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*WBS*: 1.2.9.1
*QA*: N/A.

H-37279

August 7, 1995

LA-EES-13-08-95-001

Dr. Colin A. Heath
CRWMS M&O Assistant General Manager for Program Integration
TRW Environmental Safety Systems Inc.
2650 Park Tower Drive
Suite 800
Vienna, VA 22180

Dear Dr. Heath,

**Submittal of Los Alamos Monthly Management Analysis Report for July 1995**

Attached is the Los Alamos Monthly Management Analysis Report for July 1995. This report includes five sections:

(1) a summary of our technical efforts, including information on completion of contract deliverables and major problems;
(2) a summary of personnel changes;
(3) a list of any unusual current or anticipated financial performance problems;
(4) a list of programmatic issues that may impact the overall CRWMS M&O effort; and
(5) a summary of work planned for next reporting period.

The technical sections of this report have not received formal technical or policy reviews by Los Alamos or the YMP. Data presented in this document constitute predecisional information, should not be referenced, and are not intended for release from the U.S. Department of Energy as information to be referenced.

If you have changes to our distribution list, please call Susan Klein at (505) 667-0916.

Sincerely,

Julie A. Canepa

Julie A. Canepa

JAC/SHK/cmv

Attachment: a/s

AUG 15

**ENCLOSURE 4**

Cy w/att:
R.W. Andrews, M&O/INTERA, MS 32
**W.E. Barnes, YMSCO, MS 523**
H.A. Benton, M&O, MS 423
A.I. Berusch, DOE/Forrestal, Washington DC
K.K. Bhattacharyya, M&O, MS 423
J.A. Blink, LLNL/LV, MS 423
B. Bodvarsson, LBL, Berkeley, CA
S.J. Brocoum, DOE/YMSCO, MS 523
G.A. Bussod, EES-13, MS J521
J.A Canepa, EES-13, MS J521
M.W. Chisholm, M&O/TRW, MS 12
W.J. Clarke, LLNL, MS 423
P.L. Cloke, M&O/SAIC, MS 423
L.S Costin, SNL, Albuquerque, NM
R.L. Craun, YMSCO, MS 523
C. DiBella, NWTRB, Arlington, VA
W.R. Dixon, YMSCO, MS 523
J.R. Dyer, YMSCO, MS 523
N.Z. Elkins, EES-13/LV, MS J900/527
L.D. Foust, M&O/TRW, MS 423
A.V. Gil, YMSCO, Las Vegas, NV
L.R. Hayes, USGS, Denver, CO
S. Hanauer, OCRWM, Washington, DC
V.F. Iorii, YMSCO, MS 523
S.B. Jones, YMSCO, MS 523
S.H. Klein, EES-13, MS J521
S. T. Nelson, M&O/WCFS, MS 423
S.F. Saterlie, M&O/LV, MS 423
W.D. Schutt, M&O/LV, MS 423
A.M. Simmons, DOE/YMSCO, MS 523
E.T. Smistad, DOE/YMSCO, MS 523
D. Stahl, M&O/B&W, MS 423
C.T. Statton, M&O/WCFS, MS 423
R.L. Strickler, M&O/TRW, MS 6
D.P Stucker, DOE/YMSCO, MS 523
A.L. Thompson, EES-13/LV, MS J900/527
A.E. VanLuik, M&O/INTERA, MS 423
R.G. Vawter, M&O/TRW, MS 423
M.D. Voegele, SAIC, MS 423
K.A. West, EES-13, MS J521
N. White, Nuclear Regulatoy Commission, LV, NV
D.R. Williams, YMSCO, MS 523
J.L. Younker, M&O/TRW, MS 423
RPC File (S. Martinez), MS M321
LA-EES-13 File, MS J521

## Los Alamos Monthly Management Analysis Report for July 1995

**(1) Summary of (a) Los Alamos' technical accomplishments, (b) deliverables completed, and (c) major problems that may impact future performance.**

**(a) Technical accomplishments**

**WBS 1.2.3.2.1.1.1 Transport Pathways.** ***Data for Radionuclide Transport Retardation Studies.*** Steve Chipera completed quantitative XRD analyses on 28 samples for the sorption task (WBS 1.2.3.4.1.2.1). Results for these samples are incorporated into milestone 4055, which summarizes XRD analyses for the sorption task. The complete data collection for this milestone includes quantitative XRD data for 43 samples, purity data for 12 mineral standards, analyses of fines washed from two column experiments, and purity analysis for seven prepared clinoptilolite separates. These data will be used in determining the effects of mineralogy in radionuclide transport retardation models.

***Studies of Calcite as a Factor in Flow Models and Radionuclide Transport Retardation.*** Studies of calcite surfaces by scanning electron microscope (SEM) were being pursued as a part of milestone 3326, which is a compilation of results from chemical and petrographic studies of calcites from Yucca Mountain to understand their environments of formation and their potential role in retarding radionuclide transport (particularly of Np). The SEM analysis of calcites from UE-25 UZ#16 shows that calcites above the static water level (SWL) have only minimal and equivocal evidence of etch pits, whereas rare calcites below the SWL have extensive surface etching and are draped by fibrous crystals of a Ca, Al-silicate (possibly a zeolite). These results indicate that some zones beneath the SWL may be geochemically unfavorable for calcite precipitation; such zones may not be effective for radionuclide retardation if the retardation mechanism requires coprecipitation.

Instrumental Neutron Activation Analyses (INAA) were completed for samples of fracture calcite from the ESF (Tiva Canyon Tuff horizon), USW NRG-6, and UE-25 UZ-16. These data confirm the characteristic "fingerprint" of a negative Ce anomaly in chondrite-normalized rare-earth element data for most calcites of the unsaturated zone, principally in the Topopah Spring Tuff, but they also show that calcites of the Tiva Canyon Tuff lack this anomaly. These results suggest that either the Tiva and Topopah UZ flow systems are generally isolated from each other or the geochemical processes that lead to development of a negative Ce anomaly are generally inoperative or ineffective until downward flux has passed into the Topopah Spring Tuff.

***Inputs to Modeling of Transport.*** A mineral-stratigraphic model was prepared for use in transport calculations by C. Gable and B. Robinson (WBS 1.2.3.4.1.5.1). This model defines mineralogic horizons, currently exclusive of fracture-mineral distributions, for the unsaturated zone beneath the potential repository. It will be tested and refined in an iterative approach to define the most critical mineralogic factors in retarding the transport of a variety of radionuclides.

**WBS 1.2.3.2.1.1.2 Alteration History.** Staff wrote new criteria statements, resource distributions, and statements of work for the FY96 Summary and Synthesis Reports. They also prioritized existing FY96 milestones and evaluated the programmatic impacts of deferring or deleting specific milestones.

Schön Levy began examination of an optional repository expansion area west of the Solitario Canyon fault. The purpose of this examination is to identify possible similarities and differences in mineralogy and inferred geochemical processes between this area and the primary study area at Yucca Mountain. The optional area includes drill hole USW H-6, which was cored at selected intervals. Staff performed x-ray diffraction, petrographic examination, and some electron microprobe analyses of the cores and a few cutting samples. They also made use of the USGS lithologic log (Craig, Reed, and Spengler, 1983) for the hole. H-6 is lithologically and mineralogically very similar to USW H-5, located on the western edge of the primary area. The stratigraphic position of the principal vitric-zeolitic transition is about the same in both holes. This similarity is probably an indication that the zeolitic alteration responsible for the vitric-zeolitic transition predated much of the offset on the Solitario Canyon fault, i.e., alteration occurred while the affected stratigraphic units were laterally continuous across the fault trace (Levy 1991).

One question for which the staff has no data on hand is whether the "perched" zeolite zone, about 5 m thick, at the base of the Calico Hills Formation in H-5, also exists in H-6. This zone might be a hydrologic barrier that could affect the flow path of water below a repository in the optional area. The zone is of restricted extent at Yucca Mountain. The lithologic log of Craig, Reed, and Spengler (1983) suggests that the zone does exist in H-6.

Two papers from *Natural Zeolites '93* were published in the conference proceedings. The paper by Dave Bish reviews the research on thermal behavior of natural zeolites. Recent data show that distance "types" of water do not exist. Rather, water is bound, primarily to extra-framework cations, with a continuum of energies, giving rise to a pseudocontinuous loss of water accompanied by a dynamic interaction between remaining water molecules, extra-framework cations, and the tetrahedral framework. These interactions in the channels of zeolites give rise to dehydration behavior that is very dependent on the nature of the extra-framework cations, in addition to temperature and water vapor pressure. A paper by Giday WoldeGabriel reviews his geochronologic studies of zeolites and clays at Yucca Mountain. The striking and consistent pattern of zeolite K/Ar apparent ages that increases with depth is described and compared to illite/smectite ages.

Some of the potential processes responsible for the K/Ar apparent age distributions are being tested using experiments to investigate argon diffusion in clinoptilolite as a function of time, temperature, and water vapor pressure. Clinoptilolite fractions from the Jurassic Morisson Formation, New Mexico, and the early Miocene John Day Formation, Oregon, were selected for this experiment. About 3 g of each sample were weighed and placed in Teflon cups that were in turn placed in larger Teflon cups. The larger cups were half filled with deionized water, and the sample-containing cups were placed on a stand above the water level. The water level was kept constant and monitored regularly. The containers were placed in an oven at 150°C and will be kept there for 8 months. Sample aliquots will be taken from each of the containers at 1, 2, 4, and 8 months and prepared for argon determination. Another experiment was set up to determine the effect of dry heating at 100°C. These experimental studies will be used to understand the causes of argon loss from clinoptilolites in unsaturated environments such as Yucca Mountain.

Bill Carey prepared an abstract for the Geological Society of America titled "Consequences of the dehydration and hydration of clinoptilolite-rich rocks on the thermo-hydrologic evolution of a model radioactive waste repository." Bruce Robinson and Stephen Henderson are coauthors of the abstract, which describes a numerical model of the effect of clinoptilolite-bearing rocks on temperature and fluid flow in a waste repository similar to Yucca Mountain.

**WBS 1.2.3.2.1.2. Stability of Minerals and Glasses.** ***Clinoptilolite rates.*** Penn State researchers completed a second dissolution rate experiment on Na-exchanged clinoptilolite (FB) at 125°C. In this experiment, they measured the dissolution rate at two ($G_R$ states, one close to equilibrium and the other far from equilibrium. The first rate agrees with the rates measured in the first dissolution run (FA). The dissolution rate far from equilibrium (($G_R$ = -24 kcal/mol) is ~5.2e-10 mol/m-sec. Combined rate data from experiments FA and FB do not show the 'dissolution plateau' that is characteristic of many silicate minerals. A third experiment is now underway to investigate the dissolution rate when the input Al concentration is maximized. The Penn State researchers will then continue the experiments at 150°C.

The long experiments at 50 and 25°C to test the effect of Al inhibition on the clinoptilolite dissolution rate are now in their final stages at Yale. Results from the 50°C experiments appear to be giving the best combination of reasonably slow dissolution rates (i.e., reducing the problem of major mass loss and surface area change over the duration of the experiment) and measurable Al and Si.

Also at Yale, a clinoptilolite 80°C experiment was started close to equilibrium and will then be moved to conditions far from equilibrium for a short time. It is possible that this procedure will reduce the problems with mass loss while still giving accurate rate data far from equilibrium.

Yale researchers also started several short clinoptilolite experiments with different Na concentrations at 80°C. The results will be compared with the previous experiments as a function of ($G_R$. At this point they expect the Na rate effect to be the contribution to the ($G_R$, and, therefore, similar to the dependence of the rate on Al and Si.

Anye Mercy, a new graduate student in the Yale lab, was QA-oriented and started the pH surface titration experiments at 25°C. These experiments should give an independent estimate of the pH dependence of the clinoptilolite rates. The experiments are currently being set up and should be completed in the next few weeks.

*Clinoptilolite solubility.* The 80°C solubility experiments at Yale have reached equilibrium for clinoptilolite. The clinoptilolites at 50 and 25°C also appear to be close to equilibrium. Note that the solubility experiments for both analcime and clinoptilolite are important in defining the rate laws.

| T((C) | log(Ksp) for 12 oxygens |
|---|---|
| 80 | -23.223 |
| 50 | -25.764 |
| 25 | -29.195 |

*Analcime rates.* The far-from-equilibrium analcime experiment at Yale is also nearing an end, although a slight delay has resulted from flow-rate fluctuations due to leaking and pump problems under these higher flow conditions. The preliminary results suggest that the "dissolution plateau" has not been reached, a result similar to the clinoptilolite experiments. Yale researchers are now left with the possibility that the maximum dissolution rate for either mineral far from equilibrium cannot be predicted.

*Analcime solubility.* Penn State researchers completed reversible solubility runs on the Wikieup analcime at 125, 175, and 225°C, and at 90°C approaching from supersaturated conditions. This analcime (Si/Al=2.54) is considerably more soluble than the Mont. St. Hilaire analcime. Calculated free energies of formation of this analcime are less negative by about 50 kJ/mol compared with the Mont St. Hilaire analcime. The data for the Wikieup analcime should be more representative of Yucca Mountain siliceous analcimes than either published data or data for the Mont St. Hilaire analcime.

The 80°C analcime experiments at Yale have reached equilibrium for the Yale preparation of the Mont St. Hilaire analcime and the Wikieup sedimentary analcime. The sedimentary analcime has approached equilibrium very rapidly at all temperatures (nearly to equilibrium at 50 and 25°C at this point), apparently due to the very fine grain size (i.e., high specific surface area). At this point the sedimentary analcime appears to have considerably higher solubility than the hydrothermal Mont St. Hilaire analcime at 50 and 25°C. However, the slow reaction of the Mont St. Hilaire experiments (due to coarser grain size) might be the cause of this discrepancy. Note that all of the data are in reasonable agreement with the results of the Penn State hydrothermal experiments.

Analcime Solubilities

| | log(Ksp) | | |
|---|---|---|---|
| T(° C) | MSH1 | MSH2 | Sed |
| 80 | -14.02 | | -13.91 |
| 80 | | -14.21 | |
| 50 | | -16.62 | -14.93 |
| 25 | | -18.72 | -15.66 |

MSH1 = Yale preparation of Mont St. Hilaire analcime
MSH2 = Penn State preparation of Mont St. Hilaire analcime
Sed = Wikieup sedimentary analcime

***Conceptual Model of Mineral Evolution.*** Staff continued to prepare milestone 3444, the report on a modeling study of the clinoptilolite-to-analcime transition, for publication in the journal *Clays and Clay Minerals*. This study used estimated thermodynamic data and representative chemical formulae for clinoptilolite and analcime at Yucca Mountain, Nevada, to calculate $\log[(aK^+)^2/aCa^{2+}]$ vs. $\log[(aNa^+)^2/aCa^{2+}]$ stability diagrams to model the conditions under which clinoptilolite could transform to analcime. The calculations show that temperature, relative cation abundances, and silica activity are all important factors in determining clinoptilolite-analcime stability. In particular, the models show that most clinoptilolite samples at Yucca Mountain are stable as long as the aqueous silica activity is at or above cristobalite saturation. In the vicinity of the potential repository horizon, there is sufficient unaltered glass, cristobalite, and tridymite to ensure that the aqueous silica activity remains at levels at or above cristobalite saturation for extended periods. As long as these relatively soluble silica phases remain, even if temperatures rise significantly (e.g., to 150°C), not all of the clinoptilolite should alter to analcime. Furthermore, the calculations show that some clinoptilolite will remain even at 150°C with an aqueous silica activity at quartz saturation.

**WBS 1.2.3.2.5 Volcanism.** *Eruptive Effects.* Staff continued to compile data from lithic studies aimed at constraining the quantity of wall debris that can be carried to the surface during a small basaltic eruption. Final revisions were made on a paper on the first set of lithic studies. This paper will be published in the *Journal of Geology*.

*Subsurface Effects.* Staff analyzed samples from Paiute Ridge and Grants Ridge for chemical evidence of migration of fluids during hydrothermal activity accompanying a shallow basaltic intrusion. Work continued on theoretical modeling of hydrothermal processes for subsurface effects. A paper was presented at the International Union of Geodesy and Geophysics conference in Boulder, Colorado. This paper described some of the theoretical work carried out during early phases of this study.

*Magma System Dynamics.* Work continued on literature review of mantle melting processes and melt migration into the crust.

*Structural Controls of Basaltic Volcanism.* Data on spatial and structural controls of the location of basaltic volcanic centers in the Yucca Mountain region were assembled and transferred to Golder Associates. Staff from volcanism studies traveled to Seattle to work with Golder Associates on initiating simulation modeling for the structural controls studies. Three scenarios will be run in the simulations:

1. Direct disruption of a repository with eruptions.
2. Indirect disruption of a repository (intersection by dikes not feeder conduits) with a low or moderate probability of eruption.
    - 2a. Simple dike/dike swarm model
    - 2b. Dike swarm geometry equivalent to cluster-length event models
3. Penetration of the repository system but not subsurface penetration of the repository
    - 3a. Simple dike/dike swarm model
    - 3b. Cluster-length dike swarm model

Staff ran several trial simulations, checked the output ranges of data parameters, and tested the model representations of the spatial and structural models.

*Field Geologic Studies.* Field mapping, sample collection for geochemistry, and trenching were completed at the Hidden Cone center. The cone-slope apron on the northern side of the center was trenched at three localities using our backhoe-mounted 4 x 4 truck and the trench sections were described. An integrated soil-geomorphic model was developed for the center that is consistent with field observations and does not require multiple volcanic events during construction of the main cone. These observations combined with the results of geochemical studies of scoria indicate the center is most likely a simple monogenetic center. The northwestern lava flow was mapped, and staff verified through the mapping that the flow was derived from the north flanks of the main cone. Field and trenching studies are now completed at the Sleeping Butte centers.

*General.* Work continued on the assembly of the data appendix that will become a companion document for the volcanism status report. Staff met with a QA audit team to discuss and refine the structure of and the data items to be included in the data appendix.

Staff worked with staff from the M&O to assemble volcanism data requested by the NRC, as a preliminary part of an in-field visit by the NRC to audit volcanism studies.

**WBS 1.2.3.3.1.2.5 Diffusion Tests in the ESF.** Sorption tests using one of the possible tracers was started this month. Preparation of the Test Planning Package (TPP) was proceeding without problems. Planning for the drilling program related to fielding the diffusion tests continued to proceed with some resolution of the approach to overcoring the completed diffusion test and how to break off the core from the bottom of the hole.

John Musgrave, Gilles Bussod, June Fabryka-Martin, Andy Wolfsberg, and Paul Reimus met with Bruce Parks, hydrology coordinator for the M&O, and other YMP hydrology participants in Las Vegas. The meeting was held to review budget information from phase II of budget negotiations for FY96 and prepare budget requests for phase III budget negotiations.

**WBS 1.2.3.3.1.3.1 Reactive Tracer Testing.** ***Lithium Bromide Column Experiments*** Results from experiments on the effects of kinetics and nonlinear sorption on the transport behavior of Li in columns packed with Bullfrog tuff from the C-wells were being analyzed. The conclusions drawn from this study could have an important impact on both the pre-test predictions of LiBr transport in the C-wells field-scale experiments and on the interpretation of the field experiments.

*Field Testing* Staff participated in a tracer test at the Raymond Quarry site in California. The injection and recovery wells in this test were 7.5 meters apart, and the test was conducted with recirculation of 5 percent of the produced fluid (production rate was ~2 gpm). In addition, the injection interval was recirculated and sampled at the surface so that the concentration of tracers in the injection well as a function of time could be determined. Two sizes of microspheres (~0.85-μm and ~0.35-μm diameter) were used as tracers, and recovery of the microspheres was approximately 1 percent (0.85-μm) and 5 percent (0.35-μm), compared to 60-70 percent for fluorescein. The microspheres arrived at the production well sooner than the fluorescein, but their breakthrough curves had very short tails. These results are very preliminary, but they suggest that the microspheres may be attenuated by settling in the system. LiBr was also used as a tracer(s) in this test, but these results will be analyzed in the next reporting period.

Tracer tests at the C-wells are scheduled to commence in August 1995 at the earliest according to most recent schedule information. A Moyno progressing cavity pump, which will offer additional options for tracer injection, will be used. Staff wrote draft detailed technical for (1) conducting field tracer experiments, (2) preparation of standards for tracer concentration measurements, and (3) the use of a spectrophotometer or fluorometer to determine constituent concentrations in solution. Two previously written procedures were modified: (1) the use of a flow cytometer to determine particle concentrations in solution, and (2) the use of an ion-selective electrode to determine ion concentrations in solution. These technical procedures are expected to be approved before any tracer tests are conducted at the C-wells.

*Pre-Test Predictions of Solute Transport.* A 3-D finite element grid was being constructed to allow 3-D calculations of flow and tracer transport at the C-wells. Analysis of preliminary 2-D finite-difference calculations of solute transport in idealized parallel-plate fractures revealed that widely accepted models describing solute transport in fractures, coupled with diffusion into a porous matrix, may significantly overestimate the effects of matrix diffusion over short time and length scales (e.g., in tracer experiments). Thus, greater solute recoveries might be expected in tracer experiments than would be predicted by these existing models. In another activity, a 2-D particle-tracking code is being developed to predict tracer breakthrough curves at the C-wells in convergent or recirculating interwell tests in which it is assumed that the media are homogeneous and isotropic. This relatively simple model will be used to offer comparisons with the more sophisticated 3-D finite-element calculations and to investigate tradeoffs associated with different tracer injection schemes. Finally, a spreadsheet-like MathCad model has been developed to predict tracer breakthrough curves in convergent tracer tests. This model will be the subject of a paper presented at the Fall 1995 Materials Research Society meeting. These efforts will culminate in milestone 4077, scheduled for completion at the end of FY 1995.

***Laboratory Experiments to Support Model Development/Validation.*** Laboratory-scale tracer transport experiments were completed at three different flow rates in a glass column packed with glass beads. These tests are being conducted to investigate the transport behavior of both a nonsorbing solute (iodide) and polystyrene microspheres (~1.0-µm diameter and ~0.3-µm diameter) through dual-porosity media. Similar experiments are now being conducted in "columns" made from actual tuff cores of different porosities (these columns are also packed with glass beads). Preliminary results from the glass-column tests indicate that microspheres are being attenuated in the glass column, with the larger microspheres experiencing greater attenuation than the smaller microspheres. The attenuation of both microspheres increases as the flow rate decreases, suggesting that the attenuation may be due to settling. If attenuation were due to surface interactions, one would expect greater attenuation of the smaller microspheres because they should come in contact with surfaces more often (because of their smaller size and greater diffusivity). These results are also consistent with the field test results at Raymond Quarry (see above), where the larger microspheres were more attenuated. The results of both the laboratory experiments and the field tests could have important implications for future field tests because residence times in the field will typically be even longer than in the experiments discussed in this report. Thus, microsphere attenuations in the field may be significant. Iodide analyses associated with the column experiments suggest that iodide transport does not strongly depend on flow rate, which is to be expected in a column with nonporous walls. The information obtained from this study could be valuable in the prediction of tracer and radionuclide movement through saturated fractures over large scales at Yucca Mountain, and it could potentially help in interpreting the C-wells tracer tests.

**WBS 1.2.3.2.6.1.4. Paleoenvironmental History of Yucca Mountain. Independent Dating.** On a sampling trip in early July, staff acquired the necessary samples for assessing cliff retreat on bedrock outcrops on the west side of Yucca Mountain. Staff sent samples to a laboratory at the University of Pennsylvania. Staff was evaluating first data from the Ghost Dance Fault dating study.

Staff forwarded a report to the USGS on a scoping study of the cosmogenic dating of the scarps along the Solitario Canyon and the Windy Wash faults in Crater Flat. This study will be included in a USGS circular. A TDIF was prepared for the data generated in this study, and a copy was forwarded to the USGS.

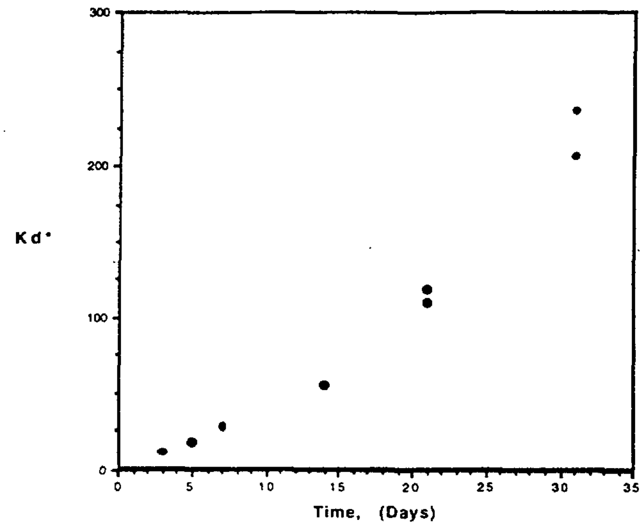
**WBS 1.2.3.4.1.1 Ground-Water Chemistry Model.** Analytical data were obtained for water compositions resulting from 10-day water/rock interaction experiments with two synthetic ground-water compositions (AGW #1 and AGW #2) and seven different rocks. The rock samples used in the experiments included two surface samples of Tiva Canyon Tuff containing caliche and opal, a nonwelded vitric tuff from the PTn, three devitrified tuffs, and one zeolitic tuff. Relative to the original water compositions, the waters in contact with the Tiva Canyon Tuff, vitric tuff and the zeolitic tuff show the greatest changes in composition. The data indicate that ion-exchange reactions have been the most important reactions in this 10-day span. These experiments will be sampled on a regular basis to document changes in water chemistry with time. The data resulting from these experiments will be used to test conceptual models of the evolution of ground-water chemistry in the unsaturated zone at Yucca Mountain.

Staff expended considerable effort to revise work scopes for FY96.

**WBS 1. 2. 3. 4. 1. 2. 1. Batch Sorption Studies.** Staff completed a study of Pu-239 sorption onto tuffs (under atmospheric conditions) to determine the sorption of Pu onto Yucca Mountain tuffs as a function of time. A well characterized Pu(V) acidic stock solution was used to prepare the Pu solutions in synthetic UE-25p #1 water. Three types of tuffs were used: vitric (represented by GU3-1414), devitrified (represented by G4-272), and zeolitic (represented by G4-1515). All tuffs were crushed and wet-sieved. The pH for these experiments was approximately 8.9. These experiments involved 1) pre-treating crushed tuff with synthetic UE-25 p# 1 water, 2) adding a Pu(V) solution in synthetic UE-25 p# 1 to the pretreated solid phase, 3) separating the phases, and 4) determining the Pu concentration in each phase.

The sorption distribution coefficients (measured for Pu) as a function of time may be seen in Figures 1 -3. The results of these experiments indicated that the kinetics of Pu sorption onto tuff is slow. Even after a sorption period of 21 days, sorption equilibrium has not been achieved. Sorption of Pu onto tuffs in synthetic UE-25 p# 1 decreases in the order: vitric > zeolitic > devitrified. The significance of these results is that likely a minimum $K_d$ can be used to describe sorption of Pu onto the major tuff types. After 21 days, the sorption of Pu(V) in synthetic UE-25 p# 1 water onto vitric and zeolitic tuffs is greater than 100 ml/g. The sorption of Pu onto devitrified tuff is a factor of 2 less.

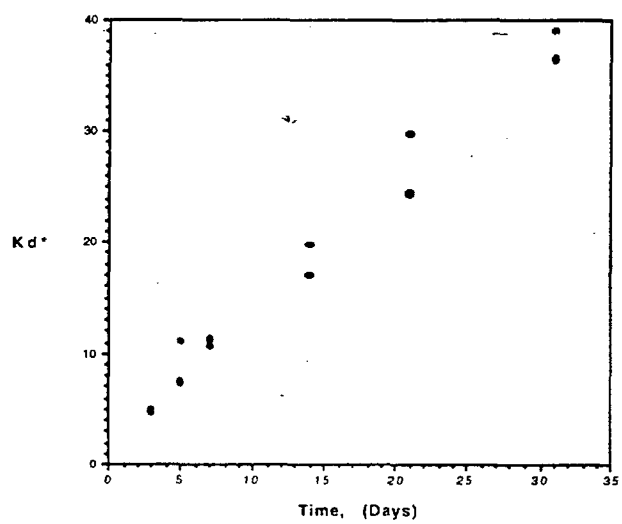
EXPERIMENT Pu SORP. #103: Kd VALUES VS SORPTION TIME
Pu (V) sorbed onto G4-1515 in Syn.P1 water (under atmospheric conditions)




* (ml/g) Based on original Pu solution.

Fig. 1

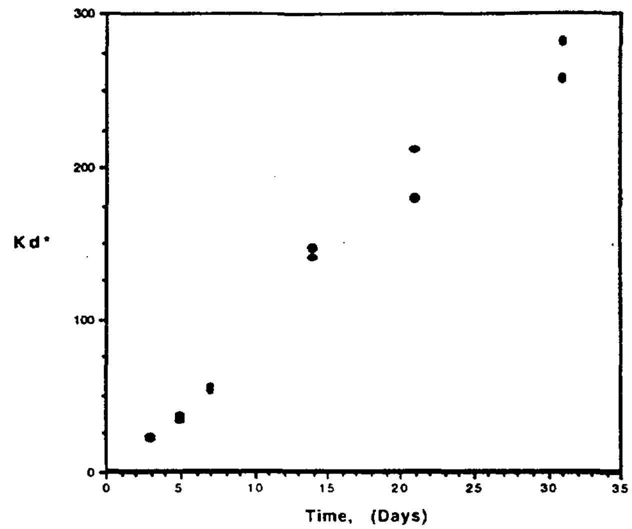
EXPERIMENT Pu SORP. #103: Kd VALUES VS SORPTION TIME
Pu (V) sorbed onto G4-272 in Syn.P1 water (under atmospheric conditions)




* (ml/g) Based on original Pu solution.

Fig. 2

EXPERIMENT Pu SORP. #103: Kd VALUES VS SORPTION TIME
Pu (V) sorbed onto Gu3-1414 in Syn.P1 water (under atmospheric conditions)




* (ml/g) Based on original Pu solution.

Fig. 3

WBS 1.2.3.3.1.2.2. Water Movement Test. Staff issued a detailed technical procedure for the analysis of packrat midden samples for chlorine-36. Midden samples, which have been dated by carbon-14 as part of a separate YMP activity, were being analyzed for chlorine-36 to test the hypothesis that the chlorine-36 signal was significantly higher in the past than it is at present. If such is the case, then the elevated chlorine-36 signals observed in perched water from UZ-14 and in the Calico Hills unit at UZ-16 would be consistent with ground-water travel time estimates of tens of thousands of years, instead of indicating the presence of a component of bomb-pulse water.

Staff submitted a suite of 48 samples for chlorine-36 analysis. The suite included samples of overland flow, which will provide an indication of the chlorine-36 content of water entering the soil at the present day; ground-water samples from 3 different intervals in G-2; drill core from UZ-N55, which will be compared with results obtained on ream cuttings from the corresponding depths to evaluate whether the cuttings had been contaminated; ground-water samples from regional springs and wells; SD-7 perched water; ESF construction water; and samples representing the in-situ chlorine-36 content of Yucca Mountain tuffs.

Samples forming a transect across the Bow Ridge Fault in the ESF tunnel were analyzed for chloride and bromide. In contrast with the previous set, this set of samples showed no indication of contamination by ESF construction water. These samples are now being prepared for chlorine-36 analysis.

Staff applied a step-leaching procedure to characterize the variability of the rock bromide-to-chloride (Br/Cl) ratio throughout the units comprising Yucca Mountain. This value must be known to correct chlorine-36 based ground-water travel times for any dilution by chloride released from the rock during sample collection or processing. Without such correction, calculated travel times will be older than the true value. Staff began processing 36 samples in replicate by this procedure to build a data base of the Br/Cl ratios, which will involve over 180 Br/Cl analyses by the end of the month. As expected, corrected ground-water travel times using these data are significantly faster than the uncorrected times. Based on these data, an abstract titled "36Cl-based water ages in the unsaturated zone, Yucca Mountain, Nevada, corrected for dilution by rock Cl"was prepared for presentation at the Fall Meeting of the American Geophysical Union.

**WBS 1.2.3.4.1.2.2. Biological Sorption and Transport.** The third replication of the unsaturated flow crushed column experiment was completed (each relicate requires over a month to complete). As with the previous two replicates, iron transport through the column was enhanced when the iron was chelated with a bacterial siderophore. The results of this work are being incorporated into milestone 3410. The results of previously completed batch sorption studies and the column studies all demonstrate that chelation to a bacterial siderophore has a profound effect on the solubility of the Fe(III) cation, an analog of Pu(IV).

**WBS 1.2.3.4.1.3 Speciation/Solubility.** The PAS laser system has been upgraded with a new OPO laser from Spectra-Physics, and it is now running. Trial PAS spectra of the standard $Nd^{3+}$ in 1 M HCl have been and continue to be taken at low concentrations. Such background work is required to test the sensitivity of the new system versus the old dye-laser-based system and to test the calibration of the wavelength drive over extended periods of use. The ability to scan throughout the visible without time-consuming dye changes and laser realignments will be advantageous to the Project.

In EQ3 modeling studies, the redox state of the LBL solubility experiments on Pu in J-13 25 C has been examined. The distribution of Pu IV, V, and VI can be well modeled at pH 7 and suggests an Eh of 684 mV. The observed distribution of Pu species at pH 5.9 and 8.5 suggests a similar Eh, but details of the distribution cannot be duplicated as well. These values are considerably more oxidizing than the 126 to 342 mV values that were measured using a platinum electrode. It is not obvious what is controlling the Eh in these experiments. The log $FO_2$s, indicated by the Eh of 684 mV, range from approximately -15 at pH 5.9 to -5 at pH 8.5 and therefore are not consistent with control by a single gas phase. The observed solubilities are in reasonable agreement with either $Pu(OH)_4(s)$ or $PuO_2(OH)_2(s)$, depending on the pH.

The actinide solubility studies (Pu and Np) have been aging for 3 months now at Los Alamos. In contrast to previous bulk solubility experiments, the pH has not been manipulated by adding HCl or NaOH during the experiments, thereby maintaining low-ionic-strength waters of the natural J-13 and UE-25 systems. The pH was set at the beginning of the experiment and will simply be monitored periodically throughout the experiment. The lack of additional Na is especially important for the neptunium solubility study, as the sodium-containing "double salt" $NaNpO_2CO_3$ precipitation product has been reported. At LBL work continued on the paper "Determination of Solubilities and Complexation of Waste Radionuclides Pertinent to Disposal at Yucca Mountain." Scoping experiments continued on fission product selenium solubility and speciation studies.

Accordingly, the two Proton Dissociation of Selenic Acid is as follows:

$H_2Se0_4 = H+ + Hse0_{4-}$ $Ka1 = 1.2 \times 10^{-2}$ $pKa = 1.92$

$HSe0_{4-} = H+ + Se0_4-^{-}$ $Ka2 = 8.9 \times 10^{-3}$ $pKa = 2.05$

Thus, dissolution of sodium selenate in distilled water yields a solution at about pH 2 that corresponds to approximately 50% $HSeO_4$- and 50 percent $SeO_4$-$^{-}$. The scoping experiments performed thus far on observation of complex formation of actinides with selenate have been
around this pH region, due to experimental conditions. We are learning how to adjust the pH of these solutions toward the basic side (in order to more nearly relate to Yucca Mountain near- and far-field conditions), without chancing to precipitate the hydroxide of the actinide metal (a common problem).

To date, complexes of Np(V), Pu(III, IV, and VI) have been observed. As might be expected, tetravalent Pu spectra show the strongest complex formation by selenate ligands.

Solubility experiments with calcium selenate were in progress and show much greater solubility (> iM) than would be expected with selenium's lighter homolog, calcium sulfate.

**WBS: 1. 2. 3. 4. 1. 4. 1/2.** Transport Studies. Staff completed the elution of Np(V) through four natural fractures. Saturated fractured tuff columns and J-13 ground-water were used for this study. The results of these experiments indicate that Np can be significantly retarded during transport through fractures relative to conservative tracers such as tritiated water.

Much of the efforts during this month were devoted to setting up the newly received unsaturated flow apparatus, which will be used for unsaturated transport experiments.

**WBS 1.2.3.4.1.5.1 Retardation Sensitivity Analysis.** ***Site-Scale Transport Modeling.*** The text for several sections of milestone 3468, "Unsaturated Zone Site Scale Transport Model for Np," has been written. Sections summarizing the laboratory-scale work performed to characterize the sorption and diffusion properties of Np have been written, along with a summary of the model assumptions used in the calculations.

Finite-element grids of various resolution have been created to perform the transport calculations. In addition, the stratigraphic representation of the Calico Hills is being reworked from the information used in the site-scale hydrologic model to provide a more accurate representation of the regions that are thought to be zeolitized. Since the zeolitic rock is probably the only rock type that sorbs Np to any appreciable extent, properly delineating the spatial extent of the zeolitic Calico Hills is essential to performing accurate predictions of Np transport.

Two-dimensional cross sections were being used to develop flow fields for both the equivalent continuum and dual permeability model formulations. The infiltration rate will be varied to examine the impact on Np transport.

***Code Development.*** A dual-permeability solute transport capability was debugged and determined to work properly in FEHM. In addition, the method for determining the velocity dependent dispersion coefficient for the solute transport equation was developed, which is appropriate for the unstructured grids that are being used in the site scale transport simulations. The particle tracking module was also upgraded to simulate dual permeability transport.

**WBS 1.2.5. Site Suitability Evaluation.** C. Harrington participated in the NAS meetings in Las Vegas. He was the only meeting participant who was involved in the technical work described in the technical basis report.

**WBS 1.2.5.3.5 Technical Database Input.** Staff has completed the development of a technical-data submittal schedule in response to the new requirements imposed in Yucca Mountain Site Characterization Project Procedure YAP-5.1Q, Revision 2 titled, "Document Development, Change, Review, Approval, and Acceptance Control."

Staff has completed the following Automated Technical Data Tracking (ATDT) System submissions:

- Calorimetric Measurement of the Enthalpy of Hydration of Clinoptilolite, DTN LA000000000131.001
- Thermodynamic Analysis of Calorimetric Measurement of the Enthalpy of Hydration of Clinoptilolite, DTN LA000000000131.002

Staff has completed the following Technical Database (GENISES) submissions:

- Eolian-Deposited Minerals Around Drill Hole USW SD-9, DTN LA000000000109.002
- Modeling the X-Ray Diffraction of Opal, DTN LA000000000122.002

**WBS 1.2.5.4.7 Performance Assessment Calculations.** ***Code Development.*** Work was carried out in the area of multiply defined nodes and upwinding for dual permeability methods. The work on multiply defined nodes consisted of reworking some on the internal storage arrangements to allow for geometric symmetry and to interface the multiple node output from the GEOMESH grid generator. Initial tests have been successful. This technology will allow us to interface with the Golder Fracman code and will provide the tools necessary for realistic fracture grids in both the unsaturated and saturated zones. The work on dual permeability methods focused on allowing full upwinding of the transmissibility terms for the fracture-fracture and matrix-matrix connections while allowing only fluid upwinding for the fracture matrix connections. We think this formulation, since it uses the matrix-saturated permeability , will be the most realistic and most conservative formulation.

***Grid Generation.*** The grid generation effort centered around producing FEHM geometric coefficients within GEOMESH. Since positive area coefficients are required for grids, an interface was created to allow these to be directly inputted into FEHM. The coefficient generation could take half the CPU time for large problems in FEHM; consequently, using the coefficients generated in GEOMESH was a great improvement.

Three-dimensional models for both the unsaturated and saturated zones were generated, and steady-state flow fields were calculated.

**WBS 1.2.11.2/.3/.5 Quality Assurance.** ***Program Development.*** The final transition plan to transfer the audit activities to DOE was submitted. The quality assurance transition plan for Los Alamos joining the M&O was in final preparation. Staff completed all QP revisions required for the audit transition, and these procedures have been sent to controlled documents for distribution. At the TCO, quality support was provided to discussions on development of a data management plan, potential changes to the ESFDR, Appendix B, and various TPP, JP, and strategy discussions on testing. A new electronic distribution list was implemented. A policy regarding TRW and Los Alamos personnel verifications was agreed upon.

*Personnel.* Andy Gallegos will become the QAL for the Chemical Sciences and Technology Division at Los Alamos on 31 July. Lyle Wichman was designated the CAR, PR/DR and deficiency coordinator; he also is the trend coordinator. Michael Clevenger and Paul Gillespie will serve as backup coordinators.

*Procedure Revisions.* Several procedures were revised in anticipation of the transition of the audit function to DOE. Staff continued to develop a field work package procedure.

*Travel.* S. Bolivar met with DOE and M&O officials on 6 July to discuss budget and audit issues. He also attended a Q team meeting in Las Vegas on 11-13 July. This meeting provided the opportunity to attend a PMR and discuss several quality issues with both the DOE and the M&O.

*Training.* S. Bolivar attended an Effective Listening class in Las Vegas on 6 July. Several personnel attended an annual Q team meeting held in Las Vegas on 11 July.

*M&TE.* At the request of DOE, the Los Alamos YMP vendor status in the QSL was reviewed. A summary report was submitted to DOE on 11 July.

*Audits & Surveys.* The FY95 audit schedule was completed and all reports issued. Survey SR-EES-LS-2-95-03, which was a general review of all work in Los Alamos Life Sciences Division, was completed and issued. Three minor deficiencies were corrected during the survey. Two surveys were initiated: LA-SR-EES-13-95-04 is to examine the document control manuals, and LA-SR-EES-13/LV/Vol is to review data and sample traceability related to the recently issued volcanism report. Both surveys are still in progress. The quarterly trend report was distributed. There were no adverse conditions recognized.

*Verifications.* There are three open internal corrective action reports (CARs). One of these is awaiting verification. There are no open DOE CARs.

*Quality Engineering/Software.* The Software Management Coordinator continued to upgrade network hardware and software. One of two software procedures still needs to be reformatted.

**(b) Deliverables completed and documents published**

**Milestone completed:**

Milestone 4055, summarizing the mineralogic analysis of sorption samples

**Documents published:**

B. Carlos, S. Chipera, D. Bish, and R. Raymond (1995) "Distribution and Chemistry of Fracture-Lining Zeolites at Yucca Mountain, Nevada," in Natural Zeolites '93; Occurrence, Properties, Use (D.W. Ming and F.A. Mumpton, eds.). Internat. Committee on Natural Zeolites, Brockport, NY, p. 547-563.

S. Chipera, D. Bish, and B. Carlos (1995)"Equilibrium Modeling of the Formation of Zeolites in Fractures at Yucca Mountain, Nevada," in Natural Zeolites '93; Occurrence, Properties, Use (D.W. Ming and F.A. Mumpton, eds.). Internat. Committee on Natural Zeolites, Brockport, NY, p. 565-577.

D. Vaniman and D. Bish (1995) "The Importance of Zeolites in the Potential High-Level Radioactive Waste Repository at Yucca Mountain, Nevada" in Natural Zeolites '93; Occurrence, Properties, Use (D.W. Ming and F.A. Mumpton, eds.). Internat. Committee on Natural Zeolites, Brockport, NY, p. 533-546.

P. W. Reimus, "Transport of Synthetic Colloids through Single Saturated Fractures: A Literature Review," LA-12707-MS, Los Alamos National Laboratory, Los Alamos, NM (July 1995).

**(c) Problems areas**

**WBS: 1.2.3.2.1.1.1** B. Carlos, the principal researcher in Fracture Mineralogy studies, has been required to remain at home through the month of July following major surgery in June. She will be return to work on August 1st. Because of her medical emergency, completion of milestone LA4079 will be offset from this month to 31 August.

**WBS 1.2.3.3.1.3.1** The only problems or issues that may adversely affect performance during future reporting periods are issues that involve preparation for tracer tests at the C-wells. These issues are largely beyond the control of Los Alamos personnel, but they could result in significant delays in tracer testing.

**WBS 1.2.3.4.1.2.2 Biological Sorption.** Staff were unable to collect samples from the ESF because of 1) planned maintenance of the TBM, and 2) a decreased rate of progress by the TBM. (The TBM has slowed down because it is now in much harder rock.) They were planning to collect samples either on 8 or 15 August.

**(2) Personnel changes**

WBS 1.2.3.2.1.2 Anye Mercy, a new graduate student in the Yale lab, has been QA-oriented and has begun research.

**(3) Unusual costs and possible financial performance problems**

NA

**(4) Programmatic issues that may impact the overall CRWMS M&O effort**

WBS: 1.2.3.2.1.1.1 **Transport Pathways.** Exercises this month in modeling the mineral stratigraphy of the Yucca Mountain site for transport calculations indicate that better mineralogic data are needed from drill holes USW H-3, H-5, and H-6. With no prospects of obtaining new core from these critical areas in the necessary time frame, it is important to the Project to use available resources to the maximum possible extent. We plan to revisit the collections of cuttings, sidewall samples, and rare core runs available from these holes to answer questions about the transport pathways through the Unsaturated Zone at the western margin of the exploration block and in the western optional area.

WBS: 1.2.3.2.1.1.2 **Alteration History.** The status of ongoing research, especially experiments in progress, is uncertain under the programmatic priorities established for FY96.

WBS 1.2.3.2.1.2 **Stability of Minerals and Glasses.** Experimental results on a sedimentary analcime sample show that published thermodynamic data on analcime are not directly applicable to Yucca Mountain. The differences between data for hydrothermal and sedimentary zeolites emphasize the importance of studying minerals and glasses similar or identical in composition to those occurring at Yucca Mountain rather than relying on published, often idealized, data.

Preliminary results from far-from-equilibrium experiments for both analcime and clinoptilolite suggest that the "dissolution plateau" has not been reached. These results present the possibility that the maximum dissolution rate for either mineral far from equilibrium cannot be predicted.

Thermodynamic modeling results show that *some* Yucca Mountain clinoptilolites may remain stable at elevated temperatures, even with an aqueous silica activity at quartz saturation. These results differ from previous results suggesting that clinoptilolite is stable only with an aqueous silica activity at or above cristobalite saturation.

**WBS 1.2.3.4.1.3 Radionuclide Sorption/Speciation.** Obviously, the lack of laboratory work planned for FY96 will adversely affect the drive to license Yucca Mountain. In addition, the lack of YMP scientific presence at MIGRATION 95 will adversely affect the scientific credibility of the entire YM project, initially, in the eyes of the international radioactive waste programs but, eventually, in the US and in court as well.

**WBS 1.2.3.5 Site Suitability Evaluation.** Charles Harrington attended the two-day meeting of the National Academy of Science Review Committee and helped to plan a three-day field trip that will be conducted 27-29 August.

**WBS 1.2.5.4.7** The USGS interaction on the saturated zone flow and transport model is working well. John Czarnecki worked at Los Alamos during the last week of July, and much was accomplished as a result.

**(5) Worked planned**

**WBS 1.2.3.2.1.1.1 Transport Pathways.** Work planned for the coming months includes the following: (1) continue analysis of calcites to understand transport and precipitation mechanisms; (2) examine drill core from USW NRG-7/7A, USW UZ-14, USW SD-9, and USW SD-12; (3) continue analysis of background dust mineralogy around Yucca Mountain; (4) continue characterization of trace minerals and continue microautoradiography experiments; (5) continue analysis of fracture coatings in core; and (6) examine rock-matrix and fracture samples from the ESF.

**WBS 1.2.3.2.1.1.2 Alteration History.** Studies of ESF and drill core samples, now in progress, will continue. A milestone letter report, due at the end of the fiscal year, will contain the data collected from the ESF. Argon diffusion experiments and thermodynamic studies of hydrous mineral dehydration and rehydration under repository thermal loading are also ongoing. Bill Carey will calculate the effects on clinoptilolite-bearing rocks of four thermal load levels. The effects will be calculated at 50-m intervals from the 100- to 550-m-depth interval. Calculations will be performed for zeolitic rock distributions in three drill holes: USW G-1, G-3, and G-4. These drill holes represent near-end points of the range in zeolite content of the Calico Hills unit from near-zero (almost all glassy in G-3) to mostly zeolitic. These calculations, plus the evaluations of optional repository expansion areas, will be largely completed by the end of August.

**WBS 1.2.3.2.1.2. Stability of Minerals and Glasses.** The experiments and modeling described above continue. Four milestone reports will be prepared.

**WBS 1.2.3.3.1.2.5 Diffusion Tests in the ESF.** Staff will continue sorption tests with other potential tracers. Staff will start laboratory diffusion tests with the possible tracers. Staff will continue to prepare technical procedures.

**WBS 1.2.3.3.1.3.1 Reactive Tracer Testing.** Staff will continue to prepare milestone 3249, which describes the results of the LiBr column studies. This report will discuss the ability to predict the transport behavior of lithium by assuming an equilibrium adsorption isotherm based on the results of earlier batch sorption experiments. Staff will continue to prepare milestone 4077, which presents pre-test predictions for tracer transport at the C-wells.

Staff will participate in a second FY 1995 field tracer test at the Raymond Quarry site in California. This test will have a greater separation between the injection and production wells. Los Alamos staff will provide fluorescent polystyrene microspheres for injection into the system, and they will analyze the effluent samples to determine microsphere concentrations in the samples.

**WBS 1.2.3.2.5 Volcanism.** Work will continue on the assembly of the data appendix that will become a companion document for the volcanism status report. The report titled "Geochemistry of the Lathrop Wells Volcanic Center" will be formatted for publication as a Los Alamos report.

**WBS 1.2.3.2.6.1.4. Paleoenvironmental History of Yucca Mountain. Independent Dating.** Staff anticipates receiving significant cosmogenic data from the University of Pennsylvania. The evaluation of this data (including field evaluation) will be the major work during the month of August.

**WBS 1.2.3.4.1.1 Ground-Water Chemistry Model.** Staff will continue to develop quantitative models for soil-zone chemical processes. Staff will continue to refine conceptual models for processes that could control ground-water chemistry at Yucca Mountain. Staff will continue planning and implementation of laboratory experiments designed to evaluate controls on ground-water compositions in the unsaturated and saturated zones at Yucca Mountain.

**WBS 1. 2. 3. 4. 1. 2. 1. Batch Sorption Studies.** Staff will complete the milestones associated with this study. Staff will complete experiments in which the sorption of Se onto tuffs as a function of ground-water chemistry is described.

**WBS 1.2.3.3.1.2.2. Water Movement Test.** Staff will acquire chlorine-36 analytical results for 48 samples and select a suite of 50-100 borehole and ESF samples from the SMF for analysis. Staff will process about 100 soil, water, borehole cuttings, ESF and packrat midden samples for Br/Cl and 36Cl/Cl ratios over the next two months. Staff will continue acquiring data from a step-leaching procedure to characterize in-situ Br/Cl and 36Cl/Cl ratios in rocks. Staff will participate in planning activities for sample collection from ESF and boreholes. Staff will complete milestone reports and submit data to the YMP Technical Data Base. Staff will continue to build a database.

**WBS 1.2.3.4.1.2.2. Biological Sorption and Transport.** Staff will continue to collect samples from the ESF for microbial analysis. Milestone 3410 will be written during August. Staff will continue work on the dissolution of hematite by the Pseudomonas sp.

**WBS 1.2.3.4.1.3 Speciation/Solubility.** With the OPO installation complete, the work on Pu(VI) hydrolysis can be completed. Efforts in all other areas mentioned above will continue.

**WBS: 1. 2. 3. 4. 1. 4. 1/2. Transport Studies.** Staff will complete studies of the diffusion behavior of Np and Tc through saturated tuff.

**WBS 1.2.3.4.1.5.1 Retardation Sensitivity Analysis.** Staff will perform Np transport simulations on two- and three-dimensional grids. Staff will continue preparing the text for milestone 3468.

Staff will complete development of grids that represent the zeolitized Calico Hills and the rest of the unsaturated zone.

Staff will continue interpretation of Np sorption and transport data using SORBEQ for equilibrium sorption column experiment analyses and FEHM to examine kinetics results and diffusion experiments.

Staff will complete the writing and review of milestone 3469, "Report on Code Development." The milestone will consist of two separate documents: a Master's thesis on the reactive transport code developments in FEHM and a paper to be submitted to a refereed journal on the particle tracking method.

**WBS 1.2.5. Site Suitability Evaluation.** Staff will be a major player in the NAS field trip at which the technical work and results from the erosion studies will be discussed.

**WBS 1.2.5.3.5 Technical Database.** Staff will continue to determine which technical data needs to be entered into the ATDT and GENISES databases. Staff will continue to review data residing in the Participant Data Archive to identify candidate material for submission to the ATDT and/or the RPC.

**WBS 1.2.5.4.7 Performance Assessment Calculations.** Staff will continue work on site scale flow-flow model. Staff will check on the LBL model.

**WBS 1.2.11.2/.3/.5 Quality Assurance.** The two in-process surveys will be completed. Staff will continue to prepare the two software procedures for distribution and continue work on the 1994 status report.

Cy w/att:
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W.E. Barnes, YMSCO, MS 523
H.A. Benton, M&O, MS 423
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M.D. Voegele, SAIC, MS 423
K.A. West, EES-13, MS J521
N. White, Nuclear Regulatoy Commission, LV, NV
D.R. Williams, YMSCO, MS 523
J.L. Younker, M&O/TRW, MS 423
RPC File (S. Martinez), MS M321
LA-EES-13 File, MS J521

ENCLOSURE 5

# Los Alamos
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*WBS*: 1.2.9.1
*QA*: N/A.

September 13, 1995

LA-EES-13-09-95-001

Dr. Colin A. Heath
CRWMS M&O Assistant General Manager for Program Integration
TRW Environmental Safety Systems Inc.
2650 Park Tower Drive
Suite 800
Vienna, VA 22180

Dear Dr. Heath,

**Submittal of Los Alamos Monthly Management Analysis Report for August 1995**

Attached is the Los Alamos Monthly Management Analysis Report for August 1995. This report includes five sections:

(1) a summary of our technical efforts, including information on completion of contract deliverables and major problems;
(2) a summary of personnel changes;
(3) a list of any unusual current or anticipated financial performance problems;
(4) a list of programmatic issues that may impact the overall CRWMS M&O effort; and
(5) a summary of work planned for next reporting period.

The technical sections of this report have not received formal technical or policy reviews by Los Alamos or the YMP. Data presented in this document constitute predecisional information, should not be referenced, and are not intended for release from the U.S. Department of Energy as information to be referenced.

If you have changes to our distribution list, please call Susan Klein at (505) 667-0916.

Sincerely,

Julie A. Canepa

JAC/SHK/cmv

Attachment: a/s

## Los Alamos Monthly Management Analysis Report for August 1995

### (1) Summary of (a) Los Alamos' technical accomplishments, (b) deliverables completed, and (c) major problems that may impact future performance.

### (a) Technical accomplishments

WBS 1.2.3.2.1.1.1 Transport Pathways. *Studies of Calcite as a Factor in Flow Models and Radionuclide Transport Retardation.* Staff was using studies of calcite chemistry at Yucca Mountain to supply information on the transport of elements that occur in the natural environment as well as in high-level waste (Sr, Cs, Ba, C) and other chemical species that occur in the natural environment and are geochemically analogous to man-made radionuclides (e.g., lanthanide elements as analogs to Am, Pu, and Np). Results from studies of a large data set from core, surface, and ESF samples have been compiled and analyzed this month. Results will be used by sorption modelers to better interpret the application of sorption data from calictes, which appear to have significant potential for retarding migration of Np at Yucca Mountain. Interpretations will be written up in milestone 3326 and supplied to sorption researchers and modelers.

During the writing and data analysis for milestone 3326, "Calcite Surface Chemistry and Mineralogy," which discusses calcite deposition within Yucca Mountain, it became evident that there is a stratigraphic sense to the distribution of calcites and their compositions with depth. Staff now has sufficient data to indicate that some of the key geochemical characteristics of calcites from the unsaturated zone, especially the magnitude of the negative Ce anomaly in chondrite-normalized plots, tend to increase with depth. Nevertheless, there is also evidence that interactions with quartz-latitic glass at depth (especially with the upper vitrophyre of the Topopah Spring Tuff) can strongly affect calcite lanthanide-element compositions.

Geochemical models of calcite precipitation were tested and refined; it was found that the principal factors that determine calcite chemistries at Yucca Mountain appear to be (1) the nature of the source (for most elements, and in particular the lanthanide analogs of radionuclides, this is a rhyolitic or quartz-latitic glass) and (2) competition with other minerals (principally Mn oxides and zeolites). The variations in calcite chemistry, based on samples from the unsaturated zone and from transmissive portions of the saturated zone, provide geochemical markers that strongly indicate that (a) cations readily exchanged by zeolites, represented by Sr, may be removed from waters that are in contact with zeolitic horizons and (b) traces of Mn oxides found in the tuffs have an effect on ground-water chemistry that is both strong and universal in the UZ and upper SZ (evidenced by characteristic Ce depletions in calcite-precipitated from these waters); this latter observation shows that even trace minerals can have a significant impact on transport. Finally, the lanthanide-element contents of calcites can closely approach those of the source glasses, indicating that the transport of heavy metals similar to transuranics (especially Am and Pu) can be effectively retarded in situations where calcite is precipitating,

*Mineralogic Input to Modeling of Transport.* The mineral-stratigraphic model prepared for use in transport calculations by Carl Gable, Bruce Robinson, and Andy Wolfsberg was tested and refined. David Vaniman visited the Yucca Mountain site 2-3 August to examine cuttings and core from USW H-3, USW H-5, and USW H-6 to improve on available information for the site mineralogic model for these transport studies. The nominal model is based on our current best estimates of locations and thicknesses of major zeolitized horizons. In addition, a "maximal zeolite" stratigraphic model was prepared, based on the maximum credible thicknesses of zeolite-bearing horizons. The two models will provide some of the data needed to test the sensitivity of transport to encounters with zeolitic rocks; a further "minimal zeolite" model is being prepared to further test this transport parameter.

*Studies of Erionite.* The erionite-rich sample from USW UZ-14, 1363 ft depth, was examined by SEM to determine the morphology, distribution, and compositional variations between clinoptilolite and erionite in this sample. Initial results indicate that the erionite has somewhat lower Al/Si and higher K/Ca ratios; however, the differences in composition are not large. Textural relations indicate that erionite formed after clinoptilolite. These data will be used in preparing milestone 4058, addressing the geochemical constraints on erionite formation and distribution at Yucca Mountain.

*Fracture Mineralogy Studies.* Two samples from USW UZ-14 containing both stellerite and heulandite fracture coatings were examined by SEM to determine the relationship between the two minerals. In sample 1229.8-.9, stellerite crystals are large and protrude above the heulandite, but heulandite grew around the stellerite and therefore formed later. There may have been a second generation of heulandite deposited over the first. Crystals that appear to be stellerite have also been deposited on the heulandite, but are too small to be reliably analyzed for chemistry. Heulandite also postdates stellerite in the sample from 1268.8. Milestone 4079, which discusses the multiple episodes of zeolite deposition at Yucca Mountain, was completed.

A fracture coating from USW UZ-14 1370.3-.6 was also examined using the SEM. The XRD analysis for this sample indicated major erionite and smectite, with minor clinoptilolite. No clinoptilolite was observed. It was found that erionite rods 20-50 μm long (not fibers as seen in vitrophyre samples) were coated with balls of smectite 5-8 μm in diameter. The erionite rods are 5-10 μm in diameter. Some rods were completely coated, whereas others protruded from the smectite which had grown on and around them.

A fracture coating from UZ-16 at 1649.7-.9 ft was also examined. This fracture is about 14 m below the SWL. Using XRD analysis, staff identified major quartz, with minor lithiophorite and cryptomelane. SEM images show rods (and fibers?) of cryptomelane over a silica phase (quartz). Lithiophorite was not identified and may underlie the quartz or may occur on surface areas not examined. The cryptomelane, although exposed at the surface, was not abundant or continuous. This fracture occurs about 3 m below a major calcite fracture that is at 500 m. Either or both may be present-day transport pathways below the SWL.

*Planning Activities.* Min-Pet PIs evaluated the new License Application schedule sheets for future Min-Pet activities and identified feeds and ties to other activities.

*Project Support.* David Vaniman attended the SOC meeting at the NTS on 2 and 12 August, standing in for B. Carlos, who is recuperating from surgery.

**WBS 1.2.3.2.1.1.2 Alteration History.** Schön Levy and Bill Carey supported the "Thermal Loading System Study Report" by providing evaluations of possible repository expansion areas and calculations of water evolved from zeolitic rocks at a range of repository thermal loads. Optional areas to the west and south of the primary study area were compared to the primary area on the basis of general stratigraphy, unit thicknesses, hydrologic setting, mineralogic distribution, abundance, and location of important alteration features such as vitric-zeolitic transitions. Mineralogic attributes for the optional areas west of the primary area were extrapolated from the nearest drill hole data based on conceptual models of mineralogic alteration developed by YMP researchers. The extrapolations suggest that in the optional area furthest to the west, there may be little or no zeolitic rock above the static water level. This difference, if it exists, would place the optional area well outside the range of variability for thickness of zeolitic rocks in the unsaturated zone within the primary area. The effects of the differences in radionuclide sorptive capacity, hydraulic conductivity, and thermal buffer capacity would have to be evaluated.

The calculations of the responses of zeolitic rocks to a variety of repository thermal loads were based on experimental and theoretical research described under Activity 8.3.1.3.2.2.2. The purpose was to provide an estimate of the magnitude of the effect of hydrous minerals on the thermal and hydrologic evolution of Yucca Mountain under repository conditions. Calculations were made for clinoptilolite and mordenite abundance data from three drill holes (USW G-1, G/GU-3, and G-4) and for thermal loads of 110.5, 83.4, 55.3, and 35.9 MTU/acre. To illustrate the thermal buffering capacity of clinoptilolite dehydration, a calculation was made for a thermally insulated "box" of pure clinoptilolite with 10 percent porosity that is initially at 25°C and 100% relative humidity (RH). The box is porous to water vapor and can maintain a maximum pressure of 1 bar. For a thermal flux of 14 watts, the box reaches a temperature of 250°C after 844 days of heating with thermal buffering provided by zeolite dehydration. Under the same conditions but with no dehydration, a temperature of 395°C is reached in the same period of time.

A change was made in the conditions of the experimental studies described last month to investigate argon diffusion in clinoptilolite as a function of time, temperature, and water vapor pressure. The water vapor-saturated experiments will be conducted at 140°C instead of 150°C as reported earlier. The change to a slightly lower temperature was made to avoid exceeding the pressure capabilities of the reaction vessels. The experiments were designed to test the hypothesis that young apparent ages of clinoptilolite from the unsaturated zone are the result of radiogenic argon loss rather than being indicators of recent and pervasive geochemical alteration. A detailed alteration chronology, which identifies geochemical processes active during the Quaternary Period, is part of the basis for determining whether the site possesses the favorable geochemical condition. Inasmuch as zeolitization relates to paleohydrology, the timing of zeolitization also is relevant to the potentially adverse condition of water table rise sufficient to cause saturation of an underground facility located in the unsaturated zone.

Steve Chipera presented a paper (co-authored by Bill Carey and Dave Bish) on controlled-humidity x-ray diffraction analysis and its applications to the study of smectite expansion and contraction at the 44th Annual Denver Conference on Applications of X-Ray Analysis, held 31 July to 4 August in Colorado Springs. A new computer-automated humidity control system for the x-ray powder diffractometer allowed accurate real-time control of humidity, facilitating detailed analysis of the changes in the structures of six cation-exchanged smectites in response to small changes in humidity for a range from 0 – 80 percent RH. Results showed that the observed degree of expansion/contraction of smectite is dependent of the $P(H_2O)$, the exchangeable cation, and the particular smectite sample. In addition, the results showed conclusively that the expansion/contraction behavior is path dependent, exhibiting significant hysteresis between expansion and collapse. The complexity of these results complicates the incorporation of smectite dehydration/rehydration energetics into calculations of the response of hydrous minerals to repository thermal loads as was done for zeolites (above).

Samples of altered rock from the ESF North Ramp exposure around 1032 m were prepared for XRD analysis. This is an exposure that has been identified by the wall mapping team as a possible fossil fumarole in pre-Pah Canyon Tuff a few meters above the Topopah Spring Tuff. The immediate concern with this occurrence for site suitability is the question of age and possible recurrence of activity. The exposure will be compared with similar features exposed in outcrop at the same stratigraphic level around southern Yucca Mountain and Busted Butte.

The Data Transmittal Package for "Thermodynamics of Hydration of Na- C-, and Ca-Clinoptilolite" was successfully entered into GENISES, the YMP technical database.

**WBS 1.2.3.2.1.2. Stability of Minerals and Glasses.** ***Clinoptilolite Rate.*** Penn State researchers have completed a third dissolution rate experiment on Na-exchanged clinoptilolite (FC) at 125°C. The dissolution rates measured in this experiment are in general agreement with the previous experiments (i.e., FA and FB). A flow-through experiment at 175°C was underway.

The long experiments at Yale University at 50 and 25°C to test the effect of Al inhibition on the clinoptilolite dissolution rate have been completed and most of the chemical and BET analyses were completed. The clinoptilolite experiments with different Na concentrations at 80°C were completed and were being analyzed. An experiment with KCl substituted for NaCl was completed as a test of the ionic strength effect associated with the addition of NaCl in these experiments. However, the rate was actually decreased compared with the NaCl experiments, suggesting that exchange of K with Na in the clinoptilolite had occurred. This exchange was to be expected given the known selectivity of clinoptilolite for K over Na.

***Clinoptilolite Solubility.*** The surface titrations to test the pH effect on clinoptilolite dissolution are still in progress, with some unexpected results. It appears that the number of sites available for $H^+$ adsorption is much smaller than expected for the specific surface area of the material. Therefore, the surface area measured by the BET method (i.e., $N_2$ adsorption) might not be representative of the reactive surface area in the case of clinoptilolite in solution.

The temperature dependence of the logarithm of the solubility product of Castle Creek Na-clinoptilolite in aqueous solutions can be described over the temperature range 25-265°C by the following equation:

$$\text{Log } K_{sp} = 467.97 - 35{,}814.0/T - 152.59 \log T.$$

This equation gives Log $K_{sp}$ values that are generally within ±0.3 log units of the values measured both at Penn State and Yale Universities. The measured Gibbs free energy of formation for Na-clinoptilolite at 25°C is -6263 ± 15 kJ/mol. This value may be slightly low because of the slow approach to equilibrium at low temperatures: thus a better estimate was made by regressing the data from 80 to 265 to 25°C which gives -6260 ±15kJ/mol. This value is preferred because it is weighted by reversible solubility measurements. A direct comparison between the value presented here for Na-clinoptilolite and the value estimated by Bowers and Burns (1990) (-6316 ± 38 kJ/mol) is complicated by differences in the exchangeable cation composition, Si/Al ratio, and water content between the two clinoptilolites.

These solubility data show that high concentrations of silica result from clinoptilolite-water reactions. Measured concentrations of silica generated by dissolving clinoptilolite in the solubility experiments were typically between cristobalite and amorphous silica saturation. It appears that, for this clinoptilolite composition, the persistence of clinoptilolite apparently requires the suppression of quartz nucleation and growth. Based on a metastable equilibrium model, if the solubility of silica glass is taken as the maximum allowed silica concentration in solution, the data indicate that Na-clinoptilolite would never persist above ~50° The fact that clinoptilolite does persist to temperatures above 100°C suggests that the Na-clinoptilolite-analcime reaction is a kinetically controlled process.

*Reports.* Staff spent a great deal of time preparing text, figures, and tables for the Technical Progress Report and the final reports due shortly.

**Conceptual Model of Mineral Evolution**. Work continued on preparation of milestone 3444, the report on a modeling study of the clinoptilolite-to-analcime transition, for publication in the journal Clays and Clay Minerals. This report will be ready for internal technical review in early September. The modeling results included in this paper were presented at the second Thermohydrologic Modeling and Testing Program Peer Review in Las Vegas, NV.

**WBS 1.2.3.2.5 Volcanism.** *Eruptive Effects.* Staff visited analog sites for eruptive effects studies in the San Francisco Volcanic Field with visiting scientists from Japan. Ongoing field studies were reviewed and discussed, and plans for completing the studies in the San Francisco Volcanic Field were finalized. Field studies are planned to be completed in this area in September 1995. The report titled "Entrainment of country rock during basaltic eruptions of the Lucero Volcanic Field," which describes the first set of eruptive effects analog studies, was formally accepted for publication in

Journal of Geology. Work began on incorporating data from these studies into performance assessment models. Lithic fragment data from volcanic effects activity using analog studies of eroded volcanic centers on the Colorado Plateau were examined using uniform, modified triangular, and lognormal distribution models. Lithic fragment data from multiple basalt sites exhibit a normal distribution suggesting lithic fragment data from diverse analogs sites may be appropriate to apply to strombolian facies of basaltic pyroclastic eruptions for studies of volcanic effects.

*Subsurface Effects.* Analysis of samples from the Grants Ridge and Paiute Ridge natural analog sites continued. Field work, including detailed mapping and sampling, was completed at Paiute Ridge. Modeling studies focused on vapor flow in response to basaltic intrusions in Yucca Mountain itself, using 2-D and 3-D finite element meshes with full hydrostratigraphic representation.

*Magma System Dynamics.* Literature research continued on melting and magma migration at depth under conditions of very low degrees of partial melting.

*Structural Controls of Basaltic Volcanism.* Data were assembled and distributions were evaluated for data parameters that will be used in simulation modeling for assessing the effects of different disruption scenarios associated with associated with volcanic and intrusive magmatic activity using the RIP code. Data for eruption volumes were modeled using uniform, modified triangular, and lognormal distributions to assess data sensitivity in preparation for simulation modeling.

*Geochemistry Studies.* Thirty five instrumental neutron activation analyses were completed for whole-rock basalt samples from Buckboard Mesa, Lathrop Wells, Hidden Cone, Little Black Peak, Black Cone, Little Cones, Makani Cone, Red Cone, and Thirsty Mesa.

Nine instrumental neutron activation analyses were completed for basaltic ash samples from trench sites on the Solitario, Fatigue Wash, Windy Wash, Stagecoach Road and Paintbrush Canyon faults. Results of these analyses were compared with data from Quaternary basalt centers in the Yucca Mountain region in order to identify the sources of the ashes.

*Geochronology Studies.* Helium exposure ages were obtained from two scoria samples from Hidden Cone at Sleeping Butte. These ages indicate that the cone is significantly younger than the lava flows at the Hidden Cone center, but final conclusions await assessment of geomorphic models for cone erosion at the center.

***Evolution of Basaltic Volcanic Fields Studies.*** The software package "MELTS" was evaluated as a tool to constrain melt dynamics and polybaric ascent history of magmas in the Yucca Mountain region. This package will be used to help constrain changes in melt generation and ascent history of magmas that have occurred in the Yucca Mountain region in the past 5 million years. Extrapolation of these patterns into the future will help to evaluate whether volcanism is waxing or waning and will provide a physical framework for interpretation of volcanism probability results.

***General.*** Final editing is being completed on the data appendix for a milestone report due at the end of the fiscal year. A second data table was proposed and is in preparations. When completed the two data tables will allow data to be referenced and traced from field and laboratory notebooks to specific pages of the volcanism status report as well as the opposite (specific pages of the volcanism status report to entries in field and laboratory notebooks).

Volcanism staff for the YMP participated in tours of the Lathrop Wells volcanic center with the new chairman of the NRC, the inspector general of the NRC and the subcommittee of the National Academy of Sciences that is reviewing the erosion topical basis report.

**WBS 1.2.3.3.1.2.5 Diffusion Tests in the ESF.** Sorption tests with several of the other possible tracers were started this month. Informal approval was granted for the proposed tracers. The approval was termed "informal" because it has been decided that these tracers will not need the formal submission to the State of Nevada and public hearings usually required for these types of requests. The reason for this decision is that the chemicals to be used as tracers are relatively innocuous and at low concentrations and volumes.

John Musgrave traveled to NTS on 1 August to tour the ESF and acquaint himself with the Yucca Mountain Site.

**WBS 1.2.3.3.1.3.1 Reactive Tracer Testing.** ***Lithium Bromide Column Experiments.*** Staff conducted experiments to investigate the effects of kinetics and nonlinear sorption on the transport behavior of Li in columns packed with Bullfrog tuff from the C-wells. A description of the tests and a brief discussion of the preliminary results was included in the May 1995 monthly report. The conclusions drawn from this study could have an important impact on both the pre-test predictions of LiBr transport in the C-wells field-scale experiments and on the interpretation of the field experiments.

*Field Testing.* Staff participated in a tracer test at the Raymond Quarry site in California during August (a test was also conducted in July; see July monthly report). The injection and recovery wells in this test were 30 m apart (vs. 7.5 m apart in the July test), and the test was conducted with recalculating of ~5% of the produced fluid (production rate was ~2 gpm). In addition, the injection interval was recirculated and sampled at the surface so that the concentration of tracers in the injection well as a function of time could be determined. 0.35-µm diameter polystyrene microspheres were used as tracers in this test. Fluorescein and lithium bromide were also used as a tracer(s). None of the tracers had been analyzed at the time this report was written. Tracer analyses from the July test also have not yet been completed. More details and interpretations of these tests will be provided in subsequent monthly reports.

*Pre-Test Predictions of Solute Transport.* A three-dimensional finite element grid was being constructed to allow three-dimensional calculations of flow and tracer transport at the C-wells using the FEHMN code. Two- and three-dimensional particle-tracking codes were also being developed to predict tracer breakthrough curves at the C-wells in convergent or recirculating interwell tests where it is assumed that the media are homogeneous and isotropic. These particle-tracking models will be used to offer comparisons with the more sophisticated three-dimensional finite-element calculations and to investigate tradeoffs associated with different tracer injection schemes. An easy-to-use spreadsheet-like MathCad model has been developed to predict tracer breakthrough curves in convergent tracer tests. This model will be the subject of a paper presented at the Fall 1995 Materials Research Society meeting (see July monthly report). These efforts will culminate in a milestone 4077, scheduled for completion at the end of FY 1995.

*Laboratory Experiments to Support Model Development/Validation.* Laboratory-scale tracer transport experiments were completed at three different flow rates in a glass column packed with glass beads, and at two different flow rates in tuff "columns" packed with glass beads. These tests were conducted to investigate physical transport mechanisms under fully saturated conditions where the geometry and porosity of the flow system was kept constant (approximately), but the porosity of the column walls was varied to allow different amounts of matrix diffusion into the walls. Iodide was used as a nonsorbing solute tracer that should presumably diffuse into the column walls, and polystyrene microspheres (~1.0-µm diameter and ~0.3-µm diameter) were used as tracers that should not diffuse into the column walls. It was expected that the iodide breakthrough curves would show a flow rate dependence in the columns with porous walls (with lower recoveries at lower flow rates because of the greater residence time in the system and hence the greater opportunity to diffuse into the walls), while the microsphere breakthrough curves would not show a flow rate dependence unless the microspheres deposited onto system surfaces. All of the columns were made by coring either the glass or the tuff with a 1/4-in-diameter coring tool. Each column was approximately 7.5 in long and flow rates were varied so that average residence time ranged from less than two hours to approximately one day. The glass column walls had no porosity while the walls of the tuff columns had porosities of 0.07 and 0.32. The columns were oriented horizontally in all experiments. Preliminary results from the glass column tests indicated that iodide breakthrough curves were relatively independent of flow rate, which was expected in a column with nonporous walls. However, both microspheres experienced greater attenuation at lower flow rates, and the larger microspheres always experienced greater attenuation than the smaller microspheres. These results suggest that the microspheres were probably attenuated by settling. If attenuation were due to surface interactions, one would expect greater attenuation of the smaller microspheres because they should come in contact with surfaces more often (as a result of their greater diffusivity). These results are also consistent with the preliminary results from the July field test at Raymond Quarry, where the larger microspheres were more attenuated (see July monthly report). Project scientists have not yet completed tracer analyses from the tuff column experiments. The implications of these experiments on tracer testing at the C-holes and on radionuclide migration in the saturated zone near Yucca Mountain will be discussed in future monthly reports.

**WBS 1.2.3.2.6.1.4. Paleoenvironmental History of Yucca Mountain.** ***Independent Dating.*** Basalt samples previously collected from two boulder deposits and from Black Cone have been analyzed by researchers at the University of Pennsylvania, and preliminary beryllium numbers were received at Los Alamos. These analytical results were being evaluated and interpreted. The beryllium concentrations for the two basalt boulder deposits suggest these deposits do have considerable antiquity as stable hillslope deposits.

Staff received additional data from the Ghost Dance Fault dating study. These results are being evaluated along with those obtained earlier. Preliminary indications suggest a long term stability for the hillslope graded across the fault and thus a long time since last movement on the fault.

Staff participated in the NAS field trip to examine surface processes at Yucca Mountain and to present and defend the erosion studies as part of the technical Basis Report conclusions that the Academy Panel will review. The new preliminary beryllium dates were presented to the panel during the field presentations.

**WBS 1.2.3.4.1.2.1. Batch Sorption Studies.** Staff completed experiments on the sorption of selenite using vitric, devitrified, and zeolitic tuffs and waters from well J-13 and UE-25p #1. They found that selenite appears to have very low sorption with respect to any of the tuff types in all waters studied

Staff expended a great deal of effort on completing two isotherms describing the sorption of Np onto tuffs and minerals in J-13 water at pH 7 and at pH 8.5 with initial Np concentrations ranging over 5 orders of magnitude ($10^{-5}$ to $10^{-9}$ M). The analytical data for the Np analyses, which is being carried out by ICP-MS, was not yet complete. These experiments are of extreme importance because sorption experiments at extremely low Np concentrations may exhibit higher values than values obtained close to the Np solubility limit. This finding would have very important implications for radionuclide transport calculations at Yucca Mountain.

Data collection was completed for Np sorption onto clinoptilolite as a function of ionic strength in the ground-water at pH 7 (which was obtained by controlling the $pCO_2$ inside gloveboxes). These experiments indicated that 1) Np sorption onto zeolitic tuffs is controlled by ion exchange at near-neutral pH and 2) Sorption sites in clinoptilolite are more selective for Ca than for Na. Both of these are extremely important findings and are needed to predict the transport of Np through tuff at Yucca Mountain.

**WBS 1.2.3.4.1.1 Ground-Water Chemistry Model.** Additional analytical data was collected from water/rock interaction experiments started last month. These experiments involve two synthetic ground-water compositions (AGW #1 and AGW #2) and seven different rock samples. The rock samples used include two surface samples of Tiva Canyon Tuff containing caliche and opal, a nonwelded vitric tuff from the PTn, three devitrified tuffs and one zeolitic tuff. Relative to the original water compositions, the waters in contact with the Tiva Canyon Tuff, vitric tuff and the zeolitic tuff show the greatest changes in composition. The data obtained this month show the impact of silicate hydrolysis reactions as well as ion exchange and carbonate dissolution reactions. The data obtained in these experiments will be evaluated in the coming month. The results will be used to test conceptual models of the evolution of ground-water chemistry in the unsaturated zone at Yucca Mountain. Work is progressing on milestone 3387.

**WBS 1.2.3.4.1.4 Transport Studies.** Staff completed data collection on the migration of Tc in devitrified, vitric, and zeolitic tuffs in ground-waters from well J-13 and UE-25p #1 (as a function of flow velocity) using crushed-rock columns. The results of these data indicate that Tc is not retarded by tuffs because it exists as pertechnetate in ground-waters and can be excluded from the tuff pores because of its size and charge.

Staff began diffusion experiments in six rock beakers (zeolitic, devitrified, and vitric tuffs) using water from wells J-13 and UE-25 p# 1 and radionuclides (Tc-95m, Np-237, U-238, Pu-239, and H-3). Results of these experiments will complete the database for diffusion coefficients for radionuclides in the waste as a function of tuff type. This database will be used to describe diffusion as a retardation mechanism in the transport codes.

Staff completed eight diffusion cells experiments to elucidate the diffusion behavior of Tc, Np(V), U(VI), and Pu(V) through devitrified tuff (from the Topopah Spring Tuff) and zeolitic tuff (from the Calico Hills) using waters from the wells J-13 and UE-25p #1. Tritiated water was used as a non-sorbing tracer. These data will also form part of the diffusion database that will be used to describe diffusion by retardation in transport codes.

Staff began four diffusion cell experiments using natural fractures from Yucca Mountain. These experiments involve observing the diffusion of radionuclides from the fracture into the matrix. In all of these cases, the fractures have mineral coatings. These experiments are extremely important because they will address the assumption often made in transport codes dealing with fast paths in which diffusion from the fractures into the tuff matrix does not occur. If these experiments indicate that this is not the case, one will begin to question the often-made assumptions, which may be too conservative and over-predict radionuclide releases.

**WBS 1.2.3.3.1.2.2. Water Movement Test.** Staff received preliminary chlorine-36 results, from which the following observations are made: (1) Six samples from the saturated zone in 2 boreholes (G-2 and C wells) all had ratios at present-day meteoric background, despite coming from different depths separated by as much as 1000 ft. These results are consistent with those obtained for waters from the saturated zone at SD-7 and J-13. (2) The chlorine-36 signal measured for 4 samples of perched water from SD-7 ranged from present-day background to about 40% above background. This pattern is similar to that observed for perched water from UZ-14, although these two water bodies are believed to be independent, not connected. (3) Three drillcore samples from UZ-N55 show the presence of bomb-pulse chlorine-36 with signals similar to those measured for nearby UZ-N53 as well as for surface soil samples forming a transect across the wash at this location. However, the concentrations for the core samples are less by an order of magnitude than those measured previously for the corresponding ream-bit cuttings. This difference supports the hypothesis that the cuttings were contaminated during the drilling or collection process. (4) Values for the present-day (post-bomb) chlorine-36 input were determined, based on analyses of overland flow following rain events at Yucca Mountain. These had chlorine-36 signals ranging from two to seven times above present-day background, reflecting the lingering presence of global fallout chlorine-36 at the surface. (5) Results for 3 UZ-16 samples fit the previous profile, with no indication of a component of bomb-pulse chlorine-36 at the sampled depths (73, 123, and 1586 ft).

Staff selected a suite of 100 borehole samples from the SMF, from boreholes UZ-N15, UZ-N16, UZ-N17, UZ-N39, UZ-N61, UZ-N64, and ONC-1. Processing has begun on over 30 of these samples, slated for chlorine-36 analysis next month. The objective of these analyses is to provide confirmatory evidence for the magnitude of infiltration rates indicated from moisture monitoring of the neutron holes. Also ready for submission are samples from the Bow Ridge Fault in the ESF North Ramp and Midway Valley soil profiles.

Staff revised the detailed technical procedure for step-leaching for determining the intrinsic bromide-to-chloride (Br/Cl) ratio of tuffs. This parameter is needed for correcting ground-water travel time estimates based on chlorine-36 concentrations. The procedure involves repeated grinding and leaching of the rock sample, thereby decreasing the meteoric component and increasing the rock component of Cl and Br (presumedly released from fluid inclusions) with each step. Staff completed processing (but not yet analyzing) 36 samples in replicate, with 3-5 leaching steps per sample, in order to build a data base of Br/Cl ratios. Preliminary results are as expected, with the Br/Cl ratio in the leachate tending to a constant value (average 0.019) with the last couple steps, representing the intrinsic ratio for the rock. Unfortunately, an as-yet unidentified source of contamination prevents this approach from being used to measure the in-situ chlorine-36/chlorine ratio of the rock as well.

Staff submitted the first two of several packrat midden samples for chlorine-36 analysis. These samples have been dated by carbon-14 as part of a separate YMP activity and are being analyzed for chlorine-36 in order to test the hypothesis that the chlorine-36 signal was significantly higher in the past than it is at present. If such is the case, then the elevated chlorine-36 signals observed in deep samples from UZ-14 and UZ-16 would be consistent with ground-water travel time estimates of tens of thousands of years, instead of indicating the presence of a component of bomb-pulse water.

**WBS 1.2.3.4.1.2.2. Biological Sorption and Transport.** As reported in the previous monthly report, the third replication of the unsaturated -flow crushed-tuff column experiments were completed. These results will be submitted as milestone 3410. They show clearly that chelation has a significant effect on transport of Fe through crushed tuff under unsaturated flow conditions.

Samples were collected from the ESF on 15 August. They were collected at location 10 + 22, on the right rib in the Pre Pah formation. As with previous samples, these were also sent to four universities for microbial analyses (see June 1995 monthly report for description of analyses).

**WBS 1.2.3.4.1.3 Speciation/Solubility.** The upgrade to the PAS laser system was completed, and the new OPO laser from Spectra-Physics was up and running. Trial PAS spectra of $Pu^{6+}$ at pH=4 have been taken and continue to be taken at low concentrations. Such background work is required to test the sensitivity of the new system versus the old dye-laser based system and to finish the work of $Pu^{6+}$-hydrolysis experiments.

The actinide solubility studies (Pu and Np) have been aging for four months at Los Alamos. In contrast to previous bulk solubility experiments performed at LBL, the pH has not been manipulated through addition of HCl or NaOH during these experiments, thereby maintaining low ionic strengths of the natural waters such as the J-13 system. The lack of additional $Na^+$ is especially important for the neptunium solubility study, as the sodium-containing "double salt" $NaNpO_2CO_3$ precipitation product has been reported. This solid is not what the current thermodynamic database (mostly from Lemire, see last semi-annual progress report). The $NpO_2$ that is expected may be kinetically slow to form, or the double salt may have been seeded in earlier experiments through the addition of excess $Na^+$ during pH changes. Confirmation of the formation of $NpO_2$ would lead to lower neptunium concentrations than observed previously. However, if the double salt turns out to be the stable solid, then the bulk solubility for neptunium from earlier studies is too low to accurately reflect real neptunium solubility at Yucca Mountain (non-conservative estimate) due to the addition of excess $Na^+$. From EQ3 modeling done last month, the distribution of plutonium oxidation states may also be suspect, and experiments on this distribution will be carried out on the new steady-state solutions.

Staff continued to evaluate Np data in the standard EQ3/6 v7.2a-PC release package which includes data sets with R22a versions. A series of calculations were run to assist in defining sorption experiments on calcite and specifically probe interactions with selected Np species. Expansion of the calculation suite to include Pu and Am were also performed this month. Calculations were run to scope redox dependence of solution speciation and mineral solubility, as well as temperature dependence (25-90°C). Results were being compared with data from solubility experiments and other measurements. The SoLWOG group met in Berkeley, CA, to discuss the priority matrix of radionuclides, the up-coming NRC conference call about SolWOG's data qualification efforts, and a specific example of these efforts ($Np^{6+}$ carbonate logβ's and their comparison to $U^{6+}$-carbonates logβ's).

***Solubility.*** During the reporting period work was continued on the project "Determination of Solubilities and Complexation of Waste Radionuclides Pertinent to Disposal at Yucca Mountain." Scoping experiments are continuing on fission product selenium solubility and speciation studies. In addition, active participation in SoLWOG continued.

On August 3 and 4, staff at LBNL **hosted** the SoLWOG VIII meeting. During that meeting,they provided numerous presentations on selenium solubility and speciation work and on the Color SOLWOG Radionuclide Priority MATRIX. D. Hobart was assigned to complete a Matrix Cover Letter with the assistance of Dr. Paul Cloke, SAIC, and Dr. Ardyth Simmons, YMP DOE-NVO program manager. This assignment was completed.

Samples of selenate ion solutions at steady-state solubility in J-13 well water simulant have been submitted for analysis via hydride generation atomic absorption (Earth Sciences Division Analytical Laboratory). These are at pH values of 7, 8.5, and 10 at 25 degrees Celsius. A fourth sample contains calcium ion at pH 7 and 25 degrees.

**WBS 1.2.3.4.1.5.1 Retardation Sensitivity Analysis.** ***Site-Scale Transport Modeling.*** The text for several sections of milestone 3468, "Unsaturated Zone Site Scale Transport Model for Np," have been written. Sections summarizing the laboratory-scale work performed to characterize the sorption and diffusion properties of Np have been written, along with a summary of the model assumptions used in the calculations.

Finite-element grids of various resolution have been created to perform the transport calculations. In addition, the stratigraphic representation of the Calico Hills has been reworked from the information used in the site scale hydrologic model to provide a more accurate representation of the regions that are thought to be zeolitized. Since the zeolitic rock is probably the only rock type that sorbs Np to any appreciable extent, properly delineating the spatial extent of the zeolitic Calico Hills is essential to performing accurate predictions of Np transport. Thus far, cases representing the nominal and maximum extent of zeolitization have been developed.

A systematic study of the effect of the hydrologic properties of the fractures has been carried out in an attempt to reconcile the large infiltration rates being cited in recent YMP studies. Using the parameter values generally used for fractures within the Project, the matrix saturations in the Tiva

Canyon welded and Topopah Springs welded units approach unity at the nominal 10 mm/y infiltration rates now being measured. What is required from the models to better represent the field data is for the fractures to flow at less than complete matrix saturation. The fracture characteristic-curve parameters can be varied to better represent the data.

Two-dimensional cross sections are being used to develop flow fields for both the equivalent continuum and dual permeability model formulations. The infiltration rate will be varied to examine the impact on Np transport. At the same time, three-dimensional simulations are being carried out to compare to the Project's hydrologic model. Initial results show that the FEHM flow simulations agree quite well with those performed elsewhere in the project.

The available data for sorption of Np on zeolitic tuffs has been reduced to obtain a mean and standard deviation of sorption Kd for the site scale simulations.

The dual permeability particle tracking feature now allows us to explain through numerical simulations the reason for the identification of bomb-pulse Cl-36 in the Paintbrush nonwelded unit. Rapid fracture transport through the uppermost Tiva Canyon welded unit is shown to be the mechanism for this observation. Quantitative simulations of the effect of fracture transport on the Cl-36 profile will be reported on in milestone 3468.

*Code Development.* A new version of FEHM was baselined that fully implements the dual permeability solute transport and particle tracking options. Minor changes to the extrapolation techniques for the van Genuchten characteristic curve relationships have also been made.

**WBS 1.2.5.3.5 Technical Database Input.** Staff has completed the following Automated Technical Data Tracking (ATDT) System submissions:

- Chemical Analysis and Cosmogenic Dating Data, DTN LA000000000133.001
- Geochemistry of the Lathrop Wells Volcanic Center, DTN LA000000000099.001

Staff has completed the following Technical Database (GENISES) submissions:

- Geochemistry of the Lathrop Wells Volcanic Center, DTN LA000000000099.002

**WBS 1.2.5.4.9 Performance Assessment Calculations.** *Code Development.* Work continued on multiply defined nodes. The interface between GEOMESH and FEHM was designed and was tested. Work was initiated on establishing a criteria for respecting fracture interfaces. This will allow for reasonable grids to be generated from complicated FRACMAN Meshes. We plan on respecting the well connected fractured networks while ignoring the others. A small interface was written to distribute flow correctly over the top surfaces of the site model. This will allow correct distribution of very heterogeneous flow maps such as those being produced by the USGS.

*Grid Generation.* The grid generation efforts consisted of creating code to use the symmetry in the Area Coefficient file(GEOMESH) to minimize memory requirements and producing several grids for M and O/INTERA. The effort to minimize memory requirements saved 1/3-1/2 the total memory requirements for FEHMN and allowed the dual permeability runs to be made on the IBM-risc machine. The grids produced for INTERA were models of the near-repository environment They were medium size 3-d grids which depicted cavities, cannisters and pedestals.

**WBS 1.2.9.1.2. Technical Project Office Management.** The TPO attended a series of Blue Team meetings regarding project planning. The TPO supported the CP2LA (critical path to licensing) full time. She provided schedule contrainsts, workscope, and cost.

**WBS 1.2.11.2/.3/.5 Quality Assurance.** ***Program Development.*** One Q team meeting was held. Discussions centered around a volcanism video. Several budget scenarios were submitted at the request of the DOE. The M&O line procedure, NLP-5-2, RO was reviewed and approved at a PQAM meeting. We are currently evaluating several options for putting forms on line. A. Gallegos is examining all CST files to determine which can be combined and/or deleted. This has resulted in the deletion of two redundant data systems and associated hardware.

*Procedure Revisions.* RTN reviews were completed for four procedures (data, software, TIPs) which are now awaiting controlled distribution. Several procedures, which reflect the transfer of audit functions to DOE, were released. These include QP 1.4 (Organization); 2.4 (Management Assessment); 2.11 (Personnel Orientation); 4.6 (Procurement); 12.3 (M&TE); 16.2 (Trending); 17.6 (records); and 18.2 (surveys). The QPs for Stop Work, audits, and auditor qualification (1.2, 18.1, 18.4) were deleted. One technical procedure (CST-DP-101, R0, Colloid Sampling for YMP Studies) was issued. Efforts continue to develop a field work package procedure. A new Field Work Package procedure QP-06.4 (which deals with test planning package, job package, and work plan) was issued for review. QALs reviewed technical procedures for YMP applicability and have suggested deletion of several.

*Travel.* Steve Bolivar attended a Project QA Managers Meeting on 16 August. Several issues were discussed with Don Horton, Director of QA for OCRWM. Bolivar, John Day and Andrew

Burningham attended the Nuclear Information Records Management Association (NIRMA) meeting and presented two papers.

***Training.*** A. Burningham attend the M&O Indoctrination class and DOE deficiency procedures training.

***Audits and Surveys.*** The FY 95 audit schedule has been completed and all reports issued. Survey SR-EES-13/LV/Vol-95-05 was completed. This survey was conducted to evaluate volcanism sample and data traceability. No deficiencies were found. Survey SR-EES-13-95-04 was designed to examine the document control manuals, and is still in progress. Our DR/CAR coordinator has been becoming familiar with the new DOE deficiency and trending procedures. The Las Vegas QAL has been assisting the M&O with resolution of two DOE CARs.

***Verifications.*** There are 3 open internal deficiencies. One of these is a "DR" issued under the new project procedure on deficiency reports; the other two deficiencies are corrective action reports that will be closed within the next 60 days. We have no open DOE CARs.

***Quality Engineering.*** The Software Management Coordinator continues to upgrade network hardware and software. Staff reviewed draft versions of the QARD, Supplement I. Staff also compiled a draft home page for program activities, addressing Web page security issues. Next, on-line documentation distribution will be addresses. Minor problems with the training database continued to be resolved.

### (b) Deliverables Completed and Documents Published

**Milestone completed**

4054, "Mineralogy and Petrology of the Unsaturated Flow and Transport Test Site in the P-Tunnel Vent Drift, Aqueduct Mesa, Nevada Test Site"

**Report published**

Reimus, P. W. "The Use of Synthetic Colloids in Tracer Transport Experiments in Saturated Rock Fractures," LA-13004-T, Los Alamos National Laboratory, Los Alamos, NM (August 1995).

### (c) Problems areas

**WBS 1.2.3.2.1.1.1 Transport Pathways.** B. Carlos, the principal researcher in Fracture Mineralogy studies, has returned to work following surgery. Her delayed milestone, 4079, has been completed and will be submitted to YMSCO in September.

**WBS 1.2.3.4.1.5.1. Retardation Sensitivity Analysis.** The criteria statement for Milestone 3468 requires that we perform a comparison between the hydrologic model developed by LBL/USGS and the hydrologic behavior that we simulate using FEHM in the process of performing our transport calculations. We only recently received a data file from LBL that will allow us to make this comparison. The extent of our comparison will thus be quite superficial in Milestone 3468. In updates to the site scale transport model, we will perform more rigorous comparisons of the two models.

### (2) Personnel changes

NA

### (3) Unusual costs and possible financial performance problems

See attached Variance Analysis Report and FTE Report.

### (4) Programmatic issues that may impact the overall CRWMS M&O effort

**WBS: 1.2.3.2.1.1.1 Mineralogy of Transport Pathways.** Geochemical studies of calcite at Yucca Mountain have shown that trace minerals at the site (especially Mn-oxides) can have a significant impact on transport of elements geochemically analogous to transuranic radionuclides. Moreover, the lanthanide-element contents and ratios of calcites can closely approach those of the source glasses, providing valuable information on the fate of heavy metals leached from glass sources at the site, analogous to leaching that might be expected from emplaced vitrified wastes.

Exercises in modeling the mineral stratigraphy of the Yucca Mountain site for transport indicate that better mineralogic data are needed from drill holes USW H-3, H-5, and H-6. The H-5 samples were re-examined in August to help refine this model. We plan to revisit H-3 and H-6 in the near future to improve the model, in order to address questions about the transport pathways through the Unsaturated Zone at the western margin of the exploration block and in the western optional area

## (5) Worked planned

**WBS: 1.2.3.2.1.1.1 Mineralogy of Transport Pathways.** Work planned for the coming months includes the following: (1) continue analysis of calcites to understand transport and precipitation mechanisms; (2) complete the examination of drill core USW SD-12; (3) continue characterization of trace minerals and continue microautoradiography experiments; (4) continue analysis of fracture coatings in core; and (5) examine rock-matrix and fracture samples from the ESF.

**WBS: 1.2.3.2.1.1.2 Alteration History.** Studies of ESF and drill core samples, now in progress, will continue. A milestone letter report, due at the end of the fiscal year, will contain the data collected from the ESF. Argon diffusion experiments and thermodynamic studies of hydrous mineral dehydration and rehydration under repository thermal loading are also ongoing.

**WBS: 1.2.3.2.1.2 Stability of Minerals and Glasses.** The experiments and modeling will continue. Four milestone reports will be completed next month.

**WBS 1.2.3.3.1.2.2. Water Movement Test.** Acquire chlorine-36 analytical results for about 80 samples Continue acquisition of halide data from step-leaching procedure to characterize in-situ Br/Cl in rocks. Participate in planning activities for sample collection from ESF and boreholes. Submit abstract to Fall 1995 AGU meeting Complete milestone reports
Submit data to YMP Technical database. Continue building database.

**WBS 1.2.3.2.5. Volcanism.** Work will continue on the assembly of the data appendix that will become a companion document for the volcanism status report. The report "Geochemistry of the Lathrop Wells volcanic center" will be formatted for publication as a Los Alamos report.

**WBS 1.2.3.3.1.3.1 Reactive Tracer Testing.** Continue to work on milestone 3249, describing the results of the LiBr column studies. This report will discuss the ability to predict the transport behavior of lithium by assuming an equilibrium adsorption isotherm based on the results of earlier batch sorption experiments. (Milestone 3249)

Continue to work on a YMSCO milestone report presenting pre-test predictions for tracer transport at the C-wells (milestone 4077).

Continue the efforts described under "pre-test predictions of solute transport" and "laboratory experiments to support model development/validation."

**WBS 1.2.3.4.1.5.1. Retardation Sensitivity Analysis.** Staff will perform Np transport simulations on two and three dimensional grids. Complete Milestone 3468.

Complete development of grids that represent the zeolitized Calico Hills and the rest of the unsaturated zone.

Continue interpretation of Np sorption and transport data using SORBEQ for equilibrium sorption column experiment analyses and FEHM to examine kinetics results and diffusion experiments.

Complete the review of Milestone 3469, Report on Code Development. The milestone will consist of two separate documents: a Master's thesis on the reactive transport code developments in FEHM and a paper to be submitted to a refereed journal on the particle tracking method.

**WBS 1.2.3.4.1.2.2 . Biological Sorption and Transport.** The continued uncertainties with the FY96 budget has made it nearly impossible to plan future sampling in the ESF, to renew the subcontracts with the four universities, or to commit to the two post doctoral fellows who planned to begin work at Los Alamos at the beginning of the fiscal year. The future of the lab column studies is also uncertain.

**WBS 1.2.3.4.1.1 Ground-Water Chemistry Model.** Continue development of quantitative models for soil zone chemical processes. Continue to refine conceptual models for processes that could control ground-water chemistry at Yucca Mountain. Continue planning and implementation of laboratory experiments designed to evaluate controls on ground-water compositions in the unsaturated and saturated zones at Yucca Mountain.

**WBS 1.2.5.4.7. Supporting Calculations for Postclosure Performance Analysis.** Staff will continue work on the site-scale flow-flow model. Staff will review the LBL model.

**WBS 1.2.11.2/.3/.5 Quality Assurance.** The one in process surveys will be completed and a draft survey schedule for FY95 will be developed. Efforts on the QA home page will continue, as will work on the 1994 status report. We will continue to examine options for putting forms on line and streamlining the QP revision process.

# YMP PLANNING AND CONTROL SYSTEM (PACS)

| Participant: | LANL | | MONTHLY COST/FTE REPORT | | | | Fiscal Month/Year August FY1995 | |
|---|---|---|---|---|---|---|---|---|
| Date Prepared: | 11-Sep-95 | | | | | | Page 1 | |
| | | | | | | | Fiscal Year 1995 | |
| WBS Element | Actual Costs | Participant Hours | Subcon Hours | Purchase/Subcon Commitments | Accrued Costs* | Approved Budget | Approved Funds | Cumulative Costs |
| 1.2.1 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 | 12.0 | 30.4 |
| 1.2.3 | 820.2 | 4,800.5 | 816.4 | 637.9 | 0.0 | 12,428.0 | 6,903.0 | 11,474.2 |
| 1.2.5 | 64.7 | 491.3 | 0.0 | 34.1 | 0.0 | 1,534.0 | 603.4 | 1,159.2 |
| 1.2.6 | 207.8 | 1,680.0 | 599.1 | 93.6 | 0.0 | 2,413.0 | 648.2 | 1,476.2 |
| 1.2.9 | 149.9 | 921.8 | 291.0 | 34.9 | 0.0 | 1,103.0 | 438.2 | 886.9 |
| 1.2.11 | 84.5 | 0.0 | 19.7 | 163.9 | 0.0 | 1,270.0 | 555.4 | 1,028.7 |
| 1.2.12 | 34.4 | 0.0 | 0.0 | 36.2 | 0.0 | 477.0 | 199.2 | 357.0 |
| 1.2.13 | 3.7 | 0.0 | 0.0 | 6.4 | 0.0 | 111.0 | 16.3 | 35.7 |
| 1.2.15 | 4.8 | 0.0 | 32.3 | 100.0 | 0.0 | 483.0 | 225.0 | 429.1 |
| | | | *** TH & WD funding allocations received from TRW. | | | | 11,070.0 | |
| Totals | 1,370.8 | 7,893.6 | 1,758.5 | 1,107.0 | 0.0 | 19,919.0 | 20,670.7 | 16,877.4 |

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

PARTICIPANT: LANL PEM: NESBIT WBS: 1.2.3.9.7

WBS TITLE: ESF and SB Test Coordination

P&S ACCOUNT: 0A397

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 1184 | 1175 | 726 | -9 | -0.8 | 99.2 | 449 | 38.2 | 161.8 | 1446 | 1397 | 49 | 3.4 | 894 | 40.4 |

Analysis

Cumulative Cost Variance:

Delays in hiring TCO staff is the major contributor to the cumulative cost variance for this account. Extended work week plans have been implemented to expedite the work. Efforts to reduce this variance are continuing.

Cumulative Schedule Variance:

(Not reportable)

Variance At Complete:

(Not reportable)

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.2.1.1.2

WBS TITLE: MINERALOGIC AND GEOCHEMICAL ALTERATION

P&S ACCOUNT: 0A32112

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 396 | 397 | 293 | 1 | 0.3 | 100.3 | 104 | 26.2 | 135.5 | 492 | 489 | 3 | 0.6 | 363 | 48.5 |

Analysis

Cumulative Cost Variance:

The variance on this account is due to the lag in salary adjustment for an FTE reclassified from GRA to Staff Member. This variance will be corrected when this process is completed.

mulative Schedule Variance:

(Not reportable)

Variance At Complete:

(Not reportable)

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.2.1.2.2

WBS TITLE: KINETICS AND THERMODYNAMICS OF MINERAL EVOLUTION

P&S ACCOUNT: 0A32122

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 314 | 314 | 99 | 0 | 0 | 100 | 215 | 68.5 | 317.2 | 390 | 356 | 34 | 8.7 | 123 | 29.6 |

Analysis

Cumulative Cost Variance:

The cost variance shown for this account is due to the lag in billing for work performed by two subcontractors working under this account and the reporting of these costs in the LANL accounting system. This variance will be corrected as these costs are reported.

Cumulative Schedule Variance:

(Not reportable)

Variance At Complete:

(Not reportable)

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.4.1.4.2

WBS TITLE: DIFFUSION

P&S ACCOUNT: 0A34142

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 392 | 629 | 570 | 237 | 60.5 | 160.5 | 59 | 9.4 | 110.4 | 738 | 688 | 50 | 6.8 | 668 | 92.4 |

Analysis

Cumulative Cost Variance:

(Not reportable)

Cumulative Schedule Variance:

is variance is due to delays in billing costs for capital equipment being purchased under this P&S account. The variance will be corrected when the cost is billed and reported in the accounting system.

Variance At Complete:

(Not reportable)

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

PARTICIPANT: LANL PEM: _SPENCE WBS: 1.2.B.5

WBS TITLE: QUALITY ASSURANCE - QUALITY ENGINEERING

P&S ACCOUNT: 0AB5

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 266 | 266 | 258 | 0 | -0.0 | 100 | 8 | 3.0 | 103.1 | 331 | 388 | -57 | -17.2 | 321 | 50 |

Analysis

Cumulative Cost Variance:

(Not reportable)

Cumulative Schedule Variance:

ot reportable)

Variance At Complete:

This variance is due to work being performed earlier than planned. The variance is expected to be reduced by the end of the fiscal year.

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

PARTICIPANT: LANL PEM: REPLOGLE WBS: 1.2.6.1.1

WBS TITLE: ESF MANAGEMENT, PLANNING & TECHNICAL ASSESSMENT

P&S ACCOUNT: 0A611

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 636 | 636 | 459 | 0 | -0.0 | 100 | 177 | 27.8 | 138.6 | 769 | 691 | 78 | 10.1 | 555 | 57.3 |

Analysis

Cumulative Cost Variance:

Full staffing levels to support this effort have not been achieved. Extended work weeks have been implemented to utilize current personnel to help correct this variance.

Cumulative Schedule Variance:

(Not reportable)

Variance At Complete:

Extended work weeks for current personnel have been implemented to help correct this variance.

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.4.1.1

WBS TITLE: GROUND WATER CHEMISTRY MODEL

P&S ACCOUNT: 0A3411

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 303 | 201 | 189 | -102 | -33.7 | 66.3 | 12 | 6.0 | 106.3 | 386 | 383 | 3 | 0.8 | 363 | 95.4 |

Analysis

Cumulative Cost Variance:

(Not reportable)

Cumulative Schedule Variance:

The variance on this account is due to unplanned support work on activies requested by the DOE and delays in delivery of samples for analysis. The work is being replanned to reduce this variance to a no schedule impact status.

Variance At Complete:

(Not reportable)

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

PARTICIPANT: LANL PEM: NESBIT WBS: 1.2.3.2.5.5.1

WBS TITLE: CHARACTERIZATION OF VOLCANIC FEATURES

P&S ACCOUNT: 0A32551

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 340 | 265 | 369 | -75 | -22.1 | 77.9 | -104 | -39.2 | 71.8 | 425 | 431 | -6 | -1.4 | 592 | 258.1 |

Analysis

Cumulative Cost Variance:

The variance on this account is primarily due to unplanned work being performed at the request of the DOE. This work was performed by participating in the Expert Judgement Activity, and participation in the NRC Site Visit. The work has been replanned and the variance is being reduced.

Cumulative Schedule Variance:

(Not reportable)

Variance At Complete:

(Not reportable)

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.2.1.1.1

WBS TITLE: MIN. PETROL., AND ROCK CHEM. OF TRANSP. PATHWAYS

P&S ACCOUNT: 0A32111

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 846 | 815 | 701 | -31 | -3.7 | 96.3 | 114 | 14.0 | 116.3 | 1049 | 1020 | 29 | 2.8 | 902 | 75.4 |

Analysis

Cumulative Cost Variance:

The variance on this account is primarily due to less work performed than was planned. More effort will be applied in future work which will result in correction in the variance.

mulative Schedule Variance:

(Not reportable)

Variance At Complete:

(Not reportable)

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.4.1.2.1

WBS TITLE: BATCH SORPTION STUDIES

P&S ACCOUNT: 0A34121

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 717 | 720 | 925 | 3 | 0.4 | 100.4 | -205 | -28.5 | 77.8 | 880 | 945 | -65 | -7.4 | 1131 | 800.0 |

## Analysis

### Cumulative Cost Variance:

Higher than anticipated front end costs are responsible for the variance on this account. Adjustments to the work plan are being made to complete the work and reduce the projected overrun. No schedule impact is expected.

### Cumulative Schedule Variance:

(Not reportable)

### Variance At Complete:

(Not reportable)

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

PARTICIPANT: LANL PEM: WATERS WBS: 1.2.6.1.6

WBS TITLE: ESF Test Management

P&S ACCOUNT: 0A616

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 949 | 939 | 783 | -10 | 1.1 | 98.9 | 156 | 16.6 | 119.9 | 1161 | 1114 | 47 | 4.0 | 968 | 67.1 |

## Analysis

### Cumulative Cost Variance:

Uncertainties in funding levels have created delays in ramping up staffing to support this effort. These lower than anticipated staffing levels have impacted the spending plan resulting in the month to month variance on this account.

### Cumulative Schedule Variance:

(Not reportable)

### Variance At Complete:

(not reportable)

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

PARTICIPANT: LANL PEM: WATERS WBS: 1.2.6.8.4

WBS TITLE: INTEGRATED DATA SYSTEMS

P&S ACCOUNT: 0A684

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 333 | 333 | 199 | 0 | 0 | 100 | 134 | 40.2 | 167.3 | 409 | 398 | 11 | 2.7 | 244 | 38.2 |

Analysis

Cumulative Cost Variance:

Delays in implementing a sub-contract and performing work under this sub-contract are responsible for the variance in this account. The work has been expedited to reduce this variance.

Cumulative Schedule Variance:

(Not reportable)

Variance At Complete:

(Not reportable)

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: JULY 1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.4.1.3.1

WBS TITLE: DISSOLVED SPECIES CONCENTRATION LIMITS

P&S ACCOUNT: 0A34131

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 828 | 803 | 948 | -25 | -3.0 | 97.0 | -145 | -18.1 | 84.7 | 1007 | 1022 | -15 | -1.5 | 1189 | 275.7 |

Analysis

Cumulative Cost Variance:

This variance is due to more extensive analysis earlier than planned. This effort is due to taper off and provide a correction to this variance.

Cumulative Schedule Variance:

(Not reportable)

Variance At Complete:

(Not reportable)

P&S ACCOUNT MANAGER DATE TPO DATE

# Los Alamos
NATIONAL LABORATORY

**Earth and Environmental Sciences Division**
EES-13 – Nuclear Waste Management R&D
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*WBS*: 1.2.9.1
*QA*: N/A

DIVISION Barnes
CC: Craun
CC: Dixon
CC: Dyer
CC: Gil
CC: Iorii
CC: Jones
CC: Williams
CC:

REC'D IN YMP
10/19/95

October 12, 1995

LA-EES-13-10-95-001

Dr. Colin A. Heath
CRWMS M&O Assistant General Manager for Program Integration
TRW Environmental Safety Systems Inc.
2650 Park Tower Drive
Suite 800
Vienna, VA 22180

Dear Dr. Heath,

**Submittal of Los Alamos Monthly Management Analysis Report for September 1995 (SCPB:NA)**

Attached is the Los Alamos Monthly Management Analysis Report for September 1995. This report includes five sections:

(1) a summary of our technical efforts, including information on completion of contract deliverables and major problems;
(2) a summary of personnel changes;
(3) a list of any unusual current and/or anticipated financial performance problems;
(4) a list of programmatic issues that may impact the overall CRWMS M&O effort; and
(5) a summary of work planned for next reporting period.

This technical sections of this report have not received formal technical or policy review by Los Alamos or the YMP. Data presented in this document constitute predecisional information, should not be referenced, and are not intended for release from the U.S. Department of Energy as referenceable information.

If you have changes to our distribution list, please call Susan Klein at (505) 667-0916.

Sincerely,

Julie A. Canepa

Julie A. Canepa

JAC/SHK/lb

Attachment: a/s

Cy w/att:
W.E. Barnes, YMSCO, Las Vegas, NV
G. Bovarddson, LBL, Berkeley, CA
M.W. Chisholm, , M&O/TRW, Las Vegas, NV
W.L. Clarke, LLNL, Livermore, CA
L. Costin, SNL, Albuquerque, NM
R.L. Craun, YMSCO, Las Vegas, NV
W.R. Dixon, YMSCO, Las Vegas, NV
J.R. Dyer, YMSCO, Las Vegas, NV
L.D. Foust, M&O/TRW, Las Vegas, NV
A.V. Gil, YMSCO, Las Vegas, NV
L.R. Hayes, USGS, Denver, CO
V.F. Iorii, YMSCO, Las Vegas, NV
S.B. Jones, YMSCO, Las Vegas, NV
M.D. Voegele, SAIC, Las Vegas, NV
D.R. Williams, YMSCO, Las Vegas, NV
G.A. Bussod, EES-13, MS J521
N.Z. Elkins, EES-13/LV, MS J900/527
S.H. Klein, EES-13, MS J521
A.L. Thompson, EES-13/LV, MS J900/527
K.A. West, EES-13, MS J521

RPC File (S. Martinez), MS M321
LA-EES-13 File, MS J521

ENCLOSURE 6

# Los Alamos Monthly Management Analysis Report for September 1995

**(1) Summary of (a) Los Alamos' technical accomplishments, (b) deliverables completed, and (c) major problems that may impact future performance.**

**(a) Technical accomplishments**

**WBS 1.2.3.1 Site Investigation Coordination and Planning.** Staff represented the Los Alamos Site Characterization Project Leader at weekly surface-based testing meetings and Civilian Radioactive Waste Management System Management & Operating (CRWMS M&O) Contractor work scope consolidation meetings

**WBS 1.2.3.2.1.1.1 Transport Pathways.** ***Studies of Calcite as a Factor in Flow Models and Radionuclide Transport Retardation.*** Report LA3326 was completed on 9/27 ("Stratigraphy, Trace-Element Geochemistry, and Evidence for Surface Reaction among Calcites in Tuffs of Yucca Mountain, Nevada"; D. T. Vaniman and S. J. Chipera). This report concludes that the principal factors in determining calcite trace-element chemistry at Yucca Mountain appear to be (1) the nature of source glasses for lanthanide elements (rhyolitic or quartz-latitic glass) and (2) competition with other minerals (principally Mn oxides for lanthanides and zeolites or smectites for Sr). Variations in calcite chemistry, based on samples from the upper 1 km where UZ and SZ waters are oxidizing, indicate that (a) cations readily exchanged by clays or zeolites, represented by Sr, are essentially removed from solutions along some flowpaths that are in contact with these minerals and (b) traces of Mn oxides found in the tuffs have an effect on groundwater chemistry that is both strong and universal in the oxidizing zone (evidenced by characteristic Ce depletions in calcite throughout this zone). This latter observation shows that even trace minerals can have a significant impact on transport. The lanthanide-element contents of calcites can closely approach those of the source glasses, indicating that the transport of heavy metals similar to transuranic elements can be effectively retarded in situations where calcite is precipitating. Finally, heat released by radioactive decay in a high-level waste repository may lead to increased calcite precipitation, entrapping $^{14}C$ and transuranic wastes that might be released from waste canisters while temperatures are elevated.

Studies of calcite chemistry at Yucca Mountain are being used to supply information on the transport of elements that occur in the natural environment as well as in high-level waste (Sr, Cs, Ba, C). Other chemical species that occur in the natural environment and are geochemically analogous to man-made radionuclides (e.g., lanthanide elements as analogs to Am, Pu, and Np) are also important in evaluating site performance.

***TEM Studies in Support of Sorption Models.*** Studies by transmission electron microscopy (TEM) have been pursued in order to determine the mechanisms of Pu sorption on smectites from Yucca Mountain. The TEM work by G. Guthrie on smectites from the zeolitic Calico Hills Formation in core USW UZ-16 show no evidence of either crystalline or amorphous Fe-oxide inclusions, inferred by some researchers to account for the strong sorption of transuranics by clay minerals. Data obtained from TEM studies will help in constraining the mechanisms of sorption, in providing verification of the validity of specific sorption models, and in determining how robust the sorption coefficients are in situations where temperature, solution composition, and rock mineralogy may all be variable.

***Mineralogic Input to Modeling of Transport.*** The mineral-stratigraphic model prepared for use in transport calculations by C. Gable, B. Robinson, and A. Wolfsberg has been further refined. D. Vaniman visited the Sample Management Facility on 9/6-9/7 to examine the completed lower portions of cores USW SD-9 and USW SD-12, cores that are in locations critical to the zeolite stratigraphy model for the exploration block. Although quantitative XRD data are not yet available for these cores, hand-sample and binocular microscope studies are able to provide approximate depths for "maximal zeolite", "minimal zeolite", and "nominal zeolite" models to be used in transport calculations. The observations made this month can be used in interim tests but will need to be updated when XRD data become available.

***Studies of Erionite.*** Letter report LA4058 was completed on 9/18 ("The Occurrence and Distribution of Erionite in Drill Holes at Yucca Mountain, Nevada"; D. L. Bish, S. J. Chipera, G. D. Guthrie, and D. T. Vaniman). This report summarizes all work completed to date at LANL on the topic of erionite occurrences at Yucca Mountain, including the current status of biological data on the hazards of erionite inhalation. The report emphasizes that all erionite occurrences at Yucca Mountain are restricted to either the altered zone immediately above the Topopah Spring Tuff lower vitrophyre or the underlying moderately-welded vitric subzone. Trace-element geochemical data suggest that the most abundant erionite occurrence, in core USW UZ-14, experienced chemical exchange in alkalis and alkaline earths but behaved as a closed system with respect to heavy elements (lanthanides) during alteration. Moreover, Ce fractionation indicates that the system was oxidizing or of relatively high pH. These observations are in accord with thermodynamic modeling that points to formation of erionite in a relatively K-rich geochemical environment. At present there is too little information on where and why such environments occur at Yucca Mountain to use this information in a predictive manner and it remains important for the project to remain watchful for erionite occurrences when excavations are crossing the lower vitrophyre of the Topopah Spring Tuff.

**WBS 1.2.3.2.1.1.2 Alteration History**. Schön Levy and Bill Carey followed up on their contributions to the Thermal Loading System Study Report by reviewing their input as incorporated into the draft report and responding to reviewer comments.

Steve Chipera, Bill Carey, and Dave Bish finished the paper entitled "Controlled-Humidity XRD Analyses: Application to the Study of Smectite Expansion/Contraction." The paper will be submitted to Advances in X-ray Analysis 39, Proceedings of the 44th Annual Denver Conference on Application of X-ray Analysis.

Dave Bish and Steve Chipera completed milestone LA4011, "Quantitative X-ray Diffraction Analysis of FY95 LLNL Hydrothermal Experiments." Based on examination of treated (steam atmosphere) and untreated samples of Topopah Spring Tuff (Tpt) lower vitrophyre and Calico Hills Formation (Tch) nonwelded vitric tuff, the report shows that the Calico Hills Formation sample experienced significant amounts of alteration. It is also noteworthy that alteration appears to have permeated the rock wafers. Not only was the sample partially devitrified, the smectite in the sample was greatly affected. The behavior of the Tch smectite on steam heating was similar, but not identical, to the effects described by Couture and Seitz (1984), Couture (1985a,b), and Oscarson and Dixon (1987). Although the osmotic swelling ability of the Tch smectite was not evaluated, the interlayer swelling capability decreased so that smectite in the altered sample adsorbed little more than one water layer whereas the original material adsorbed two water layers near 100% RH. Such changes in intracrystalline expansion have the potential to affect rock permeability because smectite-bearing regions of the rock no longer occupy as much volume under the same saturation conditions. These results emphasize the importance of conducting experiments under partially saturated conditions in order to simulate expected repository environment conditions.

In contrast, the Tpt vitrophyre sample experienced no statistically significant amount of alteration, possibly due to the very low hydraulic conductivity of the Tpt lower vitrophyre. The hydraulic conductivity of the vitrophyre is typically several orders of magnitude lower than that of the vitric, nonwelded Tch. (e.g., Lin and others, 1986). Alteration of the Tpt smectite could not be discerned due to the low amount of smectite in the sample.

An abstract entitled "Ion exchange and dehydration effects on potassium and argon contents of clinoptilolite," by Giday WoldeGabriel and Schön Levy, and an abstract entitled "Alteration History Studies in the Exploratory Studies Facility, Yucca Mountain, Nevada, USA," by Schön Levy and Dave Norman, were accepted for presentation at the Scientific Basis for Nuclear Waste Management XIX symposium of the Materials Research Society fall meeting in Boston, 27 November through 1 December, 1995.

Schön Levy and Steve Chipera completed milestone letter report LA4009, "Alteration History Research in the Exploratory Studies Facility, Yucca Mountain, Nevada." As of mid-1995, the Exploratory Studies Facility extended slightly over one kilometer from Exile Hill westward toward Yucca Mountain. Approximately 700 m of the tunnel lies within densely welded, devitrified Tiva Canyon Tuff. Notable secondary mineral occurrences in this unit include breccia cements of relatively coarse-grained mordenite, a fibrous zeolite, and syngenetic vapor-phase deposits of silica, alkali feldspar, apatite, hollandite, amphibole, and zircon.

A highly altered interval within pre-Pah Canyon tuffs just above the top of the Topopah Spring Tuff may be a fossil fumarole or other hydrothermal feature associated with cooling pyroclastic deposits overprinted by later zeolitic alteration. The observed smectitic alteration, silicification, and zeolitization are known as products of moderate-temperature hydrothermal alteration elsewhere in the Paintbrush Group. However, there are usually other minerals such as alkali feldspar, cristobalite, tridymite, or apatite present somewhere within the altered zones. These minerals are common constituents of vapor-phase deposits formed usually in the upper parts of cooling tuffs. The presence of one or more of these minerals at the study site would strengthen a hydrothermal interpretation and, in the case of feldspar or apatite, might provide an age of alteration.

Local zeolitic alteration of nonwelded tuffs at or just above the top of the Topopah Spring Tuff has been noted in drill hole USW G-2 and in outcrop at northeastern Yucca Mountain. The hydrologic, geochemical, and perhaps thermal conditions that favored zeolitization only in certain areas have yet to be determined.

**WBS 1.2.3.2.1.2. Stability of Minerals and Glasses.** ***Clinoptilolite Rates.*** Over the past several weeks, Penn State researchers have had a clinoptilolite flow-through experiment at 175 C in progress (FD). In this experiment, input solutions are set very far from equilibrium (undersaturated). In subsequent experiments, they will also explore reaction rates at 175 C closer to equilibrium and from both undersaturated and supersaturated conditions. Similar runs are planned also for 100 C to better establish the dependence of the rate constants for clinoptilolite on temperature.

The apparent Al-inhibition of clinoptilolite at 50 C, but not at 80 C has led to two new series of experiments. One of the main differences between 80 C and 50 C experiments is the larger mass of clinoptilolite that is calculated to have dissolved before reaching the first steady state at 80 C. Therefore, the new 50 C experiments are being run at a higher flow rate (~10 times faster than typical experiments) in order to dissolve a larger amount of material. These first stages of the experiments will also provide a rate measurement farther from equilibrium than the previous 50 C experiments. The next stages of the experiments will be run at lower flow rates (i.e., closer to equilibrium). One series will vary Si and the other will vary Al concentrations in the input solutions for comparison with the previous 50 C experiments.

The 80 C clinoptilolite experiment at pH~9.5 is nearly complete. The problems with cell and tubing leakage at the higher pH have finally been solved (using the new polysulfone cells with semi-rigid Teflon tubing and compression fittings). Additional pH~9.5 experiments at 50 C and at pH~8 will be started in the next month in order to continue testing the pH effect on the clinoptilolite dissolution rate.

***Kinetics of the Smectitie-to-illite reaction.*** Penn State investigators have investigated the effect of solution chemistry on the illitization of precursor smectite (K-saturated SWy-1) in dilute KCl-bearing solutions under hydrothermal flow-through conditions (T= 200(, 250(, 300( C). The use of a flow-through apparatus allowed them to control the composition of input solutions and to monitor changes in clay and outlet solution composition. Reaction products closely matched those found in nature and consisted of mixed layer smectite/illite clays which increased in illite content as reaction progressed. A 10Å non-expandable product formed upon completion.

pH has an important influence on the specific mode of illitization. At pH's slightly below neutral, illitization involves net tetrahedral $Al^{3+}$ for $Si^{4+}$ exchange; whereas at basic pH's, illitization involves net octahedral $Mg^{2+}$ for $Al^{3+}$ exchange. This behavior reflects the relative pH-dependence of $Al^{3+}$ and $Mg^{2+}$ solubilities. At pH's slightly below neutral, $Mg^{2+}$ is significantly more soluble than $Al^{3+}$ and dissolution of precursor smectite resulted in the incongruent formation of Al-rich (muscovitic) illite layers. At pH's above neutral, the opposite effect resulted in the formation of Mg-rich (celadonitic) illite layers.

Aqueous silica activity also affects the extent of illitization so that the illite content of mixed-layer products systematically increases with decreasing aH4SiO4(aq). Complete illitization was rapidly achieved (e.g., 1000 hours) in solutions maintained well below quartz saturation. In solutions held above quartz saturation, illitization did not go to completion and a smectite-rich product was stabilized.

The results of this study may explain illitization trends observed in nature. The prevalence of pore conditions that are slightly acidic and near the solubility minimum of aluminum may explain the Al3+-for-Si4+ reaction stoichiometry that typifies illitization in sedimentary basins. Furthermore, spatially abrupt increases in the illite content of mixed-layer clays may be due to episodic reduction of aqueous silica activity by fluid flow under relatively open-system conditions (e.g., at fault zones and sandstone/shale interfaces). These results also suggest that, as with reactions involving clinoptilolite, the relatively high aqueous silica activity in Yucca Mountain waters near the repository horizon will tend to stabilize smectite with respect to illite. Thus, as long as the abundant soluble silica minerals and glasses are present in the vicinity of the repository horizon, keeping the aqueous silica activity high, the smectite-to-illite reaction should not progress. It therefore appears that the smectite-to-illite reaction need not be a major concern in connection with repository-induced alteration of rock properties.

*Conceptual Model of Mineral Evolution.* Milestone 3444, the report on a modeling study of the clinoptilolite-to-analcime transition, was completed this month and transmitted to the YMSCPO. After Project approval, the manuscript will be prepared for submission to the journal Clays and Clay Minerals.

Penn State researchers completed milestone LA4038 on the solubility of Na-clinoptilolite and analcime. Penn State and Yale researchers worked extensively on the clinoptilolite kinetics manuscript, milestone LA3445. Penn State researchers also completed the letter report on the kinetics of the smectite-to-illite reaction, milestone LA4037.

**WBS 1.2.3.2.5 Volcanism.** ***Probability Studies.*** Revised probability calculations were completed and the results were summarized in a milestone letter report submitted to DOE (T056).Recurrence rates were assembled for 7 spatial, structural and regional background models that are a synthesis of multiple alternative models described in the volcanism status report (Crowe et al. 1995). Mean or most likely estimates for the recurrence rate are consistent with previous probabilistic assessments (3.5 to 5.2 x 10-6 events yr-1). Low recurrence rates were obtained for recurrence models that extend to the volcanic record of the Older Postcaldera basalt (9.1 Ma). A new approach to probability bounds for the recurrence rate was applied where a triangular distribution was assumed and minimum and maximum bounds established that are outside of the distribution space. The upper bound for these models includes an analysis of undetected volcanic events. Minimum and maximum bounds were examined for E2 for the 7 spatial, structural, and regional background models. The probability of magmatic disruption of a repository at Yucca Mountain [Pr(E2 given E1)Pr(E1)] were examined. A new approach of assessing regional background rates of magmatic disruption was developed. The estimations for the probability of disruption of a 4.6 km2 repository at the Yucca Mountain site must be between bounds defined by estimates using maximum E2 models (3.4 to 4.4 x10-8 events yr-1) and the regional background estimates (1.4 to 4.2 x10-9 events yr-1).

The data appendix for the volcanism status report (Crowe et al. 1995) was completed and submitted to a Quality Assurance review. The error rate of entries noted in the review was too high and a decision was made to conduct another edit/review cycle of the report prior to its submittal as a milestone report.

*Geophysics Studies.* A milestone letter report (4050) was completed on geophysical studies related to probabilistic volcanic hazard assessments. Significant results obtained that were summarized in the report include the identification of one, possibly two magnetic lows of about 100 nT amplitude associated with the 10 Ma basalt dike of Yucca Mountain, establishment of location coordinates and target depth (200 m) for the aeromagnetic anomaly of southern Crater Flat, and integration of results from the seismic refraction/reflection experiment into volcanism studies.

*Structural Controls of Basaltic Volcanism.* Simulation modeling of E2 using the FRACMAN code was applied to 7 spatial and structural models of the distribution of Quaternary and Plio-Quaternary basaltic volcanic centers in the Yucca Mountain region. The modeling shows maximum sensitivity to feeder dike length and spatial and structural models that include the Yucca Mountain site. Volcanism scenarios were run using the computer code RIP to evaluate radiological releases for eruptive and subsurface effects of volcanic and intrusive events. The modeling output will be assembled in Milestone Report 3399 and will be analyzed in FY96. Analyses of the time-space patterns of basaltic volcanism in the Yucca Mountain region for the last 9.1 Ma show a statistically significant component of southwest-directed drift through time. The results of the simulation modeling and spatial analyses were completed as part of volcanism work conducted through a contract with Golder Associates.

*Geologic Field Studies.* Volcanism staff completed trenching studies of the cone crater at the Lathrop Wells volcanic center. A series of trenches constructed from the cone rim to the crater floor revealed a consistent colluvial stratigraphy which suggests that erosion of the cone rim was relatively minor.

A milestone report (3169) was completed describing results of field studies at Sleeping Butte and Buckboard Mesa.

*Geochronology Studies.* $^{40}Ar/^{39}Ar$ dating of sanidine crystals in tuff xenoliths were completed for eruptive units at the Lathrop Wells volcanic center. These dates indicate that lava flow Ql2a erupted between 60 and 100 ka.

A milestone report (4049) was completed which summarizes the progress made in geochronology studies in FY95.

***Geochemistry Studies.*** Major, trace-element and isotopic analyses from Thirsty Mesa, Buckboard Mesa, S.E. Crater Flat, Black Cone, Red Cone, Little Cones, Makani Cone, Little Black Peak and Hidden Cone were compiled. A milestone report (3166) was completed which presents geochemical data for these volcanic centers.

***Magma system dynamics.*** A milestone report (4021) describing progress in magma system dynamics studies was completed.

***General.*** Final editing is being completed on the data appendix for a milestone report due at the end of the fiscal year. A second data table was proposed and is in preparations. When completed the two data tables will allow data to be referenced and traced from field and laboratory notebooks to specific pages of the volcanism status report as well as the opposite (specific pages of the volcanism status report to entries in field and laboratory notebooks).

Volcanism staff for the YMP participated in tours of the Lathrop Wells volcanic center with the new chairman of the NRC, the inspector general of the NRC and the subcommittee of the National Academy of Sciences that is reviewing the erosion topical basis report.

**WBS 1.2.3.3.1.2.5 Diffusion Tests in the ESF.** Tests have been deferred due to lack of funding.

**WBS 1.2.3.3.1.3.1 Reactive Tracer Testing.** ***Lithium Bromide Column Experiments***: A draft milestone report is expected to be completed later this year. These experiments were conducted to investigate the effects of kinetics and nonlinear sorption on the transport behavior of Li in columns packed with Bullfrog tuff from the C-wells. A description of the tests and a brief discussion of the preliminary results was included in the May 1995 monthly report. The conclusions drawn from this study could have an important impact on both the pre-test predictions of LiBr transport in the C-wells field-scale experiments and on the interpretation of the field experiments.

*Field Testing*: Samples collected in the July and August (1995) tracer tests at the Raymond Quarry fractured granite site in California have been analyzed for polystyrene microspheres (see the July and August monthly reports for details of the tests). Briefly, the July test was conducted with the injection and production wells 7.5 m apart, and the August test was conducted with the wells 30 m apart (in the same direction as the first test). Interestingly enough, there was less than a factor of two difference in the recovery of 0.36-μm diameter microspheres in the two tests despite the different distances between the wells. The recovery of these microspheres was 3-5% in the two tests (compared to about 1% for 1-μm diameter microspheres, which were used in the first test but not in the second test). We are still waiting for solute breakthrough data from the tests (from LBL), but preliminary indications are that the microspheres broke through sooner than conservative solutes in both tests, and that the difference between the microspheres and solutes was greater in the second test. In fact, the peak of the microsphere breakthrough curve occurred at the time of first arrival of conservative solutes in the second test. This result seems to indicate preferred transport pathways for the microspheres, with matrix diffusion and/or more pronounced channeling being possible explanations for the differences in arrival times. More details and interpretations of these tests will be provided in subsequent monthly reports.

***Pre-Test Predictions of Solute Transport:*** Progress is continuing on activities reported in previous monthly reports. A three-dimensional finite element grid is being constructed to allow 3-D calculations of flow and tracer transport at the C-wells using the FEHMN code. Two- and three-dimensional particle-tracking codes have been developed to predict tracer breakthrough curves at the C-wells in convergent or recirculating interwell tests where it is assumed that the media are homogeneous and isotropic. These particle-tracking models will be used to provide pre-test predictions for a milestone report (milestone 4077) that is scheduled for completion at the end of FY 1995. The particle-tracking models will also offer comparisons with the more sophisticated 3-D finite-element calculations when they become available.

***Laboratory Experiments to Support Model Development/Validation***: Analyses of microspheres in samples from these experiments have been completed (see August monthly report for a description of the experiments). However, iodide has not yet been analyzed in samples from the last three experiments. Unfortunately, the microsphere analyses were not as precise as in previous experiments because there were delays of several weeks before the samples could be analyzed. It appears that microsphere aggregation becomes more and more of a problem as the samples age (something we also see in samples collected in the field). This aggregation results in greater error and uncertainty when measuring microsphere concentrations using flow cytometry. Project scientists are exploring methods of keeping the microspheres from aggregating after they have been collected in sample containers. Periodic agitation and/or addition of small amounts of surfactant to the samples are being considered as anti-aggregation measures. The implications of these experiments on tracer testing at the C-wells and on radionuclide migration in the saturated zone near Yucca Mountain will be discussed in future monthly reports.

**WBS 1.2.3.2.6.1.4. Paleoenvironmental History of Yucca Mountain. *Independent Dating.***

a. All tuff samples previously collected for beryllium dating have now been analyzed by the University of Pennsylvania laboratory. These data are expected at Los Alamos within a few days so that the process of calculating ages and erosion rates can be completed.

b. Received some additional beryllium data from the Ghost Dance Fault dating study. These results are being evaluated along with those obtained earlier. Preliminary indications suggest a long term stability for the hillslope graded across the fault and thus a long time (< 200 ka) since the last scarp forming event occurred along this segment of the Ghost Dance fault.

c. All additional samples for beryllium analyses have now been obtained and are in the process of chemical preparation prior to being sent to the Penn Laboratory for analysis.

**WBS 1.2.3.4.1.1 Groundwater Chemistry Model.** Additional analytical data have been obtained for water/rock interaction experiments started in the month of July. These experiments involve two synthetic ground water compositions (AGW #1 and AGW #2) and seven different rock samples. The rock samples used in the experiments include two surface samples of Tiva Canyon Tuff containing caliche and opal, a nonwelded vitric tuff from the PTn, three devitrified tuffs and one zeolitic tuff. Relative to the original water compositions, the waters in contact with the Tiva Canyon Tuff, vitric tuff and the zeolitic tuff show the greatest changes in composition. The data obtained this month show the impact of silicate hydrolysis reactions as well as ion exchange and carbonate dissolution reactions. a preliminary evaluation of these experiments has been included in Milestone 3387 completed this month.

**WBS 1.2.3.4.1.2.2 Biological Sorption and Transport.** Sample was collected from 14 + 25 m of the ESF right rib (20 Sept.). As with the previous samples, this sample was returned to the lab at UNLV, subdivided, and shipped overnight, fed-x to the three other participating laboratories. This sample will be analyzed for microbial activity, as described in previous monthly reports (June, 1995).

Both milestones (3410 and 3178),due by 30 Sept, have been completed and have been submitted. Milestone 3178 was submitted as a DP, while 3410 is currently undergoing technical review.

**WBS 1.2.3.4.1.3 Speciation/Solubility.** The actinide bulk solubility studies (Pu and Np) have been aging for 5 months now at Los Alamos and will be opened next week to measure the solubility and precipitation solid. The Pu(VI) hydrolysis will be completed next week as well, the extra week required because of a manufacturer's defect in the laser system. Besides this experimental work, the bulk of the effort for this month has been the writing of milestones and letter reports. Letter Reports 4084 (database evaluation) and 4082 (Se solubility study) have been submitted. Milestone 3463 (solubility modeling with EQ3/6) will be submitted Monday (10/2) and Letter Report 4091 (Pu(VI) hydrolysis) will be submitted a week late. As arranged earlier, Milestone 3464 (actinide bulk solubility study) will be delivered at the end of October.

**WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes.** ***Code Development.*** Put the finishing touches on several FEHM submodels. The were the tabular relative permeability and capillary functions, the GUI interface, and the multiply defined nodes. The work on tabular relative permeability and capillary pressure models has been tested and provisions for adding it to the controlled(and released versions) of FEHM have been made. It is being used currently to input some relative permeability data from the P tunnel tests. An in-depth description of this capability ,along with descriptions of the GUI and multiply defined nodes can be found in milestone 4075.

*Grid Generation.* Documentation was the primary focus. This can be found in Milestone 4074. Many grids were generated in support of the Superstone 3468.

**WBS 1.2.3.9.7 ESF Test Coordination.** Staff provided multiple-shift field coordination and PI support for ESF North Ramp and Alcove tests. Planning for the Thermal Test Program was continued.

Geologic Mapping and Consolidated sampling activities are underway using the mapping gantry.

Work continues on assembling Field Document Records Center files for activities conducted in the North Ramp. This effort includes the maintenance of an administrative data base that identifies sample locations and their corresponding photo identifiers.

Administrative test management progress reports are generated to assure test requirements are met and issues are identified. ESF TCO Staff continues to support both the Field Change Control Board and the Baseline Change Control Board (level III) on a weekly basis.

**WBS 1.2.3.11.3** LLNL continues to provide Sub-surface geophysical activities. LANL completed the letter report on Laser Induced Breakdown Spectroscopy to complete their assigned scope of work.

**WBS 1.2.6.1.1 Exploratory Studies Facility (ESF) Management, Planning and Technical Assessments.** Staff attended the weekly design and construction meetings. Staff has participated in discussions with the DOE & the design team to merge planned future design activities into the existing 2C design package. Provided design input to support field changes related to the North Ramp Alcove #3 construction. *Developed weekly and monthly administrative management reports for testing activities and facilitated job package record development. Provided field test coordination and administrative support for ESF North Ramp construction.*

**WBS 1.2.6.1.2 / 3 Quality Assurance and Safety Analysis.** Staff attended the weekly design and construction meetings and routinely observed ESF field testing activities. *Reviewed test planning records and test-related Field Change Requests for compliance with QA and safety concerns.*

**WBS 1.2.6.1.6 Exploratory Studies Facility (ESF) Test Management.** Staff attended the weekly design and construction meetings. Supported the development of weekly and monthly administrative management reports for testing activities and facilitated job package record development. Provided field test coordination and administrative support for ESF North Ramp construction.

**WBS 1.2.6.8.4 Integrated Data and Control System.** IDS design and development oversight continues. *Staff actively pursued program integration and review of data flow requirements that are implemented and controlled by test planning records and Project procedures. Continued the review of field record submissions and facilitated data transfers to the constructor and test organizations.*

**WBS 1.2.11.2/.3/.5 Quality Assurance. Program Development (WBS 1.2.11.2)** Budget scenarios continue to be submitted at the request of DOE. We are still evaluating several options for putting forms on line. All support staff are baselining their activities to assist us in FY96 work assignments when budgets are finalized.

***Procedure Revisions.*** . Detailed technical procedures CST-DP-101, R0 (Colloid Sampling...), CST-DP-102, R0 (Redox Potential...), CST-DP-93, R1 (Step-Leaching ...), and CST-DP-105, R0 (Extraction of Chloride...) were approved and issued.. Procedure EES-5-DP-701, R0 (...LIDAR) has been deleted. Seventeen HSE12 procedures were also deleted. The Field Work Package quality administrative procedure, QP-06.4, was approved and sent to controlled documents for distribution.

***Travel.*** S. Bolivar, J. Day and A. Burningham resented two papers at the NIRMA Symposium in Washington, DC, Aug 27-30.

***Audits and Surveys.*** Survey SR-EES-13-95-04 was completed. This survey was conducted to evaluate the status of selected controlled documents. One DR was issued for a minor infraction. Our DR/CAR Coordinator has been becoming familiar with the new DOE deficiency and trending procedures.

***Verifications.*** There are 3 open deficiencies. One of these is a "DR" issued under the new project procedure on deficiency reports; the other two deficiencies are internal corrective action reports that should be closed within the next 30 days. The QAPL is currently doing an investigation to determine closure dates and frequency of deficiencies per group. The quarterly trend report was completed. No adverse trends were identified.

***Quality Engineering.*** The Software Management Coordinator continues to compile a draft home page for program activities. He also is completing several miscellaneous configuration management tasks, reviewing SCM documentation assets and cleaning up SCM files in preparation for a potential shutdown. Several problems related to a statewide "brownout" were fixed.

**(b) Deliverables Completed and Documents Published**

**Milestones completed**

3B04, "Fourth Quarter Quality Program Status Report"
T056, "Revised Probability Estimates for the Yucca Mountain Region"
3043, "Techniques Conducting Unsaturated Column Experiments"
3063, "Transport of Radionuclides by Fracture Flow Through Natural Fractures Under Saturated Conditions"
3064, "Techniques to Study Diffusion in Unsaturated Tuff"
3166, "Geochemistry of Post-Miocene Basalts in the Yucca Mountain Region"
3169, "Completion of Field Geochemistry and Geochronology at the Sleeping Butte and Buckboard Mesa Basalt Centers"

3219, "Sorption as Function of Groundwater Composition to Elucidate Sorption Mechanism"

3178, "ESF Sample Collection for Microbial Analyses"

3326, "Stratigraphy, Trace-Element Chemistry, and Surface Evidence for Reaction Among Calcites in Tuffs of Yucca Mountain Nevada"

3339, "Interim Report: Sorption Isotherms"

3387, "Modeling and Experimental Results on Saturated Zone Water Chemistry"

3431, "Distribution of Cl36 in UZ-16, UZ-14, Perched Water and the ESF North Ramp"

3444, "Equilibrium Modeling study of Clinoptilolite-Analcime Equilibria at Yucca Mountain, Nevada"

3457, "Column Experiments with Crushed Tuff"

3463, "Modeled Actinide Solubilities and Speciation"

3467, "Modification of the Finite Element Heat and Mass Transfer Code (FEHMN) to Model Multicomponent Reactive Transport"

3468, "An Unsaturated Flow and Transport Model of Yucca Mountain"

3472, "Results of LIDAR Remote Sensing Techniques for Finding and Characterizing the Surface Expression of Preferred Pneumatic Pathways"

4009, "Alteration History in the Exploratory Studies Facility, Yucca Mountain, Nevada"

4011, "Quantitative X-ray Diffraction Analysis of FY95 LLNL Hydrothermal Experiments"

4021, "Magma System Dynamics Yearly Report"

4037, "Letter Report on Kinetics of Smectite to Illite Reaction"

4048, "Final Report on Feasibility of Real-Time Geochemical Analysis at Yucca Mountain Nevada Using LIBS Technology

4049, "Progress Report on Geochronology Studies"

4050, "Letter Report on Detection of Basaltic Intrusions"

4058, "The Occurrence and Distribution of Erionite in Drill Holes at Yucca Mountain Nevada"

4073, "Letter Report: Technical Support to Performance Assessment"

4074, "Letter Report: Grid Generation Extension for FEHM"

4075, "Letter Report: Model Implementation"

4079, "Multiple Episodes of Zeolite Deposition in Fractured Silicic Tuff"

4082, "The Solubility and Speciation of Selenium in Waters Pertinent to the Yucca Mountain Project"

4084, "Literature Evaluation for use with the EQ3/6 Database"

4087, "Measuring the Spatial Distribution of Latent Energy Flux over Complex Terrain Using the Mobile Scanning Water-Vapor Raman LIDAR"

4089, "Distribution of Cl36 in Near-Surface and Deep Borehole Samples"

4092, "Solubility Measurements to Evaluate the Thermodynamic Stabilities of Na-Clinoptilolite"

4096, "Fourth Quarter Technical Data Programmatic Status Report"

**(c) Problems areas**

**WBS 1.2.3.3.1.3.1 Reactive Tracer Testing.** The only problems or issues that may adversely affect performance during future reporting periods are issues that involve preparation for tracer tests at the C-wells. These issues are largely beyond the control of LANL personnel, but they could result in significant delays in tracer testing.

**WBS 1.2.11.2/.3/.5 Quality Assurance Program Development, Verification, and Engineering.** Twelve M&TE calibrations are due in October. These are normally done by a contractor who will face budget cuts come October 1.

**(2) Personnel changes**

**WBS 1.2.3.2.1.1.1 Mineralogy of Transport Pathways** B. Carlos, the principal researcher in Fracture Mineralogy studies, left the Yucca Mountain Project effective 9/30/95 because of funding shortfalls. Work on fracture minerals will be absorbed by other parts of the 1.2.3.2.1.1.1 task as support permits, but B. Carlos' many years of experience with Yucca Mountain fracture mineralogy will be sorely missed.

**WBS 1.2.3.2.1.2.2 Stability of Minerals and Glasses.** Emily Woglom of Yale University is no longer working on the Project.

**WBS 1.2.3.4.1.3** Due to budget cuts, Clarence Duffy and David Hobart will no longer be working on the project

**(3) Unusual costs and possible financial performance problems**

NA See attached Variance Analysis Report and FTE Report.

**(4) Programmatic issues that may impact the overall CRWMS M&O effort**

**WBS 1.2.3.2.1.1.1 Mineralogy of Transport Pathways.** Consideration of calcite solubility as a function of temperature has shown that enhanced calcite precipitation at elevated temperatures may be a significant factor in radionuclide retardation in the thermal aureole of a repository at Yucca Mountain. Calcite precipitation can be successful in retarding transport not only of transuranics (especially Pu and Am) but also of $^{14}C$.

**WBS 1.2.3.2.1.1.2 History of Mineralogic and Geochemical Alteration at Yucca Mountain.** The status of ongoing research, especially experiments in progress, is uncertain under the programmatic priorities established for FY96.

Thermodynamic modeling and trace-element studies of erionite formation of Yucca Mountain point to high-K and possibly high-pH solutions for erionite formation. Further geochemical studies, integrated with UZ water analyses, could lead to a predictive tool for determining where the project should expect to find this carcinogen.

**WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes.** Comparison of FEHM and TOUGH2 saturation fields were made with data provided by LBL. The two codes compared well with the exception of a slight saturation offset in the Paint Brush Tuff. A movie was made which highlights some of the grid generation ,flow, and transport capability at Los Alamos.

**(5) Worked planned**

**WBS 1.2.3.1.2/.3 Site Investigation Coordination And Planning/Test Management and Integration.** Continue support of Los Alamos Exploratory Studies Facility (ESF) and surface-based site characterization activities in response to Project programmatic requirements

**WBS 1.2.3.2.1.1.1 Mineralogy of Transport Pathways.** Work will begin on summary and synthesis reports in support of site suitability determinations and license application submission. Full papers on ion exchange and dehydration effects on potassium and argon contents of clinoptilolite and on alteration history studies in the ESF will be prepared for inclusion in the Scientific Basis for Nuclear Waste Management XIX symposium proceedings. Argon diffusion experiments and thermodynamic studies of hydrous mineral dehydration and rehydration under repository thermal loading are also ongoing.

**WBS 1.2.3.2.1.1.2 Alteration History.** Work will begin on summary and synthesis reports in support of site suitability determinations and license application submission. Full papers on ion exchange and dehydration effects on potassium and argon contents of clinoptilolite and on alteration history studies in the ESF will be prepared for inclusion in the Scientific Basis for Nuclear Waste Management XIX symposium proceedings. Argon diffusion experiments and thermodynamic studies of hydrous mineral dehydration and rehydration under repository thermal loading are also ongoing.

**WBS 1.2.3.2.1.2.2 Stability of Minerals and Glasses.** Yale researchers will complete resolution of technical comments on milestone 3445 and the milestone will be delivered to the YMSCPO. Los Alamos personnel will begin writing the summary and synthesis report for this study as soon as Project Office guidance is received. The above-described in-progress experiments and modeling will be stopped and the Penn State and Yale postdoctoral fellows will be terminated.

**WBS 1.2.3.2.6.1.4 Paleoenvironmental History of Yucca Mountain.** We anticipate the receipt of additional (tuff samples) cosmogenic data from the Univ. of Penn. The evaluation of this data (including field evaluation) will be the major work during the next month.

**WBS 1.2.3.2.5 Volcanism.** Synthesis of volcanism activities will proceed.

**WBS 1.2.3.3.1.3.1 Reactive Tracer Testing.** Continue to work on a YMSCO milestone report describing the results of the LiBr column studies. This report will discuss the ability to predict the transport behavior of lithium by assuming an equilibrium adsorption isotherm based on the results of earlier batch sorption experiments (Milestone 3249). Continue to work on a YMSCO milestone report presenting pre-test predictions for tracer transport at the C-wells (Milestone 4077). Continue the efforts described under "pre-test predictions of solute transport" and "laboratory experiments to support model development/validation."

**WBS 1.2.3.4.1.1 Ground-Water Chemistry Model.** Continue development of quantitative models for soil zone chemical processes. Continue to refine conceptual models for processes that could control groundwater chemistry at Yucca Mountain.

**WBS 1.2.3.4.1.2.2 Biological Sorption and Transport.** Staff will collect three more samples from the ESF for microbial analysis. Once the Upper Lithophysal Topopah Spring sample has been collected (the final sample) Staff will meet with the investigators from the four universities to discuss the data and publications. In addition to those publications, Staff will publish the results of the column transport studies (milestone 3410) and two papers on microbial promoted hematite dissolution.

**WBS 1.2.3.4.1.3** Efforts in database evaluation will continue for next month's work.

**WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes.** Continue work on Site Scale flow model. Check with LBL model.

**WBS 1.2.3.9.7 Special Studies: ESF Test Coordination.** Continue support of ESF test coordination site characterization activities in response to Project programmatic requirements

**WBS 1.2.3.11.3 Geophysics - ESF Support, Subsurface Geophysical Testing.** Work under this WBS is being terminated October 1, 1995, and test requirements will be met under other TRW WBS accounts.

**WBS 1.2.6.1.1 Exploratory Studies Facility (ESF) Management, Planning and Technical Assessments.** Support of the finalization of Title II Design Packages for the North Portal surface facility and ESF excavations. Continue field test coordination for Construction Monitoring, Geologic Mapping, Consolidated Sampling, Perched Water, Radial Boreholes, Hydrologic Properties of Major faults and Hydrochemistry test activities being conducted in the North Ramp and alcoves.

**WBS 1.2.6.1.2/.3 Quality Assurance and Safety Analysis.** Support of the evolution of Title II Design Packages for the North Portal surface facility and ESF. Evaluate interactions and processes planned between testers and Tunnel Boring Machine operations.

**WBS 1.2.6.1.6 Exploratory Studies Facility (ESF) Test Management.** Support of the finalization of Title II Design Packages for the North Portal surface facility and ESF.

**WBS 1.2.6.8.4 Integrated Data and Control System.** Provide management for the Yucca Mountain Site Characterization Project Office to deploy ESF Test Data collection equipment to meet test requirements.

**WBS 1.2.11.2/.3/.5 Quality Assurance Program Development, Verification, and Engineering.** As soon as budgets become finalized, we will direct our efforts to determining which functions we can provide. Efforts on the QA homepage will continue, as will work on the 1994 status report. We will continue to examine options for putting forms on-line and streamlining the QP process

# YMP PLANNING AND CONTROL SYSTEM (PACS)

| Participant: | LANL | | MONTHLY COST/FTE REPORT | | | | Fiscal Month/Year September FY1995 | |
|---|---|---|---|---|---|---|---|---|
| Date Prepared: | 16-Oct-95 | | | | | | Page 1 | |
| | | | | | | | Fiscal Year 1995 | |
| WBS Element | Actual Costs | Participant Hours | Subcon Hours | Purchase/Subcon Commitments | Accrued Costs* | Approved Budget | Approved Funds | Cumulative Costs |
| 1.2.1 | 20.8 | 252.0 | 87.8 | 0.0 | 0.0 | 100.0 | 13.0 | 51.2 |
| 1.2.3 | 979.8 | 4,430.2 | 855.8 | 170.8 | 0.0 | 12,428.0 | 6,904.5 | 12,454.0 |
| 1.2.5 | 117.8 | 981.1 | 0.0 | 14.3 | 0.0 | 1,534.0 | 604.1 | 1,277.0 |
| 1.2.6 | 172.8 | 1,446.5 | 378.3 | 52.2 | 0.0 | 2,413.0 | 649.9 | 1,649.0 |
| 1.2.9 | 53.2 | 206.6 | 137.9 | 14.4 | 0.0 | 1,103.0 | 441.0 | 940.1 |
| 1.2.11 | 69.9 | 0.0 | 29.5 | 28.5 | 0.0 | 1,270.0 | 555.6 | 1,098.6 |
| 1.2.12 | 22.5 | 0.0 | 0.0 | 0.4 | 0.0 | 477.0 | 200.7 | 379.5 |
| 1.2.13 | 18.3 | 0.0 | 0.0 | 9.4 | 0.0 | 111.0 | 19.4 | 54.0 |
| 1.2.15 | 2.5 | 0.0 | 32.6 | 1.0 | 0.0 | 483.0 | 225.4 | 431.6 |
| | | | *** TH & WD funding allocations received from TRW. | | | | 11,421.0 | |
| Totals | 1,457.6 | 7,316.4 | 1,521.9 | 291.0 | 0.0 | 19,919.0 | 21,034.6 | 18,335.0 |

Re-distributed with attachments 10/25/95


# Los Alamos
NATIONAL LABORATORY

*WBS*: 1.2.9.1
*QA*: N/A

**Earth and Environmental Sciences Division**
EES-13 – Nuclear Waste Management R&D
Mail Stop J521, Los Alamos, NM 87545
Phone (505) 667-9768, Fax (505) 667-1934


October 12, 1995

LA-EES-13-10-95-001

Dr. Colin A. Heath
CRWMS M&O Assistant General Manager for Program Integration
TRW Environmental Safety Systems Inc.
2650 Park Tower Drive
Suite 800
Vienna, VA 22180

Dear Dr. Heath,

**Submittal of Los Alamos Monthly Management Analysis Report for September 1995 (SCPB:NA)**

Attached is the Los Alamos Monthly Management Analysis Report for September 1995. This report includes five sections:

(1) a summary of our technical efforts, including information on completion of contract deliverables and major problems;
(2) a summary of personnel changes;
(3) a list of any unusual current and/or anticipated financial performance problems;
(4) a list of programmatic issues that may impact the overall CRWMS M&O effort; and
(5) a summary of work planned for next reporting period.

This technical sections of this report have not received formal technical or policy review by Los Alamos or the YMP. Data presented in this document constitute predecisional information, should not be referenced, and are not intended for release from the U.S. Department of Energy as referenceable information.

If you have changes to our distribution list, please call Susan Klein at (505) 667-0916.

Sincerely,

Julie A. Canepa

JAC/SHK/lb

Attachment: a/s

Cy w/att:
W.E. Barnes, YMSCO, Las Vegas, NV
G. Bovarddson, LBL, Berkeley, CA
M.W. Chisholm, , M&O/TRW, Las Vegas, NV
W.L. Clarke, LLNL, Livermore, CA
L. Costin, SNL, Albuquerque, NM
R.L. Craun, YMSCO, Las Vegas, NV
W.R. Dixon, YMSCO, Las Vegas, NV
J.R. Dyer, YMSCO, Las Vegas, NV
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A.V. Gil, YMSCO, Las Vegas, NV
L.R. Hayes, USGS, Denver, CO
V.F. Iorii, YMSCO, Las Vegas, NV
S.B. Jones, YMSCO, Las Vegas, NV
M.D. Voegele, SAIC, Las Vegas, NV
D.R. Williams, YMSCO, Las Vegas, NV
G.A. Bussod, EES-13, MS J521
N.Z. Elkins, EES-13/LV, MS J900/527
S.H. Klein, EES-13, MS J521
A.L. Thompson, EES-13/LV, MS J900/527
K.A. West, EES-13, MS J521

RPC File (S. Martinez), MS M321
LA-EES-13 File, MS J521

**Los Alamos Monthly Management Analysis Report for September 1995**

**(1) Summary of (a) Los Alamos' technical accomplishments, (b) deliverables completed, and (c) major problems that may impact future performance.**

**(a) Technical accomplishments**

**WBS 1.2.3.1 Site Investigation Coordination and Planning.** Staff represented the Los Alamos Site Characterization Project Leader at weekly surface-based testing meetings and Civilian Radioactive Waste Management System Management & Operating (CRWMS M&O) Contractor work scope consolidation meetings

**WBS 1.2.3.2.1.1.1 Transport Pathways.** ***Studies of Calcite as a Factor in Flow Models and Radionuclide Transport Retardation.*** Report LA3326 was completed on 9/27 ("Stratigraphy, Trace-Element Geochemistry, and Evidence for Surface Reaction among Calcites in Tuffs of Yucca Mountain, Nevada"; D. T. Vaniman and S. J. Chipera). This report concludes that the principal factors in determining calcite trace-element chemistry at Yucca Mountain appear to be (1) the nature of source glasses for lanthanide elements (rhyolitic or quartz-latitic glass) and (2) competition with other minerals (principally Mn oxides for lanthanides and zeolites or smectites for Sr). Variations in calcite chemistry, based on samples from the upper 1 km where UZ and SZ waters are oxidizing, indicate that (a) cations readily exchanged by clays or zeolites, represented by Sr, are essentially removed from solutions along some flowpaths that are in contact with these minerals and (b) traces of Mn oxides found in the tuffs have an effect on groundwater chemistry that is both strong and universal in the oxidizing zone (evidenced by characteristic Ce depletions in calcite throughout this zone). This latter observation shows that even trace minerals can have a significant impact on transport. The lanthanide-element contents of calcites can closely approach those of the source glasses, indicating that the transport of heavy metals similar to transuranic elements can be effectively retarded in situations where calcite is precipitating. Finally, heat released by radioactive decay in a high-level waste repository may lead to increased calcite precipitation, entrapping $^{14}C$ and transuranic wastes that might be released from waste canisters while temperatures are elevated.

Studies of calcite chemistry at Yucca Mountain are being used to supply information on the transport of elements that occur in the natural environment as well as in high-level waste (Sr, Cs, Ba, C). Other chemical species that occur in the natural environment and are geochemically analogous to man-made radionuclides (e.g., lanthanide elements as analogs to Am, Pu, and Np) are also important in evaluating site performance.

***TEM Studies in Support of Sorption Models.*** Studies by transmission electron microscopy (TEM) have been pursued in order to determine the mechanisms of Pu sorption on smectites from Yucca Mountain. The TEM work by G. Guthrie on smectites from the zeolitic Calico Hills Formation in core USW UZ-16 show no evidence of either crystalline or amorphous Fe-oxide inclusions, inferred by some researchers to account for the strong sorption of transuranics by clay minerals. Data obtained from TEM studies will help in constraining the mechanisms of sorption, in providing verification of the validity of specific sorption models, and in determining how robust the sorption coefficients are in situations where temperature, solution composition, and rock mineralogy may all be variable.

***Mineralogic Input to Modeling of Transport.*** The mineral-stratigraphic model prepared for use in transport calculations by C. Gable, B. Robinson, and A. Wolfsberg has been further refined. D. Vaniman visited the Sample Management Facility on 9/6-9/7 to examine the completed lower portions of cores USW SD-9 and USW SD-12, cores that are in locations critical to the zeolite stratigraphy model for the exploration block. Although quantitative XRD data are not yet available for these cores, hand-sample and binocular microscope studies are able to provide approximate depths for "maximal zeolite", "minimal zeolite", and "nominal zeolite" models to be used in transport calculations. The observations made this month can be used in interim tests but will need to be updated when XRD data become available.

***Studies of Erionite.*** Letter report LA4058 was completed on 9/18 ("The Occurrence and Distribution of Erionite in Drill Holes at Yucca Mountain, Nevada"; D. L. Bish, S. J. Chipera, G. D. Guthrie, and D. T. Vaniman). This report summarizes all work completed to date at LANL on the topic of erionite occurrences at Yucca Mountain, including the current status of biological data on the hazards of erionite inhalation. The report emphasizes that all erionite occurrences at Yucca Mountain are restricted to either the altered zone immediately above the Topopah Spring Tuff lower vitrophyre or the underlying moderately-welded vitric subzone. Trace-element geochemical data suggest that the most abundant erionite occurrence, in core USW UZ-14, experienced chemical exchange in alkalis and alkaline earths but behaved as a closed system with respect to heavy elements (lanthanides) during alteration. Moreover, Ce fractionation indicates that the system was oxidizing or of relatively high pH. These observations are in accord with thermodynamic modeling that points to formation of erionite in a relatively K-rich geochemical environment. At present there is too little information on where and why such environments occur at Yucca Mountain to use this information in a predictive manner and it remains important for the project to remain watchful for erionite occurrences when excavations are crossing the lower vitrophyre of the Topopah Spring Tuff.

**WBS 1.2.3.2.1.1.2 Alteration History**. Schön Levy and Bill Carey followed up on their contributions to the Thermal Loading System Study Report by reviewing their input as incorporated into the draft report and responding to reviewer comments.

Steve Chipera, Bill Carey, and Dave Bish finished the paper entitled "Controlled-Humidity XRD Analyses: Application to the Study of Smectite Expansion/Contraction." The paper will be submitted to Advances in X-ray Analysis **39**, Proceedings of the 44th Annual Denver Conference on Application of X-ray Analysis.

Dave Bish and Steve Chipera completed milestone LA4011, "Quantitative X-ray Diffraction Analysis of FY95 LLNL Hydrothermal Experiments." Based on examination of treated (steam atmosphere) and untreated samples of Topopah Spring Tuff (Tpt) lower vitrophyre and Calico Hills Formation (Tch) nonwelded vitric tuff, the report shows that the Calico Hills Formation sample experienced significant amounts of alteration. It is also noteworthy that alteration appears to have permeated the rock wafers. Not only was the sample partially devitrified, the smectite in the sample was greatly affected. The behavior of the Tch smectite on steam heating was similar, but not identical, to the effects described by Couture and Seitz (1984), Couture (1985a,b), and Oscarson and Dixon (1987). Although the osmotic swelling ability of the Tch smectite was not evaluated, the interlayer swelling capability decreased so that smectite in the altered sample adsorbed little more than one water layer whereas the original material adsorbed two water layers near 100% RH. Such changes in intracrystalline expansion have the potential to affect rock permeability because smectite-bearing regions of the rock no longer occupy as much volume under the same saturation conditions. These results emphasize the importance of conducting experiments under partially saturated conditions in order to simulate expected repository environment conditions.

In contrast, the Tpt vitrophyre sample experienced no statistically significant amount of alteration, possibly due to the very low hydraulic conductivity of the Tpt lower vitrophyre. The hydraulic conductivity of the vitrophyre is typically several orders of magnitude lower than that of the vitric, nonwelded Tch. (e.g., Lin and others, 1986). Alteration of the Tpt smectite could not be discerned due to the low amount of smectite in the sample.

An abstract entitled "Ion exchange and dehydration effects on potassium and argon contents of clinoptilolite," by Giday WoldeGabriel and Schön Levy, and an abstract entitled "Alteration History Studies in the Exploratory Studies Facility, Yucca Mountain, Nevada, USA," by Schön Levy and Dave Norman, were accepted for presentation at the Scientific Basis for Nuclear Waste Management XIX symposium of the Materials Research Society fall meeting in Boston, 27 November through 1 December, 1995.

Schön Levy and Steve Chipera completed milestone letter report LA4009, "Alteration History Research in the Exploratory Studies Facility, Yucca Mountain, Nevada." As of mid-1995, the Exploratory Studies Facility extended slightly over one kilometer from Exile Hill westward toward Yucca Mountain. Approximately 700 m of the tunnel lies within densely welded, devitrified Tiva Canyon Tuff. Notable secondary mineral occurrences in this unit include breccia cements of relatively coarse-grained mordenite, a fibrous zeolite, and syngenetic vapor-phase deposits of silica, alkali feldspar, apatite, hollandite, amphibole, and zircon.

A highly altered interval within pre-Pah Canyon tuffs just above the top of the Topopah Spring Tuff may be a fossil fumarole or other hydrothermal feature associated with cooling pyroclastic deposits overprinted by later zeolitic alteration. The observed smectitic alteration, silicification, and zeolitization are known as products of moderate-temperature hydrothermal alteration elsewhere in the Paintbrush Group. However, there are usually other minerals such as alkali feldspar, cristobalite, tridymite, or apatite present somewhere within the altered zones. These minerals are common constituents of vapor-phase deposits formed usually in the upper parts of cooling tuffs. The presence of one or more of these minerals at the study site would strengthen a hydrothermal interpretation and, in the case of feldspar or apatite, might provide an age of alteration.

Local zeolitic alteration of nonwelded tuffs at or just above the top of the Topopah Spring Tuff has been noted in drill hole USW G-2 and in outcrop at northeastern Yucca Mountain. The hydrologic, geochemical, and perhaps thermal conditions that favored zeolitization only in certain areas have yet to be determined.

**WBS 1.2.3.2.1.2. Stability of Minerals and Glasses.** ***Clinoptilolite Rates.*** Over the past several weeks, Penn State researchers have had a clinoptilolite flow-through experiment at 175 C in progress (FD). In this experiment, input solutions are set very far from equilibrium (undersaturated). In subsequent experiments, they will also explore reaction rates at 175 C closer to equilibrium and from both undersaturated and supersaturated conditions. Similar runs are planned also for 100 C to better establish the dependence of the rate constants for clinoptilolite on temperature.

The apparent Al-inhibition of clinoptilolite at 50 C, but not at 80 C has led to two new series of experiments. One of the main differences between 80 C and 50 C experiments is the larger mass of clinoptilolite that is calculated to have dissolved before reaching the first steady state at 80 C. Therefore, the new 50 C experiments are being run at a higher flow rate (~10 times faster than typical experiments) in order to dissolve a larger amount of material. These first stages of the experiments will also provide a rate measurement farther from equilibrium than the previous 50 C experiments. The next stages of the experiments will be run at lower flow rates (i.e., closer to equilibrium). One series will vary Si and the other will vary Al concentrations in the input solutions for comparison with the previous 50 C experiments.

The 80 C clinoptilolite experiment at pH~9.5 is nearly complete. The problems with cell and tubing leakage at the higher pH have finally been solved (using the new polysulfone cells with semi-rigid Teflon tubing and compression fittings). Additional pH~9.5 experiments at 50 C and at pH~8 will be started in the next month in order to continue testing the pH effect on the clinoptilolite dissolution rate.

***Kinetics of the Smectitie-to-illite reaction.*** Penn State investigators have investigated the effect of solution chemistry on the illitization of precursor smectite (K-saturated SWy-1) in dilute KCl-bearing solutions under hydrothermal flow-through conditions (T= 200(, 250(, 300( C). The use of a flow-through apparatus allowed them to control the composition of input solutions and to monitor changes in clay and outlet solution composition. Reaction products closely matched those found in nature and consisted of mixed layer smectite/illite clays which increased in illite content as reaction progressed. A 10Å non-expandable product formed upon completion.

pH has an important influence on the specific mode of illitization. At pH's slightly below neutral, illitization involves net tetrahedral Al3+ for Si4+ exchange; whereas at basic pH's, illitization involves net octahedral Mg2+

for Al3+ exchange. This behavior reflects the relative pH-dependence of Al3+ and Mg2+ solubilities. At pH's slightly below neutral, Mg2+ is significantly more soluble than Al3+ and dissolution of precursor smectite resulted in the incongruent formation of Al-rich (muscovitic) illite layers. At pH's above neutral, the opposite effect resulted in the formation of Mg-rich (celadonitic) illite layers.

Aqueous silica activity also affects the extent of illitization so that the illite content of mixed-layer products systematically increases with decreasing aH4SiO4(aq). Complete illitization was rapidly achieved (e.g., 1000 hours) in solutions maintained well below quartz saturation. In solutions held above quartz saturation, illitization did not go to completion and a smectite-rich product was stabilized.

The results of this study may explain illitization trends observed in nature. The prevalence of pore conditions that are slightly acidic and near the solubility minimum of aluminum may explain the Al3+-for-Si4+ reaction stoichiometry that typifies illitization in sedimentary basins. Furthermore, spatially abrupt increases in the illite content of mixed-layer clays may be due to episodic reduction of aqueous silica activity by fluid flow under relatively open-system conditions (e.g., at fault zones and sandstone/shale interfaces). These results also suggest that, as with reactions involving clinoptilolite, the relatively high aqueous silica activity in Yucca Mountain waters near the repository horizon will tend to stabilize smectite with respect to illite. Thus, as long as the abundant soluble silica minerals and glasses are present in the vicinity of the repository horizon, keeping the aqueous silica activity high, the smectite-to-illite reaction should not progress. It therefore appears that the smectite-to-illite reaction need not be a major concern in connection with repository-induced alteration of rock properties.

***Conceptual Model of Mineral Evolution.*** Milestone 3444, the report on a modeling study of the clinoptilolite-to-analcime transition, was completed this month and transmitted to the YMSCPO. After Project approval, the manuscript will be prepared for submission to the journal Clays and Clay Minerals..

Penn State researchers completed milestone LA4038 on the solubility of Na-clinoptilolite and analcime. Penn State and Yale researchers worked extensively on the clinoptilolite kinetics manuscript, milestone LA3445. Penn State researchers also completed the letter report on the kinetics of the smectite-to-illite reaction, milestone LA4037.

**WBS 1.2.3.2.5 Volcanism.** ***Probability Studies.*** Revised probability calculations were completed and the results were summarized in a milestone letter report submitted to DOE (T056).Recurrence rates were assembled for 7 spatial, structural and regional background models that are a synthesis of multiple alternative models described in the volcanism status report (Crowe et al. 1995). Mean or most likely estimates for the recurrence rate are consistent with previous probabilistic assessments (3.5 to 5.2 x 10-6 events yr-1). Low recurrence rates were obtained for recurrence models that extend to the volcanic record of the Older Postcaldera basalt (9.1 Ma). A new approach to probability bounds for the recurrence rate was applied where a triangular distribution was assumed and minimum and maximum bounds established that are outside of the distribution space. The upper bound for these models includes an analysis of undetected volcanic events. Minimum and maximum bounds were examined for E2 for the 7 spatial, structural, and regional background models. The probability of magmatic disruption of a repository at Yucca Mountain [Pr(E2 given E1)Pr(E1)] were examined. A new approach of assessing regional background rates of magmatic disruption was developed. The estimations for the probability of disruption of a 4.6 km2 repository at the Yucca Mountain site must be between bounds defined by estimates using maximum E2 models (3.4 to 4.4 x10-8 events yr-1) and the regional background estimates (1.4 to 4.2 x10-9 events yr-1).

The data appendix for the volcanism status report (Crowe et al. 1995) was completed and submitted to a Quality Assurance review. The error rate of entries noted in the review was too high and a decision was made to conduct another edit/review cycle of the report prior to its submittal as a milestone report.

***Geophysics Studies.*** A milestone letter report (4050) was completed on geophysical studies related to probabilistic volcanic hazard assessments. Significant results obtained that were summarized in the report include the identification of one, possibly two magnetic lows of about 100 nT amplitude associated with the 10 Ma basalt dike of Yucca Mountain, establishment of location coordinates and target depth (200 m) for the aeromagnetic anomaly of southern Crater Flat, and integration of results from the seismic refraction/reflection experiment into volcanism studies.

***Structural Controls of Basaltic Volcanism.*** Simulation modeling of E2 using the FRACMAN code was applied to 7 spatial and structural models of the distribution of Quaternary and Plio-Quaternary basaltic volcanic centers in the Yucca Mountain region. The modeling shows maximum sensitivity to feeder dike length and spatial and structural models that include the Yucca Mountain site. Volcanism scenarios were run using the computer code RIP to evaluate radiological releases for eruptive and subsurface effects of volcanic and intrusive events. The modeling output will be assembled in Milestone Report 3399 and will be analyzed in FY96. Analyses of the time-space patterns of basaltic volcanism in the Yucca Mountain region for the last 9.1 Ma show a statistically significant component of southwest-directed drift through time. The results of the simulation modeling and spatial analyses were completed as part of volcanism work conducted through a contract with Golder Associates.

***Geologic Field Studies.*** Volcanism staff completed trenching studies of the cone crater at the Lathrop Wells volcanic center. A series of trenches constructed from the cone rim to the crater floor revealed a consistent colluvial stratigraphy which suggests that erosion of the cone rim was relatively minor.

A milestone report (3169) was completed describing results of field studies at Sleeping Butte and Buckboard Mesa.

***Geochronology Studies.*** $^{40}Ar/^{39}Ar$ dating of sanidine crystals in tuff xenoliths were completed for eruptive units at the Lathrop Wells volcanic center. These dates indicate that lava flow Ql2a erupted between 60 and 100ka.

A milestone report (4049) was completed which summarizes the progress made in geochronology studies in FY95.

***Geochemistry Studies.*** Major, trace-element and isotopic analyses from Thirsty Mesa, Buckboard Mesa, S.E. Crater Flat, Black Cone, Red Cone, Little Cones, Makani Cone, Little Black Peak and Hidden Cone were compiled. A milestone report (3166) was completed which presents geochemical data for these volcanic centers.

***Magma system dynamics.*** A milestone report (4021) describing progress in magma system dynamics studies was completed.

***General.*** Final editing is being completed on the data appendix for a milestone report due at the end of the fiscal year. A second data table was proposed and is in preparations. When completed the two data tables will allow data to be referenced and traced from field and laboratory notebooks to specific pages of the volcanism status report as well as the opposite (specific pages of the volcanism status report to entries in field and laboratory notebooks).

Volcanism staff for the YMP participated in tours of the Lathrop Wells volcanic center with the new chairman of the NRC, the inspector general of the NRC and the subcommittee of the National Academy of Sciences that is reviewing the erosion topical basis report.

**WBS 1.2.3.3.1.2.5 Diffusion Tests in the ESF.** Tests have been deferred due to lack of funding.

**WBS 1.2.3.3.1.3.1 Reactive Tracer Testing.** ***Lithium Bromide Column Experiments***: A draft milestone report is expected to be completed later this year. These experiments were conducted to investigate the effects of kinetics and nonlinear sorption on the transport behavior of Li in columns packed with Bullfrog tuff from the C-wells. A description of the tests and a brief discussion of the preliminary results was included in the May 1995 monthly report. The conclusions drawn from this study could have an important impact on both the pre-test predictions of LiBr transport in the C-wells field-scale experiments and on the interpretation of the field experiments.

***Field Testing***: Samples collected in the July and August (1995) tracer tests at the Raymond Quarry fractured granite site in California have been analyzed for polystyrene microspheres (see the July and August monthly reports for details of the tests). Briefly, the July test was conducted with the injection and production wells 7.5 m apart, and the August test was conducted with the wells 30 m apart (in the same direction as the first test).

Interestingly enough, there was less than a factor of two difference in the recovery of 0.36-μm diameter microspheres in the two tests despite the different distances between the wells. The recovery of these microspheres was 3-5% in the two tests (compared to about 1% for 1-μm diameter microspheres, which were used in the first test but not in the second test). We are still waiting for solute breakthrough data from the tests (from LBL), but preliminary indications are that the microspheres broke through sooner than conservative solutes in both tests, and that the difference between the microspheres and solutes was greater in the second test. In fact, the peak of the microsphere breakthrough curve occurred at the time of first arrival of conservative solutes in the second test. This result seems to indicate preferred transport pathways for the microspheres, with matrix diffusion and/or more pronounced channeling being possible explanations for the differences in arrival times. More details and interpretations of these tests will be provided in subsequent monthly reports.

***Pre-Test Predictions of Solute Transport:*** Progress is continuing on activities reported in previous monthly reports. A three-dimensional finite element grid is being constructed to allow 3-D calculations of flow and tracer transport at the C-wells using the FEHMN code. Two- and three-dimensional particle-tracking codes have been developed to predict tracer breakthrough curves at the C-wells in convergent or recirculating interwell tests where it is assumed that the media are homogeneous and isotropic. These particle-tracking models will be used to provide pre-test predictions for a milestone report (milestone 4077) that is scheduled for completion at the end of FY 1995. The particle-tracking models will also offer comparisons with the more sophisticated 3-D finite-element calculations when they become available.

***Laboratory Experiments to Support Model Development/Validation***: Analyses of microspheres in samples from these experiments have been completed (see August monthly report for a description of the experiments). However, iodide has not yet been analyzed in samples from the last three experiments. Unfortunately, the microsphere analyses were not as precise as in previous experiments because there were delays of several weeks before the samples could be analyzed. It appears that microsphere aggregation becomes more and more of a problem as the samples age (something we also see in samples collected in the field). This aggregation results in greater error and uncertainty when measuring microsphere concentrations using flow cytometry. Project scientists are exploring methods of keeping the microspheres from aggregating after they have been collected in sample containers. Periodic agitation and/or addition of small amounts of surfactant to the samples are being considered as anti-aggregation measures. The implications of these experiments on tracer testing at the C-wells and on radionuclide migration in the saturated zone near Yucca Mountain will be discussed in future monthly reports.

**WBS 1.2.3.2.6.1.4. Paleoenvironmental History of Yucca Mountain. *Independent Dating.***

a. All tuff samples previously collected for beryllium dating have now been analyzed by the University of Pennsylvania laboratory. These data are expected at Los Alamos within a few days so that the process of calculating ages and erosion rates can be completed.

b. Received some additional beryllium data from the Ghost Dance Fault dating study. These results are being evaluated along with those obtained earlier. Preliminary indications suggest a long term stability for the hillslope graded across the fault and thus a long time (< 200 ka) since the last scarp forming event occurred along this segment of the Ghost Dance fault.

c. All additional samples for beryllium analyses have now been obtained and are in the process of chemical preparation prior to being sent to the Penn Laboratory for analysis.

**WBS 1.2.3.4.1.1 Groundwater Chemistry Model.** Additional analytical data have been obtained for water/rock interaction experiments started in the month of July. These experiments involve two synthetic ground water compositions (AGW #1 and AGW #2) and seven different rock samples. The rock samples used in the experiments include two surface samples of Tiva Canyon Tuff containing caliche and opal, a nonwelded vitric tuff from the PTn, three devitrified tuffs and one zeolitic tuff. Relative to the original water compositions, the waters in contact with the Tiva Canyon Tuff, vitric tuff and the zeolitic tuff show the greatest changes in composition. The data obtained this month show the impact of silicate hydrolysis reactions as well as ion exchange and carbonate dissolution reactions. a preliminary evaluation of these experiments has been included in Milestone 3387 completed this month.

**WBS 1.2.3.4.1.2.2 Biological Sorption and Transport.** Sample was collected from 14 + 25 m of the ESF right rib (20 Sept.). As with the previous samples, this sample was returned to the lab at UNLV, subdivided, and shipped overnight, fed-x to the three other participating laboratories. This sample will be analyzed for microbial activity, as described in previous monthly reports (June, 1995).

Both milestones (3410 and 3178),due by 30 Sept, have been completed and have been submitted. Milestone 3178 was submitted as a DP, while 3410 is currently undergoing technical review.

**WBS 1.2.3.4.1.3 Speciation/Solubility.** The actinide bulk solubility studies (Pu and Np) have been aging for 5 months now at Los Alamos and will be opened next week to measure the solubility and precipitation solid. The Pu(VI) hydrolysis will be completed next week as well, the extra week required because of a manufacturer's defect in the laser system. Besides this experimental work, the bulk of the effort for this month has been the writing of milestones and letter reports. Letter Reports 4084 (database evaluation) and 4082 (Se solubility study) have been submitted. Milestone 3463 (solubility modeling with EQ3/6) will be submitted Monday (10/2) and Letter Report 4091 (Pu(VI) hydrolysis) will be submitted a week late. As arranged earlier, Milestone 3464 (actinide bulk solubility study) will be delivered at the end of October.

**WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes.** ***Code Development.*** Put the finishing touches on several FEHM submodels. The were the tabular relative permeability and capillary functions, the GUI interface, and the multiply defined nodes. The work on tabular relative permeability and capillary pressure models has been tested and provisions for adding it to the controlled(and released versions) of FEHM have been made. It is being used currently to input some relative permeability data from the P tunnel tests. An in-depth description of this capability ,along with descriptions of the GUI and multiply defined nodes can be found in milestone 4075.

***Grid Generation.*** Documentation was the primary focus. This can be found in Milestone 4074. Many grids were generated in support of the Superstone 3468.

**WBS 1.2.3.9.7 ESF Test Coordination.** Staff provided multiple-shift field coordination and PI support for ESF North Ramp and Alcove tests. Planning for the Thermal Test Program was continued.

Geologic Mapping and Consolidated sampling activities are underway using the mapping gantry.

Work continues on assembling Field Document Records Center files for activities conducted in the North Ramp. This effort includes the maintenance of an administrative data base that identifies sample locations and their corresponding photo identifiers.

Administrative test management progress reports are generated to assure test requirements are met and issues are identified. ESF TCO Staff continues to support both the Field Change Control Board and the Baseline Change Control Board (level III) on a weekly basis.

**WBS 1.2.3.11.3** LLNL continues to provide Sub-surface geophysical activities. LANL completed the letter report on Laser Induced Breakdown Spectroscopy to complete their assigned scope of work.

**WBS 1.2.6.1.1 Exploratory Studies Facility (ESF) Management, Planning and Technical Assessments.** Staff attended the weekly design and construction meetings. Staff has participated in discussions with the DOE & the design team to merge planned future design activities into the existing 2C design package. Provided design input to support field changes related to the North Ramp Alcove #3 construction. *Developed weekly and monthly administrative management reports for testing activities and facilitated job package record development. Provided field test coordination and administrative support for ESF North Ramp construction.*

**WBS 1.2.6.1.2 / 3 Quality Assurance and Safety Analysis.** Staff attended the weekly design and construction meetings and routinely observed ESF field testing activities. *Reviewed test planning records and test-related Field Change Requests for compliance with QA and safety concerns.*

**WBS 1.2.6.1.6 Exploratory Studies Facility (ESF) Test Management.** Staff attended the weekly design and construction meetings. Supported the development of weekly and monthly administrative management reports for testing activities and facilitated job package record development. Provided field test coordination and administrative support for ESF North Ramp construction.

**WBS 1.2.6.8.4 Integrated Data and Control System.** IDS design and development oversight continues. *Staff actively pursued program integration and review of data flow requirements that are implemented and controlled by test planning records and Project procedures. Continued the review of field record submissions and facilitated data transfers to the constructor and test organizations.*

**WBS 1.2.11.2/.3/.5 Quality Assurance. Program Development (WBS 1.2.11.2)** Budget scenarios continue to be submitted at the request of DOE. We are still evaluating several options for putting forms on line. All support staff are baselining their activities to assist us in FY96 work assignments when budgets are finalized.

***Procedure Revisions.*** Detailed technical procedures CST-DP-101, R0 (Colloid Sampling...), CST-DP-102, R0 (Redox Potential...), CST-DP-93, R1 (Step-Leaching ...), and CST-DP-105, R0 (Extraction of Chloride...) were approved and issued.. Procedure EES-5-DP-701, R0 (...LIDAR) has been deleted. Seventeen HSE12 procedures were also deleted. The Field Work Package quality administrative procedure, QP-06.4, was approved and sent to controlled documents for distribution.

***Travel.*** S. Bolivar, J. Day and A. Burningham resented two papers at the NIRMA Symposium in Washington, DC, Aug 27-30.

***Audits and Surveys.*** Survey SR-EES-13-95-04 was completed. This survey was conducted to evaluate the status of selected controlled documents. One DR was issued for a minor infraction. Our DR/CAR Coordinator has been becoming familiar with the new DOE deficiency and trending procedures.

***Verifications.*** There are 3 open deficiencies. One of these is a "DR" issued under the new project procedure on deficiency reports; the other two deficiencies are internal corrective action reports that should be closed within the next 30 days. The QAPL is currently doing an investigation to determine closure dates and frequency of deficiencies per group. The quarterly trend report was completed. No adverse trends were identified.

***Quality Engineering.*** The Software Management Coordinator continues to compile a draft home page for program activities. He also is completing several miscellaneous configuration management tasks, reviewing SCM documentation assets and cleaning up SCM files in preparation for a potential shutdown. Several problems related to a statewide "brownout" were fixed.

**(b) Deliverables Completed and Documents Published**

**Milestones completed**

3B04, "Fourth Quarter Quality Program Status Report"
T056, "Revised Probability Estimates for the Yucca Mountain Region"
3043, "Techniques Conducting Unsaturated Column Experiments"

3063, "Transport of Radionuclides by Fracture Flow Through Natural Fractures Under Saturated Conditions"

3064, "Techniques to Study Diffusion in Unsaturated Tuff"

3166, "Geochemistry of Post-Miocene Basalts in the Yucca Mountain Region"

3169, "Completion of Field Geochemistry and Geochronology at the Sleeping Butte and Buckboard Mesa Basalt Centers"

3219, "Sorption as Function of Groundwater Composition to Elucidate Sorption Mechanism"

3178, "ESF Sample Collection for Microbial Analyses"

3326, "Stratigraphy, Trace-Element Chemistry, and Surface Evidence for Reaction Among Calcites in Tuffs of Yucca Mountain Nevada"

3339, "Interim Report: Sorption Isotherms"

3387, "Modeling and Experimental Results on Saturated Zone Water Chemistry"

3431, "Distribution of Cl36 in UZ-16, UZ-14, Perched Water and the ESF North Ramp"

3444, "Equilibrium Modeling study of Clinoptilolite-Analcime Equilibria at Yucca Mountain, Nevada"

3457, "Column Experiments with Crushed Tuff"

3463, "Modeled Actinide Solubilities and Speciation"

3467, "Modification of the Finite Element Heat and Mass Transfer Code (FEHMN) to Model Multicomponent Reactive Transport"

3468, "An Unsaturated Flow and Transport Model of Yucca Mountain"

3472, "Results of LIDAR Remote Sensing Techniques for Finding and Characterizing the Surface Expression of Preferred Pneumatic Pathways"

4009, "Alteration History in the Exploratory Studies Facility, Yucca Mountain, Nevada"

4011, "Quantitative X-ray Diffraction Analysis of FY95 LLNL Hydrothermal Experiments"

4021, "Magma System Dynamics Yearly Report"

4037, "Letter Report on Kinetics of Smectite to Illite Reaction"

4048, "Final Report on Feasibility of Real-Time Geochemical Analysis at Yucca Mountain Nevada Using LIBS Technology

4049, "Progress Report on Geochronology Studies"

4050, "Letter Report on Detection of Basaltic Intrusions"

4058, "The Occurrence and Distribution of Erionite in Drill Holes at Yucca Mountain Nevada"

4073, "Letter Report: Technical Support to Performance Assessment"

4074, "Letter Report: Grid Generation Extension for FEHM"

4075, "Letter Report: Model Implementation"

4079, "Multiple Episodes of Zeolite Deposition in Fractured Silicic Tuff"

4082, "The Solubility and Speciation of Selenium in Waters Pertinent to the Yucca Mountain Project"

4084, "Literature Evaluation for use with the EQ3/6 Database"

4087, "Measuring the Spatial Distribution of Latent Energy Flux over Complex Terrain Using the Mobile Scanning Water-Vapor Raman LIDAR"

4089, "Distribution of Cl36 in Near-Surface and Deep Borehole Samples"

4092, "Solubility Measurements to Evaluate the Thermodynamic Stabilities of Na-Clinoptilolite"

4096, "Fourth Quarter Technical Data Programmatic Status Report"

**(c) Problems areas**

**WBS 1.2.3.3.1.3.1 Reactive Tracer Testing.** The only problems or issues that may adversely affect performance during future reporting periods are issues that involve preparation for tracer tests at the C-wells. These issues are largely beyond the control of LANL personnel, but they could result in significant delays in tracer testing.

**WBS 1.2.11.2/.3/.5 Quality Assurance Program Development, Verification, and Engineering.** Twelve M&TE calibrations are due in October. These are normally done by a contractor who will face budget cuts come October1.

**(2) Personnel changes**

**WBS 1.2.3.2.1.1.1 Mineralogy of Transport Pathways** B. Carlos, the principal researcher in Fracture Mineralogy studies, left the Yucca Mountain Project effective 9/30/95 because of funding shortfalls. Work on fracture minerals will be absorbed by other parts of the 1.2.3.2.1.1.1 task as support permits, but B. Carlos' many years of experience with Yucca Mountain fracture mineralogy will be sorely missed.

**WBS 1.2.3.2.1.2.2 Stability of Minerals and Glasses.** Emily Woglom of Yale University is no longer working on the Project.

**WBS 1.2.3.4.1.3** Due to budget cuts, Clarence Duffy and David Hobart will no longer be working on the project

**(3) Unusual costs and possible financial performance problems**

NA See attached Variance Analysis Report and FTE Report.

**(4) Programmatic issues that may impact the overall CRWMS M&O effort**

**WBS 1.2.3.2.1.1.1 Mineralogy of Transport Pathways.** Consideration of calcite solubility as a function of temperature has shown that enhanced calcite precipitation at elevated temperatures may be a significant factor in radionuclide retardation in the thermal aureole of a repository at Yucca Mountain. Calcite precipitation can be successful in retarding transport not only of transuranics (especially Pu and Am) but also of $^{14}C$.

**WBS 1.2.3.2.1.1.2 History of Mineralogic and Geochemical Alteration at Yucca Mountain.** The status of ongoing research, especially experiments in progress, is uncertain under the programmatic priorities established for FY96.

Thermodynamic modeling and trace-element studies of erionite formation of Yucca Mountain point to high-K and possibly high-pH solutions for erionite formation. Further geochemical studies, integrated with UZ water analyses, could lead to a predictive tool for determining where the project should expect to find this carcinogen.

**WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes.** Comparison of FEHM and TOUGH2 saturation fields were made with data provided by LBL. The two codes compared well with the exception of a slight saturation offset in the Paint Brush Tuff. A movie was made which highlights some of the grid generation ,flow, and transport capability at Los Alamos.

**(5) Worked planned**

**WBS 1.2.3.1.2/.3 Site Investigation Coordination And Planning/Test Management and Integration.** Continue support of Los Alamos Exploratory Studies Facility (ESF) and surface-based site characterization activities in response to Project programmatic requirements

**WBS 1.2.3.2.1.1.1 Mineralogy of Transport Pathways.** Work will begin on summary and synthesis reports in support of site suitability determinations and license application submission. Full papers on ion exchange and dehydration effects on potassium and argon contents of clinoptilolite and on alteration history studies in the ESF will be prepared for inclusion in the Scientific Basis for Nuclear Waste Management XIX symposium proceedings. Argon diffusion experiments and thermodynamic studies of hydrous mineral dehydration and rehydration under repository thermal loading are also ongoing.

**WBS 1.2.3.2.1.1.2 Alteration History.** Work will begin on summary and synthesis reports in support of site suitability determinations and license application submission. Full papers on ion exchange and dehydration effects on potassium and argon contents of clinoptilolite and on alteration history studies in the ESF will be prepared for inclusion in the Scientific Basis for Nuclear Waste Management XIX symposium proceedings. Argon diffusion experiments and thermodynamic studies of hydrous mineral dehydration and rehydration under repository thermal loading are also ongoing.

**WBS 1.2.3.2.1.2.2 Stability of Minerals and Glasses.** Yale researchers will complete resolution of technical comments on milestone 3445 and the milestone will be delivered to the YMSCPO. Los Alamos personnel will begin writing the summary and synthesis report for this study as soon as Project Office guidance is received. The above-described in-progress experiments and modeling will be stopped and the Penn State and Yale postdoctoral fellows will be terminated.

**WBS 1.2.3.2.6.1.4 Paleoenvironmental History of Yucca Mountain.** We anticipate the receipt of additional (tuff samples) cosmogenic data from the Univ. of Penn. The evaluation of this data (including field evaluation) will be the major work during the next month.

**WBS 1.2.3.2.5 Volcanism.** Synthesis of volcanism activities will proceed.

**WBS 1.2.3.3.1.3.1 Reactive Tracer Testing.** Continue to work on a YMSCO milestone report describing the results of the LiBr column studies. This report will discuss the ability to predict the transport behavior of lithium by assuming an equilibrium adsorption isotherm based on the results of earlier batch sorption experiments (Milestone 3249). Continue to work on a YMSCO milestone report presenting pre-test predictions for tracer transport at the C-wells (Milestone 4077). Continue the efforts described under "pre-test predictions of solute transport" and "laboratory experiments to support model development/validation."

**WBS 1.2.3.4.1.1 Ground-Water Chemistry Model.** Continue development of quantitative models for soil zone chemical processes. Continue to refine conceptual models for processes that could control groundwater chemistry at Yucca Mountain.

**WBS 1.2.3.4.1.2.2 Biological Sorption and Transport.** Staff will collect three more samples from the ESF for microbial analysis. Once the Upper Lithophysal Topopah Spring sample has been collected (the final sample) Staff will meet with the investigators from the four universities to discuss the data and publications. In addition to those publications, Staff will publish the results of the column transport studies (milestone 3410) and two papers on microbial promoted hematite dissolution.

**WBS 1.2.3.4.1.3** Efforts in database evaluation will continue for next month's work.

**WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes.** Continue work on Site Scale flow model. Check with LBL model.

**WBS 1.2.3.9.7 Special Studies: ESF Test Coordination.** Continue support of ESF test coordination site characterization activities in response to Project programmatic requirements

**WBS 1.2.3.11.3 Geophysics - ESF Support, Subsurface Geophysical Testing.** Work under this WBS is being terminated October 1, 1995, and test requirements will be met under other TRW WBS accounts.

**WBS 1.2.6.1.1 Exploratory Studies Facility (ESF) Management, Planning and Technical Assessments.** Support of the finalization of Title II Design Packages for the North Portal surface facility and ESF excavations. Continue field test coordination for Construction Monitoring, Geologic Mapping, Consolidated Sampling, Perched Water, Radial Boreholes, Hydrologic Properties of Major faults and Hydrochemistry test activities being conducted in the North Ramp and alcoves.

**WBS 1.2.6.1.2/.3 Quality Assurance and Safety Analysis.** Support of the evolution of Title II Design Packages for the North Portal surface facility and ESF. Evaluate interactions and processes planned between testers and Tunnel Boring Machine operations.

**WBS 1.2.6.1.6 Exploratory Studies Facility (ESF) Test Management.** Support of the finalization of Title II Design Packages for the North Portal surface facility and ESF.

**WBS 1.2.6.8.4 Integrated Data and Control System.** Provide management for the Yucca Mountain Site Characterization Project Office to deploy ESF Test Data collection equipment to meet test requirements.

**WBS 1.2.11.2/.3/.5 Quality Assurance Program Development, Verification, and Engineering.** As soon as budgets become finalized, we will direct our efforts to determining which functions we can provide. Efforts on the QA homepage will continue, as will work on the 1994 status report. We will continue to examine options for putting forms on-line and streamlining the QP process

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: SEPTEMBER 1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.4.1.1

WBS TITLE: GROUND WATER CHEMISTRY MODEL

P&S ACCOUNT: 0A3411

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 386 | 386 | 303 | 0 | 0.0 | 100 | 83 | 21.5 | 127.4 | 386 | 303 | 83 | 21.5 | 303 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

(Not reportable)

**Cumulative Schedule Variance:**

Not reportable.

**Variance At Complete:**

The variance on this account is due to unplanned work requested by DOE and delays in receiving samples for analysis.

HAWest for JACanepa 10/18/95 HAWest for JACanepa 10/18/95
P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: SEPTEMBER 1995

**PARTICIPANT:** LANL **PEM:** WILSON **WBS:** 1.2.13.2.1

**WBS TITLE:** MANAGEMENT AND ADMISISTRATION

**P&S ACCOUNT:** 0AD21

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 115 | 115 | 64 | 0 | 0.0 | 100 | 51 | 44.3 | 179.7 | 115 | 64 | 51 | 44.3 | 64 | 0.0 |

Analysis

Cumulative Cost Variance:

Not reportable

Cumulative Schedule Variance:

Not reportable

Variance At Complete:

Less effort was required than was originally planned.

Kevin G. West for JA Canepa 10/18/95
P&S ACCOUNT MANAGER DATE

KG West for JA Canepa 10/18/95
TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: SEPTEMBER 1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.4.1.2.3

WBS TITLE: SORPTION MODELS

P&S ACCOUNT: 0A34123

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 104 | 104 | 55 | 0 | 0.0 | 100 | 49 | 47.1 | 189.1 | 104 | 55 | 49 | 47.1 | 55 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

Not reportable

**Cumulative Schedule Variance:**

Not reportable)

**Variance At Complete:**

Less effort was required than was originally planned.

P&S ACCOUNT MANAGER (signature) 10/18/95 DATE    TPO (signature) 10/18/95 DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: SEPTEMBER 1995

PARTICIPANT: LANL PEM: NESBIT WBS: 1.2.3.2.5.1.2

WBS TITLE: EFFECTS OF A VOLCANIC ERUPTION PENETRATING THE REPOSITORY

P&S ACCOUNT: 0A32512

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 745 | 745 | 669 | 0 | 0.0 | 100 | 76 | 10.2 | 111.4 | 745 | 669 | 76 | 10.2 | 669 | 0.0 |

Analysis

Cumulative Cost Variance:

(Not reportable)

Cumulative Schedule Variance:

(Not reportable)

Variance At Complete:

The variance on this account is due to unplanned support work requested by the DOE under P&S account 0A32551.

P&S ACCOUNT MANAGER 10/18/95 DATE TPO 10/18/95 DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: SEPTEMBER 1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.4.1.4.2

WBS TITLE: DIFFUSION

P&S ACCOUNT: 0A34142

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 738 | 722 | 652 | -16 | -2.2 | 97.8 | 70 | 9.7 | 110.7 | 738 | 652 | 86 | 11.7 | 667 | 0.0 |

Analysis

Cumulative Cost Variance:

(Not reportable)

Cumulative Schedule Variance:

(Not reportable)

Variance At Complete:

This variance is due to delays in billing costs for capital equipment being purchased under this P&S account, and less effort was required than was originally planned on activity 0A34142KBW.

P&S ACCOUNT MANAGER DATE 10/18/95 TPO DATE 10/18/95

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: SEPTEMBER 1995

PARTICIPANT: LANL PEM: NESBIT WBS: 1.2.3.9.7

WBS TITLE: ESF and SB Test Coordination

P&S ACCOUNT: 0A397

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 1446 | 1437 | 1030 | -9 | -0.6 | 99.4 | 407 | 28.3 | 139.5 | 1446 | 1030 | 416 | 28.8 | 1037 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

Delays in hiring TCO staff is the major contributor to the cumulative cost variance for this account.

**Cumulative Schedule Variance:**

(Not reportable)

**Variance At Complete:**

The reason for this variance is described above.

H.W. West for J.L. Canepa 10/8/95
P&S ACCOUNT MANAGER DATE

H.W. West for J.L. Canepa 10/8/95
TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: SEPTEMBER 1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.2.1.1.2

WBS TITLE: MINERALOGIC AND GEOCHEMICAL ALTERATION

P&S ACCOUNT: 0A32112

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 492 | 492 | 427 | 0 | 0.0 | 100 | 65 | 13.2 | 115.2 | 492 | 427 | 65 | 13.2 | 427 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

Not reportable.

**Cumulative Schedule Variance:**

(Not reportable)

**Variance At Complete:**

This variance is due to a longer than expected lag in salary adjustment for a Staff Member working under this account.

H.West for J.A.Canepa 10/18/95
P&S ACCOUNT MANAGER DATE

H.West for J.A.Canepa 10/18/95
TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: SEPTEMBER 1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.2.1.2.2

WBS TITLE: KINETICS AND THERMODYNAMICS OF MINERAL EVOLUTION

P&S ACCOUNT: 0A32122

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 390 | 373 | 323 | -17 | 4.4 | 95.6 | 50 | 13.4 | 115.5 | 390 | 323 | 67 | 17.2 | 338 | 0.0 |

Analysis

Cumulative Cost Variance:

Not reportable

Cumulative Schedule Variance:

(Not reportable)

Variance At Complete:

This variance is due to less effort required than was originally planned.

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: SEPTEMBER 1995

PARTICIPANT: LANL PEM: GIL WBS: 1.2.5.1.1

WBS TITLE: REGULATORY COORDINATION AND PLANNING

P&S ACCOUNT: 0A511

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 117 | 117 | 54 | 0 | 0 | 100 | 63 | 53.8 | 216.7 | 117 | 54 | 63 | 53.8 | 54 | 0.0 |

Analysis

Cumulative Cost Variance:

Not reportable

Cumulative Schedule Variance:

Not reportable

Variance At Complete:

This task required less effort than was originally planned.

H.L. West for J.A. Canepa 10/18/95 H.L. West for J.A. Canepa 10/18/95
P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: SEPTEMBER 1995

PARTICIPANT: LANL PEM: REPLOGLE WBS: 1.2.6.1.1

WBS TITLE: ESF MANAGEMENT, PLANNING, & TECHNICAL ASSESSMENT

P&S ACCOUNT: 0A611

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 769 | 769 | 517 | 0 | 0 | 100 | 252 | 32.8 | 148.7 | 769 | 517 | 252 | 32.8 | 517 | 0.0 |

Analysis

Cumulative Cost Variance:

This variance is due to lower staffing than was originally planned to accomplish this task.

Cumulative Schedule Variance:

Variance At Complete:

This task had lower staffing than was originally planned.

K West for J A Canepa 10/18/95
P&S ACCOUNT MANAGER DATE

K West for J A Canepa 10/18/95
TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: SEPTEMBER 1995

PARTICIPANT: LANL PEM: WATERS WBS: 1.2.6.1.6

WBS TITLE: EXPLORATORY STUDIES FACILITY

P&S ACCOUNT: 0A616

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 1161 | 1151 | 994 | -10 | -.0.9 | 99.1 | 157 | 13.6 | 115.8 | 1161 | 994 | 167 | 14.4 | 1003 | 0.0 |

Analysis

Cumulative Cost Variance:

This variance is due to lower staffing than was originally planned to accomplish this task.

Cumulative Schedule Variance:

Variance At Complete:

This task had lower staffing than was originally planned.

HAWest for AMCerepa 10/18/95
P&S ACCOUNT MANAGER DATE

HAWest for JRCanepa 10/18/95
TPO DATE

# Yucca Mountain Site Characterization Project
## Variance Analysis Report
## Status Thru: SEPTEMBER 1995

PARTICIPANT: LANL PEM: WATERS WBS: 1.2.6.8.4

WBS TITLE: INTEGRATED DATA SYSTEMS

P&S ACCOUNT: 0A684

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 409 | 409 | 290 | 0 | 0.0 | 100 | 119 | 29.1 | 141 | 409 | 290 | 119 | 29.1 | 290 | 0.0 |

### Analysis

**Cumulative Cost Variance:**

This variance is due to lower staffing than was originally planned to accomplish this task.

**Cumulative Schedule Variance:**

**Variance At Complete:**

This task had lower staffing than was originally planned.

P&S ACCOUNT MANAGER DATE 10/18/95 TPO DATE 10/18/95

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru:SEPTEMBER 1995

PARTICIPANT: LANL PEM: SIMMONS WBS: 1.2.3.4.1.2.2

WBS TITLE: BIOLOGICAL SORPTION AND TRANSPORT

P&S ACCOUNT: 0A34122

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 652 | 612 | 713 | -40 | -6.1 | 93.9 | -101 | -16.5 | 85.8 | 652 | 713 | -61 | -9.4 | 760 | 0.0 |

Analysis

Cumulative Cost Variance:

More effort was required than was originally planned.

Cumulative Schedule Variance:

Not reportable

Variance At Complete:

Not reportable

P&S ACCOUNT MANAGER 10/18/95 DATE TPO 10/18/95 DATE

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Box 25046 M.S. 425
Denver Federal Center
Denver, Colorado 80225

IN REPLY REFER TO:

I 3/3/80.1

INFORMATION ONLY

September 14, 1995

Vince Iorii
Yucca Mountain Site Characterization
Project Office
U. S. Department of Energy
P.O. Box 98608
Las Vegas, Nevada 89193-8608

SUBJECT: Yucca Mountain Project Branch - U.S. Geological Survey (YMPB-USGS) Progress Report, August 1995

Dear Vince:

Attached is the USGS progress report in the required format for the month of August, 1995.

It should be noted that **variance at completion numbers are based on PACS budgets and do not necessarily indicate available funds**. A number of Approved Funding Program changes (AFP) have been made which do not involve a change in scope of work and therefore do not require a Cost/Schedule Change Request. Reductions in USGS funding must be made based on available funds in the AFP, not the PACS budget.

If you have any questions or need further information, please call Raye Ritchey at (303)236-0516, ext. 282.

Sincerely,

Raye E. Ritchey
for Robert W. Craig
Acting Technical Project Officer
Yucca Mountain Project Branch
U.S. Geological Survey

Enclosure:
cc: S. Hanauer, DOE/Forrestal
R. Dyer, DOE,Las Vegas
A. Gil, DOE,Las Vegas
S. Jones, DOE,Las Vegas
W. Kozai, DOE,Las Vegas
R. Patterson, DOE,Las Vegas
A. Simmons, DOE,Las Vegas
R. Spence, DOE,Las Vegas
T. Sullivan, DOE,Las Vegas
M. Tynan, DOE,Las Vegas

ACTION
DIVISION
CC: Iorii
CC: see cc
CC: list (10)
CC:
CC:
CC:
CC:

REC'D YMP 9/ /95

ENCLOSURE 7

D. Williams, DOE, Las Vegas
C. Glenn, NRC, Las Vegas (2 copies)
P. Burke, M&O, Las Vegas
M. Lawson, LANL, Las Vegas
J. Schelling, SNL, Las Vegas
R. St. Clair, M&O, Las Vegas
M. Chornack, USGS, Denver
L. Ducret, USGS, Denver
D. Gillies, USGS, Denver
W. Day, USGS, Denver
R. Keefer, USGS, Denver
R. Luckey, USGS, Denver
B. Parks, USGS, Denver
Z. Peterman, USGS, Denver
R. Ritchey, USGS, Denver
R. Spengler, USGS, Denver
J. Whitney, USGS, Denver
R. Williams, USGS, Denver
T. Williams, USGS, Denver

U.S. Geological Survey

EXECUTIVE SUMMARY

August 1995

WBS 1.2.3.1. Coordination and Planning

U.S. Geological Survey-Yucca Mountain Branch is currently processing 205 scientific publications, of which 83 are hydrologic-related reports, and 122 are geologic-related reports. In addition, 89 abstracts are being processed as well as 27 reports from LBL.

WBS 1.2.3.2 Geology

Geologic Framework

Detailed geologic mapping (scale 1:2,400) of the Sundance fault zone shows that this northwest-striking feature can be traced for a distance of about 750 m across the northern part of the potential repository site. Maximum width of the fault zone is about 75 m, and the cumulative down-to-the-northeast displacement of the Tiva Canyon Tuff bedrock does not exceed 11 m. Individual faults within the zone are vertically and laterally discontinuous. Field relations do not indicate that significant strike-slip movement occurred along the fault. Toward the southeast, the north-trending Ghost Dance fault does not appear to be offset by the Sundance structure.

In addition to the Sundance fault zone investigation, detailed mapping and related studies are continuing to provide new data on those features -- mainly north-trending, west-dipping normal faults and northwest-trending strike-slip faults -- that dominate the structure of the potential repository site area. The surface traces and subsurface projections of these faults are being used to delineate various crustal "blocks" that, together with their contained lithostratigraphic units, provide the basic geologic framework for the development of 3-D models. Studies are likewise continuing to provide more detailed and accurate information with respect to the location and placement of lithostratigraphic contacts of most importance to the 3-D modeling effort. These contacts, being surveyed on the west flank of Yucca Mountain in Solitario Canyon, include (1) the base of the Tiva Canyon Tuff which provides the primary structural control for the modeling of the central block of Yucca Mountain; (2) the base of the crystal-rich moderately welded subzone of the Topopah Spring Tuff which is the base of the nonwelded Paintbrush Tuff hydrogeologic unit (PTn); and (3) the base of the crystal-poor upper lithophysal zone of the Topopah Spring Tuff which is the conceptual upper boundary for the potential repository.

Detailed geologic mapping and observations of exposed fracture networks indicate that each of the lithostratigraphic units within the PTn has its own fracture network with characteristic fracture spacing, intensity, and spacing that are controlled by variations in lithology and degree of welding. For pyroclastic flows, fracture characteristics are primarily controlled by variations in the degree of welding -- as the degree of welding increases, the number and size of tectonic fractures increase. In general, increases in welding also lead to increases in fracture intensity and connectivity. For nonwelded pyroclastic flows, interstratified fallout tephra, and reworked pyroclastic deposits, on the other hand, fracture characteristics are primarily controlled through changes in lithology. Increasing pumice content is correlated to decreasing fracture intensity, and in pumice-rich units there are fewer fractures and fracture trace lengths are shorter. Most of the fractures in the PTn are stratabound, and terminate at welding or lithologic breaks. The welding transitions at the top and base of the PTn unit tend to limit fracture connectivity with the adjacent welded units. The accumulated fracture data support the existing hydrologic models that assume relatively unfractured rock and little vertical flow of ground-water through the PTn. Lack of fracture filling and alteration or mineralization on fracture walls within the unit also suggests that vertical fracture flow has been limited in the past.

Geologic mapping of the North Ramp (ESF) was accomplished as follows: (1) full periphery field maps completed to station 12+20; (2) detailed line surveys completed to station 12+20.8; (3) stereophotography completed to station 12+26; (4) RQD and Q ratings calculated to station 12+10; (5) ninety-four samples collected as part of the consolidated sampling program; and (6) petrographic and X-ray diffraction analyses conducted on samples from the altered zone at the top of the Topopah Spring Tuff.

Effects of Tectonic Events and Processes

Work was concluded on a two-dimensional cross-sectional computer simulation of coupled fluid and heat flow in the saturated-zone, under Yucca Mountain, based on three alternative conceptual models (dam, drain, and spillway) for the large hydraulic gradient that exists there. The observed water-table configuration was successfully simulated in all three models. In attempts to simultaneously simulate both the hydraulic head and thermal structure of the area, a good match with the drain model and an adequate match with the spillway model were achieved, but the thermal structure could not be matched with the dam model. Both the spillway and drain models can be used to explain the low heat anomaly centered under northern Yucca Mountain, because the flow of water descends abruptly at the large hydraulic gradient in both models. However, flow encountering a dam would be diverted either over or around the dam, resulting in a different thermal structure than what had previously been observed in boreholes.

Ground Motion

The empirical method for estimating ground motion attenuation at a given site involves the compilation of ground motion records from earthquakes that have actually occurred. Because of the low rate of seismicity in the Yucca Mountain region (no earthquake with $M \geq 6$ has occurred within 100 km of the potential repository since 1852 when record-keeping began) it has been necessary to base estimates of ground motion on data derived primarily from seismic activity in other regions, but also including the Little Skull Mountain sequence. "Candidate" earthquakes for this purpose were chosen on the basis that: (1) they are located in an extensional regime, (2) their moment magnitude is $\geq 5$, and (3) useable digitized ground motion recordings were obtained within 100 km of the earthquake source. Based on these criteria, some 60 earthquakes worldwide were selected to provide appropriate data for estimating ground motion at Yucca Mountain, with emphasis on strong motion data but weak motion data are also being applied. To date, records for 22 of the "candidate" earthquakes have been compiled and analyzed, and the study is continuing.

Preclosure Tectonics

Results of the investigation of detachment faults in the Yucca Mountain area are given in a report, "Characterization of detachment faults in the Yucca Mountain region". The studies focused on an evaluation of all known or postulated detachment structures in the vicinity of Yucca Mountain, the development of the Crater Flat Basin, and the pattern and timing of tectonic activity at Yucca Mountain. Whether the faults at Yucca Mountain are predominantly listric and flatten to a shallow detachment structure at the base of the Tertiary strata or whether they are mostly planar features that penetrate to the brittle-ductile transition zone was not unequivocally determined. However, work conducted as part of this study indicates that a detachment fault may not exist under Yucca Mountain for the following reasons: 1) the Paleozoic-Tertiary contact is not a regional locus for detachment faulting, 2) no detachment faults are known to exist within a reasonable distance to the east of Yucca Mountain, 3) a detachment fault which was verified in the Bare Mountain-Bullfrog Hills area does not extend east of Tram Ridge, 4) the late-stage lower-plate uplift predicted by the detachment model is contradicted by the fact that Paleozoic rocks at Bare Mountain were exposed at the surface during the period of major extension at Yucca Mountain, and 5) listric normal faults that sole into a detachment structure are not required to explain the features observed at Yucca Mountain.

According to a recently completed study, the numerous precarious rocks occurring at Yucca Mountain are considered to be strong motion seismoscopes that have been in operation for thousands of years, and to therefore provide direct constraints on the magnitude of ground shaking that has occurred at the potential repository site in the past. Estimates of toppling accelerations using computer models, physical models, and field tests indicate that precariously balanced rocks could be dislodged by ground accelerations of less than 0.3 g. Based on observations in Solitario Canyon, supplemented by dated paleoseismic events along the Solitario Canyon fault and by the absence of down-slope boulders on dated alluvial deposits, the conclusion is drawn that the immediate Yucca Mountain area has not been subjected to ground accelerations greater than 0.3 g during the last 40,000-80,000 yr. Comparison of the locations of precarious rocks in other areas with respect to intensity maps of earthquakes in California and Nevada indicates that few zones of precarious rocks have been exposed to Intensity VII ($M \approx 6$) and none are known to have been exposed to Intensity VIII ($M \approx 7$). The inference is therefore made, based on these relationships, that an Intensity VII event, if it had occurred near Yucca Mountain, would have toppled most of the precarious rocks that have been observed there.

WBS 1.2.3.3 Hydrology

Regional Hydrology

USW G-2 is one of two boreholes at Yucca Mountain that is located on the upgradient side of the large hydraulic gradient, an area where the apparent potentiometric surface drops about 300 meters in a distance of 2 kilometers. Since initial water-level measurements were made in the borehole in 1981, water levels have declined almost 12 meters; present depth to water is about 533 meters below the land surface. Between late 1981 and mid-1984, a persistent, nearly isothermal section of the borehole was detected between the depths of 616 and 740 meters. This vertical discontinuity in heat flow is attributed to a downward flow of water across the zone penetrated by the borehole (see, also, section on Effects of Tectonic Events and Processes). Temperature profiles obtained during 1992-1995 show a collapse of the "stairstep" shape of the temperature profile, and a slight increase of temperature at the 740-meter depth, suggesting a decrease in vertical flow velocity.

Fortymile Wash, an ephemeral stream fed by tributaries draining the east side of Yucca Mountain, is considered to be a potential source of regional ground-water recharge and thus may significantly influence the position of the water table beneath the potential repository. Estimates of ground-water recharge from Fortymile Wash streamflow are based on considerations of both drainage basin-size events and partial drainage basin-size events, as well as global climatic events. During streamflow events, water infiltrated into the streambed sediments and then moved down to the water table (< 30 meters). After small streamflow events, where only a minor portion of the drainage basin contributed streamflow (contributing drainage area < 10 $km^2$), ground-water levels usually rose from 0.5 to 2.0 meters. After large streamflow events, where a major portion of the drainage basin contributed streamflow (contributing drainage area > 10 $km^2$), ground water levels rose over 4 meters. Rises in ground-water levels from streamflow appear to correlate with El Niño events.

Regional ground-water flow models provide valuable syntheses of available hydrogeologic data as well as estimates of ground-water potentiometric levels, flow paths, fluxes, and velocities. Sensitivity and parameter estimation simulations of the model using MODFLOWP are being conducted to define (1) what aspects of the hydrologic system to represent with estimated parameters, and (2) what data are to be used to estimate the parameters and how the associated calculated values are to be simulated. The data to be matched in the simulations include 591 water-level observations and 88 spring-flow observations. Objectives of the simulations are to match water-level observations to within 30 meters of observed values, and total spring-flow for each major discharge area within one order of magnitude. Results to date indicate that the model is especially sensitive to the amount of ground-water recharge at the defined locations and the value of defined low hydraulic conductivity units. Information as to the sensitivity, or insensitivity, of the model to various parameters is important in the continuing effort to calibrate the model.

Unsaturated Zone Hydrology

Data for modeling flow through the thick unsaturated zone beneath Yucca Mountain are being collected in studies designed to characterize the upper flux boundary condition under present-day climatic conditions. Current activities include:

1. Logging of neutron access boreholes to monitor natural infiltration.

2. Statistical and graphical analysis of neutron logging records from nearly 100 boreholes over a period of about 10 years to determine relative water content changes as a function of depth and time; results are applicable to the continued development and verification of the conceptual model of infiltration.

3. Continued measurement of solar radiation and net radiation using a network of radiometers for monitoring the effects of topography on potential evapotranspiration and for calibrating the net radiation model.

4. Development of a program for numerically integrating precipitation data (obtained from the network of gages on Yucca Mountain) to provide precipitation amounts and average intensities over constant time periods; the results are needed for completion of the stochastic precipitation model component, and for calibration of the rainfall-runoff model component of the infiltration model.

5. Continued development of programs and methodologies for analyzing and applying the neutron logging database to both conceptual and numerical modeling efforts; results are being used to evaluate (a) the influence of alluvial cover on infiltration, (b) the maximum and average depths of influence of evapotranspiration processes in both alluvium and bedrock, (c) the influence of near-surface fracture flow in bedrock, and (d) the general hydrologic response of the system in terms of water content changes in response to topographic controls, surficial material properties, and meteorological conditions during the 10-year period.

As part of the preparation of a net infiltration map covering 150 $km^2$ around Yucca Mountain, yearly shallow infiltration rates at 84 locations around the area were estimated from monthly neutron moisture meter logs for varying lengths of time between October 1984 and April 1995. Multiple linear regression techniques were used to develop a statistical relationship to predict the estimated yearly shallow infiltration rates at each borehole based on yearly precipitation, soil depth, and geomorphic position.

To conduct numerical simulations of gas flow at Yucca Mountain, a three-dimensional computational mesh consisting of approximately 10,000 nodes has been developed for the crestal area of Yucca Mountain around borehole UZ6s using a mesh generator developed expressly for that purpose. The mesh generator permits a three-dimensional surface topography and flexible initial and boundary conditions. The model domain covers an area that extends from the Ghost

Dance Fault on the east to Solitario Canyon on the west, from Ghost Dance Wash on the south to an unnamed wash about 100 meters on the north, and from the ground surface to approximately the base of the Prow Pass Formation. To calibrate the model using measured flow logs from UZ6s, the effects of borehole UZ6s were explicitly simulated. Estimates of permeability obtained for the Tiva Canyon Tuff using these flow logs are approximately 1000 times the values measured elsewhere at Yucca Mountain through air-injection testing and inversion of the barometric pressure response, suggesting that local effects, such as faulting, weathering or stress unloading are strongly influencing flow around UZ6s. The three-dimensional model of the crestal area also shows that east-west trending washes contribute significantly to flow from UZ6s, a flow-pattern that had gone unrecognized using the two-dimensional models in earlier stages of the study.

Preliminary analyses of pneumatic pressure records for boreholes UZ#4 and UZ#5 indicate that stations within the top of the Topopah Spring Tuff respond to surface barometric pressure fluctuations earlier than do shallower stations in the overlying nonwelded units. This implies that some short-circuiting of the PTn unit is occurring, possibly as a result of the recent penetration of the PTn by the North Ramp of the ESF.

Saturated Zone Hydrology

Development of a preliminary three-dimensional model of the site saturated zone at Yucca Mountain advances the technology of interfacing: (1) complex three-dimensional geologic framework modeling; (2) fully three-dimensional, unstructured, finite-element mesh generation; and (3) ground-water flow, heat, and transport simulation. The three-dimensional hydrogeologic framework model was developed using maps, cross sections, and well data that were gridded at an interval of 500 meters by 500 meters with variable depth. The framework-model subset provided different hydrogeologic units covering an irregularly shaped area of about 400 $km^2$. The framework-model-subset data were used to feed an automated mesh generator (GEOMESH), designed to discretize irregular three-dimensional solids, and to assign material properties from the hydrogeologic framework model to the tetrahedral elements. GEOMESH provided node lists that were used to assign boundary conditions in the ground-water simulation code (FEHMN). GEOMESH also facilitated the addition of nodes corresponding to the exact three-dimensional position of the potentiometric surface based on water-levels from wells, which were used for model calibration. FEHMN was run with the resulting 3D finite-element mesh, within a parameter estimation program (PEST). The application of PEST was designed to provide optimal values of permeability and specified fluxes over the model domain to minimize the residual between observed and simulated potentiometric levels.

As part of the cross-hole hydraulic and traces testing program, borehole UE-25c#3 was reinstrumented with 5 packers, 6 ParoScientific transducers, and a 200 gallon/minute pump. Sampling of strontium and uranium will be conducted when pumping from isolated, packed-off intervals of the borehole begins at a later date. The sampling is for the purpose of determining chemical stratification at the c-hole complex and whether pumping at later stages produces water of Paleozoic rather than Tertiary origin.

WBS 1.2.3.6 Climatology

Carbon dioxide concentrations and isotopic compositions within the soil zone in the vicinity of Yucca Mountain fall within broad ranges which fluctuate seasonally and interannually at individual sites, and vary systematically with elevation. These data constrain contemporary chemical and isotopic inputs to the unsaturated zone, and provide a basis for calibrating reconstructions of past climate and hydrology based on the isotopic compositions of secondary hydrogenic minerals (primarily calcite and silica). Preliminary results of analyses to determine fluid isotopic compositions in soils indicate that:

1. Mineral precipitation in soils and the unsaturated zone is probably episodic, driven by the wide swings in fluid chemistry caused mainly by variable $CO_2$ loading of soils. This $CO_2$ loading depends strongly on climate, and is most pronounced under wet conditions.

2. Climatic changes should leave recognizable imprints on the isotopic composition of unsaturated zone minerals, since the isotopic compositions of soil fluids (and therefore infiltrating waters) are strongly climate dependent.

3. The recovery of climate records from soil and unsaturated zone minerals will require modeling of fluid chemical and isotopic evolution, transfer functions relating mineral isotopic composition to climate, and dating of hydrogenic minerals.

A systematic collection of diatoms has been made from the younger portions of several cores obtained at Owen's Lake. It is anticipated that studies of this collection will provide a regional climate record for the past 800,000 years expressed in terms of limnologic properties. Ostracodes are also being collected from these cores, in part for stable isotopic analyses. Samples obtained from modern springs, wetlands, and lakes in the northeastern part of Nevada and southern Idaho are intended to serve as a modern data set for reconstruction of paleoclimate parameters associated with paleowetland faunas in the Yucca Mountain area. Radiocarbon dates being determined for a number of mollusc samples will provide key information about the timing of climatic/hydrologic linked changes in a local area near Yucca Mountain.

WBS 1.2.13.4 Water Resources Monitoring

Ground water levels were measured at 28 sites, and discharges were measured at 5 springs and one flowing well.

**USGS LEVEL 3 MILESTONE REPORT**
OCTOBER 1, 1994 - AUGUST 31, 1995
Sorted by Baseline Date

| Deliverable | Due Date | Expected Date | Completed Date | Comments |
|---|---|---|---|---|
| RPT: STRUCT/STRAT OF THE ESF - NORTH RAMP<br>Milestone Number: 3GGF530M | 01/31/95 | 09/29/95 | | |
| CATALOG OF SEISMIC ACTIVITY IN SGB FOR 1994<br>Milestone Number: 3GSM500M | 03/30/95 | 09/29/95 | | |
| LETTER REPORT: SITE SZ CONCEPTUAL MODEL<br>Milestone Number: 3GWM151M | 03/30/95 | 09/29/95 | | |
| LTR RPT: IN-SITU BOREHOLE MONITORING DATA REPORT<br>Milestone Number: 3GUP421M | 03/31/95 | 08/28/95 | 08/28/95 | |
| RPT: QUATERNARY FLTING - MINE MTN FLT SYSTEM<br>Milestone Number: 3GTN510M | 05/31/95 | 09/15/95 | | |
| FINAL REPORT: DETACHMENT FAULTING<br>Milestone Number: 3GTD500M | 05/31/95 | 08/11/95 | 08/11/95 | |
| RPT: QUAT. FLT - POSTULATED FORTYMILE WASH FLT<br>Milestone Number: 3GPF520M | 05/31/95 | 09/20/95 | | |
| LTR RPT: BOW RIDGE/PAINTBRUSH CYN<br>Milestone Number: 3GPF530M | 05/31/95 | 09/29/95 | | |
| TECHNICAL REPORT: TECTONIC MODEL(S)<br>Milestone Number: 3GTE500M | 05/31/95 | 09/29/95 | | |
| RPT: STRUCT/STRAT OF THE ESF - NORTH RAMP<br>Milestone Number: 3GGF540M | 06/30/95 | 09/29/95 | | |
| RPT: PRECARIOUS ROCK METH.- APPLICATIONS TO YM<br>Milestone Number: 3GSM530M | 06/30/95 | 09/29/95 | | |
| RPT: CHAR. QUAT. FLTING - ROCK VALLEY FAULT ZONE<br>Milestone Number: 3GTN500M | 06/30/95 | 09/29/95 | | |



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| Deliverable | Due Date | Expected Date | Completed Date | Comments |
|---|---|---|---|---|
| LTR RPT: ANALYSIS OF REGIONAL AVG ANNUAL PRECIP<br>Milestone Number: 3GMM105M | 06/30/95 | 09/29/95 | | |
| LETTER RPT: FY93-FY94 DATA FROM FORTYMILE WASH<br>Milestone Number: 3GRG137M | 06/30/95 | 09/29/95 | | |
| LTR RPT: OSTRACODE & ISOTOPIC DATA<br>Milestone Number: 3GCL500M | 07/17/95 | 08/07/95 | 08/07/95 | |
| LETTER REPORT: 3RD QTR FY95<br>Milestone Number: 3GWR124M | 07/27/95 | 08/03/95 | 08/03/95 | |
| RPT: QUAT. FLTING - CANE SPRING FAULT SYSTEM<br>Milestone Number: 3GTN520M | 07/31/95 | 09/29/95 | | |
| ANLYS PPR: QUAT FLTING-GHOST DANCE FLT<br>Milestone Number: 3GPF510M | 07/31/95 | 09/29/95 | | |
| LTR RPT: FAUNA & FLORA AGES<br>Milestone Number: 3GCL510M | 07/31/95 | 08/02/95 | 08/02/95 | |
| LTR RPT: DATING OF CALCITE/SILICA VEIN DEPOSITS<br>Milestone Number: 3GQH560M | 07/31/95 | 08/02/95 | 08/02/95 | |
| RPT: SOIL FLUID/GAS ISOTOPIC CHEMISTRY<br>Milestone Number: 3GQH580M | 07/31/95 | 08/28/95 | 08/28/95 | |
| PROV RESULTS: SECONDARY MINERAL ORIGINS<br>Milestone Number: 3GQH590M | 07/31/95 | 08/07/95 | 08/07/95 | |
| LTR RPT:GEOMETRY & CONTINUITY - SUNDANCE FAULT<br>Milestone Number: 3GGF510M | 08/31/95 | 08/28/95 | 08/28/95 | |
| LTR RPT: VERT CONT/FRAC CHAR PAINTBRUSH GRP<br>Milestone Number: 3GGF550M | 08/31/95 | 08/17/95 | 08/17/95 | |
| PROV. RESULTS: TEMP. DATA COLLECTED FROM ESF<br>Milestone Number: 3GAT106M | 08/31/95 | 08/21/95 | 08/21/95 | |

| Deliverable | Due Date | Expected Date | Completed Date | Comments |
|---|---|---|---|---|
| PROV RESULTS: SUMMARY OF GM MODELING RESULTS<br>Milestone Number: 3GSA511M | 08/31/95 | 08/28/95 | 08/28/95 | |
| FINAL RPT: QUATERNARY ACT. - BARE MTN FAULT ZONE<br>Milestone Number: 3GTQ530M | 08/31/95 | 09/29/95 | | |
| RPT: QUAT. ACT. -DEATH VALLEY/FURNACE CRK FLT<br>Milestone Number: 3GTQ540M | 08/31/95 | 09/29/95 | | |
| ANLYS PPR: QUAT FLTING-SOLITARIO CYN/CRATER FLAT<br>Milestone Number: 3GPF500M | 08/31/95 | 11/30/95 | | |
| LTR RPT: PRELIMINARY PALEOCLIMATE SYNTHESIS<br>Milestone Number: 3GQH570M | 08/31/95 | 09/29/95 | | |
| LTR RPT: USGS SUP TO SURF FAC FIELD TEST & CHAR<br>Milestone Number: 3GSR500M | 08/31/95 | 08/31/95 | | |
| PROG. RPT: TECTONIC EFFECTS ON YM HYDROLOGY<br>Milestone Number: 3GTW520M | 09/29/95 | 09/29/95 | | |
| DATA RPT: SYN. OF GEOL/GEOPHYS/SEISMIC DATA<br>Milestone Number: 3GSS500M | 09/29/95 | 09/29/95 | | |
| PROV RESULTS: NET INFILTRATION FLUX MAP TO DOE<br>Milestone Number: 3GUI240M | 09/29/95 | 09/29/95 | | |
| PRV RLTS: POTENTIAL FAST PATHWAYS FLUX MAP - DOE<br>Milestone Number: 3GUI241M | 09/29/95 | 09/29/95 | | |
| LTR RPT: ALCOVE 1 TESTING<br>Milestone Number: 3GUS208M | 09/29/95 | 01/29/96 | | |
| LTR RPT: PRELIMINARY UZ HYDROCHEMISTRY AT YM<br>Milestone Number: 3GUH105M | 09/29/95 | 09/29/95 | | |
| LTR RPT: PRELIM FRACTURE MODEL, TIVA CANYON, YM<br>Milestone Number: 3GUF105M | 09/29/95 | 12/29/95 | | |

| Deliverable | Due Date | Expected Date | Completed Date | Comments |
|---|---|---|---|---|
| INTERMEDIATE UZ HYDROLOGIC FRAMEWORK MODEL<br>Milestone Number: 3GUM107M | 09/29/95 | 09/29/95 | | |
| MEMO TO DOE: AWARD HOIST SYSTEM CONTRACT<br>Milestone Number: 3GWH142M | 09/29/95 | 09/29/95 | | |
| MEMO TO DOE: AWARD BH DISCRETIZATION CONTRACT<br>Milestone Number: 3GWH146M | 09/29/95 | 09/29/95 | | |



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Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: August 31, 1995

PARTICIPANT: USGS     PEM: Royer     WBS: 1.2.1.6

WBS TITLE: Technical Interface

P&S ACCOUNT: OG16

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 99 | 99 | 27 | 0.0 | 0.0 | 100.0 | 72 | 72.7 | 366.7 | 109 | 30 | 79 | 72.5 | 30 | 333.3 |

Analysis

**Cumulative Cost Variance:**

Not applicable.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

Cause:
Delays in staffing and less than the planned level of effort result in the positive cost variance.

Impact:
There will be a cost underrun in this P&S account.

Corrective Action:
Continue to review planned work and expenditures on a monthly basis to determine whether this variance at completion is reflective of progressing work.

P&S ACCOUNT MANAGER     DATE     TPO     DATE

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: August 31, 1995**

PARTICIPANT: USGS    PEM: TYNAN    WBS: 1.2.3.2.2.1.1

WBS TITLE: Vertical and Lateral Distribution of Stratigraphic Units in the Site Area

P&S ACCOUNT: OG32211

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 2121 | 2122 | 1656 | 1 | 0.0 | 100.0 | 466 | 22.0 | 128.1 | 2263 | 2007 | 256 | 11.3 | 1767 | 40.2 |

**Analysis**

**Cumulative Cost Variance:**

Cause:

The cost variance is primarily due to the bids for the processing portion of the seismic reflection contract coming in much lower than the budgeted amount. While $348K had been budgeted for this portion of the contract, costs to date are around $25K, resulting in a large positive cost variance. There are also smaller cost underruns in several summary accounts comprising this total.

Impact:

There is no schedule impact resulting from this cost underrun because it is due to lower than planned costs for the same work. There should be little impact to the total cost for this P&S account. Some (approximately $125K) of the positive cost variance is offset by unplanned charges incurred this fiscal year for the acquisition portion of the contract for the seismic reflection line. These costs were to allow complete coverage of the last shothole which required running the line for three additional miles covering twenty-three rather than twenty miles. Additional costs included survey costs, a water truck for dust control which earlier had been indicated was not needed, and rental of an electrical generator.

Corrective Action:

None at this time. There are some cost overruns within this P&S account, which may provide additional offset to this projected cost underrun. Analyses have indicated an underrun of approximately $200K for this P&S account, based on the planned budget. This underrun has been presented to the AM for Scientific Programs as a source of funds for the M&O/WCFS shortfall in WBS 1.2.3.2.8.3.6, Probabilistic Seismic Hazards Analysis; an AFP change form has been submitted to transfer $180K to the M&O/WCFS for additional support to the USGS for this work. Funds are also needed for other geophysical surveys in conjunction with the seismic reflection that were underfunded due to fiscal limitations, and additional support to magnetic investigations.

Cumulative Schedule Variance:

Not Applicable

**Variance At Complete:**

See "Cumulative Cost Variance".

| | | | |
|---|---|---|---|
| **P&S ACCOUNT MANAGER** | **DATE** | **TPO** | **DATE** |

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: August 31, 1995**

PARTICIPANT: USGS PEM: SULLIVAN WBS: 1.2.3.2.8.3.6

WBS TITLE: Probabilistic Seismic Hazards Analyses

P&S ACCOUNT: OG32836

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 226 | 228 | 117 | 2 | 0.9 | 100.9 | 111 | 48.7 | 194.9 | 247 | 182 | 65 | 26.3 | 127 | 29.2 |

**Analysis**

**Cumulative Cost Variance:**

Cause:

Costs are accruing at less than the planned rate due to delays in planned workshops. The greatest costs associated with this account are labor and travel costs for the group of experts participating in the workshops and documenting results of the workshops.

Impact:

There may be a slight underrun in this account. The workshops are taking place and costs eventually will catch up with the planned rate. Because costs are direct charged by non-YMPB staff, due to experts being called upon to support the workshop from other USGS branches, there will be some delay in cost accounting, and it is more difficult to project total costs.

Corrective Action:

None required.

**Cumulative Schedule Variance:**

Not Applicable.

**Variance At Complete:**

See "Cumulative Cost Variance".

| | | | |
|---|---|---|---|
| P&S ACCOUNT MANAGER | DATE | TPO | DATE |

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: August 31, 1995

PARTICIPANT: USGS    PEM: SULLIVAN    WBS: 1.2.3.2.8.4.4

WBS TITLE: Quaternary Faulting Within Northeast Trending Fault Zone

P&S ACCOUNT: OG32844

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 370 | 325 | 220 | -45.0 | -12.2 | 87.8 | 105 | 32.3 | 147.7 | 370 | 267 | 103 | 27.8 | 251 | 95.7 |

## Analysis

Cumulative Cost Variance:

Cause:

The positive cumulative cost variance is partly due to work costing somewhat less than planned. Also, the USGS has been unable to obtain access to the restricted part of Area 27 to collect field data resulting in lower than planned costs.

Impact:

Milestone report 3GTN520M will not be able to be completed as planned because of the inability to collect field data in Area 27.

Corrective Action:

Milestone report 3GTN520M will be prepared on the basis of presently available data. This will result in a technically incomplete report, and the deficiency will need to be made up in a revised report when funds are available.

Cumulative Schedule Variance:

Not Applicable

Variance At Complete:

See "Cumulative Cost Variance"

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: August 31, 1995

PARTICIPANT: USGS PEM: SULLIVAN WBS: 1.2.3.2.8.4.10

WBS TITLE: Geodetic Leveling

P&S ACCOUNT: OG3284A

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 200 | 200 | 145 | - 0.0 | - 0.0 | 100.0 | 55 | 27.5 | 137.9 | 200 | 145 | 55 | 27.5 | 145 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

Not Applicable.

**Cumulative Schedule Variance:**

Not Applicable

**Variance At Complete:**

Cause:
Scope of work cost less than budgeted.

Impact:
There will be a cost underrun of approximately 38K in this P&S account.

Corrective Action:
None required.

P&S ACCOUNT MANAGER DATE TPO DATE

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: August 31, 1995

PARTICIPANT: USGS     PEM: PATTERSON     WBS: 1.2.3.3.1.1.1

WBS TITLE: Precipitation and Meteorological Monitoring for Regional Hydrology

P&S ACCOUNT: OG33111

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 293 | 293 | 173 | 0 | 0.0 | 100.0 | 120 | 41.0 | 169.4 | 320 | 305 | 15 | 4.7 | 189 | 20.5 |

## Analysis

**Cumulative Cost Variance:**

Cause:

The positive cost variance is the result of two unplanned vacancies, and delay in filling a third vacancy.

Impact:

Due to staffing shortages, some of the planned work for FY1995 will not be completed. Level 3 milestones 3GMM107M, LTR RPT:Analysis Regional Storm Events, and 3GGM108M, LTR RPT:Analysis Site Meteorological Data will not be completed. Current analyes indicate this account is expected to underrun about $100K from the planned budget.

Corrective Action:

A report currently in process documents analysis of regional storm types through FY1993; analysis through FY1994 is not needed. Statistical analysis of FY1994 site meteorological data has been performed already and incorporated in a report currently in review that was intended originally to document conditions only through FY1993. An AFP change was processed transfering $91K of the projected underrun funds to the M&O for peer reviews, resulting in a final projected underrun of only about $18K.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

Not Applicable.

| | | | |
|---|---|---|---|
| P&S ACCOUNT MANAGER | DATE | TPO | DATE |

## Yucca Mountain Site Characterization Project
## Variance Analysis Report
## Status Thru: August 31, 1995

PARTICIPANT: USGS PEM: PATTERSON WBS: 1.2.3.3.1.1.3

WBS TITLE: Regional Groundwater Flow System

P&S ACCOUNT: OG33113

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 232 | 211 | 201 | -21.0 | -9.1 | 90.9 | 10 | 4.7 | 105.0 | 250 | 310 | -60 | -24.0 | 238 | 35.8 |

### Analysis

Cumulative Cost Variance:

Not applicable.

Cumulative Schedule Variance:

Not applicable.

Variance At Complete:

Cause:

The negative variance at completion results from not budgeting an MOA with the Geologic Division for $72K to analyze and log core data. Geologic Divsion personnel will compute porosity, water content, and saturation in selected boreholes using density and epithermal neutron logs; provide cross-sections of computed logs for the Wt series of holes; and provide large format plots of log, core, and computed logs for selected boreholes. A positive cost variance of $56K was previously indicated in this account, and an AFP change was processed transferring 56K to the M&O for peer reviews. The reprogramming of this $56K results in the $62K overrun now projected.

Impact:

This P&S account will overrun because funds were reprogrammed to the M&O. However, there should be adequate underruns in the saturated zone program to cover this now projected overrun.

Corrective Action:

No corrective action possible at this time. Monitor spending within the saturated zone carefully to ensure adequate underruns to cover projected overruns.

| | | | |
|---|---|---|---|
| P&S ACCOUNT MANAGER | DATE | TPO | DATE |

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: August 31, 1995

PARTICIPANT: USGS PEM: Patterson WBS: 1.2.3.3.1.1.4

WBS TITLE: Regional Hydrologic System Synthesis & Modeling

P&S ACCOUNT: OG33114

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 406 | 384 | 242 | -22.0 | -5.4 | 94.6 | 142 | 37.0 | 158.7 | 450 | 390 | 60 | 13.2 | 284 | 44.6 |

## Analysis

**Cumulative Cost Variance:**
See "Variance at Complete"

**Cumulative Schedule Variance:**
Not Applicable.

**Variance At Complete:**

Cause:

Projected variance at complete is due to awarding contract with University of Minnesota later in the year than planned. Funds were carried over from FY1994 but unable to be spent this FY. Also, staff working under MOA from WRD Research were not available to begin work on MODFLOW conversion to MODFLOWP as early as planned and budgeted.

Impact:

Contract with University of Minnesota was awarded in May. Work is proceeding. Work on MODFLOW conversion began in April and conversion was completed in late June. Work on forward calibration was emphasized and has moved ahead of schedule. No other milestones are impacted.

Corrective Action:

Monitor analytical element modeling work by University of Minnesota to ensure negotiated schedule is met.

P&S ACCOUNT MANAGER DATE TPO DATE

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: August 31, 1995

PARTICIPANT: USGS PEM: PATTERSON WBS: 1.2.3.3.1.2.4

WBS TITLE: Percolation in the Unsaturated Zone - ESF Study

P&S ACCOUNT: OG33124

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 1205 | 1111 | 928 | -94 | -7.8 | 92.2 | 183 | 16.5 | 119.7 | 1393 | 1225 | 168 | 12.1 | 1164 | 94.9 |

## Analysis

### Cumulative Cost Variance:

Cause:

Underspending in two of the five summary accounts encompasses over 100% of the P&S level cost variance. Underspending in summary account OG33124E97 (Air-K & Hydrochemistry Testing - North Ramp Alcoves, 169K) is due to 1) lower than expected federal labor hours for ESF alcove testing due to the current priority on testing in surface-based boreholes along the ESF alignment, and a 2 to 3 month delay in construction of alcove 2, and 2) delays in procurement of supplies and equipment to support air-K testing, gaseous hydrochemical sampling, and long-term monitoring of boreholes in ESF alcoves, especially alcove 2. Underspending in summary account OG33124A96 (North Ramp Perched Water, 52K) is due to 1) lower than expected federal labor hours for ESF testing because no perched water has been encountered in the ESF, and 2) delays in procurement of supplies and equipment to support perched-water sampling and monitoring.

Impact:

There is expected to be a cost underrun of $168K at the end of the fiscal year. Supplies and equipment originally scheduled for procurement in October and November 1994 are for testing and monitoring primarily in Alcove 2 which is delayed and Alcove 3, which is not scheduled for testing until September 1995. Delays in procurement of supplies and equipment for alcove testing did not have a serious impact because of a delay of three months in the start of testing for alcove 2, with similar delays in testing of alcove 3 expected.

Corrective Action:

Technician vacancy for ESF air-K testing was filled during second quarter FY 95. All supplies and equipment to support ESF air-K, hydrochemistry, and perched-water testing will be procured in time to accommodate ESF-testing schedules.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

See "Cumulative Cost Variance".

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: August 31, 1995

PARTICIPANT: USGS PEM: Patterson WBS: 1.2.3.3.1.2.7

WBS TITLE: Unsaturated Zone Hydrochemistry

P&S ACCOUNT: OG33127

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 903 | 861 | 683 | -42 | -4.7 | 95.3 | 178 | 20.7 | 126.1 | 1005 | 905 | 100 | 10.0 | 797 | 64.9 |

## Analysis

**Cumulative Cost Variance:**

Cause:

The positive cumulative cost variance results from reductions in the estimated cost of hydrochemical sample analyses due to fewer samples being available from the surface-based drilling program and ESF, and deferral in hiring of a contract hydrochemical technician for pore-water extraction.

Impact:

There is a projected cost underrun of $100K in this account. There is no schedule impact resulting from this cost underrun as the reduction in the number of pore-water and gas samples is justified given the current drilling and ESF schedules, and current staff can extract pore water as fast as current equipment configuration will allow.

Corrective Action:

Projected variance at completion is being monitored and updated monthly. An additional technician will be hired once an additional set of drainage plates is available for the load cell allowing additional production.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

See "Cumulative Cost Variance".

| | | | |
|---|---|---|---|
| P&S ACCOUNT MANAGER | DATE | TPO | DATE |

# Yucca Mountain Site Characterization Project
## Variance Analysis Report
## Status Thru: August 31, 1995

PARTICIPANT: USGS    PEM: Patterson    WBS: 1.2.3.3.1.3.1

WBS TITLE: Site Saturated Zone Ground-Water Flow System

P&S ACCOUNT: OG33131

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 1105 | 1107 | 987 | 2 | 0.2 | 100.2 | 120 | 10.8 | 112.2 | 1200 | 1150 | 50 | 4.2 | 1070 | 57.1 |

## Analysis

**Cumulative Cost Variance:**

Cause:

The positive cost variance is due largely to an expensive relocation not being costed this fiscal year, and less being spent on supplies and materials than was budgeted.

Impact:

There is expected to be a small cost underrun ($50K) in this P&S account at the end of the fiscal year.

Corrective Action:

Monitor expenditures and update estimate at complete monthly.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

Not applicable.

P&S ACCOUNT MANAGER    DATE    TPO    DATE

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: August 31, 1995**

PARTICIPANT: USGS PEM: Morris WBS: 1.2.3.6.2.1.3

WBS TITLE: CLIMATIC IMPLICATIONS OF TERRESTRIAL PALEOECOLOGY

P&S ACCOUNT: OG36213

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 177 | 153 | 36 | -24 | -13.6 | 86.4 | 117 | 76.5 | 425.0 | 200 | 83 | 117 | 58.5 | 47 | -100.0 |

## Analysis

**Cumulative Cost Variance:**

Cause:

All funds budgeted for C-14 dating are not able to be used this FY because paperwork was not processed in time to award a contract this FY. Some dating is being done under smaller purchase orders, which have a later cutoff for processing; however, no costs have been reported to date.

Impact:

This account is expected to have a cost underrun at the end of the fiscal year. However, needed C-14 dating will still need to be completed.

Corrective Action:

Additional C-14 dating may be able to be completed under purchase order yet this fiscal year which would result in more work being completed and less of a projected underrun. Account will be monitored closely to maximize the dating able to be completed.

Cumulative Schedule Variance:
Not applicable.

**Variance At Complete:**
See "Cumulative Cost Variance"

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: August 31, 1995

PARTICIPANT: USGS PEM: MORRIS WBS: 1.2.3.6.2.1.4

WBS TITLE: Paleoenvironmental History of Yucca Mountain

P&S ACCOUNT: OG36214

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 644 | 650 | 438 | 6 | 0.9 | 100.9 | 212 | 32.6 | 148.4 | 725 | 550 | 175 | 24.1 | 489 | 67.0 |

## Analysis

**Cumulative Cost Variance:**

See "Variance at Complete"

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

Cause:

Additional cost variances result from work costing less than the budgeted amount in the surficial deposits mapping activity. Also, some equipment procurements were cancelled because they are not in accordance with FY1996 priorities.

Impact:

There is no expected impact resulting from this variance at completion. Work is expected to be completed.

Corrective Action:

Estimate to complete will be updated monthly to reflect actual funding underrun projection.

P&S ACCOUNT MANAGER DATE TPO DATE

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: August 31, 1995**

PARTICIPANT: USGS    PEM: MORRIS    WBS: 1.2.3.6.2.2.1

WBS TITLE: Quaternary Regional Hydrology

P&S ACCOUNT: OG36221

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 698 | 698 | 399 | - 0 | -0.0 | 100.0 | 299 | 42.8 | 174.9 | 720 | 534 | 186.0 | 25.8 | 412 | 16.3 |

## Analysis

**Cumulative Cost Variance:**

Cause:

The positive cost variance is in summary account OG36221E95 and is due to cancellation of the lease of a mass spectrometer and automated carbonate device for small samples, originally planned for February 1995. This procurement has been cancelled because it is not in accordance with FY1996 priorities.

Impact:

There is no impact to the cancellation of procurement for the leasing contract as the existing mass spectrometer is able to handle the pre-summer season sample load. The leasing contract is cancelled because it is not in accordance with FY1996 priorities. There is a cost underrun projected in this P&S account at fiscal year end.

Corrective Action:

No corrective action is required. Existing mass spectrometer will be used to complete FY1995 samples.

**Cumulative Schedule Variance:**

Not Applicable.

**Variance At Complete:**

See "Cumulative Cost Variance"

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: August 31, 1995

PARTICIPANT: USGS PEM: Gil WBS: 1.2.5.7

WBS TITLE: Technical Evaluation

P&S ACCOUNT: OG57

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 500 | 500 | 348 | 0 | 0.0 | 100.0 | 152 | 30.4 | 143.7 | 558 | 395 | 163 | 29.2 | 388 | 123.4 |

## Analysis

### Cumulative Cost Variance:

Cause:

The positive cost variance results from lower than planned spending in this level of effort account. This account needs to be reviewed regularly for planned spending for the balance of the fiscal year. No work has been requested on issue resolution this fiscal year, and therefore, no costs have been incurred in that summary account budgeted at $59K.

Impact:

There is no impact to work being performed in this level of effort account. This account is currently projecting a cost underrun of about $163K at the end of the year.

Corrective Action:

Actual and planned spending will be closely reviewed on a monthly basis to update the estimate at completion to accurately reflect the underrun.

### Cumulative Schedule Variance:

Not applicable.

### Variance At Complete:

See "Cumulative Cost Variance"

P&S ACCOUNT MANAGER DATE TPO DATE

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: August 31, 1995

PARTICIPANT: USGS PEM: Iorii WBS: 1.2.9.2.2

WBS TITLE: Participant Project Control

P&S ACCOUNT: OG922

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 543 | 543 | 399 | 0.0 | 0.0 | 100.0 | 144 | 26.5 | 136.1 | 655 | 490 | 165 | 25.2 | 481 | 123.1 |

## Analysis

**Cumulative Cost Variance:**
See "Variance at Complete"

**Cumulative Schedule Variance:**
Not applicable.

**Variance At Complete:**
Cause:

The positive variance at complete is primarily due to delays in filling a planned staff position for additional support in the area of cost estimating. Part time matrix support is currently supporting this effort.

Impact:

This P&S account will underrrun at the end of the fiscal year. However, work is being accomplished through a combination of matrix support and extended hours on the part of existing staff.

Corrective Action:

No corrective action required at this time. This cost underrun is necessary to cover projected cost overruns in P&S account OG912195B.

P&S ACCOUNT MANAGER DATE TPO DATE

# Yucca Mountain Site Characterization Project
## Variance Analysis Report
### Status Thru: August 31, 1995

PARTICIPANT: USGS    PEM: Dixon    WBS: 1.2.13.4.7

WBS TITLE: Water Resources

P&S ACCOUNT: OGD47

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 674 | 677 | 494 | 3 | 0.4 | 100.4 | 183 | 27.0 | 137.0 | 977 | 883 | 94 | 9.6 | 713 | 77.1 |

## Analysis

**Cumulative Cost Variance:**

Cause:

This account is showing a positive cumulative cost variance due to delays in procuring large value items. There is approximately $225K planned for procurements in this account, of which none has been costed.

Impact:

This account has projected an actual underrun at the end of the fiscal year of $100K. Procurements are expected to be completed. Milestones will be met, and budgeted costs less the $100K projected underrun will be incurred before fiscal year end.

Corrective Action:

None required. A requisition is in process to procure needed equipment items.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

See "Cumulative Cost Variance".

P&S ACCOUNT MANAGER    DATE    TPO    DATE

WBS No. - 1.2.1

WBS Title - Systems Engineering

Parent WBS No. - 1.2

Parent WBS Title - Yucca Mountain Project

Element ID - 221

Statement of Work:

See the current WBS Dictionary

Cost/Schedule Performance

| | | Current Period | | | | | FY1995 Cumulative to Date | | | | | FY1995 at Completion | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Id | Description | BCWS | BCWP | ACWP | SV | CV | BCWS | BCWP | ACWP | SV | CV | BAC | EAC | VAC |
| 1.2.1.6 | Technical Interface | 10 | 10 | 0 | 0 | 10 | 99 | 99 | 27 | 0 | 72 | 109 | 30 | 79 |
| 1.2.1.10 | Q-List Development and Mai | 2 | 2 | 0 | 0 | 2 | 22 | 22 | 4 | 0 | 18 | 25 | 8 | 17 |
| Total | | 12 | 12 | 0 | 0 | 12 | 121 | 121 | 31 | 0 | 90 | 134 | 38 | 96 |

Resource Distributions by Element of Cost

Fiscal Year 1995

Budgeted Cost of Work Scheduled

| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LBRHRS | 207 | 225 | 223 | 225 | 223 | 224 | 224 | 224 | 223 | 225 | 223 | 223 | 2669 |
| LABOR | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 13 | 134 |
| SUBS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TRAVEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PM&E | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total BCWS | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 13 | 134 |

Actual Cost of Work Performed

| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LBRHRS | -16 | 0 | 0 | 48 | 104 | 56 | 64 | 128 | 32 | 16 | 0 | 0 | 432 |
| LABOR | 0 | 3 | 1 | 3 | 5 | 2 | 3 | 5 | 1 | 2 | 0 | 0 | 25 |
| SUBS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TRAVEL | 0 | 1 | 0 | 0 | 0 | 0 | 11 | -11 | 1 | 0 | 0 | 0 | 2 |
| PM&E | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 4 |
| OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total ACWP | 0 | 4 | 1 | 3 | 5 | 2 | 14 | -6 | 6 | 2 | 0 | 0 | 31 |

Estimate to Complete

| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LBRHRS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 223 | 223 |
| LABOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 7 |
| SUBS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TRAVEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PM&E | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 7 |

Participant USGS | Yucca Mtn. Site Char. Project-Planning & Control System | 01-Aug-95 to 31-Aug-95
PACS Participant Work Station (PPWS) | Page - 2
Prepared - 09/14/95:10:39:45 | WBS Status Sheet (WBS02) | Inc. Dollars in Thousands

WBS No. - 1.2.1 -Systems Engineering

Resource Distributions

| Fiscal Year 1995 | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 13 | 134 |
| BCWP | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 0 | 121 |
| ACWP | 0 | 4 | 1 | 3 | 5 | 2 | 14 | -6 | 6 | 2 | 0 | 0 | 31 |
| ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 7 |

Fiscal Year Distribution

| | Prior | FY1995 | FY1996 | FY1997 | FY1998 | FY1999 | FY2000 | FY2001 | FY2002 | FY2003 | FY2004 | Future | At Complete |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | 0 | 134 | 109 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 243 |
| BCWP | 0 | 121 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ACWP | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ETC | 0 | 7 | 109 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 147 |

YMP PLANNING AND CONTROL SYSTEM (PACS)

Participant U.S. Geological Survey

Date Prepared 09/08/95 15:09

**MONTHLY COST/FTE REPORT**

Fical Month/Year AUGUST 1995



| | CURRENT MONTH END | | | | | | FISCAL YEAR | | |
|---|---|---|---|---|---|---|---|---|---|
| WBS ELEMENT | ACTUAL COSTS | PARTICIPANT HOURS | SUBCON HOURS | PURCHASE COMMITMENTS | SUBCON COMMITMENTS | ACCRUED COSTS | APPROVED BUDGET | APPROVED FUNDS | CUMMULATIVE COSTS |
| 1.2.1 | 0 | 0 | 0 | 0 | 0 | | 134 | 134 | 30 |
| 1.2.3 | 2330 | 26426 | 12721 | 161 | 615 | | 24928 | 24807 | 21130 |
| 1.2.5 | 109 | 1429 | 947 | 0 | 60 | | 1276 | 1276 | 879 |
| 1.2.9 | 67 | 920 | 357 | 0 | 40 | | 1091 | 1091 | 822 |
| 1.2.11 | 169 | 1288 | 1834 | 0 | 125 | | 1840 | 1840 | 1642 |
| 1.2.12 | 40 | 32 | 1042 | 0 | 70 | | 530 | 530 | 407 |
| 1.2.13 | 77 | 759 | 184 | 0 | 10 | | 842 | 842 | 609 |
| 1.2.15 | 252 | 1686 | 1174 | 0 | 40 | | 2180 | 2180 | 1959 |
| TOTALS | 3044 | 32540 | 18259 | 161 | 960 | 0 | 32821 | 32700 | 27478 |

U.S. GEOLOGICAL SURVEY
ESTIMATED COSTS FOR 10/1/94 - 08/31/95

| | | OCT EST | NOV EST | DEC EST | JAN EST | FEB EST | MAR EST | APR EST | MAY EST | JUN EST | JUL EST | AUG EST | SEP EST | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0G1695B | Project Change Control Board Suport | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.3 | 3.6 | 0.5 | 0.3 | 0.0 | 5.1 |
| 0G1695B1 | | 0.0 | 0.0 | 1.3 | 2.9 | 4.6 | 2.1 | 13.4 | -5.9 | 2.0 | 1.0 | 0.0 | 0.0 | 21.4 |
| 1.2.1.6 | | 0.0 | 0.0 | 1.3 | 2.9 | 4.6 | 2.1 | 13.8 | -5.6 | 5.6 | 1.5 | 0.3 | 0.0 | 26.5 |
| *1.2.1.6 | | 0.0 | 0.0 | 1.3 | 2.9 | 4.6 | 2.1 | 13.8 | -5.6 | 5.6 | 1.5 | 0.3 | 0.0 | 26.5 |
| 0G1A95B | Q-List Development and Maintenance | 0.0 | 3.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.7 |
| 1.2.1.10 | | 0.0 | 3.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.7 |
| *1.2.1.1 | | 0.0 | 3.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.7 |
| **1.2.1 | | 0.0 | 3.7 | 1.3 | 2.9 | 4.6 | 2.1 | 13.8 | -5.6 | 5.6 | 1.5 | 0.3 | 0.0 | 30.2 |
| 0G31295B1 | ESI Science Advisory Group | 1.6 | 0.5 | 0.3 | 1.5 | 36.6 | 26.3 | 12.1 | 7.0 | 12.4 | -0.6 | 33.0 | 0.0 | 130.7 |
| 0G31295B2 | Nevada Operations | 19.6 | 19.9 | 18.5 | 17.7 | 17.5 | 28.2 | 23.5 | 77.1 | 31.5 | -13.4 | 21.4 | 0.0 | 261.5 |
| 0G31295B3 | Tracer Gas Support | 0.0 | 31.4 | -3.5 | 19.5 | 5.6 | -6.7 | 9.1 | 6.7 | 13.2 | -10.1 | 6.8 | 0.0 | 72.0 |
| 0G31295B5 | YMPB Computer Operations | 25.6 | 27.3 | 31.1 | 40.7 | 29.8 | 40.3 | 39.0 | 47.2 | 71.7 | 19.0 | 32.7 | 0.0 | 404.4 |
| 0G31295B6 | YMPB Scientific Rpts/Project Documents | 14.8 | 7.0 | 19.5 | 17.4 | 17.6 | 15.9 | 25.5 | 22.2 | 12.5 | 20.9 | 33.8 | 0.0 | 207.1 |
| 0G31295B7 | Earth Science Investigations (ESI) | 47.9 | 33.3 | 47.2 | 46.5 | 44.9 | 53.5 | 58.4 | 67.1 | 91.1 | 67.2 | 83.8 | 0.0 | 640.9 |
| 0G31295B8 | ESI QA Implementation | 37.3 | 39.7 | 20.0 | 30.7 | 21.2 | 26.0 | 17.3 | 27.0 | 42.1 | 31.6 | 43.4 | 0.0 | 336.3 |
| 1.2.3.1.2 | | 146.8 | 159.1 | 133.1 | 174.0 | 173.2 | 183.5 | 184.9 | 254.3 | 274.5 | 114.6 | 254.9 | 0.0 | 2052.9 |
| *1.2.3.1 | | 146.8 | 159.1 | 133.1 | 174.0 | 173.2 | 183.5 | 184.9 | 254.3 | 274.5 | 114.6 | 254.9 | 0.0 | 2052.9 |
| 0G32211B96 | Update 3D models lithostrat/structural/r | 26.1 | 23.7 | 31.4 | 65.2 | 26.1 | 24.8 | 25.9 | 29.1 | 26.0 | 23.9 | 85.7 | 0.0 | 387.9 |
| 0G32211C95 | Results of Measured Sections in Site Are | 18.6 | 21.5 | 22.2 | -5.6 | 34.9 | 24.2 | 40.6 | 14.0 | 19.4 | 8.1 | 12.9 | 0.0 | 210.8 |
| 0G32211D95 | Geophysics White Paper, Phase II | 0.0 | 4.2 | 4.0 | 16.6 | 1.9 | 1.7 | -3.1 | 5.6 | 1.7 | 1.7 | -0.1 | 0.0 | 34.2 |
| 0G32211E96 | Regional Seismic Reflection Profiles | 101.7 | 31.9 | 4.9 | 31.6 | 34.6 | 14.5 | 25.8 | 26.2 | 11.7 | 4.3 | 34.4 | 0.0 | 321.6 |
| 0G32211F96 | Integration of Geology and Geophysics | 1.1 | -0.2 | 3.0 | 43.5 | 4.5 | 6.8 | 4.1 | 19.0 | 17.2 | 30.0 | 17.7 | 0.0 | 146.7 |
| 0G32211G96 | Lithologic Logging of Core | 20.9 | 12.3 | 13.1 | 25.7 | 30.5 | 10.8 | 41.6 | 19.9 | 3.0 | 25.7 | 21.3 | 0.0 | 224.8 |
| 0G32211H95 | Magnetic Investigations - YM/Jet Ridge | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.5 | 10.7 | 1.2 | 16.0 | -13.5 | 6.9 | 0.0 | 35.8 |
| 0G32211J95 | Magnetic/Gravity Investigations, at YM | 0.0 | 0.0 | 0.0 | 18.2 | 2.0 | 2.3 | 7.2 | 10.2 | -11.6 | 10.3 | 3.6 | 0.0 | 42.2 |
| 0G32211K96 | Mag Along Seismic Profile, Crater Flat, | 0.0 | 0.6 | 0.0 | 20.2 | 6.2 | 2.4 | -1.5 | 3.6 | 3.2 | 7.4 | 24.6 | 0.0 | 66.7 |
| 0G32211L96 | Strat Desc of Bullfrog & Tram Tuffs | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.1 | 6.4 | 9.4 | 0.0 | 20.9 |
| 0G32211M95 | Lithology & Hydrologic Properties in the | 1.7 | 7.7 | 11.7 | 10.3 | -2.7 | 15.9 | 14.5 | 15.8 | 8.3 | 15.2 | 0.6 | 0.0 | 99.0 |
| 0G32211Q95 | Mag/Grav Studies to Locate Volcanic Dril | 0.0 | 1.4 | 0.0 | 11.3 | 10.6 | 13.0 | 4.5 | 6.1 | -2.2 | 4.5 | 8.1 | 0.0 | 57.3 |
| 1.2.3.2.2.1.1 | | 170.1 | 103.1 | 90.3 | 237.0 | 148.6 | 130.9 | 170.3 | 150.7 | 97.8 | 124.0 | 225.1 | 0.0 | 1647.9 |
| 0G32212A95 | Enhance Surface Geologic Maps | 48.8 | 63.7 | 60.2 | 7.1 | -8.5 | 36.2 | 25.3 | 37.8 | 42.9 | 10.6 | 19.0 | 0.0 | 343.1 |
| 0G32212B95 | Geometry & Continuity of the Sundance Fa | 5.8 | 0.2 | 1.4 | 67.5 | 28.6 | 75.8 | 41.7 | 28.2 | 10.4 | 36.4 | 34.4 | 0.0 | 330.4 |
| 0G32212C96 | Expanded Surface Geology Mapping | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 18.6 | 25.8 | 0.0 | 44.4 |
| 0G32212D96 | Mapping in the ESF | 55.8 | 95.6 | 70.2 | 20.2 | 277.7 | 237.5 | 238.9 | 167.8 | 180.1 | 194.6 | 230.1 | 0.0 | 1768.5 |
| 0G32212E95 | Vert Continuity of Fracture/Char-Paintbr | 8.3 | 2.8 | 9.1 | -16.0 | 9.8 | 18.0 | 31.7 | 23.1 | 9.9 | 21.9 | 17.3 | 0.0 | 135.9 |
| 0G32212F95 | Pavement Mapping At Fran Ridge | 1.1 | 3.2 | 1.3 | 15.9 | 2.3 | 6.3 | 9.7 | 7.6 | 21.0 | 9.2 | 2.0 | 0.0 | 79.6 |
| 0G32212G96 | Verif & Enhance Scott & Bonk-Jet Ridge/M | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 38.2 | 21.4 | 0.0 | 59.6 |

U.S. GEOLOGICAL SURVEY
ESTIMATED COSTS FOR 10/1/94 - 08/31/95

| | | OCT EST | NOV EST | DEC EST | JAN EST | FEB EST | MAR EST | APR EST | MAY EST | JUN EST | JUL EST | AUG EST | SEP EST | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.2.3.2.2.1.2 | | 119.8 | 165.5 | 142.2 | 94.7 | 309.9 | 373.8 | 347.3 | 264.5 | 264.3 | 329.5 | 350.0 | 0.0 | 2761.5 |
| 0G3252A95 | Structural Controls on Basaltic Volcanis | 3.6 | -0.4 | 6.0 | 13.6 | -2.2 | 7.8 | 6.3 | 5.4 | 8.7 | 13.4 | 26.9 | 0.0 | 89.1 |
| 0G3252C95 | Tectonic Effects on YM Hydrologic System | 0.0 | 0.0 | 0.0 | 0.0 | 18.0 | 21.3 | 5.2 | 23.1 | 5.3 | 18.8 | 14.8 | 0.0 | 106.5 |
| 1.2.3.2.5.2 | | 3.6 | -0.4 | 6.0 | 13.6 | 15.8 | 29.1 | 11.5 | 28.5 | 14.0 | 32.2 | 41.7 | 0.0 | 195.6 |
| 0G32623A95 | Technical Support for Soil and Rock | 0.0 | 0.1 | 0.7 | 1.9 | 3.5 | -0.5 | 0.1 | 1.8 | -0.3 | 0.7 | 2.4 | 0.0 | 10.4 |
| 1.2.3.2.6.2.3 | | 0.0 | 0.1 | 0.7 | 1.9 | 3.5 | -0.5 | 0.1 | 1.8 | -0.3 | 0.7 | 2.4 | 0.0 | 10.4 |
| 0G32722A96 | Collect/Interpret Heat Flow Data | 0.0 | 0.1 | 0.8 | 0.0 | 27.7 | 40.5 | 4.1 | 1.2 | 20.2 | 35.8 | -6.8 | 0.0 | 123.6 |
| 1.2.3.2.7.2.2 | | 0.0 | 0.1 | 0.8 | 0.0 | 27.7 | 40.5 | 4.1 | 1.2 | 20.2 | 35.8 | -6.8 | 0.0 | 123.6 |
| 0G32831A95 | Synthesis of Geol/Geophys/Seismic Data | 5.7 | 11.4 | -1.1 | 10.2 | 20.3 | 30.8 | 13.8 | 13.7 | 12.1 | 24.8 | 13.1 | 0.0 | 154.8 |
| 1.2.3.2.8.3.1 | | 5.7 | 11.4 | -1.1 | 10.2 | 20.3 | 30.8 | 13.8 | 13.7 | 12.1 | 24.8 | 13.1 | 0.0 | 154.8 |
| 0G32833A95 | Ground Motion Attenuation | 0.0 | 0.0 | 0.0 | 52.6 | 10.8 | 28.8 | 17.8 | 16.9 | 57.2 | 0.0 | 84.8 | 0.0 | 268.9 |
| 0G32833B96 | Ground Motion Modeling | 0.0 | 0.0 | 0.0 | 8.2 | 33.1 | 134.6 | 2.8 | 13.9 | 16.3 | 3.4 | 22.3 | 0.0 | 234.6 |
| 1.2.3.2.8.3.3 | | 0.0 | 0.0 | 0.0 | 60.8 | 43.9 | 163.4 | 20.6 | 30.8 | 73.5 | 3.4 | 107.1 | 0.0 | 503.5 |
| 0G32836A95 | GM Char in Prob. Seismic Hazard Analysis | 2.0 | -0.3 | 0.0 | -1.7 | 6.1 | 1.2 | 3.5 | 12.0 | 6.5 | 5.4 | 1.4 | 0.0 | 36.1 |
| 0G32836B95 | Probalistic Seismic Hazard Analysis | 6.9 | 4.4 | 23.6 | 20.4 | -20.5 | 6.8 | 0.7 | 12.6 | 6.6 | -0.5 | 7.1 | 0.0 | 68.1 |
| 1.2.3.2.8.3.6 | | 8.9 | 4.1 | 23.6 | 18.7 | -14.4 | 8.0 | 4.2 | 24.6 | 13.1 | 4.9 | 8.5 | 0.0 | 104.2 |
| 0G32841A95 | Catalog of Seismic Activity | 116.0 | 10.9 | 22.4 | 63.9 | 61.1 | 51.7 | 49.4 | 47.9 | 49.7 | 34.5 | 178.3 | 0.0 | 685.8 |
| 0G32841B95 | Excavation Induced Seismic Activity | 0.0 | 9.1 | 20.5 | 2.7 | 2.4 | 1.5 | 1.5 | 2.2 | 1.4 | 1.0 | 5.4 | 0.0 | 47.7 |
| 0G32841C96 | Digital Upgrade SGB Seismic Network | 0.0 | 68.0 | 20.5 | 36.6 | 35.8 | 38.4 | 68.2 | 58.1 | 57.4 | 38.5 | 58.1 | 0.0 | 479.6 |
| 0G32841D95 | Precarious Rock Methodology | 0.0 | 0.0 | 20.5 | 4.6 | 4.3 | 7.1 | 8.9 | 7.7 | 7.0 | 8.0 | 29.4 | 0.0 | 97.5 |
| 0G32841E95 | Strong Motion Array | 0.0 | 22.7 | 20.5 | 6.2 | 5.1 | 9.2 | 4.9 | 7.2 | 7.5 | 21.8 | 23.4 | 0.0 | 128.5 |
| 1.2.3.2.8.4.1 | | 116.0 | 110.7 | 104.4 | 114.0 | 108.7 | 107.9 | 132.9 | 123.1 | 123.0 | 103.8 | 294.6 | 0.0 | 1439.1 |
| 0G32843A95 | Quaternary Faulting - Amargosa Desert | 0.0 | 0.0 | 0.0 | 24.2 | 24.2 | -0.2 | 1.0 | 18.0 | 21.0 | 44.8 | 0.2 | 0.0 | 133.2 |
| 0G32843B95 | Quaternary Faulting - Regional Faults | 0.0 | 0.0 | 0.0 | 42.0 | 12.5 | 26.8 | 11.6 | 47.1 | 37.7 | 81.1 | 19.3 | 0.0 | 278.1 |
| 0G32843C95 | Quaternary Flting - Bare Mtn Fault Zone | 8.6 | 8.0 | 3.3 | 7.6 | 3.0 | 28.0 | 30.4 | 46.5 | 34.2 | 26.6 | 8.3 | 0.0 | 204.5 |
| 0G32843D95 | Char Death Valley-Furnace Creek Flt. Zon | 0.0 | 42.9 | 7.9 | 29.2 | 15.5 | 23.9 | 22.5 | 5.1 | 0.0 | 0.0 | 0.0 | 0.0 | 147.0 |
| 1.2.3.2.8.4.3 | | 8.6 | 50.9 | 11.2 | 103.0 | 55.2 | 78.5 | 65.5 | 116.7 | 92.9 | 152.5 | 27.8 | 0.0 | 762.8 |
| 0G32844A95 | Quaternary Fltling Rock Valley Flt Sys | 0.0 | 0.6 | 10.1 | 13.2 | 17.0 | 29.1 | 18.0 | 9.7 | 23.9 | 9.0 | 23.1 | 0.0 | 153.7 |
| 0G32844B95 | Quaternary Flting - Mine Mtn Flt System | 0.0 | 0.0 | 0.0 | 0.0 | 4.9 | -0.1 | 10.0 | 3.4 | 2.4 | 0.2 | 6.9 | 0.0 | 27.7 |
| 0G32844C95 | Quaternary Flting - Cane Springs Flt Sys | 3.3 | 2.7 | -6.0 | 0.0 | 9.5 | 1.1 | 4.0 | 4.1 | 5.1 | 11.0 | 4.0 | 0.0 | 38.8 |
| 1.2.3.2.8.4.4 | | 3.3 | 3.3 | 4.1 | 13.2 | 31.4 | 30.1 | 32.0 | 17.2 | 31.4 | 20.2 | 34.0 | 0.0 | 220.2 |
| 0G32845A95 | Detachment Faults | 5.8 | 14.5 | 46.3 | -21.8 | 19.3 | 23.0 | 29.3 | 15.0 | 29.3 | 44.7 | 36.0 | 0.0 | 241.4 |
| 1.2.3.2.8.4.5 | | 5.8 | 14.5 | 46.3 | -21.8 | 19.3 | 23.0 | 29.3 | 15.0 | 29.3 | 44.7 | 36.0 | 0.0 | 241.4 |
| 0G32846A95 | Quat Flting-Solitario Cyn/Crater Flt/Win | 11.0 | 7.0 | 18.4 | -3.7 | 25.8 | 14.5 | 15.0 | 7.8 | 15.6 | 27.9 | 13.6 | 0.0 | 152.9 |
| 0G32846B95 | Quaternary Flting - Ghost Dance Flt | 2.4 | 6.9 | 9.9 | 2.4 | 8.2 | 21.5 | 17.6 | 20.5 | 18.9 | 21.4 | 22.8 | 0.0 | 152.5 |
| 0G32846C95 | Quaternary Flting - Post Fortymile Wash | 0.0 | 0.5 | 0.0 | 0.0 | 3.1 | 1.2 | 10.3 | 9.6 | 14.3 | 5.0 | -0.9 | 0.0 | 43.1 |
| 0G32846D95 | Quat Flting-Bow Ridge/Paintbrush Cyn/Sta | 8.9 | 10.8 | 14.0 | 13.6 | 19.8 | 20.1 | 4.8 | 9.7 | 5.9 | 2.2 | 5.0 | 0.0 | 114.8 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.2.3.2.8.4.6 | 22.3 | 25.2 | 42.3 | 12.3 | 56.9 | 57.3 | 47.7 | 47.6 | 54.7 | 56.5 | 40.5 | 0.0 | 463.3 |
| 0G32848A95 In-situ Stress Measurements | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 0.0 | 0.0 | 0.8 | 0.0 | 4.6 | 0.0 | 0.0 | 8.5 |
| 1.2.3.2.8.4.8 | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 0.0 | 0.0 | 0.8 | 0.0 | 4.6 | 0.0 | 0.0 | 8.5 |
| 0G3284AA95 Geodetic Leveling | 0.0 | 0.0 | 0.0 | 17.0 | -6.4 | 22.0 | 0.0 | 14.5 | 39.6 | 0.0 | 4.4 | 0.0 | 91.1 |
| 0G3284AB95 Death Valley/Furnace Creek Leveling | 0.0 | 0.0 | 0.0 | 5.4 | 9.4 | 6.8 | 0.0 | 17.9 | 0.5 | 12.9 | 0.4 | 0.0 | 53.3 |
| 1.2.3.2.8.4.10 | 0.0 | 0.0 | 0.0 | 22.4 | 3.0 | 28.8 | 0.0 | 32.4 | 40.1 | 12.9 | 4.8 | 0.0 | 144.4 |
| 0G3284CA96 Tectonic Models and Synthesis | 4.4 | 40.0 | 7.8 | -12.5 | 27.8 | 21.0 | 3.1 | 33.5 | 27.7 | 35.9 | 15.9 | 0.0 | 204.6 |
| 1.2.3.2.8.4.12 | 4.4 | 40.0 | 7.8 | -12.5 | 27.8 | 21.0 | 3.1 | 33.5 | 27.7 | 35.9 | 15.9 | 0.0 | 204.6 |
| *1.2.3.2 | 468.5 | 528.5 | 478.6 | 667.5 | 860.7 | 1122.6 | 882.4 | 902.1 | 893.8 | 986.4 | 1194.7 | 0.0 | 8985.8 |
| 0G33111A96 Char of the Meteorology for Regional Hyd | 11.3 | 8.5 | 11.9 | 8.4 | 6.3 | 11.8 | 6.9 | 12.0 | 26.9 | 25.6 | 41.1 | 0.0 | 170.7 |
| 1.2.3.3.1.1.1 | 11.3 | 8.5 | 11.9 | 8.4 | 6.3 | 11.8 | 6.9 | 12.0 | 26.9 | 25.6 | 41.1 | 0.0 | 170.7 |
| 0G33112A95 Streamflow Data, FY94 | 5.5 | 5.5 | 8.1 | 13.5 | 4.8 | 10.6 | 16.7 | 24.2 | 0.0 | 0.0 | 0.0 | 0.0 | 88.9 |
| 0G33112B96 Streamflow Data, FY95 | 21.7 | 23.5 | 26.2 | 25.2 | 28.6 | 21.3 | 19.9 | 32.2 | 19.3 | 29.7 | 38.0 | 0.0 | 285.6 |
| 1.2.3.3.1.1.2 | 27.2 | 29.0 | 34.3 | 38.7 | 33.4 | 31.9 | 36.6 | 56.4 | 19.3 | 29.7 | 38.0 | 0.0 | 374.5 |
| 0G33113A95 Assessment of Key Data/Modeling Problems | 4.3 | 4.6 | 2.4 | 5.9 | 15.0 | 5.9 | 4.8 | 11.2 | 36.3 | 14.6 | 11.0 | 0.0 | 116.0 |
| 0G33113C95 Fortymile Wash Recharge | 5.5 | 5.4 | 6.0 | 7.2 | 5.5 | 5.8 | 7.2 | 21.2 | 7.2 | 6.9 | 7.0 | 0.0 | 84.9 |
| 1.2.3.3.1.1.3 | 9.8 | 10.0 | 8.4 | 13.1 | 20.5 | 11.7 | 12.0 | 32.4 | 43.5 | 21.5 | 18.0 | 0.0 | 200.9 |
| 0G33114A96 Regional SZ Numerical Flow Model | 7.0 | 17.8 | 5.3 | -6.5 | 15.6 | 2.3 | 3.9 | 41.5 | 8.2 | 9.8 | 18.7 | 0.0 | 123.6 |
| 0G33114B96 SZ Flow Model Boundary Conditions Evalua | 0.0 | 0.2 | 0.6 | 0.8 | 3.6 | 3.8 | 3.0 | 3.6 | -1.3 | 0.7 | 1.1 | 0.0 | 16.1 |
| 0G33114C96 Regional SZ Hydrogeologic Framework Mode | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 7.0 | 10.7 | 13.8 | 59.2 | 2.5 | 5.7 | 0.0 | 100.4 |
| 1.2.3.3.1.1.4 | 7.0 | 18.0 | 5.9 | -5.7 | 20.7 | 13.1 | 17.6 | 58.9 | 66.1 | 13.0 | 25.5 | 0.0 | 240.1 |
| 0G33121A96 Infiltration Properties | 35.0 | 50.0 | 58.8 | 33.6 | 49.4 | 49.0 | 52.8 | 48.1 | 61.3 | 44.5 | 62.4 | 0.0 | 544.9 |
| 0G33121B96 Infiltration Processes | 26.3 | 30.5 | 40.3 | 28.8 | 49.6 | 29.0 | 36.1 | 39.2 | 15.5 | 27.3 | 35.0 | 0.0 | 357.6 |
| 0G33121C95 Infiltration Distribution | 22.5 | 15.2 | 19.7 | 31.2 | 19.8 | 24.1 | 20.3 | 23.2 | 23.7 | 17.0 | 25.1 | 0.0 | 241.8 |
| 1.2.3.3.1.2.1 | 83.8 | 95.7 | 118.8 | 93.6 | 118.8 | 102.1 | 109.2 | 110.5 | 100.5 | 88.8 | 122.5 | 0.0 | 1144.3 |
| 0G33123A96 Matrix Properties of Hydrogeologic Units | 29.7 | 26.2 | 30.5 | 37.3 | 33.2 | 39.8 | 29.0 | 35.0 | 35.6 | 37.2 | 32.1 | 0.0 | 365.6 |
| 0G33123B95 Surface-Based Air-Permeability Testing | 23.5 | 20.4 | 27.9 | 22.5 | 168.1 | 24.7 | 38.2 | 34.0 | 18.7 | 21.8 | 24.4 | 0.0 | 424.2 |
| 0G33123C95 Vertical Seismic Profiling Test | 14.3 | 9.8 | 2.6 | 9.4 | 73.0 | 18.3 | 46.4 | -10.8 | 13.9 | 20.1 | 12.9 | 0.0 | 209.9 |
| 0G33123D95 Drilling & Drillhole Instrumentation | 102.1 | 76.5 | 40.4 | 46.4 | 30.6 | 66.4 | 23.7 | 130.3 | 38.0 | 47.3 | 34.7 | 0.0 | 636.4 |
| 0G33123E95 Sensor Calibration & In-Situ Testing | 33.6 | 41.7 | 38.6 | 42.7 | 42.3 | 36.8 | 32.2 | 29.6 | 63.9 | 49.6 | 44.3 | 0.0 | 455.3 |
| 0G33123F95 UZ Monit, DataBase Mgnt, QA Support, & C | 24.4 | 25.1 | 23.9 | 30.4 | 23.3 | 36.4 | 23.8 | 23.4 | 21.7 | 25.3 | 32.0 | 0.0 | 289.7 |
| 0G33123G95 Integrated Data Analysis and Interpretat | 0.0 | 1.0 | 7.5 | -2.6 | 5.5 | 3.8 | 17.2 | 20.3 | 14.7 | 21.7 | 13.2 | 0.0 | 102.3 |
| 1.2.3.3.1.2.3 | 227.6 | 200.7 | 171.4 | 186.1 | 376.0 | 226.2 | 210.5 | 261.8 | 206.5 | 223.0 | 193.6 | 0.0 | 2483.4 |
| 0G33124A96 North Ramp Perched Water Testing | 6.0 | 6.5 | 6.6 | 6.9 | 6.0 | 10.8 | 6.7 | 10.2 | 10.2 | 20.2 | 8.7 | 0.0 | 98.8 |
| 0G33124B95 Percolation Test in the ESF | 6.0 | 11.2 | 10.6 | 7.3 | 7.4 | 7.2 | 6.1 | 4.5 | 6.9 | 10.6 | 6.4 | 0.0 | 84.2 |
| 0G33124C95 Excavation Effects Test in the ESF | 6.3 | 2.0 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 0.0 | 10.5 |
| 0G33124D96 Intact Fractures Test, ESF | 22.1 | 50.7 | 29.0 | 32.2 | 22.9 | 35.6 | 29.3 | 34.2 | 30.4 | 32.3 | 35.0 | 0.0 | 353.7 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0G33124E97 Air-K & Hydrochemistry Testing-North Ram | 16.4 | 20.8 | 23.6 | 24.4 | 36.0 | 64.2 | 15.3 | 66.1 | 43.3 | 27.9 | 33.4 | 0.0 | 371.4 |
| 1.2.3.3.1.2.4 | 56.8 | 91.2 | 70.5 | 70.8 | 72.3 | 117.8 | 57.4 | 115.0 | 90.8 | 91.0 | 85.0 | 0.0 | 918.6 |
| 0G33126A96 North Ramp, ESF Gas Phase Circulation | 20.2 | 17.5 | 24.3 | 50.1 | 43.1 | 24.1 | 20.5 | 8.5 | 16.2 | 11.3 | 16.2 | 0.0 | 252.0 |
| 1.2.3.3.1.2.6 | 20.2 | 17.5 | 24.3 | 50.1 | 43.1 | 24.1 | 20.5 | 8.5 | 16.2 | 11.3 | 16.2 | 0.0 | 252.0 |
| 0G33127A96 UZ Hydrochemistry | 71.7 | 69.8 | 71.6 | -24.6 | 43.9 | 59.1 | 78.1 | 39.4 | 66.7 | 95.9 | 75.7 | 0.0 | 647.3 |
| 1.2.3.3.1.2.7 | 71.7 | 69.8 | 71.6 | -24.6 | 43.9 | 59.1 | 78.1 | 39.4 | 66.7 | 95.9 | 75.7 | 0.0 | 647.3 |
| 0G33128A95 Fluid Flow in UZ Fractured Rock | 6.5 | 3.5 | 11.7 | 8.8 | 10.5 | 11.2 | 39.5 | -5.8 | 18.4 | 12.7 | 23.4 | 0.0 | 140.4 |
| 1.2.3.3.1.2.8 | 6.5 | 3.5 | 11.7 | 8.8 | 10.5 | 11.2 | 39.5 | -5.8 | 18.4 | 12.7 | 23.4 | 0.0 | 140.4 |
| 0G33129A96 Intermediate Site UZ Flow Model | 15.2 | 16.8 | 21.2 | 20.3 | 14.2 | 22.2 | 25.1 | 21.6 | 15.9 | 19.5 | 20.5 | 0.0 | 212.5 |
| 1.2.3.3.1.2.9 | 15.2 | 16.8 | 21.2 | 20.3 | 14.2 | 22.2 | 25.1 | 21.6 | 15.9 | 19.5 | 20.5 | 0.0 | 212.5 |
| 0G33131A97 Conduct Hydraulic/Tracer Test C-Holes | 23.2 | 47.4 | 47.5 | 35.2 | 29.3 | 45.2 | 61.6 | 57.0 | 60.6 | -43.6 | 45.8 | 0.0 | 409.2 |
| 0G33131B95 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.6 | 9.7 | 0.0 | 19.3 |
| 0G33131C97 Site Potentiometric Levels Monitoring | 28.6 | 42.6 | 84.4 | 44.3 | 25.1 | 41.9 | 32.1 | 18.8 | 44.6 | 46.1 | 45.5 | 0.0 | 454.0 |
| 0G33131E96 Pumping and Testing Existing Monitoring | 0.0 | 1.3 | -0.7 | 0.6 | 13.0 | 15.6 | 5.7 | 10.5 | 7.9 | 8.9 | 13.0 | 0.0 | 75.8 |
| 1.2.3.3.1.3.1 | 51.8 | 91.3 | 131.2 | 80.1 | 67.4 | 102.7 | 99.4 | 86.3 | 113.1 | 21.0 | 114.0 | 0.0 | 958.3 |
| 0G33132A96 SZ Hydrochemistry Data Summary | 2.3 | 2.8 | 6.5 | 2.7 | 1.5 | 5.0 | 30.6 | -12.0 | 27.5 | 5.1 | 9.6 | 0.0 | 81.6 |
| 0G33132B96 Death Valley SZ Hydrochemistry | 3.8 | 1.2 | 3.9 | 1.0 | 4.0 | 5.0 | 8.5 | 6.8 | 1.6 | 3.9 | 1.8 | 0.0 | 41.5 |
| 0G33132C96 SZ Hydrochemistry Equipment Procurement | 0.0 | 29.2 | 34.0 | 0.9 | 0.8 | 1.2 | 16.2 | 33.6 | 23.6 | 82.5 | -3.1 | 0.0 | 218.9 |
| 1.2.3.3.1.3.2 | 6.1 | 33.2 | 44.4 | 4.6 | 6.3 | 11.2 | 55.3 | 28.4 | 52.7 | 91.5 | 8.3 | 0.0 | 342.0 |
| 0G33133A96 Site SZ Flow Model Framework | 16.7 | 32.0 | 43.8 | 4.5 | 51.9 | 33.4 | 10.0 | 9.0 | 18.4 | 15.8 | 10.8 | 0.0 | 246.3 |
| 0G33133B96 Site 3-D SZ Model | 5.7 | 13.1 | 11.9 | 7.8 | 14.4 | 18.7 | 19.0 | 41.4 | 14.4 | 41.4 | -6.5 | 0.0 | 181.3 |
| 0G33133C95 Site SZ Conceptual Model Report | 0.4 | 1.9 | 3.5 | 5.6 | 4.2 | 0.0 | -2.3 | 2.2 | 1.8 | 0.4 | 1.5 | 0.0 | 19.2 |
| 1.2.3.3.1.3.3 | 22.8 | 47.0 | 59.2 | 17.9 | 70.5 | 52.1 | 26.7 | 52.6 | 34.6 | 57.6 | 5.8 | 0.0 | 446.8 |
| *1.2.3.3 | 617.8 | 732.2 | 784.8 | 562.2 | 903.9 | 797.2 | 794.8 | 878.0 | 871.2 | 802.1 | 787.6 | 0.0 | 8531.8 |
| 0G36211B96 Isotopic Analysis of Modern Precipitatio | 0.6 | 1.4 | 0.1 | 1.8 | -0.4 | 9.6 | 9.7 | 15.0 | 9.4 | 2.7 | 3.3 | 0.0 | 53.2 |
| 1.2.3.6.2.1.1 | 0.6 | 1.4 | 0.1 | 1.8 | -0.4 | 9.6 | 9.7 | 15.0 | 9.4 | 2.7 | 3.3 | 0.0 | 53.2 |
| 0G36212A96 Ostracodes, C-14, & Stable Isotopic Data | 9.3 | 6.9 | 27.1 | 15.3 | 13.4 | 30.4 | 36.3 | 99.1 | 53.5 | 50.1 | 40.1 | 0.0 | 381.5 |
| 1.2.3.6.2.1.2 | 9.3 | 6.9 | 27.1 | 15.3 | 13.4 | 30.4 | 36.3 | 99.1 | 53.5 | 50.1 | 40.1 | 0.0 | 381.5 |
| 0G36213A96 Packrat Middens & Pollen Studies | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 35.9 | 0.0 | 0.0 | 36.4 |
| 1.2.3.6.2.1.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 35.9 | 0.0 | 0.0 | 36.4 |
| 0G36214A95 Document Erosion at Jake Ridge | 0.0 | 0.0 | 0.0 | 3.7 | 0.8 | 1.0 | 0.5 | 0.0 | 0.5 | 0.3 | -0.2 | 0.0 | 6.6 |
| 0G36214B95 Geochronological Studies of Surface Depo | 9.5 | 7.4 | 12.2 | 85.1 | 90.8 | 57.5 | 41.1 | 13.5 | 9.4 | 29.9 | -0.3 | 0.0 | 356.1 |
| 0G36214C96 Surficial Deposits Mapping | 5.4 | 4.8 | 10.8 | 7.4 | 5.5 | 4.8 | 5.9 | 6.2 | 8.0 | 7.4 | 8.2 | 0.0 | 74.4 |
| 1.2.3.6.2.1.4 | 14.9 | 12.2 | 23.0 | 96.2 | 97.1 | 63.3 | 47.5 | 19.7 | 17.9 | 37.6 | 7.7 | 0.0 | 437.1 |
| 0G36215A95 Paleoclimate/Environmental Synthesis Stu | 3.9 | 6.6 | 3.1 | 3.5 | 2.9 | 1.2 | -4.1 | 7.2 | -0.6 | 0.0 | 0.0 | 0.0 | 23.7 |
| 0G36215C95 Paleoclimate Synthesis | 0.0 | 0.1 | 0.0 | 6.6 | 5.8 | 6.2 | 0.0 | 0.0 | 0.1 | 5.4 | 13.0 | 0.0 | 37.2 |
| 1.2.3.6.2.1.5 | 3.9 | 6.7 | 3.1 | 10.1 | 8.7 | 7.4 | -4.1 | 7.2 | -0.5 | 5.4 | 13.0 | 0.0 | 60.9 |

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| | | OCT EST | NOV EST | DEC EST | JAN EST | FEB EST | MAR EST | APR EST | MAY EST | JUN EST | JUL EST | AUG EST | SEP EST | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0G36221A96 | Formation of Silica Within Yucca Mountai | 2.4 | 3.6 | 8.5 | 0.1 | 5.2 | -15.9 | 26.0 | 0.9 | 1.9 | -1.8 | 13.3 | 0.0 | 44.2 |
| 0G36221B96 | Dating Calcite Vein Deposits | 0.3 | 8.8 | 14.3 | 8.9 | 25.9 | 9.4 | 2.0 | 7.8 | 14.7 | 5.1 | -4.8 | 0.0 | 92.4 |
| 0G36221C95 | Evaluation of Past Discharge Areas | 1.9 | 3.1 | 10.9 | 5.7 | 26.7 | 14.4 | 12.2 | 7.9 | 6.7 | -0.6 | 1.6 | 0.0 | 90.5 |
| 0G36221D96 | Soil Fluid/Gas Isotopic Chemistry | 5.9 | 4.0 | 13.6 | 8.3 | 11.3 | -2.6 | 11.0 | 6.2 | 10.7 | 8.1 | 8.8 | 0.0 | 85.3 |
| 0G36221E95 | Vein Filling Calcite & Opaline Silica De | 12.6 | 7.8 | 7.9 | 7.3 | 24.2 | 5.8 | 40.7 | 7.1 | 5.5 | -40.8 | 6.5 | 0.0 | 84.6 |
| 1.2.3.6.2.2.1 | | 23.1 | 27.3 | 55.2 | 30.3 | 93.3 | 11.1 | 91.9 | 29.9 | 39.5 | -30.0 | 25.4 | 0.0 | 397.0 |
| *1.2.3.6 | | 51.8 | 54.5 | 108.5 | 153.7 | 212.1 | 121.8 | 181.8 | 170.9 | 119.8 | 101.7 | 89.5 | 0.0 | 1366.1 |
| 0G3721A95 | Geochem Assessment of YM/Pot for Mineral | 12.6 | 20.6 | 21.4 | 11.1 | 27.1 | 21.5 | 2.2 | 2.8 | 1.5 | 3.5 | 3.4 | 0.0 | 127.7 |
| 0G3721B95 | Assess Geothermal Energy Potential at YM | 0.0 | 0.6 | 0.0 | 7.7 | 18.2 | 0.7 | 0.4 | 2.1 | 0.0 | 0.0 | 0.0 | 0.0 | 29.7 |
| 1.2.3.7.2.1 | | 12.6 | 21.2 | 21.4 | 18.8 | 45.3 | 22.2 | 2.6 | 4.9 | 1.5 | 3.5 | 3.4 | 0.0 | 157.4 |
| *1.2.3.7 | | 12.6 | 21.2 | 21.4 | 18.8 | 45.3 | 22.2 | 2.6 | 4.9 | 1.5 | 3.5 | 3.4 | 0.0 | 157.4 |
| 0G39995B4 | Study Plan Comment Resolution | 0.0 | 7.0 | 2.4 | 7.9 | 5.2 | 0.0 | 5.1 | 4.3 | 4.1 | -1.0 | 0.0 | 0.0 | 35.0 |
| 1.2.3.9.9 | | 0.0 | 7.0 | 2.4 | 7.9 | 5.2 | 0.0 | 5.1 | 4.3 | 4.1 | -1.0 | 0.0 | 0.0 | 35.0 |
| *1.2.3.9 | | 0.0 | 7.0 | 2.4 | 7.9 | 5.2 | 0.0 | 5.1 | 4.3 | 4.1 | -1.0 | 0.0 | 0.0 | 35.0 |
| **1.2.3 | | 1297.5 | 1502.5 | 1528.8 | 1584.1 | 2200.4 | 2247.3 | 2051.6 | 2214.5 | 2164.9 | 2007.3 | 2330.1 | 0.0 | 21129.0 |
| 0G51195B | Regulatory Coordination and Planning | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 8.7 | -9.3 | 15.0 | -1.4 | 2.3 | 0.6 | 0.0 | 16.7 |
| 1.2.5.1.1 | | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 8.7 | -9.3 | 15.0 | -1.4 | 2.3 | 0.6 | 0.0 | 16.7 |
| *1.2.5.1 | | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 8.7 | -9.3 | 15.0 | -1.4 | 2.3 | 0.6 | 0.0 | 16.7 |
| 0G53595B | Technical Data Coordination | 31.9 | 28.5 | 28.2 | 33.9 | 32.0 | 79.8 | 35.2 | 71.2 | 50.0 | 66.0 | 51.4 | 0.0 | 508.1 |
| 1.2.5.3.5 | | 31.9 | 28.5 | 28.2 | 33.9 | 32.0 | 79.8 | 35.2 | 71.2 | 50.0 | 66.0 | 51.4 | 0.0 | 508.1 |
| *1.2.5.3 | | 31.9 | 28.5 | 28.2 | 33.9 | 32.0 | 79.8 | 35.2 | 71.2 | 50.0 | 66.0 | 51.4 | 0.0 | 508.1 |
| 0G5695B | Site Suitability Evaluation | 2.9 | 0.8 | 0.3 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 1.1 | -5.5 | 0.0 | 0.0 | 0.0 |
| 0G5695B1 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.5 | 4.2 | 0.0 | 9.7 |
| 1.2.5.6 | | 2.9 | 0.8 | 0.3 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 | 4.2 | 0.0 | 9.7 |
| *1.2.5.6 | | 2.9 | 0.8 | 0.3 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 | 4.2 | 0.0 | 9.7 |
| 0G5795B1 | NRC/NWTRB/ACNW Interactions | 4.5 | 20.0 | -6.8 | 8.4 | 13.5 | 6.9 | 2.7 | 24.5 | 25.6 | 1.1 | 17.3 | 0.0 | 117.7 |
| 0G5795B2 | Site Characterization Program | 22.5 | 22.4 | 29.3 | 34.2 | -26.7 | 7.3 | 13.1 | 5.8 | 9.0 | 9.1 | 24.7 | 0.0 | 150.7 |
| 0G5795B4 | Semi-Annual Progress Report | 0.0 | 1.4 | -1.4 | 0.3 | 0.0 | 8.5 | -5.0 | 11.0 | 7.4 | 11.1 | 5.3 | 0.0 | 38.6 |
| 0G5795B5 | Issue Resolution | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.6 |
| 0G5795B6 | Volcanic Hazards | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.9 | 4.8 | 7.7 | 5.9 | 5.9 | 5.2 | 0.0 | 36.4 |
| 1.2.5.7 | | 27.0 | 43.8 | 21.4 | 42.9 | -13.2 | 29.6 | 15.6 | 49.0 | 47.9 | 27.2 | 52.8 | 0.0 | 344.0 |
| *1.2.5.7 | | 27.0 | 43.8 | 21.4 | 42.9 | -13.2 | 29.6 | 15.6 | 49.0 | 47.9 | 27.2 | 52.8 | 0.0 | 344.0 |
| **1.2.5 | | 62.6 | 73.1 | 49.9 | 76.8 | 19.2 | 118.1 | 41.5 | 135.2 | 97.6 | 95.5 | 109.0 | 0.0 | 878.5 |
| 0G912195B | Technical Project Office Management | 38.4 | 42.7 | 54.3 | 50.6 | 28.8 | 79.3 | 32.1 | 19.3 | 26.2 | 24.2 | 27.0 | 0.0 | 422.9 |
| 1.2.9.1.2.1 | | 38.4 | 42.7 | 54.3 | 50.6 | 28.8 | 79.3 | 32.1 | 19.3 | 26.2 | 24.2 | 27.0 | 0.0 | 422.9 |
| *1.2.9.1 | | 38.4 | 42.7 | 54.3 | 50.6 | 28.8 | 79.3 | 32.1 | 19.3 | 26.2 | 24.2 | 27.0 | 0.0 | 422.9 |
| 0G92295B | Participant Project Control | 29.2 | 30.6 | 28.6 | 31.4 | 42.0 | 38.7 | 41.8 | 37.8 | 44.0 | 35.6 | 39.5 | 0.0 | 399.2 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.2.9.2.2 | | 29.2 | 30.6 | 28.6 | 31.4 | 42.0 | 38.7 | 41.8 | 37.8 | 44.0 | 35.6 | 39.5 | 0.0 | 399.2 |
| *1.2.9.2 | | 29.2 | 30.6 | 28.6 | 31.4 | 42.0 | 38.7 | 41.8 | 37.8 | 44.0 | 35.6 | 39.5 | 0.0 | 399.2 |
| **1.2.9 | | 67.6 | 73.3 | 82.9 | 82.0 | 70.8 | 118.0 | 73.9 | 57.1 | 70.2 | 59.8 | 66.5 | 0.0 | 822.1 |
| OGB195Q | Quality Assurance Coordination and Plann | 20.9 | 16.7 | 20.2 | 20.8 | 22.2 | 27.7 | 22.6 | 25.9 | 39.4 | 17.8 | 28.8 | 0.0 | 263.0 |
| 1.2.11.1 | | 20.9 | 16.7 | 20.2 | 20.8 | 22.2 | 27.7 | 22.6 | 25.9 | 39.4 | 17.8 | 28.8 | 0.0 | 263.0 |
| *1.2.11.1 | | 20.9 | 16.7 | 20.2 | 20.8 | 22.2 | 27.7 | 22.6 | 25.9 | 39.4 | 17.8 | 28.8 | 0.0 | 263.0 |
| OGB295Q | Quality Assurance Program Development | 49.6 | 46.9 | 48.5 | 52.7 | 35.7 | 33.6 | 30.0 | 41.2 | 37.2 | 40.3 | 43.9 | 0.0 | 459.6 |
| 1.2.11.2 | | 49.6 | 46.9 | 48.5 | 52.7 | 35.7 | 33.6 | 30.0 | 41.2 | 37.2 | 40.3 | 43.9 | 0.0 | 459.6 |
| *1.2.11.2 | | 49.6 | 46.9 | 48.5 | 52.7 | 35.7 | 33.6 | 30.0 | 41.2 | 37.2 | 40.3 | 43.9 | 0.0 | 459.6 |
| OGB3195Q | Quality Assurance Verification - Audits | 33.6 | 17.1 | 38.2 | 16.7 | 12.8 | 37.8 | 59.3 | 42.1 | 39.9 | 32.9 | 21.0 | 0.0 | 351.4 |
| 1.2.11.3.1 | | 33.6 | 17.1 | 38.2 | 16.7 | 12.8 | 37.8 | 59.3 | 42.1 | 39.9 | 32.9 | 21.0 | 0.0 | 351.4 |
| OGB3295Q | Quality Assurance Verification - Surveil | 8.8 | 30.1 | 26.5 | 16.7 | 23.2 | 20.3 | 11.0 | 26.4 | 12.2 | 19.4 | 32.6 | 0.0 | 227.2 |
| 1.2.11.3.2 | | 8.8 | 30.1 | 26.5 | 16.7 | 23.2 | 20.3 | 11.0 | 26.4 | 12.2 | 19.4 | 32.6 | 0.0 | 227.2 |
| *1.2.11.3 | | 42.4 | 47.2 | 64.7 | 33.4 | 36.0 | 58.1 | 70.3 | 68.5 | 52.1 | 52.3 | 53.6 | 0.0 | 578.6 |
| OGB595Q | Quality Assurance - Quality Engineering | 2.2 | 8.7 | 21.0 | 23.1 | 31.2 | 63.7 | 26.1 | 59.2 | 39.3 | 24.1 | 42.4 | 0.0 | 341.0 |
| 1.2.11.5 | | 2.2 | 8.7 | 21.0 | 23.1 | 31.2 | 63.7 | 26.1 | 59.2 | 39.3 | 24.1 | 42.4 | 0.0 | 341.0 |
| *1.2.11.5 | | 2.2 | 8.7 | 21.0 | 23.1 | 31.2 | 63.7 | 26.1 | 59.2 | 39.3 | 24.1 | 42.4 | 0.0 | 341.0 |
| **1.2.11 | | 115.1 | 119.5 | 154.4 | 130.0 | 125.1 | 183.1 | 149.0 | 194.8 | 168.0 | 134.5 | 168.7 | 0.0 | 1642.2 |
| OGC2295B | Local Records Center Operation | 24.5 | 24.5 | 21.2 | 26.3 | 20.0 | 22.7 | 20.2 | 54.9 | 24.2 | 19.2 | 29.2 | 0.0 | 286.9 |
| 1.2.12.2.2 | | 24.5 | 24.5 | 21.2 | 26.3 | 20.0 | 22.7 | 20.2 | 54.9 | 24.2 | 19.2 | 29.2 | 0.0 | 286.9 |
| OGC2395B | Participant Records Management | 6.8 | 9.5 | 10.5 | 9.9 | 8.9 | 6.0 | 9.5 | 16.5 | 12.6 | 19.7 | 10.6 | 0.0 | 120.5 |
| 1.2.12.2.3 | | 6.8 | 9.5 | 10.5 | 9.9 | 8.9 | 6.0 | 9.5 | 16.5 | 12.6 | 19.7 | 10.6 | 0.0 | 120.5 |
| *1.2.12.2 | | 31.3 | 34.0 | 31.7 | 36.2 | 28.9 | 28.7 | 29.7 | 71.4 | 36.8 | 38.9 | 39.8 | 0.0 | 407.4 |
| **1.2.12 | | 31.3 | 34.0 | 31.7 | 36.2 | 28.9 | 28.7 | 29.7 | 71.4 | 36.8 | 38.9 | 39.8 | 0.0 | 407.4 |
| OGD2595B | Occupational Safety and Health | 6.7 | 8.2 | 5.1 | 13.1 | 8.7 | 8.5 | 6.5 | 8.7 | 6.7 | 13.2 | 10.9 | 0.0 | 96.3 |
| 1.2.13.2.5 | | 6.7 | 8.2 | 5.1 | 13.1 | 8.7 | 8.5 | 6.5 | 8.7 | 6.7 | 13.2 | 10.9 | 0.0 | 96.3 |
| *1.2.13.2 | | 6.7 | 8.2 | 5.1 | 13.1 | 8.7 | 8.5 | 6.5 | 8.7 | 6.7 | 13.2 | 10.9 | 0.0 | 96.3 |
| OGD4795B | Regional Groundwater Quality Network | 0.0 | 3.1 | 2.7 | 4.4 | 3.9 | 6.1 | 7.5 | 13.2 | 10.0 | 37.6 | 17.3 | 0.0 | 105.8 |
| OGD4795H | Water Resources Monitoring | 35.2 | 31.8 | 49.1 | 34.3 | 35.0 | 29.5 | -7.0 | 80.1 | 34.0 | 35.8 | 48.5 | 0.0 | 406.3 |
| 1.2.13.4.7 | | 35.2 | 34.9 | 51.8 | 38.7 | 38.9 | 35.6 | 0.5 | 93.3 | 44.0 | 73.4 | 65.8 | 0.0 | 512.1 |
| *1.2.13.4 | | 35.2 | 34.9 | 51.8 | 38.7 | 38.9 | 35.6 | 0.5 | 93.3 | 44.0 | 73.4 | 65.8 | 0.0 | 512.1 |
| **1.2.13 | | 41.9 | 43.1 | 56.9 | 51.8 | 47.6 | 44.1 | 7.0 | 102.0 | 50.7 | 86.6 | 76.7 | 0.0 | 608.4 |
| OGF2395B1 | Administrative Support | 27.1 | 36.2 | 45.2 | 42.2 | 36.2 | 56.5 | 42.8 | 44.4 | 45.0 | 39.6 | 44.9 | 0.0 | 460.1 |
| OGF2395B2 | Space and Facilities | 100.6 | 84.0 | 117.2 | 230.8 | 153.5 | 95.4 | 118.5 | 45.1 | 68.1 | 24.9 | 166.1 | 0.0 | 1204.2 |
| OGF2395B3 | | 0.0 | 9.9 | 5.9 | 9.5 | 6.4 | 7.5 | 5.8 | 12.3 | 7.6 | 6.2 | 8.8 | 0.0 | 79.9 |
| 1.2.15.2.3 | | 127.7 | 130.1 | 168.3 | 282.5 | 196.1 | 159.4 | 167.1 | 101.8 | 120.7 | 70.7 | 219.8 | 0.0 | 1744.2 |
| *1.2.15.2 | | 127.7 | 130.1 | 168.3 | 282.5 | 196.1 | 159.4 | 167.1 | 101.8 | 120.7 | 70.7 | 219.8 | 0.0 | 1744.2 |

U.S. GEOLOGICAL SURVEY
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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OGF395B YMP Support of the Training Mission | 10.2 | 17.7 | 16.3 | 16.9 | 16.8 | 18.9 | 19.1 | 20.0 | 25.1 | 21.6 | 32.1 | 0.0 | 214.7 |
| 1.2.15.3 | 10.2 | 17.7 | 16.3 | 16.9 | 16.8 | 18.9 | 19.1 | 20.0 | 25.1 | 21.6 | 32.1 | 0.0 | 214.7 |
| *1.2.15.3 | 10.2 | 17.7 | 16.3 | 16.9 | 16.8 | 18.9 | 19.1 | 20.0 | 25.1 | 21.6 | 32.1 | 0.0 | 214.7 |
| **1.2.15 | 137.9 | 147.8 | 184.6 | 299.4 | 212.9 | 178.3 | 186.2 | 121.8 | 145.8 | 92.3 | 251.9 | 0.0 | 1958.9 |
| 1.2 OPERATING | 1753.9 | 1997.0 | 2090.5 | 2263.2 | 2709.5 | 2919.7 | 2552.7 | 2891.2 | 2739.6 | 2516.4 | 3043.0 | 0.0 | 27476.7 |
| CAPITAL EQUIPMENT | 0.0 | 0.0 | 0.0 | 0.0 | 39.2 | 11.9 | 20.8 | 59.9 | 44.8 | 18.7 | 22.7 | 0.0 | 218.0 |
| GRAND TOTAL | 1753.9 | 1997.0 | 2090.5 | 2263.2 | 2748.7 | 2931.6 | 2573.5 | 2951.1 | 2784.4 | 2535.1 | 3065.7 | 0.0 | 27694.7 |
| FTEs | | | | | | | | | | | | | |
| FEDERAL | 104.9 | 112.4 | 103.7 | 161.4 | 143.4 | 169.8 | 159.0 | 171.2 | 183.9 | 184.1 | 188.3 | 0.0 | |
| CONTRACT | 80.4 | 83.7 | 86.8 | 97.2 | 117.6 | 135.4 | 128.2 | 127.0 | 131.0 | 127.9 | 115.1 | 0.0 | |
| TOTAL | 185.3 | 196.1 | 190.5 | 258.6 | 261.0 | 305.2 | 287.2 | 298.2 | 314.9 | 312.0 | 303.4 | 0.0 | |

* Fourth level WBS roll-up
** Third level WBS roll-up

United States Department of the Interior

U. S. GEOLOGICAL SURVEY
Box 25046 M.S. 425
Denver Federal Center
Denver, Colorado 80225

IN REPLY REFER TO:

INFORMATION ONLY

October 17, 1995

Charles Fox
Yucca Mountain Site Characterization
Project Office
U. S. Department of Energy
P.O. Box 98608
Las Vegas, Nevada 89193-8608

SUBJECT: Yucca Mountain Project Branch - U.S. Geological Survey (YMPB-USGS) Progress Report, September, 1995

Dear Vince:

Attached is the USGS progress report in the required format for the month of September, 1995.

It should be noted that **variance at completion numbers are based on PACS budgets and do not necessarily indicate available funds**. A number of Approved Funding Program changes (AFP) have been made which do not involve a change in scope of work and therefore do not require a Cost/Schedule Change Request. Reductions in USGS funding must be made based on available funds in the AFP, not the PACS budget.

If you have any questions or need further information, please call Raye Ritchey Arnold at (303)236-0516, ext. 282.

Sincerely,

Raye Ritchey Arnold
for Robert W. Craig
Acting Technical Project Officer
Yucca Mountain Project Branch
U.S. Geological Survey

Enclosure:
cc: S. Hanauer, DOE/Forrestal
R. Dyer, DOE,Las Vegas
A. Gil, DOE,Las Vegas
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DIVISION Dyer / Tynan
CC: Gil / Williams
CC: Jones
CC: Kozai
CC: Patterson
CC: Simmons
CC: Spence
CC: Sullivan

REC'D IN YMP 10/25/95

ENCLOSURE 8

D. Williams, DOE, Las Vegas
C. Glenn, NRC, Las Vegas (2 copies)
P. Burke, M&O, Las Vegas
M. Lawson, LANL, Las Vegas
J. Schelling, SNL, Las Vegas
R. St. Clair, M&O, Las Vegas
M. Chornack, USGS, Denver
L. Ducret, USGS, Denver
D. Gillies, USGS, Denver
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J. Whitney, USGS, Denver
R. Williams, USGS, Denver
T. Williams, USGS, Denver

U. S. Geological Survey
EXECUTIVE SUMMARY
September 1995

WBS 1.2.3.1 Coordination and Planning

U.S. Geological Survey - Yucca Mountain Project Branch is currently processing 210 scientific publications, of which 84 are hydrologic-related reports, and 126 are geologic-related reports. In addition, 89 abstracts are being processed as well as 27 reports from LBL.

WBS 1.2.3.2 Geology

Geologic Framework

Detailed geologic mapping north of Drill Hole Wash has helped to delineate the structural setting and stratigraphic variations within the Tiva Canyon, Yucca Mountain, and Pah Canyon Tuffs. This area appears to be much less fractured and faulted than the area to the south (south of Antler Ridge). The new mapping helps to better characterize the Drill Hole Wash fault zone where it is exposed along the north side of the potential repository block, as well as the Pagany Wash fault to the north and the northern part of the Solitario Canyon fault to the northwest. Additional mapping along the Sundance fault, which transects the repository site, indicates that it does not offset the Solitario Canyon fault to the northwest. The new mapping also indicates that an apparent offset of the Ghost Dance fault zone as it crosses Live Yucca Ridge within the site area is not caused by the Sundance fault, but represents two separate strands of the Ghost Dance which probably connect at depth. Faulting within the Tiva Canyon Tuff (during Tertiary time) is found to be quite heterogeneous; individual faults are laterally and vertically discontinuous, implying distributed strain accommodation within diffuse breccia zones and through minor displacements along pre-existing cooling joints. The new fault maps help to refine the structural framework of the potential site area for use in the three-dimensional framework modeling effort.

Lithostratigraphic studies that also help to refine the three-dimensional geologic framework model continued, including the preparation of preliminary maps and reports on the Bullfrog Tuff and pre-Bullfrog bedded tuffs. Comparison of lithologic logs with geophysical logs for boreholes G-1, G-2, and G-4 indicate that the upper and lower contacts of the Bullfrog Tuff (of the Crater Flat Group) are not well marked by distinctive geophysical signatures. Neither can the upper and lower pyroclastic-flow deposits within the formation be distinguished. The effects of welding can be detected on some logs, but in most cases the changes in physical characteristics between different units are too subtle to be identified without benefit of core samples.

Geologic mapping of the North Ramp (ESF) was accomplished as follows: (1) full periphery field maps completed to station 18+82; (2) detailed line surveys completed to station 18+77; (3) stereophotography completed to station 18+49; (4) RQD and Q ratings calculated to station 17+90; (5) fifty-five samples collected as part of the consolidated sampling program; and (6) petrographic analyses conducted on samples from the altered zone in bedded tuffs at the base of the pre-Pah Canyon Tuff.

Heat Flow

A recent temperature log of the unsaturated zone in borehole USW G-2 shows that the temperature profile has remained unchanged since June, 1984. This condition indicates that the non-conductive processes, most likely vertical fluid movement, are occurring in the unsaturated zone at this locality. The temperature log also shows, however, that significant temperature changes continue to occur in the active zone below the water surface in the depth interval 1750-2430 feet in this well.

Preliminary interpretation of temperature logs obtained in horizontal hole HPF-1 in the Bow Ridge alcove (of the ESF) indicates that the ventilation transient has penetrated a distance of 19 feet in from the alcove wall. A small signal associated with the Bow Ridge fault zone between 45 and 55 feet and a stronger one associated with the fracture zones between 35 and 40 feet from the wall were detected. The interference of other surface excavations and the surface itself are also evident on the temperature log.

Ground Motion

A completed report, entitled "Initial summary of geological, geophysical, and seismicity data to support earthquake source characterization for seismic hazard analyses at the potential nuclear waste repository at Yucca Mountain, Nevada", incorporates a preliminary inventory of basic datasets for use in the probabilistic analyses of vibratory ground motion and fault displacement at the potential waste facility. Included are separate sections on historical and instrumental seismicity, Quaternary faults and paleoseismicity, Quaternary geochronology, geologic maps, geodesy, geophysics, volcanism and volcanic earthquakes, tectonic models, and fault ruptures from earthquakes in the Basin and Range. Each section provides a brief discussion of the particular topic involved, and a relatively comprehensive bibliography of publications related to Yucca Mountain site investigations, as well as to more regional studies and datasets. Included are references to soon-to-be-available maps and reports being prepared to document recent findings and interpretations that have resulted from the geological, geophysical, seismological, and related studies currently being conducted in the Yucca Mountain site characterization program.

Preclosure Tectonics

In activities associated with the monitoring of seismic events in the southern Great Basin, 160 events were located during the month of September from the records obtained by the 62-station network. The largest earthquake, with a magnitude of 3.5, occurred in the Rock Valley area. With the addition of two new sites in Plutonium Valley and Topopah Wash, the digital upgrade currently includes 15 stations. Continuous data from all these sites were collected at 20 samples per second (sps), and triggered data were collected at 100 sps. An LIO geophone and a CMG5 strong-motion sensor were installed in the first alcove of the ESF. Preliminary analysis of the data collected (7 days for the LIO geophone and 3 weeks for the CMG5 instrument) has resulted in the identification of several microearthquakes in the immediate vicinity of the tunnel, and at least one has been correlated with other surface recordings.

Most studies in the preclosure tectonics program were involved primarily in data compilation and analysis, and in the preparation of interpretive reports several of which are now being technically reviewed. Reports in preparation and/or review include:

1. Catalog of seismic activity for 1994
2. Excavation induced seismicity
3. Evaluation and characterization of Quaternary faulting, Bare Mountain fault zone
4. Evaluation and characterization of Quaternary faulting on the Death Valley and Furnace Creek faults
5. Quaternary faulting -- Bow Ridge, Paintbrush Canyon and Stagecoach Road faults
6. Quaternary faulting -- postulated Fortymile Wash fault zone
7. Quaternary faulting -- Ghost Dance fault and northwest-trending faults
8. Quaternary faulting -- Solitario Canyon, Crater Flat, Windy Wash, and Fatigue Wash faults
9. Characterization of Quaternary faulting within the Rock Valley fault system
10. Characterization of Quaternary faulting within the Mine Mountain fault system
11. Characterization of Quaternary faulting within the Cane Spring fault system
12. Current evaluation of tectonic models for the Yucca Mountain region.

WBS 1.2.3.3 Hydrology

Regional Hydrology

Based on the report "A hydrogeologic map of the Death Valley region, Nevada and California", the ground-water flow system at Yucca Mountain and in the surrounding areas is best described as a series of interconnected intermontane basins in which ground-water flow occurs in basin-fill deposits, carbonate rocks, clastic rocks, and volcanic rocks. For purposes of developing a regional hydrogeologic framework, the bedrock and surficial deposits have been separated into ten laterally extensive hydrogeologic units with distinct hydrologic properties. These are: (1) Quaternary playa deposits, (2) Quaternary-Tertiary valley fill, (3) Quaternary-Tertiary volcanic rocks, (4) late Tertiary volcanic rocks, (5) late Tertiary volcanic and volcaniclastic rocks, (6) Late Jurassic-Tertiary intrusive granites, (7) Mesozoic sedimentary and metavolcanic rocks, (8) Paleozoic carbonate rocks, (9) Precambrian-Paleozoic clastic rocks, and (10) Precambrian igneous and metamorphic rocks. The report describes the geometry, composition, and physical properties of these various units, and the map (scale 1:500,000) shows their distribution over an area of about 100,000 $km^2$; Yucca Mountain is approximately at the center of the map area. Analysis of the regional flow system helps to define the hydrologic conditions at the potential repository site, and facilitates subsequent detailed site-scale hydrologic modeling.

Flow surveys in borehole USW G-2 provide additional data on the large hydraulic gradient directly north of the potential repository site at Yucca Mountain. Downward flows of between 0.1 and 0.2 gallons per minute were observed within the topmost 300 meters of the water column in the well. The data indicate that (1) flow rates are very small; and (2) flow, where repeatedly measurable, was downward. Geophysical log data also indicate that partial saturation may exist in the rock adjacent to the topmost 300 meters of the water column, and that the water content of the rock is consistently less than total saturation to a depth of about 825 meters, which coincides with an altitude of about 730 meters that represents the general potentiometric level for the saturated zone based on information from wells only a few kilometers south of borehole USW G-2. Below this depth (825 meters), water content is calculated to be nearly that of total porosity. Interpretations of the flow data are consistent with the results of the temperature logging, which, as reported earlier, indicate a vertical discontinuity in heat flow that is attributed to a downward flow of water across the zone penetrated by the borehole. Further testing is being planned in efforts to bring about a better understanding of this steep hydraulic gradient and its potential effect on repository performance.

No stream runoff was reported or observed in the Yucca Mountain area during September. Computation of peak-flow discharges from data collected after the March 11 runoff that had occurred in Fortymile Wash, Amargosa River, and their tributaries near Yucca Mountain continued. This information will be used to help define new ratings or modify existing ratings of stage-discharge relations for several of the Yucca Mountain and regional recording streamflow-gaging stations and to provide peak discharges at crest-stage gages. The Fortymile Wash drainage channel in particular is considered to be a potentially important zone of regional ground-water recharge into the repository block beneath Yucca Mountain.

Unsaturated Zone

Unsaturated zone infiltration studies are being conducted to (1) determine the effective hydraulic conductivity and storage and transport properties of rocks and surficial deposits covering Yucca Mountain, and (2) determine the present and estimate the future spatial distribution of infiltration rates over the potential repository block. Various activities -- such as mapping and physical and hydrologic properties testing of surficial deposits, monitoring natural infiltration through logging of neutron-access boreholes, compiling fault and fracture information, and preparing depth-to-bedrock and geomorphic surface maps -- are nearing completion, and the data are being applied in the development of conceptual models that portray the present state of understanding of the processes and mechanisms of infiltration in the unsaturated zone at Yucca Mountain. A report entitled "Estimation of shallow infiltration and presence of potential fast pathways for shallow infiltration in the Yucca Mountain area" is currently in review. This report supports the concept that deep water percolation through fractures is occurring even under the relatively arid climatic conditions that exist today.

A set of data that includes physical and hydrologic-flow properties measurements on outcrop samples from most of the rock units present at Yucca Mountain is presented in a report entitled "Physical and hydrologic properties of rock outcrop samples at Yucca Mountain, Nevada". The samples were collected from several different transects, located so as to represent both the vertical and lateral variability of the exposed volcanic tuff units. Physical properties measured were bulk density, particle density, and porosity. Hydrologic properties were saturated hydraulic conductivity, sorptivity determined from measurements of imbibition, and moisture retention curves. Observed porosity values range from 2 to 60 percent, and saturated hydraulic conductivity values range from 1E-12 to 4E-6 m/s. The porosity ranges are relatively small within most lithologic units. However, a range of 15 to 55 percent was found to occur within a vertical interval of only 7.3 m in a shard-rich subunit of the Tiva Canyon Tuff, and an abrupt porosity change from 4 to 39 percent was measured in the transition from a vitric to a nonwelded tuff in a vertical distance of a few centimeters in the upper part of the Topopah Spring Tuff. It is therefore apparent that (1) there are many subunits with distinct properties that could affect the estimation of ground water flow through the unsaturated zone, and (2) major geologic boundaries (such as formation contacts) do not always reflect hydrologic differences. The existence of very rapid vertical changes will probably require two-dimensional and three-dimensional models in several locations to predict the likely occurrence of lateral diversions of flow.

Pneumatic pressure records for boreholes UZ#4 and UZ#5 were examined and manipulated into a format that could be analyzed with the AIRK program. Preliminary analyses have been completed for UZ#4 and are underway for data collected at UZ#5. AT UZ#4, permeabilities inferred for subunits of the Paintbrush nonwelded hydrogeologic unit (PTn) were generally greater than $10^{-12}$ $m^2$, except for the shardy base subunit of the Tiva Canyon Tuff, where permeabilities were approximately an order of magnitude smaller. The densely welded vitrophyre at the top of the Topopah Spring Tuff also had an estimated permeability that was an order of magnitude smaller than the overlying nonwelded units.

Construction of a multiport gas sampling packer system to be installed in Alcove 2 borehole 1 was begun. The system is designed to provide gas samples from the Bow Ridge fault zone, and from both the foot-wall (lower lithophysal zone of the Tiva Canyon Tuff) and the hanging-wall (pre-Ranier Mesa Tuff) blocks.

Work continued on the development of programs and methodologies for analyzing and applying the neutron logging database to both conceptual and numerical modeling of infiltration processes in the unsaturated zone. This includes the development of macro programs (PAL) in the PARADOX database, the development of FORTRAN programs to perform calculations using the 10-year logging record, and the integration of the logging record with the meteorological database and information from GIS.

Saturated Zone

Aquifer tests done in 1984 in the c-holes have been analyzed in the context of more recently acquired hydrogeologic and geophysical site information; the results are incorporated in the report "Results and interpretation of preliminary aquifer tests in boreholes UE-25c#1, UE-25c#2, and UE-25c#3, Yucca Mountain, Nye County, Nevada". The three c-holes, each of which is about 915 m deep, are completed in tuffs and lavas of the Calico Hills Formation and the Crater Flat Group. Below the water table (at a depth of about 400 m), tectonic and cooling fractures are distributed mainly in 11 transmissive intervals, many of which also have matrix permeability. Although high-angle, north-trending fractures predominate in the rocks penetrated by the boreholes, fractures in the transmissive intervals have diverse orientations. From the water table to a depth of about 520 m, transmissive intervals are unconfined; however, deeper transmissive intervals respond to pumping as fissure-block or confined aquifers. Where intersected by faults below 825 m, transmissive intervals are recharged by water released from faults. Diverse aquifer tests (which are still continuing) have consistently indicated layered heterogeneity, and the dependence of calculated hydrologic properties on the volume of aquifer being tested.

Test runs of the FEHMN ground-water flow and transport code nested within a commercial parameter estimation program (PEST) were prepared. Test cases were done by taking results from forward simulations, using these results as observations, and having PEST calculate selected variables to minimize the residual between the observations and the current simulated results. Pressure boundaries and permeability values were calculated successfully by PEST to within 2 percent of the values. This result marks a significant advance in making FEHMN capable of running as an inverse model, which is the strategy planned for obtaining a calibrated model of the Yucca Mountain saturated zone flow system.

Activities involved in the monitoring of water levels and the study of hydraulic properties of rocks in the upper part of the saturated zone at Yucca Mountain included:

1. Continuation of testing in borehole UE-25 WT#12, with pumping cycles of 6 and 4 days, respectively. Total discharge during the two testing periods was 290,000 gallons, and the cumulative discharge for all tests at this well was about 433,000 gallons. Maximum drawdown was approximately 63 feet.

2. Continued analysis of results from the 6/12/95, 356 gallons/minute pumping test in UE-25c#3. In this test, the well was pumped in open-hole configuration while 6 packed-off intervals were monitored in wells UE-25c#1 and UE-25c#2.

3. Monitoring of 20 zones in 18 wells on a monthly basis and 16 zones in 11 wells on an hourly basis; collection of continuous analog data from 4 zones in 2 wells to monitor water-level responses to seismic events.

WBS 1.2.3.6 Climatology

Paleoclimatic and paleohydrologic studies continued along several lines of investigation, including:

1. Collection of numerous samples in the Crater Flat and Amargosa areas for analyses of fossil materials that will help to determine the paleoclimatic conditions responsible for the apparent rise in the water-table of the regional volcanic aquifer to ground level. Carbonate and fine-grained eolian detritus materials were also obtained at several sites for radiocarbon, uranium-series disequilibrium, and thermoluminescence dating; the carbonate samples will provide chemical and isotopic information on hydrogenic sources.

2. Collection and submission of more samples for radiocarbon dating, including approximately 100 recently collected packrat middens that will provide additional key information on the timing of climatic- and hydrologic-linked changes in the Yucca Mountain area.

3. Collection of sediment cores from Great Salt Lake; analyses of the fossil materials from these cores will provide the final regional climate dataset for inclusion in the Yucca Mountain climate program.

4. Chemical processing and isotopic analyses of uranium and thorium for dating pedogenic components collected from fault trenches, soil pits, and natural exposures associated with surficial deposits in Midway Valley and Fortymile Wash, as well as trenches along the Bare Mountain and Windy Wash fault systems.

5. Sampling of clasts with silica-rich rinds from trench RV-3, the analyses of which will help constrain the strike-slip component of movement on the northern strand of the Rock Valley fault.

6. Collection of pedogenic and detrital eolian materials from two trenches on the Crater Flat fault to provide geochronological control for Quaternary dip-slip movement based on uranium-series disequilibrium and thermoluminescence dating techniques.

7. Synthesis of all available geochronological data from Yucca Mountain trench and pit sites, and preparation of a report summarizing the results.

Compilation of available data from the chemical processing and isotopic analyses of opal and calcite vein material collected in the ESF indicates that age estimates of between 200 and 300 thousand years continue to dominate the resulting geochronological spectrum. The absence of a younger component, reflecting more recently precipitated calcite/opal from infiltrating waters during the last wet cycle, may either be (1) real, if the mountain remained closed to water infiltration; or (2) an analytical artifact of not being able to sample only the youngest, outermost materials. In order to assess the sensitivity of these estimates to sampling procedures, work was initiated to construct mathematical models designed to simulate the effects of mechanical mixing of various-aged components on final age estimates.

WBS 1.2.13.4 Water Resources Monitoring

Ground-water levels were measured at 28 sites, and discharge was measured at one flowing well.

# USGS LEVEL 3 MILESTONE REPORT
OCTOBER 1, 1994 - SEPTEMBER 30, 1995
Sorted by Baseline Date

| Deliverable | Due Date | Expected Date | Completed Date | Comments |
|---|---|---|---|---|
| ADMIN RPT: 1994 REGIONAL SEISMIC PROFILES<br>Milestone Number: 3GGU130M | | 10/16/95 | | |
| LTR RPT: 1991/1992 BOREHOLES<br>Milestone Number: 3GGU150M | | 10/16/95 | | |
| ADMIN RPT: SHEAR- & P-WAVE VELOCITIES, UZ-16 VSP<br>Milestone Number: 3GUP620M | | 10/31/95 | | |
| LTR RPT: 4th QUATER FY95<br>Milestone Number: 3GWR623M | | 10/31/95 | | |
| RPT: STRUCT/STRAT OF THE ESF - NORTH RAMP<br>Milestone Number: 3GGF530M | 01/31/95 | 10/31/95 | | |
| CATALOG OF SEISMIC ACTIVITY IN SGB FOR 1994<br>Milestone Number: 3GSM500M | 03/30/95 | 10/13/95 | | |
| LETTER REPORT: SITE SZ CONCEPTUAL MODEL<br>Milestone Number: 3GWM151M | 03/30/95 | 12/29/95 | | |
| RPT: QUATERNARY FLTING - MINE MTN FLT SYSTEM<br>Milestone Number: 3GTN510M | 05/31/95 | 11/30/95 | | |
| RPT: QUAT. FLT - POSTULATED FORTYMILE WASH FLT<br>Milestone Number: 3GPF520M | 05/31/95 | 10/31/95 | | |
| LTR RPT: BOW RIDGE/PAINTBRUSH CYN<br>Milestone Number: 3GPF530M | 05/31/95 | 10/31/95 | | |
| TECHNICAL REPORT: TECTONIC MODEL(S)<br>Milestone Number: 3GTE500M | 05/31/95 | 09/28/95 | 09/28/95 | |
| RPT: STRUCT/STRAT OF THE ESF - NORTH RAMP<br>Milestone Number: 3GGF540M | 06/30/95 | 10/31/95 | | |

| Deliverable | Due Date | Expected Date | Completed Date | Comments |
|---|---|---|---|---|
| RPT: PRECARIOUS ROCK METH.- APPLICATIONS TO YM<br>Milestone Number: 3GSM530M | 06/30/95 | 09/18/95 | 09/18/95 | |
| RPT: CHAR. QUAT. FLTING - ROCK VALLEY FAULT ZONE<br>Milestone Number: 3GTN500M | 06/30/95 | 10/27/95 | | |
| LTR RPT: ANALYSIS OF REGIONAL AVG ANNUAL PRECIP<br>Milestone Number: 3GMM105M | 06/30/95 | 10/31/95 | | |
| LETTER RPT: FY93-FY94 DATA FROM FORTYMILE WASH<br>Milestone Number: 3GRG137M | 06/30/95 | 09/28/95 | 09/28/95 | |
| RPT: QUAT. FLTING - CANE SPRING FAULT SYSTEM<br>Milestone Number: 3GTN520M | 07/31/95 | 11/15/95 | | |
| ANLYS PPR: QUAT FLTING-GHOST DANCE FLT<br>Milestone Number: 3GPF510M | 07/31/95 | 11/15/95 | | |
| FINAL RPT: QUATERNARY ACT. - BARE MTN FAULT ZONE<br>Milestone Number: 3GTQ530M | 08/31/95 | 10/27/95 | | |
| RPT: QUAT. ACT. -DEATH VALLEY/FURNACE CRK FLT<br>Milestone Number: 3GTQ540M | 08/31/95 | 10/27/95 | | |
| ANLYS PPR: QUAT FLTING-SOLITARIO CYN/CRATER FLAT<br>Milestone Number: 3GPF500M | 08/31/95 | 11/30/95 | | |
| LTR RPT: PRELIMINARY PALEOCLIMATE SYNTHESIS<br>Milestone Number: 3GQH570M | 08/31/95 | 09/28/95 | 09/28/95 | |
| LTR RPT: USGS SUP TO SURF FAC FIELD TEST & CHAR<br>Milestone Number: 3GSR500M | 08/31/95 | 08/31/95 | | |
| PROG. RPT: TECTONIC EFFECTS ON YM HYDROLOGY<br>Milestone Number: 3GTW520M | 09/29/95 | 10/30/95 | | |
| DATA RPT: SYN. OF GEOL/GEOPHYS/SEISMIC DATA<br>Milestone Number: 3GSS500M | 09/29/95 | 09/28/95 | 09/28/95 | |

 Printed: 10/17/95 08:47

| Deliverable | Due Date | Expected Date | Completed Date | Comments |
|---|---|---|---|---|
| PROV RESULTS: NET INFILTRATION FLUX MAP TO DOE<br>Milestone Number: 3GUI240M | 09/29/95 | 11/30/95 | | |
| PRV RLTS: POTENTIAL FAST PATHWAYS FLUX MAP - DOE<br>Milestone Number: 3GUI241M | 09/29/95 | 11/30/95 | | |
| LTR RPT: ALCOVE 1 TESTING<br>Milestone Number: 3GUS208M | 09/29/95 | 01/29/96 | | |
| LTR RPT: PRELIMINARY UZ HYDROCHEMISTRY AT YM<br>Milestone Number: 3GUH105M | 09/29/95 | 10/10/95 | | |
| LTR RPT: PRELIM FRACTURE MODEL, TIVA CANYON, YM<br>Milestone Number: 3GUF105M | 09/29/95 | 12/29/95 | | |
| INTERMEDIATE UZ HYDROLOGIC FRAMEWORK MODEL<br>Milestone Number: 3GUM107M | 09/29/95 | 09/20/95 | 09/20/95 | |
| MEMO TO DOE: AWARD HOIST SYSTEM CONTRACT<br>Milestone Number: 3GWH142M | 09/29/95 | 09/25/95 | 09/25/95 | |
| MEMO TO DOE: AWARD BH DISCRETIZATION CONTRACT<br>Milestone Number: 3GWH146M | 09/29/95 | 09/22/95 | 09/22/95 | |
| ANLYS PPR: MAGNETIC INVESTIGATIONS-YM/JET RIDGE<br>Milestone Number: 3GGU570M | 10/02/95 | 09/28/95 | 09/28/95 | |
| PROV RESULTS: GEOPHYSICS PERTAINING TO VOLCANISM<br>Milestone Number: 3GTW500M | 10/02/95 | 10/30/95 | | |
| LTR RPT: GM ATTENUATION RELATIONSHIPS<br>Milestone Number: 3GSA500M | 10/02/95 | 10/30/95 | | |
| LTR RPT: SEISMICITY INDUCED BY TBM<br>Milestone Number: 3GSM510M | 10/02/95 | 11/16/95 | | |
| ANLYS PAPER: HYDROGEOLOGY OF USW G-2<br>Milestone Number: 3GRG103M | 10/02/95 | 09/28/95 | 09/28/95 | |

| Deliverable | Due Date | Expected Date | Completed Date | Comments |
|---|---|---|---|---|
| ANALYSIS PAPER: FORTYMILE WASH RECHARGE<br>Milestone Number: 3GRG133M | 10/02/95 | 02/02/96 | | |
| DATA TO TDB: FINAL INVERSE MODFLOWP DATA SETS<br>Milestone Number: 3GRM127M | 10/02/95 | 10/31/95 | | |
| LTR RPT: ANALYTICAL ELEMENT MODELING REPORT<br>Milestone Number: 3GRM147M | 10/02/95 | 01/30/96 | | |
| DATA TO TDB: INTERP REGIONAL FRAMEWORK DATA<br>Milestone Number: 3GRM163M | 10/02/95 | 09/28/95 | 09/28/95 | |
| LTR RPT: IN-SITU BOREHOLE MONITORING DATA REPORT<br>Milestone Number: 3GUP423M | 10/02/95 | 03/04/96 | | |
| LETTER REPORT: PRELIM TRACER TEST ANALYSIS<br>Milestone Number: 3GGP108M | 10/02/95 | 12/04/95 | | |
| LTR RPT: AGES OF SURFICIAL SOIL DEPOSITS<br>Milestone Number: 3GCH510M | 10/02/95 | 09/28/95 | 09/28/95 | |
| LETTER REPORT: FY95 FIELD AND LAB DATA<br>Milestone Number: 3GWR105M | 10/02/95 | 03/29/96 | | |
| LETTER REPORT: SUMMARY MONITORING THRU FY94<br>Milestone Number: 3GWR125M | 10/02/95 | 11/30/95 | | |
| ANLYS PPR: REGIONAL SEISMIC REFLECTION PROFILES<br>Milestone Number: 3GGU640M | 10/31/95 | 10/31/95 | | |

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: September 30, 1995**

PARTICIPANT: USGS PEM: Royer WBS: 1.2.1.6

WBS TITLE: Technical Interface

P&S ACCOUNT: OG16

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 109 | 109 | 28 | 0 | 0.0 | 100.0 | 81 | 74.3 | 389.3 | 109 | 28 | 81 | 74.3 | 28 | 0.0 |

## Analysis

### Cumulative Cost Variance:

Not applicable.

### Cumulative Schedule Variance:

Not applicable.

### Variance At Complete:

Cause:

Delays in staffing and less than the planned level of effort result in the positive cost variance.

Impact:

There is a cost underrun of $81K in this P&S account.

Corrective Action:

No corrective action required. Account is closed and due to less than the planned level of effort being requested, there is a valid underrun.

P&S ACCOUNT MANAGER DATE TPO DATE

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: September 30, 1995

PARTICIPANT: USGS PEM: NESBIT WBS: 1.2.3.2.2.1.1

WBS TITLE: Participant Management & Integration

P&S ACCOUNT: OG312

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 2138 | 2129 | 2349 | -9 | -0.4 | 99.6 | -220 | -10.3 | 90.6 | 2138 | 2349 | -211 | -9.9 | 2360 | 0.0 |

## Analysis

Cumulative Cost Variance:

Cause:

This cost overrun is due to 1)unplanned staffing of a Quality Assurance Implementation Specialist in Nevada to assist USGS staff in the field with ensuring data collected meets quality assurance requirements; 2)installation of a new telephone system for the Denver Federal Center offices to replace an outdated system; 3)significant unplanned travel (about 30K) for discipline lead support to the M&O contractor at the Dawson Building; and 4)general funding shortfalls in this P&S account in FY1995 leaving very minimal funding for supplies & materials, publications, vehicle support, etc.

Impact:

There is a cost overrun in this P&S account of approximately $211K.

Corrective Action:

No corrective action possible. There are adequate cost underruns within the 1.2.3 cost accounts to cover this cost overrun.

Cumulative Schedule Variance:

Not Applicable

Variance At Complete:

See "Cumulative Cost Variance".

| | | | |
|---|---|---|---|
| P&S ACCOUNT MANAGER | DATE | TPO | DATE |

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: September 30, 1995**

**PARTICIPANT: USGS PEM: TYNAN WBS: 1.2.3.2.2.1.1**

**WBS TITLE: Vertical and Lateral Distribution of Stratigraphic Units in the Site Area**

**P&S ACCOUNT: OG32211**

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 2263 | 2263 | 1796 | 0 | 0.0 | 100.0 | 467 | 20.6 | 126.0 | 2263 | 1796 | 467 | 20.6 | 1796 | 0.0 |

**Analysis**

Cumulative Cost Variance:

Cause:

The cost variance is primarily due to the bids for the processing portion of the seismic reflection contract coming in much lower than the budgeted amount. While $348K had been budgeted for this portion of the contract, costs to date are around $25K, resulting in a large positive cost variance. There are also smaller cost underruns in several summary accounts comprising this total.

Impact:

There is no schedule impact resulting from this cost underrun because it is due to lower than planned costs for the same work. There is a cost underrun of approximately $287K for this P&S account (see explanation below).

Corrective Action:

No corrective action possible. Some of this cost underrun is required to offset cost overruns within the 1.2.3 cost accounts. $180K of this underrun was presented to the AM for Scientific Programs as a source of funds for the M&O/WCFS shortfall in WBS 1.2.3.2.8.3.6, Probabilistic Seismic Hazards Analysis; an AFP change form has been submitted to transfer $180K to the M&O/WCFS for additional support to the USGS for this work. There was no C/SCR submitted for this transfer of funds so the budget at complete indicates a greater overrun than actual funds available.

Cumulative Schedule Variance:

Not Applicable

**Variance At Complete:**

See "Cumulative Cost Variance".

| | | | |
|---|---|---|---|
| **P&S ACCOUNT MANAGER** | **DATE** | **TPO** | **DATE** |

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: September 30, 1995**

**PARTICIPANT: USGS PEM: TYNAN WBS: 1.2.3.2.2.1.2**

**WBS TITLE: Structural Features Within the Site Area**

**P&S Account: OG32212**

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 2887 | 2586 | 3097 | -301 | -10.4 | 89.6 | -511 | -19.8 | 83.5 | 2887 | 3097 | -210 | -7.3 | 3457 | 0.0 |

## Analysis

Cumulative Cost Variance:

Cause:

The negative cost variance is due to a combination of the negative schedule variance resulting from overdue milestone reports on the mapping of the North Ramp of the ESF and restructuring of the rock characteristics program, resulting in unplanned and unbudgeted staff being added to this P&S account after planning and budgeting for FY1995 had been completed. The urgency to complete the planned mapping in FY1995 made it necessary to procure support from the Geologic Division of the USGS, resulting in additional unplanned costs.

Impact:

This account has a cost overrun of $210K at fiscal year end, with several milestones remaining to be completed (see schedule variance).

Corrective Action:

There is no corrective action possible. Costs were incurred to meet the approved scope of work. There are adequate cost underruns within this third level WBS to offset cost overruns.

Cumulative Schedule Variance:

Cause:

Slow penetration rates by the TBM early in the fiscal year reduced the amount of mapping information collected, and on the date the first deliverable was due, no data was available to report on. The agreement was then to combine this deliverable with the following deliverable on the same data and submit it by the end of FY1995. Progress of the TBM increased in the latter part of FY1995, and the workload on the USBR ESF mapping staff increased. The demands to provide geotechnical data, and the large amount of mapping to be completed delayed completion of the milestone.

Impact:

Several ESF mapping milestones planned for FY1995 were delayed beyond the end of the fiscal year. Preliminary input was provided to DOE.

Corrective Action:

Milestones will be completed and submitted at no additional cost to the Project.

**Variance At Complete:**

Not applicable.

| | | | |
|---|---|---|---|
| **P&S ACCOUNT MANAGER** | **DATE** | **TPO** | **DATE** |

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: September 30, 1995

PARTICIPANT: USGS PEM: Sullivan WBS: 1.2.3.2.5.2

WBS TITLE: Tectonic Effects Eval Chng in NEBS Result. Tect. Proc.

P&S ACCOUNT: OG3252

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 265 | 243 | 343 | - -22 | --8.3 | 91.7 | -100 | -41.2 | 70.8 | 265 | 343 | -78 | -29.4 | 374 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

Cause:

The negative cost variance is due to higher than anticipated contractor costs to conduct hydrologic modeling to determine tectonic effects on the ground water flow system at Yucca Mountain.

Impact:

This account is overrun by approximately $78K and the level 3 milestone was not completed due to a misunderstanding of the acceptance criteria by the principal investigator for this activity, resulting in the milestone being rejected by the TPO.

Corrective Action:

The principal investigator is revising the milestone to meet the acceptance criteria, and will complete the milestone prior to 12/31/95 at no additional cost to the Project.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

See "Cumulative Cost Variance".

P&S ACCOUNT MANAGER DATE TPO DATE

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: September 30, 1995

PARTICIPANT: USGS     PEM: SULLIVAN     WBS: 1.2.3.2.8.4.1

WBS TITLE: Historical & Current Seismicity

P&S ACCOUNT: OG32841

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 1757 | 2148 | 1713 | -391 | -22.3 | 122.3 | 435 | 20.3 | 125.4 | 1757 | 1713 | 44 | 2.5 | 1401 | 0.0 |

## Analysis

Cumulative Cost Variance:

Cause:

The positive cumulative cost variance is the result of the digital upgrade to the seismic network being completed to the extent possible ahead the scheduled date. This was a multi-year task that, due to funding constraints in FY1996 which preclude continuation of the digital upgrade, was statused as complete on 09/29/95 resulting in both a large cost and schedule variance, although no work was actually completed ahead of schedule and there was no work completed for significantly less cost.

Impact:

There is no impact from either the cost or schedule variance as the upgrade was completed to the extent possible, just not to the extent originally planned.

Corrective Action:

No corrective action required.

Cumulative Schedule Variance:

Cause:

The positive schedule variance results from the digital upgrade being statused as complete because it was completed to the extent possible given the available funding. See discussion under "Cumulative Cost Variance".

Impact:

See "Cumulative Cost Variance".

Corrective Action:

See "Cumulative Cost Variance".

**Variance At Complete:**

Not applicable.

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: September 30, 1995**

PARTICIPANT: USGS PEM: SULLIVAN WBS: 1.2.3.2.8.4.6

WBS TITLE: Quaternary Faulting Within the Site Area

P&S ACCOUNT: OG32846

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 475 | 424 | 532 | -51 | -10.7 | 89.3 | -108 | -25.5 | 79.7 | 475 | 532 | -57 | -12.0 | 596 | 0.0 |

Analysis

Cumulative Cost Variance:

Cause:

The negative cumulative cost variance is the result of the principal investigator assigned to this study being overcommitted and the account being underbudgeted for the scope. The PI was responsible for the completion of four level three milestone reports, all of which required field work in the form of trench logging and report preparation. Other staff members had to be funded to support the completion of field work and report preparation. Two unbudgeted YMPB-USGS and one contract employee were added to this activity. The delay in completing milestone reports also resulted in a behind schedule condition, increasing the cost variance.

Impact:

This account was overrun by about $57K.

Corrective Action:

No corrective action possible for cost variance. There are adequate cost underruns in this third level WBS to offset cost overruns. Milestones will be completed early in FY1996.

Cumulative Schedule Variance:

Not Applicable

**Variance At Complete:**

See "Cumulative Cost Variance"

| | | | |
|---|---|---|---|
| P&S ACCOUNT MANAGER | DATE | TPO | DATE |

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: September 30, 1995

**PARTICIPANT: USGS** **PEM: PATTERSON** **WBS: 1.2.3.3.1.1.1**

**WBS TITLE: Precipitation and Meteorological Monitoring for Regional Hydrology**

**P&S ACCOUNT: OG33111**

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 320 | 293 | 206 | -27 | -8.4 | 91.6 | 87 | 29.7 | 142.2 | 320 | 206 | 114 | 35.6 | 225 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

Not applicable.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

Cause:

The positive variance at complete is the result of two unplanned vacancies, and delays in filling a third vacancy.

Impact:

Due to staffing shortages, some of the planned work for FY1995 were not completed. Level 3 milestones 3GMM107M, LTR RPT:Analysis Regional Storm Events, and 3GGM108M, LTR RPT:Analysis Site Meteorological Data were not completed. This account has a cost underrun of about $114K from the planned budget.

Corrective Action:

A report currently in process documents analysis of regional storm types through FY1993; analysis through FY1994 is not needed. Statistical analysis of FY1994 site meteorological data has been performed already and incorporated in a report currently in review that was intended originally to document conditions only through FY1993. An AFP change was processed by the M&O contractor in June 1995 transferring $91K of the projected underrun funds to the M&O for peer reviews, resulting in a final underrun of only about $23K.

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: September 30, 1995

PARTICIPANT: USGS     PEM: PATTERSON     WBS: 1.2.3.3.1.2.3

WBS TITLE: Percolation in the Unsaturated Zone - Surface Based

P&S ACCOUNT: OG33123

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 3050 | 2513 | 2845 | -537 | -17.6 | 82.4 | -332.0 | -13.2 | 88.3 | 3050 | 2845 | 205 | 6.7 | 3454 | 0.0 |

## Analysis

Cumulative Cost Variance:

Cause:

1) $181 K of the cost overrun is due to actual spending for the VSP summary account that closely matched the original cost of planned work even though a number of planned tasks were not completed. This was because the planning and execution of the initial UZ-16 VSP survey took considerably more time than anticipated and staff were required to support the entire protracted effort.

2) $40 K of the cost overrun is due to overspending in the Drilling and Drillhole-Instrumentation summary account for the separation incentive paid to a Federal employee who took the Government-wide buyout (30 K) and for additional supplies and materials (10 K) needed for instrumentation of boreholes UZ-7a and SD-12, which is occurring early in FY 96.

3) $184 K of the cost overrun was due to a) a schedule-variance error in summary account 0G33123E95 (75 K), b) an actual schedule variance in the same summary account (35 K), c) unanticipated spending in the Sensor Calibration and In-Situ Testing summary account for the separation incentive paid to a Federal employee who took the Government-wide buyout (30 K), and d) unanticipated spending for supplies and materials needed by the HRF calibration lab to support instrumentation of UZ-7a and SD-12 (44 K).

Impact:

1) There is no significant cost impact because follow-on UZ-16 VSP work already has been replanned and budgeted in FY 96.

2) Overspending contributed to modest overrun in the P&S account (13%), but this was more than offset by underspending in other USGS 1.2.3 P&S accounts.

3) Overspending contributed to modest overrun in the P&S account (13%), but this was more than offset by underspending in other USGS 1.2.3 P&S accounts.

Corrective Action:

1) Replanning and budgeting for FY 96 UZ-16 VSP work has been completed.

2) None; 3) None

Cumulative Schedule Variance:

Cause:

1) $154 K of the schedule variance is due to scheduled but unexecuted capital-equipment purchases. Of this, 53 K was for equipment for borehole instrumentation that will not be needed until FY 97 because of postponement of additional borehole instrumentation until that time. $100 K was for an air permeameter for the matrix-properties summary account that will not be purchased under current plans because, with staffing reductions mandated by reduced FY 96 budget, there is no one available to run the machine.

2) $27 K of the variance is due to failure to complete the second air-K testing field trailer and testing system.

3) $175 K of the variance is due to delay in the conduct of the initial VSP survey at UZ-16 which was scheduled for completion in January 1995 but will not be completed until some time in October.

4) $16 K of the variance is due to a slight delay in the submittal of borehole- instrumentation records for UZ-4 and UZ-5.

5) $110 K of the variance is due to failure to complete a technical procedure for in-situ recalibration of pressure transducers, and failure to correctly status as complete a task for gas sampling of instrumented boreholes (75 K).

6) $24 K of the variance is due to delay in processing and submittal of the second batch of raw data from monitoring of NRG-6 and NRG-7a, and the first batch from UZ-4 and UZ-5.

7) $31 K of the variance is due to delay in completion of level-3 milestone report 3GUP423M, which is the second borehole monitoring data report, and delay in completion of the draft interpretive report on North Ramp Hydrogeology (level 4 milestone 3GUP430M). Both reports have been delayed because of loss of staff due to FY 96 budget reduction and diversion of available staff to the instrumentation of boreholes UZ-7a and SD-12.

Impact:

1) There is no schedule impact from failure to purchase the capital equipment because of reconfiguration and down-scoping of work for FY 96.

2) There is no schedule impact from failure to complete the second air-K testing field trailer and testing system because the YMSCO has deferred any further surface-based air-K testing due to FY 96 budget reduction.

3) Subsequent VSP tasks involving reduction, analysis, and interpretation of UZ-16 VSP data will be delayed proportionately.

4) No impact because records have been completed and submitted.

5) In-situ recalibration of pressure transducers installed in boreholes may not be accomplished.

6) No significant impact because results of monitoring have been transmitted informally within YMP and were summarized in Site-Characterization Progress Report #13.

7) Delay in completion of these reports is likely to result in delay of subsequent reports (semiannual data reports; annual interpretive reports).

Corrective Action:

1) None; 2) None

3) Delayed UZ-16 VSP tasks have been replanned into FY 96.

4) None

5) The importance/need for in-situ pressure-transducer recalibration will have to be reevaluated. With FY 96 budget reductions, there is no staff available to complete this technical procedure.

6) None. Processing of data is proceeding as fast as possible given reduced FY 96 staffing.

7) The only viable corrective action to avoid future delays would be restoration of budget and lost staff, which seems unlikely given FY 96 budget constraints.

Variance At Complete:

Not applicable.

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: September 30, 1995**

PARTICIPANT: USGS PEM: PATTERSON WBS: 1.2.3.3.1.2.4

WBS TITLE: Percolation in the Unsaturated Zone - ESF Study

P&S ACCOUNT: OG33124

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | ICPI |
| 1393 | 1198 | 1127 | -195 | -14.0 | 86.0 | 71 | 5.9 | 106.3 | 1393 | 1127 | 266 | 19.1 | 1310 | 0.0 |

## Analysis

### Cumulative Cost Variance:

Cause:

Negative cost variances totaling $143 K occurred in three summary accounts as follows: $27 K in the Percolation Test due to overspending on contract labor during the last quarter of FY 95 to conduct detailed planning for Alcove 3 and 4 tests that were believed at the time to be budgeted; $88 K in the Intact Fractures Test summary account due to the schedule variance described below; and $28 K in the Air-K and Hydrochemistry Testing summary account due to overspending on a capital-equipment purchase for packers.

The negative cost variances were more than offset by underspending totaling $214 K in three other summary accounts as follows: $48 K in the Perched Water summary account due to lower labor and equipment costs than planned because no perched water was encountered in the ESF; $13 K in the Excavation Effects Test due to underspending on labor; and $153 K in the Air-K and Hydrochemistry Testing summary account due to underspending for supplies, equipment, and chemical analyses because of delays in construction, borehole drilling, and testing in Alcoves 2 and 3.

Impact: Overall there is no cost impact because the P&S account is underspent by $266 K.

Corrective Action: None

### Cumulative Schedule Variance:

Cause:

1) $50 K of the schedule variance is due to a planned but unexecuted capital-equipment purchase of a high-pressure cell for the Intact Fractures summary account.

2) $7 K of the variance is due to noncompletion of detailed plans for Percolation Block Testing in ESF Alcoves 3 and 4.

3) $41 K of the variance is due to noncompletion of sensor calibration and technical procedures for the Excavation Effects Test.

4) $97 K of the variance is due to noncompletion of fabrication and testing of the axial-fracture high-pressure vessel.

Impact:

1) There is no schedule impact because the Intact Fracture Test is not funded in FY 96 and all work has been suspended indefinitely.

2) There is no schedule impact because the Percolation Block Tests are not funded in FY 96 and all work has been suspended indefinitely.

3) There is no schedule impact because the Excavation Effects Test is not funded in FY 96 and all work has been suspended indefinitely.

4) There is no schedule impact because the Intact Fracture Test is not funded in FY 96 and all work has been suspended indefinitely.

Corrective Action:

1) None; 2) None; 3) None; 4) None

Variance At Complete:

See "Cumulative Cost Variance" and "Cumulative Schedule Variance".

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: September 30, 1995

PARTICIPANT: USGS PEM: Patterson WBS: 1.2.3.3.1.2.7

WBS TITLE: Unsaturated Zone Hydrochemistry

P&S ACCOUNT: OG33127

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 1005 | 943 | 826 | -62 | -6.2 | 93.8 | 117 | 12.4 | 114.2 | 1005 | 826 | 179 | 17.8 | 880 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

Cause:

The positive cumulative cost variance results from reductions in the estimated cost of hydrochemical sample analyses due to fewer samples being available from the surface-based drilling program and ESF, and deferral in hiring of a contract hydrochemical technician for pore-water extraction.

Impact:

There is an approximate cost underrun of $179K in this account. There is no schedule impact resulting from this cost underrun as the reduction in the number of pore-water and gas samples is justified given the current drilling and ESF schedules, and current staff can extract pore water as fast as current equipment configuration will allow.

Corrective Action:

No corrective action possible. There is a cost underrun in this P&S account.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

See "Cumulative Cost Variance".

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: September 30, 1995

PARTICIPANT: USGS PEM: Patterson WBS: 1.2.3.3.1.3.2

WBS TITLE: Saturated Zone Hydrochemistry

P&S ACCOUNT: OG33132

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 455 | 426 | 352 | -29 | -6.4 | 93.6 | 74 | 17.4 | 121.0 | 455 | 352 | 103 | 22.6 | 376 | 0.0 |

## Analysis

Cumulative Cost Variance:

Not applicable.

Cumulative Schedule Variance:

Not applicable.

Variance At Complete:

Cause:

The positive variance at complete is the result of not filling a vacancy planned to be staffed in mid-FY1995. Work was performed by a temporary detail, so the majority of budgeted salary and relocation costs were not incurred. The position was not filled as planned because cleanouts of existing boreholes did not occur as planned due to the unavailability of drill crews.

Impact:

Due to staffing shortages, some of the work planned for FY1995 was not completed. Level 3 milestone 3GWH126M, scheduled for completion by 11/30/95, will not be met as scheduled. Level 3 milestone 3GWH108M will have a significantly reduced scope because many of the anticipated cleanouts did not occur and will not occur. Given the extremely reduced funding anticipated for FY1996, milestone 3GWH108M may not be completed at all because priority will be given to 3GWH126M.

Corrective Action:

No corrective action is required because of the greatly reduced funding expected in FY1996. The funding that is available will be used to complete milestone 3GWH126M, and to archive the data that would have gone into milestone 3GWH108M.

| | | | |
|---|---|---|---|
| **P&S ACCOUNT MANAGER** | **DATE** | **TPO** | **DATE** |

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: September 30, 1995

**PARTICIPANT:** USGS **PEM:** Patterson **WBS:** 1.2.3.3.1.3.3

**WBS TITLE:** Saturated Zone Hydrologic System Synthesis & Modeling

**P&S ACCOUNT:** OG33133

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 573 | 599 | 497 | 26 | 4.5 | 104.5 | 102 | 17.0 | 120.5 | 573 | 497 | 76 | 13.3 | 476 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

Cause:

The positive cost variance is primarily the result of diversion of personnel to other activities, primarily summary accounts OG33113A95, OG33131E95, and management and integration tasks. It was necessary to divert personnel to collect otherwise irretrievable data on perched water, and to support extensive testing at borehole WT-12. In addition, personnel had to be diverted from completing the conceptual model to support interactions with various groups and to support the extremely detailed planning exercises for FY1996.

Impact:

Milestone 3GWM151M was not completed in FY1995 and is currently scheduled to be completed by 12/31/95 pending availability of appropriate funding levels in FY1996. The site numerical model did not reach the level of maturity that was anticipated because sufficient time could not be spent on it. Additionally, the regional inverse model was not calibrated to the degree anticipated by the end of FY1995; this likely will delay the final calibration of the site model.

Corrective Action:

Replan completion of milestone 3GWM151M into FY1996, and fund at the level at which summary account OG33133C96 was underspent in FY1995 ($24K). Continue work on the site-scale numerical model to the degree that FY1996 funding permits.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

See "Cumulative Cost Variance".

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: September 30, 1995

PARTICIPANT: USGS PEM: Morris WBS: 1.2.3.6.2.1.3

WBS TITLE: CLIMATIC IMPLICATIONS OF TERRESTRIAL PALEOECOLOGY

P&S ACCOUNT: OG36213

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 200 | 176 | 137 | -24 | -12.0 | 88.0 | 39 | 22.2 | 128.5 | 200 | 137 | 63 | 31.5 | 156 | - 0.0 |

## Analysis

Cumulative Cost Variance:

Not applicable.

Cumulative Schedule Variance:
Not applicable.

Variance At Complete:

Cause:

All funds budgeted for C-14 dating were not able to be used this FY because paperwork was not processed in time to award a contract this FY. Some dating was done under smaller purchase orders, which have a later cutoff for processing.

Impact:

This account has a cost underrun of about $63K. However, needed C-14 dating will still need to be completed.

Corrective Action:

Account has a cost underrun of about $63K; if appropriate, work not completed will be replanned to FY1996.

P&S ACCOUNT MANAGER DATE TPO DATE

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: September 30, 1995**

PARTICIPANT: USGS     PEM: MORRIS     WBS: 1.2.3.6.2.1.4

WBS TITLE: Paleoenvironmental History of Yucca Mountain

P&S ACCOUNT: OG36214

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 725 | 725 | 538 | 0 | 0.0 | 100.0 | 187 | 25.8 | 134.8 | 725 | 538 | 187 | 25.8 | 538 | 0.0 |

## Analysis

Cumulative Cost Variance:

Cause:

Positive cost variances result from work costing less than the budgeted amount in the surficial deposits mapping activity. Some sample analyses were completed at no cost to the Project. Also, some equipment procurements were cancelled because they were not in accordance with FY1996 priorities.

Impact:

There is no impact resulting from this cost variance. Work was completed.

Corrective Action:

No corrective action required. Account has a cost underrun of about $187K.

Cumulative Schedule Variance:

Not applicable.

Variance At Complete:

See "Cumulative cost variance."

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: September 30, 1995

PARTICIPANT: USGS PEM: MORRIS WBS: 1.2.3.6.2.2.1

WBS TITLE: Quaternary Regional Hydrology

P&S ACCOUNT: OG36221

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 720 | 720 | 403 | - 0 | -0.0 | 100.0 | 317 | 44.0 | 178.7 | 720 | 403 | 317.0 | 44.0 | 403 | 0.0 |

## Analysis

### Cumulative Cost Variance:

Cause:

The positive cost variance is due to cancellation of the lease of a mass spectrometer and automated carbonate device for small samples, originally planned for February 1995. This procurement was cancelled because it is not in accordance with FY1996 priorities.

Impact:

There is no impact to the cancellation of procurement for the leasing contract as the existing mass spectrometer was able to handle the FY1995 sample load. The leasing contract was cancelled because it is not in accordance with FY1996 priorities. There is a cost underrun in this P&S account of about $317K.

Corrective Action:

No corrective action is required. Existing mass spectrometer was used to complete FY1995 samples. FY1996 work scope does not require purchase of a new mass spectrometer.

### Cumulative Schedule Variance:

Not Applicable.

**Variance At Complete:**

See "Cumulative Cost Variance"

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

Yucca Mountain Site Characterization Project
Variance Analysis Report
Status Thru: September 30, 1995

PARTICIPANT: USGS PEM: Gil WBS: 1.2.5.6

WBS TITLE: Site Suitability Evaluation

P&S ACCOUNT: OG56

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 68 | 68 | 12 | 0 | 0.0 | 100.0 | 56 | 82.4 | 566.7 | 68 | 12 | 56 | 82.4 | 12 | 0.0 |

Analysis

Cumulative Cost Variance:

**Not applicable.**

Cumulative Schedule Variance:

Not applicable.

Variance At Complete:

Cause:

The positive cost variance results from less than the planned level of effort in this account.

Impact:

There is no impact to work being performed in this level of effort account. There is a cost underrun of $56K in this P&S account.

Corrective Action:

No corrective action possible. Work was completed as requested and there are funds remaining in this P&S account.

P&S ACCOUNT MANAGER DATE TPO DATE

# Yucca Mountain Site Characterization Project
# Variance Analysis Report
# Status Thru: September 30, 1995

PARTICIPANT: USGS     PEM: Gil     WBS: 1.2.5.7

WBS TITLE: Technical Evaluation

P&S ACCOUNT: OG57

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 558 | 558 | 435 | 0 | 0.0 | 100.0 | 123 | 22.0 | 128.3 | 558 | 435 | 123 | 22.0 | 435 | 0.0 |

## Analysis

Cumulative Cost Variance:

Cause:

The positive cost variance results from less than the planned level of effort in this account. No work was requested on issue resolution this fiscal year, and therefore, no costs were incurred in that summary account budgeted at $59K.

Impact:

There is no impact to work being performed in this level of effort account. This account has a cost underrun of about $123K.

Corrective Action:

No corrective action possible. Account has a cost underrun of about $123K; work was performed as requested in this level of effort account.

Cumulative Schedule Variance:

Not applicable.

Variance At Complete:

See "Cumulative Cost Variance"

P&S ACCOUNT MANAGER     DATE     TPO     DATE

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: September 30, 1995**

PARTICIPANT: USGS    PEM: Fox    WBS: 1.2.9.1.2.1

WBS TITLE: Technical Project Office Management

P&S ACCOUNT: OG9121

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 436 | 436 | 506 | 0.0 | 0.0 | 100.0 | -70 | -16.1 | 86.2 | 436 | 506 | -70 | -16.1 | 506 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

Not applicable.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

Cause:

The negative cumulative cost variance is primarily due to continuing costs being incurred in the relocation of USGS offices, as well as costs incurred in moving additional personnel to new space. Additional space was required to be added, and costs for moving personnel, phone and computer lines to this space was unplanned.

Impact:

Account has a cost overrun of $70K.

Corrective Action:

No corrective action possible. Costs were legitimately incurred in this account. There are adequate cost underruns in this third level WBS to cover the cost overruns.

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: September 30, 1995**

**PARTICIPANT: USGS** **PEM: Fox** **WBS: 1.2.9.2.2**

**WBS TITLE: Participant Project Control**

**P&S ACCOUNT: OG922**

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 655 | 655 | 433 | 0.0 | 0.0 | 100.0 | 222 | 33.9 | 151.3 | 655 | 433 | 222 | 33.9 | 433 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

Cause:

The positive variance at complete is primarily due not filling a planned staff position for additional support in the area of cost estimating. Part time matrix support is currently supporting this effort. Contractor support was provided at a cost less than estimated. Travel and procurements were considerably below budgeted amount.

Impact:

This P&S account has a cost underrun of approximately $222K. Work was accomplished through a combination of matrix support and unpaid extended hours on the part of existing staff.

Corrective Action:

No corrective action is possible. A portion of this cost underrun is necessary to cover cost overruns of approximately $70Kin P&S account OG912195B.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

See "Cumulative cost variance".

P&S ACCOUNT MANAGER DATE TPO DATE

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: September 30, 1995**

PARTICIPANT: USGS PEM: Gandi WBS: 1.2.12

WBS TITLE: Local Records Center Operation

P&S ACCOUNT: OGC22

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 367 | 367 | 304 | 0 | 0.0 | 100.0 | 63 | 17.2 | 120.7 | 367 | 304 | 63 | 17.2 | 304 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

Not applicable.

**Cumulative Schedule Variance:**

Not applicable.

**Variance At Complete:**

Cause:

The positive variance at complete results from delays in filling unplanned staffing vacancies, and less than was budgeted being spent for supplies and materials.

Impact:

There is a cost underrun of about $63K in this level of effort account.

Corrective Action:

No corrective action possible. Account has a cost underrun of approximately $63K.

P&S ACCOUNT MANAGER DATE TPO DATE

**Yucca Mountain Site Characterization Project**
**Variance Analysis Report**
**Status Thru: September 30, 1995**

PARTICIPANT: USGS PEM: Dixon WBS: 1.2.13.4.7

WBS TITLE: Water Resources

P&S ACCOUNT: OGD47

| FY 1995 Cumulative to Date | | | | | | | | | FY 1995 at Completion | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | BCWP | ACWP | SV | SV% | SPI | CV | CV% | CPI | BAC | EAC | VAC | VAC% | IEAC | TCPI |
| 964 | 677 | 616 | -287 | -29.8 | 70.2 | 61 | 9.0 | 109.9 | 964 | 616 | 348 | 36.1 | 877 | 0.0 |

## Analysis

**Cumulative Cost Variance:**

Not applicable.

**Cumulative Schedule Variance:**

Cause:
Due to a lack of staff, delays were encountered in the start of work on the water quality monitoring project, resulting in delays in completion of milestone 3GWR105M, Letter Report FY1995 Field and Lab Data.

Impact:
There is no impact. Data collected in FY1995 is available to the Project upon request. This work is not funded in FY1996.

Corrective Action:
No corrective action. Work is not funded in FY1996.

**Variance At Complete:**

Cause:
This account is showing a positive variance at complete due to cancellation of procurements of large value items. There was $225K planned for procurements in this account, which was cancelled due to lack of funds in FY1996. Also, planned sample analyses were not completed at the level budgeted.

Impact:
This account has an underrun of about $348K. Procurements will not be completed.

Corrective Action:
None possible.

| P&S ACCOUNT MANAGER | DATE | TPO | DATE |
|---|---|---|---|

Participant USGS | Yucca Mtn. Site Char. Project-Planning & Control System | 01-Sep-95 to 30-Sep-95
PACS Participant Work Station (PPWS) | Page - 1
Prepared - 10/16/95:10:54:33 | WBS Status Sheet (WBS02) | Inc. Dollars in Thousands

WBS No. - 1.2

WBS Title - Yucca Mountain Project

Parent WBS No. -

Parent WBS Title -

Element ID - ZZ

Statement of Work:

See the current WBS Dictionary

Cost/Schedule Performance

| | | Current Period | | | | | FY1995 Cumulative to Date | | | | | FY1995 at Completion | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Id | Description | BCWS | BCWP | ACWP | SV | CV | BCWS | BCWP | ACWP | SV | CV | BAC | EAC | VAC |
| 1.2.1 | Systems Engineering | 13 | 13 | 1 | 0 | 12 | 134 | 134 | 32 | 0 | 102 | 134 | 32 | 102 |
| 1.2.3 | Site Investigations | 2163 | 1879 | 2890 | -284 | -1011 | 26294 | 25141 | 24336 | -1153 | 805 | 26294 | 24336 | 1958 |
| 1.2.5 | Regulatory | 130 | 130 | 146 | 0 | -16 | 1236 | 1236 | 1031 | 0 | 205 | 1236 | 1031 | 205 |
| 1.2.9 | Project Management | 160 | 160 | 116 | 0 | 44 | 1091 | 1091 | 939 | 0 | 152 | 1091 | 939 | 152 |
| 1.2.11 | Quality Assurance | 152 | 152 | 172 | 0 | -20 | 1840 | 1840 | 1817 | 0 | 23 | 1840 | 1817 | 23 |
| 1.2.12 | Information Management | 44 | 44 | 33 | 0 | 11 | 530 | 530 | 444 | 0 | 86 | 530 | 444 | 86 |
| 1.2.13 | Environment, Safety, and H | 298 | 8 | 135 | -290 | -127 | 1066 | 779 | 726 | -287 | 53 | 1066 | 726 | 340 |
| 1.2.15 | Support Services | 180 | 180 | 223 | 0 | -43 | 2180 | 2180 | 2187 | 0 | -7 | 2180 | 2187 | -7 |
| Total | | 3140 | 2566 | 3716 | -574 | -1150 | 34371 | 32931 | 31512 | -1440 | 1419 | 34371 | 31512 | 2859 |

Resource Distributions by Element of Cost

Fiscal Year 1995
Budgeted Cost of Work Scheduled

| | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LBRHRS | 30178 | 30906 | 26588 | 30827 | 32174 | 33470 | 32656 | 33376 | 31077 | 31090 | 30757 | 28724 | 371823 |
| LABOR | 1192 | 1194 | 1020 | 1176 | 1290 | 1334 | 1314 | 1326 | 1289 | 1280 | 1263 | 1243 | 14921 |
| SUBS | 868 | 898 | 892 | 866 | 903 | 924 | 889 | 931 | 910 | 939 | 892 | 876 | 10788 |
| TRAVEL | 128 | 147 | 112 | 135 | 129 | 144 | 132 | 132 | 115 | 112 | 93 | 72 | 1451 |
| PM&E | 194 | 188 | 219 | 353 | 128 | 269 | 125 | 151 | 147 | 151 | 82 | 67 | 2074 |
| OTHER | 299 | 283 | 282 | 632 | 517 | 352 | 328 | 264 | 300 | 326 | 325 | 321 | 4229 |
| CAPITAL | 0 | 0 | 0 | 0 | 39 | 12 | 21 | 99 | 144 | 0 | 32 | 561 | 908 |
| Total BCWS | 2681 | 2710 | 2525 | 3162 | 3006 | 3035 | 2809 | 2903 | 2905 | 2808 | 2687 | 3140 | 34371 |

WBS No. - 1.2 -Yucca Mountain Project

Resource Distributions by Element of Cost

Fiscal Year 1995

| Actual Cost of Work Performed | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LBRHRS | 18146 | 19477 | 17987 | 27965 | 24888 | 29359 | 23962 | 29636 | 31795 | 31865 | 32540 | 28878 | 316498 |
| LABOR | 679 | 676 | 787 | 1397 | 1107 | 1279 | 1046 | 1388 | 1302 | 1196 | 1371 | 1368 | 13596 |
| SUBS | 783 | 845 | 760 | 562 | 811 | 1028 | 715 | 805 | 867 | 908 | 983 | 1303 | 10370 |
| TRAVEL | 22 | 68 | 61 | 58 | 87 | 62 | 153 | 15 | 87 | 29 | 95 | 147 | 884 |
| PM&E | 135 | 234 | 227 | -81 | 223 | 327 | 403 | 326 | 153 | 247 | 256 | 256 | 2706 |
| OTHER | 143 | 170 | 263 | 337 | 493 | 230 | 235 | 379 | 348 | 145 | 335 | 493 | 3571 |
| CAPITAL | 0 | 0 | 0 | 0 | 39 | 12 | 21 | 59 | 45 | 19 | 41 | 149 | 385 |
| Total ACWP | 1762 | 1993 | 2098 | 2273 | 2760 | 2938 | 2573 | 2972 | 2802 | 2544 | 3081 | 3716 | 31512 |
| **Estimate to Complete** | | | | | | | | | | | | | |
| LBRHRS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LABOR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SUBS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TRAVEL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PM&E | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OTHER | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CAPITAL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Resource Distributions

| Fiscal Year 1995 | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | 2681 | 2710 | 2525 | 3162 | 3006 | 3035 | 2809 | 2903 | 2905 | 2808 | 2687 | 3140 | 34371 |
| BCWP | 2375 | 2559 | 2591 | 3397 | 2784 | 2640 | 2797 | 3027 | 2851 | 2642 | 2702 | 2566 | 32931 |
| ACWP | 1762 | 1993 | 2098 | 2273 | 2760 | 2938 | 2573 | 2972 | 2802 | 2544 | 3081 | 3716 | 31512 |
| ETC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Fiscal Year Distribution

| | Prior | FY1995 | FY1996 | FY1997 | FY1998 | FY1999 | FY2000 | FY2001 | FY2002 | FY2003 | FY2004 | Future | At Complete |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCWS | 0 | 34371 | 44570 | 473 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 79414 |
| BCWP | 0 | 32931 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ACWP | 0 | 31512 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| ETC | 0 | 0 | 44897 | 473 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 76882 |

YMP PLANNING AND CONTROL SYSTEM (PACS)

Participant U.S. Geological Survey
Date Prepared 10/18/95 08:56

**MONTHLY COST/FTE REPORT**

Fiscal Month/Year SEPTEMBER 1995


| | CURRENT MONTH END | | | | | | FISCAL YEAR | | |
|---|---|---|---|---|---|---|---|---|---|
| WBS ELEMENT | ACTUAL COSTS | PARTICIPANT HOURS | SUBCON HOURS | PURCHASE COMMITMENTS | SUBCON COMMITMENTS | ACCRUED COSTS | APPROVED BUDGET | APPROVED FUNDS | CUMMULATIVE COSTS |
| 1.2.1 | 1 | 16 | 0 | 0 | 0 | | 134 | 134 | 31 |
| 1.2.3 | 2722 | 23344 | 17929 | 268 | 0 | | 26294 | 25611 | 23853 |
| 1.2.5 | 146 | 1506 | 977 | 0 | 0 | | 1236 | 1276 | 1025 |
| 1.2.9 | 115 | 728 | 314 | 0 | 0 | | 1091 | 1091 | 938 |
| 1.2.11 | 170 | 1176 | 1780 | 0 | 0 | | 1840 | 1840 | 1811 |
| 1.2.12 | 33 | 0 | 1070 | 0 | 0 | | 530 | 530 | 440 |
| 1.2.13 | 133 | 796 | 127 | 0 | 0 | | 1066 | 1019 | 742 |
| 1.2.15 | 222 | 1312 | 1273 | 0 | 0 | | 2180 | 2180 | 2181 |
| TOTALS | 3542 | 28878 | 23470 | 268 | 0 | 0 | 34371 | 33681 | 31021 |

U.S. GEOLOGICAL SURVEY

ESTIMATED COSTS FOR 10/1/94 - 09/30/95

| | | OCT EST | NOV EST | DEC EST | JAN EST | FEB EST | MAR EST | APR EST | MAY EST | JUN EST | JUL EST | AUG EST | SEP EST | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0G1695B | Technical Interface | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.3 | 3.6 | 0.5 | 0.3 | 0.7 | 5.8 |
| 0G1695B1 | Special Studies | 0.0 | 0.0 | 1.3 | 2.9 | 4.6 | 2.1 | 13.4 | -5.9 | 2.0 | 1.0 | 0.0 | 0.0 | 21.4 |
| 1.2.1.6 | | 0.0 | 0.0 | 1.3 | 2.9 | 4.6 | 2.1 | 13.8 | -5.6 | 5.6 | 1.5 | 0.3 | 0.7 | 27.2 |
| *1.2.1.6 | | 0.0 | 0.0 | 1.3 | 2.9 | 4.6 | 2.1 | 13.8 | -5.6 | 5.6 | 1.5 | 0.3 | 0.7 | 27.2 |
| 0G1A95B | Q-List Development and Maintenance | 0.0 | 3.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.7 |
| 1.2.1.10 | | 0.0 | 3.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.7 |
| *1.2.1.1 | | 0.0 | 3.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.7 |
| **1.2.1 | | 0.0 | 3.7 | 1.3 | 2.9 | 4.6 | 2.1 | 13.8 | -5.6 | 5.6 | 1.5 | 0.3 | 0.7 | 30.9 |
| 0G31295B1 | ESI Science Advisory Group | 1.6 | 0.5 | 0.3 | 1.5 | 36.6 | 26.3 | 12.1 | 7.0 | 12.4 | -0.6 | 33.0 | 11.8 | 142.5 |
| 0G31295B2 | Nevada Operations | 19.6 | 19.9 | 18.5 | 17.7 | 17.5 | 28.2 | 23.5 | 77.1 | 31.5 | -13.4 | 21.4 | 45.6 | 307.1 |
| 0G31295B3 | Tracer Gas Support | 0.0 | 31.4 | -3.5 | 19.5 | 5.6 | -6.7 | 9.1 | 6.7 | 13.2 | -10.1 | 6.8 | 11.0 | 83.0 |
| 0G31295B5 | YMPB Computer Operations | 25.6 | 27.3 | 31.1 | 40.7 | 29.8 | 40.3 | 39.0 | 47.2 | 71.7 | 19.0 | 32.7 | 36.8 | 441.2 |
| 0G31295B6 | YMPB Scientific Rpts/Project Documents | 14.8 | 7.0 | 19.5 | 17.4 | 17.6 | 15.9 | 25.5 | 22.2 | 12.5 | 20.9 | 33.8 | 8.5 | 215.6 |
| 0G31295B7 | Earth Science Investigations (ESI) | 47.9 | 33.3 | 47.2 | 46.5 | 44.9 | 53.5 | 58.4 | 67.1 | 91.1 | 67.2 | 83.8 | 128.2 | 769.1 |
| 0G31295B8 | ESI QA Implementation | 37.3 | 39.7 | 20.0 | 30.7 | 21.2 | 26.0 | 17.3 | 27.0 | 42.1 | 31.6 | 43.4 | 41.2 | 377.5 |
| 1.2.3.1.2 | | 146.8 | 159.1 | 133.1 | 174.0 | 173.2 | 183.5 | 184.9 | 254.3 | 274.5 | 114.6 | 254.9 | 283.1 | 2336.0 |
| *1.2.3.1 | | 146.8 | 159.1 | 133.1 | 174.0 | 173.2 | 183.5 | 184.9 | 254.3 | 274.5 | 114.6 | 254.9 | 283.1 | 2336.0 |
| 0G32211B96 | Update 3D models lithostrat/structural/r | 26.1 | 23.7 | 31.4 | 65.2 | 26.1 | 24.8 | 25.9 | 29.1 | 26.0 | 23.9 | 85.7 | 19.3 | 407.2 |
| 0G32211C95 | Results of Measured Sections in Site Are | 18.6 | 21.5 | 22.2 | -5.6 | 34.9 | 24.2 | 40.6 | 14.0 | 19.4 | 8.1 | 12.9 | 12.4 | 223.2 |
| 0G32211D95 | Geophysics White Paper, Phase II | 0.0 | 4.2 | 4.0 | 16.6 | 1.9 | 1.7 | -3.1 | 5.6 | 1.7 | 1.7 | -0.1 | 0.4 | 34.6 |
| 0G32211E96 | Regional Seismic Reflection Profiles | 101.7 | 31.9 | 4.9 | 31.6 | 34.6 | 14.5 | 25.8 | 26.2 | 11.7 | 4.3 | 34.4 | 2.7 | 324.3 |
| 0G32211F96 | Integration of Geology and Geophysics | 1.1 | -0.2 | 3.0 | 43.5 | 4.5 | 6.8 | 4.1 | 19.0 | 17.2 | 30.0 | 17.7 | 9.1 | 155.8 |
| 0G32211G96 | Lithologic Logging of Core | 20.9 | 12.3 | 13.1 | 25.7 | 30.5 | 10.8 | 41.6 | 19.9 | 3.0 | 25.7 | 21.3 | 41.4 | 266.2 |
| 0G32211H95 | Magnetic Investigations - YM/Jet Ridge | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 14.5 | 10.7 | 1.2 | 16.0 | -13.5 | 6.9 | 7.9 | 43.7 |
| 0G32211J95 | Magnetic/Gravity Investigations, at YM | 0.0 | 0.0 | 0.0 | 18.2 | 2.0 | 2.3 | 7.2 | 10.2 | -11.6 | 10.3 | 3.6 | 1.6 | 43.8 |
| 0G32211K96 | Mag Along Seismic Profile, Crater Flat, | 0.0 | 0.6 | 0.0 | 20.2 | 6.2 | 2.4 | -1.5 | 3.6 | 3.2 | 7.4 | 24.6 | 10.5 | 77.2 |
| 0G32211L96 | Strat Desc of Bullfrog & Tram Tuffs | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.1 | 6.4 | 9.4 | 13.5 | 34.4 |
| 0G32211M95 | Lithology & Hydrologic Properties in the | 1.7 | 7.7 | 11.7 | 10.3 | -2.7 | 15.9 | 14.5 | 15.8 | 8.3 | 15.2 | 0.6 | 8.3 | 107.3 |
| 0G32211Q95 | Mag/Grav Studies to Locate Volcanic Dril | 0.0 | 1.4 | 0.0 | 11.3 | 10.6 | 13.0 | 4.5 | 6.1 | -2.2 | 4.5 | 8.1 | 13.7 | 71.0 |
| 1.2.3.2.2.1.1 | | 170.1 | 103.1 | 90.3 | 237.0 | 148.6 | 130.9 | 170.3 | 150.7 | 97.8 | 124.0 | 225.1 | 140.8 | 1788.7 |
| 0G32212A95 | Enhance Surface Geologic Maps | 48.8 | 63.7 | 60.2 | 7.1 | -8.5 | 36.2 | 25.3 | 37.8 | 42.9 | 10.6 | 19.0 | 9.8 | 352.9 |
| 0G32212B95 | Geometry & Continuity of the Sundance Fa | 5.8 | 0.2 | 1.4 | 67.5 | 28.6 | 75.8 | 41.7 | 28.2 | 10.4 | 36.4 | 34.4 | 5.8 | 336.2 |
| 0G32212C96 | Expanded Surface Geology Mapping | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 18.6 | 25.8 | 34.9 | 79.3 |
| 0G32212D96 | Mapping in the ESF | 55.8 | 95.6 | 70.2 | 20.2 | 277.7 | 237.5 | 238.9 | 167.8 | 180.1 | 194.6 | 230.1 | 228.0 | 1996.5 |
| 0G32212E95 | Vert Continuity of Fracture/Char-Paintbr | 8.3 | 2.8 | 9.1 | -16.0 | 9.8 | 18.0 | 31.7 | 23.1 | 9.9 | 21.9 | 17.3 | 25.8 | 161.7 |
| 0G32212F95 | Pavement Mapping At Fran Ridge | 1.1 | 3.2 | 1.3 | 15.9 | 2.3 | 6.3 | 9.7 | 7.6 | 21.0 | 9.2 | 2.0 | 2.0 | 81.6 |
| 0G32212G96 | Verif & Enhance Scott & Bonk-Jet Ridge/M | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 38.2 | 21.4 | 36.0 | 95.6 |

U.S. GEOLOGICAL SURVEY

ESTIMATED COSTS FOR 10/1/94 - 09/30/95

| | | OCT EST | NOV EST | DEC EST | JAN EST | FEB EST | MAR EST | APR EST | MAY EST | JUN EST | JUL EST | AUG EST | SEP EST | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.2.3.2.2.1.2 | | 119.8 | 165.5 | 142.2 | 94.7 | 309.9 | 373.8 | 347.3 | 264.5 | 264.3 | 329.5 | 350.0 | 342.3 | 3103.8 |
| 0G3252A95 | Structural Controls on Basaltic Volcanis | 3.6 | -0.4 | 6.0 | 13.6 | -2.2 | 7.8 | 6.3 | 5.4 | 8.7 | 13.4 | 26.9 | 73.2 | 162.3 |
| 0G3252C95 | Tectonic Effects on YM Hydrologic System | 0.0 | 0.0 | 0.0 | 0.0 | 18.0 | 21.3 | 5.2 | 23.1 | 5.3 | 18.8 | 14.8 | 71.9 | 178.4 |
| 1.2.3.2.5.2 | | 3.6 | -0.4 | 6.0 | 13.6 | 15.8 | 29.1 | 11.5 | 28.5 | 14.0 | 32.2 | 41.7 | 145.1 | 340.7 |
| 0G32623A95 | Technical Support for Soil and Rock | 0.0 | 0.1 | 0.7 | 1.9 | 3.5 | -0.5 | 0.1 | 1.8 | -0.3 | 0.7 | 2.4 | 7.1 | 17.5 |
| 1.2.3.2.6.2.3 | | 0.0 | 0.1 | 0.7 | 1.9 | 3.5 | -0.5 | 0.1 | 1.8 | -0.3 | 0.7 | 2.4 | 7.1 | 17.5 |
| 0G32722A96 | Collect/Interpret Heat Flow Data | 0.0 | 0.1 | 0.8 | 0.0 | 27.7 | 40.5 | 4.1 | 1.2 | 20.2 | 35.8 | -6.8 | 14.7 | 138.3 |
| 1.2.3.2.7.2.2 | | 0.0 | 0.1 | 0.8 | 0.0 | 27.7 | 40.5 | 4.1 | 1.2 | 20.2 | 35.8 | -6.8 | 14.7 | 138.3 |
| 0G32831A95 | Synthesis of Geol/Geophys/Seismic Data | 5.7 | 11.4 | -1.1 | 10.2 | 20.3 | 30.8 | 13.8 | 13.7 | 12.1 | 24.8 | 13.1 | 25.0 | 179.8 |
| 1.2.3.2.8.3.1 | | 5.7 | 11.4 | -1.1 | 10.2 | 20.3 | 30.8 | 13.8 | 13.7 | 12.1 | 24.8 | 13.1 | 25.0 | 179.8 |
| 0G32833A95 | Ground Motion Attenuation | 0.0 | 0.0 | 0.0 | 52.6 | 10.8 | 28.8 | 17.8 | 16.9 | 57.2 | 0.0 | 84.8 | 12.5 | 281.4 |
| 0G32833B96 | Ground Motion Modeling | 0.0 | 0.0 | 0.0 | 8.2 | 33.1 | 134.6 | 2.8 | 13.9 | 16.3 | 3.4 | 22.3 | 0.9 | 235.5 |
| 1.2.3.2.8.3.3 | | 0.0 | 0.0 | 0.0 | 60.8 | 43.9 | 163.4 | 20.6 | 30.8 | 73.5 | 3.4 | 107.1 | 13.4 | 516.9 |
| 0G32836A95 | GM Char in Prob. Seismic Hazard Analysis | 2.0 | -0.3 | 0.0 | -1.7 | 6.1 | 1.2 | 3.5 | 12.0 | 6.5 | 5.4 | 1.4 | 23.0 | 59.1 |
| 0G32836B95 | Probalistic Seismic Hazard Analysis | 6.9 | 4.4 | 23.6 | 20.4 | -20.5 | 6.8 | 0.7 | 12.6 | 6.6 | -0.5 | 7.1 | 30.8 | 98.9 |
| 1.2.3.2.8.3.6 | | 8.9 | 4.1 | 23.6 | 18.7 | -14.4 | 8.0 | 4.2 | 24.6 | 13.1 | 4.9 | 8.5 | 53.8 | 158.0 |
| 0G32841A95 | Catalog of Seismic Activity | 116.0 | 10.9 | 22.4 | 63.9 | 61.1 | 51.7 | 49.4 | 47.9 | 49.7 | 34.5 | 178.3 | 114.5 | 800.3 |
| 0G32841B95 | Excavation Induced Seismic Activity | 0.0 | 9.1 | 20.5 | 2.7 | 2.4 | 1.5 | 1.5 | 2.2 | 1.4 | 1.0 | 5.4 | 16.8 | 64.5 |
| 0G32841C96 | Digital Upgrade SGB Seismic Network | 0.0 | 68.0 | 20.5 | 36.6 | 35.8 | 38.4 | 68.2 | 58.1 | 57.4 | 38.5 | 58.1 | -14.8 | 464.8 |
| 0G32841D95 | Precarious Rock Methodology | 0.0 | 0.0 | 20.5 | 4.6 | 4.3 | 7.1 | 8.9 | 7.7 | 7.0 | 8.0 | 29.4 | -42.5 | 55.0 |
| 0G32841E95 | Strong Motion Array | 0.0 | 22.7 | 20.5 | 6.2 | 5.1 | 9.2 | 4.9 | 7.2 | 7.5 | 21.8 | 23.4 | 19.9 | 148.4 |
| 1.2.3.2.8.4.1 | | 116.0 | 110.7 | 104.4 | 114.0 | 108.7 | 107.9 | 132.9 | 123.1 | 123.0 | 103.8 | 294.6 | 93.9 | 1533.0 |
| 0G32843A95 | Quaternary Faulting - Amargosa Desert | 0.0 | 0.0 | 0.0 | 24.2 | 24.2 | -0.2 | 1.0 | 18.0 | 21.0 | 44.8 | 0.2 | 0.0 | 133.2 |
| 0G32843B95 | Quaternary Faulting - Regional Faults | 0.0 | 0.0 | 0.0 | 42.0 | 12.5 | 26.8 | 11.6 | 47.1 | 37.7 | 81.1 | 19.3 | 0.8 | 278.9 |
| 0G32843C95 | Quaternary Flting - Bare Mtn Fault Zone | 8.6 | 8.0 | 3.3 | 7.6 | 3.0 | 28.0 | 30.4 | 46.5 | 34.2 | 26.6 | 8.3 | 4.1 | 208.6 |
| 0G32843D95 | Char Death Valley-Furnace Creek Flt. Zon | 0.0 | 42.9 | 7.9 | 29.2 | 15.5 | 23.9 | 22.5 | 5.1 | 0.0 | 0.0 | 0.0 | 0.0 | 147.0 |
| 1.2.3.2.8.4.3 | | 8.6 | 50.9 | 11.2 | 103.0 | 55.2 | 78.5 | 65.5 | 116.7 | 92.9 | 152.5 | 27.8 | 4.9 | 767.7 |
| 0G32844A95 | Quaternary Fltling Rock Valley Flt Sys | 0.0 | 0.6 | 10.1 | 13.2 | 17.0 | 29.1 | 18.0 | 9.7 | 23.9 | 9.0 | 23.1 | 68.3 | 222.0 |
| 0G32844B95 | Quaternary Flting - Mine Mtn Flt System | 0.0 | 0.0 | 0.0 | 0.0 | 4.9 | -0.1 | 10.0 | 3.4 | 2.4 | 0.2 | 6.9 | -2.1 | 25.6 |
| 0G32844C95 | Quaternary Flting - Cane Springs Flt Sys | 3.3 | 2.7 | -6.0 | 0.0 | 9.5 | 1.1 | 4.0 | 4.1 | 5.1 | 11.0 | 4.0 | 15.5 | 54.3 |
| 1.2.3.2.8.4.4 | | 3.3 | 3.3 | 4.1 | 13.2 | 31.4 | 30.1 | 32.0 | 17.2 | 31.4 | 20.2 | 34.0 | 81.7 | 301.9 |
| 0G32845A95 | Detachment Faults | 5.8 | 14.5 | 46.3 | -21.8 | 19.3 | 23.0 | 29.3 | 15.0 | 29.3 | 44.7 | 36.0 | 10.7 | 252.1 |
| 1.2.3.2.8.4.5 | | 5.8 | 14.5 | 46.3 | -21.8 | 19.3 | 23.0 | 29.3 | 15.0 | 29.3 | 44.7 | 36.0 | 10.7 | 252.1 |
| 0G32846A95 | Quat Flting-Solitario Cyn/Crater Flt/Win | 11.0 | 7.0 | 18.4 | -3.7 | 25.8 | 14.5 | 15.0 | 7.8 | 15.6 | 27.9 | 13.6 | 22.6 | 175.5 |
| 0G32846B95 | Quaternary Flting - Ghost Dance Flt | 2.4 | 6.9 | 9.9 | 2.4 | 8.2 | 21.5 | 17.6 | 20.5 | 18.9 | 21.4 | 22.8 | 31.7 | 184.2 |
| 0G32846C95 | Quaternary Flting - Post Fortymile Wash | 0.0 | 0.5 | 0.0 | 0.0 | 3.1 | 1.2 | 10.3 | 9.6 | 14.3 | 5.0 | -0.9 | 1.2 | 44.3 |
| 0G32846D95 | Quat Flting-Bow Ridge/Paintbrush Cyn/Sta | 8.9 | 10.8 | 14.0 | 13.6 | 19.8 | 20.1 | 4.8 | 9.7 | 5.9 | 2.2 | 5.0 | 7.4 | 122.2 |

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| | OCT EST | NOV EST | DEC EST | JAN EST | FEB EST | MAR EST | APR EST | MAY EST | JUN EST | JUL EST | AUG EST | SEP EST | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.2.3.2.8.4.6 | 22.3 | 25.2 | 42.3 | 12.3 | 56.9 | 57.3 | 47.7 | 47.6 | 54.7 | 56.5 | 40.5 | 62.9 | 526.2 |
| 0G32848A95 In-situ Stress Measurements | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 0.0 | 0.0 | 0.8 | 0.0 | 4.6 | 0.0 | 0.9 | 9.4 |
| 1.2.3.2.8.4.8 | 0.0 | 0.0 | 0.0 | 0.0 | 3.1 | 0.0 | 0.0 | 0.8 | 0.0 | 4.6 | 0.0 | 0.9 | 9.4 |
| 0G3284AA95 Geodetic Leveling | 0.0 | 0.0 | 0.0 | 17.0 | -6.4 | 22.0 | 0.0 | 14.5 | 39.6 | 0.0 | 4.4 | 0.0 | 91.1 |
| 0G3284AB95 Death Valley/Furnace Creek Leveling | 0.0 | 0.0 | 0.0 | 5.4 | 9.4 | 6.8 | 0.0 | 17.9 | 0.5 | 12.9 | 0.4 | 16.5 | 69.8 |
| 1.2.3.2.8.4.10 | 0.0 | 0.0 | 0.0 | 22.4 | 3.0 | 28.8 | 0.0 | 32.4 | 40.1 | 12.9 | 4.8 | 16.5 | 160.9 |
| 0G3284CA96 Tectonic Models and Synthesis | 4.4 | 40.0 | 7.8 | -12.5 | 27.8 | 21.0 | 3.1 | 33.5 | 27.7 | 35.9 | 15.9 | 35.8 | 240.4 |
| 1.2.3.2.8.4.12 | 4.4 | 40.0 | 7.8 | -12.5 | 27.8 | 21.0 | 3.1 | 33.5 | 27.7 | 35.9 | 15.9 | 35.8 | 240.4 |
| *1.2.3.2 | 468.5 | 528.5 | 478.6 | 667.5 | 860.7 | 1122.6 | 882.4 | 902.1 | 893.8 | 986.4 | 1194.7 | 1049.5 | 10035.3 |
| 0G33111A96 Char of the Meteorology for Regional Hyd | 11.3 | 8.5 | 11.9 | 8.4 | 6.3 | 11.8 | 6.9 | 12.0 | 26.9 | 25.6 | 41.1 | 32.5 | 203.2 |
| 1.2.3.3.1.1.1 | 11.3 | 8.5 | 11.9 | 8.4 | 6.3 | 11.8 | 6.9 | 12.0 | 26.9 | 25.6 | 41.1 | 32.5 | 203.2 |
| 0G33112A95 Streamflow Data, FY94 | 5.5 | 5.5 | 8.1 | 13.5 | 4.8 | 10.6 | 16.7 | 24.2 | 0.0 | 0.0 | 0.0 | 0.0 | 88.9 |
| 0G33112B96 Streamflow Data, FY95 | 21.7 | 23.5 | 26.2 | 25.2 | 28.6 | 21.3 | 19.9 | 32.2 | 19.3 | 29.7 | 38.0 | 24.4 | 310.0 |
| 1.2.3.3.1.1.2 | 27.2 | 29.0 | 34.3 | 38.7 | 33.4 | 31.9 | 36.6 | 56.4 | 19.3 | 29.7 | 38.0 | 24.4 | 398.9 |
| 0G33113A95 Assessment of Key Data/Modeling Problems | 4.3 | 4.6 | 2.4 | 5.9 | 15.0 | 5.9 | 4.8 | 11.2 | 36.3 | 14.6 | 11.0 | 17.4 | 133.4 |
| 0G33113C95 Fortymile Wash Recharge | 5.5 | 5.4 | 6.0 | 7.2 | 5.5 | 5.8 | 7.2 | 21.2 | 7.2 | 6.9 | 7.0 | 7.1 | 92.0 |
| 1.2.3.3.1.1.3 | 9.8 | 10.0 | 8.4 | 13.1 | 20.5 | 11.7 | 12.0 | 32.4 | 43.5 | 21.5 | 18.0 | 24.5 | 225.4 |
| 0G33114A96 Regional SZ Numerical Flow Model | 7.0 | 17.8 | 5.3 | -6.5 | 15.6 | 2.3 | 3.9 | 41.5 | 8.2 | 9.8 | 18.7 | 19.5 | 143.1 |
| 0G33114B96 SZ Flow Model Boundary Conditions Evalua | 0.0 | 0.2 | 0.6 | 0.8 | 3.6 | 3.8 | 3.0 | 3.6 | -1.3 | 0.7 | 1.1 | 117.3 | 133.4 |
| 0G33114C96 Regional SZ Hydrogeologic Framework Mode | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 7.0 | 10.7 | 13.8 | 59.2 | 2.5 | 5.7 | -0.2 | 100.2 |
| 1.2.3.3.1.1.4 | 7.0 | 18.0 | 5.9 | -5.7 | 20.7 | 13.1 | 17.6 | 58.9 | 66.1 | 13.0 | 25.5 | 136.6 | 376.7 |
| 0G33121A96 Infiltration Properties | 35.0 | 50.0 | 58.8 | 33.6 | 49.4 | 49.0 | 52.8 | 48.1 | 61.3 | 44.5 | 62.4 | 61.5 | 606.4 |
| 0G33121B96 Infiltration Processes | 26.3 | 30.5 | 40.3 | 28.8 | 49.6 | 29.0 | 36.1 | 39.2 | 15.5 | 27.3 | 35.0 | 50.8 | 408.4 |
| 0G33121C95 Infiltration Distribution | 22.5 | 15.2 | 19.7 | 31.2 | 19.8 | 24.1 | 20.3 | 23.2 | 23.7 | 17.0 | 25.1 | 2.5 | 244.3 |
| 1.2.3.3.1.2.1 | 83.8 | 95.7 | 118.8 | 93.6 | 118.8 | 102.1 | 109.2 | 110.5 | 100.5 | 88.8 | 122.5 | 114.8 | 1259.1 |
| 0G33123A96 Matrix Properties of Hydrogeologic Units | 29.7 | 26.2 | 30.5 | 37.3 | 33.2 | 39.8 | 29.0 | 35.0 | 35.6 | 37.2 | 32.1 | 35.6 | 401.2 |
| 0G33123B95 Surface-Based Air-Permeability Testing | 23.5 | 20.4 | 27.9 | 22.5 | 168.1 | 24.7 | 38.2 | 34.0 | 18.7 | 21.8 | 24.4 | 33.4 | 457.6 |
| 0G33123C95 Vertical Seismic Profiling Test | 14.3 | 9.8 | 2.6 | 9.4 | 73.0 | 18.3 | 46.4 | -10.8 | 13.9 | 20.1 | 12.9 | 82.4 | 292.3 |
| 0G33123D95 Drilling & Drillhole Instrumentation | 102.1 | 76.5 | 40.4 | 46.4 | 30.6 | 66.4 | 23.7 | 130.3 | 38.0 | 47.3 | 34.7 | 60.2 | 696.6 |
| 0G33123E95 Sensor Calibration & In-Situ Testing | 33.6 | 41.7 | 38.6 | 42.7 | 42.3 | 36.8 | 32.2 | 29.6 | 63.9 | 49.6 | 44.3 | 61.9 | 517.2 |
| 0G33123F95 UZ Monit, DataBase Mgnt, QA Support, & C | 24.4 | 25.1 | 23.9 | 30.4 | 23.3 | 36.4 | 23.8 | 23.4 | 21.7 | 25.3 | 32.0 | 17.2 | 306.9 |
| 0G33123G95 Integrated Data Analysis and Interpretat | 0.0 | 1.0 | 7.5 | -2.6 | 5.5 | 3.8 | 17.2 | 20.3 | 14.7 | 21.7 | 13.2 | 14.6 | 116.9 |
| 1.2.3.3.1.2.3 | 227.6 | 200.7 | 171.4 | 186.1 | 376.0 | 226.2 | 210.5 | 261.8 | 206.5 | 223.0 | 193.6 | 305.3 | 2788.7 |
| 0G33124A96 North Ramp Perched Water Testing | 6.0 | 6.5 | 6.6 | 6.9 | 6.0 | 10.8 | 6.7 | 10.2 | 10.2 | 20.2 | 8.7 | 14.2 | 113.0 |
| 0G33124B95 Percolation Test in the ESF | 6.0 | 11.2 | 10.6 | 7.3 | 7.4 | 7.2 | 6.1 | 4.5 | 6.9 | 10.6 | 6.4 | 16.0 | 100.2 |
| 0G33124C95 Excavation Effects Test in the ESF | 6.3 | 2.0 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.5 | 2.6 | 13.1 |
| 0G33124D96 Intact Fractures Test, ESF | 22.1 | 50.7 | 29.0 | 32.2 | 22.9 | 35.6 | 29.3 | 34.2 | 30.4 | 32.3 | 35.0 | 43.2 | 396.9 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0G33124E97 Air-K & Hydrochemistry Testing-North Ram | 16.4 | 20.8 | 23.6 | 24.4 | 36.0 | 64.2 | 15.3 | 66.1 | 43.3 | 27.9 | 33.4 | 52.6 | 424.0 |
| 1.2.3.3.1.2.4 | 56.8 | 91.2 | 70.5 | 70.8 | 72.3 | 117.8 | 57.4 | 115.0 | 90.8 | 91.0 | 85.0 | 128.6 | 1047.2 |
| 0G33126A96 North Ramp, ESF Gas Phase Circulation | 20.2 | 17.5 | 24.3 | 50.1 | 43.1 | 24.1 | 20.5 | 8.5 | 16.2 | 11.3 | 16.2 | 8.2 | 260.2 |
| 1.2.3.3.1.2.6 | 20.2 | 17.5 | 24.3 | 50.1 | 43.1 | 24.1 | 20.5 | 8.5 | 16.2 | 11.3 | 16.2 | 8.2 | 260.2 |
| 0G33127A96 UZ Hydrochemistry | 71.7 | 69.8 | 71.6 | -24.6 | 43.9 | 59.1 | 78.1 | 39.4 | 66.7 | 95.9 | 75.7 | 127.8 | 775.1 |
| 1.2.3.3.1.2.7 | 71.7 | 69.8 | 71.6 | -24.6 | 43.9 | 59.1 | 78.1 | 39.4 | 66.7 | 95.9 | 75.7 | 127.8 | 775.1 |
| 0G33128A95 Fluid Flow in UZ Fractured Rock | 6.5 | 3.5 | 11.7 | 8.8 | 10.5 | 11.2 | 39.5 | -5.8 | 18.4 | 12.7 | 23.4 | 27.4 | 167.8 |
| 1.2.3.3.1.2.8 | 6.5 | 3.5 | 11.7 | 8.8 | 10.5 | 11.2 | 39.5 | -5.8 | 18.4 | 12.7 | 23.4 | 27.4 | 167.8 |
| 0G33129A96 Intermediate Site UZ Flow Model | 15.2 | 16.8 | 21.2 | 20.3 | 14.2 | 22.2 | 25.1 | 21.6 | 15.9 | 19.5 | 20.5 | 12.8 | 225.3 |
| 1.2.3.3.1.2.9 | 15.2 | 16.8 | 21.2 | 20.3 | 14.2 | 22.2 | 25.1 | 21.6 | 15.9 | 19.5 | 20.5 | 12.8 | 225.3 |
| 0G33131A97 Conduct Hydraulic/Tracer Test C-Holes | 23.2 | 47.4 | 47.5 | 35.2 | 29.3 | 45.2 | 61.6 | 57.0 | 60.6 | -43.6 | 45.8 | 37.9 | 447.1 |
| 0G33131B95 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.6 | 9.7 | 19.1 | 38.4 |
| 0G33131C97 Site Potentiometric Levels Monitoring | 28.6 | 42.6 | 84.4 | 44.3 | 25.1 | 41.9 | 32.1 | 18.8 | 44.6 | 46.1 | 45.5 | 47.3 | 501.3 |
| 0G33131E96 Pumping and Testing Existing Monitoring | 0.0 | 1.3 | -0.7 | 0.6 | 13.0 | 15.6 | 5.7 | 10.5 | 7.9 | 8.9 | 13.0 | 20.0 | 95.8 |
| 1.2.3.3.1.3.1 | 51.8 | 91.3 | 131.2 | 80.1 | 67.4 | 102.7 | 99.4 | 86.3 | 113.1 | 21.0 | 114.0 | 124.3 | 1082.6 |
| 0G33132A96 SZ Hydrochemistry Data Summary | 2.3 | 2.8 | 6.5 | 2.7 | 1.5 | 5.0 | 30.6 | -12.0 | 27.5 | 5.1 | 9.6 | 19.1 | 100.7 |
| 0G33132B96 Death Valley SZ Hydrochemistry | 3.8 | 1.2 | 3.9 | 1.0 | 4.0 | 5.0 | 8.5 | 6.8 | 1.6 | 3.9 | 1.8 | 5.4 | 46.9 |
| 0G33132C96 SZ Hydrochemistry Equipment Procurement | 0.0 | 29.2 | 34.0 | 0.9 | 0.8 | 1.2 | 16.2 | 33.6 | 23.6 | 82.5 | -3.1 | -30.2 | 188.7 |
| 1.2.3.3.1.3.2 | 6.1 | 33.2 | 44.4 | 4.6 | 6.3 | 11.2 | 55.3 | 28.4 | 52.7 | 91.5 | 8.3 | -5.7 | 336.3 |
| 0G33133A96 Site SZ Flow Model Framework | 16.7 | 32.0 | 43.8 | 4.5 | 51.9 | 33.4 | 10.0 | 9.0 | 18.4 | 15.8 | 10.8 | 21.5 | 267.8 |
| 0G33133B96 Site 3-D SZ Model | 5.7 | 13.1 | 11.9 | 7.8 | 14.4 | 18.7 | 19.0 | 41.4 | 14.4 | 41.4 | -6.5 | 21.0 | 202.3 |
| 0G33133C95 Site SZ Conceptual Model Report | 0.4 | 1.9 | 3.5 | 5.6 | 4.2 | 0.0 | -2.3 | 2.2 | 1.8 | 0.4 | 1.5 | 4.2 | 23.4 |
| 1.2.3.3.1.3.3 | 22.8 | 47.0 | 59.2 | 17.9 | 70.5 | 52.1 | 26.7 | 52.6 | 34.6 | 57.6 | 5.8 | 46.7 | 493.5 |
| *1.2.3.3 | 617.8 | 732.2 | 784.8 | 562.2 | 903.9 | 797.2 | 794.8 | 878.0 | 871.2 | 802.1 | 787.6 | 1108.2 | 9640.0 |
| 0G36211B96 Isotopic Analysis of Modern Precipitatio | 0.6 | 1.4 | 0.1 | 1.8 | -0.4 | 9.6 | 9.7 | 15.0 | 9.4 | 2.7 | 3.3 | 3.8 | 57.0 |
| 1.2.3.6.2.1.1 | 0.6 | 1.4 | 0.1 | 1.8 | -0.4 | 9.6 | 9.7 | 15.0 | 9.4 | 2.7 | 3.3 | 3.8 | 57.0 |
| 0G36212A96 Ostracodes, C-14, & Stable Isotopic Data | 9.3 | 6.9 | 27.1 | 15.3 | 13.4 | 30.4 | 36.3 | 99.1 | 53.5 | 50.1 | 40.1 | 52.2 | 433.7 |
| 1.2.3.6.2.1.2 | 9.3 | 6.9 | 27.1 | 15.3 | 13.4 | 30.4 | 36.3 | 99.1 | 53.5 | 50.1 | 40.1 | 52.2 | 433.7 |
| 0G36213A96 Packrat Middens & Pollen Studies | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 35.9 | 0.0 | 100.6 | 137.0 |
| 1.2.3.6.2.1.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 35.9 | 0.0 | 100.6 | 137.0 |
| 0G36214A95 Document Erosion at Jake Ridge | 0.0 | 0.0 | 0.0 | 3.7 | 0.8 | 1.0 | 0.5 | 0.0 | 0.5 | 0.3 | -0.2 | 0.0 | 6.6 |
| 0G36214B95 Geochronological Studies of Surface Depo | 9.5 | 7.4 | 12.2 | 85.1 | 90.8 | 57.5 | 41.1 | 13.5 | 9.4 | 29.9 | -0.3 | 55.3 | 411.4 |
| 0G36214C96 Surficial Deposits Mapping | 5.4 | 4.8 | 10.8 | 7.4 | 5.5 | 4.8 | 5.9 | 6.2 | 8.0 | 7.4 | 8.2 | 43.3 | 117.7 |
| 1.2.3.6.2.1.4 | 14.9 | 12.2 | 23.0 | 96.2 | 97.1 | 63.3 | 47.5 | 19.7 | 17.9 | 37.6 | 7.7 | 98.6 | 535.7 |
| 0G36215A95 Paleoclimate/Environmental Synthesis Stu | 3.9 | 6.6 | 3.1 | 3.5 | 2.9 | 1.2 | -4.1 | 7.2 | -0.6 | 0.0 | 0.0 | 0.0 | 23.7 |
| 0G36215C95 Paleoclimate Synthesis | 0.0 | 0.1 | 0.0 | 6.6 | 5.8 | 6.2 | 0.0 | 0.0 | 0.1 | 5.4 | 13.0 | 8.6 | 45.8 |
| 1.2.3.6.2.1.5 | 3.9 | 6.7 | 3.1 | 10.1 | 8.7 | 7.4 | -4.1 | 7.2 | -0.5 | 5.4 | 13.0 | 8.6 | 69.5 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0G36221A96 | Formation of Silica Within Yucca Mountai | 2.4 | 3.6 | 8.5 | 0.1 | 5.2 | -15.9 | 26.0 | 0.9 | 1.9 | -1.8 | 13.3 | 1.2 | 45.4 |
| 0G36221B96 | Dating Calcite Vein Deposits | 0.3 | 8.8 | 14.3 | 8.9 | 25.9 | 9.4 | 2.0 | 7.8 | 14.7 | 5.1 | -4.8 | -33.4 | 59.0 |
| 0G36221C95 | Evaluation of Past Discharge Areas | 1.9 | 3.1 | 10.9 | 5.7 | 26.7 | 14.4 | 12.2 | 7.9 | 6.7 | -0.6 | 1.6 | -1.6 | 88.9 |
| 0G36221D96 | Soil Fluid/Gas Isotopic Chemistry | 5.9 | 4.0 | 13.6 | 8.3 | 11.3 | -2.6 | 11.0 | 6.2 | 10.7 | 8.1 | 8.8 | 16.4 | 101.7 |
| 0G36221E95 | Vein Filling Calcite & Opaline Silica De | 12.6 | 7.8 | 7.9 | 7.3 | 24.2 | 5.8 | 40.7 | 7.1 | 5.5 | -40.8 | 6.5 | 20.4 | 105.0 |
| 1.2.3.6.2.2.1 | | 23.1 | 27.3 | 55.2 | 30.3 | 93.3 | 11.1 | 91.9 | 29.9 | 39.5 | -30.0 | 25.4 | 3.0 | 400.0 |
| *1.2.3.6 | | 51.8 | 54.5 | 108.5 | 153.7 | 212.1 | 121.8 | 181.8 | 170.9 | 119.8 | 101.7 | 89.5 | 266.8 | 1632.9 |
| 0G3721A95 | Geochem Assessment of YM/Pot for Mineral | 12.6 | 20.6 | 21.4 | 11.1 | 27.1 | 21.5 | 2.2 | 2.8 | 1.5 | 3.5 | 3.4 | 15.2 | 142.9 |
| 0G3721B95 | Assess Geothermal Energy Potential at YM | 0.0 | 0.6 | 0.0 | 7.7 | 18.2 | 0.7 | 0.4 | 2.1 | 0.0 | 0.0 | 0.0 | 0.0 | 29.7 |
| 1.2.3.7.2.1 | | 12.6 | 21.2 | 21.4 | 18.8 | 45.3 | 22.2 | 2.6 | 4.9 | 1.5 | 3.5 | 3.4 | 15.2 | 172.6 |
| *1.2.3.7 | | 12.6 | 21.2 | 21.4 | 18.8 | 45.3 | 22.2 | 2.6 | 4.9 | 1.5 | 3.5 | 3.4 | 15.2 | 172.6 |
| 0G39995B4 | Study Plan Comment Resolution | 0.0 | 7.0 | 2.4 | 7.9 | 5.2 | 0.0 | 5.1 | 4.3 | 4.1 | -1.0 | 0.0 | 0.0 | 35.0 |
| 1.2.3.9.9 | | 0.0 | 7.0 | 2.4 | 7.9 | 5.2 | 0.0 | 5.1 | 4.3 | 4.1 | -1.0 | 0.0 | 0.0 | 35.0 |
| *1.2.3.9 | | 0.0 | 7.0 | 2.4 | 7.9 | 5.2 | 0.0 | 5.1 | 4.3 | 4.1 | -1.0 | 0.0 | 0.0 | 35.0 |
| **1.2.3 | | 1297.5 | 1502.5 | 1528.8 | 1584.1 | 2200.4 | 2247.3 | 2051.6 | 2214.5 | 2164.9 | 2007.3 | 2330.1 | 2722.8 | 23851.8 |
| 0G51195B | Regulatory Coordination and Planning | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 8.7 | -9.3 | 15.0 | -1.4 | 2.3 | 0.6 | 2.3 | 19.0 |
| 1.2.5.1.1 | | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 8.7 | -9.3 | 15.0 | -1.4 | 2.3 | 0.6 | 2.3 | 19.0 |
| *1.2.5.1 | | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 8.7 | -9.3 | 15.0 | -1.4 | 2.3 | 0.6 | 2.3 | 19.0 |
| 0G53595B | Technical Data Coordination | 31.9 | 28.5 | 28.2 | 33.9 | 32.0 | 79.8 | 35.2 | 71.2 | 50.0 | 66.0 | 51.4 | 54.8 | 562.9 |
| 1.2.5.3.5 | | 31.9 | 28.5 | 28.2 | 33.9 | 32.0 | 79.8 | 35.2 | 71.2 | 50.0 | 66.0 | 51.4 | 54.8 | 562.9 |
| *1.2.5.3 | | 31.9 | 28.5 | 28.2 | 33.9 | 32.0 | 79.8 | 35.2 | 71.2 | 50.0 | 66.0 | 51.4 | 54.8 | 562.9 |
| 0G5695B | Site Suitability Evaluation | 2.9 | 0.8 | 0.3 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 1.1 | -5.5 | 0.0 | 0.0 | 0.0 |
| 0G5695B1 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.5 | 4.2 | 1.7 | 11.4 |
| 1.2.5.6 | | 2.9 | 0.8 | 0.3 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 | 4.2 | 1.7 | 11.4 |
| *1.2.5.6 | | 2.9 | 0.8 | 0.3 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 | 4.2 | 1.7 | 11.4 |
| 0G5795B1 | NRC/NWTRB/ACNW Interactions | 4.5 | 20.0 | -6.8 | 8.4 | 13.5 | 6.9 | 2.7 | 24.5 | 25.6 | 1.1 | 17.3 | 16.8 | 134.5 |
| 0G5795B2 | Site Characterization Program | 22.5 | 22.4 | 29.3 | 34.2 | -26.7 | 7.3 | 13.1 | 5.8 | 9.0 | 9.1 | 24.7 | 17.3 | 168.0 |
| 0G5795B4 | Semi-Annual Progress Report | 0.0 | 1.4 | -1.4 | 0.3 | 0.0 | 8.5 | -5.0 | 11.0 | 7.4 | 11.1 | 5.3 | 52.8 | 91.4 |
| 0G5795B5 | Issue Resolution | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.6 |
| 0G5795B6 | Volcanic Hazards | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.9 | 4.8 | 7.7 | 5.9 | 5.9 | 5.2 | 0.0 | 36.4 |
| 1.2.5.7 | | 27.0 | 43.8 | 21.4 | 42.9 | -13.2 | 29.6 | 15.6 | 49.0 | 47.9 | 27.2 | 52.8 | 86.9 | 430.9 |
| *1.2.5.7 | | 27.0 | 43.8 | 21.4 | 42.9 | -13.2 | 29.6 | 15.6 | 49.0 | 47.9 | 27.2 | 52.8 | 86.9 | 430.9 |
| **1.2.5 | | 62.6 | 73.1 | 49.9 | 76.8 | 19.2 | 118.1 | 41.5 | 135.2 | 97.6 | 95.5 | 109.0 | 145.7 | 1024.2 |
| 0G912195B | Technical Project Office Management | 38.4 | 42.7 | 54.3 | 50.6 | 28.8 | 79.3 | 32.1 | 19.3 | 26.2 | 24.2 | 27.0 | 80.8 | 503.7 |
| 1.2.9.1.2.1 | | 38.4 | 42.7 | 54.3 | 50.6 | 28.8 | 79.3 | 32.1 | 19.3 | 26.2 | 24.2 | 27.0 | 80.8 | 503.7 |
| *1.2.9.1 | | 38.4 | 42.7 | 54.3 | 50.6 | 28.8 | 79.3 | 32.1 | 19.3 | 26.2 | 24.2 | 27.0 | 80.8 | 503.7 |
| 0G92295B | Participant Project Control | 29.2 | 30.6 | 28.6 | 31.4 | 42.0 | 38.7 | 41.8 | 37.8 | 44.0 | 35.6 | 39.5 | 34.4 | 433.6 |

U.S. GEOLOGICAL SURVEY

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| | | OCT EST | NOV EST | DEC EST | JAN EST | FEB EST | MAR EST | APR EST | MAY EST | JUN EST | JUL EST | AUG EST | SEP EST | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.2.9.2.2 | | 29.2 | 30.6 | 28.6 | 31.4 | 42.0 | 38.7 | 41.8 | 37.8 | 44.0 | 35.6 | 39.5 | 34.4 | 433.6 |
| *1.2.9.2 | | 29.2 | 30.6 | 28.6 | 31.4 | 42.0 | 38.7 | 41.8 | 37.8 | 44.0 | 35.6 | 39.5 | 34.4 | 433.6 |
| **1.2.9 | | 67.6 | 73.3 | 82.9 | 82.0 | 70.8 | 118.0 | 73.9 | 57.1 | 70.2 | 59.8 | 66.5 | 115.2 | 937.3 |
| 0GB195Q | Quality Assurance Coordination and Plann | 20.9 | 16.7 | 20.2 | 20.8 | 22.2 | 27.7 | 22.6 | 25.9 | 39.4 | 17.8 | 28.8 | 25.1 | 288.1 |
| 1.2.11.1 | | 20.9 | 16.7 | 20.2 | 20.8 | 22.2 | 27.7 | 22.6 | 25.9 | 39.4 | 17.8 | 28.8 | 25.1 | 288.1 |
| *1.2.11.1 | | 20.9 | 16.7 | 20.2 | 20.8 | 22.2 | 27.7 | 22.6 | 25.9 | 39.4 | 17.8 | 28.8 | 25.1 | 288.1 |
| 0GB295Q | Quality Assurance Program Development | 49.6 | 46.9 | 48.5 | 52.7 | 35.7 | 33.6 | 30.0 | 41.2 | 37.2 | 40.3 | 43.9 | 38.5 | 498.1 |
| 1.2.11.2 | | 49.6 | 46.9 | 48.5 | 52.7 | 35.7 | 33.6 | 30.0 | 41.2 | 37.2 | 40.3 | 43.9 | 38.5 | 498.1 |
| *1.2.11.2 | | 49.6 | 46.9 | 48.5 | 52.7 | 35.7 | 33.6 | 30.0 | 41.2 | 37.2 | 40.3 | 43.9 | 38.5 | 498.1 |
| 0GB3195Q | Quality Assurance Verification - Audits | 33.6 | 17.1 | 38.2 | 16.7 | 12.8 | 37.8 | 59.3 | 42.1 | 39.9 | 32.9 | 21.0 | 11.9 | 363.3 |
| 1.2.11.3.1 | | 33.6 | 17.1 | 38.2 | 16.7 | 12.8 | 37.8 | 59.3 | 42.1 | 39.9 | 32.9 | 21.0 | 11.9 | 363.3 |
| 0GB3295Q | Quality Assurance Verification - Surveil | 8.8 | 30.1 | 26.5 | 16.7 | 23.2 | 20.3 | 11.0 | 26.4 | 12.2 | 19.4 | 32.6 | 43.7 | 270.9 |
| 1.2.11.3.2 | | 8.8 | 30.1 | 26.5 | 16.7 | 23.2 | 20.3 | 11.0 | 26.4 | 12.2 | 19.4 | 32.6 | 43.7 | 270.9 |
| *1.2.11.3 | | 42.4 | 47.2 | 64.7 | 33.4 | 36.0 | 58.1 | 70.3 | 68.5 | 52.1 | 52.3 | 53.6 | 55.6 | 634.2 |
| 0GB595Q | Quality Assurance - Quality Engineering | 2.2 | 8.7 | 21.0 | 23.1 | 31.2 | 63.7 | 26.1 | 59.2 | 39.3 | 24.1 | 42.4 | 50.5 | 391.5 |
| 1.2.11.5 | | 2.2 | 8.7 | 21.0 | 23.1 | 31.2 | 63.7 | 26.1 | 59.2 | 39.3 | 24.1 | 42.4 | 50.5 | 391.5 |
| *1.2.11.5 | | 2.2 | 8.7 | 21.0 | 23.1 | 31.2 | 63.7 | 26.1 | 59.2 | 39.3 | 24.1 | 42.4 | 50.5 | 391.5 |
| **1.2.11 | | 115.1 | 119.5 | 154.4 | 130.0 | 125.1 | 183.1 | 149.0 | 194.8 | 168.0 | 134.5 | 168.7 | 169.7 | 1811.9 |
| 0GC2295B | Local Records Center Operation | 24.5 | 24.5 | 21.2 | 26.3 | 20.0 | 22.7 | 20.2 | 54.9 | 24.2 | 19.2 | 29.2 | 17.1 | 304.0 |
| 1.2.12.2.2 | | 24.5 | 24.5 | 21.2 | 26.3 | 20.0 | 22.7 | 20.2 | 54.9 | 24.2 | 19.2 | 29.2 | 17.1 | 304.0 |
| 0GC2395B | Participant Records Management | 6.8 | 9.5 | 10.5 | 9.9 | 8.9 | 6.0 | 9.5 | 16.5 | 12.6 | 19.7 | 10.6 | 15.9 | 136.4 |
| 1.2.12.2.3 | | 6.8 | 9.5 | 10.5 | 9.9 | 8.9 | 6.0 | 9.5 | 16.5 | 12.6 | 19.7 | 10.6 | 15.9 | 136.4 |
| *1.2.12.2 | | 31.3 | 34.0 | 31.7 | 36.2 | 28.9 | 28.7 | 29.7 | 71.4 | 36.8 | 38.9 | 39.8 | 33.0 | 440.4 |
| **1.2.12 | | 31.3 | 34.0 | 31.7 | 36.2 | 28.9 | 28.7 | 29.7 | 71.4 | 36.8 | 38.9 | 39.8 | 33.0 | 440.4 |
| 0GD2595B | Occupational Safety and Health | 6.7 | 8.2 | 5.1 | 13.1 | 8.7 | 8.5 | 6.5 | 8.7 | 6.7 | 13.2 | 10.9 | 12.2 | 108.5 |
| 1.2.13.2.5 | | 6.7 | 8.2 | 5.1 | 13.1 | 8.7 | 8.5 | 6.5 | 8.7 | 6.7 | 13.2 | 10.9 | 12.2 | 108.5 |
| *1.2.13.2 | | 6.7 | 8.2 | 5.1 | 13.1 | 8.7 | 8.5 | 6.5 | 8.7 | 6.7 | 13.2 | 10.9 | 12.2 | 108.5 |
| 0GD4795B | Regional Groundwater Quality Network | 0.0 | 3.1 | 2.7 | 4.4 | 3.9 | 6.1 | 7.5 | 13.2 | 10.0 | 37.6 | 17.3 | 94.3 | 200.1 |
| 0GD4795H | Water Resources Monitoring | 35.2 | 31.8 | 49.1 | 34.3 | 35.0 | 29.5 | -7.0 | 80.1 | 34.0 | 35.8 | 48.5 | 26.7 | 433.0 |
| 1.2.13.4.7 | | 35.2 | 34.9 | 51.8 | 38.7 | 38.9 | 35.6 | 0.5 | 93.3 | 44.0 | 73.4 | 65.8 | 121.0 | 633.1 |
| *1.2.13.4 | | 35.2 | 34.9 | 51.8 | 38.7 | 38.9 | 35.6 | 0.5 | 93.3 | 44.0 | 73.4 | 65.8 | 121.0 | 633.1 |
| **1.2.13 | | 41.9 | 43.1 | 56.9 | 51.8 | 47.6 | 44.1 | 7.0 | 102.0 | 50.7 | 86.6 | 76.7 | 133.2 | 741.6 |
| 0GF2395B1 | Administrative Support | 27.1 | 36.2 | 45.2 | 42.2 | 36.2 | 56.5 | 42.8 | 44.4 | 45.0 | 39.6 | 44.9 | 65.9 | 526.0 |
| 0GF2395B2 | Space and Facilities | 100.6 | 84.0 | 117.2 | 230.8 | 153.5 | 95.4 | 118.5 | 45.1 | 68.1 | 24.9 | 166.1 | 107.4 | 1311.6 |
| 0GF2395B3 | | 0.0 | 9.9 | 5.9 | 9.5 | 6.4 | 7.5 | 5.8 | 12.3 | 7.6 | 6.2 | 8.8 | 9.4 | 89.3 |
| 1.2.15.2.3 | | 127.7 | 130.1 | 168.3 | 282.5 | 196.1 | 159.4 | 167.1 | 101.8 | 120.7 | 70.7 | 219.8 | 182.7 | 1926.9 |
| *1.2.15.2 | | 127.7 | 130.1 | 168.3 | 282.5 | 196.1 | 159.4 | 167.1 | 101.8 | 120.7 | 70.7 | 219.8 | 182.7 | 1926.9 |

U.S. GEOLOGICAL SURVEY

ESTIMATED COSTS FOR 10/1/94 - 09/30/95

| | OCT EST | NOV EST | DEC EST | JAN EST | FEB EST | MAR EST | APR EST | MAY EST | JUN EST | JUL EST | AUG EST | SEP EST | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0GF395B YMP Support of the Training Mission | 10.2 | 17.7 | 16.3 | 16.9 | 16.8 | 18.9 | 19.1 | 20.0 | 25.1 | 21.6 | 32.1 | 39.0 | 253.7 |
| 1.2.15.3 | 10.2 | 17.7 | 16.3 | 16.9 | 16.8 | 18.9 | 19.1 | 20.0 | 25.1 | 21.6 | 32.1 | 39.0 | 253.7 |
| *1.2.15.3 | 10.2 | 17.7 | 16.3 | 16.9 | 16.8 | 18.9 | 19.1 | 20.0 | 25.1 | 21.6 | 32.1 | 39.0 | 253.7 |
| **1.2.15 | 137.9 | 147.8 | 184.6 | 299.4 | 212.9 | 178.3 | 186.2 | 121.8 | 145.8 | 92.3 | 251.9 | 221.7 | 2180.6 |
| | | | | | | | | | | | | | |
| 1.2 OPERATING | 1753.9 | 1997.0 | 2090.5 | 2263.2 | 2709.5 | 2919.7 | 2552.7 | 2891.2 | 2739.6 | 2516.4 | 3043.0 | 3542.0 | 31018.7 |
| CAPITAL EQUIPMENT | 0.0 | 0.0 | 0.0 | 0.0 | 39.2 | 11.9 | 20.8 | 59.9 | 44.8 | 18.7 | 41.9 | 148.9 | 386.1 |
| GRAND TOTAL | 1753.9 | 1997.0 | 2090.5 | 2263.2 | 2748.7 | 2931.6 | 2573.5 | 2951.1 | 2784.4 | 2535.1 | 3084.9 | 3690.9 | 31404.8 |
| | | | | | | | | | | | | | |
| FTEs | | | | | | | | | | | | | |
| FEDERAL | 104.9 | 112.4 | 103.7 | 161.4 | 143.4 | 169.8 | 159.0 | 171.2 | 183.9 | 184.1 | 188.3 | 167.0 | |
| CONTRACT | 80.4 | 83.7 | 86.8 | 97.2 | 117.6 | 135.4 | 128.2 | 127.0 | 131.0 | 127.9 | 115.1 | 144.8 | |
| TOTAL | 185.3 | 196.1 | 190.5 | 258.6 | 261.0 | 305.2 | 287.2 | 298.2 | 314.9 | 312.0 | 303.4 | 311.8 | |

* Fourth level WBS roll-up

** Third level WBS roll-up