

HQO.871130.0025

Office of Civilian Radioactive Waste Management



***Annotated Outline for
Site Characterization Plans
(OGR/B-5)***

April 1987

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

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***U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Washington, DC 20585***

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FOREWORD

The Nuclear Waste Policy Act of 1982 (NWPA) requires that site characterization plans (SCPs) be submitted to the Nuclear Regulatory Commission (NRC), affected States and Indian Tribes, and the general public for review and comment prior to the sinking of shafts at a candidate repository site. The SCP is also required by the NRC licensing procedures contained in 10 CFR 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories." The NRC has additionally provided guidance to the DOE for the preparation of SCPs in the form of Regulatory Guide 4.17 (RG 4.17, "Standard Format and Content of Site Characterization Plans for High-Level-Waste Geologic Repositories," Proposed Revision 1, dated September 1984).

The annotated outline (AO) that follows provides the DOE's standard format and guidance for the preparation of SCPs. It has been developed primarily for the use of the DOE and its contractors to aid in the preparation of SCPs to a common format. Although the AO differs to some extent from RG 4.17, it is considered to be consistent to the maximum extent practicable with the intent of the regulatory guide and the philosophy contained therein. There are some format differences between the AO and RG 4.17; however, there are very few content differences. These format changes include such things as combining discussions for clarity and ease of reference, moving discussions to sections believed to be more appropriate, and making format revisions, such as in Chapters 4, 6, and 8. The format and content changes are clearly indicated in a correlation of the AO with RG 4.17 that is included as Attachment A.

Chapters 1 through 7 form Part A of the SCP (Description of the Mined Geologic Disposal System), and Chapter 8 forms Part B (Site Characterization Program), which is consistent with RG 4.17. Provision for an unnumbered introduction, which is to contain important background information, is also included.

INTRODUCTION TO ANNOTATED OUTLINE

The Nuclear Waste Policy Act of 1982 (NWSA) requires the preparation of a site characterization plan (SCP)¹ prior to the initiation of shaft construction at any candidate repository site (Sec. 113(b)). The SCP is also required by the Nuclear Regulatory Commission (NRC) licensing procedures for the disposal of high-level waste as contained in 10 CFR Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories." As part of the precicensing procedures, the Department of Energy (DOE) is required to submit an SCP to the NRC and the States for a particular geologic repository operations area prior to sinking shafts. The basic purpose of the SCP is simple: to provide a mechanism for identifying and delimiting the specific issues² at a proposed repository site³ and to identify the plans to obtain data for resolving those issues at an early time in order to avoid delays in the licensing process. As reflected in the logic sequence and organization of this Annotated Outline (AO) of Site Characterization Plans for High-Level-Waste Geologic Repositories, the SCP will accomplish the following objectives:

- Establish what is known about a site from site exploration activities completed to date
- Describe the issues that the DOE has identified at a site in light of the results of investigations to date
- Describe the detailed plans to obtain data to be used to resolve the issues identified.

¹As defined in 10 CFR Part 60, site characterization means the program of exploration and research, both in the laboratory and in the field, undertaken to establish the geologic conditions and the ranges of those parameters of a particular site relevant to the procedures under Part 60. Site characterization includes borings, surface excavations, excavation of exploratory shafts, limited subsurface lateral excavations and borings and in-site testing at depth needed to determine the suitability of the site for a geologic repository. It does not include preliminary borings and geophysical testing needed to decide whether site characterization will be undertaken.

²Issues are defined as questions that must be answered or resolved to complete licensing assessments of a site and design suitability in terms of 10 CFR 60 and 10 CFR 960. The role of issues in the Site Characterization Program are described in Chapter 8 of the AO.

³Site and other terms appearing in this Introduction have the meanings set forth in § 60.2 of 10 CFR Part 60, except that "mined geologic system" is used to refer to the total system that includes the site, the repository and the waste package.

Objective of Site Characterization

Site characterization will include exploration and research, both in the laboratory and in the field, to establish the geologic conditions at a site and the ranges of parameters that characterize the site. The objective of site characterization is to collect pertinent geological and other site characteristic information that will be needed for site selection and ultimately for a license application (i.e., sufficient information about a site to support a finding, prior to construction, of reasonable assurance that there is no unreasonable risk to public health and safety).

Objectives of Site Characterization Plan

The purpose of the SCP is to provide a document in which the DOE:

- Describes the site, design of a repository and engineered barriers appropriate to the site, waste packages, emplacement environment, and performance analysis in sufficient detail so that the planned site characterization program may be understood.
- Identifies the uncertainties and limitations on site- and design-related information developed during site screening, including issues that need further investigation or for which additional assurance is needed.
- Describes the detailed programs for additional work, including performance confirmation, to (1) resolve outstanding issues, (2) reduce uncertainties in the data, and (3) make site suitability findings relative to DOE siting guidelines, 10 CFR 960.

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

During the conduct of site characterization activities the DOE will report to the NRC Director of the Office of Nuclear Material Safety and Safeguards (NMSS) at least semiannually on the results of site characterization studies, including any new information that might affect the design assumptions concerning waste form and packaging and the planned repository itself. Such semiannual reporting will also include the identification of new issues, plans for additional studies to resolve these issues, the elimination of planned studies no longer necessary, and the identification of decision points reached and modifications to schedules, where appropriate.

Purpose, Applicability, and Use of this Annotated Outline (AO)

The purpose of this AO is to indicate the types of information that the DOE intends to include in the SCP in accordance with 10 CFR Part 60 and to establish a uniform format for presenting the information. Use of this format will help ensure the completeness of the information provided, will assist the NRC staff and others in locating the information, and will aid in shortening the time needed for the review process.

Any information collection requirements mentioned in this AO are exempt from the Paperwork Reduction Act (44 U.S.C. 3518(c)(1)), as stated in NRC Reg. Guide 4.17.

The AO is divided into an introductory chapter and two parts:

1. Part A provides guidance on the types of information needed to describe the site and the design (including the waste package and its emplacement environment) of a repository appropriate to the site. There is no threshold amount of data to be accumulated during the preliminary site exploration activities required prior to the submittal of an SCP. Rather, Part A provides guidance on how to submit information that is currently available.
2. Part B provides guidance on the presentation of the site characterization program, on the identification of information needs and unresolved issues, and on the plans to resolve these issues during site characterization.

The DOE will prepare Part B with the expectation that the NRC will look for answers to the following questions:

- Have the important information needs and unresolved issues been identified?
- Does the SCP specifically address these information needs and present program plans to obtain the needed information?
- Are the methods of testing and analysis proposed for the planned site characterization program appropriate?
- Have alternative methods of testing and analysis been identified and evaluated, and has an adequate basis been provided for the selection of the methods to be used?
- Will the data to be collected and the reliability of the collection methods and analysis be of adequate quality to support site selection and a future license application?
- Have the testing plans been based on the performance requirements for the Mined Geologic Disposal System (MGDS) components, and are the tests adequate to enable evaluation of whether or not the MGDS components will perform as required?

It is expected that the SCP will be principally evaluated by the NRC according to the completeness of Part B, its most critical part.

In developing Part B of the SCP, the DOE will focus attention on those aspects of siting, development of waste packaging, and the design of a repository appropriate to the site that may require the most effort in the site characterization program. While the SCP must be complete in developing the issues of site characterization, it is important -- particularly in initial planning phases -- that those issues considered critical or most important to site selection and licensing be identified and given highest priority in the SCPs.

The DOE intends that Part B will contain information about the planned tests at a level of detail sufficient to enable determination of whether adequate information for site selection and licensing will be produced. This information will include definitive descriptions of the parameters to be controlled and measured in planned tests, or analyses that show how the tests adequately bound the range of potential limiting conditions that are important to performance of the aspect of the repository being investigated. The word "definitive" is intended to: (1) connote explicit descriptions of test procedures, suitable for prelicensing consultation between DOE and NRC; and (2) recognize the maturation processes of a phased approach to testing which reflects and responds to the results of ongoing system performance assessments.

The DOE recognizes that the quality of data is virtually determined by the specific data-gathering methods and procedures that are used. In addition to questioning the relevancy and completeness of data supplied in the license application, the licensing process must explicitly address the question of whether or not the data are of adequate quality so that licensing determinations can be made with reasonable confidence. It is important, therefore, that specific methods to be used in data gathering and in the site characterization program be the subject of the prelicensing consultation between the DOE and the NRC.

The DOE program of site characterization will be a phased process. The depth of information provided may be determined considering the need for flexibility to account for the exploratory, developing nature of the investigations. Plans included in the SCP may be better defined and more detailed for early phases of site characterization (e.g., testing in the exploratory shaft) and less detailed for later phases (e.g., testing in an underground facility with two shafts). However, for testing currently being conducted or planned as the first stage of future investigations, definitive plans must be documented. As the DOE completes plans for later phases of site characterization, additional information will be provided to the NRC via semi-annual reporting or referenced in such reporting and provided through other mechanisms provided for under the Procedural Agreement between the NRC and the DOE entitled "Identifying Guiding Principles for Interface During Site Investigation and Site Characterization."

In any event, all site characterization plans for gathering the necessary information to conduct evaluations of site suitability and design acceptability that will accompany the license application, as well as the 10 CFR 960 site selection, will be addressed fully in the SCP for each site.

Identification of Agents and Contractors

The DOE project management organization will be identified, and the DOE technical projects and tasks will be described. Prime agents or contractors for site investigations, design, waste form and packaging research and development, and performance analysis will also be identified. The division of responsibility and lines of communication among these various parties will be delineated.

Supplemental Information

Detailed supplemental information not explicitly identified in this AO may be provided in appendices to the SCP. Examples include the following:

- Technical information in support of design features
- Reports furnished by consultants
- Summaries of how appropriate NRC regulations and guides were addressed
- Portfolios of maps.

In cases where only representative data (e.g., selected geophysical data from selected borehole logs) are submitted, the original raw data will be accessible either at the site or other appropriate locations and will be readily available to the NRC. Representative data will be of sufficient quality and quantity to permit an understanding of the nature and extent of the data actually available.

Style and Composition

The AO has been prepared to minimize duplication of information. Similar or identical information may be requested in various sections of the AO because it is appropriate to more than one portion of the SCP. In such cases, the information will be presented in the principal section and referenced appropriately in the other applicable sections.

The SCP will be prepared according to a DOE style guide in the following manner:

- Information will be presented clearly and concisely
- Claims of adequacy of designs or design methods will be supported with technical bases
- Units of measurement (both fundamental and derived) be given in the International System of Units (SI). If common industrial usage is in other units and the use of SI would be confusing, give the measurement in accepted units with SI units in parentheses

- The SCP will be completely consistent with the numbering system and headings of the AO
- Where numerical values are stated, the number of significant figures given will reflect the accuracy or precision to which the number is known. Where appropriate, estimated limits of error or uncertainty will be provided
- Abbreviations will be consistent with generally accepted usage throughout the SCP. Any abbreviations, symbols, or special terms not in general use will be defined when they first appear in the SCP
- Graphic presentations such as drawings, maps, diagrams, sketches, and charts will be used where the information can be presented more adequately or conveniently by such means or when the interpretation of data can be clarified. All information presented in drawings will be legible, symbols defined, and drawings not reduced to the extent that visual aids are necessary to easily interpret pertinent items of information presented in the drawings. When a series of maps is submitted, a common scale will be used whenever possible.

Bibliography

Bibliographic listings of documents or reports discussed in the SCP will appear at the end of the chapter in which they are mentioned. For each report or document (e.g., articles in professional journals) listed in the bibliography, the citation will include the author, the title, the report or document number, and the date of publication and/or of submittal to the NRC. For any reports that have been withheld from public disclosure as proprietary documents, nonproprietary summary descriptions of the general content of such report will also be included in the bibliography. In cases where proprietary documents were used to obtain information, nonproprietary summary of the document will be provided. In addition to documents and reports, bibliographic listings may include data on file at the site or project office (e.g., drill logs, hydrologic test data).

Physical Specifications

1. Paper Size

Text pages: 8-1/2 x 11 inches.

Drawings and graphics: 8-1/2 x 11 inches preferred; however, a larger size is acceptable provided the bound side does not exceed 11 inches, except where required for legibility, and the finished copy when folded does not exceed 8-1/2 x 11 inches.

2. Paper Stock and Ink

Suitable quality in substance, paper color, and ink density must be maintained for handling and reproduction by microfilming or image-copying equipment.

3. Page Margins

A margin of no less than 1 inch will be maintained on the top, bottom, and binding side of all pages.

4. Printing

Composition: will be single-spaced text pages.

Type font and style: must be suitable for microfilming.

Reproduction: may be mechanically or photographically reproduced. Text pages will preferably be printed on two sides with the image printed head to head.

5. Binding

Pages will be punched for standard 3-hole loose-leaf binder.

6. Page Numbering

Pages will be numbered with the two digits corresponding to the chapter and first-level section numbers followed by a hyphen and a sequential number within the section (i.e., the third page in Section 4.1 of Chapter 4 will be numbered 4.1-3). The entire report will not be numbered sequentially.

**ANNOTATED OUTLINE FOR
SITE CHARACTERIZATION PLANS**

INTRODUCTION

The introduction will provide an overall description of the background, purpose, and organization of the site characterization plan (SCP). It will demonstrate the purpose of the SCP by relating the SCP to the process by which the MGDS will be developed by the Department of Energy (DOE).

THE PROCESS OF REPOSITORY DEVELOPMENT

This section will summarize the process of repository siting, construction, operation, closure, and decommissioning. It will include a discussion of the types of waste to be received at the repository and the principal interactions with the Nuclear Regulatory Commission (NRC).

REGULATIONS FOR GEOLOGIC DISPOSAL

This section will discuss the regulations promulgated by the Environmental Protection Agency (EPA), the NRC and the DOE that affect the siting and licensing of repositories, and specifically, how these regulations dictate the scope and content of the site characterization program.

SITE CHARACTERIZATION

This section will define site characterization and provide an overview of the types of studies planned for surface-based and exploratory-shaft activities. It will refer to the environmental and socioeconomic studies that will be conducted concurrently with site characterization to collect the nongeologic information necessary to demonstrate the suitability of the site.

THE SITE CHARACTERIZATION PLAN

This section will provide an overview of the scope of the SCP. It will describe the requirements of the Act for the DOE to submit the SCP to the States, affected Indian Tribes, the NRC, and the public and to hold public hearings in the vicinity of the candidate site to receive comments on the SCP.

Purpose and objectives

This section will list the basic purposes of the SCP.

Content

This section will discuss the required contents of the SCP or refer to the documents that specify the content, such as Section 113(b)(1)(A) of the Act, 10 CFR Part 60, and the NRC's Regulatory Guide 4.17.

The issues hierarchy and the issue-resolution strategy

This section will describe two basic organizing principles--the issues hierarchy and the issue-resolution strategy. It will describe the relationship among key issues, issues, and information needs in developing the test program. This section will also discuss the general steps of the issue-resolution strategy.

Organization of the SCP

This section will describe the organization of Parts A and B of the SCP, the structure of each chapter, and the relationship of Parts A and B.

Supporting documents

This section will explain how a number of separate documents support the SCP by providing additional details about the site, the design of the repository, and plans for site-characterization activities. The relationships among the documents and the timing and availability of the documents will be described.

Periodic progress reports on site characterization

This section will describe the timing and the content of the periodic progress reports required by the Act.

PART A

**DESCRIPTION OF THE MINED
GEOLOGIC DISPOSAL SYSTEM**

INTRODUCTION TO PART A

The introduction to Part A will present the introductory information that is generally applicable to the seven chapters of this part, explaining where, when, and how the information reported in Chapters 1 through 5 was collected and giving general background information for Chapters 6 and 7. It will describe and illustrate with maps the geographic setting and location of the site, defining and explaining the terms "candidate area," "site," "study area," and any other location-related terms that are used in the SCP. It will describe and show on a map or maps the areas and locations of previous geologic, hydrologic, and meteorological studies (e.g., boreholes, seismic surveys, meteorological towers), presenting brief summaries on the types and numbers of field studies, laboratory analyses, etc. It will also summarize the history of site investigations. (The site-selection process should not be discussed; the discussion in the environmental assessment should be referenced instead.) In addition, the introduction to Part A will define terms common to Chapters 6 and 7 (e.g., "SCP conceptual design," "advanced conceptual design," "license-application design") and explain in general terms the scope and status of the design work reported in Chapters 6 and 7.

Chapter 1 - GEOLOGY

This chapter will provide a description of the geology of the candidate area and site. This information is needed to understand the relationship between the design of a repository appropriate to the specific site and the rationale for the proposed site characterization program. This chapter will also describe field and laboratory activities conducted in support of geologic studies as well as geologic data acquired from the literature. Sources of geologic information will be referenced at the end of this chapter.

1.0 INTRODUCTION

This section will introduce the site geology to indicate the role in the site characterization program of the material covered in the chapter. This section will cover in a brief introductory fashion:

- Summary remarks about how the presently available information has been obtained and plans for obtaining additional information,
- Summary remarks about how the information will be used.
- Discussions about the quality of present data and the sophistication of models which will use the data.

1.1 GEOMORPHOLOGY

The physiography, geomorphic units, and geomorphic processes for the candidate area and site will be described.

1.1.1 Physiography

The physiographic provinces in which the candidate area and site are located will be described, including areal relationships to surrounding provinces, distinguishing characteristics, and major active processes modifying the present-day topography of the provinces. This information will be provided by means of topographic maps of the candidate area and site, using appropriate scales and contour intervals to support other studies associated with this site. When available, representative ground-level photographs, vertical and oblique aerial photographs, and satellite imagery will be included.

1.1.2 Geomorphic Units

This section will describe the common land forms in the candidate area and the landforms at the site. Each geomorphic unit will be described giving its name, areal extent, distinguishing characteristics, and other pertinent information defined by factors such as relief and landform morphology. All units will be shown on a topographic map.

1.1.3 Geomorphic Processes

Geomorphic processes that could affect the ability of the site to isolate radioactive waste will be described and discussed from the perspective of past, present, and estimated future activity. While emphasis will be placed on present and Quaternary processes, information on older processes will also be given where it is useful for understanding present ground-water systems or predicting future changes, or where it may contribute to estimating the potential occurrence of future processes. The description of geomorphic processes will include (1) rate of activity, (2) frequency of occurrence and cycles, and (3) controlling mechanisms and factors.

1.2 STRATIGRAPHY AND LITHOLOGY

The stratigraphic framework of the candidate area and site will be described, including both surface and subsurface geology. Distinctions will be made between Quaternary and pre-Quaternary stratigraphic units.

1.2.1 Stratigraphic Framework of the Candidate Area

This section will describe all the major rock units in the candidate area. It will contain a geologic map of the candidate area that shows in sufficient detail the distribution of the major rock units described in this section.

The stratigraphic and lithologic characteristics of the candidate area will be described using geologic maps, representative lithostratigraphic columns, and cross sections. Lithostratigraphic sequences will be characterized, and for each lithostratigraphic sequence, major unconformities, ages, range of thickness, spatial extent, major rock units, and vertical and lateral variations will be described. This information will be used to compile and discuss the stratigraphic history and origin of the rock units, and will also contain an overall geologic time sequence (periods, epochs, and ages) for the rock units of the candidate area. Discussions will consider provenance, depositional and diagenetic processes, volcanism, plutonism, and metamorphism.

1.2.2 Stratigraphic Framework of the Site

This section will describe the lithology, lateral extent, thickness, origin, and age of all the formal and informal rock units at the site. It will contain a geologic map of the site (or reference another part of the SCP) that shows in sufficient detail the distribution of the rock units described in this section. The location of all stratigraphic test holes used to determine the site's stratigraphy will be indicated, and any other data that were used to determine the stratigraphy will be described. A variety of graphic displays may be used to illustrate salient features of the stratigraphic section (e.g., outcrop photos, core photos, portions of geophysical logs). For wells that have been cored, detailed information

regarding representative drillers logs, lithologic and geophysical logs, and core photographs, if available, will be provided through references.

Each lithostratigraphic unit description will include the following data:

- The unit name, using established nomenclature
- Lithologic and mineralogic composition of the unit
- Diagnostic physical and paleontological characteristics useful for identification and correlation (e.g., color, sedimentary structures, texture, fabric, trace element content, fossil content)
- Physical characteristics which may be significant to isolation of radioactive waste such as bedding, mineralogy, grain size, and porosity
- Geophysical characteristics or signatures, such as density, magnetic susceptibility, remnant magnetism, conductivity, and velocity profiles (surface and subsurface, including downhole)
- Vertical and lateral variation of composition and characteristics and comparison to surrounding units
- Thickness and spatial extent (using isopach maps, structure contour maps, or other appropriate presentation formats)
- Vertical and lateral relationships to surrounding rock units
- Age
- Origin and alteration history of the unit, including rock formation processes and models (deposition, intrusion, extrusion), and rock alteration processes and models (metamorphism and diagenesis).

1.3 STRUCTURAL GEOLOGY AND TECTONICS OF CANDIDATE AREA AND SITE

This section will describe the type, magnitude, and duration of structural and igneous events that have affected the candidate area and site through geologic time, and will emphasize the structural development of the candidate area and site during the Quaternary. In order to adequately evaluate the tectonic setting of, and formulate tectonic models for, the candidate area, the tectonics and structural geology of a larger surrounding region must also be investigated. For this reason, regional tectonic studies at a reconnaissance scale will be incorporated to determine the relationships between the candidate area and bounding structural provinces.

Tectonic elements of the candidate area and site will be defined and all structural elements described, with emphasis on those features which may create pathways from proposed repository depths to the accessible

environment. Structural measurements related to rates of deformation and features providing information about tectonic stability will be described. Appropriate tectonic models that describe both static and dynamic conditions will be included.

1.3.1 Tectonic Framework

This section will describe the type, magnitude, and duration of structural and igneous events that have affected the candidate area through geologic time and will emphasize the structural development of the candidate area and site during the Quaternary. Maps and cross sections showing major tectonic features of the candidate area and region will be included.

1.3.2 Tectonic History

This section will describe the structural and igneous development and tectonic setting of the candidate area through geologic time, with emphasis on Quaternary events. A description of the major structural features within the candidate area, such as folds, faults, and joints, and maps showing the regional distribution of these structural features and their relationships to the various rock units will be included. Where relevant, this section will include a discussion of contrasting theories on the structural development of the candidate area. The tectonic history will include the age and sequence of development of all major crystalline shields, sedimentary basins, uplifts, orogenic and fold belts, volcanics, major faults, and major joint sets.

1.3.2.1 Volcanic History

The volcanic history of a particular candidate area or site will be described when applicable, using maps and cross sections showing the distribution of extrusive and intrusive rocks. Tables will be included describing the type of extrusive or intrusive rock, composition of the volcanics, age, geometric relationship to other volcanics, and the stratigraphy of the surrounding rocks. A description of each major period of volcanism will be presented for each volcanic episode listed in the tables.

The mineralogy and geochemistry of each volcanic unit will be summarized in this section with reference made to detailed descriptions in Section 1.2.2 and Chapter 4 - Geochemistry. Alteration, contact metamorphism, and mineralization of country rocks will be discussed as well as any weathering and alteration of the volcanic rocks themselves. Fracturing and faulting associated with volcanism will be described, including attitude, spacing and size of fractures, and cross-cutting relationships among fractures in country and volcanic rocks. The effects of volcanism on interstitial and secondary porosities and permeabilities of the country rocks will be described. The effect of volcanism on regional hydrogeology will also be described.

Based on the Quaternary volcanic history, the potential for future volcanic activity in the candidate area will be predicted, with emphasis on the next 10,000 years. The types of activity, volumes of material, and spatial and temporal probabilities will be considered.

1.3.2.2 Structural History

The history and relationship of folding, faulting, and jointing will be discussed in this section. A tectonic map showing locations and attitudes of these features within the candidate area and site will be included.

The description of faulting will include the distribution, causes, characteristics, attitude, spacing, length, and width of the fault zones. This will be accompanied by a map showing the location and orientation of all known and suspected faults. Reference will be made to Chapter 3, Section 3.9.3.1, for discussions of the extent to which faults may act as hydrologic pathways and to Chapter 8, Section 8.3.5, for a discussion of the extent to which faults may act as pathways to the accessible environment.

Information on surface offsets and net slip of all Quaternary faults and the amount of basement offset associated with each fault will be provided. All assumptions used in determining true offset will be explained. The movement history, including rate of displacement and recurrence interval, will be identified, as well as the absolute and relative dating techniques used to date the faults. If more than one period of Quaternary faulting is present within the candidate area or site, the fault systems of different ages will be tabulated, and the evidence for the age of faulting will be presented.

The geometry, symmetry, wavelength, and amplitude of the folds; their mode of origin (e.g., flexural slip); and their attitudes relative to the earth's surface will be described. The trend and plunge of fold axes and the strike and dip of the axial surface of each major fold, along with its sense of symmetry, will be presented on a map. If more than one period of folding is present, the evidence that allows the relative or absolute dating of the individual episodes of folding will be included. Any change in porosity and permeability of the rocks due to folding will be discussed.

The jointing history of the candidate area and site will be described. A map showing the location and trend of all known joint sets will be included. For each joint set, the areal distribution, attitude, and frequency of jointing within the candidate area and site will be presented. Absolute or relative dating of the joint sets will be provided when known. The mineralogy and age of fillings along joints will be discussed. The possibility that joints may form pathways from the repository to the accessible environment will be discussed. The effect of various joint sets on the fracture permeability of the rock will be provided, or reference will be made to Chapter 3 - HYDROLOGY. The mode of origin of joints and the relationship of joints to regional faulting and folding will also be discussed. A table will be included which lists the various joint sets in order of age, along with their principal characteristics and probable mode of origin.

1.3.2.3 Existing Stress Regime

This section will discuss what is known of the existing stress regime at the site based on regional models, the type and orientation of faulting, seismic evidence, strain measurements, hydrofracture stress measurements, and borehole ellipticity. Stress data pertinent to this discussion will be presented in Section 2.6 and referenced here.

1.3.2.4 Vertical and Lateral Crustal Movement

This section will describe the history of crustal movements at the site and vicinity, and will present existing data which may be available from geodetic surveys, geomorphic analyses of landforms, and strain rates from triangulation and trilateration surveys. Uplift, tilting, and subsidence in the candidate area and site, including effects caused by withdrawing or injecting fluids and mining, will be discussed when applicable. This discussion will include the suspected causes of uplift, tilting, and subsidence as well as the rate, magnitude, and areal extent of the uplift, tilting, and subsidence. Quaternary deformation not classified as folds, faults, or joints (e.g., features related to salt tectonics) will also be described.

1.3.2.5 Geothermal Regime

The geothermal characteristics of the site will be described, including temperatures, thermal properties, and heat flux. The implication of the geothermal regime for tectonics and for repository design, performance, and energy resource extraction will be discussed. This section will be cross referenced in Section 1.5 and Chapters 2, 3, and 6.

1.4 SEISMOLOGY OF CANDIDATE AREA AND SITE

This section will describe the natural and man-induced seismicity of the candidate area and site, the extent of the area's seismic record, the relation of seismicity to structural features, and the potential seismic hazards in the candidate area and site. The rationale will be explained for using any seismic parameters as bases for any portion of the design of a repository appropriate to the site.

1.4.1 Seismology of Candidate Area

This section will describe the extent of the seismic record available for the region; the general characteristics of the seismic environment such as depth, magnitude, acceleration, and trends; and the relation of the seismicity to structural features.

1.4.1.1 Seismicity of Candidate Area

This section will provide a description of the seismic history of the candidate area, including hypocentral coordinates, origin time, magnitude

including scale (M_S , m_b , m_{blg} , M_L , or other), moment, maximum Modified - Mercalli (MM) intensity, total dislocation, focal mechanism, and error estimates for these data. It will also identify the techniques used to locate all epicenters or hypocenters and to determine magnitudes. Revised locations of earthquake epicenters or hypocenters that differ substantially from original locations will be noted and explained. A listing of all known historical earthquakes of magnitude greater than 3 on the Richter scale or MM intensity greater than IV that have been reported for the candidate area will be provided. Separate lists of any sequences of earthquakes such as swarms or aftershocks that merit special study and that may fall beyond the criteria stated above will be provided along with a regional-scale map of all the listed earthquake epicenters. Cross sectional views of hypocenters will be presented, if needed, to clarify the understanding of patterns of seismicity.

1.4.1.2 Relationship of Seismicity to Geologic or Tectonic Characteristics of Candidate Area

This section will correlate, wherever possible, historical earthquakes to recognized geologic structures or seismo-tectonic zones. Stresses derived from focal mechanisms will be described and related whenever possible to regional stresses that characterize the candidate area.

1.4.1.3 Determination of Earthquake-Generating Potential of Geologic Structures and Seismo-Tectonic Zones Within Candidate Area

Where earthquakes are associated with geologic structure, the maximum potential or credible earthquake that could occur on that structure will be described, taking into account such factors as the type of faulting, fault length, fault displacement, and earthquake history. Where earthquakes are associated with a tectonic zone, the largest historical earthquake within the zone will be identified. Any trends in the geologic history that could affect the earthquake-generating potential of geologic structures or seismo-tectonic zones within the candidate area will be described.

1.4.1.4 Earthquake-Induced Phenomena Within Candidate Area That May Affect Site

Any earthquake-induced geologic failure such as liquefaction, landsliding, and lurching that has occurred or is characteristic of strong earthquakes in the area will be described. Any manner in which such failures could affect the site will be identified.

1.4.1.5 Seismic Hazard in the Candidate Area

Estimates of recurrence intervals of maximum probable and credible earthquakes for the candidate area and the derivation of these estimates will be discussed. The probabilities of occurrence of future major earthquakes and their effects on the site will be derived from past evidence. Factors that may modify these probabilities in the long term will be described.

1.4.2 Seismology of Site

This section will include a determination of the maximum horizontal and vertical vibratory ground motion due to the most probable maximum potential or credible earthquake that can affect the site. An analysis of the amplification or damping due to the overlying strata will be made for the site both at the surface and at repository depth.

1.4.2.1 Vibratory Ground Motion at Site Resulting from Potential Earthquakes in Area

The conditions describing the occurrence of the earthquake that would produce the largest vibratory ground motion at the site will be defined. Potential earthquakes from different sources which could produce maximum ground motion with different dominant frequencies will be discussed. The ground motion at the site will be evaluated.

1.4.2.2 Characteristics of Seismic Wave Transmission at Site

For each set of conditions describing the occurrence of the maximum potential earthquake, the type of seismic waves producing the maximum potential earthquake, the type of seismic waves producing the maximum ground motion, and the significant frequencies will be determined. For each set of conditions, an analysis will be performed to determine the effects of transmission in the site material for the identified seismic wave types at the significant frequencies. Separate analyses will be done for the surface at the site and for the repository depth.

1.4.2.3 Potential for Induced Seismicity Affecting Site

The potential for human activity significantly modifying stresses on the site or in the candidate area and inducing seismicity will be described. These activities include relatively short-term functions such as reservoir impoundment, weapons testing, and nearby mining activities.

1.5 LONG-TERM REGIONAL STABILITY WITH RESPECT TO TECTONIC AND GEOLOGIC PROCESSES

Based on Tertiary, Quaternary, and active present-day tectonic and geological processes, an assessment of the future stability of the candidate area will be presented with emphasis on the next 10,000 years. All models, assumptions, parameters, and sensitivity tests to be used for making these assessments will be described. This section will be cross-referenced to Section 1.3.2 Tectonic History.

1.6 DRILLING AND MINING

This section will tabulate the location and characteristics of all drill holes and excavations at and near the site, and will provide available information on the effects of the active and abandoned wells, boreholes, and

excavations on the principal hydrogeologic units. The completeness and accuracy of the historical record examined in making this tabulation will be discussed. The tabulation will include such information as the location, depth, diameter, drilling method, casing left in the hole, and method of plugging or sealing, if available. The methods used to investigate the extent of previous drilling and excavation will be discussed. A map showing the location of active and abandoned wells, boreholes, and excavations and the plan view of the design of a repository appropriate to the site will be provided. If the information is available, a description of the former use of previous boreholes and the types of tests that were conducted in them, along with copies of representative data, logs, and interpretations, will be included. The techniques employed in collecting this data will be described. For critical or representative well information used in the site evaluation, available information regarding instrument calibration and data reduction techniques will be provided or referenced. Also, any known boreholes that were lost because of cave-ins or equipment failures will be included. If sufficient information is available, the presence of potential hydraulic pathways will be indicated, and the net flux and hydraulic gradients created by this activity will be assessed. The appropriate sections of Chapter 3 - HYDROLOGY will be referenced.

Descriptions, plans, and sections of all active or inactive underground mines within the candidate area, including both conventional mines and in-situ extraction types of operations, will be provided when applicable. The kinds of minerals extracted, methods of mineral extraction, volume of rock removed, and volume of rock replaced will be described, including a statement of the present condition of the workings as to subsidence, stability, and flooding.

A description of all active or inactive injection wells within the candidate area will be provided, including the type and amount of material injected and any known resulting effects.

1.7 MINERAL AND HYDROCARBON RESOURCES

Information pertaining to the mineral and hydrocarbon resources of the candidate area and site will be presented in this section.

1.7.1 Mineral Resources

To the extent that information on the mineral resources is available prior to site characterization, the following information will be provided. In this section, the resources of the site will be compared to the resources in comparable areas. A tabulation of the total resources will be provided, including the quantity of resource, the cutoff values used in estimating the quantity, and the value (gross, net, and unit) of each resource. For each resource assessment, the assessment method will be described.

1.7.2 Hydrocarbon Resources

The location of any past or present oil and gas wells in the candidate area will be described. The likelihood of future development in the candidate area, including both reserves and potential resources, will be provided.

1.8 SUMMARY

This section will link the data and analyses presented in Part A - Chapter 1 to Part B of the Site Characterization Plan.

1.8.1 Summary of Significant Results

This section will present a synopsis of the significant results recorded in Chapter 1 in terms of:

- Performance objectives
- Conceptual models and boundary conditions
- Need for further data from site characterization
- Quality of the data, including uncertainties.

Cross-references to other parts of the SCP will be provided.

1.8.2 Relation to Design

This section will summarize the significant interrelationships between the information presented in this chapter and the design characteristics discussed in Chapters 6 and 7.

1.8.3 Identification of Information Needs

Information needs relevant to geology will be identified in this section. The relationship to Part B will be discussed, and a preliminary priority of information needed to complete site characterization will be presented.

1.8.4 Relation to Regulatory Guide 4.17

This section will present a site-specific synopsis of the information required in Reg. Guide 4.17 which has not been shown to be a requirement for this SCP.

REFERENCES

A list of all pertinent references will be provided.

Chapter 2 - GEOENGINEERING

In this chapter, the mechanical, thermal, and thermomechanical properties of the rock units and the expected mechanical boundary conditions that are the basis for the design of the repository will be presented. Each discussion will include a brief summary of generic information from similar rock units and projects and site-specific information,* if available. The information will be in sufficient detail to (1) permit an understanding of the geomechanical basis of the proposed design of a repository appropriate to the site (Chapter 6) and (2) support the discussion of design issues in Part B. The discussions will include values or ranges of values for the design parameters used in the design and will provide the rationale for selecting these preliminary values.

2.0 INTRODUCTION

This section will introduce the site Geoengineering to indicate the role in the site characterization program of the material covered in the chapter. This section will include in a brief introductory fashion:

- Summary remarks about how the presently available information has been obtained and plans for obtaining additional information
- Summary remarks about how the information will be used
- Discussions about conceptual models that are based upon or are supported by the information contained in the chapter
- Discussions about the quality of present data and the sophistication of models which will use the data.

2.1 MECHANICAL PROPERTIES OF ROCK UNITS - INTACT ROCK

The scope of the section, background, equipment and procedures, limitations and uncertainties in data, and definitions (where needed) will be stated.

2.1.1 Mechanical Properties of Other Rocks

Mechanical properties of rocks from locations other than the site will be presented, as appropriate.

*Site-specific information means information gained from tests done in, or samples taken from, limited borings, surface outcrops, near-surface test facilities, pre-existing tunnels or mines, etc., near the site proposed for characterization. It does not imply that a shaft has been sunk.

2.1.2 Mechanical Properties of Rocks at the Site

This section will present the mechanical properties as determined by laboratory tests on samples of the potential host rock and of other rock units important for the design of a repository appropriate to the site. Data on elastic and inelastic behavior, compressive and tensile strength, and the effects of heating and fluid pressure are presented. Geologic borehole logs, geologic cross sections, or photographs accumulated during preliminary site exploration activities will be provided, as appropriate, to show where the tests were conducted or samples taken. Anisotropic properties will be addressed or isotropic approximations justified.

2.2 MECHANICAL PROPERTIES OF ROCK UNITS - DISCONTINUITIES

The scope of the section, background, equipment and procedures, limitations and uncertainties in data, and definitions (where needed) will be stated.

2.2.1 Mechanical Properties of Discontinuities in Other Rocks

Mechanical properties of discontinuities in rocks from locations other than the site will be presented, as appropriate.

2.2.2 Mechanical Properties of Discontinuities in Rocks at the Site

The mechanical properties and physical characteristics of discontinuities (fractures, joints, bedding planes, inclusions, voids) present in the rock units will be described. Site-specific data as well as available generic data from similar rock units and environments will be provided. The discussion will include the coefficient of friction, the compressibility of fractures and filling materials, and the effect of heating and changes of pore pressure on the mechanical properties of the joints, fractures, bedding planes, and other discontinuities.

2.3 MECHANICAL PROPERTIES OF ROCK UNITS - LARGE SCALE

The scope of the section, background, equipment and procedures, limitations and uncertainties in data, and definitions (where needed).

2.3.1 Mechanical Properties of Other Rocks

Strength, deformability, and creep data (where appropriate) for rocks from locations other than the site will be presented, as appropriate.

2.3.2 Mechanical Properties of the Rocks at the Site

The results of any large-scale laboratory and field tests, such as plate-bearing test, block test, chamber test, flat jack test, Goodman jack test, or convergence test will be presented. Large-scale here means tests of sufficient size to take into account the discontinuities, such as fractures,

tests that have been conducted to obtain such results will be discussed in detail, including procedures, equipment, instrumentation, data reduction, and uncertainties.

2.5.3 Relationship Between Intact Rock and Large Scale Properties

The relationship between the results of laboratory tests and the results of large-scale tests will be discussed. The effect of joints and inhomogeneous material will be discussed.

2.6 EXISTING STRESS REGIME

The scope of the section, background, equipment and procedures, limitations and uncertainties in data, and definitions (where needed) will be presented.

2.6.1 Stress Regime in Region of the Site

Information will be presented from direct measurement and other observations concerning the regional stress field.

2.6.2 Stress Regime at the Site

The stress field data specific to the site and the assumptions used to infer stress from field observations will be provided. The expected direction and magnitude of the principal stresses as a function of depth will be discussed. The data presented here will be referenced in Section 1.3 and will provide the basis for discussions relating stress field to tectonics contained therein.

2.7 SPECIAL GEOENGINEERING PROPERTIES

This section will describe any special thermal, mechanical, thermomechanical coupled properties, or other properties of the rock units that were considered in developing the design of a repository appropriate to the site (e.g., brine migration, thermal decrepitation, thermal dewatering). Available site-specific data as well as generic data from similar rock units will be provided.

2.8 EXCAVATION CHARACTERISTICS OF ROCK MASS

The scope of the section and background information will be provided.

2.8.1 Excavation Characteristics of Similar Rocks

Excavations under rock conditions similar to the rock conditions at the site will be discussed, including various techniques such as controlled blasting and mechanical excavation. The discussion will address the monitoring and analysis of the excavations.

2.8.2 Excavation Characteristics of Rock at the Site

Excavations in rock at or near the site will be discussed, including excavation methods and procedures, monitoring techniques, and analysis.

2.8.3 Changes in Geoengineering Properties Due to Excavation

The potential changes in geoengineering properties that might be produced by the various excavation techniques will be evaluated. Appropriate methods for avoiding or mitigating such damages will be discussed. The impact of these considerations on repository design will be summarized.

2.9 SUMMARY

This section will link the data and analyses presented in Part A - Chapter 2 to Part B of the Site Characterization Plan.

2.9.1 Summary of Significant Results

This subsection will present a synopsis of the significant results recorded in Chapter 2 in terms of:

- Performance objectives
- Conceptual models and boundary conditions
- Need for further data from site characterization
- Quality of the data, including uncertainties.

Cross-references to other parts of the SCP will be provided.

2.9.2 Relation to Design

This section will summarize the significant interrelationships between the information presented in this chapter and the design characteristics discussed in Chapters 6 and 7.

2.9.3 Identification of Information Needs

Information needs relevant to geoengineering will be identified in this section. The relationship to Part B will be discussed, and a preliminary priority of information needed to complete site characterization will be presented.

2.9.4 Relation to Regulatory Guide 4.17

This section will present a site-specific synopsis of the information requested in Reg. Guide 4.17 which has not been shown to be a requirement for this SCP.

REFERENCES

A list of all pertinent references will be provided.

Chapter 3 - HYDROLOGY

This chapter will include pertinent information gathered on hydrologic conditions of the candidate area and site. Surface and subsurface hydrologic regimes will be addressed. The information will be presented in sufficient detail to (1) describe the hydrology based on available literature and preliminary site exploration activities and (2) provide information to be used to analyze the hydrologic aspects of the planned site characterization program.

3.0 INTRODUCTION

This section will introduce the site Hydrology to indicate the role in the site characterization program of the material covered in the chapter. This section will include in a brief introductory fashion:

- Summary remarks about how the presently available information has been obtained and plans for obtaining additional information
- Summary remarks about how the information will be used
- Discussions about the quality of present data and the sophistication of models which will use the data.

3.1 DESCRIPTION OF SURFACE HYDROLOGY

This section will provide a general description of the surface hydrology of the candidate area and site. A general description of the hydrographic subdivisions of the region and the location of all water bodies and gaging stations in the area will be included. This section will address the location and physical and hydrologic characteristics of surface-water bodies such as streams, lakes, and shore regions influencing the site. A description of existing and proposed water-control structures, both upstream and downstream, that may influence conditions at the site will be included.

3.2 FLOODS

This section will describe the floods that have occurred in the Candidate area and at the site. The probable maximum flood at and near the site will then be estimated, and the measures that will be used to protect the site from floods will be described.

3.2.1 Flood History and Potential for Future Flooding

This section will describe the flood history of the candidate area and site. This will include stream floods, surges, seiches, tsunamis, dam failures, ice jams, floods induced by landslides, and similar events, as appropriate. The data used will be based on measurements from gaging stations and on inferences from the geologic record. The probable maximum flood and its relationship to the planned facilities will be estimated, and the

potential for future flooding of the site will be discussed. Identification of whether the site will be flood dry or non-flood dry using procedures presented in ANSI/ANS 2.8 N170-1981* will be included. If procedures other than those presented in ANSI/ANS 2.8 N170-1981 are used, the reasons and description of the procedures used will be stated. Long-term changes in the hydrometeorology of the region and the potential for floods induced by maximum glaciation will be addressed. Geologic evidence of Pleistocene and Holocene flooding used to assess future flood potential will also be described. Cross-references will be made to other chapters where applicable (e.g., Section 1.1 GEOMORPHOLOGY and Chapter 5 - CLIMATOLOGY AND METEOROLOGY).

3.2.2 Flood Protection

This section will reference the appropriate sections of Chapter 6 for a discussion of the methods by which the surface and underground facilities will be protected.

3.3 LOCATIONS AND DISTANCES TO POINTS OF SURFACE-WATER USE

This section will describe the quantity of surface water used in the candidate area, the chief areas where the water is used, the types of water users, the quality of the water, and the projected amount of future use.

3.3.1 Present Quantity and Quality of Surface Water Extracted

This section will describe those parts of the candidate area where surface water is currently being used. A tabulation of existing surface-water intakes, including collector well systems, downstream of any identified ground-water discharge areas will be included. For each surface-water intake, the location, population served, type of intake, and maximum daily and average quantities of water pumped will be provided. Also, water quality at the intake locations and the type of treatment given to the water before distribution will be discussed.

3.3.2 Projected Surface-Water Uses

This section will describe the likely future uses of surface water in the candidate area and any potential future increases of water use in the area.

*See American National Standards Institute Standard ANSI/ANS 2.8-1981, "Standards for Determining Design Basis Flooding at Power Reactor Sites." Copies may be obtained from the American Nuclear Society, 555 North Kensington Avenue, La Gauge Park, Illinois 60525

Estimated quantities and potential areas of water use for the region for the next 50 and 100 years will be described. The discussion will be based on the projected growth rate of the region; industries likely to develop in the future because of location, climate, or natural resources; and probable changes in technology or economic requirements. The section will also locate possible points of withdrawal for any potential future water users that have been identified.

3.4 CHEMICAL COMPOSITION OF ADJACENT WATERCOURSES

This section will describe the chemical composition of surface water that could potentially be affected by releases from the facility on the basis of available data. This description will include measured baseline data derived from historical records and onsite monitoring programs.

The seasonal cycles of physical and chemical limnological parameters will be provided, as appropriate. Additionally, information that describes the bottom and shoreline configuration, sedimentation rates, sedimentation gradation analysis, and distribution (sorption) coefficients will be included, as appropriate.

3.5 POINTS OF GROUND-WATER DISCHARGE

This section will identify known sources of ground-water discharge within the candidate area, including springs, seeps, and wells, and to surface water bodies. The section will provide estimates of the rate of ground-water discharge at these points and will provide the basis for discharge estimates. Measurements such as base flow, water balance calculations, and aquifer hydraulics will be included. Potential for contamination of surface and ground water caused by site characterization activities will be identified.

3.6 REGIONAL HYDROGEOLOGIC RECONNAISSANCE OF CANDIDATE AREA AND SITE

This section will describe the regional hydrogeologic units and the relationships among them, potentiometric levels, and the hydraulic characteristics of the principal hydrogeologic units.

3.6.1 Hydrogeologic Units

This section will distinguish and describe the various hydrogeologic units in the candidate area and site in terms of location, thickness, and lateral extent. A description will be included which will indicate the principal hydrogeologic units (both confining units and aquifers), their stratigraphic relationships, lithology, generalized potentiometric levels for a given time and location, and hydrologic characteristics. A hydrogeologic map of the candidate area will be presented, indicating areal extent of the regional hydrogeologic units and unit interfaces and data points. Cross sections, including a regional hydrogeologic column, will be provided where appropriate.

Cross-references will be made to other chapters where applicable, (e.g., Section 1.2 STRATIGRAPHY AND LITHOLOGY).

3.6.2 Relationship Among Hydrogeologic Units

This section will describe the relationships among the units defined in Section 3.6.1. The principal relationships to be described are potentiometric levels, recharge-discharge and leakage, hydrochemical facies, hydrologic interconnection between units (e.g., fractures, faults), and ground-water residence times. The effects of these relationships and structural features on the movement of ground water will also be described.

Cross-reference will be made to other chapters where applicable, (e.g., Section 1.2 STRATIGRAPHY AND LITHOLOGY; Section 1.3 STRUCTURAL GEOLOGY; and Chapter 4 - GEOCHEMISTRY).

3.6.3 Potentiometric Levels

This section will define the time history and areal distribution of the potentiometric surface in the candidate area. Information such as the location of the monitoring wells, hydrogeologic unit boundaries, surface-water bodies, and specific well information will be provided.

3.6.4 Hydraulic Characteristics of Principal Hydrogeologic Units

This section will provide the principal hydraulic characteristics (range, mean values, and methods for determining) for each of the principal regional hydrogeologic units. The section will also include a discussion of the appropriateness of assuming Darcian flow conditions in the various hydrogeologic units.

3.7 REGIONAL GROUND-WATER FLOW SYSTEM

This section will describe ground-water flow through the candidate area. The principal ground-water flow paths will be defined, and discrete ground-water basins will be identified. The regional hydrochemistry will be presented, the ages of the ground water will be estimated, and the regional paleohydrology will be described.

3.7.1 Identification of Recharge and Discharge Areas

This section will present information regarding locations of areas of ground-water recharge and discharge in the candidate area. It will also identify the modes of recharge and discharge, residence times of the ground water, and the bulk rates of ground-water flow for specific hydrogeologic units. The section also will include surface- and ground-water interrelationships, and will present the information on hydrogeologic maps developed for the region.

3.7.2 Principal Ground-Water Flow Paths

This section will describe known principal ground-water flow paths within the regional ground-water flow system. Cross sections and maps (flow nets or potentiometric maps) will be used to indicate the principal ground-water flow paths.

3.7.3 Isotopic and Regional Hydrochemistry

This section will describe the chemical composition data for the ground water in the region and candidate area, including the isotopic chemistry and ambient ground-water temperatures. The age of the ground water will be estimated from the isotopic chemistry, and ground-water origins, residence times, and travel times will be estimated from these data. There will also be a discussion of the relative degree of circulation within the hydrogeologic units, and areas and modes of recharge to and discharge from the hydrogeologic units. Regional hydrochemical zones will be delineated on the basis of this information.

Cross-references will be made to other chapters where applicable, (e.g., Chapter 4 - GEOCHEMISTRY).

3.7.4 Paleohydrology

This section will describe the hydrologic conditions that have occurred over the past 20,000 years that have significantly differed from present conditions. The effect of each major episode on the ground-water flow regime and its likelihood of recurrence over the next 10,000 years will be discussed.

3.8 GROUND-WATER USES

This section will identify the principal regional ground-water users, including locations, rates, and hydrogeologic unit source. The section will include irrigation, industrial, municipal, domestic livestock, and energy resource development uses. The section will identify areas of large ground-water pumping or injection on the regional hydrogeologic map, including the extent of depression or impression cones on the potentiometric surfaces.

3.8.1 Regional Ground-Water Aquifers Used for Human Activities

This section will delineate the water use from shallow alluvial aquifers and the use of water from deeper aquifers. It will also assess the impact of these withdrawals.

3.8.2 Regional Ground-Water Management Plans

This subsection will provide estimates of future ground-water withdrawal and use within the candidate area. Regional ground-water management agencies and their programs will be identified. Projections for the next 50 to 100 years will be provided. The estimates will be based on population changes (number and location) during these periods.

3.9 SITE HYDROGEOLOGIC SYSTEM

This section will describe the site hydrogeologic system including monitoring; hydraulic characteristics; the ground-water flow system, velocity, and travel times; hydrochemistry and ground-water age; local ground-water users; and paleohydrology.

3.9.1 Baseline Monitoring

Information gathered from the baseline monitoring program, including seasonal variations, long-term trends in potentiometric levels, and hydrochemistry of the principal hydrogeologic units, will be presented.

3.9.1.1 Monitoring Networks

This section will provide specifications and designs (i.e., locations, elevations of screens, measuring points, and seals), selection process for choosing the location and depth of monitoring points, the hydrogeologic units being monitored, the method and frequency of measurement, and the method of hydrochemical sampling for the monitoring network used in establishing the existing baseline monitoring program.

3.9.1.2 Potentiometric Levels

This section will provide data on potentiometric levels from the wells of the existing monitoring network. Hydrographs will include precipitation, surface-water levels, and rates of ground water pumpage where appropriate. Current assessments for the potential for long-term or significant short-term changes in the water levels will be provided.

3.9.1.3 Hydrochemistry

This section will present water chemistry data obtained from site well-water samples. In-situ water temperature data will be given, and major chemical constituents and dissolved solids and gases will be described. Water hardness, specific conductance, Eh-pH, radioisotopes, organics, and fluid density will be presented. The extent and duration of variations of the hydrochemical system will be described. Site ground-water composition will be compared with the regional information given in section 3.7.3. This section will also provide cross references to additional data which will be presented in Chapter 4 - GEOCHEMISTRY.

3.9.2 Hydraulic Characteristics

Information on the vertical and horizontal hydraulic characteristics for principal hydrogeologic units, and a discussion of statistical parameters and values will be provided. Hydraulic characteristics which will be discussed include:

- Permeability. An indication whether the permeability is developed by secondary processes such as fracturing, weathering dissolution, or degassing of igneous rocks and the extent to which Darcian flow can be assumed will be included. The data will be expressed as intrinsic permeability.
- Saturated Flow Hydraulic Conductivity and Transmissivity. The representative volume applicable and the saturated thicknesses assumed will be indicated.
- Unsaturated Flow Hydraulic Properties. The unsaturated zone hydraulic properties will be indicated. The moisture content (specific retention) for the unsaturated zone and any relation to hydraulic potential and hydraulic conductivity will be included.
- Total and Effective Porosity. The nature of the pore space (i.e., interstitial, fractured, or solutioning) and primary and secondary porosity will be indicated.
- Saturated Flow Storage Coefficient. An indication whether phreatic or confined conditions are constant throughout the region will be made.

3.9.3 Ground-Water Flow System Conceptual Model

This section will describe the credible pathways of ground-water flow to the accessible environment. Flow paths through the saturated and/or unsaturated zones will be presented. Conceptual models of ground-water flow controls will also be presented, and comparisons will be made among these conceptual models.

3.9.3.1 Accessible Environment and Credible Pathways

This section will define the accessible environment for the site and predict credible pathways of ground-water flow to the accessible environment.

3.9.3.2 Potentiometric Levels and Head Relationships

This section will provide a synthesis and analysis of potentiometric levels and head relationships, including hydraulic gradients, flow directions, and potential for variations in the saturated zones. For the unsaturated zone, similar information will be provided on negative potential, flow characteristics, and seepage fluxes.

3.9.3.3 Recharge-Discharge and Leakage

Information on the location and rates of recharge-discharge and leakage for the principal hydrogeologic units will be presented. Hydrochemical data used in support of these analyses will be presented.

3.9.3.4 Unsaturated Zone Relationships

This section will identify the extent and duration of the unsaturated zone, and will indicate the principal modes of recharge. The duration and presence of perched water tables and their confining units, and water-flow rates and flow direction will be presented. Local flux rates for the unsaturated units to the regional water table or surface-water bodies will also be presented. Credible pathways, including the potential for vapor transport, will be identified.

3.9.4 Ground-Water Velocity and Travel Time

This section will discuss and estimate ground-water velocity and travel times from the design of a repository to the accessible environment based on presently available data. Estimates will be made for flow through the saturated and unsaturated zones as appropriate. The physical mechanisms which retard ground-water movement will be discussed. The effects of thermal gradients on ground-water flow will be described, including the expected temperature profiles and existing geothermal temperatures.

3.9.5 Hydrochemical Confirmation of Ground-Water Behavior

This section will use the data presented in Section 3.9.1.3 to provide hydrochemical evaluation of the ground-water system, including the age and sources of the ground water, and possible origin, travel paths, and flow rates of the ground water.

3.9.6 Monitoring and Verification

This section will summarize the ground-water monitoring and verification programs which will be described in Chapter 8.

3.9.7 Local Ground-Water Users

This section will identify the ground-water users near the site, the amounts and rates of ground water used, the hydrogeologic unit sources, and the effects that this usage may have on the potentiometric surface and ground-water flow system.

3.9.8 Paleohydrology

This section will describe hydrogeologic conditions that have occurred over the past 20,000 years that have significantly differed from present conditions. The effect of each major episode on the ground-water flow regime and its likelihood of recurrence over the next 10,000 years will be discussed.

3.10 SUMMARY

This section will link the data analyses presented in Part A - Chapter 3 to Part B of the Site Characterization Plan.

3.10.1 Summary of Significant Results

This section will present a synopsis of the significant results recorded in Chapter 3 in terms of:

- Performance objectives
- Conceptual models and boundary conditions
- Need for further data from site characterization
- Quality of the data, including uncertainties.

Cross-references to other parts of the SCP will be provided.

3.10.2 Relation to Design

This section will summarize the significant interrelationship between the information presented in this chapter and the design characteristics discussed in Chapters 6 and 7.

3.10.3 Identification of Information Needs

Information needs relevant to hydrology will be identified in this section. The relationship to Part B will be discussed, and a preliminary priority of information needed to complete site characterization will be presented.

3.10.4 Relation to Regulatory Guide 4.17

This section will present a site-specific synopsis of the information requested in Reg. Guide 4.17 which has not been shown to be a requirement for this SCP.

REFERENCES

A list of all pertinent references will be provided.

Chapter 4 - GEOCHEMISTRY

In this chapter, pertinent descriptions of the geochemical properties of the rocks, minerals, sediments, and water of the candidate area and site will be presented. The anticipated radionuclide transport mechanisms (i.e., liquid, water, vapor, gas) to the accessible environment and anticipated geochemical reactions that have influenced the design of a repository appropriate to the site will be included. Where appropriate, generic data from similar rock types and site-specific information will also be included, if available. For natural variables (e.g., rock compositions and ground-water chemistry), expected ranges of values and by what process these values were assumed will be indicated. For chemical and geochemical reactions affecting radionuclide containment and transport (e.g., any of the reactions among the water, vapor, gas, rock), the rationale for the identification of these reactions (e.g., theoretical, laboratory experimental, observed in nature) will be indicated and to what extent the nature of the reactions would be expected to change because of changing conditions at the site (e.g., changes in solubility of constituents in ground water resulting from heating the ground water). The information will be presented in sufficient detail to (1) permit an understanding of the geochemical factors of the candidate area and site based on available literature and site-screening studies and (2) support the planned site characterization program.

4.0 INTRODUCTION

This section will introduce the site Geochemistry to indicate the role of the material covered in the chapter in the site characterization program. This section will include in a brief introductory fashion:

- Summary remarks about how the presently available information has been obtained and plans for obtaining additional information
- Summary remarks about how the information will be used
- Discussions about conceptual models that are based upon or are supported by the information contained in the chapter
- Discussions about the quality of present data and sophistication of models which will use the data.

4.1 GEOCHEMISTRY OF THE HOST ROCK AND SURROUNDING UNITS

This section will describe the geochemistry of the rocks and ground water along credible pathways to the accessible environment. Rock characteristics and water composition in the emplacement horizon and surrounding rocks will be discussed based on available data, as well as their interrelationships and relevance to waste isolation.

4.1.1 Mineralogy and Petrology

This section will discuss the mineralogic and petrologic characteristics of the rock mass.

4.1.1.1 General Description of Host Rock and Surrounding Units

An overview of specific mineralogic and petrologic characteristics of the host rock and surrounding units will be provided. Diagenetic and post-depositional alteration will be discussed.

4.1.1.2 Analytical Techniques

Techniques for obtaining and analyzing data for rocks along probable flow paths, as defined in Section 3.9.3, will be described.

4.1.1.3 Mineralogic, Petrologic, and Chemical Composition of the Host Rock and Surrounding Units

This section will provide specific details on the mineralogic, petrologic, and chemical composition of the host rock and surrounding units. Discussions of the composition of the whole rock and primary and secondary phases in the rock and along fractures will be discussed.

4.1.1.4 Mineral Stability

This section will discuss the mineral stability of the host rock and surrounding units along possible flow paths. Major dependencies will be identified and the availability of related data will be discussed.

4.1.2 Ground-Water Geochemistry

This section provides a summary of hydrochemical information under baseline conditions. This discussion includes the host rock and surrounding units along credible pathways to the accessible environment.

4.1.2.1 General Description of the Hydrochemistry

This section will summarize the hydrochemical data which are treated in detail under appropriate hydrochemistry discussions within Chapter 3 - HYDROLOGY. The data given here will support the discussions of geochemical conditions and processes as well as experimental investigations.

4.1.2.2 Major Inorganic Content

This section will present major and minor constituents of ground waters from the host rock and surrounding units, and will include ionic composition, speciation concentrations of potential complexing ions, pH, DO, and redox couples. Temporal and spatial variations in ground-water composition will be discussed.

4.1.2.3 Trace Elements

This section will present a brief summary of trace element concentrations in the ground water.

4.1.2.4 Organic Content

This section will present identification of organic constituents of ground waters from the host rock and surrounding units. The discussion will identify organic constituents that may be potential complexing agents.

4.1.2.5 Dissolved Gas

This section will present data on the concentrations of dissolved gases in the ground water for the host rock and surrounding units.

4.1.2.6 Background Radioactivity

This section will present measurements of background radiation in the surface and ground water for the host rock and surrounding units. Concentrations of naturally occurring radionuclides will be included.

4.1.2.7 Particulates and Colloids

This section will present data on the identity and properties of colloidal and particulate material expected within ground water along pathways to the accessible environment.

4.1.2.8 Temperature and Pressure

This section will present data on temperature and pressure within the host rock and surrounding units along pathways to the accessible environment.

4.1.2.9 Mineralogical Controls on Water Composition

This section will discuss available data and information regarding the relationships between water composition and the mineral assemblages in contact with the water. The physical and chemical features or properties which significantly affect water chemical composition will be identified and discussed.

4.1.2.10 Reference Ground-Water Composition

The composition of waters used in experimental work (e.g., sorption experiments, leach testing, geochemical modeling) will be discussed. The relation between reference water compositions and the ground-water data base will be demonstrated.

4.1.3 Geochemical Retardation Processes

This section will discuss the major processes by which movement of radionuclides in ground water can be described under baseline conditions.

4.1.3.1 General Description of Geochemical Retardation

This section will identify the major processes by which movement of radionuclides in ground water can be retarded. For each process, a brief discussion will be provided describing the nature of the physical process and its relation to radionuclide movement. A list of radionuclides important for waste isolation (key radionuclides) will be presented with the rationale for the development of the list.

4.1.3.2 Analytical Techniques

This section will present a synopsis of the analytical and experimental techniques used to investigate the geochemical processes mentioned in the SCP. Detailed descriptions of the techniques will be presented in the discussions of each process.

4.1.3.3 Sorption

This section will present relevant data describing the sorptive behavior of the host rock and surrounding units. Discussions of sorption-desorption mechanisms, ionic and isotopic exchange, and the sorptive behavior of colloids will be included. Kinetic considerations will be addressed where appropriate.

4.1.3.4 Processes Affecting Radionuclide Concentrations and Speciation in Solution

This section will discuss precipitation and dissolution reactions and the stability of precipitated phases, complexation as a function of water chemistry, chemical substitution, and radioanalysis effects. The discussions will focus on radionuclide behavior.

4.1.3.5 Matrix Diffusion

This section will discuss the diffusion of radionuclides into the rock matrix, including diffusion into pore spaces. Retardation by matrix diffusion during fracture flow will be discussed where appropriate.

4.1.3.6 Radionuclide Transport

This section will discuss the conceptual aspects of radionuclide transport through the ground-water system by means of advection, dispersion, colloid transport, and any other potential mechanisms.

4.1.3.7 Geochemical Retardation in the Host Rock and Surrounding Units - Anticipated Conditions

This section will synthesize current understanding of the geochemical retardation processes of the key radionuclides listed in Section 4.1.3.1 under anticipated (nominal) conditions. This section will identify those radionuclides requiring additional investigation.

4.1.3.8 Geochemical Retardation in the Host Rock and Surrounding Units - Unanticipated Conditions

This section will discuss potential changes in the geochemical retardation processes described in Sections 4.1.3.3 through 4.1.3.6 under the range of potential conditions. The discussion will consider the changes in relative importance of these processes to the retardation of the key radionuclides in the host rock and surrounding units.

4.2 GEOCHEMICAL EFFECTS OF WASTE EMPLACEMENT

This section will discuss the geochemical effects of waste emplacement on the host rock. Discussions of the interactions within the engineered barrier system will be presented in Chapter 6 (backfill and seals) and Chapter 7 (waste package).

4.2.1 Anticipated Thermal Conditions Resulting from Waste Emplacement

This section discusses the expected thermal conditions resulting from waste emplacement and how these conditions will vary with time.

4.2.2 Hydrothermal Alteration Due to the Thermal Pulse

This section will discuss the waste-induced hydrothermal alteration of minerals in the host rock and surrounding units.

4.2.3 Changes in Water Chemistry Due to the Thermal Pulse

This section will discuss the thermal influence of the repository on the chemical composition of waters in the host rock and surrounding units along possible flow paths.

4.2.4 Effects of the Thermal Pulse on Radionuclide Migration

This section will discuss the effects of the thermal pulse on the mineralogy and water composition in the host rock. This discussion will focus on how these changes affect radionuclide migration.

4.3 NATURAL ANALOGS AND RELATED FIELD TESTS

This section will describe studies being performed to obtain data relative to radionuclide transport, hydrothermal alteration, and engineered barrier performance. Studies may include both natural analogs and relevant field tests. The significance of these studies to performance assessment model evaluation will be discussed.

4.3.1 Natural Analogs

This section will identify and describe naturally occurring processes analogous to those expected in the natural and engineered barrier systems.

4.3.2 Related Field Tests

This section will describe field tests to provide information relevant to radionuclide migration in the host rock and surrounding units.

4.4 GEOCHEMICAL STABILITY

This section will identify the human and natural factors that could potentially affect the geochemical stability of the host rock and surrounding units. For both situations, the importance of potential effects will be evaluated.

4.4.1 Potential Man-Induced Effects

This section will identify and discuss potential man-induced effects and their effect on geochemical stability. These influences may include solution mining, injection disposal, ground-water withdrawal, and ground-water mining.

4.4.2 Potential Effects of Natural Changes

This section will identify and discuss the natural factors that could potentially affect geochemical stability. These changes may include climatic variations and seismic, volcanic, and hydrothermal activity.

4.5 SUMMARY

This section will link the data and analyses presented in Part A - Chapter 4 to Part B of the Site Characterization Plan.

4.5.1 Summary of Significant Results

This section will present a synopsis of the significant results recorded in Chapter 4 in terms of:

- Performance objectives
- Conceptual models and boundary conditions

- Need for further data from site characterization
- Quality of the data, including uncertainties.

Cross-references to other parts of the SCP will be provided.

4.5.2 Relation to Design

This section will summarize the significant interrelationships between the information presented in this chapter and the design characteristics discussed in Chapters 6 and 7.

4.5.3 Identification of Information Needs

Information needs relevant to geochemistry will be identified in this section. The relationship to Part B will be discussed, and a preliminary priority of information needed to complete site characterization will be presented.

4.5.4 Relation to Regulatory Guide 4.17

This section will present a site specific synopsis of the information requested in Regulatory Guide 4.17 which has not been shown to be a requirement for this SCP.

REFERENCES

A list of all pertinent references will be provided.

Chapter 5 - CLIMATOLOGY AND METEOROLOGY

A description will be provided of the climatology and meteorology of the candidate area and site. An analysis of paleoclimatic conditions will provide an assessment of the climatic changes that might occur in the future, based on evaluations of the past and present climatic conditions. Paleoclimatic analysis will include at least the complete climatic spectrum ranging from maximum glacial to maximum interglacial conditions. Sources of the information and data provided will be referenced. Those areas where sufficient data or information are presently not available will be identified.

5.0 INTRODUCTION

This section will introduce the site Climatology and Meteorology to indicate the role in the site characterization program of the material covered in the chapter. This section will include in a brief introductory fashion:

- Summary remarks about how the presently available information has been obtained and plans for obtaining additional information
- Summary remarks about how the information will be used
- Discussions about conceptual models that are based upon or are supported by the information contained in the chapter
- Discussions about the quality of present data and sophistication of models which will use the data.

5.1 RECENT CLIMATE AND METEOROLOGY

This section will provide a description of the recent climate and meteorology of and measurement programs at the candidate area and site.

5.1.1 Climate

The general climate will be described with respect to types of air masses, synoptic features and frontal systems, and general airflow patterns and relationships between synoptic-scale atmospheric processes and local (site) meteorological conditions. Climatological characteristics attributable to the terrain will be identified. Data will be provided in sufficient detail to indicate impacts on the design and potential operation of a repository at the site.

All information will be fully documented and will be based on data for the most recent 30-year record period. Climatic conditions that will be described will include, but not be limited to, precipitation, temperature, wind, and severe weather phenomena.

5.1.2 Local and Regional Meteorology

This section will describe the local and regional meteorology, and provide data to be used in characterizing atmospheric dispersion processes (i.e., airflow trajectories, atmospheric stability conditions, depletion and deposition characteristics).

5.1.3 Site Meteorological Measurement Program

This section will describe the measurement program for obtaining data to be used to estimate offsite concentrations of effluents released during site characterization. Data such as temperature, wind direction and speed, relative humidity, precipitation, and barometric pressure will be collected. Locations and elevations of measurements and descriptions of the instrumentation will be provided.

5.2 LONG-TERM CLIMATIC ASSESSMENT

An analysis of paleoclimatic conditions at the candidate area and site will be presented. From this analysis and recent climatic characteristics of the candidate area, an assessment of the magnitude and rate of climatic changes that might be expected to occur will be provided.

5.2.1 Paleoclimatology

This section will provide an analysis of the Quaternary paleoclimatology of the candidate area and site, including atmospheric, hydrospheric, and cryospheric aspects of the successive climatic regimes. The magnitude of the climatic changes and the rates at which the changes occurred will be determined. Potential changes in precipitation regimes and their influence on aquifer recharge and locations of potential aquifer recharge areas, and locations of glaciated areas, and windflow patterns will be identified. Geologic, biological, and ecological evidence to support the analysis will be provided.

5.2.2 Future Climatic Variation

This section will discuss how paleoclimate information developed in Section 5.2.1 is used to define:

- Potential maximum and minimum changes and rates of change in precipitation and air temperature from the present that could be expected to occur
- Potential regional windflow and precipitation patterns that may evolve in the future as a result of climatic and geologic changes
- The potential for glaciation, including estimates of times of onset of glaciation and lengths and severity of glacial regimes in the site area

- Future fluctuations in sea levels and cryosphere due to climatic changes.

Based on this information, the potential impacts of climatic change on precipitation patterns, wind-flow regimes, the cryosphere, and sea levels will be discussed.

The major forces likely to cause significant climatic change will be identified and discussed. All procedures and models used in climatic extrapolations will be identified, as well as all assumptions and areas where insufficient data make extrapolations uncertain.

5.2.3 Site Paleoclimatic Investigation

Information obtained during the site characterization stage will be used to increase the paleoclimatology data base of the area. This section will summarize program plans; detailed program plans will be presented in Chapter 8.

5.3 SUMMARY

This section will link the data and analyses presented in Part A - Chapter 5 to Part B of the Site Characterization Plan.

5.3.1 Summary of Significant Results

This section will present a synopsis of the significant results recorded in Chapter 5 in terms of:

- Performance objectives
- Conceptual models and boundary conditions
- Need for further data from site characterization
- Quality of the data, including uncertainties.

Cross references to other parts of the SCP will be provided.

5.3.2 Relation to Design

This section will summarize the significant interrelationships between the information presented in this chapter and the design characteristics discussed in Chapters 6 and 7.

5.3.3 Identification of Information Needs

Information needs relevant to climatology and meteorology will be identified in this section. The relationship to Part B will be discussed, and a preliminary priority of information needed to complete site characterization will be presented.

5.3.4 Relation to Regulatory Guide 4.17

This section will present a site-specific synopsis of the information requested in Regulatory Guide 4.17 which has not been shown to be a requirement for this SCP.

REFERENCES

A list of all pertinent references will be provided.

Chapter 6 - CONCEPTUAL DESIGN OF A REPOSITORY

6.0 INTRODUCTION

The objective of this section will be to state the purpose of Chapter 6 and to provide an overview of the current repository concepts as they relate to the Site Characterization Program. Chapter 6 will provide the requirements and reference the media-specific design data base, describe the current design concepts, and discuss design information needs. The discussion of design information needs will address the topics listed in Chapter 6 of Reg. Guide 4.17.

The introduction will specify that design information will provide:

- The basis for the design
- Information detailed enough to permit an evaluation of whether the kinds and amounts of tests and analyses to be performed during site characterization will be adequate
- Sufficient repository, design information that an assessment can be made on whether the suitability of the site will be compromised by the facilities that will be constructed for site characterization.

The introduction will reference other chapters of the SCP which provide:

- Discussions of site characterization activities that utilize the information contained in the chapter
- Discussion of performance assessment models that are based upon or supported by the information contained in the chapter
- Discussion about the accuracy and uncertainties of present performance assessment design data.

The introduction will reference the SCP Conceptual Design Report (CDR) as the basis for preparing Chapter 6 of the SCP. The SCP-CDR will be referenced for most of the details of the design.

6.1 DESIGN BASIS

6.1.1 Repository Design Requirements

This section will present the technical requirements and assumptions established as a basis and rationale for repository design. Site constraints that affect the design or the approach to the design will be discussed. Project Functional Design Criteria will be summarized and will include site functional

requirements and criteria from laws or regulations, natural phenomena, safety or waste isolation considerations, and other design criteria imposed by repository operations. The design basis imposed by safety considerations will require the preliminary identification and classification of buildings, structures, excavations, systems, and components important to safety or waste isolation.

6.1.2 Reference Design Data Base

A summary of the geological and geotechnical data used for repository design will be presented in this section. The objectives will be to develop a data base of site characteristics and data important to the design of the repository. The source of the data will be discussed (i.e., whether the data is derived from in-situ tests, references, etc.). Appropriate sections of Chapters 1-5 will be referenced as needed. A description of the site characteristics needed to perform the design analysis will be provided.

Specific consideration will be given to rock strength, rock discontinuities, in-situ stress, thermal properties, the hydrologic regime, stratigraphy, and seismic motion. Uncertainties in these site characteristics will be quantified to the extent possible. A reasonable expected range for each characteristic will be established, either through quantitative analysis or using engineering judgment, as appropriate. Discussions of the methods used to establish these ranges will be included.

6.1.3 Analytical Tools for Geotechnical Design

This section will present the analytical tools used in establishing and analyzing the geotechnical design.

The description of the computer codes being used will include author, ownership, and code name; a description of analysis that the code performs; and design areas for which the code is used. References will be made to Chapter 8, discussions of performance assessment, as required.

6.1.4 Structures, Systems, and Components Important to Safety

Reference will be made to the information presented in Sections 2.7, 4.6, and 7.4 of the SCP-CDR. This section will present the list of structures, system, and components important to safety, including only those items that need to be considered for planning site characterization. Status of the safety analyses work for each item on the list will be provided. Applicable items in the list will be linked to the appropriate test plans in Section 8.3 and to the appropriate design items and construction plans in Section 8.4 with suitable reference. The list presented in this section will be preliminary and will be subject to change as the design is developed further.

6.1.5 Engineered Barriers Important to Waste Isolation

Reference will be made to the information presented in Sections 2.7, 4.6,

and 7.4 of the SCP-CDR. This section will present the list of items important to waste isolation, including only those items that need to be considered for planning site characterization. Status of the performance assessments for each item on the list will be provided. Applicable items in the list will be linked to the appropriate test plans in Section 8.3 and to the appropriate design items and construction plans in Section 8.4 with suitable reference. The list presented in this section will be preliminary and will be subject to change as further information about the site is obtained and the design is developed further.

6.2 CURRENT REPOSITORY DESIGN DESCRIPTION

This section will describe the current design concepts. Design information will reflect current design concepts being considered for the site. The design description will reference design documents or portions of the documents that are consistent with the reference concepts. Design concepts known to be outdated will not be presented for the sake of including greater detail in the SCP.

The description of design concepts will focus on design features that are influenced by site characteristics. Details of the design will be included in the SCP, where they are important to planning site-characterization. It will be noted that design development and the site testing program are interactive, and that design detail will progress during the site characterization program.

Major alternative design concepts currently being considered in the design process will be described, along with a discussion of how the alternatives allow for parametric uncertainty and subsystem component tradeoffs.

Where uncertainties in site or other SCP-related design parameters are currently identified, plans for bounding design parameters and for performing preliminary sensitivity analyses will be discussed or referenced as appropriate. These plans will indicate how parametric changes on system or component performance will be assessed.

6.2.1 Background

This section will summarize the background and history of repository design for the site and will explain how the design has evolved to its current status.

6.2.2 Overall Facility Design

The information provided on repository design in this section will include a description of the design concept along with the general arrangement drawings of the repository as a whole. The description and drawings will show how the surface, subsurface, and shafts and/or ramps are integrated with the site. The general arrangements shall include the location of site characterization boreholes and the Exploratory Shaft Facility (ESF).

6.2.3 Repository Operations

This section will describe the current surface and subsurface waste transport, emplacement, and retrieval concepts. The current emplacement and retrieval descriptions will account for "normal" and "anticipated" failure conditions. The results will be provided or the plans will be referenced for performing accident analyses. In addition to the operational accident analysis, other problems will be included which could prevent the emplacement holes or waste packages from functioning as anticipated (e.g., emplacement hole failure, container failure, stuck container).

6.2.4 Design of Surface Facilities

This section will describe and provide drawings of the most recent concepts for surface facility layout. These drawings will illustrate the major surface facility arrangements, including shafts/ramps, buildings, structures, major utility corridors, material, and extensive storage area(s). This section will also provide current drawing(s) of the existing surface features and terrain, and a general layout of structures and facilities within the site area(s) such as buildings, wells, roads, drainages, utilities, etc. Sources of water for construction and operation will also be identified.

6.2.4.1 Foundation Considerations

This section will discuss the properties of surface materials and foundation soil or rock considered in the design of structural foundations for the above surface facilities. Expected or known soil and rock conditions, and the depth to and quality of foundation soil or rock will be described. Any known or inferred foundation problems will be discussed.

6.2.4.2 Flood Protection

This section will describe the consequences of all types of flooding that could occur at the candidate area and site, and the methods by which the surface and underground facilities will be protected from surface flooding.

6.2.5 Shaft and Ramp Design

This section will describe the functions of the shafts/ramps and will provide or reference drawings which show the location and general arrangement of shafts and ramps. Alternative design, construction, and lining concepts under consideration will be described in this section.

6.2.6 Subsurface Design

This section will describe the general layout and design of underground openings. Drawings will be provided or referenced to show the relationship of shafts, ramps, drifts, ES facilities, and known or inferred geologic discontinuities. Sketches or drawings will be provided with a narrative description of all underground excavations, including their functions and general arrangement.

6.2.6.1 Excavation, Development, and Ground Support

Excavation, shaft sinking, and muck removal methods currently being considered will be described. The ground support design and shaft lining design with installation methods will also be described.

6.2.6.2 Ground-Water Control

Proposed methods for controlling ground-water inflow that may be encountered during construction and operation will be described. Methods for dealing with high pressure water sources, if encountered, will be discussed. In addition, the pumping system concept which will handle water inflow from the subsurface to the surface will be described.

6.2.6.3 Ventilation

Air flow logic diagrams, with estimated air quantities and velocities for the development and emplacement ventilation systems, will be described.

6.2.7 Backfill of Underground Openings

Describe the need for backfill and decommissioning seals in the repository design. If backfill or seals are required, preliminary materials, specifications, the functions, handling, and emplacement concepts will be provided.

6.2.8 Shaft and Borehole Seals

6.2.8.1 Shaft Seal Characteristics

A conceptual description of shaft seals will identify components (e.g., backfill, seals, cutoffs, rock treatment) for shaft seals for each of the repository shafts that will be sealed and will indicate their tentative locations.

For each component of the shaft seals, this section will describe key features, types of seal materials, seal materials properties (mechanical, chemical, hydrologic), backfill material properties, and properties of the rock and ground water surrounding the shafts that are relevant to shaft seal design, if such information is available.

Shaft seal design will be addressed in reference to shaft sinking method, shaft lining, and any treatment of the rock for stability and ground-water control necessary for repository construction and operation. The uncertainties (quantitatively, where possible) in the site characteristics affecting design (in particular, those of the rock immediately surrounding the shafts) and in the material properties for sealing materials will be identified.

6.2.8.2 Shaft Seal Emplacement

The construction method and the general construction sequence will be described for each component of the shaft seals proposed.

6.2.8.3 Borehole Seal Characteristics

The approximate number and location of the boreholes that require sealing will be listed. Any boreholes drilled by others prior to site characterization will be identified.

Borehole seal design will be addressed with consideration of borehole casings and other materials placed in the borehole, and any damage of the rock surrounding the borehole during drilling and subsequent use of the borehole (e.g., hydrofracturing). The expected range of parameters and associated uncertainties (quantitatively, where possible) in the site characteristics affecting borehole seal design and in the material properties for sealing materials will be identified.

For each of the various types of borehole seals that are important to postclosure performance, this section will describe key features, types of seal materials, seal material properties, and properties of the rock and ground water surrounding the boreholes that are relevant to borehole seal design. If such information is not yet available, plans will be referenced for its development.

6.2.8.4 Borehole Seal Emplacement

This section will describe the methods for borehole seal placement, including the sequence of sealing each borehole type and the timing of sealing relative to repository construction, operation, and closure.

6.3 ASSESSMENT OF DESIGN INFORMATION NEEDS

6.3.1 Introduction

This section will explain the relationship between the repository design described in Section 6.2 of this outline and the elements listed in Chapter 6 of Regulatory Guide 4.17 (Proposed Revision 1, September 1984). The design regulations will identify the design information required for licensing and, consequently, the data requirements on the site characterization program. The data requirements will be evaluated including the sensitivity of data accuracy and the effect of uncertainty on the design. These data requirements supported by the evaluation of the sensitivity and uncertainty will partially determine the in-situ testing plans.

6.3.2 Design of Underground Openings

This section will reference the general layout and design of proposed subsurface openings, and will show their relationship to proposed plans for in-situ testing at depth and to known or inferred geologic and hydrologic conditions of the site. Proposed locations of shafts will be related to the proposed plan for in-situ testing at depth and to known or inferred subsurface conditions. Shaft stability based on inferred subsurface rock stresses and ground-water conditions and their relationship to the proposed test shaft(s)

will be discussed. Test considerations for ground-water conditions, thermal output, the natural and thermally induced stress regime, rock creep where applicable, and the need for ventilation will be included in the discussion. Factors such as space requirements for emplacement of the waste, layout requirements for separation and control of excavation, and waste emplacement operations, ventilation requirements, and worker safety considerations will be related to the test requirements.

6.3.3 Backfill

Section 6.2.7 will be referenced for the proposed characteristics and functions of the backfill material handling and emplacement. The mechanical properties of the proposed backfill that are critical for the site and design will be provided. This section will discuss the relationship between the mechanical properties of the proposed backfill and the expected conditions at the site (e.g., temperature, moisture, stress, radiation). The geochemical characteristics of the backfill materials will be described, as well as anticipated chemical interactions among the waste package, backfill, ground-water, and host rock under assumed waste emplacement conditions. The measured or inferred material and site parameters used to estimate those reactions will be identified. Any effect of the backfill on retrieval procedures will be described as well as any effects of radiation on the backfill or its interactions. (The geochemical discussion here will be in sufficient detail to describe the geochemical role of the backfill at the site. The full descriptions of the geochemical investigations on the waste form, container, packing, rock, and ground-water interactions will be provided in Chapter 4 - GEOCHEMISTRY, in Chapter 7 - WASTE PACKAGE, or in Chapter 8 - SITE CHARACTERIZATION PROGRAM.)

6.3.4 Strength of Rock Mass

This section describes the testing requirements necessary to supplement or confirm preliminary design values used for the mechanical properties of the rock, including elastic and inelastic behavior of the rock mass, the thermomechanical behavior of the rock mass, and the mechanical behavior of rock discontinuities (e.g., joints, shear zones). A description of how these requirements were determined is included, as well as a description of effects of radiation on these properties. (The rock mechanics information will be presented here in sufficient detail to describe the relationship of the rock properties to the design. The full description of the rock mechanics background will be presented in Chapter 2 - GEOENGINEERING). This section will also describe how these values for the mechanical and thermomechanical behavior of the rock were used in developing the design of a repository. Plans for confirming the results of model studies used in developing the design of a repository appropriate to the site will be presented in Chapter 8.

6.3.5 Sealing of Shafts, Boreholes, and Underground Openings

This section will reference the design of proposed treatment of the disturbed section of rock around openings and excavated surfaces, the proposed design measures to control ground-water movement into the facility, and the available laboratory and field data. The geochemical characteristics of the seal material will be described, as well as the anticipated chemical interactions among the seal materials, ground water, host rock and backfill, under assumed emplacement conditions. It will also describe methods for confirming inferred site conditions on which the selection of the treatment measures was based. The proposed design for the sealing of boreholes and shafts will be referenced, as well as available laboratory and field data and methods for confirming inferred site conditions on which the design was based.

6.3.6 Construction

This section will describe construction techniques being considered for potential repository development at the site as well as any known or inferred site conditions requiring specialized construction techniques. It will also describe how the construction of exploratory workings at the site will not compromise the integrity of the site.

The methods under consideration for breaking and removing rock during construction will be described. The potential for the construction to cause additional fracturing will be assessed, and any special action taken to minimize propagation of additional fractures that could be potential pathways considering the inferred rock conditions will be noted. This section will also describe how the planned excavation techniques match the expected site characteristics and rock mass properties. (The full description of excavation investigations will be given in Chapter 2 - GEOENGINEERING). Temporary or permanent rock reinforcement and rock support structures proposed will be described, and the compatibility with rock mass properties will be discussed. In addition, this section will discuss or reference methods planned to control, collect, and dispose of ground-water during excavation and their compatibility with the data obtained from exploratory investigations.

6.3.7 Design of Surface Facilities

This section will describe tests to confirm properties of surface materials and foundation soil or rock considered in the design of structural foundations for surface facilities, including known or inferred foundation problems. It will also discuss or reference the sources of water for construction and operation of the proposed facilities.

6.3.8 Mined Geologic Disposal System Component Performance Requirements

Preliminary numerical values for the performance goals and design criteria for the MGDS will be provided to ensure that the MGDS as a whole meets the overall regulatory requirements. As the design evolves, these goals will be subdivided to the component level and will evolve into system and component requirements.

Early assignment of numerical goals for systems and components cannot be accomplished with a high degree of accuracy.

The general nature of the design and performance assessment will establish what site data need to be obtained. The specific analytic tools used in the design process and performance assessment will establish the accuracy requirements on the data collection and analysis systems. Tentative values for acceptable ranges of natural barrier properties can be established using an assumed design. If the measured natural barrier data falls within the initially assumed values only modest design changes are required. If the measured site values fall outside the initially assumed values more extensive design changes may be required to continue to meet the overall repository performance requirements.

6.4 SUMMARY OF DESIGN ISSUES AND DATA NEEDS

This section will provide a summary of design issues and related data needs, and will be cross-referenced to appropriate sections of Chapter 6.3 and Chapter 8.

REFERENCES

A list of all pertinent references will be provided.

Chapter 7 - WASTE PACKAGE

7.0 INTRODUCTION

This section presents a brief overview of the site characterization waste package design task and develops information necessary to indicate the role of the topical material covered in the chapter. It will introduce in a brief fashion:

- The components of the waste package
- A statement of the requirements (e.g., regulatory requirements - 10 CFR 60)
- The history of the waste package investigations
- The topics that will be discussed in this chapter
 - emplacement environment,
 - design basis,
 - design descriptions, and
 - status of waste package research and development.

7.1 EMPLACEMENT ENVIRONMENT

This section will describe the waste package environment, including the host rock immediately adjacent to the waste package. Repository location, depth, water conditions, and other pertinent physical, chemical, and radiological characteristics will be discussed or referenced to other SCP chapters.

Geotechnical parameters that are pertinent to the waste package environment, such as external pressure, rock density, porosity, moisture content, thermal conductivity, heat capacity, and geochemical parameters, will be discussed or referenced to other SCP chapters. Uncertainties in these characteristics will be quantified to the extent possible. A reasonable expected range for each characteristic will be established, either through quantitative analysis or engineering judgment.

Relevant chemical, physical, and radiation conditions and processes between the waste package and its environment that could compromise or enhance waste package performance will be discussed or referenced.

7.2 DESIGN BASIS

This section will present the requirements that are specific to each project and that were used as the basis for waste package design. The relationship of these requirements to 10 CFR Part 60 requirements will be identified. The section will include a summary discussion of the function of

each waste package component in meeting the overall waste package performance requirements. Preliminary numerical values for the performance goals and design criteria for the waste package system will be provided to assure that the waste package as a whole meets the overall regulatory requirements. As the design evolves, these goals will be subdivided to the component level and will evolve into system and component requirements. A quantitative description of design constraints used in developing the design (e.g., maximum heat loads, maximum temperatures, maximum radiation levels) and references to appropriate documentation which supports the constraints will be included.

Reference will be made to the information presented in Sections 6.1.4 and 6.1.5 of SCP Chapter 6 that includes waste package items important to safety or waste isolation.

7.3 DESIGN DESCRIPTIONS

This section will introduce the subject of waste package designs. Reference designs and alternative designs will be included.

7.3.1 Reference Design

Current reference waste package designs considered appropriate for the emplacement environment will be described, including candidate waste forms and waste package materials. To the extent information is available, this section will include the following:

- A description of the reference designs in narrative form and illustrative sketches of the waste package design for each waste type
- A narrative description of waste package component materials, waste package material properties and chemical compositions, and the range of expected variations
- A description of the ways in which the spectrum of spent fuel waste types will be accommodated within the waste emplacement package concept (e.g., what provisions will be made to accommodate intact fuel assemblies and consolidated rods; how rods consolidated at reactors will be accommodated; how short-cooled or high-burnup spent fuel will be accommodated)
- A quantitative description of important waste package parameters such as overall dimensions, wall thickness, heat loads (expected values and range), number of assemblies (of various types), and radiation levels (expected values and range)
- A description of waste package component fabrication and assembly processes and their potential impact on performance.

7.3.2 Alternative Designs

This section will describe the waste package designs that will continue to be considered as alternatives to the reference design. Alternative design concepts will be presented in a level of detail adequate to allow identification of site data needed to support development of those designs. A description of the factors arising from the characterization program which could lead to selection of an alternative over the reference design concept will be provided. Alternatives that have been considered and dropped from further consideration will be included by way of reference to appropriate design concept selection reports.

7.4 RESEARCH AND DEVELOPMENT STATUS - WASTE PACKAGE DESIGN AND GEOCHEMICAL INTERACTIONS

This section will summarize the available results of tests and analyses related to waste package performance. The status or results of the following waste package test activities will be described as applicable:

- Tests aimed at characterizing the waste package environment
- Tests of appropriate waste package components such as waste forms, metal barriers, and packing materials.
- Component interaction tests, including waste-barrier and waste-barrier-rock interaction tests
- Tests to evaluate processes which might be active in the waste package environment and might affect a component's ability to perform its assigned functions
- Tests to determine releases of matrix and/or radionuclide species from the waste form under anticipated waste package environmental conditions (e.g., temperature, oxidation state).

The role of predictive models in the design of the waste package will be addressed briefly. The availability and interrelationship of individual component models will be discussed. Quantitative estimates of the performance of each component with respect to its assigned function and preliminary estimates of the performance of the waste package as a whole will be included. Analytical results related to demonstration of reasonable assurance of compliance with regulatory requirements will be presented. Results of available sensitivity studies of performance related to expected variation in parameters will also be provided. As available, analysis of failure modes and effects will be provided or referenced.

7.5 SUMMARY

This section will link the data and analyses presented in Part A - Chapter 7 to Part B of the Site Characterization Plan. It will include the following material:

- Synopsis of the significant results with respect to performance of the waste package reference design
- Discussion of the major design issues and related information needs. Refer to appropriate Chapter 8 subsections for plans to obtain the necessary information.

REFERENCES

A list of all pertinent references will be provided.

PART B
SITE CHARACTERIZATION PROGRAM

Chapter 8 - SITE CHARACTERIZATION PROGRAM

8.0 INTRODUCTION

This section will provide a brief introduction to Part B, Site Characterization Program, of the Site Characterization Plan (Chapter 8). The section will discuss the purpose, significance, content, and organization of Chapter 8. In addition, it will discuss the relationship of Chapter 8 to Part A, Description of the Mined Geologic Disposal System (Chapters 1 through 7). Finally, it will discuss the relationship of Chapter 8 to separate program documents which will present plans for conducting site investigations, including environmental studies and socioeconomic studies.

Purpose of Chapter 8

This chapter will present the rationale behind the proposed site characterization program and will describe in detail the program of exploration and testing to be conducted during site characterization. The description of the site characterization program at the named sites will include:

- Issues to be resolved and information to be acquired during site characterization
- Investigations to be performed
- Schedule, sequence, and duration of testing and data analyses
- Extent of planned excavation and in-situ at-depth testing
- Elements of the design of a repository appropriate to the site relevant to data acquisition, analyses, and scheduling
- Key milestones against which the progress of site characterization can be measured
- Provisions to control or mitigate any adverse safety-related impacts from site characterization activities that are important to safety or that are important to waste isolation
- The quality assurance methods to be used in data acquisition and analysis
- Decision points at which the direction of the site characterization program might be changed if warranted by the results obtained.

In addition, this section will stress the significance of Chapter 8 in providing the link and focus between data that has already been obtained for a site and has been presented in Chapters 1 through 7, and data that will be acquired during site characterization.

Relationship of Chapter 8 to Chapters 1 through 7

This section will discuss the relationship between Part B, Chapter 8, Site Characterization Program and Part A, Chapters 1 through 7, Description of the Mined Geologic Disposal System.

Part A, Chapters 1 through 7 will present a synthesis of all relevant information concerning site characterization and repository and waste package design that will be available at the time the SCP is written. In addition these chapters will briefly describe how the information in the chapter and the information to be obtained will be used.

The depth of information provided will consider the need for flexibility to account for the exploratory, developing nature of the investigations. The initial investigation steps may need to be completed before a full program can be developed. The relative importance of various aspects of the program will change as investigations proceed. A phased approach to testing is necessary. Flexibility is required not only to make fine adjustments in the investigations on a particular subsystem or technical program area, but also to make major shifts in the overall program based on the results of ongoing system performance assessments. The relative priorities among the investigations of the subsystems will change as data are gathered, analyzed, and evaluated. Thus, plans may be better defined and more detailed for early phases of site characterization, and less detailed for later phases.

Part B, Chapter 8 will provide the rationale behind the proposed site characterization program and will describe in detail the program of exploration and testing to be conducted during site characterization. The level of detail will be sufficient to determine whether adequate information for licensing will be produced.

Organization of Chapter 8

This section will present the overall organization of Chapter 8 and a summary of the contents of the chapter. The section will explain how Chapter 8 will provide a general description of investigations to be conducted during site characterization, and that the details of tests and analyses will be provided separately in study plans.

Relationship of Chapter 8 to Other Plans

This section will describe the relationship of Chapter 8 to plans to obtain other information required by 10 CFR 960. The scope of the discussions of the plans in Chapter 8 will be limited to activities undertaken to establish the geologic conditions of a candidate site relevant to the location of a repository, and activities that are important to containment and isolation of the waste and the safe construction, operation, and closure of the repository.

Other site investigation activities which will establish the preclosure radiological safety, environmental, transportation, and socioeconomic characteristics of the site will be conducted concurrently with the site characterization activities described in Chapter 8. Plans for these site investigation activities will not be presented in the Site Characterization Plan. They will be presented in separate documents which will be made available to the public on a separate schedule.

8.1 RATIONALE FOR THE PLANNED SITE-CHARACTERIZATION PROGRAM

This section will introduce the concepts of the issues hierarchy and the issue-resolution strategy that will be common to all of DOE's SCPs. It will describe in general terms the rationale and logic for identifying and resolving issues.

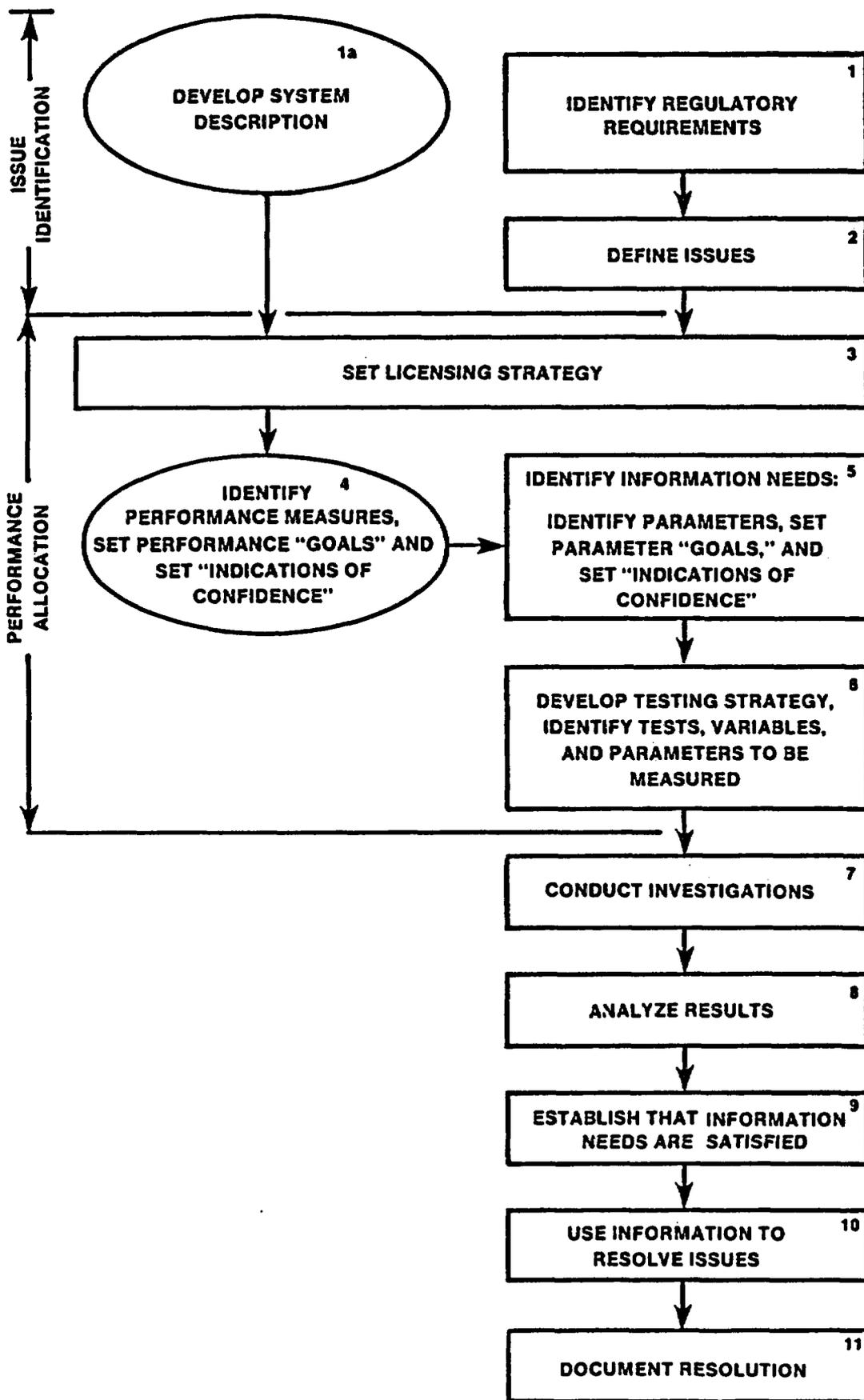
8.1.1 The Issues-Based Approach to Planning Site Characterization

This section will describe how issues are used to guide development of plans for site characterization. The issues in the issues hierarchy are defined as the questions relating to the performance of the MGDS that must be resolved to demonstrate compliance with the applicable Federal regulations (including 10 CFR Part 60, 10 CFR Part 960, 40 CFR Part 191, and 10 CFR Part 20). The section will explain that issues are organized in an issues hierarchy and will discuss the general structure and the conceptual content of the issues hierarchy, referring the reader to Section 8.2, where the issues hierarchy, is presented and discussed. It will explain the general basis for the identification of issues in the hierarchy (10 CFR Part 960, 40 CFR Part 191, 10 CFR Part 60, Mission Plan), describe the three-tiered structure of the hierarchy (key issues, issues, and information needs), and briefly describe the three categories of issues (performance, design and characterization) and their relationship. It will explain that the key issues and issues in the hierarchy are those of the OGR Issues Hierarchy (OGR/B-10), common to all of DOE's SCPs, but that the information needs are site-specific.

8.1.2 Issue-Resolution Strategy

This section will describe the general approach to issue resolution, as represented in the diagram of the issue-resolution strategy (see Figure 1). It will describe the general application of the strategy to performance design and characterization issues. It will explain the purpose of performance allocation and discuss the steps of the performance-allocation process: establishing a licensing strategy, defining performance measures, identifying information needs, and developing the testing strategy. It will include the approach to establishing priorities for information needs; combining information needs common to program elements; identifying the studies, tests, and analyses required to obtain the information; and formulating detailed study plans.

This section will explain how the issue-resolution strategy and its components will be used to demonstrate compliance with regulatory requirements, including the higher-level findings for the siting guidelines. It will explain how the information developed in the issue-resolution process will be used for final design, site selection, and the preparation of the license application.



Revision 1

Figure 1. Issue resolution strategy.

8.2 ISSUES TO BE RESOLVED AND INFORMATION REQUIRED DURING SITE CHARACTERIZATION

This section will present the site-specific issues hierarchy and describe how that issues hierarchy is used in planning the site characterization program.

8.2.1 Issues to be Resolved

8.2.1.1 Site-Specific Issues Hierarchy

The section will present the site-specific issues hierarchy related to siting and licensing of an MGDS that will be resolved by information acquired during site characterization. It will include a presentation of the key issues and issues of the OGR Issues Hierarchy and the site-specific set of information needs for each issue, which make up the third tier of the site-specific issues hierarchy. Site characterization as defined by the Nuclear Waste Policy Act means those activities undertaken to establish the geologic condition and ranges of parameters at a candidate site. Site characterization does not include activities undertaken to establish site conditions relating to socioeconomics, transportation, and the environment. Key Issue 3, which covers these areas of concern, therefore, will not be discussed in the SCP.

The discussion of the issues and information needs will be brief, referring to Section 8.2.2 for a detailed discussion of each issue, the rationale for the identification of the information needs, and how the information needs are necessary and sufficient for the resolution of the issues. The issues and information needs presented in this section will be closely correlated with the subsections of Sections 8.3 presenting the plans for conducting investigations, studies, tests, and analyses necessary to resolve issues.

8.2.1.2 Other Issues

This section will explain the relation of the site-specific issues hierarchy to other previously developed issue sets such as those presented in the Mission Plan, NRC-Issue-Oriented Site Technical Positions, and issues identified by NRC in site characterization analyses. It will include a matrix correlating the site-specific issues hierarchy with other major issue sets.

8.2.2 Approach to Issue Resolution

This section will describe the strategy that has been developed to resolve each of the issues associated with Key Issues 1, 2, and 4 and will identify the information needs resulting from this strategy. The strategies will be developed using the general approach to issue resolution described in Section 8.1.2.

For each performance issue the section will present issue resolution strategies that provide or reference (to Section 8.3) the following information:

- **Licensing strategy**

The anticipated approach to the demonstration of compliance with the regulatory requirements addressed by the performance issue will be presented. Current information supporting this approach will be provided or referenced to other sections of the SCP. This information includes descriptions of the elements of the system pertinent to the resolution of the issue, conceptual models (including alternative models), expected conditions, and scenarios for disruptive processes and events relevant to the issue.

The system elements that will be relied upon to resolve the issue and that require information from the site characterization program will be identified. These elements include those primary elements (e.g., barriers) that will be relied upon to meet performance objectives associated with the issue, as well as those elements (and related processes) that could adversely affect performance. The elements to be specified as held in reserve will also be identified. The functions of each system element in meeting the performance objectives will be specified. The processes that should be taken into account in evaluating the performance of the element will also be specified.

- **Performance measures, performance goals, and indications of confidence**

The performance measure selected for each specified function of a system element will be identified. A performance measure is a physical quantity that indicates the level to which a function is performed. A performance goal will be selected for each performance measure. These goals are values which, based upon current information, appear to be obtainable and consistent with meeting the regulatory requirements associated with the issue. The performance goals are not criteria, need not be identical to performance objectives or other regulatory requirements, and are not something that must be attained for the issue to be resolved. For each goal an indication of confidence that should be achieved will also be specified. This indication of confidence depends upon the level of uncertainty that would be acceptable for the performance goal. The rationale for performance goals and indications of confidence will be given.

- **Information needs**

The information needs for the issue will be identified and described. These information needs are categories of information that will be obtained in the site characterization program to address the performance issue; they correspond to the objectives of the investigations to be conducted in the site characterization program. Information needs will be identified on the basis of the sets of parameters needed to evaluate the performance measures. For each parameter needed a parameter goal will be set. The goal chosen will depend upon the goal for the associated performance measure and the goals chosen for other parameters that will be used in the evaluation of the performance measure. Likewise, an indication of confidence, or the level of confidence needed for the parameter goal in order to

meet the associated performance goal, will be specified. Additional information needs may be specified that include such items as scenario probabilities and characteristics, analytical models that will be used in the analyses, or design information that will be developed during site characterization. If parameters or other information are required from the design issues, the appropriate design issue should be referenced.

- Link to testing strategy and site characterization program

For each information need that identifies design or characterization parameters, the design or characterization issues that encompass those parameters will be referenced. For each of the other information needs, the investigation that addresses the information need will be identified and the description of the investigations will be referenced to Section 8.3.

For each design issue of Key Issues 1, 2, and 4, the section will present issue resolution strategies for the two functions of the design issues: (1) to show compliance with design criteria, and (2) to provide information for resolution of the performance issues. With respect to the first function, the section will present or reference (to Section 8.3) the following information:

- Licensing strategy

The anticipated approach to meeting the design criteria addressed by the design issue will be presented. Current information supporting this approach will be provided or referenced. This information includes the system elements (subsystems and components) that will be designed or relied upon to meet the design criteria and that require information from site characterization. The role of each of these elements in meeting the design criteria will be specified. The processes that should be taken into account in evaluating the performance of the elements will also be specified.

- Performance measures, performance goals, and indications of confidence

The performance measures selected for each specified function of a system element will be identified. Goals for each performance measure will also be provided. The indication of confidence that should be achieved for each goal will also be specified. The rationale for the goals and indications of confidence will be given.

- Information needs

The information needs associated with the specified performance measures will be identified and described. These information needs are the categories of information to be obtained in the site characterization program to address this function of the design issue; they correspond to the objectives of the investigations to be conducted in the site characterization program. Information needs will be identified on the basis of sets of site and design parameters to be obtained in the site characterization program to evaluate the performance measures. For each parameter needed, goals and indications of confidence for the goals will be set. Additional

information needs may be specified based on the identification of other needed information (e.g., analytical models to be used in design analyses).

- Link to testing strategy and the site characterization program

For each information need, that identifies design or characterization parameters the design or characterization issues that encompass those parameters will be referenced. For each of the other information needs, the investigations that address the information needs will be identified and the description of the investigations will be referenced to Section 8.3.

With respect to the second function of the design issue, the section will present or reference the following information:

- Information required by performance issues

The information needs (including parameters) that are identified in the issue resolution strategies for the performance issues and that are relevant to the design issue will be identified. The parameters that are needed to evaluate the performance measures will be identified, along with their goals and indications of confidence, and will be consolidated and grouped into sets of information needs for the design issue.

- Link to testing strategy and the site characterization program

For each information need that identifies characterization parameters, the characterization issue that encompasses those parameters will be referenced. For each of the other information needs, the investigations that address the information needs will be identified and the description of the investigations will be referenced to Section 8.3.

For each characterization issue covered in the SCP, the section will present issue resolution strategies that provide or reference (to Section 8.3) the following information:

- Information required by performance and design issues

The information needs (including the parameters) that are identified in the issue resolution strategies for the performance and design issues and that are relevant to the characterization issue will be identified. The parameters that are needed to evaluate the performance measures for the performance and design issues will be identified, including the goals and indications of confidence for these parameters, and will be consolidated and grouped into sets of information needs for the characterization issue. The information needs for characterization issues represent categories of site information needed and grouped according to area of study.

- Link to testing strategy and the site characterization program.

The descriptions of the investigations that address the information needs for the characterization issue and that present the testing strategies for those information needs will be referenced to Section 8.3.

This section will be closely correlated and cross-referenced with Section 8.3, where the proposed plans for the investigations to obtain data needed to address unresolved issues during site characterization, including the specifications for performing the investigations and the applicability and limitations of the investigations for resolving the issues, will be described.

8.2.3 Issue Tracking

This section will present a description of an issue-tracking system. The issue-tracking system will be capable of providing a summary of the issue resolution status for each issue and a link to documents that provide detailed information relevant to the issue (e.g., results of site-characterization activities, detailed plans for site-characterization activities). The need for developmental work on the system, and the procedures and schedule for implementation of the system, should be discussed.

8.3 PLANNED INVESTIGATIONS

This section will describe the investigations to be conducted during site characterization. This section will relate the investigations to information presented in Part A or to the unresolved issues discussed in Section 8.2. The relationship between the site-characterization program and the system performance goals will be described.

For the proposed investigations involving tests and other data-collection activities, Chapter 8 will describe and support with a technical rationale the systematic features of the planned programs that are designed to ensure that--

- Data are representative of the properties or behavior of the feature, component, system, or process with respect to extent and duration that are significant to required findings.
- Data are known to the precision and accuracy necessary to make the required findings.
- Data are collected and analyzed under the quality assurance procedures as described in Section 8.6.
- Characterization activities will be conducted such that adverse safety-related impacts, if any, that could affect waste isolation will be controlled.

The description of the site characterization program in Section 8.3 will use a hierarchy of terms for individual activities and groups of activities. At the lowest level in the hierarchy are individual tests and analyses. Tests include the measurements of physical parameters or observations of physical phenomena and are performed in the field or in the laboratory. Test activities include the preparation of procedures, test setup, conduct of the test, data acquisition, and data reduction. Analyses include the calculations or other evaluations needed to assess site characteristics and support design activities. A study comprises a single test or a set of tests and analyses, as appropriate. An investigation comprises a single study or set of studies, as appropriate. Investigations are grouped into five generic programs, corresponding to the five subsections of Section 8.3 (i.e., site, repository, seal system, waste package, and performance assessment). The site program is further divided into five more specific programs.

Section 8.3 of the SCP will describe the generic programs, specific programs, and investigations that comprise the total site characterization program. Details for studies and tests and analyses, listed in Chapter 8, will be presented in study plans separate from the SCP. Individual test procedures will be referenced in the study plans.

Table 1 describes the content requirements for investigations that will be presented in Section 8.3. The items listed in the outline will be addressed for studies and tests and analyses to the extent that each item applies. Not all items will be applicable in all studies.

The description of investigations for site characterization in Chapter 8 will be guided by the following:

- Each investigation described will be clearly related to the information needs.
- The investigation descriptions will relate test conditions to expected repository conditions.
- If the purpose of the tests is to guide the development of subsequent tests, the application of expected test results to the development of follow-up testing will be described.
- The process by which the acceptable range of expected test results will be established will be discussed.

This section will also describe testing for purposes other than site characterization, to the extent that such testing influences the selection and conduct of tests for site characterization. The performance-confirmation tests required in 10 CFR Part 60, Subpart F, will be addressed in Chapter 8 in this regard, with particular attention to the tests that will be initiated during site characterization.

Table 1. Content Requirements for Descriptions of Investigations

I. Purpose and objectives of investigations

- Describe the information that will be obtained in this investigation. Briefly discuss how this information will be used.
- Provide the rationale* and justification for the information to be obtained by the investigation. It can be justified by (1) a performance goal and a confidence level for that goal (developed via the performance allocation process described in Section 8.1.2); (2) a design goal and a confidence level in that goal (design goals beyond those related to performance issues); and (3) a direct Federal, State, or other regulatory requirement for specific studies. Where relevant performance or design goals actually apply at a higher level than the investigation (e.g., where the goals apply to a group of investigations), describe the relationship between this investigation and that higher level goal.

II. Rationale for selected investigation

- Provide the rationale* and technical basis for why the investigation will be conducted. Identify relevant technical issues.
- Describe the constraints that exist for the investigation, explain how these constraints affect selection of studies, include a summary of the interrelationships involving significant interference among studies and investigations and how plans have been designed or sequenced to address such interferences, and include a summary of the interrelationships involving significant interferences among studies and the design and construction of the exploratory-shaft facility.
- Discuss the strategy, including how the planned studies, tests and analyses will be collectively used for resolving the relevant technical issues.

III. Description of studies

- Since investigations consist of one or more studies, for each study--
 - State the objectives of the study, including those of the tests and analyses that make up the study.
 - Indicate whether the study is to provide information for the development of conceptual models (e.g., the collection of water-level data will provide input to the development of the conceptual and numerical ground-water flow models).
 - Indicate whether the study is being performed to guide the development of subsequent characterization, performance assessment,

* Sections I and II both require that the 'rationale' for the investigation be provided. In Section I, rationale refers to an explanation of why the information to be obtained by the investigation is needed. In Section II, rationale refers to an explanation of how the investigation is necessary and sufficient, in general terms, to obtain the needed information.

Table 1. Content Requirements for Descriptions of Investigations (Continued)

or design activities (e.g., simulations with ground-water flow models will be performed to determine where additional drilling will be required).

- List the tests, the test methods to be used, the data and parameters that are to be collected or evaluated for each test, the locations and numbers of tests, and the technical procedures that will be used for the test. Reference the study plans, as appropriate.
- For each analysis that the study will support, list the method of analysis and the information that will result from the analysis.

IV. Application of results

- Briefly discuss where the results from the investigation will be used for the support of other investigations (performance assessment, design, and characterization investigations).
- For performance-assessment uses, refer to specific performance-assessment studies that will use the information produced from the studies described above and refer to any use of the results for model validation.
- For design uses, refer to or describe where the information from the studies described above will be used in construction-equipment design and development and engineering-system design and development (e.g., waste package, repository engineered barriers, and shafts and borehole seals).
- For characterization uses, refer to or describe where the information from the studies described above will be used in planning other characterization activities.

V. Schedule and milestones

- List in tabular form major milestones that will result from the studies that comprise the investigation. Include proposed titles and expected delivery dates.
- Present the schedule for the studies supporting the investigation, providing beginning and end dates for tests and analyses, or groups thereof.
- Show the interrelationships and sequencing of the tests, analyses, or groups, with particular attention to those that will affect, or be affected by, the scheduled completion of other activities. Dependences on data derived from other investigations should also be indicated on the schedule as well as the major milestones and decision points associated with the studies. A simple PERT chart should be used to illustrate these relationships.

8.3.1 Site Program

This section will describe the planned site-characterization investigations required to characterize the geology, hydrology, geochemistry, climatology, and resource potential of a candidate area and site to meet regulatory standards, guidelines, and requirements for licensing a mined geologic disposal system.

Discussions in Sections 8.3.1.2 through 8.3.1.6 of the planned investigations will explain--

- Why the investigation is planned and what data or information will be obtained.
- How the results will be used to help resolve specific information needs.
- What methods, techniques, and data analysis will be used.

In addition, discussion of in situ tests will include--

- A description of tests that might use radioactive materials.
- A description of tests that might affect the capability of the site to isolate waste.
- A summary of how significant environmental impacts, if any, resulting from site-characterization activities are minimized or mitigated.

The content requirements for each investigation to be described in this section are listed in Table 1.

8.3.1.1 Overview

This section will state the purpose of Section 8.3.1 and provide an overview of the site program. The overview will summarize the overall objectives and approach of the site program. The interrelationships and sequencing of the primary activities of the program will be described.

8.3.1.2 Geology

This section will present the investigations to characterize the geomorphologic, stratigraphic, mineralogic and petrologic, and tectonic systems of the candidate area. Past drilling and mining will be addressed.

8.3.1.3 Hydrology

This section will present the investigations to characterize the surface and subsurface hydrologic systems of the candidate area.

8.3.1.4 Geochemistry

This section will present the investigations to characterize the far-field and near-field geochemical systems of the candidate area.

8.3.1.5 Climatology

This section will present the investigations to characterize the meteorology and paleoclimatology of the candidate area.

8.3.1.6 Resource Potential

This section will present the investigations to assess the economic mineral and fossil fuel potential and the ground-water resources of the candidate area.

8.3.2 Repository Program

This section will summarize the repository test program and provide an overview of the research and development and engineering activities required to ensure that the repository is capable of satisfying applicable performance objectives. Current design bases and concepts are presented in Chapter 6, "Conceptual Design of a Repository."

Discussions in Subsections 8.3.2.2 through 8.3.2.5 of the planned investigations will explain--

- Why the investigation is planned and what data or information will be obtained.
- How the results will be used to help resolve specific information needs.
- What methods, techniques, and data analysis will be used.

In addition, discussion of in situ tests will include--

- A description of tests that might use radioactive materials.
- A description of tests that might affect the capability of the site to isolate waste.

The content requirements for each investigation to be described in this section are listed in Table 1.

8.3.2.1 Overview

This section will state the purpose of Section 8.3.2 and provide an overview of the repository program. The overview will summarize the overall objectives and approach of the repository program. The interrelationships and sequencing of the primary activities of the program will be described.

8.3.2.2 Verification or Measurement of Host Rock Environment

This section will identify and describe the site characterization program investigations that will define the geologic/geotechnical environment of the host rock for three conditions:

- Before subsurface excavation
- Post subsurface excavation (i.e., reflecting rock stress as a result of rock excavation)
- Post waste emplacement.

The objective of these investigations will be the measurement of those geologic/geotechnical properties necessary to model the repository design.

8.3.2.3 Coupled Interaction Investigations

Thermal-hydrological-mechanical-geochemical interaction investigations will be described in this section.

The test plans will either provide for direct testing of the coupled behavior or demonstrate that tests of the coupled behavior is unnecessary. The need for coupled tests will be based on site-specific conditions. The following guidance will be useful in deciding when direct testing of coupled behavior may not be required:

1. The component of the natural system (far-field geology) for which performance credit is taken is characterized adequately for evaluation of overall repository performance.
2. In evaluating overall MGDS performance, no credit is taken for the near-field host rock that cannot be characterized adequately.
3. Components of the engineered system such as the waste package are designed with adequate conservatism with respect to the coupled thermal conditions that will be encountered. Examples of conservatism in design include limiting the host rock thermal loading and thickening container walls.
4. The tests that support the design of the engineered system are carried out under a much wider range of conditions than the anticipated repository conditions. This means that the design of the tests takes into account conditions above and beyond the full range of coupled thermal behavior that is expected to be encountered.

The test plans will specify the scale and the duration of the planned tests and will describe how this scale and duration will be adequate to assess compliance with 10 CFR Part 60.

8.3.2.4 Design Optimization Investigations

The design optimization investigations that require site characterization data will be described. Typical topics which may be discussed include the refinement of design data needed to resolve design alternatives, decisions, construction feasibility issues, and design performance verification for such activities as rock excavation and mining techniques, waste package emplacement, and retrieval issues.

8.3.2.5 Repository Modeling

This section will identify and describe planned repository design model and code development, utilization, verification, and validation activities that require site characterization data. Potential subjects include repository component and subsystem models, and their use to conduct performance, safety, and design optimization analyses. Reference will be made to Section 8.3.5.1, as appropriate.

8.3.3 Seal System Program

This section will summarize the seal system test program and provide an overview of the research and development activities required to ensure that the repository seals and backfill are capable of satisfying applicable design and performance objectives. The current design bases and concepts are presented in Chapter 6, "Conceptual Design of a Repository.

Discussions in Subsections 8.3.3.2 through 8.3.3.5 of the planned investigations will explain:

- Why the investigation is planned and what data and information will be obtained.
- How the results will be used to help resolve specific information needs.
- What methods, techniques, and data analysis will be used.

This section will discuss plans with regard to in situ testing of seals. The discussion of in situ tests will include:

- A description of tests that might use radioactive materials
- A description of tests that might affect the capability of the site to isolate waste

If no such tests are planned, Chapter 8 will explain why these tests are unnecessary in order to provide sufficient data for licensing. If the final decision on such tests will depend on results of preceding tests, the SCP will describe the logical steps which lead to the decision.

The content requirements for each investigation to be described in this section are listed in Table 1.

8.3.3.1 Overview

This section will state the purpose of Section 8.3.3 and provide an overview of the seals program. The overview will summarize the overall objectives and approach of the seals program. The interrelationships and sequencing of the primary activities of the program will be described.

8.3.3.2 Seal System Environment

This section will identify and describe the investigations needed to establish the repository seal and backfill environments. The objective of these investigations is to define the physical and chemical characteristics (e.g., ground-water chemistry, flow transport behavior) that influence the design and performance of the repository seals.

8.3.3.3 Seal System Components and Interaction Investigations

This section will identify and describe planned seal system component investigations, including component-environment interaction testing. Repository backfill investigations will also be identified and described in this section.

8.3.3.4 Seal System Design Optimization

This section will identify and describe seal system design optimization activities that will require site characterization data. Potential subjects include investigations to assist in design concept selection, development of design requirements, and studies to translate design requirements into specific design descriptions. Development tests to demonstrate feasibility of fabrication processes and to help verify the designs will be described.

8.3.3.5 Seal System Modeling

This section will describe planned modeling and code development studies associated with seal system development, utilization, verification, and validation, for those investigations requiring data from site characterization. Potential subjects include development of seal component and subsystem models, the use of these models to conduct performance, safety, and optimization analyses, and tests planned to help assess the validity of these models. Reference will be made to Subsection 8.3.5.2.2, as appropriate.

8.3.4 Waste Package Program

This section will summarize the waste package test program and provide an overview of the research and development, and engineering activities required to ensure that the waste packages are capable of satisfying applicable design and performance objectives. The current design basis and concepts are presented in Chapter 7, "Waste Package."

Discussions in Subsections 8.3.4.2 through 8.3.4.5 of the planned investigations will explain:

- Why the investigation is planned and what data or information will be obtained.
- How the results will be used to help resolve specific information needs.
- What methods, techniques, and data analysis will be used.

This section will discuss plans with regard to in-situ testing of waste packages. The discussion of in-situ tests will include:

- A description of tests that might use radioactive materials.
- A description of tests that might affect the capability of the site to isolate waste.

If no such tests are planned, Chapter 8 will explain why these tests are unnecessary in order to provide sufficient data for licensing. If the final decision on such tests will depend on results of preceding tests, the SCP will describe the logical steps which lead to the decision.

The content requirements for each investigation to be described in this section are listed in Table 1.

8.3.4.1 Overview

This section will state the purpose of Section 8.3.4 and provide an overview of the waste package program. The overview will summarize the overall objectives and approach of the waste package program. The interrelationships and sequencing of the primary activities of the program will be described.

8.3.4.2 Waste Package Environment

This section will identify and describe the investigations needed to establish the waste package emplacement environment. The objective of these investigations is to define the physical and chemical characteristics (e.g., ground-water chemistry, flow and transport behavior) which influence the performance of the waste package.

8.3.4.3 Waste Package Components and Interaction Testing

This section will identify and describe planned waste package component investigations, including component-environment interaction testing. Potential characterization or testing activities might include waste form, container, packing material, and waste-barrier-rock interactions.

8.3.4.4 Waste Package Design Development

This section will identify and describe planned waste package development activities. Potential subjects include engineering studies to assist in design concept selection and alternate design definition, development of design requirements, waste package studies to translate design paragraph requirements into specific design descriptions, and development tests to demonstrate feasibility, including fabrication processes, and to help verify the designs.

8.3.4.5 Waste Package Modeling

This section will identify and describe planned areas of study associated with waste package model development, utilization, and verification and validation. Potential subjects include development of waste package component and subsystem models; the use of these models to conduct performance, safety, optimization, and economic analyses; and tests planned to help assess the validity of these models. Reference will be made to Subsection 8.3.5.2.1, as appropriate.

8.3.5 Performance Assessment Program Plan

This section will summarize the performance assessment strategy described in the Performance Assessment Plan and describe the licensing assessment strategy, as appropriate. Performance assessment is the process of quantitatively evaluating component, subsystem, and system behavior relating to containment and isolation of radioactive wastes to support the development of a high-level waste repository and to determine compliance with applicable regulations.

Performance assessment is one part of licensing assessment strategy. Licensing assessment also includes semi-quantitative and qualitative assessments that will address the non-numerical requirements and criteria and will provide input to quantitative assessments.

The performance assessment program provides plans for:

- Preclosure safety assessment (10 CFR 20)
- Engineered barrier performance assessment
- Shaft/ramp seals and borehole seals performance assessments
- Site performance assessment
- Demonstration of compliance with the EPA standard (40 CFR 191) and NRC preclosure and postclosure performance objectives and criteria (10 CFR 60).

8.3.5.1 Strategy for Preclosure Performance Assessment

This section will describe the safety analyses that will be performed during each phase of repository design. It describes an iterative approach in which the level of detail and the techniques will be governed by the complexity and detail available at each iteration. These safety analyses will

follow the design through each major phase. Performance assessments during the design stages will focus on identification and qualitative descriptions of radiological safety hazards. Detailed design phases will rely on quantitative techniques. To the extent possible, standard codes and other safety-analysis methods will be used. Topics to be discussed include:

- System criteria
- System description
- Characterization of events, conditions, and accidents
- Characterization of normal operations hazards
- Selection and characterization of accident scenarios
- Preclosure performance assessment, including consequence analysis and sensitivity studies
- Recommendation of preventive and mitigative measures
- Preclosure performance assessment schedule and interfaces, including preliminary safety analysis, design support, upgraded design, safety assessment, and preclosure license application input.

8.3.5.2 Strategy for Postclosure Performance Assessment

This section will discuss the strategy for assessing the long-term behavior of the mined geologic disposal system and its major subsystems. The approach will be to describe the performance goals* for the system and subsystems and provide the plans for meeting these goals with reasonable assurance. These assessments will be performed on the overall waste disposal postclosure system and the following three subsystems:

- The engineered barriers
- The shaft/ramp seals and borehole seals
- The site

8.3.5.2.1 Plans for Assigning and Assessing Engineered Barriers Subsystem and Component Performance Goals

This section will describe elements of the approach which include:

- Describing the role of performance assessment in defining the data and information needs and reviewing tests to ensure adequacy of data and information

* Preliminary performance goals will be provided as part of the issue resolution strategies for the postclosure performance issues (see Section 8.1.2 and Section 8.2.2) in the SCP.

- Setting tentative performance/design goals for individual components in the reference design
- Developing site and design specific scenarios (processes and events) which need to be accounted for in assessing the performance of the engineered system components. (Data will include repository design material data and site specific information.)
- Developing a conceptual model of the engineered barrier subsystem
- Developing numerical codes based on the conceptual models
- Conducting performance assessments including sensitivity and uncertainty analyses using reference codes and data to determine if design goals are met
- Reallocating performance/design goals as necessary, and/or recommending design changes and/or additional tests to reduce uncertainties where necessary
- Making decisions on final design and evaluating the contribution of the individual components to the overall performance of that design
- Recommending confirmatory tests and monitoring as required.

8.3.5.2.2 Plans for Assigning and Assessing Seal Systems Performance Goals

This section will describe elements of the approach which include:

- Defining data and information needs and reviewing tests to ensure adequacy of data and information
- Setting tentative performance goals for the seals
- Developing site-and seal-specific scenarios (processes and events) which need to be included in assessments of seal performance. (Data will include seal design and materials information and site specific information)
- Developing a conceptual model of the seal systems
- Developing numerical codes based on the conceptual models
- Conducting performance assessments, including sensitivity and uncertainty analyses to determine if seal design goals are met
- Reallocating performance design goals and/or recommending design changes and/or additional testing to reduce uncertainties where necessary
- Making decisions on final seal system design and determining their performance for the license application

- **Recommending confirmatory tests and monitoring as required.**

8.3.5.2.3 Plans for Assessing the Contribution of Site Characteristics to Site Subsystem Performance

This section will discuss the elements used in assessing the performance of individual site characteristics in site subsystem performance. These elements include:

- **Developing site subsystem performance goals that will support the higher level findings of compliance required by Appendix IV of 10 CFR 960, for those siting guidelines requiring site characterization.**
- **Establishing a baseline set of conditions for each of the site regulatory criteria specified in 10 CFR 60**
- **Defining scenarios for site subsystem performance, including both expected and disruptive events**
- **Describing the role of performance assessment in the data and information needs and reviewing tests to ensure the adequacy of data and information for performance assessments**
- **Developing a conceptual model of the site subsystem**
- **Developing numerical codes based on the conceptual models**
- **Conducting performance assessment sensitivity studies, and uncertainty analyses of the system based upon the site and engineered barriers conceptual models, and making preliminary determination of the reliability of the performance assessment.**
- **Making final determination of site suitability.**

8.3.5.2.4 Plans for Assessing System Performance

- **Establishing a description of the system for performance assessments**
- **Describing the role of performance assessment in defining the data and information needs**
- **Establishing individual radionuclide release limits as the system performance goals based on 40 CFR 191**
- **Developing system release scenarios for expected and disruptive events**
- **Developing a conceptual model for the overall system**
- **Developing a system code or codes based on the conceptual model**

- Conducting performance assessments and sensitivity and uncertainty analyses to determine if the system goals are met
- Recommending design changes and/or additional testing to reduce or accommodate uncertainties where necessary.

8.3.5.3 Plans for Demonstrating Compliance with EPA Standards, NRC Preclosure and Postclosure Performance Objectives, and DOE Siting Guidelines

This section will explain, using text and schematic diagrams, how the tools described in Subsections 8.3.5.1 through 8.3.5.3 will be used to demonstrate compliance with EPA standards, NRC performance objectives for the release rate and lifetime of the waste package, operational safety and retrievability objectives, and DOE siting guidelines.

8.3.5.4 Substantially Completed Analytical Techniques

This section will present, in the text and in a matrix chart, a description of those performance assessment techniques, including simplifying assumptions, limitations, and boundary conditions, for which development work is substantially completed, with particular emphasis on identification of the types and quality of data needed and on the plans for documentation, verification, and validation of performance assessments during or after site characterization. In the description, specific sections from other documents, such as user manuals and code documentations, may be incorporated by reference provided these documents are either publicly available or, if proprietary, are readily available to the NRC.

8.3.5.5 Analytical Techniques Requiring Significant Development

This section will present, in the text and in a matrix chart, a description of those analytical techniques that are expected to be important for evaluating the performance of the site but that still require significant additional developmental work at the time the SCP is prepared. Site-specific and generic models and computer codes will be included. The programs formulated for undertaking the developmental work during site characterization will be described, including plans for documentation, verification, and validation of models and codes.

This section will specifically discuss plans for the development of the following:

- Approach to selection and characterization of scenarios for long-term release from system and subsystems
- Model development and the control and certification of computer codes. This section will discuss the certification process, using the definitions in NUREG-0856, including the numerical model, code documentation, verification, benchmarking, and validation. The section will categorize these plans according to the two major applications of performance assessment (performance objectives and EPA standards)

- Approach to uncertainty analyses. This section will explain the plans for using uncertainty analyses to understand basic phenomena, resolve uncertainties in data (e.g., by krieging) resolve uncertainties in model parameters, and resolve uncertainties in models.
- Approach to sensitivity analyses. This section will describe the plans for sensitivity analyses. The objectives of these analyses are to assign priorities to the data needs and to reduce the needs for data, models, and tests. The analyses will identify critical parameters and boundary conditions. The section will discuss the techniques to be used (e.g., Latin hypercube)
- Approach to utilizing professional judgment. This section will explain the plans for using professional judgment in performance assessment
- Approach to construction and use of complementary cumulative distribution functions (CCDFs). This section will explain how the performance assessment task expects to construct complementary cumulative distribution functions (CCDFs).

8.4 PLANNED SITE PREPARATION ACTIVITIES

Plans for surface and subsurface excavations and construction related to site characterization will be presented in this section. These plans will be developed considering the environmental impact resulting from the activity. The specific impact and mitigation measures will be documented in the appropriate documents.

Reference will be made to the information presented in Sections 2.7, 4.6, and 7.4 of the SCP-Conceptual Design Report and in Sections 6.1.4, 6.1.5, and 8.6.4.2 of the SCP that include discussion on items important to safety or waste isolation pertaining to the exploratory shaft facility.

8.4.1 Surface Site Preparation Activities

This section will describe the surface activities needed to prepare the site for site characterization activities. These activities will include surface preparation (e.g., grading and stabilization) at the exploratory shaft location, provisions for utilities (e.g., water and electricity), roadway and borrow pit construction, and installation of support facilities. Also included will be the anticipated starting and completion dates for the preparatory activities and a description of any surface facilities to be erected at the site.

8.4.2 Underground Test Facility

This section will present a detailed description of the exploratory shaft and the underground test facility (exploratory shaft and breakout drifts) to be used for the in-situ testing portion of the site characterization program. The description will provide a detailed layout of the planned excavation, including design dimensions, boring locations, and the planned locations

within the test facility for each scheduled test or experiment. Details of construction, including the location of the underground test facility with respect to the design of the repository, will also be provided. This section will also include an analysis of the potential impact of in-situ testing on the waste isolation integrity of the repository site.

8.5 MILESTONES, DECISION POINTS, AND SCHEDULE

This section will identify the milestones and decision points established for the site characterization program up to submittal of the license application. It will present a schedule for the attainment of these milestones and decision points, and the completion of activities related to site characterization. Tasks accomplished and yet to be completed will be identified. Progress toward milestones and decision points will be reported semi-annually.

8.5.1 Site Characterization Activities and Milestones

This section will identify the scheduled activities and milestones directly related to site characterization. These include activities involved with the exploratory shaft, drilling and borehole testing, hydrology, geology and geophysics, geochemistry, tectonics, geoenvironment, and meteorology and climatology.

8.5.2 Performance Assessment Activities and Milestones

This section will identify the activities and milestones for performance assessment.

8.5.3 Repository Design Activities and Milestones

This section will identify the activities and milestones related to repository design, including the preparation and publication of reports for the Advanced Conceptual Design, the License Application Design, and the Final Procurement and Construction Design.

8.5.4 Waste Package Design Activities and Milestones

This section will identify the activities and milestones related to waste package design. This will include the preparation and publication of the applicable documentation leading to the final design reports.

8.5.5 Project Major Decision Points

This section will define the milestones that are the major decision points and program element interfaces (including performance assessment) for the Project. The logic (in flow chart form) leading to these decision points will also be discussed. When a decision point is reached, a choice will have to be made between two or more alternatives. These alternatives and their consequences will also be described in this section.

8.5.6 Schedules

This section will provide graphic presentations of the schedule of activities, analyses, milestones, decision points, reports, and submittals. Flowcharts will be used with tables and other graphs and figures as needed for emphasis or clarity. Detailed schedules related to site characterization will constitute the bulk of this section, but less detailed flowcharts will illustrate major milestones up to the beginning of repository construction.

8.6 QUALITY ASSURANCE PROGRAM

This section will describe the Quality Assurance Program for the Project, including requirements, administrative QA procedures, and detailed technical procedures. It is not expected that all test plans and procedures will be completed at the time of SCP submittal; those that are completed will be referenced.

8.6.1 Quality Assurance Plan Summary

This section will summarize the Quality Assurance Plan as it applies to site characterization activities. The project philosophy on quality assurance will be described, and the individual quality assurance plans for the participating organizations will be listed in this section.

8.6.2 Requirements for Quality Assurance

This section will summarize the regulatory requirements on which quality assurance criteria are based. This will include reference to the relevant portions of the following documents: 10 CFR 50, Appendix B; 10 CFR 60, Subpart G; OGR QA Plan for High-Level Radioactive Waste Repositories (OGR/B-3); ANSI/ASME NQA-1; and the NRC Review Plan: "QA Programs for Site Characterization of High-Level Nuclear Waste Repositories."

8.6.3 Organization of the Project with Respect to Quality Assurance

This section will describe the general organization of the Project and outline the responsibility breakdown for quality assurance among the Project participants.

The DOE project management organization will be identified, and the DOE technical projects and tasks will be described. Prime agents or contractors for site investigations, design, waste form and packaging research and development, and performance analysis will also be identified. The division of responsibility and lines of communication among these various parties will be delineated.

8.6.4 Application of Quality Assurance

This section will describe the general application of quality assurance established by the Project.

8.6.4.1 Quality Assurance Before Site Characterization

This section will describe and reference the quality assurance procedures that were applied to data gathering and other activities before site characterization (during site exploration or screening).

8.6.4.2 Quality Assurance During Site Characterization

This section will describe the methods for determining which items and activities are to be controlled by the QA Program during site characterization. There will be a summary of the Q-List Methodology; however, the list of items important to safety or waste isolation and the rationale for the determination will be provided in Section 6.1.4 and 6.1.5. A preliminary list of activities, related to site characterization, which are important to safety or waste isolation and the rationale for the determination will be provided in this section.

8.6.5 Administrative QA Procedures

This section will identify the administrative QA procedures which provide instructions for the implementation and application of the 18 criteria of 10 CFR 50, Appendix B. It should be noted that these QA procedures are generated by the QA organization, with assistance from the technical groups, and apply to all technical program areas.

8.6.6 Detailed Technical Procedures and Test Plans

This section will reference the detailed implementing technical procedures and test plans which are developed by the technical groups in accordance with the requirements specified in the administrative QA procedures and which include appropriate QA requirements. Although all the actual detailed procedures and test plans will not be completed at the time of submittal of the SCP, those that are completed will be identified and referenced in Section 8.3.

8.7 DECONTAMINATION AND DECOMMISSIONING

This section will provide plans for 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 license application for an MGDS.

8.7.1 Decontamination

This section will describe plans for the decontamination of the site characterization facilities at the candidate site. Prospective methods to be

used in decontamination and the timing of decontamination activities with respect to the cessation of site characterization will be described. Intended levels of residual radioactivity following decontamination will be described.

8.7.2 Decommissioning

This section will identify alternative decommissioning strategies. Plans for the subsurface facilities will be discussed, such as the exploratory shaft and underground in-situ test facilities' water supply distribution, and collection pipes and electrical cables. Information on the physical layout of the site following decommissioning will be provided.

8.7.3 Plans for Mitigation of Any Significant Adverse Environmental Impacts Caused by Site Characterization Activities

This section will describe or reference, as appropriate, plans for the mitigation of any significant adverse environmental impacts caused by site characterization activities, if the candidate site is eliminated from consideration as a potential repository. Reclamation and habitat restoration will be described. Plans for the improved roads, borrow pits, and any fluids or effluents generated during site characterization will be discussed. Plans to minimize erosion and to stabilize slopes will be presented. Plans for protecting any archaeological sites that were discovered during site characterization will be described.

REFERENCES

ATTACHMENT A

CORRELATION OF REGULATORY GUIDE 4.17

WITH THE ANNOTATED OUTLINE

The Annotated Outline for Site Characterization Plans (AO) was prepared by the DOE with the intent of addressing all of the material contained in NRC Regulatory Guide 4.17: "Standard Format and Content of Site Characterization Plans for High-Level Waste Geologic Repositories (Proposed Revision 1 dated September 1984). This attachment correlates the information requested in each portion of Regulatory Guide 4.17 with corresponding sections of the AO where that information has been addressed.

The format of Regulatory Guide 4.17 and the format of the AO are essentially the same. The AO presents background material referred to as "Introduction to the Annotated Outline" which is similar to the "Introduction" of Regulatory Guide 4.17. This background material provides general information about site characterization and the SCP, and does not represent any specific section that will be written in the SCP. In this background material presented in the AO, the text of Regulatory Guide 4.17 is generally used verbatim; notable exceptions are listed in Table 1.

The AO calls for an introductory chapter in the SCP referred to as "Introduction," which provides a description of the purpose and scope of the SCP, relevant program history, requirements of the Nuclear Waste Policy Act for the program, and the organization of the SCP. This introductory chapter, while not requested by Regulatory Guide 4.17, is considered important material to include in the SCP.

For Chapters 1 through 8, there is a one-to-one correspondence between Regulatory Guide 4.17 and the AO. Tables 2 through 9 provide a correlation of Regulatory Guide 4.17 with the AO for the contents of Chapters 1 through 8, respectively. In the left hand column, a list of the section and subsection titles for each chapter in Regulatory Guide 4.17 is presented. In the middle column, the section or subsection of the AO that addresses the information requested in the Regulatory Guide section or subsection is indicated. In the right hand column, an explanation and rationale for differences between Regulatory Guide 4.17 and the AO is provided. For some sections or subsections of Regulatory Guide 4.17, the requested information is provided in more than one section or subsection of the AO. In such cases, individual topics are listed in the left hand column and the location in the AO where the topics are addressed is indicated in the middle column.

Table 1

Modifications to the Introduction to Regulatory Guide 4.17 for the
Introduction to the Annotated Outline

<u>Page From Regulatory Guide 4.17</u>	<u>Modification to Text of Regulatory Guide 4.17</u>
vii	A sentence is added to the beginning of the paragraph to state the NHPA requirement for preparation of an SCP.
vii	In the second sentence, words are added to acknowledge submittal of the SCP to the States.
vii	In the third sentence, the phrase "plans for resolving those <u>issues</u> " is changed to "plans to obtain data for resolving those issues." This reflects that the SCP will present plans to obtain data that will ultimately be used to resolve issues. This same change is also made in item 3 in the list following the first paragraph.
viii	In the second sentence of the first paragraph, it is acknowledged that the information collected during site characterization will be used for site selection as well as for the license application.
viii	In item 3 on this page, a third purpose for the additional work has been added, i.e, to "(3) make site suitability findings relative to DOE Siting Guidelines, 10 CFR 960."
ix	In the first sentence of the first paragraph, the words "during the conduct of site characterization activities" are substituted for "following commencement of site characterization" to bring this language in conformance with the NHPA.
ix	In the second paragraph, the third, fourth, and fifth sentences are omitted because they do not apply to this Annotated Outline prepared by the DOE.
x	In item e, the word "to support a future construction authorization application" are changed to "support site selection a future license application."
xi	The meaning of the word "definition", as used in the second sentence of the second paragraph, is clarified by a sentence added to the end of the paragraph.
xi	In the second sentence of the second paragraph, the word "definitive" is omitted from the sentence. Since the site characterization program will evolve as it progresses, it is not possible to be definitive in the SCP.

Table 1 (Continued)

Page From
Regulatory Guide 4.17

Modification to Text of Regulatory Guide 4.17

- | | |
|------|--|
| xii | In the second paragraph, a reference to the role of the siting guidelines (10 CFR 960) is added. The SCP will describe plans for obtaining information for 10 CFR 960 evaluations. |
| xii | In the third paragraph, the sentence "All principal consultants, outside service organizations, and key research groups to be involved with site characterization should be listed" is omitted. This information will be made available to NRC through their on site representatives upon request. Since the list of contractors beyond the prime contractors may change frequently, it is not practical to list all in the SCP. |
| xiii | In the section concerning style and composition, reference is made to the DOE style guide, which will be used in the preparation of the SCP. |

Table 2

Correlation of Chapter 1 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
1. GEOLOGIC DESCRIPTION OF CANDIDATE AREA AND SITE	1. GEOLOGY	The chapter title has been changed to make it consistent with other chapter titles that do not specifically mention the candidate area and the site. This chapter will include a description of the candidate area. In addition, tectonic studies discussed in this chapter include information outside the candidate area.
	1.0 <u>Introduction</u>	This section has been added to provide a general discussion of the information contained in the chapter and to explain the role of that information in the site characterization program.
1.1 Geomorphology	1.1 Geomorphology	Same.
1.1.1 Physiography and Topography	1.1.1 <u>Physiography</u>	Because topography is typically included within the subject of physiography, it has not been included in the section title.
1.1.2 Geomorphic Units	1.1.2 Geomorphic Units	Same.
1.1.3 Geomorphic Processes	1.1.3 Geomorphic Processes	Same.
1.2 Stratigraphy	1.2 <u>Stratigraphy and Lithology</u>	Lithology is a major topic in this section and, therefore, it has been included in the section title.
1.2.1 Surface Geology	[1.1 Geomorphology and 1.2 Stratigraphy and Lithology]	Surface geology is discussed in Sections 1.1 (Geomorphology) and 1.2 (Stratigraphy and Lithology) as it relates to those sections. Therefore, a separate section for surface geology has not been included.
1.2.2 Stratigraphic Framework of the Candidate Area	1.2.1 Stratigraphic Framework of the Candidate Area	Same.
1.2.3 Stratigraphic Framework of Site	1.2.2 Stratigraphic Framework of Site	Same.

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 2 (continued)

Correlation of Chapter 1 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
1.3 Structural Geology and Tectonics of Candidate Area and Site	1.3 Structural Geology and Tectonics of Candidate Area and Site	Same.
1.3.1 Tectonic Framework	1.3.1 Tectonic Framework	Same.
1.3.2 Tectonic History	1.3.2 Tectonic History	Information within this section is reorganized as indicated below.
1.3.2.1 Volcanic History	1.3.2.1 Volcanic History	Same.
1.3.2.2 Faulting History	1.3.2.2 <u>Structural History</u>	The sections on faulting history, folding history, and jointing history have been combined into one section. The structures resulting from faulting, folding and jointing are closely related and need to be discussed together.
1.3.2.3 Folding History	1.3.2.2 <u>Structural History</u>	
1.3.2.4 Jointing History	1.3.2.2 <u>Structural History</u>	
1.3.2.5 Uplift, Tilting, Subsidence	1.3.2.4 <u>Vertical and Lateral Crustal Movement</u>	The section title has been changed to reflect the combination of Sections 1.3.2.5 and 1.3.2.7 from RG 4.17. The sections were combined because the topics are similar and should be addressed more effectively together.
1.3.2.6 Active Stress Field	1.3.2.3 <u>Existing Stress Regime</u>	The term "existing" more clearly reflects the information in this section on the stress regime, which may or may not be active. Regime is a more general term that does not imply that the complete three-dimensional stress field will be presented in this section.
1.3.2.7 Vertical Crustal Movement	[1.3.2.4 Vertical and Lateral Crustal Movement]	See explanation for Section 1.3.2.5.
	1.3.2.5 <u>Geothermal Regime</u>	This section includes information not specifically requested by RG 4.17.
1.4 Seismology of Candidate Area and Site	1.4 Seismology of Candidate Area and Site	Same.
1.4.1 Seismology of Candidate Area	1.4.1 Seismology of Candidate Area	Same.

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 2 (continued)

Correlation of Chapter 1 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
1.4.1.1 Seismicity of Candidate Area	1.4.1.1 Seismicity of Candidate Area	Same.
1.4.1.2 Relationship of Seismicity to Geologic or Tectonic Characteristics of Candidate Area	1.4.1.2 Relationship of Seismicity to Geologic or Tectonic characteristics of Candidate Area	Same.
1.4.1.3 Determination of Earthquake - Generating Potential of Geologic Structures and Seismotectonic Zones Within Candidate Area	1.4.1.3 Determination of Earthquake-Generating Potential of Geologic structures and Seismotectonic Zones Within Candidate Area	Same.
1.4.1.4 Earthquake-Induced Phenomena Within Candidate Area That May Affect Site	1.4.1.4 Earthquake-Induced Phenomena Within Candidate Area that May Affect Site	Same.
1.4.1.5 Seismic Risk in Candidate Area	1.4.1.5 <u>Seismic Hazard in the Candidate Area</u>	The information requested by R.G. 4.17 in this section is related to seismic hazard rather than seismic risk. Seismic risk will be addressed in Section 8.3.5.2.3.
1.4.2 Seismology of Site	1.4.2 Seismology of Site	Same.
1.4.2.1 Vibratory Ground Motion at Site Resulting from Potential Earthquakes in Area	1.4.2.1 Vibratory Ground Motion at Site Resulting from Potential Earthquakes in Area	Same.

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 2 (continued)

Correlation of Chapter 1 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
1.4.2.2 Characteristics of Seismic Wave Transmission at Site	1.4.2.2 Characteristics of Seismic Wave Transmission at Site	Same.
1.4.2.3 Potential for Induced Seismicity Affecting Site	1.4.2.3 Potential for Induced Seismicity Affecting Site	Same.
1.5 Long Term Regional Stability with Respect to Tectonic and Geological Processes	1.5 Long-Term Regional Stability with Respect to Tectonic and Geologic Processes	Same.
1.6 Subsurface Drilling and Mining	1.6 <u>Drilling and Mining</u>	Since mining and drilling always take place below the earth's surface, the adjective subsurface is unnecessary.
1.7 Mineral and Hydrocarbon Resources	1.7 Mineral and Hydrocarbon Resources	Same.
1.7.1 Mineral Resources	1.7.1 Mineral Resources	Same.
1.7.2 Hydrocarbon Resources	1.7.2 Hydrocarbon Resources	Same.
	1.8 <u>Summary</u>	This section has been added to provide a link between the data and analyses presented in this chapter and the plans described in Chapter 8.
	1.8.1 <u>Summary of Significant Results</u>	
	1.8.2 <u>Relation to Design</u>	
	1.8.3 <u>Identification of Information Needs</u>	
	1.8.4 <u>Relation to R.G. 4.17</u>	

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 3

Correlation of Chapter 2 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
2. GEOENGINEERING	2. GEOENGINEERING 2.0 <u>Introduction</u>	This section has been added to provide a general discussion of the information contained in the chapter and to explain the role of that information in the site characterization program.
2.1 Mechanical Properties of Rock Units - Continua	2.1 Mechanical Properties of Rock Units - Intact Rock 2.1.1 <u>Mechanical Properties of Other Rocks</u> 2.1.2 <u>Mechanical Properties of Rocks at the Site</u>	In the section title, the term "Intact Rock" has been substituted for "Continua" since the former term is more widely used.
2.2 Mechanical Properties of Rock Units - Large Scale	2.3 Mechanical Properties of Rock Units - Large Scale 2.3.1 <u>Mechanical Properties of Other Rocks</u> 2.3.2 <u>Mechanical Properties of Rocks at the Site</u> 2.3.3 <u>Relationship Between Intact Rock, Discontinuities, and Large-Scale Rock Properties.</u>	This section has been relocated so that it follows the section on discontinuities, since "large-scale" behavior includes both the "intact rock" and "discontinuities."
2.3 Mechanical Properties of Rock	2.2 <u>Mechanical Properties of Rock Units - Discontinuities</u> 2.2.1 <u>Mechanical Properties of Discontinuities in Other Rocks</u>	"Discontinua" could be interpreted to include both intact rock and discontinuities that form a discontinuum. This section concerns only the properties of the discontinuities, therefore, the section title has been changed.

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 3 (continued)

Correlation of Chapter 2 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
2.4 Thermal and Thermomechanical Properties - Laboratory Results	2.2.2 <u>Mechanical Properties of Discontinuities in Rocks at the Site</u>	This section has been renamed and a new section added (2.5) so that thermal properties could be addressed in the same manner as mechanical properties (i.e., intact rock and rock mass).
	2.4 <u>Thermal and Thermomechanical Properties - Intact Rock</u>	
	2.4.1 <u>Thermal and Thermomechanical Properties of Other Rocks</u>	
	2.4.2 <u>Thermal and Thermomechanical Properties of Rock at the Site</u>	
	2.5 <u>Thermal and Thermomechanical Properties - Large Scale</u>	
2.5 Stress Field	2.5.1 <u>Thermal and Thermomechanical Properties of Other Rocks</u>	This title has been changed to be consistent with title for Section 1.3.2.3.
	2.5.2 <u>Thermal and Thermomechanical Properties of Rock at the Site</u>	
	2.5.3 <u>Relationship between Intact Rock and Large-Scale Properties</u>	
	2.6 <u>Existing Stress Regime</u>	
	2.6.1 <u>Stress Regime in Region of the Site</u>	

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 3 (continued)

Correlation of Chapter 2 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
	2.6.2 <u>Stress Regime at the Site</u>	
2.6 Special Geoengineering Properties	2.7 Special Geoengineering Properties	Same.
2.7 Excavation Characteristics of Rock Mass	2.8 Excavation Characteristics of Rock Mass	Same.
	2.8.1 <u>Excavation Characteristics of Similar Rocks</u>	
	2.8.2 <u>Excavation Characteristics of Rock at the Site</u>	
	2.8.3 <u>Changes in Geoengineering Properties Due to Excavation</u>	
	2.9 <u>Summary</u>	This section has been added to provide a link between the data and analyses in this chapter and the plans described in Chapter 8.
	2.9.1 <u>Summary of Significant Results</u>	
	2.9.2 <u>Relation to Design</u>	
	2.9.3 <u>Identification of Information Needs</u>	
	2.9.4 <u>Relation to R.G. 4.17.</u>	

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 4

Correlation of Chapter 3 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
3. HYDROLOGY	3. HYDROLOGY	
	3.0 <u>Introduction</u>	This section has been added to provide a general discussion of the information contained in the chapter and to explain the role of that information in the site characterization program.
3.1 Description of Surface Hydrology	3.1 Description of Surface Hydrology	Same.
3.2 Floods	3.2 Floods	Same.
3.2.1 Flood History	3.2.1 <u>Flood History and Potential for Future Flooding</u>	The title has been to indicate the two major emphases of the discussions in this section.
3.2.2 Flooding Protection	3.2.2 Flooding Protection	Same. Reference will be made in Section 3.2.2 to Chapter 6 for the information requested in R.G. 4.17.
3.3 Locations and Distances to Points of Surface-Water Use	3.3 Locations and Distances to Points of Surface-Water Use	Same.
3.3.1 Present Quantity and Quality of Surface-Water Extracted	3.3.1 Present Quantity and Quality of Surface-Water Extracted	Same.
3.3.2 Projected Surface-Water Use	3.3.2 Projected Surface-Water Use	Same.
3.4 Chemical Composition of Adjacent Water Courses	3.4 Chemical Composition of Adjacent Water Courses	Same.
3.5 Surface-Water/Ground-Water Disposition of Releases	3.5 <u>Points of Ground-Water Discharge</u>	The title has been changed to more clearly indicate the content of the section (i.e., the identification and discussion of known points of ground-water discharge).

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 4 (continued)

Correlation of Chapter 3 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
3.6 Regional Hydrologic Reconnaissance of Candidate Area and Site	3.6 Regional Hydrologic Reconnaissance of Candidate Area and Site	Same.
3.6.1 Hydrogeologic Units	3.6.1 Hydrogeologic Units	Same.
3.6.2 Relationships Among Hydrogeologic Units	3.6.2 Relationships Among Hydrogeologic Units	Same.
3.6.3 Potentiometric Level	3.6.3 Potentiometric Level	Same.
3.6.4 Hydraulic Characteristics of Principal Hydrogeologic Units	3.6.4 Hydraulic Characteristics of Principal Hydrogeologic Units	Same.
3.7 Regional Ground-Water Flow System	3.7 Regional Ground-Water Flow System	Same.
3.7.1 Identification of Recharge and Discharge Areas	3.7.1 Identification of Recharge and Discharge Areas	Same.
3.7.2 Principal Ground-Water Flow Paths	3.7.2 Principal Ground-Water Flow Paths	Same.
3.7.3 Isotopic and Regional Hydrochemistry	3.7.3 Isotopic and Regional Hydrochemistry	Same.
3.7.4 Paleohydrology	3.7.4 Paleohydrology	Same.
3.8 Ground-Water Uses	3.8 Ground-Water Uses	Same.
3.8.1 Regional Ground-Water Aquifers Used for Human Activities	3.8.1 Regional Ground-Water Aquifers Used for Human Activities	Same.
3.8.2 Regional Ground-Water Management Plans	3.8.2 Regional Ground-Water Management Plans	Same.
3.9 Site Hydrogeologic Systems	3.9 Site Hydrogeologic Systems	Same.
3.9.1 Baseline Modeling	3.9.1 Baseline Modeling	Same.
3.9.1.1 Monitoring Network	3.9.1.1 Monitoring Network	Same.
3.9.1.2 Potentiometric Levels	3.9.1.2 Potentiometric Levels	Same.
3.9.1.3 Hydrochemistry	3.9.1.3 Hydrochemistry	Same.

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 4 (continued)

Correlation of Chapter 3 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
3.9.2 Hydraulic Characteristics	3.9.2 Hydraulic Characteristics	Same.
3.9.3 Ground-Water Flow System	3.9.3 <u>Ground-Water Flow System Conceptual Model</u>	The title has been changed to emphasize that studies of the ground-water flow system at the site will be conducted in order to develop a conceptual model.
3.9.3.1 Accessible Environment and Credible Pathways	3.9.3.1 Accessible Environment and Credible pathways	
3.9.3.2 Potentiometric Levels and Head Relationships	3.9.3.2 Potentiometric Levels and Head Relationships	
3.9.3.3 Recharge-Discharge and Leakage	3.9.3.3 Recharge-Discharge and Leakage	
3.9.3.4 Unsaturated Zone Relationships	3.9.3.4 Unsaturated Zone Relationships	
3.9.4 Ground-Water Velocity and Travel Time	3.9.4 Ground-Water Velocity and Travel Time	Within this section, the subsections requested by R.G. 4.17 (3.9.4.1 and 3.9.4.2) have been deleted, because the information requested by those sections is covered partly in Section 3.9.4 of the AO and partly elsewhere in the AO.
3.9.4.1 Radionuclide Transport Factors		
o Temperature, viscosity	3.9.4 Ground-Water Velocity and Travel Time	
o Water chemistry, retardation, oxidation-reduction potential	4.1.3 Geochemical Retardation Processes	These are geochemical topics and are discussed in Chapter 4.
3.9.4.2 Geothermal Gradient and Convective Component	3.9.4 Ground-Water Velocity and Travel Time	
3.9.5 Hydrochemistry and Ground-Water Age	3.9.5 <u>Hydrochemical Confirmation of Ground-Water Behavior</u>	The title has been changed to more clearly indicate the purpose of this section which is to discuss the evolution and present day movement of ground water at the site.

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 4 (continued)

Correlation of Chapter 3 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
3.9.6 Monitoring and Verification	3.9.6 Monitoring and Verification	Within this section, the subsections requested by R.G. 4.17 have been deleted. The information requested will be presented in Chapter 8 (Section 8.3); only a summary will be presented in Section 3.9.6 which eliminates the need for subsections.
3.9.6.1 Baseline Condition Changes	3.9.6 Monitoring and Verification	
3.9.6.2 Well Construction, Development, and Completion	3.9.6 Monitoring and Verification	
3.9.6.3 Monitoring Methods	3.9.6 Monitoring and Verification	
3.9.7 Local Ground-Water Uses	3.9.7 Local Ground-Water Uses	Same.
3.9.8 Paleohydrology	3.9.8 Paleohydrology	Same.
	3.10 <u>Summary</u>	This section has been added to provide a link between the data analyses presented in this chapter and the plans described in Chapter 8.
	3.10.1 <u>Summary of Significant Results</u>	
	3.10.2 <u>Relation to Design</u>	
	3.10.3 <u>Identification of Information Needs</u>	
	3.10.4 <u>Relation to R.G. 4.17</u>	

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 5

Correlation of Chapter 4 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
4. GEOCHEMISTRY	4. GEOCHEMISTRY 4.0 <u>Introduction</u>	This section has been added to provide a general discussion of the information contained in the chapter and to explain the role of that information in the site characterization program.
4.1 Host Rock Geochemistry	4.1 <u>Geochemistry of the Host Rock and Surrounding Units</u>	The title has been expanded to include the geochemistry of surrounding units as distinct from only the geochemistry of the emplacement unit.
o Discussions of thermal effects associated with the thermal pulse (coupled effects)	[4.2 Geochemical Effects of Waste Emplacement]	
o Other material called for in Section 4.1	4.1 <u>Geochemistry of the Host Rock and Surrounding Units</u> 4.1.1 <u>Mineralogy and Petrology</u> 4.1.2 <u>Ground-Water Geochemistry</u> 4.1.3 <u>Geochemical Retardation Processes</u>	Section 4.1 was subdivided to organize the material called for in R.G. 4.17.
4.2 Chemistry of Waste, Barriers, and Environment of a Conceptual Design Repository Appropriate to Site	4.2 <u>Geochemical Effects of Waste Emplacement</u>	This section has been reorganized in order to eliminate unnecessary redundancies between Chapters 4 and 7. Many of the topics requested in Section 4.2 of R.G. 4.17 will be covered in Chapter 7, as indicated below. These topics include the chemistry of the waste package and the chemical interaction between the host rock and the waste package. The section title has been changed accordingly.
	4.2.1 <u>Anticipated Thermal Conditions Resulting from Waste Emplacement</u>	Section 4.2.1 provides the basic temperature information used in section that follow.

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 5 (continued)

Correlation of Chapter 4 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
<ul style="list-style-type: none"> • Anticipated interactions among waste form, engineered barriers, and environment 	7.1 <u>Emplacement Environment</u> [6.3.3 <u>Backfill</u>] [6.3.5 <u>Sealing of Shafts, Bore-holes, and Underground Openings</u>]	The material requested concerning waste package-ground-water interactions has been placed in Chapter 7, so that a more cohesive presentation can be given in support of the waste package design program. Equivalent material related to backfill and seals has been placed in Chapter 6 for the same reason.
<ul style="list-style-type: none"> • Chemical composition and form of the waste • Solubility of waste form in ground water 	[7.3 <u>Design Descriptions</u>]	Because solubility and speciation are an integral part of waste package testing programs, they are best discussed in Section 7.4.
<ul style="list-style-type: none"> • Species released by leaching of the waste form • Anticipated chemical and mineralogical composition of barriers 	[7.4 <u>Waste Package Research and Development Status</u>] [7.3 <u>Design Descriptions</u>] [6.3.3 <u>Backfill</u>] [6.3.5 <u>Sealing of Shafts, Bore-holes, and Underground Openings</u>]	Similarly, chemical composition data have been addressed in the waste package, backfill, and seal descriptions.
<ul style="list-style-type: none"> • Changes in speciation imposed on radionuclides released from waste 	[7.4 <u>Waste Package Research and Development Status</u>]	
<ul style="list-style-type: none"> • Anticipated interaction of the waste, water, vapor, gas, and rock, including <ul style="list-style-type: none"> - Hydrothermal alteration of host rock during thermal pulse - Changes in ground-water chemistry during thermal pulse - Effect of changes of mineralogy and ground-water on radionuclide migration 	[7.1 <u>Emplacement Environment</u>] 4.2.2 <u>Hydrothermal Alteration Due to Thermal Pulse</u> 4.2.3 <u>Changes in Water Chemistry Due to Thermal Pulse</u> 4.2.4 <u>Effects of the Thermal Pulse on Radionuclide Migration</u> [4.1.3 <u>Geochemical Retardation Processes.</u>]	Anticipated interactions have been treated as part of the emplacement environment definition. These section (4.2.2-4.2.4) complement the discussions in Section 4.1 on rock-ground water geochemistry under pre-emplacement conditions and geochemical retardation processes.

Editorial conventions used in Section titles of the AO:

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2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 5 (continued)

Correlation of Chapter 4 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
4.3 Natural Analogs	4.3 <u>Natural Analogs and Related Field Tests</u> 4.3.1 <u>Natural Analogs</u> 4.3.2 <u>Related Field Tests</u>	The title has been expanded to be more descriptive of the section contents. Subheadings have been inserted to better organize the section.
4.4 Geochemical Stability	4.4 <u>Geochemical Stability</u> 4.4.1 <u>Potential Man-Induced Effects</u> 4.4.2 <u>Potential Effects of Natural Changes</u>	The subheadings have been added to better organize the section content.
	4.5 <u>Summary</u> 4.5.1 <u>Summary of Significant Results</u> 4.5.2 <u>Relation to Design</u> 4.5.3 <u>Identification of Information Needs</u> 4.5.4 <u>Relation to Regulatory Guide 4.17.</u>	This section has been added to provide a link between the data and analyses in this chapter and the plans described in Chapter 8.

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 6

Correlation of Chapter 5 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
5. CLIMATOLOGY AND METEOROLOGY	5. CLIMATOLOGY AND METEOROLOGY 5.0 <u>Introduction</u>	This section has been added to provide a general discussion of the information contained in the chapter and to explain the role of that information in the site characterization program.
5.1 Recent Climate and Meteorology	5.1 Recent Climate and Meteorology	Same.
5.1.1 Climate	5.1.1 Climate	Same.
5.1.2 Local and Regional Meteorology	5.1.2 Local and Regional Meteorology	Same.
5.1.3 Site Meteorological Measurement Program	5.1.3 Site Meteorological Measurement Program.	Same.
5.2 Long-Term Climatic Assessment	5.2 Long-Term Climatic Assessment	Same.
5.2.1 Paleoclimatology	5.2.1 Paleoclimatology	Same.
5.2.2 Future Climatic Variation	5.2.2 Future Climatic Variation	Same.
5.2.3 Site Paleoclimatic Investigation	5.2.3 Site Paleoclimatic Investigation	Same.
	5.3 <u>Summary</u>	This section has been added to provide a link between the data and analyses presented in this chapter and the plan described in Chapter 8.
	5.3.1 <u>Summary of Significant Results</u>	
	5.3.2 <u>Relation to Design</u>	
	5.3.3 <u>Identification of Information Needs</u>	
	5.3.4 <u>Relation to R.G. 4.17</u>	

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 7

Correlation of Chapter 6 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
6. CONCEPTUAL DESIGN OF A REPOSITORY	6. CONCEPTUAL DESIGN OF A REPOSITORY	Same.
	6.0 <u>Introduction</u>	This section has been added to provide a general discussion of the information contained in the chapter and to explain the role of that information in the site characterization program.
	6.1 <u>Design Basis</u>	The organization of R.G. 4.17 did not easily allow for presentation of all the relevant design information, nor did it allow easiest presentation of a logical design description. An approach has been used in the AO which provides all of the information requested by R.G. 4.17 in a single section of Chapter 6 and the additional information necessary to present design information. To accomplish this two sections, 6.1 Design Basis, and 6.2 Current Repository Design Description have been added to provide the assumptions and rationale for the design basis and to describe the current design status. The requirements of Section 6.1 through 6.7 of R.G. 4.17 are included as subsections of Section 6.3 in the Annotated Outline, as indicated below. The information presented in Sections 6.1 and 6.2 will be referenced as appropriate in Sections 6.3.
	6.1.1 <u>Repository Design Requirements</u>	
	6.1.2 <u>Reference Design Data Base</u>	
	6.1.3 <u>Analytical Tools for Geotechnical Design</u>	
	6.1.4 <u>Structures, Systems, and Components Important to Safety</u>	
	6.1.5 <u>Engineered Barriers Important to Waste Isolation</u>	
	6.2 <u>Current Repository Design Description</u>	
	6.2.1 <u>Background</u>	
	6.2.2 <u>Overall Facility Design</u>	
	6.2.3 <u>Repository Operations</u>	
	6.2.4 <u>Design of Surface Facilities</u>	
	6.2.5 <u>Shaft and Ramp Design</u>	
	6.2.6 <u>Subsurface Design</u>	
	6.2.7 <u>Backfill of Underground Opening</u>	
	6.2.8 <u>Shaft and Borehole Seals</u>	

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 7 (continued)

Correlation of Chapter 6 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
	6.3 Assessment of Design Information Needs	
	6.3.1 <u>Introduction</u>	This section has been added in order to provide a general discussion of the contents of the section.
6.1 Design of Underground Openings	6.3.2 Design of Underground Openings	Same.
6.2 Backfill	6.3.3 Backfill	Same.
6.3 Strength of Rock Mass	6.3.4 Strength of Rock Mass	Same.
6.4 Sealing of Shafts, Boreholes, and Underground Openings	6.3.5 Sealing of Shafts, Boreholes, and Underground Openings	Same.
6.5 Construction	6.3.6 Construction	Same.
6.6 Design of Surface Facilities	6.3.7 Design of Surface Facilities	Same.
6.7 Repository System Component Performance Requirements	6.3.8 <u>Mined Geologic Disposal System Component Performance Requirements</u>	"Mined geologic disposal system" replaces "repository system" to use DOE terminology. The meaning is the same.
	6.4 <u>Summary of Design Issues and Data Needs</u>	This section has been added to summarize design issues and data needs, and to provide a link between Chapter 6 and the plans presented in Chapter 8.

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 8

Correlation of Chapter 7 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
7. WASTE FORM AND PACKAGE	7. WASTE PACKAGE	The waste package includes the waste form, and therefore, specific mention of waste form in the title is unnecessary. The contents of this chapter have been rearranged from the order requested in R.G. 4.17, as indicated below.
	7.0 <u>Introduction</u>	This section has been added to provide a general discussion of the information contained in the chapter and to explain the role of that information in the site characterization program.
	7.2 <u>Design Basis</u>	This section has been added so that the design basis could be discussed separately and before the design description. It provides information not specifically requested by R.G. 4.17.
7.1 Description	7.3 <u>Design Descriptions</u>	This section includes reference designs and alternative designs, with corresponding subsections.
	7.3.1 <u>Reference Design</u>	
	7.3.2 <u>Alternative Designs</u>	
7.2 Design Concepts	[7.3 Design Descriptions]	A discussion of design concepts has been combined with the design description for ease and clarity of presentation.
7.3 Research and Development	7.4 <u>Research and Development Status- Waste Package Design and Geochemical Interactions</u>	The title has been changed to more completely reflect the content of the section.
7.4 Emplacement Environment	7.1 Emplacement Environment	Since the emplacement environment is part of the information used to develop the design, this section has been relocated to the beginning of the chapter.

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 8 (continued)

Correlation of Chapter 7 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
7.5 Alternative Waste Forms and	[7.3.2 Alternative Designs	Alternatives will be discussed together with the reference design for ease and clarity of presentation.
	7.5 <u>Summary</u>	This section has been added to summarize design issues and related data needs, and to provide a link between Chapter 6 and the plans presented in Chapter 8.

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 9

Correlation of Chapter 8 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
8. SITE CHARACTERIZATION PROGRAM	8. SITE CHARACTERIZATION PROGRAM	The general format suggested in R.G. 4.17 has been followed in this chapter. Some sections have been combined and/or reorganized in order to facilitate the presentation of information. R.G. 4.17 sections 8.3, and 8.4 have been combined in a single section 8.3, and R.G. 4.17 sections 8.6 and 8.7 are combined in a single section 8.5. Details are provided below.
	8.0 <u>Introduction</u>	This section has been added to provide an overview to the chapter. The purpose, significance, content, and organization of the chapter need to be discussed here because of the size and complexity of the chapter.
8.1 Rationale for Planned Site Characterization Program	8.1 Rationale for Planned Site Characterization Program	To facilitate clear presentation of information, this section has been organized into two subsections: 8.1.1 The Issues-Based Approach to Site Characterization and 8.1.2 Issue Resolution Strategy.
<ul style="list-style-type: none"> • Types of information to be obtained during site characterization • Why the information is needed 	8.1.1 <u>The Issues-Based Approach to Site Characterization</u> 8.1.1 <u>The Issues-Based Approach to Site Characterization</u> 8.1.2 <u>Issue Resolution Strategy</u> 8.1.2 Issue Resolution Strategy	
<ul style="list-style-type: none"> • Whether the information will confirmatory/supplementary data or new data • Objectives of site characterization 	[8.0 <u>Introduction</u>]	The introductory section that has been added (see above) provides a more appropriate location to discuss objectives.

Editorial conventions used in Section titles of the AO:

1. Titles that are underlined (e.g., 1.1.1 Physiography) indicate that the title in the AO is changed from that in R.G. 4.17 or that the title is of a Section not specifically requested by R.G. 4.17.
2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 9 (continued)

Correlation of Chapter 8 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
<ul style="list-style-type: none"> Relationship between site characterization program and system component performance requirements Criteria developed pursuant to Section 112(a) of NWPA and how information will be used to determine if criteria are met 	[8.3 Planned Investigations]	
	8.1.2. Issue Resolution Strategy	
8.2 Issues to Be Resolved and Information Required During Site Characterization	8.2 Issues to be Resolved and Information Required During Site Characterization	Section 8.2 has been reorganized and its content is somewhat different from that requested in R.G. 4.17. R.G. 4.17 divided issue discussion (Section 8.2) into 4 subcategories: 1) issues related to design of geologic operations areas; 2) issues related to waste form and package; 3) performance assessment issues; and 4) issues for NRC review. A number of topics requested by R.G. 4.17 were related to plans for obtaining information. For clearest presentation of information in the AO, and to avoid redundancy, Section 8.2 has been reorganized to address issues relating to both the design of the repository and the waste package. The section now identifies the issues and describes the general approach to the resolution of these issues. Planned tests, studies, and analyses to obtain the information will be presented in Section 8.3. A separate Performance Assessment Program Plan has been developed and is part of Section 8.3.

Editorial conventions used in Section titles of the AO:

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2. Titles in brackets (e.g., [1.1 Geomorphology]) indicate that the information requested by R.G. 4.17 is relocated to the bracketed Section in the AO.

Table 9 (continued)

Correlation of Chapter 8 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
<ul style="list-style-type: none"> • Identification of all known issues • Discussion of the types of information needed to resolve the issues in listed areas of study • Whether necessary data will be gathered from surface or subsurface activities • Identification of information related to design development or modeling efforts • Plans for resolving unresolved issues, including specifications for the investigations and the applicability and limitations of the investigations • For each test or data collection activity, a description of such activities and supporting rationale to indicate that <ul style="list-style-type: none"> - Data are representative - Data are known to sufficient precision and accuracy - Data are collected under appropriate quality assurance procedures 	<p>8.2.1 <u>Issues to be Resolved</u> 8.2.2 <u>Approach to Issue Resolution, and</u> <u>8.3 Planned Investigation Analyses, Studies</u></p> <p>[8.3 <u>Planned Investigations</u></p> <p>[8.3 <u>Planned Investigations</u></p> <p>8.2.2 <u>Approach to Issue Resolution, and</u> [8.3 <u>Planned Investigations</u></p> <p>[8.3 <u>Planned Investigations</u></p> <p>[8.6 <u>Quality Assurance Program</u></p>	<p>Details of data gathering will be presented in Section 8.3.</p> <p>The relationship between site characterization information and its used in design and modeling will be presented in Section 8.3.</p> <p>These details will be presented in Section 8.3.</p>

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Table 9 (continued)

Correlation of Chapter 8 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
8.2.1 Unresolved Issues Related to Design of Geologic Repository Operations Area		
8.2.1.1 Verification or Measurement of Site Conditions	8.2.1 <u>Issues to be Resolved</u> 8.3.1, <u>Site Program</u> , and 8.3.2.2, <u>Verification or Measurement of Environment</u> .	
8.2.1.2 Coupled Interaction Tests	[8.3.2.3 Coupled Interaction Investigations]	
8.2.2 Unresolved Issues Related to Waste Form and Package		
o Identification of unresolved issues	8.2.1 <u>Issues to be Resolved</u>	
o Plans to resolve issues	[8.3.4 <u>Waste Package Program</u>]	
8.2.3 Performance Assessment Issues		
8.2.3.1 Substantially Completed Analytical Techniques	8.3.5.4 Substantially Completed Analytical Techniques	The information requested in this section is closely related to the plans in Section 8.3 and is presented there.
8.2.3.2 Analytical Techniques Requiring Significant Development	8.3.5.5 Analytical Techniques Requiring Significant Development	
8.2.4 Issues for NRC Review	8.2.1 <u>Issues to be Resolved</u>	

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Table 9 (continued)

Correlation of Chapter 8 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
8.3 Planned Tests and Experiments	8.3 <u>Planned Investigations</u>	The title of this section has been changed to clearly indicate that analysis of data and conduct of other studies would be an important part of any test plan. This section will include information requested in R.G. 4.17 Section 8.3 Planned Tests and Experiments, and 8.4 Planned Testing, Instrumentations, and Monitoring. To facilitate presentation of test plans, this section has been organized into the following five subsections: 8.3.1 Site Program; 8.3.2 Repository Program; 8.3.3 Seal System Program; 8.3.4 Waste Package Program; and 8.3.5 Performance Assessment Program Plan.
8.3.1 Planned Tests with Radioactive Materials	8.3.1 <u>Site Program</u> 8.3.2 <u>Repository Program</u> 8.3.3 <u>Seal System Program</u> 8.3.4 <u>Waste Package Program</u>	
8.3.2 Planned Tests That May Affect Capability of Site to Isolate High Level Radioactive Wastes	8.3.1 <u>Site Program</u> 8.3.2 <u>Repository Program</u> 8.3.3 <u>Seal System Program</u> 8.3.4 <u>Waste Package Program</u> 8.3.5 <u>Performance Assessment Program Plan</u>	
8.4 Planned Testing, Instrumentation and Monitoring	8.3 <u>Planned Investigations</u> (in particular, 8.3.1 Site Program through 8.3.4 Waste Package Program)	As discussed above, the requirements of this section have been incorporated into Section 8.3 (Planned Tests, Analyses, and Studies).
8.5 Planned Site Preparation Activities	8.4 Planned Site Preparation Activities	Section 8.4 of the DOE's AO corresponds with Section 8.5 of R.G. 4.17. The discrepancy in numbering occurs because, as noted above, DOE's Section 8.3 Planned Tests, Analyses and studies includes R.G. 4.17 Sections 8.3 and 8.4.
8.5.1 Surface Site Preparation Activities	8.4.1 Surface Site Preparation Activities	

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Table 9 (continued)

Correlation of Chapter 8 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
8.5.2 Underground Test Facility <ul style="list-style-type: none"> • Description of underground test facility • Detailed rationale for proposed underground testing • Detailed layout excavations, borings, test locations • Details of construction • Location of test facility with respect to repository, including shafts and borings • Analysis of potential impacts of testing on site integrity 	8.4.2 Underground Test Facility [8.3 <u>Planned Investigations</u> 8.4.2 Underground Test Facility 8.4.2 Underground Test Facility 8.4.2 Underground Test Facility 8.4.2 Underground Test Facility	
8.6 Milestones, Analyses, Decision Points <ul style="list-style-type: none"> • Key milestones used to mark progress 	8.5 <u>Milestones, Decision Points, and and Schedule</u> 8.5.1 <u>Site Activities and Milestones,</u> 8.5.2 <u>Performance Assessment Activities and Milestones</u> 8.5.3 <u>Repository Design Activities and Milestones</u> 8.5.4 <u>Waste Package Design Activities and Milestones</u>	Section 8.5 includes information required in R.G. 4.17 Section 8.6 Milestones, Analyses, and Decision Points and 8.7 Schedules. These sections were combined because the contents were closely interrelated and could be discussed more effectively together.

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Table 9 (continued)

Correlation of Chapter 8 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
<ul style="list-style-type: none"> Data analyses to be performed Use of acquired data Stages in site characterization program where options would be assessed and decisions made 	8.3 <u>Planned Investigations</u> [8.1.4 <u>Utilization of Information</u> 8.5.5 <u>Project Major Decision Points</u> 8.5.6 Schedules	
8.7 Schedule <ul style="list-style-type: none"> Graphic presentation of activities, analyses, milestones, decision points, reports, and submittals for NRC, State, Indian Tribal, and public review Logic leading to decision points and selection among alternatives 	[8.5.6 Schedules] [8.5.5 Project Major Decision Points]	
8.8 Quality Assurance	8.6 <u>Quality Assurance Program</u> 8.6.1 <u>Quality Assurance Plan Summary</u> 8.6.2 <u>Requirements for Quality Assurance</u> 8.6.3 <u>Organization of the Project with Respect to Quality Assurance</u> 8.6.4 <u>Application of Quality Assurance</u>	Section 8.6 of the DOE AO corresponds with Section 8.8 of R.G. 4.17. The discrepancy in numbering occurs because in two instances above, two sections were combined into a single section. Please see notes for 8.4 and 8.5 above.

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Table 9 (continued)

Correlation of Chapter 8 of Regulatory Guide 4.17 with the Annotated Outline

<u>Section of Regulatory Guide 4.17</u>	<u>Analogous Section of Annotated Outline for SCP</u>	<u>Explanation and Rationale for Differences Between Regulatory Guide 4.17 and the Annotated Outline</u>
	8.6.5 <u>Administrative QA Procedures</u>	
	8.6.6 <u>Detailed Technical Procedures and Test Plans</u>	
8.9 Decontamination and Decommissioning	8.7 Decontamination and Decommissioning	Section 8.7 of the DOE AO corresponds with Section 8.8 of R.G. 4.17. See note above regarding discrepancy in numbering.
8.9.1 Decontamination	8.7.1 Decontamination	Decontamination of the <u>site characterization facilities</u> rather than the <u>repository</u> will be discussed in this section.
8.9.2 Decommissioning	8.7.2 Decommissioning	Same.
8.9.3 Plans for Mitigation of Any Significant Adverse Environmental Impacts Caused By Site Characterization Activities	8.7.3 Plans for Mitigation of any Significant Adverse Environmental Impacts Caused By Site Characterization Activities	Same.

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