YUCCA
MOUNTAIN
PROJECT

Studies

Viability Assessment
Volume 1 - Introduction and Site Characteristics

Presented to:
Nuclear Waste Technical Review Board

Presented by:
Tim Sullivan
Department of Energy

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

January 26-27, 1999

Viability Assessment - Volume 1 Introduction and Site Characteristics

- **The purpose of the introduction is to provide background information about the repository program, including:**
  - **Waste forms destined for geologic disposal**
  - **The history of the program**
  - **The regulatory framework**
  - **How the DOE manages the program**
  - **A description of the key components of the program, including the strategy for safely isolating waste at Yucca Mountain**
  - **The approach to prioritizing work required to complete the LA**

Viability Assessment - Volume 1 Introduction

- **The Repository Safety Strategy identifies attributes of the potential repository system**
  - **Limited water contacting waste packages**
  - **Long waste package lifetimes**
  - **Low rate of release from breached waste packages**
  - **Radionuclide concentration reduction during transport**

Viability Assessment - Volume 1
Site Characteristics

- **The description of site characteristics is divided into seven sections:**
  - **Geology**
  - **Climate**
  - **Unsaturated zone hydrology (water above the water table)**
  - **Saturated Zone hydrology (water below the water table)**
  - **Factors affecting radionuclide transport**
  - **Effects of repository construction and operation (including thermal and mechanical stresses on conditions and processes)**
  - **Disruptive processes and events**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

- **In each section, the discussion is intended to:**
  - **Provide a comprehensive (but not detailed) description of our current understanding of features and processes that could affect the site's ability to isolate waste**
  - **Be technically accurate and defensible, but written at a level of detail accessible and understandable to a non-technical reader**
  - **Outline the uncertainty associated with our understanding**
- **In addition to the site description, each section contains:**
  - **A brief statement of issues and concerns identified by NRC in each technical area (key technical issues)**
  - **A brief summary of the current status of site investigations and planned future work**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

Geology

- **The stratigraphic and structural features of the site are well-known and are incorporated in the Integrated Site Model to form a consistent geologic framework for process models**
- **The distribution of fractures with respect to rock characteristics and geologic structures is generally understood**
- **A potential repository host horizon, which will support the construction of stable openings, is of sufficient lateral extent, and located sufficiently below the surface and above the water table, exists at Yucca Mountain**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

- **The locations of block bounding faults are well defined; they are restricted to areas outside the potential repository block**
- **Alternative tectonic models are compatible with available data and are considered in assessing geologic hazards**
- **Long-term erosion rates at Yucca Mountain are low, approximately 0.1 to 1.1 cm per thousand years**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

Climate

- **The Yucca Mountain vicinity is currently semiarid with annual precipitation averaging about 170 mm per year**
- **Evidence of past climates in the Yucca Mountain vicinity indicate the area was often wetter and cooler than today**
- **Future climates at Yucca Mountain will likely be similar to those in the past (wetter and cooler). Future annual precipitation may be double or triple that observed today**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

Unsaturated Zone Hydrology

- **Yucca Mountain exhibits a thick unsaturated zone (about 600 meters)**
- **Available data support an infiltration model indicating that infiltration varies spatially across Yucca Mountain and ranges from about 0 to 40 mm per year with an average value of about 7 mm/yr**
- **The infiltration model indicates infiltration will increase by a factor of 7 to 20 under expected future climate conditions**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

- **Multiple approaches to determining percolation flux through Yucca Mountain yield values ranging from 0.1 to 18 mm per year**
- **Percolation occurs through a combination of fracture and matrix flow. Some fraction of the flux moves downward relatively quickly; much of it, however, travels more slowly**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

- **Current data support a model of unsaturated zone flow that yields a percolation flux within the potential repository area that varies spatially and ranges from about 1 to 20 mm per year**
- **Perched water is probably common throughout the site near the base of the Topopah Spring tuff or in the Calico Hills formation and may indicate some lateral diversion of flow**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

Saturated Zone Hydrology

- **At Yucca Mountain volcanic rocks below the water table have been divided into four hydrogeologic units: the upper volcanic aquifer, the upper volcanic confining unit, the lower volcanic aquifer, and the lower volcanic confining unit**
- **Regionally, an underlying carbonate aquifer and a valley-fill aquifer beneath the Amargosa desert also are important**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

- **Hydraulic tests in the volcanic rocks suggest fractures are more important than rock type in determining conductivity**
- **The regional saturated zone flow model, which is limited by sparse data, indicates water from Yucca Mountain flows first to the southeast towards Fortymile Wash and then to the south-southwest towards Amargosa Valley**
- **Mineralogical and paleodischarge studies indicate past maximum water levels have been no more than 60 to 130 m higher than present**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

Factors Affecting Radionuclide Transport

- **The range of solubility for key radionuclides has been determined for expected geochemical conditions in a repository**
- **Sorption coefficients have been determined for key radionuclides**
- **Three principal mineral groups may function as barriers to radionuclide transport: zeolites, clays, and manganese oxides**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

- **A 3-D mineralogic model based on site data indicates that zeolitic altered zones are present between the proposed repository and the water table**
- **Work continues to determine the effect of colloids on radionuclide transport**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

Potential Effects of Repository Construction and Operation

- **Thermal effects on rock properties have been characterized for Yucca Mountain tuffs**
- **Thermal effects on the hydrologic system at Yucca Mountain may include dry-out zones caused by boiling of water, condensation zones, and alteration of fracture properties affecting flow**
- **Thermal effects on the geochemical system at Yucca Mountain may include redistribution of silica in the UZ, change in the sorptive properties of zeolites, and alteration of water chemistry**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

Potentially Disruptive Events

- **A probabilistic analysis of volcanic hazard indicates the annual probability of a volcanic event disrupting a repository at Yucca Mountain is 1.5 x 10-8**
- **A probabilistic analysis of seismic hazard indicates ground accelerations of 0.17 and 0.53 g, for a reference rock outcrop, have an 10-3 and 10-4 annual probability of being exceeded, respectively**

Viability Assessment - Volume 1
Site Characteristics
(Continued)

- **Fault displacement hazard has been assessed to be low, except along primary block-bounding faults**
  - **Away from block bounding faults, displacements with a10-5 annual probability of being exceeded are 0.1 cm or less**
  - **For block bounding faults, corresponding values are 7.8 cm (Bow Ridge) and 32 cm (Solitario Canyon)**
- **Economically viable natural resource potential at Yucca Mountain is low**

Summary

- **Volume 1, Section 1 (Introduction to the VA) provides background information**
- **Volume 1, Section 2 (Site Characteristics) is a summary of our current knowledge of the natural setting at Yucca Mountain; it is not a comprehensive, detailed technical discussion**
- **A detailed discussion of the natural setting is found in the Yucca Mountain Site Description, which is available on the Internet**