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Nuclear Waste Policy Act
(Section 113)

Site Characterization Plan

Yucca Mountain Site, Nevada Research and Development Area, Nevada

Volume I, Part A

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Chapters 1 and 2

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INTRODUCTION

The Nuclear Waste Policy Amendments Act of 1987 (the Amendments Act), which amended the Nuclear Waste Policy Act of 1982, has directed the U.S. Department of Energy (DOE) to characterize the Yucca Mountain site as a candidate site for the first geologic repository for radioactive waste. The characterization of a site is a program of studies directed at collecting the geologic information necessary to demonstrate the suitability of a site for development as a repository, to design the repository and the waste package, to prepare an environmental impact statement, and to obtain a construction authorization from the NRC. This program will be conducted in accordance with this site characterization plan (SCP), which has been prepared by the DOE in accordance with the requirements of Section 113(b)(1)(A) of the Nuclear Waste Policy Act, as amended. The purpose of the SCP is to summarize the information collected to date about the geologic conditions* at the site; to describe the conceptual designs for the repository and the waste package; and to present the plans for obtaining the geologic information necessary to demonstrate the suitability of the site for a repository, to design the repository and the waste package, to prepare an environmental impact statement, and to obtain from the U.S. Nuclear Regulatory Commission (NRC) an authorization to construct the repository.

This introduction begins with a brief section on the process for siting and developing a repository, followed by a discussion of the pertinent legislation and regulations. A description of site characterization is presented next; it describes the facilities to be constructed for the site characterization program and explains the principal activities to be conducted during the program. Finally, the purpose, content, organizing principles, and organization of this site characterization plan are outlined, and compliance with applicable regulations is discussed.

THE PROCESS OF REPOSITORY DEVELOPMENT

For the convenience of the reader, this section summarizes the process of repository siting, construction, operation, closure, and decommissioning. The discussion includes the types of waste to be received at the repository and the principal interactions with the NRC.

The siting of a repository

Yucca Mountain is one of three sites that had been selected for site characterization before the enactment of the Amendments Act. The other two sites were the Deaf Smith County site in Texas and the Hanford site in the state of Washington. These sites had been selected in a siting process that

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*In this introduction, the term "geologic conditions" encompasses the geoengineering, hydrologic, geologic, geochemical, climatological, and meteorological conditions at the site, and the term "geologic information" is used in a general sense to refer to all the information that will be obtained from the site characterization program described in this plan.

had started in the late 1970s and culminated with the publication of environmental assessments that evaluated their suitability as potential sites for repositories. The Amendments Act directed the DOE to characterize only one of the sites--the Yucca Mountain site in Nevada--and to stop siting activities at the other two sites.

When site characterization has been completed, the DOE will determine whether the Yucca Mountain site is suitable for a repository. If the site is suitable, the Secretary of Energy will recommend to the President that the site be developed as a repository. This recommendation will be accompanied by an environmental impact statement prepared in accordance with the requirements of Section 114(f) of the Nuclear Waste Policy Act, the National Environmental Policy Act (NEPA), and DOE guidelines for NEPA implementation. If the President considers the site to be qualified for application for a construction authorization, the President will submit the recommendation to the Congress.

If the Yucca Mountain site is recommended to the Congress by the President, the State may submit, within 60 days, a notice of disapproval to the Congress. This disapproval prevents the use of the site for a repository unless the Congress passes a joint resolution of repository-siting approval within the next 90 days of continuous session. If no notice of disapproval is submitted or if a notice of disapproval is overturned by the joint resolution, then the site designation becomes effective. If the notice of disapproval is not overturned, then the disapproval stands, and the DOE will await further instructions from the Congress.

However, if the DOE determines at any time that the Yucca Mountain site is unsuitable for development as a repository, then the Secretary of Energy will terminate all site characterization activities at the site; notify the Congress, the Governor of Nevada, and the legislature of Nevada of the termination and the reasons therefore; and within 6 months, report to the Congress recommendations for further action to ensure permanent waste disposal, including the need for new legislative authority.

The Amendments Act also specifies that the State of Nevada is eligible to enter into a benefits agreement with the DOE, and this benefits agreement is to be negotiated in consultation with affected units of local government. If the benefits agreement is negotiated, the DOE will make payments to the State of Nevada in accordance with a specified schedule. However, the benefits must include the provision that the State of Nevada will waive its right to submit a notice of disapproval to the Congress.

In addition, the Amendments Act establishes the Office of the Nuclear Waste Negotiator, who is to attempt to find a State or Indian Tribe willing to host a repository at a technically qualified site on reasonable terms. The negotiator may seek to enter into negotiations with the State of Nevada.

The construction, operation, closure, and decommissioning of a repository

When the site designation becomes effective, the DOE will seek from the NRC authorization to construct the repository by submitting a license application. The Nuclear Waste Policy Act, as amended, requires that this license application be submitted not later than 90 days after the effective

date of the site designation. The license application will contain a description of the site, a description of the design of the repository and the waste package, and an assessment of the performance of the entire mined geologic disposal system--that is, the site and the natural barriers at the site, the repository, and the waste package--with respect to applicable regulatory performance objectives. The NRC will review the application and decide whether to authorize the construction of the repository. When a construction authorization has been received from the NRC, the construction of the repository will begin.

When the repository is ready for operation, the DOE will submit an updated application to the NRC for a license to receive and possess radioactive material at the site. When this license has been received, the repository will begin to receive and emplace waste.

The Act specified that the waste accepted by the first repository cannot exceed the equivalent of 70,000 metric tons of heavy metal (MTHM) until a second repository becomes operational. Most of this waste (more than 60,000 MTHM) will consist of spent nuclear fuel from commercial power reactors. The remainder will consist of defense high-level waste and a small quantity of commercial high-level waste. Both the defense and the commercial high-level waste will be solidified into borosilicate glass before acceptance by the DOE.

After being filled to capacity, which is expected to take about 25 yr from the start of waste emplacement, the repository will be kept open for a period of time (up to 25 yr) in order to determine that the repository is performing as expected and the emplaced waste need not be retrieved. The DOE will then submit to the NRC an application for a license amendment that will allow it to permanently close the underground facilities of the repository and to decommission the surface facilities. When closure is completed, the DOE will apply for a license amendment to terminate the license.

REGULATIONS FOR GEOLOGIC DISPOSAL

As directed by the Nuclear Waste Policy Act, geologic repositories are subject to, and guided by, regulations promulgated by the U.S. Environmental Protection Agency (EPA), the NRC, and the DOE. More specifically, the scope and the content of the site characterization program are dictated by the information needed to demonstrate compliance with these regulations for site selection and licensing.

Primary standards and technical criteria

The primary standards for geologic repositories are concerned with protecting the health and safety of the public from the hazards of the waste to be emplaced in the repository; they have been promulgated by the EPA in 40 CFR Part 191. The key provisions of these standards are contained in Subpart B of 40 CFR 191. They specify (1) a limit on the amount of radioactivity that may enter the environment for 10,000 yr after disposal, (2) limits on the radiation dose that can be delivered to any member of the public for 1,000 yr after disposal, and (3) requirements for the protection of ground water. The U.S. Court of Appeals for the First Circuit has vacated and remanded to the EPA for further proceedings the environmental standards in

Subpart B of 40 CFR 191. Some of the plans described in this SCP were specifically designed to furnish data needed for demonstrating compliance with those standards as promulgated by the EPA in 1985. The basic information needed to demonstrate compliance with any disposal standards eventually promulgated by the EPA is expected to remain substantially the same, and therefore the approach to testing set forth in this SCP is expected to remain substantially the same. Nevertheless, any changes that may be made by the EPA to its standards will be evaluated by the DOE to ensure that the planned testing program will be adequate.

The EPA standards are implemented and enforced by the NRC regulations in 10 CFR Part 60. These regulations consist of (1) procedures for the licensing of geologic repositories and (2) technical criteria to be used in the evaluation of license applications under those procedural rules. The procedural portion of 10 CFR Part 60 provides specific requirements for a site characterization program and the associated site characterization plan. In addition to requiring that the EPA standards be met, the technical criteria of 10 CFR Part 60 provide a number of performance objectives. Among these requirements are the NRC radiation-protection standards contained in 10 CFR Part 20, design criteria for the surface and underground facilities of the repository, and three additional requirements: a minimum lifetime for the waste package, a limit on the release rate from the engineered barriers of the repository, and, for the natural system at the site, a minimum time of ground-water travel from the disturbed zone to the accessible environment.

DOE siting guidelines

As required by the Nuclear Waste Policy Act, the DOE has developed guidelines for nominating and recommending sites for characterization and selecting sites for the development of repositories. Promulgated as 10 CFR Part 960, they are referred to here as the "siting guidelines." The siting guidelines are based on both the EPA and the NRC regulations.

The siting guidelines are divided into implementation guidelines, postclosure guidelines, and preclosure guidelines. The implementation guidelines are not directly used in the evaluation of sites; their purpose is to specify how the postclosure and preclosure guidelines are to be applied in site screening and selection. The postclosure guidelines govern the siting considerations that deal with the long-term performance of a repository--that is, performance after waste emplacement and repository closure. The preclosure guidelines govern the siting considerations that deal with the siting, construction, operation, and closure of the repository.

SITE CHARACTERIZATION

Before the Yucca Mountain site can be judged suitable for development as a repository, it will be necessary to demonstrate that its long-term performance is likely to meet or exceed the established standards. In order to do this, extensive geologic data describing the site must be collected in a program of site characterization. Such a program is required by the Nuclear Waste Policy Act, as amended, by 10 CFR Part 60, and by the siting guidelines.

The Nuclear Waste Policy Act defines site characterization as "activities, whether in the laboratory or in the field, undertaken to establish the geologic condition and the ranges of parameters of a candidate site relevant to the location of a repository, including borings, surface excavations, excavations of exploratory shafts, limited subsurface excavations and borings, and in situ testing needed to evaluate the suitability of a candidate site for the location of a repository, but not including preliminary borings and geophysical testing needed to assess whether site characterization should be undertaken."

The activities planned for site characterization consist primarily of surface-based field studies, the construction of an exploratory shaft facility, and the tests conducted in that facility.

The field studies will be directed at obtaining information on the geologic, hydrologic, geochemical, climatologic, and engineering characteristics of the site and the surrounding area through exploratory drilling and testing, the testing of rock and water samples, geophysical surveys, and mapping.

To provide access for detailed study of the potential host rock as well as the overlying strata, the DOE will construct an exploratory shaft facility. The exploratory shaft facility will consist of (1) two exploratory shafts that will provide for access to the host rock, the transport of people and equipment, and ventilation; (2) underground testing areas; and (3) surface facilities needed to support construction and testing.

The exploratory shafts will be sunk to approximately the level where the underground facilities of a repository would be built. At this level they will be connected to one another and to underground testing areas. The shafts and the underground testing areas will be used to conduct tests and make observations and measurements of site conditions. The tests will be started during the construction of the exploratory shafts and will be continued in the exploratory shaft facility.

In conducting the site characterization program, care will be taken to reduce adverse environmental and socioeconomic impacts. As reported in the final environmental assessment (DOE, 1986b), no significant adverse impacts are expected to result from site characterization. Nonetheless, the DOE will monitor site characterization activities that might have significant environmental and socioeconomic impacts and, to the extent practicable, will implement mitigation measures if necessary. Plans to monitor and mitigate those impacts have been developed in consultation with the State of Nevada. Those plans are not part of this document; they will be issued separately.

The environmental and socioeconomic effects of the repository will be addressed in an environmental impact statement (EIS) to be issued after site characterization. Before beginning to prepare the EIS, the DOE will hold scoping hearings to provide the general public an opportunity to present issues to be considered in the EIS. In support of the EIS, the DOE will conduct a site investigation program to collect the nongeologic information needed to determine the suitability of the site and to prepare the license application for submittal to the NRC. Included in this program will be studies of environmental conditions (e.g., air and water quality, terrestrial

and aquatic ecosystems, noise); archaeological, cultural, and historical resources; and the social and economic conditions in the area that could be affected by the repository. The environmental and socioeconomic studies to be conducted will be described in other planning documents.

THE SITE CHARACTERIZATION PLAN

Before beginning to sink the exploratory shafts, the DOE is required by the Nuclear Waste Policy Act (Section 113(b)(1)(A)) to prepare a site characterization plan (SCP). This plan is to be submitted to the NRC as well as the Governor and the legislature of the State of Nevada; it is also to be made available to the public. Furthermore, the DOE is required to hold public hearings in the vicinity of the Yucca Mountain site to inform the residents of the area about the SCP and to receive their comments.

Purpose and objectives

The basic purpose of the SCP is threefold:

1. To describe the site, the preliminary designs of a repository and a waste package appropriate to the site, and the waste-emplacement environment in sufficient detail that the basis for the planned site characterization program can be understood.

2. To identify the uncertainties and limitations on the site- and design-related information developed during site screening, to identify the issues to be resolved during site characterization and the information needed to resolve the issues, and to present the strategy for resolving the issues.

3. To describe general plans for the work, including performance confirmation, needed to (a) resolve outstanding issues and (b) reduce uncertainties in the data.

In this context, "issues" are defined as questions related to the performance of the geologic disposal system that must be resolved to demonstrate compliance with the applicable Federal regulations. The issues, which have been organized into a hierarchy, and the strategy for their resolution are discussed later in this section.

The SCP will provide the NRC, the State of Nevada, and the public with a vehicle for early input on the DOE's data-gathering and development work so as to avoid postponing issues to the point where modifications would entail major delays in, or disruptions of, the program. Early review of the plans presented in the SCP will provide an opportunity for the NRC to comment on whether the DOE's proposed program is likely to generate the data necessary for a license application.

The issues hierarchy and the issue resolution strategy

The issues that must be resolved to demonstrate the compliance of the disposal system with the applicable Federal regulations have been organized into a hierarchy, and this hierarchy served as one of the basic organizing principles for the site characterization program. The second principle is a

strategy for resolving each issue. An understanding of these principles is helpful in following the discussions in the rest of this document; this section therefore discusses them briefly.

The issues hierarchy, which is described in more detail in a recent DOE report (DOE, 1986c), is a multitiered framework that lays out what must be known before a site can be selected and licensed. In providing this information, each tier contains progressively more detail than the tier above it. On the first, or highest, tier are the four "key issues." Stated as questions, they are derived from the system guidelines in the DOE siting guidelines; they therefore embody the principal requirements established by the regulations governing repositories. Affirmative answers to the key issues will be necessary if a site is to be selected and licensed.

Each of the key issues is followed, in the second tier, by two groups of issues related to performance and design. Also stated as questions, these issues expand on the requirement stated in the key issue they represent. When each group of issues was constructed, an effort was made to include in the group all the questions that must be answered to resolve the key issue.

The third tier consists of "information needs." Unlike the key issues and issues, the information needs are stated as requirements for technical information, rather than as questions. In constructing the information needs, the DOE attempted to list all the information necessary for resolving the issues. In principle, then, acquiring all the information called for at the third tier of the issues hierarchy will allow all the issues to be resolved through analyses and evaluations that use the information. If the issues are resolved affirmatively, the key issues will also have been resolved.

The issues hierarchy is useful in site characterization because it furnishes a framework for developing the test program and for explaining why the test program is adequate and necessary. In simple terms, the test program will be adequate if it adequately addresses all the information needs in the third tier of the issues hierarchy. And the necessity for any particular planned test can be established by determining its role in supplying an information need. For these reasons, the issues hierarchy is used as an organizing principle for Chapter 8 of this plan, which describes the site characterization program.

To use the issues hierarchy effectively, the DOE has adopted a formal strategy for resolving issues. This strategy, discussed in detail in Chapter 8, guides the development of specific plans for resolving each issue and provides the rationale for the associated site characterization activities.

The strategy begins with the identification of regulatory requirements, the development of the issues hierarchy from these requirements, and the preparation of a detailed description of the proposed geologic disposal system. The next part is a process called "performance allocation." It leads to detailed specifications of the information needed to resolve each issue and hence to plan for the investigations and studies that will produce the needed information. The issue resolution strategy then proceeds with the investigations and with analyses of their results until it is possible to

show that the information needs have been satisfied. The collected information is used in a concluding set of analyses to resolve the issues, and the resolution is documented.

Scope

In accordance with Section 112(b)(2) of the Nuclear Waste Policy Act, scoping hearings were held in the State of Nevada in March 1983. The purpose of these hearings was to receive comments and recommendations with respect to the issues that should be addressed in the environmental assessment and the SCP.

The comments received from the public and the State were categorized in the report of the public hearings panel according to the document wherein the comments would be addressed. The comments from the public hearings were considered during the preparation of the SCP. The comments that are addressed in the SCP are tabulated in Section 8.2.1.2, Tables 8.2-3 and 8.2-4, and a correlation is provided to the appropriate SCP section where the technical concerns raised by the comments are addressed.

Regulatory requirements for the content of the SCP

The requirements of the Act. Section 113(b)(1)(A) of the Nuclear Waste Policy Act requires that the DOE prepare a general plan for site characterization activities. The plan is to include the following:

1. A description of the candidate site.

2. The extent of planned excavations during site characterization.

3. Plans for any onsite testing with radioactive or nonradioactive material.

4. Plans for any activities that may affect the capability of the candidate site to isolate the waste.

5. Plans to control any adverse, safety-related impacts from site characterization activities.

6. Plans for the decontamination and decommissioning of the candidate site and for the mitigation of any significant adverse environmental impacts caused by site characterization activities if the site is determined to be unsuitable for a repository.

7. Criteria to be used to determine the suitability of the candidate site for the location of a repository, developed pursuant to Section 112(a).

8. Any other information required by the NRC.

In addition, Section 113(b)(1)(B) requires a description of the waste package and relationship between the waste package and the site, and waste package activities being conducted by the DOE. Section 113(b)(1)(C) requires a conceptual repository design for the site.

Items 1 and 6 in the list above seem to be self-explanatory, but items 2, 3, 4, 5, and 7 may require some explanation and are briefly discussed below. Item 8 is included in the subsequent discussion of NRC requirements.

The extent of planned excavations (item 2 in the list above) is of interest for several reasons. First, some of the excavations at the site--that is, the exploratory shafts--will extend to the depth of the repository and, if not constructed properly, may adversely affect the waste-isolation potential of the site. Second, of the activities carried out during site characterization, the construction of shafts has the greatest potential for environmental impacts. In addition, the extent of planned excavations is related to the information about the host rock that can be collected in the exploratory shaft facility.

The use of radioactive materials (item 3) is of concern because of the potential for releases to the environment. The DOE does not currently plan to use radioactive materials in site characterization except as follows. Some activities will use well-logging tools that contain radioactive materials and are commonly used in geologic and hydrologic exploration. After these tools have been removed, no radioactive material will be left behind at the site. The use of appropriate nonradioactive tracers will be evaluated during site characterization.

Plans for any investigation activities that may affect the waste-isolation capability of the site (item 4) are of concern because, if the waste-isolation capability is unduly compromised, the site may be found to be unsuitable for a repository. Related to this requirement is item 5 in the list above, which asks for plans to control adverse safety-related impacts. The NRC has interpreted this to mean adverse impacts that are related to safety during the preclosure period of repository operations and to waste isolation after the closure of the repository (10 CFR 60.17(a)(2)(iv)).

The requirement for criteria to determine site suitability (item 7) refers to the siting guidelines developed by the DOE pursuant to Section 112(a) of the Act and promulgated as 10 CFR Part 960. One of the objectives of site characterization is to collect the data necessary to demonstrate that the site meets the guidelines.

NRC requirements. Specifications for the content of the SCP are also presented in 10 CFR 60.17. These specifications are essentially the same as those of the Nuclear Waste Policy Act. However, as allowed by Section 113(b)(1)(A)(v) of the Act (item 8 in the list above), the NRC has specified in 10 CFR 60.17 the following additional requirements:

1. In describing the candidate site, the SCP is to include information on the quality-assurance programs that were applied to the collection, recording, and retention of the information used in preparing the description (10 CFR 60.17(a)(1)).

2. The SCP is to present plans for the application of quality assurance to data collection, recording, and retention during site characterization (10 CFR 60.17(a)(2)(v)).

3. The description of plans for the use of radioactive materials is to include the use of radioactive tracers.

Regulatory Guide 4.17. To facilitate compliance with the requirements for the SCP, the NRC has prepared Regulatory Guide 4.17, Standard Format and Content of Site Characterization Plans for High-Level-Waste Geologic Repositories (NRC, 1987). The guide suggests the types of information to be provided in the SCP and establishes a uniform format for presenting the information. The DOE considered this guidance in developing the Annotated Outline for Site Characterization Plans (DOE, 1987), which has been reviewed by the NRC staff, who agreed that it was acceptable for the preparation of the SCP.

Organization of the site characterization plan and compliance with regulatory requirements

In preparing the SCP, the DOE made every effort to comply with the content requirements of the Nuclear Waste Policy Act and 10 CFR Part 60. The discussion that follows explains how the SCP is organized and how it meets the regulatory requirements discussed above. Table 1 presents the regulatory requirements and shows which sections of the SCP provide compliance with each particular requirement.

In preparing this SCP, the DOE has also made every effort to provide the detailed information that is identified in NRC Regulatory Guide 4.17 and that has been requested by NRC staff in a number of DOE-NRC meetings. As a result, this SCP provides considerably more information than the "general plan" required by the Act and by 10 CFR Part 60. The additional information has been provided to allow for a comprehensive review of DOE's site characterization program by the NRC, the State of Nevada, and the public.

The SCP is divided into two parts: Part A, which provides a description of the site, the waste package, and the design of the repository, and Part B, which presents the DOE's plans for the site characterization program.

Part A consists of an introduction and seven chapters. The introduction describes the geographic setting of the site and discusses sources of information and the history of site investigations. Chapters 1 through 5 discuss the available information about the site. Their objective is to comply with the requirements of Section 113(b)(1)(A)(i) and (v) of the Nuclear Waste Policy Act and 10 CFR 60.17(a)(1).*

In particular, Chapter 1 presents the data collected to date on the geologic conditions; Chapter 2 discusses the geoengineering properties of the rock units at the site; Chapters 3 and 4 discuss the hydrologic and geochemical conditions, respectively; and Chapter 5 addresses climate and meteorology. Each chapter concludes with a summary whose purpose is to link the data and analyses presented in the chapter with the issues hierarchy and

*The quality assurance requirements of 10 CFR 60.17 are addressed in Section 8.6 of the SCP.

Table 1. Compliance of the site characterization plan with regulatory requirements

Requirement	Section of the Act	Paragraph in 10 CFR 60	SCP chapter or section
1. Description of the candidate site	113(b)(1)(A)(i)	60.17(a)(1)	Chapters 1-5
2. Information on quality assurance programs that have been applied to the collection, recording, and retention of information used in preparing the description of the site	Not applicable	60.17(a)(1)	8.6.4.1
3. Description of site characterization activities, including--	113(b)(1)(A)(ii)	60.17(a)(2)	8.3, 8.4
3a. Description of the extent of planned excavations	113(b)(1)(A)(ii)	60.17(a)(2)(i)	8.4.2
3b. Plans for any onsite testing with radioactive material and nonradioactive material	113(b)(1)(A)(ii)	60.17(a)(2)(ii)	8.3.1.2.3[a]
3c. Plans for investigations that may affect the waste-isolation capability of the site	113(b)(1)(A)(ii)	60.17(a)(2)(iii)	8.4.2
3d. Plans to control adverse safety-related impacts	113(b)(1)(A)(ii)	60.17(a)(2)(iv)	8.4.2
3e. Plans to apply quality assurance to data collection, recording, and retention	Not applicable	60.17(a)(2)(v)	8.6.4.2

Table 1. Compliance of the site characterization plan with regulatory requirements (continued)

Requirement	Section of the Act	Paragraph in 10 CFR 60	SCP chapter or section
4. Plans for decontamination and decommissioning and the mitigation of significant adverse environmental impacts	113(b)(1)(A)(iii)	60.17(a)(3)	8.7
5. Criteria to be used to determine site suitability	113(b)(1)(A)(iv)	60.17(a)(4)	8.3.5.6, 8.3.5.7, 8.3.5.18
6. Description of the waste package and associated activities	113(b)(1)(B)	60.17(b)	Chapter 7, 8.3.4, 8.3.5
7. Conceptual repository design	113(b)(1)(C)	60.17(c)	Chapter 6, 8.3.2, 8.3.3

[a]No radioactive materials will be used in site characterization except as noted in the text. Nonradioactive materials are described in the referenced sections.

site characterization program presented in Part B. This summary, therefore, (1) summarizes the significant results, discussing, as appropriate, performance objectives, conceptual models and boundary conditions, and the quality of the data, including uncertainties; (2) describes how the data are related to the design of the repository and the waste package; and (3) identifies the information needs for the issues hierarchy (Part B). In addition, the summaries of Chapters 1 through 5 present a synopsis of the information that is requested by Regulatory Guide 4.17 but has not been shown to be relevant to the Yucca Mountain site. The uncertainties in the data presented in Chapters 1 through 5 were used in identifying the information needed to resolve the issues and in developing the plans presented in Part B.

The last two chapters in Part A are concerned with the conceptual design of the repository (Chapter 6) and the waste package (Chapter 7). Their objective is to comply with the requirements of Section 113(b)(1)(B) and (C) and 10 CFR 60.17(b). Each begins with an introduction that explains the purpose of the chapter, provides an overview of the current design concepts, and shows which SCP chapters contain the data on which the design is based and which chapters use or discuss the information presented in Chapter 6 or 7. Like the preceding chapters, Chapters 6 and 7 conclude with a summary

section that links the design of the repository and the waste package, respectively, to the issues hierarchy and the site characterization program of Part B by providing a summary of design issues and related information needs. Chapter 6 presents the design basis for the repository, describes the conceptual design, discusses the information needed for the later phases of the design, and summarizes design issues. Chapter 7 describes what is currently known about the host rock in which the waste package will be emplaced, presents the design basis for the waste package, describes the current design and the alternatives that have been or are being considered, and discusses the status of research and development.

Part B, which consists of only one chapter (Chapter 8), describes the site characterization program. Its objective is to comply with the requirements of Sections 113(b)(1)(A)(ii), (iii), and (iv) of the Nuclear Waste Policy Act, Section 113 (b)(1)(B) of the Act, as well as 10 CFR 60.17(a)(2), (3), (4), and (5) and the quality assurance requirements of 10 CFR 60.17(a)(1) (see Table 1).

Part B begins with an introduction that provides an overview of the approach used in planning the site characterization program. The introduction is followed by the rationale for the site characterization program--namely, the issues hierarchy and the approach to issue resolution (Section 8.1). The next two sections are the most important components of Part B: Section 8.2 presents the site-specific issues hierarchy, whereas Section 8.3 presents the complete strategies for issue resolution and describes the investigations planned for the site; describes the design activities planned for the repository, the seals, and the waste-package programs; and describes the performance-assessment program. The purpose of the performance-assessment program is to determine whether the performance of the disposal system meets the requirements of the applicable Federal regulations. Section 8.4 presents the approach adopted by the DOE to guide the site characterization program, describes the characterization programs, and discusses the potential impacts of characterization activities on postclosure performance objectives. The remainder of Chapter 8 covers milestones, decision points, and schedules (Section 8.5); quality assurance (Section 8.6); and decontamination and decommissioning (Section 8.7).

Supporting documents

Numerous separate documents support the SCP by providing additional details concerning site data, design information, and plans for site characterization activities. The SCP, primarily in Chapters 1 through 7, presents relatively brief summaries of the data relevant to the site, much of which is obtained from organizational reports, professional papers, and other sources. Copies of the material that is summarized in Part A of the SCP will be made available in three locations. A full set of these references will be provided to the State of Nevada and to the NRC. The set of references will also be made available in the public reading room at the DOE Nevada Operations Office, located in Las Vegas, Nevada. One particular reference, the Site Characterization Plan-Conceptual Design Report (SCP-CDR) (SNL, 1987) merits specific discussion at this time. The Nuclear Waste Policy Act requires a conceptual design for the repository. While the SCP contains sufficient information to assess the relationships between the design and the site characterization program, the complete SCP-CDR contains detailed

information on aspects of the design not strictly relevant to site characterization. This information is, however, of interest in understanding the functions of the repository. Copies of the complete SCP-CDR will be provided in the same manner as the other references.

Section 8.3.1 of Chapter 8 of the SCP describes the site investigations to be conducted to obtain site data. More-detailed descriptions of the individual studies comprising each investigation will be provided in study plans. Study plans will be made available to the NRC staff, and will typically reference more detailed technical procedures.

Periodic progress reports on site characterization

During site characterization at the Yucca Mountain site, the DOE will report not less than once every 6 months to the NRC as well as the Governor and the legislature of the State of Nevada on the nature and extent of such activities, the information developed from such activities, and the progress of waste-form and waste-package research and development. These reports will include the results of site characterization studies, the identification of new issues, plans for additional studies to resolve new issues, the elimination of planned studies no longer necessary, the identification of decision points reached, and modifications to schedules where appropriate. The reports will also describe progress in developing the repository design, noting when key design parameters or features that depend on the results of site characterization will be established.

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(Section 113)

Site Characterization Plan

Yucca Mountain Site, Nevada Research and Development Area, Nevada

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Introduction References

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U. S. Department of Energy
Office of Civilian Radioactive Waste Management

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Nuclear Waste Policy Act
(Section 113)

Site Characterization Plan

Yucca Mountain Site, Nevada Research and Development Area, Nevada

Volume I, Part A

Part A, Mined Geologic Disposal System

December 1988

U. S. Department of Energy
Office of Civilian Radioactive Waste Management

INTRODUCTION

Part A of this site characterization plan (SCP) presents the research and exploration data compiled by the Yucca Mountain Project (formerly called the Nevada Nuclear Waste Storage Investigations Project) on the Yucca Mountain site during the site selection process. Conceptual designs for the proposed repository and waste package are also described. This information should be viewed as a preliminary step leading to, and providing a basis for, the site characterization investigations, studies, and design activities described in Part B. Performance assessment analyses discussed in Part B will determine whether a mined geologic disposal system can be constructed, operated, closed, and decommissioned to contain and isolate wastes without adverse effects to public health and safety.

Part A comprises seven chapters that provide information on the following topics:

1. Geologic, geomorphic, and geophysical characteristics of Yucca Mountain and the surrounding region.

2. Geomechanical and thermomechanical properties of the proposed host rock and its environment.

3. Hydrologic and hydrogeologic features of Yucca Mountain and the surrounding region.

4. Mineralogical, petrological, geochemical, and hydrochemical analyses of the Yucca Mountain area.

5. Present and past meteorological and climate data and analyses for the Yucca Mountain region.

6. Models and analyses used in previous and current site-investigation activities.

7. Preliminary conceptual repository and waste package designs appropriate for the present knowledge of the site.

Chapters 1 through 5 present the available data describing the physical characteristics of, and processes occurring at, the Yucca Mountain site and the surrounding region. Chapter 6 describes the preliminary conceptual design of the proposed repository, and Chapter 7 discusses investigations that have examined the expected waste-package environment and the proposed conceptual design for the waste package. The information in Part A is presented in sufficient detail to prepare the reader for the discussion of proposed site characterization activities in Part B.

GEOGRAPHIC SETTING OF THE CANDIDATE SITE

The Yucca Mountain site is located in southern Nevada about 160 km by road northwest of Las Vegas and is situated on land controlled by three Federal agencies: the U. S. Air Force, the U. S. Department of Energy (DOE), and the Bureau of Land Management. Yucca Mountain is in the southwestern Great Basin, which is a subprovince of the Basin and Range physiographic

province (Figure A-1). The area is characterized by long, north to northwest-trending mountain ranges that are separated by intermontane sediment-filled structural basins. Yucca Mountain is an irregularly shaped volcanic upland with elevations of about 1,500 to 1,930 m at the crest and about 650 m of relief (Figure A-2). The mountain is composed of eastward-dipping, volcanic and volcaniclastic strata broken into en echelon fault blocks. The climate of the Yucca Mountain area is considered arid with less than 10 in. (25 cm) of rain per year and no perennial streams in the general vicinity.

Favorable attributes of the proposed repository location include (1) the location of the target emplacement horizon in the unsaturated zone and the aridity of the region, which help ensure that minimal moisture will contact the waste packages; (2) the sorptive qualities of the strata underlying the target emplacement horizon; (3) the isolation of the location from major population centers; (4) few competing uses for the land; and (5) close proximity to the Nevada Test Site, which is already a federally regulated area.

The reader should be familiar with certain terms used throughout Part A to refer to various locations or boundaries associated with the Yucca Mountain site. Some of the terms may be used interchangeably. The following discussion of terms will assist the reader in understanding Part A.

Yucca Mountain is being considered for use as a mined geologic disposal system (MGDS), which is defined as a system, requiring licensing by the U. S. Nuclear Regulatory Commission (NRC), that is used for the disposal of high-level radioactive waste in excavated geologic media. The surface location, as indicated on a map, of the principal area that may be suitable for waste emplacement is known as the primary area. When projected downward along the location of faults and other geologic features, the boundary of the primary area encompasses the principal region within the target emplacement horizon that is considered potentially suitable for waste emplacement. The specific geologic stratum in which waste will be emplaced below the earth's surface is called the emplacement horizon. A portion of the Topopah Spring Member of the Paintbrush Tuff is currently the proposed emplacement horizon at Yucca Mountain. Target horizon may also be used in place of this term. Any system licensed by the NRC that is intended to be used for, or may be used for, the permanent deep geologic disposal of high-level radioactive waste and spent nuclear fuel is known as a repository, whether or not such system is designed to permit the retrieval, for a limited period during initial operation, of any materials placed in such system. This includes both surface and subsurface areas at which high-level radioactive waste and spent nuclear fuel handling activities are conducted. More specifically, a system that is intended to be used for, or may be used for, the disposal of radioactive wastes in geologic media is known as a geologic repository. A geologic repository includes (1) the geologic repository operations area, which is a facility for radioactive waste that includes both surface and subsurface areas and facilities, in which waste-handling activities are conducted and (2) the portion of the geologic setting that provides isolation of the radioactive waste and is within the controlled area. The development area is the underground area being prepared for emplacement of waste packages. Development includes excavating the emplacement drifts and boreholes, installing rock support in the drifts, and outfitting the emplacement boreholes with liners and covers.

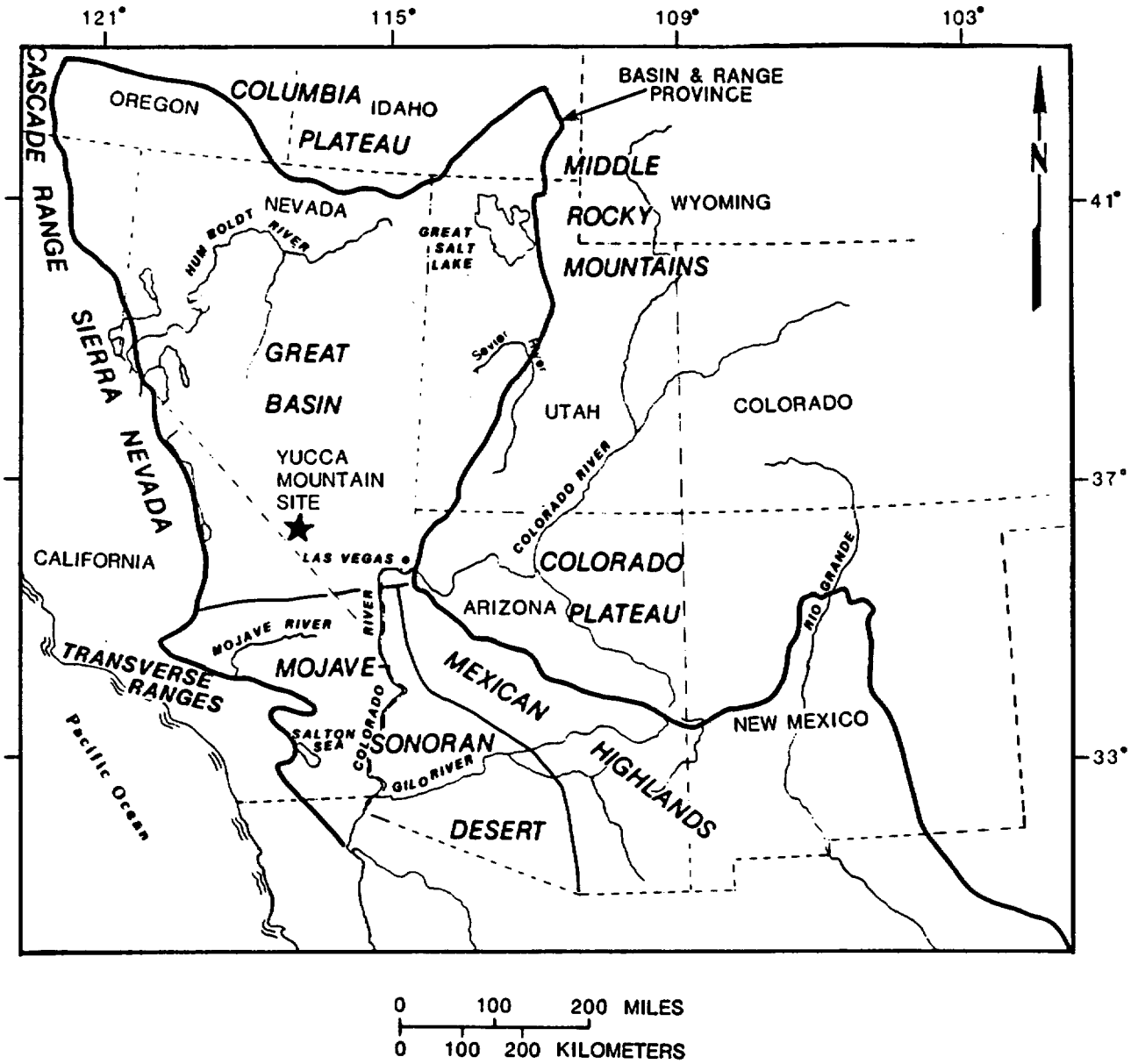

Figure A-1. Boundaries and larger subprovinces of the Basin and Range physiographic province (Hunt, 1974). Province boundary is indicated by heavy solid line. Salton Trough subprovince of southern California and Sacramento Mountains subprovince of central New Mexico are not shown.

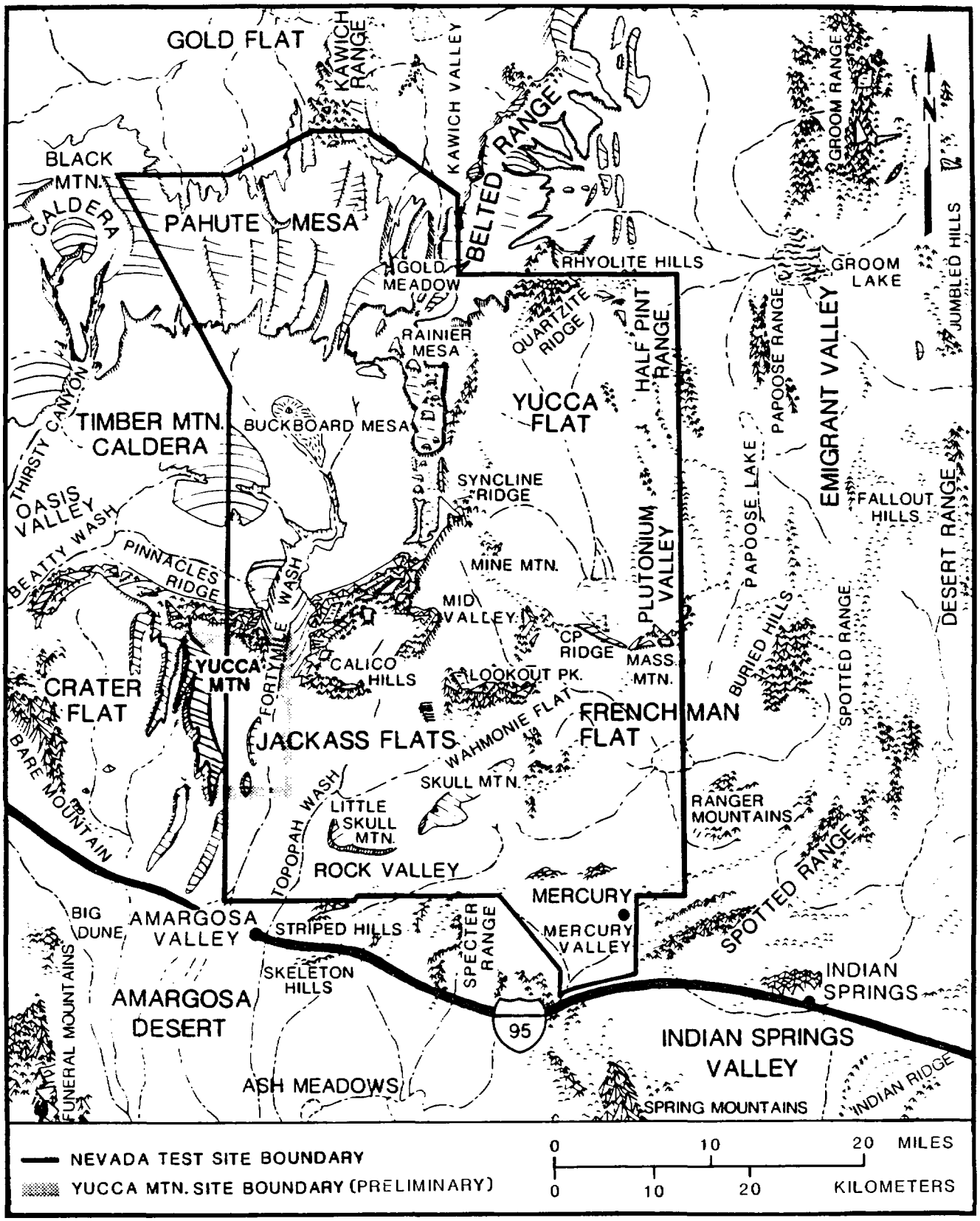

Figure A-2. Physiographic features of Yucca Mountain and surrounding region (DOE, 1986).

The underground facility includes the underground structure, openings, and backfill materials, but excluding shafts, boreholes, and their seals.

The controlled area is a specific location, to be identified by passive institutional controls, that encompasses no more than 100 km^2 and extends no more than 5 km in any direction from the outer boundary of the original locations of the radioactive waste in a disposal system plus the subsurface underlying such a surface location. The term "site" is often used when referring to the controlled area, however, specific boundaries for the Yucca Mountain site have not been determined, and site boundaries shown on maps in this document should be considered preliminary and subject to change. The place, both at and below the surface, where the repository and ancillary facilities are constructed is called the repository site. This area includes the disturbed zone and the surrounding buffer zone, and has a surface area of several square kilometers. The atmosphere, the land surface, surface water, oceans, and all of the lithosphere that is beyond the controlled area is referred to as the accessible environment.

The candidate site is an area, within a geohydrologic setting, that is recommended for site characterization by the Secretary of Energy under Section 112 of the Nuclear Waste Policy Act of 1982, approved for characterization by the President under Section 112, or undergoing site characterization under Section 113 (NWPA, 1983). The hydrogeologic study area is delimited by the boundaries of the regional ground-water flow system that surrounds Yucca Mountain. The boundaries and subdivisions of this study area are shown in Figure A-3. The regional surface-water system that encompasses Yucca Mountain is called the hydrographic study area. Figure A-4 illustrates the boundaries of this study area.

SOURCES OF INFORMATION AND HISTORY OF SITE INVESTIGATIONS

Part A presents research and exploration data compiled during the site-selection process. The site-selection process is discussed in Chapter 2 of the Yucca Mountain environmental assessment (DOE, 1986). Part A contains information from research and exploration activities conducted directly by the Yucca Mountain Project, as well as data from other investigations of the characteristics of the Yucca Mountain region. The data and interpretations presented in Part A are available in separate program documents or data sets that have been released to the public.

Geologic investigations

During the past 80 years, the region surrounding Yucca Mountain has been the subject of numerous investigations. These studies have been conducted in support of mineral and energy resource exploration, nuclear-weapons testing, and other DOE activities at the Nevada Test Site. Studies of the Nevada Test Site region by the Yucca Mountain Project to aid the DOE in the site-selection process for the first repository began in late 1977. These investigations have included literature reviews of existing published data; 182 drillholes and 23 trenches within 10 km of the site; 53 seismic stations for recording earthquake data at, and within 160 km of, Yucca Mountain; geothermal and geophysical logging of drill holes; regional geophysical investigations; and detailed geologic mapping of the site area.

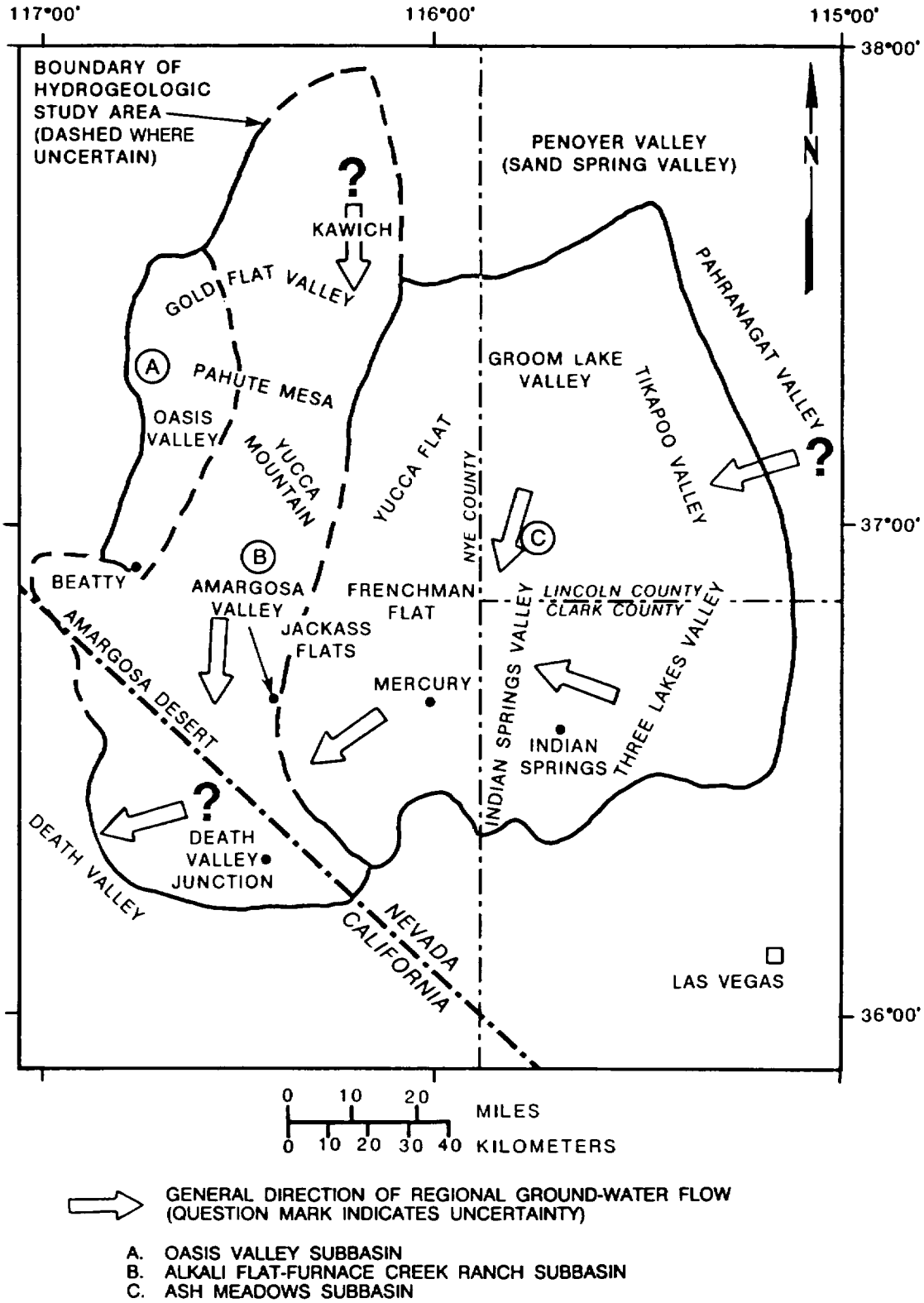

Figure A-3. Hydrogeologic study area, showing three ground-water subbasins. Modified from Rush (1970), Blankennagel and Weir (1973), Winograd and Thordarson (1975), Dudley and Larsen (1976), Waddell (1982), and Waddell et al. (1984).

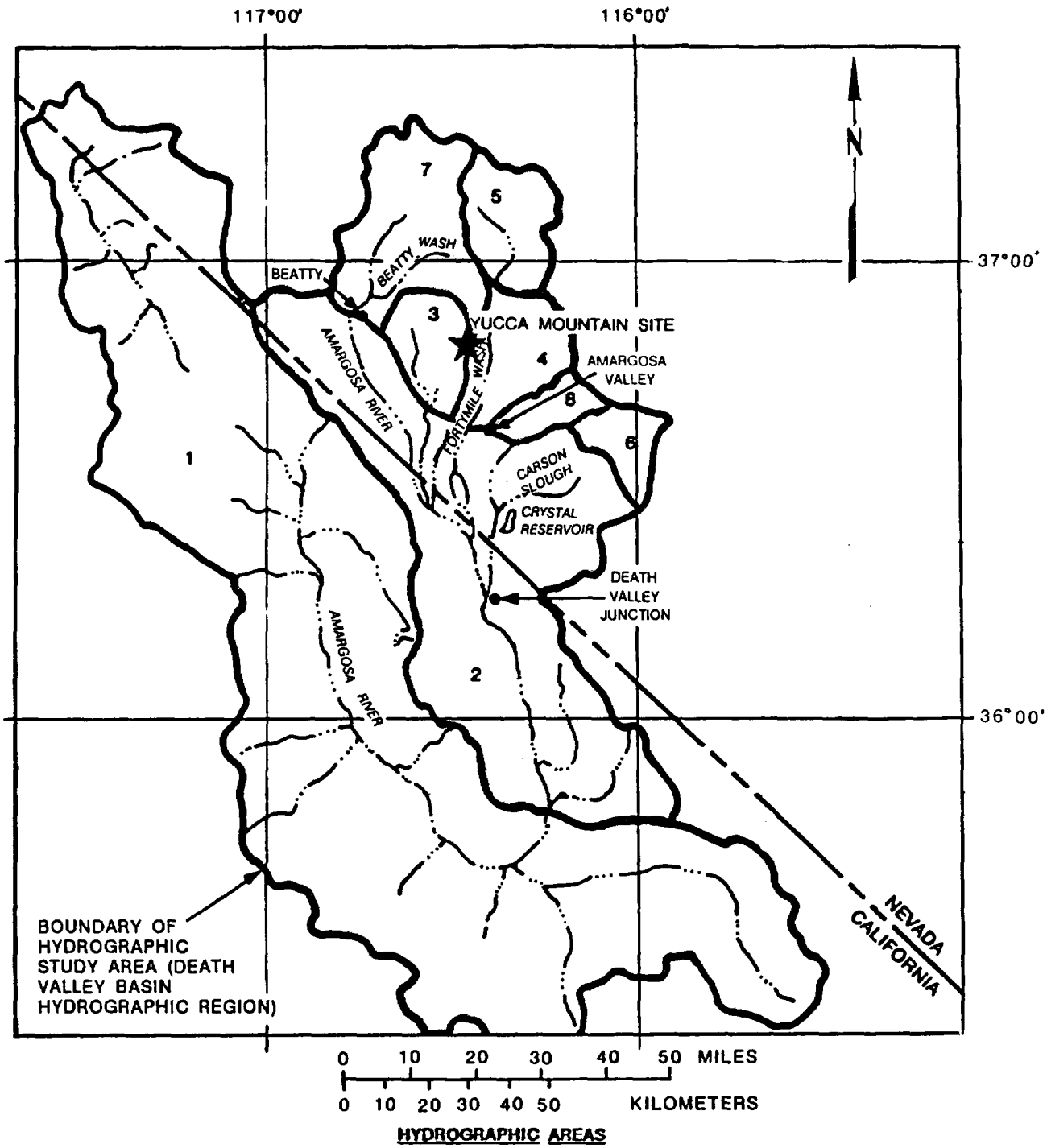

Figure A-4. Hydrographic study area, showing the eight hydrographic areas and major intermittent streams.

Geoengineering investigations

When the Yucca Mountain Project (formerly called Nevada Nuclear Waste Storage Investigations (NNWSI) Project) began, no site-specific samples were available for studying the effects of parameter variation on the mechanical properties of tuff. Laboratory data developed under the Yucca Mountain Project consist of test results on core samples from boreholes at Yucca Mountain, outcrops of the Topopah Spring Member (the proposed emplacement horizon), and an underground test facility in G-Tunnel at Rainier Mesa (Figure A-2) on the Nevada Test Site. The current data base was derived primarily from tests performed on relatively small-diameter core (approximately 6 cm). This data base consists of approximately 100 thermal-conductivity tests, 300 thermal-expansion tests, 75 mineralogical-petrological analyses, 700 bulk-property (porosity, density) measurements, and 350 mechanical-properties tests.

The field testing program in G-Tunnel has been a valuable part of the current design evaluation. The data and observations gathered from the Grouse Canyon Member of the Belted Range Tuff in G-Tunnel suggest this unit is a reasonable analog for the proposed emplacement horizon at Yucca Mountain in many aspects, including similar bulk, thermal, and mechanical properties; a similar degree and nature of fracturing; and a similar degree of saturation for geoengineering purposes; however, the hydrologic properties are substantially different. The overburden loading and openings dimensions are similar to those of the proposed repository.

Hydrologic investigations

Much of the preliminary data base is made up of regional hydrologic investigations performed since the 1960s for ground-water resource appraisals and evaluations of the hydrologic system at the Nevada Test Site done since the late 1950s. There have been few studies of surface waters because of the general aridity and the ephemeral nature of streamflow in the area. Most of the hydrologic information about the Yucca Mountain site has been obtained by Yucca Mountain Project studies since 1978. The emphasis of the studies shifted from the saturated zone to the unsaturated zone when the advantages of locating the proposed repository in the thick unsaturated zone became apparent.

Data on flooding and streamflow in ephemeral stream channels throughout Nevada have been collected since the 1960s. While data collection at many sites was discontinued in 1980, several sites near Yucca Mountain have been reactivated to support the Yucca Mountain Project work, and the surface-water investigations network in the Yucca Mountain region has been expanded. Since 1981, hydrogeologic test holes up to 1.8 km deep have been drilled into the saturated zone. Tests have been performed to determine hydrogeologic parameters such as depth to water table, total water yield, hydraulic conductivity, transmissivity, and water chemistry, including apparent carbon-14 ages of some samples. Multiple-well tests to determine effective porosity and the nature and extent of the permeability contributed by fractures are continuing. Beginning in 1983, test holes deeper than 300 m were drilled into the unsaturated zone. These boreholes allowed the determination of hydrogeologic properties from the recovered core and the monitoring of ambient water

saturation, potential, and flux in the rocks above, below, and within the proposed emplacement horizon.

Geochemical investigations

Geochemical information about the Nevada Test Site region has been collected for some time in support of the nuclear testing program. Much additional information has been collected since late 1977 for the Yucca Mountain Project. Information from sources other than the Yucca Mountain Project has been used primarily to aid interpretations or to confirm more recent data.

The geochemical data base compiled for the Yucca Mountain Project has been obtained from the examination of samples taken from the surface or at depth from Yucca Mountain and vicinity. Samples examined to determine mineralogy and petrology have come from drill cores, sidewall samples, drill cuttings, and surface outcrops. Ground-water samples have been taken from wells in the vicinity to characterize water chemistry. In addition to compiling a geochemical data base, laboratory experiments have been conducted to evaluate the stability of geochemical conditions and the effects of waste emplacement on geochemical conditions. Processes investigated include sorption, speciation, precipitation of waste elements, natural colloid formation, radiolysis, solubility, dissolution, diffusion, retardation, transport by both water and gas, hydrothermal alteration, and effects of the thermal pulse due to waste emplacement.

Climatological and meteorological investigations

Meteorological data have been collected in the Yucca Mountain region at Beatty since 1922 and at the town of Amargosa Valley since 1949. Meteorological data collection in support of the DOE activities at the Nevada Test Site has been ongoing since the late 1950s. Additional meteorological stations at different elevations near Yucca Mountain have been added since 1983 in support of the Yucca Mountain Project. Meteorological data that are currently being collected and calculated include wind speed and direction, standard deviation of wind direction, temperature and temperature difference due to elevation, net radiation, standard deviation of vertical wind speed, precipitation, relative humidity, and dew point.

Information regarding paleoclimatic conditions is required to evaluate the potential for future climate changes. Records of meteorological conditions for the Quaternary Period do not exist; however, climatological proxy data that give indications of the climatic conditions that existed in the Yucca Mountain region during the Quaternary have been collected and analyzed. These data include the analysis of packrat middens for information regarding past vegetation; the analyses of the chemistry, sediments, fossils, and fossil pollen from cores of lacustrine or paludal deposits; and the analysis of paleolake-level variations. These dated records can provide estimates of past climatic fluctuations and indications of potential future climatic changes can be obtained from these estimates.

DEFINITIONS OF DESIGN PHASES

The four design phases as used in this document have specific meanings. The conceptual design phase concentrates on the surface and underground system, structure, emplacement, and component designs that require site characterization data and provides the information to ensure that data-gathering plans related to design are adequately included in the SCP. Data-accuracy requirements are established and site-specific licensing issues related to site characterization are identified. This phase is called the SCP conceptual design in this report.

The advanced conceptual design phase presents the selected design alternatives and refines and fixes the design criteria and concepts to be made final in later design efforts. This design forms the basis for demonstrating project feasibility and estimating life-cycle costs. Preliminary drawings are prepared and a construction schedule developed as required by DOE Order 6410.1 (DOE, 1983).

The license application design presents the resolution of design and licensing issues identified and assessed in earlier design phases and develops the design of the items necessary to demonstrate compliance with the design requirements and performance objectives of 10 CFR Part 60.

The final procurement and construction design will develop the final (working) drawings and specifications for procurement and construction. The completion of this design phase will match the completion of the Title II design effort for the entire repository. This design phase will emphasize the completion of design and ancillary support items, final design refinement for the items necessary to demonstrate compliance with the design criteria and performance objectives of 10 CFR Part 60, the development of construction bid packages for all systems, and the development of final procurement and construction schedules.

SCOPE AND STATUS OF DESIGN WORK

As mentioned previously, Chapters 1 through 5 present the data and results of previous investigations and analyses concerning the geology, geoengineering, hydrology, geochemistry, and climatology and meteorology of the Yucca Mountain site. This information was instrumental in developing the conceptual designs for the repository and waste package discussed in Chapters 6 and 7. Studies discussed in Part B are planned to supplement and expand the current data base. As the data base is modified or expanded in the future, the conceptual designs found in Chapters 6 and 7 may be refined or changed after this report is released.

Site characteristics that have the principal effects on facility design are geology, geoengineering, hydrology, and geochemistry. Some information on meteorology was used in the siting of the surface facilities. The purpose of the conceptual design is to establish project feasibility, identify site characteristics that would be needed for future design efforts, and to obtain a preliminary cost estimate for facility construction and operation. The conceptual design is a preliminary design that serves as a basis for deciding

whether to proceed to subsequent design phases and helps to guide the gathering of information for later design phases. Design concepts may be refined and design details will be provided in later phases of design.

The conceptual design phase produced a conceptual design report (SNL, 1987) that is summarized in this SCP. This design phase, concentrated on design features of the surface repository, underground repository, special waste-emplacement and retrieval equipment, waste-emplacement envelope, and waste package that require site characterization data. The conceptual design also provided input into the plans described in Part B to ensure that adequate information will be gathered to complete the remaining design phases. The conceptual designs described in Chapters 6 and 7 satisfy the requirements of the Nuclear Waste Policy Act of 1982, Section 113(b)(1)(C) (NWPA, 1983).

In establishing the basic characteristics and configurations of the repository engineered barriers, the conceptual design presented in Chapter 6 accomplished two purposes:

1. Delineation of those structures, systems, and components important to safety and isolation that are necessary to receive, process, transport, and permanently store radioactive waste in an underground facility.

2. Identification of needed information relative to both the design data base and the methods available for the engineering design of the repository.

Three overall capabilities must be considered in designing and operating the repository. The repository must be designed to safely emplace waste, retain the option to retrieve waste, and provide for the long-term containment and isolation of the waste.

Design elements of the repository shown in Figure A-5 include the following:

1. The main surface facilities that will be built on gently sloping terrain at the eastern base of Yucca Mountain. The surface facilities would be segregated into (a) the waste-receiving and inspection area, (b) the waste-operations area, and (c) the general support facilities area.

2. The shafts and ramps. Two exploratory shafts would initially be used for construction of the exploratory shaft facility. If the proposed repository is built, these shafts will be used as fresh air intakes, one for the waste emplacement area and one for the shops in the emplacement area and the decontamination area. Two 20-ft (6-m) diameter shafts would be constructed, one to provide access for men and materials and air intake for the development area and one to be the exhaust shaft for the emplacement area. Two ramps would be built: the waste ramp would allow transport of the waste packages to the underground facilities and the tuff ramp would be used for excavation of the underground facility and for removing excavated tuff.

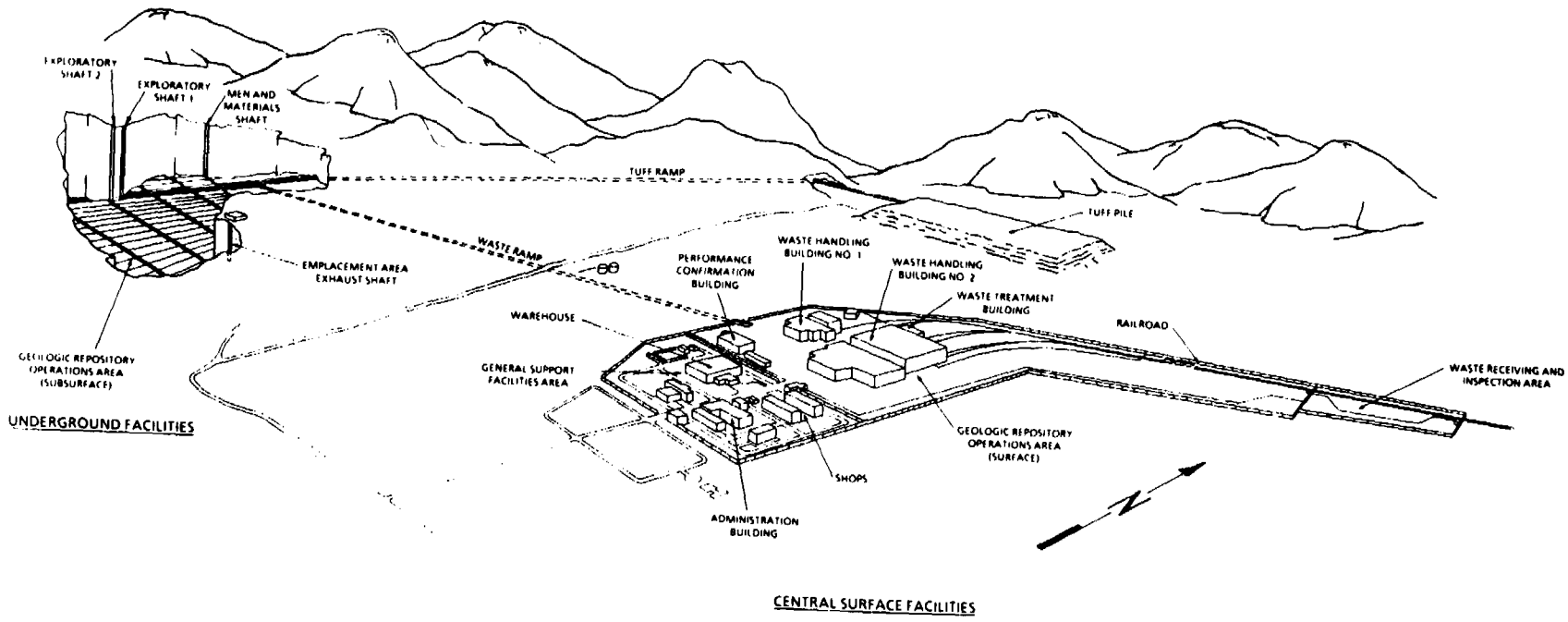

Figure A-5. Tuff repository perspective.

3. Underground facilities that will be located in the unsaturated zone in the Topopah Spring Member of the Paintbrush Tuff at least 657 ft (200 m) below ground level and will have an area of about 1,400 acres (570 hectares). Three parallel main entry drifts are planned to extend southwest through the underground facility to provide access to the emplacement panels during the development and emplacement phases. The 18 emplacement panels will be approximately rectangular and approximately 1,400 ft (430 m) wide, parallel to the main drifts, and 1,500 to 3,200 ft (460 to 980 m) long, perpendicular to the main drift. The panels will be divided into emplacement drifts with a midpanel drift to provide ventilation during development or retrieval.

Chapter 7 describes the conceptual design for the waste package. The purpose of the Yucca Mountain Project waste-package program is to develop a waste package for the disposal of spent fuel and high-level nuclear waste in a repository in tuff that will demonstrably meet the performance requirements established in 10 CFR Part 60.

Waste packages consist of two components: (1) the waste form, which includes any structures, canisters, or other means of encapsulation or stabilization, and (2) the container, which surrounds the individual waste form. American Iron and Steel Institute 304L stainless steel is the reference waste-package material for the current conceptual design. Different conceptual designs for containers have been developed for the various types of radioactive wastes and are discussed in Chapter 7.

Before 1982, waste-package research and development was conducted on a generic basis by the National Waste Terminal Storage program, rather than on a media-specific basis by the Yucca Mountain Project. When the emphasis of the Project shifted to the consideration of a repository in the unsaturated zone, the direction of research development and testing was modified to accommodate the appropriate site-specific environmental conditions. Four main categories of activities regarding the waste package have been conducted by the Project since 1982. These categories are (1) waste-package environment; (2) waste-form and materials testing; (3) design, analysis, fabrication, and prototype testing; and (4) performance assessment.

Construction of a repository and the emplacement of waste that generates heat and radiation will cause changes in the waste-package emplacement environment. A thorough understanding of these effects is needed to design and predict the performance of the waste package. This category includes activities that characterize the hydrothermal reactions between tuff and ground water and the rates and mechanisms of dehydration and rehydration of the rock adjacent to the emplacement boreholes.

Waste-form and materials testing involves measurement of radionuclide release rates to provide input for modeling efforts; determination of whether a packing material must be incorporated into the waste-package design; selection of candidate metals for fabrication of containers; characterization of the corrosion rates of these materials under expected conditions; and evaluation of the effects that other materials associated with the repository might have on the performance of the waste form and container materials.

Design, analysis, fabrication, and prototype testing involves the development and testing of waste-package designs that are compatible with repository design.

Performance assessment involves development and validation of models for use in predicting waste-package performance. The development of advanced computer codes for modeling geochemical processes in the repository environment is a part of this activity.

SUMMARY

In addition to presenting the research and data gathered to date, Part A also briefly identifies information needed to satisfy regulatory guidelines or to fully characterize the site. The absence or sparseness of site-specific data in certain technical areas results in varying degrees of uncertainties on the current data base. Site characterization activities are planned to help decrease these uncertainties and to improve the data base for the resolution of issues. Part B presents the detailed identification of the needed information, deriving the needs from the regulatory requirements, which are embodied in a formal hierarchy of issues. Part B also discusses the currently planned studies, tests, analyses, and design work needed to characterize the site. Part A identifies the applicable sections in Part B that discuss the planned work.

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(Section 113)

Site Characterization Plan

Yucca Mountain Site, Nevada Research and Development Area, Nevada

Volume I, Part A

Part A References

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Office of Civilian Radioactive Waste Management

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