United States Department of the Interior

U. S. GEOLOGICAL SURVEY
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IN REPLY REFER TO:

INFORMATION ONLY

May 13, 1996

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SUBJECT: Yucca Mountain Project Branch - U.S. Geological Survey (YMPB-USGS) Progress Report, April, 1996

Attached is the USGS progress report in the required format for the month of April, 1996.

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

Sincerely,

for Raye Ritchey Arnold
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U.S. Geological Survey

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U.S. GEOLOGICAL SURVEY
EXECUTIVE SUMMARY
APRIL, 1996

WBS 1.2.3.1 Coordination and Planning

U. S. Geological Survey - Yucca Mountain Branch is currently processing 157 scientific papers prepared by USGS authors. Of these, 54 are related to hydrologic studies and 104 to geologic studies. In addition, 24 abstracts by USGS authors are being processed, as well as 18 report from LBL.

WBS 1.2.3.2 Geology

Geologic Framework

Compilation of thicknesses for units within the Topopah Spring Tuff continued, the data derived primarily from boreholes (e.g., H-3 and UZ-6) and from exposures in Solitario Canyon. The stratigraphic interval comprising the nonlithophysal and lithophysal zones of the crystal-rich member and the upper lithophysal zone of the crystal-poor member appears to be definitely thinner along Yucca Crest and in Solitario Canyon than it is in adjacent borehole localities. Paleotopography and growth faulting are possible explanations for these thickness variations. Computation of water content and porosities, based on analysis of wireline log data from selected boreholes, also continued.

Magnetic data obtained from the geophysical surveys across the central block of Yucca Mountain are being plotted on a base map, together with digital topographic data and mapped fault locations. Aeromagnetic and gravity maps are also being prepared for the area covered by a map recently published by Simonds and others (1996; Map of fault activity in the Yucca Mountain area, Nye County, Nevada: U.S. Geological Survey Miscellaneous Investigations Map I-2520, scale 1:24,000). Digital fault data from the fault activity map are being incorporated on the aeromagnetic map. Final modeling of calculated theoretical potential-field sources for gravity and magnetic data obtained along seismic reflection lines 2 and 3 is leading towards improved interpretations of deeper structure beneath Yucca Mountain and Crater Flat, but additional work is still needed to provide a better resolution of data for interpreting shallow structure.

New mapping has demonstrated that northwest-trending faults (e.g., the Pagany Wash fault) are cut by north-trending faults in several places across the central block of Yucca Mountain, but some examples can also be found where north-trending faults are cut by northwest-trending faults. The relationships suggest that the northwest-trending faults were dominantly early, then tectonic forces shifted to produce north-trending faults. The general conclusion, however, is that both sets of faults developed in response to a single, protracted tectonic event

punctuated by episodic extension along an east-west axis of minimum structural compression.

All surface-based fracture data have been entered into the digital fracture data base. Stereonets for fractures from various geologic formations, relative to their areal settings, are being prepared to assist in evaluating regional tectonic effects on the timing of fracture development. With respect to the Tiva Canyon Tuff, there are three distinct tectonic fracture populations with north, northwest, and northeast trends, with the latter set appearing to be the youngest. Data indicate that the north- and northwest-trending fractures probably formed at or near the same time, a relationship that is compatible with the relative timing of faulting discussed above.

Geologic mapping of the North Ramp ESF was accomplished as follows: (1) full periphery mapping was completed to station 48+43; (2) detailed line surveys were completed to station 48+36; and (3) stereophotography was completed to station 48+66.

Seismotectonic Studies

Nearly all of the data on the geologic effects associated with 100 earthquakes of magnitude greater than 5.5 in the cordillera of the western U. S. have been compiled and summarized, including rupture maps and descriptions of 18 historical surface-faulting earthquakes. Preliminary analyses reveal relations between earthquake magnitude, focal depth, fault dip and the mapped rupture patterns (widths and displacements), secondary rupture lengths and displacements, splaying and branching ruptures, and fault segmentation. Testing of, and refinements to, these preliminary findings are in progress.

Reports on "Ground motion modeling of scenario earthquakes at Yucca Mountain" and "Earthquake ground motions in extensional tectonic regimes" have been reviewed, and revisions are in progress. Both reports (in the form of milestone reports) will provide significant input to the synthesis report on seismotectonic studies at Yucca Mountain.

Technical field reviews of the mapping and associated studies in the remaining trenches across the Ghost Dance, Rock Valley, and northern and southern Crater Flat faults were completed. Compilation and synthesis of these data, and the data obtained in the earlier logging of other trenches, continued as part of the preparation of sections on Quaternary faulting and paleoseismicity at Yucca Mountain for the seismotectonic synthesis report.

WBS 1.2.3.3 Hydrology

Regional Hydrology

After a comparison of FY95 meteorological data collected by SAIC at 9 locations on Yucca Mountain with data collected at the two weather stations still being maintained by the USGS, it was determined that the USGS stations were not providing unique data at the two locations and

for the most part were duplicating measurements being obtained by the SAIC monitoring sites. A decision to discontinue monitoring at the two USGS weather stations was supported by DOE in an attempt to consolidate the measurement efforts. Operation of the expanded network of tipping bucket precipitation gages is continuing in an effort to characterize the spatial and temporal distribution of precipitation frequency, intensity, and storm duration at Yucca Mountain. The monitoring of the rate of precipitation does not represent a duplication of effort between SAIC and the USGS.

Runoff was neither observed nor reported during the month for the three gages at the site or for the Yucca Mountain area. Routine maintenance was made on the three streamflow-gaging stations located along Fortymile Wash during the first week in April and levels were run to check reference mark and outside staff plate settings.

Milestone 3GRG605, Key Data Uncertainties was completed and submitted to TPO for approval and release on April 24. The report discusses Key Issues, Potential Issues, Important Issues, and Resolved Issues. The final phase of pumping on USW G-2 was concluded on April 25. Recovery is expected to take several weeks.

The water-quality section of the final portion of the FY95 Fortymile Wash data package has been reviewed and review comments have been answered. Final assembly and submission of the data package is being completed.

Work continued on evaluation of some conceptual models of regional ground-water flow using the numerical model. Staff provided updated site boundary fluxes based on the most recent regional model calibration runs, and also completed software QA baseline documents for the MLAEM, MODFLOW and MODFLOWP codes. Input of 1995 water-level data for Yucca Mountain into the USGS national computer database was completed.

Regional SZ hydrogeologic framework model staff completed work on documenting the vegetation map, the potentiometric-surface map, and the recharge/discharge area map and submitted them for colleague review. The review draft of Milestone 3GRM621M, Regional Hydrologic Data Set, was completed on 4/30/96.

Unsaturated Zone

The U.S. Geological Survey Water Resources Investigation Report entitled, "Estimation of shallow infiltration and presence of potential fast pathways for shallow infiltration in the Yucca Mountain area, Nevada", is complete and the revised manuscript has been reviewed by three technical reviewers. ArcInfo export files supporting the report are ready for submittal to the TDB and contain spatial distributions of depth to bedrock, geomorphic position, precipitation, shallow infiltration, and potential fast pathways (faults in zones of high shallow infiltration) in the Yucca Mountain vicinity. Four data packages in support of this data package are through

technical review and are in Denver for further QA processing. The fifth and final data package for this report is being assembled.

In support of infiltration studies the Preliminary Surficial Materials Properties Map has been completed. All of the data associated with the map have been technically reviewed and submitted for further processing.

Analysis of the spatial distribution of episodic and average infiltration rates is continuing using the simplified version of the infiltration model and the 100-year stochastic simulations of daily precipitation. Comparisons to the field data (neutron holes) with the remainder of the modeling domain being analyzed is continuing to determine what percentage of the site is represented by the field data. The effort to determine the representativeness of the 10 years of rainfall and neutron logging data relative to longer-term records and average infiltration rates also is continuing.

Calibration of the modified infiltration model which uses a finite difference approximation of Richards Equation for simulating infiltration, evapotranspiration, and redistribution was continued using the developed 16-year record of daily precipitation for Yucca Mountain. Inverse modeling of neutron moisture profiles was continued to evaluate the evapotranspiration component of the water balance and to determine the potential for near-surface fracture flow. A dynamic root-zone function was developed to better simulate the response of plants to moisture redistribution and to help account for differences between shallow and deep rooted plants as well as for differences in rooting densities and the percentage of bare soil evaporation. The function was also modified to allow for automatic adjustment of the root-zone depth as a function of both the thickness of alluvium cover and fractured versus unfractured bedrock. Efforts will now be concentrated on the calibration of the dynamic root-zone function and the development of an improved alpha coefficient function for simulating the response of plants to available moisture, time of year, and antecedent conditions (drought versus wet periods). This work will also be supported by studies of vegetation at Yucca Mountain conducted by the Environmental Program. The alpha coefficient function and the dynamic root-zone function will also be used to empirically account for possible contributions to evaporation caused by vapor flow through alluvium and fractures in the near-surface.

Writing of the manuscript for the Synthesis of UZ Infiltration is continuing with the inclusion of information gathered from the literature review. Work on the introduction section and on the development of tables and figures was continued. Results obtained from inverse modeling using the developed 16-year daily precipitation record for Yucca Mountain, the 12-year neutron logging record, and 16-year simulations of shallow infiltration have provided important results in terms of the timing and frequency of important infiltration events at Yucca Mountain and the characteristics of the timing, magnitude, and frequency of daily precipitation most conducive for initiating near-surface fracture flow, episodic infiltration, and runoff. New results obtained for the spatial distribution of average and episodic infiltration rates also are being analyzed using 100-year simulations for the areal coverage of the 3-D site scale model of

unsaturated ground-water flow. Preliminary results indicate that average infiltration rates throughout the modeling domain are approximately 60 percent less for 100-year simulations as compared to average rates using the developed precipitation record for 1980 through 1995.

Data were downloaded from heat dissipation probes and net radiometers. The eddy correlation stations have been redeployed in the field to collect winter evapotranspiration data. It has been determined in development of the numerical model of infiltration that these data are important. Calibration of heat dissipation probes was continued, and filed sites for analysis of topography on conditions at the alluvium/tuff interface were identified.

Analysis of component data from vertical seismic profiling of the unsaturated zone at UE-25 UZ #16 was continued. Calculation of rotations for receiver alignments from line A data to produce in-line and cross-line components was completed during the reporting period. Checking of calculated rotations has been completed, with the conclusion that polarization of first-arrival shear waves is poorly defined due to various attenuation and scattering events in the traversed section; calculations appear to be correct, and hodograms representing the checks clearly confirm this result and indicate nonlinear shear-wave polarization. Several strong, persistent reflections have been tentatively identified. Polarization filtering has been successful in enhancement of several P-wave reflections. Times have been picked, and migration is underway. Potential reflections are being checked at various levels in the borehole (different receivers in the borehole string). Source rotations in the horizontal plane appear also to enhance reflections, although vertical rotations were less successful.

Preparation of documentation for data packages for the VSP results was completed. As a result of the quality and apparent usefulness of previously sent zero-offset data, additional offset data from borehole UE-25 UZ #16 have been requested by LBNL staff in support of central-block high-resolution velocity determinations. Requested data sets from lines A, B, and C (offsets of 500 ft, 1000 ft, 1500 ft, and 2000 ft) have been in preparation; information sets from Lines C and A have been compiled and have now been sent to LBNL.

Several activities were undertaken and completed for UZ borehole instrumentation and monitoring. Monitoring at UZ-7a indicates that the TBM has had no effect on pressure measurements in this borehole. The TBM reached minimum offset distance, 650 feet, from UZ-7a during the last week of April.

HRF prototype holes continued to be monitored on an on-going basis for the 54th month. Borehole data from these hole as well as NRG-7a, NRG-6, UZ#4, UZ#5, UZ-7a, and SD-12 were transferred to Denver, converted to engineering units, and archived to optical disk on a routine basis throughout the month.

Borehole monitoring data for NRG-7a, NRG-6, UZ#4, UZ#5, UZ-7a, and SD-12 to cover the period 10/01/95 - 3/30/96 were forwarded to the LRC/CRF in mid-April completing the

activity. Instrument records for SD-12 were forwarded to the CRF during the first week of April completing the activity.

The report on the North Ramp Hydrology was sent for colleague review during the first week of April. The four reviewers for this report have completed their reviews and the comments have been distributed to authors for comment resolution. Work on the in-situ borehole monitoring data report continued for NRG-6, NRG-7a, UZ#4 and UZ#5.

Monitoring of UZ-7a indicates that the TBM has had no obvious effect on pressure measurements in the borehole. TBM reached minimum offset distance, 650 feet, from UZ-7a during the last week of April. Monitoring of SD-12 indicates significant thermal activity down to depths of at least 250 feet. Temperature data at these depths indicate seasonal variations that cannot be directly attributed to conductive heat flow for temperature changes at the surface.

For the review draft on hydrogeologic units and matrix properties error analysis is being conducted to assess errors in measurements which are often magnified in particular lithologic units. A drying experiment using samples from all units was performed to aid in a correction of water potential measurements based on drilling penetration rate and evaporation due to sample processing. The corrections were made and will be used in the final statistics for the units which is currently ongoing. The analysis of porosity vs. permeability was redone per suggestions from colleagues. An analysis calculating the flux through the deep boreholes based solely on matrix properties is being redone using the corrected water potential data. Geophysical logs were used to corroborate identification of hydrogeologic units, particularly in the altered zones below the Topopah Spring. Revisions were made to the review draft. Additional work includes the finalization of moisture retention parameters, final figures, and text.

Air-K and hydrochemistry testing continued in the North Ramp Alcoves. In the Bow Ridge Fault Alcove, a vacuum system consisting of downhole packer and vacuum pump was installed in borehole #2 and the drilling air removed. Based on the geophysical logs (caliper, natural gamma, and televiewer) pneumatic monitoring and gas sampling intervals were located in borehole #2. A PVC packer assembly, consisting of 11 packers that will isolate 11 monitor and gas sampling intervals, was constructed and installed in borehole #2. Pneumatic pressure monitoring is presently being conducted in borehole #2.

In the Upper Paintbrush Tuff Alcove, gas sampling and pneumatic monitoring were completed in boreholes 1 and 4. Selected gas samples were sent for age dating, results are not yet known. The multizone packer assemblies were removed from boreholes 1 and 4 and air-injection testing begun. Initial permeability values of the Tiva Canyon crystal-poor lower nonlithophysal columnar zone are from 1 to 10 Darcy.

No activity occurred in the Lower Paintbrush Tuff Contact Alcove. The borehole has been sealed off from the alcove, and is not scheduled for testing in the near future.

The data package for the North Ramp Perched Water Testing has been completed and sent to the QA office for review and approval. Analyses of Borehole SD 7 perched water testing is ongoing. No perched water was encountered in April.

In preparation for the UZ synthesis report frequency analyses were conducted on pressure data from several boreholes in order to determine the phase lag and amplitude of barometric pressure induced changes, both before and after the effects of the ESF were noticed. These analyses will 'quantify' some of the ESF effects that have only been identified through graphical comparisons. One dimensional modeling of NRG 5 data has been conducted to determine vertical permeability to air, prior to effects of the TBM passage. Comparative analysis of pneumatic data from NRG 6, NRG 5, NRG 7a, and SD 9 is ongoing to chart the effects if the TBM as it progressed westward along Drillhole Wash and turned across the Drillhole Wash fault. A small-scale 3 dimensional model of the North Ramp and part of the Main Drift has been constructed to analyze the horizontal permeability of the rocks effected by the ESF excavation. The model simulates the progress of the TBM by applying barometric stresses at the ESF horizon and will be calibrated against both pressure changes within each geologic unit and the time at which the borehole first began to be affected by the ESF. Down hole pressure data were collected from borehole NRG-5. No gas samples were collected this reporting period.

In support of UZ Hydrochemistry, eight stainless steel gas collection cylinders containing molecular sieve material and eighteen stainless steel storage cylinders were leak tested and heat evacuated to remove residual CO_2 gas and H_2O vapor. The evacuated gas collection cylinders were pressurized with nitrogen gas and shipped to the NTS for gas sample collection.

Preparations are underway to provide the necessary equipment and technical support to install the Seamist packer liner at the 1200-foot depth interval at UZ-14. The liner will then be used to pack off seven zones for gas sampling in the Calico Hills Formation and Prow Pass Tuff. The borehole liner installation is scheduled to begin on May 20.

Gas sampling will begin on May 6 at SD-12, and gas sampling equipment will be installed at UZ-14 beginning May 20. The necessary equipment (gas cylinders, power strips and converters, balloons, tubing connectors, etc.) has been prepared or ordered.

The paper titled, "Preliminary 3-Dimensional Discrete Fracture Model, Tiva Canyon Tuff, Yucca Mountain Area, Nye County, Nevada", is through technical review. Review comments have been incorporated into the text and reviewers have signed off. The paper is through USGS reports section for technical edit, and edit comments have been incorporated into a final version. The report is not being reviewed by the QA office.

Development of a fracture-flow model for the Topopah Spring Tuff is ongoing. Because fracture sets from detailed line surveys in the ESF do not follow a fisher distribution (i.e., the fractures do not break out into statistically valid sets) work is being done to see if the fractures follow a fractal distribution. Preliminary results show that combined fractures do not follow a box dimension fractal, but they do follow a mass dimension fractal distribution. Work is proceeding to visually breakout individual sets and determine if each set follows a mass dimension fractal distribution. For combined fractures of the detailed lines surveys a fracture frequency has been calculated. Work in underway to determine frequency for individual sets as determined for the fractal work. From available full periphery maps of the ESF (stations 1078 m to 2800 m) fracture intensities have been calculated for several intervals. Calculated intensities include frequency (P10 or the number of fracture/ meter), and P21, the total length of fractures/square meter. Frequency measurements from the detailed line surveys vary from the periphery maps because there are different length cutoff criteria for each mapping method. Input data to simulate fracture networks will use the detailed line survey data, because that method uses the shortest length criteria. However, when matching mapped and simulated intensities, the periphery map data will be used.

Work continued on numerical simulation of gas flow at Yucca Mountain. A computational grid was created to analyze the pneumatic pressure response at borehole SD-12. The lowermost stations at that borehole appear to be influenced by the nearby Ghost Dance fault, and so some inferences about the permeability of fault within the basal vitrophyre and Calico Hills units in the vicinity of SD-12 appear to be possible.

Efforts towards the numerical analysis of surface-based borehole monitoring data included preparing a validation report for the code AIRK, which was used to predict pneumatic diffusivities in boreholes UZ#4, UZ#5, NRG6 and NRG7a, as described in the North Ramp Hydrogeology Report which is in comment resolution. The validation report is in QA review prior to distribution for technical review.

Saturated Zone

Project efforts at the C-hole Complex have been concentrated on reconfiguring UE-25c #3 for the upcoming pentafluorobenzoic acid tracer test to be conducted starting around 5/7/96. The tracer test is a two-well partial-recirculation test between the injection well UE-25c# 2 and the pumping well UE-25c #3, using pentafluorobenzoic acid as the tracer.

Other tracer tests planned for FY96, all with pumping from UE-25 c#3, are: 1) a two-well recirculation test with fluorescein or iodide injected into UE-25c# 1, 2) a test with the lithium ion (in the form of lithium bromide) as adsorptive tracer, and fluorescent microspheres as non-diffusive tracer, injected together into either of UE-25 c#1 or UE-25 c#2, in a two-well partial recirculation test, and 3) a convergent test with 3-Carbamoyl-2-Pyridone injected as the conservative tracer in UE-25 c#1, which is 200 feet away from the pumped well.

A long term (17-day) single-well aquifer test was completed at well USW G-2. The well was pumped at approximately 58 gallons per minute from 09:00 04/08/96 until 09:00 04/25/96. Drawdown in the well at the end of the test was approximately 124 feet. Throughout the pumping test at well USW G-2, the data sets that were transferred from the test site twice a day were continuously reviewed. Data from the first three days of testing closely followed data collected during the 55-hour test conducted at G-2 during February 1996. The author of the Death Valley hydrochemistry report is revising the report in response to technical reviews. Work began on revising the preliminary site SZ framework model. Additional geologic cross-section data were incorporated from contractors for the Environmental Restoration Program into the model. Staff personnel also worked on incorporating data from a seismic line across Yucca Mountain into the model.

Work continued on preparation of the site SZ numerical flow model software and data to begin calibration of the site flow model. Staff continued working with the parameter-estimation software (PEST) to learn how to optimally use the code in conjunction with the FEHMN flow code. Staff provided the preliminary hydrogeologic framework model to LANL staff who will generate the mesh to be used with FEHMN. LANL staff continued working on creating new meshes for the FEHMN model.

WBS 1.2.3.6 Climatology and Paleohydrology

To aid in defining high resolution aquatic climate records, 33 samples from modern lakes and marshes in western U. S. were analyzed to serve as limnologic/climatic analogs for interpretation of Owens Lake and Lathrop Wells records. Analysis of a suite of 26 modern samples collected from Pahranagat Marsh and nearby sites to serve as ecological baseline data for the high resolution Pahranagat record was also begun.

Project staff continued to study surface water discharge data from the Owens River system to compare with historical precipitation records in an effort to develop transfer functions that will allow conversion of paleolimnological record of Owens Lake to numerical estimates of past precipitation in the Sierra Nevada. Indications are that dry climate environments at Owens Lake are largely supported by spring discharge aquifers rich in sodium-bicarbonate water.

Compilation of the ostracode dataset from Owens Lake continued. The ostracode data should confirm the results from the diatom dataset and may add more information to our general understanding of the climate history at this site.

The d13C and d18O of 90 gases (28 of which were contract gas samples) extracted from carbonates, soil gases, and standards were measured as part of the study of the subsurface mineral record of past hydrology. These samples support several activities. Project staff received 20 ^{14}C age determinations of ESF calcite occurrences determined at the University of Waterloo. These ages ranged from ~16 to ~41 ky. Sampling had focused on determining

the timing of the latest calcite formed in these occurrences, so the samples represented minimal thicknesses of material milled from the outer surfaces of free-growing calcite crystals.

As part of the study of paleodischarge sites, the U-Th chemistry and mass spectrometric analyses of U and Th isotope ratios for 16 sub-samples from 9 samples of authigenic carbonate and silica cements from paleo spring deposits at the Horse Tooth Deposit near Highway 95 were completed. Ages range from 40 to >200 ka with relatively low uncertainties (<10 percent). These materials are demonstrably older than the overlying circa 15 ka layer at the top of a 5 m vertical section of fine-grained deposits reported last month. Initial $^{234}U/^{238}U$ calculated for the new samples exhibit a wider range than those observed from the youngest unit with values from of 2.9 to 4.8. No clear correlation between age and initial $^{234}U/^{238}U$ is apparent at present. Data are currently being evaluated in terms of both age of discharge and water source implications.

Work continued on subsurface mineral records of past hydrology. Project staff completed Sr purification of water leaches (water-soluble Sr salts), dilute acid leaches (carbonate Sr) and total digestions (silicate Sr) for two samples of cuttings from UZ-14. These samples will be analyzed for Sr isotopic compositions in May, and will be included with previously-obtained data from this drill hole. Data will be used to compare pore-water Sr (from soluble salts) to matrix carbonate (acid leaches) and bulk tuff Sr in order to assess the reactivity of pore water with host rock, as well as to assess potential differences between calcite-saturated and calcite-unsaturated solutions. Comparisons of these data to vein calcite Sr will also be made to assess concepts of connectivity between TSw matrix and fracture flow.

Portions of SD-7 core at the SMF were examined, and approximately 40 samples of relatively unfractured tuffs were requested from between about 50 and 1600 feet in a systematic fashion covering most of the observed lithostratigraphic units. Samples of dry-drilled core will be gently crushed and used to extract water-soluble Sr salts in order to study issues of pore-water communication between matrix and fracture flow paths.

Project staff working on the geochronology of fracture-filling material on the ESF met with LANL scientists studying the distribution of ^{36}Cl in the ESF to discuss and evaluate various results and current interpretation. SNL performance assessment staff also was present to discuss integration of data into PA models. The technical exchange represented the first opportunity for the two separate ESF materials-dating entities to discuss and cross-examine recently-completed results. Discussions contrasted the differences in high ^{36}Cl samples correlated to major structural features and suggestive of fast percolation flow, with low ^{36}Cl observed elsewhere and results from dating secondary mineral records suggestive of very slow mineral growth and the implied slow flux. Present data appear to be consistent with a two-fold flux regime where a small number of structural pathways allow relatively rapid flux whereas fractures and cavities that are characteristic of the bulk of the TSw are associated with relatively low percolation flux. Several important avenues of investigation were suggested in order to test some of the various hypotheses. Data collection from fracture-filling mineral occurrences is continuing as are initial

models to estimate possible water compositions required to reach mineral saturation in percolating fluids.

Chemical isolation of U and Th and measurements of U and Th isotope ratios by mass spectrometry for 8 new analyses from 5 ESF samples between ESF Station 37+67 and 39+51 were completed. Dated materials represented very thin opal layers exposed on outer mineral surfaces. Resulting ages range from 37 to 338 ka with calculated initial $^{234}U/^{238}U$ ranges between 2.2 and 9.3. These results include the youngest calculated age observed so far as well as the highest $^{234}U/^{238}U$ values, although not from the same sample. The expanding set of U-series mineral ages preferentially incorporates lower-aged values, in part, due to moving towards increasingly smaller sample sizes.

Project staff continued to make progress in defining a mathematical model describing the end-member process of continuous deposition of ESF minerals. Much, but not all, of the ESF data set approximate this style of crystal growth involving very slow growth rates over very long periods of time rather than being deposited in discrete, instantaneous depositional events. Models were extended to isotopic systems other than $^{230}Th/U$, including $^{231}Pa/^{235}U$, 14C, and $^{226}Ra/^{230}Th$ with increasingly short half lives. This style of crystallization along with finite sampling requirements predicts similarities to a number of observed features including discordance between isotopic systems, lack of ages at the limits of resolution, and correlations between $^{230}Th/U$ age, initial $^{234}U/^{238}U$ and sample size. Although this style of deposition acknowledges the possibility of relatively recent water flow along fractures, deposition of very small amounts of mineral over long periods of time implies substantially lower flux under conditions of continuous deposition.

WBS 1.2.13.4.7 Water-Resources Monitoring

In support of water-resources monitoring ground-water levels were measured at 28 sites and discharge was measured at one flowing well. The pressure-sensor was calibrated at site AD 6. Ground water data collected during March were checked and filed.

Staff completed preparation of camera-ready copy for JF-3 report (completed FY95 milestone 3GWR126) and forwarded to USGS-YMPB for publication on April 17, 1996. Staff received DOE concurrence for CY94 summary monitoring report (completed FY95 milestone 3GWR125) on April 8, 1996, completed preparation of camera-ready copy, and forwarded report to USGS-YMPB for publication on April 17, 1996.

USGS LEVEL 3 MILESTONE REPORT .
OCTOBER 1, 1995 - APRIL 30, 1996
Sorted by Baseline Date

Deliverable	Due Date	Expected Date	Completed Date	Comments
PRELIMINARY FRACTURE MODEL, TIVA CYN, YUCCA MTN Milestone Number: 3GUF105M	01/31/96	05/31/96		
LETTER REPORT Milestone Number: 3GWR625M	04/30/96	04/26/96	04/26/96	
SYNTHESIS OF HYDROGEOLOGIC UNIT/MATRIX PROPERTIE Milestone Number: 3GUP603M	05/30/96	07/22/96		
SUBSURFACE MINERAL RECORD OF PAST HYDROLOGY Milestone Number: 3GQH257M	05/31/96	05/31/96		

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USGS LEVEL 4 MILESTONE REPORT .
OCTOBER 1, 1995 - APRIL 30, 1996
Sorted by Baseline Date

Deliverable	Due Date	Expected Date	Completed Date	Comments
DATA TO TDB/CRF: INFIL. & FAST PATHS FLUX MAPS Milestone Number: 3GUI610M	11/30/95	05/15/96		
DATA TO CRF: 3RD/4TH QTR FY95 PERCHED WATER DATA Milestone Number: 3GUS602M	12/29/95	05/31/96		
REVIEW DRAFT: AIR-K TESTING SB Bh FY95 Milestone Number: 3GUP618M	01/31/96	05/31/96		
LETTER RPT: RESULTS OF FY 93, 94, 95 MAG SURVEYS Milestone Number: 3GGU132M	02/15/96	05/31/96		
COMPL RPT: GRND MOTION FROM YM SCENARIO EQ'S Milestone Number: 3GSA202M	02/15/96	04/17/96	04/17/96	
REVIEW DRAFT: IN-SITU MONITORING DATA PACKAGE Milestone Number: 3GUP661M	02/28/96	05/31/96		
REVIEW DRAFT: HYDROGEOLOGIC UNITS & MATRIX PROP Milestone Number: 3GUP602M	02/29/96	05/31/96		
DATA TO TDB/CRF:IN-SITU Bh MONITORING, 9/95-2/96 Milestone Number: 3GUP660M	03/28/96	07/01/96		
LTR RPT: SYSTHESIS OF TECTONICS MDLS FOR YM AREA Milestone Number: 3GTE610M	03/29/96	06/28/96		
DATA TO CRF: FY95 FORTYMILE WASH Milestone Number: 3GRG624M	03/29/96	05/31/96		
DATA TO CRF: FY95 NEUTRON LOGGING DATA Milestone Number: 3GUI624M	03/29/96	04/04/96	04/04/96	
ADMIN RPT: AIR-K TESTING IN SB Bh THRU FY95 Milestone Number: 3GUP610M	03/29/96	07/30/96		

Printed: 05/09/96 13:05

Deliverable	Due Date	Expected Date	Completed Date	Comments
DATA TO CRF: FY95 MATRIX PROPERTIES DATA Milestone Number: 3GUP601M	03/29/96	04/04/96	04/04/96	
MEMO: SUMM OF FY1995 DATA Milestone Number: 3GWH608M	03/29/96	05/31/96		
ADMIN RPT: DEATH VALLEY HYDROCHEMISTRY Milestone Number: 3GWH609M	03/29/96	05/31/96		
Compl Report: Surf Faulting in Basin/Range Milestone Number: 3GSS105M	04/29/96	05/31/96		
LETTER REPORT: KEY DATA UNCERTAINTIES Milestone Number: 3GRG605M	04/30/96	04/24/96	04/24/96	
REVIEW DRAFT: REGIONAL HYDROLOGIC DATA SET Milestone Number: 3GRM621M	04/30/96	04/29/96	04/29/96	
REV. DRAFT: PRELIM. SURFICIAL MTLS PROP MAP(S) Milestone Number: 3GUI605M	04/30/96	05/17/96		
DATA TO CRF: INSTRUMENT RECORDS, SD-12 Milestone Number: 3GUP652M	04/30/96	04/10/96	04/10/96	
DATA TO CRF: BOREHOLE MONITORING DATA Milestone Number: 3GUP655M	04/30/96	05/17/96		
REVIEW DRAFT: CONCEPTUAL MODEL OF UZ HYDRO SYS Milestone Number: 3GUM603M	04/30/96	06/12/96		
REVIEW DRAFT:GAS PHASE CIRCULATION IN VIC OF ESF Milestone Number: 3GGP604M	05/01/96	06/28/96		
REV DRAFT: SYNTHESIS RPT OF SELECT PALEO SITES Milestone Number: 3GQH670M	05/02/96	05/02/96		
ADMIN REPORT: NORTH RAMP HYDROLOGY Milestone Number: 3GUP667M	05/13/96	05/13/96		

Deliverable	Due Date	Expected Date	Completed Date	Comments
COMPL RPT: EMPIRICAL REL FOR GRND MOTION ATTEN Milestone Number: 3GSA200M	05/30/96	04/11/96	04/11/96	
LETTER REPORT: DETAILED ANALYSIS, UZ-16 VSP DATA Milestone Number: 3GUP622M	05/30/96	05/30/96		
Rpt: Comput of Porosity/Wtr Content Geophy Log Milestone Number: 3GGU245M	05/31/96	05/31/96		
Geophysical Log Analysis of H3-4-5,Pland A1/B-1H Milestone Number: 3GGU247M	05/31/96	05/31/96		
DATA TO CRF: FY95 SITE METEOROLOGY Milestone Number: 3GMM600M	05/31/96	05/31/96		
ADMIN RPT: STREAMFLOW & PRECIPITATION DATA, FY95 Milestone Number: 3GRS600M	05/31/96	06/28/96		
DATA TO CRF: FY95 STREAMFLOW DATA Milestone Number: 3GRS602M	05/31/96	06/28/96		
REVIEW DRAFT: USW G-2 TEST RESULTS Milestone Number: 3GRG603M	05/31/96	04/26/96	04/26/96	
REVIEW DRAFT: REGIONAL GROUND WATER FLOW Milestone Number: 3GRM601M	05/31/96	05/31/96		
SUMMARY MEMO: NET INFIL & FAST-PATHS FLUX MAPS Milestone Number: 3GUI611M	05/31/96	05/31/96		
DATA TO CRF: DATA FOR WELLS TESTED - 10/95-3/96 Milestone Number: 3GWF621M	05/31/96	05/31/96		
REVIEW DRAFT: PRELIM SITE SZ 3-D GW FLOW MODEL Milestone Number: 3GWM610M	05/31/96	05/31/96		

Yucca Mountain Project
Variance Analysis Report

Entered on: 05/13/96 08:53 AM **Entered by:** Raye Arnold
WBS: 1.2.3.1.2
WBS Title: Participant Management and Integration
AM: JONES S. **OM:** STATTON T.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 04/96

Data:

Cumulative Cost Variance: ($-141K / -27.8%)
Cause:

This negative cost variance is due largely to the budget and funding being at below the minimum level to manage the USGS site program. Initial budgets indicated a potential overrun of $462K . This account was not funded at a level adequate even for basic staffing requirements, leaving no funding for supplies & materials, office machine maintenance, secretarial support, publications, vehicle support, etc.

Impact:

There is a projected cost overrun in this P&S account of approximately $151K at this time. Cost underruns have been identified in P&S account 0G33131 to help offset this cost overrun.

Corrective Action:

All unbudgeted costs to this P&S account require TPO approval. Account is being closely monitored to minimize overruns. Staff time is being rebudgeted and charged to other WBS elements as appropriate.

Cumulative Schedule Variance: ($0K / 0%)
Variances are within tolerance.

Variance at Complete: ($-151K / -17.8%)
See "Cumulative Cost Variance"

Approved:

- (●) No
- ( ) Tech. Mgr
- ( ) TPO
- ( ) Yes

Yucca Mountain Project
Variance Analysis Report

Entered on: 05/13/96 09:10 AM **Entered by:** Raye Arnold
WBS: 1.2.3.2.2.1.1
WBS Title: Vert. and Lat. Dist. of Strat. Units in Site Area
AM: JONES S. **OM:** STATTON T.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 04/96

Data:

Cumulative Cost Variance: ($132K / 47.5%)
Cause:

The positive cost variance is attributable to two summary accounts in this P&S, 0G32211H96 , Geophysical Investigations, and 0G32211K96, Analysis of Pre-1985 Geophysical Logs. Work in both of these accounts is being performed primarily through direct charge task agreements with the USGS Geologic Division. Work is being performed, but no costs have shown as charges on cost report to date.

Impact:

There is no schedule impact resulting from this cost underrun because the work is being done, but costs are not being charged to the account. It is expected that all funds will be spent for the work which has been, and is being, completed.

Corrective Action:

Geologic Division personnel have been contacted to request that charges be brought current with work being performed. Adjustments have been made but there is a one month delay before these costs will show in the cost reports. Actual costs reported for May should reflect appropriate cost expenditures for both accounts.

Cumulative Schedule Variance: ($0K / 0%)
Variances are within tolerance.

Variance at Complete: ($-10K / -2.6%)
Variances are within tolerance.

Approved:

- (●) No
- ( ) Tech. Mgr
- ( ) TPO
- ( ) Yes

Yucca Mountain Project
Variance Analysis Report

Entered on: 05/13/96 09:09 AM **Entered by:** Raye Arnold
WBS: 1.2.3.2.2.1.2
WBS Title: Structural Features within the Site Area
AM: JONES S. **OM:** STATTON T.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 04/96

Data:

Cumulative Cost Variance: ($-213K / -17.8%)
Cause:

The negative cost variance results from the progress rate of the TBM requiring two shifts to support mapping activities. Initial work scope was based on a less aggressive TBM schedule, with one shift being able to support mapping. Further, multiple unplanned requests for data have required additional support.

Impact:

There is no schedule impact as the USBR currently is spending at the rate required to support mapping activities and data requests. If support requirements continue at this rate, there will be a substantial cost overrun in this account and there are no projected cost underruns to offset this overrun.

Corrective Action:

A Change Request is believed to be in process to provide additional funds to support this work. If funds are not made available, support will be cut back (collect and archive data only - no products produced) to fit available funding.

Cumulative Schedule Variance: ($0K / 0%)
Variances are within tolerance.

Variance at Complete: ($-396K / -18.7%)
See "Cumulative Cost Variance"

Approved:

- (●) No
- ( ) Tech. Mgr
- ( ) TPO
- ( ) Yes

Yucca Mountain Project
Variance Analysis Report

Entered on: 05/13/96 09:31 AM **Entered by:** Raye Arnold
WBS: 1.2.3.3.1.3.1
WBS Title: Site Saturated Zone Ground-Water Flow System
AM: JONES S. **OM:** STATTON T.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 04/96

Data:

Cumulative Cost Variance: ($75K / 12.3%)
Variances are within tolerance.

Cumulative Schedule Variance: ($0K / 0%)
Variances are within tolerance.

Variance at Complete: ($128K / 11.1%)
Cause:

This positive variance at complete is due primarily to the cleanout of WT-12 requiring less time and resources than was budgeted for the effort.

Impact:

There is no schedule impact to this projected variance at complete. Work was completed for less time and resources than budgeted. There is a projected cost underrun in this P&S account of approximately $128K at this time.

Corrective Action:

No corrective action is required. These funds have been identified to help offset cost overruns in P&S account 0G312.

Approved:

- (●) No
- ( ) Tech. Mgr
- ( ) TPO
- ( ) Yes

Yucca Mountain Project
Variance Analysis Report

Entered on: 05/13/96 09:40 AM **Entered by:** Raye Arnold
WBS: 1.2.3.6.2.2.1
WBS Title: Quaternary Regional Hydrology
AM: JONES S. **OM:** STATTON T.
Subject: Cost/Schedule Variance Analysis

YMP Participant: USGS
Submitted by: Raye Arnold
Reporting Period: 04/96

Data:

Cumulative Cost Variance: ($129K / 20.3%)
Cause:

This positive cost variance results from new, unplanned work being added to the scope of this P&S account. Because of an early milestone submittal (2/29/96) in the ESF Fracture Coating Dating account, all resources were directed to this new work. Time-phasing of other budgets within the P&S account were not adjusted at the time the new budget was added, resulting in an apparent, but not real, underrun condition. Funds will just be spent later in the year than originally budgeted.

Impact:

There is no impact resulting from this apparent underrun condition. Emphasis has shifted to other priorities within the P&S account . Budget is just not distributed appropriately to reflect spending, but all budget is expected to be expended to complete the work.

Corrective Action:

No corrective action is required.

Cumulative Schedule Variance: ($0K / 0%)
Variances are within tolerance.

Variance at Complete: ($24K / 2.2%)
Variances are within tolerance.

Approved:

- (●) No
- ( ) Tech. Mgr
- ( ) TPO
- ( ) Yes

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

Id	Description	Current Period BCWS	BCWP	ACWP	SV	CV	FY1996 Cumulative to Date BCWS	BCWP	ACWP	SV	CV	FY1996 at Completion BAC	EAC	VAC
1.2.3	Site Investigations	1040	1033	971	-7	62	6868	6826	6484	-42	342	11534	11896	-362
1.2.5	Regulatory	27	27	21	0	6	212	212	121	0	91	365	364	1
1.2.8	Environment, Safety, and H	42	42	48	0	-6	307	307	271	0	36	515	513	2
1.2.9	Project Management	56	56	34	0	22	389	389	321	0	68	664	635	29
1.2.12	Information Management	7	7	16	0	-9	47	47	45	0	2	80	90	-10
1.2.15	Support Services	154	154	170	0	-16	1095	1095	1130	0	-35	1871	1930	-59
Total		1326	1319	1260	-7	59	8918	8876	8372	-42	504	15029	15428	-399

Resource Distributions by Element of Cost

Fiscal Year 1996

Budgeted Cost of Work Scheduled

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
LBRHRS	23259	23807	23340	23449	24069	25071	23358	23331	22652	21832	21763	21501	277432
LABOR	954	972	944	959	980	1021	955	958	904	881	879	875	11282
SUBS	34	41	39	46	75	109	106	114	111	105	98	92	970
TRAVEL	30	41	38	38	43	46	42	38	31	35	22	18	422
PM&E	25	18	23	37	35	29	27	35	30	19	15	4	297
OTHER	157	159	155	165	165	214	180	181	171	190	151	154	2042
CAPITAL	0	0	0	0	0	0	16	0	0	0	0	0	16
Total BCWS	1200	1231	1199	1245	1298	1419	1326	1326	1247	1230	1165	1143	15029

Actual Cost of Work Performed

LBRHRS	21987	21558	21063	22761	20217	20627	19331	0	0	0	0	0	147544
LABOR	825	785	801	909	860	867	816	0	0	0	0	0	5863
SUBS	56	72	97	111	118	170	188	0	0	0	0	0	812
TRAVEL	8	43	29	26	40	60	25	0	0	0	0	0	231
PM&E	0	0	0	44	151	-20	48	0	0	0	0	0	223
OTHER	129	152	170	182	277	150	167	0	0	0	0	0	1227
CAPITAL	0	0	0	0	0	0	16	0	0	0	0	0	16
Total ACWP	1018	1052	1097	1272	1446	1227	1260	0	0	0	0	0	8372

WBS Status Sheet (WBS02) | Inc. Dollars in Thousands

WBS No. - 1.2 -Yucca Mountain Project

Resource Distributions by Element of Cost

Fiscal Year 1996
Estimate to Complete

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
LBRHRS	0	0	0	0	0	0	0	26736	22346	21831	21921	21766	114600
LABOR	0	0	0	0	0	0	0	1181	970	922	923	910	4906
SUBS	0	0	0	0	0	0	0	164	168	160	153	145	790
TRAVEL	0	0	0	0	0	0	0	51	36	44	28	27	186
PM&E	0	0	0	0	0	0	0	31	26	25	22	14	118
OTHER	0	0	0	0	0	0	0	218	218	239	190	191	1056
CAPITAL	0	0	0	0	0	0	0	0	0	0	0	0	0
Total ETC	0	0	0	0	0	0	0	1645	1418	1390	1316	1287	7056

Resource Distributions

Fiscal Year 1996	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
BCWS	1200	1231	1199	1245	1298	1419	1326	1326	1247	1230	1165	1143	15029
BCWP	1193	1238	1175	1189	1360	1402	1319	0	0	0	0	0	8876
ACWP	1018	1052	1097	1272	1446	1227	1260	0	0	0	0	0	8372
ETC	0	0	0	0	0	0	0	1645	1418	1390	1316	1287	7056

Fiscal Year Distribution

	Prior	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	Future	At Complete
BCWS	0	15029	0	0	0	0	0	0	0	0	0	0	15029
BCWP	0	8876	0	0	0	0	0	0	0	0	0	0	
ACWP	0	8372	0	0	0	0	0	0	0	0	0	0	
ETC	0	7056	0	0	0	0	0	0	0	0	0	0	15428

YMP PLANNING AND CONTROL SYSTEM (PACS)

Participant U.S. Geological Survey

MONTHLY COST/FTE REPORT

Fiscal Month/Year APRIL 1996

Date Prepared 05/13/96 08:04

	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
1.2.3	952	15791	3082	0	854	0	11518	0	6450
1.2.5	21	176	176	0	72	0	365	0	122
1.2.8	47	692	0	0	0	0	515	0	271
1.2.9	34	784	176	0	62	0	664	0	319
1.2.12	15	176	176	0	9	0	80	0	44
1.2.15	170	1712	352	0	25	0	1871	0	1129
TOTALS	1239	19331	3962	0	1022	0	15013	0	8335

U.S. GEOLOGICAL SURVEY
ESTIMATED COSTS FOR 10/1/95 - 04/30/96

	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
0G311968 Scientific Programs Management and Integ	13.9	15.6	15.2	17.0	29.6	30.6	29.7	0.0	0.0	0.0	0.0	0.0	151.6
1.2.3.1.1	13.9	15.6	15.2	17.0	29.6	30.6	29.7	0.0	0.0	0.0	0.0	0.0	151.6
0G312968Z U.S. Geological Survey Support	79.6	93.3	92.1	107.4	174.8	34.2	66.3	0.0	0.0	0.0	0.0	0.0	647.7
1.2.3.1.2	79.6	93.3	92.1	107.4	174.8	34.2	66.3	0.0	0.0	0.0	0.0	0.0	647.7
*1.2.3.1	93.5	108.9	107.3	124.4	204.4	64.8	96.0	0.0	0.0	0.0	0.0	0.0	799.3
0G32211D96 Compilation and Synthesis of Existing St	11.4	14.1	11.9	37.6	24.4	32.7	10.7	0.0	0.0	0.0	0.0	0.0	142.8
0G32211H96 Geophysical Investigations	3.5	0.1	0.0	0.0	0.8	-3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.8
0G32211K96 Analysis of Pre 1985 Geophysical Logs	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
1.2.3.2.2.1.1	14.9	14.2	11.9	37.6	25.2	29.7	10.7	0.0	0.0	0.0	0.0	0.0	144.2
0G32212H96 Geologic Map of the Central Block of the	34.1	33.4	34.0	31.8	35.2	55.4	60.5	0.0	0.0	0.0	0.0	0.0	284.4
0G32212J96 Exploratory Studies Facility Mapping (US	111.3	100.7	135.7	183.3	192.8	244.4	157.1	0.0	0.0	0.0	0.0	0.0	1125.3
1.2.3.2.2.1.2	145.4	134.1	169.7	215.1	228.0	299.8	217.6	0.0	0.0	0.0	0.0	0.0	1409.7
0G32831A96 Summary of Geologic, Geophysical, and Se	5.9	6.3	5.9	6.5	6.9	5.9	6.8	0.0	0.0	0.0	0.0	0.0	44.2
1.2.3.2.8.3.1	5.9	6.3	5.9	6.5	6.9	5.9	6.8	0.0	0.0	0.0	0.0	0.0	44.2
0G32833A96 Coordination and Review of Ground Motion	0.0	11.5	24.0	14.0	24.1	-10.8	0.0	0.0	0.0	0.0	0.0	0.0	62.8
1.2.3.2.8.3.3	0.0	11.5	24.0	14.0	24.1	-10.8	0.0	0.0	0.0	0.0	0.0	0.0	62.8
0G32836A96 Seismotectonics Summary and Synthesis	7.8	16.6	14.2	16.7	16.9	12.4	10.7	0.0	0.0	0.0	0.0	0.0	95.3
1.2.3.2.8.3.6	7.8	16.6	14.2	16.7	16.9	12.4	10.7	0.0	0.0	0.0	0.0	0.0	95.3
0G32846A96 Quaternary Faulting at the Site	14.7	21.7	17.7	21.9	25.1	35.8	42.8	0.0	0.0	0.0	0.0	0.0	179.7
0G32846K96 Trench Samp Dates Quat. Fits Hist GD, RV	0.0	0.0	0.0	0.0	3.8	0.0	0.7	0.0	0.0	0.0	0.0	0.0	4.5
1.2.3.2.8.4.6	14.7	21.7	17.7	21.9	28.9	35.8	43.5	0.0	0.0	0.0	0.0	0.0	184.2
0G3284CC96 Prepare Final Report on Tectonic Models	18.2	5.8	10.3	7.0	7.9	7.7	6.4	0.0	0.0	0.0	0.0	0.0	63.3
1.2.3.2.8.4.12	18.2	5.8	10.3	7.0	7.9	7.7	6.4	0.0	0.0	0.0	0.0	0.0	63.3
*1.2.3.2	206.9	210.2	253.7	318.8	337.9	380.5	295.7	0.0	0.0	0.0	0.0	0.0	2003.7
0G33111B96 Collection of Site Meteorological Data f	6.2	7.3	5.9	6.7	6.9	7.9	8.4	0.0	0.0	0.0	0.0	0.0	[illegible]
1.2.3.3.1.1.1	6.2	7.3	5.9	6.7	6.9	7.9	8.4	0.0	0.0	0.0	0.0	0.0	49.3
0G33112C96 Collection of Site Streamflow Data	7.0	19.4	9.6	10.2	8.3	4.4	1.1	0.0	0.0	0.0	0.0	0.0	60.0
1.2.3.3.1.1.2	7.0	19.4	9.6	10.2	8.3	4.4	1.1	0.0	0.0	0.0	0.0	0.0	60.0
0G33113A96 Assessment of Key Data/Modeling Problems	0.1	5.2	8.8	1.1	1.9	1.1	2.6	0.0	0.0	0.0	0.0	0.0	20.8
0G33113C96 Fortymile Wash Recharge	5.8	4.9	4.0	2.5	6.2	5.8	5.0	0.0	0.0	0.0	0.0	0.0	34.2
1.2.3.3.1.1.3	5.9	10.1	12.8	3.6	8.1	6.9	7.6	0.0	0.0	0.0	0.0	0.0	55.0
0G33114D96 Regional Saturated- Zone Numerical Model	7.1	6.2	1.5	2.7	10.4	24.6	6.0	0.0	0.0	0.0	0.0	0.0	58.5
0G33114E96 Regional Saturated- Zone Boundary Condit	5.0	12.5	12.2	15.5	4.3	3.4	-0.2	0.0	0.0	0.0	0.0	0.0	52.7
0G33114F96 Regional Saturated- Zone Framework Model	0.0	0.0	12.3	22.8	16.0	10.2	5.8	0.0	0.0	0.0	0.0	0.0	67.1
1.2.3.3.1.1.4	12.1	18.7	26.0	41.0	30.7	38.2	11.6	0.0	0.0	0.0	0.0	0.0	178.3
0G33121C96 Infiltration Distribution	7.8	9.5	9.0	11.3	11.2	8.2	9.7	0.0	0.0	0.0	0.0	0.0	66.7
0G33121D96 Infiltration Properties	5.7	6.7	5.7	9.9	11.0	5.8	6.2	0.0	0.0	0.0	0.0	0.0	51.0

U.S. GEOLOGICAL SURVEY
ESTIMATED COSTS FOR 10/1/95 - 04/30/96

		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
0G33121E96	Infiltration Processes	15.4	18.1	16.9	20.3	23.7	20.0	16.2	0.0	0.0	0.0	0.0	0.0	130.6
1.2.3.3.1.2.1		28.9	34.3	31.6	41.5	45.9	34.0	32.1	0.0	0.0	0.0	0.0	0.0	248.3
0G33123C96	Vertical Seismic Profiling: Borehole UE-	17.5	20.0	13.2	32.7	21.1	10.1	9.5	0.0	0.0	0.0	0.0	0.0	124.1
0G33123D96	Unsaturated Zone Borehole Instrumentatio	74.8	82.1	66.5	38.2	57.3	41.1	49.5	0.0	0.0	0.0	0.0	0.0	409.5
0G33123G96	Integrated Analysis and Interpretation	0.0	0.0	12.4	12.9	15.3	16.7	17.1	0.0	0.0	0.0	0.0	0.0	74.4
0G33123H96	Matrix Properties of Hydrologic Units	12.2	9.3	9.4	7.2	7.7	7.2	6.1	0.0	0.0	0.0	0.0	0.0	59.1
0G33123K96	Temporary Instrumentation of SD-7	0.0	0.0	0.0	4.6	6.6	5.8	7.5	0.0	0.0	0.0	0.0	0.0	24.5
1.2.3.3.1.2.3		104.5	111.4	101.5	95.6	108.0	80.9	89.7	0.0	0.0	0.0	0.0	0.0	691.6
0G33124E96	Air-Permeability and Hydrochemistry Test	29.5	33.8	37.6	42.4	56.3	24.9	41.2	0.0	0.0	0.0	0.0	0.0	265
0G33124F96	Perched Water Testing in the Exploratory	0.9	0.0	2.8	4.3	3.0	1.0	12.4	0.0	0.0	0.0	0.0	0.0	24
0G33124K96	ESF Moisture/Dryout	0.0	0.0	0.0	0.0	7.0	7.5	12.9	0.0	0.0	0.0	0.0	0.0	27.4
1.2.3.3.1.2.4		30.4	33.8	40.4	46.7	66.3	33.4	66.5	0.0	0.0	0.0	0.0	0.0	317.5
0G33126B96	Gas Circulation and Pneumatic Pathways	9.6	11.5	9.0	13.7	9.6	8.9	8.7	0.0	0.0	0.0	0.0	0.0	71.0
1.2.3.3.1.2.6		9.6	11.5	9.0	13.7	9.6	8.9	8.7	0.0	0.0	0.0	0.0	0.0	71.0
0G33127B96	Unsturated-Zone Hydrochemistry	26.2	26.4	32.2	23.4	53.2	18.3	46.8	0.0	0.0	0.0	0.0	0.0	226.5
1.2.3.3.1.2.7		26.2	26.4	32.2	23.4	53.2	18.3	46.8	0.0	0.0	0.0	0.0	0.0	226.5
0G33128A96	Fluid Flow in Unsaturated-Zone Fractured	6.9	6.9	6.6	7.2	8.4	8.8	9.3	0.0	0.0	0.0	0.0	0.0	54.1
1.2.3.3.1.2.8		6.9	6.9	6.6	7.2	8.4	8.8	9.3	0.0	0.0	0.0	0.0	0.0	54.1
0G33129B96	Intermediate Site Unsaturated-Zone FlowM	7.3	8.6	15.2	30.5	6.3	16.6	17.7	0.0	0.0	0.0	0.0	0.0	102.2
1.2.3.3.1.2.9		7.3	8.6	15.2	30.5	6.3	16.6	17.7	0.0	0.0	0.0	0.0	0.0	102.2
0G33131A96	Conduct Hydraulic/Tracer Tests, C-Wells	39.6	40.5	40.7	49.0	57.6	7.2	10.1	0.0	0.0	0.0	0.0	0.0	244.7
0G33131F96	Site Potentiometric Levels Monitoring	11.7	17.5	17.2	0.4	3.7	10.3	10.8	0.0	0.0	0.0	0.0	0.0	71.6
0G33131G96	Pumping and Testing Existing Monitoring	11.8	14.0	5.4	20.7	20.8	21.4	31.8	0.0	0.0	0.0	0.0	0.0	125.9
0G33131K96	Enhanced C-Wells Hydraulic and Conservat	0.0	0.0	0.0	0.0	0.0	51.2	42.1	0.0	0.0	0.0	0.0	0.0	93.3
1.2.3.3.1.3.1		63.1	72.0	63.3	70.1	82.1	90.1	94.8	0.0	0.0	0.0	0.0	0.0	535.5
0G33132D96	Saturated-Zone Hydrochemical Sample and	6.7	6.9	6.3	8.7	6.9	6.9	7.4	0.0	0.0	0.0	0.0	0.0	4
1.2.3.3.1.3.2		6.7	6.9	6.3	8.7	6.9	6.9	7.4	0.0	0.0	0.0	0.0	0.0	49.8
0G33133D96	Site Saturated Zone Framework Model	14.9	10.2	4.6	0.1	0.1	0.7	11.2	0.0	0.0	0.0	0.0	0.0	41.8
0G33133E96	Site Saturated Zone Numerical Model	11.5	10.1	3.3	13.4	17.4	21.1	15.2	0.0	0.0	0.0	0.0	0.0	92.0
1.2.3.3.1.3.3		26.4	20.3	7.9	13.5	17.5	21.8	26.4	0.0	0.0	0.0	0.0	0.0	133.8
*1.2.3.3		341.2	387.6	368.3	412.4	458.2	377.1	428.1	0.0	0.0	0.0	0.0	0.0	2772.9
0G3521968	Tracer Gas Support	5.2	5.2	5.1	5.4	5.4	5.5	5.3	0.0	0.0	0.0	0.0	0.0	37.1
1.2.3.5.2.1		5.2	5.2	5.1	5.4	5.4	5.5	5.3	0.0	0.0	0.0	0.0	0.0	37.1
*1.2.3.5		5.2	5.2	5.1	5.4	5.4	5.5	5.3	0.0	0.0	0.0	0.0	0.0	37.1
0G36212B96	Paleoclimate Study of Lake, Playa and Ma	21.0	18.3	14.8	25.4	23.3	29.2	16.0	0.0	0.0	0.0	0.0	0.0	148.0
1.2.3.6.2.1.2		21.0	18.3	14.8	25.4	23.3	29.2	16.0	0.0	0.0	0.0	0.0	0.0	148.0
0G36214A96	Geochronological Studies of Surface Desp	22.4	16.3	17.1	3.4	0.9	-10.3	11.2	0.0	0.0	0.0	0.0	0.0	61.0

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0G36214B96	Surface Deposits Mapping	5.9	5.9	6.2	7.2	8.0	7.2	10.1	0.0	0.0	0.0	0.0	0.0	80.5
1.2.3.6.2.1.4		28.3	22.2	23.3	10.6	8.9	-3.1	21.3	0.0	0.0	0.0	0.0	0.0	111.5
0G36215A96	Paleoclimate/Paleoenvironmental Synthesi	9.1	9.1	15.4	3.3	13.8	8.9	13.5	0.0	0.0	0.0	0.0	0.0	73.1
1.2.3.6.2.1.5		9.1	9.1	15.4	3.3	13.8	8.9	13.5	0.0	0.0	0.0	0.0	0.0	73.1
0G36221E96	Subsurface Mineral Record of Past Hydrol	16.9	36.8	25.6	27.0	18.8	28.2	21.4	0.0	0.0	0.0	0.0	0.0	174.7
0G36221F96		0.0	0.2	4.5	12.2	16.5	8.1	8.4	0.0	0.0	0.0	0.0	0.0	49.9
0G36221G96	Evaluation of Paleo Ground-Water Dischar	9.5	4.1	-0.7	0.0	1.7	4.2	14.9	0.0	0.0	0.0	0.0	0.0	33.7
0G36221K96	Dating of Fracture Coatings in ESF	0.0	0.0	24.3	50.5	86.9	53.0	31.3	0.0	0.0	0.0	0.0	0.0	246.0
1.2.3.6.2.2.1		26.4	41.1	53.7	89.7	123.9	93.5	76.0	0.0	0.0	0.0	0.0	0.0	504
*1.2.3.6		84.8	90.7	107.2	129.0	169.9	128.5	126.8	0.0	0.0	0.0	0.0	0.0	836.9
**1.2.3		731.6	802.6	841.6	990.0	1175.8	956.4	951.9	0.0	0.0	0.0	0.0	0.0	6449.9
0G5249682	Regulatory Documentation	5.7	5.9	0.0	8.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.4
1.2.5.2.4		5.7	5.9	0.0	8.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.4
*1.2.5.2		5.7	5.9	0.0	8.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.4
0G535968	Technical Data Base Input	7.2	10.3	12.5	14.1	11.8	13.1	20.8	0.0	0.0	0.0	0.0	0.0	89.8
1.2.5.3.5		7.2	10.3	12.5	14.1	11.8	13.1	20.8	0.0	0.0	0.0	0.0	0.0	89.8
*1.2.5.3		7.2	10.3	12.5	14.1	11.8	13.1	20.8	0.0	0.0	0.0	0.0	0.0	89.8
0G541968	Interact with Site Characterization and	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.2.5.4.1		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0G546968	Planning and Coordination of Flow- and-T	0.0	0.0	0.4	10.2	-3.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	7.8
1.2.5.4.6		0.0	0.0	0.4	10.2	-3.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	7.8
*1.2.5.4		0.0	0.0	0.4	10.2	-3.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	7.8
0G553968		0.0	0.0	0.0	0.1	-0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3
1.2.5.5.3		0.0	0.0	0.0	0.1	-0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3
*1.2.5.5		0.0	0.0	0.0	0.1	-0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0
0G57968	Technical Evaluation	0.9	0.0	0.0	0.9	0.5	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.
1.2.5.7		0.9	0.0	0.0	0.9	0.5	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.1
*1.2.5.7		0.9	0.0	0.0	0.9	0.5	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.1
**1.2.5		13.8	16.2	12.9	34.2	10.0	13.5	20.8	0.0	0.0	0.0	0.0	0.0	121.4
0G825968	Occupational Safety and Health	7.3	7.4	7.0	7.7	7.8	7.5	7.5	0.0	0.0	0.0	0.0	0.0	52.2
1.2.8.2.5		7.3	7.4	7.0	7.7	7.8	7.5	7.5	0.0	0.0	0.0	0.0	0.0	52.2
*1.2.8.2		7.3	7.4	7.0	7.7	7.8	7.5	7.5	0.0	0.0	0.0	0.0	0.0	52.2
0G845968	Radiological Studies	0.0	0.0	0.0	0.1	0.0	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	-0.3
1.2.8.4.5		0.0	0.0	0.0	0.1	0.0	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	-0.3
0G84796H	Water Resources Monitoring	33.3	26.9	27.4	27.8	31.9	31.6	39.8	0.0	0.0	0.0	0.0	0.0	218.7
1.2.8.4.7		33.3	26.9	27.4	27.8	31.9	31.6	39.8	0.0	0.0	0.0	0.0	0.0	218.7
*1.2.8.4		33.3	26.9	27.4	27.9	31.9	31.2	39.8	0.0	0.0	0.0	0.0	0.0	218.4

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**1.2.8		40.6	34.3	34.4	35.6	39.7	38.7	47.3	0.0	0.0	0.0	0.0	0.0	270.6
0G9121968	Participant Technical Project Office	27.1	29.1	29.7	25.2	24.4	22.6	15.8	0.0	0.0	0.0	0.0	0.0	173.9
1.2.9.1.2.1		27.1	29.1	29.7	25.2	24.4	22.6	15.8	0.0	0.0	0.0	0.0	0.0	173.9
*1.2.9.1		27.1	29.1	29.7	25.2	24.4	22.6	15.8	0.0	0.0	0.0	0.0	0.0	173.9
0G922968	Participant Project Control - USGS	19.9	20.9	19.7	20.5	27.0	18.8	18.1	0.0	0.0	0.0	0.0	0.0	144.9
1.2.9.2.2		19.9	20.9	19.7	20.5	27.0	18.8	18.1	0.0	0.0	0.0	0.0	0.0	144.9
*1.2.9.2		19.9	20.9	19.7	20.5	27.0	18.8	18.1	0.0	0.0	0.0	0.0	0.0	144.9
**1.2.9		47.0	50.0	49.4	45.7	51.4	41.4	33.9	0.0	0.0	0.0	0.0	0.0	318.8
0GC521968	Records Operation (USGS)	5.4	3.5	3.3	4.8	4.9	6.7	15.3	0.0	0.0	0.0	0.0	0.0	43
1.2.12.5.2.1		5.4	3.5	3.3	4.8	4.9	6.7	15.3	0.0	0.0	0.0	0.0	0.0	43.9
*1.2.12.5		5.4	3.5	3.3	4.8	4.9	6.7	15.3	0.0	0.0	0.0	0.0	0.0	43.9
**1.2.12		5.4	3.5	3.3	4.8	4.9	6.7	15.3	0.0	0.0	0.0	0.0	0.0	43.9
0GF23968I	Support/Personnel Services	49.0	42.6	37.2	41.8	39.7	52.0	43.6	0.0	0.0	0.0	0.0	0.0	305.9
0GF23968J	Facilities Management - Space	85.4	57.6	71.0	71.3	71.3	71.3	71.3	0.0	0.0	0.0	0.0	0.0	499.2
0GF23968K	Facilities Management - Computers/Phones	24.9	17.1	20.4	20.8	20.8	20.8	20.8	0.0	0.0	0.0	0.0	0.0	145.6
0GF23968L	Facilities Management - Other	13.3	8.7	11.2	11.1	11.1	11.1	11.1	0.0	0.0	0.0	0.0	0.0	77.6
0GF23968S	Procurement/Property Management - USGS	2.2	12.4	7.9	8.6	7.8	8.5	8.8	0.0	0.0	0.0	0.0	0.0	56.2
1.2.15.2.3		174.8	138.4	147.7	153.6	150.7	163.7	155.6	0.0	0.0	0.0	0.0	0.0	1084.5
*1.2.15.2		174.8	138.4	147.7	153.6	150.7	163.7	155.6	0.0	0.0	0.0	0.0	0.0	1084.5
0GF3968	YMP Support For The Training Mission (US	5.6	5.0	4.0	3.6	7.7	4.3	14.2	0.0	0.0	0.0	0.0	0.0	44.4
1.2.15.3		5.6	5.0	4.0	3.6	7.7	4.3	14.2	0.0	0.0	0.0	0.0	0.0	44.4
*1.2.15.3		5.6	5.0	4.0	3.6	7.7	4.3	14.2	0.0	0.0	0.0	0.0	0.0	44.4
**1.2.15		180.4	143.4	151.7	157.2	158.4	168.0	169.8	0.0	0.0	0.0	0.0	0.0	1128.9
1.2 OPERATING		1018.8	1050.0	1093.3	1267.5	1440.2	1224.7	1239.0	0.0	0.0	0.0	0.0	0.0	833
CAPITAL EQUIPMENT		0.0	0.0	0.0	0.0	0.0	0.0	16.0	0.0	0.0	0.0	0.0	0.0	16
GRAND TOTAL		1018.8	1050.0	1093.3	1267.5	1440.2	1224.7	1255.0	0.0	0.0	0.0	0.0	0.0	8349.5
FTEs														
FEDERAL		118.1	125.4	123.4	133.7	118.8	121.9	112.7	0.0	0.0	0.0	0.0	0.0	
CONTRACT		7.9	8.6	11.1	15.4	17.4	21.5	22.7	0.0	0.0	0.0	0.0	0.0	
TOTAL		126.0	134.0	134.5	149.1	136.2	143.4	135.4	0.0	0.0	0.0	0.0	0.0	

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