

YUCCA  
MOUNTAIN  
PROJECT

Studies

# Saturated Zone (SZ) Flow and Transport Uncertainties

Presented to:  
Nuclear Waste Technical Review Board

Presented by:  
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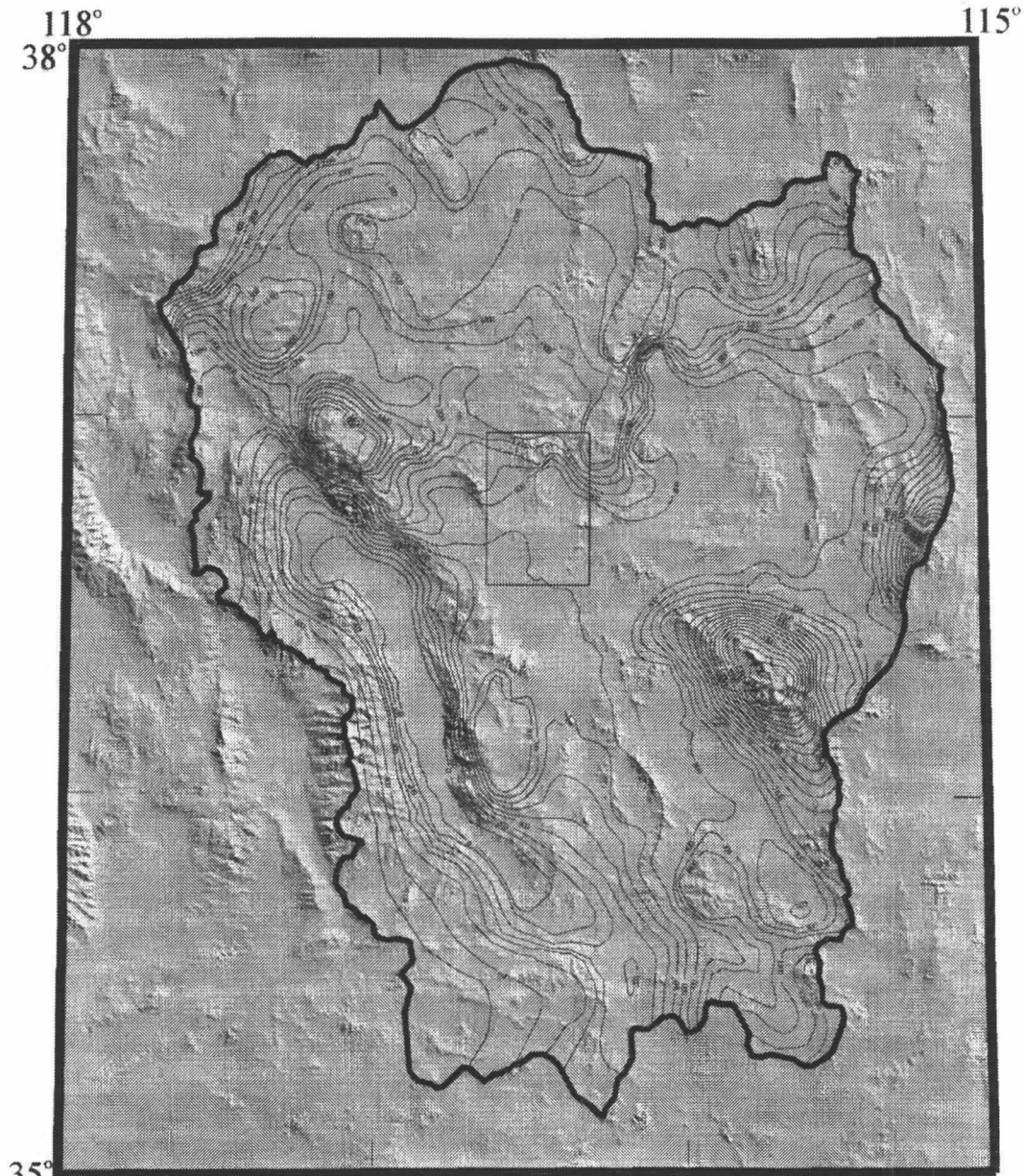
June 25-26, 1997



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




# Estimated Potentiometric Surface of the Death Valley Region

HOXIE.PPT/125/NWTRB/6-25-26-97 2

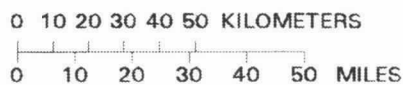


Universal Transverse Mercator projection, Zone 11.  
 Shaded-relief base from 1:250,000-scale Digital Elevation Model;  
 sun illumination from northeast at 30 degrees above horizon

## EXPLANATION

-  Death Valley ground-water flow system boundary
-  Nevada Test Site boundary
-  Model boundary

-1000- Potentiometric contour - shows altitude of potentiometric surface. Contour interval 100 meters. Datum is sea level.



# Key Uncertainties

- **Saturated Zone Flow and Transport Abstraction/ Testing Workshop, April 1-3, 1997, Denver, CO, identified issues related to key flow and transport uncertainties affecting repository-system performance assessment:**
  - **Spatial distribution of advective flux**
  - **Alternative conceptual models**
  - **Effective transport properties**
  - **Future climate change**

# **Spatial Distribution of Advective Flux**

- **Regional recharge and discharge**
- **Channelization of flow**
- **Vertical flow**

## **Significance:**

**Ground water moving beneath the site will be principal means for radionuclide transport to the accessible environment**

# Regional Recharge and Discharge

- **Spatially distributed recharge estimated by modified Maxey-Eakin method**
- **Discharge measurable at discrete locations:**
  - Springs
  - Playa evapotranspiration
  - Pumpage from wells

## **Significance:**

**Inflows and outflows determine overall regional flow system**

# Flow Channelization

- **Consequence of heterogeneity within hydrogeologic framework**
  - **Spatial distribution of hydraulic conductivity**
  - **Large-scale structural features (e.g., faults)**
  - **Fracture network connectivity**

## **Significance:**

**Defines flow and transport pathways to accessible environment**

# Vertical Flow

- **Limited data indicate potential for vertical flow upward into the volcanic aquifer near the site**
  - **Increasing head with depth in boreholes (e.g., UE-25 p#1)**
  - **Thermal data suggesting upwelling along major bounding faults (e.g., Solitario Canyon fault)**

## **Significance:**

**Downstream mixing and dilution of radionuclide concentrations**

# Alternative Conceptual Models

- **Steady-state hypothesis**
- **Equivalent continuum representation**
- **Explanations for large hydraulic gradient north of site**

## **Significance:**

**Represents uncertainty in understanding of flow and transport processes and their numerical simulation**



# Transport Issues

- **Dispersivity**
  - Transport parameter to quantify longitudinal and lateral spreading of a solute plume
- **Matrix diffusion (Effective porosity)**
  - Process of diffusion of solute into rock matrix from fracture pathways
- **Sorption**
  - Process of retardation of solute by chemical interaction with rock-mass constituents (e.g., zeolites)

# Transport Issues

(Continued)

## Significance:

- Reduce downstream radionuclide concentrations
- Delay arrival times to the accessible environment

# Future Climate Change

- **Future pluvial episodes are expected to occur in next 10,000 to 100,000 years with periods of increased regional recharge**

## **Significance:**

- **Potential water-table rise beneath the site**
- **Increased advective transport velocities**
- **Possible enhanced mixing and dilution within SZ**

# Addressing Key Uncertainties

- **Laboratory testing**
  - **Solubility and speciation experiments for Np**
  - **Column and diffusion-cell experiments for selected radionuclides**
  - **Hydrologic property measurements**
    - » **Saturated hydraulic conductivity**
    - » **Porosity**

# Addressing Key Uncertainties

(Continued)

- **Field testing**
  - **Hydraulic and tracer testing at c-holes complex**
  - **Completing Fortymile Wash recharge study**
  - **Planned WT-24 penetration of large hydraulic gradient**
  - **Planned hydraulic and hydrochemical testing in boreholes (e.g., Eh measurements in WT-17; new boreholes SD-6, SD-11, SD-13)**
  - **Planned second SZ testing complex**
  - **Paleodischarge investigations**

# Addressing Key Uncertainties

(Continued)

- **Modeling studies**
  - **Conducting sensitivity analyses for key processes and parameters using SZ flow and transport numerical models**
  - **Completed modeling of selected climate states to estimate bounds on possible future climate change and increased recharge**

# Addressing Key Uncertainties

(Continued)

- **Conducting SZ flow and transport expert elicitation to quantify uncertainty bounds on key parameters and conceptual models**
  - **Expert panel members:**
    - » **Dr. R. Allan Freeze**
    - » **Dr. Lynn Gelhar**
    - » **Dr. Donald Langmuir**
    - » **Dr. Shlomo Neuman**
    - » **Dr. Chin-Fu Tsang**

# Testing Program Support for Addressing Key Flow and Transport Issues

ISSUES	Laboratory Testing			Field Testing						Modeling Studies	
	Solubility Experiments	Column Experiments	Hydraulic Properties	C-Holes	Fortymie Wash Recharge	WT-24	WT-17, SD-6, SD-11, SD-13	SZ Testing Complex	Paleo-discharge Studies	Sensitivity Analyses	Future Climate
<b>Advective Flux</b> Recharge and Discharge Flow Channelization Vertical Flow			X X	X X	X X		X X	X X	X	X X X	X
<b>Alternative Conceptual Models</b> Steady-State Hypothesis Equivalent Continuum Model Large Hydraulic Gradient				X	X	X		X		X X X	
<b>Transport Issues</b> Dispersivity Matrix Diffusion Sorption	X			X X X				X X X		X X X	
<b>Future Climate Change</b>									X	X	X



# Conclusion

- **We will establish quantified bounds on key parameter and model uncertainties for VA**
- **We will reduce key uncertainties through additional testing for LA**