



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

# Application of Principal Factors - Seepage Studies

Presented to:

**Nuclear Waste Technical Review Board (NWTRB)**

Presented by:

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YUCCA  
MOUNTAIN  
PROJECT

# Why is Seepage a Principal Factor

- **Seepage determines the amount of water available in the drifts to contact engineered barrier components**
- **Under expected conditions, waste package last more than 100,000 years, and seepage is not an important factor**
- **In the event of an unanticipated early failure of the waste package, seepage can enter the waste package, dissolve waste, and transport radionuclides away from the waste package**
- **Current information does not preclude significant releases with early failure of the waste packages**

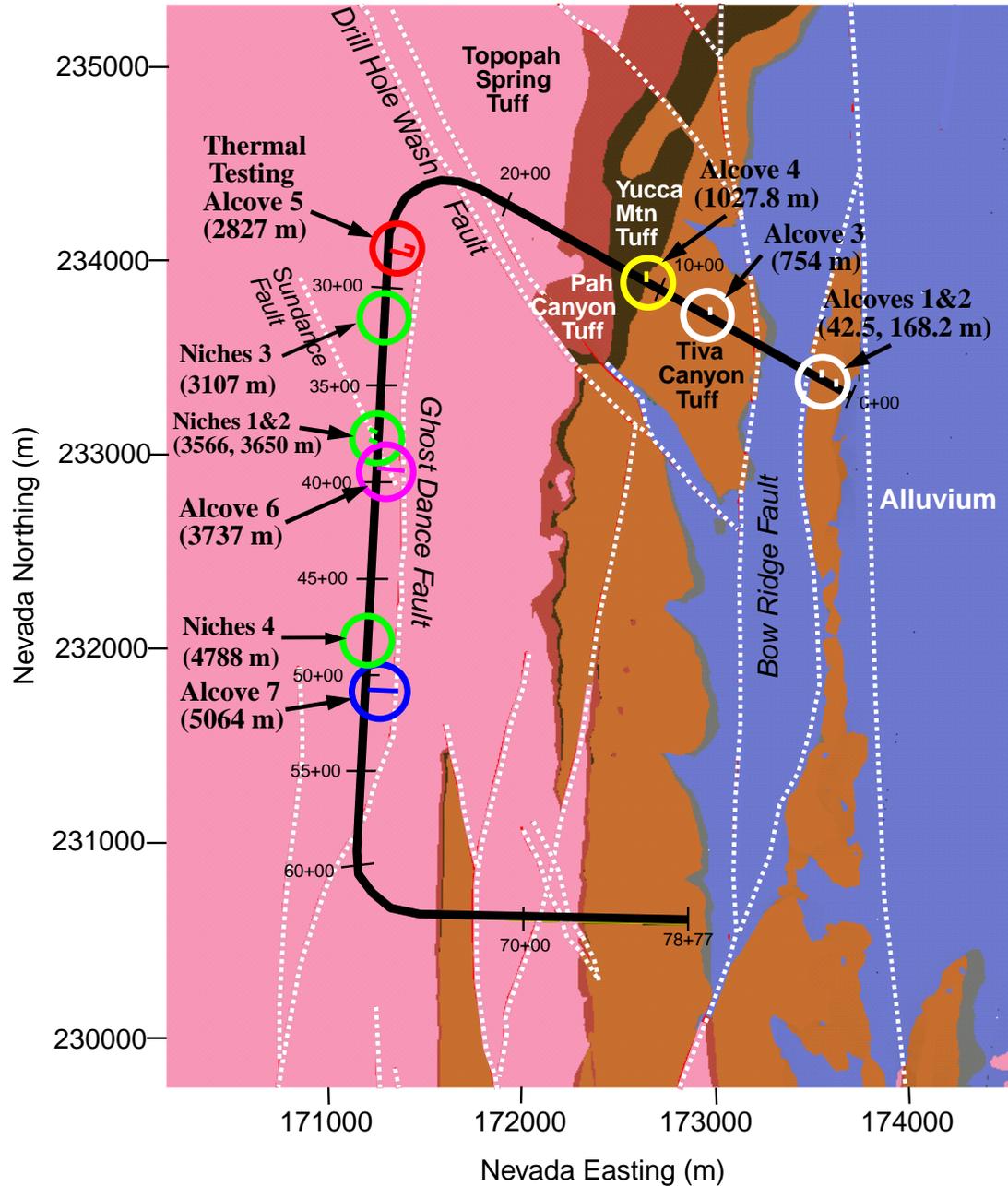
# Seepage and Uncertainties in TSPA

- **Drift Seepage Peer Review (1999)**
  - There are currently large uncertainties in quantitative estimates of seepage into drifts
  - More site data, modeling, and experimental work are needed to develop defensible estimates of seepage into drifts
- **Current data and modeling provide conceptual models of a drift acting as a capillary barrier and evaluate the seepage threshold**
- **TSPA-VA uncertainty analyses conclude that the seepage fraction is the most important parameter in determining peak dose rates for 10,000, 100,000, and 1,000,000 years**

# Seepage and Tunnel Stability

- **A seepage submodel was developed to evaluate the impact of partial collapse of a drift on seepage**
- **Results indicate that:**
  - **Effect of a single rock fall is not significant for seepage**
  - **A deeper failure in the drift roof increases seepage**
  - **As mechanical studies of drift degradation are made, seepage calculations should follow to update this preliminary assessment**

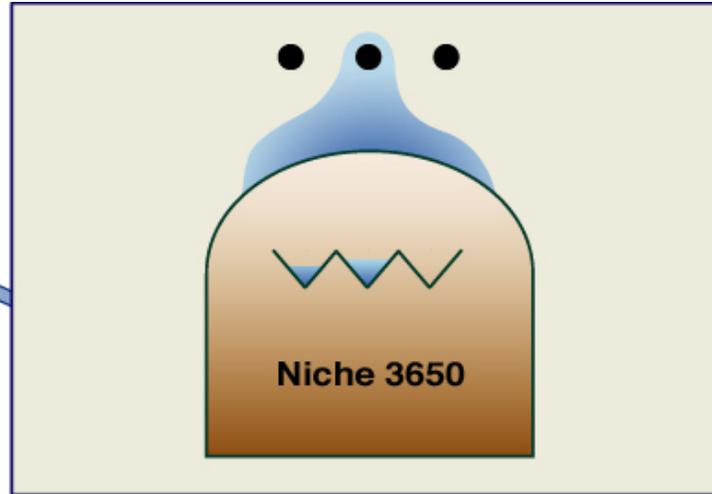
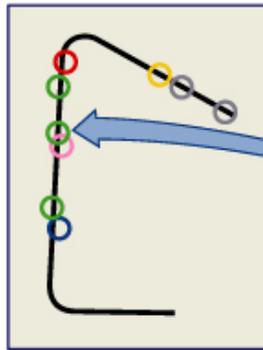
# ESF Alcove and Niche Locations



# Current Seepage Data

- **Seepage test data with controlled liquid releases in three niches in TSw middle nonlithophysal unit**
- **Air-permeability data for niche and alcove sites, including limited data in TSw lower lithophysal tuff unit (pre-test excavation monitoring boreholes)**
- **Alcove 1 large-scale tracer test in TCw unit**
- **Construction water monitoring below Cross Drift**

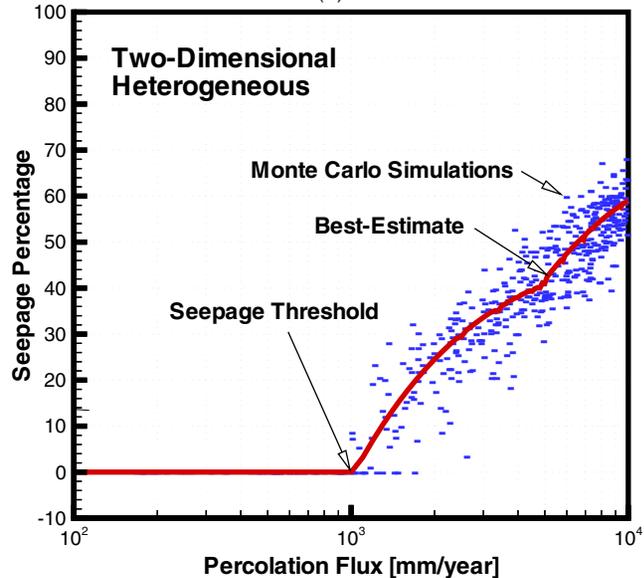
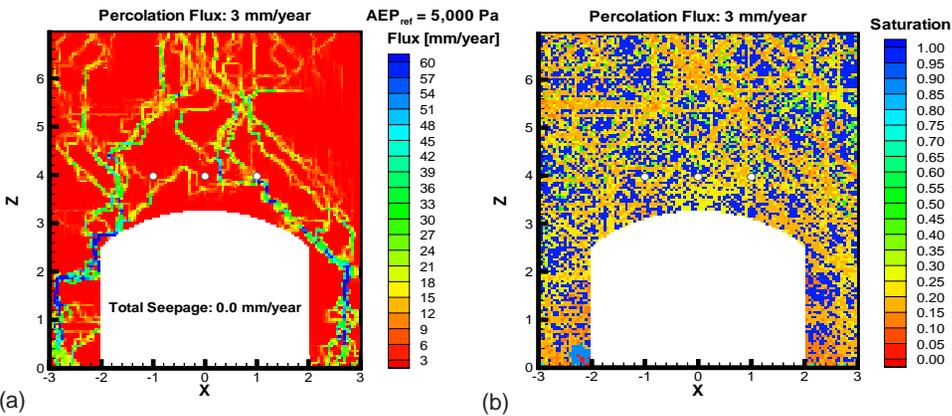
# Drift Seepage Test at Niche 3650



- Pulse releases to represent episodic percolation events
- Seepage thresholds determined by sequences of tests with reducing rates
- Seepage thresholds range from 200 mm/yr to 136,000 mm/yr at localized release intervals
- 6 out of 16 intervals did not seep
- Fracture porosity may be as high as 2.4%



# Seepage Threshold 200 mm/yr\*

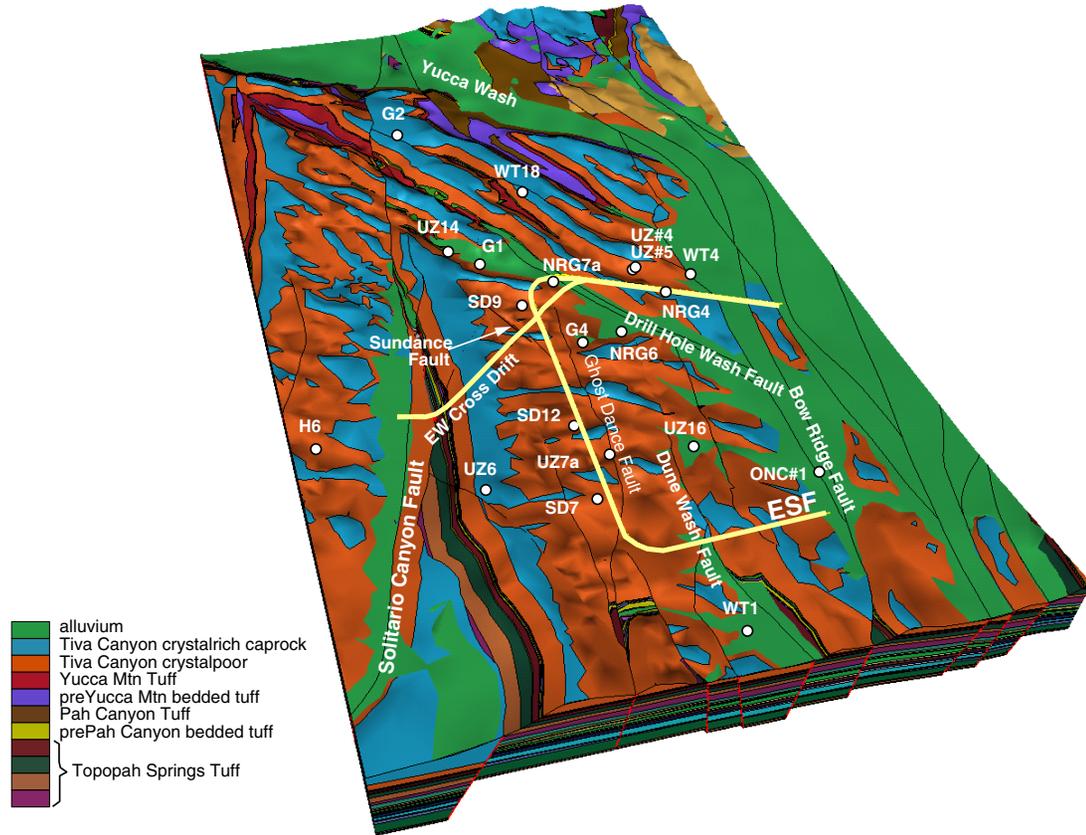


- Seepage model is calibrated to seepage data from Niche 2
- Seepage model matches the limited available data reasonably well
- Seepage model predicts a seepage threshold of 200 mm/yr for the middle nonlithophysal unit

\* Detailed information is given in the UZ AMR on seepage calibration (U0080)



# ESF and ECRB Cross Drift



# Additional Seepage Studies in the Cross Drift

- **Bulkhead Sealing Tests:**
  - **Monitor seepage and measure potential in Topopah Spring Lower Lithophysal and Lower Nonlithophysal Units and Solitario Canyon Fault Zone formation**
    - ◆ on-going since June 1999
- **Niche 5 Seepage Threshold Tests:**
  - **Conduct seepage threshold testing for a location with high density of lithophysal cavities and permeable tuff**
    - ◆ phase 1 in March 2000, phase 2 in May 2000

# Seepage Studies in the Cross Drift

(Continued)

- **Systematic Hydrologic Characterization**

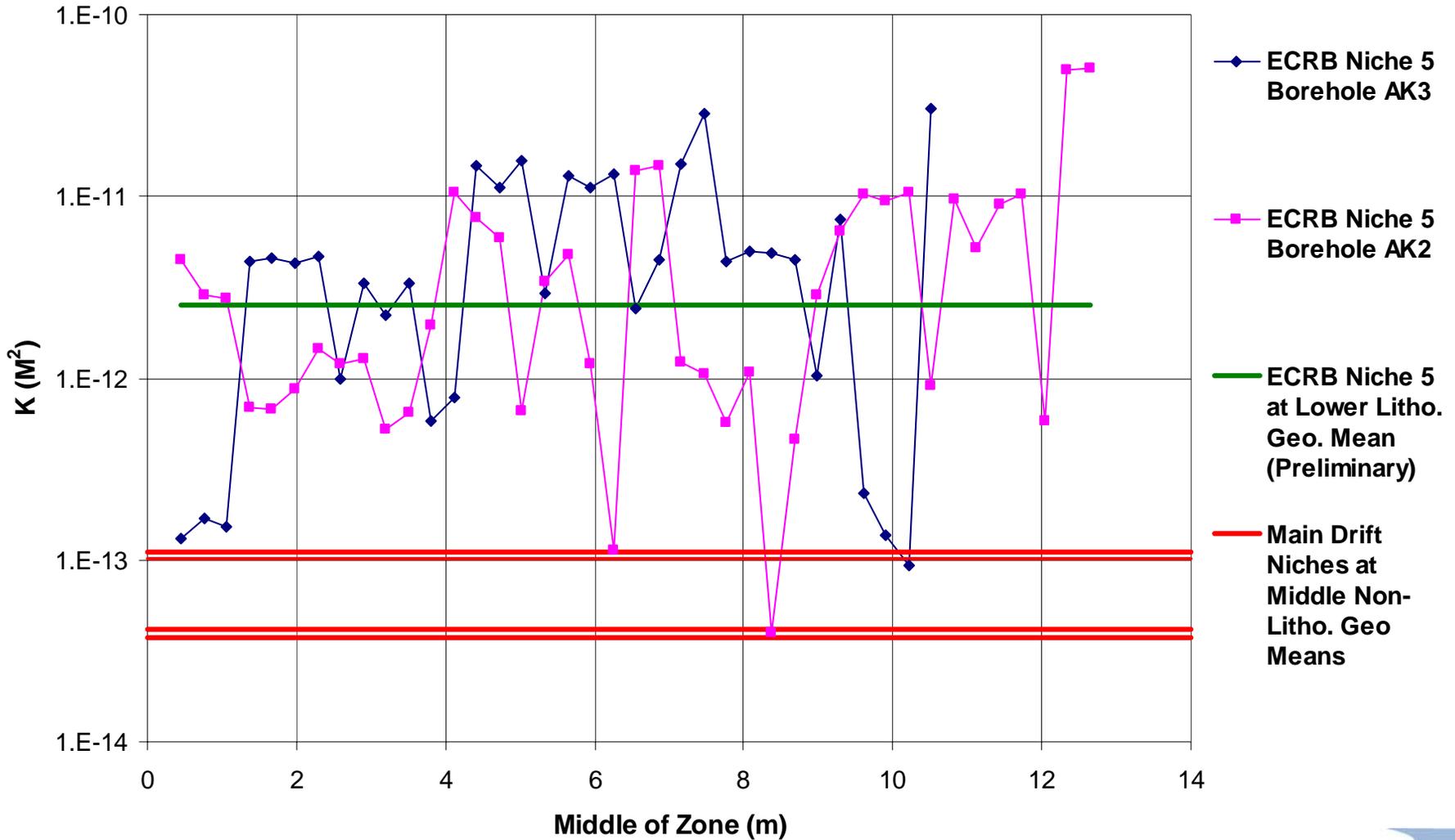
- **Quantify spatial variability in permeability and seepage capacity along Cross Drift in repository host rock**
  - ◆ **Drilling of slanted boreholes in March 2000, and testing in April 2000**

- **Cross-Drift Tracer Test**

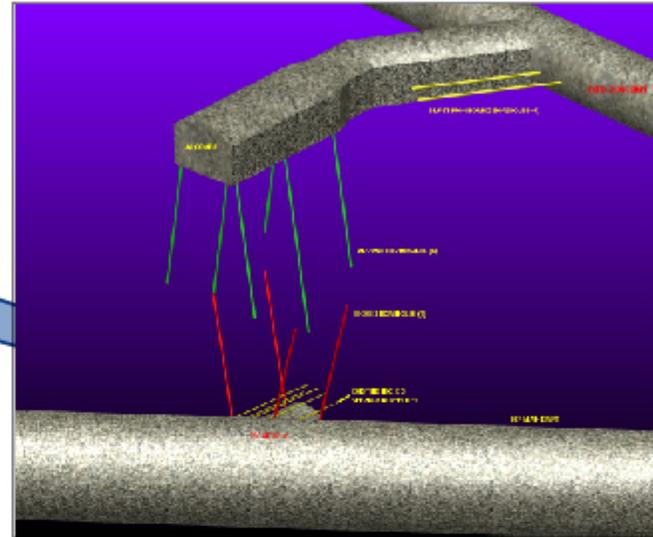
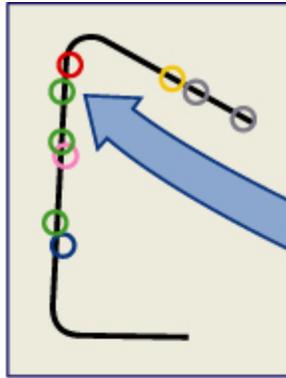
- **Flow and Seepage testing between the Crossover Alcove 8 and ESF Niche 3 in repository host rock to provide field-scale data for UZ flow, seepage, and matrix diffusion over scales of tens of meters**
  - ◆ **testing set-up May 00**



# Lower Lithophysal Air-Permeability - Preliminary Results



# Alcove 8–Niche 3107 Cross-Over Test



- Water releases in Alcove 8 and seepage collection in Niche 3107 is planned in year 2000
- Niche 3107 is located in a relatively tight unit near the top of the Tptpmn
- Seepage tests at Niche 3107 were conducted behind bulkhead to demonstrate the existence of threshold under high humidity conditions
- Drill-and-blase phase of Alcove 8 excavation is completed in 1999
- During ECRB Cross Drift construction, no water was observed to seep into the ESF Main Drift 20m below



# Goal for Site Recommendation

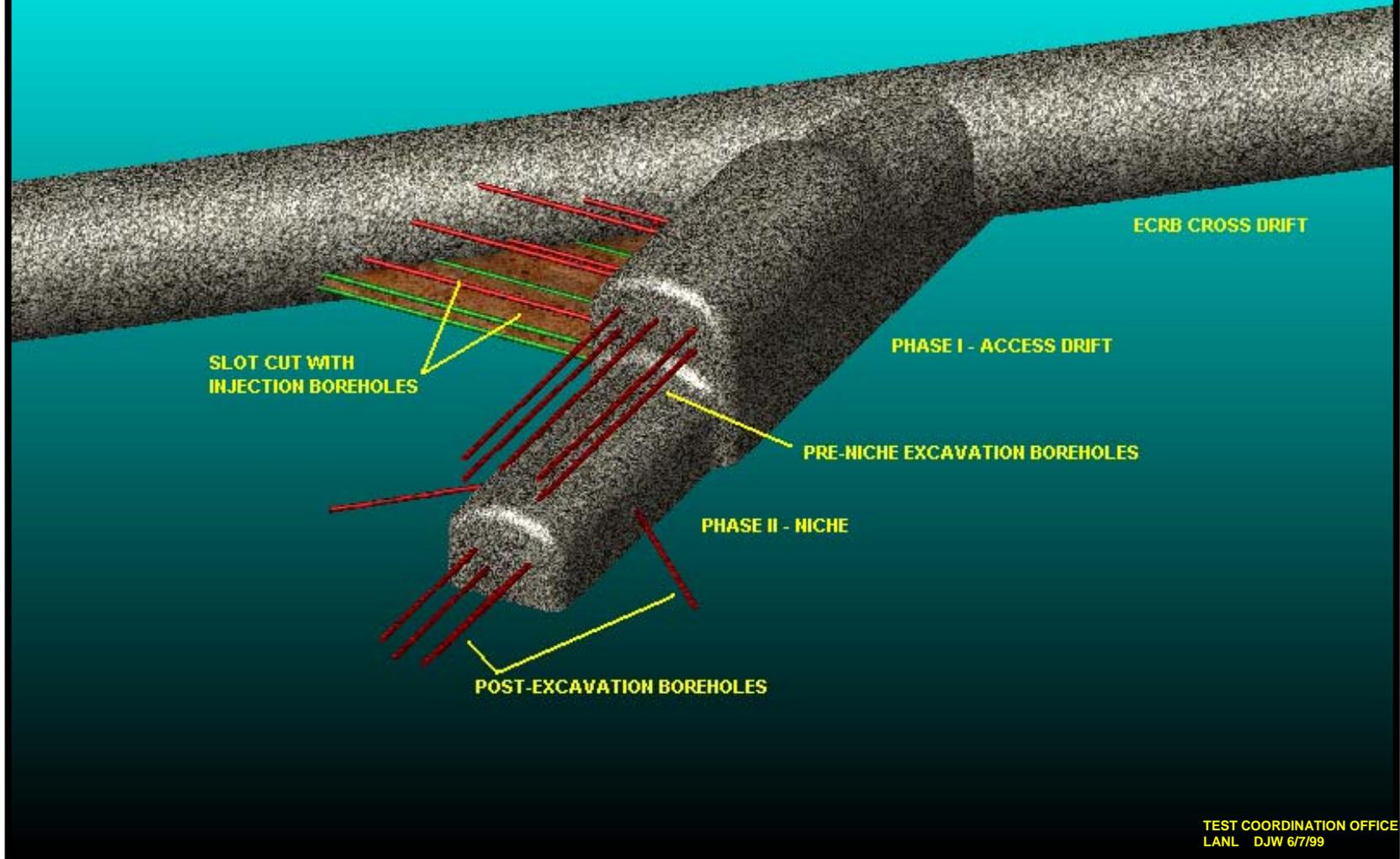
- **Incorporate seepage threshold and flow diversion field data from FY 00**
  - **Lower lithophysal seepage tests in Niche 5**
  - **Effects of excavation on hydrologic properties**
  - **Seepage, tracer, and air-k variability data (systematic testing)**
  - **Data from flow and seepage testing between the Cross Drift and ESF Niche 3**
  - **Results of flow and seepage testing from Alcove 1**

# License Application Treatment of Seepage

- **Incorporate inputs from comprehensive uncertainty analysis using results of sensitivity studies conducted for SR**
- **Long-term seepage tests for flow diversion migration around and below drifts**
- **Thermal seepage tests in Cross Drift**
- **Percolation determination below crest and below Solitario Canyon wall**

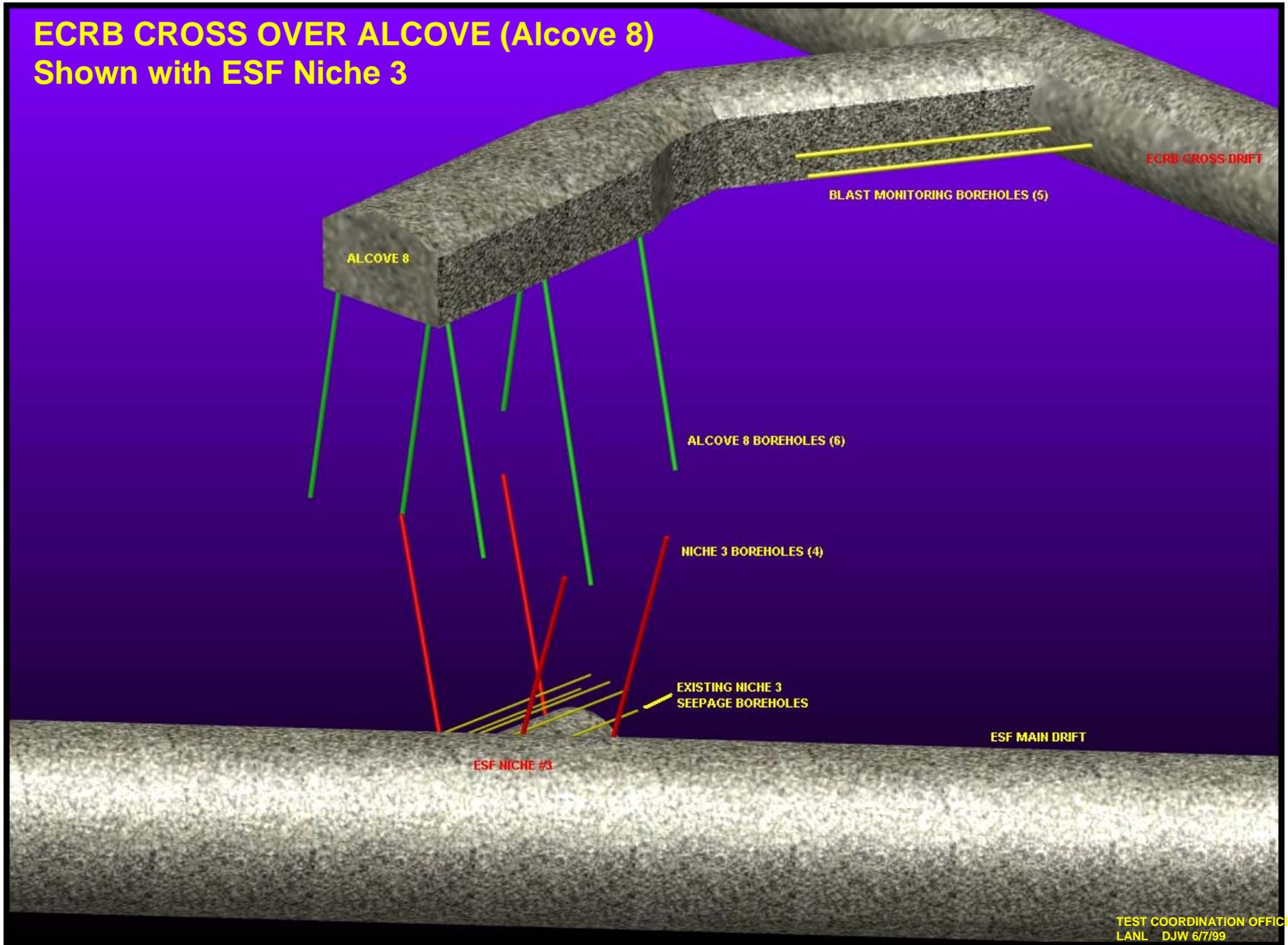
# Backup Slides

# ECRB NICHE 5



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# ECRB CROSS OVER ALCOVE (Alcove 8) Shown with ESF Niche 3

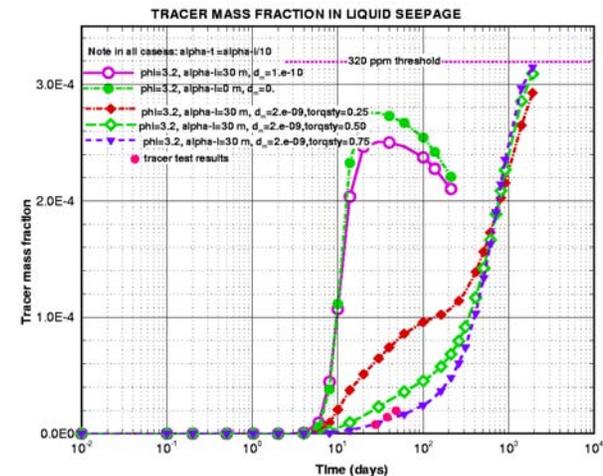
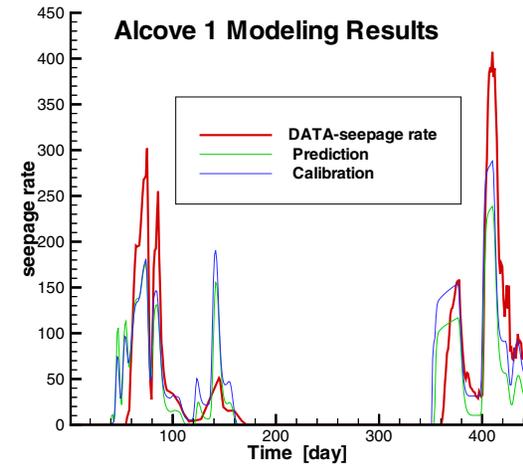


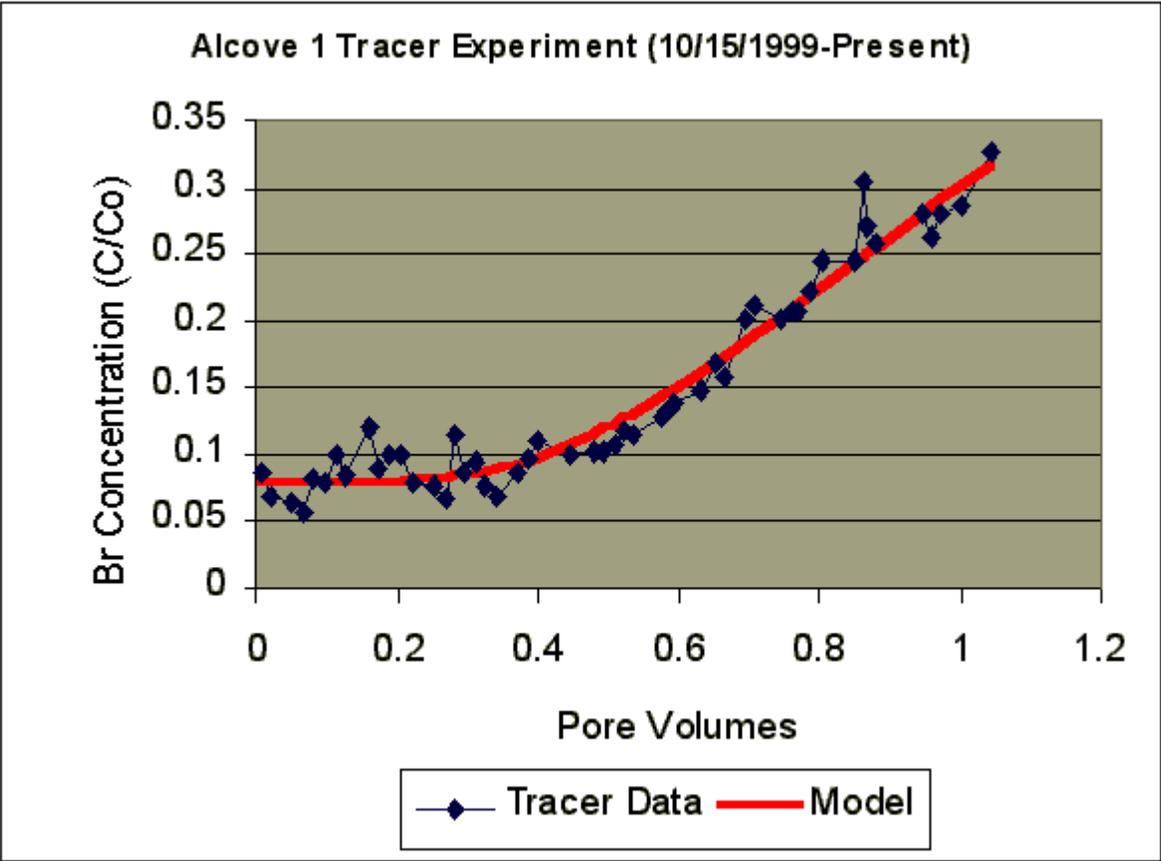
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# UZ Model Validation

## Alcove 1 Test: Seepage and Matrix Diffusion

- The Alcove 1 flow and transport test consisted of infiltration above Alcove 1 and measurements of seepage and tracer concentration in the Alcove
- The seepage data allow for calibration with the seepage model. Calibration of pulse 1 allowed for predictions for pulse II
- The tracer test data allowed for predictions of fracture/matrix interaction and matrix diffusion
- The model results indicate that 50% of the fractures flowed and that matrix diffusion was very effective in retarding the tracer





# Conceptual ECRB Schedule with Feed to the Site Recommendation

