

**U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT**

**NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING**

**SUBJECT: WASTE ISOLATION AND
CONTAINMENT STRATEGY**

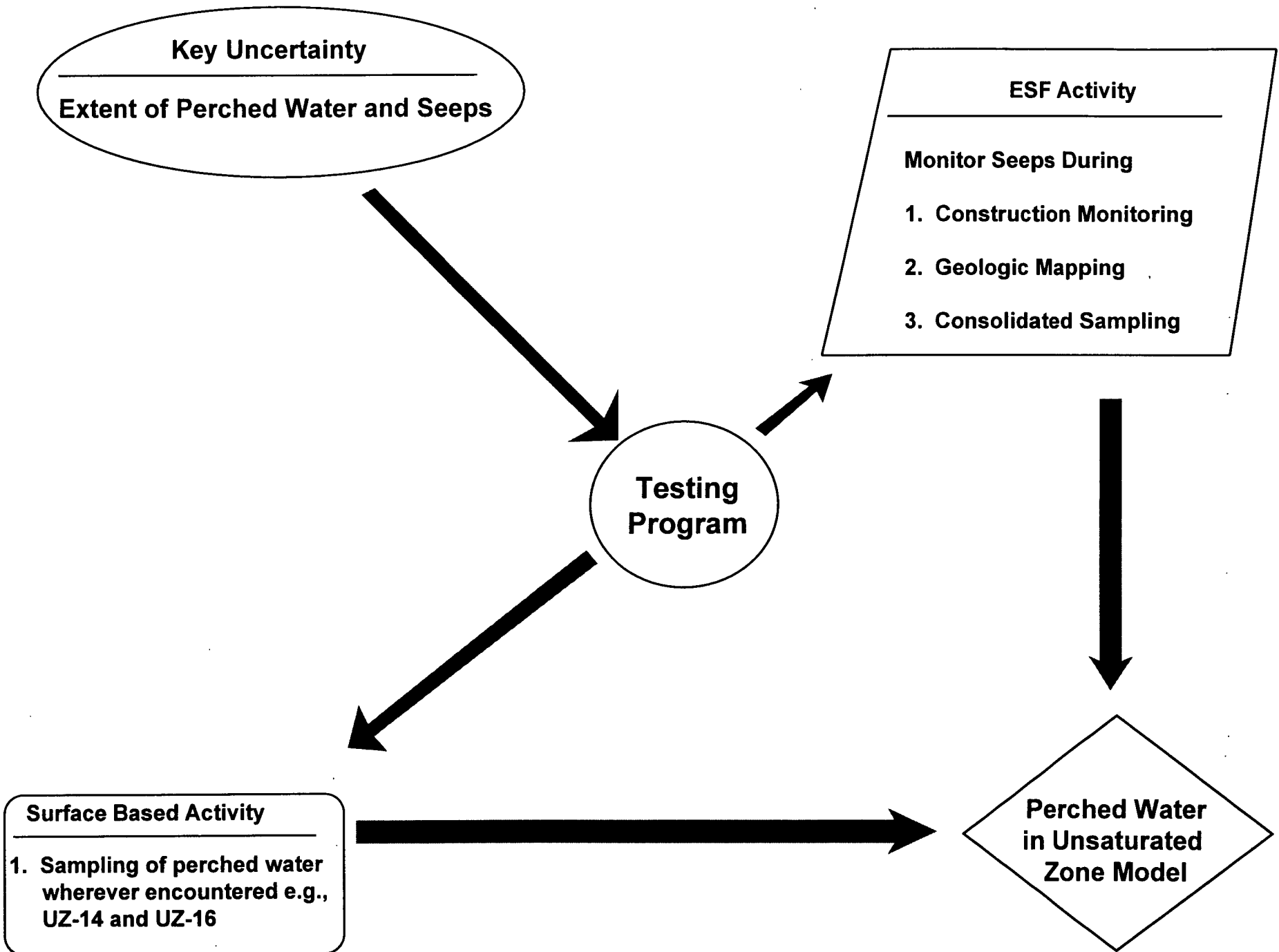
PRESENTERS: SUSAN B. JONES DENNIS R. WILLIAMS

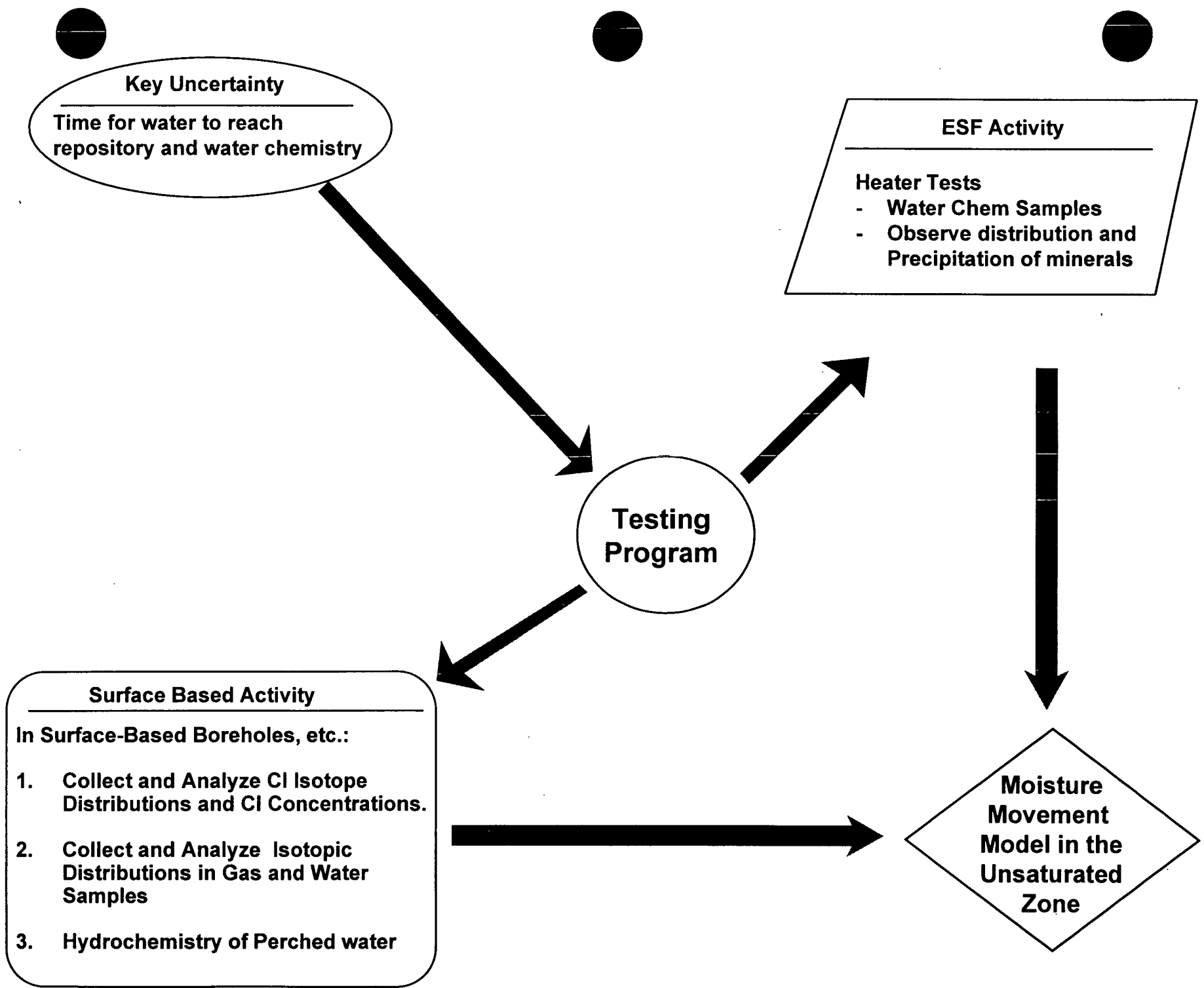
PRESENTER'S TITLE AND ORGANIZATION:	ASSISTANT MANAGER, SCIENTIFIC PROGRAMS YMSCP LAS VEGAS, NEVADA	DEPUTY ASSISTANT MANAGER SCIENTIFIC PROGRAMS YMSCP LAS VEGAS, NEVADA
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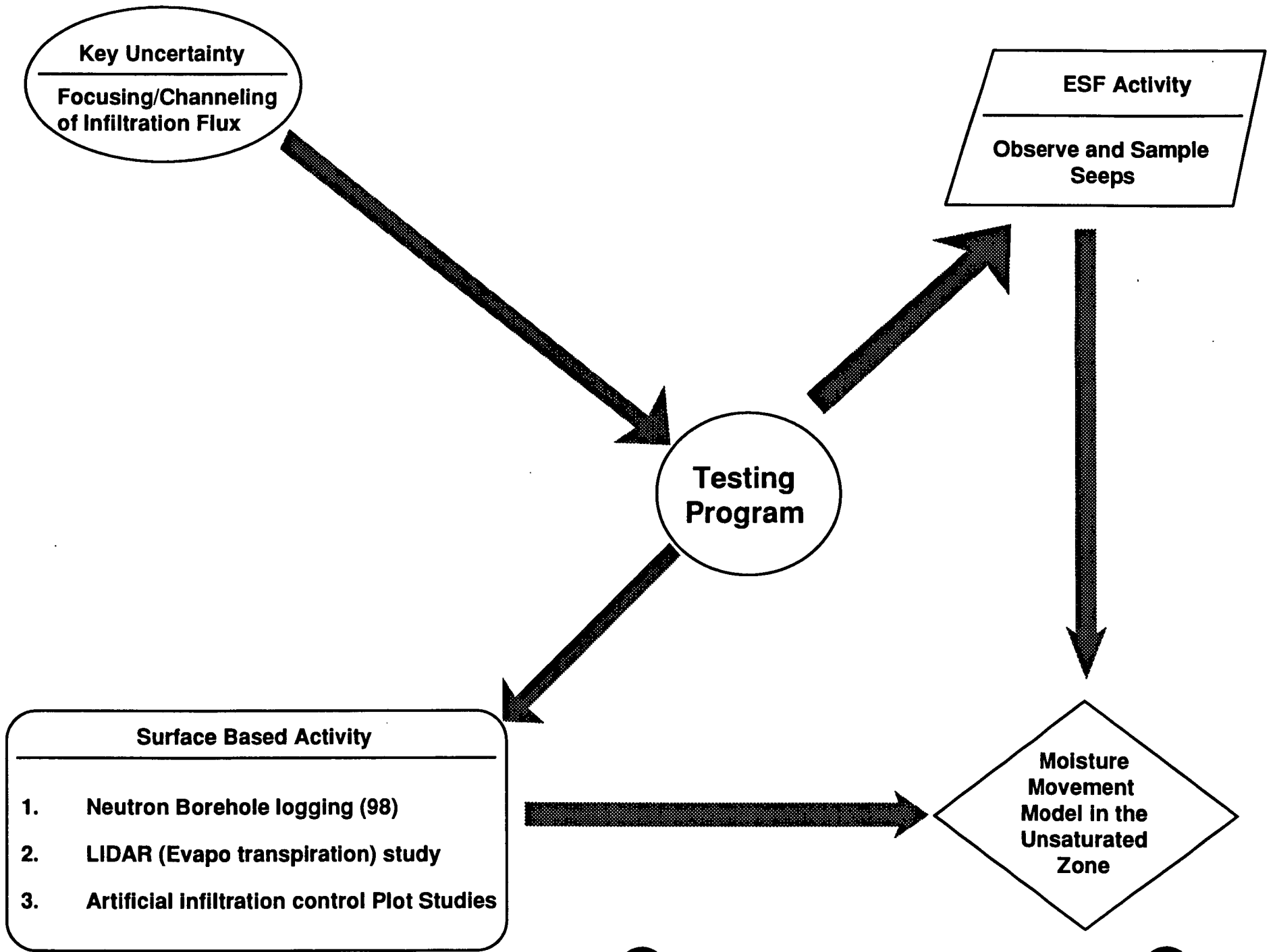
PRESENTER'S TELEPHONE NUMBER:	(702) 794-7613	(702) 794 7968
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**BEATTY, NEVADA
JANUARY 11, 1995**

Waste Package Environment

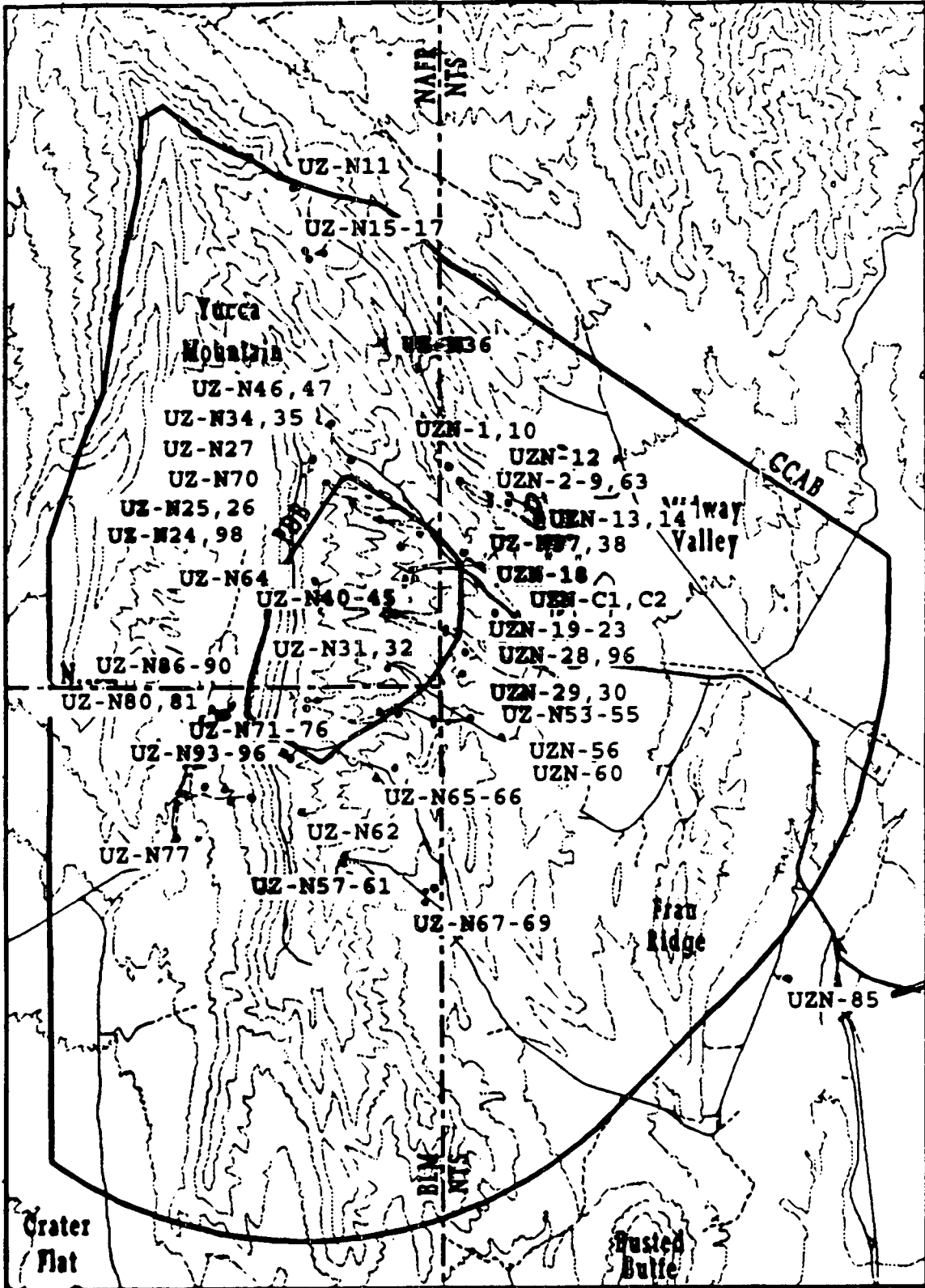




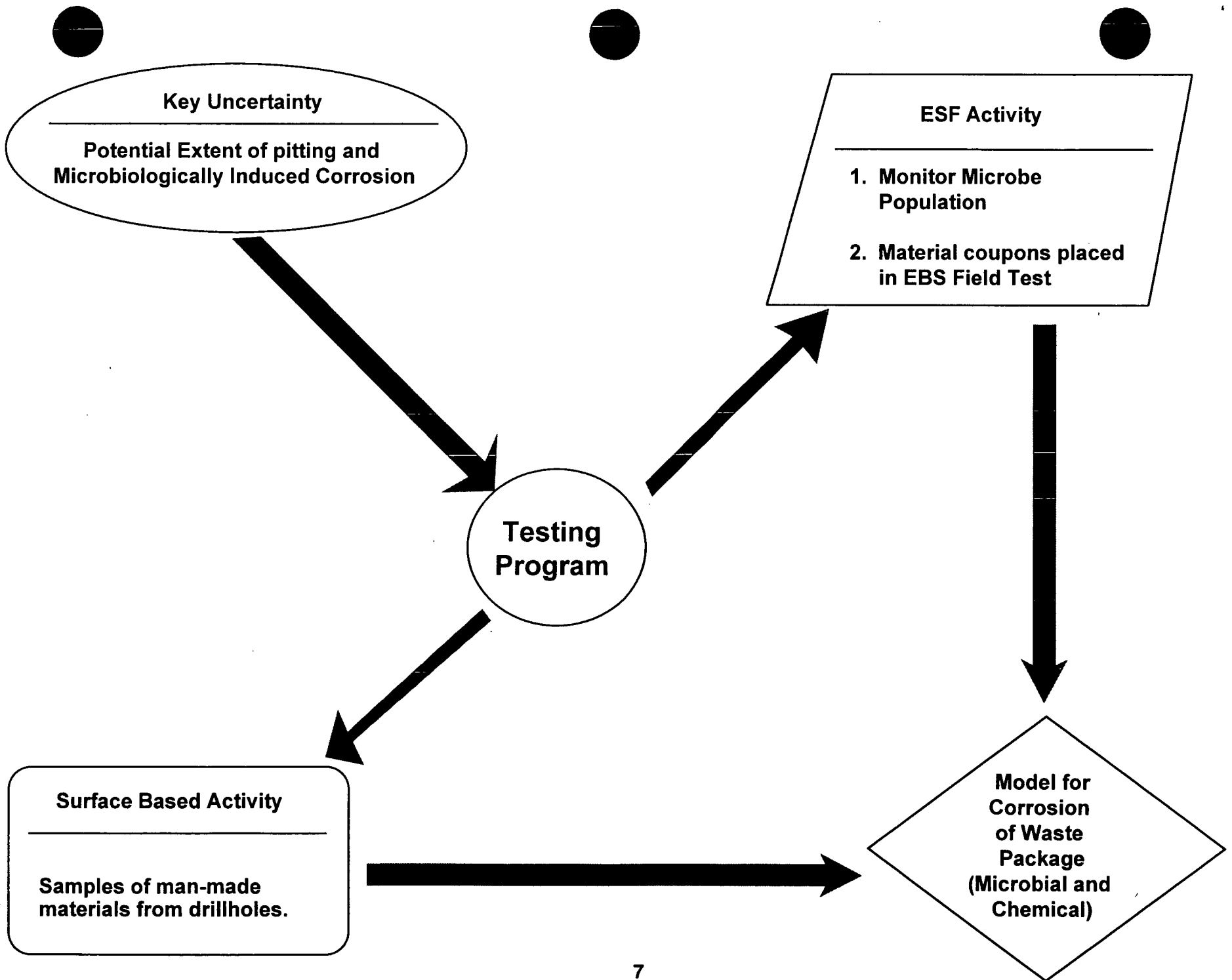


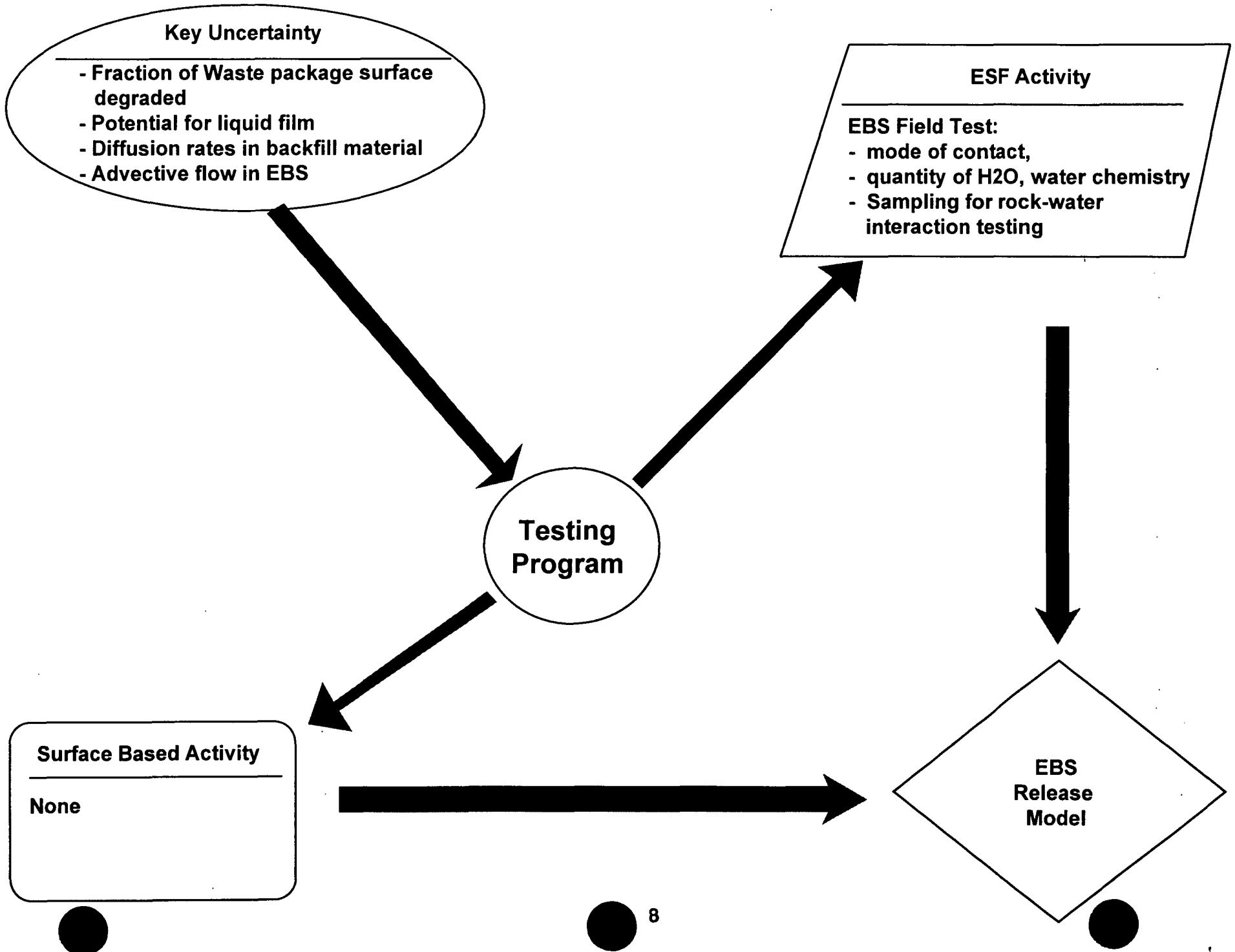
NEUTRON BOREHOLES

EXISTING BOREHOLES USED IN INFILTRATION STUDIES

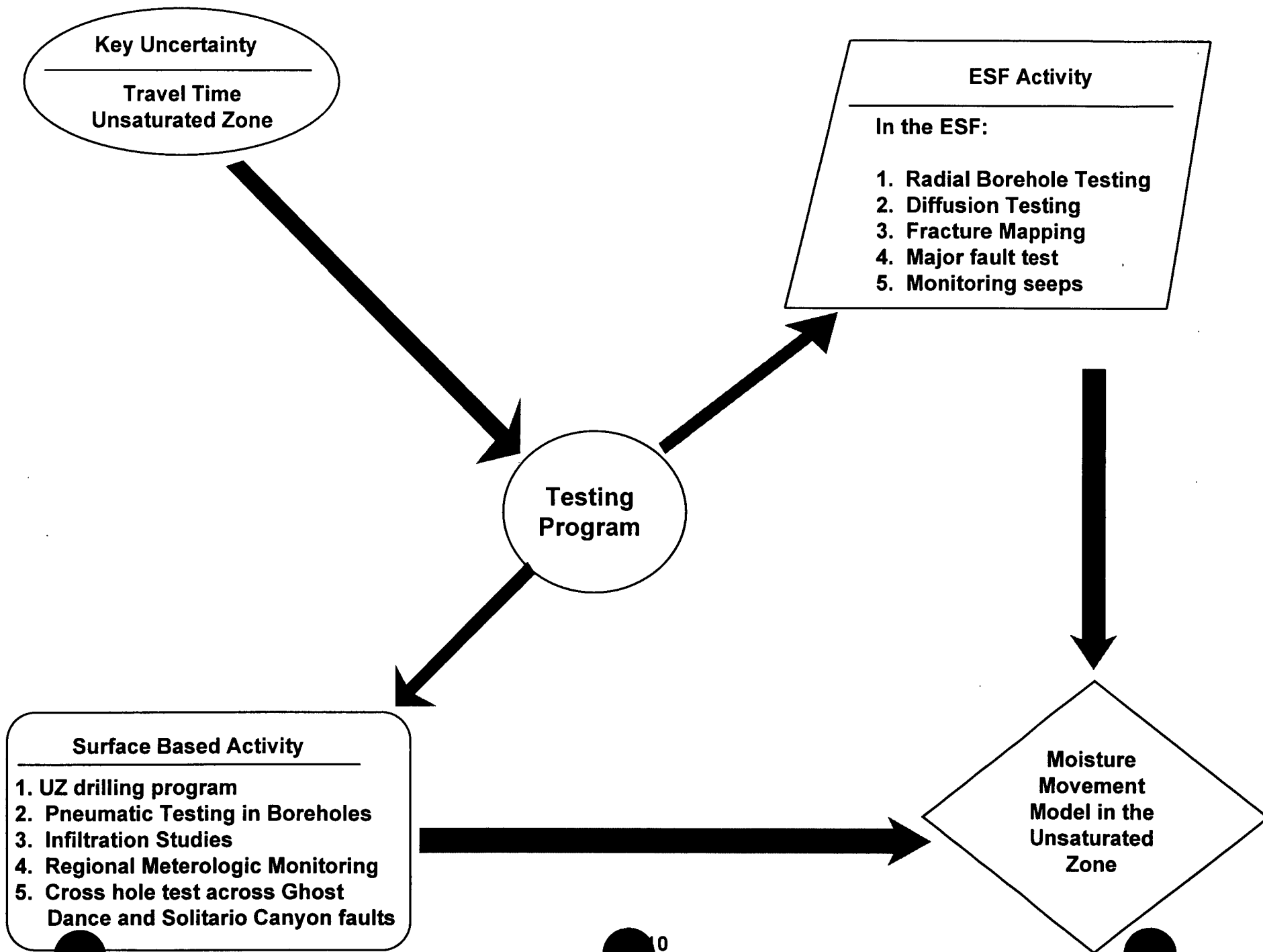


**Waste Package Performance
Radionuclide Mobilization
Release Through EBS**





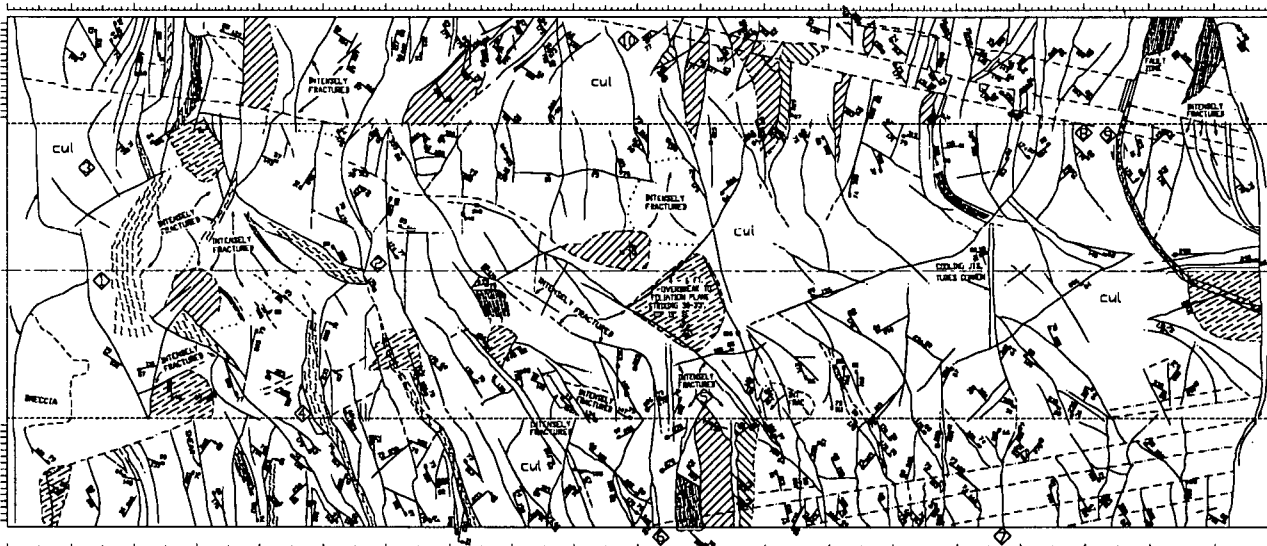
Radionuclide Migration in Geosphere



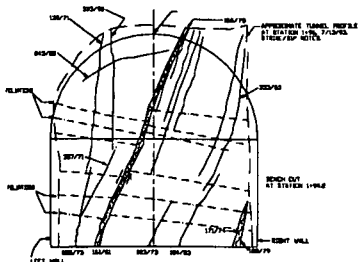
NOTES

- ◆ Distinct shear zone intersects crown centerline at Sta. 0+17 and continues into right wall as intensely fractured zone. Fracture surfaces coated with up to 3 cm of opal and calcite.
- ◆ Shear zone with breccia, no observed displacement near crown, terminates in possible cooling fracture Sta. 0+37.
- ◆ Sta. 0+03 to 0+20 Lithophysae aspect ratios range from 1/4 (L+0 to 3) in upper half of tunnel.
- ◆ Cooling fracture with bedded sand infilling, exhibits decorations on fracture surfaces consisting of elongate, anastomosing to subparallel channels extending 2cm into the wall rock. The fracture bounds a shear zone striking 035°, dipping 70-83° SW.
- ◆ Shear zone with crushed rock and breccia.
- ◆ Zone of intensely fractured rock intersecting tunnel at Sta. 0+50 in the left wall and Sta. 1+13 in the right wall.
- ◆ Brownish gray to gray, densely welded, rhyolitic, ash-flow tuff. Lithophysae comprise approximately 5-10% of the rock by volume; average diameter 7-20 cm lithophysae less than 1.5 cm are typically filled with smoky quartz and opal.
- ◆ Foliation more prominent in crown, and combined with high-angle fracture causes fallout resulting in small wedge-shaped casts in the crown.
- ◆ Fault with crushed wall rock and sandy infilling. Foliation trace is offset approximately 15 ft.
- ◆ Lithophysae oblate to spheroidal average size 5 cm diameter from Sta. 0+92 to Sta. 1+03; from Sta. 1+00 to 1+05 average size is 20 cm, maximum size is 45 cm.

STATION	TYPE	DESCRIPTION	STATION	TYPE	DESCRIPTION	STATION	TYPE	DESCRIPTION	STATION	TYPE	DESCRIPTION



SKETCH OF TUNNEL FACE
STATION 1+96

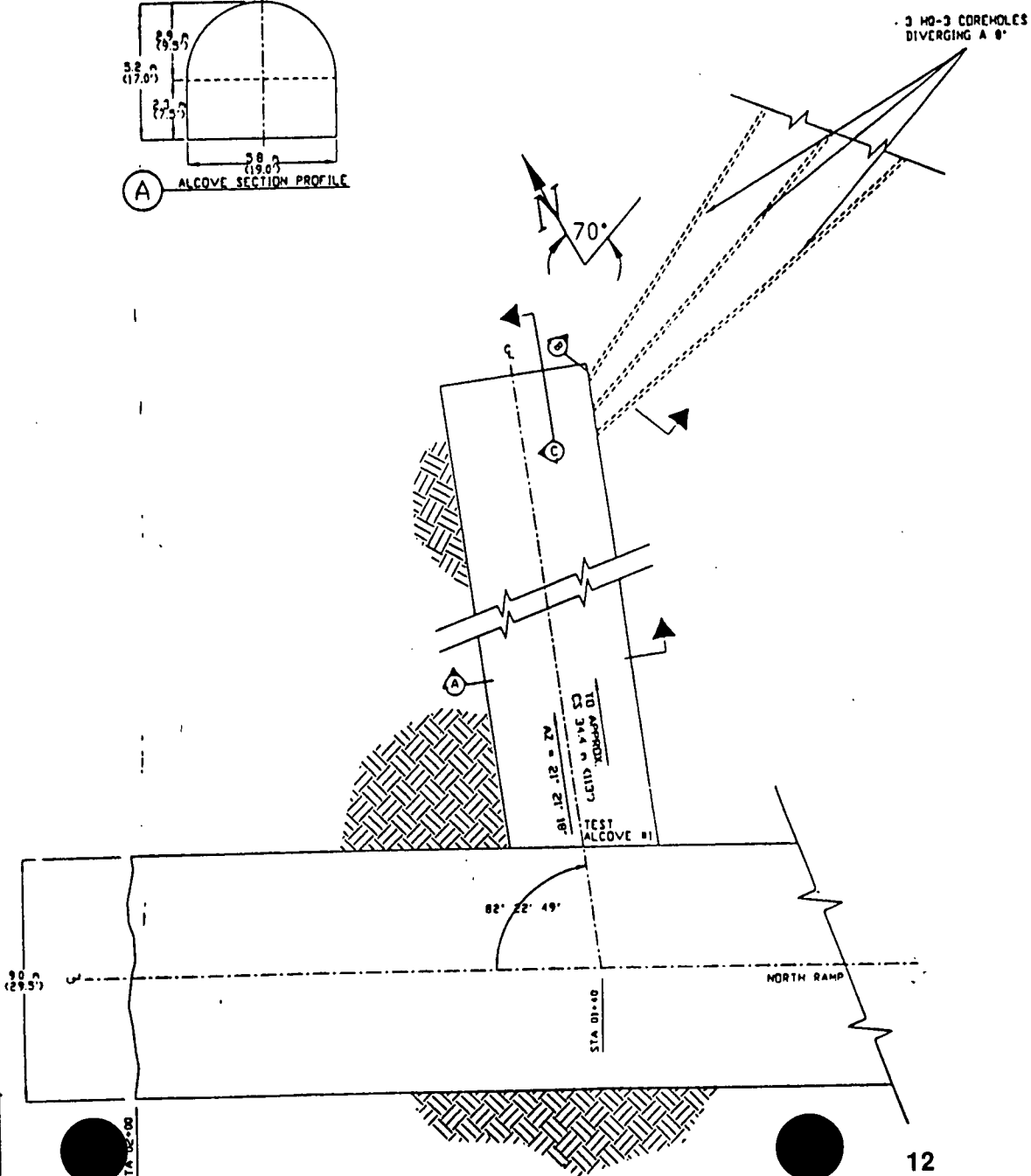
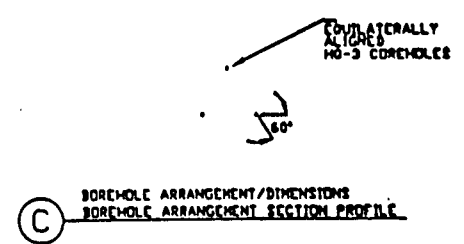
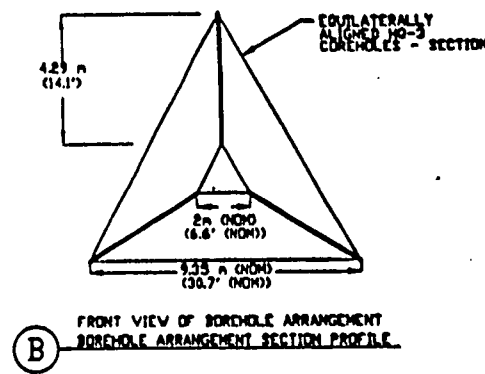
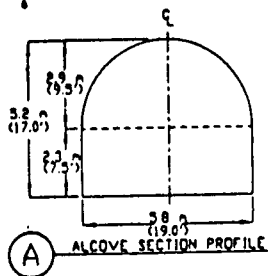


EXPLANATION

- STRIKE OF VERTICAL FRACTURE.
- FRACTURE TRACE WITH SYMBOL SHOWING STRIKE AND DIP, DASHED WHERE APPROXIMATE, DOTTED WHERE TERMINATION OBSERVED, UNDAINED WHERE TERMINATION NOT OBSERVED.
- FRACTURE TRACE ORIENTATION NOT RECORDED (DASHED WHERE INDISTINCT)
- FRACTURE FACES DECURE WHERE TUNNEL WALL HAS BROKEN TO A FRACTURE SURFACE OVER A LARGE AREA GREATER THAN 1 SQUARE METER; VERTICAL FACES ALONG HATCHING IS REVERSED; DIPS DASHED WHERE APPROXIMATE.
- CLOSELY SPACED FRACTURES SHOWING APPROXIMATE TRACES WHERE NUMEROUS FRACTURES HAVE SIMILAR ORIENTATIONS.
- FALLOUT OR OVERBREAK BOUNDARY, DASHED WHERE APPROXIMATE.
- APPROPRIATE LIMITS OF INTENSELY FRACTURED ZONE.
- TRACE OF VAPOR PHASE PARTING.

DEFINITIONS

- ◆ INTENSELY FRACTURED - ORIENTED OR UNORIENTED, PRESUMPTIVELY ANGULAR OR BY PLATE, ROCK FRAGMENTS CREATED BY MULTI-INTERSECTING FRACTURES. APPROXIMATE LIMITS OF INTENSELY FRACTURED AREAS ARE INDICATED BY DOTTED LINES AND/OR FRACTURE TRACES.
- ◆ FOLIATION - 0.5 TO 1.0 CM THICK PLANAR STRUCTURES THAT RESULT FROM FLATTENING OF CONCENTRATIONS OF PLINIC FRAGMENTS.
- ◆ BRECCIA - AT THIS LOCATION ONLY - A CLAST-SUPPORTED BRECCIA WITH SLIGHT ORIENTATION, MATRIX IS A FINELY SAND SIZE, NOT ASSOCIATED WITH A DISTINCT SHEAR.

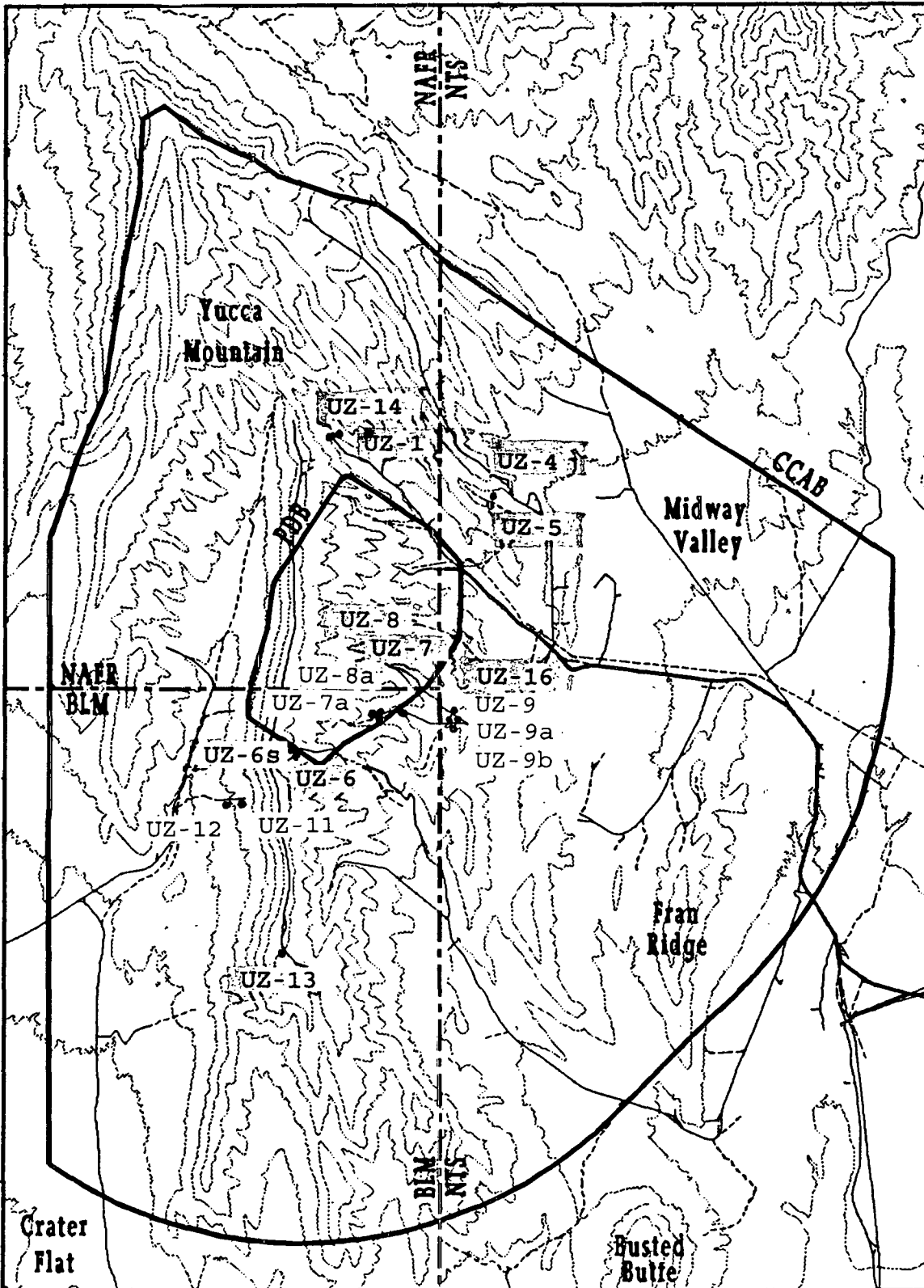


COMMENTS:
 DATA FROM MLD DESIGN DRAWING 622-M-20049 TITLED
 'TEST ALCOVE NO. 1 PROPOSED LAYOUT PLAN AND SECTION'
 DATA BASED ON LETTER, EDWARDS TO ELKINS, 'LOCATION AND
 ORIENTATION OF THE RADIAL BOREHOLE IN EST ALCOVE 21 (STUDY
 PLAN 0.3.1.2.2.4),' DATED JANUARY 31, 1994, DLE/mz.

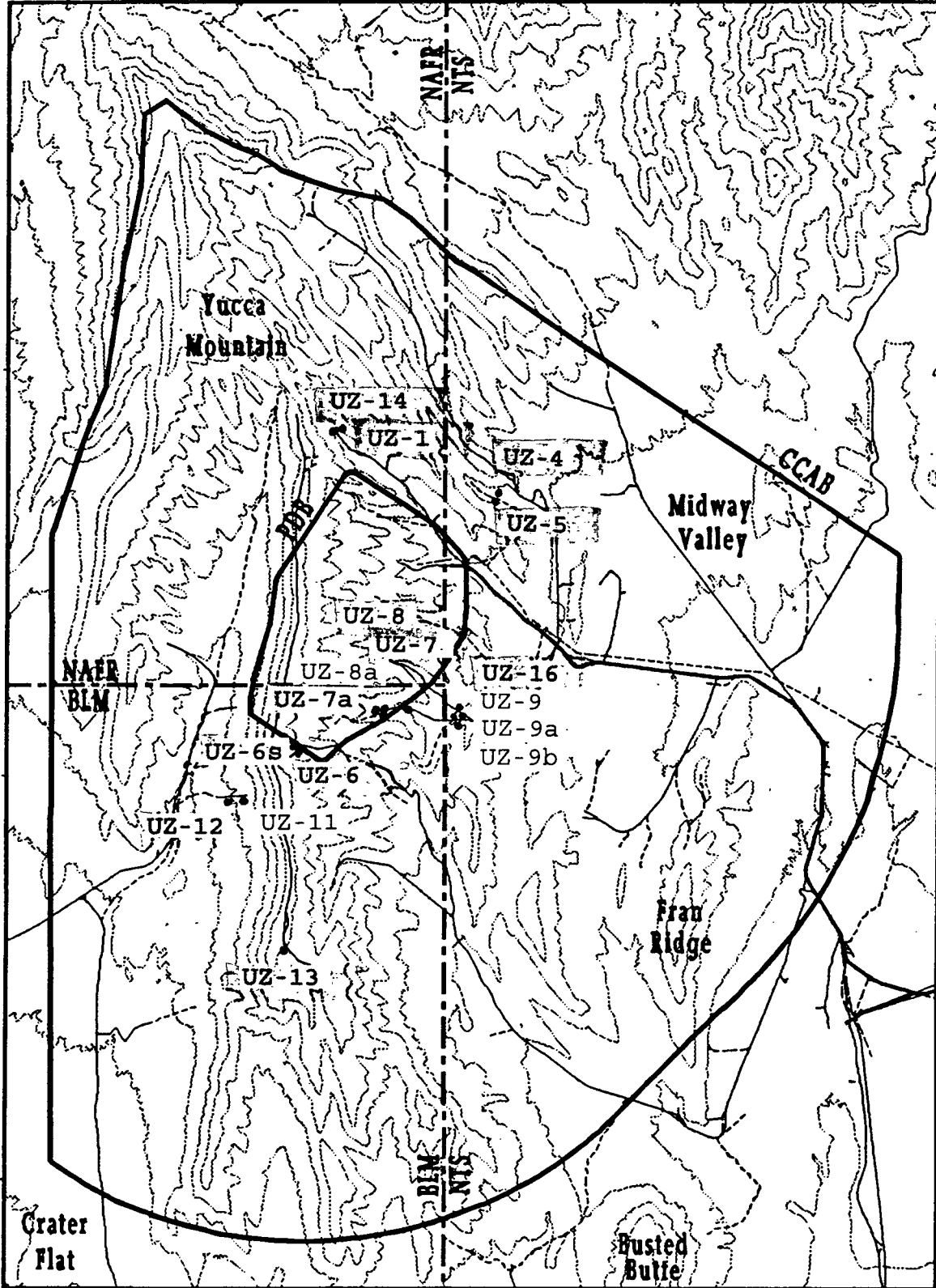
LEGEND:
 CENTER LINE OF RAMP _____
 PROPOSED BOREHOLES _____
 EXCAVATED RAMP _____

LOS ALAMOS NATIONAL LABORATORY				
TEST COORDINATION OFFICE - YUCCA MOUNTAIN PROJECT				
PROJECT: TEST ALCOVE #1				
FINAL LAYOUT PLAN AND SECTION				
CAD FILE: ALCD3F3.DWG	AUTOCAD R18	DATE SCALE	NOTED	REVISION
		A		A1
DRW. BY: D.J. WEAVER	APPROVED BY: ON FILE M.Z. ELKINS/PL	DATE DRW: 8/3/94		
NOTES: ADMINISTRATIVE/ILLUSTRATIVE			PLOT DATE 9/18/94	

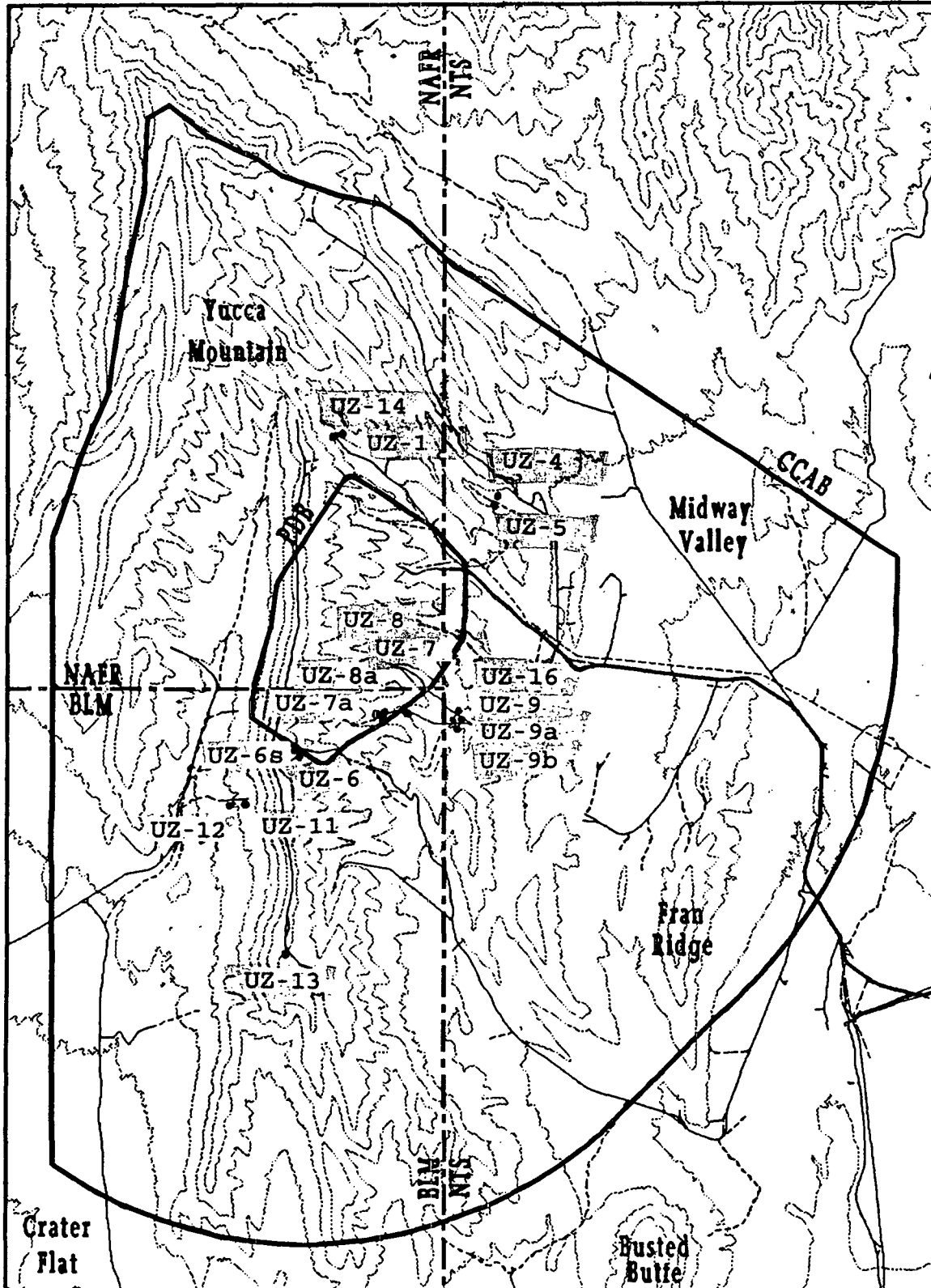
UZ BOREHOLES (EXISTING)
SITE STUDIES / HYDROCHEMISTRY / WATER QUALITY



UZ BOREHOLES (for TSS)
SITE STUDIES / HYDROCHEMISTRY / WATER QUALITY

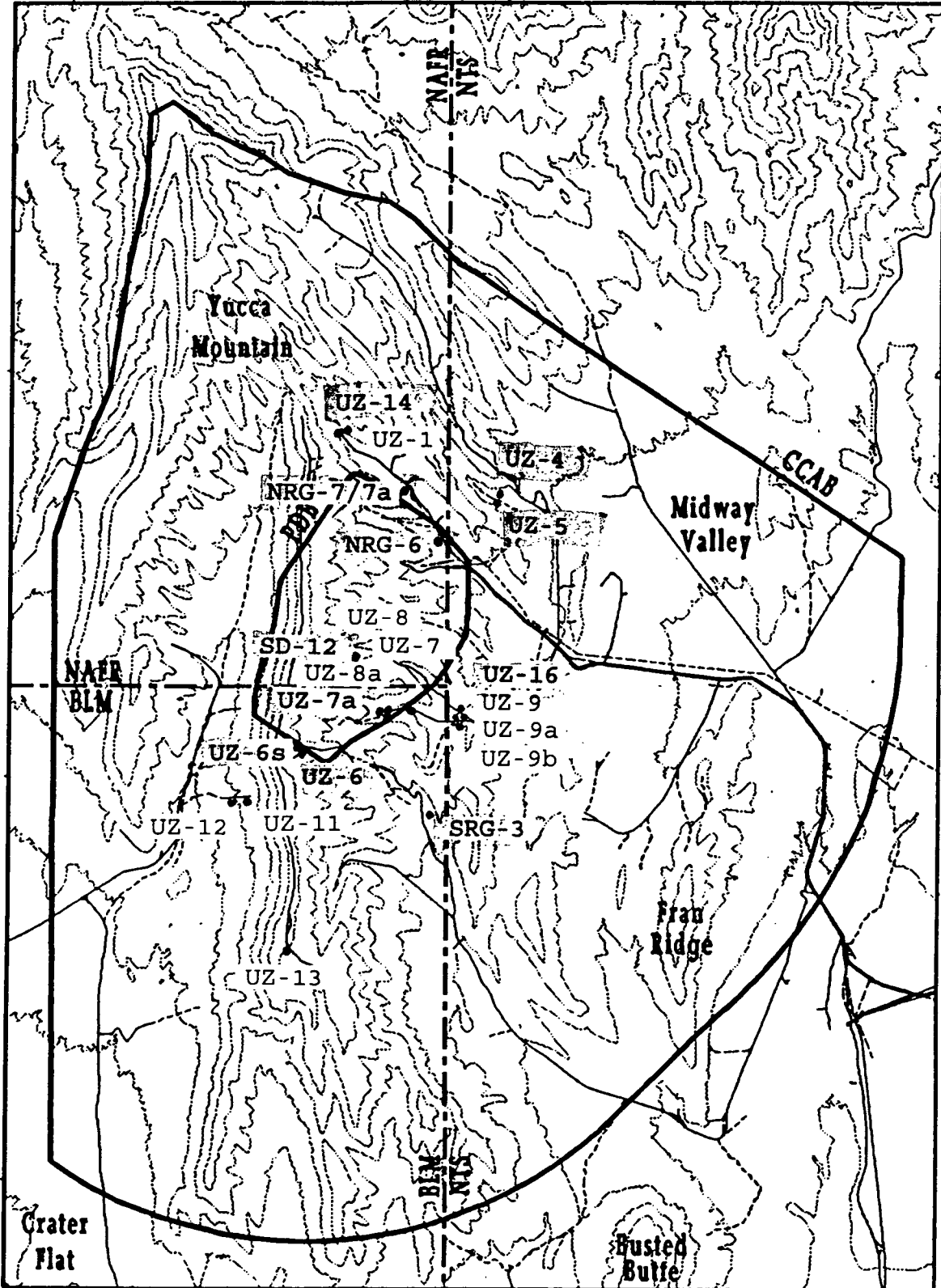


UZ BOREHOLES (for LA)
SITE STUDIES / HYDROCHEMISTRY / WATER QUALITY

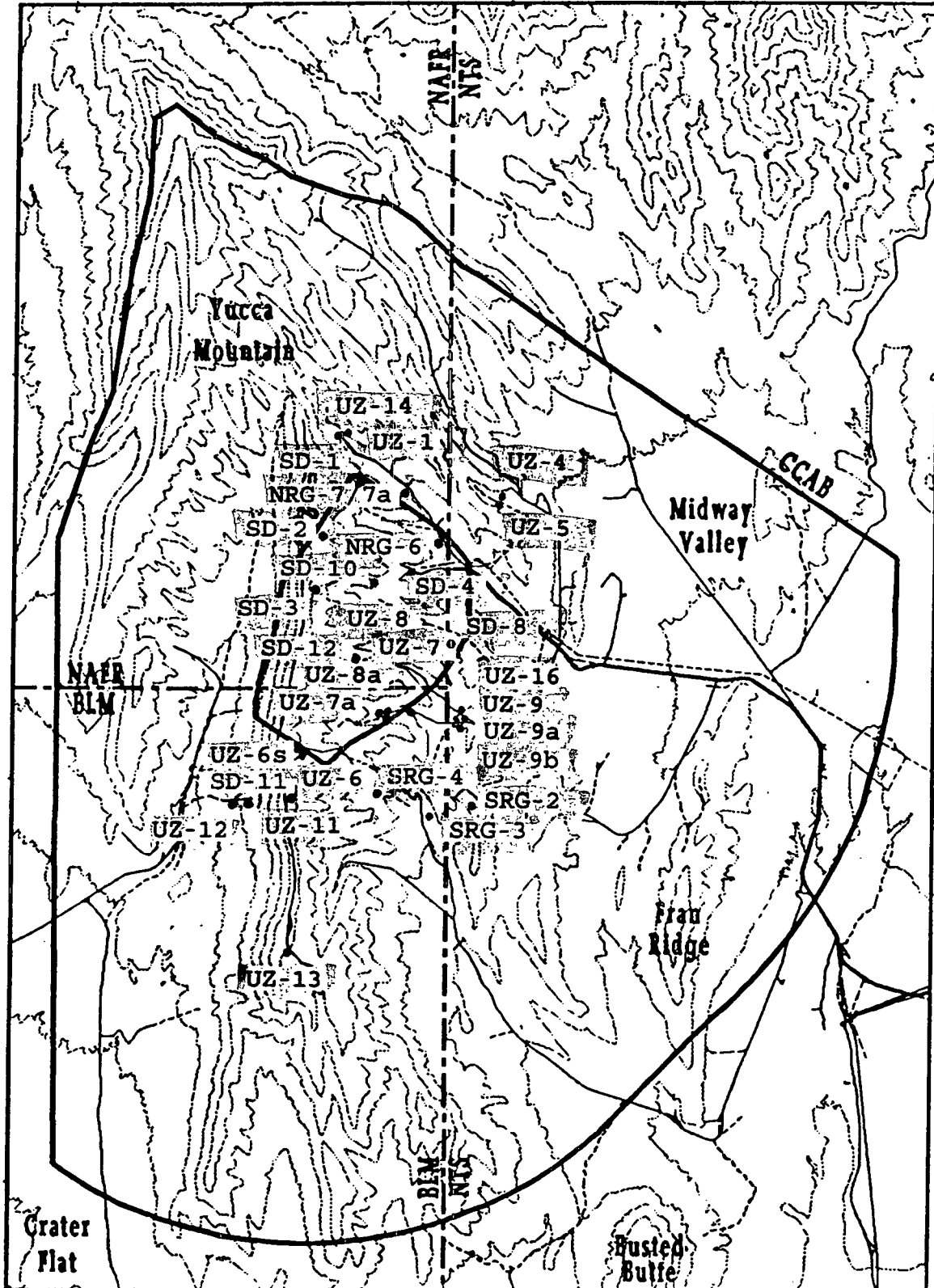


PNEUMATIC TESTING BOREHOLES

BOREHOLES USED IN PNEUMATIC STUDIES FOR TSS

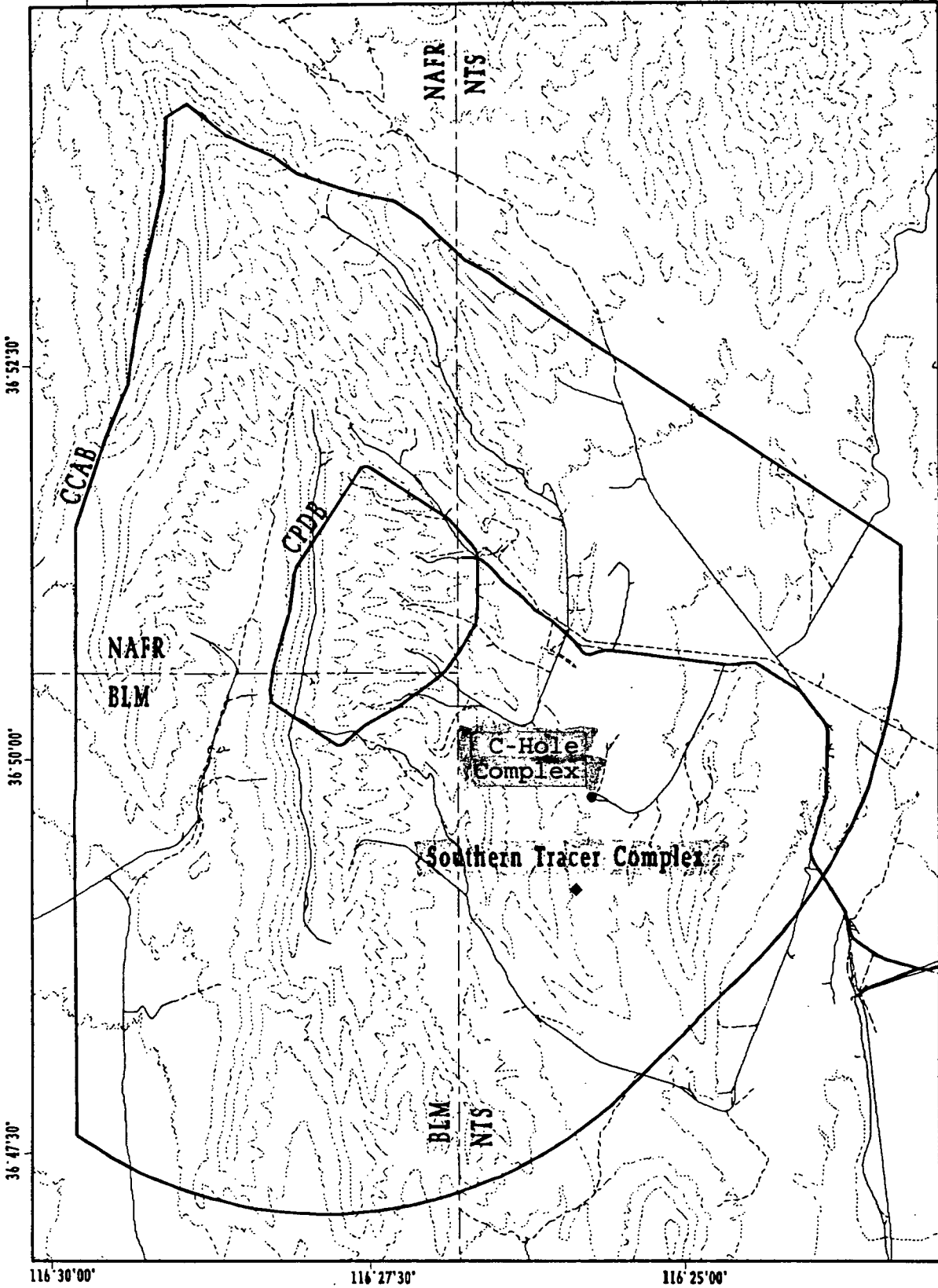


PNEUMATIC TESTING BOREHOLES
BOREHOLES USED IN PNEUMATIC STUDIES FOR LA



E550245ft
E545000m

E566660ft
E550000m



N7702101
N4060000m

N7539501
N4075000m

18

LEGEND

◆ Planned Borehole

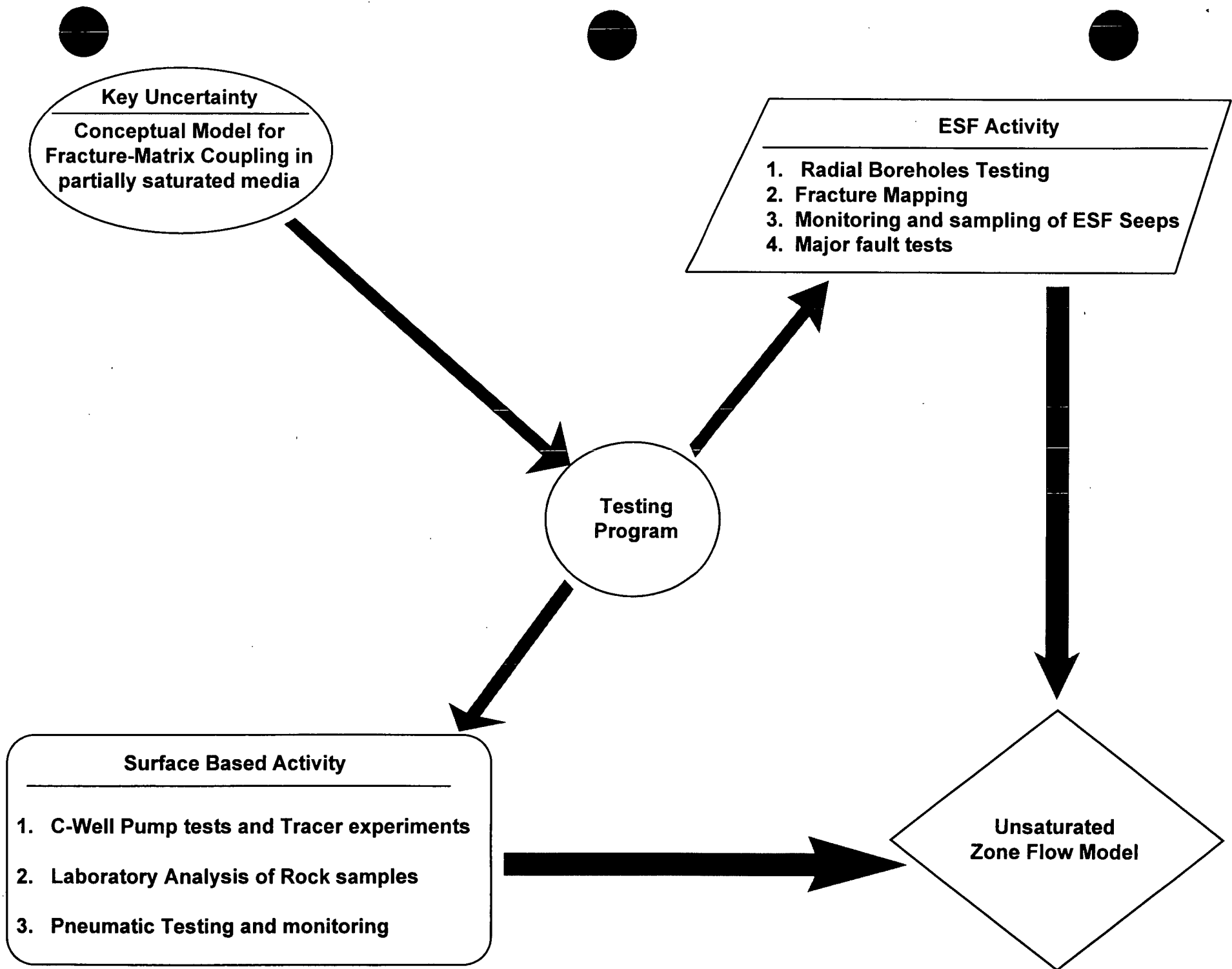


Contour Interval 200 Feet

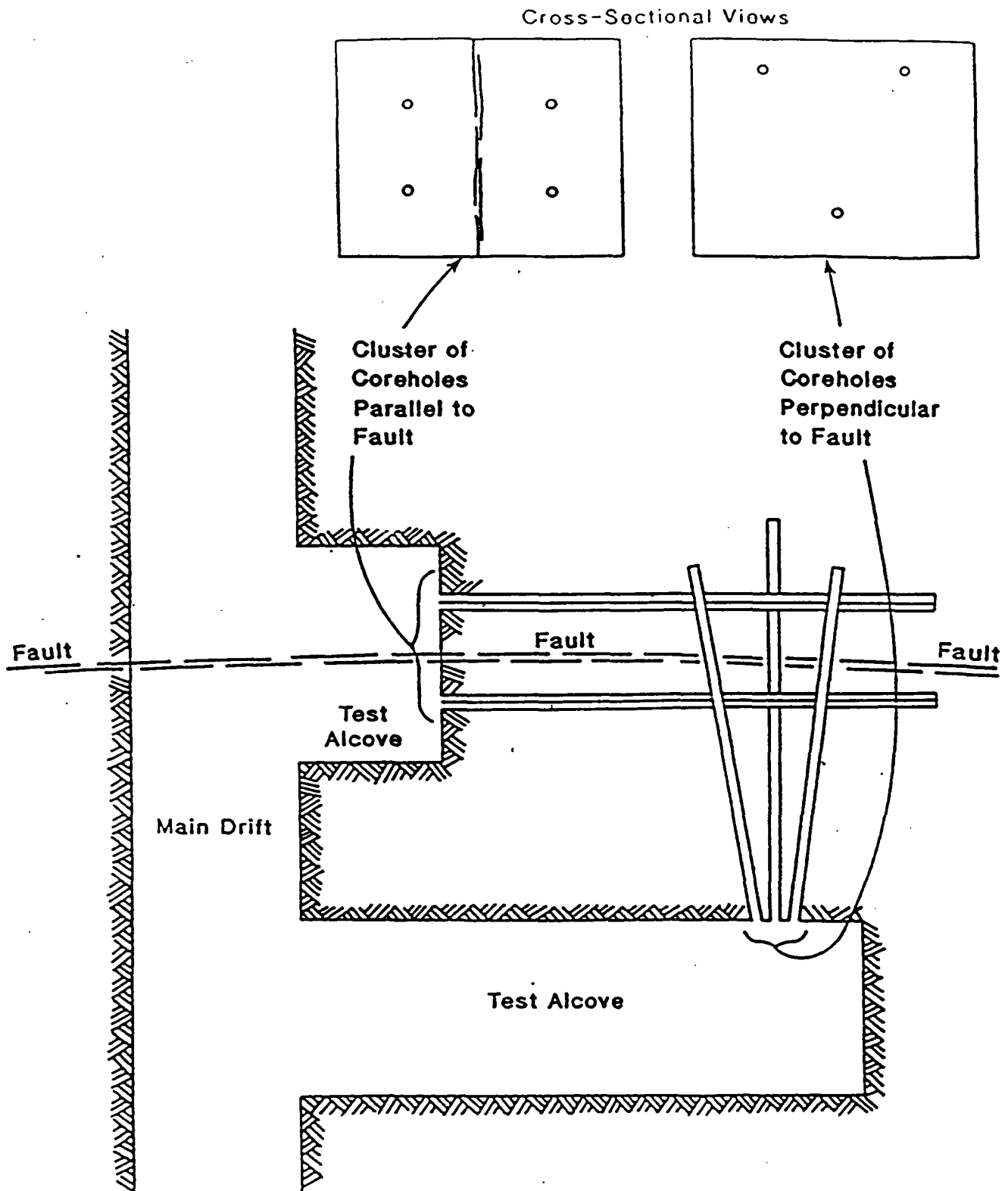
YUCCA MOUNTAIN
SITE CHARACTERIZATION PROJECT

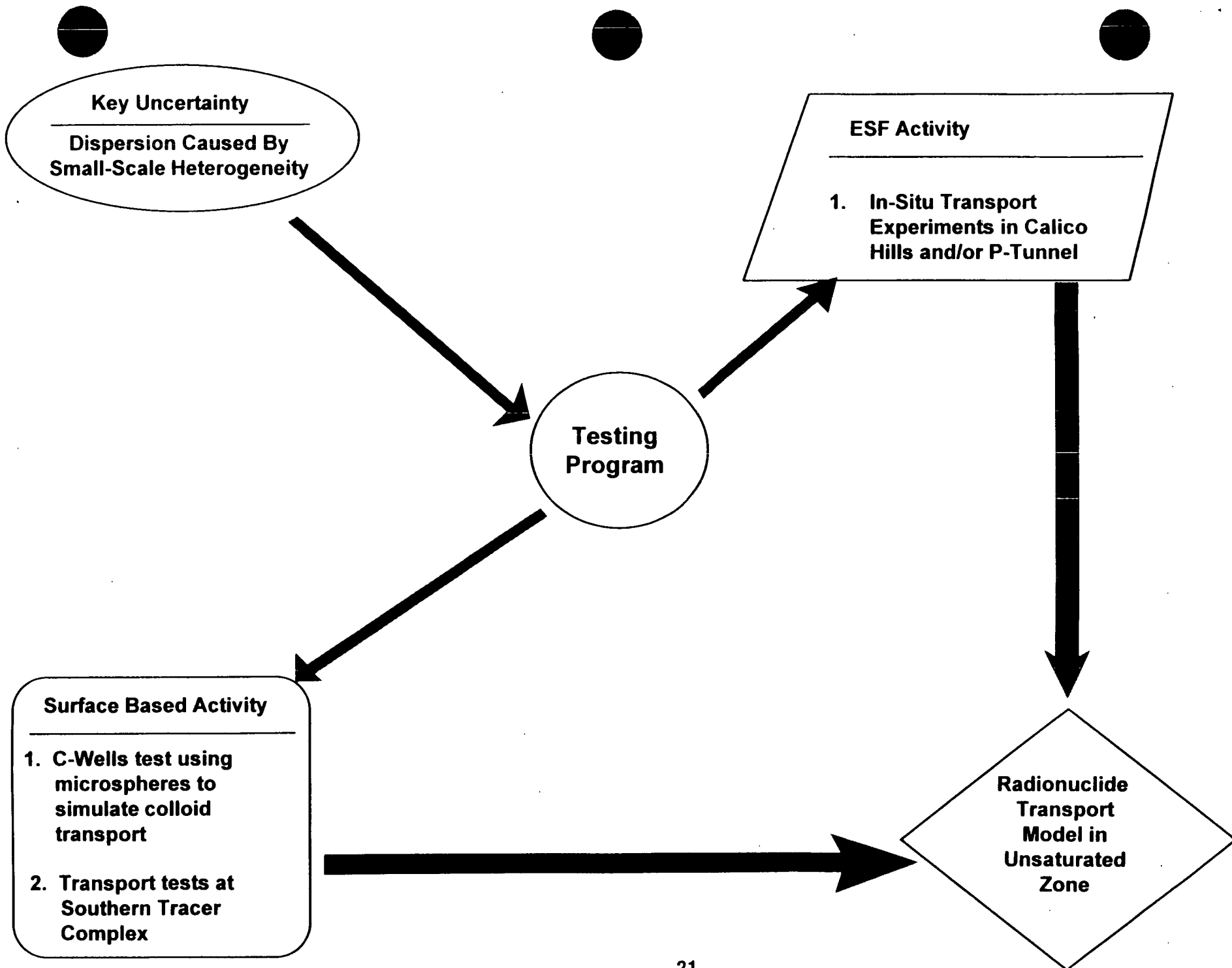
PLANNED SOUTHERN TRACER COMPLEX

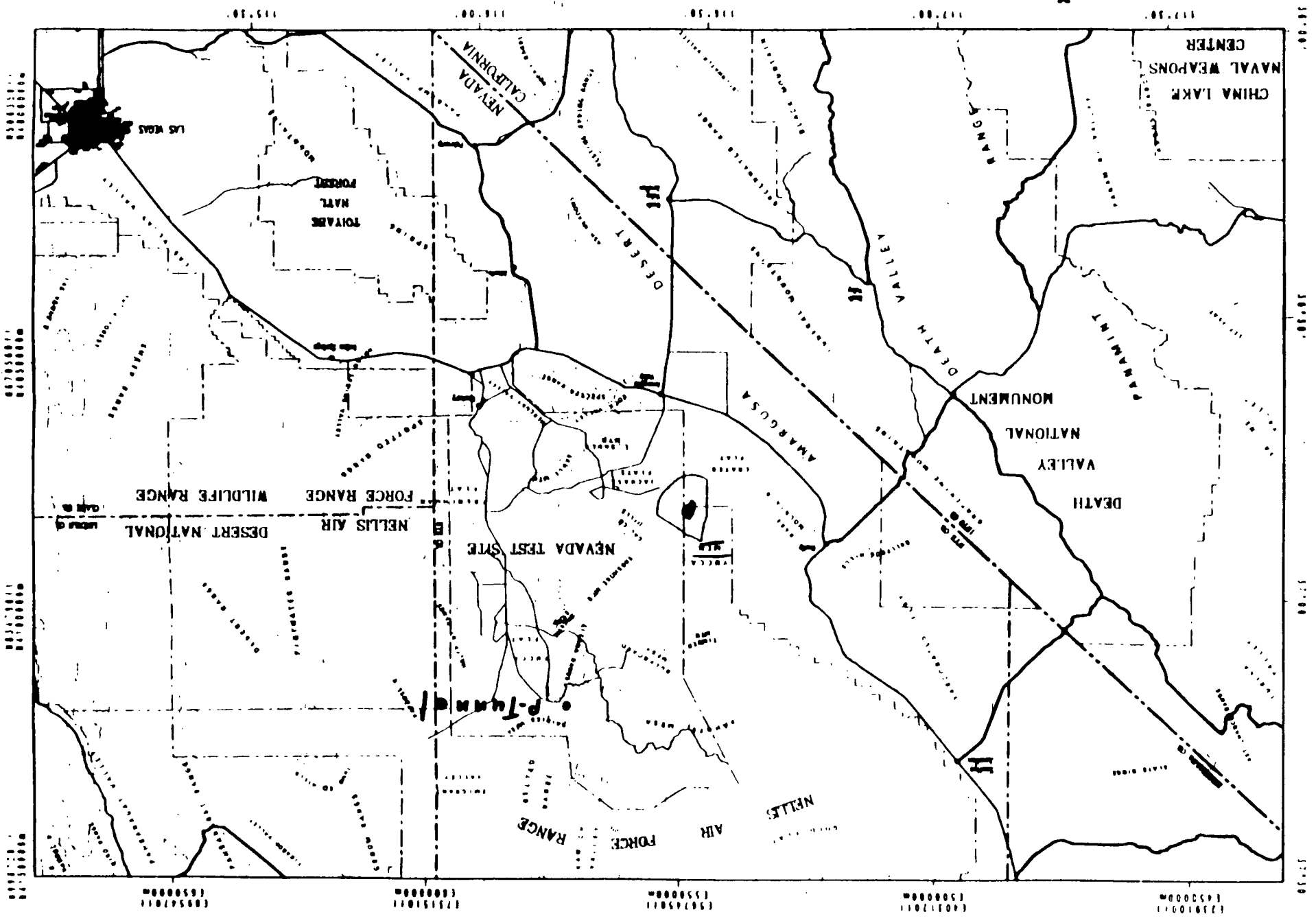
EG&G YMP-92-042.4



Possible Test Configuration for Hydrologic Properties of Major Faults



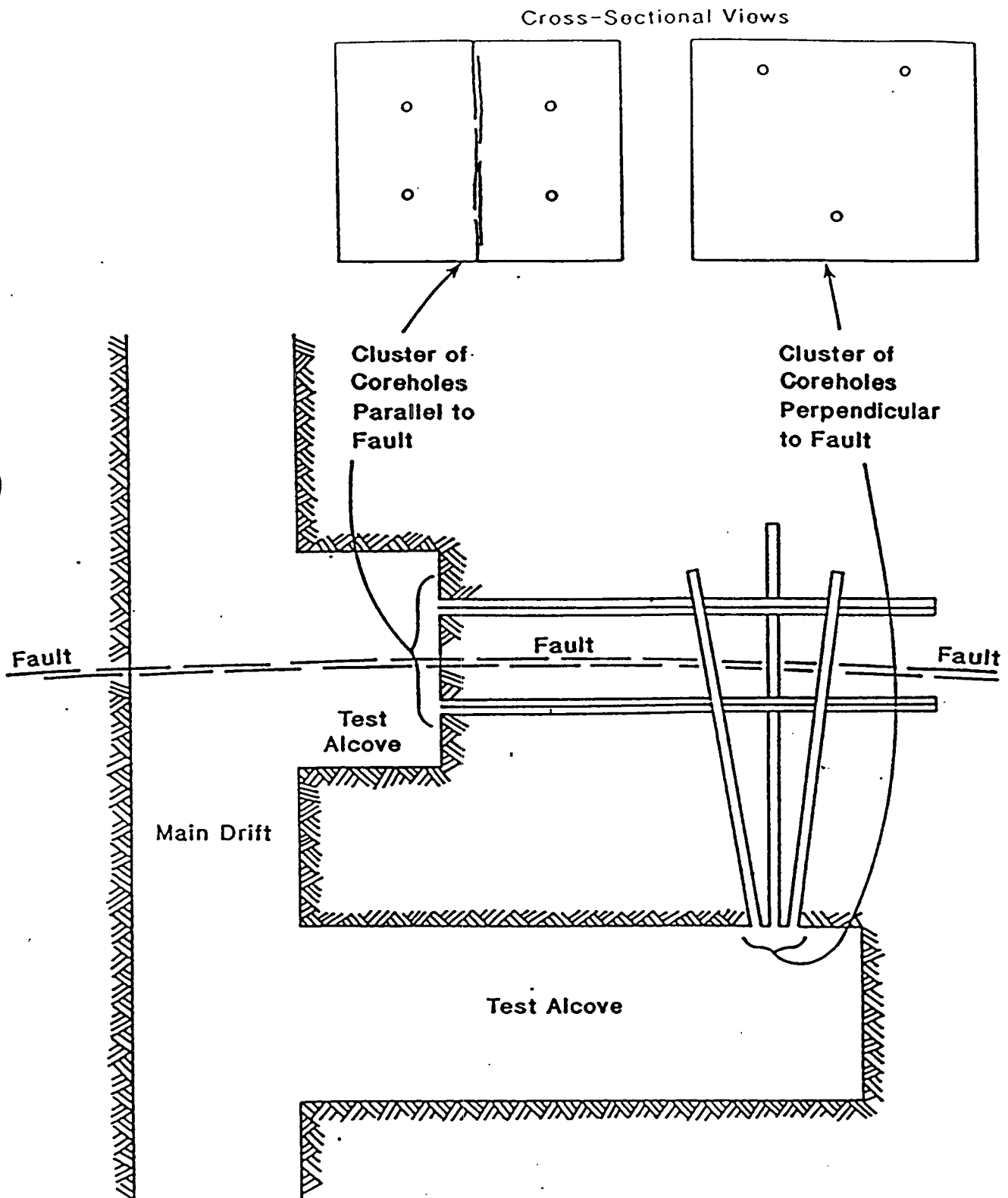


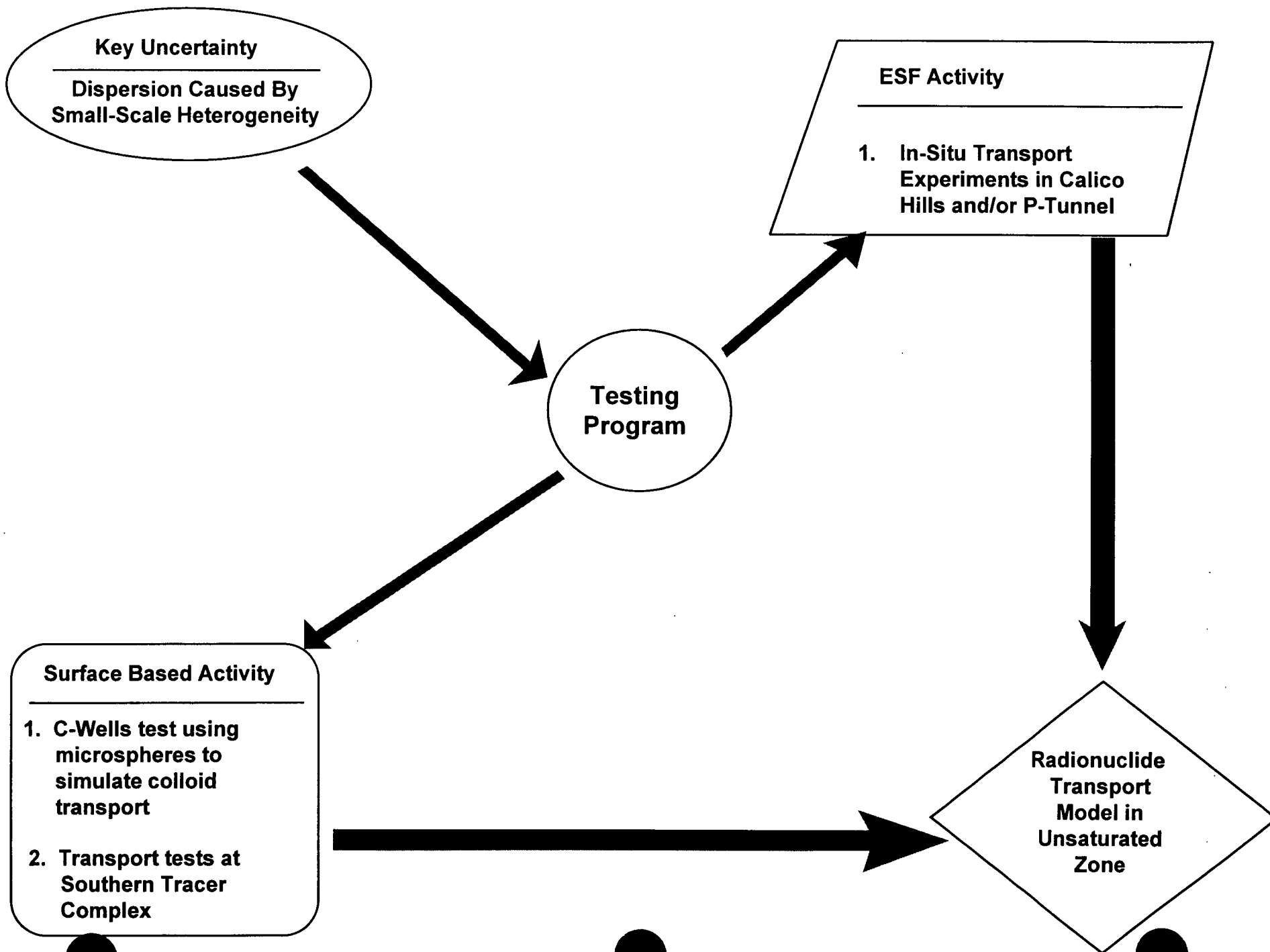


36° 00' 00" N
 119° 30' 00" W
 35° 30' 00" N
 119° 00' 00" W
 35° 00' 00" N
 118° 30' 00" W
 34° 30' 00" N
 118° 00' 00" W
 34° 00' 00" N
 117° 30' 00" W
 33° 30' 00" N
 117° 00' 00" W

1430000 1450000 1470000 1490000 1510000
 1601700 1621700 1641700 1661700 1681700
 1681700 1701700 1721700 1741700 1761700
 1761700 1781700 1801700 1821700 1841700

Possible Test Configuration for Hydrologic Properties of Major Faults





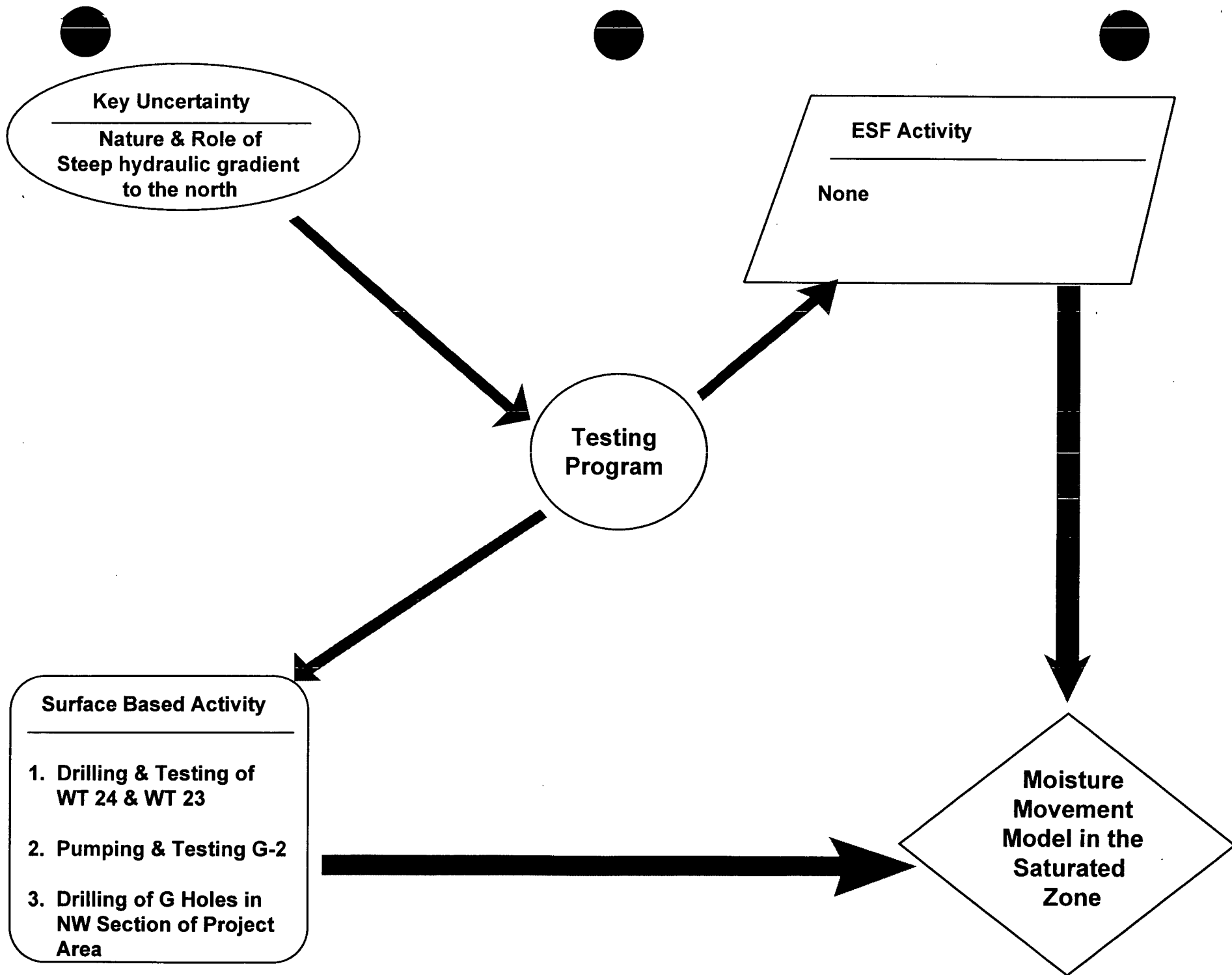
Field-Scale Transport Experiment at P-Tunnel, Rainier Mesa

Objectives

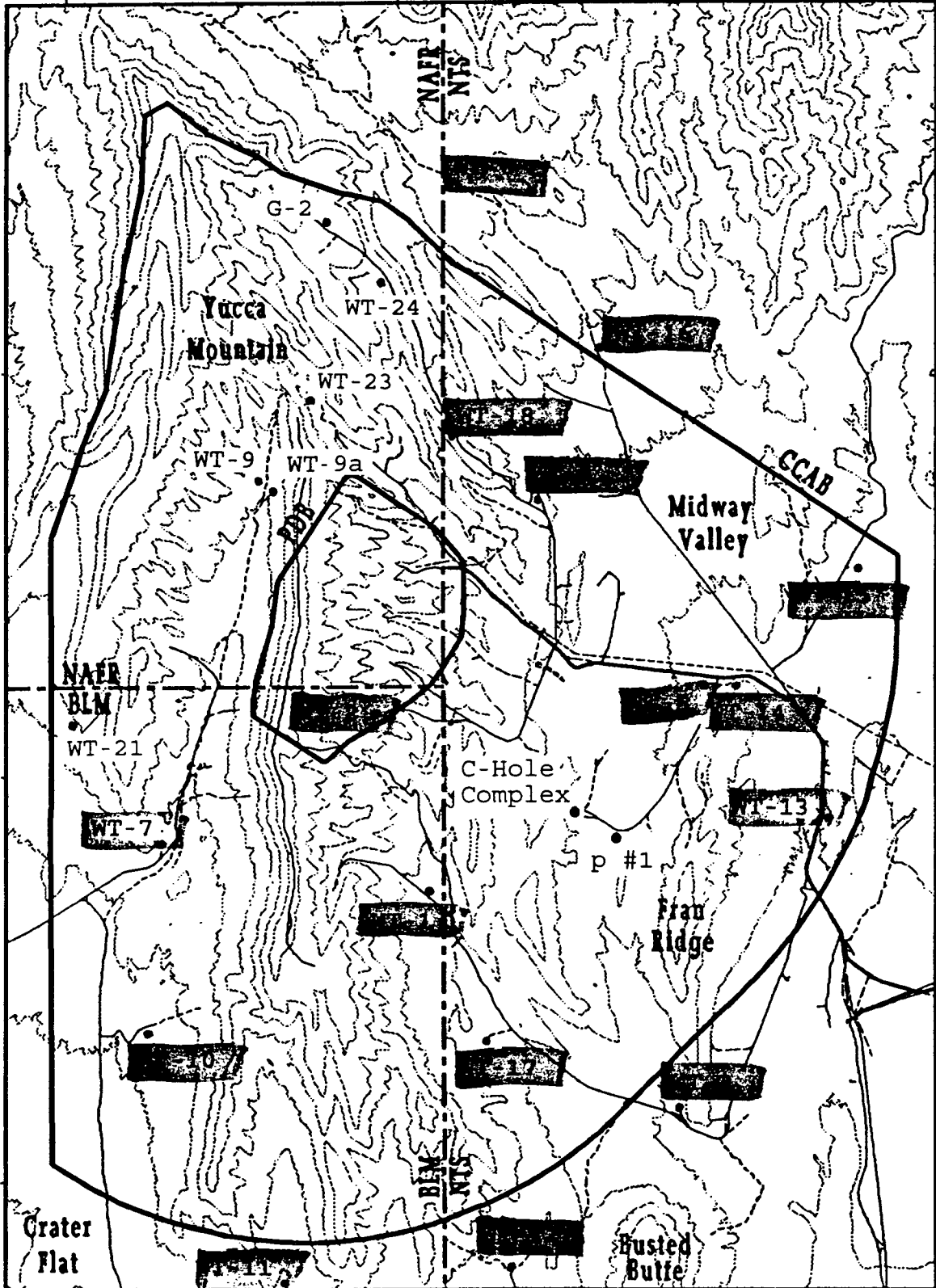
- Evaluate transport mechanisms in vitric and zeolitic tuffs similar to the Calico Hills Unit.**
- Investigate processes that may affect the ability of tuffs similar to the Calico Hills Unit to retard radionuclide transport.**
- Determine scaling effects for flow and transport parameters between laboratory and field scales.**
- Determine applicability of laboratory geochemistry work to predictions of field scale transport.**
- Identify and characterize potential fast flow paths.**
- Validate flow and transport modeling codes such as FEHM, TRACER3D and TOUGH.**
- Provide input for the design of a flow and transport experiment in the Calico Hills Unit.**

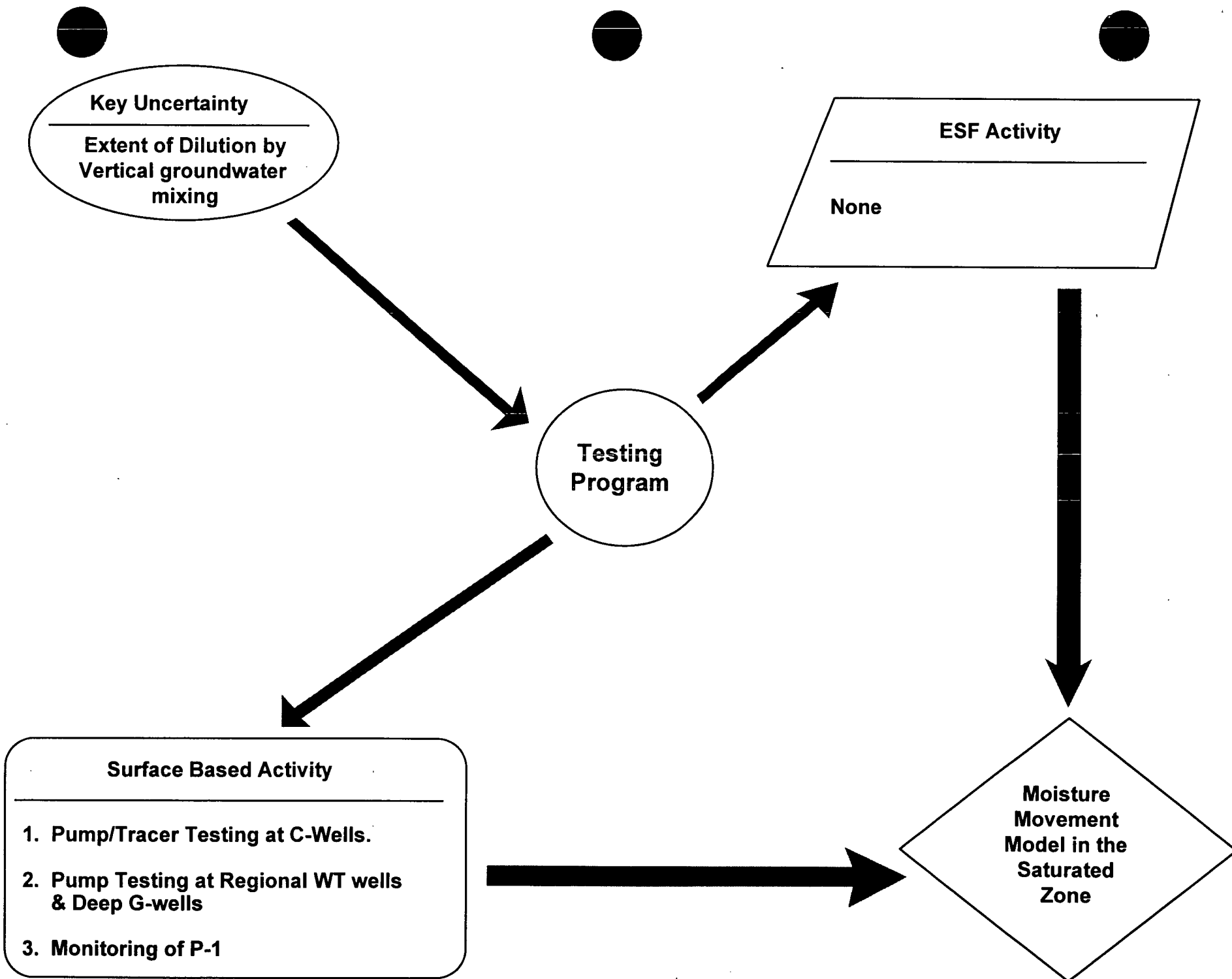
Schedule for P-Tunnel Tests

Activity	FY95	FY96	FY97	FY98
Prepare job package, test planning package, test plan	▲			
Select test site and drill two to four exploratory holes	▲			
Initiate flow and transport modeling to support design of field tests	▲			
Excavate alcove and test block		▲		
Install instrumentation and initiate tracer tests		▲		
Conduct concurrent laboratory tests		▲		
Continue data collection from field and laboratory tests			▲	
Provide input to planning and designing tests in the Calico Hills Unit			▲	
Complete field and laboratory tests, flow and transport modeling and data analysis				▲

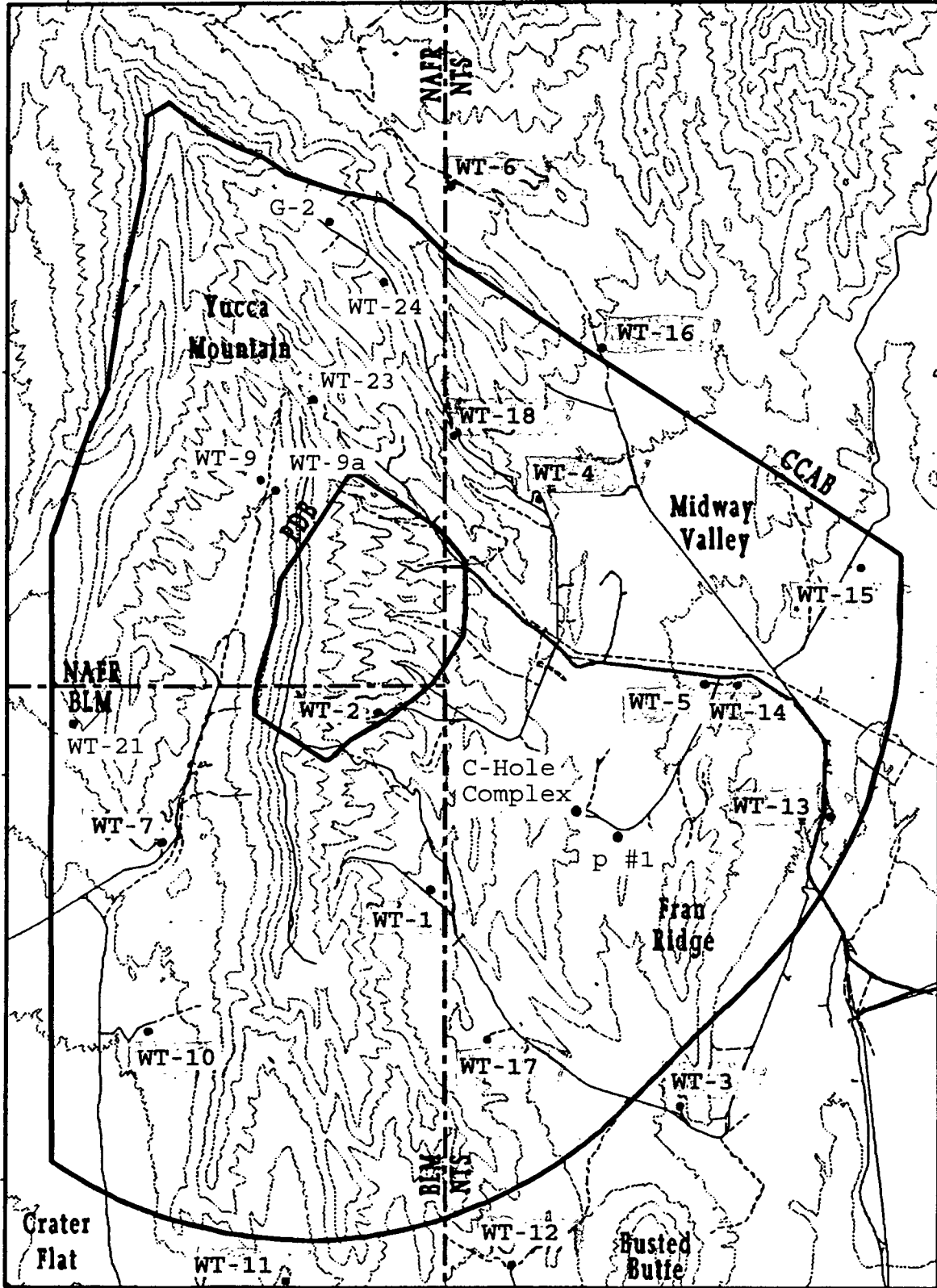


WT BOREHOLES (EXISTING)
REGIONAL STUDIES / HYDROCHEMISTRY / WATER QUALITY

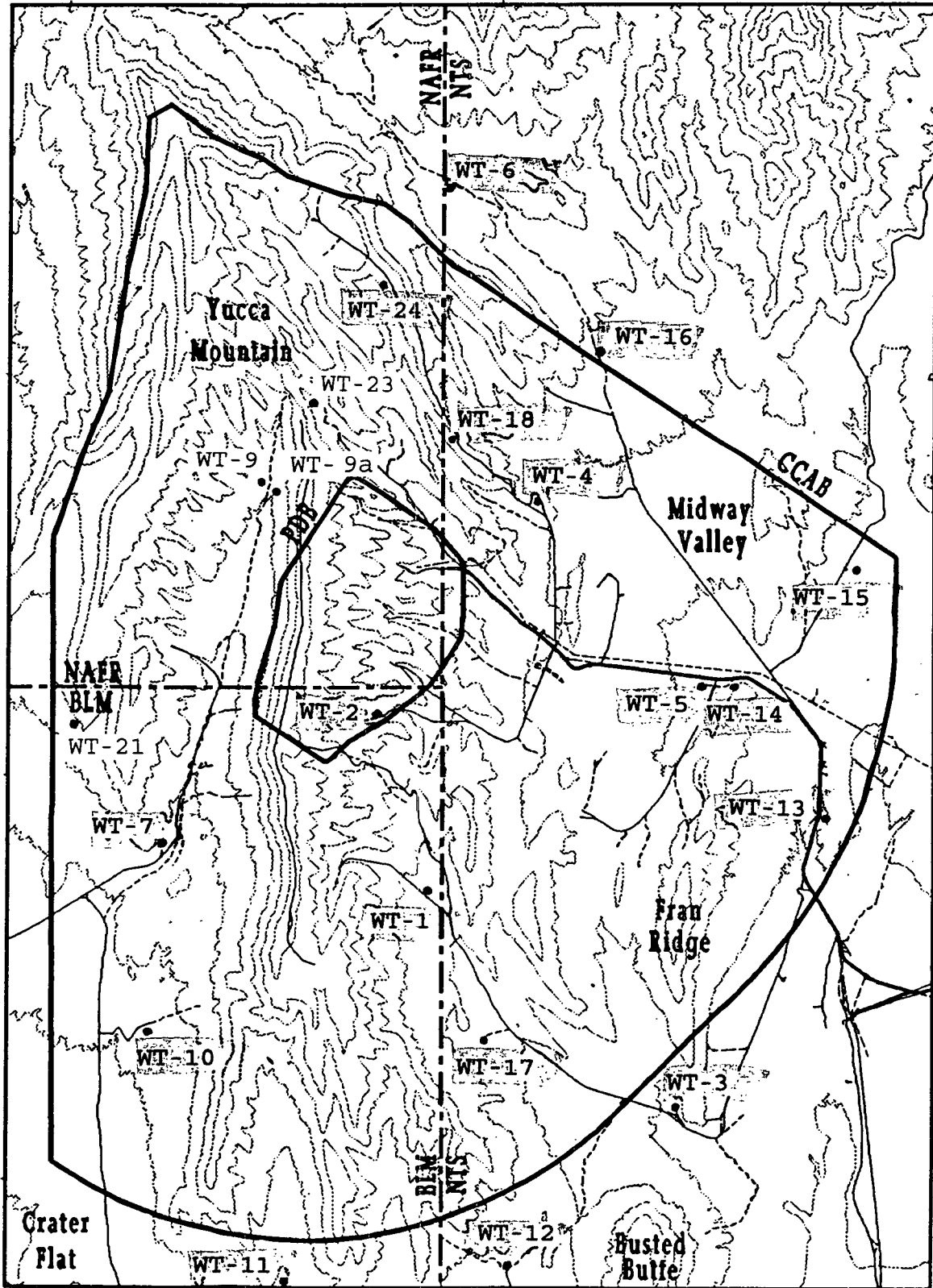




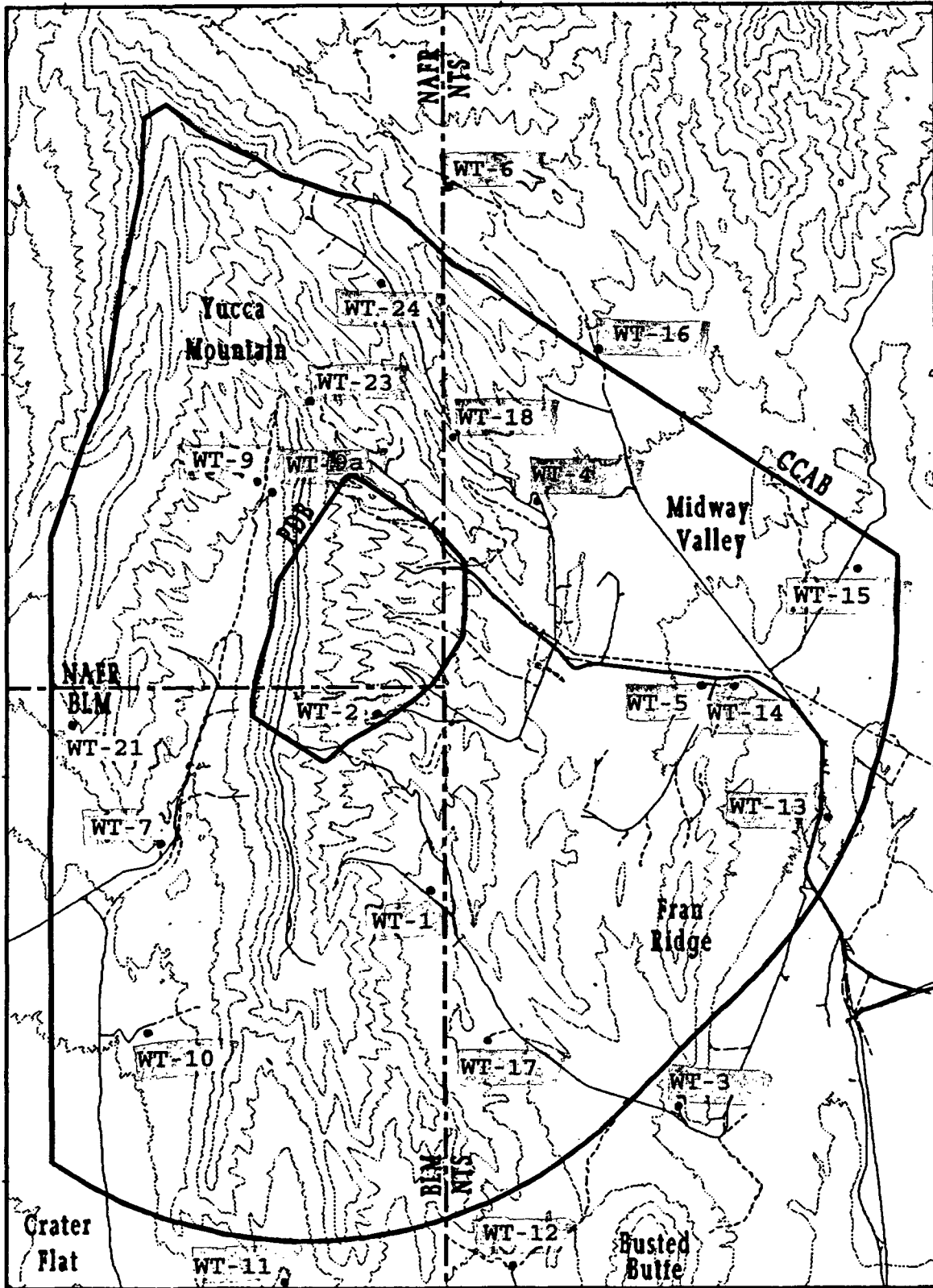
WT BOREHOLES (EXISTING)
REGIONAL STUDIES / HYDROCHEMISTRY / WATER QUALITY



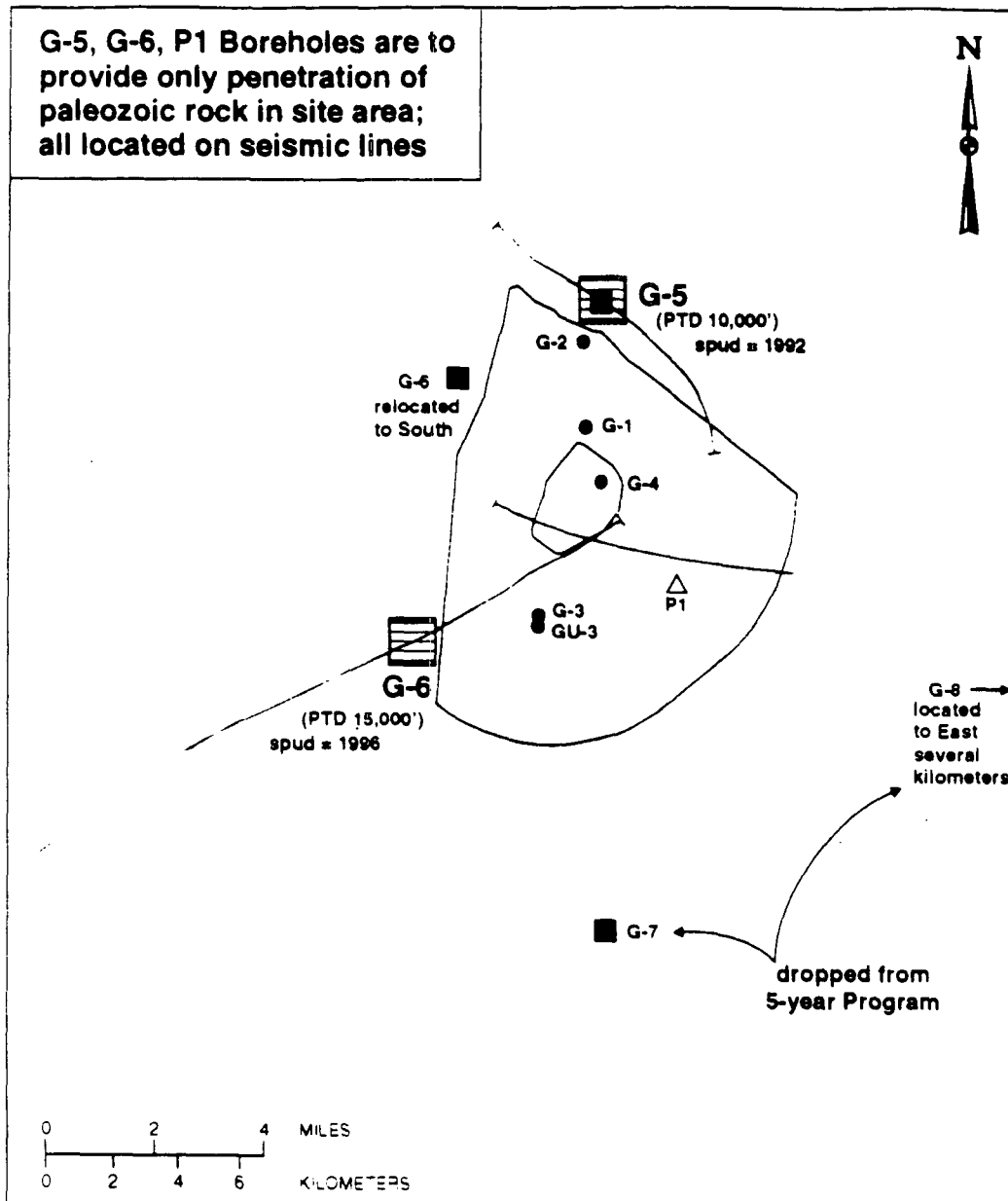
WT BOREHOLES (for TSS)
REGIONAL STUDIES / HYDROCHEMISTRY / WATER QUALITY



WT BOREHOLES (for LA)
REGIONAL STUDIES / HYDROCHEMISTRY / WATER QUALITY



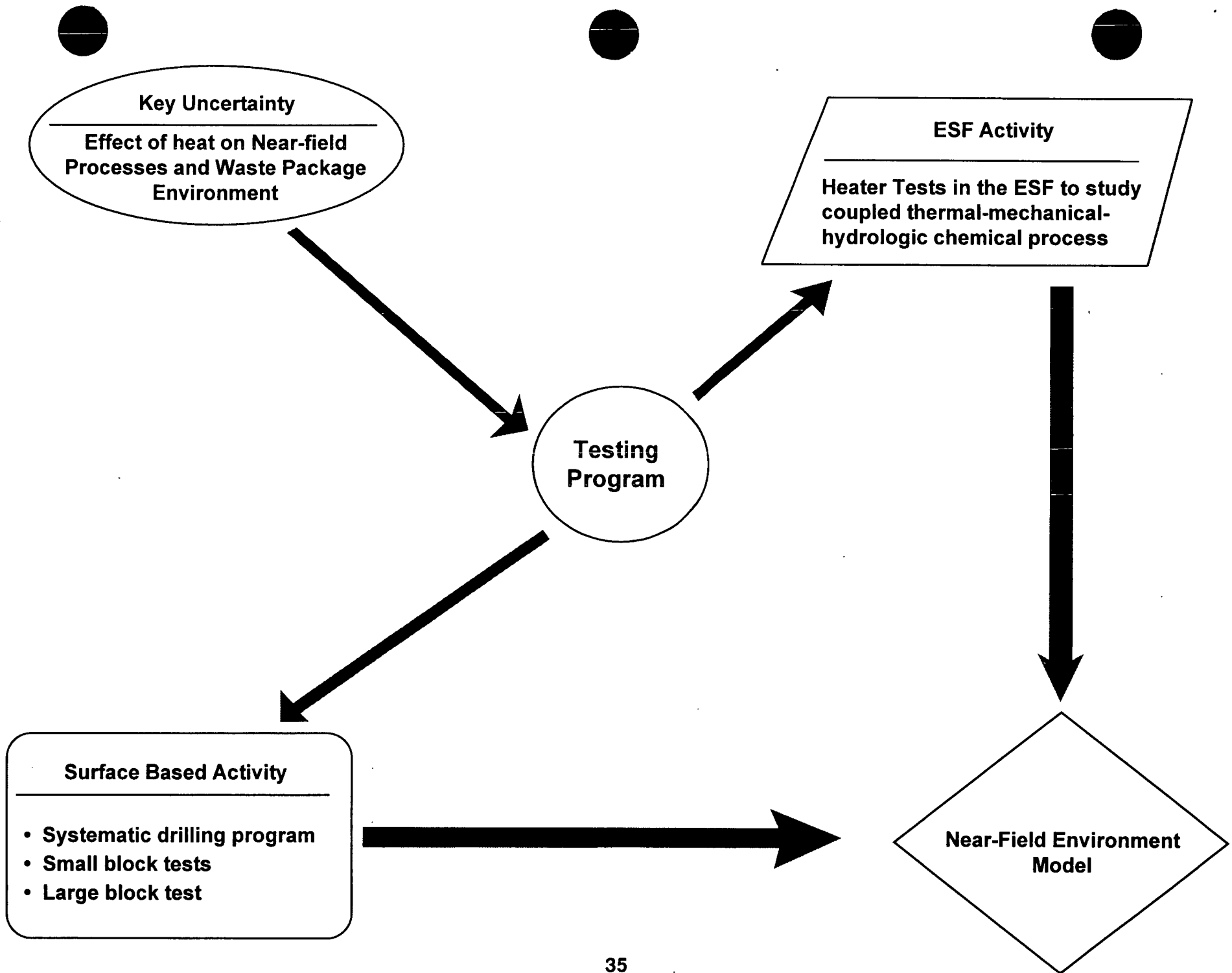
Geologic Boreholes (G-HOLES)



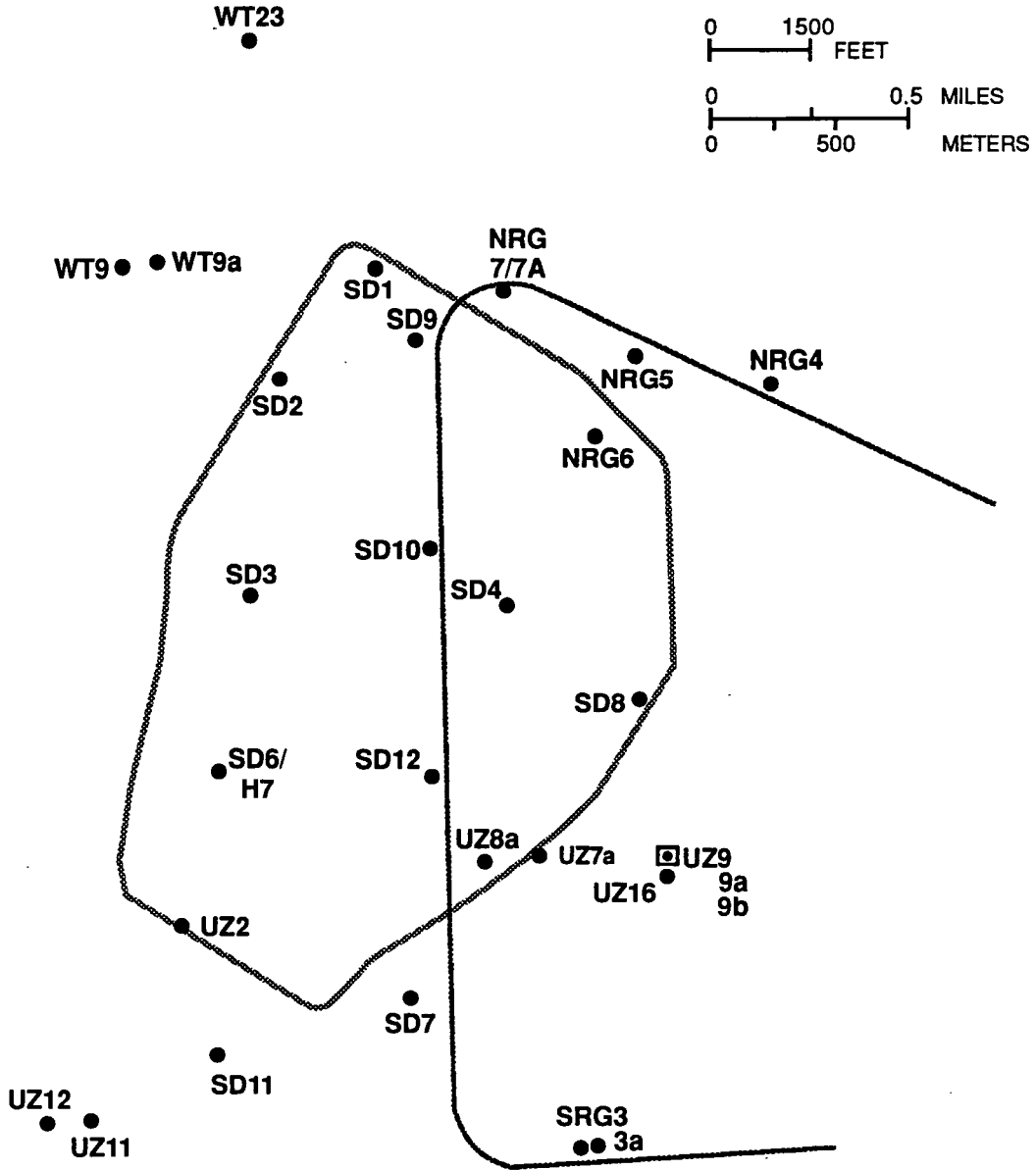
- | | | | |
|-------|--|---|--|
| — | FY84/95 Reflection Seismic Line Location | ● | Existing G-holes |
| - - - | FY95 Reflection Seismic Line Location | ■ | SCP (1988) G-borehole proposed locations |
| ○ | PDB, CCB | ▤ | 5 year plan G-hole proposed locations |

Thermal Effects





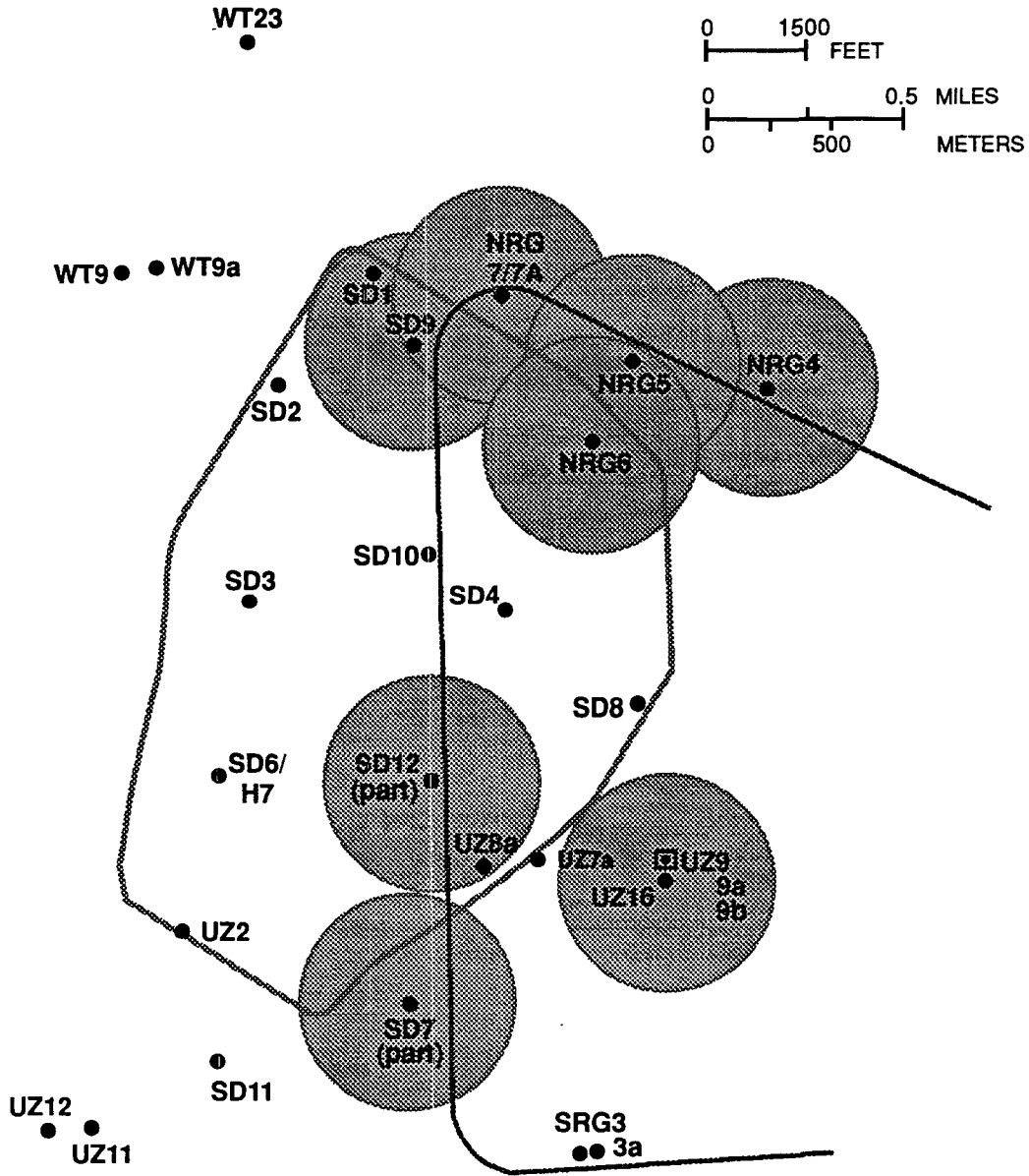
Proposed and Existing Locations



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BOREHOLES AVAILABLE FOR SD PROGRAM

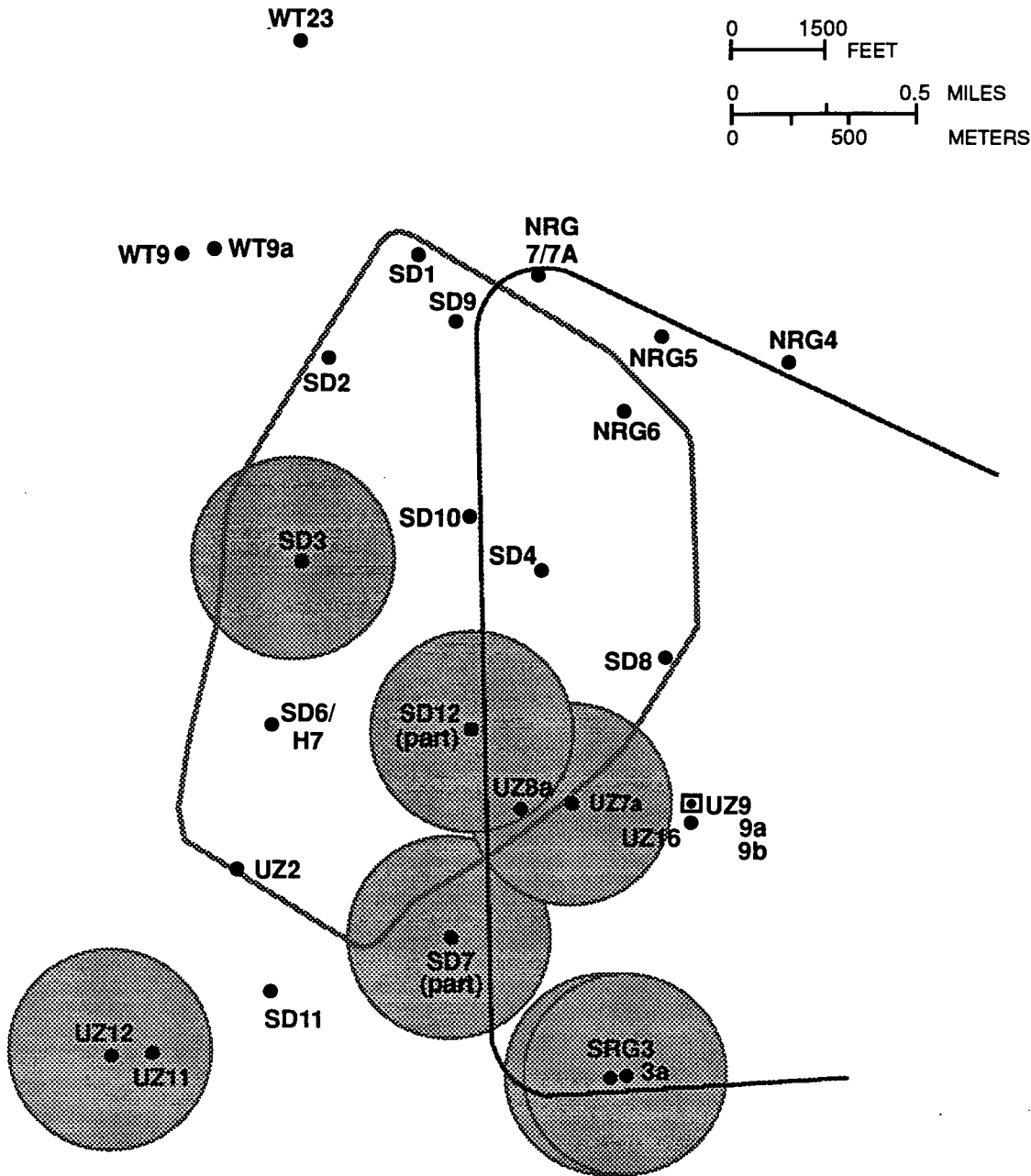
Proposed and Existing Locations



37

SD BOREHOLES AVAILABLE BY 1/95 FOR TSS

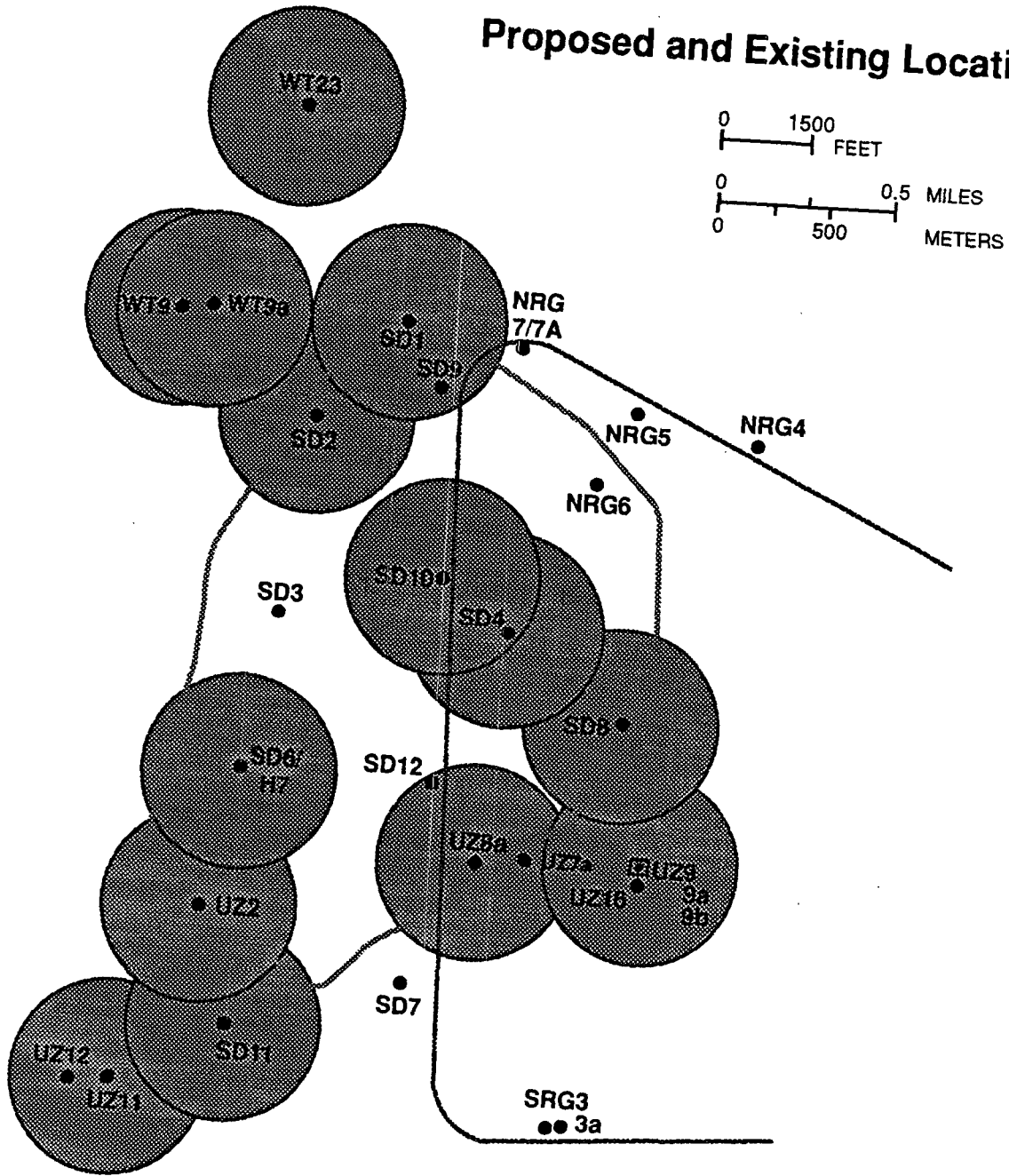
Proposed and Existing Locations



SD BOREHOLES AVAILABLE BY 9/96 FOR TSS

 by 9/96 (for TSS)
 [drilled between 1/95 and 9/96]

Proposed and Existing Locations



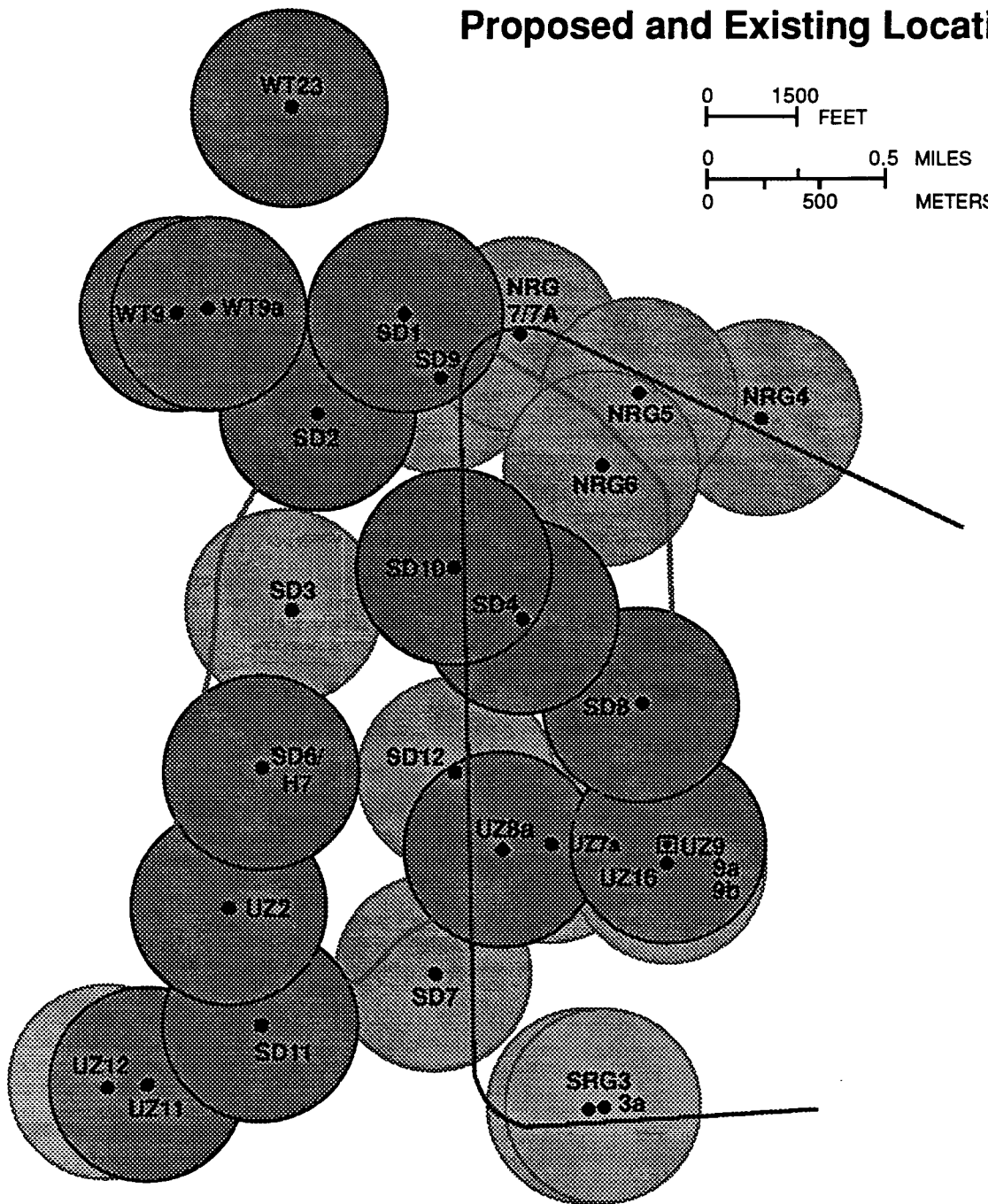
39

SD BOREHOLES AVAILABLE BY 9/99 FOR LA

● by 9/99 (for LA)
 [drilled between 9/96 and 9/99]

SYSDRIL2.CDR.125.NWTRB/1-3-95

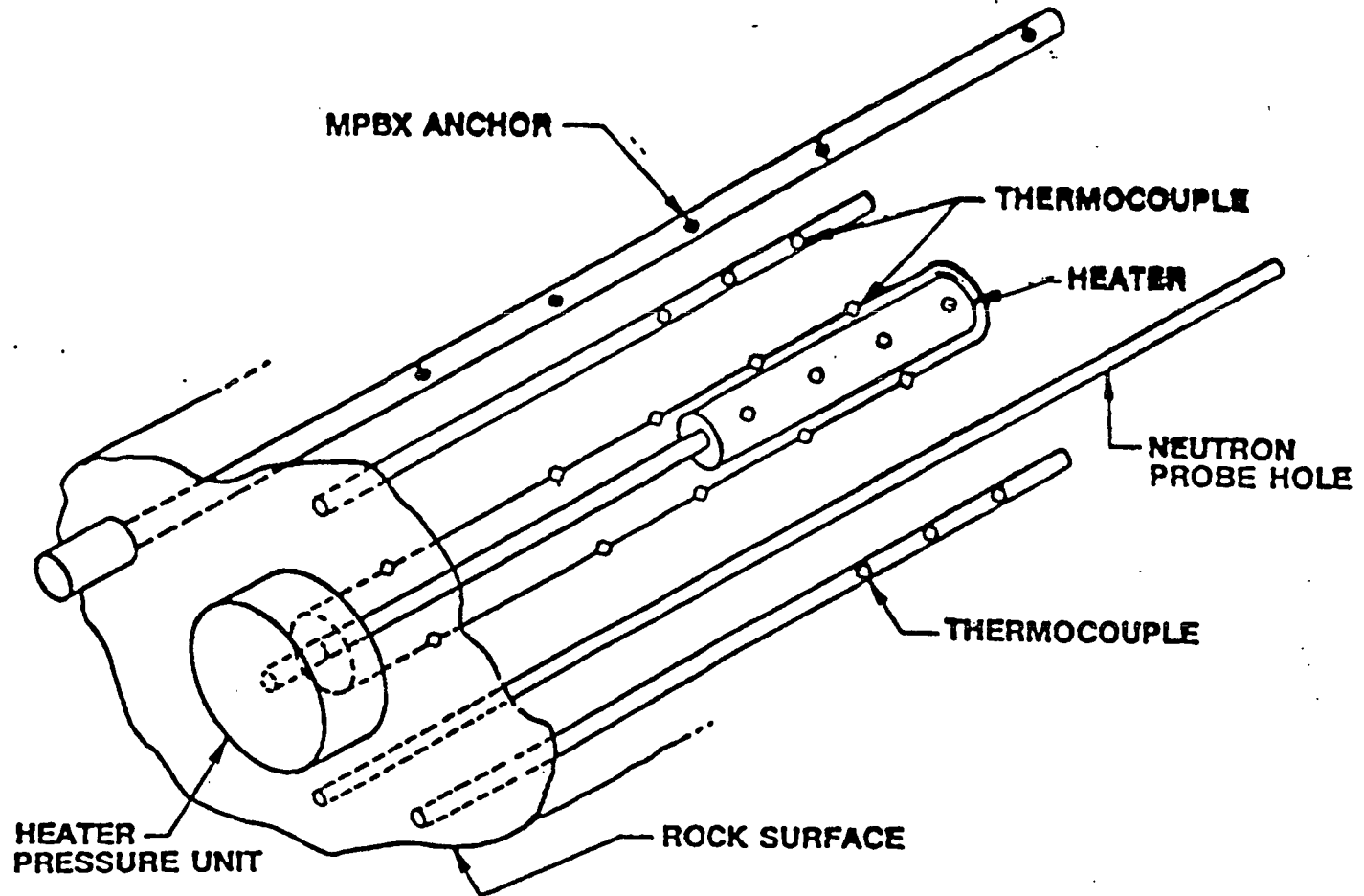
Proposed and Existing Locations



BOREHOLES AVAILABLE FOR SD PROGRAM

- 1/95 (Present)
- by 9/96 (for TSS)
[drilled between 1/95 and 9/96]
- by 9/99 (for LA)
[drilled between 9/96 and 9/99]

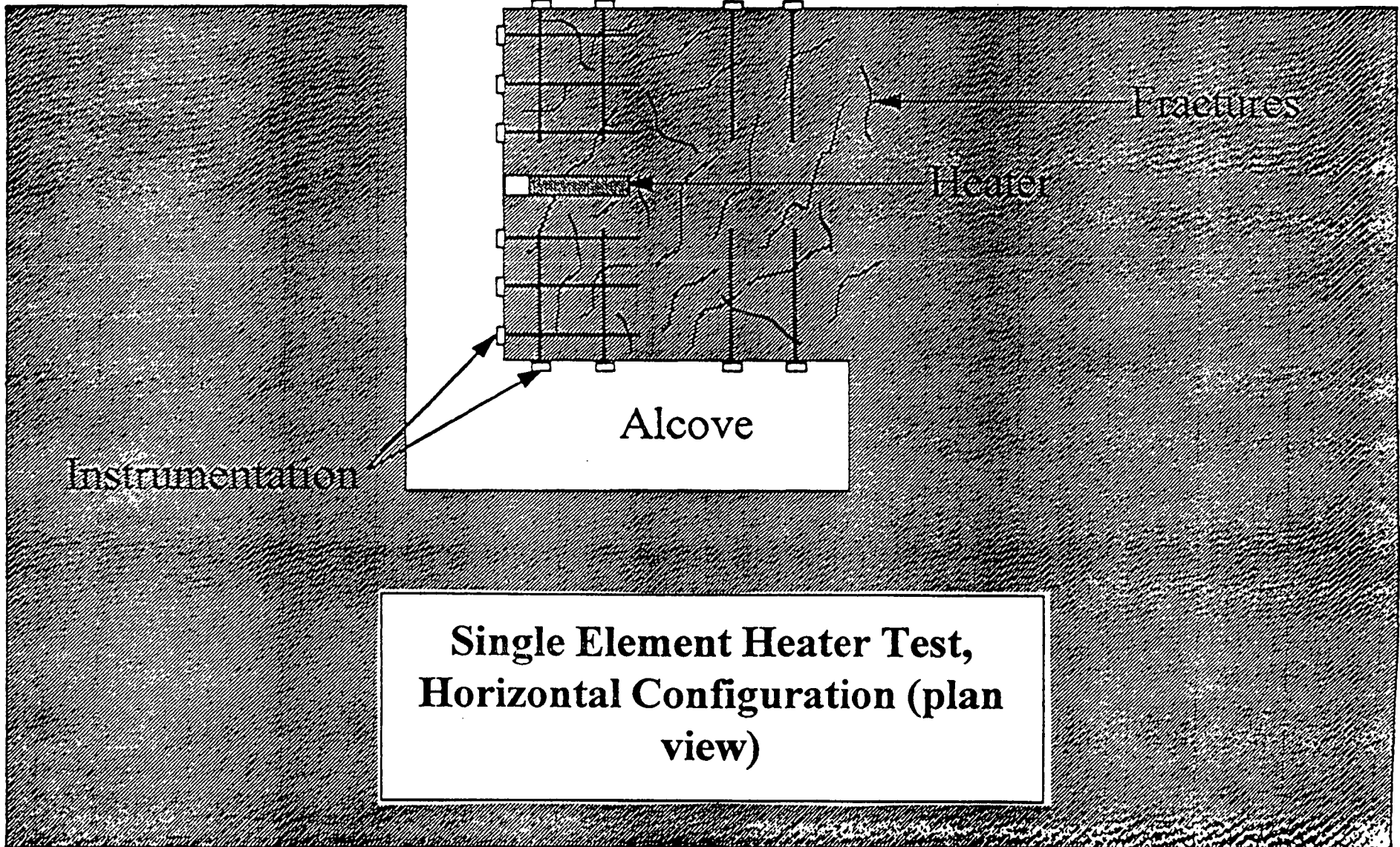
Axisymmetric Heater Test



Information Needs Satisfied By Axisymmetric Heater Test

Information Needs	Axisymmetric Heater Test
Rock-mass properties over a range of temperature	
• Thermal capacity or specific heat	Primary
• Thermal conductivity	Primary
• Thermal Expansion	Secondary
• Deformation modulus	Secondary
• Strength	(Primary, only for optional roof test)
Near-field T-M-H-C environment	
• Propagation of "drying front" (heterogeneity)	Primary
• Residual water saturation "dry zone"	Primary
• Reflux of liquid by fracture flow (heterogeneity)	Secondary
• Conductive/convective heat transfer	Primary

Tunnel

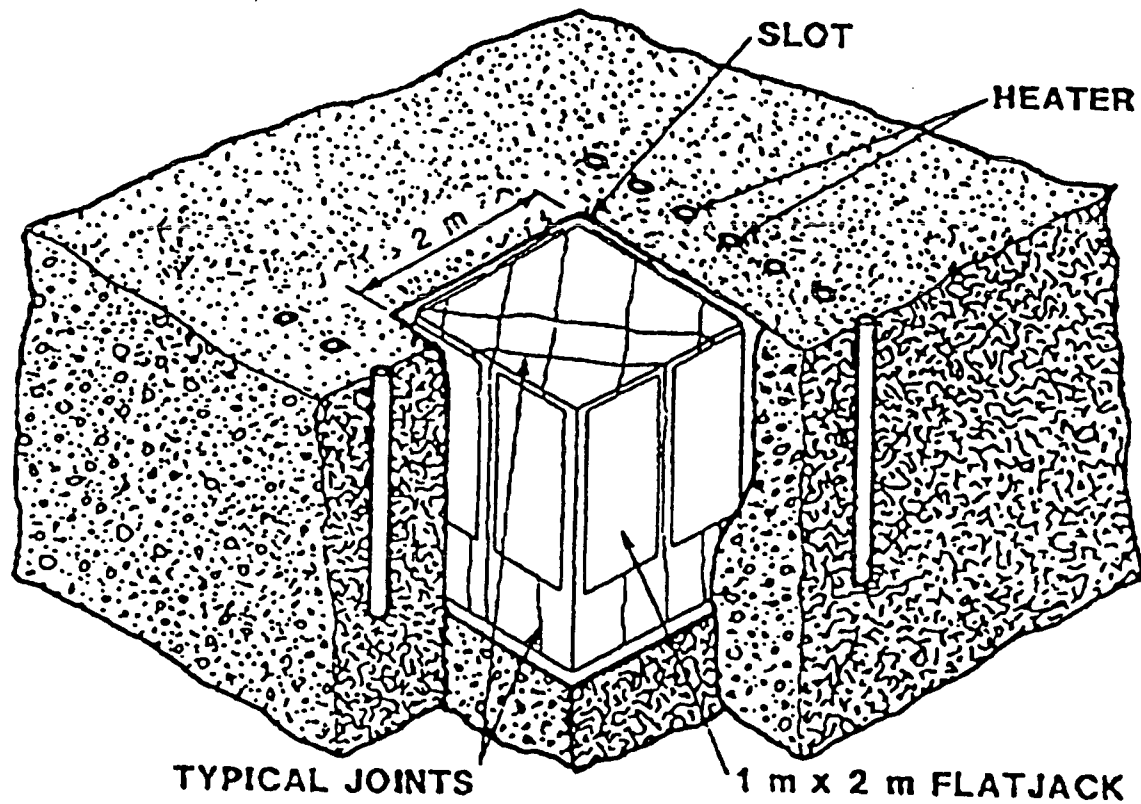


**Single Element Heater Test,
Horizontal Configuration (plan
view)**

Information Needs Satisfied By Horizontal Heater Test

Information Needs	Horizontal Heater Test
Rock-mass properties over a range of temperature	
• Thermal capacity or specific heat	Secondary
• Thermal conductivity	Secondary
• Thermal expansion	Primary
Near-field T-M-H-C environment	
• Changes in rock saturation	Secondary
• Water chemistry (liquid reflux)	Primary
• Propagation of "drying front" (heterogeneity)	Primary
• Residual water saturation in "dry zone"	Primary
• Reflux of liquid by fracture flow (heterogeneity)	Primary
• Rock mass and fracture permeability changes	Primary
• Conductive/convective heat transfer	Primary

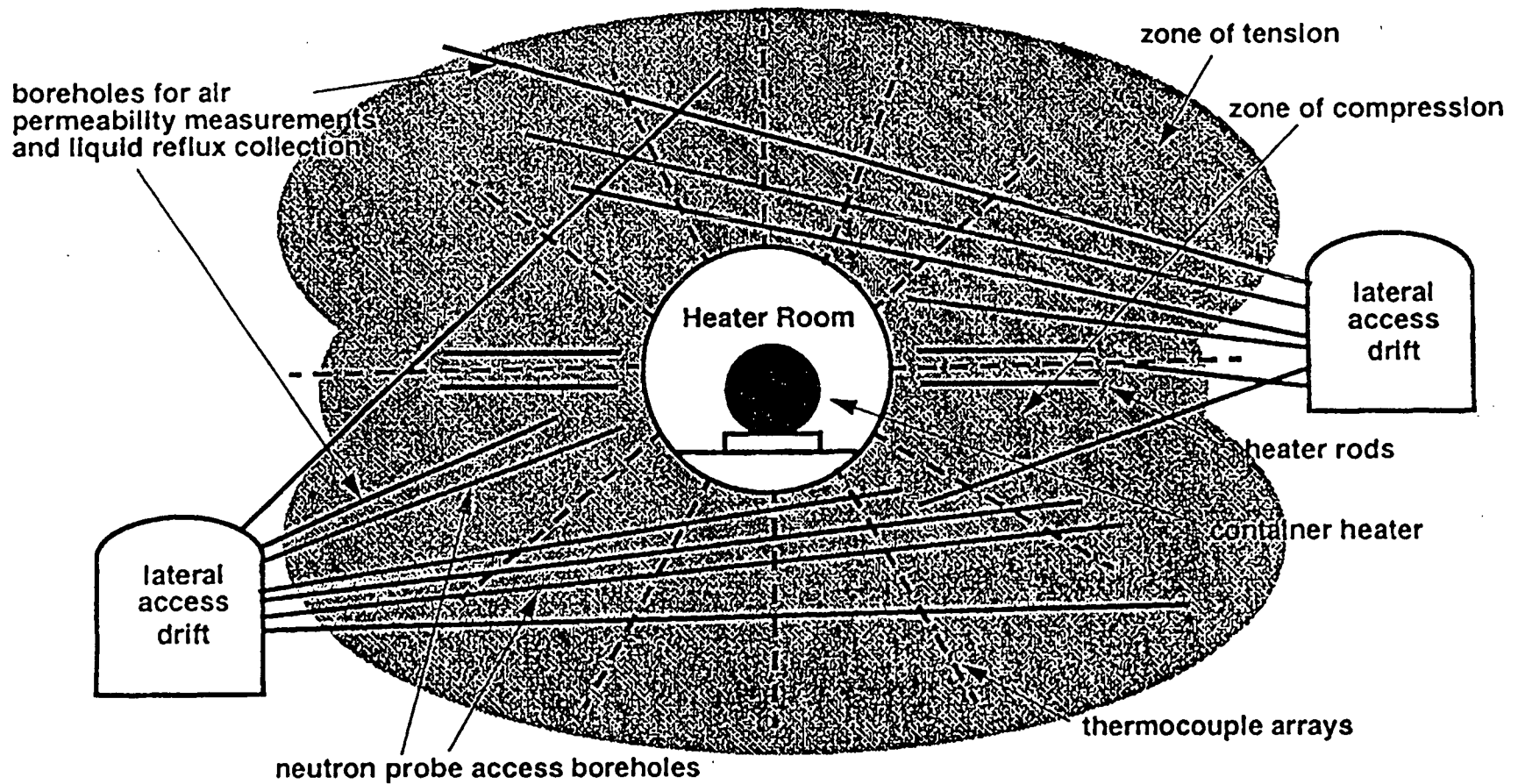
Heated Block Test



Information Need Satisfied By Heated Block Test

Information Needs	Heated Block Test
Rock mass properties	
• Thermal capacity or specific heat	Secondary
• Thermal conductivity	Secondary
• Thermal expansion	Primary
• Deformation modulus	Primary
• Strength	Primary
Properties of fractures over a range of temperature	
• Normal and shear compliance of fractures	Primary
• Shear strength	Primary
• Cohesion	Primary

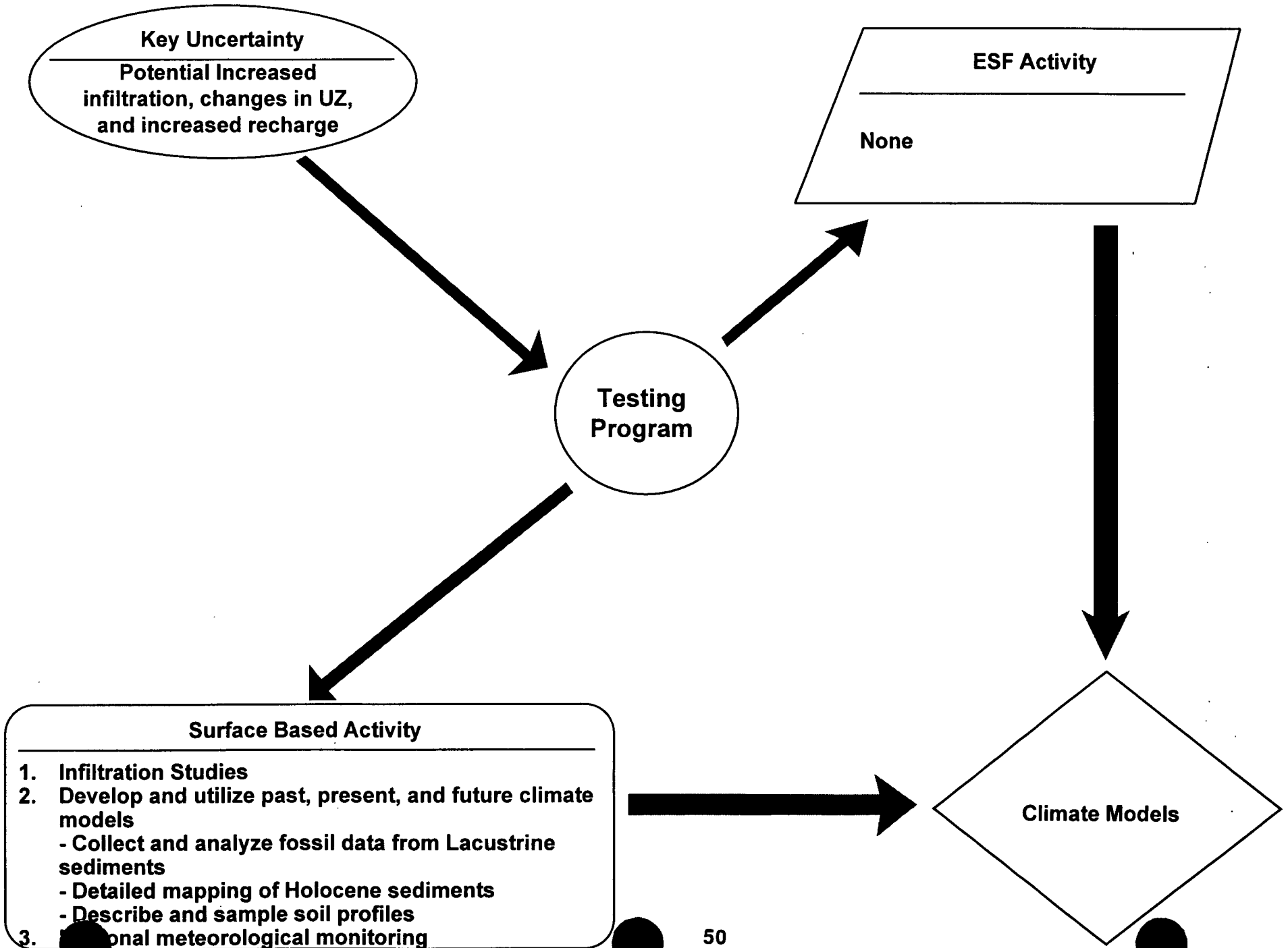
Room Scale Thermal Test



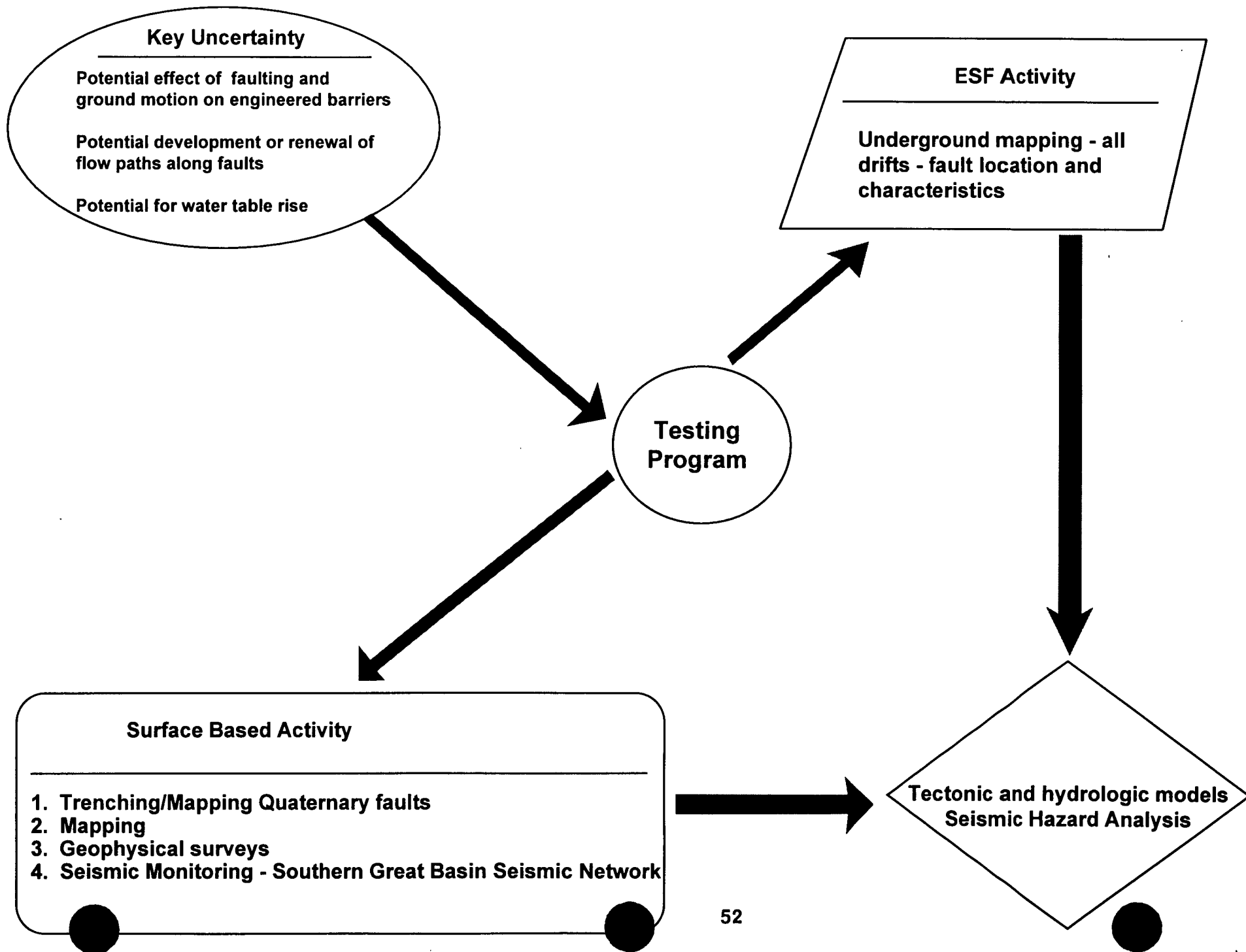
Information Need Satisfied By Room Scale Heater Test

Information Needs	Room Scale Heater Test
Rock mass properties	
Thermal capacity or specific heat	Secondary
Thermal conductivity	Secondary
Thermal expansion	Secondary
Strength	Primary
Drift response/stability under thermal conditions	Primary
Ground support and design features interactions at elevated temperature	
Rock mass-ground support interaction	Primary
Effect of materials on near-field water chemistry	Primary
Effect of near-field environment on ground support components	Primary
Near-field T-M-H-C environment	Primary
Changes in rock saturation	Primary
Drift humidity	Primary
Water chemistry (liquid reflux)	Primary
Propagation of "drying front" (heterogeneity)	Primary
Residual water saturation in "dry zone"	Primary
Reflux of liquid by fracture flow (heterogeneity)	Primary
Rock mass and fracture permeability changes (induced by construction and thermal load)	Primary
Conductive/convective heat transfer	Primary
T-H properties of backfill	Primary
In situ WP material corrosion rates	Primary

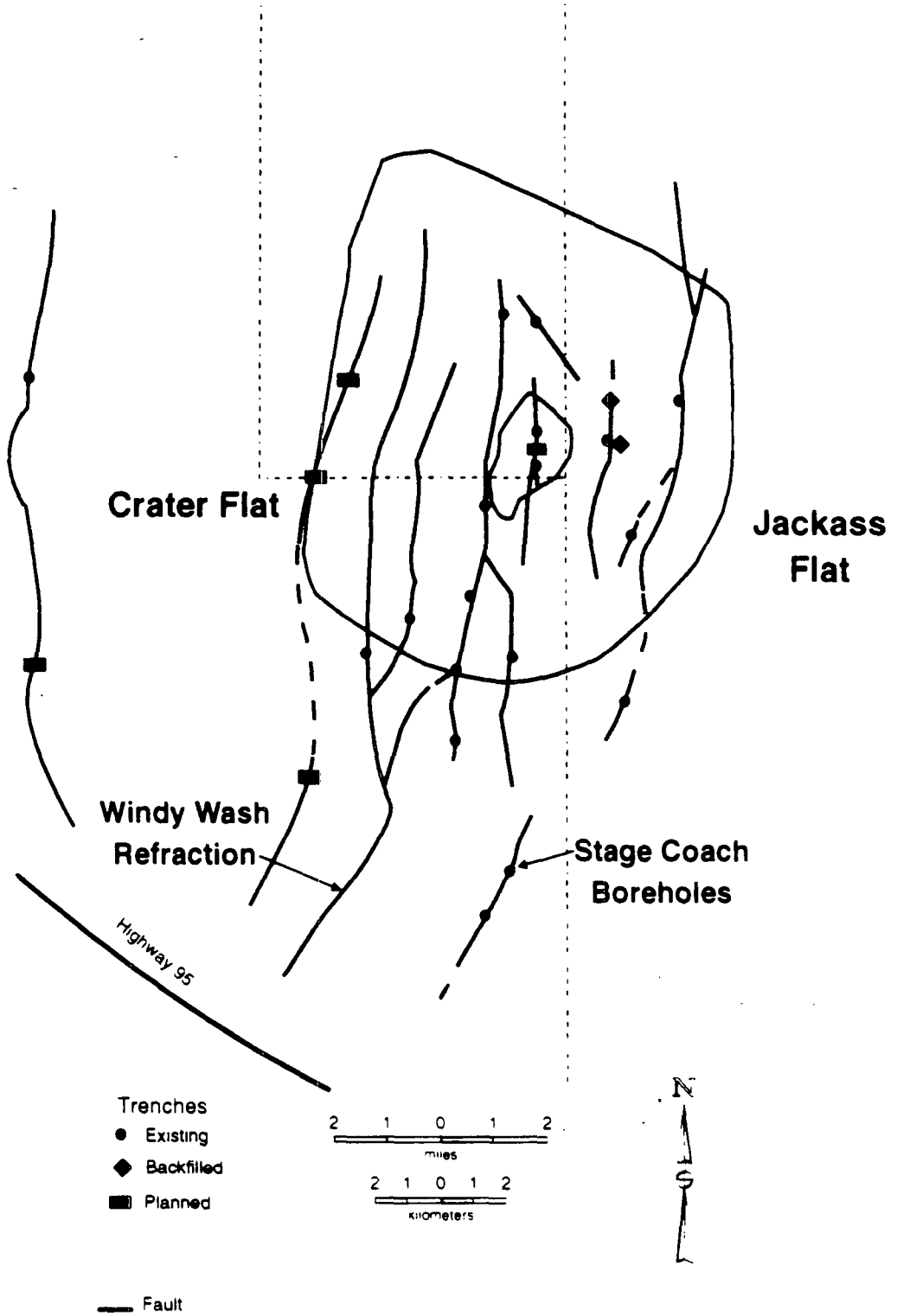
Effects of Future Climate Changes



Effects of Tectonic Events



Faults And Trenches At Yucca Mountain

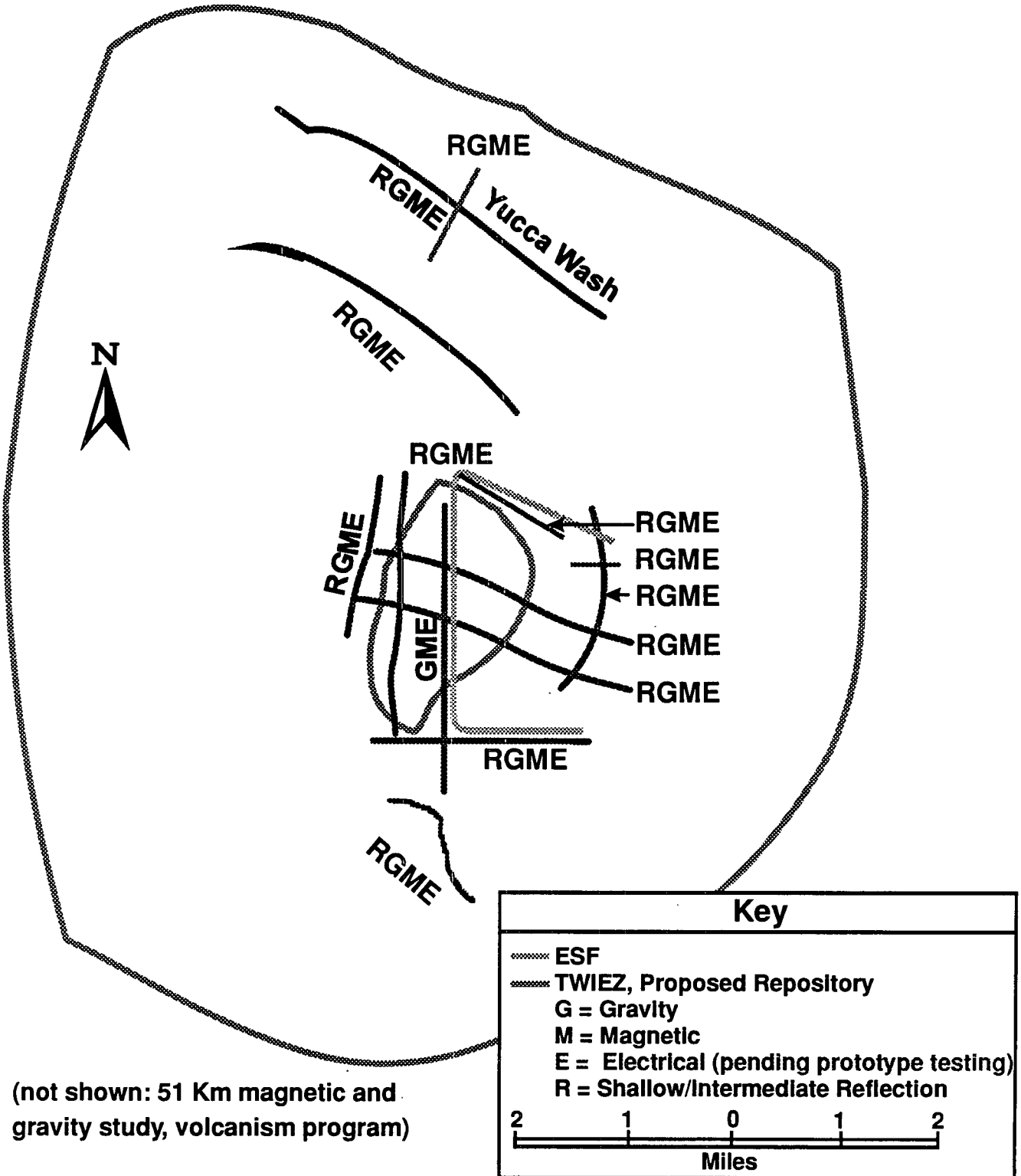


SURFACE GEOLOGY MAPPING

- | | |
|-----------------|--|
| Pre 1992 | Scott and Bonk |
| 1992-94 | Detailed mapping along Ghost Dance Fault; pavements; sub regional (tectonics) |
| 1995 | Structural Map, central repository block
Integration of Remote Sensing data sources, lineament map for repository area
Incorporation existing surface geologic maps into site area 3D model |
| 1996 | Enhancement of Scott and Bonk, updated structure for Repository Area
Compiled surface geology for site Area (Bare Mountain to Jackass Flats) |
| 1999 | Updated Surface geologic maps and incorporation in site area integrated 3D model |

SCHEMATIC MAP

1995 GEOPHYSICS PROGRAM

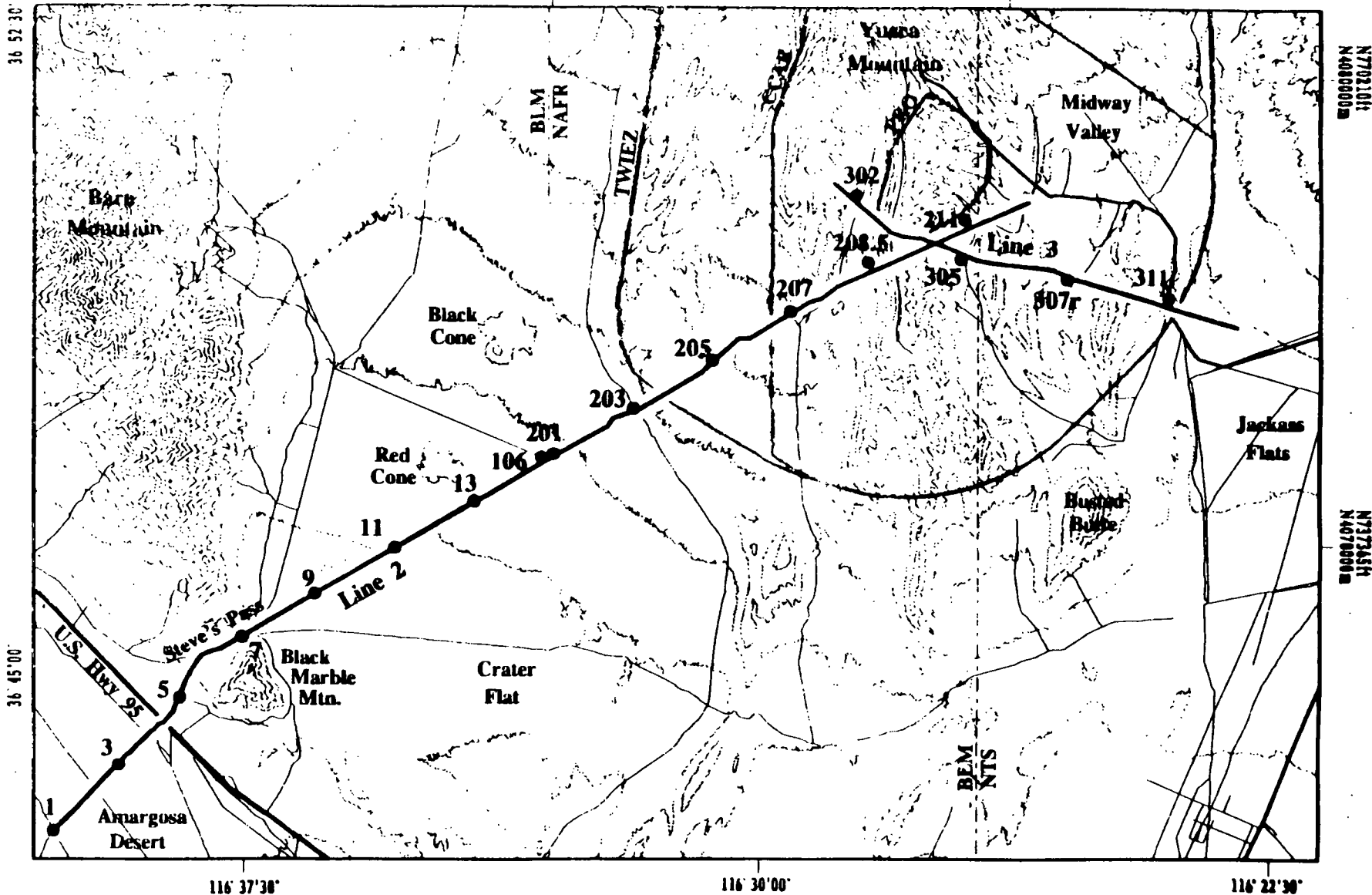


55

(not shown: 51 Km magnetic and gravity study, volcanism program)

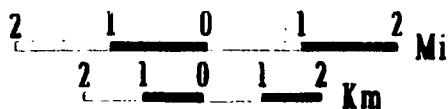
E53384011
E540000m

E56668011
E550000m



LEGEND

- Proposed Shothole
- Proposed Seismic Reflection Line



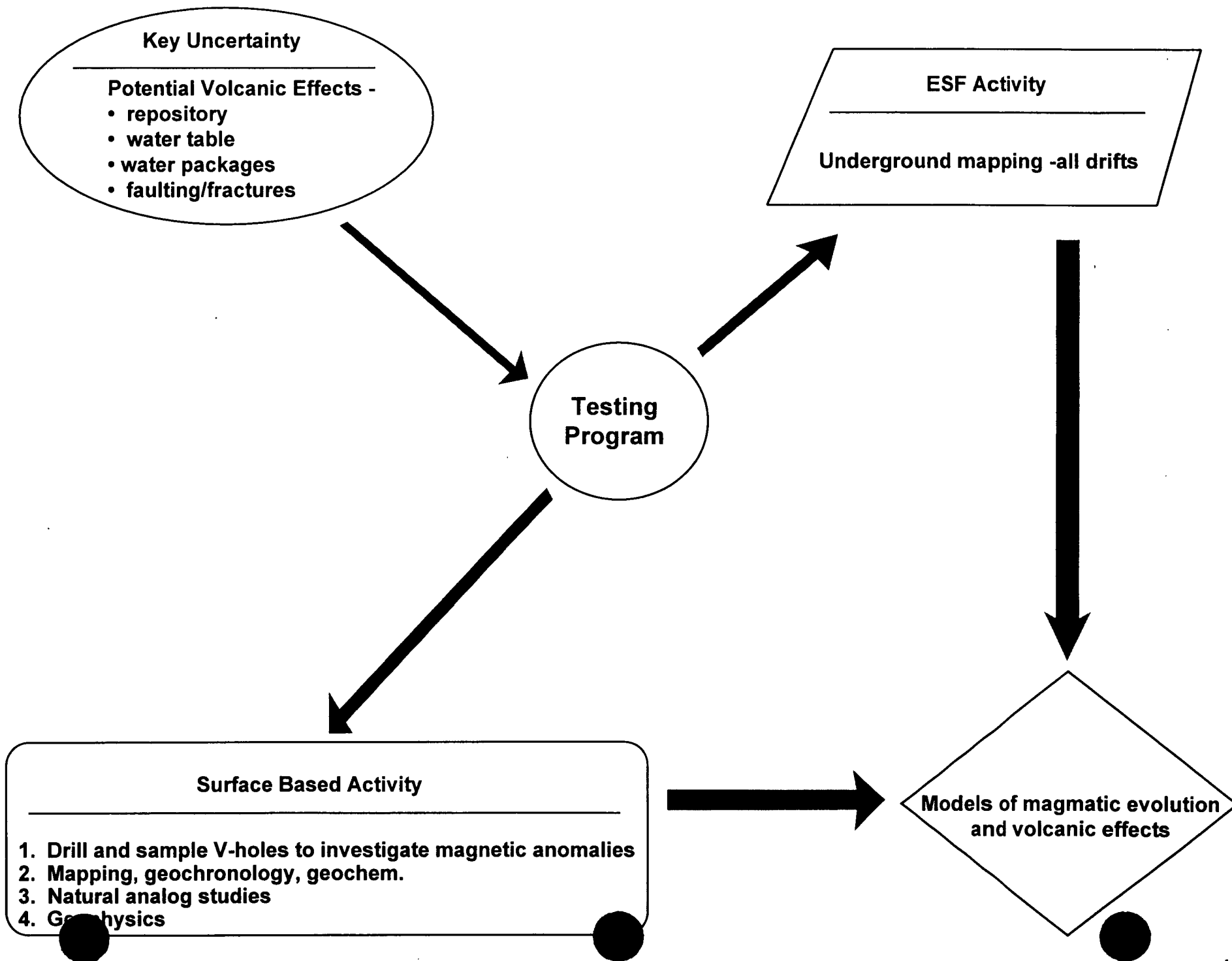
Contour Interval 54

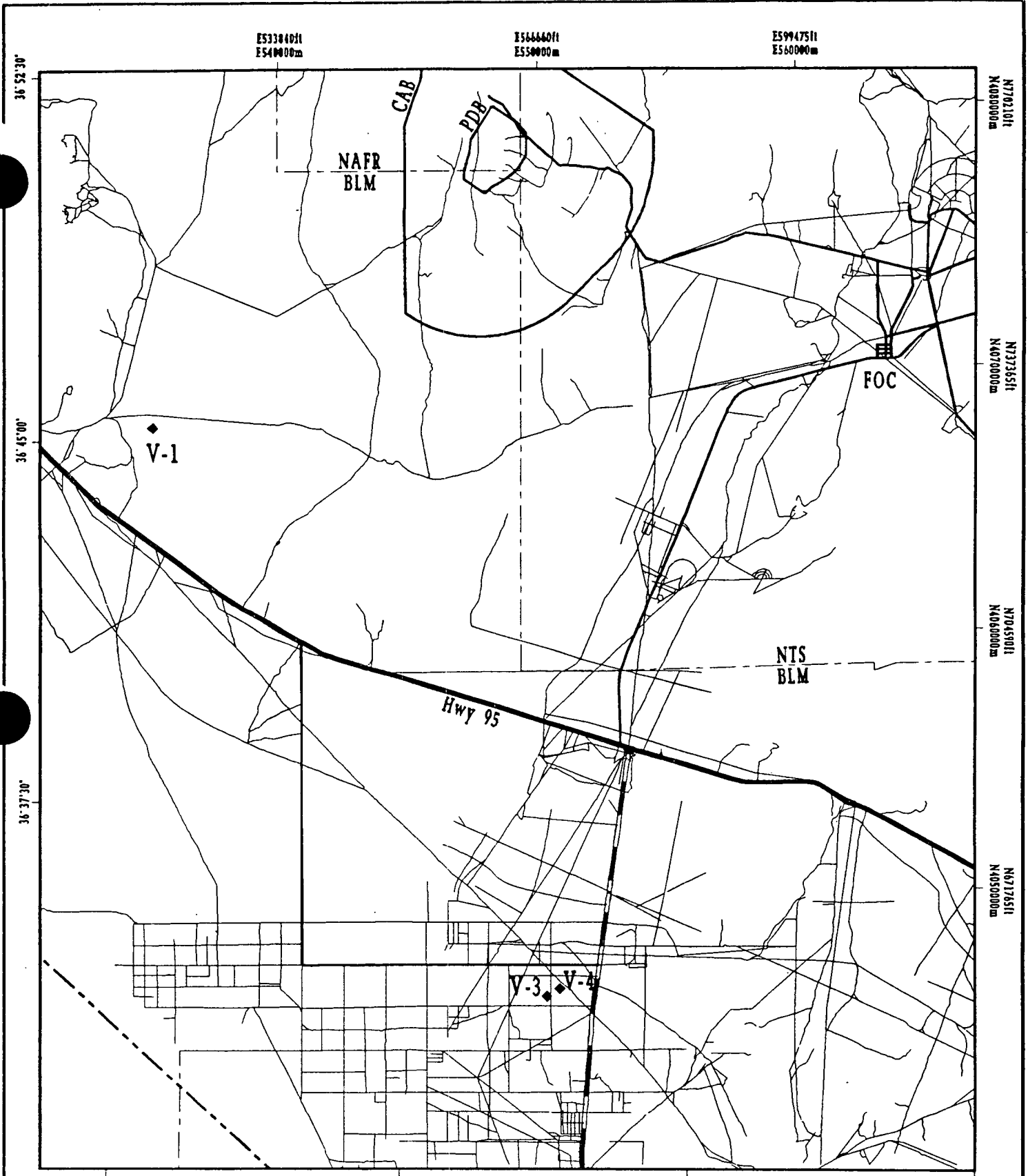
**YUCCA MOUNTAIN
SITE CHARACTERIZATION PROJECT
PROPOSED SEISMIC REFLECTION LINES**



TMP-94-21

Effects of Volcanism





LEGEND
 ◆ Volcanic Borehole



**YUCCA MOUNTAIN
 SITE CHARACTERIZATION PROJECT
 PLANNED VOLCANIC BOREHOLES**

Human Interference



