

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

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

**SUBJECT: CALICO HILLS RISK/BENEFIT
ANALYSIS - DESCRIPTION OF
NEEDED INFORMATION AND
ALTERNATE STRATEGIES**

PRESENTER: DAVID C. DOBSON

**PRESENTER'S TITLE
AND ORGANIZATION: CHIEF, REGULATORY INTERACTIONS BRANCH
YUCCA MOUNTAIN PROJECT OFFICE
U.S. DEPARTMENT OF ENERGY**

**PRESENTER'S
TELEPHONE NUMBER: (702) 794-7940**

JULY 24-25, 1990

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

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

**SUBJECT: CALICO HILLS RISK/BENEFIT
ANALYSIS - DESCRIPTION OF
NEEDED INFORMATION AND
ALTERNATE STRATEGIES**

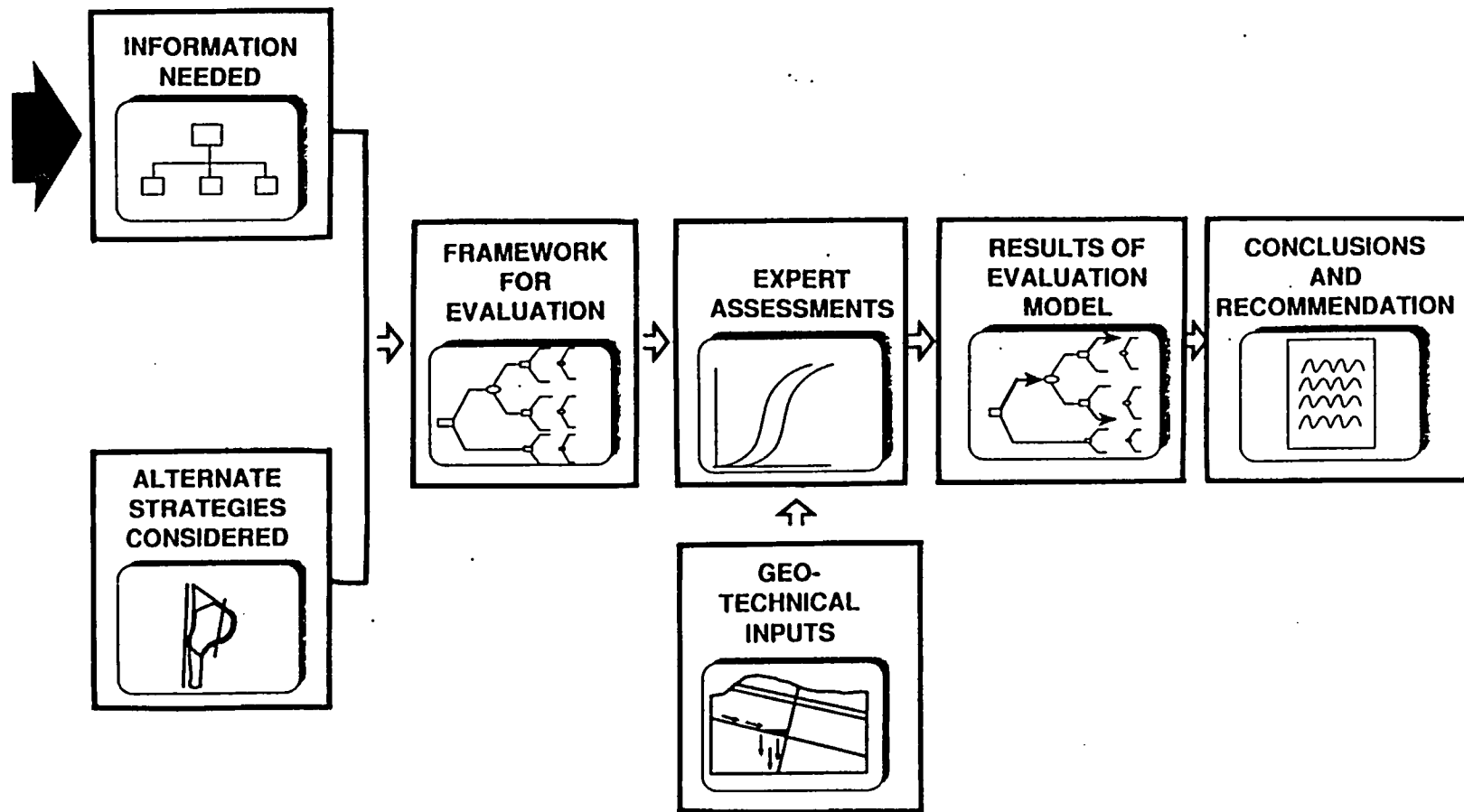
PRESENTER: DAVID C. DOBSON

**PRESENTER'S TITLE
AND ORGANIZATION: CHIEF, REGULATORY INTERACTIONS BRANCH
YUCCA MOUNTAIN PROJECT OFFICE
U.S. DEPARTMENT OF ENERGY**

**PRESENTER'S
TELEPHONE NUMBER: (702) 794-7940**

JULY 24-25, 1990

STRUCTURE OF THE CALICO HILLS RISK/BENEFIT PRESENTATION



DEFINITION OF INFORMATION NEEDS

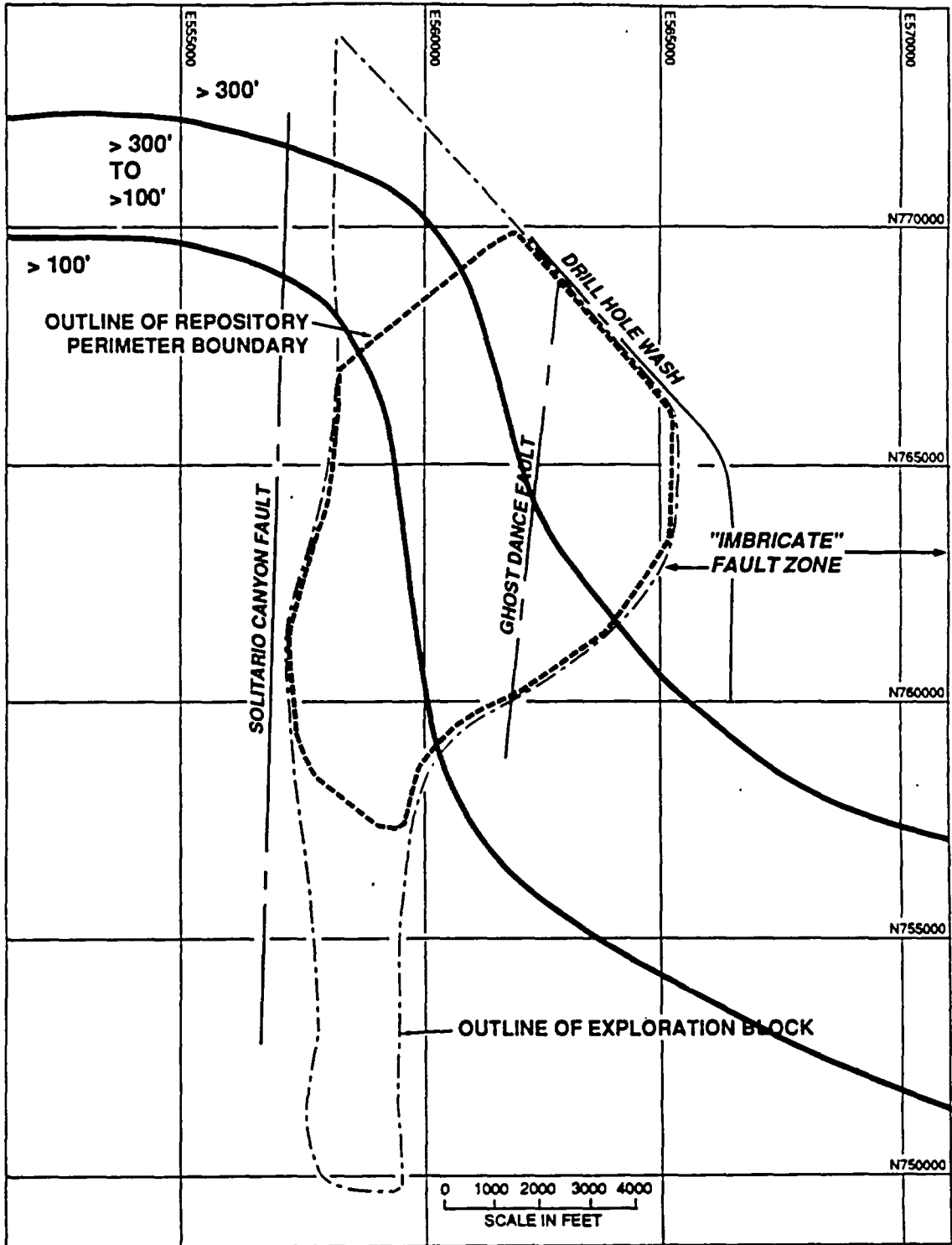
- **A SUBPANEL OF THE TASK GROUP WAS FORMED TO DEFINE INFORMATION NEEDS FROM THE CALICO HILLS NONWELDED (CH_n) HYDROGEOLOGIC UNIT CONSIDERING:**

- **TYPES OF INFORMATION NEEDS (PARAMETERS)**
- **LOCATIONS OF INFORMATION NEEDS (MATRIX vs FAULT ZONES)**
- **SPATIAL CORRELATION OF INFORMATION NEEDS**

INFORMATION NEEDS (TECHNICAL EVALUATION WORKSHEET)

	ROCK INFORMATION: MATRIX PROPERTIES/CONDITIONS	ROCK INFORMATION: FRACTURE PROPERTIES/CONDITIONS (SINGLE FRACTURE)	ROCK INFORMATION: FRACTURE PROPERTIES/CONDITIONS (FRACTURE SYSTEM)	ROCK INFORMATION: FRACTURE FAULT ZONE PROPERTIES/CONDITIONS	ROCK INFORMATION: FRACTURE FAULT SYSTEM GEOMETRY	ROCK INFORMATION: "ANOMALOUS ROCK"	LIQUID WATER INFORMATION	GAS INFORMATION
PARAMETER VALUES: MEAN, STANDARD DEVIATION FOR INDIVIDUAL UNITS								
SPATIAL PARAMETER DISTRIBUTION	HORIZONTAL							
	VERTICAL							
DIRECTIONAL PARAMETER VARIABILITY								
REPRESENTATIVENESS OF INFORMATION								
CORRELATIONS BETWEEN/ AMONG PARAMETERS								

SCHEMATIC MAP OF PROPOSED REPOSITORY AREA SHOWING STRUCTURAL FEATURES AND THICKNESS OF ZEOLITIZED CALICO HILLS UNIT



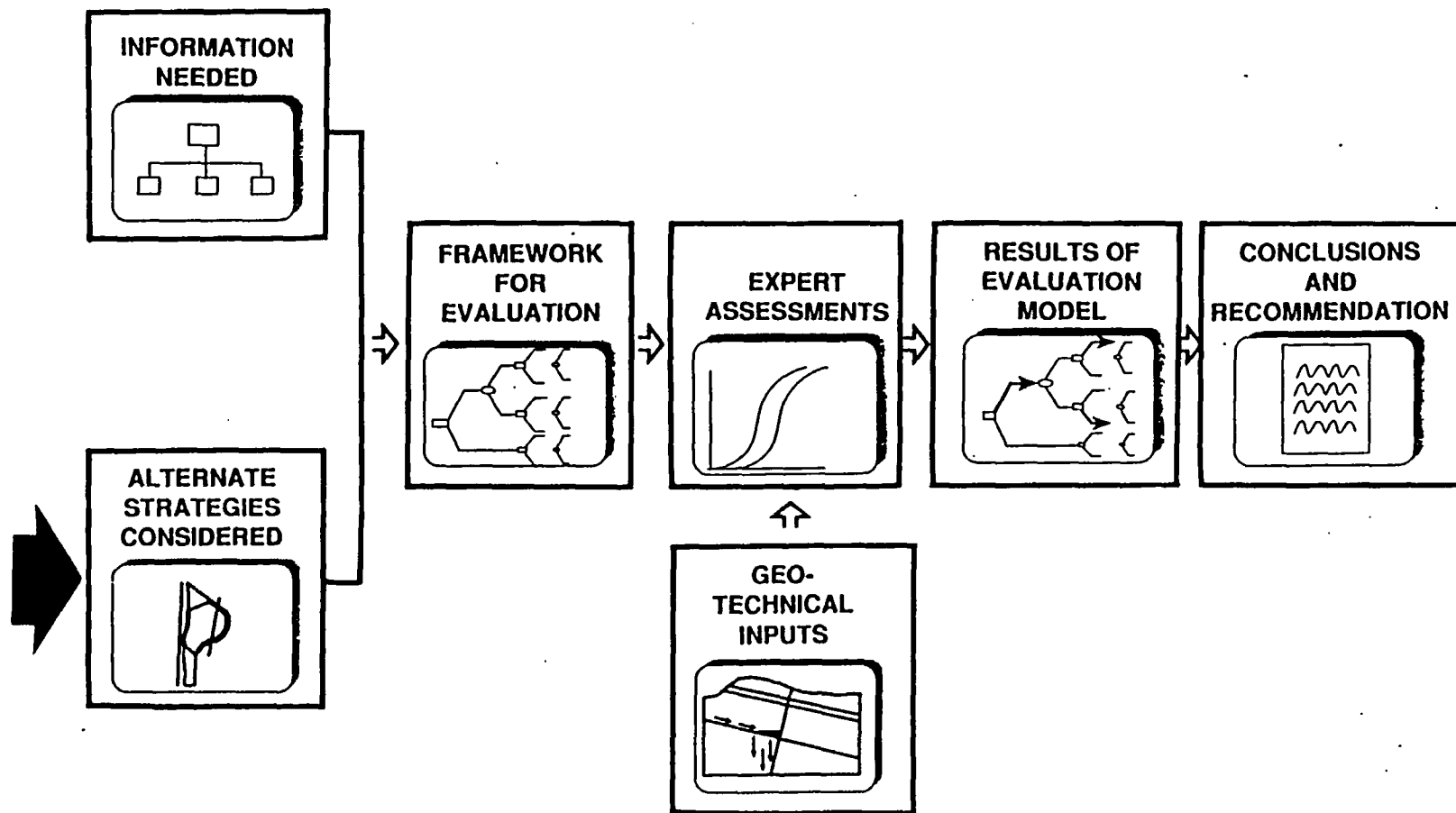
EVALUATION OF TESTING TECHNIQUES

- **THE FULL CHRBA TASK GROUP THEN CONSIDERED HOW WELL VARIOUS TESTING TECHNIQUES COULD PROVIDE THE NEEDED INFORMATION**
 - **TECHNIQUES WERE QUALITATIVELY RANKED AS A BASIS FOR COMPOSING STRATEGIES**

TECHNIQUE EVALUATION EXAMPLE WORKSHEET

		TECHNIQUES CONSIDERED									
		GEOPHYSICS		SB BOREHOLES			U/G BOREHOLES (FROM EXCAVATION)	EXCAVATION			SURFACE STUDIES
		CROSSHOLE; HOLE-TO-SURFACE; SURFACE W/ BOREHOLES	SURFACE, W/OUT SIGNIFI-CANT SUB-SURFACE CONTROL	VERTICAL HOLES (ISOLATED)	ANGLE HOLES	MULTI-WELL CLUSTERS (≥2 HOLES)		SHAFT	DRIFT	RAMP	
ROCK INFORMATION: MATRIX PROPERTIES/ CONDITIONS		L	L	M	H	M	M	M	H	H	L
PARAMETER VALUES: MEAN, STANDARD DEVIATION FOR INDIVIDUAL UNITS		L	L	M	H	M	M	M	H	H	L
SPATIAL PARAMETER DISTRIBUTION	HORIZONTAL	L	L	M	M	M	M	M	H	H	M
	VERTICAL	L	L	M	H	M	M	M	M	M	L
DIRECTIONAL PARAMETER VARIABILITY		L	L	M	M	M	H	M	H	H	L
REPRESENTATIVENESS OF INFORMATION		L	L	M	M	M	M	M	H	H	M
CORRELATIONS BETWEEN/ AMONG PARAMETERS		L	L	M	H	M	H	H	H	H	M

STRUCTURE OF THE CALICO HILLS RISK/BENEFIT PRESENTATION



DESCRIPTION OF ALTERNATE STRATEGIES

- **GIVEN THE DEFINITION OF INFORMATION NEEDS, THE GROUP DEVELOPED A SET OF VARIABLES OR OPTIONS THAT COULD BE USED TO COMPOSE DIFFERENT TESTING STRATEGIES**
- **THE VARIOUS OPTIONS HAD DIFFERENT CHARACTERISTICS WITH RESPECT TO:**
 - **THEIR ABILITY TO PROVIDE DIFFERENT TYPES AND AMOUNTS OF TESTING INFORMATION**
 - **THEIR POTENTIAL IMPACT ON THE PERFORMANCE OF THE SITE**

DESCRIPTION OF ALTERNATE STRATEGIES

- **STRATEGIES DIFFER IN THE TYPE AND AMOUNT OF SURFACE-BASED TESTING**

- **THE SURFACE PROGRAM IN THE SCP WAS INCLUDED IN ALL STRATEGIES**
- **SOME STRATEGIES INCLUDED EXPANDED VERTICAL AND ANGLE BOREHOLE DRILLING FROM BOTH THE SURFACE AND THE MAIN TEST LEVEL**
- **SOME STRATEGIES INCLUDED THE ADDITION OF A SMALL UNDERGROUND FACILITY IN ZEOLITIC CH_n AT A LOCATION NORTH OF YUCCA MOUNTAIN AT PROW PASS**

DESCRIPTION OF ALTERNATE STRATEGIES

(CONTINUED)

- **FOR STRATEGIES WITH UNDERGROUND EXCAVATION IN OR NEAR THE PROPOSED REPOSITORY BLOCK, THE PRINCIPAL VARIABLES WERE:**
 - **AMOUNT OF EXCAVATION (LIMITED vs EXTENSIVE FACILITY)**
 - **CONNECTION WITH THE MAIN TEST LEVEL ESF**
 - **LOCATION OF INITIAL PENETRATION INTO THE CH_n (INCLUDING LOCATIONS OUTSIDE OF THE EXPLORATION BLOCK)**

- **CONSTRAINTS ON POSSIBLE LOCATIONS OF UNDERGROUND FACILITIES WERE IDENTIFIED**
 - **MINIMUM 100 METER THICKNESS FROM BASE OF TOPOPAH SPRING TO WATER TABLE**
 - **FOR "OUTSIDE" STRATEGIES, A MINIMUM OF 2,000 FT FROM EXPLORATION BLOCK**

DESCRIPTION OF ALTERNATE STRATEGIES

(CONTINUED)

- **GIVEN OPTIONS AND CONSTRAINTS, SIX GENERAL AREAS WERE TENTATIVELY IDENTIFIED AS POSSIBLE SITES FOR CHn TEST FACILITY ACCESS**
- **THESE LOCATIONS WERE COMBINED WITH OTHER VARIABLES TO PRODUCE AN INITIAL SET OF 24 UNDERGROUND OPTIONS**

TABLE OF POSSIBLE COMBINATIONS

Location of Initial CH penetration		Extensive, Operational Facility	Integrate Facility w/ ESF U/G Openings	ID #
General Area	Inside/ Outside			
NE	Inside	Yes	Yes	1
			No	2
		No	Yes	3
			No	4
	Outside	Yes	Yes	5
			No	6
		No	Yes	7
			No	8
South	Inside	Yes	Yes	9
			No	10
		No	Yes	11
			No	12
	Outside	Yes	Yes	13
			No	14
		No	Yes	15
			No	16
Central	Inside	Yes	Yes	17
			No	18
		No	Yes	19
			No	20
West	Outside	Yes	Yes	21
			No	22
		No	Yes	23
			No	24

DESCRIPTION OF ALTERNATE STRATEGIES

- **THE FULL TASK GROUP THEN SCREENED AND AGGREGATED OPTIONS**
 - **OPTIONS WERE QUALITATIVELY RANKED IN TERMS OF THEIR POTENTIAL IMPACT ON PERFORMANCE AND POTENTIAL TO PROVIDE TEST INFORMATION**

SCREENED CONFIGURATIONS

LOCATION OF CH PENETRATION		EXTENSIVE, FACILITY	INTEGRATE w/ ESF OPENINGS	POTENTIAL IMPACT	TEST UTILITY
GENERAL AREA	INSIDE/ OUTSIDE				
NE	INSIDE	YES	YES		
		NO	YES		
	OUTSIDE	YES	NO		
		NO	NO		
SOUTH	INSIDE	YES	YES		
		NO	YES		
	OUTSIDE	YES	NO		
		NO	NO		
CENTRAL	INSIDE	YES	YES		
		NO	YES		
WEST	OUTSIDE	YES	NO		
		NO	NO		

DESCRIPTION OF ALTERNATE STRATEGIES

SEVERAL POSSIBLE OPTIONS WERE SCREENED OUT

- ALL "OUTSIDE" OPTIONS CONNECTED WITH ESF WERE ELIMINATED
 - EXTENDS BOUNDARY OF FACILITY

- ALL "INSIDE" OPTIONS NOT CONNECTED WITH ESF WERE ELIMINATED
 - REDUCE USABLE AREA
 - EXTRA PENETRATION FROM SURFACE THROUGH REPOSITORY HORIZON

DESCRIPTION OF ALTERNATE STRATEGIES

(CONTINUED)

- **NE "OUTSIDE" OPTION WAS ELIMINATED BECAUSE THE AVAILABLE THICKNESS OF CH_n LIMITED TEST UTILITY**
- **WEST "OUTSIDE" OPTION WAS ELIMINATED DUE TO UNCERTAINTY REGARDING REPRESENTATIVENESS**
- **CENTRAL INSIDE OPTION WAS ELIMINATED BECAUSE OF POTENTIAL REDUCTION TO USABLE REPOSITORY AREA**

DESCRIPTION OF ALTERNATE STRATEGIES

(CONTINUED)

- **REMAINING OPTIONS WERE COMBINED WITH VARIOUS SURFACE-BASED TESTING OPTIONS TO CREATE EIGHT STRATEGIES FOR EVALUATION**
- **THE EIGHT STRATEGIES REPRESENT AN APPROPRIATE RANGE OF POSSIBILITIES IN TERMS OF THE VARIABLES DEFINED**

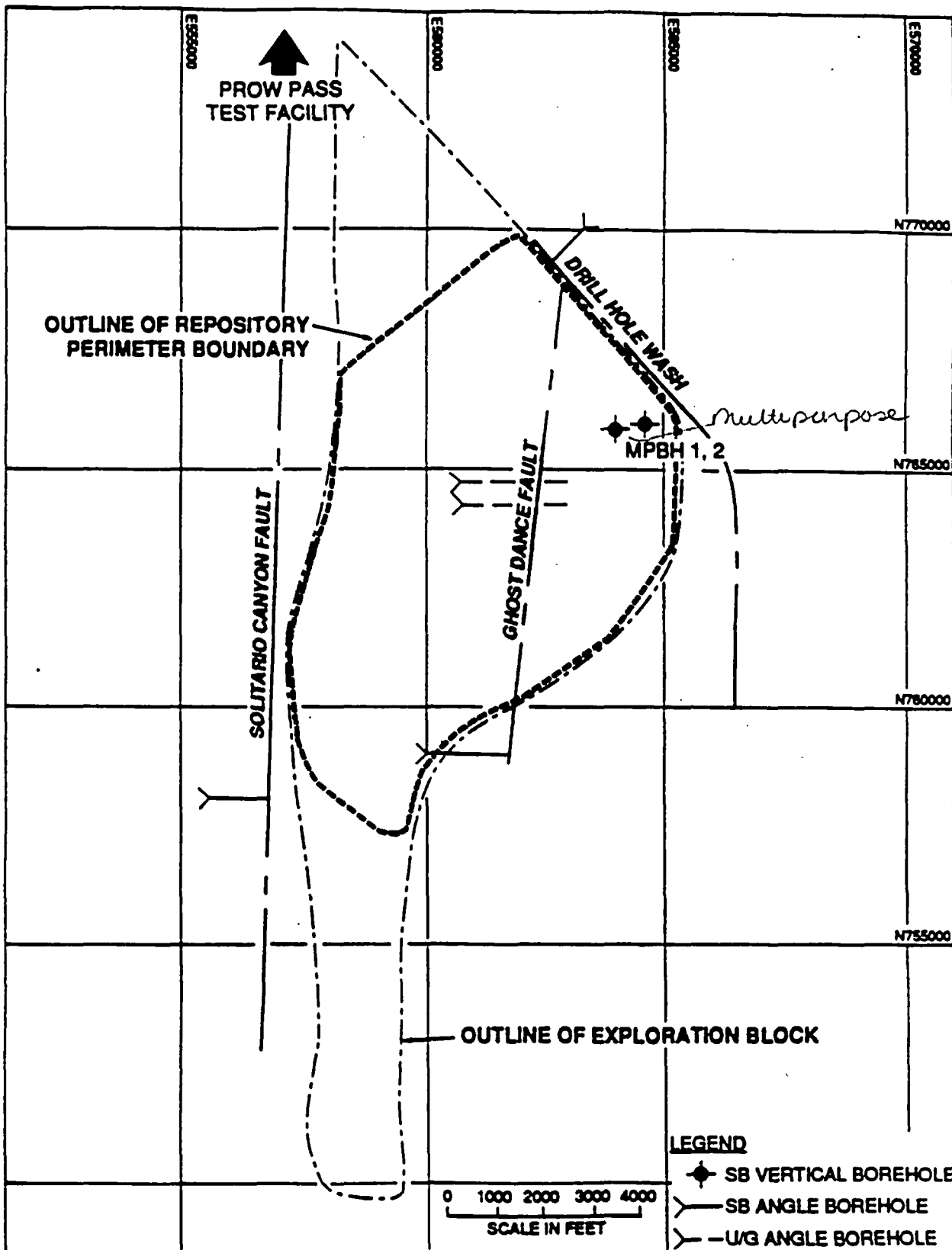
TESTING PROGRAM PLANNED FOR STRATEGIES WITH UNDERGROUND EXCAVATION IN THE CHn

- **PROGRAM BASED ON THE ORIGINAL CONSULTATION DRAFT SCP:**
 - **PHOTOGRAMMETRIC MAPPING**
 - **SAMPLING OF WALL ROCK (HYDROLOGY, GEOCHEMISTRY, GEOLOGY, ENGINEERING PROPERTIES)**
 - **PILOT BOREHOLE (ACCESS SHAFT)**
 - **HYDROLOGIC TESTING IN ACCESS SHAFT/RAMP (e.g., RADIAL BOREHOLE TEST)**
 - **EXPLORATORY DRILLING FROM UNDERGROUND OPENINGS**
 - **HYDROLOGIC TESTS OF MAJOR FEATURES INTERSECTED BY DRIFTS**

- **ADDITIONAL STUDIES ASSUMED FOR EXTENSIVE FACILITIES:**
 - **BULK PROPERTIES EXPERIMENTS (e.g., BULK PERMEABILITY TEST)**
 - **PERCOLATION/TRANSPORT EXPERIMENT (e.g., INFILTRATION TEST)**

STRATEGY NO. 6

ADDITIONAL SURFACE-BASED TESTING (WITH U/G DRILLING FROM THE ESF MTL)



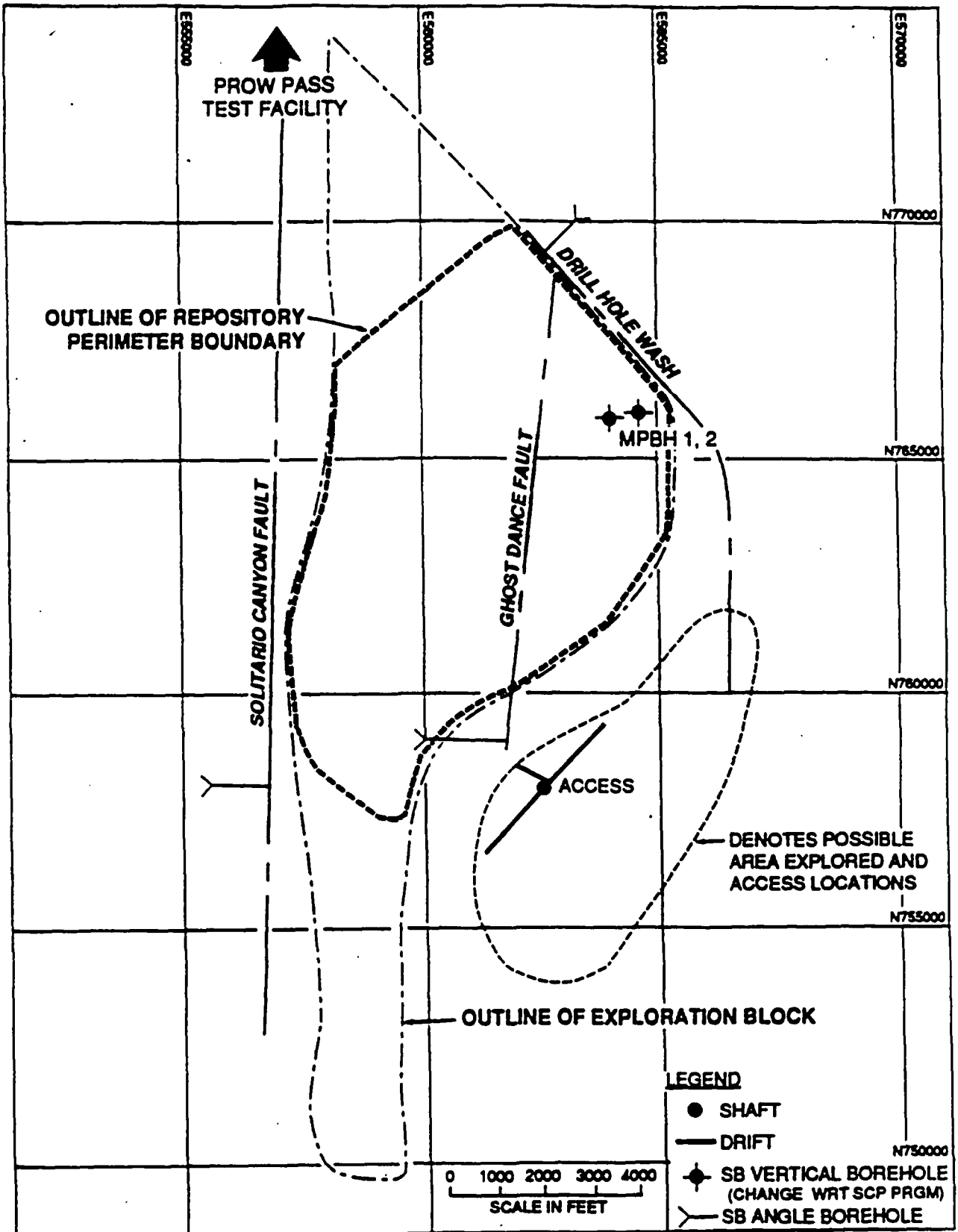
CALICO HILLS STRATEGIES

STRATEGY #6

- **ACTIVITIES LIMITED TO DRILLING FROM THE SURFACE AND FROM THE ESF MAIN TEST LEVEL**
- **ANGLED DRILLHOLES (UP TO 35 DEGREES FROM VERTICAL) FOR FAULT EXPLORATION**
- **PROW PASS TEST FACILITY ADDED TO PERMIT DIRECT INVESTIGATION OF FAULTING IN ZEOLITIC FACIES AND TRANSPORT TESTING**
- **GEOPHYSICS TO BE INCLUDED, AS APPROPRIATE**

STRATEGY NO. 8

OUTSIDE; SE; LIMITED FACILITY; NO ESF CONNECTION - ADDITIONAL SBT



CALICO HILLS STRATEGIES

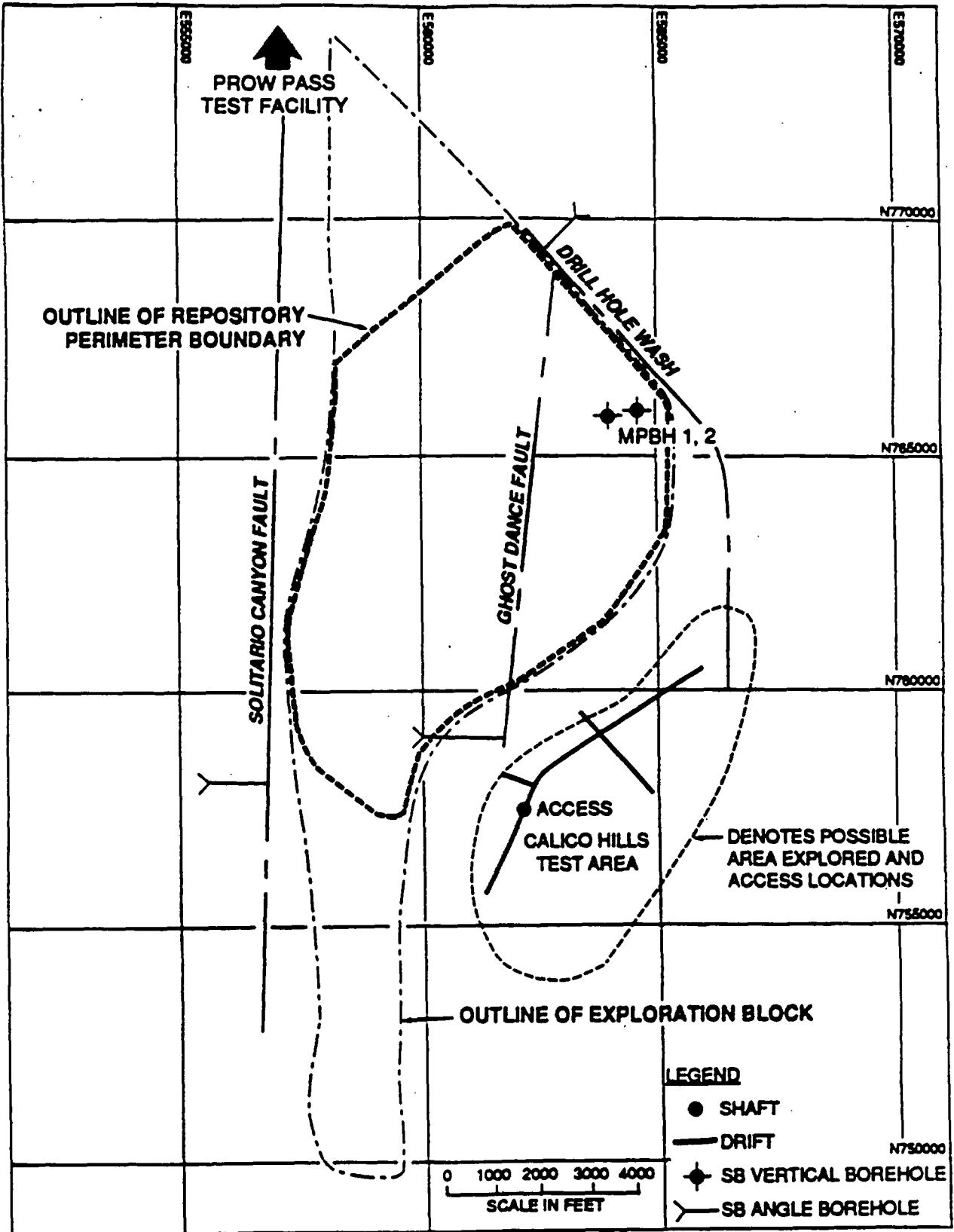
(CONTINUED)

STRATEGY #8

- **ATTEMPT TO USE EXCAVATION TO COLLECT DATA WHILE MINIMIZING POSSIBLE IMPACTS TO WASTE ISOLATION**
- **DRIFTS WOULD EXPLORE THE SOUTHERN EXTENSION OF THE GHOST DANCE FAULT (OR RELATED FAULTS)**
- **INCLUDE ADDITIONAL SBT (IN ADDITION TO SCP) TO MAXIMIZE INFORMATION WITHOUT EXCAVATION INSIDE THE BLOCK**

STRATEGY NO. 7

OUTSIDE; SE; EXTENDED DRIFTING; NO ESF CONNECTION - ADDITIONAL SBT



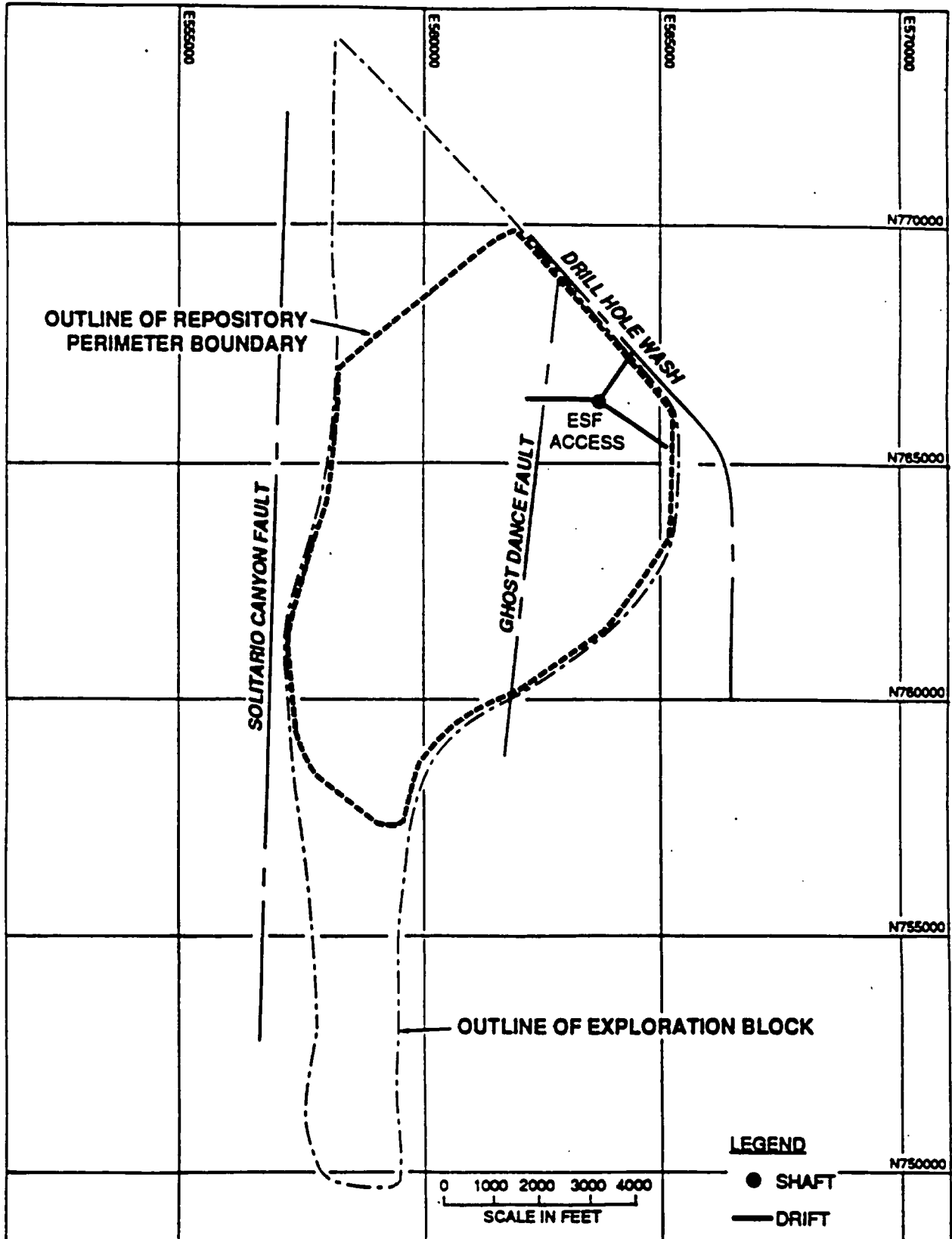
CALICO HILLS STRATEGIES

(CONTINUED)

STRATEGY #7

- **ATTEMPT TO MAXIMIZE TEST ACCURACY WITHOUT EXCAVATION INSIDE THE REPOSITORY BLOCK**
- **SIMILAR TO #8, BUT WITH EXPANDED EXCAVATION OUTSIDE THE BLOCK TO THE SOUTHEAST**
- **EXTENSIVE EXCAVATION OUTSIDE THE BLOCK EXPLORES FACIES TRANSITION AND THE SOUTHERN EXTENSION OF THE GHOST DANCE FAULT OR RELATED FAULTS)**
- **INCLUDE ADDITIONAL SBT (IN ADDITION TO SCP) TO MAXIMIZE INFORMATION WITHOUT EXCAVATION INSIDE THE BLOCK**

STRATEGY NO. 3
INSIDE; NE; LIMITED FACILITY; INTEGRATED WITH ESF



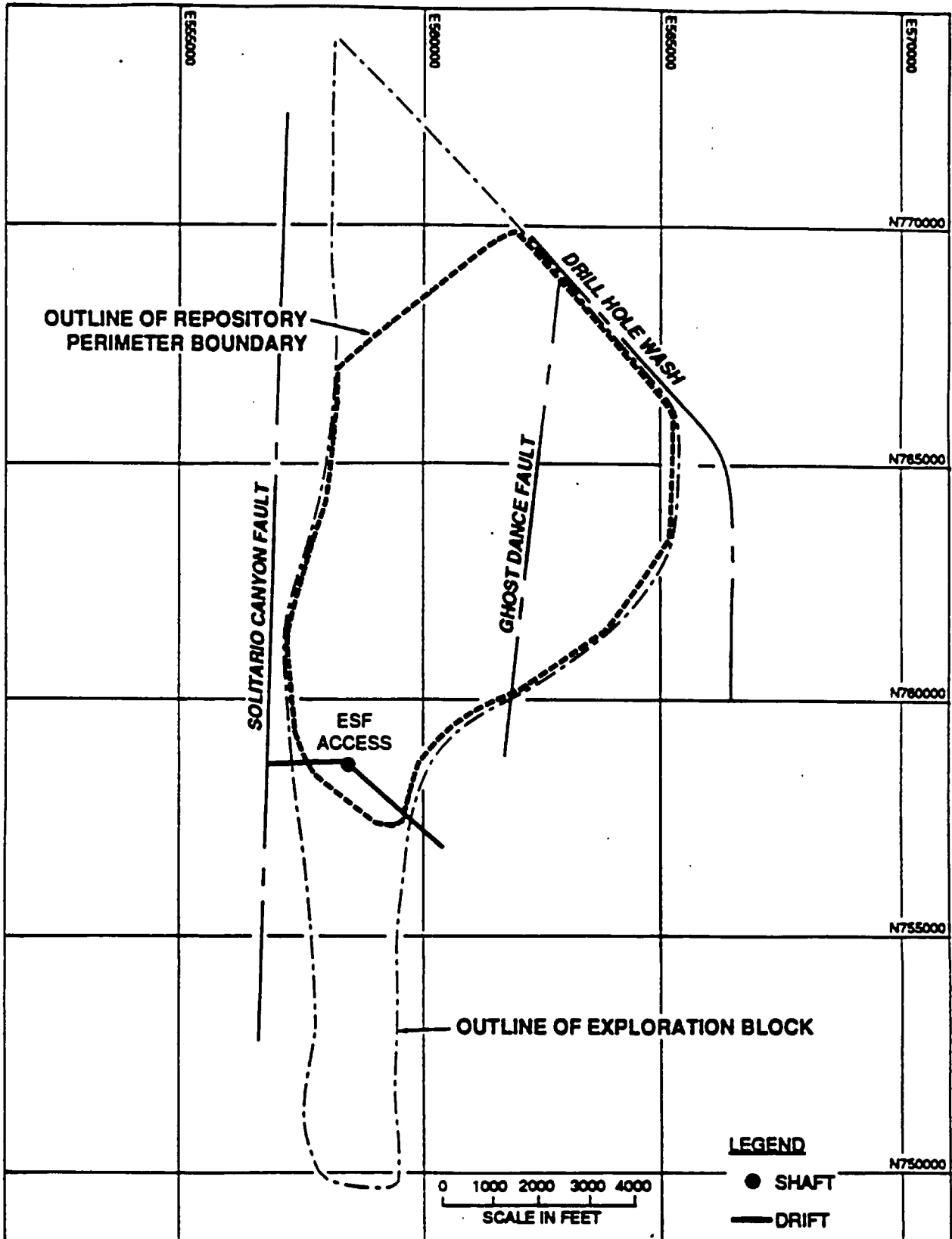
CALICO HILLS STRATEGIES

(CONTINUED)

STRATEGY #3

- **BASELINE STRATEGY, SIMILAR TO THE ORIGINAL CALICO HILLS ACTIVITY IN THE CONSULTATION DRAFT SCP**
- **LOCATION PERMITS ACCESS TO GHOST DANCE FAULT, DRILLHOLE WASH, AND FAULTING TO THE EAST, WITH LIMITED DRIFTING (5,000 FT)**

STRATEGY NO. 4
INSIDE; S; LIMITED FACILITY; INTEGRATED WITH ESF



CALICO HILLS STRATEGIES

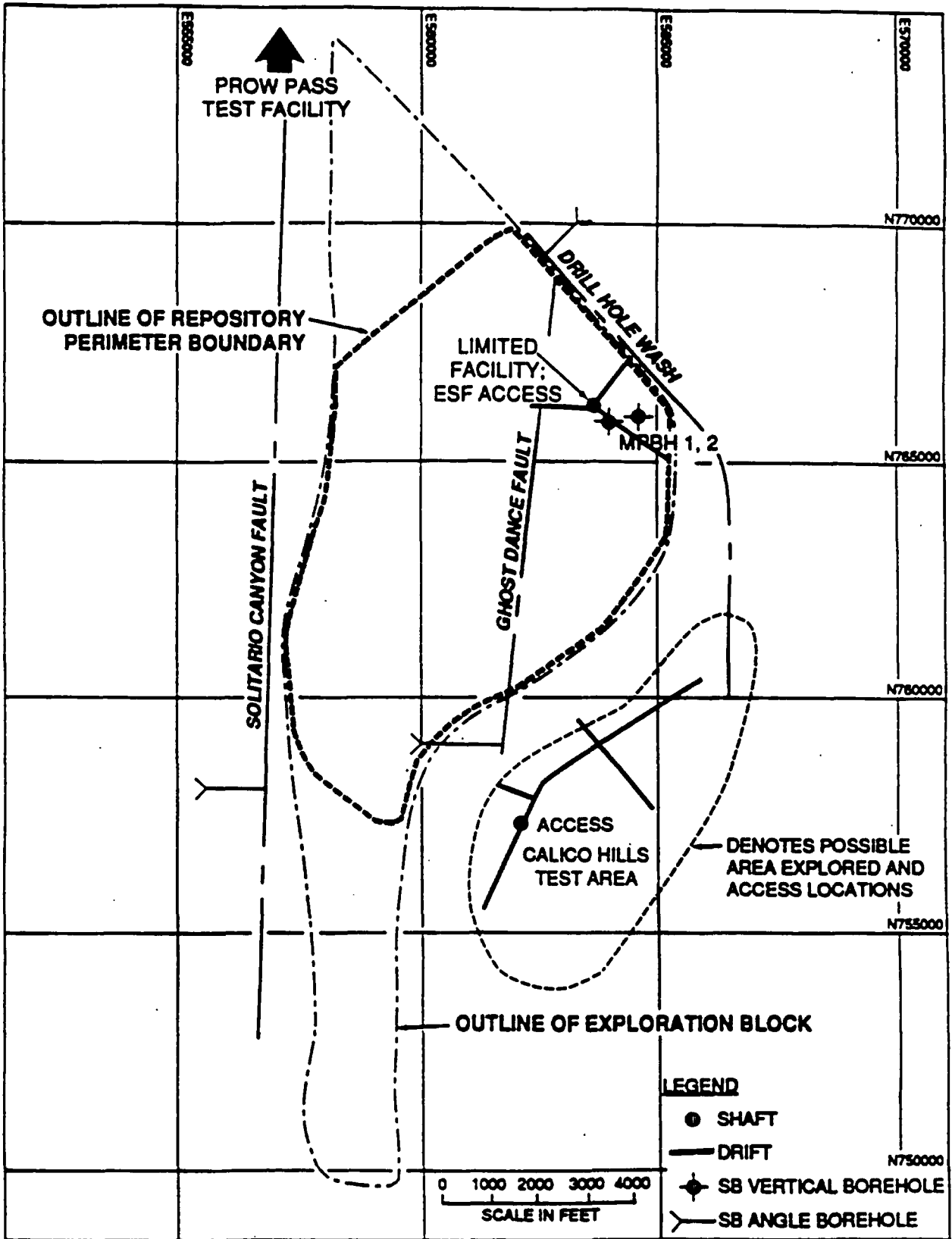
(CONTINUED)

STRATEGY #4

- **SIMILAR TO BASELINE STRATEGY (#3), BUT LOCATED IN THE SOUTH WHERE THE CH_n IS THICKER AND VITRIC**
- **PERFORMANCE IMPACTS MAY BE LESS THAN FOR BASELINE**
- **ACCESS TO FAULTS IS REDUCED RELATIVE TO BASELINE**

STRATEGY NO. 1

OUTSIDE; SE; EXTENDED DRIFTING; NO ESF CONNECTION - ADDITIONAL SBT - WITH INSIDE, NE, LIMITED FACILITY; INTEGRATED WITH ESF



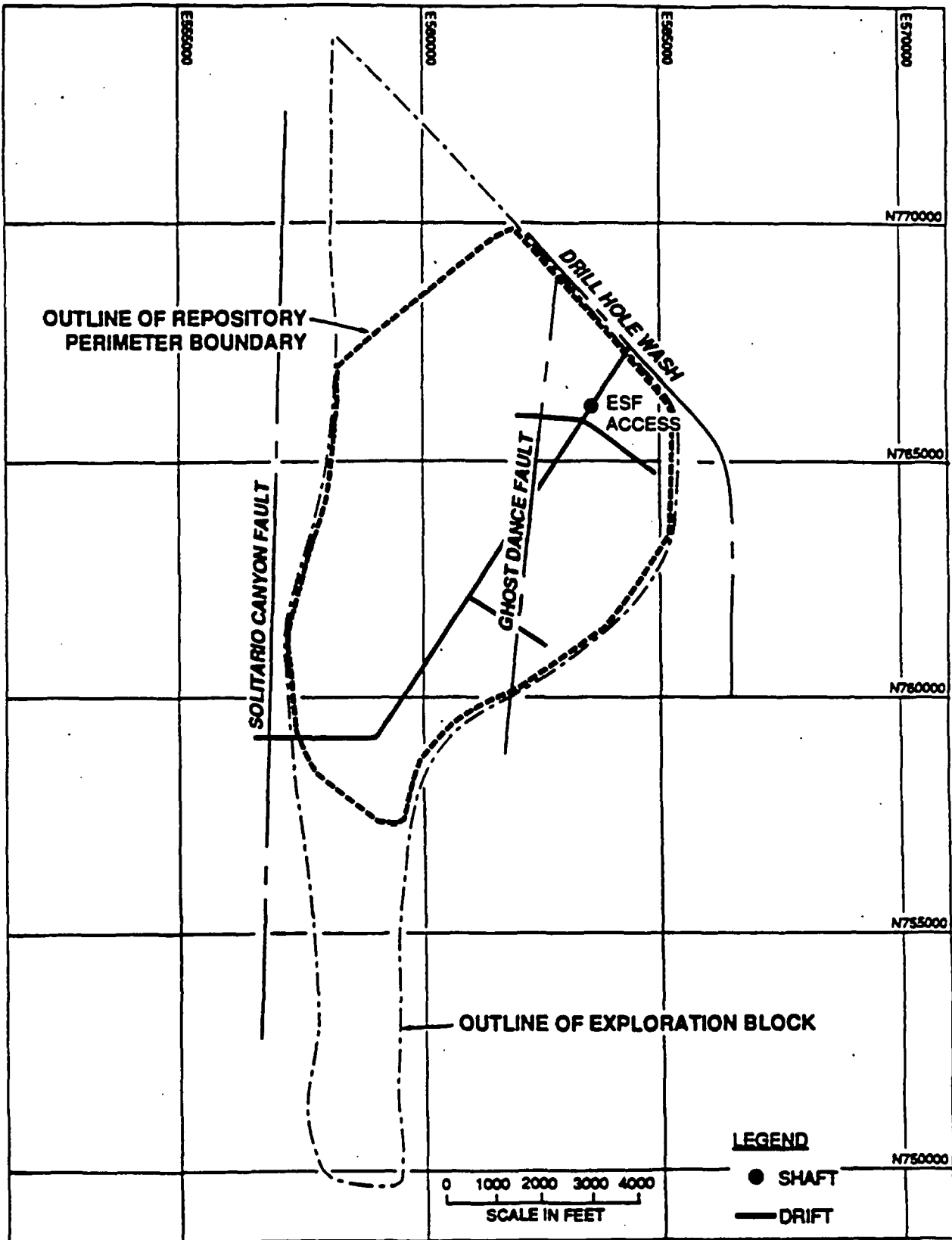
CALICO HILLS STRATEGIES

STRATEGY #1

- ATTEMPT TO ACHIEVE HIGH TEST ACCURACY WHILE LIMITING EXCAVATION WITHIN THE BLOCK
- SIMILAR TO #7, WITH THE ADDITION OF LIMITED EXCAVATION INSIDE THE NORTHEAST PART OF THE BLOCK
- EXTENSIVE EXCAVATION OUTSIDE THE BLOCK EXPLORES FAULTING AND FACIES TRANSITION
- LIMITED EXCAVATION INSIDE THE BLOCK EXPLORES GHOST DANCE FAULT, DRILLHOLE WASH, AND OTHER FEATURES IN THE ZEOLITIC FACIES
- INCLUDE ADDITIONAL SBT (IN ADDITION TO SCP) TO MAXIMIZE INFORMATION WHILE LIMITING EXCAVATION INSIDE THE BLOCK

STRATEGY NO. 5

INSIDE; NE; EXTENDED DRIFTING; INTEGRATED WITH ESF



CALICO HILLS STRATEGIES

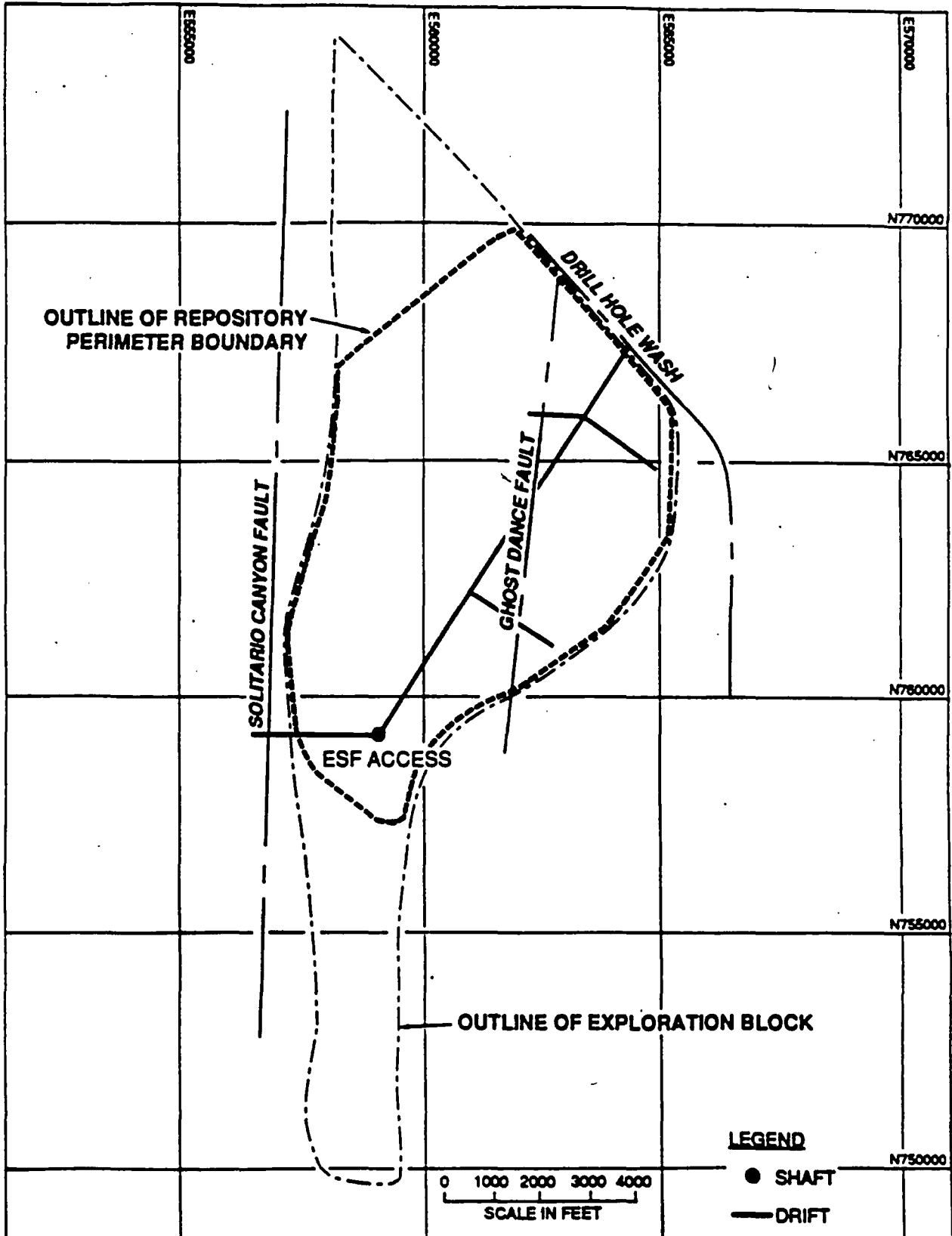
(CONTINUED)

STRATEGY #5

- **SIMILAR TO STRATEGY #2, EXCEPT ACCESSES WOULD BE LOCATED IN THE SOUTH, WHERE THE CHn IS THICKER AND VITRIC**
- **PERFORMANCE IMPACTS MAY BE LESS THAN FOR STRATEGY #2**
- **USE OF BOTH #2 AND #5 ASSURES THAT AT LEAST ONE STRATEGY WITH HIGH TEST ACCURACY CAN BE INTEGRATED WITH ANY OPTION CONSIDERED IN THE ESF STUDY**

STRATEGY NO. 2

INSIDE; S; EXTENDED DRIFTING; INTEGRATED WITH ESF



CALICO HILLS STRATEGIES

(CONTINUED)

STRATEGY #2

- **ATTEMPT TO MAXIMIZE TEST ACCURACY BY PROVIDING EXTENSIVE, REPRESENTATIVE DATA**
- **LARGEST EXTENT OF EXCAVATION CONSIDERED INSIDE THE BLOCK**
- **AS MUCH AS 19,000 FT OF DRIFTING EXPLORES:**
 - **GHOST DANCE FAULT**
 - **SOLITARIO CANYON FAULT**
 - **DRILLHOLE WASH**
 - **FAULTING TO THE EAST**
 - **FACIES TRANSITION**