UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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TO: John J. Linehan, Director, HLPD, Division of High-Level Waste Management

FROM: Paul T. Prestholt, Sr. On-Site Licensing Representative

DATE: April 13, 1989

SUBJECT: THE YUCCA MOUNTAIN PROJECT RESPONSE TO QUESTIONS OF THE NUCLEAR WASTE TECHNICAL REVIEW BOARD, APRIL 11-12, 1989

Please find enclosed the above-referenced document.

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U.S. DEPARTMENT OF ENERGY

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YUCCA MOUNTAIN

YUCCA MOUNTAIN PROJECT

THE YUCCA MOUNTAIN PROJECT RESPONSE TO QUESTIONS OF THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

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APRIL 11-12, 1989

UNITED STATES DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE/YUCCA MOUNTAIN PROJECT OFFICE

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Received w/Ltr Dated 4/19/89

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YUCCA MOUNTAIN

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THE YUCCA MOUNTAIN PROJECT RESPONSE TO QUESTIONS OF THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

APRIL 11-12, 1989

UNITED STATES DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE/YUCCA MOUNTAIN PROJECT OFFICE

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

WELCOME
AND
ORGANIZATIONAL INFORMATION

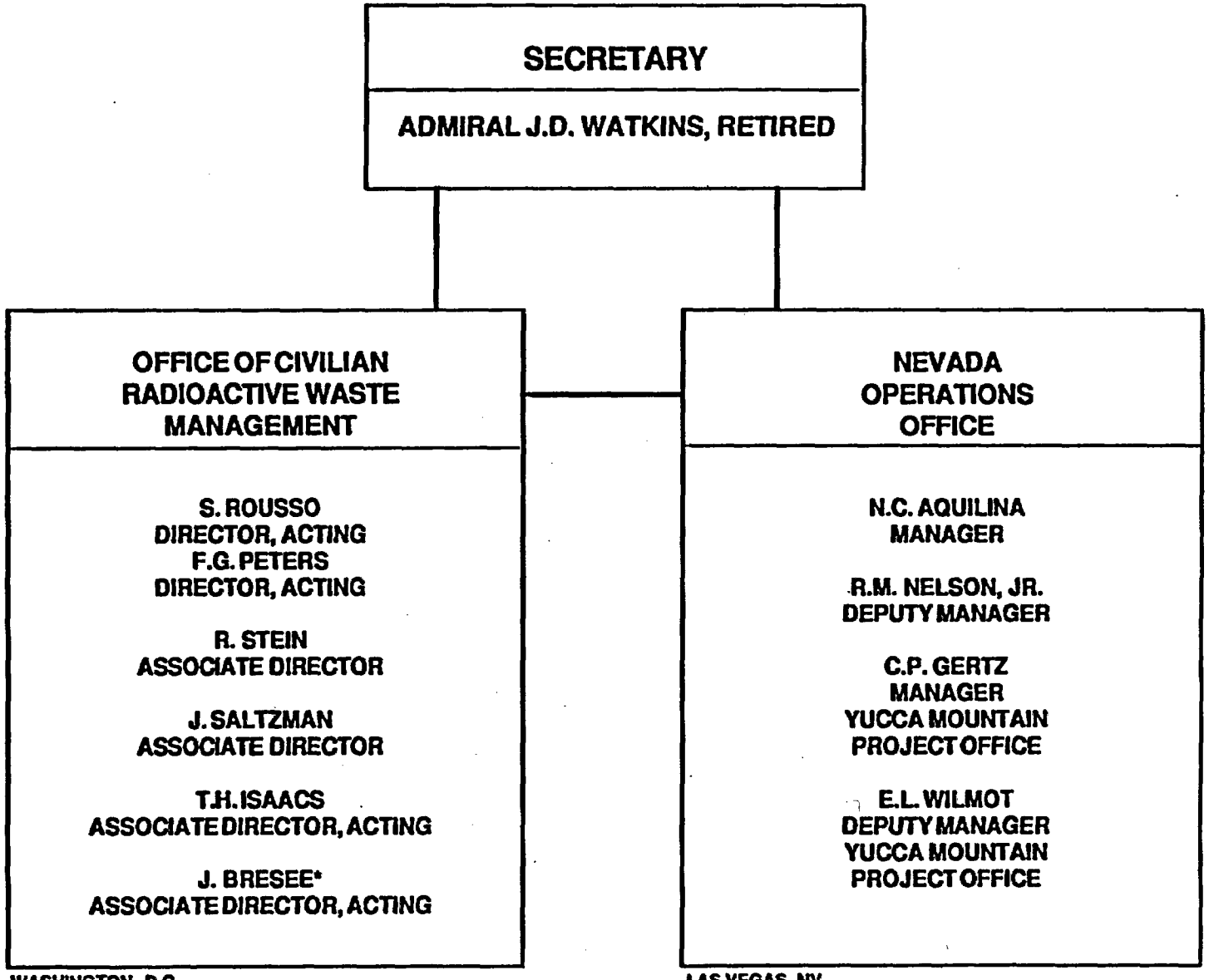
PRESENTED BY

CARL GERTZ

MANAGER, YUCCA MOUNTAIN PROJECT
U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE

APRIL 11, 1989

U.S. DEPARTMENT OF ENERGY



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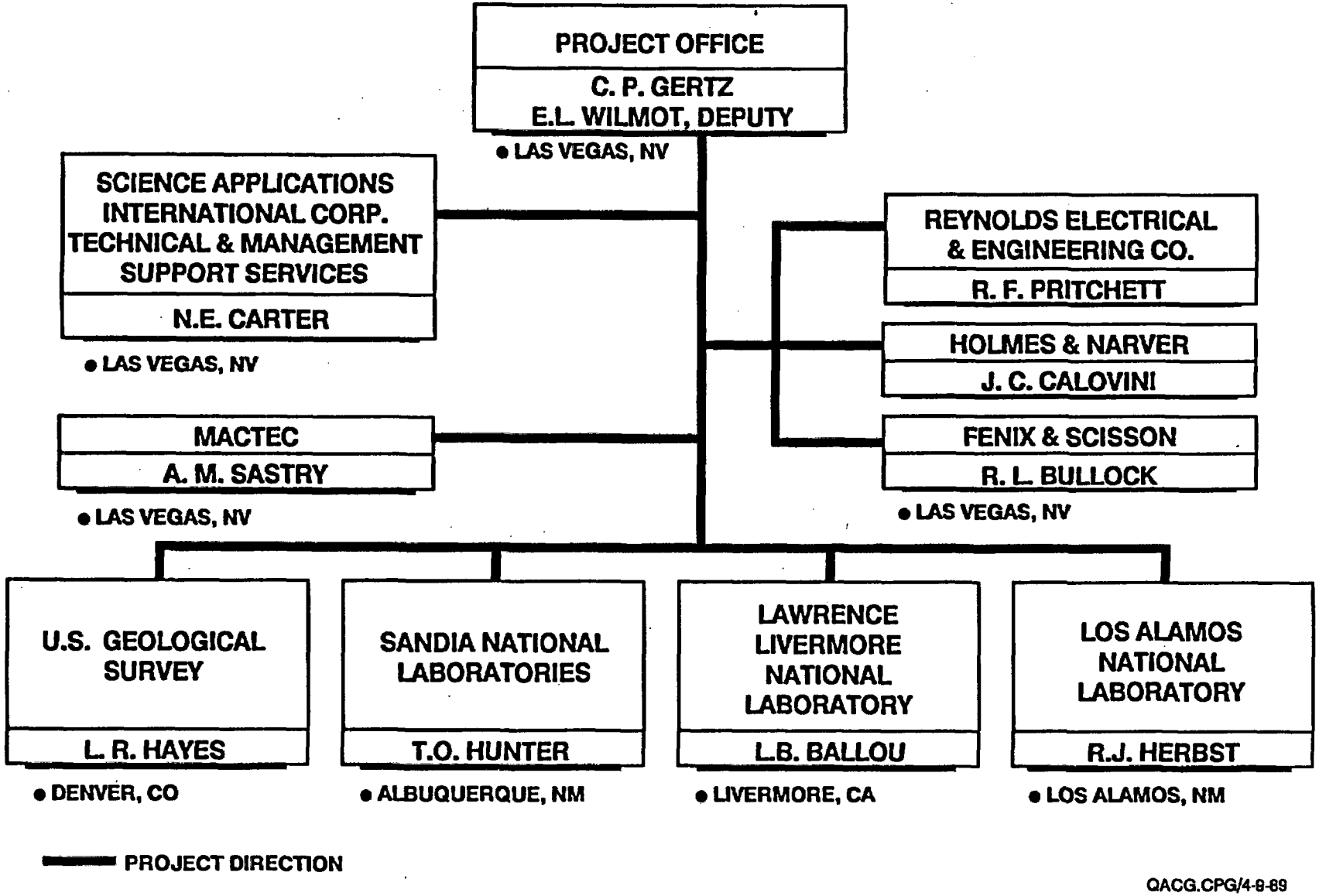
YUCCA MOUNTAIN PROJECT



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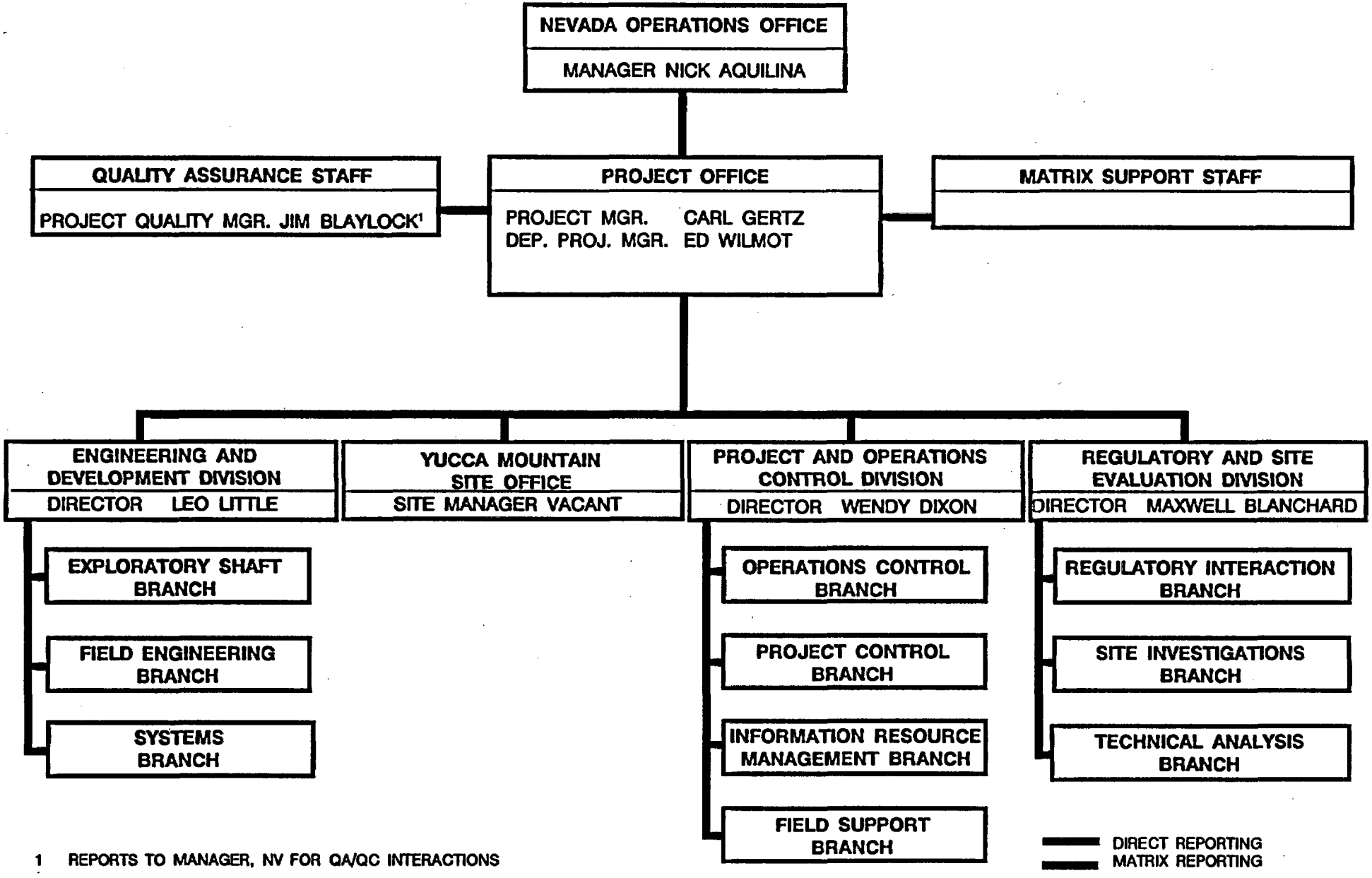
YUCCA MOUNTAIN PROJECT ORGANIZATION



1 REPORTS TO MANAGER, NV FOR QA/QC INTERACTIONS

YMPFLOW.CPG/4-3-89 NWT 4-11-8

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

REVIEW AGENDA

PRESENTED BY

MAXWELL BLANCHARD
DIRECTOR, REGULATORY AND SITE EVALUATION DIVISION
YUCCA MOUNTAIN PROJECT, U.S. DEPARTMENT OF ENERGY

APRIL 11, 1989

AGENDA
TUESDAY, APRIL 11, 1989

9:00	WELCOME	C. GERTZ
9:10	INTRODUCTORY REMARKS	T. ISAACS & D. DEERE
9:30	REVIEW AGENDA	M. BLANCHARD
10:00	KEY REGULATORY CONCERNS	R. STEIN
11:15	LUNCH	

AGENDA

TUESDAY, APRIL 11, 1989

(CONTINUED)

APPROACH TO EXPLORATORY SHAFT CONSTRUCTION & ALTERNATIVES CONSIDERED

12:30	REGULATORY CONSIDERATIONS	M. BLANCHARD
1:00	SCIENTIFIC CONSIDERATIONS	W. WILSON
2:30	BREAK	
2:45	ENGINEERING CONSIDERATIONS	K. BEALL
3:45	CONCLUSIONS	M. BLANCHARD
4:00	FURTHER DISCUSSION	ALL
4:30	ADJOURN	

AGENDA
WEDNESDAY, APRIL 12, 1989

CONSIDERATIONS FOR REPOSITORY PERIMETER DRIFTING AS PART OF SITE CHARACTERIZATION

8:00	REGULATORY CONSIDERATIONS	M. BLANCHARD
8:30	SCIENTIFIC AND TESTING CONSIDERATIONS	M. VOEGELE
10:00	BREAK	
10:15	ENGINEERING CONSIDERATIONS	J. TILLERSON
11:15	CONCLUSIONS	M. BLANCHARD
11:30	FURTHER DISCUSSION	ALL
12:30	ADJOURN	

NWTAGEN5P.A11/4-11,12-89

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

KEY REGULATORY CONCERNS

PRESENTED BY

RALPH STEIN
ASSOCIATE DIRECTOR, OFFICE OF SYSTEMS INTEGRATION AND REGULATIONS
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT,
U.S. DEPARTMENT OF ENERGY

APRIL 11, 1989

OUTLINE

- DOE PROGRAMMATIC GOAL
- TOPICS OF INTEREST TO NUCLEAR WASTE TECHNICAL REVIEW BOARD
- SYNOPSIS OF KEY NRC REGULATIONS
- KEY PROVISIONS IN 10 CFR 60 ON SITE CHARACTERIZATION
- KEY REGULATORY CONCERNS RELATED TO PLANNED SITE CHARACTERIZATION ACTIVITIES
- KEY RESTRICTIONS PLACED ON SITE CHARACTERIZATION BY CONGRESS IN THE NUCLEAR WASTE POLICY ACT, AS AMENDED
- SUMMARY OF KEY REGULATORY CONSTRAINTS ON SITE CHARACTERIZATION TESTING

NWTSTEIN5P.A11/4-11,12-89

TOPICS OF INTEREST TO NUCLEAR WASTE TECHNICAL REVIEW BOARD

NWTRB RAISED QUESTIONS RELATED TO THE FOLLOWING TOPICS:

- METHODS OF EXPLORATORY SHAFT CONSTRUCTION, AND
- EARLY PERIMETER DRIFTING

THIS PRESENTATION IS INTENDED TO PROVIDE AN OVERVIEW OF THE KEY STATUTORY AND REGULATORY REQUIREMENTS GOVERNING THE HLW PROGRAM WITH PARTICULAR FOCUS ON SITE CHARACTERIZATION PROGRAM ACTIVITIES.

DOE PROGRAMMATIC GOAL

DOE WILL DEVELOP THE NATION'S FIRST LICENSED FACILITY FOR THE SAFE DISPOSAL OF HIGH-LEVEL NUCLEAR WASTE

A PRINCIPAL OBJECTIVE IS TO ENSURE THAT THE ENVIRONMENT AND THE HEALTH AND SAFETY OF THE PUBLIC ARE PROPERLY PROTECTED.

IN CONFORMANCE WITH THE LEGISLATIVE REQUIREMENTS OF THE NUCLEAR WASTE POLICY ACT OF 1982, AS AMENDED BY THE NUCLEAR WASTE POLICY AMENDMENTS ACT OF 1987, THE NU CLEAR REGULATORY COMMISSION AND THE DOE HAVE IMPOSED REGULATIONS AND REQUIREMENTS TO ENSURE THE PRINCIPAL OBJECTIVE IS ACHIEVED.

THIS REGULATORY UMBRELLA IMPOSES A NEED FOR APPROACHES TO ACHIEVE THE OBJECTIVE WHICH MAY BE DIFFERENT FROM MORE CONVENTIONAL UNDERGROUND PROJECTS.

SYNOPSIS OF KEY NRC REGULATIONS

10 CFR 60.2	-	DEFINES SITE CHARACTERIZATION
10 CFR 60.15	-	REQUIRES A SITE CHARACTERIZATION PROGRAM AND ESTABLISHES CONSTRAINTS ON THE SITE CHARACTERIZATION PROGRAM.
10 CFR 60.140	-	REQUIRES A PERFORMANCE CONFIRMATION PROGRAM WHICH BEGINS DURING SITE CHARACTERIZATION.
10 CFR 60.151	-	REQUIRES THAT THE SITE CHARACTERIZATION PROGRAM BE CONDUCTED UNDER A QUALITY ASSURANCE PROGRAM.

KEY PROVISIONS IN 10 CFR 60 ON SITE CHARACTERIZATION

10 CFR 60.2 DEFINITIONS

"SITE CHARACTERIZATION" MEANS THE PROGRAM OF EXPLORATION AND RESEARCH, BOTH IN THE LABORATORY AND IN THE FIELD, UNDERTAKEN TO ESTABLISH THE GEOLOGIC CONDITIONS AND THE RANGES OF THOSE PARAMETERS OF A PARTICULAR SITE RELEVANT TO THE PROCEDURES UNDER THIS PART. SITE CHARACTERIZATION INCLUDES BORINGS, SURFACE EXCAVATIONS, EXCAVATION OF EXPLORATORY SHAFTS, <u>LIMITED SUBSURFACE LATERAL EXCAVATIONS AND BORINGS</u> AND IN SITU TESTING AT DEPTH NEEDED TO DETERMINE THE <u>SUITABILITY OF THE SITE FOR A GEOLOGIC REPOSITORY</u>, BUT DOES NOT INCLUDE PRELIMINARY BORINGS AND GEOPHYSICAL TESTING NEEDED TO DECIDE WHETHER SITE CHARACTERIZATION SHOULD BE UNDERTAKEN.

KEY PROVISIONS IN 10 CFR 60 ON SITE CHARACTERIZATION

(CONTINUED)

10 CFR 60.15 SITE CHARACTERIZATION (CONTINUED)

(a) PRIOR TO SUBMITTAL OF AN APPLICATION FOR A LICENSE TO BE ISSUED UNDER THIS PART DOE SHALL CONDUCT A PROGRAM OF SITE CHARACTERIZATION WITH RESPECT TO THE SITE TO BE DESCRIBED IN SUCH APPLICATION.

(b) UNLESS THE COMMISSION DETERMINED WITH RESPECT TO THE SITE DESCRIBED IN THE APPLICATION THAT IT IS NOT NECESSARY, SITE CHARACTERIZATION SHALL INCLUDE A PROGRAM OF IN SITU EXPLORATION AND TESTING AT THE DEPTHS THAT WASTES WOULD BE EMPLACED.

KEY PROVISIONS IN 10 CFR 60 ON SITE CHARACTERIZATION

(CONTINUED)

10 CFR 60.15 SITE CHARACTERIZATION

(d) THE PROGRAM OF SITE CHARACTERIZATION SHALL BE CONDUCTED IN ACCORDANCE WITH THE FOLLOWING:

(1) INVESTIGATIONS TO OBTAIN THE REQUIRED INFORMATION SHALL BE CONDUCTED IN SUCH A MANNER AS TO LIMIT ADVERSE EFFECTS ON THE LONG-TERM PERFORMANCE OF THE GEOLOGIC REPOSITORY TO THE EXTENT PRACTICAL.

(2) THE NUMBER OF EXPLORATORY BOREHOLES AND SHAFTS SHALL BE LIMITED TO THE EXTENT PRACTICAL CONSISTENT WITH OBTAINING THE INFORMATION NEEDED FOR SITE CHARACTERIZATION.

(3) TO THE EXTENT PRACTICAL, EXPLORATORY BOREHOLES AND SHAFTS IN THE GEOLOGIC REPOSITORY OPERATIONS AREA SHALL BE LOCATED WHERE SHAFTS ARE PLANNED FOR UNDERGROUND FACILITY CONSTRUCTION AND OPERATION OR WHERE LARGE UNEXCAVATED PILLARS ARE PLANNED.

(4) SUBSURFACE EXPLORATORY DRILLING, EXCAVATION, AND IN SITU TESTING BEFORE AND DURING CONSTRUCTION SHALL BE PLANNED AND COORDINATED WITH GEOLOGIC REPOSITORY OPERATIONS AREA DESIGN AND CONSTRUCTION.

KEY PROVISIONS IN 10 CFR 60 ON SITE CHARACTERIZATION

10 CFR 60.140 GENERAL REQUIREMENTS

(a) THE PERFORMANCE CONFIRMATION PROGRAM SHALL PROVIDE DATA WHICH INDICATES, WHERE PRACTICABLE, WHETHER -

(1) ACTUAL SUBSURFACE CONDITIONS ENCOUNTERED AND CHANGES IN THOSE CONDITIONS DURING CONSTRUCTION AND WASTE EMPLACEMENT OPERATIONS ARE WITHIN THE LIMITS ASSUMED IN THE LICENSING REVIEW; AND

(2) NATURAL AND ENGINEERED SYSTEMS AND COMPONENTS REQUIRED FOR REPOSITORY OPERATION, OR WHICH ARE DESIGNED OR ASSUMED TO OPERATE AS BARRIERS AFTER PERMANENT CLOSURE, ARE FUNCTIONING AS INTENDED AND ANTICIPATED.

KEY PROVISIONS IN 10 CFR 60 ON SITE CHARACTERIZATION

(CONTINUED)

10 CFR 60.140 GENERAL REQUIREMENTS (CONTINUED)

(b) THE PROGRAM SHALL HAVE BEEN STARTED DURING SITE CHARACTERIZATION AND IT WILL CONTINUE UNTIL PERMANENT CLOSURE.

(c) THE PROGRAM SHALL INCLUDE IN SITU MONITORING, LABORATORY AND FIELD TESTING, AND IN SITU EXPERIMENTS, AS MAY BE APPROPRIATE TO ACCOMPLISH THE OBJECTIVE AS STATED ABOVE.

KEY PROVISIONS IN 10 CFR 60 ON SITE CHARACTERIZATION

(CONTINUED)

10 CFR 60.140 GENERAL REQUIREMENTS(CONTINUED)

(d) THE PROGRAM SHALL BE IMPLEMENTED SO THAT:

(1) IT DOES NOT ADVERSELY AFFECT THE ABILITY OF THE NATURAL AND ENGINEERED ELEMENTS OF THE GEOLOGIC REPOSITORY TO MEET THE PERFORMANCE OBJECTIVES.

(2) IT PROVIDES BASELINE INFORMATION AND ANALYSIS OF THAT INFORMATION ON THOSE PARAMETERS AND NATURAL PROCESSES PERTAINING TO THE GEOLOGIC SETTING THAT MAY BE CHANGED BY SITE CHARACTERIZATION, CONSTRUCTION, AND OPERATIONAL ACTIVITIES.

(3) IT MONITORS AND ANALYZES CHANGES FROM THE BASELINE CONDITION OF PARAMETERS THAT COULD AFFECT THE PERFORMANCE OF A GEOLOGIC REPOSITORY.

(4) IT PROVIDES AN ESTABLISHED PLAN FOR FEEDBACK AND ANALYSIS OF DATA, AND IMPLEMENTATION OF APPROPRIATE ACTION.

KEY PROVISIONS IN 10 CFR 60 ON SITE CHARACTERIZATION

(CONTINUED)

10 CFR 60.151 APPLICABILITY

THE QUALITY ASSURANCE PROGRAM APPLIES TO ALL SYSTEMS, STRUCTURES, AND COMPONENTS IMPORTANT TO SAFETY, TO DESIGN AND CHARACTERIZATION OF BARRIERS IMPORTANT TO WASTE ISOLATION AND TO ACTIVITIES RELATED THERETO. THESE ACTIVITIES INCLUDE: SITE CHARACTERIZATION, FACILITY AND EQUIPMENT CONSTRUCTION, FACILITY OPERATION, PERFORMANCE CONFIRMATION, PERMANENT CLOSURE, AND DECONTAMINATION AND DISMANTLING OF SURFACE FACILITIES.

10 CFR 60.152 IMPLEMENTATION

DOE SHALL IMPLEMENT A QUALITY ASSURANCE PROGRAM BASED ON THE CRITERIA OF APPENDIX B OF 10 CFR 50 AS APPLICABLE, AND APPROPRIATELY SUPPLEMENTED BY ADDITIONAL CRITERIA AS REQUIRED BY §60.151

KEY REGULATORY CONCERNS RELATED TO PLANNED SITE CHARACTERIZATION ACTIVITIES

1. SITE CHARACTERIZATION ACTIVITIES MUST NOT ADVERSELY AFFECT THE ABILITY OF THE SITE TO ISOLATE RADIOACTIVE WASTES

2. SITE CHARACTERIZATION ACTIVITIES MUST NOT COMPROMISE THE ABILITY TO CHARACTERIZE THE SITE

3. SITE CHARACTERIZATION ACTIVITIES MUST PROVIDE DATA WHICH IS REPRESENTATIVE OF THE SITE

KEY REGULATORY CONCERN NO. 1

SITE CHARACTERIZATION ACTIVITIES MUST NOT ADVERSELY AFFECT THE ABILITY OF THE SITE TO ISOLATE RADIOACTIVE WASTES. SPECIFIC EXAMPLES INCLUDE:

(1) CREATION OF PREFERENTIAL PATHWAYS IN THE UNSATURATED ZONE FOR THE RELEASE OF RADIONUCLIDES TO THE ACCESSIBLE ENVIRONMENT;

(2) SIGNIFICANT INCREASES IN THE AMOUNT OR SPATIAL DISTRIBUTION OF GROUND-WATER FLUX THROUGH THE REPOSITORY HORIZON;

(3) SIGNIFICANT CHANGES TO THE HYDROLOGIC PROPERTIES, PRINCIPALLY HYDRAULIC CONDUCTIVITY, IN THE UNSATURATED ZONE; AND

(4) SIGNIFICANT DECREASE IN THE ABILITY TO CHEMICALLY OR PHYSICALLY RETARD THE TRANSPORT OF RADIONUCLIDES IN THE UNSATURATED ZONE.

KEY REGULATORY CONCERN NO. 2

SITE CHARACTERIZATION ACTIVITIES MUST NOT COMPROMISE THE ABILITY TO CHARACTERIZE THE SITE. WE MUST:

(1) AVOID CONSTRUCTION-TO-TEST INTERFERENCE BY METHODS SUCH AS BLAST CONTROL AND WATER CONTROL;

(2) AVOID TEST-TO-TEST INTERFERENCE BY METHODS SUCH AS SPACING OF TESTS AND SEQUENCING OF TESTS; AND

(3) AVOID OPERATION-TO-TEST INTERFERENCES BY METHODS SUCH AS SELECTION OF ROUTES FOR MATERIALS AND VENTILATION CONTROL

KEY REGULATORY CONCERN NO. 3

SITE CHARACTERIZATION ACTIVITIES MUST PROVIDE DATA WHICH IS REPRESENTATIVE OF THE SITE. FOR EXAMPLE, WE MUST ENSURE THAT:

(1) THE VARIABILITY OF PROCESSES THAT CONTROL SITE PERFORMANCE AND THE RELATIONSHIP OF THESE PROCESSES TO THE VARIABILITY OF SITE CONDITIONS ARE IDENTIFIED AND INVESTIGATED.

(2) THE PROPOSED DRIFTING AND TESTING ARE SUFFICIENT TO ESTABLISH THE RANGES OF THE PARAMETERS REQUIRED TO PROPERLY DETERMINE SITE CONDITIONS.

(3) DATA GATHERED DURING SITE CHARACTERIZATION PROVIDE THE INFORMATION NEEDED TO CONSTRUCT A RELIABLE THREE-DIMENSIONAL GEOLOGIC MODEL OF THE SITE.

(4) ANY ADDITIONAL DRIFTING AND/OR SURFACE-BASED TESTING NEEDED TO REDUCE UNCERTAINTIES ABOUT THE PRESENCE OF FAULTS AND OTHER GEOLOGIC AND HYDROLOGIC CONDITIONS, PARTICULARLY IN THE SOUTHERN PART OF THE REPOSITORY BLOCK, ARE CONTINUALLY EVALUATED.

KEY RESTRICTIONS PLACED ON SITE CHARACTERIZATION BY CONGRESS IN THE NUCLEAR WASTE POLICY ACT, AS AMENDED

SECTION 113(C) RESTRICTIONS

(1) THE SECRETARY MAY CONDUCT AT THE YUCCA MOUNTAIN SITE <u>ONLY SUCH SITE CHARACTERIZATION ACTIVITIES</u> AS THE SECRETARY CONSIDERS NECESSARY TO PROVIDE THE DATA REQUIRED <u>FOR EVALUATION OF THE SUITABILITY OF SUCH SITE</u> FOR AN APPLICATION TO BE SUBMITTED TO THE COMMISSION FOR A CONSTRUCTION AUTHORIZATION FOR A REPOSITORY AT SUCH SITE, AND <u>FOR COMPLIANCE WITH THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969</u> (42 U.S.C. 4321 AT SEQ.).

KEY RESTRICTIONS PLACED ON SITE CHARACTERIZATION BY CONGRESS IN THE NUCLEAR WASTE POLICY ACT, AS AMENDED

(CONTINUED)

(2) IN CONDUCTING SITE CHARACTERIZATION ACTIVITIES --

(A) THE SECRETARY MAY NOT USE ANY RADIOACTIVE MATERIAL AT A SITE UNLESS THE COMMISSION CONCURS THAT SUCH USE IS NECESSARY TO PROVIDE DATA FOR THE PREPARATION OF THE REQUIRED ENVIRONMENTAL REPORTS AND AN APPLICATION FOR A CONSTRUCTION AUTHORIZATION FOR A REPOSITORY AT SUCH SITE; AND

(B) IF ANY RADIOACTIVE MATERIAL IS USED AT A SITE --

(I) THE SECRETARY SHALL USE THE MINIMUM QUANTITY NECESSARY TO DETERMINE THE SUITABILITY OF SUCH SITE FOR A REPOSITORY, BUT IN NO EVENT MORE THAN THE CURIE EQUIVALENT OF 10 METRIC TONS OF SPENT NUCLEAR FUEL; AND

(II) SUCH RADIOACTIVE MATERIAL SHALL BE FULLY RETRIEVABLE.

SECTION 113(A) IN GENERAL

...THE SECRETARY SHALL... CONDUCT SITE CHARACTERIZATION ACTIVITIES IN A MANNER THAT <u>MINIMIZES ANY SIGNIFICANT ADVERSE ENVIRONMENTAL IMPACTS</u> IDENTIFIED IN SUCH COMMENTS OR IN THE ENVIRONMENTAL ASSESSMENT SUBMITTED UNDER SUBSECTION (b)(1).

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SUMMARY OF KEY REGULATORY CONSTRAINTS ON SITE CHARACTERIZATION TESTING

- SITE CHARACTERIZATION IS LIMITED TO THE TESTING NEEDED TO OBTAIN THE REQUIRED INFORMATION TO DETERMINE THE SUITABILITY OF THE SITE (i.e., SITE CHARACTERIZATION IS NOT INTENDED TO SERVE AS AN EARLY START OF CONSTRUCTION FOR THE GEOLOGIC REPOSITORY).

- THE NUMBER OF SUBSURFACE PENETRATIONS ABOVE AND AROUND THE UNDERGROUND FACILITY SHALL BE LIMITED (e.g., DOE HAS DEFERRED A DECISION ON THE PENETRATION OF THE EXPLORSATORY SHAFT FACILITY INTO THE CALICO HILLS FORMATION).

- SITE CHARACTERIZATION IS TO INCLUDE LIMITED SUBSURFACE EXCAVATIONS AND BORINGS

- SUBSURFACE EXPLORATORY DRILLING, EXCAVATION, AND IN-SITU TESTING SHALL BE PLANNED AND COORDINATED WITH REPOSITORY DESIGN AND CONSTRUCTION

SUMMARY OF KEY REGULATORY CONSTRAINTS ON SITE CHARACTERIZATION TESTING

(CONTINUED)

- A PERFORMANCE CONFIRMATION PROGRAM WILL BEGIN DURING SITE CHARACTERIZATION AND IS REQUIRED TO ASCERTAIN ACTUAL SITE CONDITIONS, PROVIDE FOR IN-SITU MONITORING, AND PROVIDE BASELINE INFORMATION FOR ANALYSIS OF EFFECTS CAUSED BY SITE CHARACTERIZATION

- A QUALITY ASSURANCE PROGRAM IS REQUIRED TO BE APPLIED TO ITEMS AND ACTIVITIES IMPORTANT TO SAFETY AND WASTE ISOLATION, INCLUDING SITE CHARACTERIZATION AND PERFORMANCE CONFIRMATION

- SITE CHARACTERIZAION IS TO BE CONDUCTED IN A MANNER THAT MINIMIZES ANY SIGNIFICANT ENVIRONMENTAL IMPACTS

SUMMARY OF NRC OBJECTION #2

- THE NEED HAS NOT BEEN ESTABLISHED TO EXTEND, OR TO DRIFT HORIZONTALLY FROM ES-1, INTO THE CALICO HILLS

- POTENTIAL ADVERSE IMPACTS ON WASTE ISOLATION AS A RESULT OF PENETRATING THE CALICO HILLS HAVE NOT BEEN DEMONSTRATED.

DOE RESPONSES

- CALICO HILLS IS DESIGNATED AS THE PRIMARY BARRIER TO GROUND-WATER FLOW AND RADIONUCLIDE TRANSPORT.

- THE DECISION ON WHETHER TO PROCEED WITH DEEPENING ES-1 TO THE CALICO HILLS IS DEFERRED PENDING COMPLETION OF ANALYSES COMPARING:
  - NEEDED DATA,
  - ALTERNATIVE MEANS OF OBTAINING DATA,
  - BENEFITS OF OBTAINING THE DATA, AND
  - RISKS OF SITE PERFORMANCE OF OBTAINING DATA.

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

REGULATORY CONSIDERATIONS RELATED TO THE ESF CONSTRUCTION

PRESENTED BY

MAXWELL BLANCHARD

DIRECTOR, REGULATORY AND SITE EVALUATION DIVISION
YUCCA MOUNTAIN PROJECT, U.S. DEPARTMENT OF ENERGY

APRIL 11, 1989

INTRODUCTION

THE METHOD USED FOR CONSTRUCTION OF THE ESF MUST:

- LIMIT SITE IMPACTS
- SUPPORT SITE CHARACTERIZATION INFORMATION NEEDS

CONSIDERATIONS INCLUDE:

- REGULATORY CONSTRAINTS AND GUIDANCE THAT AFFECT:
  - SCIENTIFIC NEEDS FOR CHARACTERIZATION
  - ENGINEERING/DESIGN

BASIS FOR REGULATORY CONSTRAINTS

THE REGULATORY CONSTRAINTS ARE DERIVED FROM THREE SOURCES:

- 10 CFR 60
- 10 CFR 960
- NRC GUIDANCE AND COMMENTS

REGULATORY CONSTRAINTS IN 10 CFR 60

- 10 CFR 60.15 "SITE CHARACTERIZATION" REQUIRES

  - TESTING AT DEPTH
  - LIMITING ADVERSE EFFECTS ON PERFORMANCE
  - LIMITING NUMBER OF SHAFTS AND BOREHOLES
  - COORDINATION OF EXCAVATION AND UNDERGROUND TESTING WITH GROA

- 10 CFR 60.17 "CONTENT OF SITE CHARACTERIZATION PLAN" REQUIRES:

  - PLANS FOR INVESTIGATIONS NEEDED TO ASSESS THE SITE'S ABILITY TO ISOLATE WASTE
  - PLANS TO CONTROL ADVERSE IMPACTS

REGULATORY CONSTRAINTS IN 10 CFR 60
(CONTINUED)

- 10 CFR 60.21 "LICENSE APPLICATION CONTENT" SPECIFIES TYPE OF INFORMATION TO BE INCLUDED IN THE LA, INCLUDING
  - DETAILED SITE DESCRIPTION (GEOLOGY/HYDROLOGY/ GEOPHYSICS/GEOCHEMISTRY)
  - ASSESSMENT OF BARRIERS AND PERFORMANCE

  SCP LINKS SITE CHARACTERIZATION WITH THE LA; ESF CONSTRUCTION METHOD MUST NOT INTERFERE WITH ACQUISITION OF SCIENTIFIC INFORMATION REQUIRED FOR LA

- 10 CFR 60.72 "CONSTRUCTION RECORDS" REQUIRES MAINTENANCE OF RECORDS DESCRIBING CONDITIONS ENCOUNTERED DURING CONSTRUCTION INCLUDING
  - GEOLOGIC MAPS AND CROSS SECTIONS
  - MATERIALS ENCOUNTERED

REGULATORY CONSTRAINTS IN 10 CFR 60

(CONTINUED)

- 10 CFR 60.122 "SITING CRITERIA"
  - REQUIRES DETAILED ASSESSMENT AND EVALUATION OF FAVORABLE AND POTENTIALLY ADVERSE CONDITIONS THAT ARE PRESENT, OR MAY BE PRESENT BUT UNDETECTED
  - REQUIRES KNOWLEDGE ABOUT GEOLOGY/HYDROLOGY/ TECTONICS PROCESSES
  - INTENT IS TO PROVIDE REASONABLE ASSURANCE THAT THE PERFORMANCE OBJECTIVES CAN BE MET
  - DETERMINE IF SITE CONDITIONS REQUIRE COMPLEX ENGINEERING SOLUTIONS

REGULATORY CONSTRAINTS IN 10 CFR 60

(CONTINUED)

- 10 CFR 60.130 "SCOPE OF DESIGN CRITERIA..." AND SECTIONS 60.131 - 60.134

  - SPECIFIES DESIGN CRITERIA FOR GROA AND UNDERGROUND FACILITY INCLUDING:

    * DESIGN FLEXIBILITY TO ACCOMMODATE SITE CONDITIONS
    * CONTROL OF WATER AND GAS
    * CONSTRUCTION METHOD TO LIMIT PREFERENTIAL PATHWAYS
    * ENGINEERED BARRIER CONTRIBUTION TO ISOLATION AND CONTAINMENT
    * STABILITY OF UNDERGROUND OPENINGS
    * COMPLIANCE WITH MINING REGULATIONS (MSHA)

REGULATORY CONSTRAINTS IN 10 CFR 960

THE DOE, IN ITS REGULATION 10 CFR 960.5-1 STATES, AS A QUALIFYING CONDITION, THAT:

- "REPOSITORY SITING, CONSTRUCTION, OPERATION, AND CLOSURE SHALL BE DEMONSTRATED TO BE TECHNICALLY FEASIBLE ON THE BASIS OF REASONABLY AVAILABLE TECHNOLOGY..."

NRC GUIDANCE AND COMMENTS

IN ADDITION TO THE REGULATORY REQUIREMENTS, THE NRC HAS PROVIDED ADDITIONAL GUIDANCE IN THE FORM OF

(1) A REGULATORY GUIDE
(2) TECHNICAL POSITIONS
(3) SCP-CD COMMENTS

THAT PROVIDE FURTHER CLARIFICATION OF THE STAFF'S PERCEPTION OF THE TYPE OF INFORMATION THAT MUST BE OBTAINED DURING SITE CHARACTERIZATION; AND WHICH PLACE ADDITIONAL CONSTRAINTS ON THE METHOD OF SHAFT CONSTRUCTION

REGULATORY GUIDE 4.17 "STANDARD FORMAT AND CONTENT OF SITE CHARACTERIZATION PLANS"

- IDENTIFIES TYPES OF DATA TO BE OBTAINED

  - GEOLOGY
  - GEOENGINEERING
  - HYDROLOGY
  - GEOCHEMISTRY

- DOE DEVELOPED ANNOTATED OUTLINE TO ACCOMPLISH ABOVE

NRC GUIDANCE

NRC GENERIC TECHNICAL POSITION ON IN SITU TESTING DURING SITE CHARACTERIZATION

- DIRECTED TOWARD ESF TESTING

  "THE IN SITU TESTING PROGRAM SHOULD BE DEVELOPED WITH TWO MAJOR OBJECTIVES: (i) CHARACTERIZATION OF HOST ROCK AND IN SITU MEASUREMENT OF ITS PROPERTIES PRIOR TO CONSTRUCTION AND WASTE EMPLACEMENT AND (ii) DETERMINATION OF RESPONSE CHARACTERISTICS OF THE HOST ROCK AND ENGINEERED COMPONENTS TO CONSTRUCTION AND WASTE EMPLACEMENT"

  - REFLECTED IN SCP

- SHAFT CONSTRUCTION METHOD AFFECTS ABILITY TO CONDUCT TESTS CITED IN GTP
  - INSPECTION, EXAMINATION AND MAPPING
  - EVALUATION OF GROUND WATER INFLUX
  - MEASUREMENT OF IN SITU STRESSES
  - MANY OTHER GEOTECHNICAL MEASUREMENTS

NRC COMMENTS

NRC REVIEW OF SCP-CD RESULTED IN COMMENTS THAT HAVE BEEN CONSIDERED BY DOE

- INFILTRATION OF DRILLING FLUIDS FROM PAST HOLES MAY COMPROMISE HYDROLOGIC AND GEOCHEMICAL TESTS (COMMENT 10)

- DOE SHOULD CONSIDER MAPPING OR PHOTOGRAPHING FLOOR AND FACES OF SHAFTS -- TO CHARACTERIZE FRACTURE NETWORKS (COMMENT 29)

NRC COMMENTS

SCP - CD

(CONTINUED)

- PLANS SHOULD BE MADE TO CORRELATE FROM ES-1 TO ES-2; PHOTO LOG (COMMENT 97)

- ADVERSE EFFECTS OF DRILL AND BLAST CONSTRUCTION OF ES-2 ON ES-1 TESTING SHOULD BE ADDRESSED (COMMENT 98)

- PROPOSED STRATEGY FOR MINIMIZING SHAFT-WALL DAMAGE IS REASONABLE - HOWEVER CONTROL PROCEDURES NEEDED (COMMENT 99)

CONCLUSION

IN SELECTION OF THE SHAFT CONSTRUCTION METHOD, DOE HAS CONSIDERED REGULATORY CONSTRAINTS IN THE CONTEXT THAT:

(1) SITE CHARACTERIZATION ACTIVITIES MUST NOT ADVERSELY AFFECT THE ABILITY OF THE SITE TO ISOLATE WASTE

(2) SITE CHARACTERIZATION ACTIVITIES MUST NOT INTERFERE WITH THE ACQUISITION OF DATA NEEDED TO ASSESS THE WASTE ISOLATION POTENTIAL OF THE SITE

(3) REASONABLY AVAILABLE TECHNOLOGY SHOULD BE USED

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

SCIENTIFIC CONSIDERATIONS

PRESENTED BY

WILLIAM E. WILSON
U.S. GEOLOGICAL SURVEY

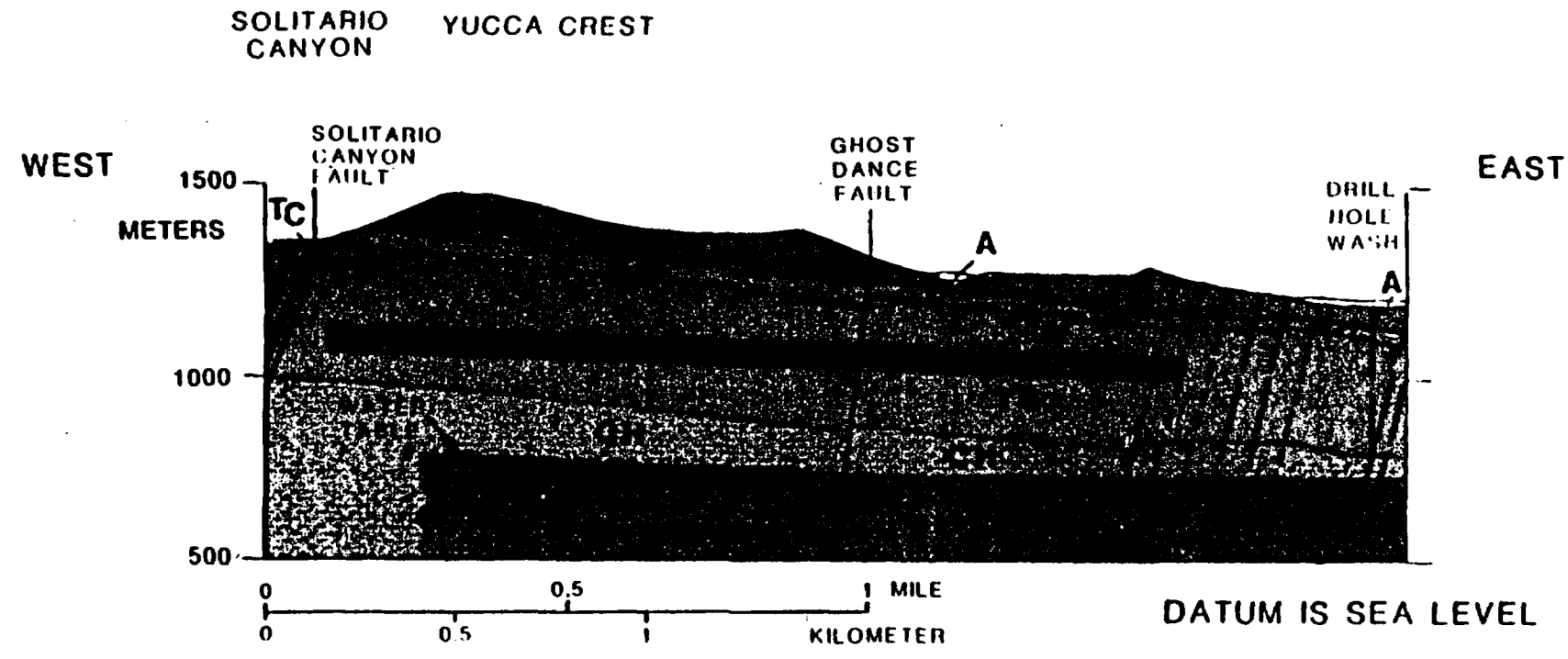
APRIL 11, 1989

OBLIQUE
VIEW OF YUCCA MOUNTAIN

MAP OF REPOSITORY AREA AND SURFACE FACILITIES

FLOW IN UNSATURATED FRACTURES

UNSATURATED ZONE
HYDROGEOLOGIC FRAMEWORK (NORTH)



A ALLUVIUM

TIVA CANYON WELDED UNIT

PAINTBRUSH NONWELDED UNIT

TOPOPAH SPRING WELDED UNIT

CALICO HILLS NONWELDED UNIT

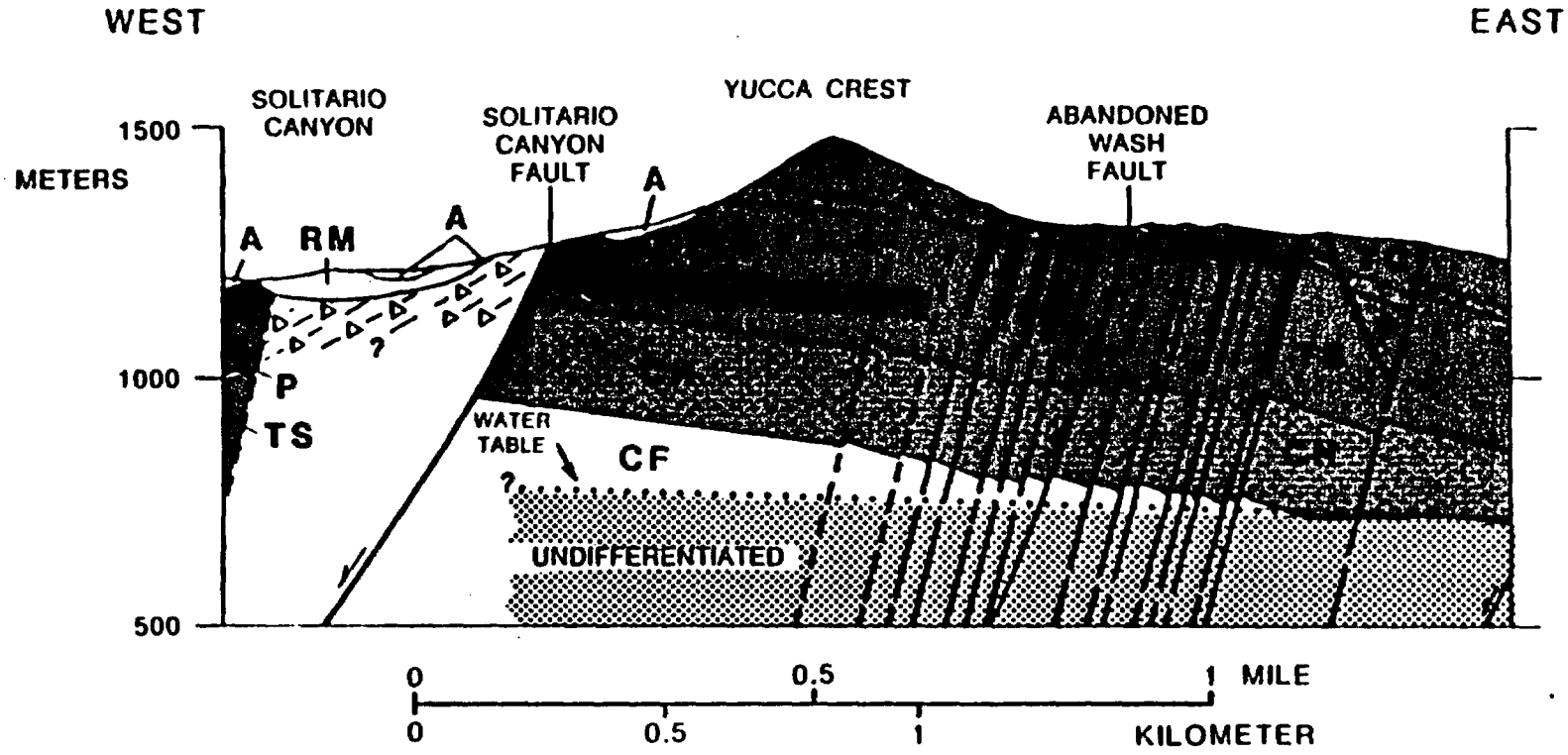
APPROXIMATE LOCATION OF REPOSITORY HORIZON

WELDED UNIT

NONWELDED UNIT

SATURATED ZONE

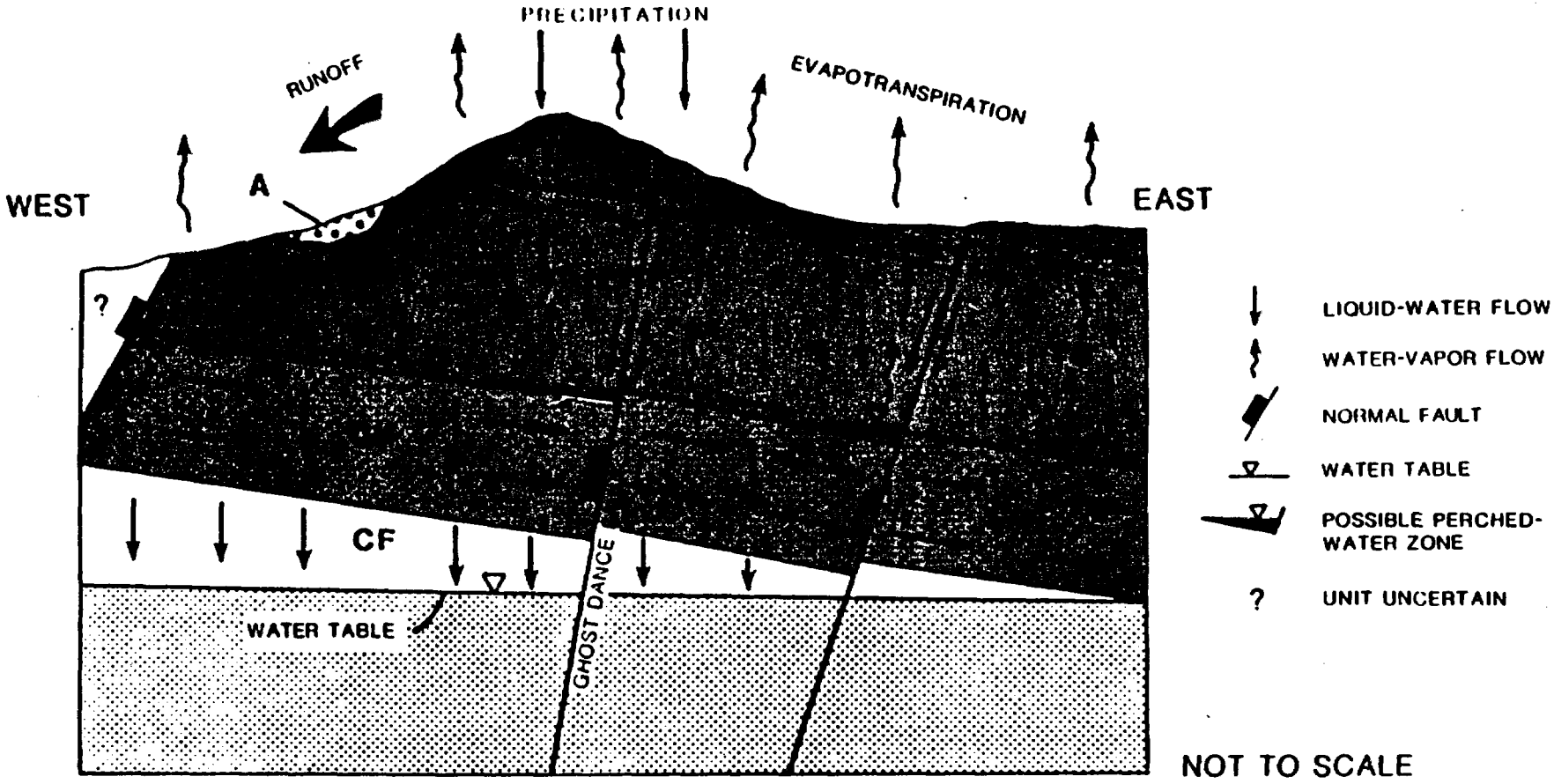
UNSATURATED ZONE
HYDROGEOLOGIC FRAMEWORK (SOUTH)



DATUM IS SEA LEVEL

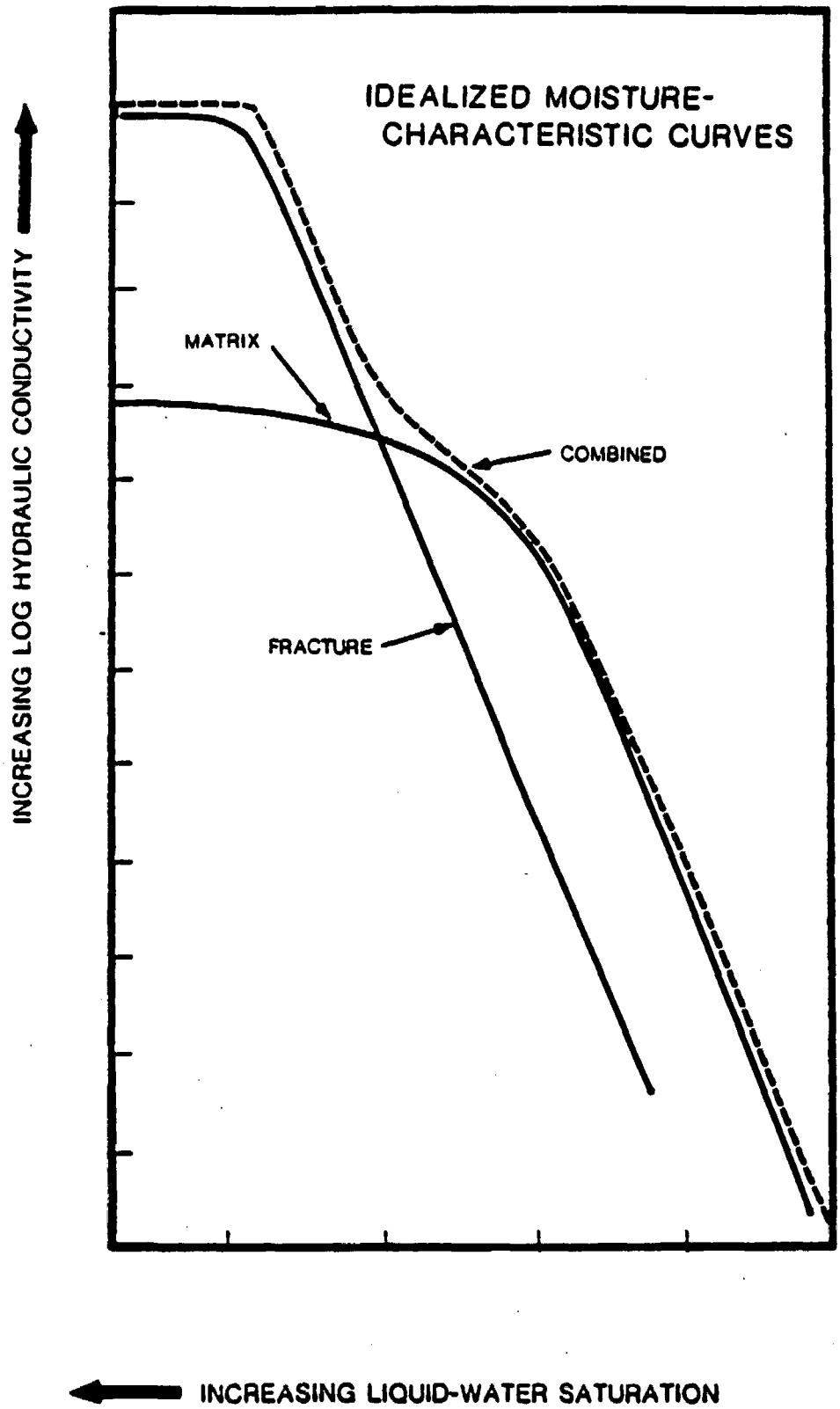
- A — ALLUVIUM
- RM — RAINIER MESA UNIT
- TIVA CANYON WELDED UNIT
- PAINTBRUSH NONWELDED UNIT
- TOPOPAH SPRING WELDED UNIT
- CALICO HILLS NONWELDED UNIT
- CF — CRATER FLAT UNIT (Undifferentiated)
- WELDED UNIT
- NONWELDED UNIT
- SATURATED ZONE
- APPROXIMATE LOCATION OF REPOSITORY HORIZON

UNSATURATED ZONE
CONCEPTUAL MODEL OF FLOW



NOT TO SCALE

A ALLUVIUM	TOPOPAH SPRING WELDED UNIT	WELDED UNIT
TIVA CANYON WELDED UNIT	CALICO HILLS NONWELDED UNIT	NONWELDED UNIT
PAINTBRUSH NONWELDED UNIT	CF CRATER FLAT UNIT (Undifferentiated)	SATURATED ZONE


IDEALIZED MOISTURE-
CHARACTERISTIC CURVES
MATRIX
COMBINED
FRACTURE
INCREASING LOG HYDRAULIC CONDUCTIVITY
INCREASING LIQUID-WATER SATURATION

GENERAL SCIENTIFIC CONSIDERATIONS RELATED TO ESF CONSTRUCTION METHOD

- PRINCIPAL REASON FOR CONSTRUCTING ESF IS TO OBTAIN SITE CHARACTERIZATION DATA

- THEREFORE, THE CONSTRUCTION METHOD SHOULD OPTIMIZE THE ABILITY TO:
  - MAKE <u>OBSERVATIONS</u> OF AMBIENT IN SITU CONDITIONS, PROCESSES, AND RELATIONSHIPS
  - OBTAIN RELIABLE <u>SAMPLES</u> FOR ANALYSIS

- TO HELP MEET SCIENTIFIC OBJECTIVES, CERTAIN FEATURES OF AN ESF CONSTRUCTION METHOD ARE DESIRABLE:
  1. DIRECT <u>ACCESS</u> TO SHAFT DURING CONSTRUCTION
  2. MINIMAL <u>DISTURBANCE</u> OF AMBIENT SITE CONDITIONS
  3. ABILITY TO <u>MONITOR</u> MAGNITUDE AND EXTENT OF DISTURBANCE

SCIENTIFIC REQUIREMENTS - ESF

• MAKE OBSERVATIONS AND OBTAIN SAMPLES

GEOLOGIC
- LITHOLOGY
- UNIT CONTACTS
- FRACTURE CHARACTERISTICS
- FAULTS
- IN SITU STRESS CONDITIONS

GEOCHEMICAL
- MINERALOGY OF FRACTURE COATINGS
- CHLORIDE AND CHLORINE-36

HYDROLOGIC
- MATRIX HYDRAULIC PROPERTIES
- FRACTURE HYDRAULIC PROPERTIES
- BULK HYDRAULIC AND PNEUMATIC PROPERTIES
- EFFECTS OF CONSTRUCTION ON HYDROLOGIC PROPERTIES
- PERCHED-WATER ZONES
  (HYDRAULIC PROPERTIES AND WATER CHEMISTRY)
- CHEMISTRY OF UZ WATER IN FRACTURES AND MATRIX PORES

DESIRABLE FEATURES OF ESF CONSTRUCTION METHOD

1. ACCESS TO SHAFT DURING CONSTRUCTION

- DIRECT, FREQUENT, PROMPT
- EVALUATE PERCHED WATER
- OBTAIN ROCK SAMPLES
- CONDUCT SHAFT-WALL MAPPING
- MONITOR DISTURBANCE
  - POTENTIAL ADVERSE EFFECTS ON SITE CONDITIONS
  - MECHANICAL RESPONSE OF ROCK MASS

DESIRABLE FEATURES

(CONTINUED)

2. MINIMIZE CONSTRUCTION-RELATED DISTURBANCE OF SITE CONDITIONS

- DISTURBANCE OF <u>HYDROGEOLOGIC</u> CONDITIONS
  - POTENTIAL EFFECTS; ROCK-MASS RESPONSE
  - ANALYSES
  - CONCLUSIONS
- DISTURBANCE OF <u>GEOCHEMICAL</u> CONDITIONS
  - POTENTIAL EFFECTS
  - ANALYSES AND CONCLUSIONS

HYDROGEOLOGIC CONDITIONS
POTENTIAL EFFECTS

- INTRODUCTION OF FLUIDS (MOST SIGNIFICANT CONCERN)

  - INCREASE MATRIX SATURATION, PERMEABILITY
  - INITIATE OR ENHANCE FLOW IN FRACTURES
  - MODIFY FLUX AMOUNT AND DISTRIBUTION
  - BIAS RESULTS OF HYDROLOGIC TESTS

- CREATION OF NEW FRACTURES; MODIFICATION OF EXISTING FRACTURES

  - CHANGE ROCK-MASS PERMEABILITY
  - CREATE PREFERENTIAL PATHWAYS FOR WATER AND GAS
  - BIAS RESULTS OF SHAFT-WALL FRACTURE MAPPING

POTENTIAL HYDROGEOLOGIC EFFECTS ANALYSES

- AS MUCH AS 3 M^3 (800 GAL) OF WATER PER METER OF SHAFT DEPTH COULD BE USED IN CONSTRUCTION ("NORMAL" DRILL AND BLAST METHOD)

- ABOUT 10% OF WATER IS NOT EXPECTED TO BE RE-COVERED

- MODIFIED PERMEABILITY ZONE (MPZ) IS ESTIMATED TO EXTEND 2-3 M BEYOND SHAFT WALL

- EXPECTED CHANGE IN MATRIX SATURATION:

  - IN MPZ: +0.035
  - BEYOND 10 M: <0.01

POTENTIAL HYDROGEOLOGIC EFFECTS ANALYSES

(CONTINUED)

- EXPECTED CHANGE IN ROCK-MASS PERMEABILITY:

  - EQUIVALENT PERMEABILITY AVERAGED OVER ANNULUS ONE RADIUS WIDE
  - COMBINED EFFECTS OF BLASTING AND STRESS REDISTRIBUTION
  - INCREASE IN PERMEABILITY:
    * IN MPZ: 20-80X
    * 4-5 M: < 2-3X
    * > 8 M: < 2X

REFERENCES:

CASE AND KELSALL (1987)
EATON AND PETERSON (1988)
SCP SECTION 8.4.3
WEST (1988)

NWTWILS5P.AII/4-11,12-89

POTENTIAL HYDROGEOLOGIC EFFECTS CONCLUSIONS

- INTRODUCTION OF FLUIDS

  - PRUDENT TO MINIMIZE INTRODUCTION OF FLUIDS

  - CONTROL AND MONITOR ALL FLUIDS USED
    * MINIMAL AMOUNTS
    * LOW HEADS
    * TRACERS

  - CHANGES IN MATRIX SATURATION EXPECTED TO BE SMALL

  - WATER IS EXPECTED TO TRAVEL ONLY SHORT DISTANCES

POTENTIAL HYDROGEOLOGIC EFFECTS CONCLUSIONS

(CONTINUED)

- MODIFICATION OF FRACTURE CHARACTERISTICS

  - IN UZ, FRACTURES GENERALLY ARE NOT PREFERENTIAL PATHWAYS, UNLESS MATRIX IS NEAR SATURATION OR FLUX IS LARGE
  - NONETHELESS, PRUDENT TO MINIMIZE EFFECTS OF BLASTING
  - USE CONTROLLED BLASTING TECHNIQUES
  - SOME TESTS ARE DESIGNED TO EVALUATE EFFECTS OF CONSTRUCTION
  - SOME ROUGHNESS OF SHAFT WALL IS DESIRABLE
  - ARTIFICIALLY CREATED FRACTURES CAN BE DISTINGUISHED FROM NATURAL FRACTURES IN SHAFT WALL

GEOCHEMICAL CONDITIONS POTENTIAL EFFECTS

- INTRODUCTION OF FLUIDS AND MATERIALS
  - WATER, SOLVENTS, AND HYDROCARBONS
  - CONCRETE SHAFT LINER
  - GASEOUS PRODUCTS FROM EXPLOSIVES
- POSSIBLE SIGNIFICANCE OF ALTERING GEOCHEMICAL ENVIRONMENT
  - AFFECT WASTE-PACKAGE INTEGRITY
  - REDUCE CAPABILITY OF TUFF TO RETARD TRANSPORT OF RADIONUCLIDES
  - CHEMICAL PRECIPITATION OR DISSOLUTION ALONG FLOW PATHS COULD ALTER FLUX DISTRIBUTION
  - BIAS RESULTS OF HYDROCHEMISTRY AND Cl-36 TESTS
  - ORGANICS COULD SUPPORT MICRO-ORGANISMS

POTENTIAL GEOCHEMICAL EFFECTS ANALYSES AND CONCLUSIONS

- WATER, HYDROCARBONS, AND SOLVENTS
  - AMOUNTS ARE SMALL, VOLUME OF ROCK AFFECTED SMALL, AND DEPTH OF PENETRATION MINIMAL
- CONCRETE SHAFT LINER
  - EFFECTS OF CONCRETE ON J-13 WATER
  - INCREASE PH; INCREASE CONCENTRATIONS OF NA^+, K^+, OH^-, AND SO_4^{--}
  - POSSIBLE FORMATION OF PRECIPITATES
  - EFFECTS ARE LOCALIZED

POTENTIAL GEOCHEMICAL EFFECTS ANALYSES AND CONCLUSIONS

(CONTINUED)

- PRESENCE OF MICRO-ORGANISMS NOT KNOWN TO BE DETRIMENTAL

- GASEOUS PRODUCTS FROM EXPLOSIVES
  - SMALL AMOUNTS OF NO, CO, NH_2, CH_4
  - MOST WILL BE VENTILATED TO SURFACE
  - SOME MAY PENETRATE 1-2 M INTO ROCK
  - CL WILL NOT BE USED IN EXPLOSIVES

- HYDROCHEMISTRY SAMPLES
  - INTERIOR CORES OF LARGE BLOCK SAMPLES
  - CORES FROM RADIAL BOREHOLES
  - TRACER ANALYSES

REFERENCES:
FERNANDEZ AND OTHERS (1988)
WEST (1988)

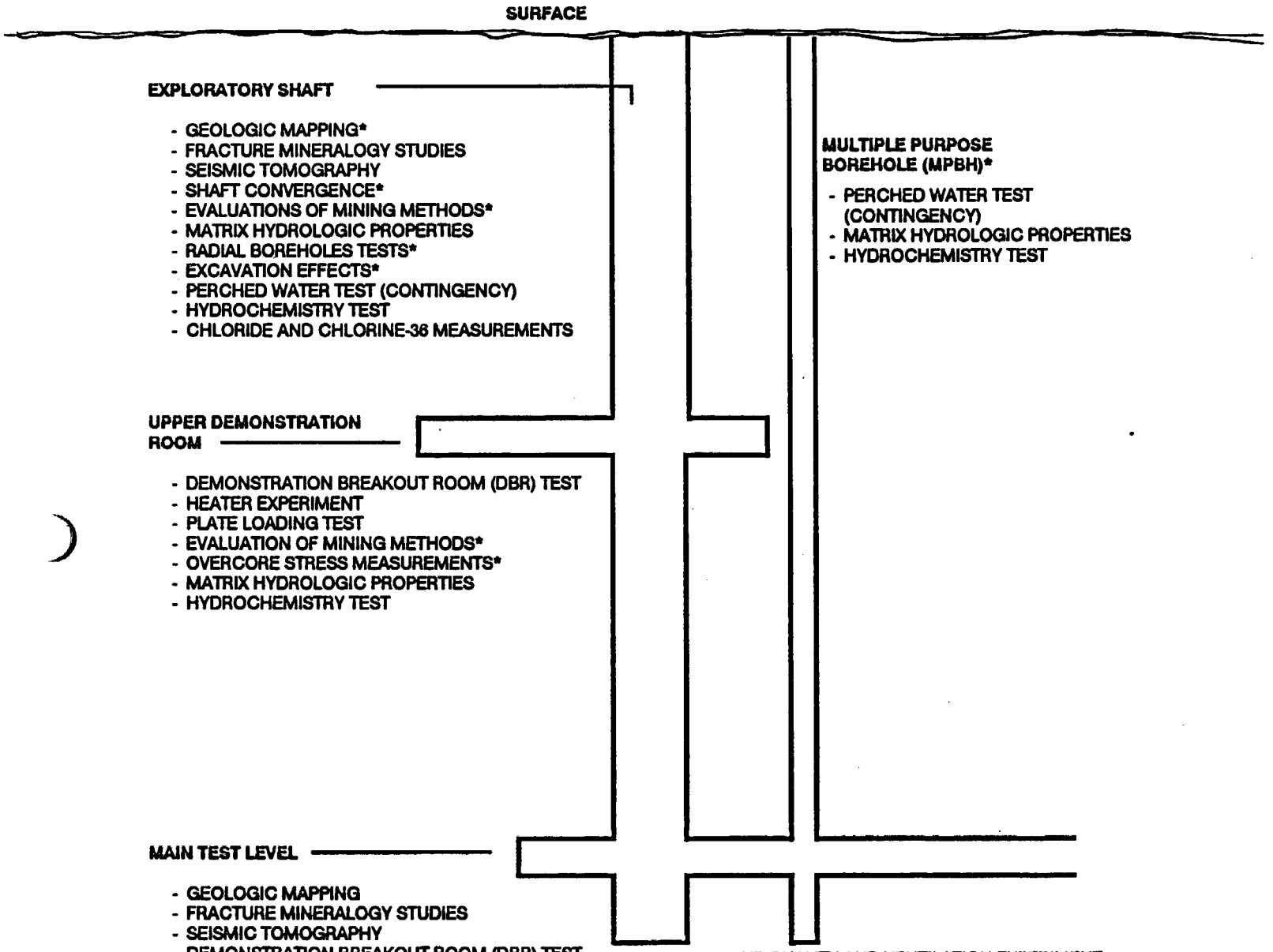
NWTWILS5P.AII/4-11,12-89

DESIRABLE FEATURES OF ESF CONSTRUCTION METHOD

3. ABILITY TO MONITOR DISTURBANCES

- NEED TO VERIFY MODELS AND CHECK PREDICTIONS
- IN ES HYDROLOGIC TESTS, NEED TO ACCOUNT FOR DISTURBANCES
- REQUIRES PRE- AND POST-CONSTRUCTION DATA
- CONDUCT CONSTRUCTION-PHASE MONITORING TESTS

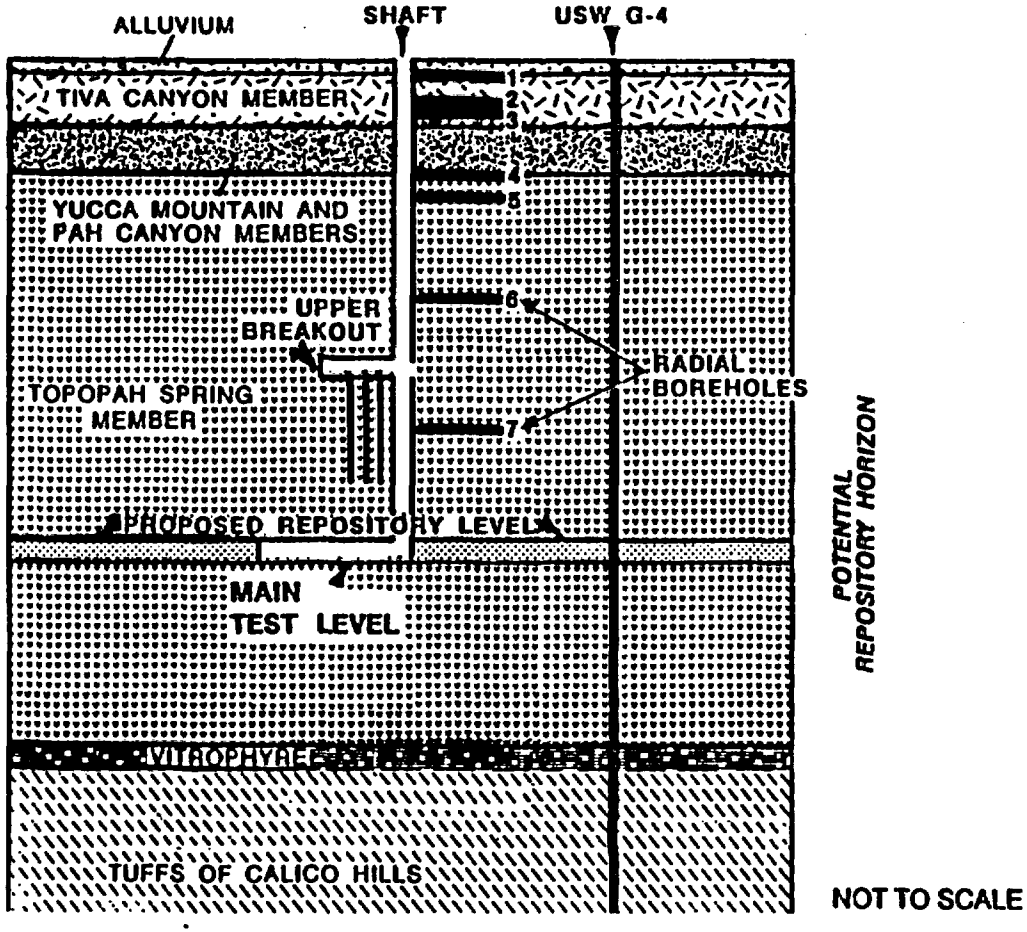
LOCATION AND TYPE OF TEST IN THE EXPLORATORY SHAFT FACILITY



* = TESTS INTENDED TO MONITOR EFFECTS OF SHAFT CONSTRUCTION

SCTPCHA.CPG 4/11/88

RADIAL BOREHOLE TESTS AND EXCAVATION EFFECTS TEST IN THE EXPLORATORY SHAFT FACILITY



- INVESTIGATE VERTICAL AND LATERAL MOVEMENT OF GAS, WATER, AND VAPOR ON AND ACROSS HYDROGEOLOGIC CONTACTS AND WITHIN THE TOPOPAH SPRING UNIT UNDER MINIMALLY DISTURBED CONDITIONS

- EVALUATE NEAR-FIELD EXCAVATION EFFECTS ON HYDROLOGIC PROPERTIES

NRCVG5P.A08/12-8-88

SUMMARY

- SCIENTIFIC CONSIDERATIONS EXERT A MAJOR INFLUENCE ON SELECTION OF SHAFT-CONSTRUCTION METHOD AT YUCCA MOUNTAIN

- UZ SETTING AT YUCCA MOUNTAIN INFLUENCES SPECIFIC INFORMATION NEEDS

- GENERAL SCIENTIFIC REQUIREMENTS:

  - MAKE HYDROGEOLOGIC AND GEOCHEMICAL OBSERVATIONS
  - OBTAIN RELIABLE ROCK AND WATER SAMPLES
  - HAVE DIRECT ACCESS DURING CONSTRUCTION
  - MINIMIZE CONSTRUCTION-RELATED DISTURBANCES
    * FLUID LOSSES AND ROCK DAMAGE
  - MONITOR DISTURBANCES
    * CHARACTERIZATION, PERFORMANCE
    * MECHANICAL RESPONSE

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

ENGINEERING CONSIDERATIONS

PRESENTED BY

KEN BEALL

APRIL 11, 1989

ENGINEERING CONSIDERATIONS OUTLINE

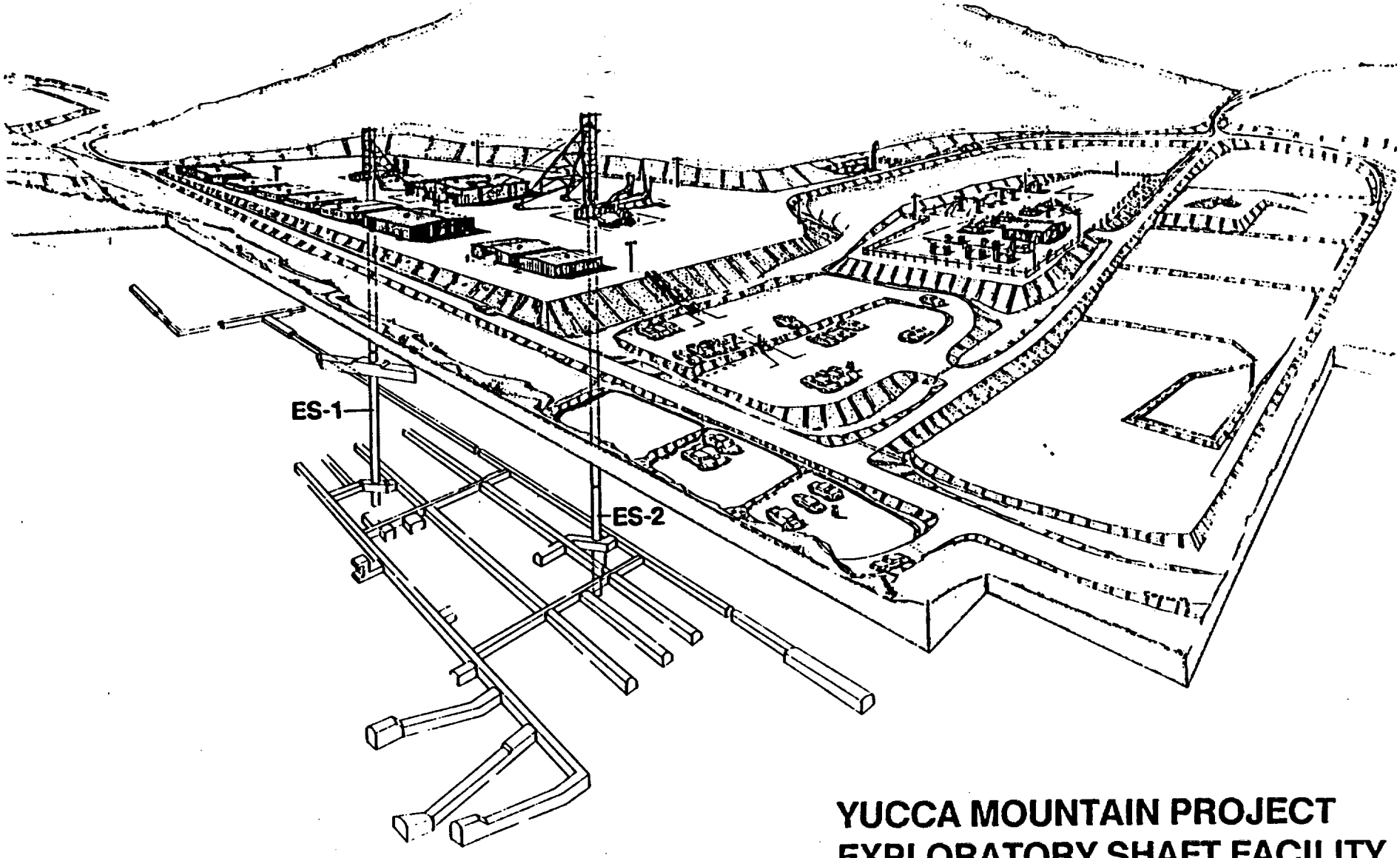
I. OVERVIEW OF ESF

II. CONSTRUCTION METHOD SELECTION CRITERIA
- A. DISCRIMINATING CRITERIA
- B. OTHER IMPORTANT CRITERIA
- C. SHAFT CONSTRUCTION PHASE TEST LOCATIONS

III. SHAFT CONSTRUCTION METHODS
- A. RAISE BORING
- B. RAISE BORING/SLASHING
- C. RAISE BORING/V-MOLE
- D. BLIND DRILLING (WET)
- E. CONVENTIONAL SINKING

IV. COMPARISON OF CONSTRUCTION METHODS VERSUS CRITERIA

V. CONCLUSION



YUCCA MOUNTAIN PROJECT
EXPLORATORY SHAFT FACILITY

ESF SHAFTS

FUNCTION	ES-1 SCIENCE/ TESTING	ES-2 MEN & MATERIALS
DIAMETER	12'	12'
UPPER DEMONSTRATION BREAKOUT ROOM	600'	N/A
MTL	1055'	1055'
SHAFT DEPTH	1105'*	1158'

* DESIGN HAS FLEXIBILITY TO DEEPEN (400') THE SHAFT TO THE CALICO HILLS FORMATION IF REQUIRED BY THE SITE CHARACTERIZATION PROGRAM

MAIN TEST LEVEL

MAIN TEST AREA DRIFTING	4,400 FT.
EXPLORATORY DRIFTING TO FAULTS	5,000 FT.
ROOM SIZES	14X14 TO 27X19
TONS OF ROCK EXCAVATED	160,000 TONS

ENGINEERING CONSIDERATIONS

II. CONSTRUCTION METHOD SELECTION CRITERIA

1. SITE CHARACTERIZATION
2. CONSTRUCTIBILITY
3. HEALTH AND SAFETY
4. ENVIRONMENT
5. SCHEDULE

ENGINEERING CONSIDERATIONS

II. CONSTRUCTION METHOD SELECTION CRITERIA (CONTINUED)

A. DISCRIMINATING CRITERIA

1. SITE CHARACTERIZATION
   - ROCK OBSERVATION
   - HYDROLOGIC OBSERVATION
   - ACCESS TO MULTIPLE HORIZONS
   - SAMPLE COLLECTION
   - ROCK DAMAGE
   - FLUID LOSSES
2. CONSTRUCTIBILITY
   - WATER AND GROUND CONTROL
   - UNEXPECTED CONDITIONS
   - OVERBREAK
5. SCHEDULE
   - CONSTRUCTION TIME

ENGINEERING CONSIDERATIONS
FOR SITE CHARACTERIZATION

ROCK OBSERVATIONS

- THE CONSTRUCTION METHOD MUST SUPPORT COMPREHENSIVE EVALUATION OF THE ROCK CHARACTERISTICS ALONG THE SHAFT WALL

  - INVESTIGATION OF FAULTS AND FRACTURES
    - * APERTURES
      INFILLING (DETERIORATION, WASH OUT, MECHANICAL DISTURBANCE)
    - * MECHANICAL RESPONSE
      RELATION TO EXCAVATION, TIME DEPENDENT EFFECTS
    - * EXCAVATION, BULK SAMPLING, INSTRUMENTATION

ENGINEERING CONSIDERATIONS FOR SITE CHARACTERIZATION

(CONTINUED)

HYDROLOGIC OBSERVATIONS

- THE CONSTRUCTION METHOD MUST SUPPORT COMPREHENSIVE INVESTIGATION OF HYDROLOGIC CHARACTERISTICS ALONG THE SHAFT WALL
  - PERCHED WATER (DETECTED AND COLLECTED AS ENCOUNTERED)
  - HYDRAULIC CHARACTER OF FAULTS OR FRACTURES
  - SATURATION PROFILE (NEAR AMBIENT CONDITIONS; BLOCK SAMPLES FROM FACE)

ENGINEERING CONSIDERATIONS FOR SITE CHARACTERIZATION

(CONTINUED)

ACCESS TO MULTIPLE HORIZONS

- THE CONSTRUCTION METHOD MUST SUPPORT TESTING AT VARIOUS LEVELS OF THE SHAFT DURING CONSTRUCTION
  - PRE-DEFINED LEVELS (UNDERSTAND BOUNDS ON GEOMECHANICAL PROPERTIES)
  - INVESTIGATE SPECIFIC UNEXPECTED FEATURES

ENGINEERING CONSIDERATIONS FOR SITE CHARACTERIZATION

(CONTINUED)

SAMPLE COLLECTION

- THE CONSTRUCTION METHOD MUST SUPPORT DURING CONSTRUCTION COMPREHENSIVE COLLECTION OF ROCK AND WATER SAMPLES
  - AS SOON AS PRACTICABLE FOLLOWING EXCAVATION
  - LIMIT SATURATION CHANGES
  - OBTAIN UNCONTAMINATED WATER SAMPLES

ENGINEERING CONSIDERATIONS FOR SITE CHARACTERIZATION

(CONTINUED)

ROCK DAMAGE

- THE CONSTRUCTION METHOD MUST LIMIT IMPACTS TO THE SITE
  - SITE AMBIENT CONDITIONS
  - ABILITY TO CORRECTLY CHARACTERIZE SITE
  - PERFORMANCE OF THE REPOSITORY

ENGINEERING CONSIDERATIONS FOR SITE CHARACTERIZATION

(CONTINUED)

FLUID LOSSES

- THE CONSTRUCTION METHOD MUST LIMIT IMPACTS TO THE SITE
  - FLUID INFILTRATION ON SITE AMBIENT CONDITIONS
  - ABILITY TO CORRECTLY CHARACTERIZE SITE
  - PERFORMACE OF THE REPOSITORY

II. CONSTRUCTION METHOD SELECTION CRITERIA

A. DISCRIMINATING CRITERIA

1. SITE CHARACTERIZATION

- ROCK OBSERVATION
- HYDROLOGIC OBSERVATION
- ACCESS TO MULTIPLE HORIZONS
- SAMPLE COLLECTION
- ROCK DAMAGE
- FLUID LOSSES

➔2. CONSTRUCTIBILITY

- WATER AND GROUND CONTROL
- UNEXPECTED CONDITIONS
- OVERBREAK

5. SCHEDULE

- CONSTRUCTION TIME

ENGINEERING CONSIDERATIONS FOR CONSTRUCTIBILITY

WATER AND GROUND CONTROL

- THE CONSTRUCTION METHOD MUST ALLOW IMMEDIATE ACCESS FOR CONTROLLING THE RESULTS OF THE EXCAVATION PROCESS
  - CONTROL GROUND WATER INFLOW
  - INSTALL GROUND SUPPORT TO PREVENT ROCKFALLS
  - KEEP EXCAVATION OVERBREAK TO ACCEPTABLE LIMITS

ENGINEERING CONSIDERATIONS FOR CONSTRUCTIBILITY

(CONTINUED)

UNEXPECTED CONDITIONS

- THE CONSTRUCTION METHOD MUST BE RESPONSIVE TO UNEXPECTED GEOLOGIC AND HYDROLOGIC CONDITIONS
  - IDENTIFY CONDITIONS QUICKLY
  - EVALUATE UNEXPECTED CONDITIONS
  - TAKE CORRECTIVE OR MITIGATING ACTION BEFORE PROCEEDING
  - NRC REQUIRES THAT UNEXPECTED CONDITIONS BE THOROUGHLY CHARACTERIZED

ENGINEERING CONSIDERATIONS FOR CONSTRUCTIBILITY

(CONTINUED)

OVERBREAK

- ABILITY OF THE METHOD TO MINIMIZE EXCAVATION ENLARGEMENT BEYOND THE INTENDED DIAMETER
  - INADEQUATE CONTROL OF DRILLING AND BLASTING
  - FRACTURED AND UNSUPPORTED ROCK

II. CONSTRUCTION METHOD SELECTION CRITERIA

A. DISCRIMINATING CRITERIA

1. SITE CHARACTERIZATION

- ROCK OBSERVATION
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- ACCESS TO MULTIPLE HORIZONS
- SAMPLE COLLECTION
- ROCK DAMAGE
- FLUID LOSSES

2. CONSTRUCTIBILITY

- WATER AND GROUND CONTROL
- UNEXPECTED CONDITIONS
- OVERBREAK

➔ 5. SCHEDULE

- CONSTRUCTION TIME

ENGINEERING CONSIDERATIONS
FOR SCHEDULE

CONSTRUCTION TIME

- LONGER TIME REQUIRED FOR RAISE BORING ES-2 OPTION THAN FOR CONVENTIONAL SINKING ES-1, ES-2 CONCURRENTLY

II. CONSTRUCTION METHOD

B. OTHER IMPORTANT CRITERIA

2. CONSTRUCTIBILITY

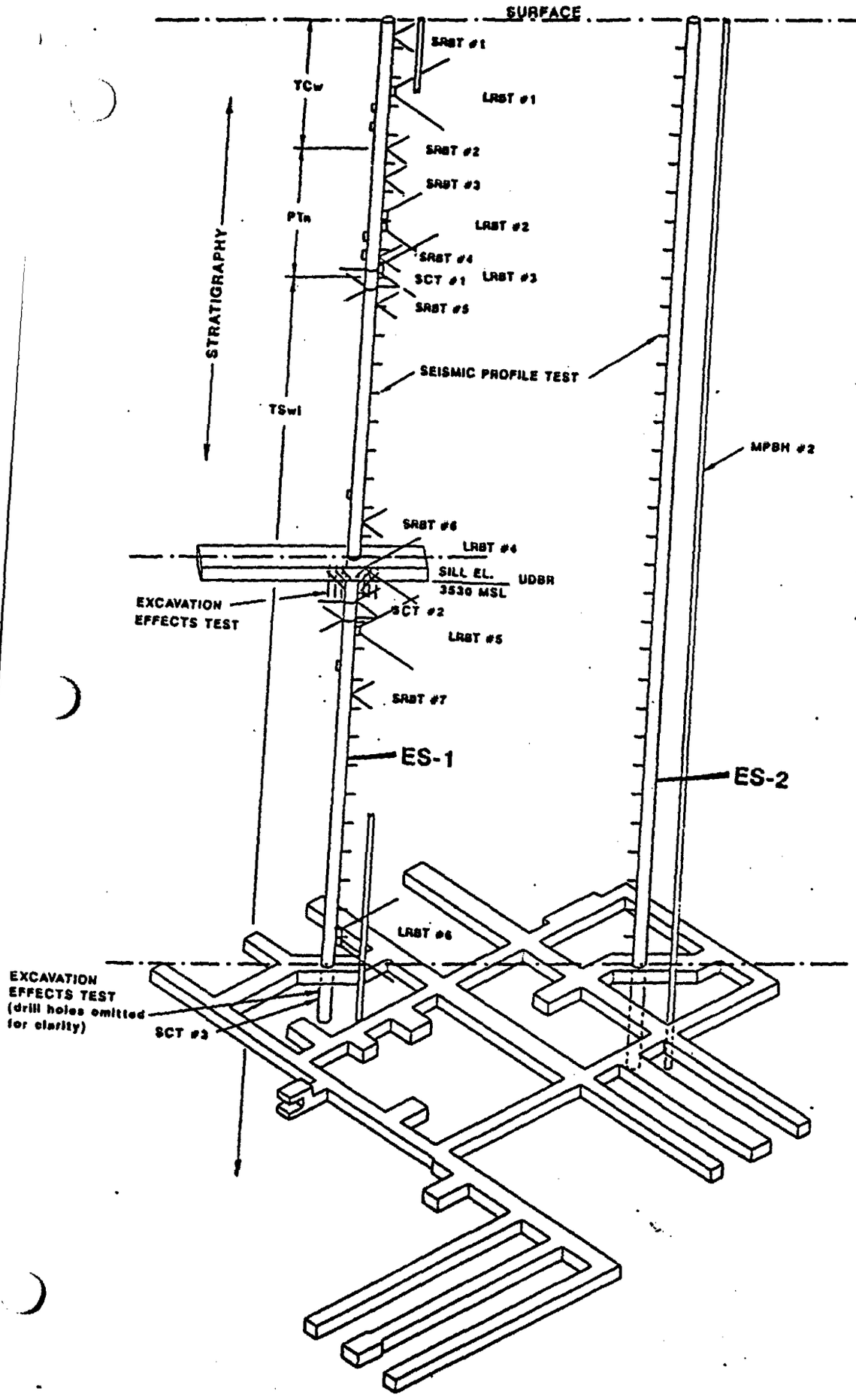
- SHAFT
- EXPERIENCE

3. HEALTH AND SAFETY

- INDUSTRIAL HAZARDS
- WORKING CONDITIONS

4. ENVIRONMENTAL

- RECLAMATION
- SURFACE DISTURBANCE
- EFFLUENT CONTROL
- AIR QUALITY



- NO. OF LANDINGS IN ES-1 REQ'D. TO ACCESS & SUPPORT TESTS----20 (DOES NOT INCLUDE UDBR & MTL)
- TIME REQUIRED FOR MAPPING INCLUDING PREPARATION - 3 HOURS PER 2 METER INTERVAL
- SHAFT TIME REQUIRED FOR TEST CONSTRUCTION (SINKING STOPS DURING CONSTRUCTION)
  - SHORT RADIAL BORE HOLES TEST - 2 WEEKS
  - LONG RADIAL BORE HOLES TEST - 2 WEEKS
  - SHAFT CONVERGENCE TEST - 2 WEEKS
  - PERCHED WATER TEST - INDEFINITE

SHAFT CONSTRUCTION PHASE TEST LOCATIONS

ENGINEERING CONSIDERATIONS OUTLINE

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➡ III. SHAFT CONSTRUCTION METHODS
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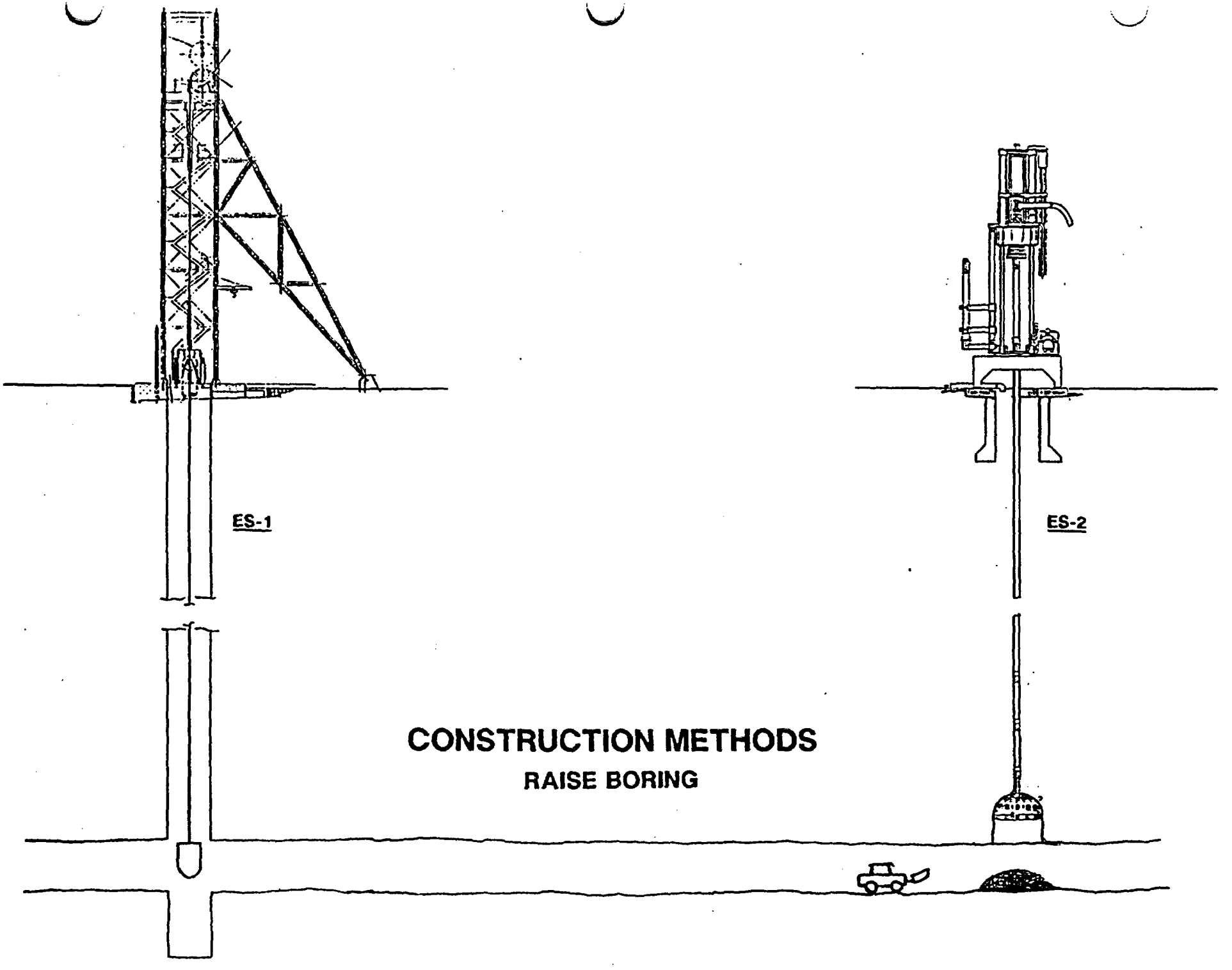
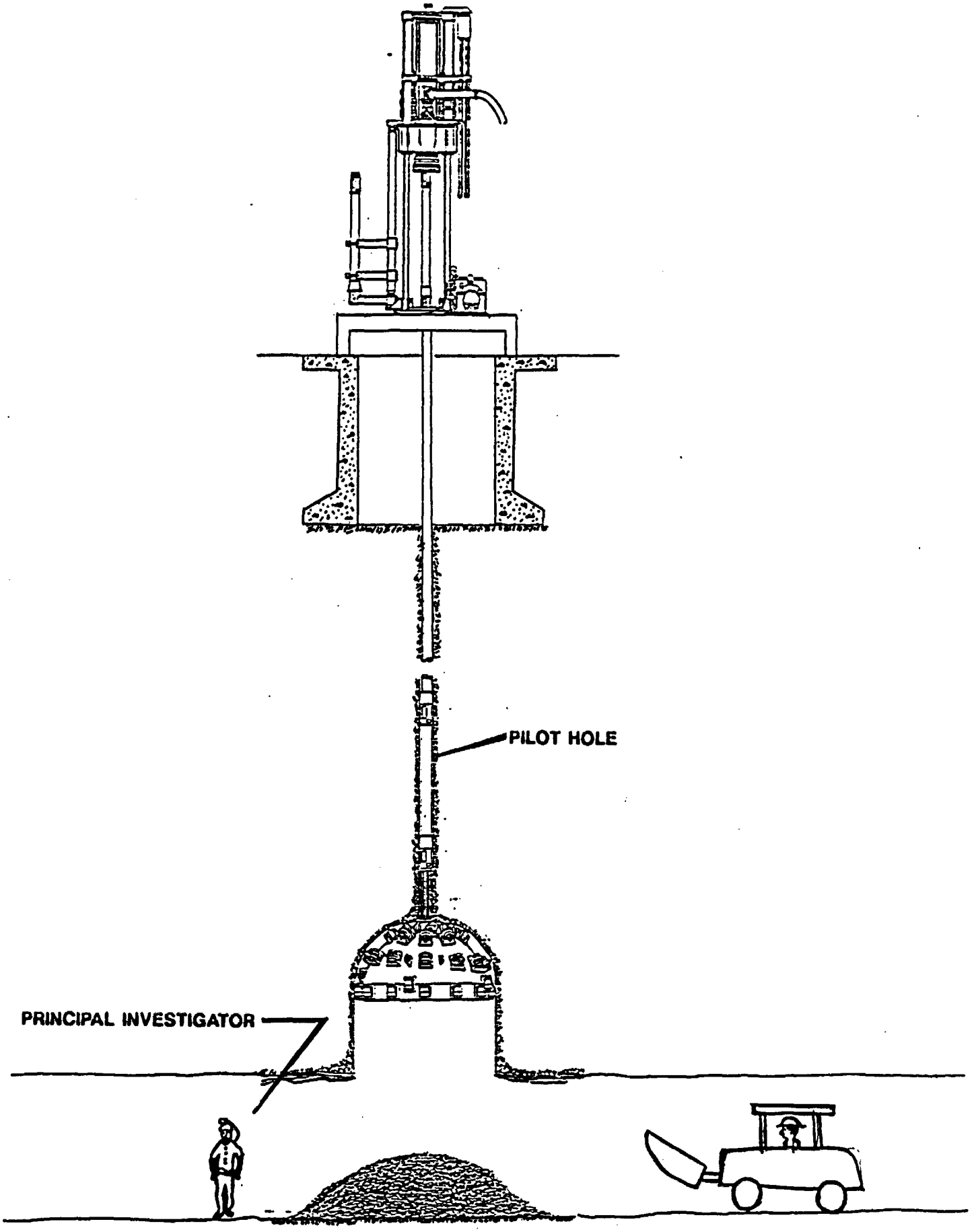
V. CONCLUSION



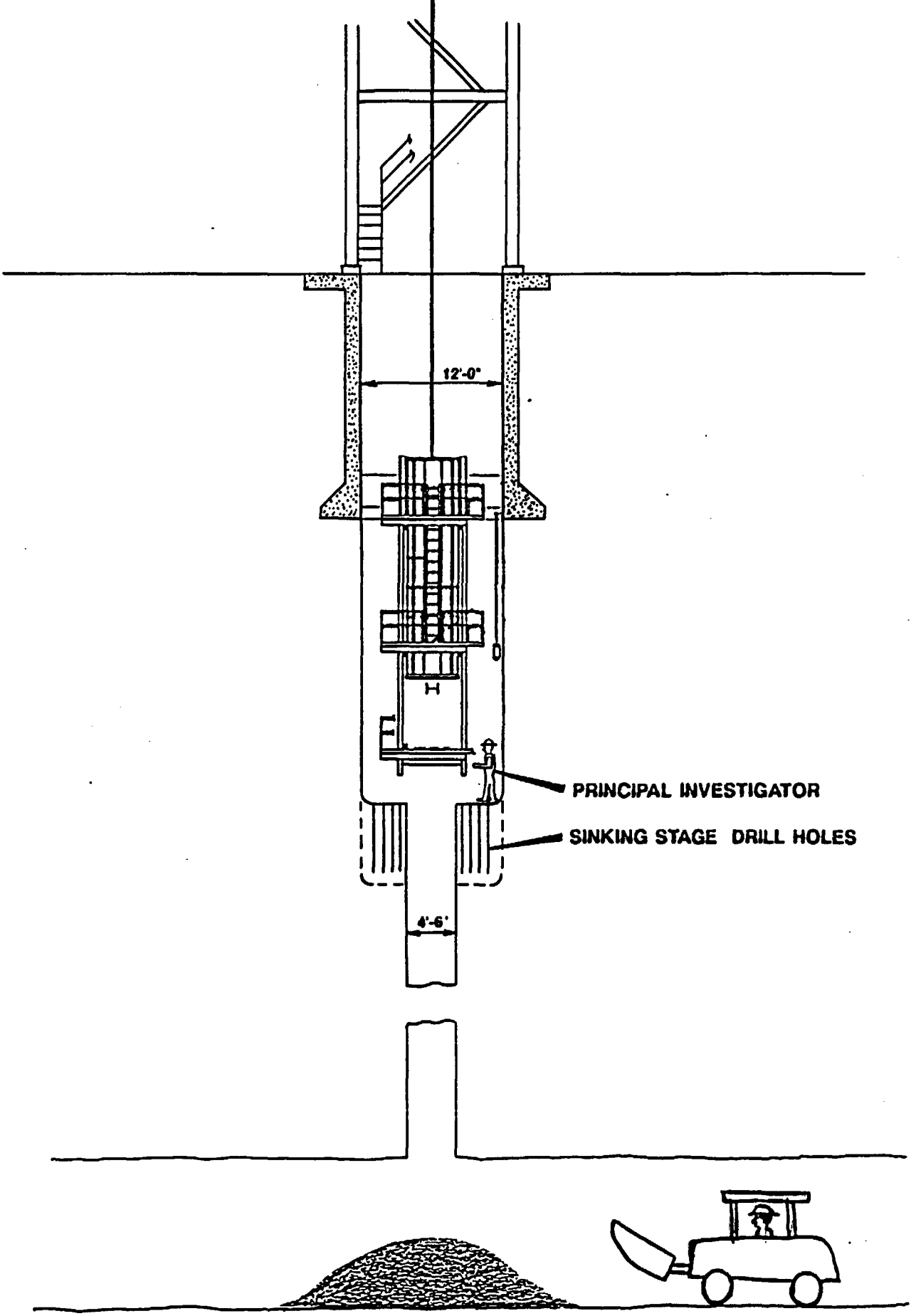
CONSTRUCTION METHODS

RAISE BORING



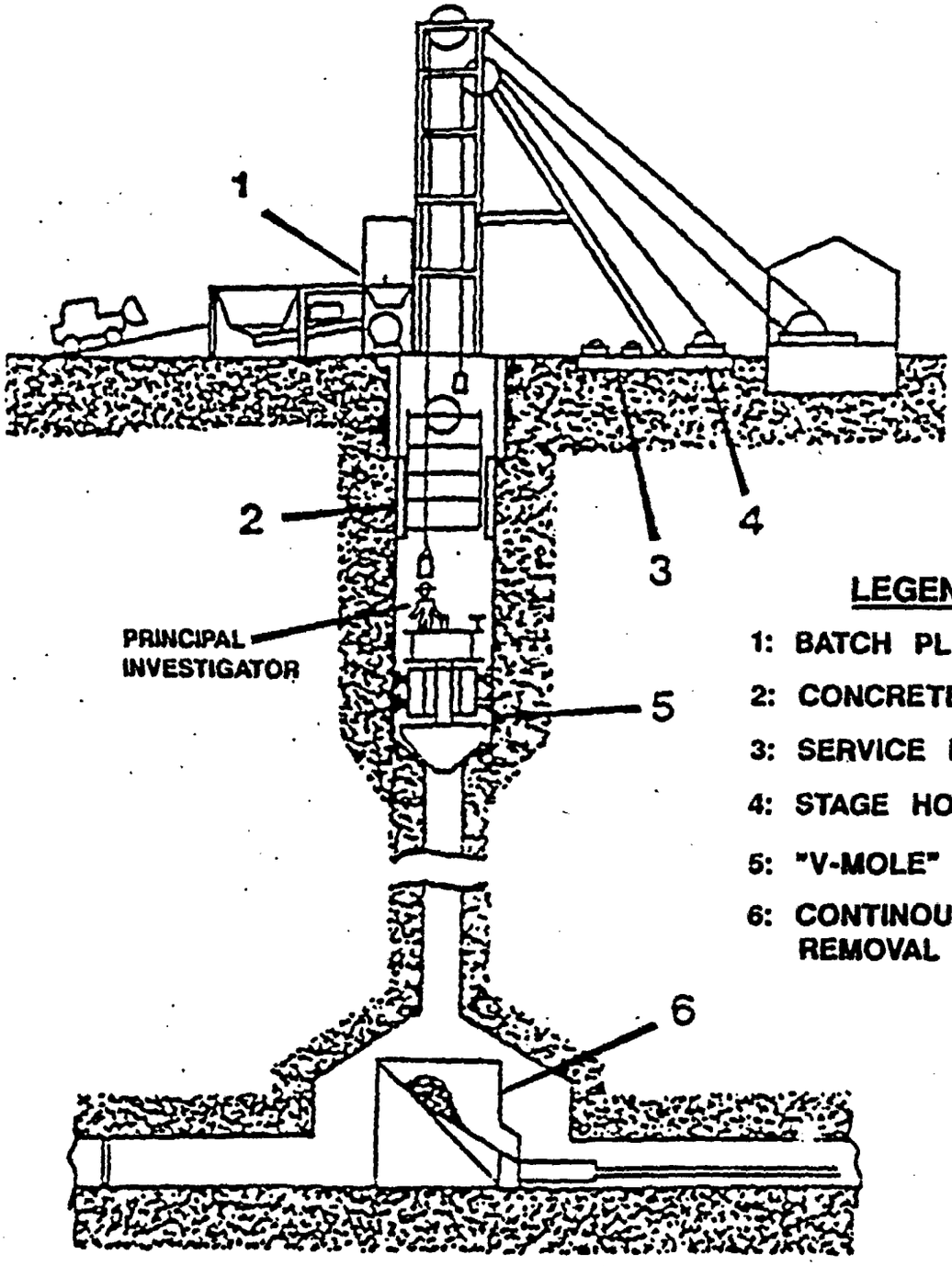
CONSTRUCTION METHODS

RAISE BORING



CONSTRUCTION METHODS

RAISE BORING / SLASHING



LEGEND:

1: BATCH PLANT

2: CONCRETE LINING

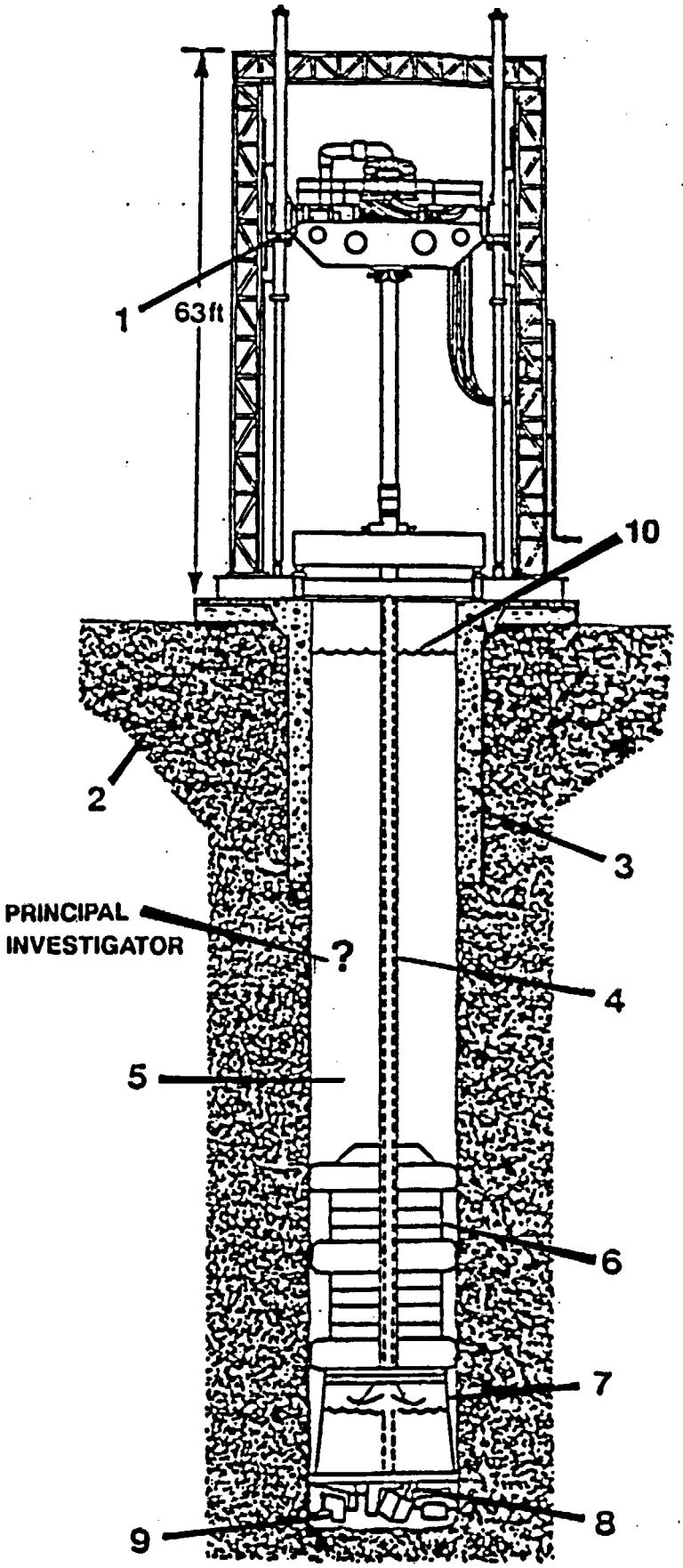
3: SERVICE HOISTS

4: STAGE HOIST

5: "V-MOLE" BORER

6: CONTINOUS MUCK REMOVAL

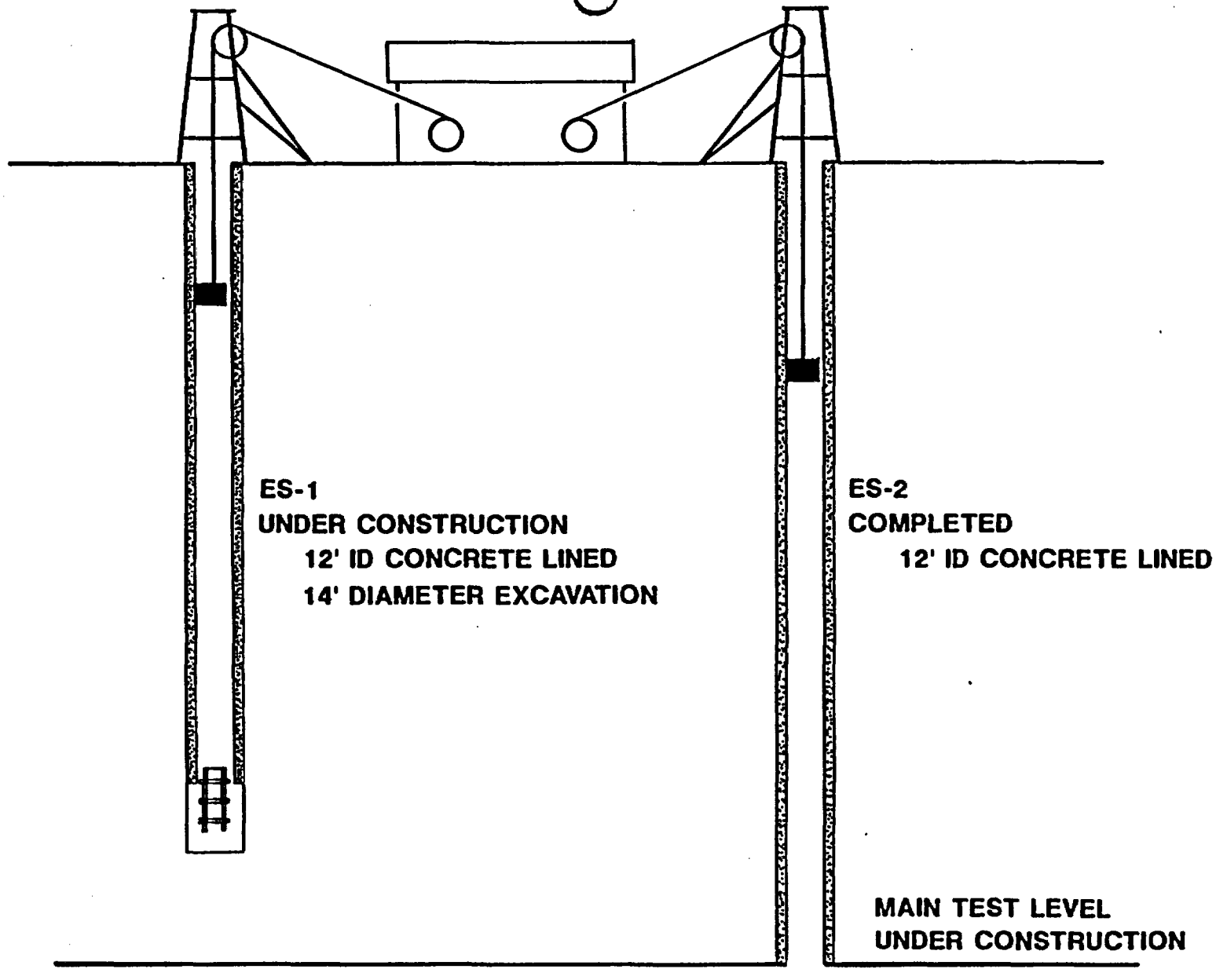
CONSTRUCTION METHODS
RAISED BORING/"V-MOLE"



LEGEND:

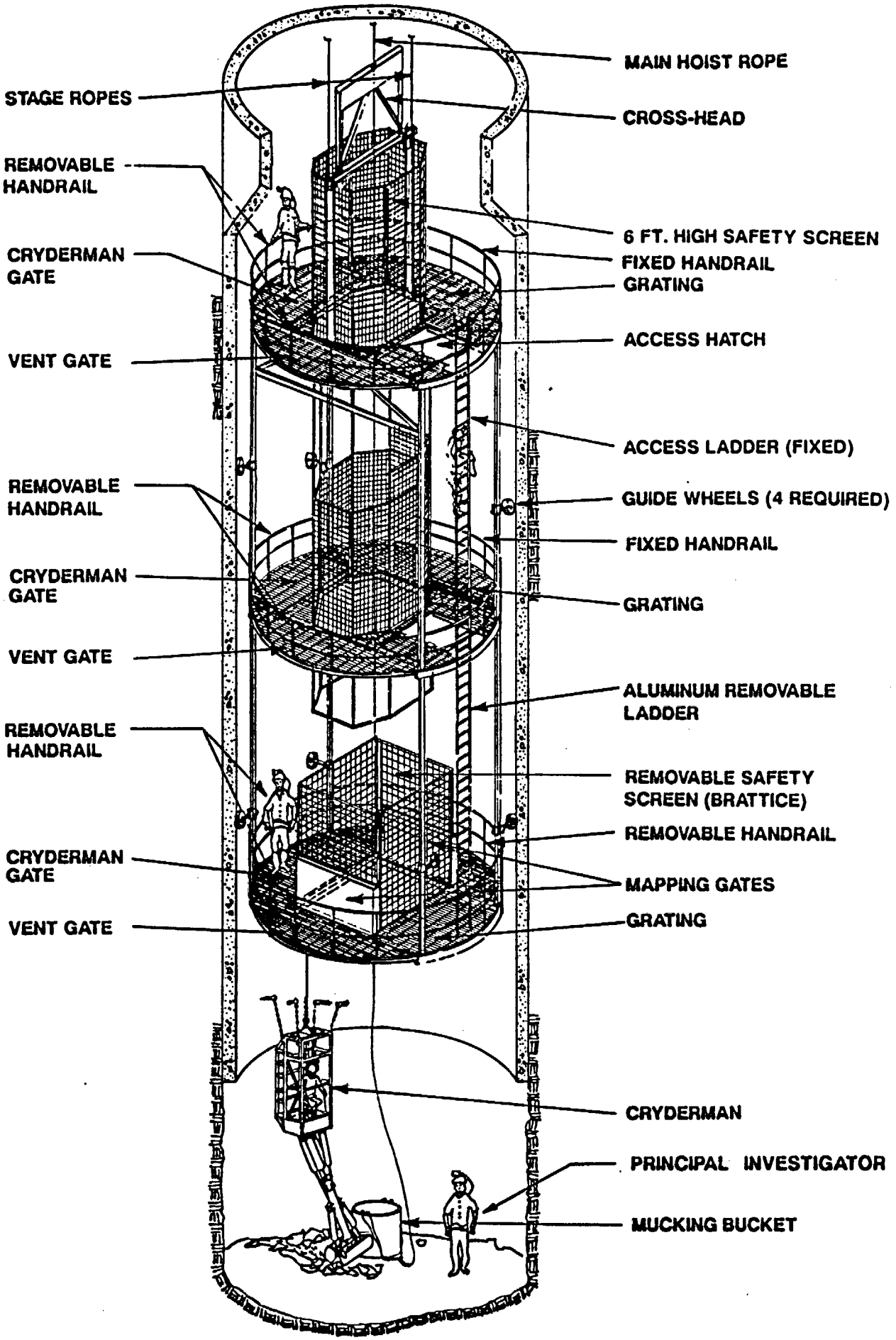
1: POWER SWIVEL
2: ROCK
3: SHAFT COLLAR
4: DUAL WALL PIPE
5: DRILL FLUID
6: WEIGHTS
7: BIT BODY
8: JET NOZZLES
9: CUTTERS
10: DRILLING FLUID SURFACE

CONSTRUCTION METHODS
"BLIND BORING"

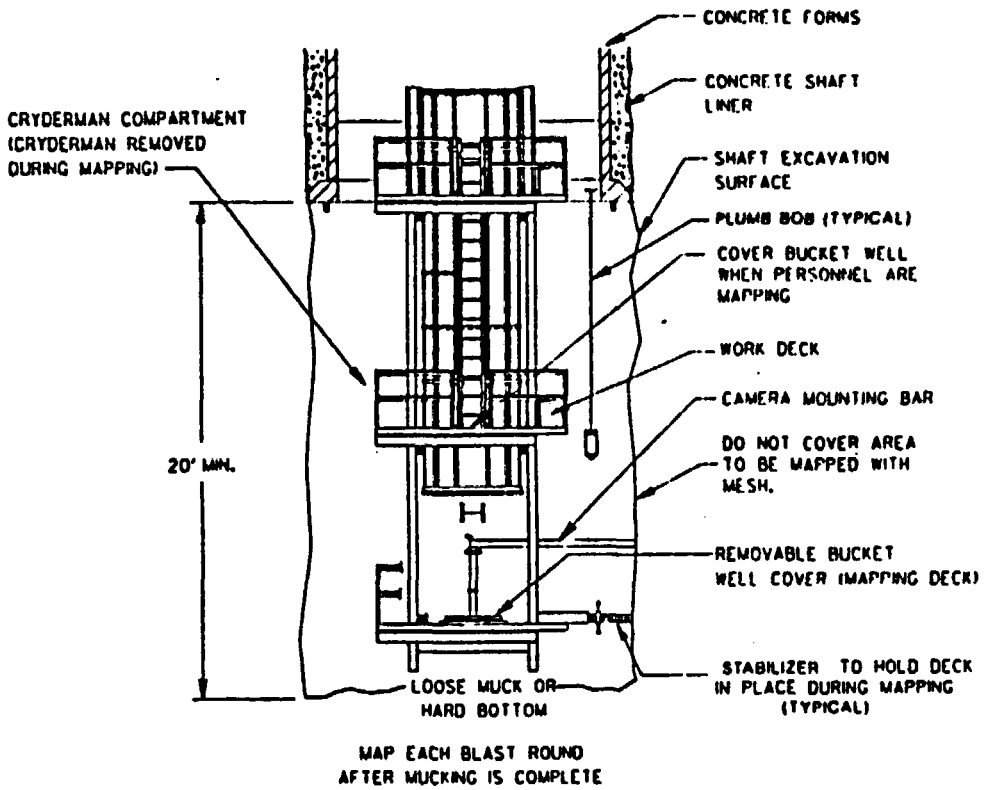


CONSTRUCTION METHODS

CONVENTIONAL SINKING



CONVENTIONAL SINKING SINKING STAGE



SHAFT MAPPING & PHOTOGRAPHY TEST

MAPPING DECK

ENGINEERING CONSIDERATIONS OUTLINE

I. OVERVIEW OF ESF

II. CONSTRUCTION METHOD SELECTION CRITERIA
- A. DISCRIMINATING CRITERIA
- B. OTHER IMPORTANT CRITERIA
- C. SHAFT CONSTRUCTION PHASE TEST LOCATIONS

III. SHAFT CONSTRUCTION METHODS
- A. RAISE BORING
- B. RAISE BORING/SLASHING
- C. RAISE BORING/V-MOLE
- D. BLIND DRILLING (WET)
- E. CONVENTIONAL SINKING

➡ IV. COMPARISON OF CONSTRUCTION METHODS VERSUS CRITERIA

V. CONCLUSION

COMPARISON OF CONSTRUCTION METHODS

RAISE BORING

- MINIMAL ROCK DAMAGE
- MINIMAL OVERBREAK IN GOOD GROUND CONDITIONS
- DOESN'T PROVIDE EARLY OR CONTINUED ACCESS FOR SITE CHARACTERIZATION ACTIVITIES DURING SHAFT CONSTRUCTION
- DOESN'T ALLOW COLLECTION OF BULK SAMPLES
- OFFERS NO CONTROL FOR INFLOWING WATER AND SLOUGHING GROUND
- MAY NOT DETECT UNEXPECTED CONDITIONS QUICKLY
- CANNOT START ES-2 UNTIL ES-1 IS COMPLETED - RESULTS IN A LONGER SHAFT CONSTRUCTION SCHEDULE

COMPARISON OF CONSTRUCTION METHODS

RAISE BORING/SLASHING

- PROVIDES EARLY AND CONTINUED ACCESS FOR SITE CHARACTERIZATION DURING SLASHING
- ALLOWS COLLECTION OF BULK SAMPLES
- SHAFT WILL BE PLUMB AND STRAIGHT
- RAISE BORED HOLE OFFERS NO CONTROL FOR INFLOWING WATER
- AMBIENT HYDROLOGIC CONDITIONS MAY BE COMPROMISED BY INITIAL RAISE BORED HOLE
- MAY NOT DETECT UNEXPECTED CONDITIONS IN THE RAISE BORED HOLE
- OVERBREAK CAN BE LIMITED WITH CONTROLLED BLASTING TECHNIQUES AND TIMELY INSTALLATION OF GROUND SUPPORT
- CANNOT START ES-2 UNTIL ES-1 IS COMPLETED - RESULTS IN A LONGER SHAFT CONSTRUCTION SCHEDULE

COMPARISON OF CONSTRUCTION METHODS

RAISE BORING/V MOLE

- MINIMAL ROCK DAMAGE
- PROVIDES EARLY AND CONTINUED ACCESS FOR SITE CHARACTERIZATION DURING SHAFT CONSTRUCTION
- CAN DETECT, EVALUATE AND RESPOND TO UNEXPECTED CONDITIONS IN THE LARGER BORED HOLE
- MINIMAL OVERBREAK AND TIMELY INSTALLATION OF GROUND SUPPORT
- SHAFT WILL BE PLUMB AND STRAIGHT
- ALLOWS SOME COLLECTION OF BULK SAMPLES
- AMBIENT HYDROLOGIC CONDITIONS MAY BE COMPROMISED BY INITIAL RAISE BORED HOLE
- RAISE BORED HOLE OFFERS NO CONTROL FOR INFLOWING WATER
- MAY NOT DETECT UNEXPECTED CONDITIONS IN THE RAISE BORED HOLE
- CANNOT START ES-2 UNTIL ES-1 IS COMPLETED - RESULTS IN A LONGER SHAFT CONSTRUCTION SCHEDULE

COMPARISON OF CONSTRUCTION METHODS

BLIND DRILLING (WET)

- MINIMAL OVERBREAK IN GOOD GROUND CONDITIONS
- DOESN'T PROVIDE EARLY OR CONTINUED ACCESS FOR SITE CHARACTERIZATION
- DOESN'T ALLOW COLLECTION OF BULK SAMPLES
- HYDROFRACTURING FROM THE DRILLING MUD COULD DAMAGE THE ROCK
- DRILLING FLUID LOSSES COULD ADVERSLY IMPACT SITE CHARACTERIZATION AND REPOSITORY PERFORMANCE
- OFFERS LIMITED CONTROL FOR WATER INFLOW AND SLOUGHING GROUND
- MAY NOT DETECT UNEXPECTED CONDITIONS
- SHAFT MAY NOT BE PLUMB OR STRAIGHT

COMPARISON OF CONSTRUCTION METHODS

CONVENTIONAL SINKING

- PROVIDES EARLY AND CONTINUED ACCESS FOR SITE CHARACTERIZATION
- ALLOWS COLLECTION OF BULK SAMPLES
- WATER AND GROUND CONTROL PROCEDURES CAN BE INITIATED IMMEDIATELY
- CAN READILY DETECT, EVALUATE AND RESPOND TO UNEXPECTED CONDITIONS
- OVERBREAK CAN BE LIMITED WITH CONTROLLED BLASTING TECHNIQUES AND TIMELY INSTALLATION OF GROUND SUPPORT
- SHAFT WILL BE PLUMB AND STRAIGHT
- RESULTS IN MINIMUM SHAFT CONSTRUCTION SCHEDULE

ENGINEERING CONSIDERATIONS OUTLINE

I. OVERVIEW OF F

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IV. COMPARISON OF CONSTRUCTION METHODS VERSUS CRITERIA

➡ V. CONCLUSION

CONCLUSION

FROM AN ENGINEERING PERSPECTIVE, WHEN ONE CONSIDERS ALL THE CRITERIA, IT IS ENGINEERING'S JUDGEMENT THAT CONVENTIONAL SHAFT SINKING IS THE BEST CONSTRUCTION METHOD FOR BOTH ES-1 AND ES-2

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

CONCLUSIONS

APPROACH TO EXPLORATORY SHAFT CONSTRUCTION AND ALTERNATIVES CONSIDERED

PRESENTED BY

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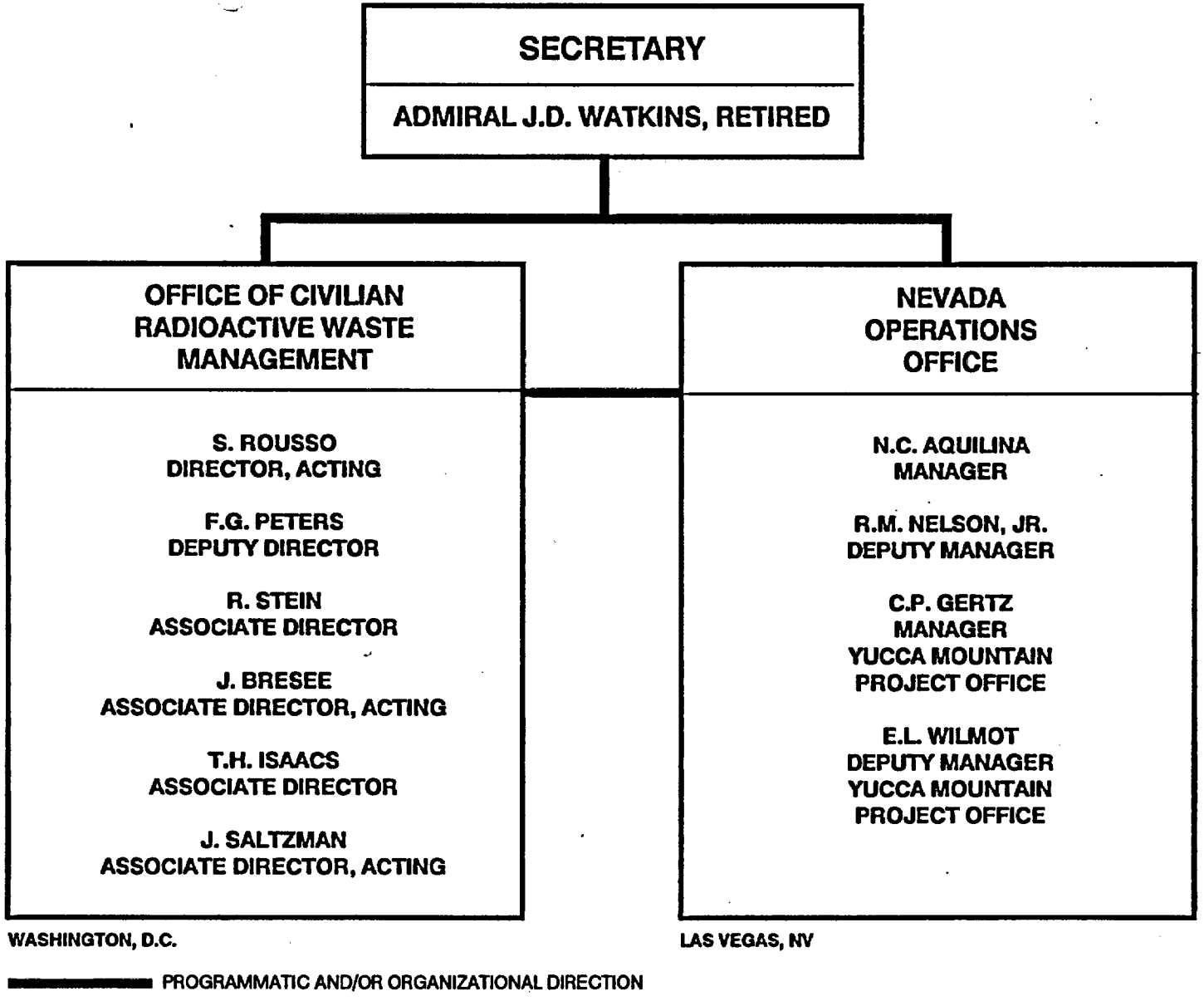
CONCLUSIONS

- CONVENTIONAL MINING TECHNIQUES BEST SUPPORT REGULATORY AND SCIENTIFIC NEEDS OF SITE CHARACTERIZATION:

  - ROUTINE ACCESSIBILITY
  - LIMITED DISTURBANCE OF IN SITU ROCK CONDITIONS
  - TIMELY
  - DEMONSTRATED TECHNOLOGY

U.S. DEPARTMENT OF ENERGY



NWTORG5P.A11/4-11-89

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

REGULATORY CONSIDERATIONS RELATED TO PERIMETER DRIFTING

PRESENTED BY

MAXWELL BLANCHARD

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APRIL 12, 1989

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

REGULATORY CONSIDERATIONS RELATED TO PERIMETER DRIFTING

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APRIL 12, 1989

INTRODUCTION

THE EXTENT OF UNDERGROUND EXCAVATION MUST:

- LIMIT SITE IMPACTS
- SUPPORT, IN CONJUNCTION WITH SURFACE-BASED TESTING, THE GATHERING OF REPRESENTATIVE DATA
- MAINTAIN FLEXIBILITY TO INTEGRATE WITH THE EXPECTED REPOSITORY DESIGN

CONSIDERATIONS INCLUDE:

- LEGISLATIVE AND REGULATORY CONSTRAINTS AND GUIDANCE THAT AFFECT:
  - SCIENTIFIC NEEDS FOR CHARACTERIZATION
  - ENGINEERING AND DESIGN

BASIS FOR REGULATORY CONSTRAINTS

THE REGULATORY CONSTRAINTS ARE DERIVED FROM THREE SOURCES:

- NUCLEAR WASTE POLICY ACT
- 10 CFR 60
- NRC COMMENTS

NUCLEAR WASTE POLICY ACT

NWPA SECTION 113(c) INCLUDES THE FOLLOWING RESTRICTION ON SITE CHARACTERIZATION:

> "THE SECRETARY MAY CONDUCT ..ONLY SUCH .. ACTIVITIES .. REQUIRED TO PROVIDE THE DATA REQUIRED FOR THE EVALUATION OF THE SUITABILITY.. FOR A CONSTRUCTION AUTHORIZATION..."

NUCLEAR WASTE POLICY ACT

(CONTINUED)

- NWPA SECTION 112(B) REQUIRED DOE TO PREPARE AN ENVIRONMENTAL ASSESSMENT FOR EACH SITE:
  - EA SCOPED MAGNITUDE OF SITE CHARACTERIZATION
  - SIGNIFICANT DEPARTURES FROM THAT SCOPE MUST HAVE STRONG JUSTIFICATION

REGULATORY CONSTRAINTS IN 10 CFR 60

- 10 CFR 60.2 DEFINES SITE CHARACTERIZATION AS "THE PROGRAM OF EXPLORATION ..UNDERTAKEN TO ESTABLISH THE GEOLOGIC CONDITIONS AND THE RANGES OF THOSE PARAMETERS.. RELEVANT UNDER THIS PART"

  - ESTABLISHING ACCURATE PARAMETER RANGES REQUIRES REPRESENTATIVE DATA
  - PLANS TO ACQUIRE REPRESENTATIVE DATA BASE INCLUDE:

    (1) EXAMINE FEATURES OF PARTICULAR INTEREST (E.G. ANOMALIES)

    (2) SYSTEMATICALLY ACQUIRE SITE DATA THAT IS GEOSTATISTICALLY MEANINGFUL.

REGULATORY CONSTRAINTS IN 10 CFR 60

(10 CFR 60.2)

- REQUIRES A BALANCED APPROACH FOR ACQUIRING DATA ABOUT HYDROGEOLOGIC CHARACTERISTICS IN ROCK UNITS ABOVE, AT, AND BELOW, THE POTENTIAL REPOSITORY HORIZON (TOPOPAH SPRING UNIT)
  - * ROCK UNITS ABOVE LIMIT THE INFLOW OF WATER TO THE REPOSITORY
  - * ROCK UNITS BELOW DETERMINE THE FLOWPATH, TRAVEL TIME, AND THE AMOUNT OF RADIONUCLIDE RETARDATION
- REQUIRES A FLEXIBLE APPROACH
  - * TO EXPAND UNDERGROUND EXCAVATION, IF WARRANTED

REGULATORY CONSTRAINTS IN 10 CFR 60

- 10 CFR 60.3 "LICENSE REQUIRED"

  "DOE SHALL NOT COMMENCE CONSTRUCTION OF A GEOLOGIC REPOSITORY OPERATIONS AREA UNLESS IT HAS FILED AN APPLICATION... AND OBTAINED CONSTRUCTION AUTHORIZATION..."

  - EXTENT OF EXCAVATION FOR CHARACTERIZATION PURPOSES MUST BE BALANCED AGAINST LIMITATION ON GROA CONSTRUCTION

REGULATORY CONSTRAINTS IN 10 CFR 60

- 10 CFR 60.15 "SITE CHARACTERIZATION," IN ADDITION TO THE REQUIREMENT TO LIMIT ADVERSE EFFECTS ON LONG-TERM PERFORMANCE, PLACES PRACTICAL CONSTRAINTS ON UNDERGROUND EXCAVATION
  - "SUBSURFACE ..EXCAVATION.. DURING SITE CHARACTERIZATION .. SHALL BE COORDINATED WITH GEOLOGIC REPOSITORY OPERATIONS AREA DESIGN AND CONSTRUCTION"
  - "TO ..EXTENT PRACTICAL.. BOREHOLES AND SHAFTS ..SHALL BE LOCATED WHERE SHAFTS ARE PLANNED FOR UNDERGROUND FACILITY.. OR WHERE LARGE UNEXCAVATED PILLARS ARE PLANNED"

REGULATORY CONSTRAINTS IN 10 CFR 60

(CONTINUED)

(10 CFR 60.15)

TO ACCOMMODATE THE NEED TO INTEGRATE EXPLORATORY ACTIVITIES WITH THE GROA DESIGN, DOE WILL:

- LOCATE SURFACE BASED BOREHOLES WHERE PILLARS ARE EXPECTED IN THE UNDERGROUND FACILITY
- USE EXPLORATORY DRIFTS FOR REPOSITORY DRIFTS, WHERE PRACTICAL
- USE EXPLORATORY SHAFTS FOR
  - MEN AND MATERIAL
  - VENTILATION

HOWEVER, FURTHER CHARACTERIZATION IS REQUIRED TO:

- MORE EXPLICITLY DEFINE VERTICAL & LATERAL EXTENT OF USABLE ROCK FOR REPOSITORY

REGULATORY CONSTRAINTS IN 10 CFR 60

- 10 CFR 60.21 "CONTENT OF APPLICATION" REQUIRES:
  - "..A COMPARATIVE EVALUATION OF MAJOR DESIGN FEATURES THAT ARE IMPORTANT TO WASTE ISOLATION, WITH PARTICULAR ATTENTION TO THE ALTERNATIVES THAT WOULD PROVIDE LONGER .. CONTAINMENT AND ISOLATION"
    - * REPOSITORY LAYOUT (INCLUDING PERIMETER DRIFT) MAY REQUIRE COMPARATIVE EVALUATION
    - * ADDITIONAL SITE CHARACTERIZATION INFORMATION NECESSARY FOR EVALUATION

NRC COMMENTS

SCP-CD

- NRC, IN OBJECTION 3, OBSERVED THAT THE SCP-CD DID NOT PROVIDE ENOUGH INFORMATION TO SUPPORT AN ANALYSIS OF POTENTIAL INTERFERENCES:
  - TEST-TO-TEST INTERFERENCE
  - INTERFERENCE OF CONSTRUCTION WITH TESTING
- STATUTORY SCP IN SECTION 8.4 EVALUATES POTENTIAL FOR INTERFERENCE
- EXPANDED EXCAVATION WOULD NEED TO BE CONSIDERED RELATIVE TO POTENTIAL INTERFERENCE WITH TESTS

CONCLUSION

SITE CHARACTERIZATION IS A COMPREHENSIVE SURFACE AND SUBSURFACE EXPLORATION PROGRAM TO GATHER REPRESENTATIVE INFORMATION TO DEVELOP A MEANINGFUL 3-DIMENSIONAL DESCRIPTION OF THE SITE AND ITS NATURAL PROCESSES. THE PROGRAM, AS PLANNED:

(1) ADDRESSES THE NEED TO OBTAIN HYDROGEOLOGIC DATA FROM OVERLYING AND UNDERLYING STRATA AS WELL AS FROM THE TOPOPAH SPRING ROCK UNIT
(2) LIMITS POTENTIAL ADVERSE IMPACTS ON SITE
(3) LIMITS INTERFERENCES
(4) RECOGNIZES NEED TO INTEGRATE EXPLORATORY ACTIVITIES WITH GROA DESIGN
(5) RETAINS FLEXIBILITY TO EXPAND CHARACTERIZATION EXCAVATIONS, IF APPROPRIATE

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

SCIENTIFIC CONSIDERATIONS

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APRIL 11, 1989

GENERAL SCIENTIFIC CONSIDERATIONS RELATED TO ESF CONSTRUCTION METHOD

- PRINCIPAL REASON FOR CONSTRUCTING ESF IS TO OBTAIN SITE CHARACTERIZATION DATA

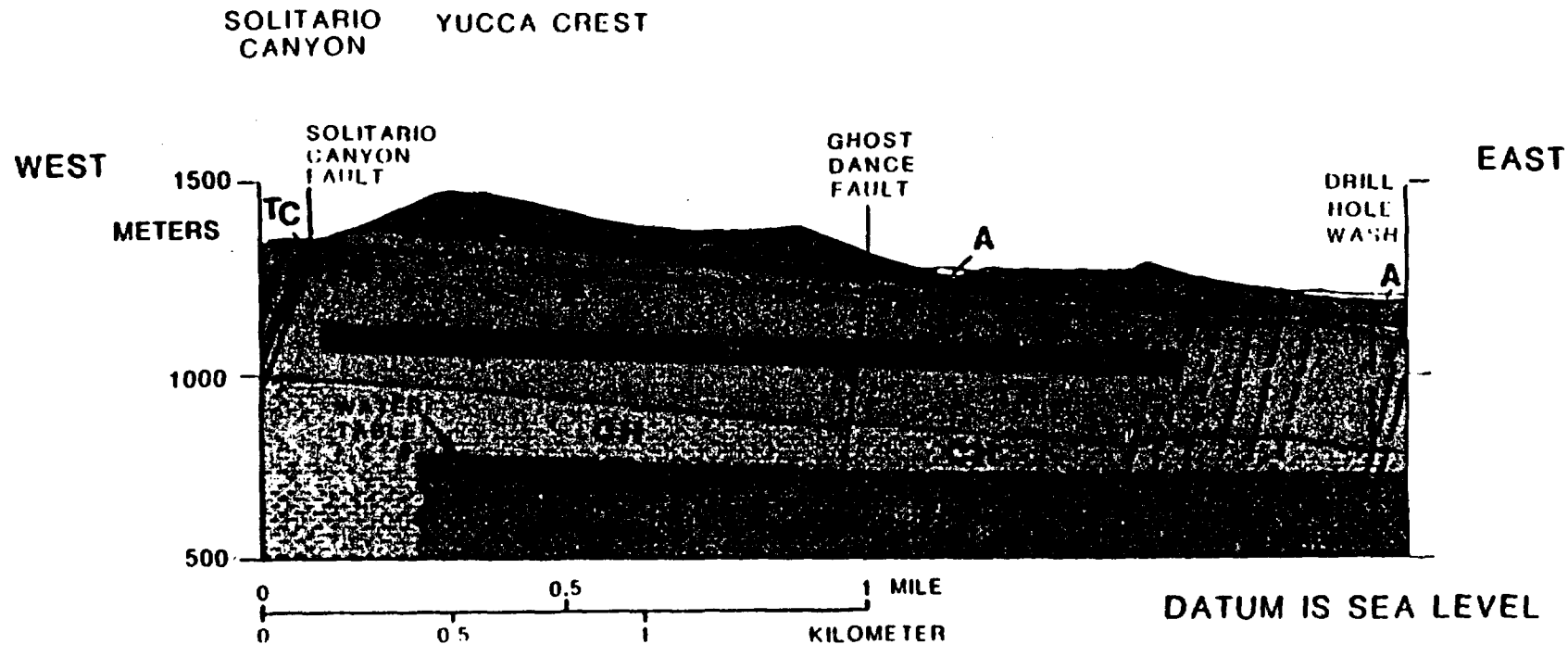
- THEREFORE, THE CONSTRUCTION METHOD SHOULD OPTIMIZE THE ABILITY TO:
  - MAKE <u>OBSERVATIONS</u> OF AMBIENT IN SITU CONDITIONS, PROCESSES, AND RELATIONSHIPS
  - OBTAIN RELIABLE <u>SAMPLES</u> FOR ANALYSIS

- TO HELP MEET SCIENTIFIC OBJECTIVES, CERTAIN FEATURES OF AN ESF CONSTRUCTION METHOD ARE DESIRABLE:
  1. DIRECT <u>ACCESS</u> TO SHAFT DURING CONSTRUCTION
  2. MINIMAL <u>DISTURBANCE</u> OF AMBIENT SITE CONDITIONS
  3. ABILITY TO <u>MONITOR</u> MAGNITUDE AND EXTENT OF DISTURBANCE

OBLIQUE
VIEW OF YUCCA MOUNTAIN

MAP OF REPOSITORY AREA AND SURFACE FACILITIES

UNSATURATED ZONE
HYDROGEOLOGIC FRAMEWORK (NORTH)



A ALLUVIUM

TIVA CANYON WELDED UNIT

PAINTBRUSH NONWELDED UNIT

TOPOPAH SPRING WELDED UNIT

CALICO HILLS NONWELDED UNIT

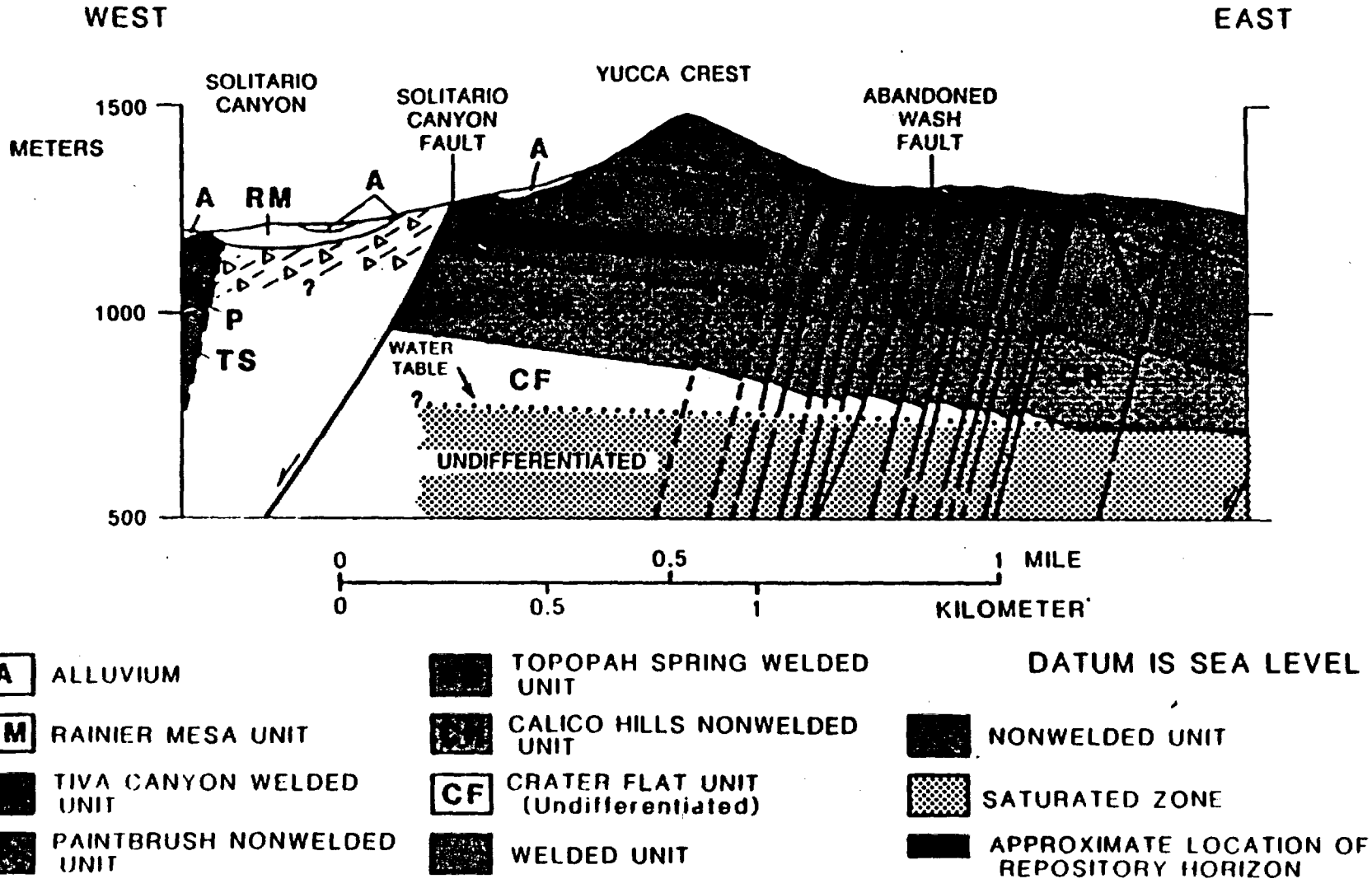
APPROXIMATE LOCATION OF REPOSITORY HORIZON

WELDED UNIT

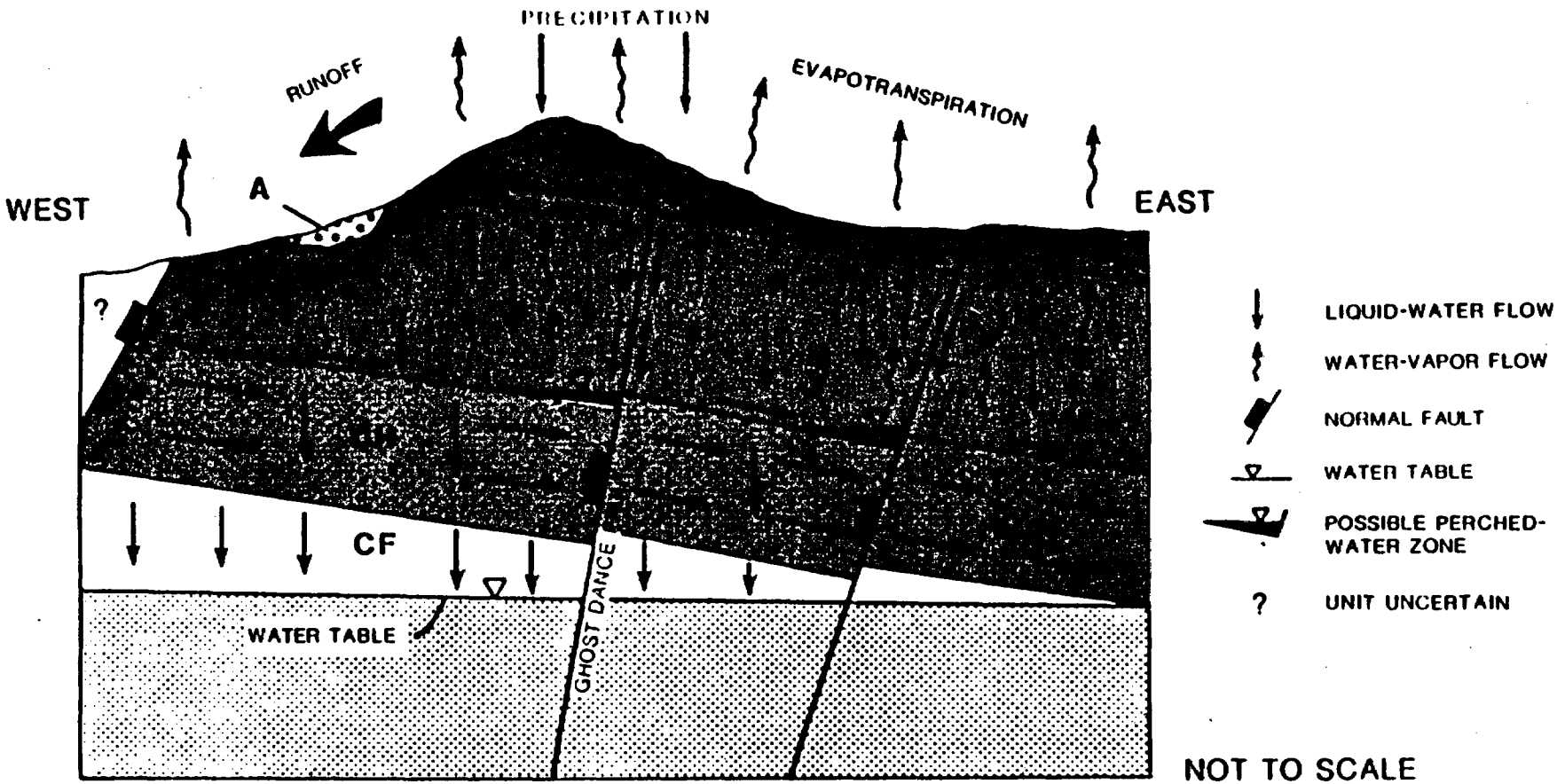
NONWELDED UNIT

SATURATED ZONE

UNSATURATED ZONE
HYDROGEOLOGIC FRAMEWORK (SOUTH)

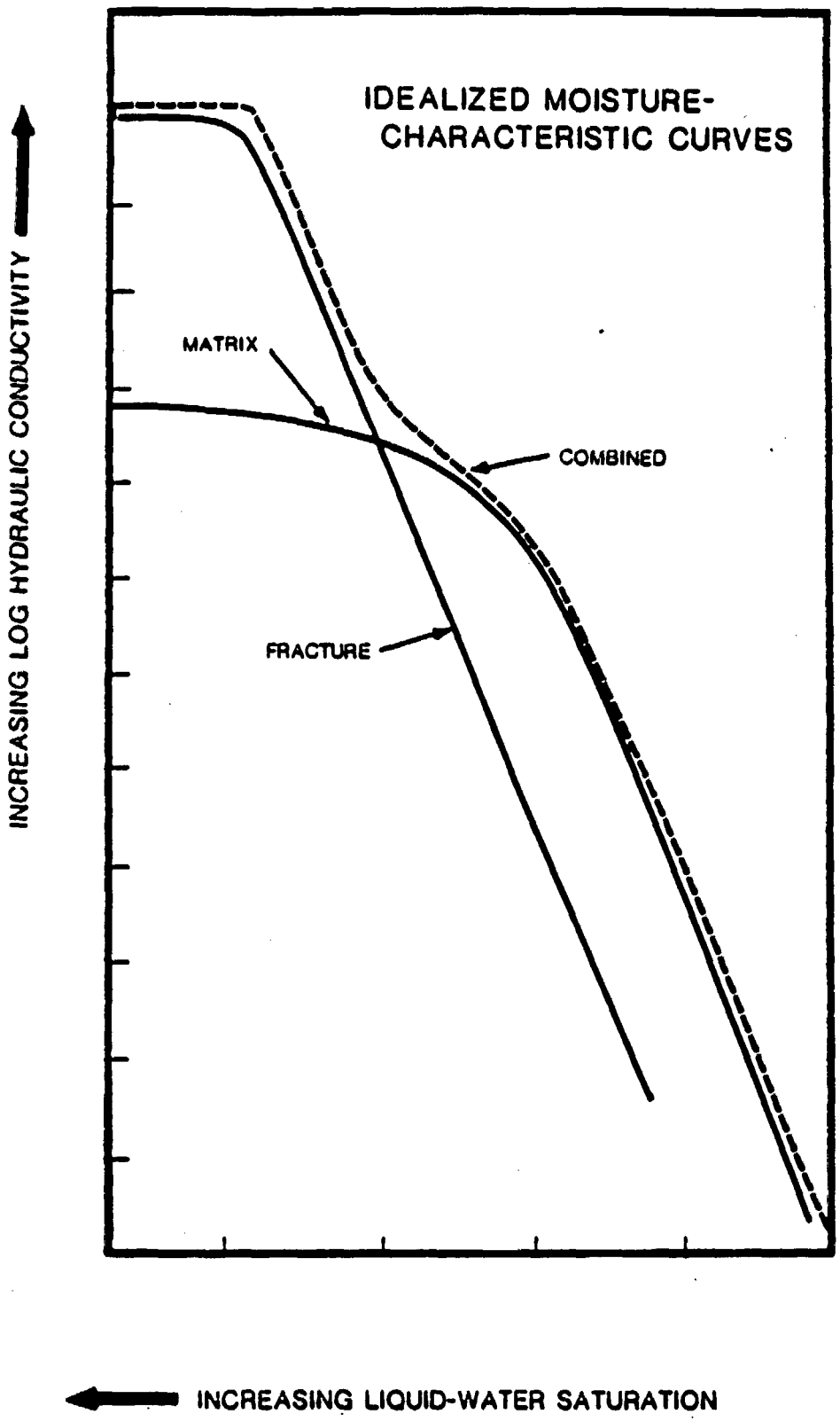


UNSATURATED ZONE
CONCEPTUAL MODEL OF FLOW



NOT TO SCALE

A ALLUVIUM	TOPOPAH SPRING WELDED UNIT	WELDED UNIT
TIVA CANYON WELDED UNIT	CALICO HILLS NONWELDED UNIT	NONWELDED UNIT
PAINTBRUSH NONWELDED UNIT	CF CRATER FLAT UNIT (Undifferentiated)	SATURATED ZONE


IDEALIZED MOISTURE-
CHARACTERISTIC CURVES
MATRIX
COMBINED
FRACTURE
INCREASING LOG HYDRAULIC CONDUCTIVITY
INCREASING LIQUID-WATER SATURATION

FLOW IN UNSATURATED FRACTURES

SCIENTIFIC REQUIREMENTS - ESF

• MAKE OBSERVATIONS AND OBTAIN SAMPLES

GEOLOGIC
- LITHOLOGY
- UNIT CONTACTS
- FRACTURE CHARACTERISTICS
- FAULTS
- IN SITU STRESS CONDITIONS

GEOCHEMICAL
- MINERALOGY OF FRACTURE COATINGS
- CHLORIDE AND CHLORINE-36

HYDROLOGIC
- MATRIX HYDRAULIC PROPERTIES
- FRACTURE HYDRAULIC PROPERTIES
- BULK HYDRAULIC AND PNEUMATIC PROPERTIES
- EFFECTS OF CONSTRUCTION ON HYDROLOGIC PROPERTIES
- PERCHED-WATER ZONES (HYDRAULIC PROPERTIES AND WATER CHEMISTRY)
- CHEMISTRY OF UZ WATER IN FRACTURES AND MATRIX PORES

DESIRABLE FEATURES OF ESF CONSTRUCTION METHOD

1. ACCESS TO SHAFT DURING CONSTRUCTION

- DIRECT, FREQUENT, PROMPT
- EVALUATE PERCHED WATER
- OBTAIN ROCK SAMPLES
- CONDUCT SHAFT-WALL MAPPING
- MONITOR DISTURBANCE
  - POTENTIAL ADVERSE EFFECTS ON SITE CONDITIONS
  - MECHANICAL RESPONSE OF ROCK MASS

DESIRABLE FEATURES

(CONTINUED)

2. MINIMIZE CONSTRUCTION-RELATED DISTURBANCE OF SITE CONDITIONS

- DISTURBANCE OF <u>HYDROGEOLOGIC</u> CONDITIONS
  - POTENTIAL EFFECTS; ROCK-MASS RESPONSE
  - ANALYSES
  - CONCLUSIONS
- DISTURBANCE OF <u>GEOCHEMICAL</u> CONDITIONS
  - POTENTIAL EFFECTS
  - ANALYSES AND CONCLUSIONS

HYDROGEOLOGIC CONDITIONS
POTENTIAL EFFECTS

- INTRODUCTION OF FLUIDS (MOST SIGNIFICANT CONCERN)
  - INCREASE MATRIX SATURATION, PERMEABILITY
  - INITIATE OR ENHANCE FLOW IN FRACTURES
  - MODIFY FLUX AMOUNT AND DISTRIBUTION
  - BIAS RESULTS OF HYDROLOGIC TESTS
- CREATION OF NEW FRACTURES; MODIFICATION OF EXISTING FRACTURES
  - CHANGE ROCK-MASS PERMEABILITY
  - CREATE PREFERENTIAL PATHWAYS FOR WATER AND GAS
  - BIAS RESULTS OF SHAFT-WALL FRACTURE MAPPING

POTENTIAL HYDROGEOLOGIC EFFECTS ANALYSES

- AS MUCH AS 3 M^3 (800 GAL) OF WATER PER METER OF SHAFT DEPTH COULD BE USED IN CONSTRUCTION ("NORMAL" DRILL AND BLAST METHOD)

- ABOUT 10% OF WATER IS NOT EXPECTED TO BE RE-COVERED

- MODIFIED PERMEABILITY ZONE (MPZ) IS ESTIMATED TO EXTEND 2-3 M BEYOND SHAFT WALL

- EXPECTED CHANGE IN MATRIX SATURATION:

  - IN MPZ: +0.035
  - BEYOND 10 M: <0.01

POTENTIAL HYDROGEOLOGIC EFFECTS ANALYSES

(CONTINUED)

- EXPECTED CHANGE IN ROCK-MASS PERMEABILITY:

  - EQUIVALENT PERMEABILITY AVERAGED OVER ANNULUS ONE RADIUS WIDE
  - COMBINED EFFECTS OF BLASTING AND STRESS REDISTRIBUTION
  - INCREASE IN PERMEABILITY:
    * IN MPZ: 20-80X
    * 4-5 M: < 2-3X
    * > 8 M: < 2X

REFERENCES:

CASE AND KELSALL (1987)
EATON AND PETERSON (1988)
SCP SECTION 8.4.3
WEST (1988)

NWTWILS5P.AII/4-11,12-89

POTENTIAL HYDROGEOLOGIC EFFECTS CONCLUSIONS

- INTRODUCTION OF FLUIDS

  - PRUDENT TO MINIMIZE INTRODUCTION OF FLUIDS

  - CONTROL AND MONITOR ALL FLUIDS USED
    * MINIMAL AMOUNTS
    * LOW HEADS
    * TRACERS

  - CHANGES IN MATRIX SATURATION EXPECTED TO BE SMALL

  - WATER IS EXPECTED TO TRAVEL ONLY SHORT DISTANCES

POTENTIAL HYDROGEOLOGIC EFFECTS CONCLUSIONS

(CONTINUED)

- MODIFICATION OF FRACTURE CHARACTERISTICS
  - IN UZ, FRACTURES GENERALLY ARE NOT PREFERENTIAL PATHWAYS, UNLESS MATRIX IS NEAR SATURATION OR FLUX IS LARGE
  - NONETHELESS, PRUDENT TO MINIMIZE EFFECTS OF BLASTING
  - USE CONTROLLED BLASTING TECHNIQUES
  - SOME TESTS ARE DESIGNED TO EVALUATE EFFECTS OF CONSTRUCTION
  - SOME ROUGHNESS OF SHAFT WALL IS DESIRABLE
  - ARTIFICIALLY CREATED FRACTURES CAN BE DISTINGUISHED FROM NATURAL FRACTURES IN SHAFT WALL

GEOCHEMICAL CONDITIONS POTENTIAL EFFECTS

- INTRODUCTION OF FLUIDS AND MATERIALS
  - WATER, SOLVENTS, AND HYDROCARBONS
  - CONCRETE SHAFT LINER
  - GASEOUS PRODUCTS FROM EXPLOSIVES
- POSSIBLE SIGNIFICANCE OF ALTERING GEOCHEMICAL ENVIRONMENT
  - AFFECT WASTE-PACKAGE INTEGRITY
  - REDUCE CAPABILITY OF TUFF TO RETARD TRANSPORT OF RADIONUCLIDES
  - CHEMICAL PRECIPITATION OR DISSOLUTION ALONG FLOW PATHS COULD ALTER FLUX DISTRIBUTION
  - BIAS RESULTS OF HYDROCHEMISTRY AND CI-36 TESTS
  - ORGANICS COULD SUPPORT MICRO-ORGANISMS

POTENTIAL GEOCHEMICAL EFFECTS ANALYSES AND CONCLUSIONS

- WATER, HYDROCARBONS, AND SOLVENTS
  - AMOUNTS ARE SMALL, VOLUME OF ROCK AFFECTED SMALL, AND DEPTH OF PENETRATION MINIMAL
- CONCRETE SHAFT LINER
  - EFFECTS OF CONCRETE ON J-13 WATER
  - INCREASE PH; INCREASE CONCENTRATIONS OF NA^+, K^+, OH^-, AND SO_4^{--}
  - POSSIBLE FORMATION OF PRECIPITATES
  - EFFECTS ARE LOCALIZED

POTENTIAL GEOCHEMICAL EFFECTS ANALYSES AND CONCLUSIONS

(CONTINUED)

- PRESENCE OF MICRO-ORGANISMS NOT KNOWN TO BE DETRIMENTAL

- GASEOUS PRODUCTS FROM EXPLOSIVES
  - SMALL AMOUNTS OF NO, CO, NH_2, CH_4
  - MOST WILL BE VENTILATED TO SURFACE
  - SOME MAY PENETRATE 1-2 M INTO ROCK
  - CL WILL NOT BE USED IN EXPLOSIVES

- HYDROCHEMISTRY SAMPLES
  - INTERIOR CORES OF LARGE BLOCK SAMPLES
  - CORES FROM RADIAL BOREHOLES
  - TRACER ANALYSES

REFERENCES:
FERNANDEZ AND OTHERS (1988)
WEST (1988)

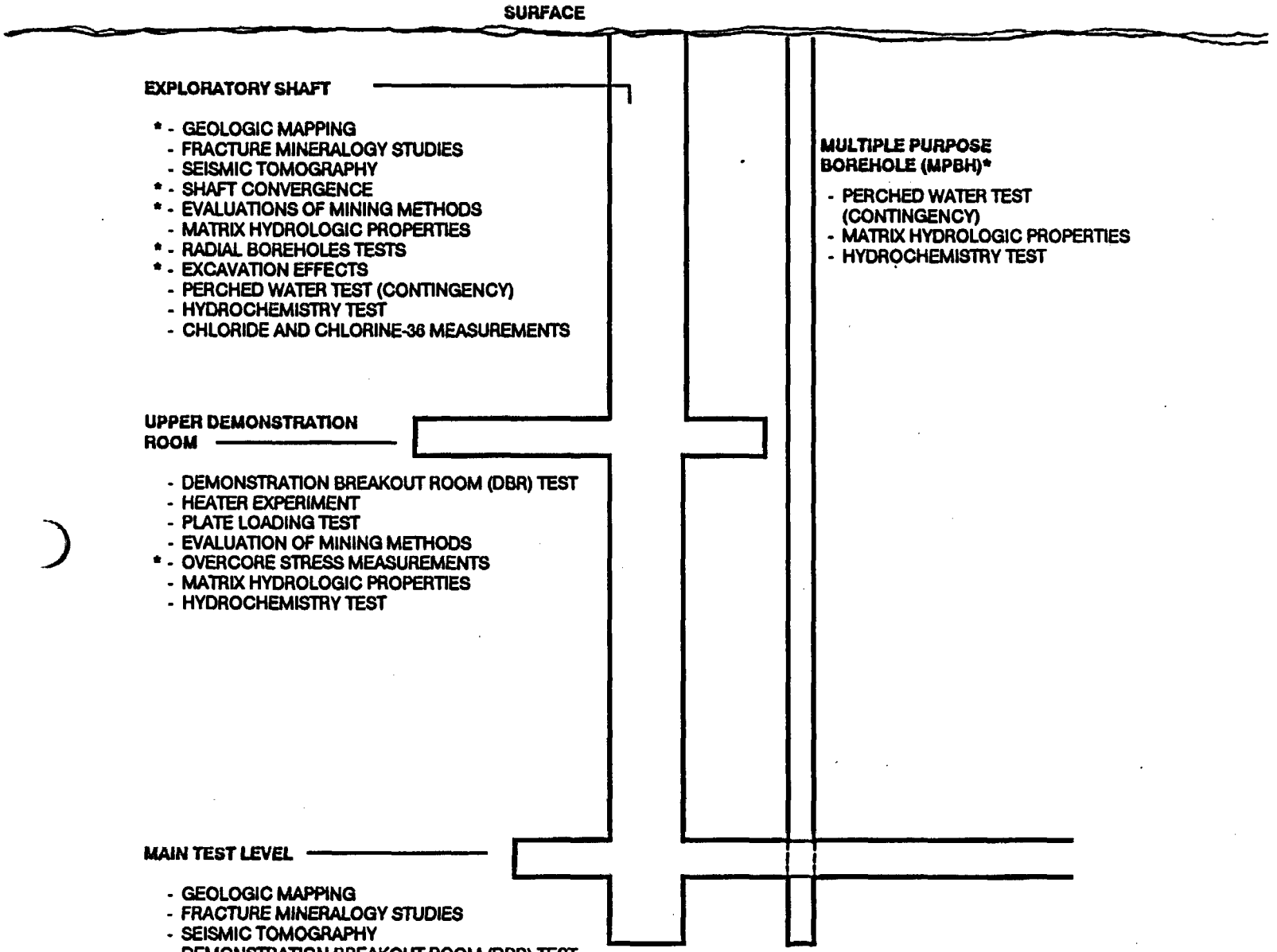
NWTWILS5P.AII/4-11,12-89

DESIRABLE FEATURES OF ESF CONSTRUCTION METHOD

3. ABILITY TO MONITOR DISTURBANCES

- NEED TO VERIFY MODELS AND CHECK PREDICTIONS
- IN ES HYDROLOGIC TESTS, NEED TO ACCOUNT FOR DISTURBANCES
- REQUIRES PRE- AND POST-CONSTRUCTION DATA
- CONDUCT CONSTRUCTION-PHASE MONITORING TESTS

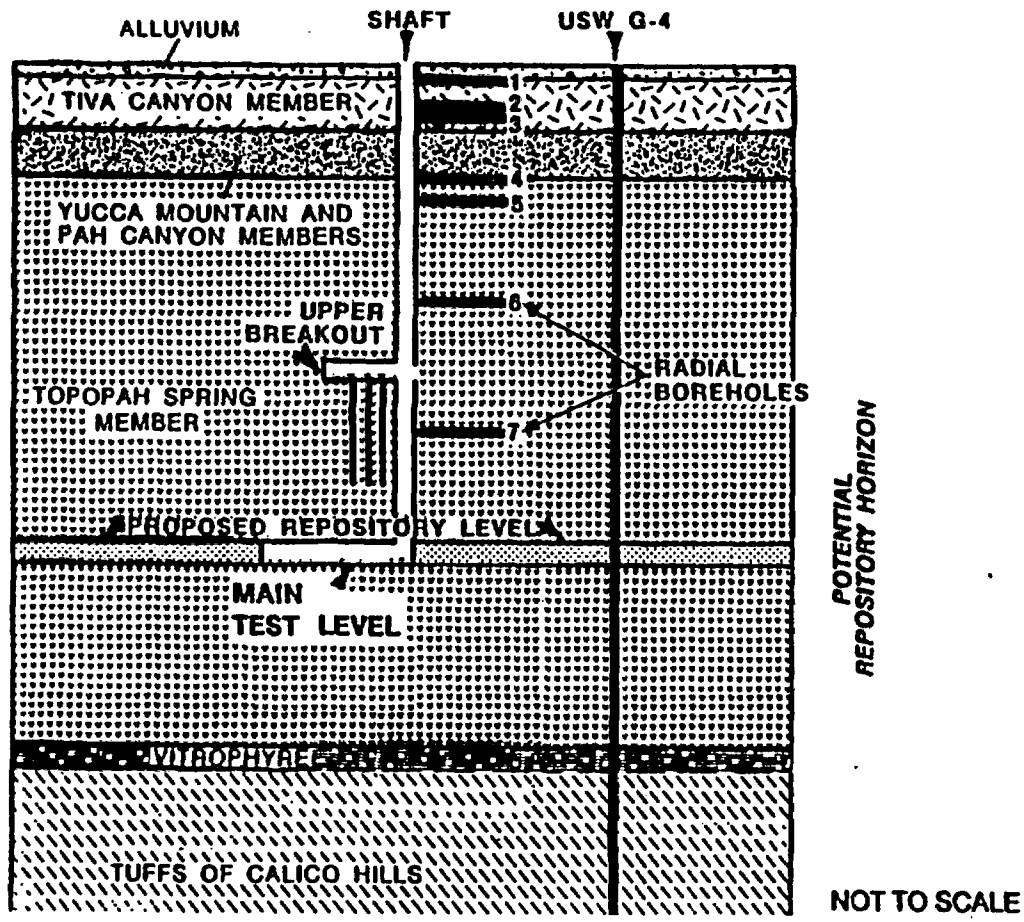
LOCATION AND TYPE OF TEST IN THE EXPLORATORY SHAFT FACILITY



* = TESTS INTENDED TO MONITOR EFFECTS OF SHAFT CONSTRUCTION

SCTPCHA.CPG 4/11/88

RADIAL BOREHOLE TESTS AND EXCAVATION EFFECTS TEST IN THE EXPLORATORY SHAFT FACILITY



NOT TO SCALE

- INVESTIGATE VERTICAL AND LATERAL MOVEMENT OF GAS, WATER, AND VAPOR ON AND ACROSS HYDROGEOLOGIC CONTACTS AND WITHIN THE TOPOPAH SPRING UNIT UNDER MINIMALLY DISTURBED CONDITIONS
- EVALUATE NEAR-FIELD EXCAVATION EFFECTS ON HYDROLOGIC PROPERTIES

NRCVG5P.A06/12-8-88

SUMMARY

- SCIENTIFIC CONSIDERATIONS EXERT A MAJOR INFLUENCE ON SELECTION OF SHAFT-CONSTRUCTION METHOD AT YUCCA MOUNTAIN

- UZ SETTING AT YUCCA MOUNTAIN INFLUENCES SPECIFIC INFORMATION NEEDS

- GENERAL SCIENTIFIC REQUIREMENTS:

  - MAKE HYDROGEOLOGIC AND GEOCHEMICAL OBSERVATIONS
  - OBTAIN RELIABLE ROCK AND WATER SAMPLES
  - HAVE DIRECT ACCESS DURING CONSTRUCTION
  - MINIMIZE CONSTRUCTION-RELATED DISTURBANCES
    * FLUID LOSSES AND ROCK DAMAGE
  - MONITOR DISTURBANCES
    * CHARACTERIZATION, PERFORMANCE
    * MECHANICAL RESPONSE

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

SCIENTIFIC AND TESTING CONSIDERATIONS

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APRIL 12, 1989

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

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APRIL 12, 1989

SCIENTIFIC AND TESTING CONSIDERATIONS

BACKGROUND

- THE DISCUSSION THAT FOLLOWS DESCRIBES THE RATIONALE FOR THE SITE CHARACTERIZATION PROGRAM TO FACILITATE DISCUSSION OF THE UTILITY OF A PERIMETER DRIFT
  - EXAMINE THE ROLE OF A PERIMETER DRIFT IN THE SITE CHARACTERIZATION PROGRAM IN LIGHT OF THE CONTRIBUTIONS IT CAN MAKE TO THE TOTAL PROGRAM

SCIENTIFIC AND TESTING CONSIDERATIONS

OUTLINE OF PRESENTATION

- DESCRIBE SURFACE BASED PROGRAM TO ACQUIRE INFORMATION NEEDED FROM SITE CHARACTERIZATION
- DESCRIBE ESF BASED PROGRAM TO ACQUIRE INFORMATION NEEDED FROM SITE CHARACTERIZATION

  - INDICATE ROLES OF SURFACE AND SUBSURFACE PROGRAMS IN A REPRESENTATIVE CHARACTERIZATION PROGRAM

SCIENTIFIC AND TESTING CONSIDERATIONS

PRIMARY EXPLORATION AREA

- SITE CHARACTERIZATION AND PROPOSED REPOSITORY DEVELOPMENT IN A PRIMARY AREA
  - RELATIVELY FEW FAULTS
  - RARE FAULT BRECCIAS
  - CONTAINS 2200 ACRES; 1850 MEET CRITERIA
  - CURRENT ESTIMATE IS 1420 ACRES NEEDED

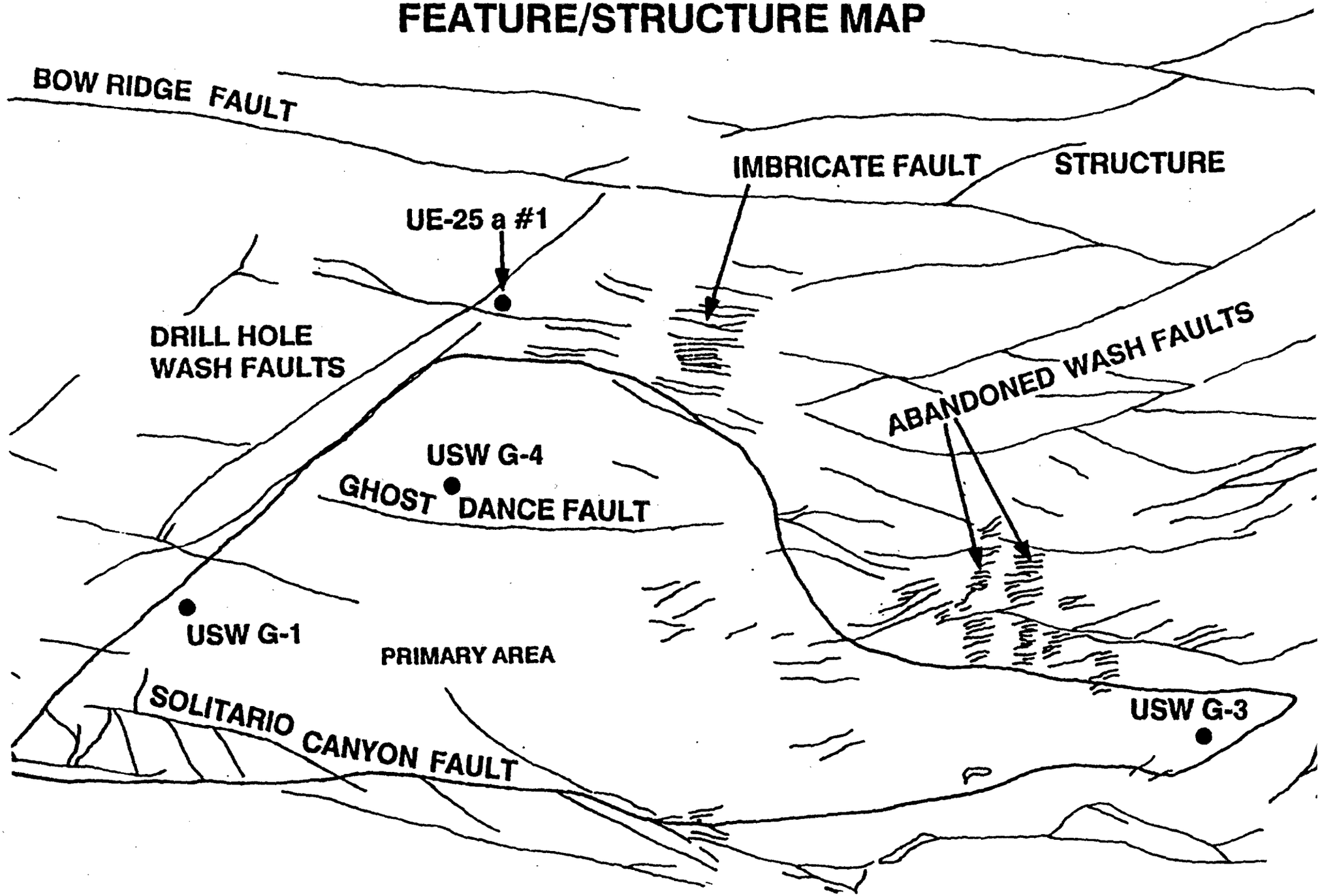
- EARLY DEFINITION OF THE PRINCIPAL AREA FOR EXPLORATION IN TERMS OF BOUNDING STRUCTURES

- AVAILABLE DATA SUGGEST THAT ROCK WITH ACCEPTABLE CHARACTERISTICS MAY BE PRESENT IN SURROUNDING AREAS

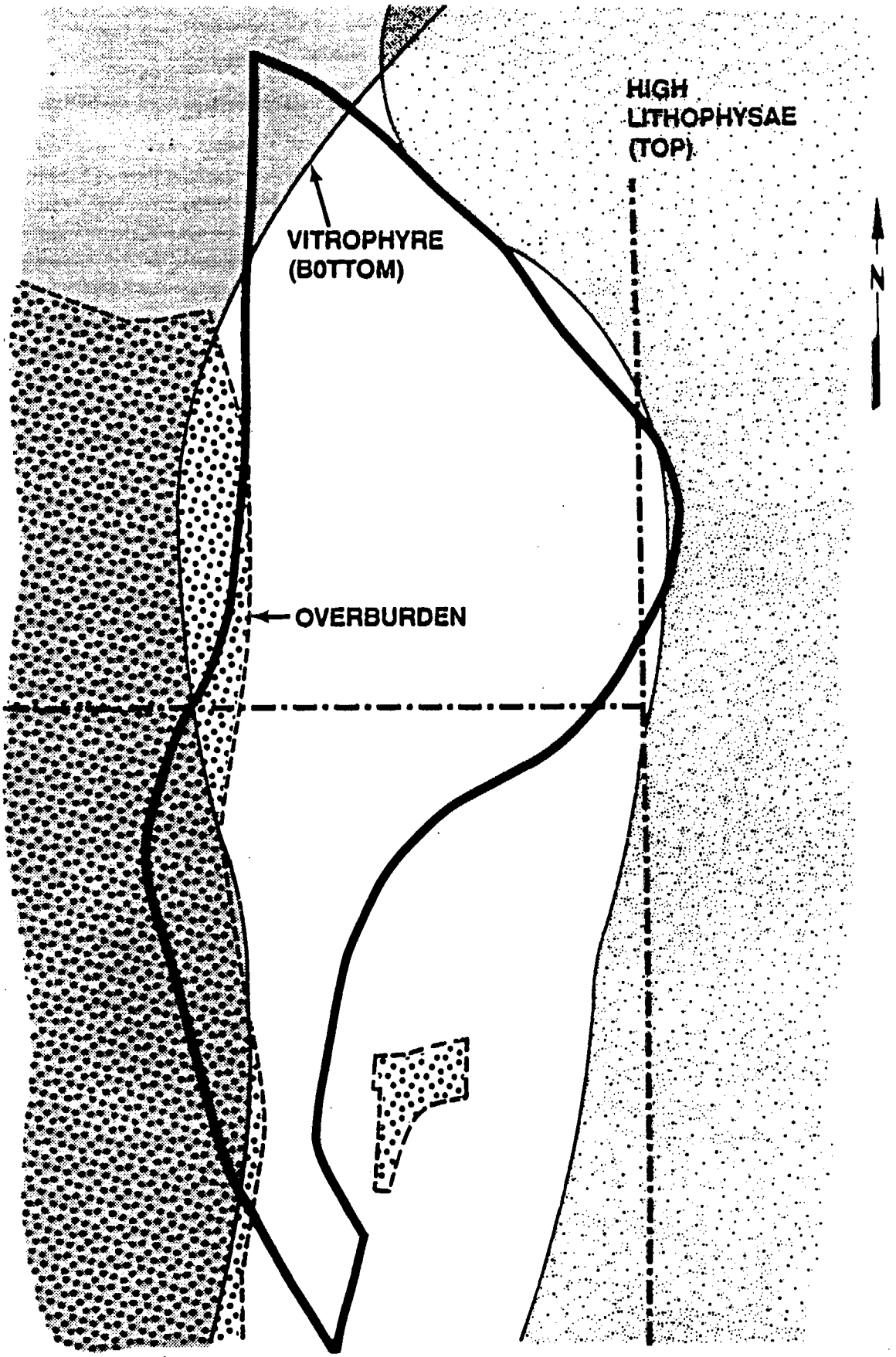
AERIAL VIEW OF YUCCA MOUNTAIN

NWTSTC5P.A11/4-11,12-89

YUCCA MOUNTAIN AREA FEATURE/STRUCTURE MAP



STRATIGRAPHIC FEATURES



SCIENTIFIC AND TESTING CONSIDERATIONS

MAJOR ELEMENTS OF THE PROGRAM

- SURFACE BASED
  - BOREHOLE COVERAGE:
    - * SYSTEMATIC DRILLING PROGRAM - SITE AND SURROUNDING AREA (PHENOMENA CHARACTERISTICS, TRENDS AND VARIABILITY)
    - * FEATURE SAMPLING PROGRAM - INVESTIGATE SPECIAL FEATURES
  - OTHER ACTIVITIES:
    - * MAPPING, GEOPHYSICAL SURVEYS, TRENCHING, METEOROLOGY, ET CETERA
- UNDERGROUND
  - SYSTEMATIC MAPPING AND SAMPLING
  - ESF TESTS TO CHARACTERIZE PROCESSES AND CONDITIONS
  - EXPLORATORY DRIFTING

SCIENTIFIC AND TESTING CONSIDERATIONS

- MAJOR ELEMENTS OF THE PROGRAM ARE COMPLEMENTARY TO PROVIDE A COMPLETE 3-DIMENSIONAL DESCRIPTION OF THE SITE
- SURFACE BASED PROGRAM WAS DESIGNED TO EXAMINE SPATIAL TRENDS, VARIABILITY AND CHARACTERISTICS OF PHENOMENA IN THREE DIMENSIONS
- THE ESF BASED PROGRAM INCLUDES TESTS SUCH AS CONTROLLED SIMULATIONS AND EXPLORATORY DRIFTING TO INVESTIGATE ACTUAL EFFECTS OF UNDERGROUND CONSTRUCTION AND CONFIRM CONSTRUCTION TECHNIQUES IN THE HOST ROCK (TOPOPAH SPRINGS FORMATION)

SCIENTIFIC AND TESTING CONSIDERATIONS

- REPRESENTATIVENESS INVESTIGATED THROUGH INTEGRATION OF DATA
  - GEOSTATISTICAL EVALUATIONS OF SPATIAL TRENDS AND VARIABILITY
  - INPUT TO EVALUATE CONCEPTUAL MODELS
  - ITERATIVE EVALUATION OF ADEQUACY OF DATA
  - GENERALLY, ESF TEST LOCATION CRITERIA CONSIDER THE NEED TO EXTRAPOLATE TEST RESULTS TO THE OVERALL SITE AREA

SCIENTIFIC AND TESTING CONSIDERATIONS

- SURFACE-BASED DRILLING PROGRAM
  - INVOLVES BOREHOLES TO THE WATER TABLE, IN OR ADJACENT TO THE REPOSITORY BLOCK
  - GEOLOGIC INVESTIGATION HOLES, INCLUDING SLANTED AND FEATURE
  - BOREHOLE AND CORE TEST DATA TO CHARACTERIZE STRATIGRAPHY, MATRIX POTENTIAL DISTRIBUTION, MOISTURE MOVEMENT ALONG CONTACTS AND FAULTS, GASEOUS PHASE PROCESSES
  - SAMPLING TO SUPPORT GEOCHEMICAL, HYDROCHEMICAL, NATURAL TRACERS INVESTIGATIONS

MAPS OF BOREHOLE LOCATIONS

SCIENTIFIC AND TESTING CONSIDERATIONS

- SURFACE-BASED INFILTRATION PROGRAM
  - COLLECT EXTENSIVE DATA FROM SURFACE INVESTIGATIONS
    CHARACTERIZE PRECIPITATION, RUNOFF, INFILTRATION, EVAPORATION, TRANSPIRATION BY PLANTS
  - MODEL NET INFILTRATION UNDER EXPECTED/UNEXPECTED CONDITIONS
  - DETERMINE AREAL DISTRIBUTION OF FLUX AT REPOSITORY HORIZON (TOPOPAH SPRING)

SCIENTIFIC AND TESTING CONSIDERATIONS

MAJOR ELEMENTS OF THE PROGRAM

- SURFACE BASED
  - BOREHOLE COVERAGE:
    - * SYSTEMATIC DRILLING PROGRAM - SITE AND SURROUNDING AREA (PHENOMENA CHARACTERISTICS, TRENDS AND VARIABILITY)
    - * FEATURE SAMPLING PROGRAM - INVESTIGATE SPECIAL FEATURES
  - OTHER ACTIVITIES:
    - * MAPPING, GEOPHYSICAL SURVEYS, TRENCHING, METEOROLOGY, ET CETERA

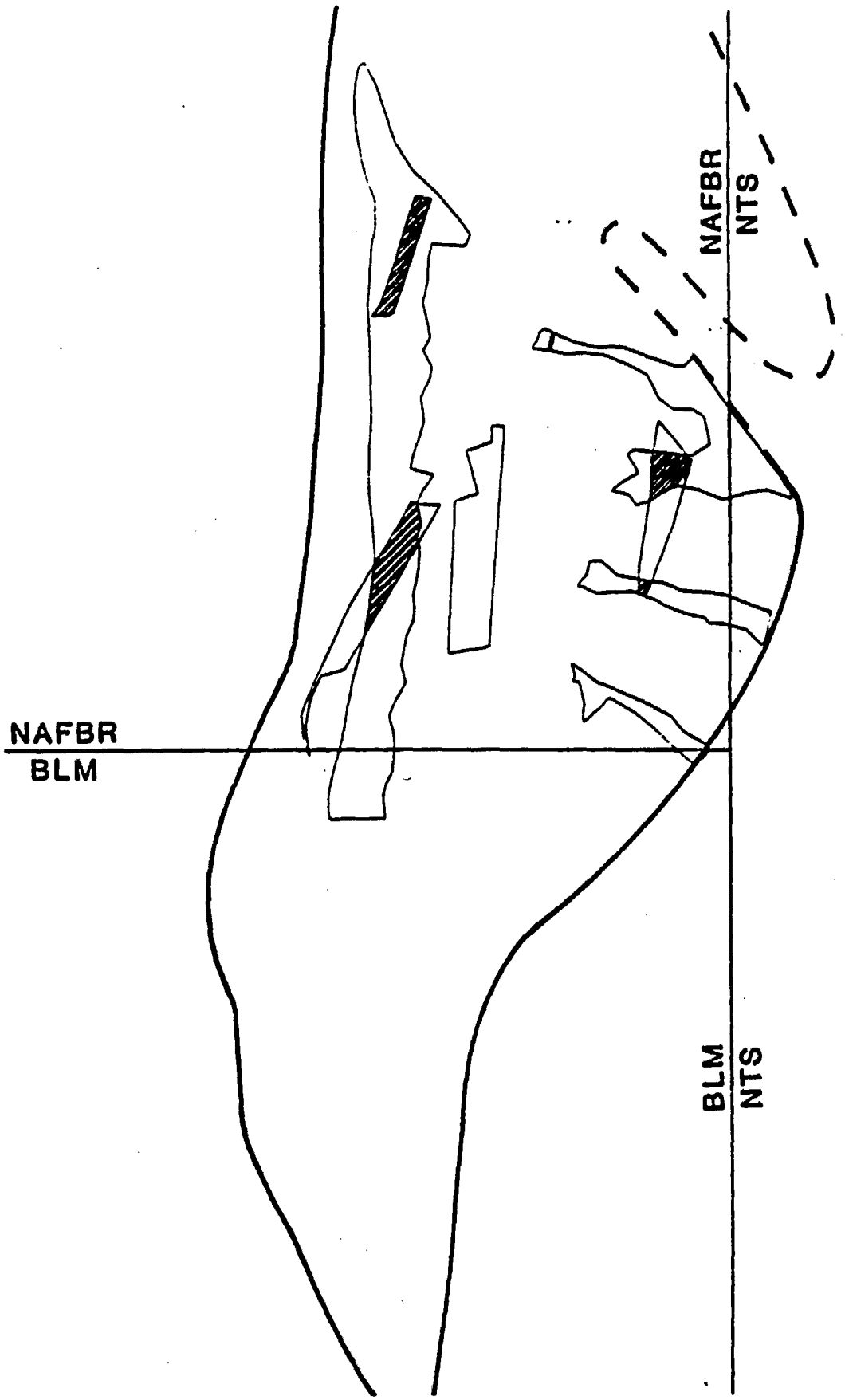
→ • UNDERGROUND
  - SYSTEMATIC MAPPING AND SAMPLING
  - ESF TESTS TO CHARACTERIZE PROCESSES AND CONDITIONS
  - EXPLORATORY DRIFTING

EXPLORATORY SHAFT LOCATION

BASIS FOR ESTABLISHING 5 ALTERNATIVE SITES

- SITE INSIDE, BUT SET BACK FROM, BLOCK BOUNDARIES IN ROCK JUDGED TYPICAL OF EXPLORATION BLOCK
- SITE 1000-2000 FEET FROM POTENTIALLY ADVERSE STRUCTURE
- SITE LOCATED TO ENSURE CONSTRUCTIBILITY
- SITE SHOULD AVOID ADVERSE TOPOGRAPHY AND SLOPES

SCIENTIFIC AND TOPOGRAPHIC PREFERENCE



SCIENTIFIC AND TESTING CONSIDERATIONS

- ESF CHARACTERIZATION PROGRAM
  - EVALUATE CONSTRUCTION EFFECTS ON ROCK MASS PERFORMANCE CHARACTERISTICS NEAR THE SHAFTS AND OTHER OPENINGS
  - INVESTIGATE DIFFUSION PROCESSES, FRACTURE/MATRIX HYDROLOGIC EQUILIBRIUM, INCLUDING SCALE DEPENDENCE, WATER MOBILITY IN FRACTURES, NATURAL TRACERS
  - OBSERVE AND EVALUATE GEOMECHANICAL RESPONSES, INCLUDING SCALE DEPENDENCE, AND TO DRIFTING THROUGH MAJOR STRUCTURES
  - INVESTIGATE NEAR-FIELD (WASTE CANISTER ENVIRONMENT) AND DRIFT SCALE HEATING EFFECTS IN THE HOST ROCK

SCIENTIFIC AND TESTING CONSIDERATIONS

- EXPLORATORY DRIFTING
- PROGRAM TO INVESTIGATE POTENTIALLY ADVERSE GEOLOGIC STRUCTURES COMPLEMENTS SURFACE BASED INVESTIGATIONS (EG. MAPPING, SLANTED HOLES)
- FEATURES TO BE INVESTIGATED ENCOMPASS A RANGE OF CONDITIONS

FLUX	LATERAL DIVERSION
HYDROLOGIC CHARACTER	AGE
TYPE OF FAULTING	NATURE OF FAULTS AT DEPTH
OFFSET	

REPOSITORY CONSTRUCTION FEASIBILITY

SCIENTIFIC AND TESTING CONSIDERATIONS

- EXPLORATORY DRIFTING

  - 3 LONG DRIFTS TO INVESTIGATE SEVERAL STRUCTURES WITH A RANGE OF FEATURES

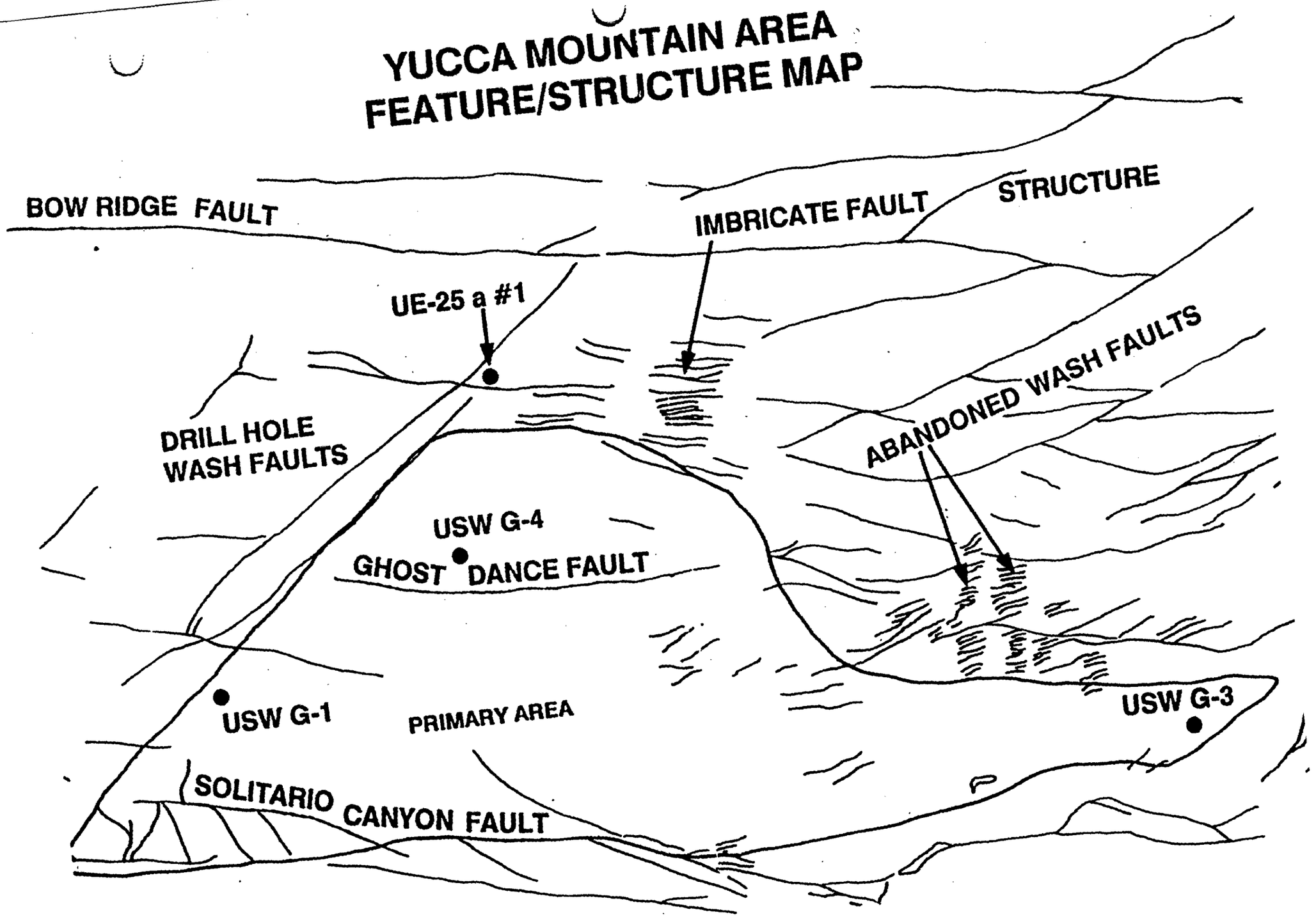
    IMBRICATE NORMAL FAULTING
    - HIGH STRUCTURAL DIP?
    - HIGH FLUX?
    - COMPETENT ROCK?

    DRILL HOLE WASH FEATURE
    - PRE-QUATERNARY AGE FAULT?
    - HIGH FLUX?
    - COMPETENT ROCK?
    - REPOSITORY EXPANSION BEYOND?

    GHOST DANCE FAULT
    - HYDROLOGIC SIGNIFICANCE?
    - GROUND SUPPORT IMPLICATIONS FOR REPOSITORY?

  - PROVISION TO INVESTIGATE OTHER FAULTS OR STRUCTURE

YUCCA MOUNTAIN AREA FEATURE/STRUCTURE MAP



PHOTOGRAPH OF CONSTRUCTION EXPERIMENT IN G-TUNNEL

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SCIENTIFIC AND TESTING CONSIDERATIONS SUMMARY

SITE CHARACTERIZATION IS AN INTEGRATED, BALANCED SET OF INVESTIGATIONS DERIVED FROM STRATEGIES TO EXAMINE SITE ATTRIBUTES FROM SURFACE AND SUBSURFACE BASED INVESTIGATIONS

SITE PERFORMANCE DEPENDS ON THE FULL UNSATURATED ZONE SECTION AND CONDITIONS INFLUENCED BY THE SATURATED ZONE

STRATEGY FOR DEMONSTRATING LONG TERM PERFORMANCE EMPHASIZES THE STRATA OVERLYING AND UNDERLYING THE HOST ROCK

EFFECTS OF FAULTING ON PERFORMANCE DEPEND ON THE FULL UZ AND ARE CHARACTERIZED BY A VARIETY OF APPROACHES

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

ENGINEERING CONSIDERATIONS

PRESENTED BY

JOE TILLERSON
SANDIA NATIONAL LABORATORIES

APRIL 12, 1989

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

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PRINCIPAL ENGINEERING FUNCTIONS RELATED TO ESF DESIGN, CONSTRUCTION, AND OPERATION

- PROVIDE TESTING FACILITY THAT WILL ALLOW GATHERING DATA OF ACCEPTABLE QUALITY
- LIMIT IMPACTS OF ESF CONSTRUCTION, OPERATIONS, AND TESTING ON PERFORMANCE
- ALLOW EFFECTIVE INTEGRATION WITH REPOSITORY DESIGN
- PROVIDE SAFE ENVIRONMENT
- PROVIDE FLEXIBILITY FOR EXPANDED EXPLORATION AND TESTING

ENGINEERING CONSIDERATIONS RELATED TO REPOSITORY PERIMETER DRIFT DEVELOPMENT

- VIABILITY OF INTEGRATION WITH REPOSITORY
- FEASIBILITY OF USING CURRENT ESF CONFIGURATION TO SUPPORT DEVELOPMENT CONSIDERING

  DATA QUALITY
  SAFE WORKING ENVIRONMENT
  FLEXIBILITY FOR EXPANSION

SCP-CONCEPTUAL DESIGN WAS DEVELOPED TO MEET REQUIREMENTS OF NUCLEAR WASTE POLICY ACT AND 10 CFR 60.17(c) FOR A CONCEPTUAL DESIGN THAT TAKES INTO ACCOUNT SITE-SPECIFIC REQUIREMENTS

THE DESIGN ALSO:

- PROVIDES BASIS FOR DEFINING NEEDED SITE CHARACTERIZATION DATA FOR SUPPORT OF REPOSITORY DESIGN AND PERFORMANCE EVALUATIONS
- PROVIDES BASIS FOR INTEGRATION WITH SITE CHARACTERIZATION ACTIVITIES SUCH AS SURFACE-BASED DRILLING, ESF DESIGN AND CONSTRUCTION, ETC.
- PROVIDES BASIS FOR INITIATION OF ADDITIONAL DESIGN PHASES (ACD, LAD)

TO UNDERSTAND VIABILITY OF INTEGRATION OF REPOSITORY PERIMETER DRIFT WITH REPOSITORY DESIGN, NEED TO UNDERSTAND:

- PERTINENT DESIGN FEATURES
- RELATED UNCERTAINTIES

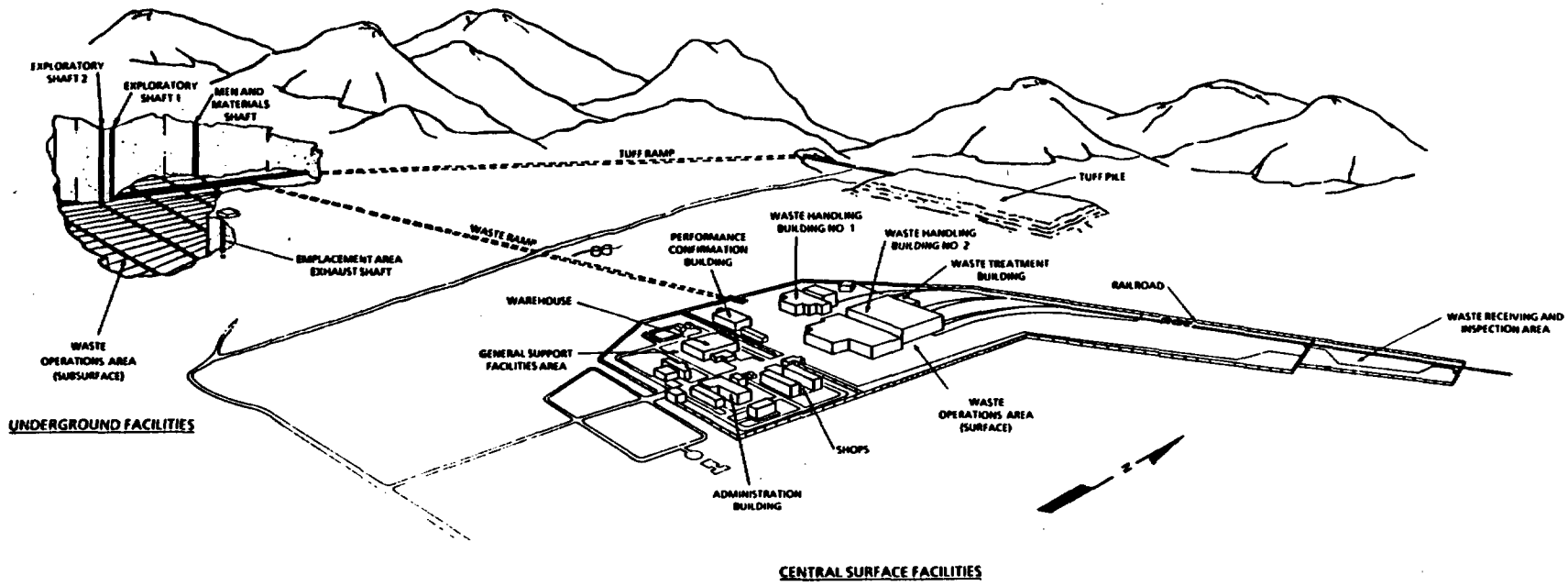
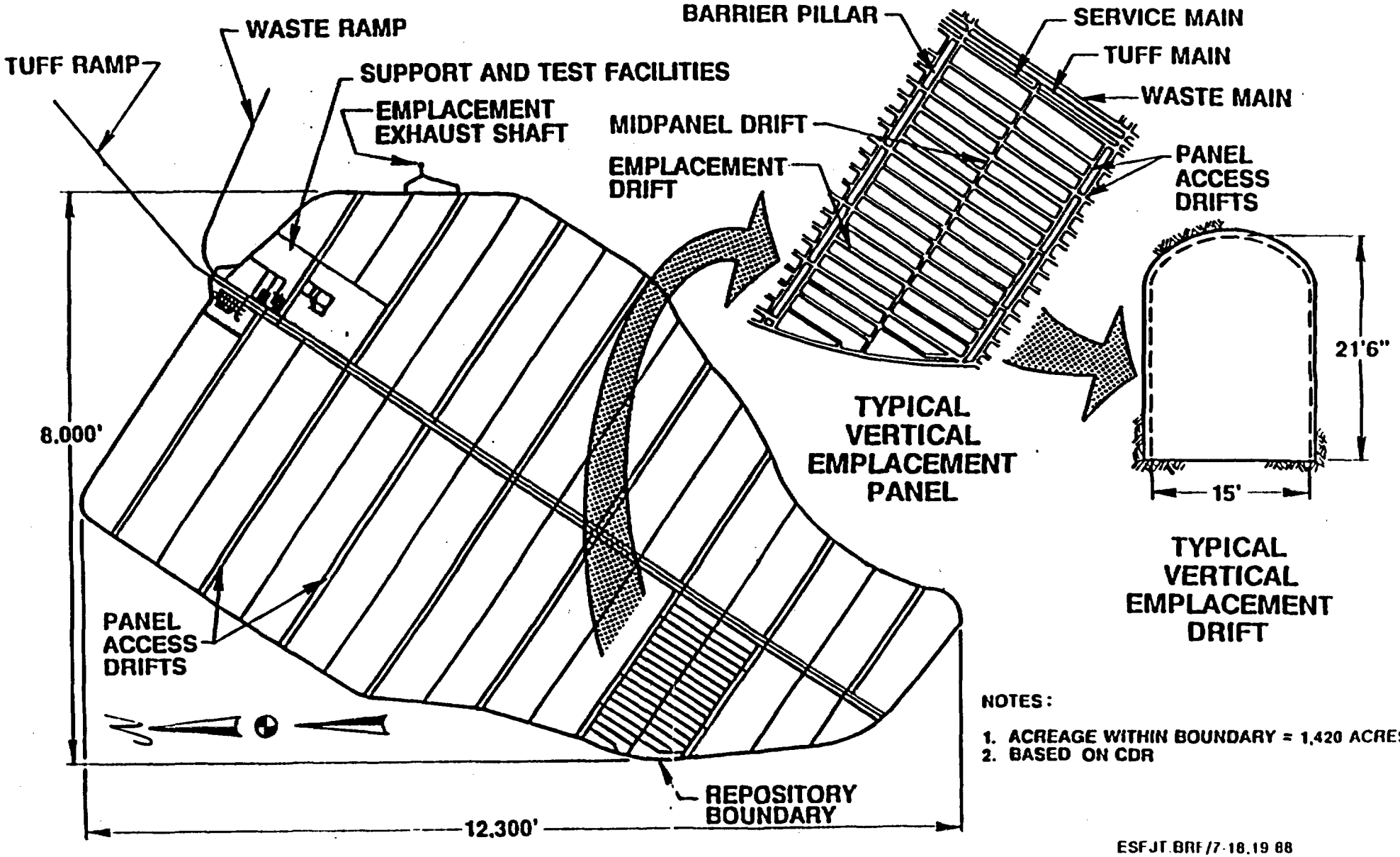


Figure 6-11. Perspective of the proposed Yucca Mountain repository.

PERTINENT REPOSITORY DESIGN FEATURES

- PLANNED CAPACITY - 70,000 MTU IN A PERIOD OF 25 YEARS
- THERMAL LOADING - 57 Kw/ACRE
- AREA NEEDED - 1,420 ACRES

UNDERGROUND DESIGN FOR VERTICAL EMPLACEMENT



NOTES:

1. ACREAGE WITHIN BOUNDARY = 1,420 ACRES
2. BASED ON CDR

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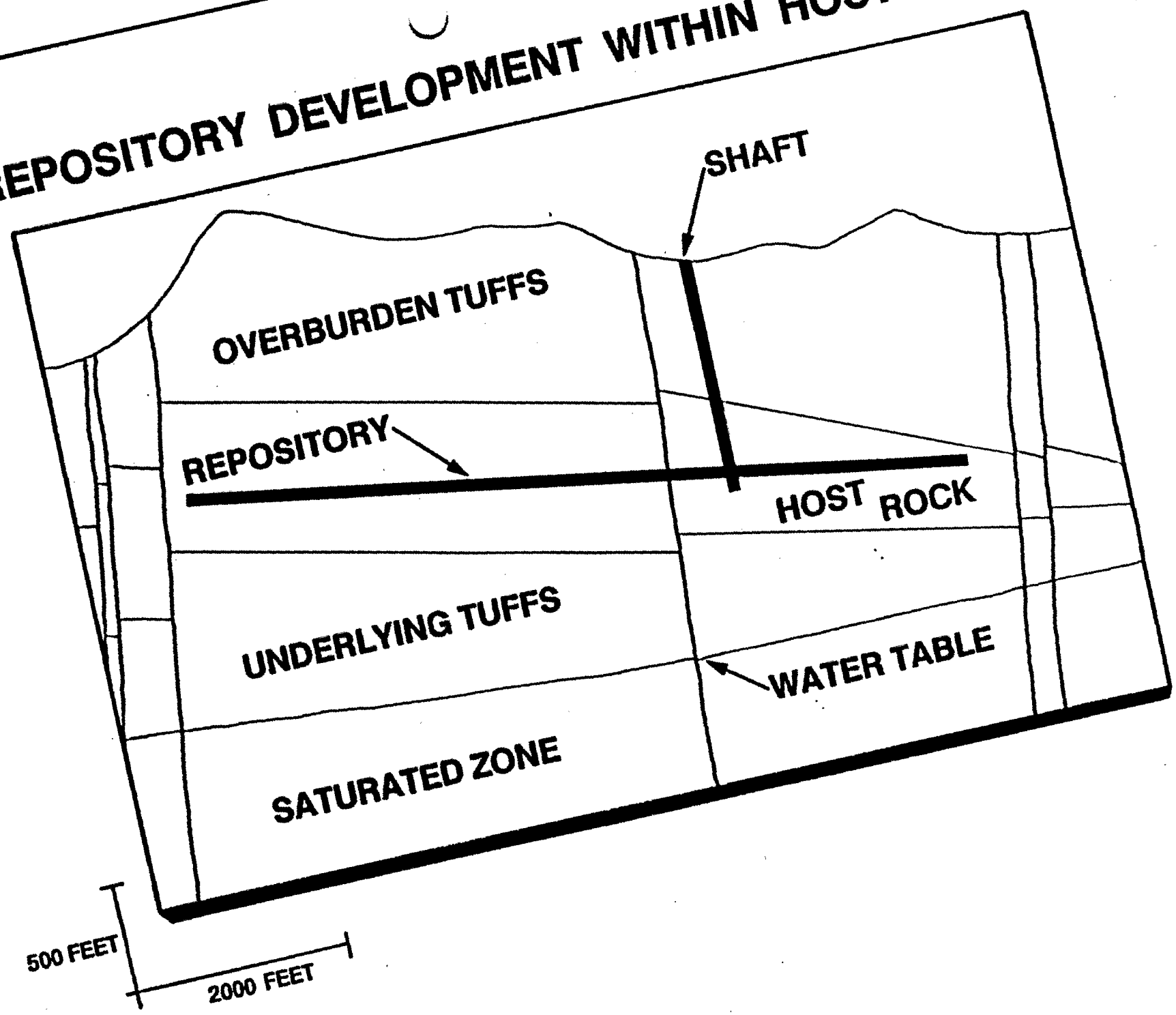
REPOSITORY DEVELOPMENT WITHIN HOST ROCK



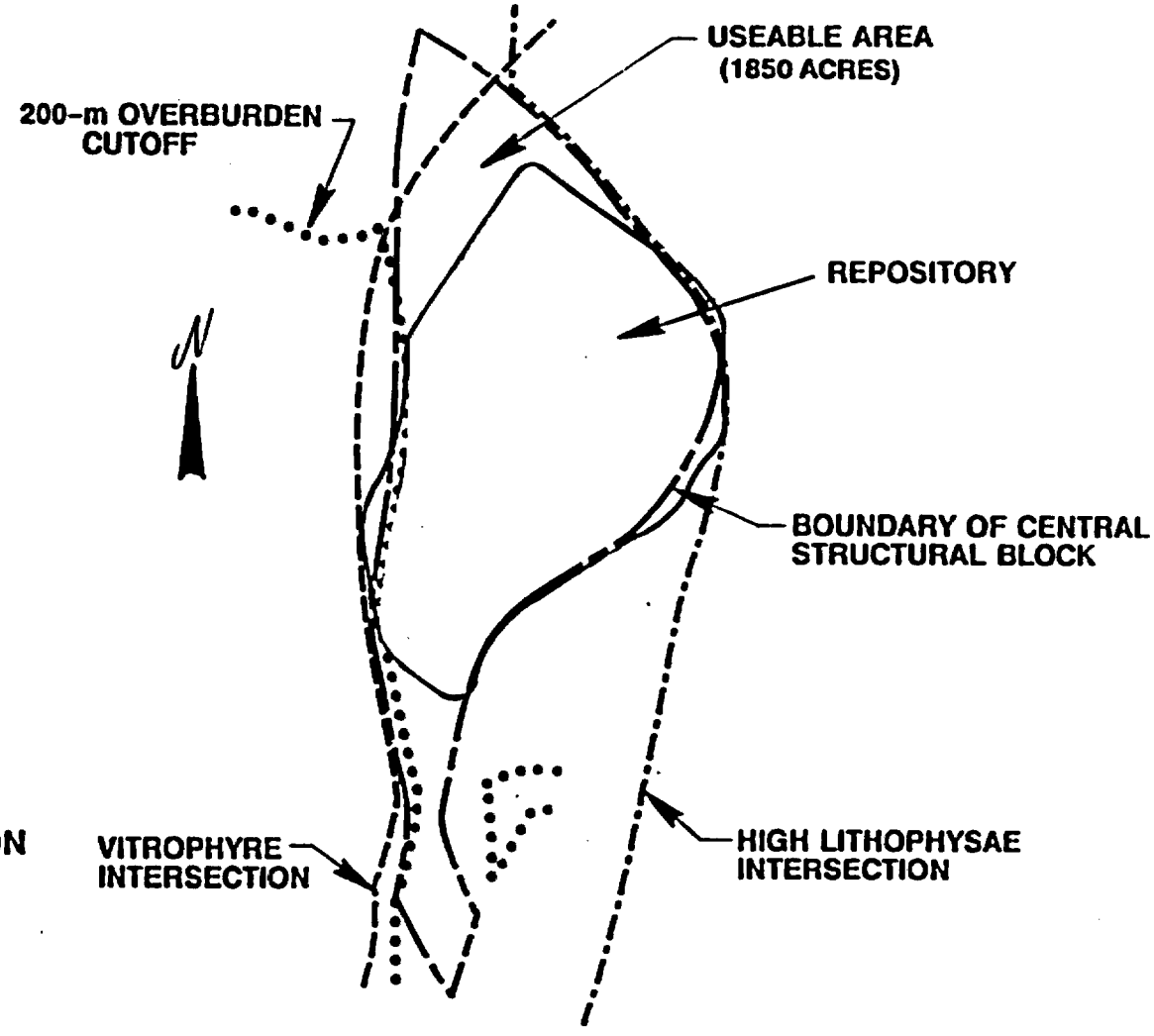
USEABLE AREA FOR NUCLEAR WASTE DISPOSAL IN YUCCA MOUNTAIN

CONSTRAINTS:

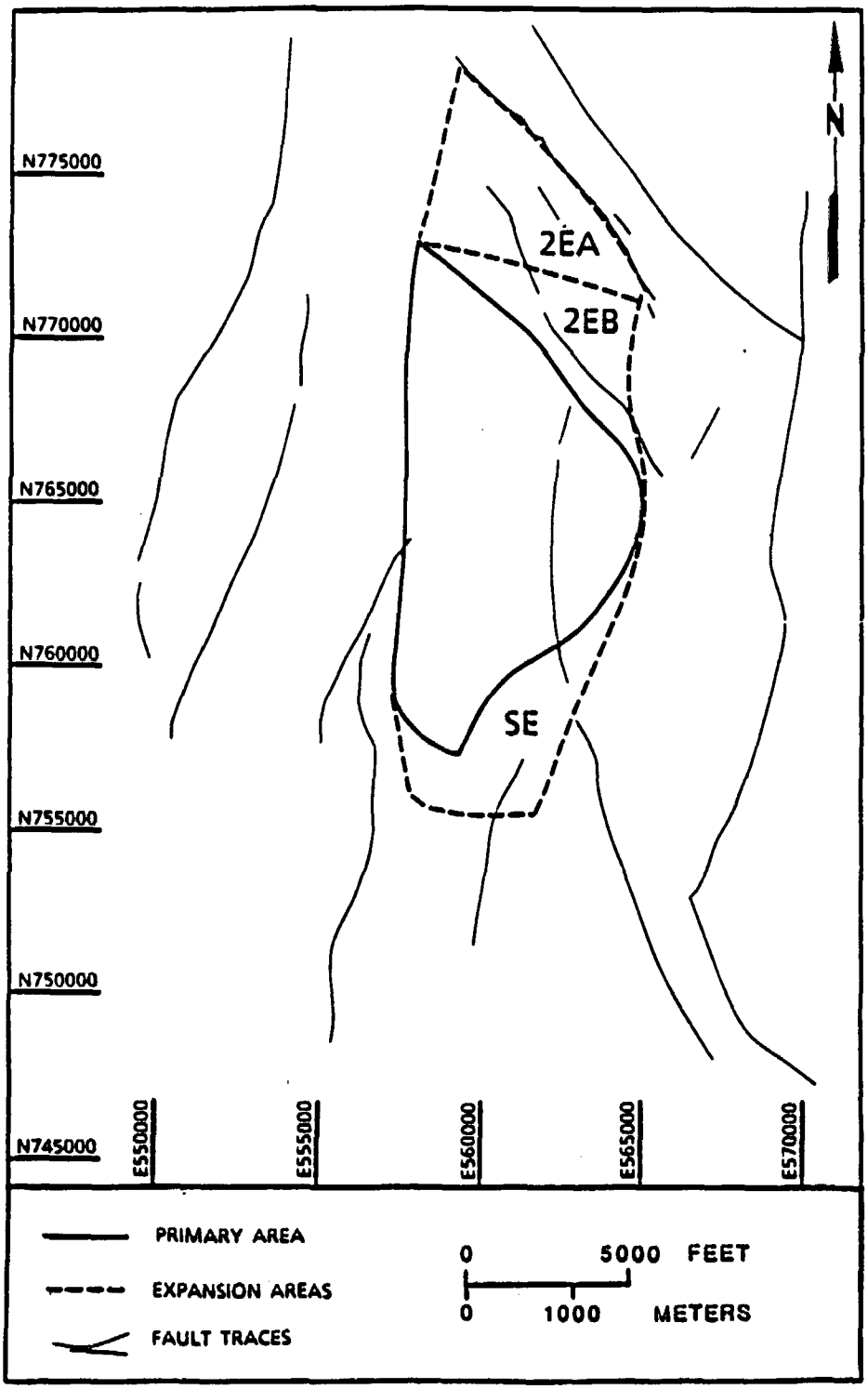
- SITING GUIDELINES:
  - 200-m OVERBURDEN
  - ROCK CHARACTERISTICS
    - -- LITHOPHYSAE
    - -- VITROPHYRE
- MINING/WASTE HANDLING EQUIPMENT LIMITATIONS:
  - 10% MAXIMUM GRADE

MODEL:

- 3-D GRAPHICS REPRESENTATION OF YUCCA MOUNTAIN



PREFERRED EXPANSION AREAS



WHY IS THE PERIMETER OF THE PROPOSED REPOSITORY SHAPED AS IT IS?

PERIMETER SHAPE IN CONCEPTUAL DESIGN INFLUENCED BY:

- **CONSTRAINTS ON USABLE AREA**

  - STRUCTURAL FEATURES
  - OVERBURDEN REQUIREMENTS
  - MAINTAINING REPOSITORY WITHIN DESIRED SECTION OF TOPOPAH SPRING UNIT

- **CONSTRAINTS ON REPOSITORY DEVELOPMENT**

  - DESIRABLE EQUIPMENT OPERATING CONSTRAINTS ($\leq$10% GRADE)
  - DESIRABLE EXTENT OF ACCESS DRIFTS ($\leq$3000' FOR BETTER VENTILATION)

WHAT IS THE CURRENTLY PLANNED SEQUENCE FOR DEVELOPMENT OF THE REPOSITORY?

- EXTEND REPOSITORY MAINS TO SW EXTENT OF REPOSITORY

- DEVELOP WASTE EMPLACEMENT PANELS

  - BEGINNING IN NE AREA OF REPOSITORY
  - PANEL CONSTRUCTION WILL PRECEDE WASTE EMPLACEMENT BY 1 - 2 YEARS
  - LATERAL EXTENT OF PANEL TO BE DETERMINED BY ROCK CONDITIONS ENCOUNTERED IN DEVELOPING PANEL ACCESS DRIFTS OR BY REACHING 3000' DESIGN LIMIT
  - SEGMENTED SINGLE-HEADING PERIMETER DRIFT WILL THEN BE CONNECTED TO PANEL ACCESS DRIFT

WHAT ARE THE PRINCIPAL UNCERTAINTIES IN THE DESIGN RELATED TO EARLY DEVELOPMENT OF THE REPOSITORY PERIMETER DRIFT?

- LOCATION OF TsW1/TsW2 BOUNDARY
  - LIMITED STRATIGRAPHIC CONTROL AVAILABLE FROM CURRENT SURFACE-BASED EXPLORATORY BOREHOLES
  - SITE CHARACTERIZATION RESULTS COULD POTENTIALLY ALLOW LOWER GRADES IN REPOSITORY DRIFTS
- UNDERGROUND LOCATION AND EFFECT OF STRUCTURAL FEATURES
  - CURRENT CONCEPTUAL DESIGN RECOGNIZES POTENTIAL UNCERTAINTIES IN FAULT PROJECTION TO DEPTH

WHAT ARE THE PRINCIPAL UNCERTAINTIES IN THE DESIGN RELATED TO EARLY DEVELOPMENT OF THE REPOSITORY PERIMETER DRIFT?

(CONTINUED)

- FEASIBILITY/NECESSITY OF REPOSITORY EXPANSION INTO CANDIDATE AREAS (SE AND 2E)
  - EARLY DEVELOPMENT OF PERIMETER DRIFT WOULD COMPLICATE REPOSITORY DEVELOPMENT IN EXPANSION REGIONS
- MATURITY OF DESIGN AND RELATED CRITERIA
  - DEVELOPMENT OF ADVANCED CONCEPTUAL DESIGN AND LICENSE APPLICATION DESIGN COULD RESULT IN CHANGES IN ELEVATION, GRADE, OR LATERAL EXTENT

ENGINEERING CONSIDERATIONS RELATED TO REPOSITORY PERIMETER DRIFT DEVELOPMENT

- VIABILITY OF INTEGRATION WITH REPOSITORY
- FEASIBILITY OF USING CURRENT ESF CONFIGURATION TO SUPPORT DEVELOPMENT CONSIDERING

  DATA QUALITY
  SAFE WORKING ENVIRONMENT
  FLEXIBILITY FOR EXPANSION

FEASIBILITY OF PERIMETER DRIFT DEVELOPMENT

- TO UNDERSTAND FEASIBILITY OF USING CURRENT ESF CONFIGURATION TO SUPPORT REPOSITORY PERIMETER DRIFT DEVELOPMENT, NEED TO CONSIDER:
  - WORKER SAFETY CONSIDERATIONS
  - POSSIBLE CONSTRUCTION-TO-TEST INTERFERENCE
  - IMPACT ON FLEXIBILITY FOR ADDITIONAL EXPLORATION

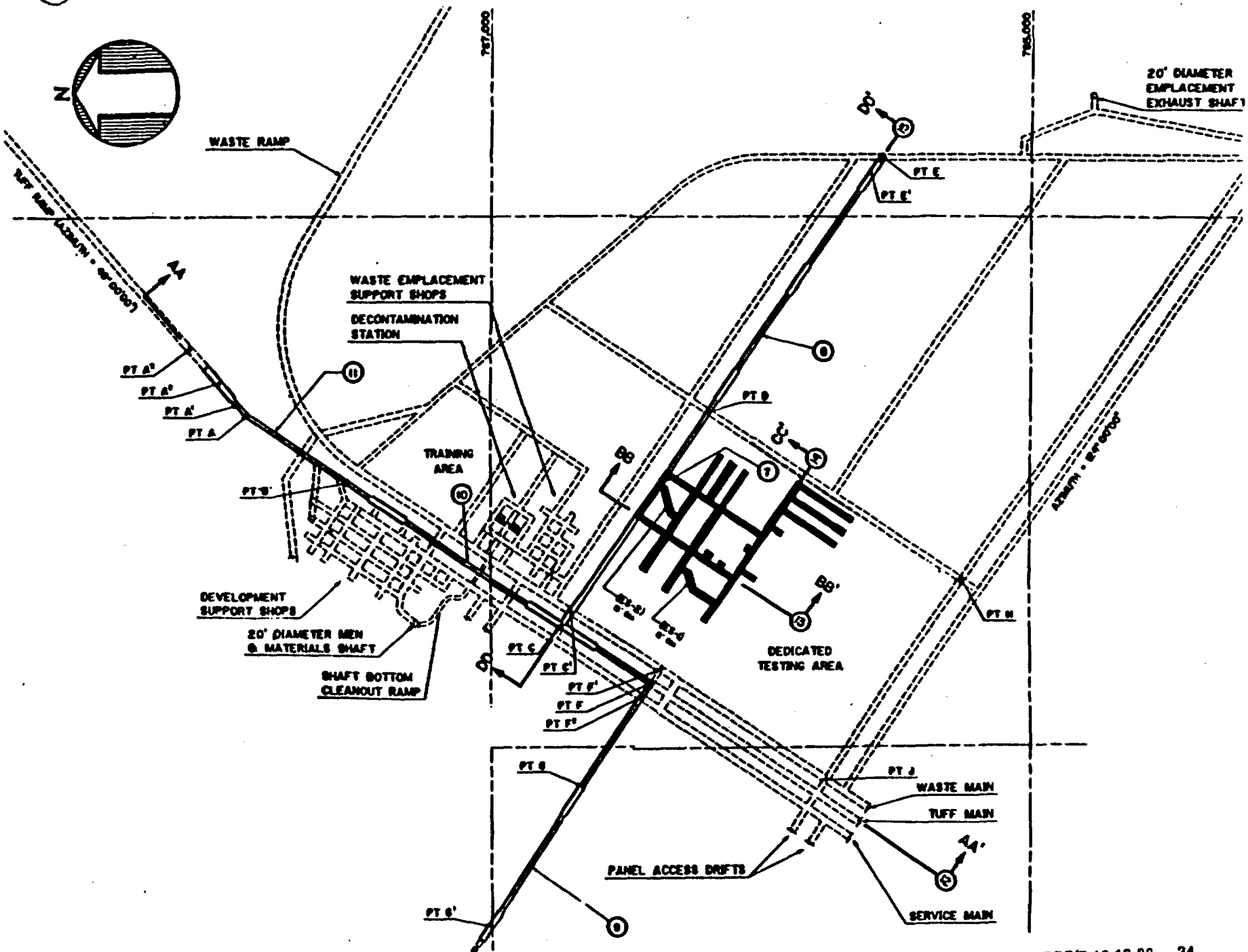
WORKER SAFETY CONSIDERATIONS RELATED TO REPOSITORY PERIMETER DRIFT DEVELOPMENT

- FEASIBILITY OF USING SINGLE ENTRY HEADING
  - LONG DISTANCE COULD LEAD TO PERSONNEL EVACUATION CONCERNS
- NEED FOR ADDITIONAL ACCESSES SHOULD BE EVALUATED

CONSTRUCTION-TO-TEST INTERFERENCE CONSIDERATIONS RELATED TO REPOSITORY PERIMETER DRIFT DEVELOPMENT

- CURRENT LAYOUT SEPARATES EXPERIMENTS IN DEDICATED TESTING AREA FROM MUCK REMOVAL AND EQUIPMENT MAINTENANCE OPERATIONS

- SIGNIFICANT (SIXFOLD?) EXPANSION OF EXPLORATION WOULD REQUIRE FURTHER EVALUATION RELATED TO DEDICATED TEST AREA AND TESTING PLANNED IN LONG LATERAL DRIFTS


N
WASTE RAMP
TUFF RAMP (AZIMUTH = 48°50'00")
AZIMUTH = 48°50'00"
20' DIAMETER EMPLACEMENT EXHAUST SHAFT
WASTE EMPLACEMENT SUPPORT SHOPS
DECONTAMINATION STATION
TRAINING AREA
DEVELOPMENT SUPPORT SHOPS
20' DIAMETER MEN & MATERIALS SHAFT
SHAFT BOTTOM CLEANOUT RAMP
DEDICATED TESTING AREA
PANEL ACCESS DRIFTS
WASTE MAIN
TUFF MAIN
SERVICE MAIN
PT A
PT A'
PT A²
PT A³
PT B'
PT C
PT C'
PT D
PT E
PT E'
PT F
PT F'
PT F²
PT G
PT G'
PT H
PT J
AA
AA'
BB
BB'
CC
CC'
DD
DD'
EE
EE'
7137,000
7135,000

CONSIDERATIONS IN ASSESSING IMPACT OF REPOSITORY PERIMETER DRIFT DEVELOPMENT ON FLEXIBILITY FOR ADDITIONAL EXPLORATION FROM ESF

- CAPABILITY OF CURRENT SUPPORT SYSTEMS (MUCK REMOVAL, VENTILATION, ETC.) TO ACCOMMODATE PERIMETER DRIFT DEVELOPMENT WITHOUT PRECLUDING OTHER POSSIBLE DRIFTING

  - TITLE I STUDY DESIGN OF POSSIBLE DRIFTING TO SOUTH, INDICATED SUFFICIENT FLEXIBILITY IN TITLE I DESIGN TO ACCOMMODATE THE 10,000 FT OF ADDITIONAL DRIFTING

  - PERIMETER DRIFT CONFIGURATION WOULD REQUIRE FURTHER EVALUATION INCLUDING SCHEDULE REQUIREMENTS BUT COULD POSSIBLY EXCEED CAPACITY OF MUCK REMOVAL SYSTEM

SUMMARY OF PRINCIPAL ENGINEERING CONSIDERATIONS RELATED TO EARLY REPOSITORY PERIMETER DRIFT DEVELOPMENT

- VIABILITY OF ESTABLISHING PERIMETER DRIFT ELEVATION AND GRADE
  - WITHOUT MORE EXTENSIVE STRATIGRAPHIC CONTROL
  - WITHOUT CONSTRAINING FEASIBILITY OF EXPANSION INTO CANDIDATE REGIONS
  - WITHOUT REFINING REPOSITORY DESIGN AND RELATED CRITERIA
- FEASIBILITY OF USING CURRENT ESF CONFIGURATION TO SUPPORT DEVELOPMENT
  - INCREASED ACCESS/EGRESS REQUIREMENTS (DUAL HEADING, OR ADDITIONAL ACCESSWAYS) RELATED TO WORKER SAFETY
  - FURTHER CONSIDERATION OF POSSIBLE CONSTRUCTION-TO-TEST INTERFERENCE WOULD BE REQUIRED
  - POSSIBLE OPERATION OF MUCK REMOVAL SYSTEM AT OR NEAR CAPACITY COULD PRECLUDE OTHER EXPLORATORY DRIFTING

SUMMARY

- PROGRAM FOR 3-DIMENSIONAL CHARACTERIZATION INCLUDES A SYSTEMATIC APPROACH AS WELL AS INVESTIGATION OF ANOMOLOUS FEATURES AND DRIFTING TO INVESTIGATE STRUCTURES; THE PROGRAM IS DESIGNED TO BE REPRESENTATIVE

- EXPECT PROGRAM AS DEVELOPED TO BE SUFFICIENT AND DOES RETAIN FLEXIBILITY TO EXPAND OR REFOCUS ACTIVITIES IF WARRANTED

- A PERIMETER DRIFT EARLY IN THE SITE CHARACTERIZATION PROGRAM COULD CONSTRAIN REPOSITORY LAYOUT

- IMPROVED DATA BASE COULD INDICATE NEED FOR ADDITIONAL EXPLORATORY DRIFTING (PERHAPS COINCIDENT WITH MAINS, DRIFTS, PERIMETER DRIFTS) OR INDICATE VIABILITY OF PERIMETER DRIFT

- REPOSITORY DESIGN CONCEPTS SHOULD INCLUDE DEVELOPMENT PLANS THAT COULD UTILIZE EARLY PERIMETER, MAINS, OR ACCESS DRIFTS

NUCLEAR WASTE TECHNICAL REVIEW BOARD BRIEFING

CONCLUSIONS

CONSIDERATIONS FOR REPOSITORY PERIMETER DRIFTING AS PART OF SITE CHARACTERIZATION

PRESENTED BY

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