

A-0297

PDR
2 PDR - WM-10(2)
WM-11(2)
WM-16(2)



Lawrence Livermore National Laboratory

NUCLEAR SYSTEMS SAFETY PROGRAM
L-196

WM-RES
WM Record File
A0297
LLL

WM Project 10, 11, 16
Docket No. _____

February 9, 1987

PDR ✓
XLPDR ✓ (B, N, S)

Mr. M. E. Blackford, MS-623ss
Project Officer, WMGT
Geotechnical Branch
Division of Waste Management, NMSS
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Distribution:
Blackford
(Return to WM, 623-SS) *Sac*

SUBJECT: LLNL Plans for Review of SCP's

Reference: NRC FIN A0297

Dear Mr. Blackford:

FEB 12 AM 8:49

The purpose of this letter is to set forth our LLNL team plans for review of DOE's Site Characterization Plans (SCP's).

In our effort to prepare ourselves in advance for the subject review and evaluation of SCP's, we are pleased to report our organizational plans as follows:

1. On the basis of "Annotated Outline For Site Characterization Plans", we anticipate that the LLNL team will have a major role in Chapters 1 through 7. We will make our input in Chapter 8 known to other NRC teams.
2. We have assigned those individuals named below with specific chapter(s) and section(s) within any particular SCP's.

Norm Burkhard, seismologist; all sites
 Dave Carpenter, engineering geologist; salt site leader
 Dae (Danny) Chung, geophysicist; project leader
 Dick Galster, geologist; BWIP geology
 Larry McKague, geologist; NNWSI site leader
 Russ Purcell, geomorphologist; NNWSI and salt sites
 Burt Slemmons, tectono-geologist; BWIP site leader

Note that in addition to the above named members of our staff, several graduate students will participate in the review of SCP's.

Note also that Dae (Danny) Chung is responsible for all sites, assisted by site leaders (Carpenter, McKague and Slemmons).

3. As in the attached marked copy of "Annotated Outline For Site Characterization Plans", we identified names of the LLNL team with

B702200385	B70209
PDR WMRES	EXILLL
A-0297	PDR

Attachment in pocket #1 (1987)
3632

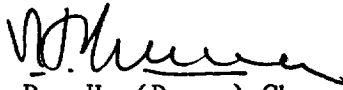
five (5) review categories as:

- (1) Review and Comment
- (2) Read for Information
- (3) Lead Role
- (4) Expertise
- (5) Assignment

The categories (1) through (5) are marked (X) on the attached marked copy of the annotated outline for SCP's.

If you have any questions, please let me know.

Sincerely yours,



Dae H. (Danny) Chung
Leader

NRC Nuclear Waste Management Project

DHC/ic
Attachment as stated.

cc: J. S. Trapp, WMGT

A-0297

W/lt. dtd. 2/9/87

To: M.E. Blackford

From: Alce H. Chung

(1) (2) (3) (4) (5)

Read for Information
Review and Comment
Assignment
Expertise
Lead Role

ANNOTATED OUTLINE FOR
SITE CHARACTERIZATION PLANS

INTRODUCTION.					X	BS/RC
PA A: DESCRIPTION OF SITE, WASTE PACKAGE, AND REPOSITORY DESIGN.						
Chapter 1 - GEOLOGY				X	X	BS/RC
1.0 INTRODUCTION.						
1.1 GEOMORPHOLOGY				X	X	R.P.
1.1.1 Physiography						
1.1.2 Geomorphic Units						
1.1.3 Geomorphic Processes						
1.2 STRATIGRAPHY AND LITHOLOGY.				X	X	BS
1.2.1 Stratigraphic Framework of the Candidate Area.						
1.2.2 Stratigraphic Framework of the Site.						
1.3 STRUCTURAL GEOLOGY AND TECTONICS OF CANDIDATE AREA AND SITE				X	X	B.S.
1.3.1 Tectonic Framework						
1.3.2 Tectonic History						
1.3.2.1 Volcanic History.						
1.3.2.2 Structural History.						
1.3.2.3 Existing Stress Regime.						
1.3.2.4 Vertical and Lateral Crustal Movement						
1.3.2.5 Geothermal Regime						
1.4 SEISMOLOGY OF CANDIDATE AREA AND SITE				X	X	BS
1.4.1 Seismology of Candidate Area						
1.4.1.1 Seismicity of Candidate Area.						
1.4.1.2 Relationship of Seismicity to Geologic or Tectonic Characteristics of Candidate Area.						
1.4.1.3 Determination of Earthquake-Generating Potential of Geologic Structures and Seismo-Tectonic Zones Within Candidate Area						
1.4.1.4 Earthquake-Induced Phenomena Within Candidate Area That May Affect Site						
1.4.1.5 Seismic Hazard in the Candidate Area.						
1.4.2 Seismology of the Site						
1.4.2.1 Vibratory Ground Motion at Site Resulting from Potential Earthquakes in Area						
1.4.2.2 Characteristics of Seismic Wave Transmission at Site						
1.4.2.3 Potential for Induced Seismicity Affecting Site						

*see page ix

TABLE OF CONTENTS (Cont'd)

Section	(1)	(2)	(3)	(4)	(5)
1.5 LONG-TERM REGIONAL STABILITY WITH RESPECT TO TECTONIC AND GEOLOGIC PROCESSES.	X		X		BS
1.6 DRILLING AND MINING	X		X		BS
1.7 MINERAL AND HYDROCARBON RESOURCES	X		X		BS
1.7.1 Mineral Resources.					
1.7.2 Hydrocarbon Resources.					
1.8 SUMMARY	X		X		BS
1.8.1 Summary of Significant Results					
1.8.2 Relation to Design					
1.8.3 Identification of Information Needs.					
1.8.4 Relation to Regulatory Guide 4.17.					
REFERENCES.					
Chapter 2 - GEOENGINEERING.		X			BS
2.0 INTRODUCTION.					
2.1 MECHANICAL PROPERTIES OF ROCK UNITS - INTACT ROCK					
2.1.1 Mechanical Properties of Other Rocks					
2.1.2 Mechanical Properties of Rocks at the Site					
2.2 MECHANICAL PROPERTIES OF ROCK UNITS - DISCONTINUITIES					
2.2.1 Mechanical Properties of Discontinuities in Other Rocks.					
2.2.2 Mechanical Properties of Discontinuities in Rocks at the Site					
2.3 MECHANICAL PROPERTIES OF ROCK UNITS - LARGE-SCALE					
2.3.1 Mechanical Properties of Other Rocks					
2.3.2 Mechanical Properties of Rocks at the Site					
2.3.3 Relationship Between Intact Rock, Discontinuities, and Large-Scale Rock Properties.					
2.4 THERMAL AND THERMOMECHANICAL PROPERTIES - INTACT ROCK					
2.4.1 Thermal and Thermomechanical Properties of Other Rocks					
2.4.2 Thermal and Thermomechanical Properties of Rock at the Site					
2.5 THERMAL AND THERMOMECHANICAL PROPERTIES - LARGE-SCALE					
2.5.1 Thermal and Thermomechanical Properties of Other Rocks					
2.5.2 Thermal and Thermomechanical Properties of Rock at the Site					
2.5.3 Relationship Between Intact Rock and Large-Scale Properties					
2.6 EXISTING STRESS REGIME.					
2.6.1 Stress Regime in Region of the Site.					

TABLE OF CONTENTS (Cont'd)

<u>Section</u>	(1)	(2)	(3)	(4)	(5)
2.6.2 Stress Regime at the Site.					
2.7 SPECIAL GEOENGINEERING PROPERTIES					
2.8 EXCAVATION CHARACTERISTICS OF ROCK MASS					
2.8.1 Excavation Characteristics of Similar Rocks.					
2.8.2 Excavation Characteristics of Rock at the Site					
2.8.3 Changes in Geoen지니어ing Properties Due to Excavation					
2.9 SUMMARY					
2.9.1 Summary of Significant Results					
2.9.2 Relation to Design					
2.9.3 Identification of Information Needs.					
2.9.4 Relation to Regulatory Guide 4.17.					
REFERENCES.					
Chapter 3 - HYDROLOGY		X			B5
3.0 INTRODUCTION.					
3.1 DESCRIPTION OF SURFACE HYDROLOGY.					
FLOODS.					
3.2.1 Flood History and Potential for Future Flooding.					
3.2.2 Flood Protection					
3.3 LOCATIONS AND DISTANCES TO POINTS OF SURFACE-WATER USE.					
3.3.1 Present Quantity and Quality of Surface Water Extracted.					
3.3.2 Projected Surface-Water Uses					
3.4 CHEMICAL COMPOSITION OF ADJACENT WATERCOURSES					
3.5 POINTS OF GROUND-WATER DISCHARGE.					
3.6 REGIONAL HYDROLOGIC RECONNAISSANCE OF CANDIDATE AREA AND SITE					
3.6.1 Hydrogeologic Units.					
3.6.2 Relationship Among Hydrogeologic Units					
3.6.3 Potentiometric Levels.					
3.6.4 Hydraulic Characteristics of Principal Hydrogeologic Units.					
3.7 REGIONAL GROUND-WATER FLOW SYSTEM					
3.7.1 Identification of Recharge and Discharge Areas					
3.7.2 Principal Ground-Water Flow Paths.					
3.7.3 Isotopic and Regional Hydrochemistry					
3.7.4 Paleohydrology					
3.8 GROUND-WATER USES					
3.8.1 Regional Ground-Water Aquifers Used for Human Activities					

TABLE OF CONTENTS (Cont'd)

(1) (2) (3) (4) (5)

Section

3.8.2 Regional Ground-Water Management Plans

3.9 SITE HYDROGEOLOGIC SYSTEM

3.9.1 Baseline Monitoring.

3.9.1.1 Monitoring Networks

3.9.1.2 Potentiometric Levels

3.9.1.3 Hydrochemistry.

3.9.2 Hydraulic Characteristics.

3.9.3 Ground-Water Flow System Conceptual Model.

3.9.3.1 Accessible Environment and Credible Pathways.

3.9.3.2 Potentiometric Levels and Head Relationships.

3.9.3.3 Recharge-Discharge and Leakage.

3.9.3.4 Unsaturated Zone Relationships.

3.9.4 Ground-Water Velocity and Travel Time.

3.9.5 Hydrochemical Confirmation of Ground-Water Behavior.

3.9.6 Monitoring and Verification.

3.9.7 Local Ground-Water Users

3.9.8 Paleohydrology

3.10 SUMMARY

3.10.1 Summary of Significant Results

3.10.2 Relation to Design

3.10.3 Identification of Information Needs.

3.10.4 Relation to Regulatory Guide 4.17.

REFERENCES.

Chapter 4 - GEOCHEMISTRY.

4.0 INTRODUCTION.

4.1 GEOCHEMISTRY OF THE HOST ROCK AND SURROUNDING UNITS

4.1.1 Mineralogy and Petrology

4.1.1.1 General Description of Host Rock and Surrounding Units

4.1.1.2 Analytical Techniques

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

4.1.1.4 Mineral Stability

4.1.2 Ground-Water Geochemistry.

4.1.2.1 General Description of the Hydrochemistry

4.1.2.2 Major Inorganic Content

4.1.2.3 Trace Elements.

4.1.2.4 Organic Content

4.1.2.5 Dissolved Gas

4.1.2.6 Background Radioactivity.

4.1.2.7 Particulates and Colloids

4.1.2.8 Temperature and Pressure.

4.1.2.9 Mineralogical Controls on Water Composition

Section

- 4.1.2.10 Reference Ground Water Composition.
- 4.1.3 Geochemical Retardation Processes.
 - 4.1.3.1 General Description of Geochemical Retardation.
 - 4.1.3.2 Analytical Techniques
 - 4.1.3.3 Sorption.
 - 4.1.3.4 Processes Affecting Radionuclide Concentrations and Speciation in Solution.
 - 4.1.3.5 Matrix Diffusion.
 - 4.1.3.6 Radionuclide Transport.
 - 4.1.3.7 Geochemical Retardation in the Host Rock and Surrounding Units - Anticipated Conditions.
 - 4.1.3.8 Geochemical Retardation in the Host Rock and Surrounding Units - Unanticipated Conditions.

- 4.2 GEOCHEMICAL EFFECTS OF WASTE EMPLACEMENT.
 - 4.2.1 Anticipated Thermal Conditions Resulting from Waste Emplacement.
 - 4.2.2 Hydrothermal Alteration Due to the Thermal Pulse
 - 4.2.3 Changes in Water Chemistry Due to the Thermal Pulse.
 - 4.2.4 Effects of the Thermal Pulse on Radionuclide Migration

- 4.3 NATURAL ANALOGS AND RELATED FIELD TESTS
 - 4.3.1 Natural Analogs.
 - 4.3.2 Related Field Tests.

- 4.4 GEOCHEMICAL STABILITY
 - 4.4.1 Potential Man-Induced Effects.
 - 4.4.2 Potential Effects of Natural Changes

- 4.5 SUMMARY
 - 4.5.1 Summary of Significant Results
 - 4.5.2 Relation to Design
 - 4.5.3 Identification of Information Needs.
 - 4.5.4 Relation to Regulatory Guide 4.17.

REFERENCES.

Chapter 5 - CLIMATOLOGY AND METEOROLOGY

- 5.0 INTRODUCTION.
- 5.1 RECENT CLIMATE AND METEOROLOGY.
 - 5.1.1 Climate.
 - 5.1.2 Local and Regional Meteorology
 - 5.1.3 Site Meteorological Measurement Program.
- 5.2 Long-Term Climatic Assessment
 - 5.2.1 Paleoclimatology

Section

5.2.2 Future Climatic Variation.

5.2.3 Site Paleoclimatic Investigation

5.3 SUMMARY

5.3.1 Summary of Significant Results

5.3.2 Relation to Design

5.3.3 Identification of Information Needs.

5.3.4 Relation to Regulatory Guide 4.17.

REFERENCES.

Chapter 6 - CONCEPTUAL DESIGN OF A REPOSITORY

6.0 INTRODUCTION.

6.1 DESIGN BASIS.

6.1.1 Repository Design Requirements

6.1.2 Reference Design Data Base

6.1.3 Analytical Tools for Geotechnical Design

6.1.4 Structures, Systems, and Components Important
to Safety.

6.1.5 Barriers Important to Waste Isolation.

2 CURRENT REPOSITORY DESIGN DESCRIPTION

6.2.1 Background

6.2.2 Overall Facility Design.

6.2.3 Repository Operations.

6.2.4 Design of Surface Facilities

6.2.4.1 Foundation Considerations

6.2.4.2 Flood Protection.

6.2.5 Shaft and Ramp Design.

6.2.6 Subsurface Design.

6.2.6.1 Excavation, Development, and Ground Support

6.2.6.2 Ground-water Control.

6.2.6.3 Ventilation

6.2.7 Backfill of Underground Opening.

6.2.8 Shaft and Borehole Seals

6.2.8.1 Shaft Seal Characteristics.

6.2.8.2 Shaft Seal Emplacement.

6.2.8.3 Borehole Seal Characteristics

6.2.8.4 Borehole Seal Emplacement

6.3 ASSESSMENT OF DESIGN INFORMATION NEEDS.

6.3.1 Introduction

6.3.2 Design of Underground Openings

6.3.3 Backfill

6.3.4 Strength of Rock Mass.

Section —

- 6.3.5 Sealing of Shafts, Boreholes, and Underground Openings.
- 6.3.6 Construction
- 6.3.7 Design of Surface Facilities
- 6.3.8 Repository System Component Performance Requirements

6.4 SUMMARY OF DESIGN ISSUES AND DATA NEEDS

REFERENCES.

Chapter 7 - WASTE PACKAGE

7.0 INTRODUCTION.

7.1 EMPLACEMENT ENVIRONMENT

7.2 DESIGN BASIS.

7.3 DESIGN DESCRIPTIONS

7.3.1 Reference Design

7.3.2 Alternative Designs.

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

7.5 SUMMARY

REFERENCES.

PART B: SITE CHARACTERIZATION PROGRAM.

Chapter 8 - SITE CHARACTERIZATION PROGRAM

8.0 INTRODUCTION.

8.1 RATIONALE FOR PLANNED SITE CHARACTERIZATION PROGRAM

8.1.1 Identification of Information Needs.

8.1.2 Prioritization of Information Needs.

8.1.3 Approach to Obtain Information

8.1.4 Utilization of Information

8.1.4.1 Determination of Whether Criteria
Developed Pursuant to Paragraph 112(a)
of NWPA are Met

8.1.4.2 Site Suitability.

8.1.4.3 Issue Resolution.

8.2 ISSUES TO BE RESOLVED AND INFORMATION REQUIRED DURING
SITE CHARACTERIZATION

8.2.1 Issues to be Resolved.

TABLE OF CONTENTS (Cont'd)

Section	(1)	(2)	(3)	(4)	(5)
8.2.1.1 Mission Plan Issues					
8.2.1.2 Site-Specific Issues.					
8.2.2 Approach to Issue Resolution					
8.3 PLANNED TESTS, ANALYSES, AND STUDIES.					
8.3.1 Site Program					
8.3.1.1 Overview.					
8.3.1.2 Geology					
8.3.1.3 Hydrology					
8.3.1.4 Geochemistry.					
8.3.1.5 Climatology					
8.3.1.6 Resource Potential.					
8.3.2 Repository Program					
8.3.2.1 Overview.					
8.3.2.2 Verification or Measurement of Environment.					
8.3.2.3 Coupled Interaction Tests					
8.3.2.4 Design Optimization Activities and Tests.					
8.3.2.5 Repository Modeling					
8.3.3 Seal System Program					
8.3.3.1 Overview.					
8.3.3.2 Seal System Environment					
8.3.3.3 Seal System Components and Interaction Tests.					
8.3.3.4 Seal System Design Optimization					
8.3.3.5 Seal System Modeling.					
8.3.4 Waste Package Program.					
8.3.4.1 Overview.					
8.3.4.2 Waste Package Environment					
8.3.4.3 Waste Package Components and Interaction Testing.					
8.3.4.4 Waste Package Design Development.					
8.3.4.5 Waste Package Modeling.					
8.3.5 Performance Assessment Program Plan.					
8.3.5.1 Strategy for Preclosure Performance Assessment.					
8.3.5.2 Strategy for Postclosure Performance Assessment					
8.3.5.2.1 Plans for Assigning and Assessing Engineered Barrier Subsystem and Component Performance Goals.					
8.3.5.2.2 Plans for Assigning and Assessing Seal Systems Performance Goals.					
8.3.5.2.3 Plans for Assessing the Contribution of Site Characteristics to Site Subsystem Performance.					
8.3.5.2.4 Plans for Assessing System Performance					
8.3.5.3 Plans for Demonstrating Compliance with EPA Standards, NRC Preclosure Postclosure Performance Objectives, and DOE Siting Guidelines.					
8.3.5.4 Substantially Completed Analytical Techniques.					
8.3.5.5 Analytical Techniques Requiring Significant Development.					

Section —

8.4 PLANNED SITE PREPARATION ACTIVITIES.
8.4.1 Surface Site Preparation Activities
8.4.2 Underground Test Facility

8.5 MILESTONES, DECISION POINTS, AND SCHEDULE.
8.5.1 Site Characterization Activities and Milestones
8.5.2 Performance Assessment Activities and Milestones.
8.5.3 Repository Design Activities and Milestones
8.5.4 Waste Package Design Activities and Milestones
8.5.5 Project Major Decision Points.
8.5.6 Schedules.

8.6 QUALITY ASSURANCE PROGRAM
8.6.1 Quality Assurance Plan Summary
8.6.2 Requirements for Quality Assurance
8.6.3 Organization of the Project with Respect to Quality Assurance.
8.6.4 Application of Quality Assurance
8.6.4.1 Quality Assurance During Site Exploration
8.6.4.2 Quality Assurance During Site Characterization.
8.6.4.3 Quality Assurance Applied to Repository and Waste Package Design.
8.6.5 Administrative QA Procedures
8.6.6 Quality Assurance Plans and Procedures for Specific Program Areas

8.7 DECONTAMINATION AND DECOMMISSIONING.
8.7.1 Decontamination
8.7.2 Decommissioning
8.7.3 Plans for Mitigation of Any Significant Adverse Environmental Impacts Caused by Site Characterization Activities.

REFERENCES

ATTACHMENT A - Correlation of the Annotated Outline with NRC Regulatory Guide 4.17

- L.M. - Larry McKague
- D.C. - Dave Carpenter
- R.P. - Russ Purcell
- B.S. - Burt Slemmons
- R.G. - Richard Galster

1.7 Mineral and hydrocarbon resources

- Petroleum Potential of Anticlines

1.8 Summary

2.6 Existing stress regime

4.1.1 Mineralogy and petrology

8.3.1.2 Geology

8.3.1.6 Resource potential

PROJECT BWIP

TASK 6 and 7

1.1 Geomorphology

1.2 Stratigraphy and Lithology

1.3 Structural geology and tectonics of candidate area and site

- Compressional Tectonics
- Anticline/Thrust Development
- Rooted/Non Rooted Origin of Folds and Thrusts

1.4 Seismology of candidate area and site

- Microseismicity
- Earthquake Swarms

1.5 Long term regional stability with respect to tectonic and geologic processes

1.6 Drilling and mining

- Catalogue of Drill Holes
- Completion of Drill Holes

(1) (2) (3) (4) (5)

Read for Information
Review and Comment
Assignment
Expertise
Lead Role

**ANNOTATED OUTLINE FOR
SITE CHARACTERIZATION PLANS**

INTRODUCTION.				X	LM
PART A: DESCRIPTION OF SITE, WASTE PACKAGE, AND REPOSITORY DESIGN.					
Chapter 1 - GEOLOGY			X	X	LM
1.0 INTRODUCTION.			X	X	LM
1.1 GEOMORPHOLOGY			X	X	RP
1.1.1 Physiography					
1.1.2 Geomorphic Units					
1.1.3 Geomorphic Processes					
1.2 STRATIGRAPHY AND LITHOLOGY.			X	X	LM
1.2.1 Stratigraphic Framework of the Candidate Area.					
1.2.2 Stratigraphic Framework of the Site.					
1.3 STRUCTURAL GEOLOGY AND TECTONICS OF CANDIDATE AREA AND SITE			X	X	LM
1.3.1 Tectonic Framework					
1.3.2 Tectonic History					
1.3.2.1 Volcanic History.					
1.3.2.2 Structural History.					
1.3.2.3 Existing Stress Regime.					
1.3.2.4 Vertical and Lateral Crustal Movement					
1.3.2.5 Geothermal Regime					
1.4 SEISMOLOGY OF CANDIDATE AREA AND SITE			X	X	LM
1.4.1 Seismology of Candidate Area					
1.4.1.1 Seismicity of Candidate Area.					
1.4.1.2 Relationship of Seismicity to Geologic or Tectonic Characteristics of Candidate Area.					
1.4.1.3 Determination of Earthquake-Generating Potential of Geologic Structures and Seismo-Tectonic Zones Within Candidate Area					
1.4.1.4 Earthquake-Induced Phenomena Within Candidate Area That May Affect Site					
1.4.1.5 Seismic Hazard in the Candidate Area.					
1.4.2 Seismology of the Site					
1.4.2.1 Vibratory Ground Motion at Site Resulting from Potential Earthquakes in Area					
1.4.2.2 Characteristics of Seismic Wave Transmission at Site					
1.4.2.3 Potential for Induced Seismicity Affecting Site					

*see page ix

TABLE OF CONTENTS (Cont'd)

<u>Section</u>	(1)	(2)	(3)	(4)	(5)
1.5 LONG-TERM REGIONAL STABILITY WITH RESPECT TO TECTONIC AND GEOLOGIC PROCESSES.	X		X		LM
1.6 DRILLING AND MINING	X		X		LM
1.7 MINERAL AND HYDROCARBON RESOURCES	X		X		LM
1.7.1 Mineral Resources.					
1.7.2 Hydrocarbon Resources.					
1.8 SUMMARY	X		X		LM
1.8.1 Summary of Significant Results					
1.8.2 Relation to Design					
1.8.3 Identification of Information Needs.					
1.8.4 Relation to Regulatory Guide 4.17.					
REFERENCES.					
Chapter 2 - GEOENGINEERING.			X		DC
2.0 INTRODUCTION.			X		DC
2.1 MECHANICAL PROPERTIES OF ROCK UNITS - INTACT ROCK					
2.1.1 Mechanical Properties of Other Rocks					
2.1.2 Mechanical Properties of Rocks at the Site					
2.2 MECHANICAL PROPERTIES OF ROCK UNITS - DISCONTINUITIES					
2.2.1 Mechanical Properties of Discontinuities in Other Rocks.					
2.2.2 Mechanical Properties of Discontinuities in Rocks at the Site					
2.3 MECHANICAL PROPERTIES OF ROCK UNITS - LARGE-SCALE					
2.3.1 Mechanical Properties of Other Rocks					
2.3.2 Mechanical Properties of Rocks at the Site					
2.3.3 Relationship Between Intact Rock, Discontinuities, and Large-Scale Rock Properties.					
2.4 THERMAL AND THERMOMECHANICAL PROPERTIES - INTACT ROCK					
2.4.1 Thermal and Thermomechanical Properties of Other Rocks					
2.4.2 Thermal and Thermomechanical Properties of Rock at the Site					
2.5 THERMAL AND THERMOMECHANICAL PROPERTIES - LARGE-SCALE					
2.5.1 Thermal and Thermomechanical Properties of Other Rocks					
2.5.2 Thermal and Thermomechanical Properties of Rock at the Site					
2.5.3 Relationship Between Intact Rock and Large-Scale Properties					
2.6 EXISTING STRESS REGIME.					
2.6.1 Stress Regime in Region of the Site.					

TABLE OF CONTENTS (Cont'd)

Section	(1)	(2)	(3)	(4)	(5)
2.6.2 Stress Regime at the Site.					
2.7 SPECIAL GEOENGINEERING PROPERTIES					
2.8 EXCAVATION CHARACTERISTICS OF ROCK MASS					
2.8.1 Excavation Characteristics of Similar Rocks.					
2.8.2 Excavation Characteristics of Rock at the Site					
2.8.3 Changes in Geoengineering Properties Due to Excavation					
2.9 SUMMARY					
2.9.1 Summary of Significant Results					
2.9.2 Relation to Design					
2.9.3 Identification of Information Needs.					
2.9.4 Relation to Regulatory Guide 4.17.					
REFERENCES.					
Chapter 3 - HYDROLOGY		X			RP
3.0 INTRODUCTION.					
3.1 DESCRIPTION OF SURFACE HYDROLOGY.					
3.2 FLOODS.				X	RP
3.2.1 Flood History and Potential for Future Flooding.					
3.2.2 Flood Protection					
3.3 LOCATIONS AND DISTANCES TO POINTS OF SURFACE-WATER USE.					
3.3.1 Present Quantity and Quality of Surface Water Extracted.					
3.3.2 Projected Surface-Water Uses					
3.4 CHEMICAL COMPOSITION OF ADJACENT WATERCOURSES					
3.5 POINTS OF GROUND-WATER DISCHARGE.					
3.6 REGIONAL HYDROLOGIC RECONNAISSANCE OF CANDIDATE AREA AND SITE					
3.6.1 Hydrogeologic Units.					
3.6.2 Relationship Among Hydrogeologic Units					
3.6.3 Potentiometric Levels.					
3.6.4 Hydraulic Characteristics of Principal Hydrogeologic Units.					
3.7 REGIONAL GROUND-WATER FLOW SYSTEM					
3.7.1 Identification of Recharge and Discharge Areas					
3.7.2 Principal Ground-Water Flow Paths.					
3.7.3 Isotopic and Regional Hydrochemistry					
3.7.4 Paleohydrology				X	RP
3.8 GROUND-WATER USES					
3.8.1 Regional Ground-Water Aquifers Used for Human Activities					

TABLE OF CONTENTS (Cont'd)

(1) (2) (3) (4) (5)

Section

3.8.2	Regional Ground-Water Management Plans				
3.9	SITE HYDROGEOLOGIC SYSTEM				
3.9.1	Baseline Monitoring				
3.9.1.1	Monitoring Networks				
3.9.1.2	Potentiometric Levels				
3.9.1.3	Hydrochemistry.				
3.9.2	Hydraulic Characteristics.				
3.9.3	Ground-Water Flow System Conceptual Model.				
3.9.3.1	Accessible Environment and Credible Pathways.				
3.9.3.2	Potentiometric Levels and Head Relationships.				
3.9.3.3	Recharge-Discharge and Leakage.				
3.9.3.4	Unsaturated Zone Relationships.				
3.9.4	Ground-Water Velocity and Travel Time.				
3.9.5	Hydrochemical Confirmation of Ground-Water Behavior.				
3.9.6	Monitoring and Verification.				
3.9.7	Local Ground-Water Users				
3.9.8	Paleohydrology			X	RP
3.10	SUMMARY				
3.10.1	Summary of Significant Results				
3.10.2	Relation to Design				
3.10.3	Identification of Information Needs.				
3.10.4	Relation to Regulatory Guide 4.17.				
	REFERENCES.				
	Chapter 4 - GEOCHEMISTRY.		X		LM
4.0	INTRODUCTION.				
4.1	GEOCHEMISTRY OF THE HOST ROCK AND SURROUNDING UNITS				
4.1.1	Mineralogy and Petrology	X		X	LM
4.1.1.1	General Description of Host Rock and Surrounding Units				
4.1.1.2	Analytical Techniques				
4.1.1.3	Mineralogic, Petrologic, and Chemical Composition of the Host Rock and Surrounding Units.				
4.1.1.4	Mineral Stability				
4.1.2	Ground-Water Geochemistry.				
4.1.2.1	General Description of the Hydrochemistry				
4.1.2.2	Major Inorganic Content				
4.1.2.3	Trace Elements.				
4.1.2.4	Organic Content				
4.1.2.5	Dissolved Gas				
4.1.2.6	Background Radioactivity.				
4.1.2.7	Particulates and Colloids				
4.1.2.8	Temperature and Pressure.				
4.1.2.9	Mineralogical Controls on Water Composition				

Section

(1) (2) (3) (4) (5)

- 4.1.2.10 Reference Ground Water Composition.
- 4.1.3 Geochemical Retardation Processes.
 - 4.1.3.1 General Description of Geochemical Retardation.
 - 4.1.3.2 Analytical Techniques
 - 4.1.3.3 Sorption.
 - 4.1.3.4 Processes Affecting Radionuclide Concentrations and Speciation in Solution.
 - 4.1.3.5 Matrix Diffusion.
 - 4.1.3.6 Radionuclide Transport.
 - 4.1.3.7 Geochemical Retardation in the Host Rock and Surrounding Units - Anticipated Conditions.
 - 4.1.3.8 Geochemical Retardation in the Host Rock and Surrounding Units - Unanticipated Conditions.

- 4.2 GEOCHEMICAL EFFECTS OF WASTE EMPLACEMENT.
 - 4.2.1 Anticipated Thermal Conditions Resulting from Waste Emplacement.
 - 4.2.2 Hydrothermal Alteration Due to the Thermal Pulse
 - 4.2.3 Changes in Water Chemistry Due to the Thermal Pulse.
 - 4.2.4 Effects of the Thermal Pulse on Radionuclide Migration

- 4.3 NATURAL ANALOGS AND RELATED FIELD TESTS
 - 4.3.1 Natural Analogs.
 - 4.3.2 Related Field Tests.

- 4.4 GEOCHEMICAL STABILITY
 - 4.4.1 Potential Man-Induced Effects.
 - 4.4.2 Potential Effects of Natural Changes

- 4.5 SUMMARY
 - 4.5.1 Summary of Significant Results
 - 4.5.2 Relation to Design
 - 4.5.3 Identification of Information Needs.
 - 4.5.4 Relation to Regulatory Guide 4.17.

REFERENCES.

Chapter 5 - CLIMATOLOGY AND METEOROLOGY

- 5.0 INTRODUCTION.
- 5.1 RECENT CLIMATE AND METEOROLOGY.
 - 5.1.1 Climate.
 - 5.1.2 Local and Regional Meteorology
 - 5.1.3 Site Meteorological Measurement Program.

- 5.2 Long-Term Climatic Assessment
 - 5.2.1 Paleoclimatology

X

RP

X

RP

Section

5.2.2 Future Climatic Variation.

5.2.3 Site Paleoclimatic Investigation

5.3 SUMMARY

5.3.1 Summary of Significant Results

5.3.2 Relation to Design

5.3.3 Identification of Information Needs.

5.3.4 Relation to Regulatory Guide 4.17.

REFERENCES.

Chapter 6 - CONCEPTUAL DESIGN OF A REPOSITORY

X Dc

6.0 INTRODUCTION.

6.1 DESIGN BASIS.

6.1.1 Repository Design Requirements

6.1.2 Reference Design Data Base

6.1.3 Analytical Tools for Geotechnical Design

6.1.4 Structures, Systems, and Components Important to Safety.

6.1.5 Barriers Important to Waste Isolation.

6.2 CURRENT REPOSITORY DESIGN DESCRIPTION

6.2.1 Background

6.2.2 Overall Facility Design.

6.2.3 Repository Operations.

6.2.4 Design of Surface Facilities

6.2.4.1 Foundation Considerations

6.2.4.2 Flood Protection.

6.2.5 Shaft and Ramp Design.

6.2.6 Subsurface Design.

6.2.6.1 Excavation, Development, and Ground Support

6.2.6.2 Ground-water Control.

6.2.6.3 Ventilation

6.2.7 Backfill of Underground Opening.

6.2.8 Shaft and Borehole Seals

6.2.8.1 Shaft Seal Characteristics.

6.2.8.2 Shaft Seal Emplacement.

6.2.8.3 Borehole Seal Characteristics

6.2.8.4 Borehole Seal Emplacement

6.3 ASSESSMENT OF DESIGN INFORMATION NEEDS.

6.3.1 Introduction

6.3.2 Design of Underground Openings

6.3.3 Backfill

6.3.4 Strength of Rock Mass.

Section	(1)	(2)	(3)	(4)	(5)
6.3.5 Sealing of Shafts, Boreholes, and Underground Openings. . .					
6.3.6 Construction					
6.3.7 Design of Surface Facilities					
6.3.8 Repository System Component Performance Requirements . .					
6.4 SUMMARY OF DESIGN ISSUES AND DATA NEEDS					
REFERENCES.					
Chapter 7 - WASTE PACKAGE		X			LM
7.0 INTRODUCTION.					
7.1 EMPLACEMENT ENVIRONMENT					
7.2 DESIGN BASIS.					
7.3 DESIGN DESCRIPTIONS					
7.3.1 Reference Design					
7.3.2 Alternative Designs.					
7.4 RESEARCH AND DEVELOPMENT STATUS - WASTE PACKAGE DESIGN AND GEOCHEMICAL INTERACTIONS					
SUMMARY					
REFERENCES.					
PART B: SITE CHARACTERIZATION PROGRAM.					
Chapter 8 - SITE CHARACTERIZATION PROGRAM		X			LM
8.0 INTRODUCTION.		X			ALL
8.1 RATIONALE FOR PLANNED SITE CHARACTERIZATION PROGRAM		X			ALL
8.1.1 Identification of Information Needs.					
8.1.2 Prioritization of Information Needs.					
8.1.3 Approach to Obtain Information					
8.1.4 Utilization of Information					
8.1.4.1 Determination of Whether Criteria Developed Pursuant to Paragraph 112(a) of NWSA are Met					
8.1.4.2 Site Suitability.					
8.1.4.3 Issue Resolution.					
8.2 ISSUES TO BE RESOLVED AND INFORMATION REQUIRED DURING SITE CHARACTERIZATION		X			ALL
8.2.1 Issues to be Resolved.					

TABLE OF CONTENTS (Cont'd)

Section	(1)	(2)	(3)	(4)	(5)
8.2.1.1 Mission Plan Issues					
8.2.1.2 Site-Specific Issues					
8.2.2 Approach to Issue Resolution					
8.3 PLANNED TESTS, ANALYSES, AND STUDIES		X			
8.3.1 Site Program		X			
8.3.1.1 Overview					
8.3.1.2 Geology	X				LM
8.3.1.3 Hydrology		X			
8.3.1.4 Geochemistry		X			
8.3.1.5 Climatology		X			
8.3.1.6 Resource Potential	X				LM
8.3.2 Repository Program					
8.3.2.1 Overview					
8.3.2.2 Verification or Measurement of Environment					
8.3.2.3 Coupled Interaction Tests					
8.3.2.4 Design Optimization Activities and Tests					
8.3.2.5 Repository Modeling					
8.3.3 Seal System Program					
8.3.3.1 Overview					
8.3.3.2 Seal System Environment					
8.3.3.3 Seal System Components and Interaction Tests					
8.3.3.4 Seal System Design Optimization					
8.3.3.5 Seal System Modeling					
8.3.4 Waste Package Program					
8.3.4.1 Overview					
8.3.4.2 Waste Package Environment					
8.3.4.3 Waste Package Components and Interaction Testing					
8.3.4.4 Waste Package Design Development					
8.3.4.5 Waste Package Modeling					
8.3.5 Performance Assessment Program Plan					
8.3.5.1 Strategy for Preclosure Performance Assessment					
8.3.5.2 Strategy for Postclosure Performance Assessment					
8.3.5.2.1 Plans for Assigning and Assessing Engineered Barrier Subsystem and Component Performance Goals					
8.3.5.2.2 Plans for Assigning and Assessing Seal Systems Performance Goals					
8.3.5.2.3 Plans for Assessing the Contribution of Site Characteristics to Site Subsystem Performance					
8.3.5.2.4 Plans for Assessing System Performance					
8.3.5.3 Plans for Demonstrating Compliance with EPA Standards, NRC Preclosure Postclosure Performance Objectives, and DOE Siting Guidelines					
8.3.5.4 Substantially Completed Analytical Techniques					
8.3.5.5 Analytical Techniques Requiring Significant Development					

Section _____

8.4 PLANNED SITE PREPARATION ACTIVITIES.

8.4.1 Surface Site Preparation Activities

8.4.2 Underground Test Facility

8.5 MILESTONES, DECISION POINTS, AND SCHEDULE.

8.5.1 Site Characterization Activities and Milestones

8.5.2 Performance Assessment Activities and Milestones.

8.5.3 Repository Design Activities and Milestones

8.5.4 Waste Package Design Activities and Milestones

8.5.5 Project Major Decision Points.

8.5.6 Schedules.

8.6 QUALITY ASSURANCE PROGRAM

8.6.1 Quality Assurance Plan Summary

8.6.2 Requirements for Quality Assurance

8.6.3 Organization of the Project with Respect to Quality Assurance.

8.6.4 Application of Quality Assurance

8.6.4.1 Quality Assurance During Site Exploration

8.6.4.2 Quality Assurance During Site Characterization.

8.6.4.3 Quality Assurance Applied to Repository and Waste Package Design.

8.6.5 Administrative QA Procedures

8.6.6 Quality Assurance Plans and Procedures for Specific Program Areas

8.7 DECONTAMINATION AND DECOMMISSIONING.

8.7.1 Decontamination

8.7.2 Decommissioning

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

REFERENCES

ATTACHMENT A - Correlation of the Annotated Outline with NRC Regulatory Guide 4.17

- L.M. - Larry McKague
- D.C. - Dave Carpenter
- R.P. - Russ Purcell
- B.S. - Burt Slemmons

PROJECT NNWSI

TASK 6 and 7

1.1 Geomorphology

- Erosion rates
- Soil Formation
- Soil/terrace/fan chronology

1.2 Stratigraphy and Lithology

1.3 Structural geology and tectonics of candidate area and site

- Listric faults
- Strike slip faulting
- Age of faulting
- Basaltic magmatism

1.4 Seismology of candidate area and site

- Microseismicity
- Focal mechanisms

1.5 Long term regional stability with respect to tectonic and geologic processes

- Regional and local tectonic model

1.6 Drilling and mining

- Catalogue of holes
- Completion information
- Catalogue of mines

1.7 Mineral and hydrocarbon resources

- List of prospects and mines
- Potential for economic mineral deposits below ash flow sheets

1.8 Summary

2.6 Existing stress regime

- Summary of current borehole information
- Level line data/interpretation
- Variation of stress with depth

4.1.1 Mineralogy and petrology

- Vertical and horizontal variations in mineralogy/chemistry/
petrology

8.3.1.2 Geology

8.3.1.6 Resource potential

(1) (2) (3) (4) (5)

Assignment
Expertise
Lead Role
Read for Information
Review and Comment

ANNOTATED OUTLINE FOR
SITE CHARACTERIZATION PLANS

INTRODUCTION.

PART A: DESCRIPTION OF SITE, WASTE PACKAGE, AND REPOSITORY DESIGN.

Chapter 1 - GEOLOGY

1.0 INTRODUCTION.

1.1 GEOMORPHOLOGY

1.1.1 Physiography

1.1.2 Geomorphic Units

1.1.3 Geomorphic Processes

1.2 STRATIGRAPHY AND LITHOLOGY.

1.2.1 Stratigraphic Framework of the Candidate Area.

1.2.2 Stratigraphic Framework of the Site.

1.3 STRUCTURAL GEOLOGY AND TECTONICS OF CANDIDATE AREA AND SITE

1.3.1 Tectonic Framework

1.3.2 Tectonic History

1.3.2.1 Volcanic History.

1.3.2.2 Structural History.

1.3.2.3 Existing Stress Regime.

1.3.2.4 Vertical and Lateral Crustal Movement

1.3.2.5 Geothermal Regime

1.4 SEISMOLOGY OF CANDIDATE AREA AND SITE

1.4.1 Seismology of Candidate Area

1.4.1.1 Seismicity of Candidate Area.

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

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

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

1.4.1.5 Seismic Hazard in the Candidate Area.

1.4.2 Seismology of the Site

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

1.4.2.2 Characteristics of Seismic Wave Transmission
at Site

1.4.2.3 Potential for Induced Seismicity Affecting Site

	(1)	(2)	(3)	(4)	(5)
INTRODUCTION.					
Chapter 1 - GEOLOGY				X	X
1.0 INTRODUCTION.				X	X
1.1 GEOMORPHOLOGY				X	X
1.1.1 Physiography					
1.1.2 Geomorphic Units					
1.1.3 Geomorphic Processes					
1.2 STRATIGRAPHY AND LITHOLOGY.				X	X
1.2.1 Stratigraphic Framework of the Candidate Area.					
1.2.2 Stratigraphic Framework of the Site.					
1.3 STRUCTURAL GEOLOGY AND TECTONICS OF CANDIDATE AREA AND SITE				X	X
1.3.1 Tectonic Framework					
1.3.2 Tectonic History					
1.3.2.1 Volcanic History.					
1.3.2.2 Structural History.					
1.3.2.3 Existing Stress Regime.					
1.3.2.4 Vertical and Lateral Crustal Movement					
1.3.2.5 Geothermal Regime					
1.4 SEISMOLOGY OF CANDIDATE AREA AND SITE				X	X
1.4.1 Seismology of Candidate Area					
1.4.1.1 Seismicity of Candidate Area.					
1.4.1.2 Relationship of Seismicity to Geologic or Tectonic Characteristics of Candidate Area.					
1.4.1.3 Determination of Earthquake-Generating Potential of Geologic Structures and Seismo-Tectonic Zones Within Candidate Area					
1.4.1.4 Earthquake-Induced Phenomena Within Candidate Area That May Affect Site					
1.4.1.5 Seismic Hazard in the Candidate Area.					
1.4.2 Seismology of the Site					
1.4.2.1 Vibratory Ground Motion at Site Resulting from Potential Earthquakes in Area					
1.4.2.2 Characteristics of Seismic Wave Transmission at Site					
1.4.2.3 Potential for Induced Seismicity Affecting Site					

DC
DC
RP
DC
DC
LM

*see page ix

TABLE OF CONTENTS (Cont'd)

Section	(1)	(2)	(3)	(4)	(5)
1.5 LONG-TERM REGIONAL STABILITY WITH RESPECT TO TECTONIC AND GEOLOGIC PROCESSES.	X		X		DC
1.6 DRILLING AND MINING	X		X		LN
1.7 MINERAL AND HYDROCARBON RESOURCES	X		X		LN
1.7.1 Mineral Resources.					
1.7.2 Hydrocarbon Resources.					
1.8 SUMMARY	X		X		DC
1.8.1 Summary of Significant Results					
1.8.2 Relation to Design					
1.8.3 Identification of Information Needs.					
1.8.4 Relation to Regulatory Guide 4.17.					
REFERENCES.					
Chapter 2 - GEOENGINEERING.		X			DC
2.0 INTRODUCTION.					
2.1 MECHANICAL PROPERTIES OF ROCK UNITS - INTACT ROCK					
2.1.1 Mechanical Properties of Other Rocks					
2.1.2 Mechanical Properties of Rocks at the Site					
2.2 MECHANICAL PROPERTIES OF ROCK UNITS - DISCONTINUITIES					
2.2.1 Mechanical Properties of Discontinuities in Other Rocks.					
2.2.2 Mechanical Properties of Discontinuities in Rocks at the Site					
2.3 MECHANICAL PROPERTIES OF ROCK UNITS - LARGE-SCALE					
2.3.1 Mechanical Properties of Other Rocks					
2.3.2 Mechanical Properties of Rocks at the Site					
2.3.3 Relationship Between Intact Rock, Discontinuities, and Large-Scale Rock Properties.					
2.4 THERMAL AND THERMOMECHANICAL PROPERTIES - INTACT ROCK					
2.4.1 Thermal and Thermomechanical Properties of Other Rocks					
2.4.2 Thermal and Thermomechanical Properties of Rock at the Site					
2.5 THERMAL AND THERMOMECHANICAL PROPERTIES - LARGE-SCALE					
2.5.1 Thermal and Thermomechanical Properties of Other Rocks					
2.5.2 Thermal and Thermomechanical Properties of Rock at the Site					
2.5.3 Relationship Between Intact Rock and Large-Scale Properties					
2.6 EXISTING STRESS REGIME.		X		X	W
2.6.1 Stress Regime in Region of the Site.					

TABLE OF CONTENTS (Cont'd)

Section	(1)	(2)	(3)	(4)	(5)
2.6.2 Stress Regime at the Site.					
2.7 SPECIAL GEOENGINEERING PROPERTIES					
2.8 EXCAVATION CHARACTERISTICS OF ROCK MASS					
2.8.1 Excavation Characteristics of Similar Rocks.					
2.8.2 Excavation Characteristics of Rock at the Site					
2.8.3 Changes in Geoengineering Properties Due to Excavation					
SUMMARY					
2.9.1 Summary of Significant Results					
2.9.2 Relation to Design					
2.9.3 Identification of Information Needs.					
2.9.4 Relation to Regulatory Guide 4.17.					
REFERENCES.					
Chapter 3 - HYDROLOGY		X		X	DC
3.0 INTRODUCTION.					
3.1 DESCRIPTION OF SURFACE HYDROLOGY.					
FLOODS.					
3.2.1 Flood History and Potential for Future Flooding.					
3.2.2 Flood Protection					
3.3 LOCATIONS AND DISTANCES TO POINTS OF SURFACE-WATER USE.					
3.3.1 Present Quantity and Quality of Surface Water Extracted.					
3.3.2 Projected Surface-Water Uses					
3.4 CHEMICAL COMPOSITION OF ADJACENT WATERCOURSES					
3.5 POINTS OF GROUND-WATER DISCHARGE.					
3.6 REGIONAL HYDROLOGIC RECONNAISSANCE OF CANDIDATE AREA AND SITE					
3.6.1 Hydrogeologic Units.					
3.6.2 Relationship Among Hydrogeologic Units					
3.6.3 Potentiometric Levels.					
3.6.4 Hydraulic Characteristics of Principal Hydrogeologic Units.					
3.7 REGIONAL GROUND-WATER FLOW SYSTEM					
3.7.1 Identification of Recharge and Discharge Areas					
3.7.2 Principal Ground-Water Flow Paths.					
3.7.3 Isotopic and Regional Hydrochemistry					
3.7.4 Paleohydrology					
3.8 GROUND-WATER USES					
3.8.1 Regional Ground-Water Aquifers Used for Human Activities					

TABLE OF CONTENTS (Cont'd)

(1) (2) (3) (4) (5)

Section

3.8.2 Regional Ground-Water Management Plans				
3.9 SITE HYDROGEOLOGIC SYSTEM				
3.9.1 Baseline Monitoring.				
3.9.1.1 Monitoring Networks				
3.9.1.2 Potentiometric Levels				
3.9.1.3 Hydrochemistry.				
3.9.2 Hydraulic Characteristics.				
3.9.3 Ground-Water Flow System Conceptual Model.				
3.9.3.1 Accessible Environment and Credible Pathways.				
3.9.3.2 Potentiometric Levels and Head Relationships.				
3.9.3.3 Recharge-Discharge and Leakage.				
3.9.3.4 Unsaturated Zone Relationships.				
3.9.4 Ground-Water Velocity and Travel Time.				
3.9.5 Hydrochemical Confirmation of Ground-Water Behavior.				
3.9.6 Monitoring and Verification.				
3.9.7 Local Ground-Water Users				
3.9.8 Paleohydrology				
3.10 SUMMARY				
3.10.1 Summary of Significant Results				
3.10.2 Relation to Design				
3.10.3 Identification of Information Needs.				
3.10.4 Relation to Regulatory Guide 4.17.				
REFERENCES.				
Chapter 4 - GEOCHEMISTRY.	X		X	LM
4.0 INTRODUCTION.				
4.1 GEOCHEMISTRY OF THE HOST ROCK AND SURROUNDING UNITS				
4.1.1 Mineralogy and Petrology	X		X	LM
4.1.1.1 General Description of Host Rock and Surrounding Units				
4.1.1.2 Analytical Techniques				
4.1.1.3 Mineralogic, Petrologic, and Chemical Composition of the Host Rock and Surrounding Units.				
4.1.1.4 Mineral Stability				
4.1.2 Ground-Water Geochemistry.				
4.1.2.1 General Description of the Hydrochemistry				
4.1.2.2 Major Inorganic Content				
4.1.2.3 Trace Elements.				
4.1.2.4 Organic Content				
4.1.2.5 Dissolved Gas				
4.1.2.6 Background Radioactivity.				
4.1.2.7 Particulates and Colloids				
4.1.2.8 Temperature and Pressure.				
4.1.2.9 Mineralogical Controls on Water Composition				

Section

4.1.2.10 Reference Ground Water Composition.

4.1.3 Geochemical Retardation Processes.

4.1.3.1 General Description of Geochemical Retardation.

4.1.3.2 Analytical Techniques

4.1.3.3 Sorption.

4.1.3.4 Processes Affecting Radionuclide Concentrations and Speciation in Solution.

4.1.3.5 Matrix Diffusion.

4.1.3.6 Radionuclide Transport.

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

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

4.2 GEOCHEMICAL EFFECTS OF WASTE EMPLACEMENT.

4.2.1 Anticipated Thermal Conditions Resulting from Waste Emplacement.

4.2.2 Hydrothermal Alteration Due to the Thermal Pulse

4.2.3 Changes in Water Chemistry Due to the Thermal Pulse.

4.2.4 Effects of the Thermal Pulse on Radionuclide Migration

4.3 NATURAL ANALOGS AND RELATED FIELD TESTS

4.3.1 Natural Analogs.

4.3.2 Related Field Tests.

4.4 GEOCHEMICAL STABILITY

4.4.1 Potential Man-Induced Effects.

4.4.2 Potential Effects of Natural Changes

4.5 SUMMARY

4.5.1 Summary of Significant Results

4.5.2 Relation to Design

4.5.3 Identification of Information Needs.

4.5.4 Relation to Regulatory Guide 4.17.

REFERENCES.

Chapter 5 - CLIMATOLOGY AND METEOROLOGY

X X RP

5.0 INTRODUCTION.

5.1 RECENT CLIMATE AND METEOROLOGY.

5.1.1 Climate.

5.1.2 Local and Regional Meteorology

5.1.3 Site Meteorological Measurement Program.

5.2 Long-Term Climatic Assessment

5.2.1 Paleoclimatology

X X RP

Section

5.2.2	Future Climatic Variation.				
5.2.3	Site Paleoclimatic Investigation	X		X	RP
5.3	SUMMARY				
5.3.1	Summary of Significant Results				
5.3.2	Relation to Design				
5.3.3	Identification of Information Needs.				
5.3.4	Relation to Regulatory Guide 4.17.				
	REFERENCES.				
	Chapter 6 - CONCEPTUAL DESIGN OF A REPOSITORY	X		X	DC
6.0	INTRODUCTION.				
6.1	DESIGN BASIS.				
6.1.1	Repository Design Requirements				
6.1.2	Reference Design Data Base				
6.1.3	Analytical Tools for Geotechnical Design				
6.1.4	Structures, Systems, and Components Important to Safety.				
6.1.5	Barriers Important to Waste Isolation.				
6.2	CURRENT REPOSITORY DESIGN DESCRIPTION				
6.2.1	Background				
6.2.2	Overall Facility Design.				
6.2.3	Repository Operations.				
6.2.4	Design of Surface Facilities				
	6.2.4.1 Foundation Considerations				
	6.2.4.2 Flood Protection.				
6.2.5	Shaft and Ramp Design.				
6.2.6	Subsurface Design.				
	6.2.6.1 Excavation, Development, and Ground Support				
	6.2.6.2 Ground-water Control.				
	6.2.6.3 Ventilation				
6.2.7	Backfill of Underground Opening.				
6.2.8	Shaft and Borehole Seals				
	6.2.8.1 Shaft Seal Characteristics.				
	6.2.8.2 Shaft Seal Emplacement.				
	6.2.8.3 Borehole Seal Characteristics				
	6.2.8.4 Borehole Seal Emplacement				
6.3	ASSESSMENT OF DESIGN INFORMATION NEEDS.				
6.3.1	Introduction				
6.3.2	Design of Underground Openings				
6.3.3	Backfill				
6.3.4	Strength of Rock Mass.				

Section	(1)	(2)	(3)	(4)	(5)
6.3.5 Sealing of Shafts, Boreholes, and Underground Openings. . .					
6.3.6 Construction					
6.3.7 Design of Surface Facilities					
6.3.8 Repository System Component Performance Requirements . .					
6.4 SUMMARY OF DESIGN ISSUES AND DATA NEEDS					
REFERENCES.					
Chapter 7 - WASTE PACKAGE	X			X	DC
7.0 INTRODUCTION.					
7.1 EMPLACEMENT ENVIRONMENT					
7.2 DESIGN BASIS.					
7.3 DESIGN DESCRIPTIONS					
7.3.1 Reference Design					
7.3.2 Alternative Designs.					
7.4 RESEARCH AND DEVELOPMENT STATUS - WASTE PACKAGE DESIGN AND GEOCHEMICAL INTERACTIONS					
7.5 SUMMARY					
REFERENCES.					
PART B: SITE CHARACTERIZATION PROGRAM.					
Chapter 8 - SITE CHARACTERIZATION PROGRAM	X			X	DC
8.0 INTRODUCTION.					
8.1 RATIONALE FOR PLANNED SITE CHARACTERIZATION PROGRAM					
8.1.1 Identification of Information Needs.					
8.1.2 Prioritization of Information Needs.					
8.1.3 Approach to Obtain Information					
8.1.4 Utilization of Information					
8.1.4.1 Determination of Whether Criteria Developed Pursuant to Paragraph 112(a) of NWPA are Met					
8.1.4.2 Site Suitability.					
8.1.4.3 Issue Resolution.					
8.2 ISSUES TO BE RESOLVED AND INFORMATION REQUIRED DURING SITE CHARACTERIZATION					
8.2.1 Issues to be Resolved.					

TABLE OF CONTENTS (Cont'd)

Section	(1)	(2)	(3)	(4)	(5)
8.2.1.1 Mission Plan Issues					
8.2.1.2 Site-Specific Issues.					
8.2.2 Approach to Issue Resolution					
8.3 PLANNED TESTS, ANALYSES, AND STUDIES.					
8.3.1 Site Program					
8.3.1.1 Overview.					
8.3.1.2 Geology	X		X		DC
8.3.1.3 Hydrology					
8.3.1.4 Geochemistry.					
8.3.1.5 Climatology					
8.3.1.6 Resource Potential.	X		X		LM
8.3.2 Repository Program					
8.3.2.1 Overview.					
8.3.2.2 Verification or Measurement of Environment.					
8.3.2.3 Coupled Interaction Tests					
8.3.2.4 Design Optimization Activities and Tests.					
8.3.2.5 Repository Modeling					
8.3.3 Seal System Program					
8.3.3.1 Overview.					
8.3.3.2 Seal System Environment					
8.3.3.3 Seal System Components and Interaction Tests.					
8.3.3.4 Seal System Design Optimization					
8.3.3.5 Seal System Modeling.					
8.3.4 Waste Package Program.					
8.3.4.1 Overview.					
8.3.4.2 Waste Package Environment					
8.3.4.3 Waste Package Components and Interaction Testing.					
8.3.4.4 Waste Package Design Development.					
8.3.4.5 Waste Package Modeling.					
8.3.5 Performance Assessment Program Plan.					
8.3.5.1 Strategy for Preclosure Performance Assessment.					
8.3.5.2 Strategy for Postclosure Performance Assessment					
8.3.5.2.1 Plans for Assigning and Assessing Engineered Barrier Subsystem and Component Performance Goals.					
8.3.5.2.2 Plans for Assigning and Assessing Seal Systems Performance Goals.					
8.3.5.2.3 Plans for Assessing the Contribution of Site Characteristics to Site Subsystem Performance.					
8.3.5.2.4 Plans for Assessing System Performance					
8.3.5.3 Plans for Demonstrating Compliance with EPA Standards, NRC Preclosure Postclosure Performance Objectives, and DOE Siting Guidelines.					
8.3.5.4 Substantially Completed Analytical Techniques.					
8.3.5.5 Analytical Techniques Requiring Significant Development.					

Section. —

8.4 PLANNED SITE PREPARATION ACTIVITIES.

8.4.1 Surface Site Preparation Activities

8.4.2 Underground Test Facility

8.5 MILESTONES, DECISION POINTS, AND SCHEDULE.

8.5.1 Site Characterization Activities and Milestones

8.5.2 Performance Assessment Activities and Milestones.

8.5.3 Repository Design Activities and Milestones

8.5.4 Waste Package Design Activities and Milestones

8.5.5 Project Major Decision Points.

8.5.6 Schedules.

8.6 QUALITY ASSURANCE PROGRAM

8.6.1 Quality Assurance Plan Summary

8.6.2 Requirements for Quality Assurance

8.6.3 Organization of the Project with Respect to Quality Assurance.

8.6.4 Application of Quality Assurance

8.6.4.1 Quality Assurance During Site Exploration

8.6.4.2 Quality Assurance During Site Characterization.

8.6.4.3 Quality Assurance Applied to Repository and Waste Package Design.

8.6.5 Administrative QA Procedures

8.6.6 Quality Assurance Plans and Procedures for Specific Program Areas

8.7 DECONTAMINATION AND DECOMMISSIONING.

8.7.1 Decontamination

8.7.2 Decommissioning

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

REFERENCES

ATTACHMENT A - Correlation of the Annotated Outline with NRC Regulatory Guide 4.17

- L.M. - Larry McKague
- D.C. - Dave Carpenter
- R.P. - Russ Purcell
- B.S. - Burt Slemmons

PROJECT Salt

TASK 6 and 7

1.1 Geomorphology

- Relationship of playas to salt dissolution and structure.

1.2 Stratigraphy and Lithology

- Dissolution potential at site.

1.3 Structural geology and tectonics of candidate area and site

- Faults penetrating salt from underneath
- Quaternary movement along faults
- Potential for unmapped faults within 12 km of site

1.4 Seismology of candidate area and site

- Microseismicity/structure relationship
- Attenuation relations
- Current seismicity

1.5 Long term regional stability with respect to tectonic and geologic processes

1.6 Drilling and mining

1.7 Mineral and hydrocarbon resources

1.8 Summary

2.6 Existing stress regime

4.1.1 Mineralogy and petrology

8.3.1.2 Geology

8.3.1.6 Resource potential