CHAPTER 8

ESF CLOSURE AND DECOMMISSIONING

8.1 INTRODUCTION

The ESF site, both surface and underground, will undergo closure and decommissioning at some future, undetermined date. Closure and decommissioning will place the facilities into a permanently non-operable and safe condition. The ESF shall be decommissioned in a manner that protects the health and safety of the workers and the public.

The ESF will be closed and decommissioned for one of the following scenarios:

Scenario No. 1 is if the site is determined to be suitable for a repository. In this case, the ESF non-permanent facilities as defined by the Repository Designer shall be decommissioned. Decommissioning of the ESF facilities will extend over a period of time to allow various ESF facilities to be utilized until permanent repository facilities are constructed and commissioned.

Scenario No. 2 is if the site is determined to be unsuitable for a repository. Requirements which follow in Sections 8.2 and 8.3 apply only to Scenario No. 2.

9112020061 - Part 2

8.2 ESF CLOSURE AND SURFACE RESTORATION

8.2.1 SUBSURFACE CLOSURE

The subsurface closure activities begin with the withdrawal of all testing and drilling equipment. Items that may be left in place include rockbolts, wire mesh, concrete foundations, concrete inverts, concrete embeds, concrete or shotcrete drift liners, and embedded instruments.

The subsurface drifts and ramps on both the Topopah Spring (TS) level and Calico Hills (CH) level are then backfilled to minimize subsidence effects at the surface from underground activities and to protect and preserve adjacent stratigraphic features. Backfilling begins at the drifts farthest from the ramp station areas. Crushed rock from the surface excavated materials stockpile is used to backfill all underground openings.

The backfilling operation continues until all subsurface drift areas have been completely backfilled, including the substation and station areas. The procedure is also followed in the vertical shaft (if constructed).

In conjunction with the backfilling operation, several seal plugs will be constructed. The locations, size, and construction details of the seal plugs are to be determined later. A seal plug at the surface of all underground

accesses will prevent personnel access and seepage of surface runoff into the abandoned accesses.

8.2.2 SURFACE RESTORATION

When the ramp backfilling operations are complete, salvage operations for buildings, trailers, and equipment are initiated. Appropriate items are separated, stockpiled in a protective manner, and prepared for salvage. All buildings and trailers are emptied of their contents and disconnected from the utility services, and anchor connections are disassembled, removed from the site, and salvaged. The balance of the surface facilities, including the substations and power poles, drainage control structures, concrete structures, and all utilities, are disassembled and removed from the site for salvage or disposal. All unsalvageable items are disposed in an approved landfill.

During the decommissioning phase, any surface drillholes not previously sealed will be sealed and plugged back in an approved manner. The site is then graded and contoured using stockpiled topsoil and reclaimed using appropriate reclamation techniques.

8.3 ALTERNATIVE USES OF THE ESF

Prior to the actual decommissioning of the ESF facilities, alternative uses may be identified that can influence the range and extent of the actual

decommissioning tasks and the designs and plans required. These alternative uses may be identified as near-term and/or long-term commitments. The ESF will be fully decommissioned and closed only if no alternative uses can be identified.

CHAPTER 9

LONG-LEAD PROCUREMENT ITEMS

9.1 LIST OF ITEMS

Long-lead procurement items may be defined as critical engineered items of such restricted availability that special design outputs are required to mitigate schedule problems. In addition, it is necessary to consider the Procurement Acquisition Time (PAT), which is the estimated time needed to award a contract. The PAT process may involve special requirements that extend the time needed to issue a purchase order. The following is a list of potential long-lead procurement items interpreted from the current construction schedule.

Concrete batch plant w/screening plant and crushing plant

25-foot diameter Tunnel Boring Machine (TBM)

36" overland conveyor system drive

Pre-engineered buildings

400-HP axial vane fans

400-HP fan starters

1500-cfm air compressors (for above-ground use)

300kVA transformers (for above-ground use)

Pad-mounted disconnect switches

Emergency generators

Above-ground power cable

Data UPS system

Motor control centers

Fire detection systems

1500-cfm rotary screen air compressors

1320-cfm, 200-psi air compressors

20-ton heat pump

15-ton heat pump

20,000-cfm rotary evaporative cooler

Computer room A/C units

200,000-gallon water storage tanks

50,000-gallon water storage tanks

Forebay water storage tanks

Package pumping stations w/chlorination systems

Computer--VAX Type 9000

Computer--VAX Type 3000

Fiberoptic cable

Data acquisition stations

9.2 ACQUISITION STRATEGY

Each Yucca Mountain Site Characterization Project (YMP) acquisition is planned and documented to assure a systematic approach. The team concept is used, with the team consisting of representatives from such functions as the requester/end user, the designer-architect/engineer, quality assurance (QA), contract administration, procurement, and the receiving warehouse. The responsibility for purchasing items in support of the Exploratory Studies Facility construction lies with REECo. Details of the strategy follow.

9.2.1 PRE-SOLICITATION

Prior to preparation of a purchase requisition (PR) for acquisition of an item, all the known characteristics of that item are outlined in writing. These characteristics are reviewed for technical accuracy and for the provision as necessary of additional technical input. Any QA requirements the vendor must meet are also developed at this stage. Once the technical specifications have been finalized, the PR is prepared and provided to procurement.

9.2.2 PROCUREMENT

All procurement actions are undertaken to comply with the intent of the Federal Acquisition Regulation (FAR), the Department of Energy Acquisition Regulation (DEAR), and REECo Purchasing Systems and Methods (SAM). The SAM is the DOE-approved document under which REECo must perform procurement actions.

The FAR, DEAR, and REECo's prime contract with the DOE stress the importance of maximizing competition. Every effort will be expended to obtain competition for each procurement. It is recognized, however, that certain items must be procured on a no-substitute or sole-source basis. Appropriate justification for these types of procurement will be prepared by the requester and approved by procurement prior to the start of the procurement process.

Standard negotiated procurement processes will be accomplished. Consideration will be given, as appropriate, to small and small disadvantaged businesses. The solicitation, technical evaluation, negotiation, and award processes will be condensed as much as possible.

If an item is determined to be quality-affecting, special QA requirements will be included in the solicitation package. Prospective vendors must demonstrate their understanding of and their capability to comply with all QA requirements. Awards for quality-affecting items will be made only with QA approval.

9.2.3 CONTRACT ADMINISTRATION

Once a procurement has been accomplished, the vendor's progress will be monitored. This will be done either through standard contract administration or on an exception basis, depending on the complexity of the items procured. Standard contract administration includes tasks such as receiving/reviewing progress, possibly in-plant inspection, and many other functions. Contract administration on an exception basis means taking action when a problem develops.

9.2.4 RECEIVING AND STORING

Once the vendor has completed in-plant work on an item, the item will be shipped to the YMP receiving warehouse at the Nevada Test Site. There the item will receive a final acceptance check. This function will be accomplished by personnel qualified based on the characteristics of the item. Once it has been determined that the material meets the requirements of the contractual document, it will either be delivered as the requester desires or stored in the receiving warehouse. Any in-storage maintenance will be accomplished based on the requirements of the item. Final disposition will be as directed by the requester. This action will constitute completion of the acquisition.

9.2.5 UNDERGROUND ACTIVITIES

A major underground construction effort is contemplated to be accomplished by a subcontractor to REECo. This subcontractor would provide most of the underground excavation and construction. The firm would operate its own underground excavation and construction equipment required to develop the ramps, drifts, and other underground openings necessary for site characterization testing activities.

CHAPTER 10

TITLE II DESIGN

10.1 MANAGEMENT

Management of the design of the Exploratory Studies Facility (ESF) system is divided into four vertically integrated levels of authority. From the top down these levels of authority are the U.S. Department of Energy/Office of Civilian Radioactive Waste Management (OCRWM), the Office of Geologic Disposal (OGD), the Yucca Mountain Site Characterization Project Office (YMPO), and the ESF Participants. Nine organizations below Project Office level are involved.

OCRWM is the overall DOE authority and the ESF project parent organization; the Project Office is one of its organizational groups.

The Project Office has five divisions: Yucca Mountain Site Office, Regulatory and Site Evaluation, Engineering and Development, Project and Operations Control, and Quality Assurance. Each division has a support staff.

The Project Office is the DOE organization responsible for the management, direction, and coordination of the overall ESF Title II design. The Project Office is assisted in this by the Technical & Management Support Services (T&MSS) contractor, which includes the Project Office Quality Assurance Support Staff. T&MSS consists of Science Applications International Corp. and its two main subcontractors, Harza Engineering Co. and Westinghouse Electric Corp.

T&MSS coordinates the activities associated with engineering analysis, technical assessment, project studies, project participant integration, and project task management. The Quality Assurance Support Staff is an autonomous organization with the responsibility for overall project quality as it relates to facility licensability. MAC Technical Services (MACTEC) also provides quality assurance and project management support to the Project Office.

The Systems Engineering Management Plan (SEMP) provides guidance for implementing systems engineering to all technical activities for the ESF. The SEMP is subordinate to the Project Plan and the Project Management Plan. The Design Plan (DP), subordinate to the SEMP, provides overall guidance for management of design activities. The Exploratory Studies Facility Plan (ESFP) is subordinate to the DP; it expands applicable portions of the DP as required for the ESF. The Engineering Plan is developed by the design organization to state the specifics of its ESF Title II work.

10.1.1 QUALITY ASSURANCE PROGRAM

The ESF Title II design phase QA program is governed by the YMPO Quality Assurance Requirements Document (QARD). The QA grading of all work is on-going. Items and activities requiring the highest degree of quality because of their relationship to the radiological health and safety of the public in the preclosure and postclosure phases of a potential repository will be the most stringently controlled.

YMP Administrative Procedures provide the methodology for the identification of items and activities important to safety, waste isolation, and quality. This methodology is consistent with NRC NUREG-1318, "Technical Position on Items and Activities in the High Level Waste Geologic Repository Program Subject to Quality Assurance Requirements."

10.1.2 MANAGEMENT OVERSIGHT AUDIT

In the process of performing ESF Title I design, the documentation and traceability of interface requirements and other design information were based on existing requirements. ESF design decisions for Title II quality-affecting items will be as rigorous as those required for a licensable activity. A Project Office-selected readiness assessment review board and team will provide the Project with an independent evaluation of the management and quality assurance activities necessary, and provide insight into the risks associated with alternative courses of action.

A procedural checklist will be prepared identifying a list of quality assurance and management areas that need development and implementation prior to release of the design for construction. Of particular importance prior to and during Title II design are: (1) organization; (2) quality assurance program; (3) design control; (4) instructions, procedures, plans, and drawings; (5) document control; (6) corrective action; (7) quality assurance

records; (8) audits; (9) logic and schedules; and (10) test support. Checklist questions will be developed for each topic. The answers will define the status and the problems associated with each topic.

The evaluation results will be identified as one of the following: (1) organization, (2) procedure availability, (3) QA assignment, (4) design input documents, (5) design control, (6) planning/design logic, and (7) other concerns.

The conclusions and recommendations made by the review team will be considered prerequisites and implemented, as appropriate, across the project. These prerequisites will then be added to the ESF schedule.

10.2 DESIGN

10.2.1 OVERVIEW

Development of the ESF design and test program is divided into three areas: surface facilities, underground facilities, and underground testing. Surface and underground facility design is the responsibility of Raytheon Services Nevada (RSN), an architect/engineering (A/E) firm experienced in nuclear industry-related work and in subsurface design and development. Los Alamos National Laboratory (LANL) has the lead responsibility to provide to the Project Office all ESF design, construction, and operational support inputs for testing. The test design and facility development are produced through the

cooperative efforts of the participants delegated the responsibility for conducting the individual tests. The ESF surface and underground testing for Title II design is based on: characterization testing identified in the statutory Site Characterization Program Baseline (SCPB); approved Title I design and the design-related comments; and the design-related requirements and guidance documents of the Project as expanded by the RSN design basis documents.

Participants are responsible for the following activities related to ESF design.

T&MSS as a participant is responsible for compliance verification and the following studies: regulatory, institutional, quality assurance, socioeconomic, and environmental.

RSN is responsible for ESF Title II engineering and design. Tasks include surface facilities and utilities, subsurface utilities related to testing, communications, data facilities, life safety systems, underground facilities and utilities, excavated materials (rock) handling systems, specifications, drawings, schedules, cost estimates, and administrative functions.

Los Alamos National Laboratory (LANL) coordinates and integrates the testing design requirements, plans, and definitive design criteria on testing for the ESF Title II as developed by the project Principal Investigators (PIs). LANL provides technical assistance to RSN for coordination of the underground

testing requirements and data acquisition portions of the ESF Title II design effort. LANL integrates test support requirements with REECo, operates and maintains the Integrated Data System (IDS), and provides IDS-related design information to RSN. In addition, LANL is in charge of the chlorine-36 test, testing for diffusion and volcanism, testing related to geochemistry, mineralogy, and petrology, and numerous other site characterization tests.

SNL is responsible for evaluating the preclosure and postclosure requirements in the ESFDR to assess compliance with the performance requirements of 10 CFR 60. Additionally, SNL has lead responsibility for the demonstration breakout room and the sequential drift excavation, heated block, canister-scale heater, plate loading, small-scale heater, slot strength, thermal stress, and heated room experiments.

The United States Geological Survey (USGS) is in charge of the following test activities: geologic mapping; overcore stress; vertical seismic profiling; matrix hydrologic properties; intact fracture; percolation; bulk-permeability; radial boreholes; excavation effects; Calico Hills; perched water; hydrochemistry; multipurpose boreholes; and hydrologic properties of major faults.

Lawrence Livermore National Laboratory (LLNL) is in charge of the waste package environment test and provides some informational support to LANL's test program.

Reynolds Electrical and Engineering Company, Inc. (REECo), as the designated constructor: (1) provides design oversight to ensure that the design is constructible, (2) ensures that worker health and safety requirements are incorporated; (3) provides technical advice on maintainability, operability, and environmental protection; (4) comments on economy of design and functional requirements; and (5) assures that the drawings and specifications are clear and unambiguous.

10.2.2 BASIS FOR TITLE II DESIGN

The RSN Basis for Design (BFD) for Title II is a comprehensive document which encompasses the applicable portions of the following documents:

10 CFR Part 60, Disposal of High Level Radioactive Wastes in Geologic Repositories

Waste Management Systems Requirements (WMSR) Document, Volume IV

Yucca Mountain Mined Geologic Disposal System Description - Exploratory Studies Facility (SD-ESF)

Yucca Mountain Mined Geologic Disposal System Requirements - Exploratory Studies Facility (SR-ESF)

ESF Design Requirements Document (ESFDR)

Reference Information Base (RIB)

DOE Order 6430.1A, General Design Criteria

DOE Order 5480.4, Environmental Protection, Safety, and Health Protection Standards

Site Characterization Program Baseline (SCPB)

Approved Engineering Change Requests

ESF Interface Control Documents

RSN ESF Title I Design Drawings and Outline Specifications

The ESFDR provides functional requirements and performance criteria for the ESF. The most stringent of the applicable regulations, codes, and standards furnish other basic design criteria. The criteria derived from these sources are considered authorized basic design criteria.

Other information may be provided as design input by the Project Office in the form of letters and oral instructions. In all cases, such design input must be reviewed and accepted by RSN in accordance with applicable procedures.

A substantial quantity of design criteria exists as a result of ESF planning activities, correspondence, meetings, and special studies. These criteria, which further define the ESF or performance requirements, are included in the BFD. Upon approval of the documents by RSN, the criteria become authorized basic design criteria.

"Authorized basic design criteria" approved as design input subsequent to BFD issuance will reside in the RSN Configuration Management System (per RSN Procedure PP-03-15).

CHAPTER 11

CONSTRUCTION

11.1 MANAGEMENT ASPECTS

Management for the construction, inspection, and acceptance testing of the Exploratory Studies Facility (ESF) system is divided into five vertically integrated levels of authority. From the top down these levels of authority are the U.S. Department of Energy/Office of Civilian Radioactive Waste Management (OCRWM), the Yucca Mountain Site Characterization Project Office (YMPO), the Yucca Mountain Site Office, the construction manager, and the constructor.

OCRWM's relationship to the work and the organization of the Project Office are described in Chapter 10.

The Project Office is responsible for management, direction, and coordination of the overall ESF construction, inspection, and acceptance testing effort. The Yucca Mountain Site Office has these responsibilities on the ESF site. T&MSS and MACTEC will support the Project Office in these areas as described in Section 11.2.2. In addition, the Western Division of the Mine Safety and Health Administration (MSHA) will provide technical support to the Project Office's Engineering and Development Division.

LANL will support the ESF Field Testing Coordinator and the overall ESF testing effort as it relates to construction activities (see Section 11.3.2).

The Construction Management Plan (CMP), which is in draft status, provides guidance and the overall management philosophy that governs all activities at the ESF. The CMP, which is subordinate to the Project Plan and the Project Management Plan, meets the general intent of DOE Order 4700.1, Project Management System. The requirements specified in these higher-tiered documents are tailored to apply specifically to the management of the ESF. Other plans at the same hierarchical level are specified in the CMP to provide specific management guidance in technical areas such as configuration management and systems engineering management.

The CMP requires the development of specific ESF-related procedures to control activities such as field changes, work authorization, inspection and acceptance, quality assurance, test support, site security, and access and visitor control. The CMP establishes the site management organizational structure, defines responsibilities and authorities, and provides guidance for the management of work to be performed at the ESF. This guidance includes quality management, work breakdown structure, logic diagrams and schedules, milestones, performance criteria, functional support requirements, performance measurement, planning and control systems, information and reporting requirements, and the application of the requirements from other plans to the ESF activities.

11.1.1 QUALITY ASSURANCE PROGRAM

The ESF Title III phase follows the requirements of the DOE Quality Assurance Requirements Document (QARD) with emphasis on the QA criteria associated with construction inspection. Additional broad guidance is found for Inspections and Tests (I&T) in Administrative Procedure AP-5.16Q, Field Technical Compliance, and in Appendix G of the Design Plan. AP-5.16Q covers procurement items, control of processes, and construction inspection. These QA requirements are imposed upon the architect/engineer (A/E) and the construction contractor, who develop and issue their own quality control operating procedures for inspection and construction operations.

During Title III, technical compliance, inspection, and testing will involve an integrated approach to activities performed by the various project participants. REECo will perform technical compliance activities (specified in the issued-for-construction specifications and drawings) as necessary to assure REECo management that the construction is in accordance with those drawings and specifications per DOE Order 4700.1, Part C, subsection 3c(3) (f)4. The A/E will perform and/or witness inspection and testing activities verifying that construction complies with the drawings and specifications, and that the constructed system, structure, or component will function in operation as intended. T&MSS will ensure that REECo and the A/E document the inspection, testing, and verification activities.

During Title III, the emphasis of the Quality Assurance Program will be on achieving quality in the construction process, in addition to the meeting of programmatic requirements such as record keeping. The Quality Assurance Program will concentrate on the actions and processes that directly affect quality of construction.

11.1.2 READINESS REVIEWS

The readiness review process is conducted and documented in accordance with AP-5.13Q. The Project Office and OCRWM have agreed to hold various readiness reviews including those for the start of site preparation and the start of underground excavation. The readiness review is therefore the precursor to the start of these activities. It also initiates the site characterization activities of testing and mapping.

The Project Office is currently completing detailed planning and scheduling activities that include identification of the prerequisites to be accomplished to assure timely and successful readiness reviews.

11.2 CONSTRUCTION PLAN

11.2.1 GENERAL

Reynolds Electric & Engineering Co. Inc. (REECo) is the Prime Construction Contractor to the Nevada Operations Office of the U.S. Department of Energy. Responsibilities under this contract include procurement for and construction of the Exploratory Studies Facility (ESF). The majority of the surface construction will be completed by REECo as the Prime Contractor using its own resources. The underground excavation and construction and some surface construction will be subcontracted by REECo.

Surface construction will be completed on a one shift/day, five-day week basis. Underground construction may be completed on a three shift/day, seven-day week basis. The requirement needs for multiple shifts will be addressed during Title II design based on the reliability, maintainability, and availability study and the project schedule.

Access to the site will be via U.S. Highway 95, north from Las Vegas to Amargosa Junction (Lathrop Wells), Nevada. At Amargosa Junction, a Nevada Test Site (NTS) road will provide access to the Yucca Mountain Site Characterization Project (YMP) site area.

11.2.2 ORGANIZATION

The REECo/YMP Division is composed of six departments and the Division Office. The YMP Construction Department is directly responsible for overseeing the surface and underground construction of the ESF. Procurement of subcontractors, equipment, materials, and supplies for REECo is through the YMP Logistical Support Department. The Construction Department will provide technical direction and support to the subcontract administrator as required. Cost, schedule, work authorization, and performance measurement of the work by the Division is through the YMP Control Department. Surface-based drilling and drilling support to testing are performed by the YMP Drilling Department, which the Construction Department will support as needed. Quality Assurance (QA) is provided by the YMP QA Department. Receipt, distribution, and records retention in support of the REECo construction effort are provided by the YMP Information Management Department.

All work performed by REECo employees shall be either by its own dedicated labor and materials or REECo NTS matrix support resources. REECo can obtain craft manpower utilizing existing project labor agreements. Resources from the REECo NTS matrixed organizations are accessible to the YMP Division upon request. Examples of matrix support include the Operations Equipment Department, NTS General Department, Power and Communications Department, the Calibration Lab, and the Welding Lab.

11.2.3 CONSTRUCTION WORK PLAN

11.2.3.1 Work to be Accomplished by REECo YMP

The surface construction will be completed by REECo resources. REECo will either perform the work with dedicated craft manpower or by using REECo matrix support craft labor provided by matrixed REECo divisions and departments.

REECo will provide the necessary temporary construction support facilities and utilities required to support the surface construction. These include parking areas, field office trailers, storage facilities, shop, sanitary facilities, electrical power, communications, and water.

Major construction activities to be completed by REECo forces may include, but are not limited to, clearing, grubbing, ripping, drilling, blasting, earth moving and grading, construction, upgrading and maintenance of site access roads, facilities sites, permanent site power, water supply, waste water discharge and treating, sewer lines and treatment facility, communications systems, surface data building, field office trailers, test support building, change houses, compressor station, shop/warehouses, main warehouse, switchgear buildings, electrical substation control buildings, standby power generating station, overland excavated rock belt conveyor system, excavated materials

stockpile site, topsoil storage site, aggregate borrow area, various auxiliary sites, underground construction and support to the ESF scientific community and, if required, hoist house and hoist, shaft headframe, and shaft conveyance.

11.2.3.2 Work to be Accomplished by Subcontractors

Construction subcontracts that REECo currently plans to utilize include underground excavation and construction, water tank fabrication and erection, and paving.

Each subcontractor may be responsible for providing its own temporary construction support facilities and utilities on the site if permanent accommodations are not available. REECo may supply permanent utility hookups to these facilities, such as electrical power, sewer, water, and communications. Subcontractors will be responsible for proper accumulation and custody of any regulated materials and hazardous wastes.

All REECo subcontractors will perform work in accordance with the REECo QA Program. Subcontractors will be required to submit to REECo a strategy that describes how the subcontractor will implement the REECo QA Program and associated procedures. The subcontractors will also perform work in accordance with other Yucca Mountain Site Characterization Project Office (YMPO) procedures and documents as directed by REECo.

The underground excavation and construction subcontract scope of work will include excavation of the Topopah Spring (TS) north and TS south ramp portals, the TS north and TS south ramps, main and exploratory drifts on the TS level and Calico Hills (CH) level, optional shaft excavation and lining, main test area excavation, underground facilities and utilities necessary to support the excavation effort, and procurement of underground excavation equipment.

11.2.4 LONG-LEAD PROCUREMENT

Major long-lead or key procurements will be accomplished either by REECo or REECo subcontractors. The subcontractor for underground construction may be responsible for furnishing or procuring the tunnel boring machines (TBMs), mobile miners (MMs), roadheaders, underground conveyor systems, and any other major long-lead items associated with underground excavation.

REECo will be responsible for procurement of surface long-lead equipment including transformers and electrical switchgear, emergency generators, power cable, optional headframe and hoist, air compressors, and the surface conveyor system between the TS ramp portals and the excavated materials storage area. A more detailed listing of long-lead procurement items is included in Chapter 9.

11.2.5 CONSTRUCTION SCHEDULE

It is currently planned that the design, procurement, and construction of the ESF will be accomplished in a ten-phase process as listed below. Certain phases overlap, but the Project Office envisions them as steps to be exercised in accordance with the approved project schedule.

PHASE 1 - TS NORTH PORTAL - Start Site Construction June 1992

PHASE 2 - TS NORTH RAMP BY 25-FT DIAMETER TBM - Start October 1994

PHASE 3 - TS SOUTH PORTAL - Start Site Construction September 1993

PHASE 4 - TS SOUTH RAMP BY 25-FT DIAMETER TBM - Start October 1994

PHASE 5 - CH NORTH RAMP FROM TS/CH NORTH RAMP INTERSECTION TO CALICO HILLS BY 18-FT DIAMETER TBM - Start April 1996

PHASE 6 - CH SOUTH RAMP FROM TS/CH SOUTH RAMP INTERSECTION TO CALICO HILLS BY 18-FT DIAMETER TBM - Start October 1995

PHASE 7 - CH MAIN DRIFT BY 18-FT DIAMETER TBM. CH IMBRICATE, EAST GHOST DANCE, WEST GHOST DANCE, AND SOLITARIO DRIFTS BY ALPINE MINERS - Start October 1996

PHASE 8 - TS MAIN DRIFT AND TS IMBRICATE, EAST, AND WEST DRIFTS BY 25-FT TBM AND MOBILE MINERS - Start December 1995

PHASE 9 - MAIN TEST AREA BY MOBILE MINERS AND/OR TBM - Start June 1996

PHASE 10 - EXCAVATE OPTIONAL SHAFT - Start September 1999

11.2.6 CONSTRUCTION SUPPORT

11.2.6.1 Maintenance

During the construction, testing, and operations phases, maintenance of the surface facilities and utilities is the responsibility of REECo. Maintenance of the underground facilities will be the responsibility of the REECo underground construction subcontractor during the construction phase. Complete maintenance procedures for the ESF will be developed. The procedures will include plans for corrective and preventive maintenance. The maintenance program will be based on protection of personnel and achievement of the desired facility availability during the construction and operating life of the facility.

A parts inventory will be identified and provided by REECo and REECo subcontractors sufficient to highlight high wear items and components for

critical systems to minimize downtime for corrective maintenance. A preventive maintenance program will be developed that includes periodic inspection and servicing of systems and their components to ensure reliable operation.

In-service inspections will be provided for those systems and components that cannot be withdrawn from operation and must continuously perform their functions.

Surveillance to detect the need for maintenance in critical systems and components will be incorporated into the facility maintenance programs during Title II design.

11.2.6.2 Site Services

Water supply, electrical power supply, roads, and telecommunications distribution are REECo responsibilities.

11.2.7 HEALTH, SAFETY, AND TRAINING

The Safety and Health Plan (SHP, 1990) defines the Yucca Mountain Site Characterization Project's program to ensure the protection of the public and worker health and safety. Participants are responsible for the development and implementation of S&H protection programs or procedures associated with their

activities, which includes meeting any applicable licensing or permit requirements. Each participant's plan or procedure must be approved by the Project Office.

All construction shall be performed in accordance with the REECo YMP Safety and Health Program Plan. All employees shall be trained in, and periodically be updated on, the applicable REECo Occupational Safety Codes (OSC) and will report emergencies in accordance with REECo Occupational Safety Code A-9. All REECo and REECo subcontractor personnel receive mandatory General Employee Training (GET) prior to performing work activities at the ESF site.

REECo and subcontractor employees shall be trained in the Emergency Preparedness procedures and in the REECo Yucca Mountain Safety Handbook during their time of employment indoctrination. REECo management shall ensure that the proper safety and emergency equipment is properly installed and inspected. Safety inspections shall be performed by REECo safety professionals to verify compliance.

To provide for the timely rescue of people from possible underground disasters, qualified employees will be given Mine Rescue Training (MRT) by REECo safety professionals. Employees who successfully pass the training shall receive a certificate and, periodically, be given a refresher course.

All operations shall conform to applicable federal and state regulations pertaining to worker health, environmental compliance, hazardous materials, and wastes. All employees shall be given training in environmental compliance and hazardous materials communications, and any further training appropriate for their safety and health in terms of their job function and the environment. REECo industrial hygiene professionals shall monitor each work place and ensure compliance.

11.2.8 CONSTRUCTION DOCUMENTATION

All procurement and construction affecting quality will be documented in accordance with the REECo QA Program and associated procedures. All construction activities will be accomplished in accordance with approved drawings, specifications, and construction work procedures and the respective job package requirements.

Title III inspection and engineering services will be provided and documented by the Architect/Engineer (RSN) for all construction activities.

11.3 ACTIVITIES DURING CONSTRUCTION

11.3.1 PARTICIPANT SERVICES

Participants will perform services during construction and operation of the ESF as described below.

T&MSS will support the Project Office in the management and integration of ESF construction, operations, and testing, and will help assure environmental compliance.

MACTEC will provide quality assurance and project management support to the Project Office.

RSN will be responsible for surveying and providing Title III engineering services during construction of its designs for surface facilities and utilities, subsurface utilities related to testing, communications, the Integrated Data System (IDS), data facilities, life safety systems, underground facilities and utilities, and the excavated materials (rock) handling systems. RSN will also support ESF materials testing.

LANL will coordinate and integrate the efforts of the Project Principal Investigators (PIs) and the resulting overall site characterization testing program at the ESF site. LANL will provide management of and be responsible for collecting, controlling, translating, maintaining, archiving, and safeguarding all test data reported through the electronic data reporting network at the ESF site. LANL will also provide technical assistance to coordinate the underground testing and data acquisition portions of the ESF operations efforts.

As the constructor for the ESF, REECo will be responsible for overall ESF procurement, site construction, management and integration of the subcontractor tasks and work packages, management and integration of ESF site operations, operational test support, and construction/operations-related quality control. REECo will also administer the personnel health and safety program for the ESF site. (See Section 11.2.)

11.3.2 TESTING

Underground scientific site characterization tests to be performed during construction of the ESF include wall mapping, fracture mineralogy, seismic tomography, radial boreholes, perched water (if encountered), convergence, demonstration breakout room (DBR), excavation effects, intact fracture (coring), chlorine-36 sampling, matrix hydrologic properties sampling, laboratory mechanical properties sampling, hydrochemistry sampling, and ramp and borehole seals. **NOTE**: Chapter 10 identifies scientific tests and studies associated with the Title II design effort.

Most testing activities can be performed either in concert with construction activities or following construction. However, test setups that require access to the construction face will potentially impede the excavation process; for example, test alcoves planned for the ramps. Tests that may require construction constraint or hold points at the Topopah Spring (TS) level

core test panels are mapping, DBR, sequential drift excavation, heated room, perched water (if encountered), matrix hydrologic properties sampling, and laboratory mechanical properties sampling.

In addition to actual hold points for construction, nearly all tests require coordination of such activities as drilling of instrumentation and other holes, installing cable/data wiring, and the protection of instruments from damage.

Coordination between test planning and construction planning is an ongoing effort as the test plans and procedures are developed. Some experience has been gained from prototype testing, but many construction hold points cannot be determined until actual observations of exposed rock in the ESF are possible.

CHAPTER 12

OPERATIONS AND TESTING

12.1 OPERATIONS

Reynolds Electrical & Engineering Company, Inc. (REECo) will provide operation and maintenance support to the Exploratory Studies Facility (ESF) during construction and testing. The support includes several areas of operations such as site maintenance, mechanical and repair services, systems services, warehousing, bus transportation, training, communications, test support, supervision, and administration. Operations and maintenance support will be required during ten major construction phases.

Most of the underground construction work may be completed by a REECo subcontractor. The majority of the surface construction will be accomplished by REECo. Some of the surface construction will require REECo subcontractors for specialty work, examples of which are asphalt paving and water tank construction. During the operations phase, subsequent to completion of major construction activities, REECo envisions no subcontractor participation.

REECo will provide operations and maintenance support to the underground construction subcontractor. This includes supplying labor, equipment, and materials for maintaining equipment, facilities, roads, sites, buildings, field office trailers, and utility systems. The utility systems include power, communications, water distribution, and sewer and underground facility waste water disposal.

Mechanical services will be provided to maintain all mobile equipment assigned to the Project. Equipment and materials will be supplied to maintain Project components stored at the Nevada Test Site and on the Project area.

Labor, materials, and equipment will be supplied to maintain all underground support systems including personnel transport systems, excavated materials handling systems, ventilation, compressed air, water and waste water systems, power systems, warning and monitoring systems, communications systems, and the optional shaft hoist. Any site characterization testing activity during the operations phase requiring labor, equipment, or materials will be directly supported by REECo.

REECo has the responsibility for maintenance of all surface facilities and utilities, and will provide the communications systems to and from the ESF. Comprehensive maintenance procedures for the construction, testing, and operations phases of the ESF will be developed. The procedures will include plans for preventive maintenance and corrective action. The maintenance program will be based upon personnel protection and the achievement of the desired facility availability during the construction and operating life of the facility.

REECo and its subcontractors will identify and provide a parts inventory sufficient to minimize downtime for corrective maintenance of high wear items

and components. A preventive maintenance program will be developed which includes periodic inspection and servicing of systems and their components to ensure reliable operation.

For those systems and components which cannot be withdrawn from operation and must continually perform their functions, in-service inspections will be provided. Surveillance to detect the need for maintenance in critical systems and components will be incorporated into the facility maintenance programs.

REECo will provide operations and maintenance support to the Yucca Mountain Project Site Office (YMSO) Field Operations Center in Area 25.

REECo will provide access control of personnel, vehicles, and equipment to the surface and underground facilities. In addition, REECo will support the YMSO as required in the handling and control of visitors to the ESF.

Water supply, electrical power supply, roads, and telecommunications distribution are REECo responsibilities. REECo will also supply warehousing services for equipment and materials during and after the construction phase. REECo-subcontracted bus transportation services will be provided to the facility from population centers. Safety and MSHA training will be provided by REECo. T&MSS will coordinate the pickup of hazardous wastes from the satellite accumulation stations, and manage the Project Accumulation Area (PAA). REECo

will provide containers and materials, and conduct on-site waste transfer activities. First aid facilities and an ambulance will be provided on an "as-required" basis. Fire protection services will be provided to all Project Participants. REECo will be prepared to provide a mine rescue team, if required.

It is currently planned that the design, procurement, and construction of the ESF will be accomplished in a ten-phase fast track process. The ten construction phases are listed in Section 11.2, Construction Plan. Certain construction phases overlap, but the Project Office envisions them as steps to be taken in accordance with the approved Project schedule. If the scientific community discovers a geotechnical disqualifier that renders the site unsuitable, the work will be stopped and closure and decommissioning will commence. (See Chapter 8.)

12.2 LONG-TERM TESTING

The Title I design of the ESF is designed with sufficient flexibility to provide space for the conduct of scientific performance confirmation tests. The performance confirmation tests are defined in 10 CFR Part 60 as a "program of tests, experiments, and analyses which is conducted to evaluate the accuracy and adequacy of the information used to determine with reasonable assurance that the performance objectives for the period after permanent closure will be met." Details of such tests are not available at this time. However, it is

anticipated that certain site characterization tests for which the ESF is being designed may become performance confirmation tests. See Provision for 10 CFR 60.137 in Chapter 7 for additional comments on long-term performance confirmation testing.

CHAPTER 13

SCHEDULES

This Chapter contains Exploratory Studies Facility Title I schedule information.

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

WBS 1.2.6, Sheet 1 of 5: YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT TITLE I DESIGN SUMMARY RPT-REV 2.0 -27-AUG-91 EXPLORATORY STUDIES FACILITY

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER: WBS 1.2.6, Sheet 1 of 5

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

WBS 1.2.6, Sheet 2 of 5: YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT TITLE I DESIGN SUMMARY RPT-REV 2.0 -27-AUG-91 EXPLORATORY STUDIES FACILITY

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER:

WBS 1.2.6, Sheet 2 of 5

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

Part 2

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

WBS 1.2.6, Sheet 3 of 5: YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT TITLE I DESIGN SUMMARY RPT-REV 2.0 -27-AUG-91 EXPLORATORY STUDIES FACILITY

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER:

WBS 1.2.6, Sheet 3 of 5

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

WBS 1.2.6, Sheet 4 of 5:

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT TITLE I DESIGN SUMMARY RPT-REV 2.0 -27-AUG-91 EXPLORATORY STUDIES FACILITY

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER:

WBS 1.2.6, Sheet 4 of 5

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

Part 2

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

WBS 1.2.6, Sheet 5 of 5: YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT TITLE I DESIGN SUMMARY RPT-REV 2.0 -27-AUG-91 EXPLORATORY STUDIES FACILITY

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER: WBS 1.2.6, Sheet 5 of 5

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

OVERSIZE DOCUMENT PAGE PULLED

SEE APERTURE CARDS

NUMBER OF OVERSIZE PAGES FILMED ON APERTURE CARDS 5

9112020061-01-05

APERTURE CARD/HARD COPY AVAILABLE FROM

RECORDS AND REPORTS MANAGEMENT BRANCH

CHAPTER 14

COST ESTIMATES

This Chapter contains Exploratory Studies Facility Title I cost estimates. Backup cost information is provided in Appendix 5.14.

ESF TITLE I DESIGN SUMMARY REPORT
SUMMARY COST ESTIMATE WBS 1.2.6
[FY'92 - FY'00]

8/23/91

MANAGEMENT & INTEGRATION		**$135,050,500**
CONSTRUCTION		**$426,523,216**
SITE PREPARATION	$61,991,122	
SURFACE FACILITIES	$15,979,916	
NORTH ACCESS	$80,685,344	
SOUTH ACCESS	$86,364,793	
SUBSURFACE EXCAVATIONS	$135,834,917	
OPTIONAL ACCESS	$45,667,124	
OPERATIONS		**$204,129,285**
OPERATIONS [MTCE.& SAFETY]	$125,098,500	
INTEGRATED DATA SYSTEM	$79,030,785	
TOTAL ESF COST ---- [TO END OF CONSTRUCTION]		**$765,703,001**

RAYTHEON SERVICES NEVADA

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

TITLE I

DESIGN SUMMARY REPORT

FOR THE EXPLORATORY STUDIES FACILITY

REVISION 1

DRAFT H

VOLUME 2

TECHNICAL DESIGN ANALYSES

SEPTEMBER 3, 1991

Prepared by:

RAYTHEON SERVICES NEVADA

101 Convention Center Drive

Las Vegas, Nevada

received with letter dtd. 12/23/91

TITLE I DESIGN SUMMARY REPORT

VOLUME 2

TECHNICAL DESIGN ANALYSES

TABLE OF CONTENTS

NORTH PORTAL AREA:

1.	ST-MN-001, Rev. 2	TS NORTH PORTAL SITING ANALYSIS
2.	ST-MN-002, Rev. 2	SOUTH RAMP SITING ANALYSIS
3.	ST-MN-003, Rev. 2	OPTIONAL SHAFT SITING ANALYSIS
4.	ST-MN-004, Rev. 2	PRELIMINARY SITING ANALYSIS
5.	ST-MN-006, Rev. 2	PRELIMINARY SIZING OF OPTIONAL SHAFT
6.	ST-MN-007, Rev. 3	PRELIMINARY TS NORTH ACCESS RAMP CROSS SECTION SIZE ANALYSIS
7.	ST-MN-008, Rev. 2	CALICO HILLS NORTH RAMP SIZING STUDY
8.	ST-MN-010, Rev. 3	PRELIMINARY UNDERGROUND TRANSPORTATION METHODS ANALYSIS
9.	ST-MN-015, Rev. 2	PRELIMINARY ESF FUNCTIONAL REQUIREMENTS ANALYSIS
10.	ST-MN-020, Rev. 3	ESF PRELIMINARY EXCAVATION PLAN

SOUTH PORTAL AREA:

11.	ST-ME-001, Rev. 1	UNDERGROUND WATER DISTRIBUTION SYSTEM ANALYSIS
12.	ST-ME-006, Rev. 1	UNDERGROUND WASTE WATER COLLECTION SYSTEM ANALYSIS
13.	ST-ME-011, Rev. 0	COMPRESSED AIR DISTRIBUTION SYSTEM ANALYSIS
14.	ST-MN-025, Rev. 1	TS SOUTH RAMP SIZING STUDY
15.	ST-MN-026, Rev. 1	CALICO HILLS SOUTH RAMP SIZING STUDY
16.	ST-MN-030, Rev. 1	PRELIMINARY VENTILATION ANALYSIS - ESF CONSTRUCTION PHASE
17.	ST-MN-031, Rev. 1	PRELIMINARY VENTILATION ANALYSIS - ESF OPERATION PHASE
18.	ST-MN-035, Rev. 1	PRELIMINARY OPENING STABILITY ANALYSES

102-8

Raytheon Services Nevada

DESIGN ANALYSIS

Number: ST-MN-001 Rev: 2

WBS No. 1.2.6	PRINT NAME	SIGNATURE	TITLE	DATE
ORIGINATOR:	R.L. Coppage	R. Coppage	SR. MING. ENGR.	8-9-9
CHECKER:	ROMEO S. JURANI	Jurani	Sr. Mining Engr.	8-9-9
APPROVAL - LDE:	B.T. Stanley	Bruce T. Stanley	Ld. Mining Eng.	8.9.9
APPROVAL - SCDM:	B.R. CHYLINOWSKI	B.R. Chylinowski	SCDM	8-9-91
QA CONCURRENCE:	PAUL B. HALE	Paul B. Hale	Sr QA Specialist	8-9-91

SUBJECT: ESF NORTH ACCESS RAMP

TITLE: TS NORTH PORTAL SITING ANALYSIS

QAG Reference: RSN-GR-013, Rev. 0

1.0 PURPOSE: The purpose of this analysis is to provide a recommended TS North Portal location (site) in support of the ESF general arrangement engineering effort. Revision 1 responds to Management review comments generated on June 3 through 5, 1991. Revision 2 responds to Technical Review Comments generated in June 1991.

2.0 METHOD: The following method will be used in the preparation of this analysis:

2.1 Review the appropriate design input documents and SAND84-2015. Evaluate the method used and the conclusions reached to site the Waste Processing Facility.

2.2 Determine that conditions have not changed since the original Waste Processing Facility siting study was done.

2.3 Establish the requirement that the TS North Ramp which is the same as the ramp portal be located in, or very close to, the potential Repository Waste Processing Facility.

3.0 ANALYSIS INPUTS

The following potentially discriminating requirements, criteria, and constraints specifically related to siting a Ramp Portal were identified in YMP/CC-0013, ESFDR, Rev. May 31, 1991:
Section 1.2.6.0 FR 2., C.c3, PC 1d

Section 1.2.6.1 ESF Site
Performance Criteria 1b
Constraint A
Assumption #1

Section 1.2.6.5 Ramp Access
Functional Requirement #1
Functional Requirement #2

Performance Criteria 1a(all), 1d(xii), 2a(i), 2b(i), 2d(iii), 2e(ii)
Interface Control Requirement #1

Section 1.2.6.5.1 Portal

Constraint B

Appendix A.2 ESF/Repository Interface Constraints

Item #2

NOTE: A comparison of the relevant parts of the RDR cited in the references with the Sections of the ESFDR cited above, indicates that no degradation of the present intent of the ESFDR will occur by inclusion or use of the conclusions and recommendations presented in the reference documents.

4.0 CODES AND STANDARDS

No codes or standards were identified which specifically apply to locating the ramp portal.

5.0 ASSUMPTIONS: None of the following assumptions will be verified at this time.

The analysis is based on the following assumptions:

5.1 The North Access Ramp Portal should be located as close as reasonable to the potential Waste Processing Facility.

5.2 The site selection methodology used in selecting the potential Waste Handling surface location and the Waste Ramp Portal is valid.

5.3 All Design Input will be included in an approved Basis for Design (BFD).

6.0 REFERENCE MATERIAL:

6.1 SAND84-2641 Site Characterization Plan Conceptual Design Report Volume 2 Chapter 4.

6.2 SAND84-2641 Volume 5 Appendix R.

6.3 SAND84-2015 Location Recommendation for Surface Facilities for the Prospective Yucca Mountain Nuclear Waste Repository (All sections).

6.4 SAND85-0260 Repository Design Requirements (3.3.1.1.2.10).

6.5 SAND85-0815 Preliminary Validation of Geology at Site for Repository Surface Facilities.

6.6 FSN-AS-430 Rev. 2, p. 9 of 13, Option B7, scenario #2. This cites the Waste Ramp Portal coordinates used in the Alternative Studies.

6.7 USBR, 4-2-91, Preliminary Engineering Geology Reconnaissance Report for Proposed Ramp Alignments, W.B.S. 1.2.6.3.1.

6.8 DOE letter, Gertz to Bullock, 3-29-91, RSED:JTS-2834.

6.9 LANL TPP91-5 Preliminary ESF Test Planning Package.

6.10 SAIC Preliminary Draft of Geologic Section along TS North Ramp alignment

6.11 Preliminary Draft Report on the Assessment of Existing Geophysical Data and Geological Cross Sections to Support a Siting Analysis Report for the ESF, SAIC, 05-10-91.

6.12 USBR, 6-12-91 Drwg. No. OA-46-118, Geologic Reconnaissance Map N. Ramp Alignment.

7.0 COMPUTER CODES USED

None applicable.

8.0 UNITS USED

All dimension units used in the cited material are English.

9.0 ANALYSIS

9.1 INTRODUCTION

9.1.1 Purpose: As stated above, the purpose of this analysis is to develop a recommendation for the location (site) of the TS North Ramp Portal.

9.1.2 Scope: The scope of this analysis is to determine if the methodology and conclusions reached by others with regard to the siting of the potential surface waste processing facilities are applicable and valid for the North Access Ramp Portal.

9.2 METHODOLOGY

GENERAL STATEMENTS:

9.2.1 Point No. One: The ESF North Access (ESF Access #2, see Option 30 of Alternative Studies) and the Waste Ramp (future Repository feature) are identical. This was clearly stated in the Alternative Studies which selected Option 30, which proposes that the North Access Ramp be made a primary access to the underground during site characterization.

9.2.2 Point No. Two: The general location of the potential Surface Waste Processing Facilities was selected and documented in SAND84-2015. No other relevant siting analyses which use a wide spectrum of perspectives i.e. Engineering, Environmental, and Performance Assessment appear in the literature.

9.2.3 Point No. Three: The methodology used in SAND84-2015 was reviewed and the results adopted for repository design by the repository Design Manager (SNL).

9.2.4 Point No. Four: Throughout the preparation of the SCP-CDR and subsequent Repository conceptual layouts, the originally selected Waste Ramp Portal location was used.

9.3 APPLICABLE REQUIREMENTS:

Definition

The test ramp is that part of the ESF system that provides access from the surface to the underground test facility. It also serves as an intake of ventilation air for the testing areas.

Functional Requirements - 1.2.6.5

1. To link the underground test facility with the support structures on the surface, providing access and egress for the personnel and equipment.

Performance Criteria

1. The ramp entry point into the potential repository block will consider the overall design of a repository layout with minimum achievable gradients and travel distances.

2. The ramp shall permit personnel walkin/walkout capability in emergency conditions and will permit access for emergency vehicles.

Constraints

A. The ramp slope shall not exceed 10% for safety of access.

B. The test ramp portal shall be designed to prevent the ingress of water into the repository from a probable maximum flood (PMF).

Assumptions

1. The test ramp descends from a portal located just west of the surface facilities to intersect the potential repository horizon at the north central part of the underground test facility.

Definition

The ramp portal is that portion of the surface structure that extends into the excavation to a distance where the rock is sufficiently competent to allow excavation to continue. The portal is bounded by the surface and by the ramp excavation, lining, and roadway.

Functional Requirements

1. To provide a safe and stable transition between the surface excavation and excavation of the ramp.

2. To house a traffic control system for material handling and other traffic in the ramp.

3. To prevent water from surface storms from flowing into the ramp.

Performance Criteria

1. The portal shall be founded in rock.

2. The portal shall control traffic entering the ramp.

3. Drainage shall be provided at the portal to prevent surface water from flowing into the ramp.

Constraints

A. The portal shall not be located in an area subject to flooding.

9.4 APPLICABLE SECTIONS OF SAND84-2015 - The following site evaluation processes were used:

9.4.1 All potential sites must have met the following Fundamental Requirements:

The Sandia Study is included here to demonstrate that a valid analysis of the requirements and conditions was made for the potential Surface Waste Handling Facility, and that the analysis can apply as well to the siting of the TS North Ramp Portal.

1. Candidate sites will be located on the eastern side of the Yucca Mountain area of interest boundary in generally flat (<5% slope) terrain, occupying a minimum of 75 acres, 30 of which must be contiguous and within reasonable distance from the remainder.

2. The potential must exist for locating potential waste handling and packaging facilities within the 30 acres of (1), where at least four acres would possess adequate material and subsurface foundation properties to permit reasonable seismic engineering design, including strong motion from underground nuclear tests.

3. The area of (2) must be adjacent to potential repository access portals so that additional waste transport will not be required.

9.4.2 All potential sites having met the Fundamental Requirements were evaluated using the following factors:

REPOSITORY SURFACE FACILITY--SITE EVALUATION FACTORS

Preclosure Radiological Safety

• Air transport and diffusion	Meteorological factors
• Flash flooding	
• Ramp inclination to centroid	Operating safety factors
• Ramp inclination to exploratory shaft	
• Tectonic/fault displacement	

Environmental Quality (0.31)

- Protection of botanical/faunal species
- Archaeologic/cultural suitability

Ease and Cost of Construction, Operation, and Closure

• Average slope	
• Area availability/contiguity	Surface characteristics
• Structural complexity/faults	Rock characteristics
• Ground motion	Tectonics
• Portal access	
• Ramp length to centroid	Operational factors
• Proximity to northern block	

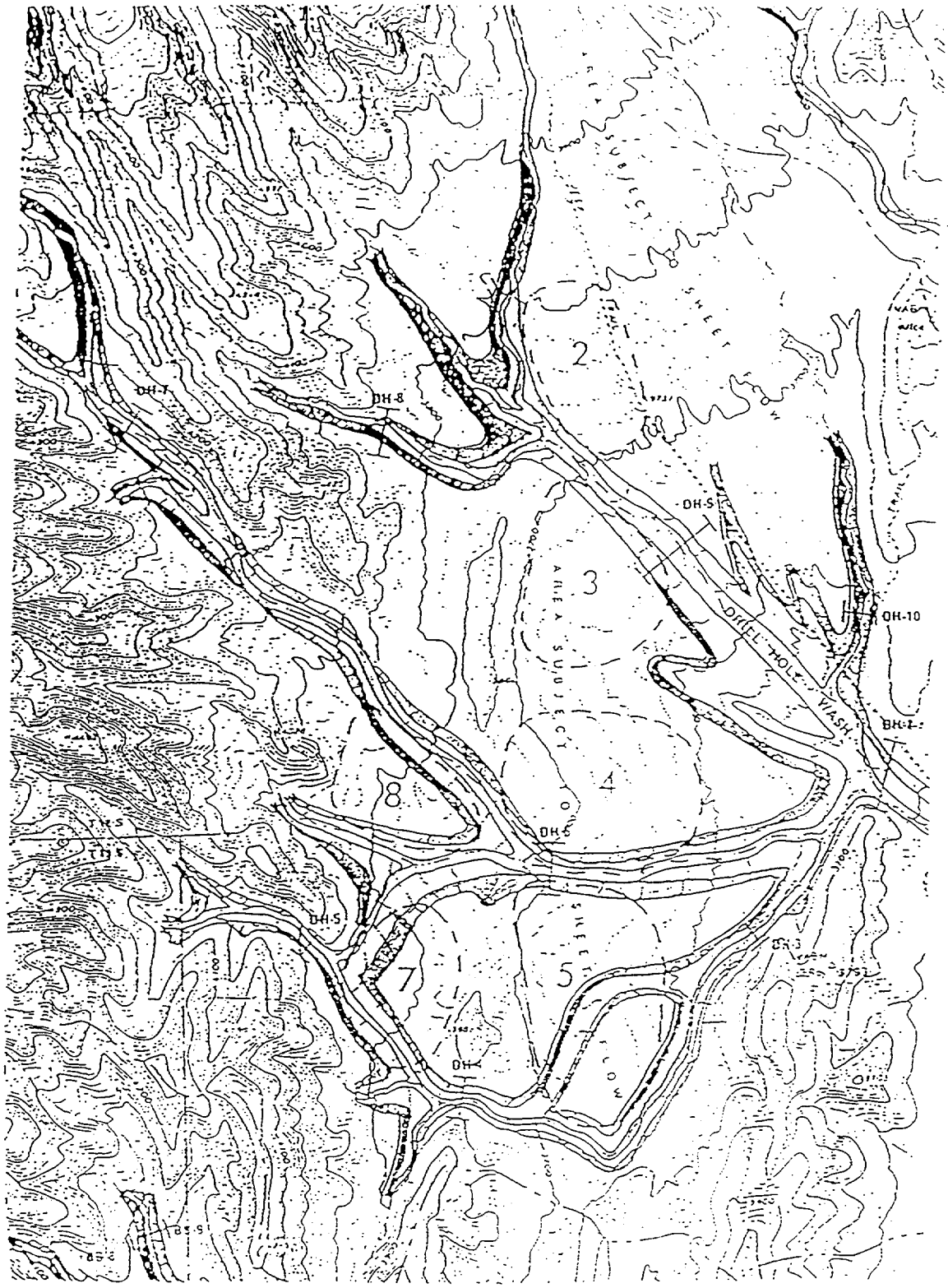
9.4.3 The following conclusion was reached in SAND84-2015:

> The evaluation of six candidate sites for repository surface facilities shows that the location east of the northern half of Exile Hill (Site 3, see Figure 1) is distinctively preferred, followed by sites to the north and south of it (Sites 2, 4, and 5). The evaluation is based on current understanding of the factors as they relate to Yucca Mountain; most of these are specified in the DOE Siting Guidelines (10 CFR Part 960). As new information becomes available, such as during detailed study of the subsurface facility area, revisions in scoring could occur and conceivably force a shift in the location of the preferred site. For these reasons, it is suggested that the recommended site be termed a "reference conceptual site," consistent with its intended use during repository conceptual design.
>
> These conclusions are applicable to the Waste Ramp Portal, because of the need for the ramp portal to be in close proximity to the Waste Handling Facility and the fact that the waste handling building has the same geological and flood prevention criteria as the ramp site.

9.5 APPLICABLE CONCEPTUAL DESIGN REPORT STATEMENTS AND CONFIGURATIONS

Using the Site No. 3 location from SAND84-2015, the Conceptual Design effort proceeded to produce the layouts shown on the following pages.

FIGURE 1



Locations of the Six Candidate Sites in Relation to Flood Potential Zones (from Squires and Young, 1984)

These layouts clearly show how the Waste Ramp Portal is integrated into the waste handling and processing surface area. The following excerpts from the SCP-CDR clearly describe the present status of the siting engineering of the Waste Ramp Portal.

"Location of the Surface Facilities and Waste Ramp

The ridges overlying the underground facility range in elevation from 4,800 to 4,900 ft. Major surface facilities cannot be located directly over the underground facility for two primary reasons: (1) the difficulty of access for waste shipments (particularly by rail), and (2) the unreasonable cost associated with construction on bedrock in the steep terrain overlying the underground facility. Therefore, the major surface facilities associated with waste handling are located on the gently sloping terrain at the eastern base of Yucca Mountain at an approximate elevation of 3,665 ft. This location allows transport of the waste to the underground facility via a ramp inclined at an 8.9% grade and 6,603 ft long.

A study has been conducted to select a reference location for the major surface facilities for the purpose of developing the conceptual design (Neal, 1985). After an initial screening, areas located on the alluvial fans along the eastern base of Yucca Mountain (Figure 4-7) were selected for evaluation. The siting factors used to compare the six areas are those given in preclosure system guidelines (preclosure radiological safety; environmental quality; and ease and cost of construction, operation, and closure). The siting factors include air transport and diffusion of ventilation exhaust, flash flooding, ramp inclination, tectonic and fault displacement, protection of botanical and faunal species, archaeologic and cultural stability, average slope, area availability and contiguity, structural complexity of faults, ground motion, portal access, ramp length, and proximity to the northern area.

Numerical weighting and ranking methods were used to select the preferred site, an area east of Exile Hill. The primary advantages of this site are gentle slopes (necessary for railroad construction), protection from flash flooding, and an unbroken area of sufficient size to accommodate the central surface facilities. The site is located adjacent to a rock outcrop, which provides a suitable foundation for constructing the portal of the waste ramp. This location also permits the ramp to be constructed at a grade of less than 10% and provides flexibility for possible expansion of the emplacement area to the north, if that becomes necessary.

Data obtained thus far indicates that there are no conditions that would disqualify the area for location of the waste-handling facilities. However, the evaluation was based only on preliminary information, and detailed site characterization studies may lead to different conclusions (Neal, 1985)."

9.6 LOCATION OF THE WASTE RAMP PORTAL WITH RESPECT TO THE SURFACE WASTE HANDLING BUILDING(S)

In the cited references SAND84-2015 and the SCP-CDR, the Waste Ramp Portal was located very close to the Waste Handling Surface Building, (Figure 2 and 3). No analysis was provided for this siting feature, however, it seems very reasonable that the buildings and ramp should be located close by each other. The following reasons would support this positioning and support Assumption #1 in Section 5.

1. The distance traveled should be as short as possible, thus making the most efficient use of the equipment.

2. The waste transporter is a highly specialized piece of equipment. Variability in the conditions through which waste is carried could cause problems in optimizing its design. Since the waste ramp is a controlled environment, the transporter should enter the ramp as soon as possible to maximize control over the operating conditions of the transporter.

3. Operating safety is enhanced by restricting operations of the vehicle to the controlled environment of the underground to the extent possible.

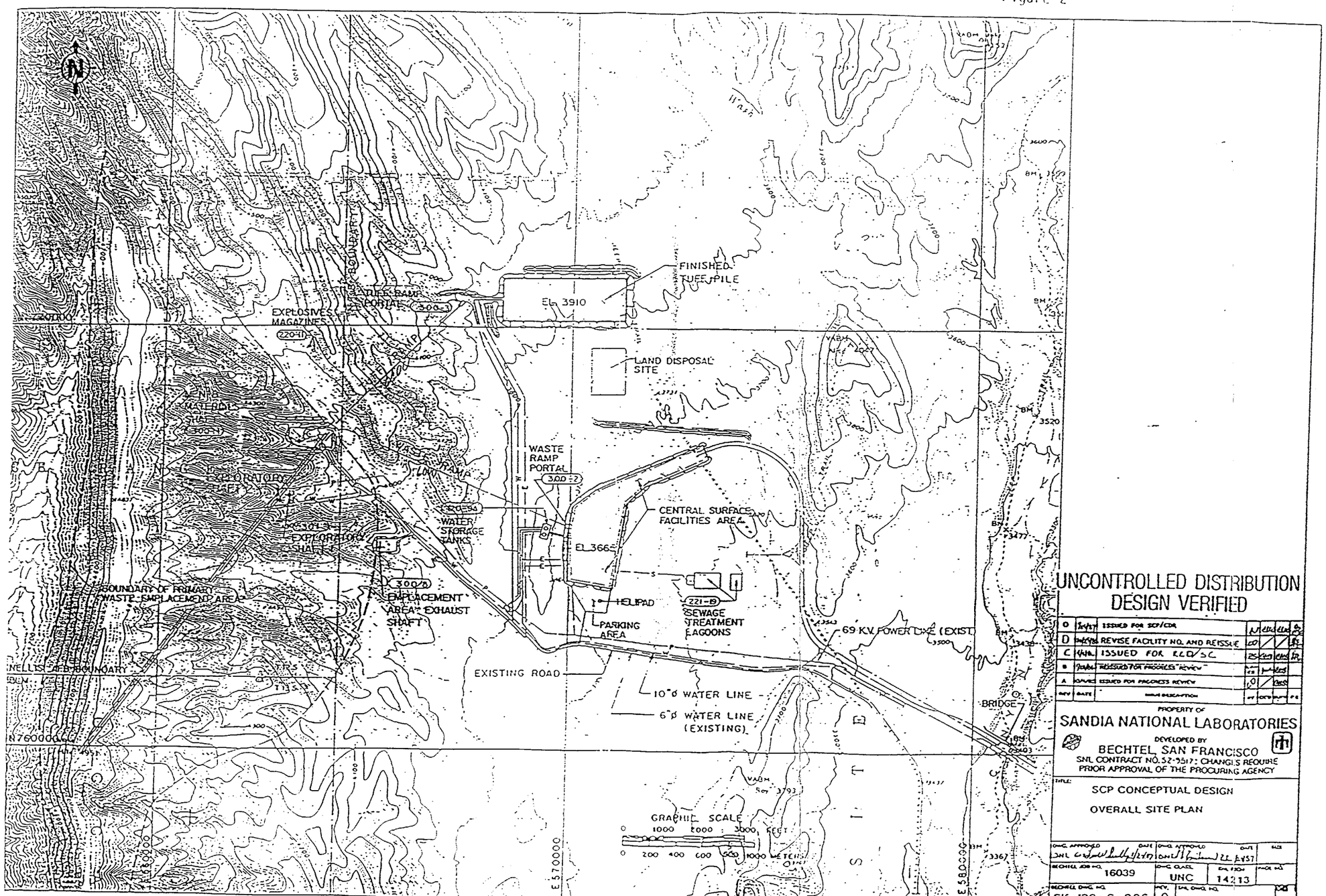
4. The design and construction of the surface facilities is simplified by restricting the amount of transporter surface travel to the minimum practical.

9.7 THE SCP-CDR - SAND84-2641 APPENDIX R SECTION 2.0 DEALS WITH THE ENTRY POINT OF THE WASTE RAMP INTO THE REPOSITORY

This section describes how the location of the waste ramp lower end was selected.

The process considered engineering factors only. It was determined that the optimum location for the waste ramp bottom to enter the repository was on the north end. Access to the indicated point of repository entry by ramp will be affected by a change in portal location, i.e. the ramp will be longer or steeper or both. Since the slope angle of 8.9% has been used and the designers have developed no evidence which indicates an inherent hazard exitsts at this slope angle, it's questionable if safety or operational advantage can be gained through

Figure 2

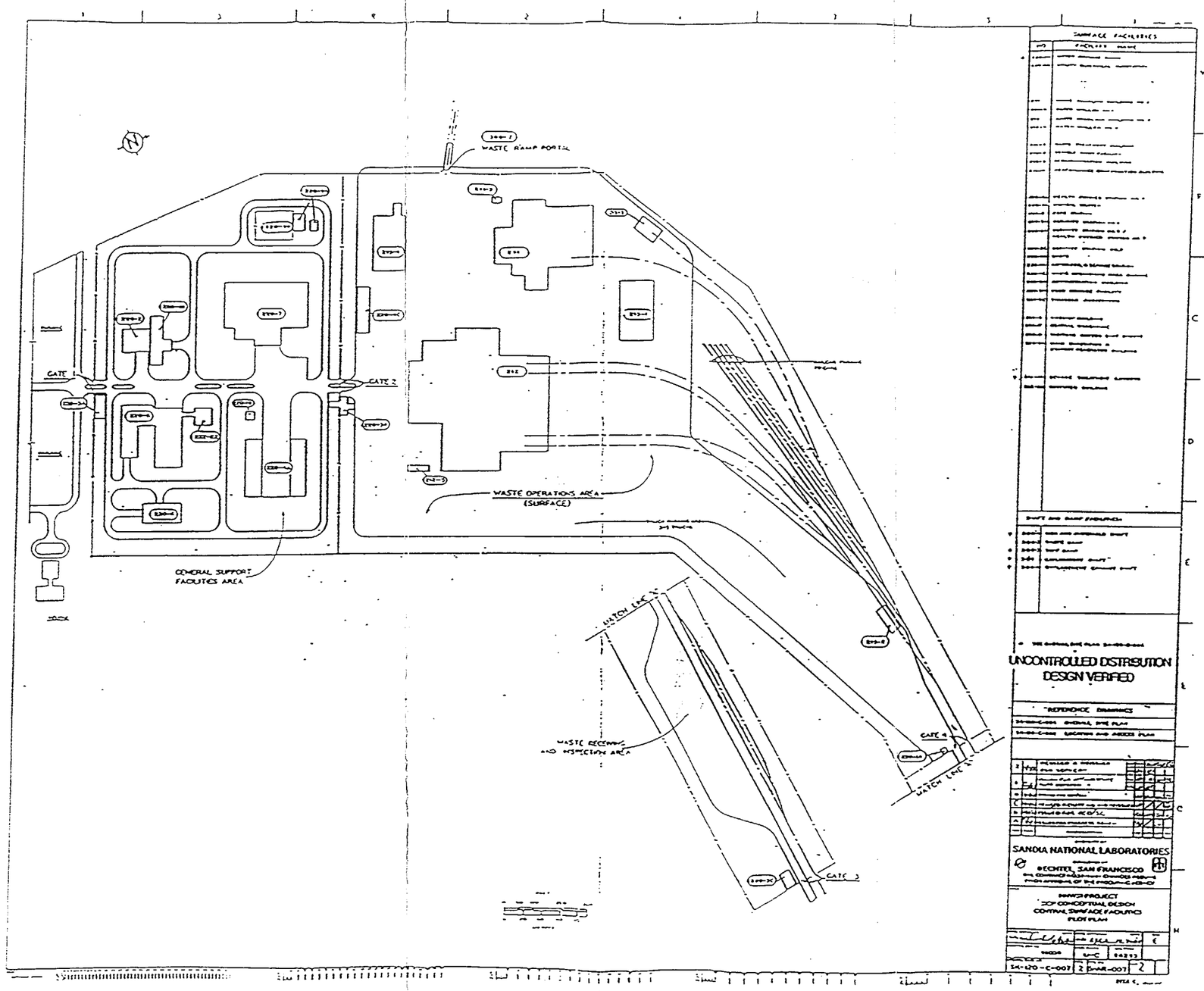


SI APERTURE CARD

Also Available On Aperture Card

9112020061-06

Figure 3



SI
APERTURE
CARD

Also Available On
Aperture Card

slope reduction achieved by portal resiting, which in turn would require additional ramp length. A safety analysis of ramp operations, if one is conducted, will either support or refute this position. Additional ramp length is not justified by any apparent safety or operating benefit evident at this time.

9.8 SINCE THE PREPARATION AND PUBLICATION OF THE SCP-CDR THE ALTERNATIVE STUDIES WERE PERFORMED.

The process that was used to arrive at a preferred option decision is documented elsewhere. (Ref SAND84-2015). Suffice it to say that the process was rigorous and encompassed all relevant concerns. The various options contained methods of entry and configurations designed to analyze the spectrum of reasonable possibilities. The option which scored highest contained a primary north TSW_2 entry (waste) ramp component. The ramp portal location of this option was established to be the one presented in the SCP-CDR. The ramp location was evaluated along with many other option features and appeared to be a favorable factor whenever the Waste Ramp Portal was a component of an option decision matrix. See Ref. 6.6 for data sheet indicating co-ordinate location of North Access Ramp Portal used in Alternative Studies.

9.9 SEVERAL OTHER FIELD EVALUATIONS HAVE BEEN MADE OF THE SCP-CDR PROPOSED NORTH ACCESS RAMP PORTAL SITE SINCE THE PUBLICATION OF SAND84-2015.

The results of these evaluations are as follows:

- USBR Geology. Refer to Preliminary Engineering Geology Recon. Rpt. USBR 4-2-91, (see Ref. 6.7). This report indicates that the present site is geologically suitable for the Waste Ramp Portal site, and can comply with the requirement for the portal to be founded in rock, and that the conditions will permit the construction of a safe and stable transition between the surface excavation and the excavation for the ramp.

- SAND85-0815 Preliminary Validation of Geology at Site for Repository Surface Facilities (see Ref. 6.5): This report summarizes what geological investigation work had been done to date (1985) on the proposed site for the surface facilities and the Waste Ramp Portal site. The conclusions reached in this report, which are applicable to the siting of the North Access Ramp Portal, are paraphrased and abridged as follows:

1. The site considerations discussed in this report do not impact appreciably on the design of the underground facility. There is sufficient flexibility with respect to engineering, so that the design and construction of portals and ramps can accommodate the range of geologic conditions that exist.

2. The following commentary by Parsons Brinckerhoff was furnished in the Appendix of the cited report:

   The North Access Ramp Portal is preferably located where the depth to good tunneling rock is small. A substantial length of soil tunnel or cut-and-cover construction is no technical obstacle but would add unnecessarily to cost and construction duration. The portal location is also to some extent controlled by the maximum feasible grade of the ramp from the portal to the underground facility; a flat ramp is desirable.

   Nothing in the findings of the geophysical surveys has suggested any significant construction, design or performance problems associated with the ramp. According to the interpreted geological profile, the ramp would be tunneled through reasonable competent rock throughout the length profiled. The Bow Ridge Fault will be encountered, as will probably other faults. While such faults will present some construction difficulties, these types of difficulties can be overcome by standard construction procedures.

The opinions expressed in SAND85-0815 above, indicate that the proposed portal site is constructible and meets the geological siting criteria.

9.10 REFER TO REFERENCE 6.9 - THE TEST PLANNING PACKAGE.

The Test Planning Package was based upon the proposed SCP-CDR ramp location and configuration. These test plans were made after consideration of the geologic features such as faults and bedding planes which would be traversed by the ramp located in the basic SCP-CDR location. The geologic information used by the test planning group is that presented in Reference 6.10. During the test plan development, no comment was transmitted to the designer as to the relative merit of the proposed ramp location with respect to other locations. Furthermore, no comment was received as to the representiveness or the worth of the proposed site in the site characterization process.

10.0 CONCLUSIONS

10.1 The location of the North TSW_2 Ramp Portal at the Waste Handling Surface Facilities was determined by a selection process utilizing the most reliable data available at the time.

10.2 Review of reports generated subsequent to the initial siting report (SAND84-2015) and others indicates that alternatives to the present ramp portal or ramp alignment are feasible. No equal or better alternatives are apparent. Reports confirm that the SCP-CDR site is suitable from geological and operational standpoints.

10.3 The surface siting decision for the Waste Handling Facility is applicable to the siting of the portal of the waste ramp because when all factors are equal it is preferable to minimize the travel distance from the surface waste handling building to the waste ramp portal.

10.4 The SCP-CDR Waste Ramp Portal Area Site supports the Functional Requirements:

1. To provide a safe and stable transition between surface excavation and excavation of the ramp, the SCP-CDR site supports this requirement by proposing a location founded within reasonable distance to bed rock, the geological sections in the reports cited.

2. To house a traffic control system: This is a designed function independent of location and siting.

3. To prevent water from storms from flowing into the ramp. The SCP-CDR location meets this requirement by being located above the PMF elevation as shown on SAND84-2015 Surface Facility Siting Analysis and Figure 1, p. 8 of 17.

10.5 Since the testing evaluation panel used the SCP-CDR North Ramp location as a basis for locating a group of site characterization and performance tests without adverse comment, it can be concluded that the proposed ramp site is at least suitable for this purpose and thus fulfills a requirement for support of site characterization testing.

10.6 The SCP-CDR Waste Ramp Portal location (N765251; E570034) is suitable for the purposes of the reference design concept engineering effort because of the conclusions cited above.

11.0 RECOMMENDATION

Adopt the Option #30 North Access Ramp Portal location coordinates of N765251 and E570034 for the relevant elements of the Reference Design Concept.

OVERSIZE DOCUMENT PAGE PULLED

SEE APERTURE CARDS

NUMBER OF OVERSIZE PAGES FILMED ON APERTURE CARDS 2

9112060263
9112020061-08

APERTURE CARD/HARD COPY AVAILABLE FROM

RECORDS AND REPORTS MANAGEMENT BRANCH

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

OA-46-118:
YUCCA MOUNTAIN PROJECT EXPLORATORY STUDIES FACILITY GEOLOGIC RECONNAISSANCE MAP NORTH RAMP ALIGNMENT

WITHIN THIS PACKAGE...OR,
BY SEARCHING USING THE DRAWING NUMBER:
OA-46-118

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

9112060263 **D-6**

9112060061 - Part 2

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: DRAWING NUMBER 1: SECTION CC TO CC'

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER: 1

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

9112020061-08 **D-7**

9112020061 - Part 2

SOUTH RAMP SITING ANALYSIS

DESIGN ANALYSIS No. ST-MN-002

REV. 2

WBS No. 1.2.6

JULY 29, 1991

RAYTHEON SERVICES NEVADA

Raytheon Services Nevada	DESIGN ANALYSIS Number: ST-MN-002 Rev: 2 Page 1 of 29

WBS No. 1.2.6	PRINT NAME	SIGNATURE	TITLE	DATE
ORIGINATOR:	W. R. Kennedy	W.R. Kennedy	Sr. Mining Engr.	7-30-9
CHECKER:	SAEED BONABIAN	Saeed Bonabian	Eng Tech Anal/Spec	8-1-91
APPROVAL - LDE:	B. T. Stanley	Bruce T. Stanley	Lead Mining Eng.	8-1-9
APPROVAL - SCDM:	B.R. Chytroxski	B.R. Chytroxski	SCDM	8-6-91
QA CONCURRENCE:	PAUL B. HALE	Paul B Hale	Sr. QA Specialist	8-6-91

SUBJECT: Preliminary Engineering Analysis for Locating Topopah Spring South Ramp Portal

TITLE: South Ramp Siting Analysis

QAG Reference: RSN-GR-013, Rev. 0

1.0 PURPOSE

The purpose of this preliminary analysis is to determine the approximate location of the TS South Ramp portal and the alignment of the ramp between the portal and the entry point to the potential repository block underground. The South Ramp will support development and testing activities related to site characterization. The recommended location will be used to support the development of general arrangement drawings and will also provide a basis for location of environmental monitoring equipment. The recommendation in this report will provide an approximate location (ie. general area) and may not be the exact final location/alignment of the ramp.

Revision 1 incorporates the Management Review comments.
Revision 2 incorporates the Technical Review comments.

2.0 METHOD

A numerical evaluation approach will be used to rank the alternative locations for the TS South Ramp Portal. The analysis will be conducted in the following steps:

2.1 Identify the portal siting requirements which will be used to screen potential candidate sites. Review the ESFDR to identify requirements, criteria, and constraints applicable to portal siting. Solicit and incorporate input from participants responsible for construction, repository design, performance assessment, site characterization, environmental compliance, and programmatic viability.

2.2 Identify alternative portal locations/ramp alignments which meet the site screening requirements.

2.3 Identify the engineering evaluation features which will provide the basis for a comparative evaluation of the alternatives. Assign weighting factor values to each feature. These determinations will be based on the consensus judgement of a team of qualified technical professionals.

2.4 Rate each of the candidate sites against each of the engineering evaluation features. A group of qualified technical professionals (individuals not involved in step 2.3) will also be used for this scoring activity.

2.5 Rank the candidate sites from an engineering perspective. The product of the numerical values for the weighting factor and the

rating provides a value for each feature of each candidate site. The sum of the values of all aspects of each alternative provides a numerical comparison among alternatives.

3.0 ANALYSIS INPUTS

3.1 The following potentially discriminating requirements, criteria, and constraints specifically related to siting the TS South Ramp Portal were identified in YMP/CC-0013 (ESFDR), Revision dated May 31, 1991:

Section 1.2.6.0 General Exploratory Shaft Facility

Functional Requirement #2

Performance Criteria 1d, 2d

Constraint C(3), I

Section 1.2.6.1 ESF Site

Performance Criteria 1b

Assumption #1

Constraint A

Section 1.2.6.5 Ramp Access

Functional Requirement #1, #2

Performance Criteria 1a, 1d(xii), 1f(v), 2a(i), 2b(i), 2d(iii), 2e(i)(ii)

Interface Control Requirement #1

Section 1.2.6.5.1 Portal

Constraint B

Appendix A.1 ESF/Repository Interface Constraints

Item #2

3.2 Topographic Maps - Transmitted from C. E. Ezra (EG&G) to Bruce Stanley (RSN), dated February 1, 1991

3.3 Flood Prone Areas - Transmitted from S. Rohde (EG&G) to Bruce Stanley (RSN), dated March 5, 1991

3.4 Ortho Photos - Transmitted from S. Rohde (EG&G) to Bruce Stanley (RSN), dated March 5. 1991

4.0 CODES AND STANDARDS

No codes or standards were identified which specifically apply to locating the ramp portal.

5.0 ASSUMPTIONS

The analysis is based on the following unverified assumptions:

5.1 Coordinates and elevation of the point of intersection (PI) of TS South Ramp and repository main entry are assumed as follows: (See Reference 6.2; Assumption used on Figures 1 and 3 in Appendix A)

North 757909

East 557584

Elevation 3785 Ft.

5.2 The primary functions of the TS South Ramp during the site characterization phase are assumed to be: (See Reference 6.1; Assumption used on page 9)

- o muck transport
- o ventilation exhaust
- o emergency egress
- o limited testing

5.3 It is assumed that all analysis inputs cited in Section 3, will be included in the Basis for Design (BFD). This assumption is used throughout the analysis.

5.4 The primary functions of the TS South Ramp during the potential repository operations phase are assumed to be: (See Reference 6.1; Assumption used on page 9)

- o muck transport
- o development ventilation exhaust
- o emergency egress

5.5 It is assumed that the ramp will be constructed from the surface down to TS level using a 25 ft diameter tunnel boring machine (TBM). (See Reference 6.1; Assumption used on page 9)

5.6 Size of the portal pad is assumed to be approximately 390 ft x 600 ft. (Assumption used on Figure 1 in Appendix A)

6. REFERENCE MATERIAL

6.1 FSN-AS-430, Rev-2 ESF Alternative Study Data (Option #30)

6.2 Information on the South Ramp/Repository Main Point of Intersection (PI), Transmittal #91-11, Brian Lawrence (PBQ&D) to Nick Tamondong (RSN), dated April 9, 1991

6.3 Preliminary Engineering Geology Reconnaissance Report For Proposed Ramp Alignments, by McKeown and Beason, US Bureau of Reclamation, dated April 2, 1991, transmittal (D-3790) from USBUREC TPO to Larry Hayes with copy to Jim Grenia (RSN).

6.4 Transmittal of Report On The Assessment of Existing Geophysical Data And Geologic Cross Sections To Support A Siting Analysis Report For The Exploratory Studies Facility (ESF), Letter from King/SAIC to Dobson/YMPO and Bullock/RSN (L91-315), Dated June 21, 1991

6.5 Request for Input on South Ramp Portal and Optional Shaft Collar Siting Requirements, FS-YMP-5190 thru 5197, dated March 28, 1991

6.6 Response to Siting Requirements, Petrie/YMPO to Bullock/RSN (EDD:EHP-3288), dated April 23, 1991

6.7 Response to Siting Requirements, Craig/USGS to Bullock/RSN, dated April 12, 1991

6.8 Evaluation of Portal and Shaft Siting Requirements, Blejwas/SNL to Bullock/RSN, dated April 8, 1991

6.9 Response to Siting Requirements, Pritchett/REECo to Bullock/RSN (580-01-353), dated April 10, 1991

6.10 Response to Siting Requirements, Lawrence/PBQ&D to Bullock/RSN (PB/RSN-1), dated April 5, 1991

6.11 Provision of Input-Siting Requirements, Elkins/LANL to Bullock/RSN (TWS-EES-13-LV-04-91-05), dated April 5, 1991

6.12 Response to Siting Requirements - Petrie (by Cikanek)/YMPO to Bullock/RSN, dated April 11, 1991

6.13 Preliminary Siting Analysis-Revised South Ramp and Optional Shaft Siting Requirements, FS-YMP-5207, dated April 16, 1991

6.14 Nominations For Support To The South Ramp and Optional Shaft Siting Analysis, FS-YMP-5201, dated April 10, 1991

6.15 Meeting Minutes - MM# 91-01, dated April 17, 1991

6.16 Comparative Evaluation of Alternate South Ramp Portal and Optional Shaft Sites - IC-1445, dated April 23, 1991

6.17 Meeting Minutes - MM# 91-03, dated April 25, 1991

7.0 COMPUTER PROGRAMS

NA

8.0 UNITS

English units are used.

9.0 ANALYSIS

The study effort and results, including a recommendation of the preferred location for the TS South Ramp portal based on engineering considerations, are documented in the following sections.

9.1 BACKGROUND

The south ramp will provide one of the primary means of access to the exploratory study facility (ESF). Primary functions to be accommodated during the site characterization phase include muck transport, ventilation exhaust, emergency egress, and limited testing. Potential repository functions to be accommodated include muck transport, development ventilation exhaust, and emergency egress. For the purpose of this study, it is assumed that the ramp will be constructed from the surface down to the Topopah Spring (TS) level using a 25 FT diameter tunnel boring machine (TBM).

9.2 PORTAL SITING REQUIREMENTS

The ESFDR-Rev. 0 was reviewed and potentially discriminating functional requirements, performance criteria, and constraints applicable to locating the TS South Ramp portal were identified. Section 3.0, Analysis Inputs, contains a listing of those requirements. The requirements can be grouped into several general categories as shown below:

NOTE: The following abbreviations for ESFDR citations are used:

FR-Functional Requirement

PC-Performance Criteria

C-Constraint

ICR-Interface Control Requirement

<u>Avoidance of Flood Prone Areas</u>

[ESFDR:Section 1.2.6.1 : PC-1b; Section 1.2.6.5 : PC-2e(i)(ii)]

<u>Suitable Surface Conditions</u>

[Section 1.2.6.5.1 : C-B]

<u>Compatibility with Repository</u>

[Section 1.2.6.0 : FR-2, C-c(3); Section 1.2.6.5 : FR-2, PC-2b(i), ICR-1]

Suitable Ramp Gradient

[Section 1.2.6.5 : PC-1f(v)]

Muckpile Visibility From Highway 95

[Appendix A.2, Item 2]

Site Characterization Considerations

[Section 1.2.6.5 : PC-1d(xii)]

An initial list of requirements for locating the TS South Ramp portal was developed, and subsequently revised based on informal comments which were received from various participant organizations. References 6.5 through 6.13 contain correspondence related to the portal site screening requirements. As a result of this effort, and based upon the ESFDR citations categorized above, the following requirements were determined to be suitable for screening potential portal sites:

(1) The ramp portal area shall be located and/or graded to prevent water inflow to the underground facilities during the probable maximum flood. [ESFDR:Section 1.2.6.1 : PC-1b, A-1; Section 1.2.6.5 : PC-2e(i)(ii)]

(2) The portal shall be founded in rock. [Section 1.2.6.5.1 : C-B]

(3) The portal location/ramp alignment must provide for the incorporation of the ramp into the future repository. The ramp shall be located, to the extent practicable, where a ramp is planned for the repository facility. [Section 1.2.6.0 : FR-2, C-(3); Section 1.2.6.5 : FR-2, PC-2b(i), ICR-1]

(4) The portal location must result in a ramp gradient which provides an acceptable slope suitable for excavation, safe vehicular traffic, and material handling equipment requirements. For the purpose of this analysis, the maximum allowable ramp gradient is set at 10%. [Section 1.2.6.5 : PC-1f(v)]

(5) The portal location must be compatible with the requirement that rock excavated from the underground facilities can be deposited at a location on the surface that is not visible from U.S. Highway 95. [Appendix A.2, Item 2]

(6) The location of accesses relative to each other shall be such that testing in one access will not be adversely affected by activities in the other. [Section 1.2.6.5 : PC-1d(xii)]

9.3 DESCRIPTION OF CANDIDATE PORTAL SITES

A base map was compiled which included topographic features, existing roads, outline of probable maximum flood (PMF) area, the repository outline and the repository waste main alignment. A point of intersection (PI) for the ramp and the waste main was assumed which would minimize the loss of usable repository expansion area (See Assumption 5.1). This PI was common for all alternative south ramp portal sites.

Candidate portal sites meeting the screening requirements of Section 9.2 were identified and plotted on the base map. Each site was located well above the valley floor to prevent inundation during a flood. Thick alluvium was avoided to facilitate construction of the portal in rock. Portal sites/ramp alignments were located to ensure compatability with a potential repository. All three sites result in a ramp gradient of less than 10%. Muck piles were conceptually located to be hidden from the view of travelers on US Highway 95. A separation distance of two or more miles between any of the candidate sites and the proposed North Ramp portal ensures that testing in one access will not adversely effect activities in the other. Engineering judgement was used to select what appeared to be the best portal location wherever several potential sites existed in the same general area. This judgement was initially based on

the information contained on the base map and was then confirmed by field visits to the candidate site areas.

The three candidate portal sites and corresponding ramp alignments which were identified are described in Sections 9.3.1 through 9.3.3. Refer to figures 1, 2, and 3 (Appendix A) for conceptual layouts of the south ramp alternatives.

9.3.1 SITE No. 1 - SOLITARIO CANYON PORTAL

The portal site is located west of Yucca Crest on a west facing, gently sloping (8-10%) hillside approximately 110 feet above the bottom of Solitario Canyon. Portal access could be provided by the construction or upgrading of approximately 16 miles of road around the south side of Busted Butte and Yucca Crest. Disposal of ESF and repository muck would require approximately 5 miles of overland conveyor to the muckpile located north of Black Cone. This portal site results in a ramp which is approximately 3500 feet long (when measured to a repository entry point common to all alternatives), driven on an azimuth of approximately 34°. The slope of the ramp would be approximately 9.0 %. The approximate coordinates and elevation of the portal are:

North 755670

East 556060

Elev.- 4030 Ft.

See Reference 6.3 for a discussion of engineering geology considerations as they apply to this site. Reference 6.4 shows a geologic section along the proposed ramp alignment.

9.3.2 SITE No. 2 - GHOST DANCE PORTAL

The portal site is located on the nose of an east-west trending ridge on the eastern flank of Yucca Mountain. It is situated between Ghost Dance Wash and Abandoned Wash, and lies approximately 75 feet above Dune Wash. The natural slope of the site area is approximately 20%. Portal access could be provided by the construction of approximately 3000 feet of new road, extending from the existing Highway Ridge Road to the portal. Disposal of ESF and repository muck would require approximately 6500 feet of overland conveyor to the muckpile located near the north end of Bow Ridge. This portal site results in a ramp which is approximately 5680 feet long (when measured to a repository entry point common to all alternatives), driven on an azimuth of approximately 286°. The slope of the ramp would be approximately 6.8 %. The approximate coordinates and elevation of the portal are:

North 756430

East 562740

Elev.- 4150 Ft.

See Reference 6.3 for a discussion of engineering geology considerations as they apply to this site. Reference 6.4 shows a geologic section along the proposed ramp alignment.

9.3.3 SITE No. 3 - BOUNDARY RIDGE PORTAL

The portal site is located on the east side of Boundary Ridge approximately 150 feet above the floor of the valley that lies between Boundary Ridge and the north end of Bow Ridge. The natural slope of the site area is approximately 5%. Portal access could be provided by the construction and/or upgrading of approximately 7000 feet of road, extending from the existing Drill Hole Wash Road to the portal. Disposal of ESF and repository muck would require approximately 3000 feet of overland conveyor to the muckpile located near the north end of Bow Ridge. This portal site results in a ramp which is approximately 9400 feet long (when measured to a repository entry point common to all alternatives), driven on an azimuth of approximately 278°. The slope of the ramp would be approximately 1.8 %. The approximate coordinates and elevation of the portal are:

North 756640

East 566640

Elev.- 3950 Ft.

See Reference 6.3 for a discussion of engineering geology considerations as they apply to this site. Reference 6.4 shows a geologic section along the proposed ramp alignment.

9.4 EVALUATION OF ALTERNATIVES

The engineering evaluation involved identification of evaluation features, assignment of weighting factor values to each of the features, and rating each of the alternatives with respect to each of the features. The results of these activities are summarized in the following sections.

9.4.1 EVALUATION FEATURES AND WEIGHTING FACTOR VALUES

A team of qualified professionals met to identify and weight the engineering evaluation features which would provide the basis for a comparative evaluation of the alternatives. See References 6.14 and 6.15 for documentation of that effort. Based on a consensus judgement of the team members, engineering evaluation features for siting the south ramp portal were identified. As can be seen from the following descriptions, most of the engineering features potentially impact cost and/or schedule.

(1) EASE OF CONSTRUCTION OF PORTAL ACCESS ROAD

- o Length of New Road
- o Topographic Considerations

A portal access road must be extended to the site. The cost of providing the road is directly related to the distance from existing roads and the terrain over which the new road must be constructed.

(2) EASE OF PORTAL PAD/HIGHWALL CONSTRUCTION

- o Topographic Considerations
- o Geologic Conditions
  - Depth to Bedrock
  - Fracturing (Spacing and Orientation)
  - Rock Strength

Topographic features at the portal location can affect ease and cost of construction for the portal pad (approximately 5 acres) and the rock face (highwall) in which the portal is started.

Geologic conditions at the site can also impact portal pad/highwall construction cost and schedule. Minimal distance to bedrock is preferred, since the portal must be founded in rock and all

unconsolidated and/or poorly consolidated overburden must be removed from the portal area. The portal face should be located in stable rock.

3) EASE OF PORTAL CONSTRUCTION

- o Geologic Conditions
  - Fracture Spacing (Faulting/Jointing)
  - Fracture Orientation
  - Rock Strength

Geologic conditions in the vicinity of the portal can impact portal construction cost and schedule. The portal area should avoid adverse geologic features such as shear zones and weak or highly weathered rock. Preferred fracture orientation is orthogonal to rather than parallel to ramp alignment.

(4) EASE OF RAMP CONSTRUCTION

- o Geologic Conditions
  - Fracture Spacing (Faulting/Jointing)
  - Fracture Orientation
  - Rock Strength
  - Intersection With Major Faults

- Ramp Alignment Maintains Stable Rock Cover

Rock characteristics and structural features encountered along the ramp alignment can affect construction costs and schedule. Excavation through major fault zones or highly fractured areas may result in rock fall-out which could require additional ground support and could adversely affect TBM advance rates. Where it is necessary to cross adverse geologic features, it is preferable to do so at or near a right angle, to minimize exposure distance.

Ideally, the ramp alignment will gain stable rock cover quickly and maintain sufficient cover along its entire length.

(5) RAMP LENGTH

- Construction Cost/Schedule Impacts
- ESF and Repository Operating Cost Impacts
- Safety Impacts

Construction cost and schedule are both directly related to ramp length. Construction cost accounts most sensitive to ramp length include labor, consumables, power, conveying equipment, and utilities. A shorter ramp can also result in reduced operating costs in the areas of muck conveying, ramp maintenance, and ventilation. Safety hazards

are associated with vehicular travel on a ramp, and exposure time to these hazards is reduced as travel distance (ie, ramp length) is decreased.

(6) RAMP GRADIENT

- o Construction/Cost Schedule Impacts
- o Safety Impacts
- o Flexibility To Re-Assign Repository Functional Requirements

The portal location/ramp alignment should provide a ramp gradient which is consistent with safe and efficient construction and operations activities. Specifically, the gradient should be compatible with the TBM excavation method, conveyor transport of mined rock, limited vehicular traffic (ie. for maintenance of ramp facilities), and emergency egress requirements. A flatter gradient should provide added flexibility with respect to future re-assignment of repository functional requirements.

(7) POTENTIAL REPOSITORY INTEGRATION IMPACTS

- o Lost Emplacement Area
- o Ease of Security

The ramp alignment should minimize "lost" emplacement area associated with the buffer zone required where the ramp passes over potential emplacement areas. The portal location should facilitate protection against unauthorized entry to the area.

(8) ESF/REPOSITORY LOGISTICS

- Ease of Muck Disposal
- Ease of Providing Surface Utilities
- Surface Travel Distance Between North and South Portals

The distance and terrain over which muck exiting the portal must be transported, prior to disposal, will impact both construction and operating costs. If the portal and the muckpile are in close proximity, less conveying/truck haulage equipment is required and lower power and maintenance costs may result.

Surface utilities (electrical power, water, communications, etc.) must be extended to the site. The cost of providing these facilities is directly related to the distance from existing utilities and the terrain over which the new facilities must be constructed.

Once the evaluation features had been identified, the team members were asked to assign weighting factor values to each of the features. Table

1 shows the approach used in assigning the weighting factor values based on a classification of the importance of each feature.

TABLE 1

APPROACH USED IN ASSIGNING WEIGHTING FACTORS

Classification of Feature	Value
Important	
Extremely Important	10
Very Important	9
Important	8
Significant	
Very Significant	7
Significant	6
Less Significant	5
Considered	
Worth Consideration	4
Worth Moderate Consideration	3
Worth Minor Consideration	2
Insignificant	1

Table 2 shows each of the engineering features and the corresponding weighting factor value determined by group consensus.

TABLE 2

WEIGHTING FACTOR VALUES FOR ENGINEERING FEATURES

EVALUATION FEATURE	WEIGHTING FACTOR VALUE
Portal Access Road Construction	7
Portal Pad/Highwall Construction	8
Portal Construction	7
Ramp Construction	10
Ramp Length	9
Ramp Gradient	8
Repository Integration Impacts	6
ESF/Repository Logistics	8

9.4.2 SCORING RESULTS

The next step in the evaluation process consisted of rating each of the candidate portal sites against each of the evaluation features. A pre-scoring briefing was held to familiarize the scorers with the evaluation features and scoring guidelines. Other information including maps, facilities layouts, geologic sections, and reports were made available to facilitate the scoring effort. The scorers briefing meeting is documented in References 6.16 and 6.17. Table 3 shows the guidelines used in rating the alternatives. The scoresheets are included in Appendix B.

TABLE 3

RATING GUIDELINES

Grade	Value
Excellent	5
Very Good	4
Good	3
Fair	2
Poor	1

The average score for each feature was multiplied by the weighting factor for that feature to obtain a weighted value or figure of merit. The sum of the weighted values for all eight features gives an overall figure of merit for that alternative. Table 4 shows the results of the engineering evaluation.

TABLE 4

SOUTH RAMP PORTAL SITING-ENGINEERING EVALUATION RESULTS

EVALUATION FACTOR	WEIGHTING FACTOR VALUE W	SITE 1-SOLITARIO *RATING V	SITE 1-SOLITARIO WTG. VAL. WV	SITE 2-GHOST DANCE *RATING V	SITE 2-GHOST DANCE WTG. VAL. WV	SITE 3-BOUNDARY RIDGE *RATING V	SITE 3-BOUNDARY RIDGE WTG. VAL. WV
1. PORTAL ACCESS ROAD CONSTRUCTION	7	1.00	7.00	3.75	26.25	3.50	24.50
2. PORTAL PAD/HIGHWALL CONSTRUCTION	8	2.00	16.00	3.25	26.00	3.25	26.00
3. PORTAL CONSTRUCTION	7	2.25	15.75	3.50	24.50	3.25	22.75
4. RAMP CONSTRUCTION	10	2.50	25.00	3.75	37.50	3.00	30.00
5. RAMP LENGTH	9	4.50	40.50	3.50	31.50	1.75	15.75
6. RAMP GRADIENT	8	3.00	24.00	3.75	30.00	5.00	40.00
7. REPOSITORY INTEGRATION IMPACTS	6	3.25	19.50	3.50	21.00	3.25	19.50
8. ESF/REPOSITORY LOGISTICS	8	2.00	16.00	3.25	26.00	4.00	32.00
WEIGHTED VALUE			163.75		222.75		210.50
WEIGHTED VALUE AS PERCENT OF TOTAL			27.43%		37.31%		35.26%

*RATING VALUE V=AVERAGE RATING

10.0 CONCLUSIONS

The results of this preliminary engineering evaluation indicate site 2, the Ghost Dance Site, is the preferred location for the South Ramp portal. Site 2 had the highest overall score, with a weighted value of 37.3 %. Site 3, the Boundary Ridge Site, scored nearly as high (35.3 %) and is ranked in second place. Site 1, the Solitario Canyon Site, received the lowest rating (27.4 %).

Site 2, the Ghost Dance Portal, was rated either first or second on all eight of the evaluation factors considered. It was found to be the most favorable site with respect to portal access, portal construction, portal pad/highwall construction (tied for first), ramp construction, and repository integration impacts. It was ranked second on the remaining three factors of ramp length, gradient, and ESF/repository logistics.

It should be noted that this is a preliminary analysis based on the limited information currently available. It is recommended that confirmatory information, particularly subsurface geologic data, be obtained prior to making a final decision on the location of the South Ramp Portal.

Also, it should be reiterated that the site coordinates listed in this analysis are intended to represent only the general portal location. Determination of the optimal location/elevation will involve trade-offs concerning construction of the portal access road, the portal and pad construction, and ramp length.

Raytheon Services Nevada

DESIGN ANALYSIS

Number: ST-MN-003 Rev: 2

WBS No. 1.2.6	PRINT NAME	SIGNATURE	TITLE	DATE
ORIGINATOR:	R. L. Coppage	R. L. Coppage	SR. Mining ENGR	8-9-91
CHECKER:	SAEED BONABIAN	Saeed Bonabian	Eng Tech Anal/Spec	8-9-91
APPROVAL - LDE:	Bruce Stanley	Bruce T. Stanley	Ld. Mining Eng.	8-9-91
APPROVAL - SCDM:	B.R. CHYTROWSKI	B.R. Chytrowski	SCDM	8-9-91
QA CONCURRENCE:	PAUL B. HALE	Paul B. Hale	Sr QA Specialist	8-9-91

SUBJECT: ESF ACCESS SHAFT

TITLE: OPTIONAL SHAFT SITING ANALYSIS

QAG Reference: RSN-GR-013, Rev.0

OPTIONAL SHAFT SITING ANALYSIS

1.0 PURPOSE: The purpose of this analysis is to support the Reference Conceptual Design by selecting a site for the collar of a vertical shaft, which may be required for the purpose of site characterization. This shaft will have utility in a future potential repository. The screening and scoring matrices produced in this analysis will be used as input to a comprehensive siting analysis incorporating input from several participant organizations. Revision 2 responds to review comments generated on June 3 through 5, 1991. Revision 2 responds to Technical Review Comments made in June 1991.

2.0 METHOD: The site selection analysis will be done in the following steps:

1. Review ESFDR to determine which requirements affect shaft siting, including site characterization testing requirements if available.
2. Review past siting studies and designs to determine what options may exist.
3. Prepare a preliminary screening plan map showing proposed shaft sites.

4. Elicit screening criteria/performance criteria from experienced engineers in RSN.
5. Evaluate all sites for conformance to screening criteria, reject any options not conforming.
6. Elicit scoring criteria and weighting factors from a group of experienced engineers.
7. A group of engineers, not having participated in the criteria and weighting factors development, shall score the options using the criteria provided.

3.0 DESIGN INPUT:

3.1 The following ESFDR Sections are shaft siting criteria: YMP/CC-0013, Rev. 0 dated 05/31/91

1.2.6.0	Constraint C.(3)
1.2.6.0	PC 2D
1.2.6.1	Constraint A.
1.2.6.1	Assumpt. 1
1.2.6.4	F.R. 1
1.2.6.4	P.C. 1.A (iii)
1.2.6.4	P.C. 1.d (xii)
1.2.6.4	P.C. 2b (i)
1.2.6.4	P.C. 2d (iii)
1.2.6.4	P.C. 2e (ii)
1.2.6.4	P.C. 2h (ii)
1.2.6.4.1	Constraint B.

3.2 Topographic Maps - Transmitted from C. E. Ezra (EG&G) to Bruce Stanley (RSN), dated 2-1-91.

3.3 Flood Prone Areas - Transmitted from S. Rohde (EG&G) to Bruce Stanley (RSN), dated 3-5-91.

3.4 Ortho Photos - Transmitted from S. Rohde (EG&G) to Bruce Stanley (RSN), dated 3-5-91.

4.0 CODES AND STANDARDS: None Used.

5.0 ASSUMPTIONS: None of the following assumptions require verification.

5.1 The shaft, if requested/required, for site characterization purposes, will be used as an emplacement exhaust shaft should the site be selected for repository development.

5.2 The shaft candidate sites should properly belong at the north end of the future repository block and near or on the Designated Test Area. The north location may better fulfill the site characterization function of the shaft (if required).

5.3 The alternative sites outside the repository are available or can be made available for development.

5.4 All Design Input will be included in an approved Basis for Design.

These assumptions will allow the evaluating team to focus on the implications and ramifications of alternative locations for the ESF Scientific/Repository shaft. All the above assumptions 5.1, 5.2, 5.3, 5.4 support various parts of the Analysis, however no specific pages or Sections can be cited.

6.0 REFERENCE MATERIAL

6.1 DOE letter to Bullock from Gertz, 3-29-91 RSED:JTS-2834, Regarding: Preliminary Siting Analysis Report to Support Exploratory Studies Facility Reference Conceptual Design.

6.2 PBQ&D letter 4-5-91, B.W. Lawrence to R.L. Bullock, RSN, regarding: Response to RSN letter FS-YMP-5195.

6.3 SNL letter 4-8-91, T.E. Blejwas to R.L. Bullock, RSN, regarding: Evaluation of Portal and Shaft Siting Requirements.

6.4 LANL letter 4-5-91, N. Elkins to R.L. Bullock, RSN, regarding: Provision of Input South Ramp Portal and Optional Shaft Collar Siting Requirements.

6.5 Letter from T. Petrie to R.L. Bullock originated by E.M. Cikanek RSW:EMC:dl 0055 4-11-91, regarding: Response to Siting Requirements.

6.6 FSN-AS-430, Rev-2 ESF Alternative Study Data (Option #30).

6.7 Title I Rev. C FS-GA-0194 G.A. shows location ES-2.

6.8 Preliminary Draft Report on the Assessment of Existing Geophysical Data and Geologic Cross Sections to Support a Siting Analysis Report for the ESF, SAIC, 05-10-91.

6.9 Preliminary Engineering Reconnaissance Report for proposed shaft locations YMP ESF US DOE Bureau of Reclamation 5-10-91.

6.10 U.S. Geological survey - 30 x 60 minute quadrangle of Beatty Nevada - California. 1:100,000 scale.

7.0 COMPUTER PROGRAMS: NONE

8.0 UNITS: Standard English

9.0 ANALYSIS:

9.1 INTRODUCTION

The process of proposing a site for a scientific shaft, is described and then executed below. The purpose of the shaft will be to support or augment site characterization efforts during the site evaluation period. The secondary consideration for the shaft siting is that the scientific shaft would serve as an emplacement exhaust shaft for a potential repository. A numerical analysis was used as a structured decision-making process that could be well documented. This report describes the engineering evaluation process and the conclusions reached by an evaluation team.

9.2 SCOPE AND OBJECTIVE

The scope of this task is to site options, examine, and evaluate the options, and recommend a location for the Scientific/Emplacement Exhaust Shaft.

The objective is to arrive at a preferred concept location for the Scientific/Emplacement Exhaust Shaft.

9.3 APPROACH

Before beginning the analysis, it is necessary to arrive at alternatives to compare. (Proposed shaft locations are presented in Figure 1.) See Sec. 9.4 for a description of the proposed sites.

A numerical analysis was used to evaluate several alternative locations for the Scientific/Emplacement Shaft. In this evaluation method, features desired or needed are first selected. Then these are classified as to their importance, effectively assigning a weighting value to each aspect. Each case is examined on the basis of these features, and the degree to which it satisfies each aspect is rated.

For each feature of each case, the product of the weighting factor and the rating gives it a value.

Summing the values of all aspects of each case then permits a numerical comparison among cases. In the absence of any overriding consideration, the case with the highest score is preferred. See the results and scoring sheets in the appendix.

9.4 DESCRIPTION OF ALTERNATIVE SHAFT SITES

Refer to Figure 1 for the proposed shaft locations. These locations were initially proposed after considering past shaft siting proposals. The descriptions and reasons for initially proposing the five sites are as follows:

Site # 1. This site is approximately the location proposed for the Emplacement Exhaust Shaft presented in the configuration for Alternative Studies Option No. 30. FSN-AS-430 Rev. 2. This site was chosen to demonstrate acknowledgement of the Alternative Studies arrangements.

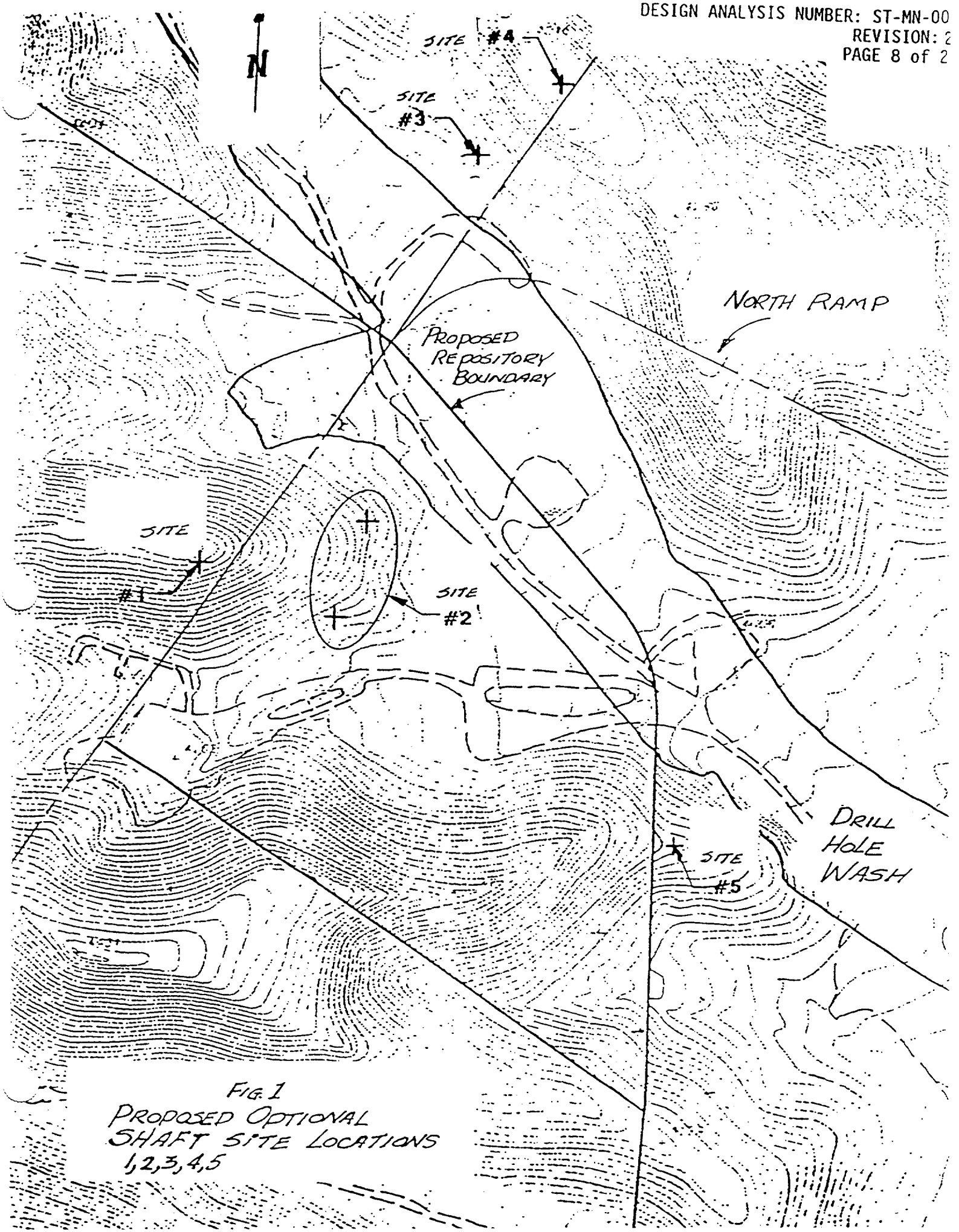


FIG. 1
PROPOSED OPTIONAL SHAFT SITE LOCATIONS 1,2,3,4,5

Site # 2. This location is approximately the ES-2 location from Title I engineering. (Ref. 6.10, p 5 of 17). The final location would be designed not to interfere with planned MTL test areas. This site was chosen because it fits well with surface construction needs and would provide a relatively short shaft.

Site # 3. This location was evaluated and scored as part of a repository men and materials shaft siting analysis. The site should be evaluated as a location for an Emplacement Exhaust and Site Characterization Access because of its several favorable aspects. Obviously this site was chosen to acknowledge the secondary (future) repository usefulness of the shaft.

Site # 4. This location was evaluated and scored as part of a repository men and materials shaft siting analysis. The site should be evaluated as a location for an Emplacement Exhaust and Site Characterization Access because of its several favorable aspects. See #3 above.

Site # 5. This location was proposed as an Exhaust Emplacement Shaft Location for an early repository configuration. This location may have significant merit in the ESF when evaluated as a site characterization data access entry.

9.5 CRITERIA: Two Types of criteria will be considered.

9.5.1 The First type will be used for Preliminary screening and is categorized as requirements.

The engineer participants have presented this type of criteria for the initial screening; the criteria is as follows:

1. The shaft collar area shall be located and/or graded to prevent water inflow to the underground facilities during the probable maximum flood. [ESFDR:Section 1.2.6.1 : PC-1b, A-1; Section 1.2.6.4 : PC-2e(i)(ii)]
2. The collar shall be founded in rock. [ESFDR:Section 1.2.6.4.1 : C-B]
3. The collar location must provide for the incorporation of the shaft into the future repository. The shaft shall be located, to the extent practicable, where a shaft is planned for the repository facility. [ESFDR:Section 1.2.6.0 : FR-2, C-c(3); ESFDR:Section 1.2.6.4 : FR-2, PC-2b(i), ICR-1]

4. The collar location must be compatible with the requirement that rock excavated from the underground facilities can be deposited at a location on the surface that is not visible from U.S. Highway 95.

5. The location of accesses relative to each other shall be such that testing in one access will not be adversely affected by activities in the other. [ESFDR:Section 1.2.6.4 : PC-1d(xii)]

The following is a brief assessment as to how the five (5) proposed sites meet the screening criteria.

1. The location map p. 8of 21 (Fig. 1) shows that all sites are located out of the flood plane.
2. Refer to ref. 6.9 for evidence that the collar can be founded in rock with reasonable effort.
3. Locations 1, 3, 4, and 5 are now, or have been in the past, sits considered to be favorable for the location of an emplacement exhaust shaft. Location number two (2) could be connected to the future repository main or perimeter drift system with relatively short drifts.

4. An examination of Ref. document 6.10 indicates that excavated material can be deposited near each proposed site out of sight from U.S. Highway 95.

5. Each of the proposed sites is more than 50 feet from any proposed test underground opening.

9.5.2 The second type of criteria is "Important Considerations." These criteria will be used to evaluate shaft candidate sites which have passed the initial requirements screening. These are engineering considerations:

1. Relative ease of construction of a collar access road, factors considered would be:
   - Length of new road
   - Topography

2. Relative ease of shaft site pad construction, factors considered would be:
   - Topography
   - Geology
     - Cut and fill requirements
     - Rock compressive strength

3. Relative ease of shaft collar construction, factors considered would be:
   - Geological conditions
     - Depth to bedrock
     - Fracture characteristics
     - Rock compressive strength

4. Shaft geology, factors considered would be:
   - Fracture characteristics
   - Rock strength - stratigraphy
   - Proximity to known fault zones

5. Potential Repository Integration Impacts:
   - Lost emplacement area
   - Potential repository utility
   - Flexibility of function
   - Degree of security

6. ESF/Repository Logistics:
   - Muck disposal
   - Surface utility construction
   - Surface convenience to operational centers

7. Shaft Depth:
   - Construction Cost and Schedule
   - ESF/Repository Operating Costs
8. Testing Related Criteria:
   - Relationship of site to other testing activity.
   - Convenience of access and IDS activity in support of testing.

9.6 Definitions of "Important Considerations"

1. Relative ease of a collar access road:
   Some options are located on the tops of steep hills, some are located in washes. The weighting and scoring must evaluate this item with respect to other important considerations and then determine the relative difficulty of providing road access to each site option.

2. Relative ease of shaft site construction:
   Some options are located where alluvium and flat space is abundant; some are located where relatively little level space and alluvium exists. The weighting and scoring must evaluate

the relative ease to construct a 400 ft. by 250 ft. level pad at each of the option sites.

3. Relative ease of shaft collar construction:
Each option should be evaluated on the basis of the degree of difficulty to construct a structurally stable shaft collar considering all applicable requirements.

4. Shaft geology:
Each option should be evaluated on the expected construction and ground support requirements considering geological factors.

5. Potential Repository Integration Impacts:
Each option should be evaluated on the relative basis of how well the option location supports the shaft repository function, i.e. emplacement exhaust and on the relative degree to which the location of the shaft might reduce the repository useable area.

6. ESF/Repository Logistics:

Each option should be evaluated on the basis of the relative degree to which it can be conveniently and effectively supported by the infrastructure of roads, utilities, and muck disposal areas.

7. Shaft Depth:

Each option should be evaluated on the basis of the relative cost of construction and operation differential attributable to its depth, which in turn is related to the collar site.

10. CONCLUSIONS AND RECOMMENDATIONS

The results of the evaluation process indicate site number 2 for the location of the Site Characterization/Emplacement Exhaust Shaft is preferred. Scoring results are represented in Appendix A.

The choice of Shaft location Alternative 2 places the Site Characterization/Emplacement Exhaust Shaft away from the vicinity of faults and the flood plain. This location requires further evaluation with respect to its future repository utility.

It is recommended that more data on the character and quality of the specific locations be obtained before or during Title II Design. These data, especially the location of geologic structures, may affect the results of this study, confirming them or indicating a need to reevaluate them. In the interim, it is recommended that the preferred shaft location #2 be used to support the Reference Conceptual Design.

OPTIONAL SHAFT SITING-ENGINEERING EVALUATION RESULTS

EVALUATION FEATURE	WEIGHTING FACTOR VALUE W	SITE 1-ABOVE COYOTE WASH *RATING V	SITE 1-ABOVE COYOTE WASH WTG. VAL. WV	SITE 2-ES-2 VICINITY *RATING V	SITE 2-ES-2 VICINITY WTG. VAL. WV	SITE 3-D. H. WASH *RATING V	SITE 3-D. H. WASH WTG. VAL. WV	SITE 4-ABOVE D. H. WASH *RATING V	SITE 4-ABOVE D. H. WASH WTG. VAL. WV	SITE 5-EAST EDGE ESF BLOCK *RATING V	SITE 5-EAST EDGE ESF BLOCK WTG. VAL. WV
1. COLLAR ACCESS ROAD CONSTRUCTION	8	2.50	20.00	4.00	32.00	3.00	24.00	1.75	14.00	2.75	22.00
2. SHAFT SITE PAD CONSTRUCTION	8	2.75	22.00	3.75	30.00	2.75	22.00	2.50	20.00	2.75	22.00
3. COLLAR CONSTRUCTION	6	3.50	21.00	3.50	21.00	3.50	21.00	3.25	19.50	3.00	18.00
4. SHAFT GEOLOGY	10	2.75	27.50	3.50	35.00	3.00	30.00	2.50	25.00	2.75	27.50
5. REPOSITORY INTEGRATION IMPACTS	9	2.25	20.25	2.50	22.50	3.00	27.00	2.75	24.75	3.25	29.25
6. ESF/REPOSITORY LOGISTICS	7	2.50	17.50	3.50	24.50	3.25	22.75	3.00	21.00	3.00	21.00
7. SHAFT DEPTH	5	2.25	11.25	3.00	15.00	3.50	17.50	2.75	13.75	3.00	15.00
WEIGHTED VALUE			139.50		180.00		164.25		138.00		154.75
WEIGHTED VALUE AS PERCENT OF TOTAL			17.97%		23.18%		21.15%		17.77%		19.93%

*RATING VALUE V=AVERAGE RATING

APPENDIX A

SCORER NAME: NICK B. TAMANDONG

DATE SCORED: APRIL 25, 1991

OPTIONAL SHAFT PORTAL SITING STUDY
ENGINEERING EVALUATION SCORESHEET

EVALUATION FEATURE	SITE 1-ABOVE COYOTE WASH					SITE 2-RS-2 VICINITY					SITE 3-DRILL HOLE WASH					SITE 4-ABOVE DRILL HOLE WASH					SITE 5-EAST EDGE OF ESF BLOCK				
	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1
1. COLLAR ACCESS ROAD CONSTRUCTION			3				4							2						1			3		
2. SHAFT SITE PAD CONSTRUCTION			3				4							2					2				3		
3. COLLAR CONSTRUCTION			3					3					3					3						2	
4. SHAFT GEOLOGY			3					3						2					2						1
5. REPOSITORY INTEGRATION IMPACTS				2				3						2					2					2	
6. ESF/REPOSITORY LOGISTICS				2			4							2					2				3		
7. SHAFT DEPTH				2				3					3						2				3		

SCORER NAME: ROMEO S. JURANI

DATE SCORED: 4/25/91

OPTIONAL SHAFT PORTAL SITING STUDY
ENGINEERING EVALUATION SCORESHEET

EVALUATION FACTORS	SITE 1-ABOVE COYOTE WASH					SITE 2-RS-2 VICINITY					SITE 3-DRILL HOLE WASH					SITE 4-ABOVE DRILL HOLE WASH					SITE 5-EAST SIDE OF ESF BLOCK				
	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1
1. COLLER ACCESS ROAD CONSTRUCTION			3				4						3						2				3		
2. SHAFT SITE PAD CONSTRUCTION			3				4						3						2				3		
3. COLLER CONSTRUCTION		4					4					4						3				4			
4. SHAFT GEOLOGY			3					3					3					3					3		
5. REPOSITORY INTERFERENCE IMPACTS				2						1		4						3				4			
6. ESF/REPOSITORY LOGISTICS				2						1		4					4						3		
7. SHAFT DEPTH				2				3				4						3					3		

SCORER NAME: MARK J. ESP

DATE SCORED: 4-26-91

OPTIONAL SHAFT PORTAL SITING STUDY
ENGINEERING EVALUATION SCORESHEET

EVALUATION FACTOR	SITE 1-ABOVE COYOTE WASH					SITE 2-ES-2 VICINITY					SITE 3-DRILL HOLE WASH					SITE 4-ABOVE DRILL HOLE WASH					SITE 5-EAST EDGE OF ESF BLOCK				
	EXCEL: 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL: 5	GOOD 4	AVG 3	FAIR 2	POOR 1
1. COLLIE ACCESS ROAD CONSTRUCTION			3			5						4						3					3		
2. SHAFT SITE PAD CONSTRUCTION				2			4					4						3						2	
3. COLLIE CONSTRUCTION		4					4					4					4						3		
4. SHAFT GEOLOGY			3				4					4						3					3		
5. REPOSITORY INTERACTION IMPACTS				2					2				3					3				4			
6. ESF/REPOSITORY LOGISTICS			3			5						4						3					3		
7. SHAFT DEPTH				2				3				4						3					3		

SCORER NAME: J. D. GRENIA

DATE SCORED: 4/28/91

OPTIONAL SHAFT PORTAL SITING STUDY
ENGINEERING EVALUATION SCORESHEET

EVALUATION FACTOR	SITE 1-ABOVE COYOTE WASH					SITE 2-BS-2 VICINITY					SITE 3-DRILL HOLE WASH					SITE 4-ABOVE DRILL HOLE WASH					SITE 5-EAST SIDE OF ESF BLOCK				
	EXCEL: 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL 5	GOOD 4	AVG 3	FAIR 2	POOR 1	EXCEL: 5	GOOD 4	AVG 3	FAIR 2	POOR 1
1. COLLER ACCESS ROAD CONSTRUCTION					1			3					3							1				2	
2. SHAFT SITE PAD CONSTRUCTION			3					3						2				3					3		
3. COLLER CONSTRUCTION			3					3					3					3					3		
4. SHAFT GEOLOGY				2			4							2					2			4			
5. REPOSITORY INTEGRATION IMPACTS			3				4						3					3					3		
6. ESF/REPOSITORY LOGISTICS			3				4						3					3					3		
7. SHAFT DEPTH			3					3					3					3					3		

PRELIMINARY SITING ANALYSIS

DESIGN ANALYSIS No. ST-MN-004

REV. 2

WBS No. 1.2.6

JULY 31, 1991

RAYTHEON SERVICES NEVADA

Raytheon Services Nevada	DESIGN ANALYSIS Number: ST-MN-004 Rev: 2 Page 1 of 64

WBS No. 1.2.6	PRINT NAME	SIGNATURE	TITLE	DATE
ORIGINATOR:	W.R. Kennedy	W.R. Kennedy	Sr. Mining Engr.	7-31-9
CHECKER:	SAEED BONABIAN	Saeed Bonabian	Eng Tech Anal/Spec	8-1-9
APPROVAL - LDE:	Bruce Stanley	Bruce T. Stanley	Lead Mining Eng.	8-1-91
APPROVAL - SCDM:	B.R. Chytrowski	B.R. Chytrowski	SCDM	8-6-9
QA CONCURRENCE:	PAUL B. HALE	Paul B Hale	SR QA Specialist	8-6-91

SUBJECT: Siting Report for North Ramp, South Ramp, and Optional Shaft

TITLE: Preliminary Siting Analysis

QAG Reference: RSN-GR-013, Rev. 0

1.0 PURPOSE

Refer to Section 1.2 of the report.
Revision 1 incorporates the Management Review comments.
Revision 2 incorporates the Technical Review comments.

2.0 METHOD

Refer to Section 1.3 of the report.

3.0 ANALYSIS INPUTS

3.1 YMP/CC-0013 (ESFDR), Rev. May 31, 1991

Section 1.2.6.0: FR-2, PC-1d, PC-2d, C-C(3), C-I
Section 1.2.6.1: PC-1b, C-A, A #1
Section 1.2.6.4: FR-1, PC-1a(iii), PC-1d(xii), PC-2b(i), PC-2d(iii), PC-2e(ii), PC-2h(ii)
Section 1.2.6.4.1: C-B

Section 1.2.6.5: FR-1, FR-2, PC-1a, PC-1d(xii), PC-1f(v), PC-2a(i), PC-2b(i), PC-2d(iii), PC-2e(i), PC-2e(ii), ICR-1

Section 1.2.6.5.1: C-B

Appendix A.1: Item #2

3.2 Topographic Maps, Transmittal from C. E. Ezra (EG&G) to Bruce Stanley (RSN), dated February 1, 1991

3.3 Flood Prone Areas, Transmittal from S. Rohde (EG&G) to Bruce Stanley (RSN), dated March 5, 1991

3.4 Ortho Photos, Transmittal from S. Rohde (EG&G) to Bruce Stanley (RSN), dated March 5. 1991

4.0 CODES AND STANDARDS

No codes or standards were identified which specifically apply to locating shafts or ramps.

5.0 ASSUMPTIONS

5.1 Coordinates and elevation of the point of intersection (PI) of TS South Access Ramp and repository main entry are assumed as follows: (See Reference 6.5) This assumption used on Figures 1

and 3 in Appendix A.

North 757909.18

East 557583.91

Elevation 3785.14 Ft

5.2 The primary functions of the TS South Access Ramp during the site characterization phase are assumed to be: (Assumption used on page 14)

- o muck transport
- o ventilation exhaust
- o emergency egress
- o limited testing

5.3 The primary functions of the TS South Ramp during the repository operations phase are assumed to be: (Assumption used on page 14)

- o muck transport
- o development ventilation exhaust
- o emergency egress

5.4 It is assumed that the South Ramp will be constructed from the surface down to TS level using a 25 ft diameter tunnel boring machine (TBM). (Assumption used on page 14)

5.5 Size of the South Ramp portal pad is assumed to be approximately 390 ft x 600 ft. (Assumption used on Figure 1 in Appendix A)

5.6 It is assumed that all analysis inputs cited in Section 3 will be included in the Basis for Design (BFD).

6.0 REFERENCE MATERIAL

Refer to Section 6.0 of the report.

7.0 COMPUTER PROGRAMS: NA

8.0 UNITS

English units are used.

9.0 ANALYSIS

The Preliminary Siting Analysis is documented on pages 7 of 63 through 63 of 63 and includes Appendix A.

10. CONCLUSIONS

Refer to Section 5 of the report.

TABLE OF CONTENTS

			PAGE
1.0		INTRODUCTION AND SUMMARY	7
	1.1	BACKGROUND	8
	1.2	PURPOSE AND SCOPE	8
	1.3	APPROACH	8
	1.4	SUMMARY	9
2.0		NORTH ACCESS RAMP	11
	2.1	INTRODUCTION	11
	2.2	BASIS FOR THE REFERENCE LOCATION	12
	2.3	RAMP PORTAL/WASTE FACILITY RELATIONSHIP	12
	2.4	REVIEW OF ESFDR	13
	2.5	SUBSEQUENT INVESTIGATION	13
3.0		SOUTH ACCESS RAMP	15
	3.1	PORTAL SITE SCREENING REQUIREMENTS	15
	3.2	DESCRIPTION OF CANDIDATE PORTAL SITES	17
		3.2.1 SITE No. 1 - SOLITARIO CANYON PORTAL	18
		3.2.2 SITE No. 2 - GHOST DANCE PORTAL	19
		3.2.3 SITE No. 3 - BOUNDARY RIDGE PORTAL	20
	3.3	EVALUATION OF ALTERNATIVES	21
		3.3.1 ENGINEERING EVALUATION	22
		3.3.2 PERFORMANCE ASSESSMENT EVALUATION	26
		3.3.3 UNDERGROUND TESTING EVALUATION	28
		3.3.4 SURFACE-BASED TESTING EVALUATION	30
		3.3.5 COMBINED SCORING RESULTS	32
		3.3.6 SENSITIVITY ANALYSIS	34
4.0		OPTIONAL ESF SHAFT	39
	4.1	COLLAR SITE SCREENING REQUIREMENTS	39
	4.2	DESCRIPTION OF ALTERNATIVE SHAFT SITES	40
	4.3	EVALUATION OF ALTERNATIVES	42
		4.3.1 ENGINEERING EVALUATION	43
		4.3.2 PERFORMANCE ASSESSMENT EVALUATION	47
		4.3.3 UNDERGROUND TESTING EVALUATION	49
		4.3.4 SURFACE-BASED TESTING EVALUATION	51
		4.3.5 COMBINED SCORING RESULTS	53
		4.3.6 SENSITIVITY ANALYSIS	55
5.0		CONCLUSIONS AND RECOMMENDATIONS	60
6.0		REFERENCES	62

LIST OF TABLES AND FIGURES

TABLES

		PAGE
TABLE 1	SOUTH RAMP PORTAL SITING-ENGINEERING EVALUATION RESULTS	25
TABLE 2	SOUTH RAMP PORTAL SITING-PERFORMANCE ASSESSMENT EVALUATION RESULTS	27
TABLE 3	SOUTH RAMP PORTAL SITING-UNDERGROUND TESTING EVALUATION RESULTS	29
TABLE 4	SOUTH RAMP PORTAL SITING-SURFACE-BASED TESTING EVALUATION RESULTS	31
TABLE 5	SOUTH RAMP PORTAL SITING-COMBINED EVALUATION RESULTS	33
TABLE 6	SOUTH RAMP PORTAL SITING-COMBINED EVALUATION RESULTS -SENSITIVITY ANALYSIS-CASE 1	35
TABLE 7	SOUTH RAMP PORTAL SITING-COMBINED EVALUATION RESULTS -SENSITIVITY ANALYSIS-CASE 2	36
TABLE 8	SOUTH RAMP PORTAL SITING-COMBINED EVALUATION RESULTS -SENSITIVITY ANALYSIS-CASE 3	37
TABLE 9	SOUTH RAMP PORTAL SITING-COMBINED EVALUATION RESULTS -SENSITIVITY ANALYSIS-CASE 4	38
TABLE 10	OPTIONAL SHAFT SITING-ENGINEERING EVALUATION RESULTS	46
TABLE 11	OPTIONAL SHAFT SITING-PERFORMANCE ASSESSMENT EVALUATION RESULTS	48
TABLE 12	OPTIONAL SHAFT SITING-UNDERGROUND TESTING EVALUATION RESULTS	50
TABLE 13	OPTIONAL SHAFT SITING-SURFACE-BASED TESTING EVALUATION RESULTS	52
TABLE 14	OPTIONAL SHAFT SITING-COMBINED EVALUATION RESULTS	54
TABLE 15	OPTIONAL SHAFT SITING-COMBINED EVALUATION RESULTS - SENSITIVITY ANALYSIS-CASE 1	56
TABLE 16	OPTIONAL SHAFT SITING-COMBINED EVALUATION RESULTS - SENSITIVITY ANALYSIS-CASE 2	57
TABLE 17	OPTIONAL SHAFT SITING-COMBINED EVALUATION RESULTS - SENSITIVITY ANALYSIS-CASE 3	58
TABLE 18	OPTIONAL SHAFT SITING-COMBINED EVALUATION RESULTS - SENSITIVITY ANALYSIS-CASE 4	59

FIGURES

FIGURE 1	LAYOUT OF SOUTH RAMP ALTERNATIVE LOCATIONS	Appendix A
FIGURE 2	LAYOUT OF NORTH ACCESS RAMP AND ALTERNATIVE SHAFT LOCATIONS	Appendix A
FIGURE 3	LOCATION OF ACCESS ALTERNATIVES	Appendix A

1.0 INTRODUCTION AND SUMMARY

1.1 BACKGROUND

The ESF Alternatives Study formally evaluated 34 ESF/repository configuration options against a wide range of criteria (Reference 6.1). The 34 options displayed various key features, including type and location of accesses to the underground facilities. The analysis resulted in the ranking of the 34 options according to their performance in achieving predetermined objectives, as estimated by panels of experts. The top ranked option, #30, would provide access to the subsurface facilities via two ramps.

Based on the findings of the ESF Alternatives Study, a DOE decision was made to proceed with ESF design activities, with option #30 forming the basis for configuration of the ESF (Reference 6.2). As part of the early design efforts, DOE directed the Design Organization (RSN) to conduct a preliminary ESF access siting analysis, with technical support from other project participants (Reference 6.3). This siting analysis would include as part of the design basis enhancements to option #30. Among those enhancements, is the requirement to design an optional ESF shaft, which may be needed to support the acquisition of scientific information above the Topopah Spring horizon. The construction of this shaft will be deferred until it is required.

1.2 PURPOSE AND SCOPE

The purpose of this preliminary siting analysis is to determine the approximate locations of the north and south ramp portals and the optional shaft collar. The recommended locations will be used to support the development of general arrangement drawings and will also provide a basis for location of environmental monitoring equipment. The recommendation in this report will provide approximate locations (ie. general area) for the ramps and shaft. The exact final locations may differ. This report is based on preliminary information and will be updated to include the results of future subsurface geological investigations, when those results are available.

1.3 APPROACH

Comparative analyses were performed to evaluate alternative sites for the south ramp portal and optional shaft collar. Screening criteria were defined and portal/collar sites were identified which met the criteria. Four independent evaluations were performed by the project participants responsible for engineering, performance assessment, underground testing, and surface-based testing. The results from the four evaluations were then combined to provide an overall rating for each of the candidate sites. Alternative sites are ranked based on these combined overall ratings. A sensitivity analysis was performed

using alternate values for the relative importance (weights) of the four perspectives being considered.

A previous study addressing the siting of the waste handling facilities included the waste ramp portal (Reference 6.4). Therefore, the approach taken for siting the north ramp consisted of conducting a review of this previous work to ensure the validity of the results with respect to current design requirements. In addition, the review was supplemented by a surface geological engineering investigation.

1.4 SUMMARY

It is concluded from this study that the portal site on the east side of Exile Hill, ie. the reference Site Characterization Plan (SCP) Conceptual Design Report (CDR) location, is the optimum location for the ESF north ramp portal. The process that led to this conclusion is described in Section 2.

Three alternative sites for the south ramp portal were considered. Based on the results of this evaluation, the east side of Boundary Ridge is the preferred location. The results of the south ramp siting analysis are presented in Section 3.

Five alternative sites for the optional shaft collar were considered. Combined evaluation results indicate a slight preference for Site #2, which is in the vicinity of Coyote Wash, well above the flood plain. The siting analysis for the optional ESF shaft is documented in Section 4.

More detailed conclusions and recommendations are presented in Section 5. A list of references is included in Section 6.

2.0 NORTH ACCESS RAMP

2.1 INTRODUCTION

The ESF north access ramp portal siting evaluation was basically a confirmation of the suitability of the reference design location presented in the Site Characterization Plan (SCP) Conceptual Design Report (CDR). This location is on the east side of Exile Hill at approximate map co-ordinates N 765251, E 570034 (see Figure 2). The approach taken in the North Ramp Siting Analysis (Reference 6.6) was: (1) to review the site selection process for the surface waste handling facility in the conceptual design; (2) to develop the connection between the Waste Ramp portal and the surface waste handling facility; (3) to review the Exploratory Studies Facilities (ESFDR) and the latest site information to confirm that the SCP CDR portal site remains the optimum choice in terms of compliance with program objectives and good site engineering practice; and (4) to review available geological and geophysical information and assess portal location suitability from site characterization and performance assessment perspectives.

2.2 BASIS FOR THE REFERENCE LOCATION

SAND84-2015 (Reference 6.4) describes the process that was used to numerically evaluate and select the reference site from a group of eight candidate sites located on the east side of Yucca Mountain. That analysis, using screening criteria developed to assure compliance with the applicable parts of all governing codes and regulations, indicated that the site on the east flank of Exile Hill should be used for the purposes of the SCP CDR. SAND84 -2015 presents an objective selection process based upon the best available scientific and engineering input information.

2.3 RAMP PORTAL/WASTE HANDLING FACILITY RELATIONSHIP

Subsequent to the selection of a site for the waste handling facilities, the repository conceptual design was developed. The conceptual general arrangements indicated the desirability of having the waste ramp portal be an integral part of the waste processing and handling facility complex. That decision was made to optimize operational safety and efficiency.

2.4 REVIEW OF ESFDR

The sections in the ESFDR applicable to ramp design were reviewed to identify requirements related to locating the north ramp portal. From that review it is apparent that whenever possible, ESF openings should be developed at a location where a potential repository access is planned. This requirement argues strongly that the ESF north access ramp be located at the SCP-CDR location for the potential repository waste ramp. The review also indicated that the SCP CDR portal location meets all of the ESFDR requirements for locating ramps. The combination of future repository utility and compliance with the current ESFDR further indicates that the Exile Hill portal site is optimum.

2.5 SUBSEQUENT INVESTIGATION

In addition to the foregoing, the US Bureau of Reclamation recently conducted a surface geological engineering investigation (see Reference 6.12) to determine the suitability of the Exile Hill location for ramp construction. The results of the investigation indicate that the SCP-CDR location will allow portal and ramp construction without any apparent major difficulties. The geological engineering report and other relevant geological and geophysical information (see Reference 6.14) were reviewed by the testing evaluation panel. The opinion of that group was that the Exile Hill portal site/ramp alignment would have

no adverse effects on site characterization activities (see Reference 6.10).

The foregoing activity and subsequent information evaluation led to the conclusion that the Exile Hill location is the optimum location for the ESF north ramp portal at the present stage of the ESF design process. Future subsurface geological investigations have been scheduled for completion prior to final design activity that will provide a basis for confirmation or reconsideration of the Exile Hill portal location.

3.0 SOUTH ACCESS RAMP

The south access ramp will provide one of the primary means of access to the subsurface portion of the exploratory study facility (ESF). Primary functions to be accommodated during the site characterization phase include muck transport, ventilation exhaust, emergency egress, and limited testing. Potential repository functions to be accommodated include muck transport, development ventilation exhaust, and emergency egress. For the purpose of this study, it is assumed that the ramp will be constructed from the surface down to the Topopah Spring (TS) level using a 25 FT diameter tunnel boring machine (TBM).

3.1 PORTAL SITE SCREENING REQUIREMENTS

The initial step in the comparative evaluation of alternative south ramp portal sites was the development of basic requirements which could be used to screen potential candidate sites. A review of the ESFDR was conducted to identify potentially discriminating functional requirements, performance criteria, and constraints applicable to locating the TS South Ramp portal. Based upon the review, the following list of screening requirements was developed:

(1) The ramp portal area shall be located to prevent water inflow to the underground facilities during the probable maximum flood. [ESFDR:Section 1.2.6.1 : PC-1b, A-1; Section 1.2.6.5 : PC-2e(i)(ii)]

(2) The portal shall be founded in rock. [Section 1.2.6.5.1 : C-B]

(3) The portal location/ramp alignment must provide for the incorporation of the ramp into the future repository. The ramp shall be located, to the extent practicable, where a ramp is planned for the repository facility. [Section 1.2.6.0 : FR-2, C-(3); Section 1.2.6.5 : FR-2, PC-2b(i), ICR-1]

(4) The portal location must result in a ramp gradient which provides an acceptable slope suitable for excavation, safe vehicular traffic, and material handling equipment requirements. For the purpose of this analysis, the maximum allowable ramp gradient is set at 10%. [Section 1.2.6.5 : PC-1f(v)]

(5) The portal location must be compatible with the requirement that rock excavated from the underground facilities can be deposited at a location on the surface so that the muck pile is not visible from U.S. Highway 95. [Appendix A.2, Item 2]

(6) The location of accesses relative to each other shall be such that testing in one access will not be adversely affected by activities in the other. [Section 1.2.6.5 : PC-1d(xii)]

3.2 DESCRIPTION OF CANDIDATE PORTAL SITES

Currently available information was used to compile base maps which included topographic features, existing roads, the outline of the regional maximum flood area, the repository outline and the repository waste main alignment (See Figures 1 and 2, Appendix A). Information concerning the regional maximum flood did not extent to the west of Yucca Mountain, hence no flood outline is available for that area. A point of intersection (PI) for the ramp and the waste main was assumed which would minimize the loss of usable repository expansion area (Reference 6.5). This PI was common for all alternative south ramp portal sites.

Candidate portal sites meeting the screening requirements of Section 3.1 were identified and plotted on the base map. Each site was located well above the valley floor to prevent inundation during a flood. Thick alluvium was avoided to facilitate construction of the portal in rock. Portal sites/ramp alignments were located to ensure compatability with a potential repository. All three sites result in a ramp gradient of less than 10%. Muck piles were conceptually located to be hidden from the

view of travelers on US Highway 95. A separation distance of two or more miles between any of the candidate sites and the proposed North Ramp portal ensures that testing in one access will not adversely effect activities in the other. Engineering judgement was used to select the apparent best portal location wherever several potential sites existed in the same general area. This judgement was initially based on the information contained on the base map and was then confirmed by field visits to the candidate site areas.

The three candidate portal sites and corresponding ramp alignments which were identified are described in Sections 3.2.1 through 3.2.3. Refer to figures 1, 2, and 3 (Appendix A) for conceptual layouts of the south ramp alternatives.

3.2.1 SITE No. 1 - SOLITARIO CANYON PORTAL

The portal site is located west of Yucca Crest on a west facing, gently sloping (8-10%) hillside approximately 110 feet above the bottom of Solitario Canyon. Portal access could be provided by the construction or upgrading of approximately 16 miles of road around the south side of Busted Butte and Yucca Crest. Disposal of ESF and repository muck would require approximately 5 miles of overland conveyor to the muckpile located north of Black Cone. This portal site results in ramp which is approximately 3500 feet long (when measured to a repository entry point

common to all alternatives), driven on an azimuth of approximately 34°. The slope of the ramp would be approximately 9.0 %. The approximate coordinates and elevation of the portal are:

North 755670

East 556060

Elev.- 4030 ft

A discussion of engineering geology considerations as they apply to this site is presented in Reference 6.12. A geologic section along the proposed ramp alignment is included in Reference 6.14.

3.2.2 SITE No. 2 - GHOST DANCE PORTAL

The portal site is located on the nose of an east-west trending ridge on the eastern flank of Yucca Mountain. It is situated between Ghost Dance Wash and Abandoned Wash, and lies approximately 75 feet above Dune Wash. The natural slope of the site area is approximately 20%. Portal access could be provided by the construction of approximately 3000 feet of new road, extending from the existing Highway Ridge Road to the portal. Disposal of ESF and repository muck would require approximately 6500 feet of overland conveyor to the muckpile located near the north end of Bow Ridge. This portal site results in ramp which is approximately 5680 feet long (when measured to a repository entry point common to all

alternatives), driven on an azimuth of approximately 286°. The slope of the ramp would be approximately 6.8 %. The approximate coordinates and elevation of the portal are:

North 756430

East 562740

Elev.- 4150 ft

A discussion of engineering geology considerations as they apply to this site is presented in Reference 6.12. Reference 6.14 includes a geologic section along the proposed ramp alignment.

3.2.3 SITE No. 3 - BOUNDARY RIDGE PORTAL

The portal site is located on the east side of Boundary Ridge approximately 150 feet above the floor of the valley that lies between Boundary Ridge and the north end of Bow Ridge. The natural slope of the site area is approximately 5%. Portal access could be provided by the construction and/or upgrading of approximately 7000 feet of road, extending from the existing Drill Hole Wash Road to the portal. Disposal of ESF and repository muck would require approximately 3000 feet of overland conveyor to the muckpile located near the north end of Bow Ridge. This portal site results in ramp which is approximately 9400 feet long (when measured to a repository entry point common to all

alternatives), driven on an azimuth of approximately 278°. The slope of the ramp would be approximately 1.8 %. The approximate coordinates and elevation of the portal are:

North 756640

East 566640

Elev.- 3950 ft

A discussion of engineering geology considerations as they apply to this site is presented in Reference 6.12. Reference 6.14 includes a geologic section along the proposed ramp alignment.

3.3 EVALUATION OF ALTERNATIVES

The evaluation of the alternative south ramp portal sites involved identification of evaluation factors, assignment of weighting values to each of the factors, and rating each of the alternatives with respect to each of the factors. This process was followed for each of the four independent evaluations addressing engineering, performance assessment, underground testing, and surface based testing considerations. The relative importance (weight) of the four perspectives being evaluated was then determined, and the scoring results combined to provide an overall weighted value for each candidate site. The results of these activities are summarized in the following sections.

3.3.1 ENGINEERING EVALUATION

Eight evaluation factors were identified and subsequently used as the basis for a comparative evaluation of the alternatives from an engineering perspective. A summary listing of those factors is shown below:

(1) EASE OF CONSTRUCTION OF PORTAL ACCESS ROAD

- o Length of New Road
- o Topographic Considerations

(2) EASE OF PORTAL PAD/HIGHWALL CONSTRUCTION

- o Topographic Considerations
- o Geologic Conditions
  - Depth to Bedrock
  - Fracturing (Spacing and Orientation)
  - Rock Strength

(3) EASE OF PORTAL CONSTRUCTION

- o Geologic Conditions

- Fracture Spacing (Faulting/Jointing)
- Fracture Orientation
- Rock Strength

(4) EASE OF RAMP CONSTRUCTION

o Geologic Conditions

- Fracture Spacing (Faulting/Jointing)
- Fracture Orientation
- Rock Strength
- Intersection With Major Faults

o Ramp Alignment Maintains Stable Rock Cove

(5) RAMP LENGTH

o Construction Cost/Schedule Impacts

o ESF and Repository Operating Cost Impacts

o Safety Impacts

(6) RAMP GRADIENT

- o Construction/Cost Schedule Impacts
- o Safety Impacts
- o Flexibility To Re-Assign Repository Functional Requirements

(7) POTENTIAL REPOSITORY INTEGRATION IMPACTS

- o Lost Emplacement Area
- o Ease of Security

(8) ESF/REPOSITORY LOGISTICS

- o Ease of Muck Disposal
- o Ease of Providing Surface Utilities
- o Surface Travel Distance Between North and South Portals

Table 1 shows the relative importance (weighting factor values) assigned to each factor, and presents the evaluation results. A detailed discussion of the engineering evaluation of the south ramp portal sites is included in Reference 6.7.

TABLE 1

SOUTH RAMP PORTAL SITING-ENGINEERING EVALUATION RESULTS

EVALUATION FACTOR	WEIGHTING FACTOR VALUE W	SITE 1-SOLITARIO *RATING V	SITE 1-SOLITARIO WTG. VAL. WV	SITE 2-GHOST DANCE *RATING V	SITE 2-GHOST DANCE WTG. VAL. WV	SITE 3-BOUNDARY RIDGE *RATING V	SITE 3-BOUNDARY RIDGE WTG. VAL. WV
1. PORTAL ACCESS ROAD CONSTRUCTION	7	1.00	7.00	3.75	26.25	3.50	24.50
2. PORTAL PAD/HIGHWALL CONSTRUCTION	8	2.00	16.00	3.25	26.00	3.25	26.00
3. PORTAL CONSTRUCTION	7	2.25	15.75	3.50	24.50	3.25	22.75
4. RAMP CONSTRUCTION	10	2.50	25.00	3.75	37.50	3.00	30.00
5. RAMP LENGTH	9	4.50	40.50	3.50	31.50	1.75	15.75
6. RAMP GRADIENT	8	3.00	24.00	3.75	30.00	5.00	40.00
7. REPOSITORY INTEGRATION IMPACTS	6	3.25	19.50	3.50	21.00	3.25	19.50
8. ESF/REPOSITORY LOGISTICS	8	2.00	16.00	3.25	26.00	4.00	32.00
WEIGHTED VALUE			163.75		222.75		210.50
WEIGHTED VALUE AS PERCENT OF TOTAL			27.43%		37.31%		35.26%

*RATING VALUE V=AVERAGE RATING

3.3.2 PERFORMANCE ASSESSMENT EVALUATION

Two discriminating criteria were used to evaluate the three south ramp locations and alignments from a performance assessment perspective. These criteria encompassed those factors most likely to compromise the ability of the site to isolate waste. The discriminating criteria were:

(1) Liquid Reaching the Repository Horizon: Includes those factors that may increase the amount of water entering the potential repository block and influence waste isolation and containment.

(2) Quantity of Gas Escaping from the Repository Horizon: Includes those factors that may increase vapor-phase transport to the accessible environment.

Table 2 shows the relative importance (weight) assigned to each factor, and presents the evaluation results. A detailed discussion of the performance assessment evaluation of the south ramp portal sites is included in Reference 6.9.

TABLE 2

SOUTH RAMP PORTAL SITING-PERFORMANCE ASSESSMENT EVALUATION RESULTS

DISCRIMINATOR	WEIGHT	SITE 1-SOLITARIO		SITE 2-GHOST DANCE		SITE 3-BOUNDARY RIDGE	
		*RATING	WTG. VAL.	*RATING	WTG. VAL.	*RATING	WTG. VAL.
	W	V	WV	V	WV	V	WV
1. LIQUID REACHING REPOSITORY HORIZON	0.7	4	2.8	3	2.1	3	2.1
2. GAS ESCAPING FROM REPOSITORY HORIZON	0.3	1	0.3	2	0.6	3	0.9
WEIGHTED VALUE			3.1		2.7		3.0
WEIGHTED VALUE AS PERCENT OF TOTAL			35.23%		30.68%		34.09%

*RATING VALUE V=AVERAGE RATING

3.3.3 UNDERGROUND TESTING EVALUATION

Three discriminating factors were used to evaluate the three south ramp locations and alignments from an underground testing perspective. The discriminating factors were:

(1) REPRESENTATIVENESS. Provides the best ability to characterize units representative of those overlying and including TSw in the block. Better = more representative units passed through; better = longer extent of horizontal and vertical look.

(2) COMPLEMENTARY INFORMATION. Provides information that is complementary to north ramp. Better = a second look at north ramp features; better = intercepts of unique features (not intercepted in north ramp).

(3) INTERFERENCE. Ability to locate tests so that introduced fluids are limited in possible interferences and migration toward the potential repository (up dip versus down dip). Better = low potential interferences between tests and construction; better = down dip test locations in relation to potential repository.

Table 3 shows the relative importance (weight) assigned to each factor, and presents the evaluation results. A detailed discussion of the underground testing evaluation of the south ramp portal sites is included in Reference 6.10.

TABLE 3

SOUTH RAMP PORTAL SITING-UNDERGROUND TESTING EVALUATION RESULTS

DISCRIMINATOR	WEIGHT	SITE 1-SOLITARIO		SITE 2-GHOST DANCE		SITE 3-BOUNDARY RIDGE	
		*RATING	WTG. VAL.	*RATING	WTG. VAL.	*RATING	WTG. VAL.
	W	V	WV	V	WV	V	WV
1. REPRESENTATIVENESS	0.5	1	0.5	3	1.5	5	2.5
2. COMPLEMENTARY INFORMATION	0.4	2	0.8	3	1.2	4	1.6
3. INTERFERENCE	0.1	3	0.3	3	0.3	4	0.4
WEIGHTED VALUE			1.6		3.0		4.5
WEIGHTED VALUE AS PERCENT OF TOTAL			17.58%		32.97%		49.45%

*RATING VALUE V=AVERAGE RATING

3.3.4 SURFACE-BASED TESTING EVALUATION

Three discriminating factors were used to evaluate the three south ramp locations and alignments from a surface-based testing perspective. The discriminating factors were:

(1) INTERFERENCE: Potential for interference with surface-based testing due to pad and ramp construction, and/or testing associated with the pad or ramp.

(2) COMPLEMENTARY INFORMATION: Potential for obtaining information/data complimentary to the surface-based testing program.

(3) MUCK PILE LOCATION: Potential for the ESF muck pile location/operation to interfere with surface-based testing.

Table 4 shows the relative importance (weight) assigned to each factor, and presents the evaluation results. A detailed discussion of the surface-based testing evaluation of the south ramp portal sites is included in Reference 6.11.

TABLE 4

SOUTH RAMP PORTAL SITING-SURFACE-BASED TESTING EVALUATION RESULTS

DISCRIMINATOR	WEIGHT	SITE 1-SOLITARIO		SITE 2-GHOST DANCE		SITE 3-BOUNDARY RIDGE	
		*RATING	WTG. VAL.	*RATING	WTG. VAL.	*RATING	WTG. VAL.
	W	V	WV	V	WV	V	WV
1. INTERFERENCE	0.55	2.00	1.10	3.00	1.65	3.33	1.83
2. COMPLEMENTARY INFORMATION	0.40	2.33	0.93	3.00	1.20	3.67	1.47
3. MUCK PILE LOCATION	0.05	3.00	0.15	3.00	0.15	3.00	0.15
WEIGHTED VALUE			2.18		3.00		3.45
WEIGHTED VALUE AS PERCENT OF TOTAL			25.28%		34.76%		39.96%

*RATING VALUE V=AVERAGE RATING

3.3.5 COMBINED SCORING RESULTS

The relative importance (weight) of the four perspectives being evaluated, ie. engineering, performance assessment, underground and surface-based testing, was determined (Reference 6.15). The rating values for the candidate sites determined by each independent evaluation were normalized (sum of rating values for all three sites = 1.00 for a given evaluation perspective) and the scoring results combined to provide an overall weighted value for each of the candidate sites. Table 5 shows the weight assigned to each evaluation perspective, and presents the combined evaluation results.

TABLE 5

SOUTH RAMP PORTAL SITING-COMBINED EVALUATION RESULTS

EVALUATION CONSIDERATION	WEIGHTING FACTOR W	SITE 1-SOLITARIO CANYON RATING * V	SITE 1-SOLITARIO CANYON WTG. VAL. WV	SITE 2-GHOST DANCE RATING * V	SITE 2-GHOST DANCE WTG. VAL. WV	SITE 3-BOUNDARY RIDGE RATING * V	SITE 3-BOUNDARY RIDGE WTG. VAL. WV
ENGINEERING	0.25	0.274	0.06850	0.373	0.09325	0.353	0.08825
PERFORMANCE ASSESSMENT	0.35	0.352	0.12320	0.307	0.10745	0.341	0.11935
UNDERGROUND TESTING	0.35	0.176	0.06160	0.330	0.11550	0.494	0.17290
SURFACE BASED TESTING	0.05	0.253	0.01265	0.348	0.01740	0.400	0.02000
TOTAL WEIGHTED VALUE			0.26595		0.33360		0.40050

* V = WEIGHTED VALUES AS A PERCENT OF TOTAL, FROM TABLES 1 THROUGH 4

3.3.6 SENSITIVITY ANALYSIS

A sensitivity analysis was performed using alternate values for the relative importance (weighting factor) of the four perspectives being considered. Four cases of alternate weights were used, corresponding to the four sets of values which were considered along with the values eventually selected and recommended by group consensus (Reference 6.15). The combined evaluation results for the four sensitivity analysis cases are shown on Tables 6 through 9. As can be seen, the total weighted values for each site are virtually the same for the base case (ie. recommended values) and each of the sensitivity analysis cases, indicating the results are quite robust.

TABLE 6

SOUTH RAMP PORTAL SITING-COMBINED EVALUATION RESULTS

SENSITIVITY ANALYSIS-CASE 1

EVALUATION CONSIDERATION	WEIGHTING FACTOR W	SITE 1-SOLITARIO CANYON RATING * V	SITE 1-SOLITARIO CANYON WTG. VAL. WV	SITE 2-GHOST DANCE RATING * V	SITE 2-GHOST DANCE WTG. VAL. WV	SITE 3-BOUNDARY RIDGE RATING * V	SITE 3-BOUNDARY RIDGE WTG. VAL. WV
ENGINEERING	0.3	0.274	0.08220	0.373	0.11190	0.353	0.10590
PERFORMANCE ASSESSMENT	0.3	0.352	0.10560	0.307	0.09210	0.341	0.10230
UNDERGROUND TESTING	0.3	0.176	0.05280	0.330	0.09900	0.494	0.14820
SURFACE BASED TESTING	0.1	0.253	0.02530	0.348	0.03480	0.400	0.04000
TOTAL WEIGHTED VALUE			0.26590		0.33780		0.39640

* V = WEIGHTED VALUES AS A PERCENT OF TOTAL, FROM TABLES 1 THROUGH 4

TABLE 7

SOUTH RAMP PORTAL SITING-COMBINED EVALUATION RESULTS

SENSITIVITY ANALYSIS-CASE 2

EVALUATION CONSIDERATION	WEIGHTING FACTOR W	SITE 1-SOLITARIO CANYON RATING * V	SITE 1-SOLITARIO CANYON WTG. VAL. WV	SITE 2-GHOST DANCE RATING * V	SITE 2-GHOST DANCE WTG. VAL. WV	SITE 3-BOUNDARY RIDGE RATING * V	SITE 3-BOUNDARY RIDGE WTG. VAL. WV
ENGINEERING	0.20	0.274	0.05480	0.373	0.07460	0.353	0.07060
PERFORMANCE ASSESSMENT	0.35	0.352	0.12320	0.307	0.10745	0.341	0.11935
UNDERGROUND TESTING	0.35	0.176	0.06160	0.330	0.11550	0.494	0.17290
SURFACE BASED TESTING	0.10	0.253	0.02530	0.348	0.03480	0.400	0.04000
TOTAL WEIGHTED VALUE			0.26490		0.33235		0.40285

* V = WEIGHTED VALUES AS A PERCENT OF TOTAL, FROM TABLES 1 THROUGH 4

TABLE 8

SOUTH RAMP PORTAL SITING-COMBINED EVALUATION RESULTS

SENSITIVITY ANALYSIS-CASE 3

EVALUATION CONSIDERATION	WEIGHTING FACTOR W	SITE 1-SOLITARIO CANYON RATING * V	SITE 1-SOLITARIO CANYON WTG. VAL. WV	SITE 2-GHOST DANCE RATING * V	SITE 2-GHOST DANCE WTG. VAL. WV	SITE 3-BOUNDARY RIDGE RATING * V	SITE 3-BOUNDARY RIDGE WTG. VAL. WV
ENGINEERING	0.23	0.274	0.06302	0.373	0.08579	0.353	0.08119
PERFORMANCE ASSESSMENT	0.40	0.352	0.14080	0.307	0.12280	0.341	0.13640
UNDERGROUND TESTING	0.27	0.176	0.04752	0.330	0.08910	0.494	0.13338
SURFACE BASED TESTING	0.10	0.253	0.02530	0.348	0.03480	0.400	0.04000
TOTAL WEIGHTED VALUE			0.27664		0.33249		0.39097

* V = WEIGHTED VALUES AS A PERCENT OF TOTAL, FROM TABLES 1 THROUGH 4

TABLE 9

SOUTH RAMP PORTAL SITING-COMBINED EVALUATION RESULTS

SENSITIVITY ANALYSIS-CASE 4

EVALUATION CONSIDERATION	WEIGHTING FACTOR W	SITE 1-SOLITARIO CANYON RATING * V	SITE 1-SOLITARIO CANYON WTG. VAL. WV	SITE 2-GHOST DANCE RATING * V	SITE 2-GHOST DANCE WTG. VAL. WV	SITE 3-BOUNDARY RIDGE RATING * V	SITE 3-BOUNDARY RIDGE WTG. VAL. WV
ENGINEERING	0.20	0.274	0.05480	0.373	0.07460	0.353	0.07060
PERFORMANCE ASSESSMENT	0.35	0.352	0.12320	0.307	0.10745	0.341	0.11935
UNDERGROUND TESTING	0.40	0.176	0.07040	0.330	0.13200	0.494	0.19760
SURFACE BASED TESTING	0.05	0.253	0.01265	0.348	0.01740	0.400	0.02000
TOTAL WEIGHTED VALUE			0.26105		0.33145		0.40755

* V = WEIGHTED VALUES AS A PERCENT OF TOTAL, FROM TABLES 1 THROUGH 4

4.0 OPTIONAL ESF SHAFT

A vertical shaft may be constructed as part of the ESF, if it is required for the purpose of site characterization. The primary function of the shaft during the site characterization phase would be to support the planned testing activities. This shaft would also have utility in a future repository, and would most likely serve as a repository emplacement exhaust shaft.

4.1 COLLAR SITE SCREENING REQUIREMENTS

The initial step in the comparative evaluation of alternative shaft collar sites was the development of basic requirements which could be used to screen potential candidate sites. A review of the ESFDR was conducted to identify potentially discriminating functional requirements, performance criteria, and constraints applicable to locating the shaft collar. Based upon that review, the following list of screening requirements was developed:

(1) The shaft collar area shall be located to prevent water inflow to the underground facilities during the probable maximum flood. [ESFDR:Section 1.2.6.1 : PC-1b, A-1; Section 1.2.6.4 : PC-2e(i)(ii)]

(2) The collar shall be founded in rock. [Section 1.2.6.4.1 : C-B]

(3) The collar location must provide for the incorporation of the shaft into the future repository. The shaft shall be located, to the extent practicable, where a shaft is planned for the repository facility. [Section 1.2.6.0 : FR-2, C-c(3); Section 1.2.6.4 : FR-2, PC-2b(i), ICR-1]

(4) The collar location must be compatible with the requirement that rock excavated from the underground facilities can be deposited at a location on the surface so that the muck pile is not visible from U.S. Highway 95. [Appendix A.2, Item 2]

(5) The location of accesses relative to each other shall be such that testing in one access will not be adversely affected by activities in the other. [Section 1.2.6.4 : PC-1d(xii)]

4.2 DESCRIPTION OF ALTERNATIVE SHAFT SITES

Five alternative locations were identified for the optional shaft collar after reviewing past shaft siting proposals. All these sites meet the screening requirements. Each site was located well above the valley floor to prevent inundation during a flood. Thick alluvium was avoided to facilitate construction of the collar in rock. Collar sites were

located to ensure compatability with a potential repository. Muck piles were conceptually located to be hidden from the view of travelers on US Highway 95. A separation distance of several hundred feet between any of the candidate sites and the proposed North Ramp ensures that testing in one access will not adversely effect activities in the other. The proposed shaft locations are shown on Figure 2, Appendix A. A discussion of engineering geology considerations as they apply to the alternative shaft sites is presented in Reference 6.13. Reference 6.14 includes geologic sections along the proposed shaft centerlines.

The potential shaft locations are:

Site #1. This site is approximately the location proposed for the emplacement exhaust shaft presented in the configuration for Alternative Studies Option No. 30.

Site #2. This location is approximately the ES-2 location from Title I Engineering (Reference 6.16). The final location would be designed not to interfere with planned MTL test areas.

Site #3. This location was evaluated and scored as part of a repository men and materials shaft siting analysis. The site should be evaluated as a location for an Emplacement Exhaust and Site Characterization Access because of its

several favorable aspects.

Site #4. This location was evaluated and scored as part of a repository men and materials shaft siting analysis. The site should be evaluated as a location for an Emplacement Exhaust and Site Characterization Access because of its several favorable aspects.

Site #5. This location was proposed as an Exhaust Emplacement Shaft Location for an early repository configuration. This location may have significant merit when evaluated as a site characterization data access entry.

4.3 EVALUATION OF ALTERNATIVES

The evaluation of the alternative shaft sites involved identification of evaluation factors, assignment of weighting values to each of the factors, and rating each of the alternatives against each of the factors. This process was followed for each of the four independent evaluations addressing engineering, performance assessment, underground testing, and surface based testing considerations. The relative importance (weight) of the four perspectives being evaluated was then determined, and the scoring results combined to provide an overall

weighted value for each candidate site. The results of these activities are summarized in the following sections.

4.3.1 ENGINEERING EVALUATION

Seven evaluation factors were identified and subsequently used as the basis for a comparative evaluation of the alternatives from an engineering perspective. A summary listing of those factors is shown below:

(1) RELATIVE EASE OF CONSTRUCTION OF COLLAR ACCESS ROAD

- o Length of new road
- o Topography

(2) RELATIVE EASE OF SHAFT SITE PAD CONSTRUCTION

- o Topography
- o Geology
  - Cut and fill requirements
  - Rock compressive strength

(3) RELATIVE EASE OF SHAFT COLLAR CONSTRUCTION

- o Geological conditions
  - Depth to bedrock
  - Fracture characteristics
  - Rock compressive strength

(4) SHAFT GEOLOGY

- o Fracture characteristics
- o Rock strength - stratigraphy
- o Proximity to known fault zones

(5) POTENTIAL REPOSITORY INTEGRATION IMPACTS

- o Lost emplacement area
- o Potential repository utility
- o Flexibility of function
- o Degree of security

(6) ESF/REPOSITORY LOGISTICS

- o Muck disposal
- o Surface utility construction
- o Surface convenience to operational centers

(7) SHAFT DEPTH

- o Construction Cost and Schedule
- o ESF/Repository Operating Costs

Table 10 shows the relative importance (weighting factor values) assigned to each feature, and presents the evaluation results. A detailed discussion of the engineering evaluation of the alternative shaft sites is included in Reference 6.8.

TABLE 10

OPTIONAL SHAFT SITING-ENGINEERING EVALUATION RESULTS

EVALUATION FEATURE	WEIGHTING FACTOR VALUE W	SITE 1-ABOVE COYOTE WASH *RATING V	WTG. VAL. WV	SITE 2-ES-2 VICINITY *RATING V	WTG. VAL. WV	SITE 3-D. H. WASH *RATING V	WTG. VAL. WV	SITE 4-ABOVE D. H. WASH *RATING V	WTG. VAL. WV	SITE 5-EAST EDGE ESF BLOCK *RATING V	WTG. VAL. WV
1. COLLAR ACCESS ROAD CONSTRUCTION	8	2.50	20.00	4.00	32.00	3.00	24.00	1.75	14.00	2.75	22.00
2. SHAFT SITE PAD CONSTRUCTION	8	2.75	22.00	3.75	30.00	2.75	22.00	2.50	20.00	2.75	22.00
3. COLLAR CONSTRUCTION	6	3.50	21.00	3.50	21.00	3.50	21.00	3.25	19.50	3.00	18.00
4. SHAFT GEOLOGY	10	2.75	27.50	3.50	35.00	3.00	30.00	2.50	25.00	2.75	27.50
5. REPOSITORY INTEGRATION IMPACTS	9	2.25	20.25	2.50	22.50	3.00	27.00	2.75	24.75	3.25	29.25
6. ESF/REPOSITORY LOGISTICS	7	2.50	17.50	3.50	24.50	3.25	22.75	3.00	21.00	3.00	21.00
7. SHAFT DEPTH	5	2.25	11.25	3.00	15.00	3.50	17.50	2.75	13.75	3.00	15.00
WEIGHTED VALUE			139.50		180.00		164.25		138.00		154.75
WEIGHTED VALUE AS PERCENT OF TOTAL			17.97%		23.18%		21.15%		17.77%		19.93%

*RATING VALUE V=AVERAGE RATING

4.3.2 PERFORMANCE ASSESSMENT EVALUATION

Two discriminating criteria were used to evaluate the five alternative shaft locations from a performance assessment perspective. These criteria encompassed those factors most likely to compromise the ability of the site to isolate waste. The discriminating criteria were:

(1) Liquid Reaching the Repository Horizon: Includes those factors that may increase the amount of water entering the potential repository block and influence waste isolation and containment.

(2) Quantity of Gas Escaping from the Repository Horizon: Includes those factors that may increase vapor-phase transport to the accessible environment.

Table 11 shows the relative importance (weight) assigned to each factor, and presents the evaluation results. Reference 6.9 includes details on the performance assessment evaluation of the alternative shaft sites.

TABLE 11

OPTIONAL SHAFT SITING-PERFORMANCE ASSESSMENT EVALUATION RESULTS

DISCRIMINATOR	WEIGHT	SITE 1-ABOVE COYOTE WASH		SITE 2-ES-2 VICINITY		SITE 3-D. H. WASH		SITE 4-ABOVE D. H. WASH		SITE 5-EAST EDGE ESF BLOCK	
		*RATING	WTG. VAL.	*RATING	WTG. VAL.	*RATING	WTG. VAL.	*RATING	WTG. VAL.	*RATING	WTG. VAL.
	W	V	WV	V	WV	V	WV	V	WV	V	WV
1. LIQUID REACHING REPOSITORY HORIZON	0.7	2	1.4	2	1.4	4	2.8	5	3.5	3	2.1
2. GAS ESCAPING FROM REPOSITORY HORIZON	0.3	2	0.6	2	0.6	3	0.9	4	1.2	2	0.6
WEIGHTED VALUE			2.0		2.0		3.7		4.7		2.7
WEIGHTED VALUE AS PERCENT OF TOTAL			13.25%		13.25%		24.50%		31.13%		17.88%

*RATING VALUE V=AVERAGE RATING

4.3.3 UNDERGROUND TESTING EVALUATION

Three discriminating factors were used to evaluate the five alternative shaft locations from an underground testing perspective. The discriminating factors were:

(1) REPRESENTATIVENESS. Provides the best ability to characterize units representative of those overlying and including TSw in the block. Better = more representative units passed through; better = longer extent of vertical look.

(2) INTERFERENCE. Location should limit potential interference between tests and operations (in the shaft and in the main test level) (MTL). Better = farther away from MTL

(3) ISOLATION. Potential for testing to impact waste isolation (testing on block versus off block). Better = further removed from possible repository.

Table 12 shows the relative importance (weight) assigned to each factor, and presents the evaluation results. A detailed discussion of the underground testing evaluation of the alternative shaft sites is included in Reference 6.10.

TABLE 12

OPTIONAL SHAFT SITING-UNDERGROUND TESTING EVALUATION RESULTS

DISCRIMINATOR	WEIGHT	SITE 1-ABOVE COYOTE WASH		SITE 2-ES-2 VICINITY		SITE 3-D. H. WASH		SITE 4-ABOVE D. H. WASH		SITE 5-EAST EDGE ESF BLOCK	
		*RATING	WTG. VAL.	*RATING	WTG. VAL.	*RATING	WTG. VAL.	*RATING	WTG. VAL.	*RATING	WTG. VAL.
	W	V	WV	V	WV	V	WV	V	WV	V	WV
1. REPRESENTATIVENESS	0.70	3	2.10	3	2.10	1	0.70	1	0.70	2	1.40
2. INTERFERENCE	0.15	4	0.60	3	0.45	5	0.75	5	0.75	5	0.75
3. ISOLATION	0.15	3	0.45	3	0.45	4	0.60	4	0.60	4	0.60
WEIGHTED VALUE			3.15		3.00		2.05		2.05		2.75
WEIGHTED VALUE AS PERCENT OF TOTAL			24.23%		23.08%		15.77%		15.77%		21.15%

*RATING VALUE V=AVERAGE RATING

4.3.4 SURFACE-BASED TESTING EVALUATION

Two discriminating factors were used to evaluate the five alternative shaft locations from a surface-based testing perspective. The discriminating factors were:

(1) INTERFERENCE: Potential for interference with surface-based testing due to pad and shaft construction, and/or testing associated with the pad or shaft.

(2) COMPLEMENTARY INFORMATION: Potential for obtaining information/data complimentary to the surface-based testing program.

Table 13 shows the relative importance (weight) assigned to each factor, and presents the evaluation results. A detailed discussion of the surface-based evaluation of the alternative shaft sites is included in Reference 6.11.

TABLE 13

OPTIONAL SHAFT SITING-SURFACE-BASED TESTING EVALUATION RESULTS

DISCRIMINATOR	WEIGHT	SITE 1-ABOVE COYOTE WASH		SITE 2-ES-2 VICINITY		SITE 3-D. H. WASH		SITE 4-ABOVE D. H. WASH		SITE 5-EAST EDGE ESF BLOCK	
		*RATING	WTG. VAL.	*RATING	WTG. VAL.	*RATING	WTG. VAL.	*RATING	WTG. VAL.	*RATING	WTG. VAL.
	W	V	WV	V	WV	V	WV	V	WV	V	WV
1. INTERFERENCE	0.50	2.67	1.335	3.00	1.500	3.00	1.500	3.00	1.500	3.33	1.665
2. COMPLEMENTARY INFORMATION	0.50	2.67	1.335	3.00	1.500	2.00	1.000	2.00	1.000	3.00	1.500
WEIGHTED VALUE			2.670		3.000		2.500		2.500		3.165
WEIGHTED VALUE AS PERCENT OF TOTAL			19.30%		21.68%		18.07%		18.07%		22.88%

*RATING VALUE V=AVERAGE RATING

4.3.5 COMBINED SCORING RESULTS

The relative importance (weight) of the four perspectives being evaluated, ie. engineering, performance assessment, underground and surface-based testing, was determined (Reference 6.15). The rating values for the candidate sites determined by each independent evaluation were normalized (sum of rating values for all three sites = 1.00 for a given evaluation perspective) and the scoring results combined to provide an overall weighted value for each of the candidate sites. Table 14 shows the weight assigned to each evaluation perspective, and presents the combined evaluation results.

TABLE 14

OPTIONAL SHAFT SITING-COMBINED EVALUATION RESULTS

EVALUATION CONSIDERATION	WEIGHTING FACTOR W	SITE 1-ABOVE COYOTE WASH RATING * V	SITE 1-ABOVE COYOTE WASH WTG. VAL. WV	SITE 2-ES-2 VICINITY RATING * V	SITE 2-ES-2 VICINITY WTG. VAL. WV	SITE 3-DRILL HOLE WASH RATING * V	SITE 3-DRILL HOLE WASH WTG. VAL. WV	SITE 4-ABOVE D.H. WASH RATING * V	SITE 4-ABOVE D.H. WASH WTG. VAL. WV	SITE 5-EAST EDGE ESF BLOCK RATING * V	SITE 5-EAST EDGE ESF BLOCK WTG. VAL. WV
ENGINEERING	0.30	0.180	0.05400	0.232	0.06960	0.211	0.06330	0.178	0.05340	0.199	0.05970
PERFORMANCE ASSESSMENT	0.25	0.132	0.03300	0.132	0.03300	0.245	0.06125	0.311	0.07775	0.179	0.04475
UNDERGROUND TESTING	0.40	0.242	0.09680	0.231	0.09240	0.158	0.06320	0.158	0.06320	0.211	0.08440
SURFACE BASED TESTING	0.05	0.193	0.00965	0.217	0.01085	0.181	0.00905	0.181	0.00905	0.229	0.01145
TOTAL WEIGHTED VALUE			0.19345		0.20585		0.19680		0.20340		0.20030

* V = WEIGHTED VALUES AS A PERCENT OF TOTAL, FROM TABLES 10 THROUGH 13

4.3.6 SENSITIVITY ANALYSIS

A sensitivity analysis was performed using alternate values for the relative importance (weighting factor) of the four perspectives being considered. Four cases of alternate weights were used, corresponding to the four sets of values which were considered along with the values eventually selected and recommended by group consensus (Reference 6.15). The combined evaluation results for the four sensitivity analysis cases are shown on Tables 15 through 18. As previously illustrated by Table 14, there is very little difference in the total weighted values for each site using the base case (ie. recommended) values. It is therefore not surprising that the results differ when alternate weighting factors are used. The top ranked option remains site #2 for sensitivity analysis cases 3 and 4, but for cases 1 and 2 site #4 is the preferred option by a slight margin.

TABLE 15

OPTIONAL SHAFT SITING-COMBINED EVALUATION RESULTS

SENSITIVITY ANALYSIS-CASE 1

EVALUATION CONSIDERATION	WEIGHTING FACTOR	SITE 1-ABOVE COYOTE WASH		SITE 2-ES-2 VICINITY		SITE 3-DRILL HOLE WASH		SITE 4-ABOVE D.H. WASH		SITE 5-EAST EDGE ESF BLOCK	
		RATING * V	WTG. VAL. WV	RATING * V	WTG. VAL. WV	RATING * V	WTG. VAL. WV	RATING * V	WTG. VAL. WV	RATING * V	WTG. VAL. WV
ENGINEERING	0.30	0.180	0.05400	0.232	0.06960	0.211	0.06330	0.178	0.05340	0.199	0.05970
PERFORMANCE ASSESSMENT	0.30	0.132	0.03960	0.132	0.03960	0.245	0.07350	0.311	0.09330	0.179	0.05370
UNDERGROUND TESTING	0.30	0.242	0.07260	0.231	0.06930	0.158	0.04740	0.158	0.04740	0.211	0.06330
SURFACE BASED TESTING	0.10	0.193	0.01930	0.217	0.02170	0.181	0.01810	0.181	0.01810	0.229	0.02290
TOTAL WEIGHTED VALUE			0.18550		0.20020		0.20230		0.21220		0.19960

* V = WEIGHTED VALUES AS A PERCENT OF TOTAL, FROM TABLES 10 THROUGH 13

TABLE 16

OPTIONAL SHAFT SITING-COMBINED EVALUATION RESULTS

SENSITIVITY ANALYSIS-CASE 2

EVALUATION CONSIDERATION	WEIGHTING FACTOR W	SITE 1-ABOVE COYOTE WASH RATING * V	SITE 1-ABOVE COYOTE WASH WTG. VAL. WV	SITE 2-ES-2 VICINITY RATING * V	SITE 2-ES-2 VICINITY WTG. VAL. WV	SITE 3-DRILL HOLE WASH RATING * V	SITE 3-DRILL HOLE WASH WTG. VAL. WV	SITE 4-ABOVE D.H. WASH RATING * V	SITE 4-ABOVE D.H. WASH WTG. VAL. WV	SITE 5-EAST EDGE ESF BLOCK RATING * V	SITE 5-EAST EDGE ESF BLOCK WTG. VAL. WV
ENGINEERING	0.30	0.180	0.05400	0.232	0.06960	0.211	0.06330	0.178	0.05340	0.199	0.05970
PERFORMANCE ASSESSMENT	0.30	0.132	0.03960	0.132	0.03960	0.245	0.07350	0.311	0.09330	0.179	0.05370
UNDERGROUND TESTING	0.35	0.242	0.08470	0.231	0.08085	0.158	0.05530	0.158	0.05530	0.211	0.07385
SURFACE BASED TESTING	0.05	0.193	0.00965	0.217	0.01085	0.181	0.00905	0.181	0.00905	0.229	0.01145
TOTAL WEIGHTED VALUE			0.18795		0.20090		0.20115		0.21105		0.19870

* V = WEIGHTED VALUES AS A PERCENT OF TOTAL, FROM TABLES 10 THROUGH 13

TABLE 17

OPTIONAL SHAFT SITING-COMBINED EVALUATION RESULTS

SENSITIVITY ANALYSIS-CASE 3

EVALUATION CONSIDERATION	WEIGHTING FACTOR W	SITE 1-ABOVE COYOTE WASH RATING * V	SITE 1-ABOVE COYOTE WASH WTG. VAL. WV	SITE 2-ES-2 VICINITY RATING * V	SITE 2-ES-2 VICINITY WTG. VAL. WV	SITE 3-DRILL HOLE WASH RATING * V	SITE 3-DRILL HOLE WASH WTG. VAL. WV	SITE 4-ABOVE D.H. WASH RATING * V	SITE 4-ABOVE D.H. WASH WTG. VAL. WV	SITE 5-EAST EDGE ESF BLOCK RATING * V	SITE 5-EAST EDGE ESF BLOCK WTG. VAL. WV
ENGINEERING	0.20	0.180	0.03600	0.232	0.04640	0.211	0.04220	0.178	0.03560	0.199	0.03980
PERFORMANCE ASSESSMENT	0.15	0.132	0.01980	0.132	0.01980	0.245	0.03675	0.311	0.04665	0.179	0.02685
UNDERGROUND TESTING	0.60	0.242	0.14520	0.231	0.13860	0.158	0.09480	0.158	0.09480	0.211	0.12660
SURFACE BASED TESTING	0.05	0.193	0.00965	0.217	0.01085	0.181	0.00905	0.181	0.00905	0.229	0.01145
TOTAL WEIGHTED VALUE			0.21065		0.21565		0.18280		0.18610		0.20470

* V = WEIGHTED VALUES AS A PERCENT OF TOTAL, FROM TABLES 10 THROUGH 13

TABLE 18

OPTIONAL SHAFT SITING-COMBINED EVALUATION RESULTS

SENSITIVITY ANALYSIS-CASE 4

EVALUATION CONSIDERATION	WEIGHTING FACTOR W	SITE 1-ABOVE COYOTE WASH RATING * V	SITE 1-ABOVE COYOTE WASH WTG. VAL. WV	SITE 2-ES-2 VICINITY RATING * V	SITE 2-ES-2 VICINITY WTG. VAL. WV	SITE 3-DRILL HOLE WASH RATING * V	SITE 3-DRILL HOLE WASH WTG. VAL. WV	SITE 4-ABOVE D.H. WASH RATING * V	SITE 4-ABOVE D.H. WASH WTG. VAL. WV	SITE 5-EAST EDGE ESF BLOCK RATING * V	SITE 5-EAST EDGE ESF BLOCK WTG. VAL. WV
ENGINEERING	0.35	0.180	0.06300	0.232	0.08120	0.211	0.07385	0.178	0.06230	0.199	0.06965
PERFORMANCE ASSESSMENT	0.20	0.132	0.02640	0.132	0.02640	0.245	0.04900	0.311	0.06220	0.179	0.03580
UNDERGROUND TESTING	0.40	0.242	0.09680	0.231	0.09240	0.158	0.06320	0.158	0.06320	0.211	0.08440
SURFACE BASED TESTING	0.05	0.193	0.00965	0.217	0.01085	0.181	0.00905	0.181	0.00905	0.229	0.01145
TOTAL WEIGHTED VALUE			0.19585		0.21085		0.19510		0.19675		0.20130

* V = WEIGHTED VALUES AS A PERCENT OF TOTAL, FROM TABLES 10 THROUGH 13

5.0 CONCLUSIONS AND RECOMMENDATIONS

It is concluded from this study that the portal site on the east side of Exile Hill, ie. the reference Site Characterization Plan (SCP) Conceptual Design Report (CDR) location, is the optimum location for the ESF north access ramp portal. A previous analysis determined this location to be the best site for potential repository waste handling facilities and concluded the north ramp (potential waste ramp) should be in close proximity to those facilities. A review of current ESF design requirements and the previous siting study indicates the study results are still valid. The Exile Hill location (approximate coordinates: N765251, E570034) is recommended as the north access ramp portal site to be used to support the Reference Conceptual Design.

Three alternative sites for the south access ramp portal were evaluated. The combined evaluation results, which are based on engineering, performance assessment, and underground and surface-based testing perspectives, indicate the east side of Boundary Ridge is the preferred location. The sensitivity analysis indicates the results are quite robust. The Boundary Ridge site (approximate coordinates: N756640, E566640) is recommended as the south ramp portal site to be used to support the Reference Conceptual Design.

Five alternative sites for the optional shaft collar were considered. Combined evaluation results indicate a slight preference for Site #2, which is in the vicinity of Coyote Wash near the ES-2 location shown in previous ESF designs (Reference 6.16). However, the combined scores are so close together that the differences may not be significant. It is therefore not surprising that the results differ when alternate weighting factors are used. The top ranked option remains site #2 for sensitivity analysis cases 3 and 4, but for cases 1 and 2 site #4 is the preferred option by a slight margin. Based on the results of this preliminary analysis, site #2 (approximate coordinates: N766337, E563918) is recommended as the Reference Conceptual Design location for the optional shaft.

This is a preliminary analysis based on the limited information currently available. It is recommended that confirmatory information, particularly subsurface geologic data, be obtained prior to making a final decision on the location of the portal/collar sites.

Also, it should be reiterated that the site coordinates listed in this analysis are intended to represent only the general portal/collar locations. Determination of the final coordinates for the ramps will involve trade-offs concerning parameters such as portal access road cut/fill requirements, main pad cut/fill requirements, and the length of the ramp. Final siting of the shaft collar must be coordinated with the underground layout and test plans.

6.0 REFERENCES

6.1 Findings of the ESF Alternatives Study, SAND90-3232, by Sandia National Laboratory, March, 1991

6.2 Authorization for Conducting a Design Study to Develop a Reference ESF Design to be Used as Input to Title I Design Summary Report, Letter from Gertz to Bullock (EDD:EHP-2080), dated February 22, 1991

6.3 Preliminary Siting Analysis Report to Support Exploratory Studies Facility (ESF) Reference Conceptional Design (Direction to Conduct a Preliminary Siting Analysis Study), Letter from Gertz to Bullock and others (RSED:JTS-2834), March 29, 1991

6.4 Location Recommendation for Surface Facilities for the Prospective Yucca Mountain Nuclear Waste Repository, SAND84-2015 by Neal/SNL, April, 1985

6.5 Information on the South Ramp/Repository Main Point of Intersection (PI), Transmittal #91-11, Brian Lawrence (PBQ&D) to Nick Tamondong (RSN), dated April 9, 1991

6.6 North TSw2 Access (Waste) Ramp Portal Siting Analysis, ST-MN-001 Rev. 0, May 1991, by Raytheon Services Nevada

6.7 South Ramp Siting Analysis, ST-MN-002 Rev. 0, May 1991, by Raytheon Services Nevada

6.8 Optional Shaft Siting Analysis, ST-MN-003 Rev. 0, May 1991, by Raytheon Services Nevada

6.9 Performance Assessment Evaluations of Potential South Ramp and Shaft Locations, Letter from Blejwas/SNL to Dobson/YMPO, Dated April 30, 1991

6.10 Submittal of Underground Testing Evaluation Report For Inclusion in Raytheon Services Nevada Preliminary Siting Analysis Report to Support Exploratory Studies Facility Reference Conceptual Design, Letter from Elkins/LANL to Bullock/RSN (TWS-EES-13-LV-05-91-01), Dated May 1, 1991

6.11 Surface-Based Testing Input To The Southern Portal, and Possible Shaft, Siting Report, Letter from Craig/USGS to Bullock/RSN, Dated April, 1991

6.12 Preliminary Engineering Geology Reconnaissance Report for Proposed Ramp Alignments, Dated April 2, 1991, by McKeown and Beason, USBUREC

6.13 Preliminary Engineering Geology Reconnaissance Report for Proposed Shaft Locations, Dated May 3, 1991, by McKeown and Beason, USBUREC

6.14 Transmittal of Report On The Assessment of Existing Geophysical Data And Geologic Cross Sections To Support A Siting Analysis Report For The Exploratory Studies Facility (ESF), Letter from King/SAIC to Dobson/YMPO and Bullock/RSN (L91-315), Dated June 21, 1991

6.15 Transmittal of Regulatory and Site Evaluation Division (RSED) Exploratory Studies Facility (ESF) Technical Integration Group (TIG) Preliminary Siting Analysis Report Weighting Factors, Letter from Dobson/YMPO to Bullock/RSN (RSED:JTS-3745), Dated May 15, 1991

6.16 Title I Design Drawing, FS-GA-0194, Rev. C, dated December 13, 1988