

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

**PRESENTATION TO  
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD**

**SUBJECT: HYDROCHEMICAL  
CHARACTERIZATION OF WATER  
IN THE SATURATED ZONE**

**PRESENTER: WILLIAM C. STEINKAMPF**

**PRESENTER'S TITLE  
AND ORGANIZATION: HYDROLOGIST  
U.S. GEOLOGICAL SURVEY  
DENVER, COLORADO**

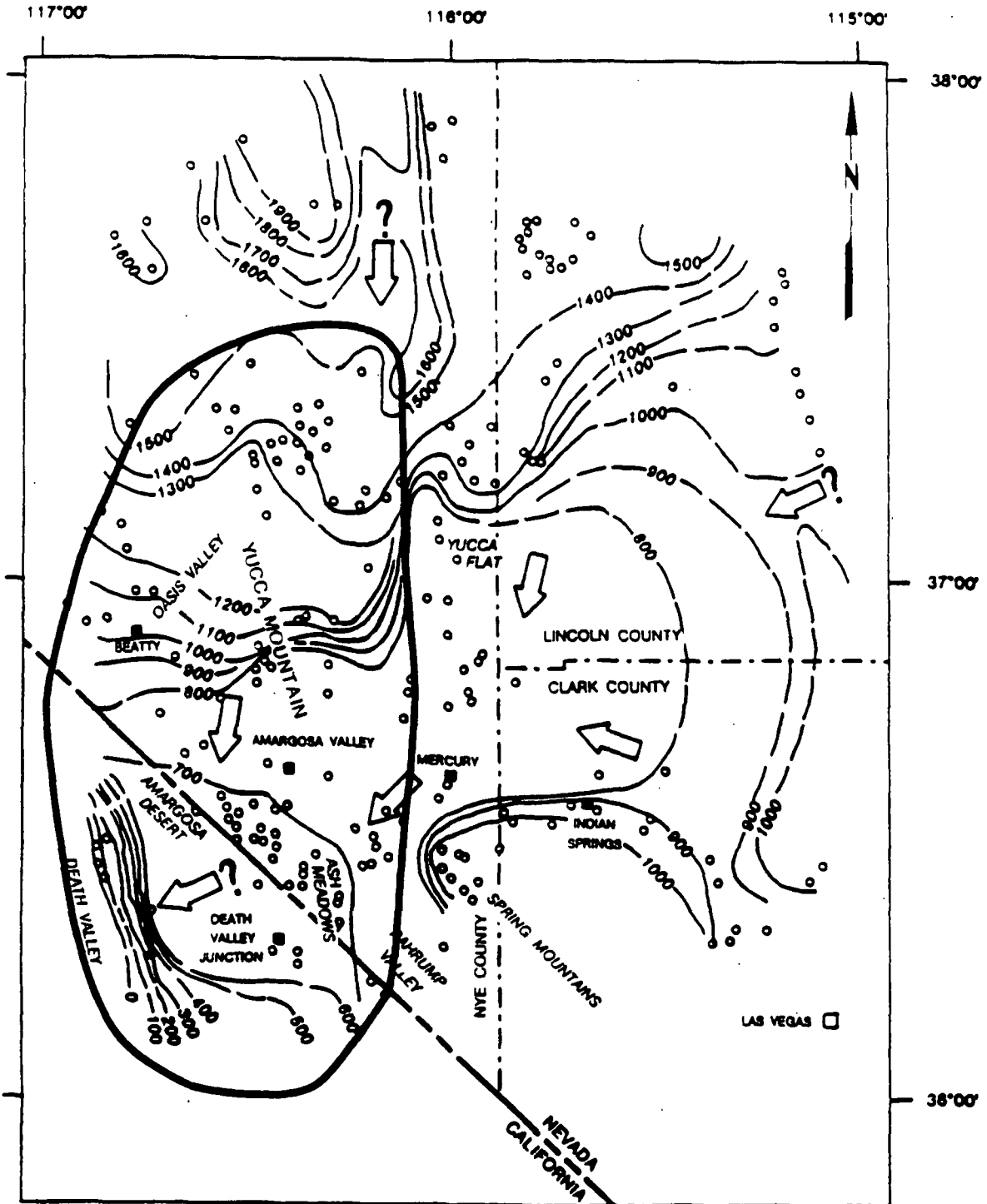
**PRESENTER'S  
TELEPHONE NUMBER: (303) 236-4939**

**REGISTRY HOTEL, DENVER, COLORADO  
JUNE 25-27, 1991**

# OBJECTIVES

- **DESCRIBE SPATIAL HYDROCHEMICAL VARIATIONS IN THE SATURATED ZONE**
- **PROVIDE INFORMATION TO DEFINE CONCEPTUAL GEOHYDROLOGIC MODELS**
- **PROVIDE A BASE OF SATURATED-ZONE HYDROCHEMICAL DATA**

# REGIONAL AREA OF INTEREST



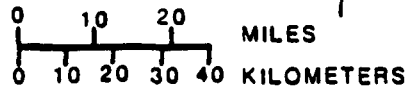
## KEY TO SYMBOLS

— 1200 — LINE OF EQUAL POTENTIOMETRIC LEVEL, IN METERS ABOVE SEA LEVEL. DASHED WHERE INFERRED. CONTOUR INTERVAL 100 M.

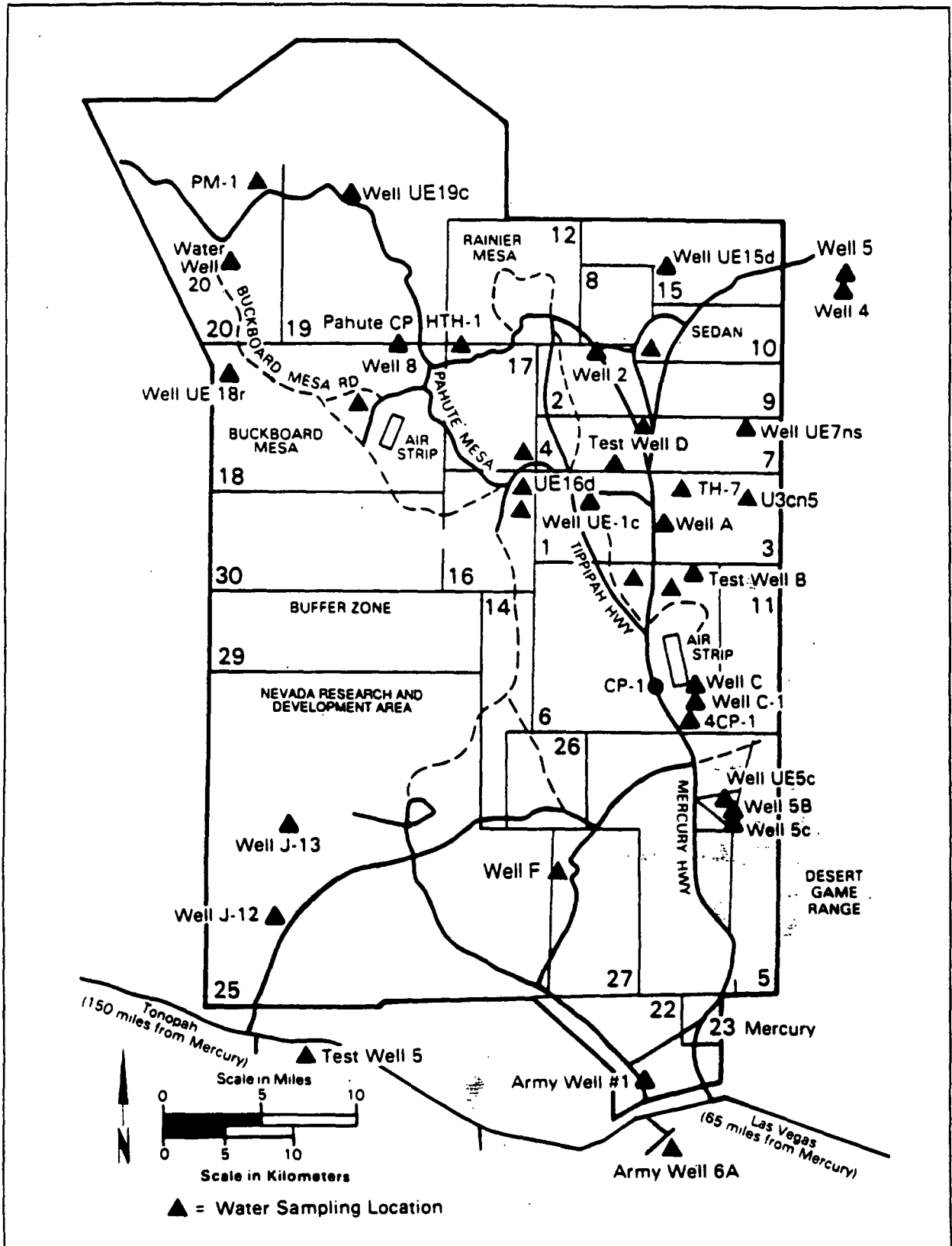


DIRECTION OF GENERAL GROUND-WATER FLOW (QUESTION MARK INDICATES UNCERTAINTY)

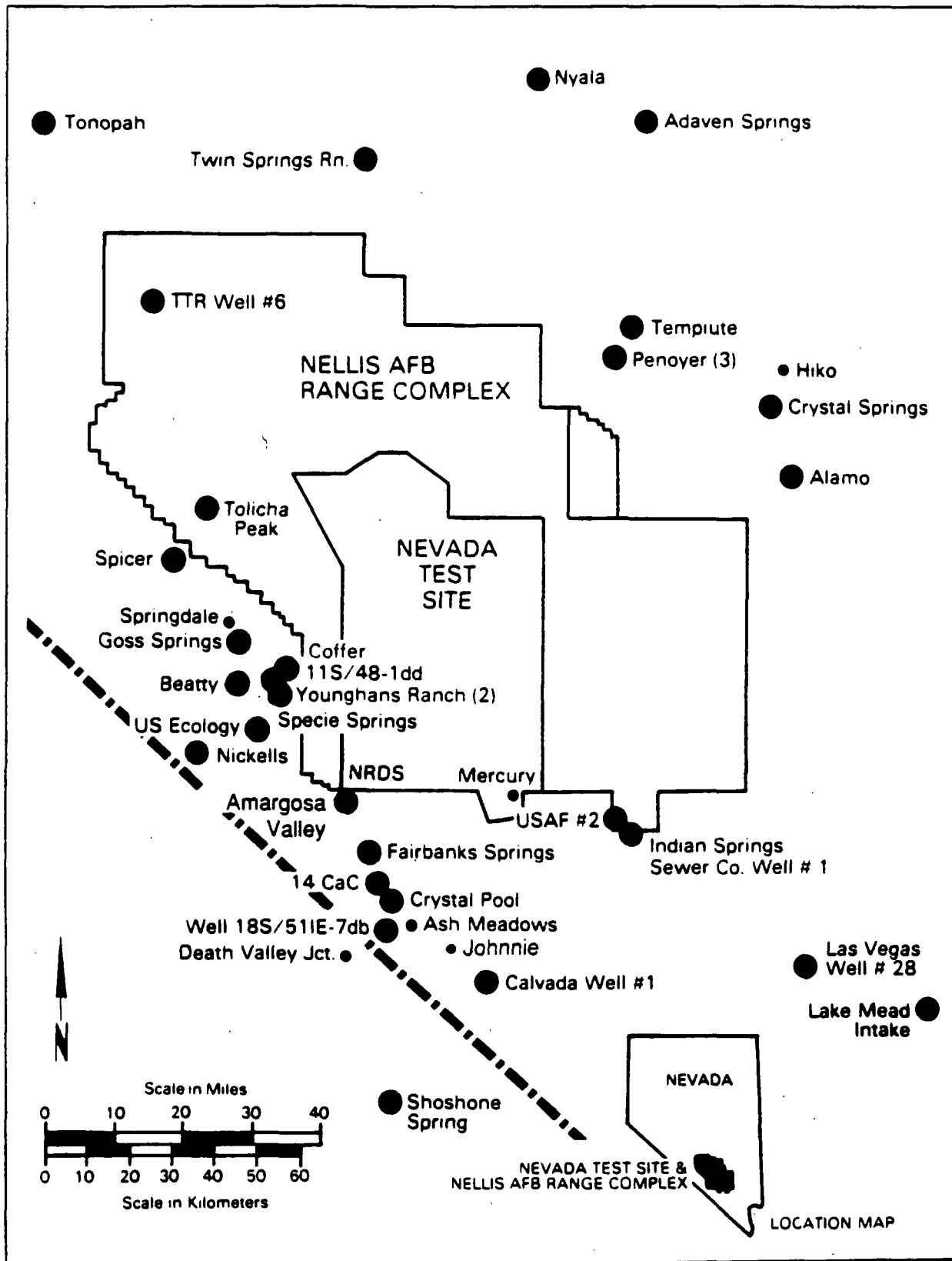
POTENTIOMETRIC-LEVEL CONTROL POINT (WELL OR SPRING) (NOT ALL CONTROL POINTS SHOWN DUE TO SCALE LIMITATIONS)



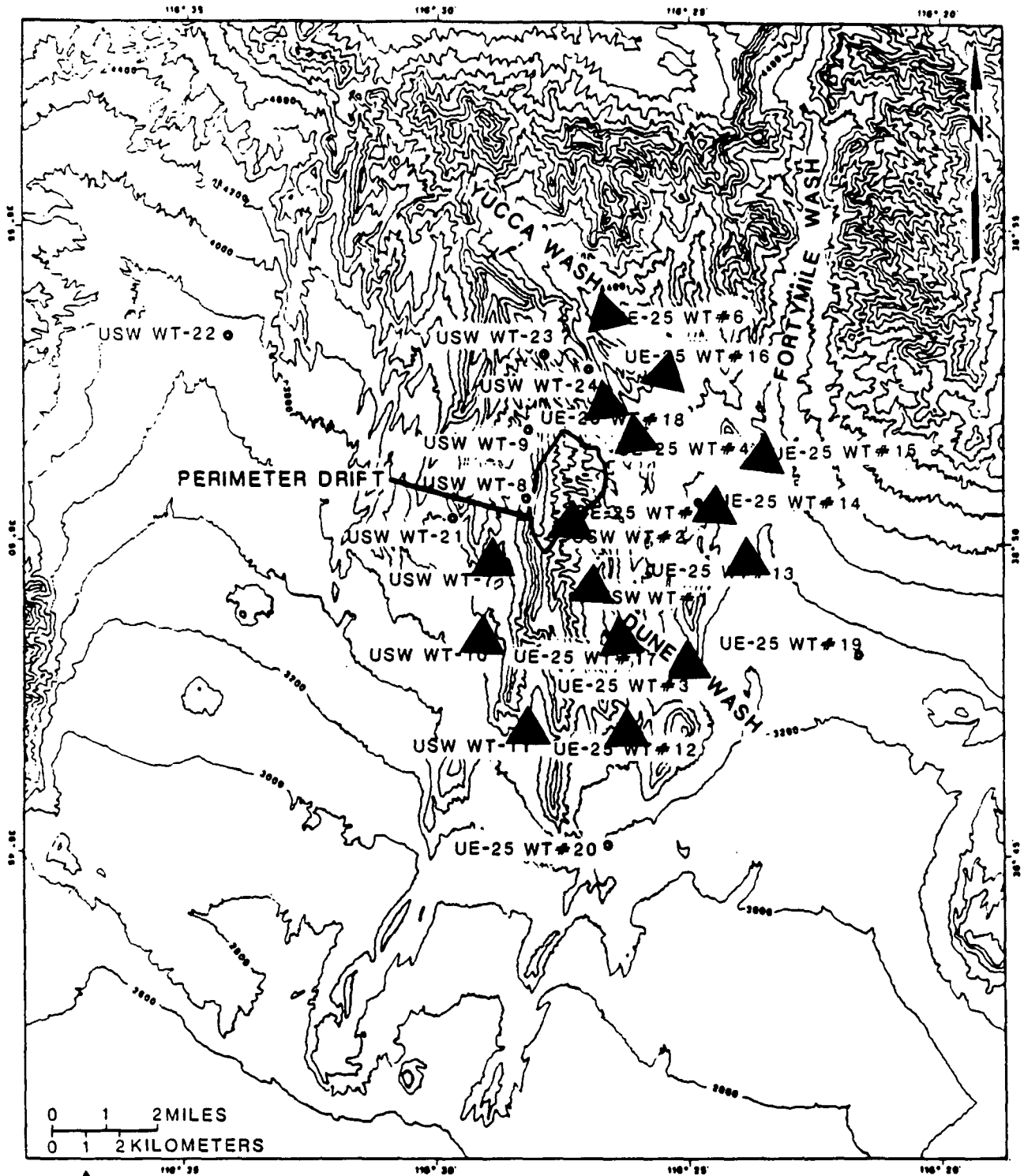
# EPA LTHMP SAMPLING LOCATIONS ON THE NTS



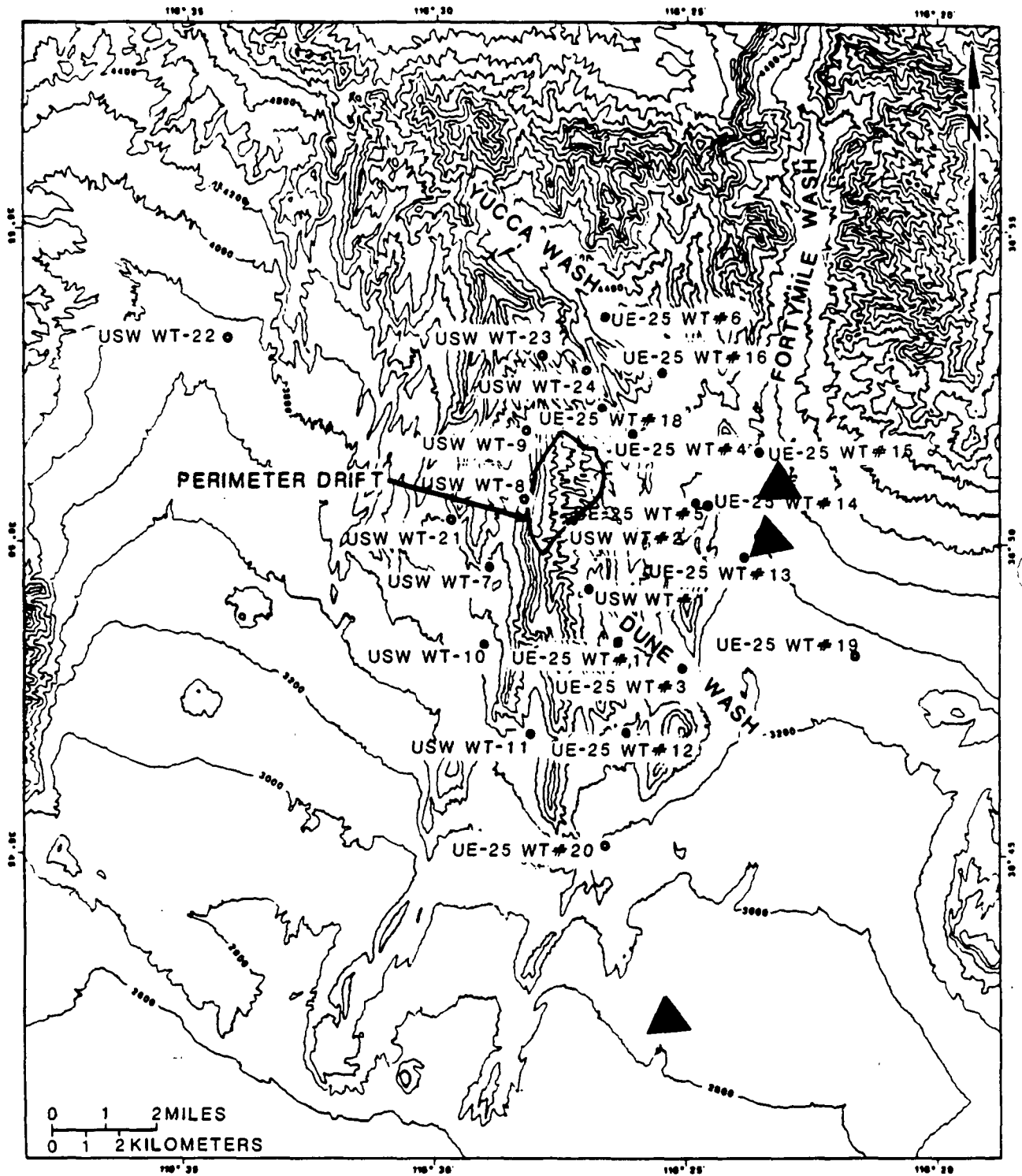
# EPA LTHMP SAMPLING LOCATIONS NEAR THE NTS



# LOCATIONS OF EXISTING WATER-TABLE HOLES

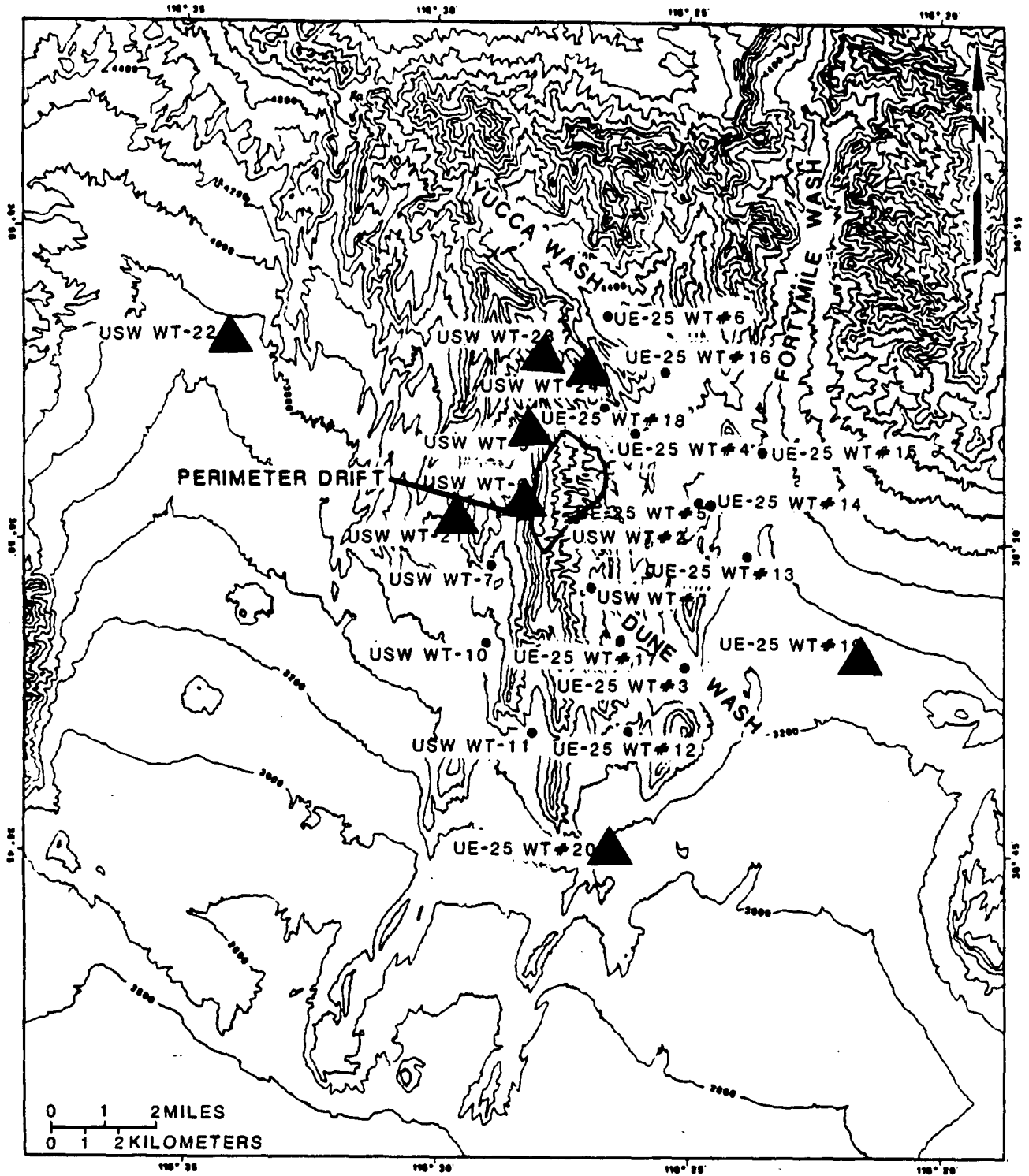


# PROPOSED WATER-TABLE HOLES IN FORTYMILE WASH



● DRILL HOLE  
▲ PROPOSED DRILL HOLE

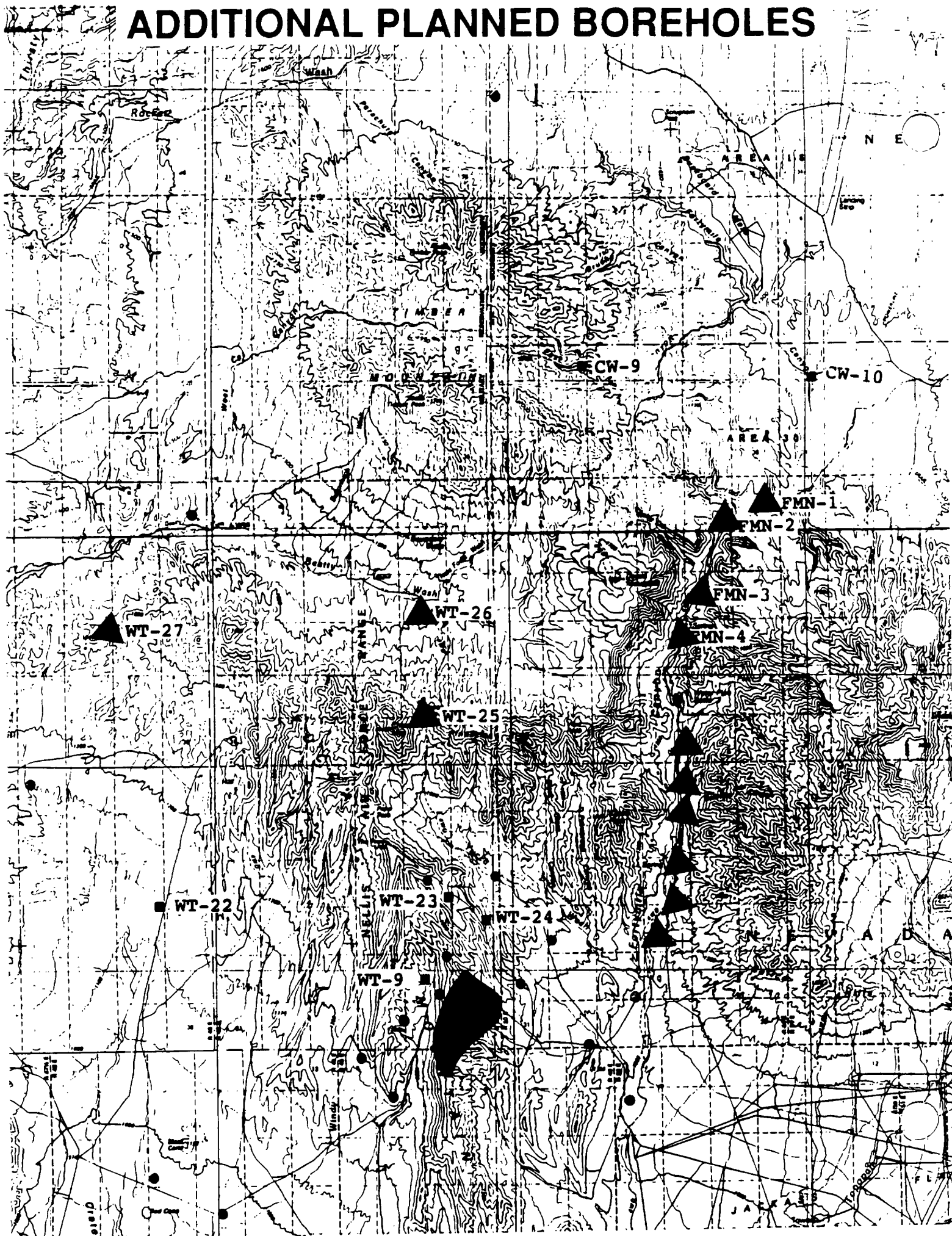
# EIGHT PLANNED WATER-TABLE HOLES DESCRIBED IN THE SCP



● DRILL HOLE  
▲ PROPOSED DRILL HOLE



# ADDITIONAL PLANNED BOREHOLES



# DISSOLVED INORGANIC SPECIES

H																		He	
Li	Be											B	C	N	O	F	Ne		
Na	Mg											Al	Si	P	S	Cl	Ar		
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
Fr	Ra	Ac																	

	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	

# **DISSOLVED INORGANIC SPECIES**

## **INORGANIC CATIONS AND ANIONS**

- **SPATIAL DESCRIPTION**
- **THERMODYNAMIC CALCULATION**
- **CONTAMINATION**
- **GROUND-WATER FLOW PATH AND MIXING**
- **HYDROCHEMICAL EVOLUTION**



# UZ AND DISSOLVED GASES

**GASES (HOH, CO<sub>2</sub>, N, CH<sub>4</sub>, SF<sub>6</sub>, FREON SPECIES,  
NOBLE GASES)**

- **SPATIAL DESCRIPTION**
- **CONTAMINATION**
- **"RECHARGE" TEMPERATURE**
- **FLUXES THROUGH THE UZ**



# ISOTOPIC RATIOS

**ISOTOPIC RATIOS (H, C, O, S, Cl, Sr, NOBLE GASES, Pb, U)**

- **SPATIAL DESCRIPTION**
- **GROUND-WATER FLOW PATH AND MIXING**
- **SOLUTE SOURCES**
- **HYDROCHEMICAL EVOLUTION**
- **FLUX THROUGH THE UZ**

# RADIOISOTOPES

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac															

	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	



# **RADIOISOTOPES**

## **RADIOISOTOPES (H, C, Cl, Kr, Rn, U)**

- **GROUND-WATER AGE**
- **CONTAMINATION**
- **UZ FLUX MECHANISM**
- **HYDROCHEMICAL EVOLUTION**

# **DISSOLVED ORGANIC CARBON (HIGH AND LOW-MOLECULAR-WEIGHT COMPOUNDS)**

- **SPATIAL DESCRIPTION**
- **PALEOCLIMATE**
- **CARBON SOURCES**

# SAMPLING IN WATER-TABLE BOREHOLES

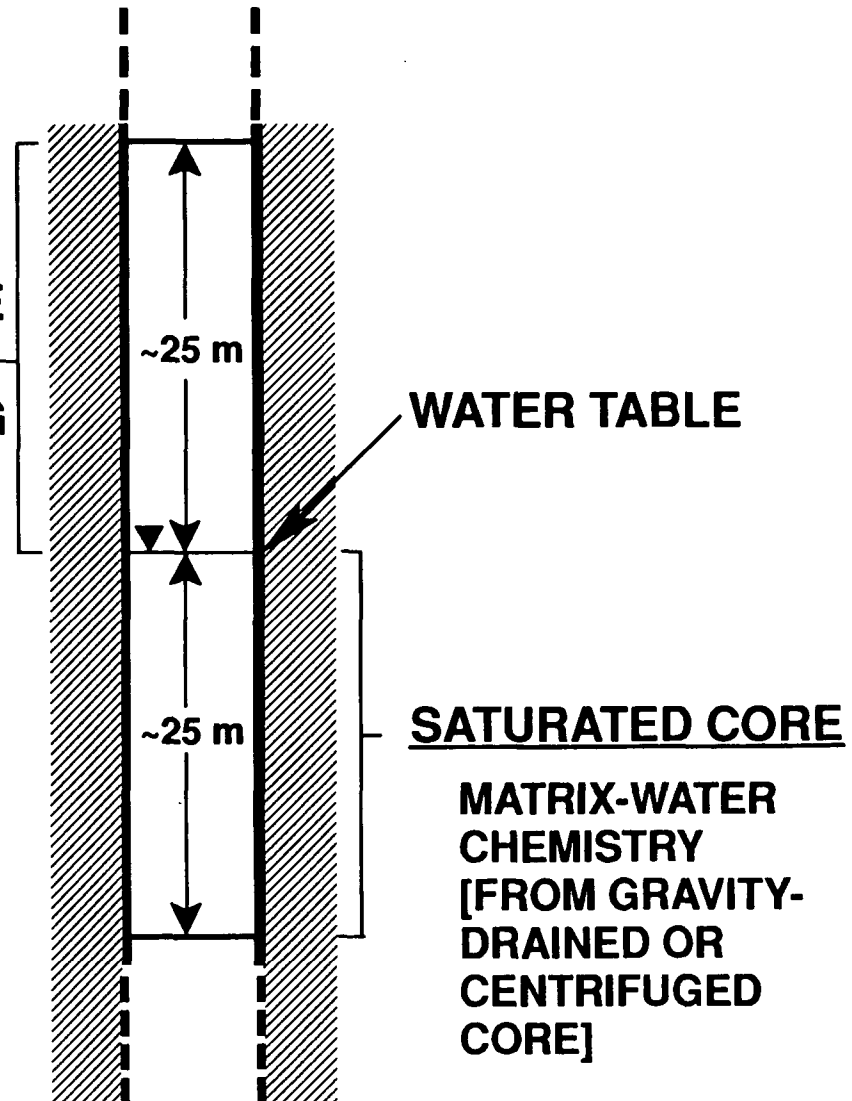
## DRY CORE

- MATRIX-WATER CHEMISTRY

## GAS SAMPLES

- GAS CONCENTRATIONS
- STABLE ISOTOPIC RATIOS [CO<sub>2</sub>, HOH, He, Ne]  
[FRACTIONATION BETWEEN VAPOR AND LIQUID PHASES]
- RADIOISOTOPES [H, C, Kr]

DRY CORE  
& GAS  
SAMPLING

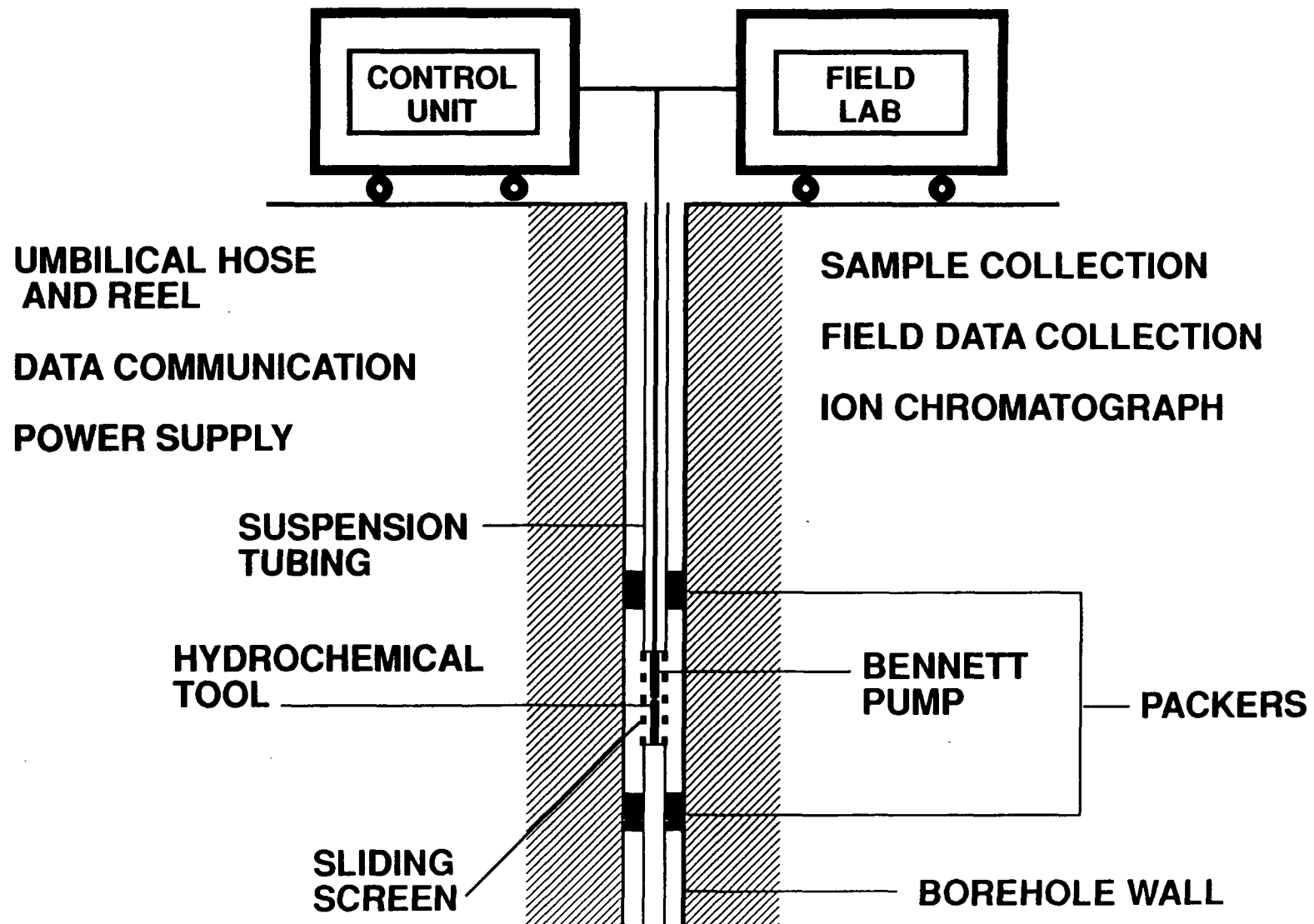


WATER TABLE

SATURATED CORE

MATRIX-WATER  
CHEMISTRY  
[FROM GRAVITY-  
DRAINED OR  
CENTRIFUGED  
CORE]

# SAMPLING & FIELD DATA COLLECTION EQUIPMENT



# WATER-TABLE BOREHOLE SAMPLING EQUIPMENT

