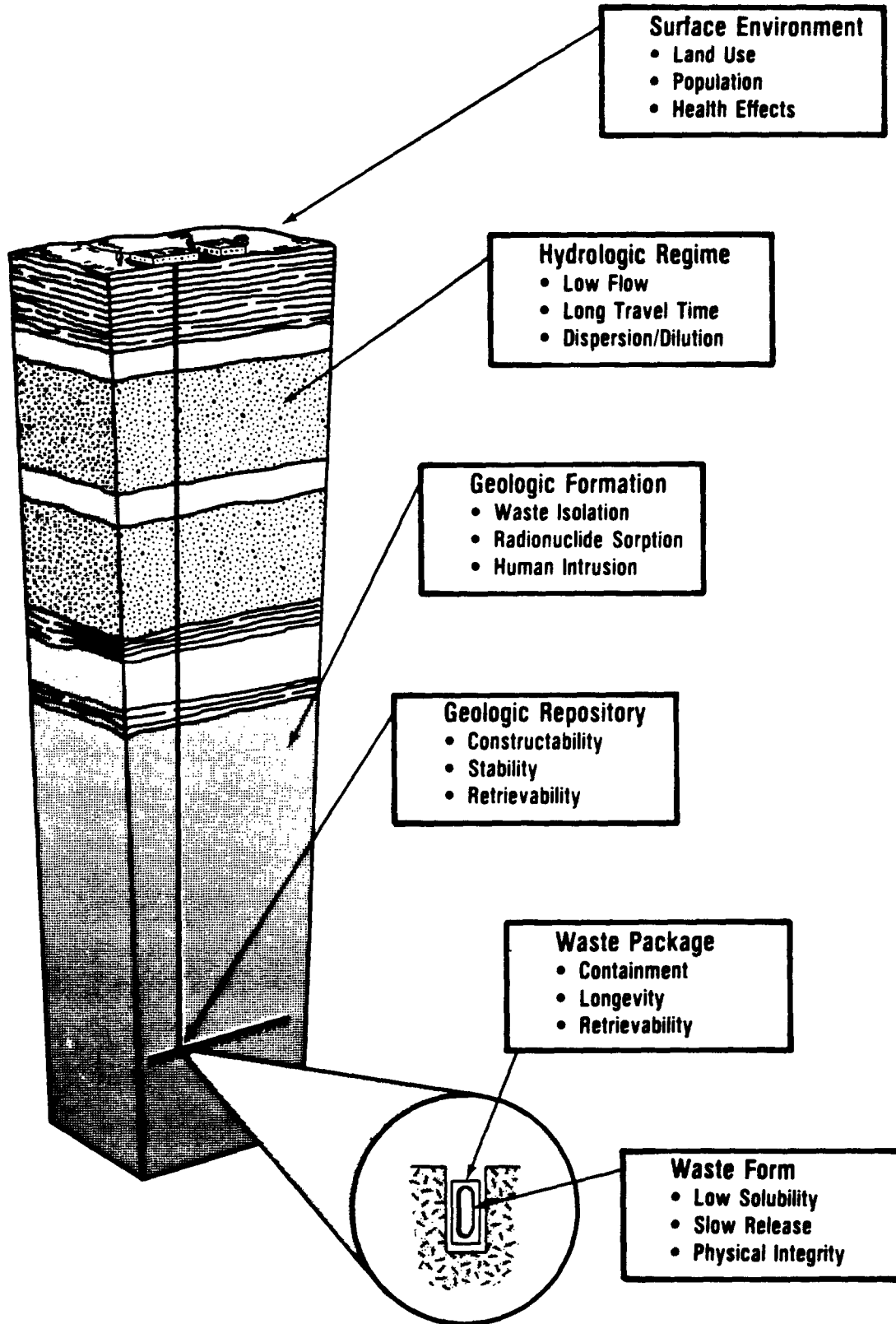


REPOSITORY SYSTEM BACKGROUND

**MARK W. FREI
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U.S. DEPARTMENT OF ENERGY**

**PRESENTATION TO THE
NUCLEAR WASTE TECHNICAL REVIEW BOARD
MARCH 7-8, 1989**

FUNCTIONAL ELEMENTS OF GEOLOGIC DISPOSAL OF HLW



REGULATIONS

NUCLEAR WASTE POLICY ACT OF 1982

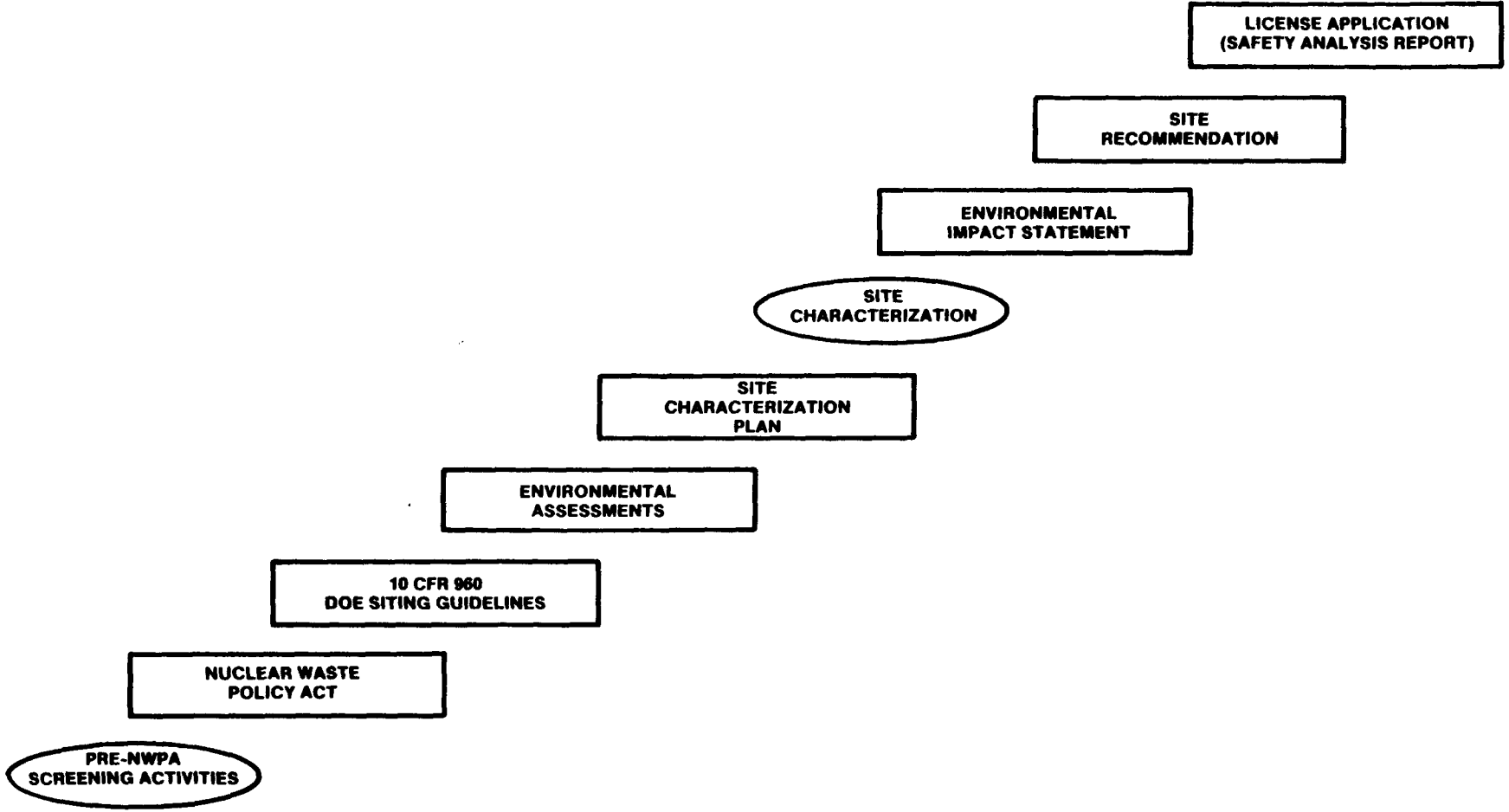
NUCLEAR WASTE POLICY AMENDMENTS ACT OF 1987

**10 CFR PART 60 DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTE
IN THE GEOLOGIC REPOSITORIES**

10 CFR PART 960 DOE SITING GUIDELINES

**40 CFR PART 191 ENVIRONMENTAL STANDARDS FOR THE
MANAGEMENT AND DISPOSAL OF SPENT FUEL,
NUCLEAR FUEL, HIGH-LEVEL AND
TRANSURANIC RADIOACTIVE WASTE**

STEPS IN THE SITING PROGRAM



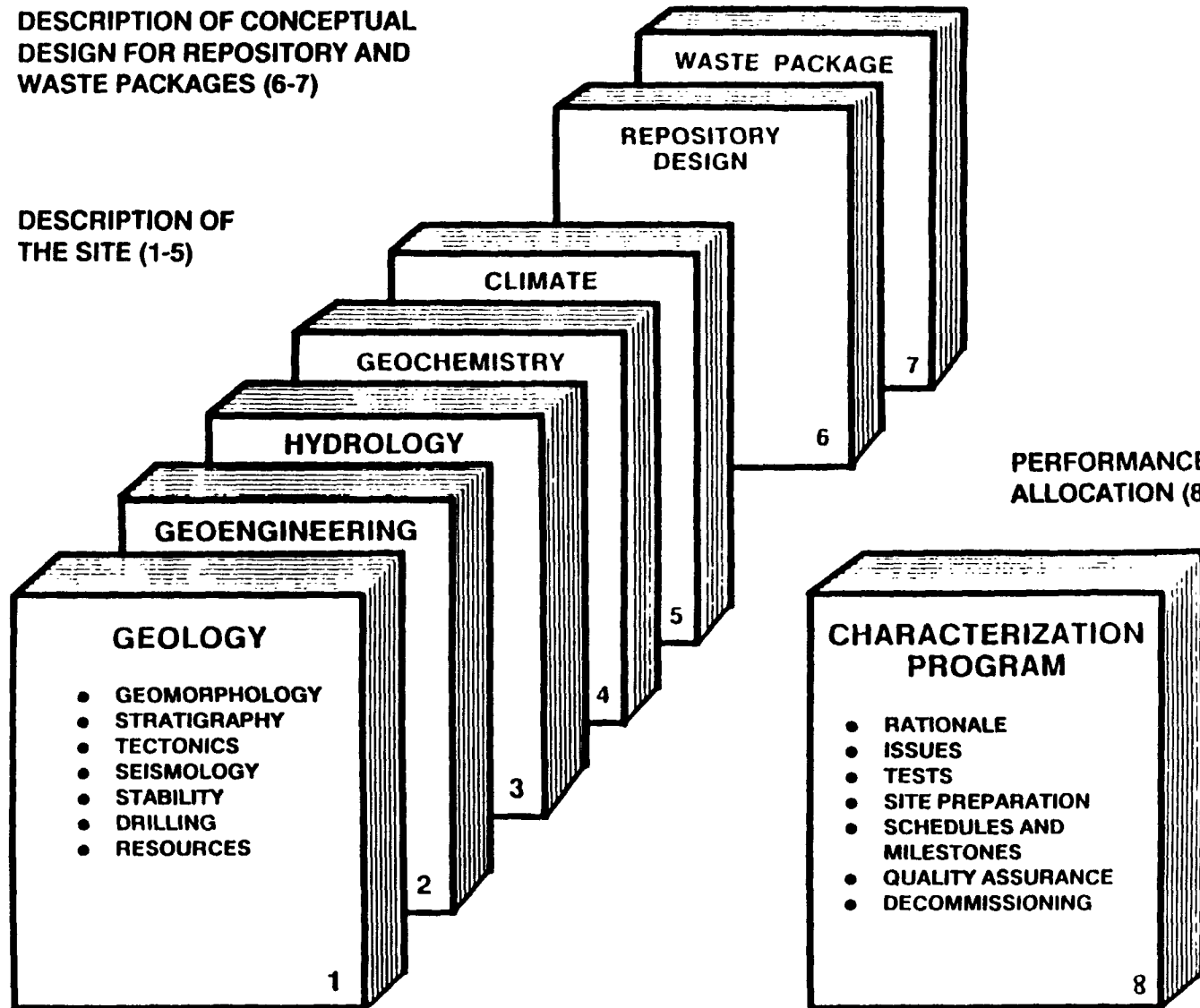
SIGNIFICANT PROGRAM ACCOMPLISHMENTS

- **COMPLETED SCP CONCEPTUAL DESIGNS FOR THE REPOSITORY AND WASTE PACKAGE, SEPTEMBER, 1987**
- **ISSUED SITE CHARACTERIZATION PLAN CONSULTATION DRAFT WHICH INCLUDED REPRESENTATIVE CONCEPTUAL DESIGN AND DETAILED TESTING PROGRAM, JANUARY, 1988**
- **ISSUED SITE CHARACTERIZATION PLAN, DECEMBER, 1988**
- **ISSUED ESF DESIGN ANALYSIS REPORT, DECEMBER, 1988**
- **ISSUED ESF TITLE I DESIGN, DECEMBER, 1988**
- **ISSUED ESF DESIGN ACCEPTABILITY ANALYSIS REPORT, FEBRUARY 1989**

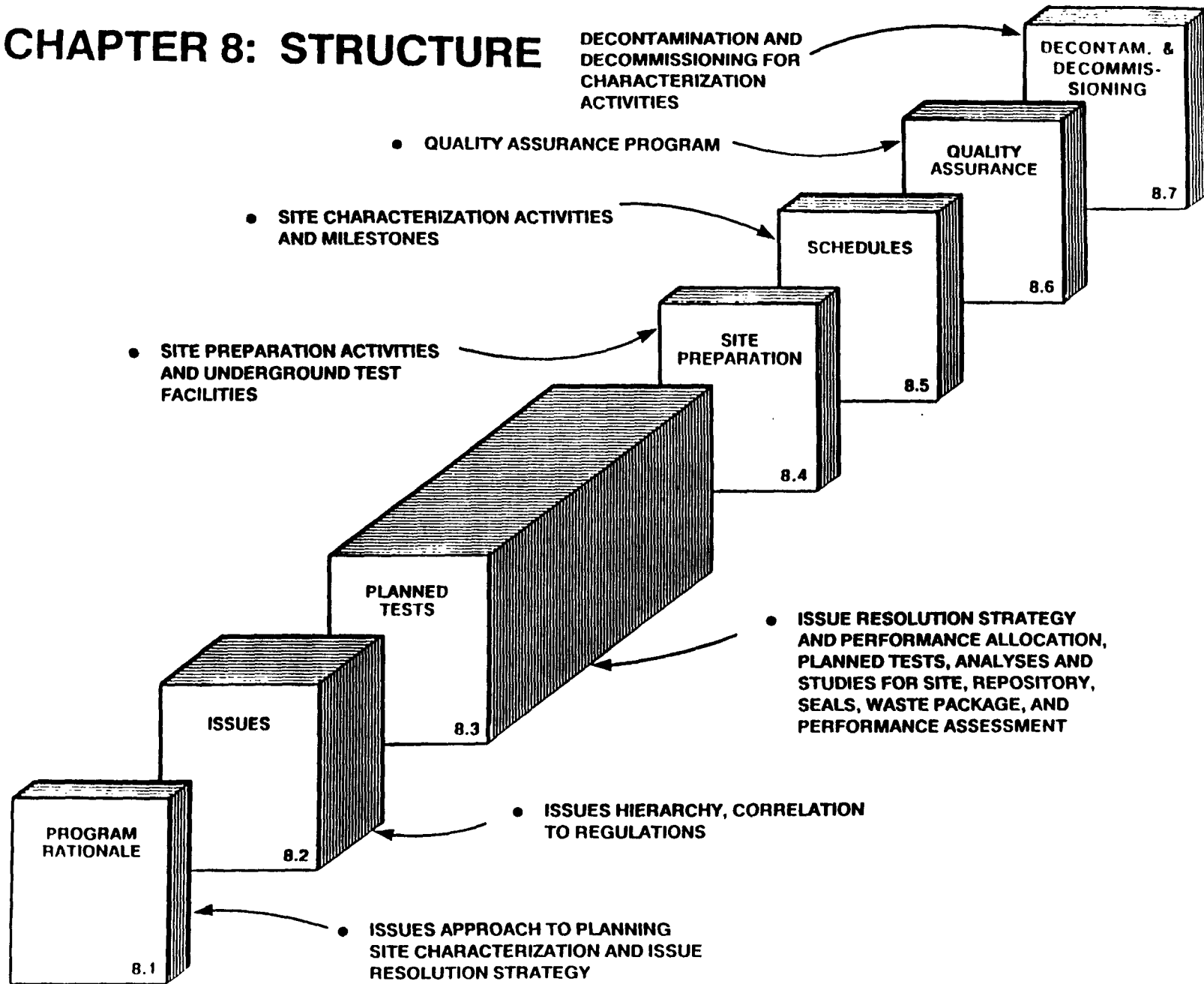
ORGANIZATION OF THE SCP

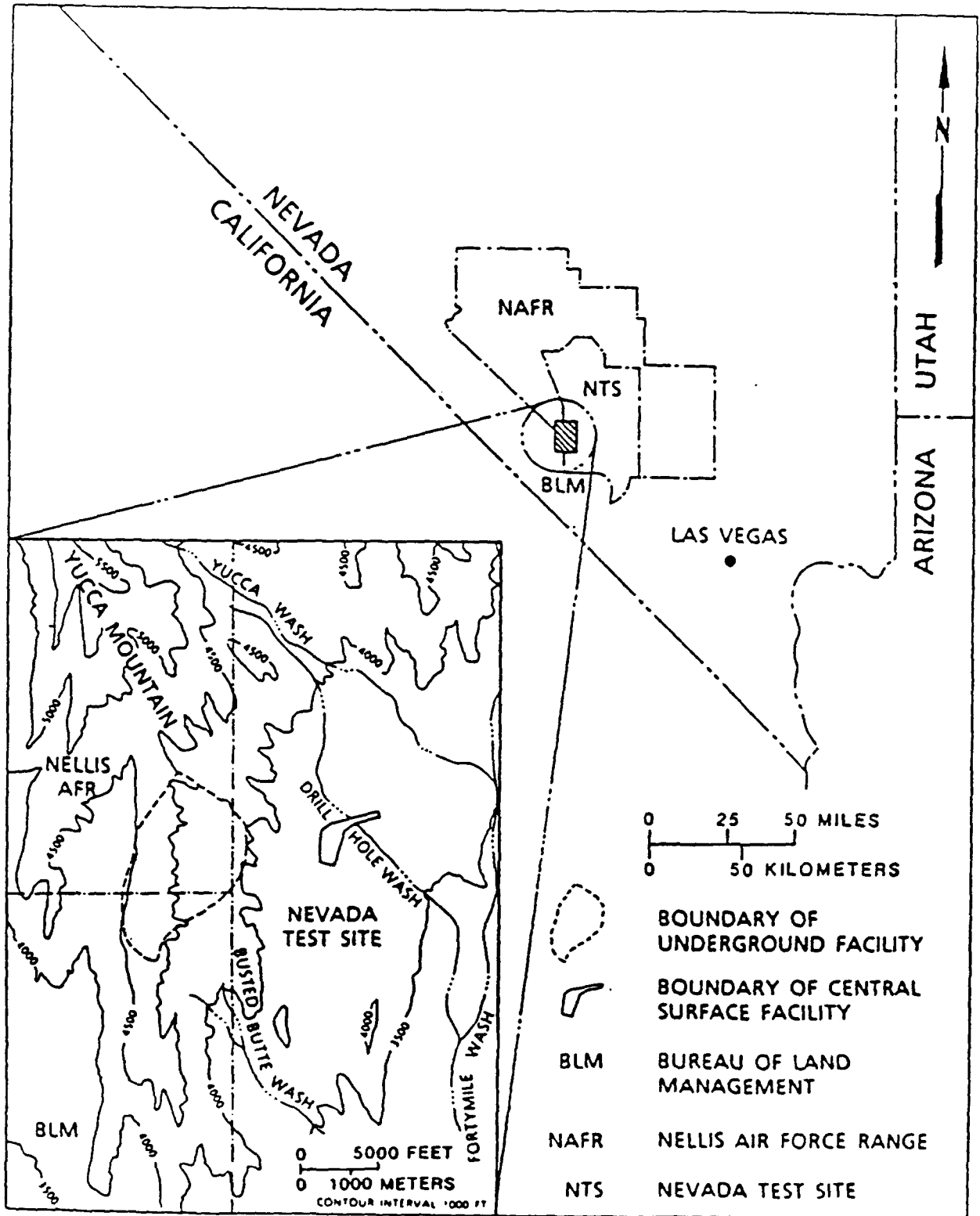
DESCRIPTION OF CONCEPTUAL
DESIGN FOR REPOSITORY AND
WASTE PACKAGES (6-7)

DESCRIPTION OF
THE SITE (1-5)

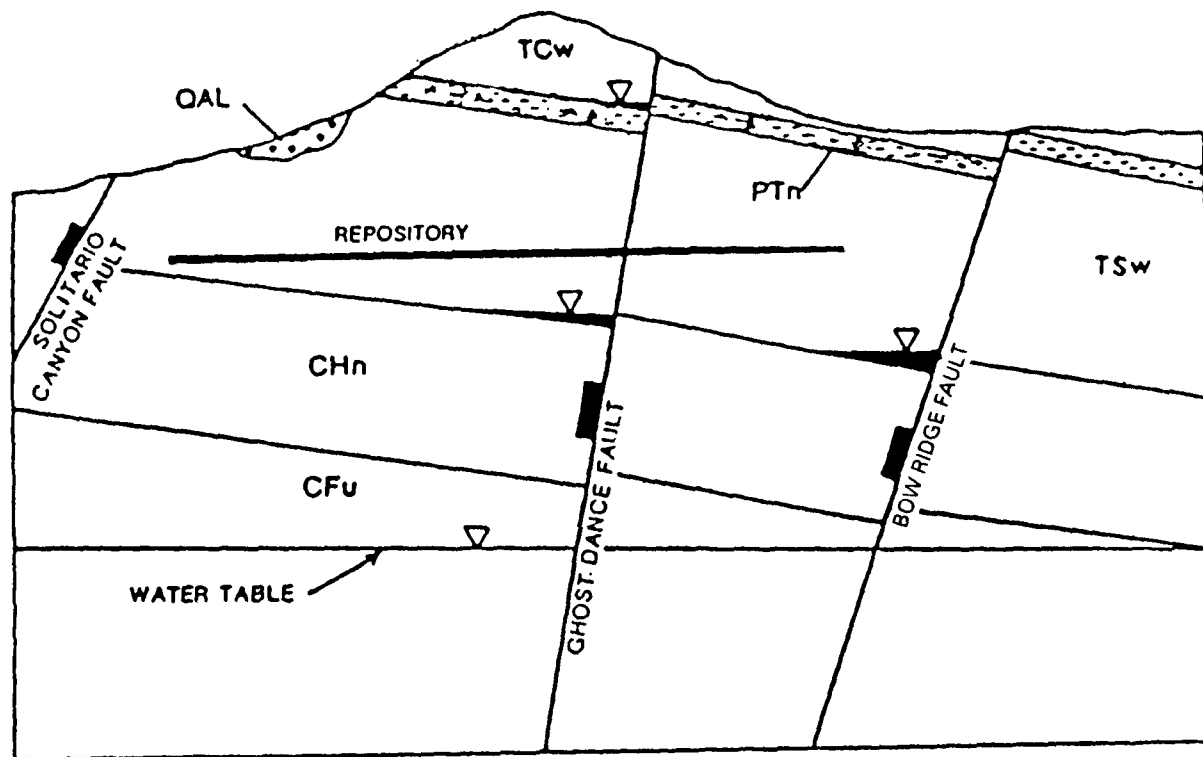


CHAPTER 8: STRUCTURE



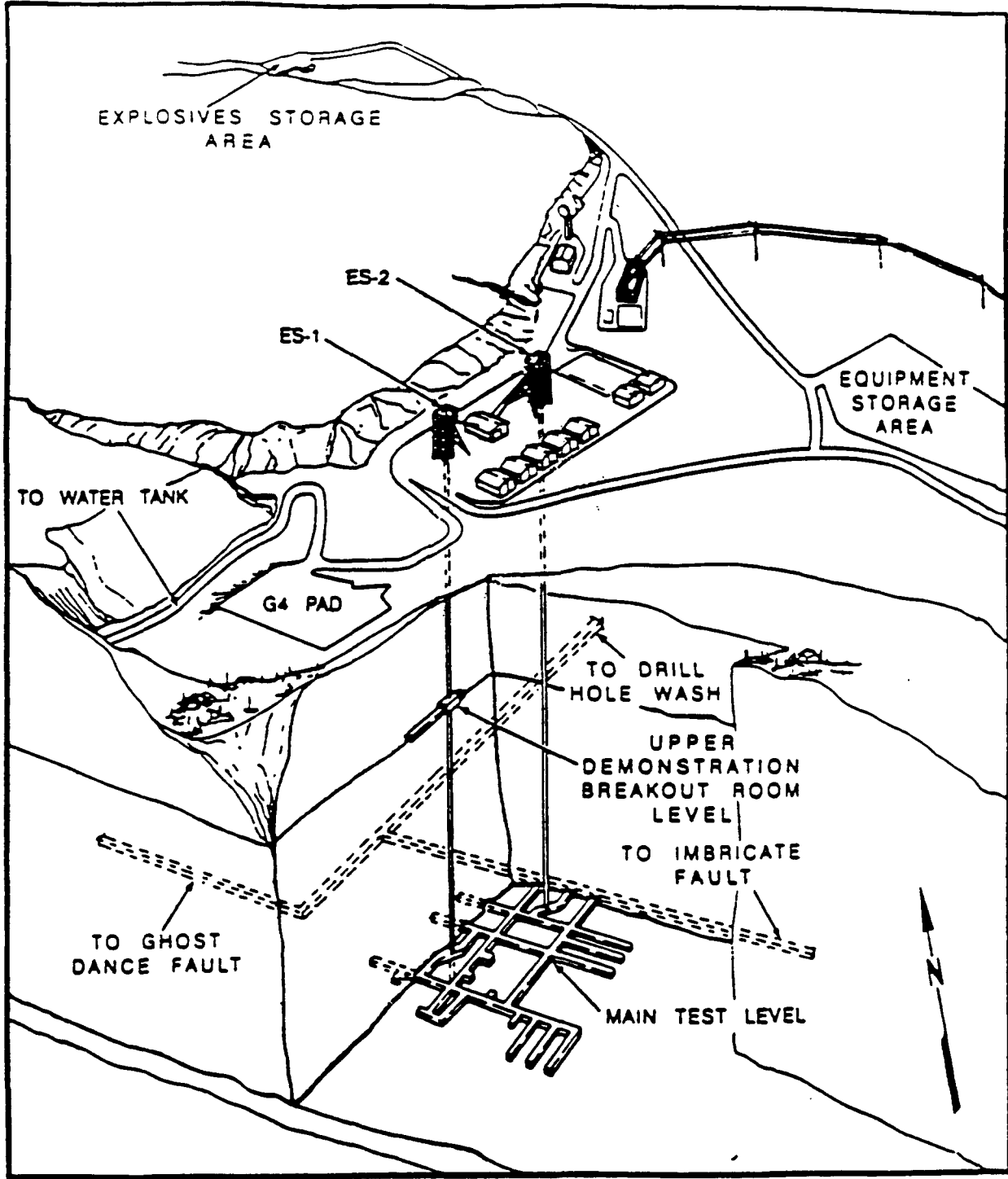


YUCCA MOUNTAIN LOCATION IN NEVADA

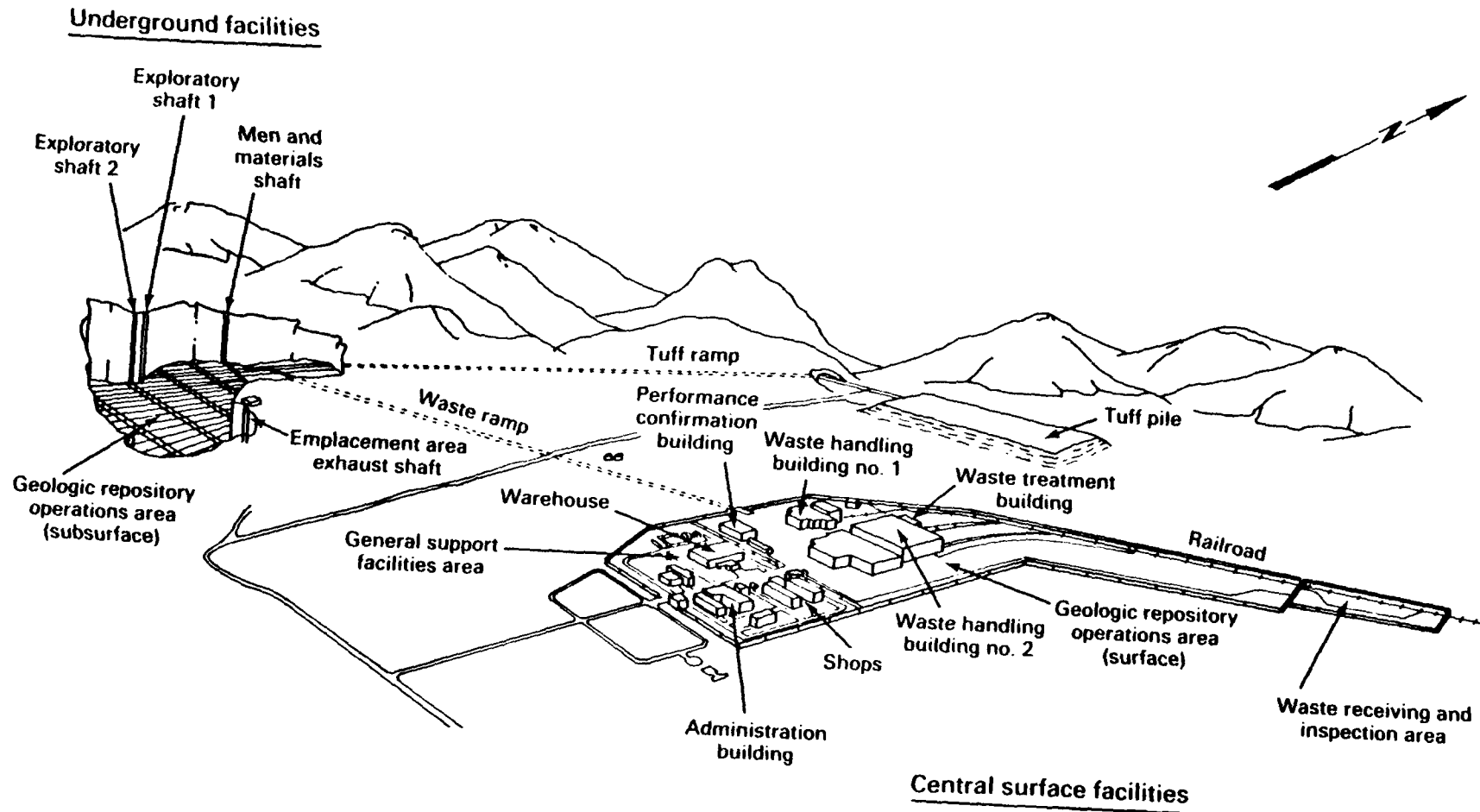


WEST

- QAL ALLUVIUM
- TCw TIVA CANYON WELDED UNIT
- PTn PAINTBRUSH NONWELDED UNIT
- TSw TOPOPAH SPRING WELDED UNIT
- CHn CALICO HILLS NONWELDED UNIT
- CFu CRATER FLAT (Undifferentiated) UNIT



CONCEPTUAL ILLUSTRATION OF THE EXPLORATORY SHAFT FACILITY



PERSPECTIVE OF THE PROPOSED YUCCA MOUNTAIN REPOSITORY

0103-0045DS 3/3/89

MAJOR MILESTONES

- **MARCH 1989** **START ESF TITLE II DESIGN**
- **MAY 1989** **START SITE PREPARATION**
- **OCTOBER 1989** **START ACD**
- **NOVEMBER 1989** **START SHAFT CONSTRUCTION**
- **1991** **COMPLETE ES-1 AND ES-2 CONSTRUCTION**
- **1992** **COMPLETE ESF EXPLORATORY DRIFTING**
COMPLETE ACD/START LAD
- **1993** **ISSUE DRAFT ENVIRONMENTAL IMPACT STATEMENT**
- **1994** **COMPLETE WASTE PACKAGE LAD**
COMPLETE REPOSITORY LAD
ISSUE FINAL ENVIRONMENTAL IMPACT STATEMENT
SUBMIT SSR TO THE PRESIDENT
- **1995** **SUBMIT LICENSE APPLICATION TO CONSTRUCT**
- **1998** **REPOSITORY CONSTRUCTION STARTS**
- **2003** **WASTE ACCEPTANCE BEGINS**

SURFACE BASED TESTING

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WHAT IS SITE CHARACTERIZATION?

- **THE ACTIVITIES CONDUCTED TO GATHER INFORMATION ABOUT THE "GEOLOGIC" CONDITIONS AT THE SITE AND TO EVALUATE THE SITE'S SUITABILITY FOR A REPOSITORY**
- **A PROCESS SET FORTH IN THE NUCLEAR WASTE POLICY ACT OF 1982 THAT LEADS TO THE LICENSE APPLICATION**

WHAT IS THE SITE CHARACTERIZATION PLAN (SCP)?

- **GENERAL PLAN REQUIRED BY THE NUCLEAR WASTE POLICY ACT AND NRC REGULATION 10 CFR PART 60**
- **COMPREHENSIVE INITIAL PLAN FOR CONDUCTING SITE CHARACTERIZATION AT A CANDIDATE SITE**

THE SCP IS THE BASIS FOR STUDY PLANS

- **PRESENTS OVERALL RATIONALE FOR SITE CHARACTERIZATION PROGRAM**
- **IDENTIFIES INFORMATION NEEDED FROM SITE CHARACTERIZATION BASED ON SYSTEMATIC ANALYSIS OF REGULATORY REQUIREMENTS**
- **DISCUSSES OVERALL TESTING STRATEGY AND DESCRIBES HIERARCHY OF PROGRAMS, INVESTIGATIONS, STUDIES AND ACTIVITIES TO BE CONDUCTED TO PROVIDE THE NEEDED INFORMATION**

RELATIONSHIP OF STUDY PLANS TO SCP

- **STUDY PLANS PROVIDE MORE DETAIL ON EACH STUDY DESCRIBED IN SCP, INCLUDING INFORMATION ON**
 - **ACTIVITIES**
 - **TESTS AND ANALYSES**
 - **METHODS AND PROCEDURES**
 - **DURATION AND SEQUENCING OF ACTIVITIES**
 - **CONSTRAINTS**
 - **QA REQUIREMENTS**
- **STUDY PLANS DEFINE THE TECHNICAL WORK TO BE PERFORMED BY THE INVESTIGATORS**
- **THERE ARE A TOTAL OF 106 STUDY PLANS**
 - **STUDIES COMPRISE 320 SEPARATE ACTIVITIES**

THE SITE CHARACTERIZATION TESTING PROGRAM

THE SITE CHARACTERIZATION PROGRAM IS DESIGNED TO PROVIDE INFORMATION NEEDED TO ESTABLISH:

- **SPATIAL TRENDS AND VARIABILITY OF SITE CONDITIONS**
- **CHARACTERISTICS OF PHENOMENOLOGICAL PROCESSES**

THE PLANNED PROGRAM INCLUDES TWO MAJOR COMPONENTS-SURFACE-BASED TESTING:

- **INVESTIGATION OF PREVIOUSLY RECOGNIZED FEATURES AND STRUCTURES**
- **SYSTEMATIC COVERAGE OF THE SITE SURROUNDING AREAS TO ESTABLISH TRENDS AND OVERALL VARIABILITY OF SITE CONDITIONS**

UNDERGROUND TESTING:

- **IN SITU TESTING AND OTHER UNDERGROUND INVESTIGATIONS TO IMPROVE UNDERSTANDING OF PHENOMENOLOGICAL PROCESSES AND SITE CONDITIONS**

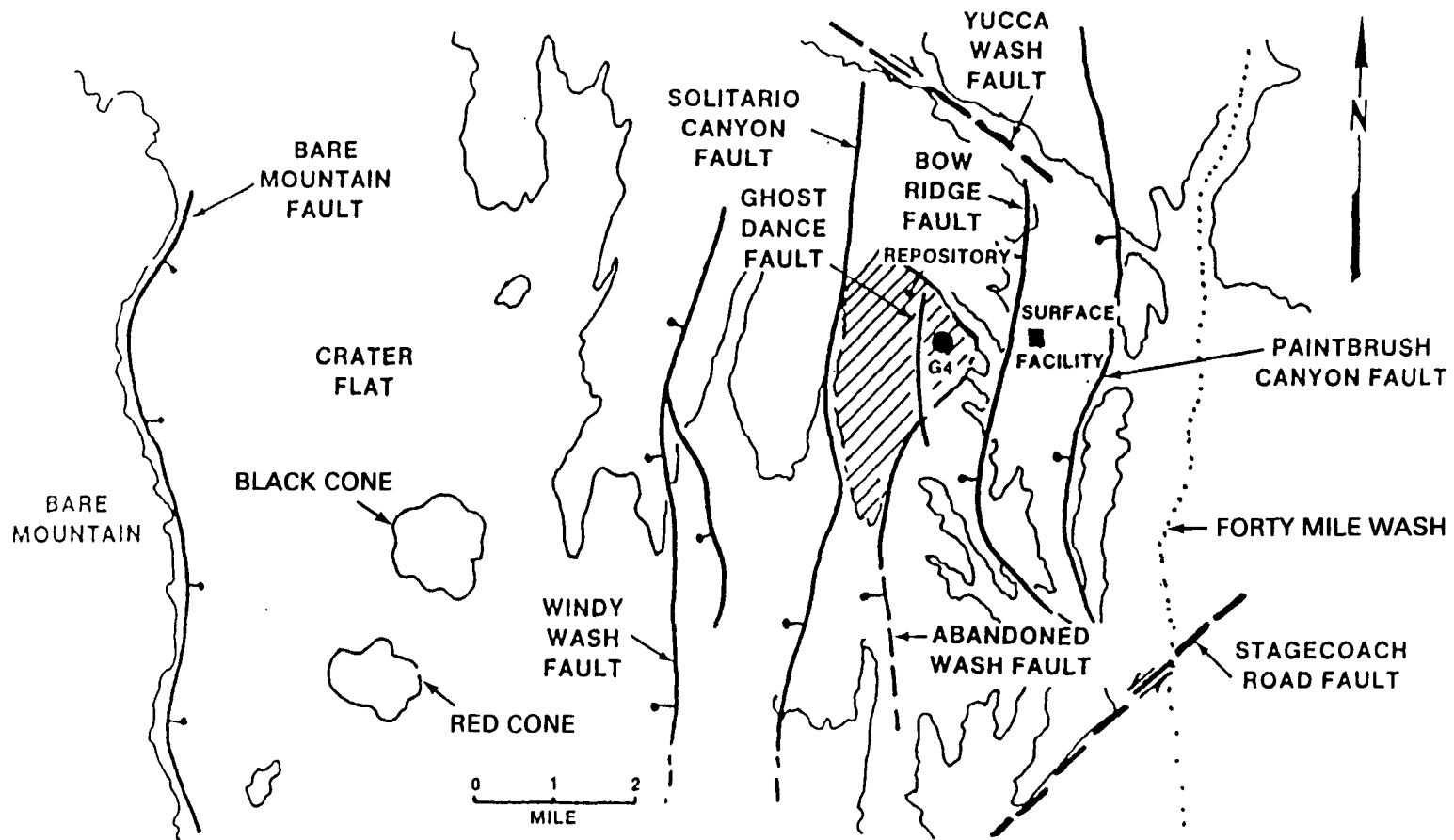
THE SITE CHARACTERIZATION TESTING PROGRAM (CONTINUED)

CONFIDENCE THAT THE DATABASE OBTAINED THROUGH SITE CHARACTERIZATION WILL BE "APPROPRIATE AND ADEQUATE" WILL BE GAINED BY

- **COLLECTING DATA TO EVALUATE THE VALUES OF BASIC PARAMETERS AT LOCATIONS THROUGH THE SITE**
- **ANALYZING STATISTICAL VARIABILITY OF VALUES FOR BASIC PARAMETERS**
- **DEVELOPING CAPABILITY TO DESCRIBE/PREDICT TRENDS IN SITE PARAMETERS USING THE BEST AVAILABLE MODELS**
- **OBTAINING VALUES FOR THE PARAMETERS NEEDED TO EVALUATE ALTERNATIVE CONCEPTUAL MODELS**
- **ESTABLISHING THE RANGE OF PARAMETER VALUES FOR INPUT TO PERFORMANCE ASSESSMENT MODELS**
- **ITERATIVE EVALUATION OF ADEQUACY TO SUPPORT DESIGN AND PERFORMANCE ASSESSMENT NEEDS**

PRINCIPAL AREAS OF GEOLOGIC UNCERTAINTY AT THE YUCCA MOUNTAIN SITE

- **GEOHYDROLOGY**
 - **FLOW PATHS AND PROCESSES IN THE UNSATURATED ZONE**
- **TECTONICS**
 - **PRECLOSURE-SURFACE AND GROUND MOTION**
 - **POSTCLOSURE-IMPACT OF TECTONICS AND HYDROLOGIC CONDITIONS**
 - **POTENTIAL FOR VOLCANISM**
- **CLIMATE CHANGE**
 - **POTENTIAL IMPACT ON HYDROLOGIC SYSTEM**
- **NATURAL RESOURCES**
 - **POTENTIAL FOR PRESENCE OF SIGNIFICANT RESOURCES**



GENERAL MAP OF YUCCA MOUNTAIN REGION

MAJOR HYDROLOGIC QUESTIONS REQUIRING INVESTIGATION

- **WHAT IS THE RATE AND AREAL DISTRIBUTION OF NET INFILTRATION NEAR THE SURFACE?**
- **WHAT IS THE RATE AND DIRECTION OF GROUND-WATER MOVEMENT IN THE UNSATURATED ZONE FROM THE SURFACE TO THE REPOSITORY?**
- **IS THERE A SIGNIFICANT COMPONENT OF LATERAL FLOW IN THE UNSATURATED ZONE?**
- **IS THERE PERCHED WATER AT THE SITE?**
- **IS THERE SIGNIFICANT GROUND-WATER FLOW IN THE FRACTURES IN THE UNSATURATED ZONE?**
- **WHAT IS THE RATE AND DIRECTION OF GROUND-WATER MOVEMENT FROM THE REPOSITORY HORIZON TO THE ACCESSIBLE ENVIRONMENT?**

PRINCIPAL NEAR-TERM SURFACE-BASED ACTIVITIES RELATED TO CHARACTERIZATION OF THE UNSATURATED ZONE

- **MULTIPURPOSE BOREHOLE TESTING NEAR EXPLORATORY SHAFTS**
 - **DETECT AND SAMPLE PERCHED WATER, IF PRESENT**
 - **MONITOR EFFECTS OF SHAFT CONSTRUCTION**
- **INFILTRATION TESTS**
 - **EVALUATE INFILTRATION FROM SIMULATED RAINFALL**
- **UNSATURATED ZONE DRILLING AND TESTING**
 - **SPATIAL AND TEMPORAL VARIABILITY OF HYDROLOGIC PROPERTIES**
- **REGIONAL STUDIES OF HYDROLOGIC SYSTEM**
 - **RECHARGE AT FORTY MILE WASH**

MAJOR TECTONICS QUESTIONS REQUIRING INVESTIGATION

- **WHAT EARTHQUAKE MAGNITUDE AND RECURRENCE INTERVALS ARE ASSOCIATED WITH LOCAL QUATERNARY FAULTS?**
- **WHAT VIBRATORY GROUND MOTION SHOULD BE USED TO DESIGN STRUCTURES, SYSTEMS AND COMPONENTS IMPORTANT TO SAFETY?**
- **WHAT ARE THE LIKELIHOOD AND CHARACTERISTICS OF POTENTIAL SURFACE FAULTING?**
- **TO WHAT EXTENT CAN FUTURE TECTONIC EVENTS CAUSE CHANGES IN THE GROUND-WATER CONDITIONS?**
- **WHAT ARE THE ORIGINS AND AGES OF CALCITE-SILICA DEPOSITS IN FAULTS AND FRACTURE ZONES? (HYDROTHERMAL, PEDOGENIC, OR OTHER)**
- **WHAT IS THE PROBABILITY THAT THE REPOSITORY WOULD BE PENETRATED BY BASALTIC MAGMA?**

PRINCIPAL NEAR-TERM SURFACE-BASED ACTIVITIES RELATED TO CHARACTERIZATION OF TECTONIC CONDITIONS AND PROCESSES

- **SEISMIC MONITORING**
 - **CONTINUED OPERATION OF SOUTHERN GREAT BASIN SEISMIC NETWORK AND YUCCA MOUNTAIN SITE NETWORK**
 - **OPERATION OF STRONG-MOTION RECORDING INSTRUMENTS**
- **SURFACE FACILITY TRENCHING STUDY**
 - **TRENCHING OF MIDWAY VALLEY TO DETERMINE NATURE OF AND POTENTIAL FOR FAULTING AT POSSIBLE SURFACE FACILITY LOCATION**
- **QUATERNARY FAULTING WITHIN THE SITE AREA**
 - **GEOLOGICAL MAPPING AND TRENCHING TO DETECT AND CHARACTERIZE POSSIBLE QUATERNARY FAULTS**
 - **EVALUATE AGE AND RECURRENCE OF MOVEMENT ON SUSPECTED AND KNOWN QUATERNARY FAULTS**
- **VOLCANIC FEATURES-POTENTIAL FOR FUTURE ACTIVITY**
 - **DRILL AND CORE GEOPHYSICAL ANOMALIES**
 - **GEOCHRONOLGY**
 - **FIELD STUDIES**
 - **GEOCHEMISTRY OF SCORIA SEQUENCES**

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MAJOR CLIMATOLOGIC QUESTIONS REQUIRING INVESTIGATION

- **HOW WILL FUTURE CLIMATE CONDITIONS BE BOUNDED?**
 - **LAKE DEPOSITS ARE USEFUL INDICATORS OF PALEOCLIMATE CHANGE**
 - **TERRESTRIAL PALEOBOTANIC DATA SERVE AS INDICATORS OF PALEOCLIMATE**
 - **CLIMATOLOGICAL MODELING WILL BE USED TO STUDY PRECIPITATION IN SOUTHERN GREAT BASIN**
- **WHAT WILL BE THE IMPACT OF FUTURE CLIMATE CHANGES ON GROUND-WATER HYDROLOGY?**

PRINCIPAL NEAR-TERM SURFACE-BASED ACTIVITIES RELATED TO CHARACTERIZATION OF CLIMATE CONDITIONS

- **STUDIES OF CALCITE-SILICA HYDROGENIC DEPOSITS MAY INDICATE PAST GEOHYDROLOGIC CONDITIONS**
- **LAKE, PLAYA, AND MARSH DEPOSIT STUDIES MAY INDICATE PALEOCLIMATE CHANGES**
- **TERRESTRIAL PALEOBOTANIC DATA SERVE AS INDICATORS OF PALEOCLIMATE**
- **QUATERNARY REGIONAL HYDROLOGY**
 - **REGIONAL PALEOFLOOD STUDIES**
 - **UNSATURATED ZONE HYDROCHEMICAL ANALYSIS**
 - **EVALUATE PAST DISCHARGE AREAS**

MAJOR NATURAL RESOURCES QUESTIONS REQUIRING INVESTIGATION

- **WHAT IS THE POTENTIAL FOR MINERAL AND ENERGY RESOURCES OF ECONOMIC VALUE?**
- **WHAT IS THE FUTURE SUPPLY AND DEMAND FOR GROUND-WATER RESOURCES NEAR THE SITE?**
- **TO WHAT EXTENT MIGHT FUTURE EXPLORATION FOR NATURAL RESOURCES LEAD TO HUMAN INTRUSION?**

PRINCIPAL NEAR-TERM SURFACE-BASED ACTIVITIES RELATED TO CHARACTERIZATION OF NATURAL RESOURCES

- **MINERAL AND ENERGY RESOURCE ASSESSMENT**
 - **EVALUATION OF GEOCHEMICAL ANALYSES FROM SURFACE SAMPLING AND CORE**
 - **EVALUATION OF GEOPHYSICAL/GEOLOGIC DATA FROM TECTONICS AND ROCK CHARACTERIZATION STUDIES**
 - **EVALUATION OF HEAT FLOW AND OTHER DATA TO ASSESS POTENTIAL FOR GEOTHERMAL ENERGY RESOURCES**
 - **EVALUATION OF DATA FROM STRATIGRAPHIC AND GEOCHEMICAL STUDIES TO ASSESS POTENTIAL FOR HYDROCARBON RESOURCES**
- **WATER RESOURCE ASSESSMENT (ANALYSIS)**
 - **EVALUATION OF EXISTING DATA ON POTENTIAL CHARACTERISTICS OF GROUND-WATER SUPPLY AT SITE**
- **INPUT TO ANALYSES OF POTENTIAL FOR HUMAN INTRUSION**

EXPLORATORY SHAFT FACILITY

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MARCH 7-8, 1989**

OBJECTIVES OF THE EXPLORATORY SHAFT FACILITY

- **PROVIDE ACCESS TO THE REPOSITORY AND NATURAL BARRIERS**
- **CONDUCT IN SITU TESTING**
- **CONSTRUCT ESF WITHOUT ADVERSELY AFFECTING LONG TERM PERFORMANCE OF THE REPOSITORY**
- **CONDUCT SITE CHARACTERIZATION ACTIVITY TO SUPPORT RECOMMENDATIONS TO THE PRESIDENT FOR SITE SUITABILITY FOR A GEOLOGICAL REPOSITORY**
- **COLLECT INFORMATION AND DATA TO SUPPORT REPOSITORY DESIGN, DEIS, AND LA**

EXPLORATORY SHAFT FACILITY

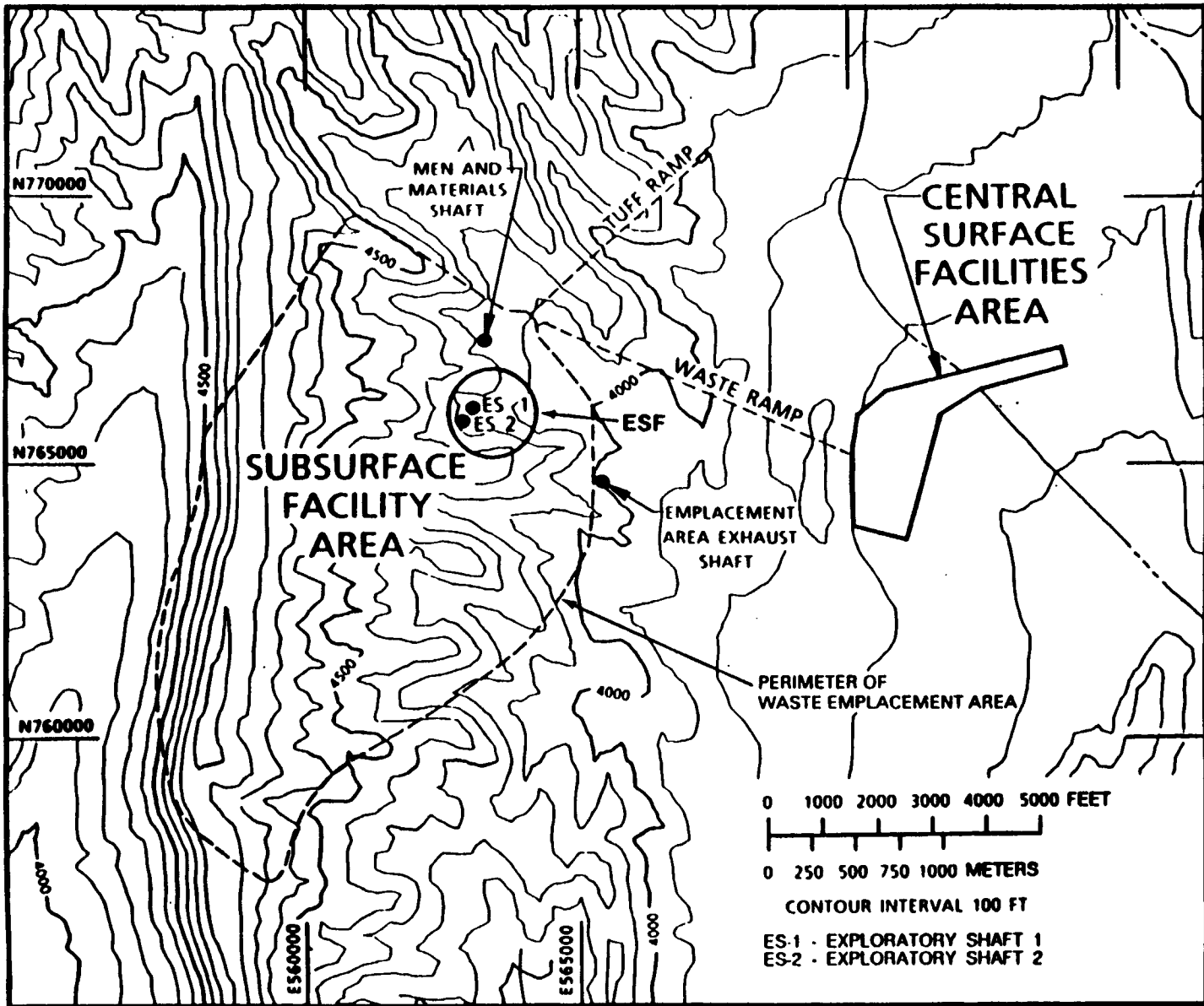
- **THE FACILITY CONSISTS OF:**
 - **SURFACE FACILITIES**
 - **TWO SHAFTS**
 - **UNDERGROUND FACILITIES**
- **THE TWO SHAFTS ARE PLANNED AS INTAKE SHAFTS FOR REPOSITORY OPERATIONS**

EXPLORATORY SHAFT FACILITY COMPONENTS

- **SURFACE FACILITIES TO SUPPORT CONSTRUCTION AND TESTING**
- **TWO SHAFTS:**
 - **12 FOOT FINISHED DIAMETER WITH MINIMUM 12 INCH CONCRETE LINING**
 - **1100 FT APPROXIMATE DEPTH**
 - **1ST SHAFT FOR TESTING; 2ND SHAFT FOR EMERGENCY EGRESS**

EXPLORATORY SHAFT FACILITY COMPONENTS (CONTINUED)

- **TWO EXPLORATORY SHAFTS PLANNED TO BE USED AS INTAKE VENTILATION SHAFTS DURING REPOSITORY OPERATION**
- **UPPER DEMONSTRATION BREAKOUT ROOM: 600 FT LEVEL**
- **MAIN TESTING HORIZON: 1055 FT LEVEL**
- **UNDERGROUND DRIFTS: 4000 FT TESTING AREA (MAIN)
DEMONSTRATION 5600 FT EXPLORATORY DRIFTS**



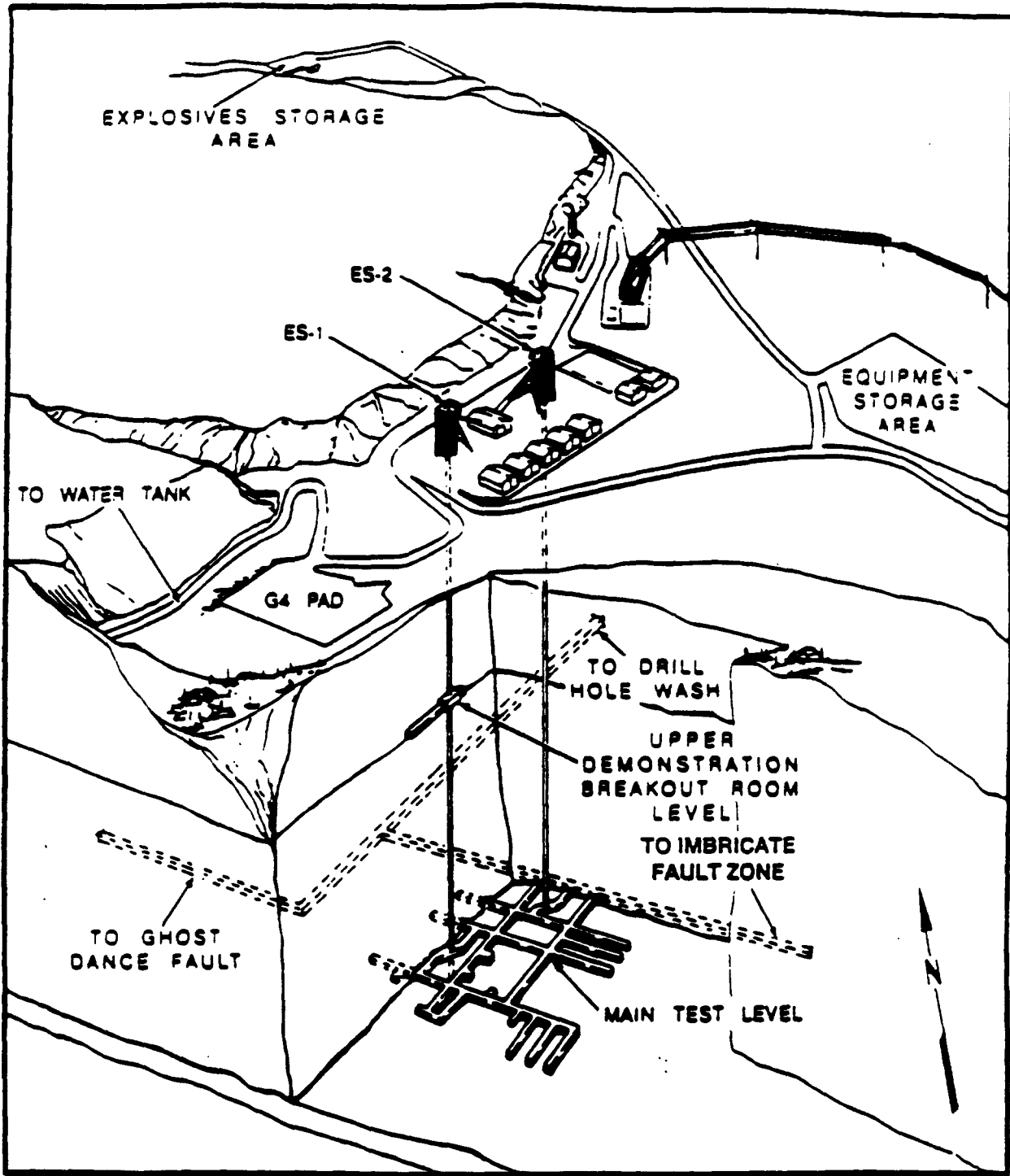
SITE PLAN

SURFACE LAYOUT

- **SURFACE FACILITIES LAYOUT FOR THE ESF COVERS APPROXIMATELY 5 ACRES**

THE MAIN PAD INCLUDES:

- **ES-1 HOIST AND HEADFRAME**
- **ES-2 HOIST AND HEADFRAME**
- **HOIST HOUSE FOR BOTH HOISTS**
- **UTILITIES**
- **TEMPORARY FACILITIES FOR OFFICES**
- **TEMPORARY FACILITIES FOR TESTING PERSONNEL**



CONCEPTUAL ILLUSTRATION OF THE EXPLORATORY SHAFT FACILITY

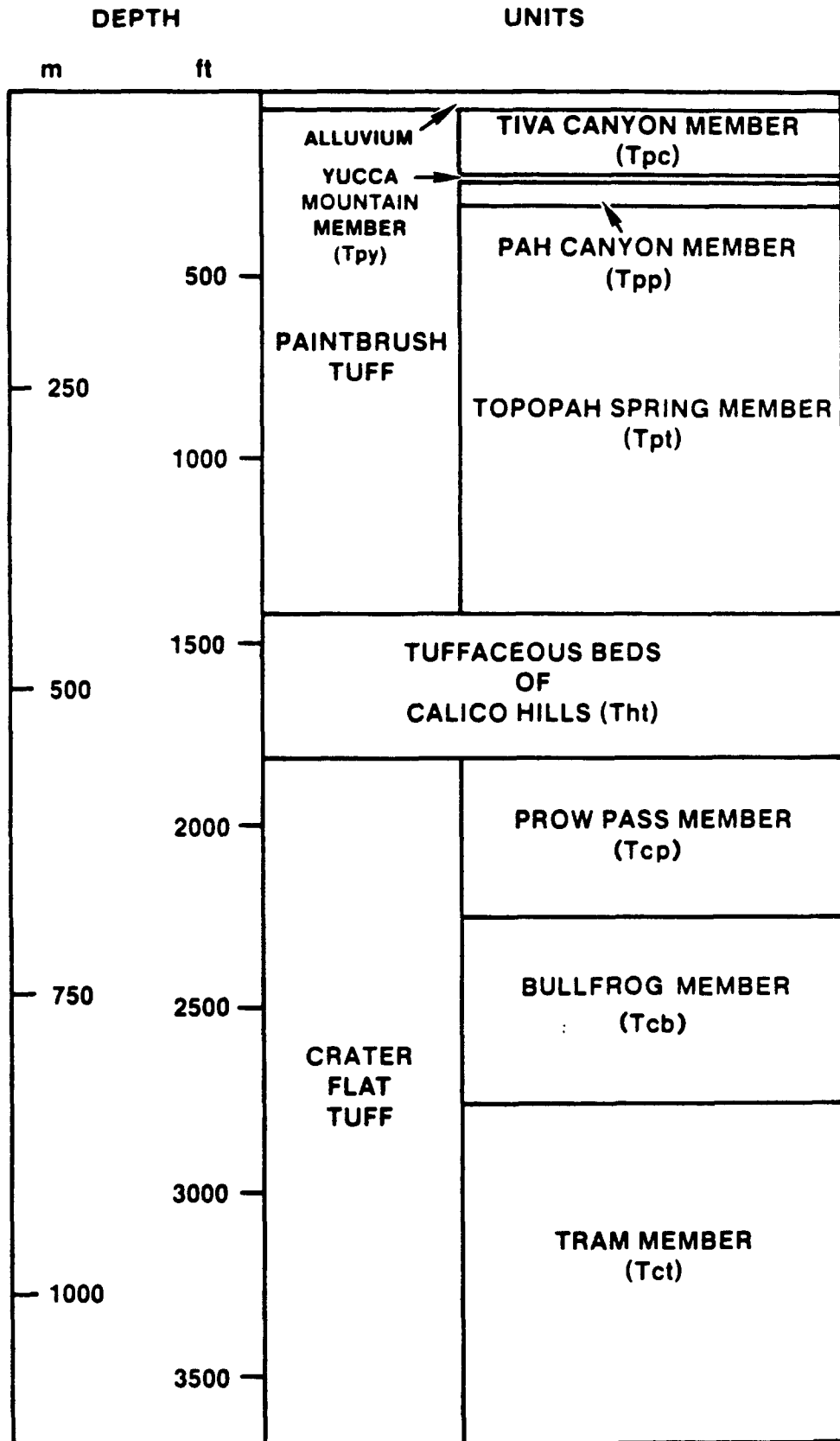
ESF TESTING PROGRAM

- **INCLUDES TESTING**
 - **IN SHAFTS**
 - **IN UPPER DEMONSTRATION BREAKOUT ROOM, AND**
 - **AT MAIN TEST LEVEL**

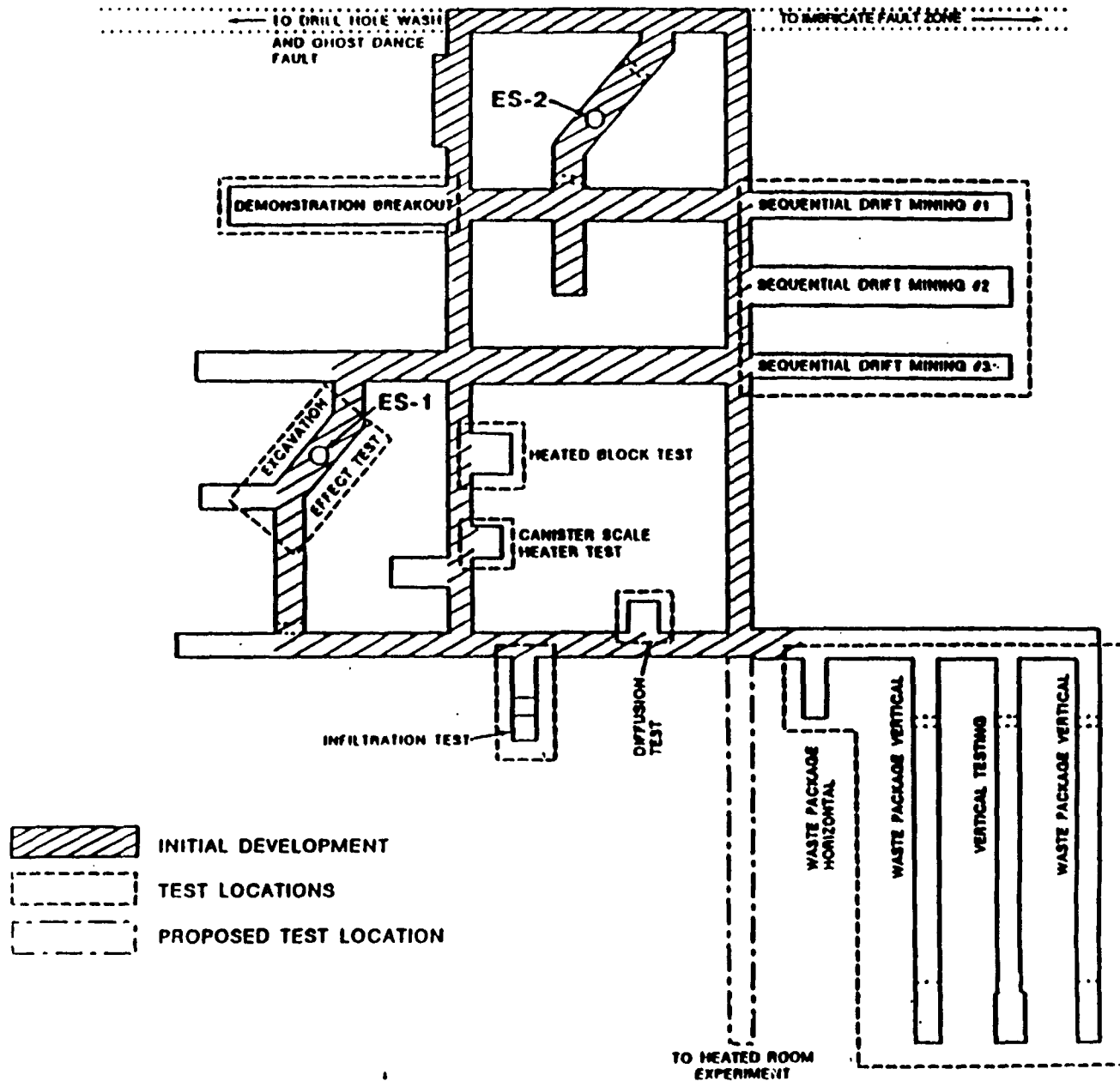
TYPES OF IN SITU AND LABORATORY TESTS CONNECTED WITH THE ESF

- **GEOLOGY**
- **MINERALOGY-PETROLOGY**
- **GEOCHEMISTRY/HYDROCHEMISTRY**
- **GEOENGINEERING**
- **HYDROLOGY/HYDROCHRONOLOGY**
- **THERMOMECHANICAL**
- **EXCAVATION TECHNIQUES**
- **ENGINEERED BARRIER**
- **SHAFT AND BOREHOLE SEALING CONCEPTS**
- **WASTE PACKAGE CONDITIONS**

STRATIGRAPHIC UNITS AT YUCCA MOUNTAIN



GENERAL ARRANGEMENT OF THE MAIN TEST LEVEL AREA



OFFSITE TESTS

- **OFFSITE TESTS IN G-TUNNEL INCLUDE:**
 - **EXCAVATION EFFECTS**
 - **MECHANICAL AND THERMAL EFFECTS**
 - **ENGINEERED BARRIER DESIGN**
 - **HYDROLOGY**

SUMMARY OF ISSUES/CONCERNS

- 1. ENVIRONMENTAL PERMITS/APPROVAL: MAJOR CONCERN**
- 2. LAND ACCESS: PROGRESSING SATISFACTORILY**
- 3. EXTERNAL REVIEWS OF SITE CHARACTERIZATION PLAN: IN PROGRESS**
- 4. IMPLEMENTATION OF QUALITY ASSURANCE PROGRAMS AND NRC AUDITS: IN PROGRESS**