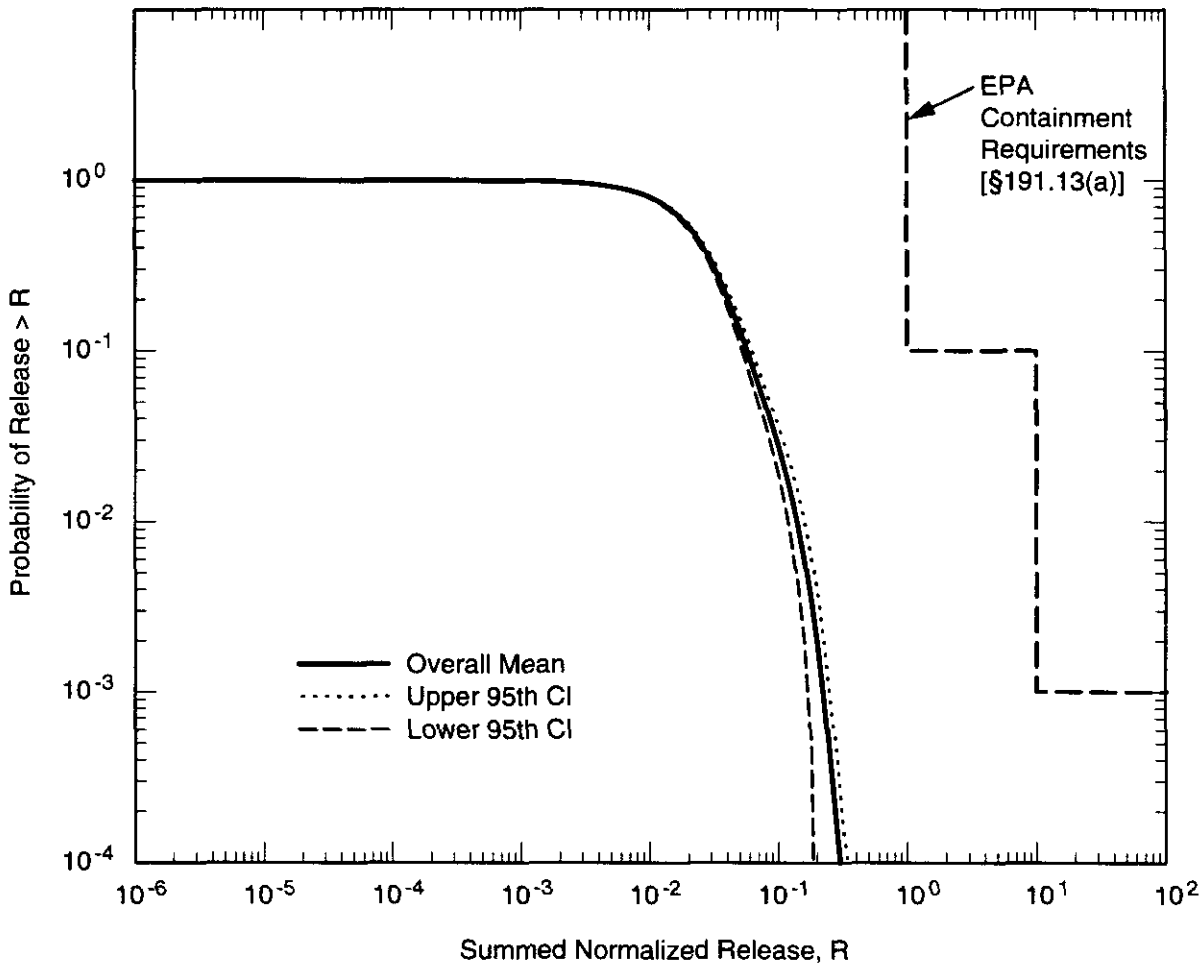
1.2 Project Background

The DOE began the development of the WIPP facility by selecting a site. The DOE evaluated several alternative sites, and the present site was selected as the best alternative based on considerable existing geotechnical information and confirmed by extensive research and testing. Based upon the properties of the site, the DOE designed the repository and prepared safety analyses. Subsequent research has expanded the understanding of the geologic, hydrologic, geochemical, and mechanical properties of the host rock and surrounding strata of the site. This siting phase ended with the publication of a Final Environmental Impact Statement (FEIS) in 1980 (DOE 1980), which evaluated alternatives for the safe, long-term isolation of TRU waste. The Record of Decision concluded that the phased development of the WIPP facility was the preferred alternative of those considered (DOE 1981).

The site and preliminary design validation phase followed the siting phase. During this phase, the DOE constructed two shafts, excavated an underground testing area, and investigated various geologic, hydrologic, and other geotechnical features, further expanding the knowledge of the site's characteristics. In addition, the DOE evaluated methods for assessing the long-term performance of the WIPP facility. A series of geologic and hydrologic studies began in 1984 under an agreement between the DOE and the state of New Mexico. These studies were completed and site characterization ended.

The construction phase followed the site and preliminary design validation phase, during which the DOE built surface structures for receiving waste and mined underground excavations, including one panel for waste emplacement and numerous areas for in-situ experiments. The DOE's decision to initiate operations was reached after all prerequisites for

[3] TRU waste that also contains hazardous waste contaminants as defined by the RCRA is referred to as TRU mixed waste.



Note: This figure is reproduced from Figure 6-39.

CCA-143-3

Figure 1-1. Final WIPP CCDF

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Table 1-1. Analyses and Studies Mandated by the Certification Criteria and Their Location in this Application

40 CFR Part 194	Criterion	Location in This Application
§ 194.23 Models and Computer Codes	(c) Documentation of all models and computer codes included as part of any compliance application performance assessment calculation shall be provided. Such documentation shall include but shall not be limited to (1) Descriptions of the theoretical backgrounds of each model and the method of analysis or assessment; (2) General descriptions of the models; discussions of the limits of applicability of each model; detailed instructions for executing the computer codes, including hardware and software requirements, input and output formats with explanations of each input and output variable and parameter (for example, parameter name and units); listings of input and output files from a sample computer run; and reports on code verification, benchmarking, validation, and quality assurance (QA) procedures; (3) Detailed descriptions of the structure of computer codes and complete listings of the source codes; (4) Detailed descriptions of data collection procedures, sources of data, data reduction and analysis, and code input parameter development; (5) Any necessary licenses; and (6) An explanation of the manner in which models and computer codes incorporate the effects of parameter correlation.	Chapter 4.0 Sections 5.3.18 and 5.3.20 Chapter 6.0 Appendix BRAGFLO Appendix CCDFGF Appendix CUTTINGS Appendix GENII Appendix MASS Appendix NUTS Appendix PANEL Appendix PAR Appendix SECOFL2D Appendix SECOTP2D Numerous support codes as discussed in Appendix CODELINK GRASP_INV (in Appendix TFIELD) FMT (in Appendix SOTERM) NONLIN (in Appendix SOTERM) SANTOS (in Appendix PORSURF)
§ 194.24 Waste Characterization	(b) The Department shall submit in the compliance certification application the results of an analysis which substantiates (1) That all waste characteristics influencing containment of waste in the disposal system have been identified and assessed for their impact on disposal system performance. . . (2) That all waste components influencing the waste characteristics identified in paragraph (b)(1) of this section have been identified and assessed for their impact on disposal system performance. . . (3) Any decision to exclude consideration of any waste characteristic or waste component because such characteristic or component is not expected to significantly influence the containment of the waste in the disposal system.	Section 4.2 Appendix WCA Appendix SOTERM

Table 1-1. Analyses and Studies Mandated by the Certification Criteria and Their Location in this Application (Continued)

40 CFR Part 194	Criterion	Location in This Application
§ 194.24 Waste Characterization	(c) For each waste component identified and assessed pursuant to paragraph (b) of this section, the Department shall specify the limiting value (expressed as an upper or lower limit of mass, volume, curies, concentration), and the associated uncertainty (that is, margin of error) for each limiting value, of the total inventory of such waste proposed for disposal in the disposal system.	Section 4.2 Appendix WCL
§ 194.27 Peer Review	(a) Any compliance application shall include documentation of peer review that has been conducted, in a manner required by this section, for (1) Conceptual models selected and developed by the Department; (2) Waste characterization analyses as required in § 194.24(b); and (3) Engineered barrier evaluation as required in § 194.44.	Chapter 9.0 Appendix PEER
§ 194.27 Peer Review	(c) Any compliance application shall (1) Include information that demonstrates that peer review processes required in paragraph (a), and conducted prior to the implementation of the promulgation of this part, were conducted in accordance with an alternate process substantially equivalent in effect to NUREG-1297 and approved by the Administrator or the Administrator's authorized representative; and (2) Document any peer review processes conducted in addition to those required pursuant to paragraph (a) of this section. Such documentation shall include formal requests, from the Department to outside review groups or individuals, to review or comment on any information used to support compliance applications, and the responses from such groups or individuals.	Chapter 9.0 Appendix PEER
§ 194.34 Results of Performance Assessments	(e) Any compliance application shall display the full range of CCDFs generated.	Section 6.5.2 Appendix SA
§ 194.41 Active Institutional Controls	(a) Any compliance application shall include detailed descriptions of proposed active institutional controls, the controls' location, and the period of time the controls are proposed to remain active. Assumptions pertaining to active institutional controls and their effectiveness in terms of preventing or reducing radionuclide releases shall be supported by such descriptions.	Section 7.1 Appendix AIC

Table 1-1. Analyses and Studies Mandated by the Certification Criteria and Their Location in this Application (Continued)

40 CFR Part 194	Criterion	Location in This Application
§ 194.42 Monitoring	(a) The Department shall conduct an analysis of the effects of disposal system parameters on the containment of waste in the disposal system and shall include the results of such analysis in any compliance application. The results of the analysis shall be used in developing plans for pre-closure and post-closure monitoring required pursuant to paragraphs (c) and (d) of this section.	Section 7.2 Appendix MON
§ 194.43 Passive Institutional Controls	(a) Any compliance application shall include detailed descriptions of the measures that will be employed to preserve knowledge about the location, design, and contents of the disposal system.	Section 7.3 Appendix PIC
§ 194.43 Passive Institutional Controls	(c) The Administrator may allow the Department to assume passive institutional control credit, in the form of reduced likelihood of human intrusion, if the Department demonstrates in the compliance application that such credit is justified because the passive institutional controls are expected to endure and be understood by potential intruders for the time period approved by the Administrator.	Section 7.3 Appendix EPIC
§ 194.44 Engineered Barriers	(b) In selecting any engineered barrier(s) for the disposal system, the Department shall evaluate the benefit and detriment of engineered barrier alternatives, including but not limited to cementation, shredding, supercompaction, incineration, vitrification, improved waste canisters, grout and bentonite backfill, melting of metals, alternative configurations of waste placements in the disposal system, and alternative disposal system dimensions. The results of this evaluation shall be included in any compliance application and shall be used to justify the selection and rejection of each engineered barrier evaluated.	Section 3.3 Section 7.4 Appendix EBS
§ 194.45 Consideration of the Presence of Resources	Any compliance application shall include information that demonstrates that the favorable characteristics of the disposal system compensate for the presence of resources in the vicinity of the disposal system and the likelihood of the disposal system being disturbed as a result of the presence of those resources. If performance assessments predict that the disposal system meets the containment requirements of § 191.13 of this chapter, then the Agency will assume that the requirements of this section and § 191.14(e) of this chapter have been fulfilled.	Section 7.5 Appendix IRD

Table 1-1. Analyses and Studies Mandated by the Certification Criteria and Their Location in this Application (Continued)

40 CFR Part 194	Criterion	Location in This Application
§ 194.46 Removal of Waste	Any compliance application shall include documentation which demonstrates that removal of waste from the disposal system is feasible for a reasonable period of time after disposal. Such documentation shall include an analysis of the technological feasibility of mining the sealed disposal system, given technology levels at the time a compliance application is prepared.	Section 7.6 Appendix WRAC

ending construction were met and documented. These documents used the data collected since 1980 to evaluate the potential short-term and long-term impacts of the WIPP facility.

Once the DOE demonstrates compliance with applicable federal and state laws and regulations and obtains required approvals to begin operations, the WIPP facility will proceed through three additional phases: an operations phase, a decommissioning phase, and a postdecommissioning phase. During the operations phase, which the DOE assumes for the purposes of this application to last 25 years, the DOE will receive, handle, and emplace TRU and TRU mixed waste in the repository. The operations phase will end when the design capacity of the repository is reached.

The decommissioning phase will follow the operations phase. The repository will be prepared for permanent closure during this phase. Surface facilities will be decontaminated and decommissioned, underground excavations will be closed, and shaft seals will be emplaced. The decommissioning phase is expected to last 10 years.

Active and passive institutional controls will be implemented following the operations phase. Active institutional controls include activities such as control of access to the site, maintenance, clean-up, and monitoring. Such controls will be implemented consistent with applicable regulations and permit conditions. Only the first 100 years of active institutional controls have been included in the assessment of the disposal system's performance consistent with 40 CFR Part 191 and 40 CFR Part 194. Passive institutional controls include notification devices such as permanent markers and archives. These controls have been designed to reduce the likelihood of inadvertent human intrusion to the extent practicable.

1.3 Site Selection Process

In 1957, the NAS National Research Council recognized salt as a medium well suited for radioactive waste disposal. Salt has relatively high thermal conductivity (which serves to conduct heat away from waste rapidly) and has favorable plastic (creep) properties, which allow significant deformation without fracturing. The existence of large salt deposits

demonstrates isolation from circulating groundwaters for long periods of geologic time. Similarly, the depositional nature and preservation of large intact salt deposits demonstrate that the region has been stable for long periods of time.

The site selection process for the WIPP began in 1973 with a review of information on potential disposal media. This work focused on salt beds and salt domes. The tentative selection criteria used in the initial stage of the process emphasized radiation and mine safety, hydrologic isolation, and ease of construction. In addition to salt lithological factors, the criteria specified the following conditions: 1,000 to 2,500 feet (305 to 762 meters) depth to salt, 200 feet (61 meters) minimum of salt thickness, lateral extent of salt sufficient to protect against dissolution, favorable tectonics (low historical seismicity and no salt-flow structures nearby), minimal groundwater, low resource potential, minimum number of existing boreholes, low population density, and maximum use of federal lands. The U.S. Geological Survey (USGS) and the Oak Ridge National Laboratory (ORNL) selected eastern New Mexico as the area that best satisfied the tentative selection criteria from the bedded salt regions surveyed.

During the second stage of the selection process, two of the three locations in this region were determined to be inadequate: the Clovis-Portales site because shallow salt formations had a significant clay content and the purer salt formations were too deep, and the Mescalero Plains area because of extensive oil field development. After shifting the potential site twice (in order to avoid borehole penetrations of the salt within 2 miles (3.2 kilometers) of the repository border), ORNL selected a site in the Delaware Basin for extensive characterization.

In the final stage of the process, eight areas in the Delaware Basin in Eddy and Lea counties were evaluated. Exploratory drilling at the first site recommended for characterization indicated unsuitable geology (see Chapter 2.0), and in 1975 the USGS and SNL reexamined the Delaware Basin for a more favorable location. This reexamination led to the selection of the Los Medaños site. Selection criteria considered at this stage of the process included:

1. The site should be at least 6 miles (10 kilometers) from the Capitan Limestone to avoid any possible deformation hazard related to the nearness of this reef structure.

2. To minimize potential conflicts with exploration of mineral resources, the central 4 square miles (10 square kilometers) of the repository itself should not be in the known Potash District, and as little as possible of the surrounding buffer zone should be in the district.

3. No part of the central area should be less than 1 mile (1.6 kilometers) away from holes drilled through the Castile Formation (hereafter referred to as the Castile) into underlying rocks in order to avoid dissolution by water flowing upward through an inadequately plugged borehole.

4. Known oil and gas stratigraphic trends should be avoided.

5. The nearest dissolution front in the Salado Formation (hereafter referred to as the Salado) should be at least 1 mile (1.6 kilometers) from the site.

6. The bedding of geological strata should be as nearly flat as can be determined by surface geophysical investigations to ensure mine safety and ease of construction and to avoid the need for numerous exploratory holes that could pose a subsequent risk to the integrity of the repository.

7. Salt of high purity should be available at depths between 1,000 and 3,000 feet (305 and 914 meters) to ensure mine safety and ease of construction. In addition, a salt thickness of 200 feet (61 meters) or more is preferred to confine thermal and mechanical effects to the salt.

8. The use of state and private land should be minimized, especially in the central area, to simplify land acquisition and to avoid any relocation of residents.

The FEIS provided the basis for making the final decision regarding siting the WIPP facility at the Los Medaños site. This decision weighed the numerous advantages of the location and its suitability against potentially adverse environmental impacts. The WIPP site (Figure 1-2) was selected as the best of the alternatives. The specific horizon in the bedded salt was selected because of its desirable stratigraphic features. The stratigraphy is continuous throughout a large geographic area and major clay seams and interbeds of anhydrite or polyhalite are absent from the repository horizon. The facility has been constructed at a horizon such that operational and rock-support problems are minimized. Subsequent validation and construction activities have confirmed that the site's features are suitable for the long-term isolation of TRU waste. The DOE has concluded, based on the demonstration in this application, that these favorable features offset any enhanced risk of human intrusion associated with resources in the vicinity.

1.4 Program for Evaluating Long-Term Performance

When ORNL scientists recommended siting criteria for selecting a waste disposal location in salt, they had a general understanding of how a salt disposal system should perform, given the nature of the waste to be managed. Siting criteria emphasized stratigraphic factors to take full advantage of thermal and creep properties of salt; purity to minimize the presence of complicating or unfavorable properties; isolation from aquifers to minimize impacts of circulating groundwaters; tectonic stability to ensure long-term isolation of waste; minimizing the presence of existing boreholes that could become conduits for release or dissolution; and minimizing resource activity that could disrupt the disposal system. This understanding was, in a broad sense, a conceptual model that linked waste isolation to key features and processes that describe or affect the disposal system (ORNL 1973).

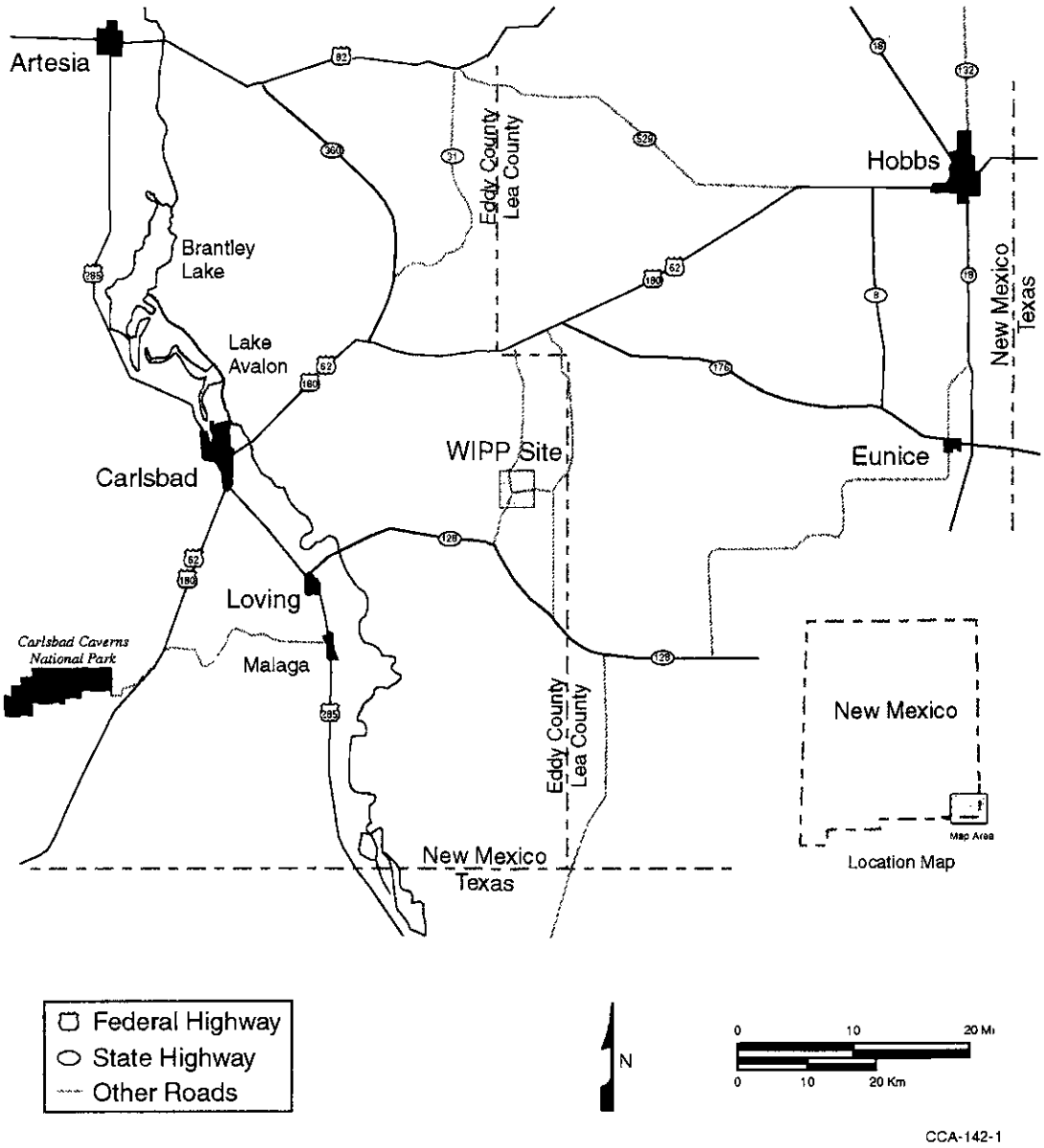
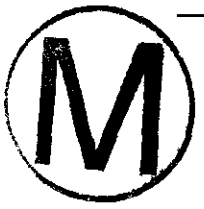


Figure 1-2. WIPP Site Location in Southeastern New Mexico



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As site selection and site characterization proceeded, emphasis was placed on obtaining additional information on those features, events, and processes (FEPs) that define disposal system performance. For this application, about 240 FEPs that could operate on the WIPP disposal system were identified and addressed by the DOE (see Appendix SCR). This information led to (1) the development of detailed conceptual models of various disposal system components such as salt creep, salt hydrology, groundwater hydrology, and waste degradation, as well as investigations to determine regional processes such as tectonism; and (2) scenarios of disposal system performance to be addressed by the modeling. The development of conceptual models led to the identification of detailed laboratory and field experimental and investigation programs to answer questions about parameter values and uncertainty. Ultimately, the interaction between the various components of the disposal system was modeled to produce estimates of expected disposal system performance. Appendix MASS contains a historical discussion of the evolutionary process that led to the conceptual model of the disposal system that is used in this application.

To evaluate the long-term performance of the disposal system, the DOE uses a technique developed especially for predicting the behavior of geologic repositories over the thousands of years required for waste isolation. This technique is performance assessment. Performance assessment is a multidisciplinary, iterative, analytical process that begins by using available information that characterizes the waste and the disposal system (the design of the repository, the repository seals, and the natural barriers provided by the host rock and the surrounding formations). The DOE uses performance assessment to estimate the releases of radionuclides, based on the probabilities of relevant FEPs occurring. Sensitivity analyses are used by the DOE to determine which characteristics of the disposal system exert the greatest effect on performance. The results of sensitivity analyses are provided in this application in Appendix SA. The results of performance assessment are used by the DOE in the 40 CFR Part 191 compliance program to assess disposal system behavior and possible environmental releases.

The DOE's methodology for performance assessment uses relevant information about the disposal system and the waste to simulate performance over the regulatory time periods. This process is schematically represented by the flow diagram in Figure 1-3, which shows how information describing the disposal system is used by the DOE to develop scenarios, scenario probabilities, and the consequence models used to estimate performance. The WIPP performance assessment method has been reviewed by the NAS, the EEG, and experts in and outside the United States. Initially, the DOE used the process in Figure 1-3 with a feedback line from the Uncertainty Analysis block to the System Description block. In this way, the DOE used performance assessment to identify important parameters and the programs needed to better define the parameters and to obtain relevant information.

Uncertainty and how it is handled in the analysis plays a major role in the formulation of a performance assessment strategy. The EPA anticipates that uncertainty in long-term predictions will be inevitable and substantial (see 40 CFR § 191.13[b]). Because of this, the EPA applies a reasonableness test to the outcome of performance assessments. In other

words, the EPA examines the record placed before it to determine if there is a reasonable expectation that compliance will be achieved.

The DOE has addressed uncertainty associated with the WIPP disposal system through careful site, facility, and waste characterization. Uncertainty remaining after these characterizations is incorporated into the performance assessment through the use of reasonable assumptions about models and parameter values.

In general, the DOE has not attempted to bias the performance assessment toward a conservative outcome, and the mean CCDF represents a best estimate of the expected, and in the case of human intrusion, prescribed performance of the disposal system. However, where realistic approaches to incorporating uncertainty are unavailable or impractical, and where the impact of the uncertainty on performance is small, the DOE has chosen to simplify the analysis by implementing conservative assumptions.[4] The conservatism in the analysis is reviewed in Section 6.5.4 and discussed in Appendix MASS (Table MASS-1), and leads to the conclusion that the conservatism does not significantly affect the location of the mean CCDF in Figure 1-1.

The format of this application is tied to the process discussed in Section 6.1 and depicted in Figure 1-3. Basic input information is included in the next four chapters. Then the subsequent chapters use the input information to predict compliance. Each is discussed in the following section.

1.5 Compliance Certification Application Synopsis

This document contains all of the information necessary for the EPA to complete its review and issue a certification of compliance. The DOE has provided links between the chapters to assist in locating data, parameters, models, and assumptions. The DOE used documented guidance provided by the EPA to assist in preparing this application. In many cases, the DOE has included information in the form of appendices. Four criteria were used by the DOE in deciding which information should be included as an appendix. These are as follows:

- The information is in existing technical reports or design documents that are heavily referenced in the application. An example is the Geological Characterization Report (Powers et al. 1978), which is Appendix GCR.

- The information is updated regularly and the latest version of the information is inserted just prior to submittal of the application. Examples are the Annual Site Environmental Report (Appendix SER) and the TRU Waste Baseline Inventory Report (Appendix BIR).

[4] Conservative assumptions are defined by the DOE as assumptions that result in the overestimation, rather than the underestimation, of any phenomenon that could contribute to the release of radionuclides from the disposal system.

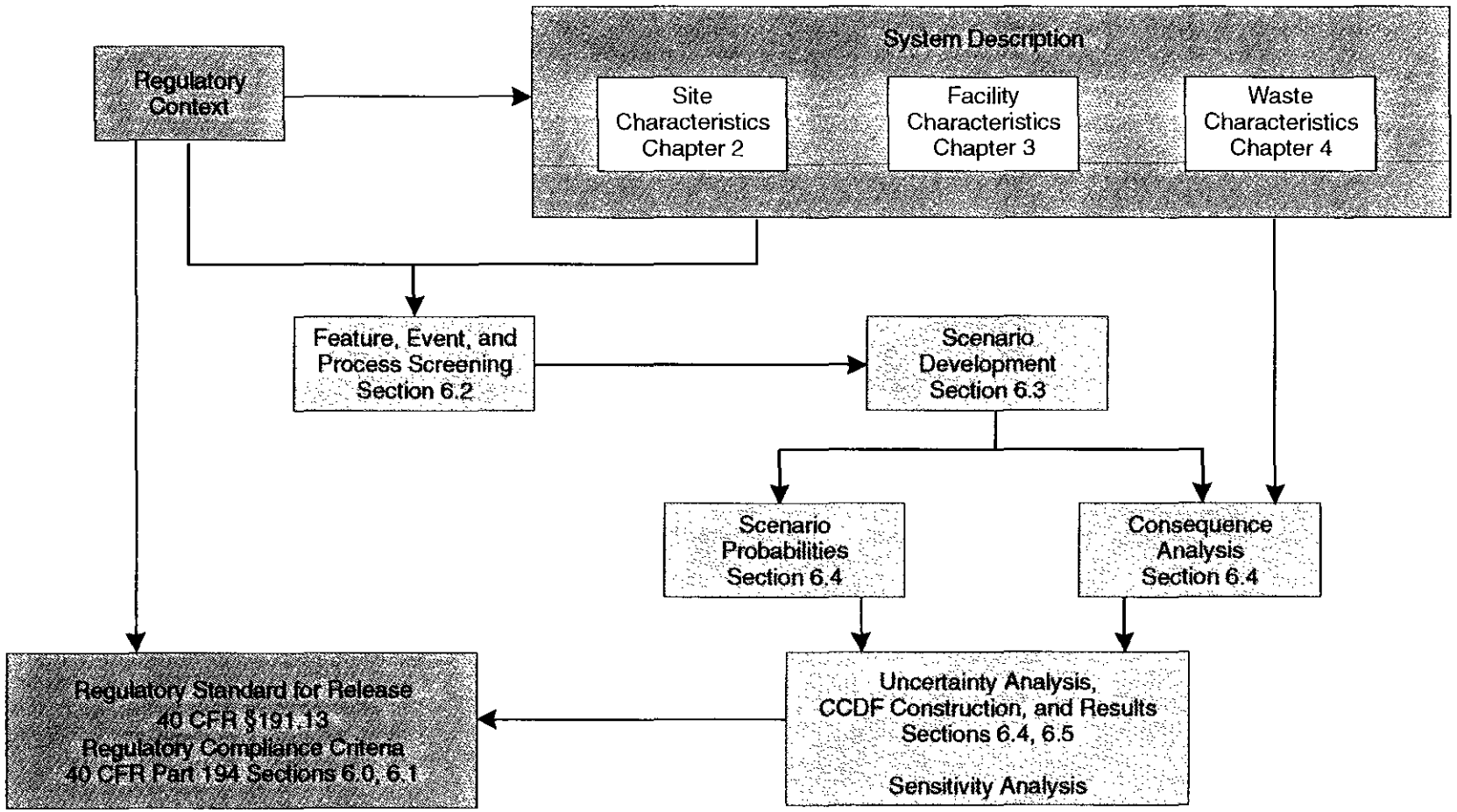

Figure 1-3. Methodology for Performance Assessment of the WIPP

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- The information is an output that is specified in the 40 CFR Part 194 certification criteria and the output is lengthy. Examples are the engineered barriers study (Appendix EBS), the waste characterization analysis (Appendix WCA), the input values and selected intermediate results for each individual calculation of compliance (Appendix IRES), and the computer code manuals (such as Appendix BRAGFLO).

- The information is required to support several chapters and is voluminous in nature. An example is Appendix PAR, which includes parameters based on site characteristics identified in Chapter 2.0, facility design features identified in Chapter 3.0, and the waste parameters identified in Chapter 4.0, in a format that can be used in the numerical models in Chapter 6.0.

The information in the appendices is needed to make the application complete; therefore, the appendices are to be treated as integral parts of the application.

The application contains references to published work that was used in preparing the demonstration of compliance. Ten copies of these references have been provided to the EPA along with the application. However, in order to enhance the readability of the application, expanded references have been provided with each chapter in this application. These are accumulated in Appendix XRE. Expanded references are intended to put referenced statements into context. This is done by providing actual excerpts from the source document in the vicinity of the referenced text. In cases where the text references a document generally (that is, no particular page or section is called out), no expansion is provided. In addition, no expansion is provided for copyrighted materials for which permission to reproduce the text could not be obtained.

Bibliographies are provided for most chapters to provide listings of further information that may be of interest to a reviewer. Bibliographic entries many times are of interest because they discuss alternative models or methodologies that are relevant to the process of assessing disposal system performance. The DOE used several criteria in deciding what entries were to be included in the bibliography. These are as follows:

- Documents were of historical interest and not necessarily WIPP specific. Examples are older geological works cited in Chapter 2.0, such as Shumard (1858), Crandall (1929), and Dunham (1972). Perusal of these documents will provide the reader with general background information on the area around the WIPP.

- Documents are generally well-known technical references (textbooks) that provide the basic understanding that the DOE assumes a technical reader has when reviewing this application. An example is the classic textbook, *Dynamics of Fluids in Porous Media,* by Jacob Bear.

- Reports that provide interim results of testing programs and experimental activities. Generally, such reports are not able to draw final conclusions in support of WIPP

conceptual models, yet the interim results may be of interest to understanding the development of the experimental or testing programs, or, some of the information in these reports has been superseded by more recent information. For example, earlier work by Brinster on the geohydrologic model of the region has been updated by the more recent work cited as references in this application.

- Project documents that reflect compliance activities associated with other regulations that, while not directly relevant to the application, are useful in understanding other aspects of the WIPP program and how the DOE has implemented regulations in a complementary fashion. Examples are the RCRA permit application and the No-Migration Variance Petition.

- Documents that are not available or for some reason cannot be obtained in sufficient numbers to comply with the certification criterion regarding the submittal of references.

- Any other document that the DOE believes would be of interest and benefit to the reader.

Chapter 2.0 describes the site and surrounding area as it existed prior to construction of the WIPP repository. Geological descriptions include both regional and local geology including structure, subsurface geology, geomorphology, geologic stability, soils, and topography. This chapter's purpose is to (1) explain the characteristics of the site, (2) describe background environmental quality, and (3) discuss features of the site that are important for inclusion in a quantitative performance assessment. The DOE has used the information in Chapter 2.0 to develop and screen FEPs (see Appendix SCR) and to develop conceptual, mathematical, and computational models to evaluate the efficacy of the natural and engineered barriers in meeting the environmental performance standards (see Section 6.4). Numerical values have been derived for key characteristics of the natural system. Information that supports these characteristics is discussed in Chapter 2.0; however, the specific values used in the performance assessment are presented in Appendix PAR.

Chapter 2.0 is supported by several appendices. These include basic site characterization reports such as Appendices GCR, HYDRO, SUM, DEF, CLI, RBP, SER, and FAC. A summary of these appendices and their role in this application is presented in Table 1-2. Other appendices were prepared specifically for this application. These include Appendices DEL, SCR, TFIELD, and BH. These are also discussed in Table 1-2.

Chapter 3.0 provides technical information about those engineered systems at the WIPP that are important in meeting the disposal standards of 40 CFR Part 191. Descriptions relevant to long-term containment are provided for underground waste disposal and support facilities, and engineered barriers. The DOE provided for independent review of the design and construction prior to allowing the WIPP facility to start up. The purpose of the review is to ensure that the needed systems and procedures are in place and that there are no errors in the

Table 1-2. Appendices That Support Chapter 2.0 and Their Relevance

Appendix	Relevance to Chapter 2.0
BH	Numerous boreholes have been drilled around the WIPP site for characterization purposes and for monitoring. These include holes for geological, hydrological, potash and soil investigations. Information and data from many of these holes were used in the preparation of Chapter 2.0. A compendium of these holes, along with summary physical and geological information is provided in Appendix BH. In addition, reference tables for non-WIPP holes (such as oil wells) that have been used in both site and regional studies by various investigators are provided in Appendix BH.
CLI	Appendix CLI is a technical study that was performed to determine climate change in the recent past as summarized in Chapter 2.0.
DEF	The DOE conducted numerous investigations to resolve the issues surrounding deformation of the evaporites and dissolution of salt. This appendix summarizes those investigations and the conclusions reached as the result. This supplements the summary information in Chapter 2.0.
DEL	The DOE has compiled information regarding drilling in the Delaware Basin. This appendix includes a summary of current drilling practices and current well plugging practices, presents an inventory of deep and shallow wells, and proposes assumptions for the inadvertent human intrusion scenarios in the performance assessment. This appendix supplements the resource discussions in Chapter 2.0.
EMP	The WIPP Environmental Monitoring Plan (EMP) is included in Appendix EMP. It describes the ongoing environmental sampling activities at the WIPP. Results are reported annually. The EMP encompasses all possible environmental pathways along which humans may be exposed to radionuclides. Media sampled include groundwater, surface water, soil, air, airborne particulate, penetrating radiation, vegetation and other biota. The EMP is relevant to the background environmental conditions discussed in Chapter 2.0.
FAC	The WIPP shafts provided an excellent opportunity to study the sediments and evaporites at the WIPP site. This report provides in-depth interpretations of the geological evidence in the shafts and proposes depositional theories for the rocks of the site region. This report is the source of some of the detailed lithological information in Chapter 2.0.
GCR	Much of Chapter 2.0 was prepared based on the 1978 Geological Characterization Report prepared by Sandia National Laboratories (SNL) as a summary of the investigations performed for the WIPP. It includes a summary of work performed in the area by numerous other scientists as well as specific studies funded by the federal government specifically for selecting a radioactive waste disposal facility site. The basic geological features such as stratigraphy, lithology, geomorphology, physiography are established in this report. Discussions of regional features such as dissolution and deformation are included; however, conclusions regarding many of these features are reserved for later studies (see, for example, Appendices SUM and DEF).
HYDRO	The USGS performed investigations and offered interpretations of the hydrological regime in the region around the WIPP site. Much of the subsequent hydrological testing and modeling are the results of the initial observations reported in Appendix HYDRO. Significant portions of the hydrological data in Chapter 2.0 are derived from this report.

Table 1-2. Appendices That Support Chapter 2.0 and Their Relevance (Continued)

Appendix	Relevance to Chapter 2.0
RBP	The first three years of environmental sampling that were conducted at the WIPP site were designed to compile the radiological baseline described in Chapter 2.0 against which future sampling will be compared. These comparisons will allow the DOE to identify instances where the environmental conditions are deteriorating. The DOE investigates all deteriorating environmental conditions to determine if WIPP activities are the cause. Mitigative actions can be taken based on ongoing observations to ensure no irreparable damage results from WIPP activities.
SCR	The natural FEPs that have been identified for the WIPP site region and are discussed in Chapter 2.0 are screened for inclusion in the performance analysis. Appendix SCR documents the screening process and decisions.
SER	The DOE reports environmental conditions at the WIPP and in the vicinity as far away as Hobbs and Carlsbad in an annual site environmental report. The most current report, summarizing environmental measurements made during 1995, is included as Appendix SER to augment the summary background environmental conditions in Chapter 2.0.
SUM	Following the final selection of the site in 1980 and a review by the NAS and the EEG, numerous additional studies were identified to resolve specific site-related issues. These included regional studies, site studies, and underground tests. These were, for the most part, to a point of completion in 1988 that the DOE could prepare a summary of the findings and offer revised interpretations of geological relationships. These results were definitive in developing conceptual models for the FEPs that were expected to act on the WIPP disposal system. This report is the source of some of the detailed information in Chapter 2.0.
TFIELD	As discussed in Chapter 2.0, the hydrological transmissivity of the Culebra is highly variable. Numerous measurements have been made to characterize this parameter. These data have been processed geostatistically to produce an array of transmissivity fields for use in the transport calculations that are part of the performance assessment. The process for generating these fields and the results themselves are included in this appendix.
USDW	The criteria in 40 CFR Part 194 mandate a map showing the location of any underground source of drinking water within the vicinity of the controlled area as discussed in Chapter 8.0. This appendix includes an analysis of the available groundwater information and concludes, based on limited information, that there are three possible underground sources of drinking water near the WIPP controlled area. One is in the Dewey Lake Redbeds, another is in the Santa Rosa Formation, and the other is in the Culebra Member of the Rustler Formation.

design, construction, or operation of the facility. In addition, details are provided for engineered features that significantly impede the movement of radionuclides to the accessible environment. These include shaft and borehole seals, panel closures, and backfill. This chapter is supported by Appendices SEAL, PCS, BACK, BECR, QAPD, and SCR. Table 1-3 summarizes these appendices as they relate to Chapter 3.0.

Table 1-3. Appendices That Support Chapter 3.0 and Their Relevance

Appendix	Relevance to Chapter 3.0
BACK	A backfill consisting of magnesium oxide (MgO) has been defined for the WIPP facility. Its configuration is defined in Chapter 3.0. This appendix contains background information on its purpose and distribution.
BECR	The Biennial Environmental Compliance Report is required by the WIPP LWA. It summarizes the DOE's compliance with applicable environmental protection standards.
EBS	The DOE performed a study of engineered barriers in accordance with the criteria in 40 CFR Part 194. The final report of this study is contained in this appendix. This study was peer reviewed and those results are summarized in Chapter 9.0 and Appendix PEER. This supports the concept of multiple barriers in Section 7.4.
DVR	The Design Validation Report discusses the analysis used in the design of the disposal system.
PCS	Chapter 3.0 discusses the closure of filled waste panels. This appendix contains the design of the Panel Closure System that will be used to close waste panels after they are filled. This closure contains conventional cement and block components to ensure that ventilation air will not enter a closed panel, thereby limiting the amount of volatile organic compounds that may be in the mine air at any given time.
QAPD	The Carlsbad Area Office (CAO) Quality Assurance Program Document (QAPD) defines the QA requirements that are applicable to WIPP quality affecting activities. DOE contractors, specifically Westinghouse Electric Corporation and SNL, have prepared QAPDs that are tiered to the CAO's QAPD. All three are provided in this appendix. Of particular relevance to Chapter 3.0 are those portions that define design and construction activities and maintenance and configuration management of facilities. In addition, the QA standards imposed for operations are included.
SCR	The repository-induced FEPs that have been identified for the WIPP site region and discussed in Chapter 3.0 are screened for inclusion in the performance analysis. Appendix SCR documents the screening process and decisions that are relevant to Chapter 3.0.
SEAL	The final design for repository seals is described in Chapter 3.0. This appendix provides the details of the design, including component descriptions, performance predictions, and materials selections.

Chapter 4.0 describes the wastes to be managed and disposed of at the facility. The waste description includes the definition, sources, types, components, and characteristics of TRU waste planned for emplacement in the repository. The description identifies those physical, chemical, and radiological characteristics of the waste that may singly or in combination affect the ability of the WIPP disposal system to meet the environmental performance standards in 40 CFR Part 191. The DOE has performed an analysis of the waste to determine those components of the waste that are important to the performance of the disposal system. The analysis is detailed in Appendix WCA and Appendix SOTERM. Waste components summarized in Chapter 4.0 are used as input into the performance assessment to determine acceptable ranges for waste components. The acceptable ranges for waste components for waste to be placed in the WIPP facility are contained in Appendix WCL. These were

determined based on the waste parameter values that were used in the performance assessment for this application. These waste ranges will be imposed on the waste generators as limits through the waste acceptance process as criteria in the WIPP Waste Acceptance Criteria document. In addition to Appendices WCA and WCL, Chapter 4.0 is supported by other appendices. These include Appendices SCR, BIR, WAP, and SA. Table 1-4 summarizes the role of each appendix relative to Chapter 4.0.

Table 1-4. Appendices That Support Chapter 4.0 and Their Relevance

Appendix	Relevance to Chapter 4.0
BIR	The DOE has assembled a database of waste information that serves to define the waste-related parameter values for the performance assessment. These data are tabulated in Chapter 4.0. This database covers existing waste and estimates of future waste. The most recent version of this database is in this appendix.
SA	The final step in the performance assessment process is to perform a sensitivity analysis. This is included in this appendix.
SCR	The waste-induced FEPs that have been identified for the TRU waste to be sent to the WIPP are screened for inclusion in the performance analysis. Appendix SCR documents the screening process and decisions that are relevant to Chapter 4.0.
SOTERM	This appendix describes the actinide source term for the WIPP performance calculations. The quantities of radionuclides are based on data summarized in Chapter 4.0.
WAP	The DOE has prepared a comprehensive plan for determining the physical and chemical characteristics of the waste as required by the RCRA. This plan (referred to as the Waste Analysis Plan or WAP) specifies acceptable sampling and analysis techniques and establishes data quality objectives for characterization. In addition, it defines the methodology for collecting and using acceptable knowledge in the characterization process.
WCA	The certification criteria state that the DOE shall perform an analysis of the TRU waste to determine the components that are important to disposal system performance. This analysis, which supports the description of waste components in Chapter 4.0, is presented in this appendix.
WCL	In calculating the performance of the disposal system, the DOE has to set bounding values for the waste components. Within these values, the analyses are valid, and the WIPP can be reasonably expected to comply with the disposal standards. These bounds are presented in this appendix.

Chapter 5.0 describes QA programs and plans for activities described in this application. The certification criteria in 40 CFR Part 194 place significant emphasis on QA. This is appropriate since an adequate QA program can instill a significant amount of confidence in measured data and in complex computational models. The chapter provides the information requested by the EPA in 40 CFR § 194.22. It establishes that the DOE has had a QA program consistent with the requirements of the American Society of Mechanical Engineers (ASME)-Nuclear Quality Assurance(NQA)-1 for many years at the WIPP facility and that the current CAO QAPD mandates, in addition to NQA-1, the ASME NQA-2a-1990 addenda to

NQA-2-1989, Part 2.7, and ASME NQA-3-1989. All WIPP participants who perform work that affects quality are required to have QA programs that meet requirements of the CAO QAPD. Chapter 5.0 documents that the data used in the performance assessment meet the QA requirements established by the EPA.

Chapter 5.0 is supported with Appendix AUD and Appendix QAPD. These are summarized in Table 1-5. In addition, all QA records (including many technical documents) related to this application are available for inspection in records facilities in Carlsbad, Albuquerque, and at other WIPP participant sites. Access to these records can be arranged through the CAO.

Table 1-5. Appendices That Support Chapter 5.0 and Their Relevance

Appendix	Relevance to Chapter 5.0
AUD	The CAO QAPD requires that the WIPP participants undergo independent QA assessments (audits and surveillances) to ensure compliance to the requirements of NQA-1, NQA-2, Part 2.7, and NQA-3. This appendix documents audits and surveillances conducted recently that were not included in Chapter 5.0 directly.
QAPD	The CAO QAPD defines the QA requirements that are applicable to WIPP quality affecting activities. DOE contractors, specifically Westinghouse Electric Corporation and SNL, have prepared QAPDs that are tiered to the CAO's QAPD. All three are provided in this appendix. The QAPDs are an integral part of the Quality Assurance Program described in Chapter 5.0.

Chapter 6.0 details compliance with the containment requirements of 40 CFR § 191.13. Included is a description of the overall system performance assessment methodology used to evaluate the performance of the WIPP disposal system; a comprehensive list of FEPs that might affect the disposal system performance, the screening methodology applied to that list, and the result of the screening process; a summary of the development of the scenarios that were used in the performance assessment; details of the conceptual and computational models used in the performance assessment, the overall flow of information in the performance assessment, and the construction of the performance measure for comparison to the disposal standards; and the results of the performance assessment along with a discussion of the reliability of those results.

Chapter 6.0 is supported by numerous appendices including Appendices BRAGFLO, CCDFGF, CODELINK, CUTTINGS, NUTS, PANEL, PORSURF, SECOFL2D, SECOTP2D, and TFIELD, all of which describe major numerical codes used in the analysis. Performance assessment parameters are in Appendix PAR. Modeling assumptions used in the construction of the conceptual models and the implementation of the mathematical models are in Appendix MASS. Justification for the source term used in the analysis is in Appendix SOTERM. In addition, Appendices SCR, SEAL, CLI, DEL, IRES, EPIC, and SA support Chapter 6.0. Each is discussed in Table 1-6.

Table 1-6. Appendices That Support Chapter 6.0 and Their Relevance

Appendix	Relevance to Chapter 6.0
BRAGFLO	BRAGFLO estimates brine and gas flow everywhere within the controlled area and beyond from the Castile to the surface. Conceptual models implemented in BRAGFLO are discussed in Section 6.4. BRAGFLO couples the flow of brine and gas to other important repository processes such as creep closure and gas generation. The resulting brine-phase, transient flow fields are used by NUTS to simulate radionuclide transport in these flow fields.
CCDFGF	CCDFGF is used to calculate and present statistical performance assessment results. CCDFGF scales BRAGFLO and SECOTP2D results to match radionuclide outputs calculated by NUTS and PANEL. It combines all the calculated release data to simulate many different repository histories, generating random sequences of future events, calculating the probabilities associated with those random sequences, and preparing the data required to produce the CCDF plots that summarize the WIPP's predicted performance as presented in Section 6.5.
CLI	Appendix CLI is a technical study that was performed to determine climate changes in the recent past as a means of anticipating further changes in the next 10,000 years. Climate variation is modeled as described in Section 6.4.9 and Appendix MASS.
CODELINK	This appendix presents overviews of and backgrounds for (1) the principal codes, and (2) the principal code-linkage sequences that support the 1996 performance assessment as reported in Chapter 6.0. Detailed user's manuals, one for each performance assessment code, have been compiled and archived as part of the QA procedure for the performance assessment, and functional descriptions of each modeling code are included elsewhere as appendices.
CUTTINGS	This appendix describes the CUTTINGS_S code. This code estimates the direct removal of radionuclides from the repository as the result of penetration by a borehole inadvertently drilled into the disposal system at some time in the future. The word direct refers to the fact that CUTTINGS_S releases to the surface occur at the time of drilling. The conceptual models for direct release are discussed in Section 6.4.7.
DEL	The DOE has compiled information regarding drilling in the Delaware Basin. This appendix includes a summary of current drilling practices, current well-plugging practices, presents an inventory of deep and shallow wells, and proposes assumptions for the inadvertent human intrusion scenarios in the performance assessment. These data are used in the performance assessment. Section 6.4 contains the conceptual model of drilling.
EPIC	This appendix provides the DOE's rationale for taking credit for 700 years of institutional controls in the calculation of the performance of the disposal system in Chapter 6.0. This means that the likelihood of an inadvertent intrusion during this period of time is significantly diminished by active and passive institutional controls.
IRES	This appendix contains intermediate results calculated during the performance assessment including Latin hypercube sampling (LHS) output for each of the three replicates, time dependent shaft-seal permeabilities used in BRAGFLO, and actinide concentrations as discussed in Chapter 6.0.

Table 1-6. Appendices That Support Chapter 6.0 and Their Relevance (Continued)

Appendix	Relevance to Chapter 6.0
MASS	Numerous modeling assumptions are used to simplify the calculations when such simplifications are justified. This appendix discusses the major modeling assumptions that are used in the WIPP performance assessment and attaches appropriate supportive information. Numerous references to Appendix MASS occur in Chapter 6.0. The appendix also discusses some alternative approaches that were considered by the DOE in developing the conceptual model.
NUTS	NUTS is a radioisotope transport code that is used for the analysis in Chapter 6.0. Its principal capabilities are (1) to decay the inventory, using Bateman's equations, and (2) to transport radionuclide through porous or fractured media. NUTS is capable of resolving and tracking many individual radioisotopes.
PANEL	PANEL is a radionuclide mobilization and decay code that is used for the analysis in Chapter 6.0. Its principal functions are (1) to decay the inventory, using Bateman's equations, and (2) to use the decayed inventory together with the repository brine volume and outflow rate, and the dissolved and colloidal actinide source terms, to estimate the quantity of all modeled radionuclides that are transported up the intrusion borehole.
PAR	Specific parameters are identified in Section 6.4 as necessary to describe the geological system, the hydrological system, engineered systems, and the waste for the purposes of numerical modeling. The parameter values, listed as either ranges or constants, are included in Appendix PAR. Parameter values in Appendix PAR go directly into the performance assessment.
PORSURF	Creep closure of the excavation and the presence of either brine or gas in the waste disposal region both influence the time-dependent changes in void volume in the waste disposal region. In order to vary them in a calculationally efficient manner, a porosity surface is generated. This surface is used by the BRAGFLO code to indirectly couple mechanical closure of the excavation and gas generation to the two-phase fluid flow calculations. This appendix discusses how the porosity surface is generated.
SA	The final step in a Monte Carlo study is sensitivity analysis, which provides information about the sensitivity of the modeling system to uncertainty in specific input parameters. Appendix SA is the sensitivity analysis for the performance assessment described in Chapter 6.0.
SCR	FEPs that have been identified for the WIPP site region are screened for inclusion in the performance analysis. Appendix SCR documents the screening process and decisions. Those that are retained (not screened out) are included in the conceptual models of repository performance as described in Chapter 6.0.
SEAL	The final design for repository seals is described in Chapter 3.0. This appendix provides the details of the design, including component descriptions, performance predictions, and materials selections. Seal parameters are an input to Chapter 6.0. The seal conceptual model is discussed in Section 6.4.4.
SECOFL2D	The SECOFL2D code calculates a groundwater flow field. The two-dimensional groundwater flow is governed by Darcy's Law. Different hydrological transmissivities are specified in the code for every node throughout the region because they vary from node to node. Direct measurements of Culebra transmissivities exist at a number of locations throughout the WIPP region. The DOE used those data to generate an ensemble of fields that define transmissivity values at each node in the computational domain.

Table 1-6. Appendices That Support Chapter 6.0 and Their Relevance (Continued)

Appendix	Relevance to Chapter 6.0
SECOTP2D	For each flow field, SECOTP2D (1) combines the flow results with material and transport parameters that affect radionuclide transport in the Culebra, (2) calculates the concentration of radionuclides everywhere in the local domain as a function of time, and (3) calculates the integrated discharge across user-defined boundaries. The conceptual model implemented by SECOTP2D for the performance assessment is discussed in Section 6.4.6.2.
SOTERM	This appendix describes the actinide source term for the WIPP performance calculations in Chapter 6.0. The source term is defined by the sum of dissolved actinide species and mobile colloidal actinide species. Appendix SOTERM establishes the mobile concentration of actinides that may be released from the repository in brine.
TFIELD	GRASP-INV is used outside of the performance assessment. It generates a field of transmissivities in the Culebra for a regional scale for each of the *n* input vectors. The conceptual model implemented by these codes for the performance assessment is described in Section 6.4.6.2.

Chapter 7.0 describes the DOE's implementation of each of the assurance requirements contained in 40 CFR Part 191. Each of the six sections in this chapter describes one of the six assurance measures required by the disposal standards. In this chapter and associated appendices, the DOE describes its plans for active institutional controls, passive institutional controls, multiple barriers, and monitoring. In addition, the chapter addresses the resource disincentive requirements of 40 CFR § 191.14 and waste removal. Chapter 7.0 is supported with numerous appendices that contain analyses needed for certification. Appendix MON describes the rationale for the monitoring program and addresses the criterion for an analysis of sensitive disposal system parameters to identify candidates for monitoring. Appendix WRAC includes a waste removal feasibility study mandated by the certification criteria. Similarly, Appendix EBS includes the mandated engineered barrier study. Other supporting appendices include Appendices AIC, BACK, D&D, DMP, EMP, EPIC, GTMP, LMP, GWMP, PIC, SA, SMP, and VCMP. Each is summarized in Table 1-7.

Chapter 8.0 describes the DOE's compliance with the individual and groundwater protection requirements in 40 CFR Part 191. Some combinations of sampled parameter values resulted in extremely small releases to the accessible environment within the marker beds in the Salado under undisturbed conditions. These releases are evaluated for compliance to the individual protection and groundwater protection standards and are shown to comply.

Chapter 8.0 is supported by Appendix USDW, which fulfills the criterion to identify underground sources of drinking water in the vicinity of the controlled area, as well as by Appendices GENII and SCR. These are summarized in Table 1-8.

Chapter 9.0 summarizes the results of peer reviews relevant to this application. The certification criteria mandated that the DOE perform peer reviews of the conceptual models,

Table 1-7. Appendices That Support Chapter 7.0 and Their Relevance

Appendix	Relevance to Chapter 7.0
AIC	This appendix includes the DOE's plans for active institutional controls that will be used immediately following facility closure. The appendix provides the rationale for the design and the details of the various measures that the DOE intends to take for active institutional control. Active institutional controls are summarized in Section 7.1.
BACK	A backfill consisting of MgO has been defined for the WIPP facility as an engineered barrier. It substantially delays the movement of radionuclides by limiting their solubility. Its configuration is defined in Chapter 3.0. This appendix contains background information on its purpose and distribution. Backfill fulfills the requirement for implementing the concept of multiple barriers in Section 7.4.
DMP	This appendix contains the Delaware Basin drilling activity surveillance program as described in Section 7.2. This program will focus on those drilling activities whose changes over time may impact the disposal system. These may include drilling rates, drill diameters, and borehole plugging practices.
D&D	The DOE has prepared an initial decommissing and decontamination (D&D) plan for the facility. This plan is in this appendix. A final plan will be prepared just prior to final closure and will reflect the condition of the facility at the time of closure. Documents and regulations applicable to D&D are included in this appendix. This activity precedes active institutional controls as discussed in Section 7.1.
EBS	The DOE performed a study of engineered barriers in accordance with the criteria in 40 CFR Part 194. The final report of this study is contained in this appendix. This study was peer reviewed and those results are summarized in Chapter 9 and Appendix PEER. This supports the concept of multiple barriers in Section 7.4.
EMP	The WIPP EMP is included in Appendix EMP. It describes the ongoing environmental sampling activities at the WIPP site. Results are reported annually. The EMP encompasses all possible environmental pathways along which humans may be exposed to radionuclides. Media sampled include groundwater, surface water, soil, air, airborne particulate, penetrating radiation, vegetation and other biota. The EMP is one monitoring activity that the DOE has committed to continue until after final facility closure. This supports monitoring discussions in Section 7.2.
EPIC	This appendix provides the DOE's rationale for taking credit for 700 years of passive institutional controls in the calculation of the performance of the disposal system. This means that the likelihood of an inadvertent intrusion during this period of time is significantly diminished by active and passive institutional controls. This appendix supports the discussion of passive institutional controls in Section 7.3.
GTMP	This appendix contains the geotechnical surveillance program that the DOE currently operates at the WIPP site and plans to continue to operate as part of the preclosure monitoring system as discussed in Section 7.2. The program will focus on observations of excavation effects such as creep closure and stresses that are useful in detecting deviations in expectations for near-term disturbed rock zone development.

Table 1-7. Appendices That Support Chapter 7.0 and Their Relevance (Continued)

Appendix	Relevance to Chapter 7.0
GWMP	This appendix contains the groundwater surveillance program that the DOE currently operates at the WIPP site and plans to continue to operate as part of the pre- and postclosure monitoring system as discussed in Section 7.2. The program will focus on those characteristics of the Culebra, Magenta Member of the Rustler, and Dewey Lake whose changes over time may be diagnostic of changes in the disposal system. These include water salinity and water levels.
IRD	This appendix supports the discussion in Section 7.5 and documents that the DOE considered natural resources and their impact during site selection and characterization. This discussion, along with the analysis of disposal system performance in Chapter 6.0, shows that the favorable features of the WIPP compensate for any increased risk from the presence of resources.
MON	The DOE has conducted an analysis of the significant performance assessment parameters to determine which, if any, are candidates for monitoring. This analysis is included in this appendix along with the details of how the DOE has selected the parameters that will be subject to monitoring and the rationale for the monitoring methods that are planned as discussed in Section 7.2.
PIC	This appendix contains the DOE's design for passive institutional controls as discussed in Section 7.3. This involves a defense in depth approach that includes monuments, markers, records and archives in addition to continued federal control of the land. The details of the designs and messages to be used are provided.
SA	The final step in the Monte Carlo process is to perform a sensitivity analysis. This is included in this appendix. The sensitivity analysis is used in the process of identifying those parameters that are candidates for monitoring as discussed in Section 7.2.
SMP	This appendix contains the subsidence surveillance program that the DOE plans to operate as the postclosure monitoring system as discussed in Section 7.2. This program monitors subsidence. Subsidence predictions will be compared to actual measurements to investigate any potential deviations that may indicate a change in repository performance.
VCMP	This appendix describes the volatile organic compound confirmatory monitoring plan that will be used to evaluate the efficacy of panel closures. The DOE believes that these measurements may provide information regarding the gas generation process and creep closure processes in closed panels as discussed in Section 7.2.
WRAC	This appendix contains a feasibility study for the removal of most of the waste from the disposal system at some time in the future as discussed in Section 7.6. Conventional mining techniques, coupled with remote-handled (RH) technology, are discussed to show that, even with today's technology, such removal would be possible at any time after facility closure.

the waste characteristics analysis, and the engineered barrier study. In addition, the DOE conducted four other peer reviews. Each of these is discussed along with the findings and recommendations of the peer panels and how the DOE has responded to these findings. Appendix PEER provides details of WIPP peer review activities. Table 1-9 summarizes this appendix.

Table 1-8. Appendices That Support Chapter 8.0 and Their Relevance

Appendix	Relevance to Chapter 8.0
GENII	This appendix contains the code manuals for the numerical codes used to calculate the doses to human receptors as the result of releases to the accessible environment.
SCR	FEPs that have been identified for the WIPP site region are screened for inclusion in the analysis of undisturbed performance. Appendix SCR documents the screening process and decisions. Those FEPs that are determined to be relevant are discussed in Chapter 6.0 in terms of their implementation into the conceptual model. The undisturbed performance analysis in Chapter 6.0 supports Chapter 8.0.
USDW	The criteria in 40 CFR Part 194 mandate a map showing the location of any underground source of drinking water within the vicinity of the controlled area as discussed in Chapter 8.0. This appendix includes an analysis of the available groundwater information and concludes, based on limited information, that there are three possible underground sources of drinking water near the WIPP controlled area. One is in the Dewey Lake, another is in the Santa Rosa, and the other is in the Culebra.

Table 1-9. Appendices That Support Chapter 9.0 and Their Relevance

Appendix	Relevance to Chapter 9.0
PEER	This appendix includes the details of the peer reviews that are discussed in Chapter 9.0. Included are the results of the peer panels deliberations, comments, and DOE responses.

1.6 Statement for the Purposes of 40 CFR Part 194, Subpart A

The DOE has not proposed any alternate provisions to the criteria in 40 CFR Part 194. The Secretary of the DOE has designated the CAO Manager as the appropriate contact with regard to matters associated with this application and applications for recertification. Should any changes occur that significantly affect the assertions and demonstrations in this application, the DOE will inform the EPA in a timely manner and in accordance with the criteria in 40 CFR § 194.4(b)(3).

The major participants in the WIPP program include the DOE, the Scientific Advisor, the WIPP Management and Operating Contractor, and the Management and Operating Contractors at eight major TRU waste generator and storage sites. Access to any site can be gained through the appropriate DOE CAO contact as shown in Table 1-10. The DOE CAO requests that all contact with the generator and storage sites be initiated through the CAO because the DOE has given the CAO management responsibility for all aspects of the TRU waste disposal program.

Table 1-10. Major WIPP Participants and Points of Contact

Name	Location	Point of Contact
DOE Carlsbad Area Office	Carlsbad, NM	Manager, CAO (505) 234-7300
Sandia National Laboratories	Carlsbad, NM	Assistant Manager, Office of Regulatory Compliance (505) 234-7486
Westinghouse Electric Corp.	Carlsbad, NM	Manager, National TRU Program (NTP) (505) 234-7456
Richland Hanford Site	Richland, WA	Manager, NTP (505) 234-7456
Idaho National Engineering Laboratory	Idaho Falls, ID	Manager, NTP (505) 234-7456
Lawrence Livermore National Laboratory	Livermore, CA	Manager, NTP (505) 234-7456
Los Alamos National Laboratory	Los Alamos, NM	Manager, NTP (505) 234-7456
Nevada Test Site	Las Vegas, NV	Manager, NTP (505) 234-7456
Oak Ridge National Laboratory	Oak Ridge, TN	Manager, NTP (505) 234-7456
Rocky Flats Environmental Technology Site	Golden, CO	Manager, NTP (505) 234-7456
Savannah River Site	Aiken, SC	Manager, NTP (505) 234-7456

1.7 Documentation Incorporated by Reference

In accordance with the provisions of 40 CFR § 194.13, the DOE has incorporated the computer code documentation specified in 40 CFR § 194.23 and data records supporting the parameters listed in Appendix PAR into this application by reference. This documentation consists of numerous quality assurance records packages that are filed in the Sandia WIPP Central Files (SWCF). A list of the packages incorporated by reference is provided in Appendix CODELINK and in references to data packages found throughout Appendix PAR. Incorporation by reference is used for the information in these records packages because of their large volume. The DOE will provide copies of the information extracted from QA records, which are incorporated by reference, upon request. In addition, 40 CFR § 194.14(g) requests information regarding the collection of radiological baseline data. This information has been reported by the DOE in the annual site environmental reports for calendar years 1985, 1986, 1987, 1988, and 1989. These reports are also incorporated into this application by reference. The specific titles of these reports are listed in Appendix RBP. Ten copies of these reports are being provided to the EPA. The DOE is also providing the EPA with copies of scientific and technical literature references and other materials used as sources of additional information that supports this application. These are listed as references at the end of each chapter. Ten copies of these materials are provided, as available, to facilitate the EPA's review of the application.

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