

# Scientific Program Overview

**Presentation to:  
Nuclear Waste Technical Review Board (NWTRB)**

**Presentation by:  
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M&O/NEPO**

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

**Yucca  
Mountain  
Project**

# Overview



- **Testing Update**
  - **Moisture Monitoring**
    - » **Alcove 1**
    - » **Alcove 7**
    - » **Cross Drift**
  - **ESF Niche Studies**
  - **<sup>36</sup>Cl Validation Study**
  - **Cooperative Work on Fluid Inclusions**
  - **Cross Drift**
    - » **Fracture Mineral Studies**
    - » **Mapping**
    - » **Alcove and Niche Studies**

# Overview

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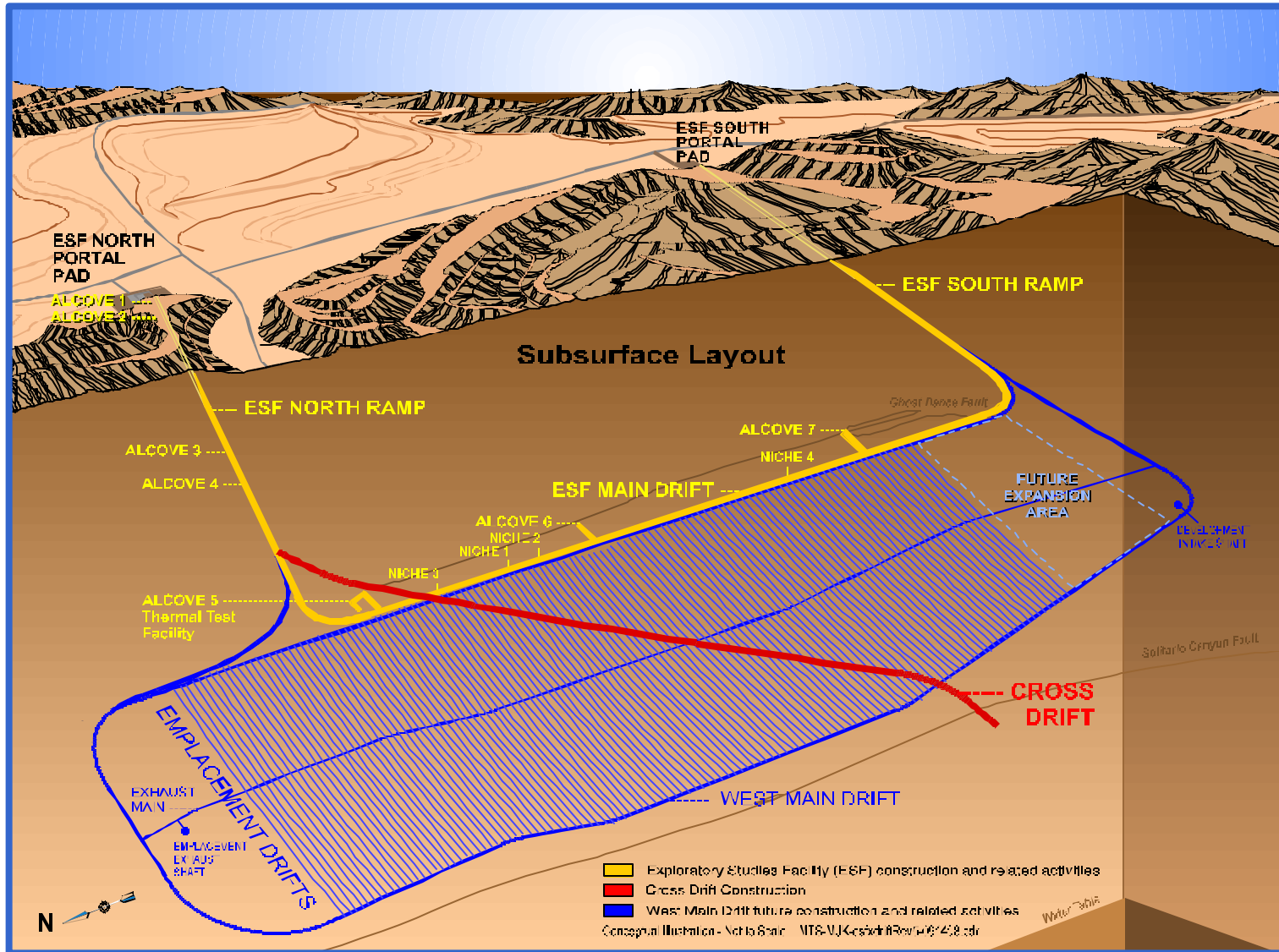
- **Testing Update** (continued)
  - **Steep Hydraulic Gradient**
  - **Status of SD-6**
  - **Cooperative Work with Nye County**
  - **EBS Pilot-Scale Testing**
- **Plan for Scientific Program**
  - **SR and LA and Integration with LADS Process**
  - **Process Model Reports**
  - **Long-Term Testing and Performance Confirmation**



# Testing Update

# Testing Update

(continued)



# Moisture Monitoring



- **Alcove 1**

- **Purpose**

- » Evaluate infiltration and percolation through the unsaturated zone above Alcove 1
    - » Evaluate the climatic effects associated with increased precipitation

- **Phase 1**

- » Over 60,000 gallons of water applied
    - » Seepage in Alcove 1 began after approximately 8.5 weeks (over 30,000 gallons of water applied)
    - » Approximately 10% of the applied water was recovered in the alcove collection system



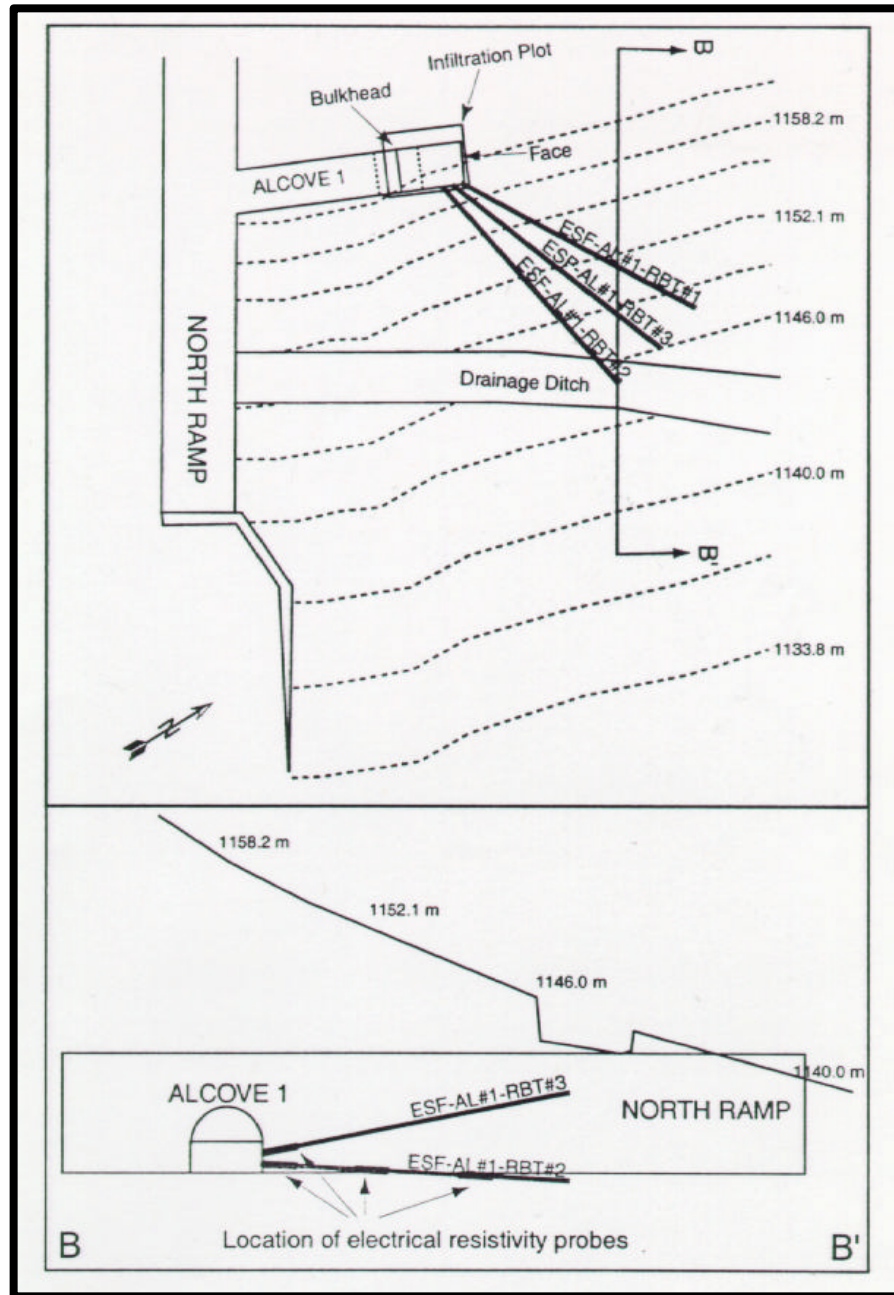
# Moisture Monitoring

(continued)

- **Alcove 1 (cont.)**

- **Phase 2**

- » **Water application started on 2/19/99**
    - » **As of mid May, approximately 27,000 gallons of water applied (varying application rates)**
    - » **Water applied equals 7 years of average annual precipitation**
    - » **Seepage in Alcove 1 began after approximately 3 weeks**
    - » **As of mid May, approximately 10% of the applied water was recovered in the alcove collection system**
    - » **Plan is to introduce a suite of aqueous tracers and compare to model predictions**

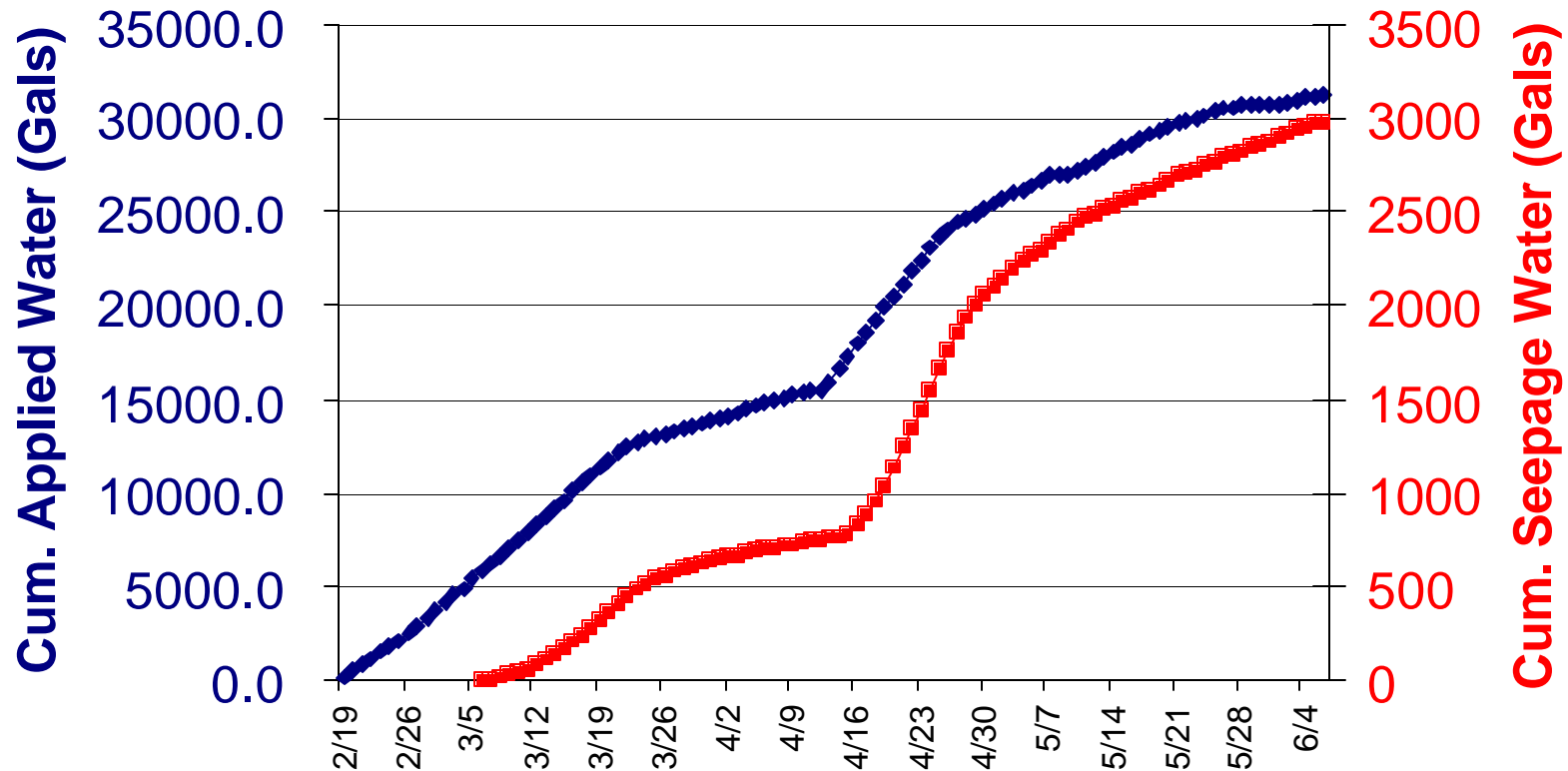




# Moisture Monitoring

(continued)

## Alcove 1 Infiltration Experiment



# Moisture Monitoring

(continued)

- **Alcove 7**

- **Purpose**

- » Study flow associated with increased precipitation (1998 “El Nino event”) in Ghost Dance Fault zone
    - » Isolated regions in the alcove within fault zone and adjacent areas using bulkheads

- **Observations**

- » Rock returned to “ambient” conditions (i.e. > 99% relative humidity) relatively quickly
    - » No dripping water has been detected either visually or using instrumentation

# Moisture Monitoring

(continued)

- **Cross Drift**

- **Observations**

- » **Construction water observed more than 30 meters from excavation in Middle Nonlithophysal unit and limited to 2 meters from excavation in the Upper Lithophysal unit**
    - » **Approximately half of the construction water was lost to the fracture network**
    - » **Overall, there is a net loss of water from the Cross Drift (on average, drier than pre-construction)**

# Moisture Monitoring

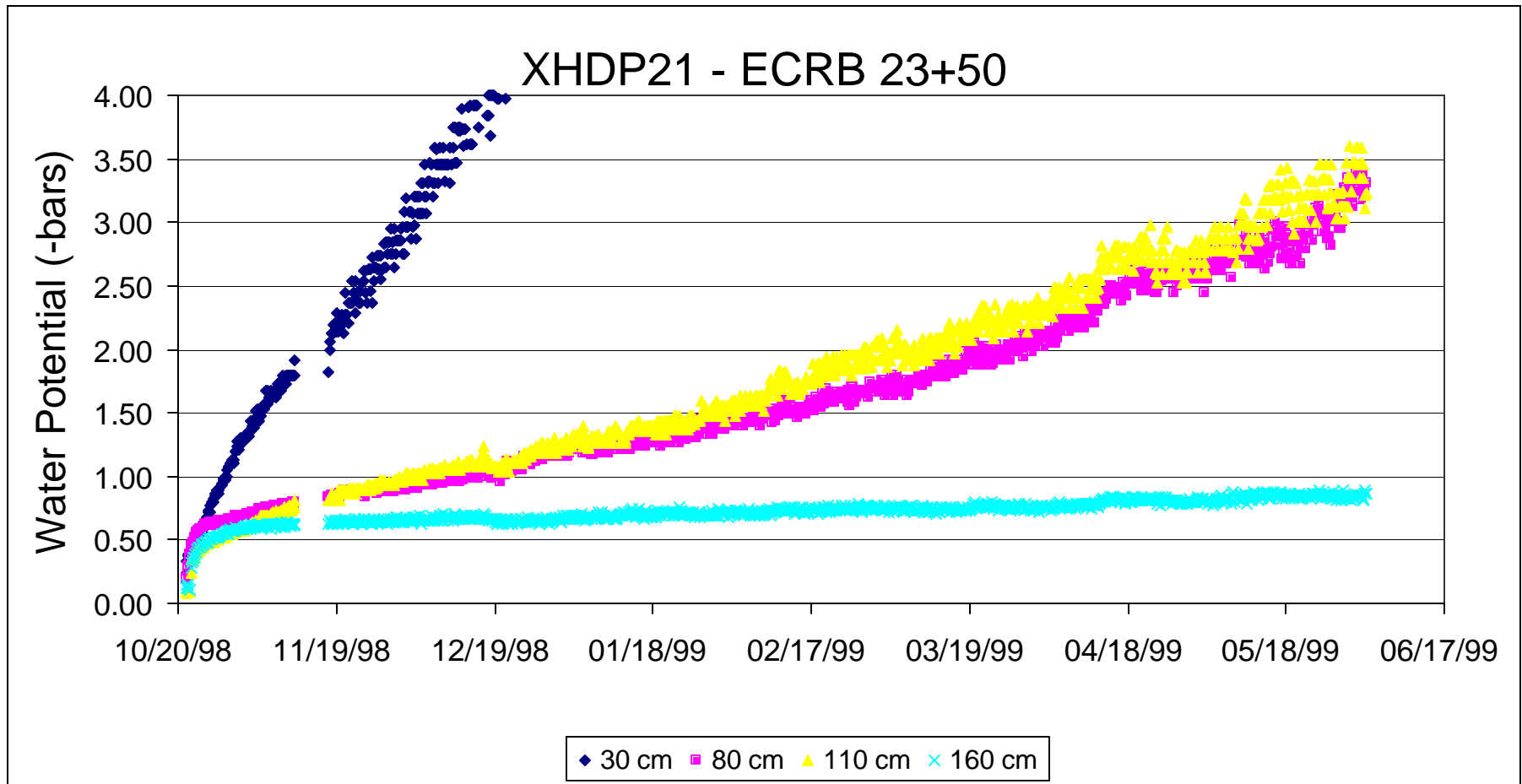
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- **Cross Drift** (continued)
  - **Observations** (continued)
    - » Migration of drying front away from excavation continuing
    - » Response varies depending on lithology
    - » Water potential in Topopah Spring units in Cross Drift relatively uniform and higher than observed previously
    - » Additional investigations are underway to further evaluate water potential data

# Moisture Monitoring

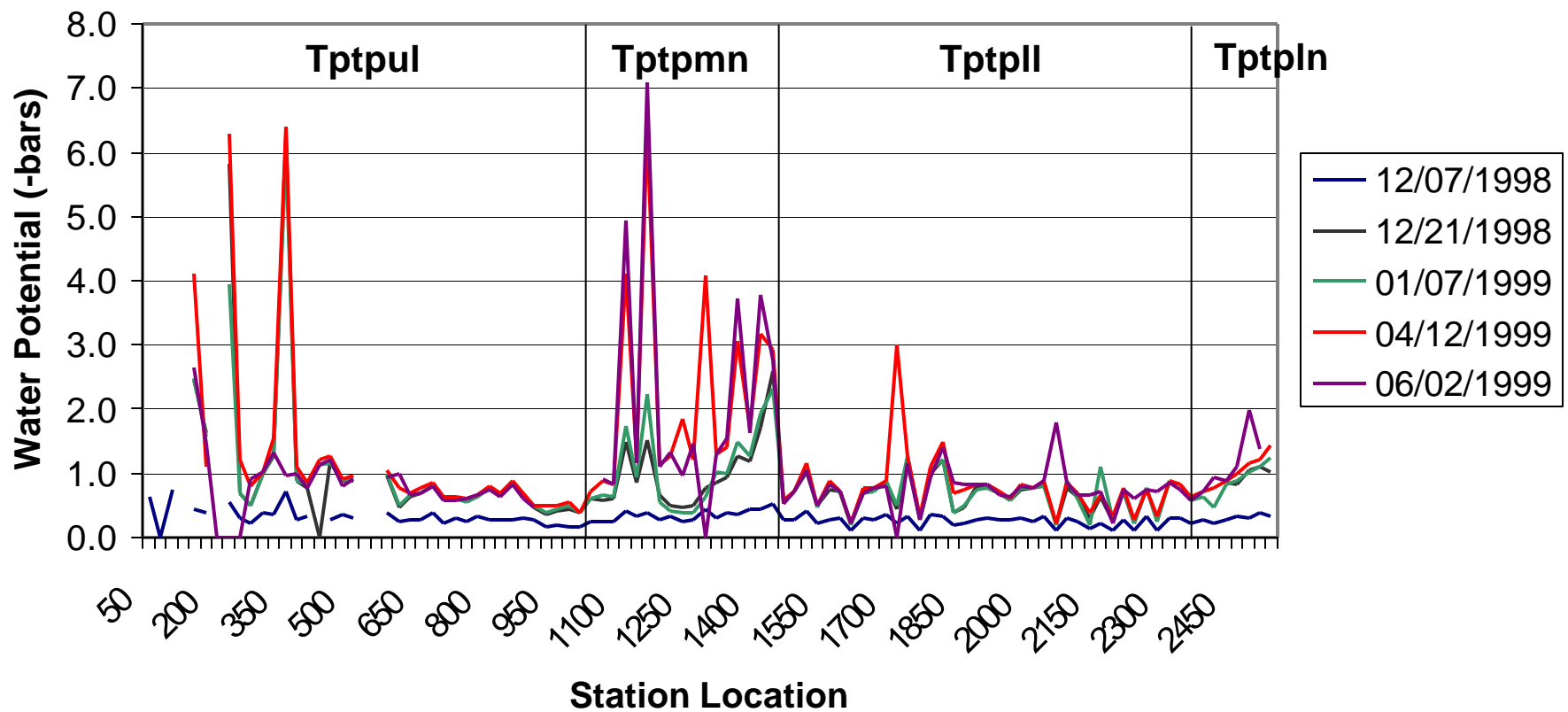
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# Moisture Monitoring

(continued)

## Water Potentials in the ECRB





# ESF Niche Studies



- **Purpose**

- Evaluate drift-scale seepage processes and seepage threshold in potential repository horizon rocks

- **Observations**

- Measured seepage threshold fluxes at Niche 2
- Observed capillary barrier forming and fracture wetting history effects at Niche 2
- Air permeabilities increase after excavation at Niche 2 and Niche 3

# ESF Niche Studies

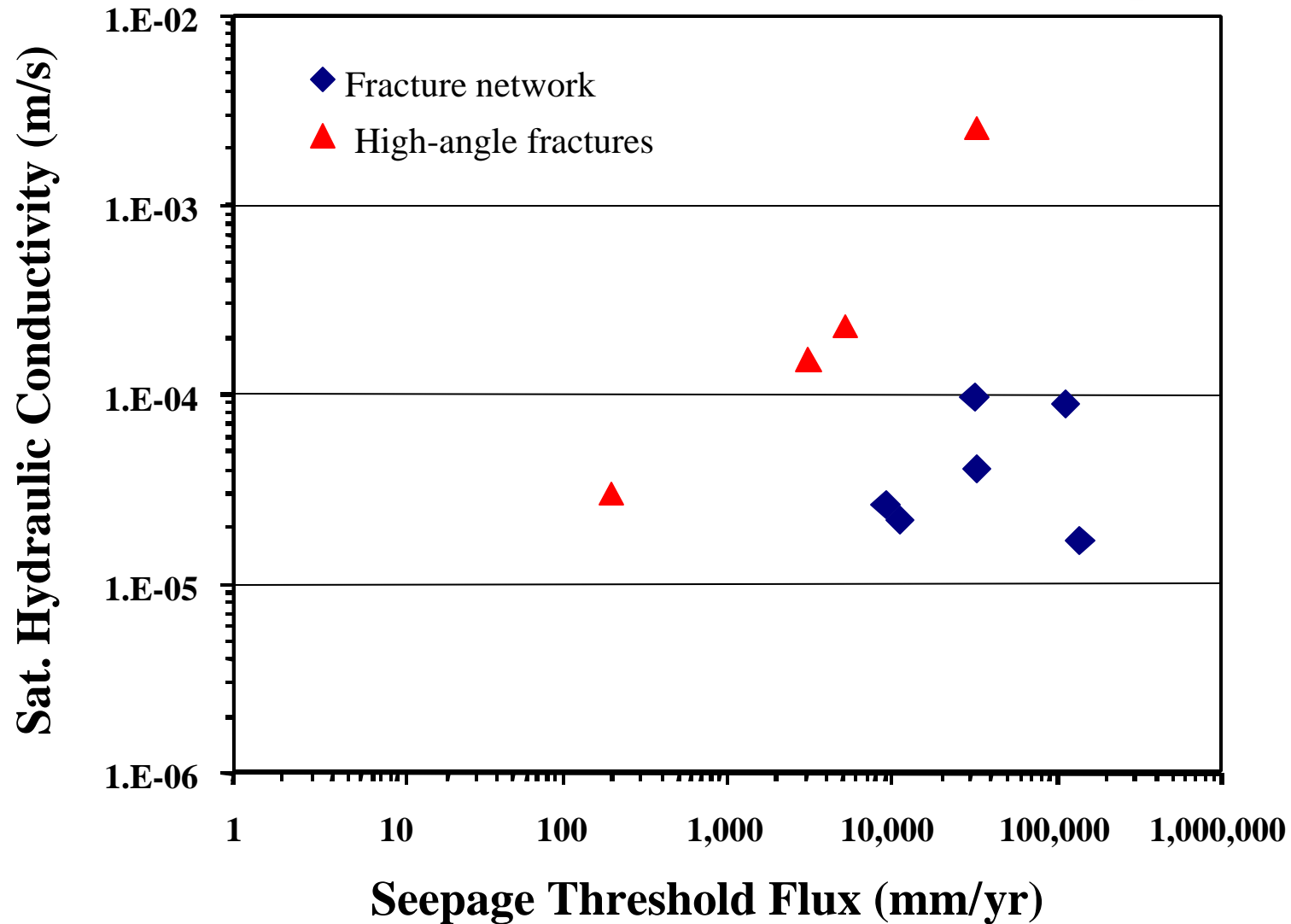
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- **Observations** (continued)

- Dye was observed in fracture system at Niche 3 to a maximum distance of 1.2 meters below the release point (as compared to 2.6 meters at Niche 2)
- Ongoing liquid-release tests at Niche 3 are focusing on the determination of seepage threshold and fracture wetting history, to compare to results from Niche 2

# ESF Niche Studies

(continued)



# **$^{36}\text{Cl}$ Validation Study**



- **Purpose**

- **New work to validate occurrence of “bomb-pulse”  $^{36}\text{Cl}$  at two locations in the ESF -- Sundance Fault zone and Drillhole Wash Fault zone**

- **Approach**

- **Collect core from 50 boreholes (40 at Sundance Fault zone and 10 at Drillhole Wash Fault zone)**
- **Conduct Cl,  $^{36}\text{Cl}$ , Tritium, U isotope, and  $^{99}\text{Tc}$  analyses - joint effort involving USGS, LLNL, LANL, AECL, and Purdue University**

# **$^{36}\text{Cl}$ Validation Study**

(continued)



- **Status**
  - **20 boreholes at Sundance Fault zone complete as of early June and initial sample selection complete**
  - **Drilling scheduled to be complete by August**
  - **Analyses ongoing -- initial  $^{36}\text{Cl}$  and U isotope analyses expected by mid July**

# Cooperative Work on Fluid Inclusions



- **Cooperative study involving UNLV, DOE, and State of Nevada**
- **Focus of sampling to date is in ESF and Cross Drift**
  - **As of early June, nearly 150 samples collected**
  - **Samples from throughout ESF tunnel, ESF alcoves, and Cross Drift**
  - **Quarterly meetings to be held to compare results and observations -- first and second meetings held in mid April and mid June, respectively**



# Cross Drift



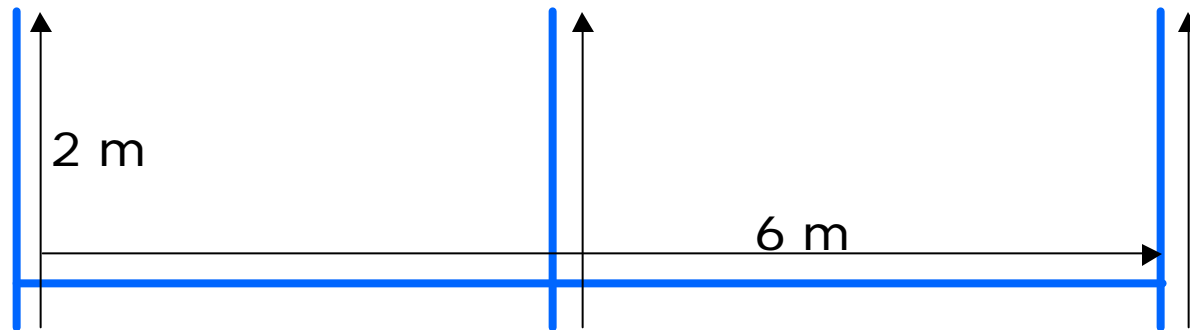
- **Fracture Mineral Studies**
  - **Line surveys to determine spatial distribution and abundance of calcite/opal deposits**
  - **Sampling of fracture minerals, including detailed sampling of Solitario Canyon Fault zone**
  - **Petrographic studies**
  - **U-series and U-Pb dating of selected samples**
  - **Oxygen, carbon, and strontium isotope analyses of selected samples**

# Cross Drift

(continued)

## Ongoing Mapping Work in the ECRB

- **Small-Scale fracture Study**
  - Six 6-m long **horizontal** line survey traverses
    - » Three 2-m long **vertical** line survey traverses

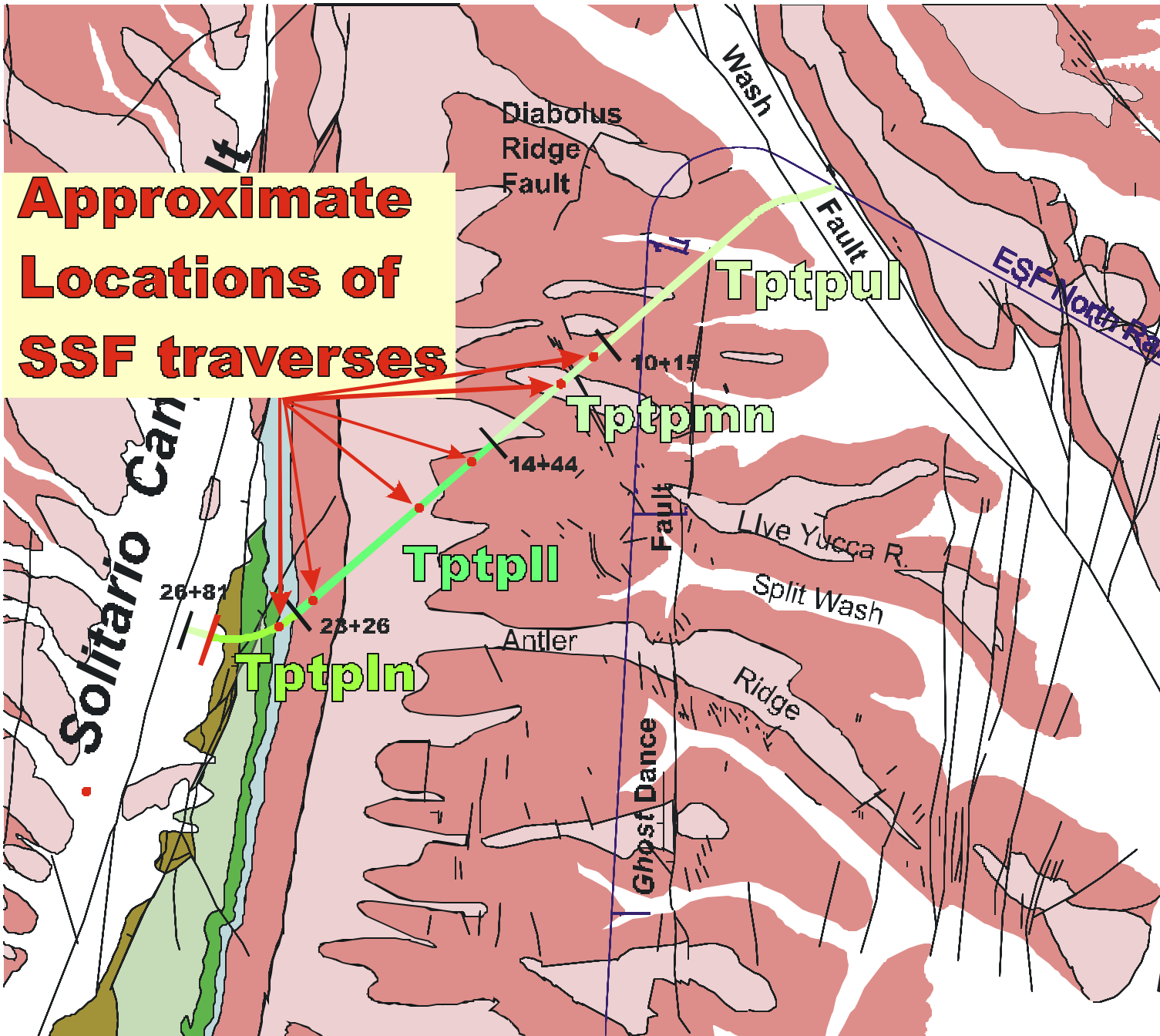


- » Characterize fractures with trace lengths between 4 cm and 1 m
- » Detailed digital photo coverage of each traverse

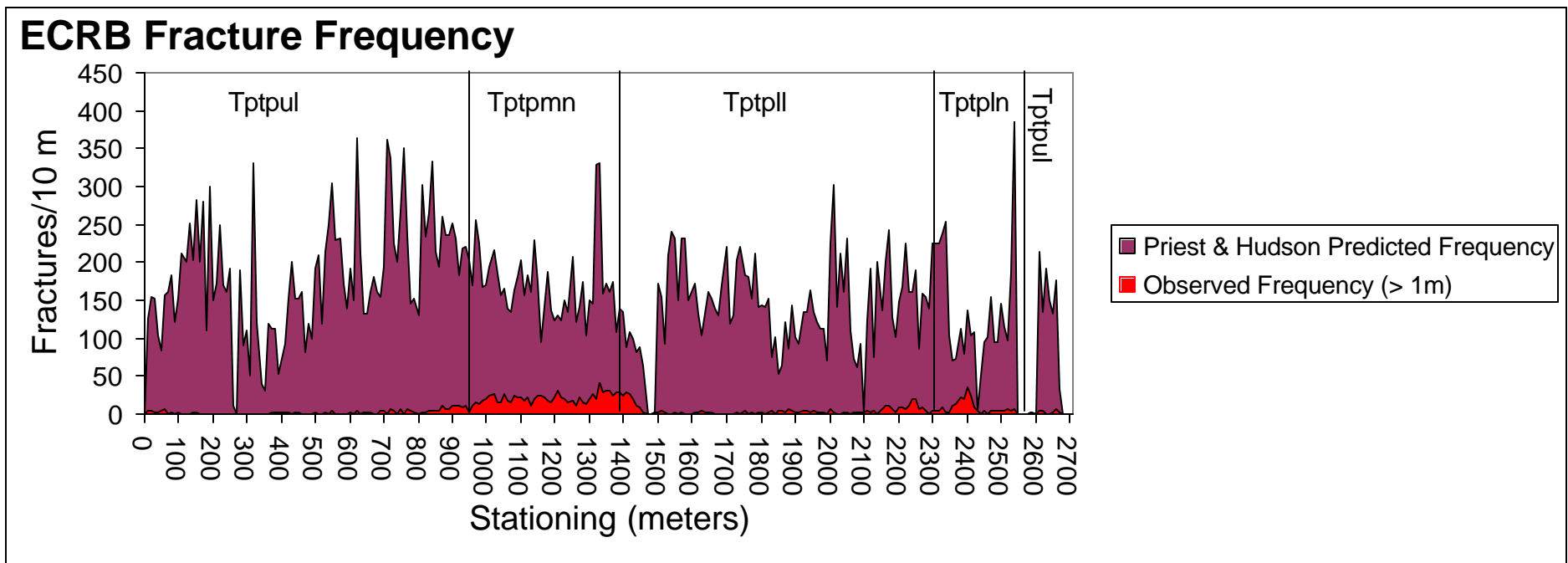
# Locations of Small-Scale Fracture Traverses



<u>Station</u>	<u>Lithostratigraphy</u>
11+15 – 11+21	Tptpmn
13+00 – 13+06	Tptpmn
15+25 – 15+31	TptplI
17+35 – 17+41	TptplI
22+15 – 22+21	TptplI
24+25 – 24+31	Tptpln



# Fracture Frequency Estimations



Priest & Hudson estimations of total fracture frequency derived from RQD (by C. Rautman)

Preliminary frequencies vary from 150 to 305 fractures per 10 meters

# Cross Drift

(continued)

- **Alcove and Niche Studies**

- **Status**

- » **Hydrologic Bulkhead Study -- began in mid June**

- **Bulkheads at Stations 17+63 meters and 25+03 meters**

- » **Crossover Alcove (Station 8+00 meters)**

- **Blast monitoring boreholes complete and drill and blast excavation planned to begin in early July**

- **Testing planned to begin in early FY00**

- » **Niche 5**

- **Blast monitoring boreholes and pre-excavation permeability boreholes complete and drill and blast excavation planned to begin in early FY00**

- **Pre-excavation permeability borehole testing planned in July-August**

- **Testing planned to continue in FY00**

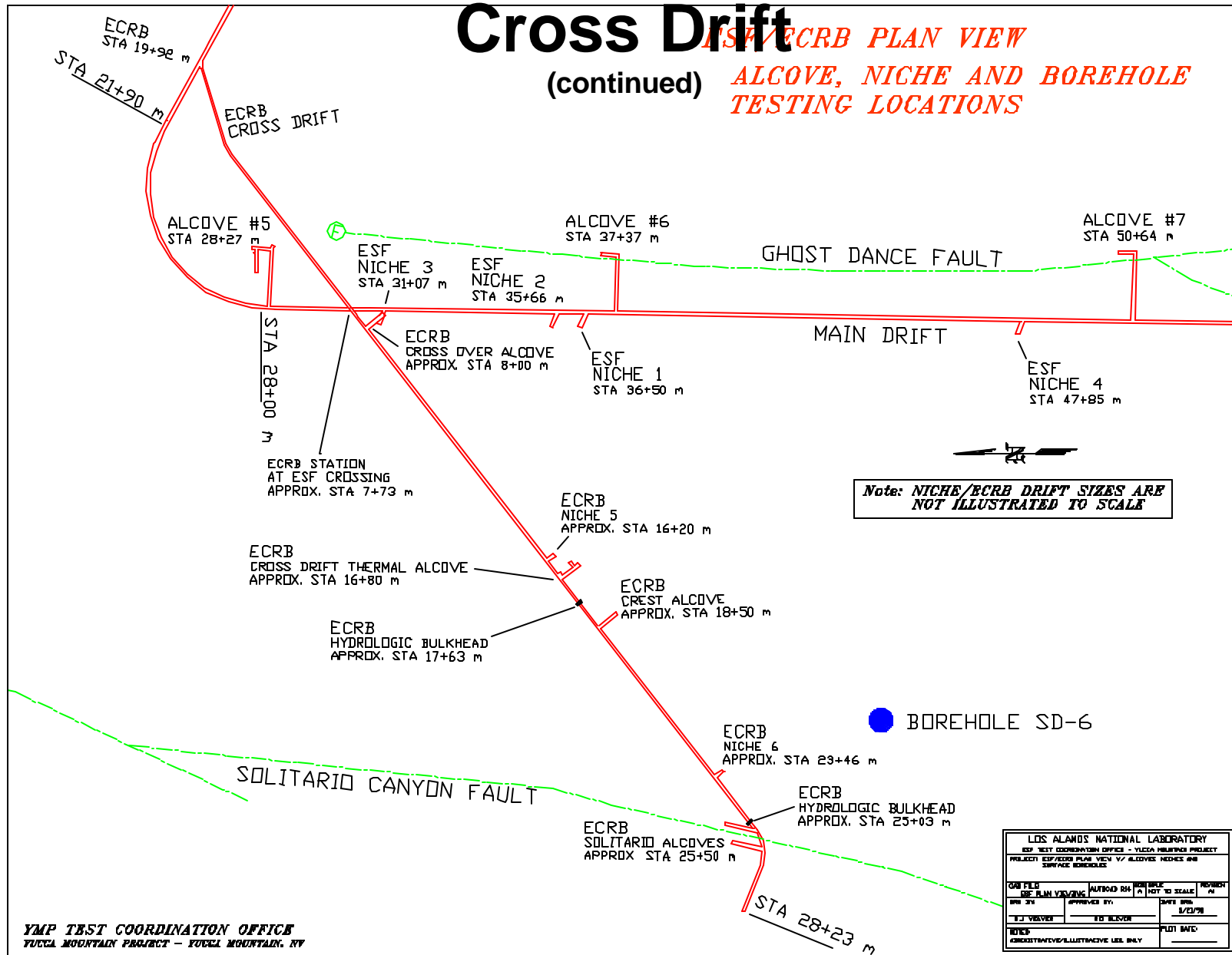


# Cross Drift

ISA/ECRB PLAN VIEW

(continued)

ALCOVE, NICHE AND BOREHOLE TESTING LOCATIONS

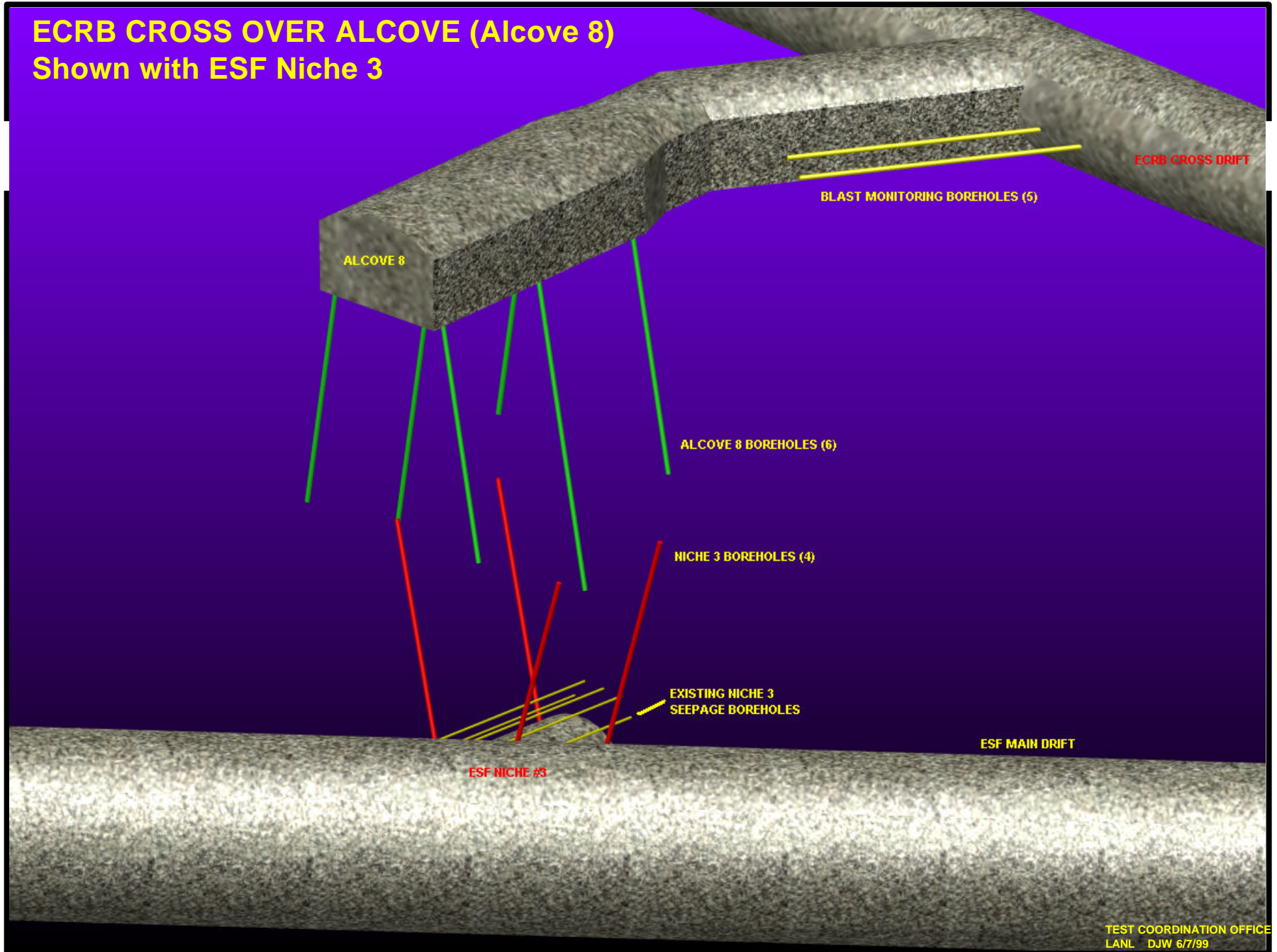


Note: NICHE/ECRB DRIFT SIZES ARE NOT ILLUSTRATED TO SCALE

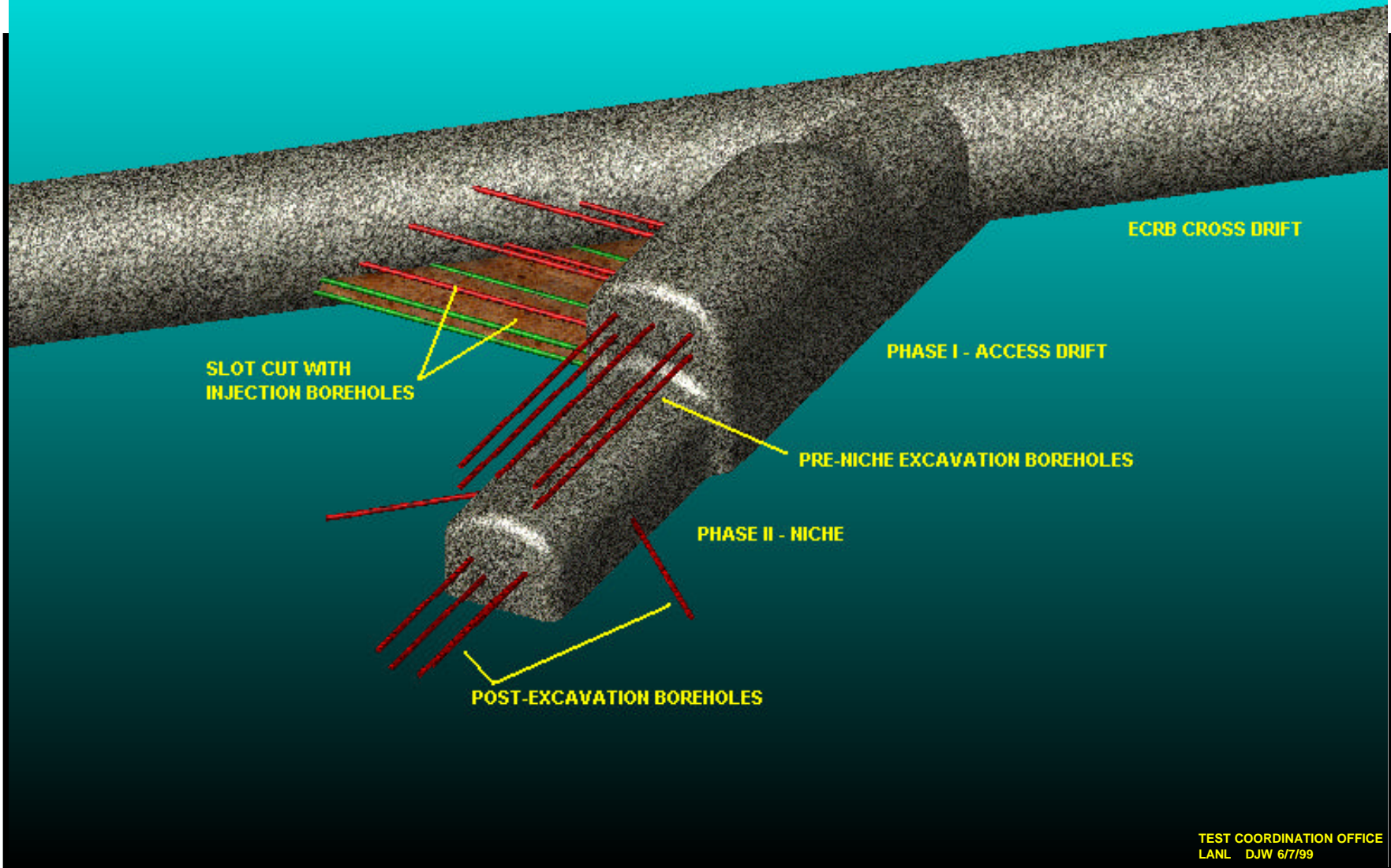
YMP TEST COORDINATION OFFICE  
YUCCA MOUNTAIN PROJECT - YUCCA MOUNTAIN, NV

LOS ALAMOS NATIONAL LABORATORY			
ECR TEST COORDINATION OFFICE - YUCCA MOUNTAIN PROJECT			
PROJECT: ECRB PLAN VIEW 1/2 ALCOVES, NICHE AND BOREHOLE			
DATE FILED	DATE PLOTTED	DATE CHECKED	PROJECT NO.
BY: JH	APPROVED BY:	DATE: 8/2/98	
BY: JH	DATE: 8/2/98	DATE: 8/2/98	
BY: JH	DATE: 8/2/98	DATE: 8/2/98	

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



# ECRB NICHE 5



TEST COORDINATION OFFICE  
LANL DJW 6/7/99

# Steep Hydraulic Gradient



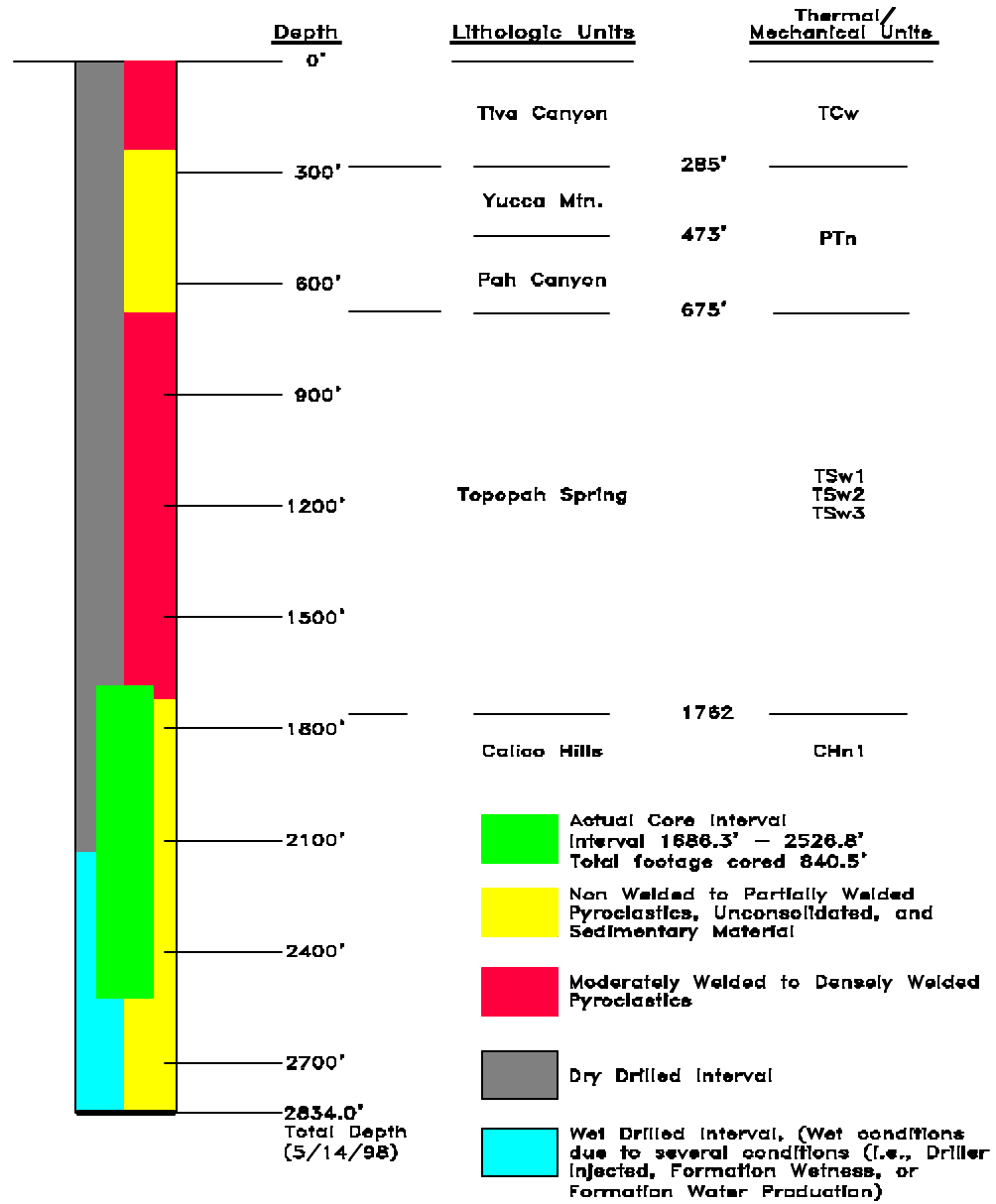
- **Further drilling at WT-24 deferred unless deemed necessary to meet PA needs in support of SR and LA**
- **Results from WT-24 and earlier testing do provide important constraints**
  - **Regional potentiometric surface encountered close to bottom of WT-24**
  - **Perched water zone also encountered above regional water table in WT-24**

# Steep Hydraulic Gradient

(continued)

- **Results from WT-24 and earlier testing to provide important constraints**
  - **Favored hypothesis is that steep hydraulic gradient does exist north of potential repository (but not as steep as once hypothesized)**
  - **Condition that causes gradient may divert some SZ flow eastward around potential repository (Midway Valley or Fortymile Wash area)**

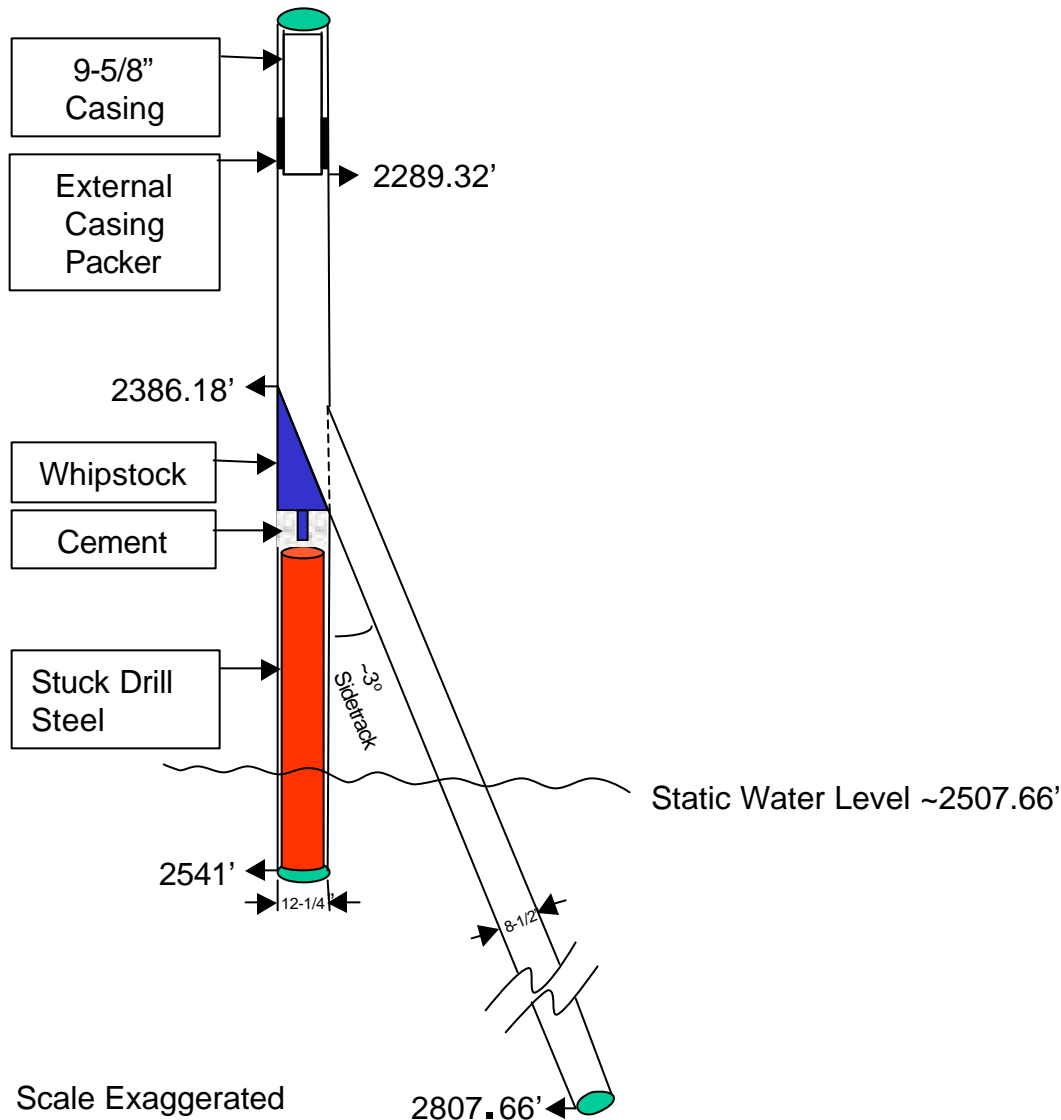
# USW WT-24 DEPTH TO SMF PICKS





# Status of SD-6

## USW SD-6ST1 As-Built Illustration



Note: Scale Exaggerated For Clarity

### Chronology Of Events

**3/25/99** - Pumped Cement Plug & Installed Whipstock.

**4/5/99** - Finished Running 9-5/8" Casing & Inflated External Casing Packer.

**4/21/99** - Air Drilled to 2582' When Water Was Intercepted In Borehole. Water Level Rose To 2507.66'. Stopped For Scientific Sampling & Water Level Measurements.

**4/29/99** - Began Injecting Air-Foam To Enhance Return Circulation.

**5/03/99** - Reached Planned Total Depth @ 2807.66' (300' Past Water Level).

**5/6/99** - Completed Geophysical Logs.

**5/24/99** - Completed Pump Installation & ~1.5 Mile Discharge Pipeline. Began Aquifer Testing.

# Cooperative Work with Nye County



- **FY99 field work mostly completed -- laboratory analyses of cuttings and water samples ongoing**
- **Data being incorporated into Project SZ flow and transport model**
- **Project involved in planning for FY00 phase of drilling activities (7 shallow wells and 2 deep wells on the Site)**



# EBS Pilot-Scale Testing



- **Test Canister #1 initiated in mid-December, 1998**
  - EBS concept is Richard's Barrier (medium sand over coarse sand) under superpluvial rates
  - Richard's Barrier continues to effectively divert water (greater than 98% water diverted)
- **Test Canister #2 initiated in mid-January, 1999**
  - EBS concept is coarse sand backfill under superpluvial rates
  - Testing completed on February 19, 1999-- water contacted mock canister very quickly

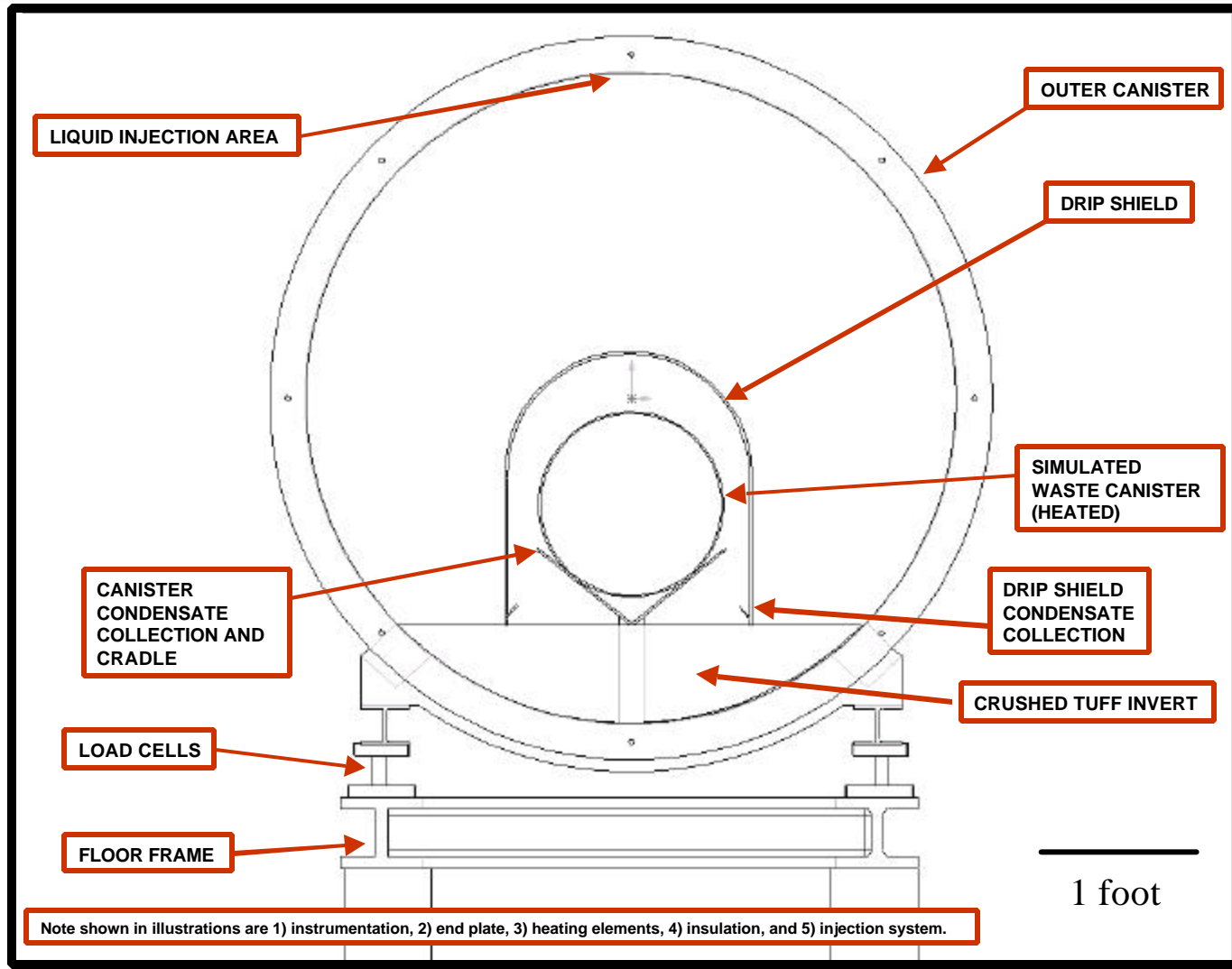
# **EBS Pilot-Scale Testing**

(continued)

- **Test Canister #3 initiated in early June, 1999**
  - **EBS concept is Drip Shield (fabricated from 2 cm thick 304 stainless steel) with crushed tuff invert (no backfill) at elevated temperatures**
  - **Phase 1 involves heating with no drip shield**
  - **Phase 2 involves heating with drip shield under superpluvial rates**

# EBS Pilot-Scale Testing

(continued)





# **Plan for Scientific Program**

# SR and LA and Integration with LADS Process

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- **Prioritization of testing program in support of SR and LA linked to principal factors of evolving safety strategy and LADS process**

# SR and LA and Integration with LADS Process

(continued)



- **To date, priorities include:**
  - **UZ flow and transport - ESF testing; Cross Drift testing; Busted Butte**
  - **Seepage - ESF testing; Cross Drift testing**
  - **Near-Field Coupled Processes - Drift Scale Test, Cross Drift testing**
  - **SZ Flow and Transport - Cooperative Work with Nye County (Hydraulic and Tracer Testing)**

# Process Model Reports (PMR's)



- **Complete technical documentation of data, analysis, process modeling, and performance assessment modeling**
- **Testing data, subsystem models, and abstractions used to develop Analysis and Model Reports (AMR's) and PMR's**
  - **AMR's provide technical details and are the basis for the PMR's**
- **Testing data collected on an ongoing basis with periodic feeds to revisions of AMR's and PMR's**

# Long-Term Testing and Performance Confirmation



- **Current plan for long-term testing includes Drift Scale Test, Cross Drift, and SZ work in cooperation with Nye County**
- **Prioritization of performance confirmation program will be linked to TSPA sensitivity analyses and regulatory requirements**



# Long-Term Testing and Performance Confirmation

(continued)



- **Ongoing revision of Performance Confirmation Plan (to be completed in FY00) linked to principal factors of evolving safety strategy and LADS process until above information becomes available**



# Backup



### Alcove 1 Infiltration Experiment

