MONTHLY HIGHLIGHTS AND STATUS REPORT

Yucca Mountain Site Characterization Project

U.S. DEPARTMENT OF ENERGY

YUCCA MOUNTAIN PROJECT

Sandia National Laboratories

March 1993

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Sandia National Laboratories

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

Monthly Status Report

March 1993

Sections At-A-Glance

Highlights

SNL staff is using the CALMA computer modeling system to generate an updated contact between thermal/mechanical units TSw1 and TSw2. The updated distinction provides important comparative information between historical estimates for the location of the potential repository/Exploratory Studies Facility and the newly emerging design specifications.

See ***1.2.3.2.2.2.2 Three-Dimensional Rock Characteristics Models*** on page 5

SNL staff submitted "Influence of Strain Rate and Sample Inhomogeneity on the Moduli and Strength of Welded Tuff" (Milestone 0S47) to the Project Office for programmatic review.

See ***1.2.3.2.7.1.3 Laboratory Determination of Mechanical Properties of Intact Rock*** on page 7.

Highlights, Continued

SNL staff submitted the excavation investigations study plan (Milestone SNL001) to the Project Office for review.

See ***1.2.4.1.1 Repository Coordination and Planning*** on page 9.

SNL staff submitted "Use of an Iterative Solution Method for Coupling Finite Element and Boundary Element Modeling" (Milestone 0S20) to the Project Office for review.

See ***1.2.4.2.3.1 Certification of Design Methods*** on page 13.

SNL staff submitted the basaltic igneous activity scenario report (Milestone M125) to the Project Office for programmatic review. The SNL Performance Assessment (PA) group also participates in the "PA Road Show" sponsored by the U.S. Department of Energy Project Office.

See ***1.2.5.4.1 Total System Performance Assessment*** on page 16

SNL staff continued to develop a methodology to produce epoxy casts of natural fractures. A natural tuff fracture cast was prepared to evaluate flow in unsaturated fractures and to assess processes potentially contributing to "fast flow" paths. SNL staff also conducted preliminary experiments investigating the effects of air entrapment on fracture permeability and tracer migration.

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WBS 1.2.3.2.2.2.2 Three-Dimensional Rock Characteristics Models

- Preliminary information for the NRG-6 drill hole was input to the Interactive Graphics Information System (IGIS) CALMA modeling system to regenerate an updated contact between thermal/mechanical units TSw1 and TSw2 at the request of the M&O ESF design engineers. The updated distinction provides important comparative information between historical estimates for the location of the potential repository/ESF and the newly emerging design specifications.

WBS 1.2.3.2.7.1.3 Laboratory Determination of Mechanical Properties of Intact Rock

- The paper, "Influence of Strain Rate and Sample Inhomogeneity on the Moduli and Strength of Welded Tuff," was submitted to the Project Office for programmatic review (Milestone (0S47)

WBS 1.2.4.1.1 Repository Coordination and Planning

- Study Plan 8.3.1.15.1.5, "Excavation Investigations," was submitted to the Project Office for review (Milestone SNL001).

WBS 1.2.4.2.3.1 Certification of Design Methods

- The report, "Use of an Iterative Solution Method for Coupling Finite Element and Boundary Element Modeling," was submitted to the Project Office for review (Milestone 0S20).

WBS 1.2.5.4.1 Total System Performance Assessment

- SAND91-1653, "Scenarios Constructed for Basaltic Igneous Activity at Yucca Mountain and Vicinity," by G. Barr, E. Dunn, H. Dockery, R. Barnard, G. Valentine, and B. Crowe, was submitted to the Project Office for programmatic review (Milestone M125).

EXECUTIVE SUMMARY, Continued
MARCH 1993

- The SNL Performance Assessment (PA) group spent two days participating in the "PA Road Show" sponsored by the DOE Project Office. The objective of the meetings, one at LANL and one at USGS, was to establish and enhance technical interactions among participants. The SNL presentations were designed to provide the participants with an understanding of the PA process and to discuss details of ongoing analyses in their specific areas of interest. The SNL presentations were followed by brief discussion of the PA needs of the project's M&O contractor and presentations of ongoing work by the host organization.

WBS 1.2.5.4.6 Development and Validation of Flow and Transport Models

- Experimental work continued to test the validity of current numerical models of unsaturated flow in fractures. This work is intended to evaluate processes controlling fracture flow and to assess potential mechanisms for "fast flow" paths in unsaturated fractures. Development of a methodology to produce epoxy casts of natural fractures continued. A natural tuff fracture cast last month was prepared for preliminary experimentation. Work to refine the casting procedure and characterize the wetting properties of the cast surfaces will continue.

- Preliminary experiments investigating the effects of air entrapment on fracture permeability and tracer migration continued. Development of image analysis techniques to delineate wetted structure within the analog fracture also continued.

1.2.1 SYSTEMS ENGINEERING

The objective of the Systems Engineering element is to apply the systems engineering discipline to transform the regulatory requirements into functional needs of the MGDS design, system configuration, and site characterization activities. The Systems Engineering element is comprised of four tasks: Systems Engineering Coordination and Planning (1.2.1.1), Program-Level Requirements Document Development (1.2.1.2.1), Project-Level Requirements Documents Development and Maintenance (1.2.1.2.2), and Special Studies (1.2.1.5), which includes development of items important to safety/waste isolation.

All major activities and deliverables scheduled within the Systems Engineering element (1.2.1.1, 1.2.1.2.1, 1.2.1.2.2, and 1.2.1.5) have been completed. No further support is presently planned in these elements for the remainder of FY93.

1.2.1.5 SPECIAL STUDIES

Status Report on Ongoing Activities

SAND92-2334, "Preclosure Radiological Safety Evaluation: Exploratory Studies Facility," by F. J. Schelling and J. D. Smith, has been submitted for Yucca Mountain Project Office (YMPO) approval.

1.2.2 WASTE PACKAGE

The objective of the Waste Package element includes support to the Container/Waste Package Interface Analysis element (1.2.2.4.3) in the conduct of thermal and structural analyses of the near-field environment that will support evaluations of emplacement orientation, the effects of backfill properties and timing, as well as other thermal loading issues related to waste package design.

1.2.2.4.3 CONTAINER/WASTE PACKAGE INTERFACE ANALYSIS

Major Activities Upcoming Next Three Months

Sandia National Laboratories (SNL) and Management and Operations (M&O) contractor personnel will meet to define specific analyses to be conducted in FY93.

1.2.3 SITE INVESTIGATIONS

The objective of the Site Investigations element includes work scope related to site data collection and analysis to support site suitability evaluation, design, licensing, performance assessment requirements, and the natural barrier system component of the multiple barrier system described in the physical system. The Site Investigations element is comprised of eight tasks: Site Investigations Coordination and Planning (1.2.3.1), Systematic Acquisition of Site-Specific Subsurface Information (1.2.3.2.2.2.1), Three-Dimensional Rock Characteristics Models (1.2.3.2.2.2.2), Laboratory Thermal Properties (1.2.3.2.7.1.1), Laboratory Thermal Expansion Testing (1.2.3.2.7.1.2), Laboratory Determination of Mechanical Properties of Intact Rock (1.2.3.2.7.1.3), Laboratory Determination of the Mechanical Properties of Fractures (1.2.3.2.7.1.4), and Future Regional Climate and Environments (1.2.3.6.2.1.6).

1.2.3.1 SITE INVESTIGATIONS COORDINATION AND PLANNING

Significant Meetings Attended

SNL staff participated in the Sample Overview Committee (SOC) meeting on March 3 in Area 25 at the Nevada Test Site (NTS). Various core requests were acted upon, principally samples from drill hole UZ-16 and the north ramp (NRG) series of holes.

SNL staff attended a March 30 meeting called by the M&O design team to discuss the planned entry-point elevation from the north ramp to the Exploratory Studies Facility (ESF) main drift as influenced by recently completed drill hole NRG-6. (See additional discussion under WBS 1.2.3.2.2.2.2.)

1.2.3.2.2.2.1 SYSTEMATIC ACQUISITION OF SITE-SPECIFIC SUBSURFACE INFORMATION

Status Report on Ongoing Activities

In support of the workscope consolidation effort for combining drill holes SRG-5 and SD-11 near the entry point from the south ramp to the ESF main drift, SNL staff engaged in numerous telephone conversations with M&O engineers to prepare specifications for the combined drill hole and resolve potential conflicts. Much discussion focused on contacts between different types of stratigraphic units. A July 1993 start date is anticipated for drilling activities. (SCP Activity 8.3.1.4.3.1.1)

Several SNL Quality Assurance Implementing Procedures (QAIPs) (implementing the revised Quality Assurance Requirements and Description [QARD]) necessary for the development of study-specific technical procedures (TPs) received formal approval during the month. Draft TPs have been written to support several aspects of core logging and other activities under both the Systematic Drilling Program (SCP Activity 8.3.1.4.3.1.1) and the Soil and Rock Properties Study (SCP Activity 8.3.1.14.2). The Soil and Rock Properties Study focuses on detailed geotechnical information related to construction of the ESF ramps, whereas the Systematic Drilling Program is broader, developing information for overall repository design and performance assessment (PA). Coordination of procedure development will assure that information acquired by SNL staff under these two studies is compatible, except for the intentional differences that result from the different objectives of the two studies. The procedures should be finalized during April.

Drafts of two data reports, "Physical and Hydrologic Properties of Outcrop Samples from a Nonwelded to

Welded Tuff Transition, Yucca Mountain, Nevada," and "Physical and Hydrologic Properties of Surface Outcrop Samples at Yucca Mountain, Nevada," have been prepared as a joint effort of U.S. Geological Survey (USGS) and SNL staff. These two reports provide laboratory results of the outcrop sampling studies conducted at Yucca Mountain over several years under this activity. The reports are being prepared as USGS open-file reports because the laboratory measurements of hydrologic properties were performed at the USGS Hydrologic Research Facility using USGS TPs. It is anticipated that the drafts will be finalized and enter internal USGS and SNL review next month. (SCP Activities 8.3.1.4.3.1.1 and 8.3.1.2.2.3.1)

Several drafts of the journal article entitled "Spatial Variability of Hydrologic Properties in Volcanic Tuff" have been circulated among the USGS and SNL staff contributing to the paper. Much of this work will be presented at the International High-Level Radioactive Waste Management Conference in April. The revised paper includes a test of the hypotheses developed by the original work based on new samples collected during February. The expanded version of the paper should enter internal USGS and SNL review next month. (SCP Activity 8.3.1.4.3.1.1 and 8.3.1.2.2.3.1)

Geostatistical analysis of hydrologic properties data from outcrop studies of the Bandelier Tuff, a natural analog for some of the nonwelded tuffs at Yucca Mountain, continues to be deferred due to limited staff resources and higher priorities attached to other work. (SCP Activity 8.3.1.4.3.1.1)

Presentation materials for the International High-Level Radioactive Waste Management Conference on April 26 through 30 are being prepared.

Major Activities Upcoming Next Three Months

Drafts of reports in preparation will be finalized and reviewed as appropriate. As ongoing scoping activities are completed, principal emphasis will be placed on completing all procedures and other prerequisites for initiating the Systematic Drilling Program with hole SD-11/SRG-5 in July.

Issues/Potential Problems Needing Resolution and Potential Impacts

Discussions with the M&O design team involved in the workscope consolidation effort for drill holes SD-11/SRG-5 indicate that there is still confusion surrounding the use of thermal/mechanical stratigraphy and conventional geologic stratigraphy. Many design requirements are specified in terms of thermal/mechanical contacts or units because the underlying analyses, conceptual design work, and other documents have used this terminology. Several years ago, an ad hoc committee convened to resolve the conflicting terminology reached agreement regarding an equivalence between specific thermal/mechanical contacts and the boundaries of the microstratigraphic zonation of the Topopah Spring Member of the Paintbrush Tuff (originally developed by Scott and Bonk, USGS OFR-84-494). However, relict problems continue to surface. The design community uses the historical thermal/mechanical terminology, whereas the site characterization community uses the geologically based formation/member/informal zone stratigraphy. Given the potential for confusion and/or erroneous actions, clarity of terminology and information in all communications is extremely important.

1.2.3.2.2.2.2 THREE-DIMENSIONAL ROCK CHARACTERISTICS MODELS

Major Accomplishments

Preliminary information for the NRG-6 drill hole was input to the Interactive Graphics Information System (IGIS) Calma modeling system to regenerate an updated contact between thermal/mechanical units TSw1 and TSw2 at the request of the M&O ESF design engineers. (See discussion of the conflicts between the thermal/mechanical and geologic stratigraphies below under Potential Problems.) Although there are significant questions regarding the utility of the concept of a TSw1 and a TSw2 subdivision of the Topopah Spring Member of the Paintbrush Tuff and the Calma algorithm used for the interpolation is somewhat dated, the updated distinction provides important comparative information between historical estimates for the location of the potential repository/ESF and the newly emerging design specifications. (SCP Activity 8.3.1.4.3.2.1)

The upgrade of the Lynx Geotechnical Modeling System (GMS), received last month from Lynx Geosystems of Vancouver, BC, has been installed on an SNL SUN workstation and is being tested. It is hoped that use of the Lynx GMS will be greatly facilitated by the new interface. (SCP Activity 8.3.1.4.3.2.1)

Status Report on Ongoing Activities

Ten simulations of the three-dimensional welded/ nonwelded indicator geostatistical model have been produced, and the models are being post-processed to extract the information required for the Total System Performance Assessment exercises. Evaluation of the continuity problems discussed last month suggests several causes. Principal among these is that the current drill hole spacing at Yucca Mountain appears to be very close to the shorter range of correlation of the nested continuity structure identified by variograms of data extracted from published geologic cross sections. The anisotropy ratios input to the geostatistical simulations have been somewhat arbitrarily increased to compensate for this data artifact. The need for these types of adjustments reinforces that modeling is an art. It also emphasizes that site characterization activities need to be driven by the results of earlier site characterization data and by the uses of those data in performance modeling. (SCP Activity 8.3.1.4.3.2.1)

Presentation materials are being prepared for the International High-Level Radioactive Waste Management Conference in Las Vegas, NV, on April 26 through 30. (SCP Activity 8.3.1.4.3.2.1)

Major Activities Upcoming Next Three Months

The study plan for the Three-Dimensional Rock Characteristics Models study will be initiated. The current requirements for study plans as described in SNL QAIPs emphasize data collection activities and not the development of modeling capabilities. Although the existing requirements (emphasizing data collection) do not fit this model developments activity, a study plan that addresses the relevant requirements will be completed. The scientific notebook process will be used to control the Three-Dimensional Rock Characteristics Study. Modifications to the QA implementing procedures are being made by Sandia QA personnel. (SCP Activity 8.3.1.4.3.2.1)

Work will also commence on attempting to modify the geostatistical simulation codes to accommodate the "soft" information provided by the microstratigraphic units known at Yucca Mountain. SNL staff will discuss the required interfaces to the geometric model being developed by USGS personnel. The initial Lynx model of the Topopah Spring Member of the Paintbrush Tuff, including its internal microstratigraphic zonation, is scheduled to be completed by the USGS in April. (SCP Activity 8.3.1.4.3.2.1)

Issues/Potential Problems Needing Resolution and Potential Impacts

Discussions with the M&O design team involved in the design of the entry point from the north ramp to the ESF main drift indicate that there is still confusion surrounding the use of thermal/mechanical stratigraphy and conventional geologic stratigraphy. Many design requirements are specified in terms of thermal/mechanical contacts or units because the underlying analyses, conceptual design work, and other documents have used this terminology. Given the potential for confusion and/or erroneous actions, clarity of terminology and information in all communications is extremely important.

1.2.3.2.7.1.1 LABORATORY THERMAL PROPERTIES

Status Report on Ongoing Activities

Calibration of the C-Matic low temperature (LT) instrument using the moisture containment cell was completed and verified in accordance with TP-202. All procedures are in place to begin the baseline-test condition study to determine the effects of sample saturation on thermal conductivity. This study will be performed as outlined in experiment procedure (EP)-41, "Saturation Effects on Thermal Conductivity." Three samples of welded devitrified tuff and three samples of nonwelded zeolitic tuff will be used for this study. The thermal conductivity of each sample will be measured at nominal temperatures of 30°C, 50°C, and 70°C, at five different saturation states (fully saturated, oven-dry, air-dry, and two other intermediate states). The purpose of this study is to establish baseline-test conditions for site characterization activities as discussed in Study Plan 8.3.1.15.1.1, "Laboratory Thermal Properties." (SCP Activity 8.3.1.15.1.1.3)

Acquisition of rock crushing and grinding equipment is in process. This equipment will be used to prepare powdered rock samples for chemical analysis and mineralogic determination by X-ray diffraction. These analyses will be used to aid in the interpretation of the thermal conductivity data. (SCP Activity 8.3.1.15.1.1.1)

Thin sections prepared by the University of New Mexico (UNM) to support the analysis of thermal and mechanical data are being compiled. Although the results of the thin-section analyses have been published in SAND reports, the petrography, petrology, and chemistry have not been examined by thermal/mechanical unit and compared with the current definition of the units. (SCP Activity 8.3.1.14.1.1.1)

Major Activities Upcoming Next Three Months

Testing activities for the scoping study on the effects of saturation on thermal conductivity will be initiated. (SCP Activity 8.3.1.15.1.1.3)

The rock crushing and grinding equipment for preparation of powdered rock samples will be installed at UNM.

1.2.3.2.7.1.2 LABORATORY THERMAL EXPANSION TESTING

Status Report on Ongoing Activities

Three thermal expansion measurements were completed using a one-inch sample from drill hole USW-G1, thermal/mechanical unit TSw1 (388.8 ft). The purpose of these preliminary tests is to determine the maximum heating rate (≤1°C) that accurately identifies the temperatures at which α-β polymorphic transformations of tridymite and cristobalite occur. The instantaneous coefficient of thermal expansion (CTE) increases at these inversion temperatures. The process is reversible, although only one reversion temperature was measured. The same sample was used for the three tests; the temperature range tested was from ambient to 325°C. The results of the thermal expansion tests follow:

Run	Heating Rate (°C/min)	Tridymite Inversion Temperature (°C)	Instantaneous CTE 10^{-6}/°C	Cristobalite Inversion Temperature (°C)
1	0.25	~145-163	~11-32	~210-250
2	0.25	~135-150	~13-35	~160-175
3	1	~135-150	~13-35	~160-275

Run	Instantaneous CTE 10^{-6}/°C	Reversion Temperature (°C)	Instantaneous CTE 10^{-6}/°C
1	~25-53	~140-120	~-32 to -63
2	~33-54	~140-120	~-37 to -63
3	~33-57	~145-120	~-38 to -68

These tests indicate the history of the sample may have significant effect on the inversion temperatures of tridymite and cristobalite. The significant shifting of the inversion temperature (from ~250°C to ~175°C) for the cristobalite transformation that occurred after the first run is not understood. The shift may be due to interactions with impurities in the rock. The tests are being repeated using a four-inch sample from the same location in USW-G1. (SCP Activity 8.3.1.15.1.2.1)

Major Activities Upcoming Next Three Months

A baseline-test condition study on the effects of sample size on thermal expansion will be initiated after the heat-up rates are established and the relevant procedures are issued. (SCP Activity 8.3.1.15.1.2.1)

1.2.3.2.7.1.3 LABORATORY DETERMINATION OF MECHANICAL PROPERTIES OF INTACT ROCK

Status Report on Ongoing Activities

New England Research, Inc. (NER) is conducting a study of time-dependent deformation involving high-temperature experiments at creep and low strain rate conditions. The most recent series of experiments consists of at least six samples of TSw2 to be tested at a pore pressure of 4.5 MPa, a confining pressure of 5 MPa, and a maximum constant differential stress of 80 MPa. Initially, the experiments are performed at room temperature and then at 250°C. The third experiment was initiated in early March. The sample has been loaded at room temperature in a series of four increasing constant differential stresses (50 MPa, 60 MPa, 70 MPa, and 80 MPa) over a two-week period. This sequence was followed by an increase in the test temperature and the beginning of creep loading of the sample under the same stepped approach to loading as used in the ambient temperature phase of this experiment. No creep (inelastic deformation in response to the constant loading) has been observed as yet. The test sequence will be continued into April, until the loading reaches at least 80 MPa. (SCP Activity 8.3.1.15.1.3.2)

An SNL staff member was in White River Junction, VT, on March 3 and 4 to meet with the staff at NER. The discussions centered around results from testing for time-dependent mechanical properties and to examine core from drill hole NRG-6 in preparation for the initiation of sample testing. (SCP Activities 8.3.1.15.1.3.1 and 8.3.1.15.1.3.2)

The paper, "Influence of Strain Rate and Sample Inhomogeneity on the Moduli and Strength of Welded Tuff" was submitted to the YMP for programmatic review on March 15 (Milestone 0S47).

Major Activities Upcoming Next Three Months

R. Price of SNL and two members of the NER staff will be in Las Vegas, NV, on April 26 through 30 to attend the 1993 International High-Level Radioactive Waste Management Conference. They will be presenting a paper entitled "Characterization of Porosity in Support of Mechanical Property Analysis." (SCP Activities 8.3.1.15.1.3.1 and 8.3.1.15.1.3.2)

The paper, "Influence of Strain Rate and Sample Inhomogeneity on the Moduli and Strength of Welded Tuff" will be presented at the 34th U.S. Symposium on Rock Mechanics in June.

1.2.3.2.7.1.4 LABORATORY DETERMINATION OF THE MECHANICAL PROPERTIES OF FRACTURES

Status Report on Ongoing Activities

A series of experiments were performed under triaxial conditions to compare the results from this experiment technique to the results observed using the rotary friction method. Rough fractures were created in three right-circular cylinders at an inclination of ~30 degrees to the cylinder axes by line loading. These samples were tested at constant normal stress by initially loading the sample in hydrostatic compression and then constantly decreasing the confining pressure while loading the sample axially. The data on stiffness, dilatancy, and strength are being analyzed. (SCP Activity 8.3.1.15.1.4.2)

SAND92-2333, "The Effect of Sliding Velocity on the Mechanical Response of Artificial Joints in Topopah Spring Member Tuff," is being revised in response to comments generated during technical and editorial review. (SCP Activity 8.3.1.15.1.3.2)

Major Activities Upcoming Next Three Months

A revised version of Study Plan 8.3.1.15.1.4, "Laboratory Determination of the Mechanical Properties of Fractures," will be submitted to the Project Office early in April. (SCP Activities 8.3.1.15.1.4.1 and 8.3.1.15.1.4.2)

1.2.3.6.2.1.6 FUTURE REGIONAL CLIMATE AND ENVIRONMENTS

Status Report on Ongoing Activities

A draft transition plan for consolidating future climate modeling work at SNL is nearing completion. The transition plan is intended to consolidate all regional and global climate modeling work under the auspices of one technical participant.

Major Activities Upcoming Next Three Months

A presentation on the future climate modeling activity is planned for the April 20 and 21 Nuclear Waste Technical Review Board (NWTRB) meeting in Reno, NV. The DOE approach to resolving technical issues using the effects of future climate on infiltration, as an example, will be discussed.

1.2.4 REPOSITORY

The objective of the Repository element includes work scope related to the repository component of the physical system including the repository operations system, the underground facility component of the engineered barrier system, the access/borehole seals, and the monitoring system component of the performance evaluation system. The Repository element is comprised of nine tasks: Repository Coordination and Planning (1.2.4.1.1), Excavation Investigations (1.2.4.2.1.1.1), In Situ Thermomechanical Properties (1.2.4.2.1.1.2), In Situ Mechanical Properties (1.2.4.2.1.1.3), In Situ Design Verification (1.2.4.2.1.1.4), Rock Mass Analyses (1.2.4.2.1.2), Certification of Design Methods (1.2.4.2.3.1), Design Analysis (1.2.4.2.3.2), and Sealing and Design Requirements (1.2.4.6.1).

1.2.4.1.1 REPOSITORY COORDINATION AND PLANNING

Status Report on Ongoing Activities

Study Plan 8.3.1.15.1.5, "Excavation Investigations," (Milestone SNL001) was submitted to the Project Office for review at the end of February. Work on the initial drafts of Study Plans 8.3.1.15.1.6, "In Situ Thermomechanical Properties," and 8.3.1.15.1.7, "In Situ Mechanical Properties," continued. SNL staff initiated a series of meetings with Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory (LANL) staff to develop an integrated set of thermal/structural/hydrological tests. The first meeting on March 17 resulted in a decision to try to combine the sequential drift mining experiment (Study Plan 8.3.1.15.1.5) and the heated room test (Study Plan 8.3.1.15.1.6) with the revised LLNL waste package environment test. Both SNL and LLNL will examine test requirements and come to the next meeting prepared to evaluate options for combining the tests. It is expected that the integrated tests will be defined in FY93 so that study plans can be completed in FY94.

SNL staff continues to work with M&O personnel and staff from LLNL to develop a plan for resolving numerous issues related to the thermal loading of the potential repository. SNL staff reviewed LLNL hydrothermal modeling techniques and results and provided a detailed written summary to the M&O. The first working group meeting to address revision of the Site Characterization Plan (SCP) thermal goals for repository design was held in Denver, Colorado. Subgroups were identified to begin work on various aspects of the thermal goals issue. This is a critical step in defining the thermal envelope for Advanced Conceptual Design (ACD) studies and for defining key information that needs to be obtained from the testing program.

SNL staff initiated a series of analyses in support of the design of the ESF north ramp. Three-dimensional thermal and structural analyses of the repository to assess the impact of the potential repository thermal loading on the ESF drifts is almost complete. These results will support two-dimensional analyses of several cross sections of the ESF north ramp to evaluate long-term stability. The analyses are expected to provide input for the 90% design review in August 1993.

Major Activities Upcoming Next Three Months

Significant effort will be required to implement the geotechnical monitoring effort in the starter tunnel (Study Plan 8.3.1.15.1.8).

Issues/Potential Problems Needing Resolution and Potential Impacts

Funding for WBS 1.2.4.2.1.1.4, Starter Tunnel Construction Monitoring, has not been received by SNL. Currently SNL is spending Coordination and Planning funds from WBS 1.2.6.1.1 to support planning and initial procurements. Funding for this effort is becoming critical. Work cannot be continued much longer without designated funds.

1.2.4.2.1.1.1 EXCAVATION INVESTIGATIONS

Major Activities Upcoming Next Three Months

Staff will work with Project Office reviewers to finalize Study Plan 8.3.1.15.1.5, "Excavation Investigations."

1.2.4.2.1.1.2 IN SITU THERMOMECHANICAL PROPERTIES

Status Report on Ongoing Activities

Staff continued work on the rough draft of Study Plan 8.3.1.15.1.6, "In Situ Thermomechanical Properties."

The SAND report "Test Instrumentation Requirements for the ESF In Situ Thermomechanical Experiments" is undergoing internal SNL technical review.

Major Activities Upcoming Next Three Months

Staff will continue drafting Study Plan 8.3.1.15.1.6.

Staff will produce a final draft of the SAND report in response to reviewers.

Under LANL coordination, SNL and LLNL staff will work to consolidate SNL's ESF thermomechanical testing with LLNL's hydrothermal testing, if possible.

1.2.4.2.1.1.3 IN SITU MECHANICAL PROPERTIES

Status Report on Ongoing Activities

Staff continued work on the rough draft of Study Plan 8.3.1.15.1.7, "In Situ Mechanical Properties."

Major Activities Upcoming Next Three Months

Staff will continue drafting Study Plan 8.3.1.15.1.7.

1.2.4.2.1.1.4 IN SITU DESIGN VERIFICATION

Status Report on Ongoing Activities

"Construction Monitoring Activities in the Yucca Mountain ESF Starter Tunnel," an extended abstract for a special session on Yucca Mountain of the 34th U.S. Rock Mechanics Symposium, was written and submitted for internal SNL technical review.

SNL staff completed a technical review of the Test Planning Package and the Job Package for construction monitoring of the ESF north ramp starter tunnel. The monitoring plans include seismic monitoring for blasting, rock quality determination, ground support system performance evaluations, and excavation closure monitoring for stability assessments.

Major Activities Upcoming Next Three Months

Staff will continue to plan construction monitoring activities and procure and design instrumentation and a data acquisition system to field the tests. Staff will work with the Test Coordination Office to produce final drafts of the Test Planning Package and the Job Package. Tests will be fielded as the north ramp starter tunnel construction proceeds.

The extended abstract will be finalized in response to comments from reviewers, and a presentation of construction monitoring activities will be made at the 34th U.S. Rock Mechanics Symposium (June 27 through 30).

Issues/Potential Problems Needing Resolution and Potential Impacts

Funds to support the construction monitoring effort have not been received to date, so these activities are being reported under WBS element 1.2.6.1.1.

1.2.4.2.1.2 ROCK MASS ANALYSES

Status Report on Ongoing Activities

Laboratory work continued on the experiments involving small polycarbonate models. Successful application of the method developed over the last several months requires a better set of data than obtained during previous experiments with an older data acquisition system. This month a new experiment was performed to obtain the quality of data needed and to study the loading/strain symmetry around the hole. A new sample was prepared with the active area of the Moiré grid centered around the hole. The data from this experiment will be analyzed in April. A new pair of loading platens were built to load the sample in a direction inclined at 10 degrees to the plates. An experiment using this inclined loading will be performed in April and analyzed in May.

A report entitled "Geometrical Moiré Method of Strain Analysis with Displacement Discontinuities" is in preparation and will be completed next month. This report describes the methods and software developed to acquire and analyze the data for this application.

A study of the surface characteristics of natural fractures and how these characteristics relate to the frictional data for replicas on the surfaces is continuing. This study will determine whether the fitting parameters in the Barton model for frictional behavior have physical significance by investigating the effect on fracture shear strength and dilation with variation in three parameters: normal stress, roughness, and the strength of the rock material. The majority of the experimental work is being done by a University of Colorado (CU) graduate student in the Geomechanics Department Laboratory at SNL. The series of eleven rotary shear experiments was completed in March. The results are being organized, analysis will continue for the next several weeks, and the data will be presented in a SAND report.

A series of experiments to study the effects of a nonstandard loading condition on frictional properties was conducted at CU in 1992. SAND92-1853 "Effect of Boundary Conditions on the Strength and Deformability of Replicas of Natural Fractures in Welded Tuff: Data Report," which details the experiment techniques and resulting data, has completed management review and is being revised. SAND92-2247, "Effect of Boundary Conditions on the Strength and Deformability of Replicas of Natural Fractures in Welded Tuff: Comparison Between Predicted and Observed Behavior," has completed technical review and is in management review. A second analysis report is being drafted and should begin SNL review in April.

SNL's plans to support the M&O's design efforts for the north ramp have been finalized. J.F.T. Agapito and Associates will work with SNL to calculate the temperatures, thermal loads, and seismic loads that the north ramp is expected to experience. Linear and nonlinear static analyses will be conducted at approximately five locations along the ramp. The dynamic analyses to assess the effects of a 0.75g earthquake will be conducted at three locations: upper, middle, and lower portions of the ramp.

Major Activities Upcoming Next Three Months

Testing, data reduction, and analysis will begin for a set of layered plate experiments.

R. Price (SNL) will visit CU staff on April 19, 1993, to discuss the progress on the data and analyses reports and the results from the ongoing study.

Static and dynamic analyses will be conducted to support the design of the north ramp.

1.2.4.2.3.1 CERTIFICATION OF DESIGN METHODS

Status Report on Ongoing Activities

The report "Use of an Iterative Solution Method for Coupling Finite Element and Boundary Element Modeling" was submitted to the YMP for programmatic review on March 18, 1993 (Milestone 0S20).

The implementation of JAC3D, a three-dimensional finite-element code, on SNL's YMP local area network (LAN) has been completed. The verification problems have been run and the documents have been submitted for QA certification.

Work at CU continues. This work will fit the experimental data developed in WBS 1.2.4.2.1.2 to a constitutive model that can be used for analyses. Plesha's joint constitutive model has been implemented and an apparent error in the model has been found. CU students are working with the model's developers at the University of Wisconsin to address the discrepancies.

In other work at CU, modifications to the discrete-element code DDA are being implemented to explore the concept of breaking rock blocks into sub-blocks to obtain better accuracy. At SNL, the equations for the blocks have been reformulated to facilitate the sub-block concept, and general penalty and Lagrangian formulations have been derived for the constraints. Workers at CU have implemented a simple penalty method and have run several problems employing the sub-block concept. An augmented Lagrangian formulation will be considered next in which both penalty and Lagrangian constraints are used. This technique will retain the simplicity of the penalty method while minimizing the ill effects of penalty methods.

In a separate activity, the coupled finite-element/boundary-element research is progressing. This month, the iron-beryllium technology has been updated to an incremental form so that nonlinear problems can be addressed. This formulation was checked using pressurized tube and pressurized cavern problems. These are both linear problems. Next month, staff will begin addressing nonlinear problems.

Major Activities Upcoming Next Three Months

QA certification of JAC3D and UDEC will be sought.

1.2.4.2.3.2 DESIGN ANALYSIS

Status Report on Ongoing Activities

The development of near-field thermal/structural/seismic models in support of the ESF north ramp design continued.

Major Activities Upcoming Next Three Months

SNL staff will complete the thermal/structural calculations supporting ESF design. Analyses will include far-field thermal evaluations of proposed repository layouts as well as near-field structural evaluations of the north ramp.

1.2.4.6.1 SEALING DESIGN AND DESIGN REQUIREMENTS

Status Report on Ongoing Activities

Staff continued to finalize SAND92-0960, "Initial Seal Test Definition of Subsurface Sealing and Backfilling Tests in Unsaturated Tuff." Focus was on consistency among different portions of the report and development of check prints for all figures. Tables defining the instrumentation to be used for each test were all proofed and Chapters 2 and 3 were reorganized based on final editorial and author reviews.

A review of WA-0007, "Review of Backfilling and Sealing Activities Performed by DNA and Others at the NTS," was performed. Three areas were reviewed and discussed: schedule for completion, review of the draft letter report on WA-0007, and the needed text for relevant photographs.

1.2.5 REGULATORY

The objective of the Regulatory element is to assure site-related compliance with Nuclear Regulatory Commission agreements, requirements, and policies; evaluate the performance of the natural barriers, engineered barriers, and total systems for meeting regulatory standards; and manage, maintain, and accumulate technical data and information produced by site characterization, design development, and performance assessment activities for the project. The Regulatory element is comprised of 11 tasks: Regulatory Coordination and Planning (1.2.5.1), Site Characterization Program (1.2.5.2.2), Technical Database Input (1.2.5.3.5), Total System Performance Assessment (1.2.5.4.1), Repository Performance Assessment (1.2.5.4.3), Site Performance Assessment (1.2.5.4.4), Interactive Graphics Information System (1.2.5.4.5), Development and Validation of Flow and Transport Models (1.2.5.4.6), Support Calculations for Postclosure Performance Analyses (1.2.5.4.7), Development and Verification of Flow and Transport Codes (1.2.5.4.9), and Special Projects (1.2.5.5).

1.2.5.1 REGULATORY COORDINATION AND PLANNING

Significant Meetings Attended

Personnel from SNL, the Project Office, and the M&O met on March 3 to continue coordination of the FY93 total-system performance assessment. The group suggested revisions to the outline proposed for the final document and arranged for technical staff to make contacts for communication among participants.

Management coordination of technical staff work for the performance-assessment presentation took place this month. The presentation, reported under WBS 1.2.5.4.1, was a pair of one-day workshops designed to foster communication between workers in performance assessment and site characterization.

Major Activities Upcoming Next Three Months

The FY94 budget process will require significant effort from the SNL managers and task leaders for regulatory activities.

1.2.5.2.2 SITE CHARACTERIZATION PROGRAM

Staff attended planning meetings to prepare for the presentation to the NWTRB in April. Staff provided responses to the NRC's review comments of the SCP.

SNL input to the Semiannual Progress Report was developed and telecommunicated to the YMP on March 30.

1.2.5.3.5 TECHNICAL DATABASE INPUT

Major Accomplishments

The preliminary FY94 budget for Technical Data Base Input was submitted to M&O/TRW.

Major Activities Upcoming Next Three Months

Staff will meet with Geographic Nodal Information Study and Evaluation System (GENISES) personnel to discuss database information exchanges.

Staff will meet to discuss FY94 budget needs for Technical Database Input.

Issues/Potential Problems Needing Resolution and Potential Impacts

Modification of Technical Data Information Forms (TDIFs) is required to facilitate usage by technical personnel.

Other Items to Report

The transfer of funds from WBS 1.2.3.x "Reserve" into WBS 1.2.5.3.5 will result in additional FY93 funds of $60,000 earmarked for the processing of backlog TDIFs.

1.2.5.4.1 TOTAL SYSTEM PERFORMANCE ASSESSMENT

Major Accomplishments

SAND91-1653, "Scenarios Constructed for Basaltic Igneous Activity at Yucca Mountain and Vicinity," by G. Barr, E. Dunn, H. Dockery, R. Barnard, G. Valentine, and B. Crowe, was submitted to the Project Office for programmatic review (Milestone M125).

Significant Meetings Attended

On March 8, SNL staff met to discuss colloid-facilitated transport with C. Degueldre, a consultant to NAGRA on the Grimsel project, at LANL. Information was obtained on a number of technical details, such as the apparent inverse relationship between the amount of calcium and natural colloids in groundwater.

The SNL Performance Assessment (PA) group spent two days participating in the "PA Road Show" sponsored by the DOE Project Office. The objective of the meetings, one at LANL and one at USGS, was to establish and enhance technical interactions among participants. The SNL presentations were designed to provide the participants with an understanding of the PA process and to discuss details of ongoing analyses in their specific areas of interest. The SNL presentations were followed by brief discussion of the PA needs of the project's M&O contractor and presentations of ongoing work by the host organization.

At the first road show, on March 17, J. Gauthier, R. Barnard, and H. Dockery made presentations at LANL. The emphasis was on geochemical issues related to repository performance. The topics identified for further interaction include how to tie groundwater chemistry to sorption data, the ability of manmade materials to form colloids, how to use information from natural analogs, and the potential for alteration of water composition near a waste package after emplacement. In addition, workers from LANL agreed to visit SNL to provide distributions for solubility and K_ds to use in the second cycle of total-system PA. An expert elicitation has been planned for mid-April.

The second road show was at the USGS in Denver, CO, on March 26. The visit focused on the treatment of unsaturated- and saturated-zone hydrology. Presentations by SNL were made by G. Barr, J. Gauthier, and H. Dockery. Several visits were also set up with the USGS to check the data set for the second cycle of total-system PA and to ensure that the

geostatistical representations of the tuff units are as reasonable as possible.

Several SNL staff members attended the "CASY" meeting on thermal loading sponsored by the USGS in Denver, CO, on March 23 through 25. G. Barr made a presentation on "Thermal Loading, the Performance Assessment Perspective." He presented the view of PA analysts that the idealized calculations of Buscheck and Nitao of LLNL must be modified to consider details of the geology and hydrology of Yucca Mountain. Important details that effect both the thermal load and the power density are bounding faults, layering of hydrogeologic units, and the effects of the thermal "footprint" of the repository below the water table. Until these and other details identified by the CASY panel are included in the model, any conclusions about thermal load and power density are premature.

Staff met with J. Long from Lawrence Berkeley Laboratory (LBL) on March 22 to discuss the usefulness of correlating fracture coatings with age of groundwater and amount of recharge occurring in fractures.

SNL staff attended a meeting in Richland, WA, on March 31 to April 1 convened by the YMP M&O contractor on the software requirements for the AREST code. Personnel from Pacific Northwest Laboratory (PNL) presented information about the capabilities of the current version of AREST and about other research on spent-fuel chemistry, geochemistry, thermal modeling, and corrosion. Information was solicited on how to embellish the next generation of AREST to provide capabilities for future TSPA analyses. If all capabilities listed in the draft specifications document were included in the new AREST, it would be able to handle all currently known aspects of near-field analyses. It was recognized, however, that the code would be so cumbersome that it would not be able to provide input to stochastic TSPA runs. As a result, "phased" development of the code, with incremental enhancements, will be pursued.

Status Report on Ongoing Activities

Scenario development:

Drafting of all drawings for the nominal-flow scenarios is about half complete. The Principal Investigator (PI) is about two-thirds finished checking the text against all drawings for consistency. Drafting is proceeding rapidly, and the text is essentially complete. The nominal-flow scenarios have turned out to be more extensive than originally envisioned, and the work is taking somewhat longer than planned.

Second cycle of the TSPA:

An effort is underway to improve the weeps model to include variable fracture sizes and locations within a given realization used for calculating the aqueous and gaseous release portions of the TSPA.

Interactions have been initiated with LANL on a test problem to explore colloid transport. Results of this problem will be presented at the colloid workshop sponsored by LANL in May 1993.

A contract to S-Cubed for the services of Dr. R. Nilson has been placed, and work on barometric pumping was initiated this past month. The objective of this study is to develop a model for moisture (liquid and vapor) movement in fractured media driven by fluctuations in barometric pressure. So far, SNL has been reviewing prior work on vapor flow performed for the YMP by LBL, LLNL, and Disposal Safety, Inc. (DSI). The range of fracture permeabilities in use by these groups is somewhat surprising, and the available data are being researched more closely.

SAND93-0852, "The Appropriateness of One-Dimensional Yucca Mountain Hydrologic Calculations" by R. Eaton, has been written to help define the calculational regimes in which one-dimensional calculations are appropriate for approximating the flow of water through Yucca Mountain for TSPA calculations. The report is in technical review.

Currently, all calculations being made in support of the TSPA study are computed using solutions to the Richards' equation, which describes isothermal single-phase water transport in porous media. A study is being initiated to investigate the effect of multiphase transport of water. This study will emphasize questions regarding the possible significance of including multiphase transport in TSPA analysis. An input data deck for the multiphase code TOUGH has been obtained from T. Buscheck (LLNL). An attempt will be made to run this case on the SNL version of the TOUGH code.

A calculation was made to look into whether Cigar Lake would be a good natural analog to validate the total-system calculations performed using the total-system simulator. Preliminary results indicated that the releases from the ore body might approach the

U.S. Environmental Protection Agency (EPA) limits. However, the doses from the system appear to be very low.

SAND92-2431, "Review of Radionuclide Source Terms used for Performance-Assessment Analyses," by R. Barnard, was modified to add information suggested by technical reviewers. The report completed management review and will be submitted to YMP for project review in April 1993.

1.2.5.4.3 REPOSITORY PERFORMANCE ASSESSMENT

Significant Meetings Attended

SNL and M&O personnel met to define analyses needed to support the ongoing thermal loading systems study. Near- and far-field thermal and thermal/mechanical analyses were discussed; however, specific study definitions have yet to be established.

SNL staff attended the USGS CASY symposium in Golden, CO on March 24 and 25. Calculations documenting the effect of general repository layout on predicted thermal response were presented.

Status Report on Ongoing Activities

A preliminary evaluation of the LLNL "extended dry" calculations has been completed and transmitted to the M&O. The evaluation specifically addresses those aspects of the modeling assumptions used by LLNL that affect the calculation of heat transfer. The transmitted results are currently being reviewed by LLNL and M&O personnel.

Progress continued on the setup of thermal analyses defined to support the 90% design review of the ESF north ramp. Input for the required far-field thermal models is being prepared, and it is expected that thermal results will be available for detailed structural calculations within the next four to six weeks.

1.2.5.4.4 SITE PERFORMANCE ASSESSMENT

Significant Meetings Attended

An SNL staff member met with J. Beckett at Edgerton, Germeshausen, & Grier Corp. (EG&G) on March 2 to review the contents of the GENISES database and in particular the available Geographic Information System (GIS) data. Discussion of the GENISES database included data sources, item definitions, scale, and other information pertinent to the integration of GENISES with the Performance Assessment Data Base (PADB). The results of the discussion will help facilitate the use at SNL of the GENISES data. GENISES comprises two databases, a geographic information system and a relational database management system (RDBMS). The geographic or spatial component uses the ARC/INFO GIS software. The tabular or drill-hole data use the INGRES RDBMS software. There is a relational link between the drill-hole and the geographic databases.

Status Report on Ongoing Activities

INTRAVAL:

The third INTRAVAL data set was received. The major component of the new data set is re-measurement of moisture-retention data. Both van Genuchten and gamma functions were fit to the new moisture-retention data. The results are much closer to other moisture-retention data sets.

The parameters from the Scott and Bonk cross sections were used in an indicator simulation based on welded and nonwelded classes. The vertical-to-horizontal anisotropy was changed from an initial guess of 100:1 to 10:1 measured from Scott and Bonk, which produced poor results. After some trials, 40:1 was used, as it provided results that better match intuition. The 10:1 measurement may be due to the non-regular grid used in discretizing the Scott and Bonk cross sections, or there may be a problem in the simulation due to the high anisotropy and sparsity of data.

An indicator simulation for the east-west INTRAVAL cross section was run using welded, nonwelded vitric, and nonwelded zeolitic as the three indicators. The results are postprocessed into five distinct units with topographical surface added. Work is beginning on generating porosities for the five units.

Geostatistical support for the TSPA:

Ten indicator simulations were completed to provide the basis for the TSPA stratigraphies. Using the Scott and Bonk parameters produced results that could not be automatically interpreted by the program GUAM, so GUAM was modified to assist in hand-picking the breakpoints between units. Breakpoints were determined for the nine columns in each of the ten simulations. Documentation of the stratigraphy has begun. Work has begun on two-dimensional stratigraphies for the gas-flow calculations based on the indicator simulations.

A major transition was made this month from the summarization of Yucca Mountain borehole descriptive logs and data acquisition to the initiation of data analysis that will provide the probability distributions to the TSPA analysts.

Geohydrologic data analysis:

This phase of the performance-assessment task was initiated with the recalculation of the van Genuchten curves and parameters based on the saturation and water-retention data from desaturation tests for drill holes USW G-4 and USW GU-3 as reported in Peters et al. (1984) and Golder Associates INTRAVAL data. The 131 sets of calculations were required to provide van Genuchten values for each discrete set of data. The results in Peters et al. grouped as many as three sets of data together and derived van Genuchten values based on combined sets. For our purposes, discrete probabilities for each set of data are necessary. The probability distributions will provide the performance-assessment modelers with one set of parameters for their analysis. Additional sets of desaturation data from Rutherford et al. (1992) will be analyzed. These sets will add USW G-1 data and an additional examination of USW GU-3 and G-4.

A reexamination of fracture data has been initiated to determine the extent of additional fracture distributions that might be added for this year's TSPA. The most important needs appear to be a better distribution of fracture apertures. Because the data on actual measured fractures are limited, the approach will back out the aperture values from bulk-permeability and fracture densities.

The SNL geotechnical staff members that have been redescribing the Yucca Mountain stratigraphy and

providing the hydrologic probability-distribution parameters for the current TSPA exercise made a geologic reconnaissance of Yucca Mountain area: Prow Pass and Busted Butte. An SNL staff member led the trip and provided an experienced overview of the geology. The purpose was to gain familiarity with the geology in the field and to understand more easily the historical descriptions in the literature. Special attention was given to the Prow Pass welded and nonwelded sequences. The Prow Pass sequence poses some question on its influence to the overall performance assessment because of its degree of welding and commensurate porosity. Additionally on this visit, the USW GU-3 core was examined, again to better understand its descriptions in the literature and in the field.

Data and GIS management

As a result of the meeting with EG&G, documentation will be sent describing the ARC/INFO coverage that EG&G has provided to SNL. At the same time, a tape containing new spatial data for Yucca Mountain will be sent. In the past, EG&G has provided SNL with raw data which has had to be processed back into the ARC/INFO format. Processing data back into the ARC/INFO format can be time consuming and inaccurate when documentation for the processed data is unavailable. EG&G provides raw data (i.e., not classified spatial) because of the requirements for spatial data transfer outlined in the Federal Information Processing Standards Publication 173 (FIPS PUB 173). A more workable solution should be devised for transfer of spatial data from the Project Office (via EG&G) to SNL.

The staff is continuing to download GENISES data from the SUN to the personal computers (PCs), building an ARC/VIEW application file for PC ARC/VIEW users. Ten new coverages have been transferred to a PC format including flood-zone boundaries, tortoise sitings, TIGER road data, hydrologic basins, controlled-area boundary (CAB), perimeter-drift boundary (PDB), hydrology, streams, and topography (5 ft and 100 ft).

ARC/PLOTS and ARC/INFO item listings have been generated for all ARC/INFO coverages currently in SNL's GENISES database.

1.2.5.4.5 INTERACTIVE GRAPHICS INFORMATION SYSTEM

Major Accomplishments

A preliminary version of a GIS coverage representing the starter tunnel has been created and made available to ARCVIEW users.

An animation video was created from simulation data to show the changing values of rock properties over a 10,000-year period using PV wave.

Status Report on Ongoing Activities

Work continues on the development of the data dictionary for existing GIS coverage. Information on the GIS coverage is being added where possible. Other information will be obtained from GENISES when needed.

The GIS database was moved to a system server and networked workstations are being configured to access the new location.

The development of a series of coverages showing the starter tunnel, alcoves, and instrument locations has begun.

Major Activities Upcoming Next Three Months

A user environment will be planned and implemented to access data obtained from instruments in the tunnels at Yucca Mountain, thus providing users with several tools to manipulate, visualize, and output the data as needed.

The following jobs are in progress:

- Job 397 for D. L. Eley - Convert GTMs to ARC/INFO
- Job 398 for D. Guerin - Hydrogeologic drill holes
- Job 401 for L. H. Skinner - Contours of Yucca Mountain
- Job 404 for D. L. Eley - Create ESF starter tunnel plan
- Job 405 for C. A. Rautman - Rebuild TSw1 model per new input

1.2.5.4.6 DEVELOPMENT AND VALIDATION OF FLOW AND TRANSPORT MODELS

All activities addressed in this monthly status report support SCP Section 8.3.5.12.2.1.1. Activities supporting SCP Section 8.3.5.12.2.2.2 are not scheduled for FY93 and hence are not addressed.

Status Report on Ongoing Activities

Flow and transport through single fractures:

The following abstracts passed internal review and were accepted for presentation at the spring meeting of the American Geophysical Union (AGU) in Baltimore, MD, on May 24 through 28, 1993:

- "Gravity-Driven Fingering in Rough-Walled Fractures: Analysis Using Modified Percolation Theory," by R. J. Glass.
- "Infiltration Flow Instability in Unsaturated Fractures," by M. J. Nicholl and R. J. Glass.
- "Influence of Fracture Saturation and Wetted Structure on Fracture Permeability," by M. J. Nicholl and R. J. Glass.

Data submitted to the Data Records Management System (DRMS) for entry into the L19/-1/159 data set (activity 2, Unsaturated Fracture Flow) included

1. Logbook for the gravity-driven instability in a partially wetted fracture experiment (201 pages)
2. Logbook for the single finger in initially dry fracture experiment (1191 pages)
3. Eight-millimeter digital tapes containing raw image files for the following experiments:
   a. Full-field instability in unsaturated fracture
   b. Single finger in initially dry fracture
   c. Gravity-driven instability in a partially wetted fracture

Development of a methodology to produce epoxy casts of natural fractures continued. A natural tuff fracture cast last month was prepared for preliminary experimentation. Inflow and outflow manifolds for the fracture ends and seals for the fracture sides were manufactured. In April, seals and manifolds will be fixed and preliminary experimentation performed under saturated conditions. Work to refine the casting procedure and characterize the wetting properties of the cast surfaces will continue.

Preliminary experiments investigating the effects of air entrapment on fracture permeability and tracer migration continued. Development of image analysis techniques to delineate wetted structure within the analog fracture also continued. Manual control of inflow and outflow valves to the analog fracture was replaced by computer-controlled solenoid valves. Computer control of the inflow pump and measurement of outflow mass was also implemented. We will continue development of software to introduce a sharply defined tracer front into the analog fracture in April.

Fracture/matrix interaction:

This month, activities have been conducted relating to investigation of the influence of matrix imbibition on saturated fracture flow in thin experimental systems with the plane normal to the fracture. Efforts have been made to upscale the size of the fracture-matrix interaction experiments to use slabs of fractured tuff (natural and sawn fractures) measuring 1 ft by 2 ft by 1 in. To achieve this goal, a new test chamber is being built while improvements to experimental components and techniques are also being explored. Calibration studies are being made on the Seimens Polytron real-time X-ray unit (available through cooperative agreement with UNM) to develop a process whereby improved image contrast may be achieved. By achieving the desired contrast, a tool for imaging highly transient moisture content and solute concentration fields in tuffaceous materials will be available, thus greatly enhancing our current experimental capabilities. Efforts to model previous fracture-matrix interaction studies using LLUVIA-2 and NORIA-SP continued this month. These results will be presented at the 1993 International High-Level Radioactive Waste Management Conference.

Field, laboratory, and numerical experimentation to determine scaling laws for effective-media properties in heterogeneous media:

Construction of the automated gas permeameter was completed. Computer control of the positioning system and permeameter has been achieved. The last step of this effort will involve integrating the two systems and performing preliminary tests on the system. Efforts have also continued in the selection/development of a model for predicting the gas permeability based on permeameter data as well as

the development of a detailed strategy for collecting gas permeability data.

Development of field and laboratory experimental capabilities:

The Philips MG161 X-ray system has recently been received at SNL. A purchase order has also been submitted for an automatic X-ray film processor. These two pieces of equipment will provide the basis for the development of an X-ray imaging laboratory to enhance investigations of fluid flow and transport in tuffaceous materials. Current efforts are being made to address all associated health and safety issues related to the operation of this equipment.

1.2.5.4.7 SUPPORT CALCULATIONS FOR POSTCLOSURE PERFORMANCE ANALYSES

Status Report on Ongoing Activities

ESF performance assessment (PA) analysis number 13 is continuing. This analysis addresses concerns regarding underground water usage for dust control during excavation and fire fighting in the north ramp tunnels and future ESF tunnels. Previous analyses have been evaluated for their applicability to the concerns documented in WA-0062 and some calculations using NORIA-SP have been performed.

The calculations described in Problem Definition Memo (PDM) 72-32 to estimate the effects on repository performance of surficial water use in the controlled zone outside the repository will be documented in SAND92-2248; this report completed editorial and technical reviews, and has been submitted for management review.

Preliminary efforts for model validation exercises in isothermal flow in collaboration with WBS 1.2.5.4.6 continue. Preliminary calculations are being performed in conjunction with a series of experiments performed by Department 6115 investigating matrix/fracture interaction by modeling flow through a discrete fracture. Current investigations include using the LLUVIA-II and NORIA-SP codes and examining the sensitivity of these measurements to numerical grid design and material properties.

Preliminary efforts have begun for model validation exercises in nonisothermal flow in collaboration with WBS 1.2.5.4.3 and with the Department 6115 Flow Laboratory. A series of experiments using two constant temperature boundaries may begin in April. The code TOUGH-2 will be used for these early efforts.

Major Activities Upcoming Next Three Months

The report SAND92-2248 will be completed.

Testing and numerical simulations for the nonisothermal experiments planned with WBS 1.2.5.4.3 will begin.

Other Items to Report

A new ESF PA analysis (number 14) investigating the sensitivity of previous analyses to uncertainty in the hydrologic properties of the nonwelded Paintbrush Tuff has been postponed until May or June.

1.2.5.4.9 DEVELOPMENT AND VERIFICATION OF FLOW AND TRANSPORT CODES

Significant Meetings Attended

SNL software QA staff completed the Software Quality Engineering Class (CS774). This class met half-days for a week and was very informative and helpful.

Status Report on Ongoing Activities

Software QA (no SCP activity):

SNL software QA staff are conducting weekly software Quality Action Team (QAT) meetings.

In an ongoing activity, QAIP 3-2 is being revised.

SNL staff are in the process of writing QA documentation for TOUGH2.

Processing of software QA records is continuing.

1.2.5.5 SPECIAL PROJECTS

Status Report on Ongoing Activities

Work consisted of minor planning activities directed at DOE consultation with the National Academy of Sciences. Additional efforts will take place after the plans reach final form.

Major Activities Upcoming Next Three Months

Products for delivery to the DOE will be prepared after their scope and format have been decided.

1.2.6 EXPLORATORY STUDIES FACILITY

The objective of the Exploratory Studies Facility element includes work scope related to the design, construction, and operation of the Exploratory Studies Facility. The Exploratory Studies Facility element includes the Exploratory Studies Facility Coordination, Planning, and Technical Assessment (1.2.6.1.1) task.

1.2.6.1.1 ESF COORDINATION, PLANNING, AND TECHNICAL ASSESSMENT

Significant Meetings Attended

SNL staff held discussions with LLNL and LANL personnel on consolidation of SNL's ESF thermomechanical testing with LLNL's hydrothermal testing. Candidates for test consolidation were identified and an approach to determine whether consolidation was possible was agreed upon.

Status Report on Ongoing Activities

SNL staff continued work on construction monitoring plans for the ESF north ramp starter tunnel. The monitoring plans include seismic monitoring for blasting, rock quality determination, ground support system performance evaluations, and excavation closure monitoring for stability assessments.

Major Activities Upcoming Next Three Months

Under LANL coordination, SNL and LLNL staff will work to consolidate SNL's ESF thermomechanical testing with LLNL's hydrothermal testing, if possible.

Issues/Potential Problems Needing Resolution and Potential Impacts

Although a change request has been submitted to fund WBS 1.2.4.2.1.1.4 for the construction-monitoring activities described above, the funds have not been received to date. These activities are being conducted and reported under WBS 1.2.6.1.1.

1.2.9 PROJECT MANAGEMENT

The objective of the Project Management element includes work scope related to project-level planning and control, and management of contract activities. The Project Management element includes two tasks: Technical Project Office Management (1.2.9.1.2) and Project Control (1.2.9.2.2).

1.2.9.1.2 TECHNICAL PROJECT OFFICE MANAGEMENT

Status Report on Ongoing Activities

SNL staff participated in a number of Project-related meetings.

Staff supported public outreach by judging a science fair at a local elementary school and a public site tour.

1.2.9.2.2 PROJECT CONTROL

Status Report on Ongoing Activities

An FY93 milestones database and report were created. Work is progressing on identification of FY94 milestones and preparing for the FY94 planning and budget exercise. P&S accounts have been established and charge requests submitted in preparation for commencing work in WBS elements 1.2.3.2.6.2.1, 1.2.3.2.6.2.2, and 1.2.3.2.6.2.3.

The Person Database is in a test phase and has been linked successfully to the Records Management System (RMS) database, thereby creating the first major integrating interface for the entire information and configuration management system.

Considerable effort was devoted to reconciling FY93 capital equipment expenditures and budget.

Significant Meetings Attended

Members of the SNL YMP Project Management Staff attended the first PACS Participant Workstation Users meeting in Las Vegas, NV, on Wednesday, March 3.

Major Activities Upcoming Next Three Months

Work in April will concentrate on initiating the FY94 budget and planning exercise and on the support to the next Semiannual Socio-Economic Monitoring Program Report. Project control staff will attend an SNL/YMP Technical Integration Retreat as well as a three-day Project Management workshop. The Procurements database will be revised to reflect the FY93 WBS structure.

Issues/Potential Problems Needing Resolution and Potential Impacts

SNL is still awaiting official notice that funding has been received to support newly designated activities in the 1.2.3.2.6.2 elements and the additional support provided under 1.2.4.2.1.1.4.

The current costs accrued in elements under 1.2.1 are approximately $2,000,000 over budget. This is an error in the crosswalk between the new WBS structure and the B & R codes. This will corrected in the near future.

1.2.11 QUALITY ASSURANCE

The objective of the Quality Assurance element includes work scope related to the development and maintenance of project participants' assurance programs consisting of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geologic repository and monitored retrievable storage facility will be met and complies with Federal regulations.

1.2.11 QUALITY ASSURANCE

Major Accomplishments

A surveillance which examined the planning and preparation for field data collection during the north ramp starter tunnel construction was conducted. This included an evaluation of the adequacy to begin work. Some additional attention to the content of planning documents for scientific notebooks was found necessary.

QAIP 1-5, "Establishing Work Agreements," QAIP 20-1, "Technical Procedures," and QAIP 20-2, "Scientific Notebooks" were issued to support upcoming scientific investigations. Training abstracts for orientation on these procedures were revised to bring them up to date. To streamline the QA Program and update the new QARD requirements, numerous other QAIPs are currently being revised.

With the approval and issuance of QAIP 20-1 and QAIP 20-2, SNL has accomplished a significant revision in the way quality assurance is addressed in the conduct of scientific investigations. At once, these procedures implement QA controls as provided for in the new QARD and also allow those controls to be readily integrated into routine scientific methodology.

Significant Meetings Attended

D. R. Hawkinson presented a revised SNL FY93 QA Audit schedule to the Technical Project Officer (TPO). Discussion focused on the QA 6319 development of a YMP procurement database to provide guidance on the status, activity, work profile of contractors performing quality-related work, and rationale to support nonaudit decisions of certain SNL YMP contracts.

Status Report on Ongoing Activities

SNL YMP QA Audits of Massachusetts Institute of Technology (MIT), Essco Laboratories, and Caley and Whitcomb Calibration Lab were conducted from March 15 to 19, 1993. The MIT audit revealed that the SNL contract issued to MIT omitted one page of the Statement of Work (SOW). That omission left out one major technical task and numerous SNL QA Program requirements unknown to the contractor. A calibration problem found at Caley and Whitcomb will require corrective action by NER.

An evaluation was conducted of the SNL Primary Standards Laboratory (PSL) from March 22 through 25. This evaluation was conducted to determine whether the PSL quality system meets requirements specified in the Office of Civilian Radioactive Waste Management (OCRWM) QARD. If so, the PSL will be identified as a qualified supplier for OCRWM and YMPO contractors. This evaluation was conducted concurrently, and in conjunction with, a similar evaluation being performed by EG&G Energy Measurements.

Major Activities Upcoming Next Three Months

SNL YMP QA Audits of International Technology Corp. (IT Corp.), J. F. T. Agapito, and Purdue University are scheduled in the next three months.

Phase two of the capability evaluation of SNL's Measuring & Test Equipment (M&TE) calibration system will continue in April or May. The SNL (secondary) Standards Laboratories will be evaluated in that phase.

1.2.12 INFORMATION MANAGEMENT

The objective of the Information Management element includes work scope related to the project-level establishment of systems to facilitate organization, storage, and retrieval of information/documents. The Information Management element is comprised of four tasks: Information Management Coordination and Planning (1.2.12.1), Local Records Center Operation (1.2.12.2.2), Participant Records Management (1.2.12.2.3), and Document Control (1.2.12.2.5).

1.2.12.1 INFORMATION MANAGEMENT COORDINATION AND PLANNING

Status Report on Ongoing Activities

Routine oversight of information management coordination and planning was conducted.

Major Activities Upcoming Next Three Months

Input to the Information Resources Management (IRM) Strategic Plan will be compiled and provided to the YMP. The Proposed FY94 budget will be developed and submitted to the YMP. The FY93 estimate will be submitted to the YMP.

1.2.12.2.2 LOCAL RECORDS CENTER OPERATION

According to the WBS Dictionary, this WBS element includes no SCP activities.

Major Accomplishments

SNL staff evaluated 15,288 pages of material regarding ESF work. The final records package submitted to the Central Records Facility (CRF) comprised 5,474 page.

Three boxes (9,600 pages) of working files were reviewed and duplicate checks completed. Approximately one box of files remains to be processed. The remaining 6,400 pages were identified as duplicates and destroyed.

Ninety cited references for publications (3,639 pages) were copied and submitted to the CRF.

Sixty-eight record packages were prepared for publications and training.

In-process record packages are being placed into dual storage. Records Management staff are involved with the record sources at generation of documents. This new process is being initiated in training and qualification and in document control. Processes and QAIPs were reviewed and discussed to ensure that responsibilities and records were properly identified. A few problem areas were noted for potential correction in the next version of the QA implementing procedure.

Seven TDIFs were prepared and submitted to the RMS.

Four TDIFs were entered into the YMP Automated Technical Data Tracking System (ATDT).

Significant Meetings Attended

On March 2nd, staff discussed in-process document control records and the establishment of dual storage and records management support for the package preparations process.

On March 18th, staff discussed In-Process Training/ Qualification records and the establishment of dual storage and records management support for the package preparation process.

On March 30th, staff met with A. Simmons, the DOE/ YMP Technical Data Manager, and Bob Lewis, the TRW/YMP ATDT Manager, to discuss the processing of backlog technical data.

Status Report on Ongoing Activities

In a major project regarding verification of Project and SNL microfilmed records/documents, 26,748 pages of materials were verified against the microfilm and boxed pending destruction approval.

A method to begin closing the 170 datasets which have been identified as closed or cancelled was developed and implemented.

Major Activities Upcoming Next Three Months

All Desk Guidances will be completed.

All microfilm will be verified against publication packages generated in 1989. Verified hardcopy will be destroyed if approvals are issued, or boxed and sent to the SNL Archives. To date, 51,748 pages have been verified. No direction has been issued by the ORCWM regarding the ownership and approved disposition of dual-storage YMP records.

Verification of 1987 SAND report publications against microfilm will be initiated.

Phase I planning will continue for the research and proposal of a phased approach to develop a Disaster Preparedness and Recovery Plan for the YMP Records Management Program.

In a new major activity, 897 SAND published reports, in the YMP Program, have been identified as requiring a review. All 897 reports must be reviewed and, as appropriate, TDIFs must be prepared. TDIFs have been prepared and submitted to the ATDT for seven of these reports. Completion of this activity will be planned. The YMPO has funded this project for the remainder of FY93. The DOE/YMP Technical Data Manager verbally authorized planning for continuation of this activity through FY94.

The final draft of the Desk Guidance for Participant Data Archive (PDA) activities will be prepared for review and approval.

Issues/Potential Problems Needing Resolution and Potential Impacts

The YMP E-mail system (ALLIN1) is incompatible with the system used at OCRWM headquarters (HQ) and the M&O Vienna office. Communication is limited and more costly using both the telephone and the fax. Records Management personnel are thus limited in their ability to request information, work effectively and efficiently on Program committees, and generally have open lines of communication throughout the program.

Approximately 170 data sets have been identified that are closed or cancelled and that required extensive research and compilation of information before submittal. The majority of these data sets were collected prior to 1990. The initial time required for research and preparation of TDIFs alone is estimated to be 6800 hours. The YMP Technical Data Manager has determined that the acquired data portion of the backlog do not require TDIF preparation, but that the 170 data sets should be prepared and submitted to the records system as record packages. The 897 SAND reports must be reviewed and processed, as required, into the ATDT.

1.2.12.2.3 PARTICIPANT RECORDS MANAGEMENT

According to the WBS Dictionary, this WBS element includes no SCP activities.

Major Accomplishments

Staff co-chaired the OCRWM Technology Integration and Methodology Analysis (TIMA) committee on communication. A preliminary report was prepared and the committee is corresponding via E-mail to finalize.

Subject Matter Experts within the Records Management Support staff have been established to work directly with Record Sources during the generation/preparation of records rather than at the receipt/review stage.

Significant Meetings Attended

On March 4th, staff attended the Technical Data Management meeting in Las Vegas, NV.

On March 12th, the TPO called a meeting of all Records Management Support staff to discuss ideas for reengineering the current processes to improve direct support to technical personnel.

On March 22nd and 23rd, staff participated in the SNL Social Styles Seminar.

Ongoing Activities

A purchase order for a faster, high quality, microfilm/fiche reader/printer was prepared and submitted. This equipment is vital to accomplishing one of the objectives of the Records Management Program, to review and determine the disposition of SNL YMP microfilmed records and remove the copies from the LRC.

Major Activities Upcoming Next Three Months

In preparation for the upcoming move offsite, weekly meetings of the Nuclear Waste Management Information Center QAT will be conducted to plan the relocation and design the space and facility needs for all Information Centers to include the SNL YMP LRC. Staff prepared a preliminary floor plan in conjunction with SNL facilities personnel. Preliminary computer and phone system needs will be communicated to appropriate personnel by April 12, 1993.

The OCRWM is preparing a final policy statement regarding SNL and OCRWM approval/authorization for the identification of YMP Project duplicate storage records as Federal nonrecords.

1.2.12.2.5 DOCUMENT CONTROL

Status Report on Ongoing Activities

A listing of an individual's controlled documents was sent to all recipients of controlled documents on February 22, 1993. This was done in answer to Corrective Action Report (CAR) #93-021, YMP audit #YMP 93-03. A second notice is being prepared to send out to all recipients that did not respond to the initial request.

Major Activities Upcoming Next Three Months

Enhancements to the Administrative Information Management System (AIMS)/Controlled Document System (CDS) continue.

1.2.15 SUPPORT SERVICES

The objective of the Support Services element includes work scope related to project-level general administrative and project support activities. The Support Services element is comprised of three tasks: Support Services Coordination and Planning (1.2.15.1), Administrative Support (1.2.15.2), and YMP Support for the Training Mission (1.2.15.3).

1.2.15.1 SUPPORT SERVICES COORDINATION AND PLANNING

Status Report on Ongoing Activities

Routine oversight of support service activities was conducted.

1.2.15.2 ADMINISTRATIVE SUPPORT

Major Accomplishments

The Socio-Economic Monitoring Forecast report was completed and submitted to the Project Office.

Forty-eight (48) pieces of excess equipment have been sent to SNL Reclamation, with the approval of the DOE/YMP. Another list of excess property will be compiled shortly.

Status Report on Ongoing Activities

Significant progress has been made defining programs and process to be used in the preparation of the Semiannual Socio-Economic Monitoring Program reports.

Updates and revisions to the SNL Property Management Database continued. New Nuclear Waste Fund tags are being applied to YMP/NWF property.

During the month of March, six SAND reports were forwarded to the Project Office for review, six were started, and two were completed.

Major Activities Upcoming Next Three Months

The semiannual socioeconomic monitoring reports will be submitted in April.

Another list of excess property will be compiled and submitted to the YMP. Property in Nevada will be inventoried and NWF labels attached.

Issues/Potential Problems Needing Resolution and Potential Impacts

The amount of staff time required to compile the socioeconomic monitoring reports has increased significantly.

1.2.15.3 *YMP SUPPORT FOR THE TRAINING MISSION*

Major Accomplishments

- Nineteen YMP participants completed a two-day course at SNL entitled "Managing Interpersonal Relationships."
- The conversion of the training database from Foxpro to the networked AIMS was initiated .
- Development was initiated for a relational database interlocking the training and CDS documents; a plan to revise the new employee orientation to include one-on-one sessions on specific procedures and training to be based on Work Assignment "point of use."

Status Report on Ongoing Activities

- Ten videotapes of the "Geology for Non-Geologists" course are being edited. Training record packages were prepared and submitted to the Local Records Center (LRC).
- A full analysis of comments on training in the annual Management Assessment is underway.

A Training Systems QAT has been formed to aid in formulating recommendations for improving the effectiveness and adequacy of the training program.

- The YMP Training Assignment form (TR-3) is being redesigned to accommodate the initiative to simplify the training process.
- The employee orientation manual is being revised to incorporate updated procedure abstracts.
- The major steps of the new Training Program flow are in the process of final approval before implementation.

Major Activities Upcoming Next Three Months

- Editing of the "Geology for Non-Geologists" course tapes will continue.
- Training for improving computing skills will be initiated.
- The training database will be improved and converted to the AIMS.
- Training support staff may be hired for the summer.

Department of Energy
Yucca Mountain Site Characterization
Project Office
P. O. Box 98608
Las Vegas, NV 89193-8608

WBS 1.2.5.2
QA: N/A

APR 22 1993

Robert R. Loux
Executive Director
Agency for Nuclear Projects
State of Nevada
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1802 North Carson Street
Carson City, NV 89710

U.S. DEPARTMENT OF ENERGY (DOE) RESPONSES TO STATE OF NEVADA COMMENTS ON STUDY PLAN 8.3.1.9.2.2 (WATER RESOURCE ASSESSMENT OF YUCCA MOUNTAIN)

Enclosed are responses to 25 comments made by the State of Nevada on the subject study plan in a letter dated December 24, 1992 (enclosure 1). Enclosure 2 contains DOE's responses.

For comments on DOE-approved study plans, the Yucca Mountain Site Characterization Project Office asks the responsible participant organization (in this case, Science Applications International Corporation) and principal investigator to perform a review and assess the impact of the state's comments on the planned study. The assessment includes a determination as to whether or not a revision is warranted. If a revision is warranted, DOE's intention is stated in responses. If a revision is not warranted, additional information is provided on how the comment is being addressed, why it is inappropriate, or where the concern is being addressed if another study plan is at issue.

The State of Nevada's comments generally concern the purpose and objectives of the study plan. The state does not appear to clearly understand that this study focuses on the social/economic issues as they relate to the human intrusion investigations. DOE's responses are intended to clarify the objectives for the study.

If you have any questions, please contact Thomas W. Bjerstedt at (702) 794-7590.

Carl P. Gertz
Project Manager

RSED:TWB-3838

Enclosures:
1. State of Nevada Comments on Study Plan 8.3.1.9.2.2
2. DOE Responses to State Comments

ENCLOSURE 4

YMP-5

cc w/encls:
L. J. Desell, HQ (RW-331) FORS
C. E. Einberg, HQ (RW-331) FORS
S. J. Brocoum, HQ (RW-22) FORS
Allen Benson, HQ (RW-5.2) FORS
L. R. Hayes, USGS, Las Vegas, NV
R. W. Craig, USGS, Las Vegas, NV
B. E. Reilly, SAIC, Las Vegas, NV
M. A. Lugo, M&O/TRW, Las Vegas, NV
C. J. Goewert, M&O/Fluor, Las Vegas, NV
T. H. Rogers, M&O/WCC, Washington, DC
R. D. Rogers, M&O/WCC, Las Vegas, NV
M. D. Voegele, SAIC, Las Vegas, NV
E. W. McCann, SAIC, Las Vegas, NV
A. C. Matthusen, SAIC, Las Vegas, NV
J. F. Carlson, SAIC, Las Vegas, NV

BOB MILLER
Governor

STATE OF NEVADA

ROBERT R LOUX
Executive Director

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December 24, 1992

Dr. John W. Bartlett, Director
Office of Civilian Radioactive
Waste Management, RW-1
U.S. Department of Energy
1000 Independence Ave. S.W.
Washington, DC 20585

Dear Dr. Bartlett:

The State of Nevada has reviewed the DOE Study Plan "Water Resource Assessment of Yucca Mountain, Nevada" (Study Plan 8.3.1.9.2.2, Revision 0) and is providing its comments in this letter and attachment. The State's comments address the adequacy, completeness, and technical accuracy of the Study Plan to meet the Department's objective in site characterization.

The purpose of a water resource assessment of Yucca Mountain and vicinity will be to obtain information on the value of the water resources in the study area to assess the potential for future exploitation of the resource and the effect of exploitation on the mined geologic disposal system. The overall objectives of the study are to assess the current and projected supply and demand situation for ground water in the study area, and estimate the value of the ground-water resource.

Two general comments on this Study Plan are provided as follows:

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1. The State questions whether the water resource assessment can provide meaningful information relative to meeting the purpose and objectives of the study. At best, the assessment can provide only a very qualified estimate of possible future demand for the resource. Given the scope, level of detail, and the time frame of the study, it is not evident that any real information will be generated appropriate for satisfying regulatory requirements.

COMMENT 1

2. The plan defines two study areas, one an "economic study area" which covers the three county area, and a second "hydrographic
COMMENT 2 study area" restricted to the three sub-basins surrounding Yucca Mountain. The entire discussion, which provides a lesson in marginal price theory, emphasizes the current water use within only part of the Alkali Flat sub-basin which is primarily agricultural. There is almost a total lack of recognization that in the future, the period which is to be considered, the marginal agriculture will likely disappear and other demands will be placed on the resource. In order to even make a very basic estimate of what those demands could be, the scope of the study needs to be greatly expanded to include Las Vegas area demands and possible future supplies.

3. The Study Plan claims that the only resource expected to have potential for future exploitation is groundwater. This
COMMENT 3 conclusion while consistent with the Department's position as articulated in the Environmental Assessment, the Site Characterization Plan, and the Early Site Suitability Evaluation, is <u>not</u> supported by facts. There are no data, analyses, or interpretations known to the State which scientifically conclude that there is no potential for future exploitation of mineral resources, hydrocarbon resources, or geothermal resources. Most of the data available to date suggest the opposite. Such conclusionary statements by the DOE prior to any study should be removed from the Study Plan, or supported by published scientific literature.

Should you have questions, this Office is available to meet with the Department to discuss the State's comments at any time.

Sincerely,

Robert R. Loux
Executive Director

CAJ:RRL:jem

Attachment

cc: Carl Gertz, YMPO
Joe Youngblood, NRC
Dade Moeller, NRC-ACNW
John Cantlon, NWTRB
Dwayne Weigel, GAO
Steve Kraft, EEI

ATTACHMENT

State of Nevada comments on DOE Study Plan 8.3.1.9.2.2. "Water Resource Assessment of Yucca Mountain, Nevada"

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1. COMMENT 4 Section 1.1 (Page 1-8) indicates that the "study area is composed of two elements: 1) the hydrographic study area where the potentially affected water supply is located, and 2) the economic study area from which water demands may develop." The two "study areas" defined and shown in Figures 1-1 and 1-3 do not totally cover the areas which could influence groundwater levels in the "hydrographic study area" since our lack of understanding of the interconnection between the deep "carbonate system" in southern Nevada and the valley fill volcanic aquifer systems is incomplete. To forecast demand on any part of the system, it is necessary that there be an understanding of the total system and its interconnections. Future demand for water near Yucca Mountain may well be a result of the availability, or lack thereof, of water from other parts of the system.

---

2. COMMENT 5 Reference to Section 1.2 (Page 1-7 to 1-10). In evaluation of the ground water resources of the valley fill and carbonate aquifers near Yucca Mountain it must be recognized that nowhere in developed regions and particularly nowhere in arid regions, is a major aquifer carrying potable water not utilized as a resource. Comparisons should be made to arid climate developments elsewhere in the United States and in the world, rather than present circumstances in Nevada. Consideration should be given to predicted population growth on a national scale, and consequent demands for fresh water supplies, rather than extrapolating from current conditions. The world including the United States is changing and the life of the repository easily spans the period of population doubling to eleven billion people and potable water supplies becoming more and more valuable. This is the "foreseeable future", as specified in 10CFR60.122(c)(17)(i). It can be said with confidence that the groundwater resources of this region will be developed or over-developed during the operational phase of the repository or a few decades later.

The argument of "institutional constraint" on groundwater resources exploitation is not valid for a future case of an urban community near Yucca Mountain seeking a source for municipal water supply. The current quest by the L.. Vegas Valley Water District (LVVWD) for additional ground-water supplies from neighboring counties to the north seems relevant.

Also, in considering the risk of unintentional human intrusion the assumption is made that instructions and authority may have changed entirely, so for this condition institutional

constraints on water resources development cannot be considered a controlling factor. If climatic change is a factor, then surely institutional change must also be a factor.

The two aquifers at the site (the tuff aquifer and the carbonate aquifer) and the alluvial aquifer adjacent to the site must be considered as one ground-water reservoir, and together comprise a Class 1 Aquifer and Special Source of water as specified by the U.S. Environmental Protection Agency.

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3. Reference to page 1-7. To address Issue 1.3, it is proposed COMMENT 6 that the study include "the economic feasibility of developing the lower carbonate aquifer." In order to do this, a study well beyond the scope of this document is required since the potential demand for further development of water resources near the repository is a function of economic and physical ability to develop additional water supplies in an area much larger than the flow system depicted in Figure 1.1. Such a hydrographic study of the carbonate aquifer would likely include a region encompassing eastern and southern Nevada. For example, the LVVWD is actively looking at potential water resources in some 28 separate basins in southern and central Nevada. If a number of these basins prove infeasible for one reason or another, then increased pressure for development of the "carbonate aquifer" or other less extensive aquifers in the Amargosa River drainage will be felt.

In addition, the level of knowledge concerning the "deep carbonate aquifer" and its ability to yield water throughout southern Nevada is still quite limited and therefore any economic analysis would be subject to large uncertainties.

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4. Reference to page 1-9. Under Issue 1.8, how does the COMMENT 7 assessment of "current markets" fit into an "assessment of the potential consequences of exploration activities . . . during the post-closure period"?

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5. The first sentence of Section 2.0 states: The analytical COMMENT 8 methods incorporated in this study will be used to estimate the future value of the water resources within the study area." Does this mean that the study is limited to the future value of water resources within the "economic study area" or within the "hydrographic study area"? The future value must be determined considering regional demands, not just projected local demands.

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6. On Page 2-3 it is stated that the definition of perennial COMMENT 9 yield also applies to the carbonate aquifer. In theory this is true, however, in reality, the concept of perennial yield cannot be applied to an aquifer system which is so poorly

understood. The recharge, extent, interconnection, and even flow direction are not known with any precision to make a "perennial yield" determination for this particular aquifer system.

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7. Section 2.1.1.2 (Pages 2-6 to 2-13) addresses the economic
COMMENT 10 supply of ground-water. The entire discussion in this section is primarily applicable to water resource economics for agriculture of fairly low value crops or large-water-use industrial projects. For most municipal and industrial uses, the pumping costs are really only a minor part of any budget and of minor importance. Demand for water in southern Nevada will be only sightly influenced by the cost of production, other economic influences will be much more significant.

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8. Section 2.1.2 (Pages 2-13 to 2-18) indicates that the purpose
COMMENT 11 and scope of the ground-water valuations to be conducted in this study are derived from 10 CFR 60. 122(c) and 10 CFR 960. 4-2-8-1. The section goes on to indicate that 10 CFR 960. 4-2-8-1 (a) requires specific consideration be given to water suitable for crop irrigation or human consumption without treatment. More correctly, 10 CFR 960. 4-2-8-1(a) requires that as a qualifying condition to siting a repository that the "site shall be located such that - considering permanent markers and records and reasonable projections of value, scarcity, and technology - the natural resources, including ground-water suitable for crop irrigation or human consumption without treatment present at or near the site will not be likely to give rise to interference activities that would lead to radionuclide releases greater than those allowable under the requirements specified in 960.4-1." There are no specific consideration requirements.

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9. In paragraph two on page 2-14 the value of water in this study
COMMENT 12 is considered only for agricultural and industrial purposes, yet the discussion in paragraph three discusses the value of water for domestic use. This inconsistency should be corrected or clarified. It should be noted that according to the discussion, domestic use has a higher value than agricultural or industrial use.

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10. The discussion in Section 2.1.3 (Pages 2-18 to 2-23)
COMMENT 13 emphasizes the agricultural sector which is a very minor part of the total southern Nevada economy. It is more correct to simply assume that the low value agriculture will disappear through existing market mechanisms and that water will be transferred to more economic uses in the future?

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11. The discussion on Pages 2-25 to 2-27 is based on the existing
COMMENT 14 economy and water use, however, the requirements are to estimate demand and use into the future, i.e., the post-closure period. Any data related to current water use within

the hydrographic area will have little relevance during that period.

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12. COMMENT 15 On Page 2/27 the following statement is made: "Municipal water value will be estimated using demand curves derived from local data, if available within the economic study area, or from studies of communities in similar arid regions of the United States." Attempt to use local disparate demand data, say a mix of one large community such as Las Vegas and other small communities such as Beatty, Pahrump, etc., will yield little value. Also, using transfer data from other arid regions may be futile since it has been demonstrated time and again that water flows to money in these regions and that demand is a function of the area's economic engine, not the true availability of the resource.

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13. COMMENT 16 In Section 2.2, the key constraint is correctly identified in the discussion, i.e., "the uncertainty inherent in making long-term predictions." There appears to be great uncertainty when attempting to estimate growth and resultant water demand in southern Nevada. The parametric approach suggested using a range of supply and demand scenarios and determining the sensitivities of the results is the only practical approach.

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14. COMMENT 17 On Page 3.1 in Section 3.1 Ground-water Supply, there is a disconnect between the "economic" and "hydrographic" study area since the demand for water from the hydrographic area may very well be a function of the availability of water from other areas to supply the economic area.

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15. COMMENT 18 On Page 3-2, how is the "carbonate aquifer" going to be evaluated with respect to either quantity or quality given our current level of understanding?

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16. COMMENT 19 On Pages 3-3 through 3-9, the entire discussion is based on the current primary water user in the hydrographic area, that of relatively low value agriculture in Amargosa Valley. However, agriculture such as currently exists will likely have little influence on future water demand and the value of water. The future value will certainly be determined by alternative uses of the water, either municipal or industrial within the hydrographic area or for export to other demand areas such as Las Vegas Valley.

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17. COMMENT 20 In Section 3.3 on Page 3-12, there is a clear acknowledgment of the uncertainty in long-term predictions of use and value of water, and the need for ". . . a range of supply and demand scenarios . . ." is stated. However, the most critical and sensitive scenario is not identified nor discussed relative to its impact on site suitability or regulations.

18. On Page 3-14 is the only mention of other areas having a COMMENT 21 future desire to use the water currently being used for agriculture in the hydrographic study area. There is still no discussion with respect to the real economic power house (Las Vegas) in the economic area and its potential influence on water demands. The assumption that the "wider region" has an institutional constraint of 14,400 persons has no basis in fact. Future impacts on the demand and value of potable ground-water in productive aquifers must be addressed in a realistic and comprehensive manner.

19. At the bottom of Page 3-14, the following statement is made: COMMENT 22 "These investigations will produce, for this period, population forecasts for the study areas (hydrographic and economic), which may produce a demand for water supplies located in the hydrographic study area." There still appears to be a dichotomy when defining study areas. The discussions focus primarily on the study defined hydrographic and economic areas however, all the economic driving forces for demand and value mechanisms will likely be from the Las Vegas area.

20. Reference to Table 4.1 on Pages 4-2 and 4-3.

COMMENT 23 (1) The study is unlikely to provide some of the results listed in Table 4-1. Specifically, the time-phased projections of rates and locations of groundwater withdrawals will be a guess at best given the high level of uncertainties inherent in the study as described. Also, the economic feasibility of development of the lower carbonate aquifer will be severely limited since the collective "we" have only a superficial understanding of this system, and the study as planned will not materially add to our understanding of the lower carbonate aquifer.

(2) Another contentious issue which is not well addressed by the Study Plan is whether only costs and values of ground water in a major aquifer, as related to present-day society and economics, provides a realistic picture of the value that society will place on the resource during the lifetime of the repository. For example environmental protection constraints are weakly addressed in the Study Plan, but may be of major importance to society in the future.

21. Reference to Table 5.1 on page 5-1. The use of the Hills COMMENT 24 method in itself is acceptable, but the method assumes a quasi-steady state for the change in ground-water levels for any change in pumping rate, and this could require years for each change. No consideration is given to this restraint on the use of the method.

22. Reference to Figure 5-1 on Page 5-2. The five and one-half month study period and the limitations as described in the plan will yield only a very general estimate of the potential changes to and likelihood of increased water resource use for the hydrographic study area. A more reasonable time frame for such a study would be to change the time scale on Figure 5-1 Schedule from months to years. Many years of study will be required to simply understand the hydrology of the lower carbonate aquifer.

COMMENT 25

DOE RESPONSES TO THE STATE OF NEVADA COMMENTS
ON STUDY PLAN 8.3.1.9.2.2
(WATER RESOURCE ASSESSMENT OF YUCCA MOUNTAIN)

Response to Comment 1

The State of Nevada's concern in this comment revolves around a general impression that it will be inadequate and incapable of achieving the stated objectives. The purpose and objective of the study plan are clearly defined to identify the water resources in the area of Yucca Mountain as a social/economic issue. The study plan is part of an investigation to identify " ... all resources at the site with current markets and estimate of their gross and net value" (Site Characterization Plan [SCP] page 8.3.1.9-11), and the overall Human Interference Investigation. DOE believes that the study plan meets the objectives as described in the SCP and study plan, and that these objectives are based on meeting the regulatory requirements.

Response to Comment 2

The two study areas are so defined because (a) the hydrographic study area comprises the water sub-basin, as defined by the Nevada State Engineer, that is assumed to be the water supply that could potentially be affected if extensive ground-water withdrawals occur, and (b) the economic study area is defined to be Clark and Nye counties because of the economic interdependence of the two counties (see SCP page 1-5, Figure 1-2).

The State's comment alludes to the marginal benefits of the agricultural activities in the Amargosa Valley area. The comment suggests that local industry should not be assumed in the study plan. In fact, agriculture has been an industry with continued presence in the Amargosa Valley area for some time and will remain until agriculture is no longer economically feasible in that area. At this point it is impossible to predict when that might be; therefore, the agricultural activity should remain in the development scenarios and there is no basis for assuming it vanishes.

Regarding the concerns of utilizing municipal water information used to construct the demand curves for completing the proposed study, there are no other reliable sources to provide the needed price/quantity relationships to construct the demand curves except for municipal water providers. Additionally, these concerns seem to be inconsistent with Comment 15 that suggests comparisons should be made to "Transfer data from other arid regions" elsewhere in the U.S. and the world.

Response to Comment 3

The U.S. Nuclear Regulatory Commission (NRC) made a comment similar to the State's. DOE explained the origin of this statement in a June 29, 1992, letter to the NRC (attached). The statement will be dropped from a future revision.

ENCLOSURE 2

Response to Detailed Comments in the Attachment

Response to Comment 4

This study plan has been established from a socioeconomic point of view with the intent of determining if the repository will have an unmitigatable adverse effect on the quantity or quality of water available for human consumption or industrial use. This study plan has been established because ground water is the only natural resource existing at the Yucca Mountain site at this time; therefore, it is reasonable that ground water be the primary focus of a socioeconomic study plan with the state of current knowledge. Other site characterization activities are designed to determine if economically exploitable natural resources exist at the site (see Section 8.3.1.9.2.1 of the SCP). Should the presence of an economically exploitable natural resource be identified at the site, then Study Plan 8.3.1.9.2.1 would be adapted and revised to assess that resource.

DOE agrees that an understanding of the hydrologic system, including the interconnection between the aquifers, is needed to forecast the demand for water near Yucca Mountain. Efforts to understand the total hydrologic system will be part of other studies in SCP Section 8.3.1.2. Water use will be estimated only after the results of total system studies are obtained. The boundary of the economic study area will then be evaluated. The current boundary shown for the economic study was only estimated for preparation of the study plan. This water use boundary will be reevaluated as work proceeds and modified as appropriate.

Response to Comment 5

With respect to the concerns expressed by the State regarding the lack of attention directed toward institutional constraints, paragraph two, page 2-5 of the study plan does identify the concern and the state's current policy of the Nevada State Engineer. At the same time, the study plan, as stated on page 2-5, does not preclude the possibility of other scenarios that would address these concerns, including institutional considerations.

Response to Comment 6

See the response to Comments 4 and 9.

Response to Comment 7

This comment, as well as others, concern the "qualified estimates" to be produced by this study. Economic studies which project variables into the future will always have qualifiers regarding the "quality" of the projection. Economic projections must factor in suppositions and assumptions which are used to generate the required forecast variables. It is the goal of any economic study to project variables into the future to generate the "best estimates" possible.

Response to Comment 8

Both the regional and local demand projections are either directly or indirectly considered. See also the response to Comment 7.

Response to Comment 9

DOE agrees that currently there is a limited knowledge of the deep aquifers in the hydrographic study area. In preparation of economic studies, the best available data will be used until particular variables for the aquifer can be better defined. As stated in the response to Comment 4, hydrogeological characterization is not part of the study. That aspect of site characterization is addressed in the suite of studies conducted under SCP Section 8.3.1.2.

Response to Comment 10

See the response to Comment 2.

Response to Comment 11

DOE disagrees that there are "no specific consideration requirements" as stated in the last sentence of the comment. The specific consideration is as stated in 10 CFR 960-4-2-8-1(a) and as is stated in the comment.

Response to Comment 12

On page 2-14 of the study plan, the discussion regarding the concept of diminishing marginal returns revolves around agriculture and mining because they are key industries in the Amargosa Valley area. The hypothetical demand curve representing the marginal value of water focuses on household usage because the trade-offs can be more clearly illustrated. From an economist's point of view this does not create an inconsistency. The examples are designed to help the reader relate to both the study area and the concepts.

Response to Comment 13

See the response to Comments 2 and 12.

Response to Comment 14

See the response to Comment 7.

Response to Comment 15

The impacts of water use in Las Vegas valley are to be factored into the ultimate analysis as stated on page 3-14 of the study plan. See also the response to Comment 2.

Response to Comment 16

See the response to Comments 4 and 7.

Response to Comment 17

See the response to Comment 2.

Response to Comment 18

See the response to Comments 4 and 9.

Response to Comment 19

See the response to Comments 2 and 7.

Response to Comment 20

As with the assumptions that will be required for the various development scenarios, the supply and demand scenarios will be developed to include all of southern Nevada (Clark and Nye counties) for all types of water use. As would be the case for all assumptions built into this proposed study plan, the supply and demand assumptions would be reviewed with the local experts to ensure that the most critical and sensitive scenarios are identified and addressed.

Response to Comment 21

See the response to Comments 2 and 15.

Response to Comment 22

See the response to Comment 2 and 15.

Response to Comment 23

See the response to Comments 7 and 9.

Response to Comment 24

The full text of the study plan discussing ground-water supply analyses indicates that changes in ground-water depths as a function of pumping level may be estimated using the Hill method. It is assumed that appropriate data are available and, if more appropriate, that the ground-water flow models used to support SCP Study 8.3.1.2.1.4 (Regional Hydrologic System Synthesis and Modeling) may be used.

Response to Comment 25

The proposed study plan was designed to study economic rather than hydrological issues; therefore, study of the carbonate aquifer is outside the scope of this study plan. Additionally, hydrogeological characterization is not part of this study. The SCP's hydrology program in Section 8.3.1.2 is designed to lay out a program of data gathering and modeling to understand the hydrology of the aquifer systems in the Yucca Mountain area, which includes the hydrographic study area as defined in this study plan. Once data and analyses from these studies attain a level of maturity, the work defined in Study Plan 8.3.1.9.2.2 will be carried out. The work defined in Study 8.3.1.9.2.2 is not to begin for several years.

Department of Energy
Washington, DC 20585

JUN 29 1992

Mr. Joseph J. Holonich, Director
Repository Licensing & Quality Assurance
Project Directorate
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Holonich:

This responds to the U.S. Nuclear Regulatory Commission's (NRC) Phase I review comments on Study Plan 8.3.1.9.2.2, "Water Resource Assessment of Yucca Mountain, Nevada." The NRC's Phase I review of the subject study plan stated a concern with the assumption that ground water is the only resource expected to have the potential for future human intrusion. The sentence at issue from the study plan states, "At present, the only resource expected to have the potential for inadvertent intrusion due to future exploitation near the repository is ground water (DOE, 1988a)." The U.S. Department of Energy (DOE) understands how such a statement might be of concern to the NRC.

The statement of concern is a paraphrased adaptation from page 9.3.1.9-11 of the Site Characterization plan which states in part, "Ground water currently is the only commodity to be classified as a resource in the immediate vicinity of the site." Study 8.3.1.9.2.1, "Natural Resource Assessment of Yucca Mountain," will evaluate the potential for mineral and energy resources, and it will not be compromised by premature conclusions.

Because of NRC's concern, DOE commits to drop the sentence at issue from any future revision of this study plan. Purely from an administrative standpoint, we do not wish to revise the plan only to remove the statement. We did wish to promptly respond to the misunderstanding arising from the statement, and we hope this clarification is satisfactory to the NRC.

Attachment

If you have any questions, please contact Mr. Chris Einberg of my office at 202-586-8869.

Sincerely,

John P. Roberts
Acting Associate Director for
Systems and Compliance
Office of Civilian Radioactive
Waste Management

cc:
Arturo Ramose, CNWRA, San Antonio, TX

cc:
C. Gertz, YMPO
R. Loux, State of Nevada
M. Baughman, Lincoln County, NV
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C. Abrams, NRC

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WBS 1.2.5.2
QA: N/A

APR 27 1993

Robert R. Loux
Executive Director
Agency for Nuclear Projects
State of Nevada
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Carson City, NV 89710

U.S. DEPARTMENT OF ENERGY (DOE) RESPONSES TO STATE OF NEVADA COMMENTS ON STUDY PLAN 8.3.1.17.3.4 (EFFECTS OF LOCAL SITE GEOLOGY ON SURFACE AND SUBSURFACE MOTIONS)

Enclosed are responses to 26 comments made by the State of Nevada on the subject study plan in a letter dated January 6, 1993 (enclosure 1). Enclosure 2 contains DOE's responses.

For comments on DOE-approved study plans, the Yucca Mountain Site Characterization Project Office asks the responsible participant organization (in this case, U.S. Geological Survey) and principal investigator to perform a review and assess the impact of the state's comments on the planned study. The assessment includes a determination as to whether or not a revision is warranted. If a revision is warranted, DOE's intention is stated in the responses. If a revision is not warranted, additional information is provided on how the comment is being addressed, why it is inappropriate, or where the concern is being addressed if another study plan is at issue.

Most of the State of Nevada's concerns involve points of minor clarification or the need for additional explanation about how the work is to be conducted in relation to other studies. DOE's responses supply this information. Also, some of the state's concerns are addressed in other study plans. Gross interrelationships between study plans are contained in the Site Characterization Plan.

If you have any questions, please contact Thomas W. Bjerstedt at (702) 794-7590.

for Robert A. Barton
Carl P. Gertz
Project Manager

RSED:TWB-3891

Enclosures:
1. State of Nevada Comments on Study Plan 8.3.1.17.3.4
2. DOE Responses to State Comments

YMP-5

ENCLOSURE 5

cc w/encls:
L. J. Desell, HQ (RW-331) FORS
C. E. Einberg, HQ (RW-331) FORS
S. J. Brocoum, HQ (RW-22) FORS
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BOB MILLER
Governor

STATE OF NEVADA

ROBERT R. LOUX
Executive Director

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January 6, 1993

John W. Bartlett, Director
Office of Civilian Radioactive
Waste Management
U.S. Department of Energy
Washington, D.C. 20585

Dear Dr. Bartlett:

The State of Nevada has reviewed the DOE Study Plan "Effects of Local Site Geology on Surface and Subsurface Motions" (Study Plan 8.3.1.17.3.4) and is providing its comments in this letter and attachment. The State's comments address the adequacy, completeness, and technical accuracy of the Study Plan to meet the Department's purpose in site characterization.

The State has two general comments regarding the subject Study Plan.

COMMENT 1

1. The model proposed in the study plan is out-dated and does not take into account new technologies. The use of a one-dimensional, linear model may not achieve the desired objectives at the needed level of confidence. It is suggested that this study plan be revised to bring it more up-to-date.

COMMENT 2

2. This study plan, as with other related study plans, appears to ignore the near-field. Given the 32 presently known faults in the site vicinity, the repository is the near field. How does DOE plan to address the near field effects?

Specific comments are listed in the attachment.

Enclosure 1

We look forward to your response to the State's comments. Should you have any questions, this Office is available to meet with the Department at any time.

Sincerely,

Robert R. Loux
Executive Director

Attachment

cc: Carl Gertz, YMPO
Joe Youngblood, NRC
Dade Moeller, NRC-ACNW
John Cantlon, NWTRB
Steve Kraft, EEI
Dwayne Weigel, GAO

SPECIFIC COMMENTS

1. Page 1-1, paragraph 2: The study plan states that methods will be developed to predict ground motion spectra and peak ground motion values that account for the effects of site geology and structure on expected shaking levels. According to the Nuclear Waste Policy Act, DOE is supposed to be using existing techniques and not developing new technology. There is an overabundance of techniques presently in existence to predict ground motion. Development of another technology does not appear to be necessary.

COMMENT 3

2. Page 1-1, paragraph 2: The study plan states that theoretical models for the observed site effects will be developed to the extent necessary to explain the observations to first order. What is the definition of "first order"?

COMMENT 4

3. Page 1-1, paragraph 3: The first sentence gives a list of sources of information for effects of site geology on ground shaking. How much of the data on UNEs has been collected under controlled conditions in the near field? How much of this data is from rock types analogous to Yucca Mountain? Shouldn't local mine blasts also be included in this list? Also, which "physical properties" of the soil and rock are meant here?

COMMENT 5

4. Page 1-1, paragraph 3: The second sentence states that the data collected will be used to "evaluate" the relative levels of ground shaking. The term "predict" would be more appropriate.

COMMENT 6

5. Page 1-2, paragraph 1: There is no mention of the design and performance of the seals. In fact, there is nothing in this paragraph that indicates that the potential seal problem is recognized.

COMMENT 7

6. Page 1-2, paragraph 1: The last sentence of this paragraph ignores the topographic effects, which are known to be important.

COMMENT 8

7. Page 1-2, paragraph 3: The study plan should give a definition of "credible accidents" and include examples.

COMMENT 9

8. Page 1-2, paragraph 4: There is no basis for still using the 10,000-year cumulative slip earthquake. This has been proposed and rejected on a number of occasions in the past. It is not relevant in dealing with vibratory ground motion. This is one of the many instances in this study plan that indicate its obsolescence.

COMMENT 10

9. Page 1-3, paragraph 1: What is the basis for the "10-percent chance of being exceeded during 100 years"?

COMMENT 11

10. Page 2-1, paragraph 1: Will the "additional seismographs" mentioned here be operated separately or as part of the Southern Great Basin Seismic Network? If it is to be operated separately, what QA program will apply?

COMMENT 12

11. Page 2-1, paragraph 1: What soil and rock properties are to be determined for this study?

COMMENT 13

12. Page 2-1, paragraph 2: It is stated that the disadvantage of estimating the effects of site geology on strong ground motion using only measurements of low level shaking is that these low level motions may not adequately simulate all aspects of strong shaking, particularly non-linear soil behavior. To our knowledge, there is not any empirical data in the near field around active faults that supports this statement. One aspect that should be considered is the possible cumulative effect of the low level vibratory ground motion on the disturbed zone, seals, and performance of both over the life of the repository.

COMMENT 14

13. Page 2-1, paragraph 2: The references cited here do not include the most recent and more appropriate information on the subject of using low level shaking to predict strong shaking effects.

COMMENT 15

14. Page 2-1, paragraph 2: This paragraph gives the general impression that neither alternative accounts for non-linear effects. Since non-linear effects could be extremely important in determining the long-term performance of the repository, how will this issue be addressed? Does DOE plan to develop a new methodology to determine the non-linear effects?

COMMENT 16

15. Page 2-2, paragraph 1: Will there be any changes necessary to the study plan to accommodate the new design of the ESF? This study plan still discusses the ESF shafts?

COMMENT 17

16. Page 2-2, paragraph 1: The statement is made that the new sites will be occupied long enough to record at least ten events simultaneously at each station in order to permit adequate statistical development of site effect characteristics. What was the basis for the selection of ten events? In the last ten years of the site studies with the SGBSN, how many events and of what magnitude have been seen simultaneously? How many of these events and of what magnitude would the new proposed have seen? Although the next sentence states that 20 earthquakes per month greater than local magnitude 1.0 are expected to be recorded, and this is probably correct in terms of the entire SGBSN, it is unlikely to be true for the immediate Yucca Mountain site. Almost all of the earthquakes recorded have been less than magnitude 2.0. Compounding the problem will be the possible increased level of background noise generated by the construction of the ESF.

COMMENT 18

Since the DOE has already stated that there are problems with estimating strong ground motions using measurements from low level shaking, perhaps the plan should be revised to include a commitment to continue recording long enough to obtain useable data.

Also, what is meant by the term "well-recorded" events? How will this selection be made, i.e., what are the criteria for this selection process?

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17. Page 2-3, paragraph 1: This paragraph gives a brief discussion of the rationale for selecting the number, location, duration, and timing of the tests. The paragraph ends with a reference to several stochastic and deterministic models of earthquake ground motions that are likely to be used. Although these referenced models may be useful, there are a number of more recent and relevant models that should be considered. At several recent meetings, the DOE and EPRI have stated that the Band-Limited-White-Noise Random Vibration Theory Model would be the basis for the theoretical work. This ambiguity in the study plan needs to be clarified.

COMMENT 19

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18. Page 3-1, paragraph 1: What is meant by "the effects of geometry"? The geometry of what?

COMMENT 20

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19. Page 3-1, paragraph 2: The statement is made that recordings will be obtained at sites underlain by both alluvium and rock and at the top and bottom of boreholes at select locations. The figure 1-2 implies that none of the surface recording stations will be at sites where there is any significant alluvium.

COMMENT 21

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20. Page 3-1, paragraph 2: The study plan states that empirical prediction of strong motion at Yucca Mountain using the world-wide strong motion data set cannot be applied directly because the data set implicitly contains site effects and attenuation properties that may not apply to the southern Great Basin. What makes the Yucca Mountain area any different from any other virgin site in the world where the empirical techniques are commonly used? It is suggested that the study plan include a provision to estimate strong motion using the classical empirical prediction techniques as a basis for comparison with the results from any new prediction techniques that may be developed.

COMMENT 22

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21. Page 3-2, paragraph 3: It is stated that technical procedures for the analytical parts of the study have yet to be prepared. What is the timetable for the development of these procedures?

COMMENT 23

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22. Page 3-2, paragraph 5: The study plan states that the seismographs will be calibrated over the range of frequencies of engineering interest, i.e., 0.2 to 20 Hz. How was this

COMMENT 24

range of frequencies determined, especially since there is no design yet available? Does this range of frequencies apply to the seals? If so, what are the references for the seal design? Also, +/-10% over the range of frequencies has not been difficult to obtain.

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23. Page 3-2, paragraph 6: The discussion of site variability is much too generic. This paragraph should be much more specific given the extensive amount of study that has been done on the Nevada Test Site. In the last sentence of this paragraph, it is stated that the magnitude of the variability is unknown. The author(s) of the study plan may not be aware of the data for the magnitude of the variability, but it is hard to believe that such data is not available for the Nevada Test Site.

COMMENT 25

~~23.~~ 24 TWB. 8/19/93 Page 3-4, paragraph 3: The study plan states that the seismic velocity structure of the site will be determined to crystalline basement and that the structure will be estimated on the basis of the known geology and geophysics. Does the DOE plan at least one borehole to the basement to fulfill this statement?

COMMENT 26

U.S. DEPARTMENT OF ENERGY (DOE) RESPONSE TO
STATE OF NEVADA COMMENTS ON
STUDY PLAN 8.3.1.17.3.4 (EFFECTS OF LOCAL SITE
GEOLOGY ON SURFACE AND SUBSURFACE MOTIONS)

Response to Comment 1

The goal of this study is to observe and model the effects of site geology on ground motion. The intent is to initially use the simplest model that explains the observations. As stated in study plan Section 3.2.1 on page 3-4, if simple models are inadequate, then more complex models will be employed until adequate results are achieved. The study plan does not limit modeling efforts to a one-dimensional, linear approach, but rather proceeds from the assumption that this is the most logical and practical point from which to start. See also the September 16, 1992, response to a similar comment made by the U.S. Nuclear Regulatory Commission (attached).

Response to Comment 2

Development of a ground motion model for near- and far-field motions, as appropriate, is the subject of Study 8.3.1.17.3.3 (Ground Motion From Regional Earthquakes and Underground Nuclear Explosions). This study plan is currently in preparation.

Response to Comment 3

It is not intended that totally new methods will be developed for this study. The term "development" as used in this context refers primarily to the development of local correction factors and standard techniques for prediction of ground motions. These correction factors will be based, to the extent possible, on instrumental recordings of ground motion, including those obtained in Study 8.3.1.17.4.1 (Historical And Current Seismicity). The methods to be followed are discussed more fully in Sections 3.1.1 and 3.1.2 of the study plan.

Response to Comment 4

By use of "first order" theoretical models to explain the observations, it is meant that models will be used to explain the significant overall characteristics of the data, but perhaps not all the details.

Response to Comment 5

The answers to questions concerning data from underground nuclear explosions will be provided by Study 8.3.1.17.3.3 (Development of Empirical Models for Underground Nuclear Explosions) during the early stages of this study. To the extent that data from local mine blasts are well recorded, such data will also be considered for inclusion in this study. The "physical properties" being collected are listed in Study Plan 8.3.1.14.2 (Studies to Provide Soil and Rock Properties of Potential Locations of Surface/Subsurface Access Facilities) as well as other studies such as 8.3.1.4.2.1 (Characterization of the Vertical and Lateral Distribution of Stratigraphic Units Within the Site Area).

ENCLOSURE 2

Response to Comment 6

DOE agrees that "predict" would be a more correct word to use than "evaluate" in the subject sentence on page 1-1, paragraph 3.

Response to Comment 7

Specific discussion of the design and performance of seals is beyond the scope of this study. As shown in Figure 1-4 of the study plan, information from Study 8.3.1.17.3.4 will be used by several other studies and investigations. Important aspects of the seals program will be discussed in Study Plan 8.3.3.2.2.1 (Seal Material Properties Development), which is yet to be developed.

Response to Comment 8

This comment does not apply to the referenced sentence (page 1-2, paragraph 1) but can be answered in any case. The intent of this study is to evaluate the effects of local site geology and geometry, including topographic effects, on ground motion at the site.

Response to Comment 9

"Credible accidents" refers to those processes and events that are sufficiently credible to warrant consideration as a potential disruption of the repository (see SCP page 8.0-10, and Section 8.3.5.13 beginning on page 8.3.5.13-26, and SCP Table 8.3.5.13.-2 in the SCP). Examples include faulting and seismicity, magmatic intrusion, extreme climate change, exploratory drilling, mining, etc.

The term "initiating event" as also used in the SCP, is an analogous term. An example of a "credible accident" is given in the cited sentence, by referring to "seismic events" as the initiating process (meaning actual faulting displacement and/or ground shaking) that may disrupt the repository and cause release of radioactive materials. The term in question is understood in the context of the site characterization program.

Response to Comment 10

The concept and application of the 10,000-year cumulative slip earthquake methodology for site characterization is being reevaluated by DOE. See, for example, the response to State of Nevada Comment 3 for Study Plan 8.3.1.17.3.1 (letter, Gertz to Loux, dated April 21, 1993). Changes, if any, in the use of this concept is the subject of issue resolution documentation being prepared by DOE. If changes in this study plan are warranted after this reevaluation, the study plan will be revised.

Response to Comment 11

As stated in the Site Characterization Plan (page 8.3.1.17-35):

> "The design-basis ground motions are to be characterized for frequencies significant to facilities important to safety such that there is less than a 10-percent chance for being exceeded during 100 yr. Accordingly, the design-basis motions are to have an annual excedance probability less than 10^{-3}/yr, which translates to an average recurrence period greater than 1,000 yr. This goal appears to be consistent with the level of conservatism used for other facilities with important consideration for safety."
>
> "An important precedent is provided by nuclear power plants where annual probabilities for exceeding the design-basis motions have been found to be on the order of 10^{-3}/yr to 10^{-4}/yr for several operating plants (Reiter and Jackson, 1983)."

Response to Comment 12

The "additional seismographs" will be operated as part of this study as well as Study 8.3.1.17.3.4 (Historical and Current Seismicity). They are part of the array of instrumentation that supports the Southern Great Basin Seismic Network. The quality assurance requirements established for operating seismic stations will remain the same for all studies.

Response to Comment 13

See the response to Comment 3.

Response to Comment 14

The study plan discusses alternative methods, including their strengths and weaknesses. Both methods will be used in the study. Effects of cumulative low-level ground motion are design analysis activities and are not within the scope of this study.

Response to Comment 15

The references cited were not meant to be all inclusive. See also the response to Comment 1.

Response to Comment 16

Nonlinear effects will be considered to the extent that they significantly affect the ground motion experienced at the site. The DOE does not plan on developing new methodologies to address nonlinear behavior.

Response to Comment 17

There are no changes that need to be introduced to the study as a result of the change from shaft to ramps, other than replacement of "shaft" by "studies" in the name for the ESF. This change will be made in a future revision to the study plan, should one be warranted for other reasons. A revision will not be initiated solely on the basis of this comment, however.

Response to Comment 18

The occurrence of the Little Skull Mountain earthquake (M = 5.6) and its numerous aftershocks has provided a wealth of data to support this study. Aftershock data collected under Study 8.3.1.17.4.1 (Historical and Current Seismicity) will be used to support the study of effects of local site geology on ground motion. As activities associated with construction of the Exploratory Studies Facility increase, increased seismic background noise is likely. Such noise will not, however, preclude the collection of required data.

The planned upgrade of the Southern Great Basin Seismic Network currently includes an array of strong-motion instruments to record strong ground motion from any local or regional earthquakes that might occur.

The criteria to define "well-recorded" will be developed as part of this study. In general, "well-recorded" events will be characterized by a signal-to-noise ratio that is sufficient to obtain meaningful results from the analyses.

Response to Comment 19

The Band-Limited White Noise (Random Vibration Theory) is one of the stochastic models that will be considered.

Responses to Comment 20

"Effects of geometry" in this context refers to effects associated with the positioning of rock units and geologic structures, as well as topographic and valley effects.

Responses to Comment 21

The referenced statement on page 3-1 gives the true intent of the study plan. The stations depicted on Figure 1-2 do not show all the stations from which data will be used for this study. Study 8.3.1.17.4.1 (Historical and Current Seismicity) also provides data for this study. Much of the aftershock data recorded under this study since the Little Skull Mountain earthquake on June 29, 1992, have been collected on both rock and alluvium sites to address the effects of local site geology.

Response to Comment 22

The cited statement is followed by a statement which indicates that strategies using world-wide strong motion data will be developed for use in this study.

Response to Comment 23

Timetables for preparation of technical procedures are not yet established, but such procedures will be completed before start of work. There is no requirement for procedures to be developed before that time, nor does DOE track the developmental stages of technical procedures beyond this requirement.

Response to Comment 24

The "range of frequencies of engineering interest" refers to standard engineering design interest in general, not to a specific design.

Response to Comment 25

While information on variability of ground motion at certain locations within the Nevada Test Site is available, this study is concerned with variability specifically in the vicinity of Yucca Mountain. Such variability will be assessed by this study and is not currently known.

Response to Comment 26

At the present time, DOE does not plan on drilling a borehole to Precambrian crystalline basement. If the results of currently planned geological investigations cannot provide the needed information on the seismic velocity structure, a deep borehole contingency may need to be reassessed.

Department of Energy
Washington, DC 20585

SEP 16 1992

Mr. Joseph J. Holonich, Director
Repository Licensing & Quality Assurance
Project Directorate
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Holonich:

In the U.S. Nuclear Regulatory Commission's (NRC) Phase I review of the U.S. Department of Energy's (DOE) Study Plan 8.3.1.17.3.4, "Effects of Local Site Geology on Surface and Subsurface Motions," the NRC expressed a technical concern (enclosure 1). Enclosure 2 contains DOE's response to this comment.

DOE forwarded the comment to the U.S. Geological Survey for an assessment of potential impact on the planned study. The NRC comment concerns the use of a more appropriate model than proposed in the study plan. DOE agrees that a model that uses two-dimensional velocity structure, nonvertical incident waves, and linear and nonlinear behavior may be required. In fact, these modified models are intended to be developed and are described in the study plan.

With respect to the request for a not-readily-available reference (Lee and Finn, 1978), the citation to this publication will be deleted in a subsequent revision to the study plan. The reference was cited in conjunction with several other papers, all of which are given as examples. Deletion of this reference will have no impact on the technical basis for this study.

If you have any questions, please contact Mr. Chris Einberg of my office at 202-586-8869.

Sincerely,

John P. Roberts
Acting Associate Director for
Systems and Compliance
Office of Civilian Radioactive
Waste Management

Attachment

Enclosures:
1. Ltr, 6/8/92, Holonich to Roberts
2. DOE Response to NRC Comment

cc: w\enclosures
Alice Cortinas, CNWRA, San Antonio, TX

cc: w\enclosures
C. Gertz, YMPO
R. Loux, State of Nevada
T. Hickey, Nevada Legislative Commission
M. Baughman, Lincoln County, NV
J. Bingham, Clark County, NV
B. Raper, Nye County, NV
P. Niedzielski-Eichner, Nye County, NV
G. Derby, Lander County, NV
P. Goicoechea, Eureka, NV
C. Schank, Churchill County, NV
F. Mariani, White Pine County, NV
V. Poe, Mineral County, NV
E. Wright, Lincoln County, NV
J. Pitts, Lincoln County, NV
R. Williams, Lander County, NV
J. Hayes, Esmeralda County, NV
M. Hayes, Esmeralda County, NV
B. Mettam, Inyo County, CA
C. Abrams, NRC

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

JUN 0 9 1992

Mr. John P. Roberts, Acting Associate Director
for Systems and Compliance
Office of Civilian Radioactive Waste Management
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, D.C. 20585

Dear Mr. Roberts:

SUBJECT: PHASE I REVIEW OF U.S. DEPARTMENT OF ENERGY STUDY PLAN, EFFECTS OF LOCAL SITE GEOLOGY ON SURFACE AND SUBSURFACE MOTIONS

On December 4, 1991, DOE transmitted the study plan, "Effects of Local Site Geology on Surface and Subsurface Motions" (Study Plan 8.3.1.17.3.4), to the U.S. Nuclear Regulatory Commission for review and comment. NRC has completed its Phase I Review of this document using the Review Plan for NRC Staff Review of DOE Study Plans, Revision 1 (December 6, 1990).

The material submitted in the study plan was considered to be consistent, to the extent possible at this time, with the NRC-DOE agreement on content of study plans made at the May 7-8, 1986, meeting on Level of Detail for Site Characterization Plans and Study Plans.

Among the references listed for this study plan is one which has not been provided to NRC and is not readily available in the public domain. We therefore request that DOE provide the NRC with the document which is listed in the Enclosure.

A major purpose of the Phase I Review is to identify concerns with studies, tests, or analyses that, if started, could cause significant and irreparable adverse effects on the site, the site characterization program, or the eventual usability of the data for licensing. Such concerns would constitute objections, as that term has been used in earlier NRC staff reviews of DOE's documents related to site characterization (Consultation Draft Site Characterization Plan and the Site Characterization Plan for the Yucca Mountain Site). It does not appear that the conduct of the activities described in this study plan will have adverse impacts on repository performance and the Phase I Review of this study plan identified no objections with any of the activities proposed.

Although the staff has not identified any concerns with DOE starting site characterization activities described in this study plan, it considers that a more appropriate model than that proposed in the study plan would use at least two-dimensional velocity structure, non-vertical incident body waves, and linear and non-linear soil behavior. Comment

After completion of the Phase I Review, selected study plans are to receive a second level of review, called a Detailed Technical Review, based on the relationship of a given study plan to key site-specific issues or NRC open

ENCLOSURE 1

DOE Response to NRC Comment on Study Plan 8.3.1.17.3.4
"Effect of Local Site Geology on Surface and Subsurface Motions"

NRC Comment

"Although the staff has not identified any concerns with DOE starting site characterization activities described in this study plan, it considers that a more appropriate model than that proposed in the study plan would use at least two-dimensional velocity structure, nonvertical incident body waves, and linear and nonlinear soil behavior."

DOE Response

DOE agrees that the above comment is justified. Although perhaps not stated strongly enough in the study plan, all available techniques will be utilized during modeling of site effects. Modified models, for example, are intended to be developed and tested against the initial reference model, and it is anticipated that use of these more sophisticated models will result in an improved fit to the observations as compared to the initial very simple model.

In the current version of Study Plan 8.3.1.17.3.4 (second paragraph in Section 3.2.1, p. 3-4) it is stated that:

> "The approach to modeling will be to construct the simplest model that predicts the first-order features of the observed site-response functions. The initial model will assume a one-dimensional velocity structure, linear response, and vertically incident body waves. More complexity (e.g., nonvertically incident body waves, surface waves, equivalent-linear site response, two-dimensional velocity structure, etc.) will be introduced as necessary."

The approach to modeling, therefore, includes more than the use of the "simplest" or "initial" model. A more complete discussion of modeling is included in Section 3.2.4 (p. 3-5) of the study plan.