WBS: 9.3.7
QA: N/A

Civilian Radioactive Waste Management System
Management & Operating Contractor

Monthly Summary Report

April 1996

Prepared for:

U.S. Department of Energy
Office of Civilian Radioactive Waste Management
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Under Contract Number
DE-AC01-91RW00134

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Enclosure 2

CONTENTS

FIGURES

FIGURES (Continued)

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1. PROGRAM-LEVEL REPORT

HIGHLIGHTS

- Completed the transition to a consolidated M&O organization in the East that focused resources on specifically defined work products, brought all functions under one Assistant General Manager, and completed destaffing required by the reprogramming to make funds available for the interim storage facility Topical Safety Analysis Report (TSAR). The new organization is called Waste Management and Integration.

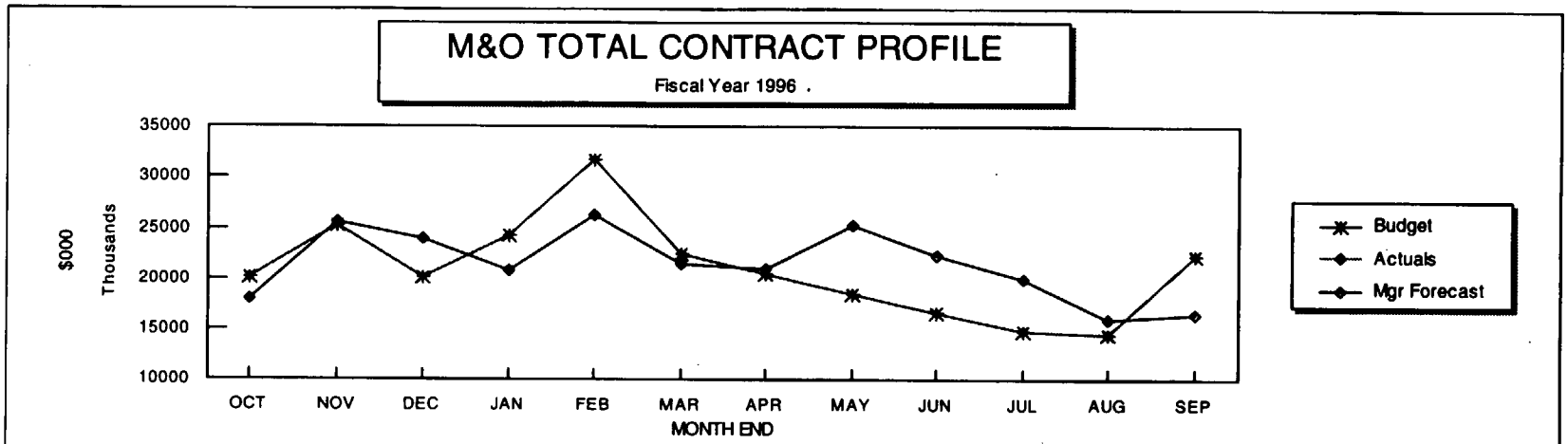
- Anticipate receipt of prime contract modification A061 that will increase the FY96 contract value by $9,538,000 from $202,090,547 to $211,628,547, realign unearned FY95 award fee ($1.6M) for FY96 QA work, and increase funding by $311K for additional depleted uranium work. The total funding inception to date will be set at $821,986,249.

TOTAL CONTRACT PERFORMANCE DATA

- Figures 1 through 4 represent key financial information for the total contract. All Financial Status and Cumulative Financial Status figures include Fiscal Year 1995 (FY95) Carryover.

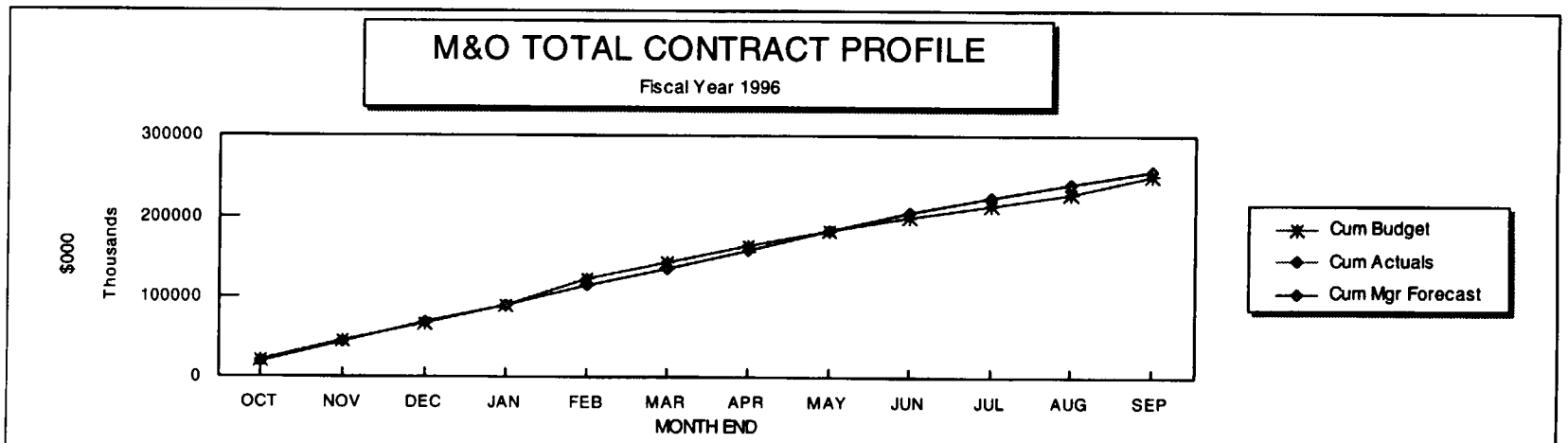
  - The $5.8M overrun forecast at complete is driven by the Yucca Mountain Project and discussed in Section 2. A slight underrun is forecast for the rest of the M&O.

- Data for the Contract Funds Status Reports (CFSRs) was unavailable at time of printing. March and April CFSRs will be delivered under separate cover.



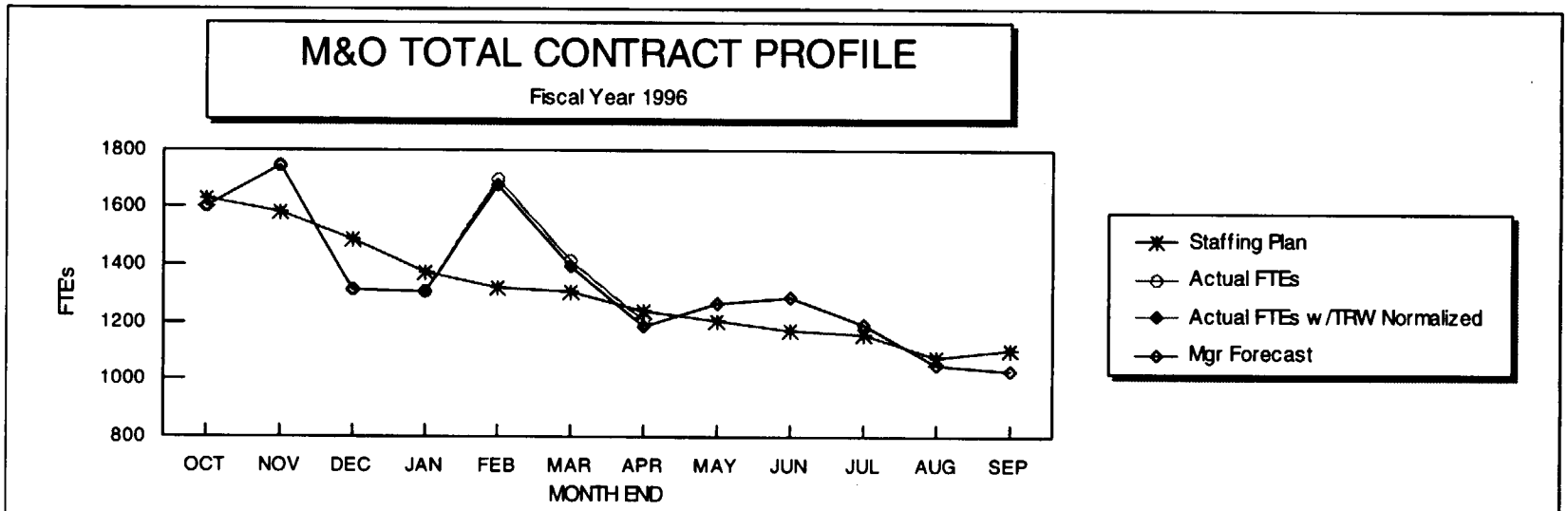
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Budget	20113	25299	20075	24194	31661	22504	20469	18377	16587	14865	14474	22278	250896
Actuals	17975	25511	23963	20794	26246	21439	20910						
Mgr Forecast	17975	25511	23963	20794	26246	21439	20910	25242	22258	19959	15911	16526	256734
Cost Variance	2138	-212	-3888	3400	5415	1065	-441	-6865	-5671	-5094	-1437	5752	-5838

Figure 1. M&O Total Financial Status



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Cum Budget	20113	45412	65487	89681	121342	143846	164315	182692	199279	214144	228618	250896	250896
Cum Actuals	17975	43486	67449	88243	114489	135928	156838						
Cum Mgr Forecast	17975	43486	67449	88243	114489	135928	156838	182080	204338	224297	240208	256734	256734
Cum Variance	2138	1926	-1962	1438	6853	7918	7477	612	-5059	-10153	-11590	-5838	-5838

Figure 2. M&O Cumulative Total Financial Status



	OCT	NOV	DEC	JAN	FEB	MAR	**APR**	MAY	JUN	JUL	AUG	SEP
Staffing Plan	1628.8	1582.7	1484.9	1373.5	1318.9	1303.2	1240.8	1206.6	1173.6	1154.2	1076.7	1100.8
Actual FTEs	1603.3	1744.3	1312.9	1307.6	1698.2	1412.1	1202.5					
Actual FTEs w/TRW Normalized				1302.6	1675.0	1392.0	1185.2					
Mgr Forecast	1603.3	1744.3	1312.9	1302.6	1675.0	1392.0	1185.2	1264.4	1288.2	1189.5	1049.4	1030.1
Variance	25.5	-161.6	172.0	70.9	-356.1	-88.8	55.6	-57.8	-114.6	-35.3	27.3	70.7

Figure 3. M&O Total Staffing

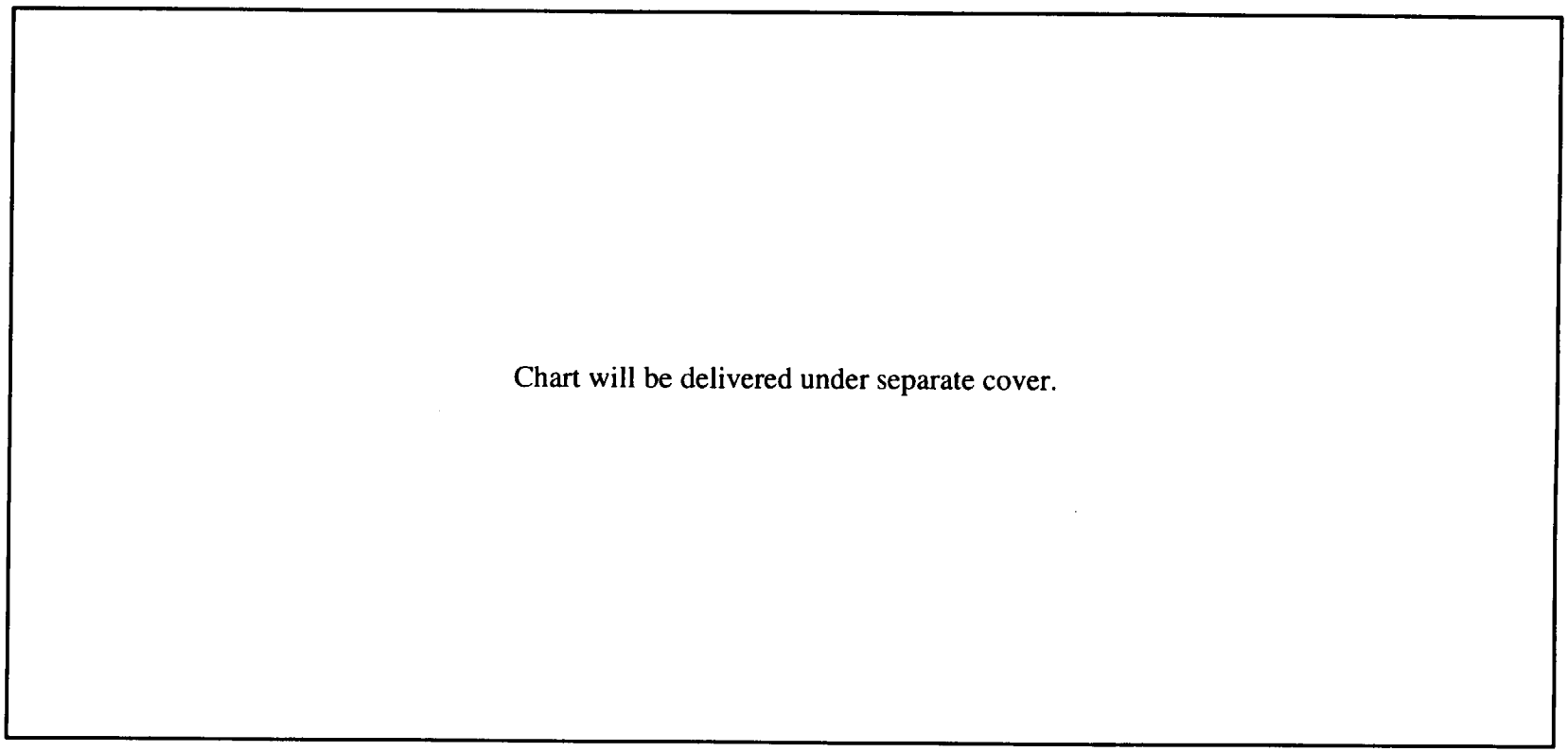


Figure 4. M&O Total Contract Funds Status Report (CFSR)

2. YUCCA MOUNTAIN PROJECT REPORT

HIGHLIGHTS

- Started excavating the Northern Ghost Dance Fault Alcove (NGDFA) with the Alpine Miner on April 27, 1996, 47 calendar days ahead of schedule. The Alpine Miner advanced 1.6m/5.3ft before the machine was returned to the Thermal Test Alcove to continue excavation during the week.

- Completed the development of a disk thermal model to evaluate waste package surface temperatures beyond 1000 years. This model will be used to support the Mined Geologic Disposal System (MGDS) study evaluations.

- Completed filler material testing at the Framatome Cogema Fuels facility in Lynchburg, VA. Two B&W Pressurized Water Reactor (PWR) dummy fuel assemblies (15x15 and 17x17) were assembled and used in a transparent filler test fixture simulating a single cell within a PWR waste package basket. Two shot sizes were used to determine filling parameters. A larger fill percentage (93-96%) was found to be obtainable using the smaller shot.

- Supported developing an integrated project schedule and a long-range plan in response to Department of Energy (DOE) Level 2 schedule guidance. Level 3 schedules with associated workscope descriptions, activity resource estimates, and interfacing logic are nearing completion. Reviewed Level 2 and 3 schedules and recommended changes to the Level 2 guidance.

- Completed the QAP 6.2 review of Exploratory Studies Facility Design Requirements Document (ESFDRD), Revision 2. Received concurrence signatures from all 13 reviewers. The document successfully passed Level 2 Change Control Board evaluations in accordance with the YAP-3.5Q procedure for baseline change. This ESFDRD revision includes the project's position on the applicability of all 10 CFR 60 requirements to the ESF.

- Completed a report on the "Ground Motion Modeling of Scenario Earthquakes at Yucca Mountain." The report describes ground motion calculations for six earthquake scenarios using different numerical modeling approaches based on past earthquake occurrences in the Yucca Mountain. The results will be used in the probabilistic seismic hazard assessment for Yucca Mountain.

- Discovered elevated levels of Chlorine-36 at five locations in the ESF. This finding is a result of an intensive test program to identify paths for water to flow from ground surface to repository depth. No conclusions can yet be drawn from these tests; however, the findings are generally consistent with our expectations. The test results will be incorporated into a comprehensive model of Yucca Mountain hydrology.

- The Tunnel Boring Maching (TBM) passed the 3-mile excavation point on April 12, 1996, and advanced to construction station 48+66.3 meters (m)/15,961.5 feet (ft), as of April 30, 1996. The TBM excavated 522.5m/1,714.2ft. for the month or an average 23.4m/76.9ft. per work day

as progress improved due to a change in ground support category from 4 to 1. The TBM underwent its third 500-hour maintenance service and remains approximately 102 working days ahead of schedule.

- The Alpine Miner machine completed excavating the Thermal Mechanical Alcove (TMA) to 24.3m/79.7ft. from the right rib of the Thermal Test Facility (TTF) Access/ Observation Drift (AOD). The machine then completed excavating the extension portion of the Thermal Mechanical Room of 12.8m/42.0ft. The Alpine Miner is now excavating in the TTF/AOD and has advanced to station 0+69.9m/229.3ft.

- Developed a two-pronged approach to resolve the air quality problem in the tunnel. Issued disposable masks to all employees as an interim measure and planned a respirator program to be implemented by mid-May 1996. Three expert consultants were brought in to determine the source of the air quality problem, conduct analyses, define the problem, and provide recommendations. Air quality sampling continues on a regular basis.

- Kiewit submitted an analysis of the ventilation duct line collapse that occurred on March 25, 1996. In addition to the repairs already performed, the architect/engineer recommended the replacement of additional duct sections at the earliest opportunity. The Kiewit analysis is being reviewed by the Construction Management Office.

PERFORMANCE DATA

- Figures 5 through 7 represent key financial information for the Yucca Mountain Project. Figure 8 will be a CFSR for the Yucca Mountain Project in future monthly reports.

  - The $6.4M overrun forecast at complete includes:

    - A $1.1M Nevada Test Site (NTS) M&O communication cost that belongs in Program Management and Integration (PM&I).

    - Three months of unbudgeted Kiewit third shift and overtime for which a change request (CR) is in process. The forecast includes an additional $900K to continue the third tunneling shift through the end of the fiscal year.

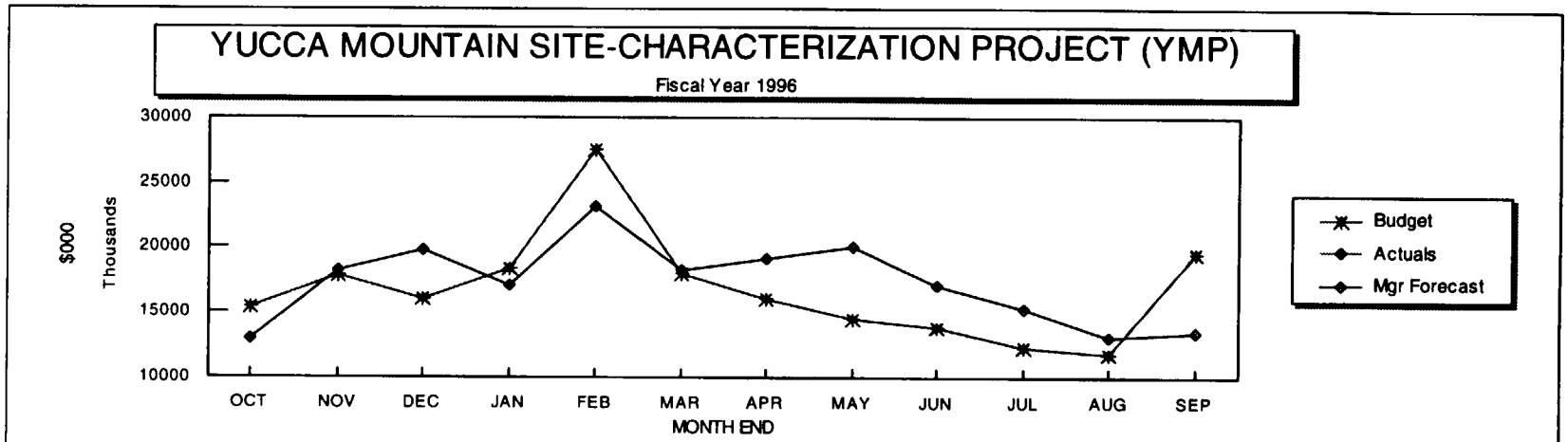
    - About $1M in overbooked Kiewit fee with additional associated PM&I.

    - $500K in closeout cost for which a CR is being prepared.

  - NTS cost previously projected for September is now spread out causing forecast increases for May through July and a decrease for September. A CR is in process.

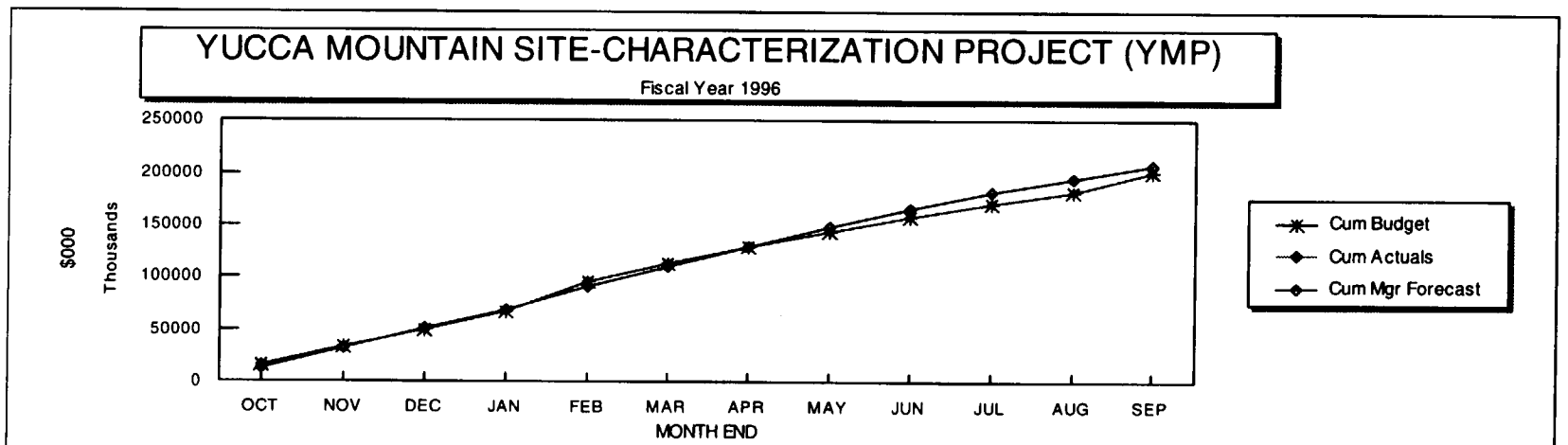
  - Mitigation of the remaining potential overrun in the ESF continues. Minimizing Kiewit procurements, delaying steel set purchases, and eliminating Kiewit overtime are among the alternatives being considered.

- The April FTE Full-Time Equivalent (FTE) chart is understated by about 150 positions due to delayed posting of actual hours charged. The adjustment will be reflected in the May Report.



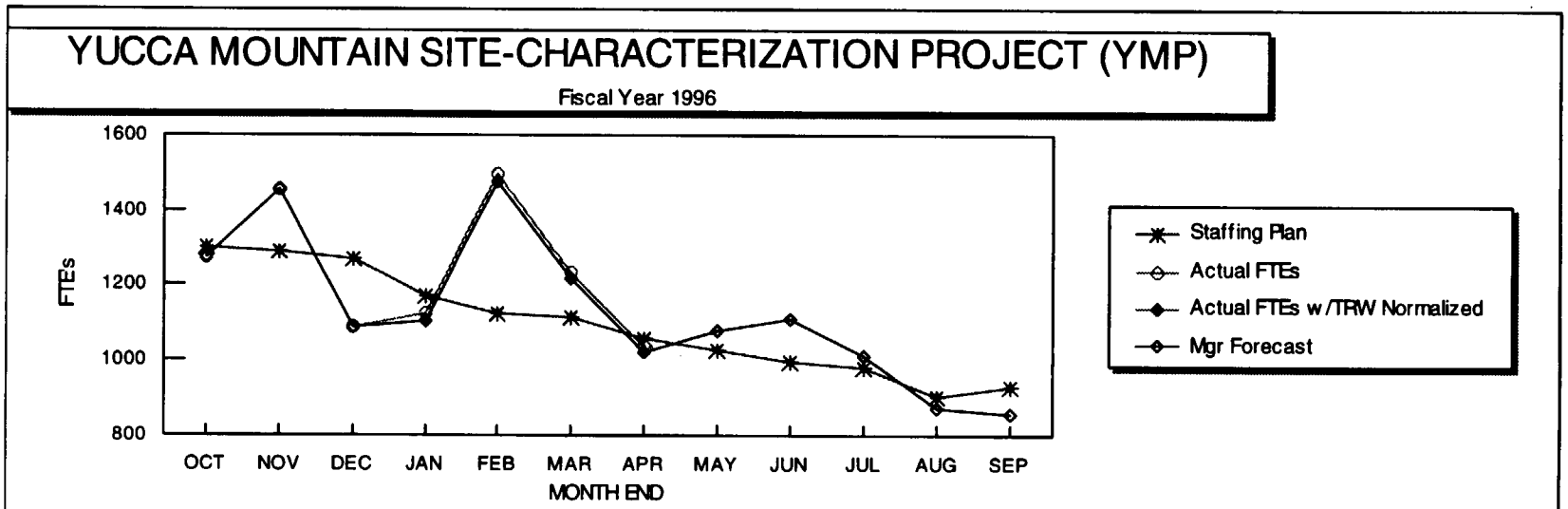
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Budget	15439	17837	16061	18326	27603	17963	16102	14495	13887	12355	11865	19512	201445
Actuals	12959	18292	19794	17134	23142	18273	19148						
Mgr Forecast	12959	18292	19794	17134	23142	18273	19148	20002	17131	15328	13097	13542	207842
Cost Variance	2480	-455	-3733	1192	4461	-310	-3046	-5507	-3244	-2973	-1232	5970	-6397

Figure 5. Yucca Mountain Project Financial Status (for M&O only)



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Cum Budget	15439	33276	49337	67663	95266	113229	129331	143826	157713	170068	181933	201445	201445
Cum Actuals	12959	31251	51045	68179	91321	109594	128742						
Cum Mgr Forecast	12959	31251	51045	68179	91321	109594	128742	148744	165875	181203	194300	207842	207842
Cum Variance	2480	2025	-1708	-516	3945	3635	589	-4918	-8162	-11135	-12367	-6397	-6397

Figure 6. Yucca Mountain Project Cumulative Financial Status (for M&O only)



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Staffing Plan	1300.6	1292.9	1271.9	1173.4	1127.2	1115.2	1057.8	1024.8	997.2	978.4	903.9	931.2
Actual FTEs	1273.9	1455.2	1089.8	1125.5	1495.8	1231.9	1038.2					
Actual FTEs w/TRW Normalized				1105.3	1473.7	1219.4	1021.2					
Mgr Forecast	1273.9	1455.2	1089.8	1105.3	1473.7	1219.4	1021.2	1079.9	1107.3	1009.8	873.4	855.8
Variance	26.7	-162.3	182.1	68.1	-346.5	-104.2	36.6	-55.1	-110.1	-31.4	30.5	75.4

Figure 7. Yucca Mountain Project Staffing (for M&O only)

CFSR is under development.

Figure 8. Yucca Mountain Project CFSR

3. WASTE ACCEPTANCE, STORAGE, AND TRANSPORTATION PROJECT REPORT

HIGHLIGHTS

- Multi-Purpose Canister (MPC) contract deliverables received from Westinghouse-GESCO included the On-Site Transfer/On-Site Storage (OST/OSS) Preliminary Design Report (PDR)-2 (Large and Small), Transportation PDR-3 (Large and Small), Multi-Purpose Canister (MPC) PDR-3 (Large and Small), and Transportation Safety Analysis Report (SAR) (Large and Small). Westinghouse-GESCO requested a delay for submitting the remaining PDRs and SARs. The delay was accepted, and the final SAR/PDR M&O review period was extended to 20 working days. All remaining deliverables are due by May 31, 1996.

- Developed an Interim Storage Facility (ISF) schedule for RW-46 based on DOE having responsibility for the Environmental Impact Statement (EIS).

- Completed cost estimates for two contingencies at RW-46's request: 1) a Phase I canistered fuel-only ISF and 2) a Phase II ISF with bare fuel capability only. The cost estimates include backup documentation and traceability to Program Plan Reference Case Option 8A.

- Received Technical Direction No. 96-01 from DOE providing authorization to proceed with development of the ISF Phase I TSAR. Began preliminary planning, staffing activities, and developing a WBS dictionary. Assigned job numbers.

- Developed a hands-on demonstration version of the Phase I Unified Data Base (UDB) Version 0.01 and installed it at one site in RW-44 for preliminary testing. UDB Version 0.01 contains an initial capability for the Acceptance Priority Ranking/Acceptance Criteria Report (APR/ACR) and a quick-look function for accessing data for specific reactors.

- Delivered a strategy paper and a management briefing on technology transfer of data from the five Cask System Development Program advanced technology contracts for RW-46 to RW-40.

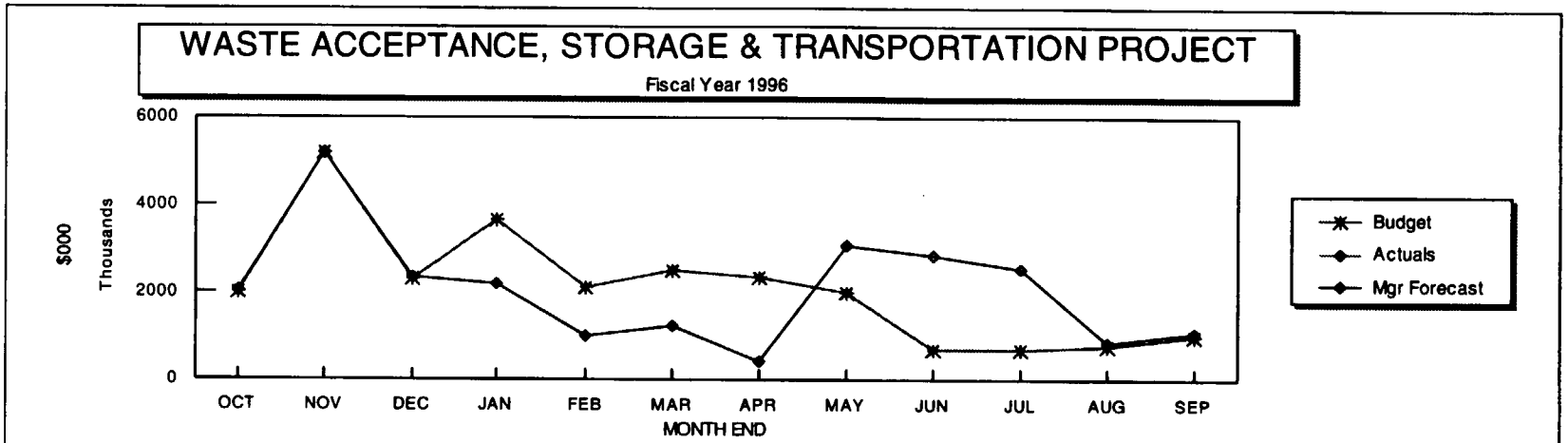
- Received NRC's first round request for additional information on the Burn Up Credit Topical Report. Additional analysis will be required to provide an acceptable response.

- Received a stop work directive for certain activities associated with Material Control and Accounting and Safeguards and Security. Submitted working drafts of the Material Control and Acceptance Plan and the Transportation Physical Protection Plan to DOE as records transfers to document the status of the tasks when the stop work direction was received.

- Presented a planning and logistics summary for the market-driven approach presolicitation conference to the contingency planning task force on April 4, 1996.

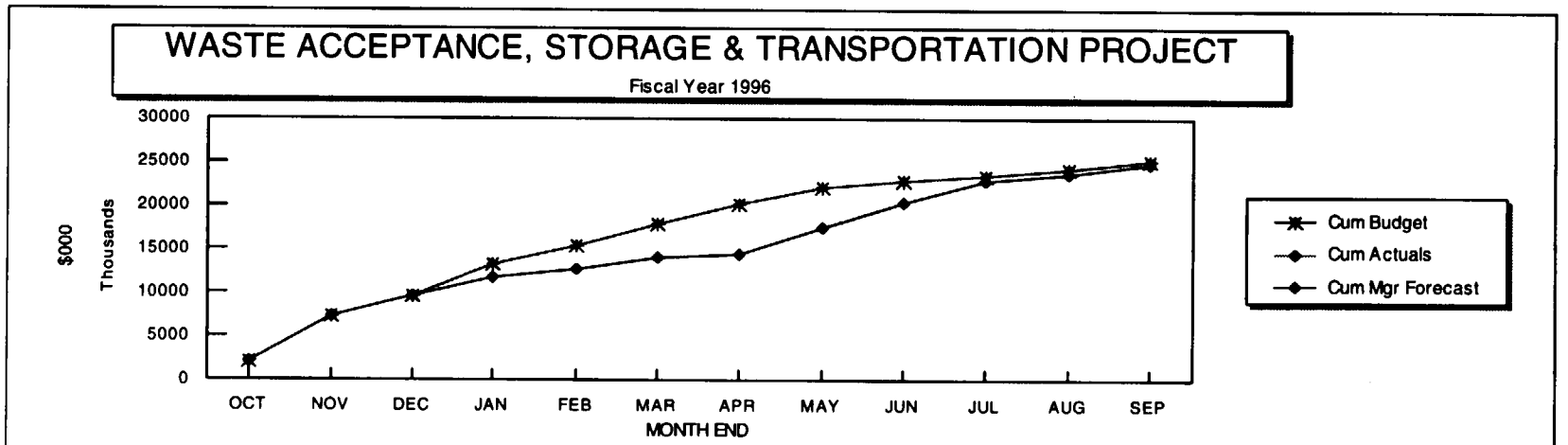
PERFORMANCE DATA

- Figures 9 through 11 represent key financial information for the WAST Project. Figure 12 will be a CFSR for the WAST Project in future monthly reports.



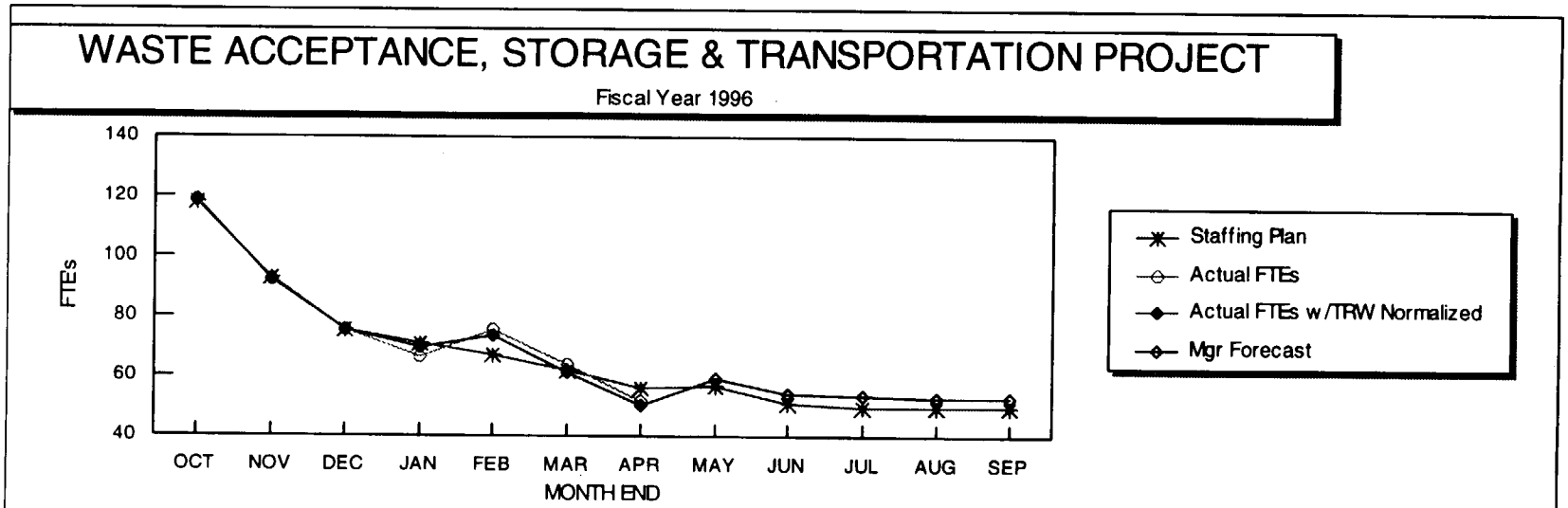
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Budget	2006	5210	2316	3651	2117	2500	2336	1989	694	691	762	1014	25286
Actuals	2027	5197	2332	2181	1001	1223	433						
Mgr Forecast	2027	5197	2332	2181	1001	1223	433	3057	2857	2553	836	1078	24775
Cost Variance	-21	13	-16	1470	1116	1277	1903	-1068	-2163	-1862	-74	-64	511

Figure 9. WAST Project Financial Status (for M&O only)



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Cum Budget	2006	7216	9532	13183	15300	17800	20136	22125	22819	23510	24272	25286	25286
Cum Actuals	2027	7224	9556	11737	12738	13961	14394						
Cum Mgr Forecast	2027	7224	9556	11737	12738	13961	14394	17451	20308	22861	23697	24775	24775
Cum Variance	-21	-8	-24	1446	2562	3839	5742	4674	2511	649	575	511	511

Figure 10. WAST Project Cumulative Financial Status (for M&O only)



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Staffing Plan	117.9	92.6	75.2	70.9	66.9	61.9	56.4	56.6	50.9	49.8	49.5	49.5
Actual FTEs	118.9	92.5	75.2	66.4	75.6	63.7	51.6					
Actual FTEs w/TRW Normalized				69.4	73.3	61.3	50.4					
Mgr Forecast	118.9	92.5	75.2	69.4	73.3	61.3	50.4	59.4	54.4	53.2	52.9	52.9
Variance	-1.0	0.1	0.0	1.5	-6.4	0.6	6.0	-2.8	-3.5	-3.4	-3.4	-3.4

Figure 11. WAST Project Staffing (for M&O only)

CFSR is under development.

Figure 12. WAST Project CFSR

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4. PROGRAM QUALITY ASSURANCE REPORT

HIGHLIGHTS

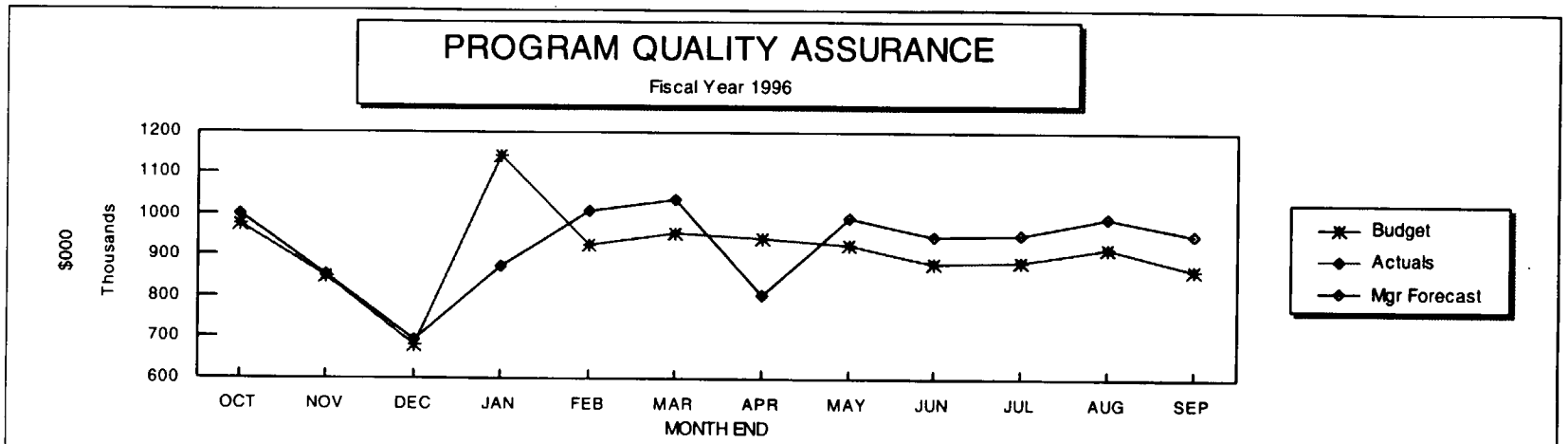
- The M&O QA Managers meeting was attended by the U.S. Geological Survey (USGS) and DOE QA Managers in April. The managers used the meeting to address common problems and issues. Agenda items varied from the FY96 and FY97 budgets to implementing new program requirements.

- Participated in a workshop on procurement issues for selecting suppliers of calibration and testing services. This workshop reinforced DOE's effort to reduce the number of vendors on the Approved Suppliers list. The following attendees participated: M&O, USGS, Los Alamos National Laboratory (LANL), DOE Office of Quality Assurance (OQA), and Quality Assurance Technical Services Support (QATSS).

- Received a letter from RW-1 instituting the One QA Program Concept. Refined details of the concept were reviewed with the Director of the DOE Office of Quality Assurance, who continues to support the M&O's efforts.

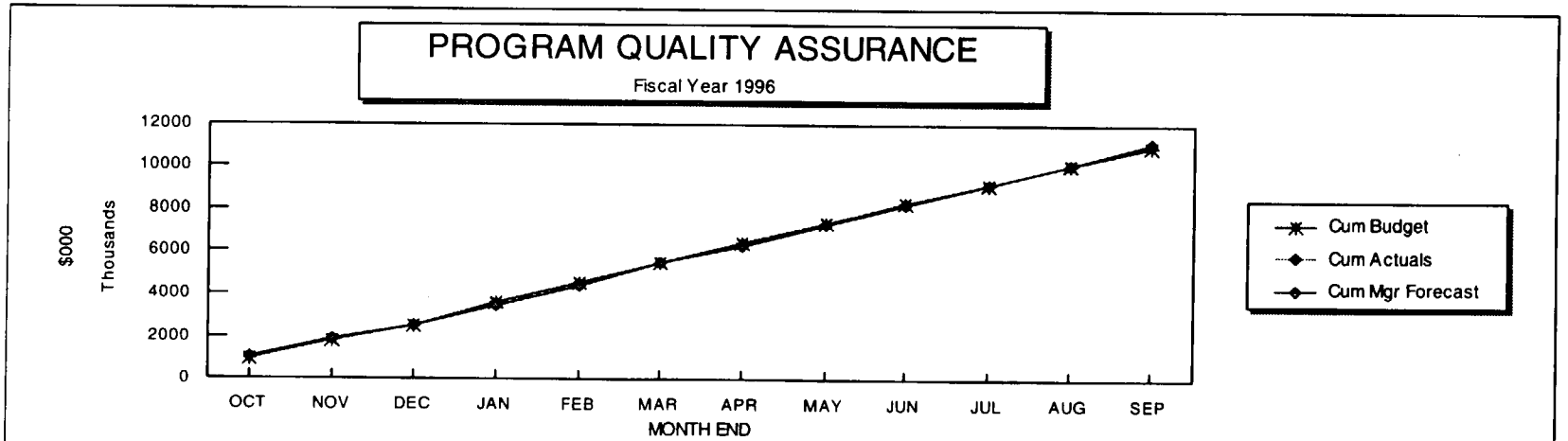
PERFORMANCE DATA

- Figures 13 through 15 represent key financial information for Program Quality Assurance. Figure 16 will be a CFSR for Program Quality Assurance in future monthly reports.



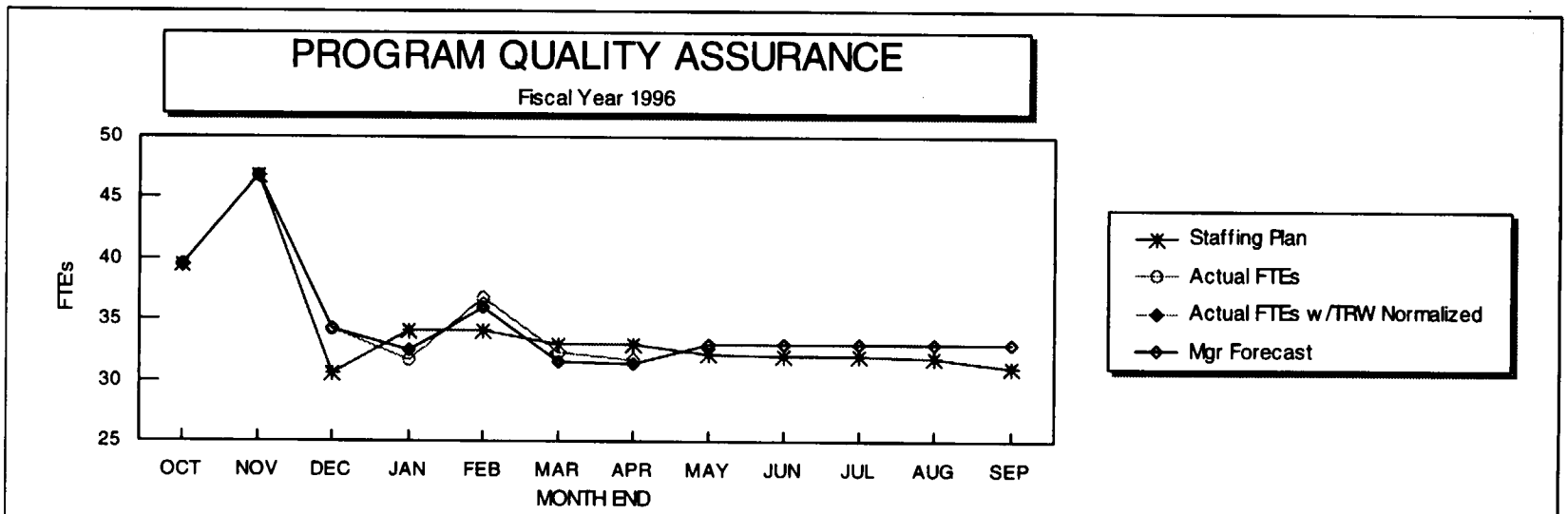
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Budget	976	850	681	1140	925	954	940	927	881	884	917	864	10939
Actuals	998	854	693	874	1005	1037	803						
Mgr Forecast	998	854	693	874	1005	1037	803	992	947	950	989	949	11091
Cost Variance	-22	-4	-12	266	-80	-83	137	-65	-66	-66	-72	-85	-152

Figure 13. Program Quality Assurance Financial Status (for M&O only)



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Cum Budget	976	1826	2507	3647	4572	5526	6466	7393	8274	9158	10075	10939	10939
Cum Actuals	998	1852	2545	3419	4424	5461	6264						
Cum Mgr Forecast	998	1852	2545	3419	4424	5461	6264	7256	8203	9153	10142	11091	11091
Cum Variance	-22	-26	-38	228	148	65	202	137	71	5	-67	-152	-152

Figure 14. Program Quality Assurance Cumulative Financial Status (for M&O only)



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Staffing Plan	39.4	46.7	30.6	34.0	34.0	33.0	33.0	32.2	32.0	32.0	31.8	31.0
Actual FTEs	39.4	46.7	34.2	31.7	36.8	32.3	31.7					
Actual FTEs w/TRW Normalized				32.5	36.0	31.6	31.4					
Mgr Forecast	39.4	46.7	34.2	32.5	36.0	31.6	31.4	33.0	33.0	33.0	33.0	33.0
Variance	0.0	0.0	-3.6	1.5	-2.0	1.4	1.6	-0.8	-1.0	-1.0	-1.2	-2.0

Figure 15. Program Quality Assurance Staffing (for M&O only)

CFSR is under development.

Figure 16. Program Quality Assurance CFSR

5. PROGRAM MANAGEMENT AND INTEGRATION REPORT

HIGHLIGHTS

- Prepared and approved the Technical Document Preparation Plan for revision of CRWMS Requirements Document as part of technical baseline streamlining.

- Prepared and submitted the Waste Acceptance Systems Requirements Document Revision 2 verification draft to the Executive Secretary of the Program Baseline Change Control Board.

- Prepared and submitted the MGDS Requirements Document Revision 2 final draft to the Executive Secretary of the Program Baseline Change Control Board.

- Provided Office of Civilian Radioactive Waste Management (OCRWM) input on repository analysis of aluminum clad spent fuel to the Foreign Research Reactor Task Force report to EM on schedule.

- Completed a feasibility analysis for repository acceptability of a longer canister for vitrified High-Level Waste (HLW).

- Submitted the first S4 (Strategic System Summary Status) report based on March 1996 program activities and data.

- **PERFORMANCE DATA**

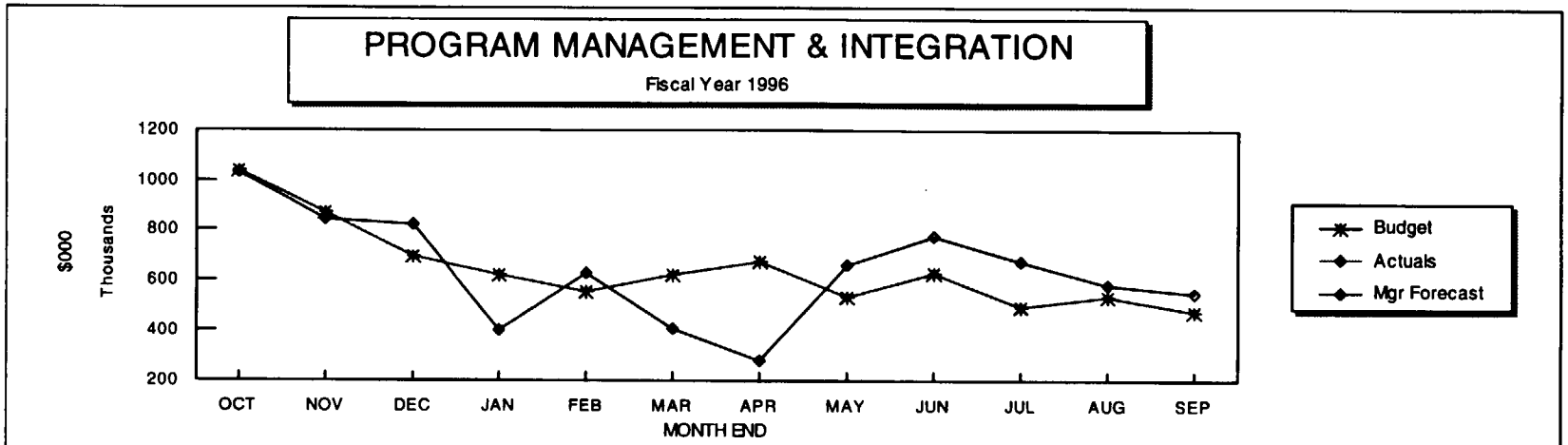
- Figures 17 through 19 represent key financial information for Program Management and Integration. Figure 20 will be a CFSR for Program Management and Integration in future monthly reports.

ISSUES AND CONCERNS

- The OCRWM Program Approach baseline needs to be revised to permit performance measurement against the Program/Project Office FY96 cost and schedule baselines and the FY96 Annual Work Plans. A previously approved plan and schedule to complete this revision by mid-May was canceled by OCRWM. FY96 activities will be controlled against approved annual work plans. The M&O is developing a plan to approve a multi-year program baseline following issuance of the Program Plan.

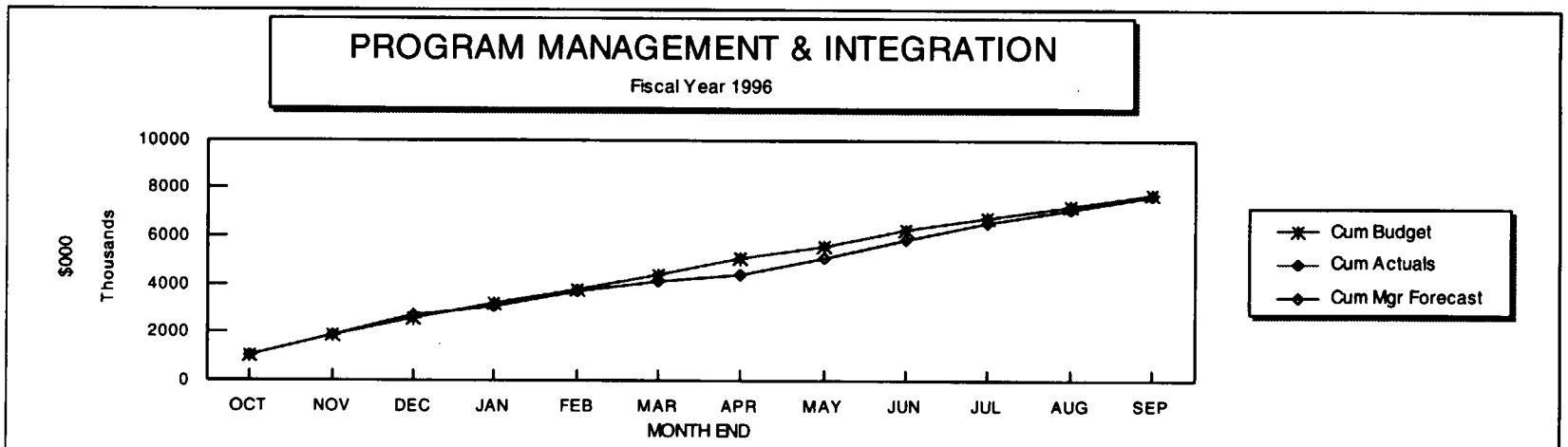
- There is a recognized need to have the program management document suite finalized and in place this summer. However, the closure schedule on OCRWM Policy documents has not been defined, and the documents are awaiting further recommendations. The M&O has delivered the fully M&O-coordinated OCRWM Planning and Control System Description and revised OCRWM Baseline Management Plan that, together with the already delivered Program Management Plan, complete three of the four overarching Strategic System management process documents. The Integrated Technical Management Plan, scheduled to be completed by the DOE this summer, will complete the set. These documents provide the basis for the

OCRWM-developed policy that, when complete, will provide vertically and horizontally consistent management processes.



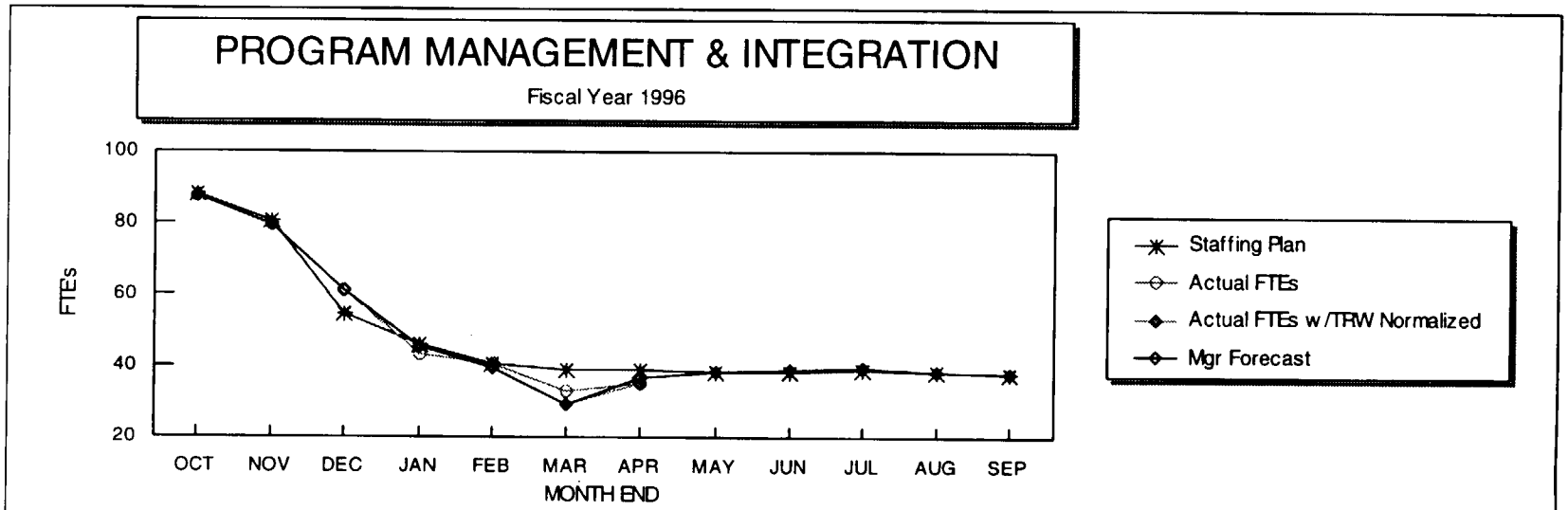
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Budget	1035	873	698	620	554	619	674	535	629	496	533	475	7741
Actuals	1029	842	820	401	632	411	282						
Mgr Forecast	1029	842	820	401	632	411	282	663	776	677	580	547	7660
Cost Variance	6	31	-122	219	-78	208	392	-128	-147	-181	-47	-72	81

Figure 17. Program Management and Integration Financial Status (for M&O only)



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Cum Budget	1035	1908	2606	3226	3780	4399	5073	5608	6237	6733	7266	7741	7741
Cum Actuals	1029	1871	2691	3092	3724	4135	4417						
Cum Mgr Forecast	1029	1871	2691	3092	3724	4135	4417	5080	5856	6533	7113	7660	7660
Cum Variance	6	37	-85	134	56	264	656	528	381	200	153	81	81

Figure 18. Program Management and Integration Cumulative Financial Status (for M&O only)



	OCT	NOV	DEC	JAN	FEB	MAR	**APR**	MAY	JUN	JUL	AUG	SEP
Staffing Plan	88.1	80.5	54.5	46.2	40.4	39.1	38.8	38.4	38.3	39.2	38.5	37.7
Actual FTEs	88.0	79.7	61.2	43.2	40.6	33.0	35.2					
Actual FTEs w/TRW Normalized				45.5	39.6	29.1	35.4					
Mgr Forecast	88.0	79.7	61.2	45.5	39.6	29.1	36.8	38.3	39.0	39.6	38.2	38.1
Variance	0.1	0.8	-6.7	0.7	0.8	10.0	2.0	0.1	-0.7	-0.4	0.3	-0.4

Figure 19. Program Management and Integration Staffing (for M&O only)

CFSR is under development.

Figure 20. Program Management and Integration CFSR

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6. HUMAN RESOURCES AND ADMINISTRATION REPORT

HIGHLIGHTS

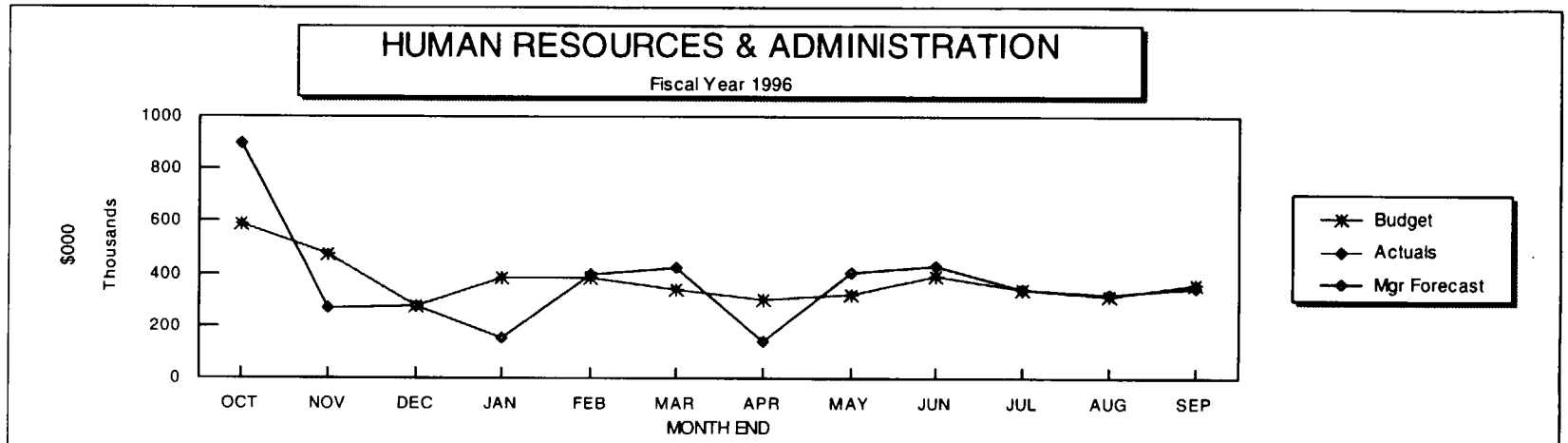
- Established a Tiger Team to support the accounting system transition to CostPoint. This commercial, off-the-shelf (COTS) software program is an integral part of the M&O initiative to streamline the financial management process. CostPoint will significantly improve financial data accuracy, presentation, and accessibility to managers. Information Management Services (IMS) will provide expertise to validate the finance system implementation plan.

- AT&T certified the upgraded Vienna Video Conference Center (VCC) April 17, 1996. The Vienna, OCRWM/HQ, and Las Vegas VCC upgrades are all complete.

- Finalized and displayed (in coordination with YMSCO) an integrated, program-wide exhibit at the International High-Level Radioactive Waste Management Conference in Las Vegas, April 29-May 2, 1996. The exhibit included a well-received OCRWM Home Page demonstration.

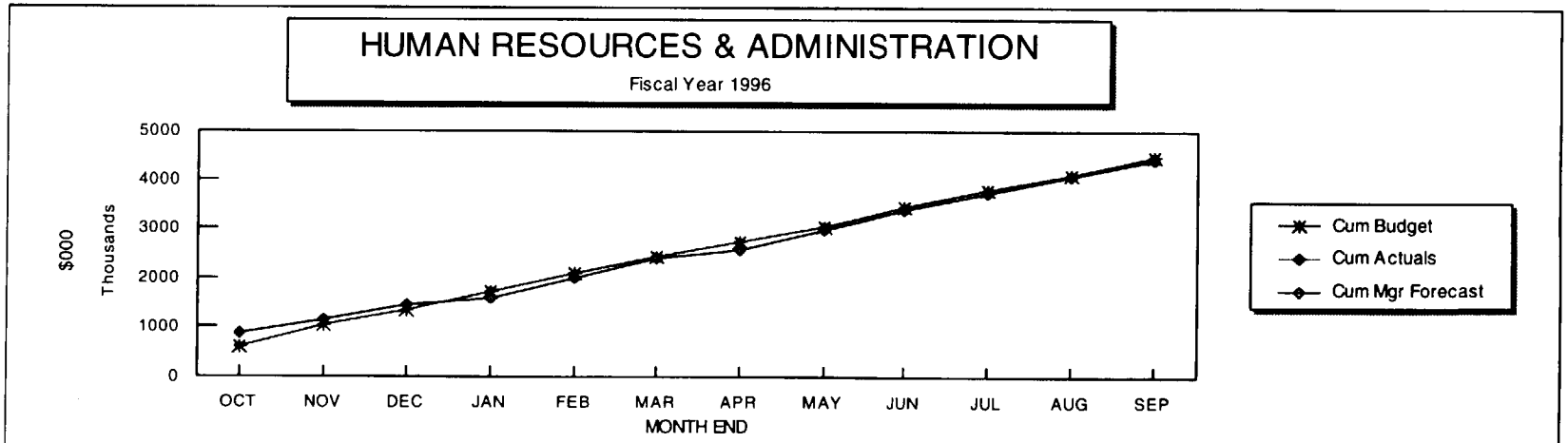
PERFORMANCE DATA

- Figures 21 through 23 represent key financial information for Human Resources and Administration. Figure 24 will be a CFSR for Human Resources and Administration in future monthly reports.



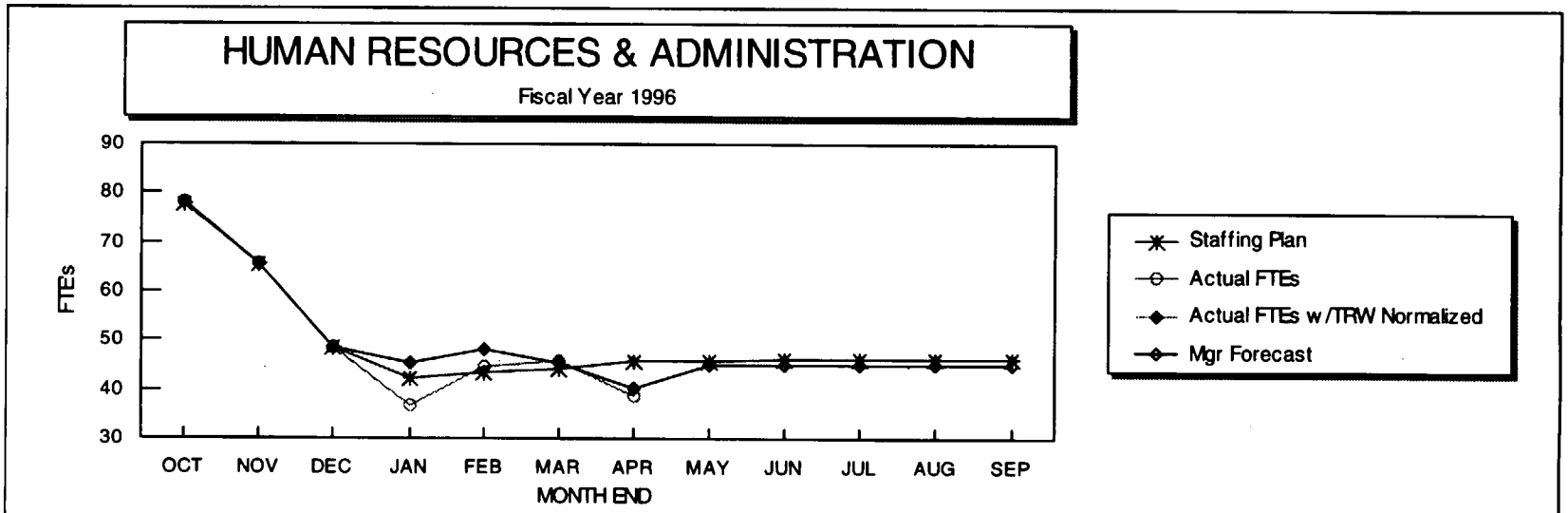
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Budget	591	474	272	384	386	341	299	320	388	336	316	359	4466
Actuals	895	270	278	156	400	421	141						
Mgr Forecast	895	270	278	156	400	421	141	406	428	341	320	343	4399
Cost Variance	-304	204	-6	228	-14	-80	158	-86	-40	-5	-4	16	67

Figure 21. Human Resources and Administration Financial Status (for M&O only)



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Cum Budget	591	1065	1337	1721	2107	2448	2747	3067	3455	3791	4107	4466	4466
Cum Actuals	895	1165	1443	1599	1999	2420	2561						
Cum Mgr Forecast	895	1165	1443	1599	1999	2420	2561	2967	3395	3736	4056	4399	4399
Cum Variance	-304	-100	-106	122	108	28	186	100	60	55	51	67	67

Figure 22. Human Resources and Administration Cumulative Financial Status (for M&O only)



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Staffing Plan	78.0	65.4	48.7	42.4	43.4	44.1	46.0	46.0	46.1	46.1	46.1	46.1
Actual FTEs	78.3	65.6	48.7	36.8	44.5	45.9	38.6					
Actual FTEs w/TRW Normalized				45.6	48.1	45.4	40.2					
Mgr Forecast	78.3	65.6	48.7	45.6	48.1	45.4	40.2	44.9	45.0	45.0	45.0	45.0
Variance	-0.3	-0.2	0.0	-3.2	-4.7	-1.3	5.8	1.1	1.1	1.1	1.1	1.1

Figure 23. Human Resources and Administration Staffing (for M&O only)

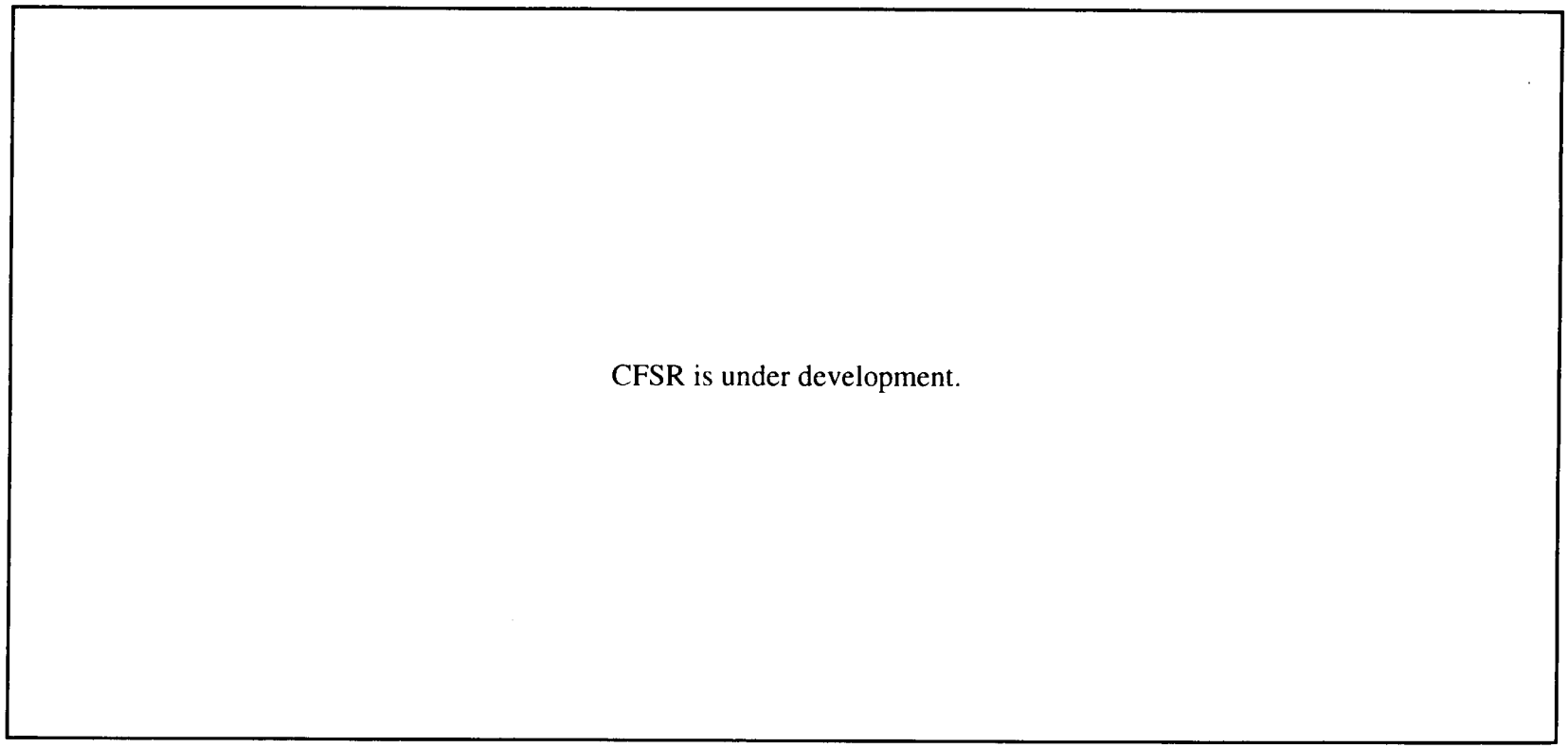
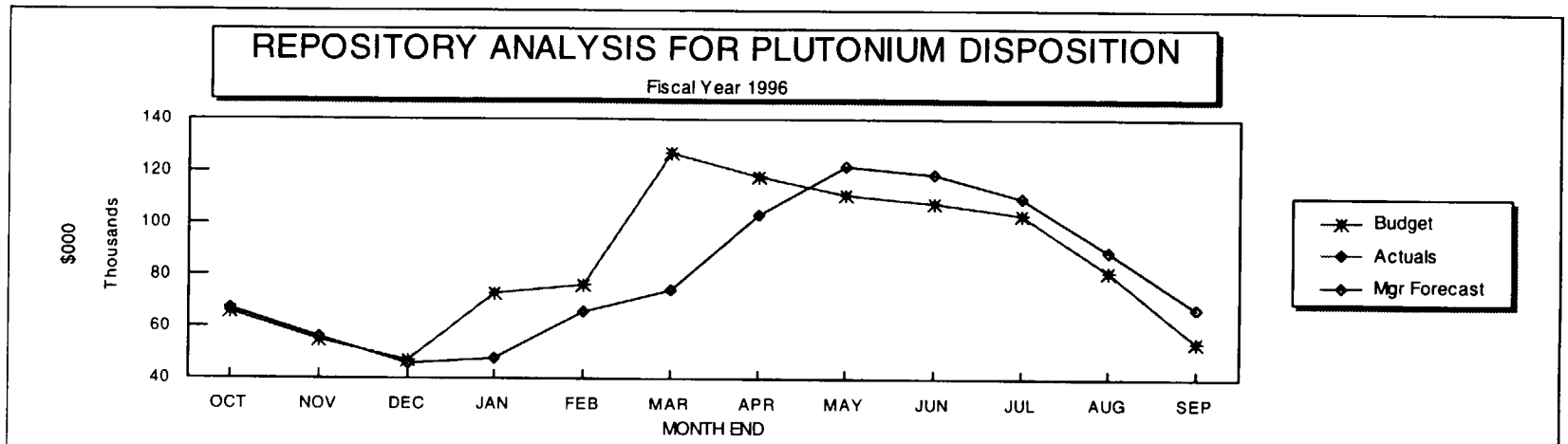


Figure 24. Human Resources and Administration CFSR

7. REPOSITORY ANALYSIS FOR PLUTONIUM DISPOSITION REPORT

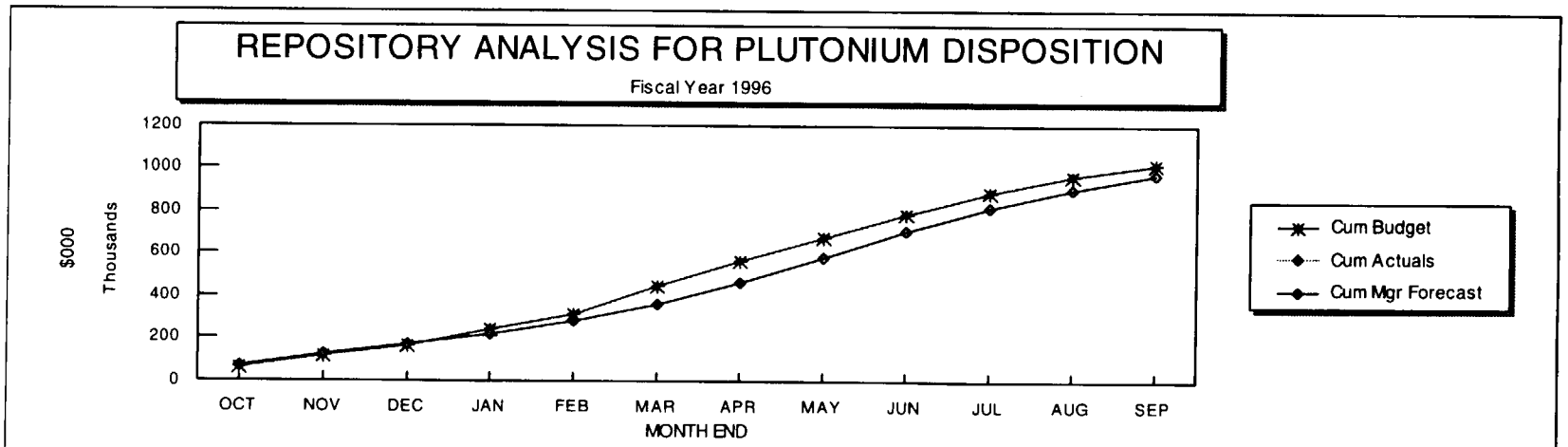
PERFORMANCE DATA

- Figures 25 through 27 represent key financial information for Repository and Analysis for Plutonium Disposition. Figure 28 will be a CFSR for Repository and Analysis for Plutonium Disposition in future monthly reports



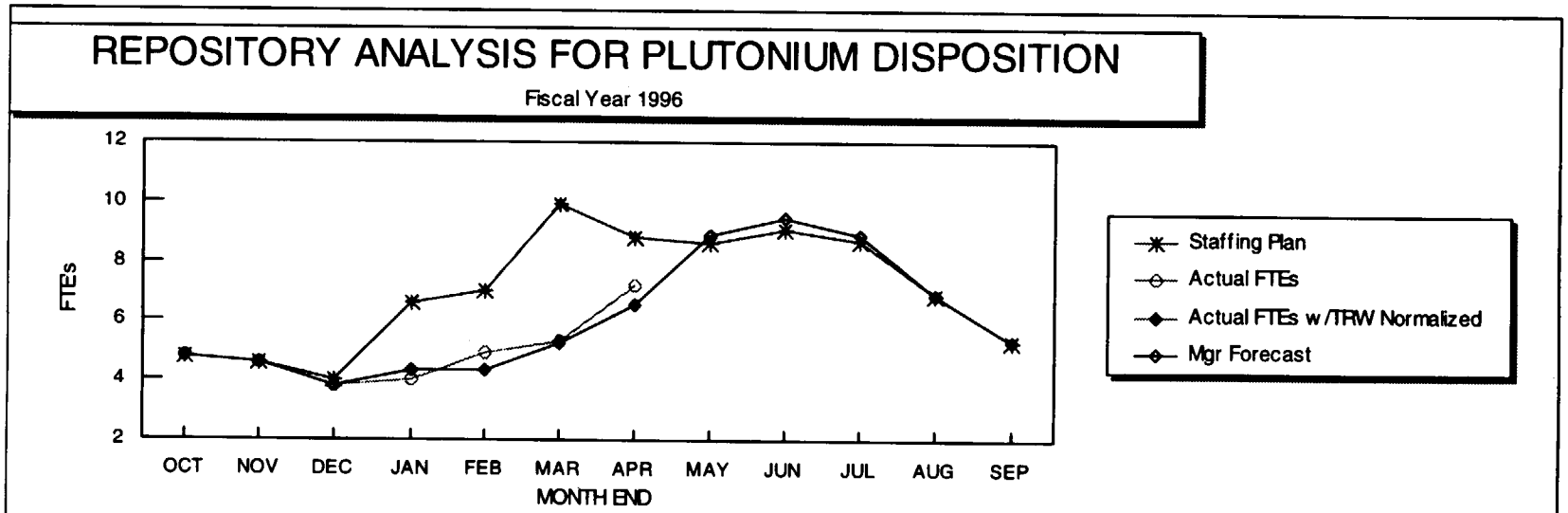
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Budget	66	55	47	73	76	127	118	111	108	103	81	54	1019
Actuals	67	56	46	48	66	74	103						
Mgr Forecast	67	56	46	48	66	74	103	122	119	110	89	67	967
Cost Variance	-1	-1	1	25	10	53	15	-11	-11	-7	-8	-13	52

Figure 25. Repository Analysis for Plutonium Disposition Financial Status (for M&O only)



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	At Complete
Cum Budget	66	121	168	241	317	444	562	673	781	884	965	1019	1019
Cum Actuals	67	123	169	217	283	357	460						
Cum Mgr Forecast	67	123	169	217	283	357	460	582	701	811	900	967	967
Cum Variance	-1	-2	-1	24	34	87	102	91	80	73	65	52	52

Figure 26. Repository Analysis for Plutonium Disposition Cumulative Financial Status (for M&O only)



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Staffing Plan	4.8	4.6	4.0	6.6	7.0	9.9	8.8	8.6	9.1	8.7	6.9	5.3
Actual FTEs	4.8	4.6	3.8	4.0	4.9	5.3	7.2					
Actual FTEs w/TRW Normalized				4.3	4.3	5.2	6.6					
Mgr Forecast	4.8	4.6	3.8	4.3	4.3	5.2	6.6	8.9	9.5	8.9	6.9	5.3
Variance	0.0	0.0	0.2	2.3	2.7	4.7	2.2	-0.3	-0.4	-0.2	0.0	0.0

Figure 27. Repository Analysis for Plutonium Disposition Staffing (for M&O only)

CFSR is under development.

Figure 28. Repository Analysis for Plutonium Disposition CFSR

Los Alamos
NATIONAL LABORATORY
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

April 22, 1996

EES-13-04-96-1063

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 March 1996 (SCPB:NA)

Attached is the Los Alamos Monthly Management Analysis Report for March 1996. 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.

The 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/shk

Attachment: a/s

Enclosure 3

APR 23 12 00 PM '96

Colin Heath, April 22, 1996, EES-13-04-96-1063

Cy w/att:

R.W. Andrews, M&O/INTERA, MS 32
W.E. Barnes, YMSCO, MS 523
H.A. Benton, M&O/B&W, MS 423
A.I. Berusch, DOE, Washington, DC
D.L. Bish, EES-1, MS D469
K.K. Bhattacharyya, M&O MK, MS 423
J.A. Blink, LLNL/LV, MS 423
B. Bodvarsson, LBL, Berkeley, CA
M. Brady, SNL, LV, NV, MS 465
S.J. Brocoum, 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
M.J. Clevenger, ESH-14, MS J521
R. Craig, USGS, LV, NV
R.L. Craun, YMSCO, MS 523
B.M. Crowe, EES-13/LV, MS J902
C. DiBella, NWTRB, Arlington, VA
W.R. Dixon, YMSCO, MS 523
J.R. Dyer, YMSCO, MS 523
N.Z. Elkins, EES-13/LV, MS J902
J.T. Fabryka-Martin, CST-7, MS J514
L.D. Foust, M&O/TRW, MS 423
A.V. Gil, YMSCO, LV, NV
L.R. Hayes, M&O/TRW, MS 423
J. Haynes, LATA, MS J521
S. Hanauer, OCRWM, Washington, DC
C.D. Harrington, EES-1, MS D462
L.E. Hersman, LS-2, MS M880
V.F. Iorii, YMSCO, MS 523
S.B. Jones, YMSCO, MS 523
H.N. Kalia, EES-13/LV, MS J902
S.H. Klein, EES-13, MS J521
S.S. Levy, EES-1, MS D462
B. Mukhopadhyay, PMO, LV, NV
S. T. Nelson, M&O/WCFS, MS 423
R. Patterson, YMSCO, MS 523
F.V. Perry, EES-13, MS J521
M. Peters, M&O/WCFS, MS 423
P.W. Reimus, EES-4, MS D443
B.A. Robinson, EES-5, MS F665
R.A. Rumsey, BUS-8, MS J521
S.F. Saterlie, M&O/TRW, LV, MS 423
W.D. Schutt, M&O/TRW, LV, MS 423
E.T. Smistad, 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, Vienna, VA, MS 6
D.P Stucker, YMSCO, MS 523
C.D. Tait, CST-4, MS G739
A.L. Thompson, EES-13/LV, MS J902
I.R. Triay, CST-7, MS J514
G.A. Valentine, EES-5, MS F665
D.T. Vaniman, EES-1, MS D462
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, NRC, LV, NV
D.R. Williams, YMSCO, MS 523
J.L. Younker, M&O/TRW, MS 423
G.A. Zyvoloski, EES-5, MS F665

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

Los Alamos Monthly Management Analysis Report for March 1996

(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 Contractor work scope consolidation meetings.

WBS 1.2.3.2.1.1.1 Transport Pathways. ***Quantitative X-ray Diffraction Studies***. Staff received samples from the SMF from SD-7, SD-9, and SD-12. Samples from these cores are needed to provide credible bounds on transport models and will be used to meet the criteria for milestone 4240.

Staff completed XRD analysis of the SD-12 samples. These data provide important detail on the locations of zeolitized horizons beneath the potential repository in this part of the exploration block. Although the highly zeolitized (>50% clinoptilolite) portion of the Calico Hills Formation in this part of Yucca Mountain is thin (60 ft), the entire overlying portion of this formation and the lowest parts of the Topopah Spring Tuff are partially zeolitized (up to 12%) over a much thicker interval (220 ft). This dispersed zeolite distribution throughout otherwise vitric tuffs will be very important in providing retardation of most radionuclides, particularly Np. In addition, the SD-12 XRD data show a significant interval of tridymite and cristobalite beneath the zeolitized Calico Hills Formation. The presence of these relatively unstable silica polymorphs is important when considering the magnitude of silica mobilization and permeability modification under the thermal influence of a repository.

The work to be accomplished for milestone 4240 will define the nature of the vitric-to-zeolitic transition beneath the potential repository and will provide the quantitative data on zeolite abundances needed to develop defensible models of radionuclide retardation.

Milestone 3664. Milestone 3664, "Electronic Submission of 3-D Mineralogy Data to Framework Model," was completed. Included in this data set are results from the analysis of USW NRG-6 that were previously unpublished. The report and data submittal do not include results from USW SD-7, 9, and 12, which will not be completed until June 1996. These later results will, however, be included in the Mineralogy of Transport Pathways Summary and Synthesis Report (see below).

In analyzing data for milestone 3664, staff found that the differences between calcite and zeolite distributions in the PTn may be related to either variations in UZ water compositions within the PTn or to differences in the transport of Ca^{2+} versus the flow and saturation required for zeolite formation. It is notable that the only significant formation of zeolites in the PTn in or near the exploration block is in UE-25 UZ#16; this may be an artifact caused by the lack of data from this interval in most other cores (e.g., UE-25a#1), but the high sample density within the PTn in NRG-6 suggests otherwise. With further analysis of PTn samples, it may be possible to map those portions of the block in which PTn saturation has been significant in the past (e.g., in the eastern imbricate fault zone).

In contrast to the patchy and restricted location of zeolite alteration in the lower part of the PTn, clays are almost ubiquitous throughout the PTn. Clay abundances vary considerably and appear to reflect the microhydrologic stratigraphy as well as the accessibility to glass in the PTn. If identified as a Project priority, it should be possible to address the past history of the PTn as a reactive barrier to downward- or lateral-flowing UZ waters at Yucca Mountain with further study of samples from USW SD-7, 9, and 12.

Silica Health Hazards in the ESF. On 7 March, D. Bish and D. Vaniman collected samples from the ESF under the guidance of N. Elkins in an effort to understand dust compositions and exposures. These samples were analyzed at Los Alamos by S. Chipera, D. Bish, and D. Vaniman using XRD methods, and the results were communicated immediately to Project participants. Chipera, Bish, and Vaniman compared the silica polymorph and feldspar mineralogy in the whole-rock samples with that in the dust collected from a wall placard in the ESF. Their results indicated that crystalline silica abundances in the dust are within the same range as in the bulk rock, as evidenced by the ratios of the crystalline silica polymorphs to feldspar (the dust contains additional minor phases probably introduced during the mining operations, such as material wearing from the conveyor belts, exhaust particles, etc.). These results suggest that the elevated crystalline silica concentrations observed on 21 and 22 February in the ESF and those observed in the thermal test alcove ***were not*** due to unusual wall-rock mineralogy. This task's studies of the host rock mineralogy indicate that the mineralogy is remarkably constant, particularly the ratio of total crystalline silica polymorphs to total feldspar (the major crystalline phases in the host rock). The primary difference observed in crystalline silica mineralogy of fracture samples was an increase in tridymite and a decrease in cristobalite relative to wall rock mineralogy. Thus, elevated airborne cristobalite and/or quartz concentrations ***cannot*** be attributed to fracture-coating minerals.

In addition, size fractionations were conducted on a dust smear removed from the ESF wall just behind the head of the TBM to determine if any mineral segregation occurs during the mining/grinding operation. The quantitative XRD results do not support the occurrence of any significant segregation/concentration of crystalline silica polymorphs in the finer fractions (although a slight increase in tridymite abundance may be possible). These results show that the fine rock material generated during the mining operation does not

deviate significantly in mineralogy from that of the bulk rock being mined. Thus, the Project should be able to predict fairly accurately the concentrations of the mineral constituents in the dust phase simply by knowing the concentrations in the rock being mined. Obviously, there are very large quantities of crystalline silica polymorphs being encountered by the TBM and potentially being released to the atmosphere.

Staff discussed the results cited above with M. Pochowski of the M&O. According to Pochowski, typical filter loadings are 750 micrograms total, with 18.4 micrograms quartz, 64.6 micrograms cristobalite, and no tridymite. The total loading can be determined very accurately (gravimetrically), whereas the individual mineral abundances are difficult to determine. The Min-Pet analyses of ESF samples and dusts suggest that these particular numbers are unusual in that the proportion of crystalline silica minerals is ***very low***—about 11%—much lower than the average of about 40%. Based on our knowledge of the mineralogy of wall rocks and dusts in the ESF, these numbers appear to be suspect. Note, that the regulated number is the total weight of quartz, cristobalite, and tridymite—low numbers for these minerals could be providing the erroneous impression that dust levels are within regulations. The fact that tridymite is seldom, if ever, detected is probably because it is generally present below the labs' detection limits.

Staff prepared standard filter samples to assist in assessing the accuracy of contract analyses of filter samples. Several standards of known mineral abundances were being used in preparing standard filter samples. These standards contain known abundances of quartz and cristobalite with a known amount of feldspar. Since tridymite is not readily obtainable in pure form, a volcanic tuff sample containing tridymite and whose mineralogic composition is known will also be used as a dust standard. Filters received from ESF industrial hygiene personnel at the end of this month are being loaded with the known dusts. These filters can then be used as standards to be sent out to the contract labs, thereby providing a means of assessing the accuracy of their quantitative analyses.

Synthesis and Summary Report. Staff continued to analyze data and write input to the Mineralogy of Transport Pathways Summary and Synthesis Report. Progress was somewhat slowed this month because of time devoted to (1) preparing milestone 3664, (2) preparing and analyzing SD-12 and SD-9 samples to meet the 20 June completion date for milestone 4240, and (3) addressing problems of high-cristobalite contents in dust at the ESF, an effort that was unplanned.

Planning Activities. Staff formulated comments to the Contingency Plan level 3 milestones, in particular noting areas in which Min-Pet personnel should participate in FY97.

Project Support. Staff discussed aspects of both the Los Alamos and OCRWM quality programs with Tom Colandrea of Colandrea and Associates, Inc., to assist in Dan Dreyfus' assessment of progress and problems in QA implementation across the Project.

Staff participated in the 28 March mid-year review of the interface between Site Characterization and Performance Assessment; the status of the summary and synthesis report was also discussed at this meeting.

WBS 1.2.3.2.1.1.2 Alteration History. Staff concentrated on preparing "Mineralogy-Petrology Contribution to the Near-Field Environment Report" (milestone 3668). This milestone, which is being prepared under WBS 1.2.3.2.1.2, includes summaries of Alteration History studies pertinent to past and expected hydrothermal processes affecting the candidate host rock and surrounding units. Other Alteration History contributions include the results of paleohydrologic studies, with short summaries of recent isotopic studies in the Exploratory Studies Facility. Experimental and theoretical studies include the effects of dehydration and rehydration of clinoptilolite, smectite, and volcanic glass and thermodynamic and kinetic considerations of mineral transformations under repository conditions.

The material written for the near-field environment report will serve as first drafts for several sections of the Alteration History Summary and Synthesis Report. New draft sections added to the report this month include material on syngenetic alteration of the Topopah Spring Tuff, Quaternary paleohydrology, and K/Ar geochronologic studies of zeolitization.

WBS 1.2.3.2.1.2 Stability of Minerals and Glasses. Staff focused on completing milestone 3668, "Contribution to the Near-Field Environment Report." This report is divided into three sections: (1) a description of the host-rock mineralogy and the importance of host-rock minerals in the near field; (2) a description of paleohydrology and evidence of past mass transport in host rock tuffs as applied to potential near-field processes; and (3) an assessment of the stability of minerals and glasses under anticipated near-field conditions. The latter also includes a discussion of the impacts of potential mineral transformations on the evolution of porosity, permeability, and water chemistry. The bulk-rock mineralogy within the near-field environment (NFE) varies with depth and laterally across Yucca Mountain. Comparatively soluble silica phases, including cristobalite, tridymite, opal-CT, and volcanic glass are ubiquitous within the NFE. Limited data illustrate the possibility of up to 14% stellerite (a zeolite) within the host rock, and major amounts of clinoptilolite and mordenite are common directly underlying the host rock in the eastern portion of Yucca Mountain, in and below the lower vitrophyre of the Topopah Spring Tuff. Natural alteration in the lower vitrophyre exemplifies hydrothermal modification of rock porosity by the dissolution of volcanic glass and precipitation of smectite, zeolite, and silica. Laboratory data illustrate the many significant effects of long-term, relatively low-temperature excursions on the minerals in the NFE, including dissolution/precipitation of silica,

dehydration of zeolites and smectite with associated large volume decreases, dehydration of volcanic glass, transformation of clinoptilolite and mordenite to analcime, and transformation of α-cristobalite to the β phase at about 220°C with an associated volume increase. Unfortunately, available dissolution kinetic data for both analcime and clinoptilolite are not well constrained and reflect the incomplete status of kinetic data measurement for these minerals. Based on existing data, the dissolution of clinoptilolite appears to be slower than analcime, by a factor near 100.

The latter results are based on recent calculations of B. Carey, who continued to work on the synthesis of kinetic data. He has formulated a criterion for evaluating the significance of kinetic reactions in the thermohydrologic evolution of the mountain that is based upon the Damköhler number derived from dimensional analysis of the diffusion-advection-reaction equation. The Damköhler number relates the relative rate of reaction to fluid velocity or material diffusion. The analysis thus far indicates that diffusion is likely to have the least significance in controlling fluid composition and that reaction rates become significant where they are less than about 10^{-9} moles/m^2/s for fluid velocities greater than 10^{-5}. This recent analysis is discussed in detail in milestone 3668.

The milestone on kinetics of the smectite to illite reaction (4037) was revised and resubmitted. The revision included new data from Pennsylvania State University.

Planning Activities. Staff began extensive planning for FY97 activities to support the viability assessment.

Project Support. Staff formulated comments to the Contingency Plan level 3 milestones, in particular noting areas in which Min-Pet personnel should participate next FY. Staff also continued to address comments on the study plan.

WBS 1.2.3.2.5 Volcanism. ***Probability Studies.*** Bruce Crowe attended the Geophysics Integration workshop at Lawrence Berkeley National Laboratory. He presented (1) geophysical data with respect to the east boundary of the Crater Flat basin and (2) information on the status of ground magnetic and aeromagnetic data with respect to detection of basaltic intrusions.

Staff started processing digital topographic data to produce a base map for compiling revised geologic maps of Hidden Cone and Little Black Peak centers of the basalt of Sleeping Butte. They also started preparing final computer-based maps of spatial and structural models used in probabilistic volcanic hazard assessment.

Staff continued editing chapter 3, "Tectonic Framework," and chapter 7, "Probabilistic Volcanic Hazard Assessment and Probabilistic Volcanic Risk Assessment," of the volcanism synthesis report. Staff

received the draft report titled "Probabilistic Volcanic Hazard Analysis for Yucca Mountain, Nevada," (Expert Judgment Panel report) from Geomatrix, and data from this report will be incorporated into chapters 3 and 7 of the Volcanism synthesis report. Chapter 7 may require only a limited revision because the probability distributions in the Geomatrix report were so similar to probability distributions presented in the Volcanism status report (Crowe et al. 1995).

Geochemistry of Eruptive Sequences. A Los Alamos report titled "Geochemistry of the Lathrop Wells Volcanic Center"(Perry and Straub, 1996) was published. This report is a compilation of detailed geochemical data from the Lathrop Wells center that was gathered during the last few years of site characterization.

Staff continued to explore statistically Lathrop Wells geochemical data as part of Volcanism synthesis studies. Geochemical data were transformed as geomean centered ratios to eliminate concerns of data closure. Multivariate statistical analyses (principal component analyses) were run on the data set and the observed effects of data closure on this data set were minor. Interpretations of the data are limited by a large number of processes (factors) affecting the data, uncertainty of unit assignments, effects of geochemical alteration of scoria units, and multicolinearity. Staff was re-running the data using elemental sets (which should clearly discriminate alternative processes affecting the data set and will compare results of analyses using only lava units with those including both lava and scoria units) to assess the effects of alteration.

A report titled "Assessment of Geochemical Variations at the Lathrop Wells Volcanic Center, Southwestern Nevada" (Perry et al.) was being prepared as part of Volcanism synthesis studies.

Field Geologic Studies. Staff conducted a field review session at the Lathrop Wells volcanic center and southern Crater Flat with the USGS to examine field relations bearing on information currently being assessed for inclusion in the Volcanism synthesis report. Topics reviewed included the stratigraphic identify of outcrops of Paintbrush Tuff near and beneath the Lathrop Wells volcanic center, the stratigraphic identity of lithic fragments in cone scoria, tectonic models of the Crater Flat basin, and Quaternary faulting affecting the 3.7 Ma basalt of southeast Crater Flat.

Eruptive Effects. Staff continued to compile field data on lithics from the San Francisco Volcanic Field. They also began writing up this material for inclusion in the Volcanism synthesis report.

Subsurface Effects. Staff began revising the Volcanism synthesis report chapter that describes structural controls on intrusion geometries at the Paiute Ridge analog center. The sections on alteration studies from Paiute Ridge and Grants Ridge were almost complete.

WBS 1.2.3.3.1.2.2 Water Movement Test. ***Chlorine-36 Studies.*** A milestone report titled "Summary report of chlorine-36 studies: systematic sampling of porewater for chlorine-36 in the Exploratory Studies Facility (ESF)" (Fabryka-Martin et al., 1996) was completed. The report summarizes chlorine-36 (^{36}Cl) activities of the past three months. As a basis for assessing ground-water travel times and for identifying potential fast paths for infiltrating water, the distribution of ^{36}Cl in the ESF tunnel was determined from analyses of samples collected at 52 locations between Stations 2 and 36. Rock samples were collected systematically every 200 m throughout the tunnel, as well as from diverse geologic features such as faults, fractures, and lithophysal cavities. All of the systematic samples as well as most of the feature-based samples contain ^{36}Cl levels consistent with travel times exceeding a few thousand years. Upper age limits range up to several hundred thousand years. Uncertainties about temporal variations in the atmospheric $^{36}Cl/Cl$ input ratio prevent calculation of more precise ground-water travel times at this time. Bomb-pulse ^{36}Cl occurs at a few distinct fractured and/or faulted zones, indicating that at least a small proportion of the water at these locations is less than 50 years old.

In this report, a flow and transport model using the FEHM code is used to simulate transport of ^{36}Cl into the ESF tunnel. Modeling results show that observed ^{36}Cl signals are consistent with existing site conceptual models and parameter estimates. Base-case parameters predict Pleistocene-aged water in the ESF, while parameter changes consistent with increased fracturing of the Paintbrush nonwelded unit (as might be associated with faults) lead to a prediction of a small component of bomb-pulse ^{36}Cl in ESF fractures. Thus, these modeling results show that the new ^{36}Cl data presented in this report do not require a major reevaluation of previous work.

WBS 1.2.3.3.1.3.1 Reactive Tracer Testing. ***Sodium Iodide Pilot Tracer Test.*** The sodium-iodide pilot tracer test begun at the C-holes on 13 February was still in progress. This test involved an injection of 5 kg of iodide into C#2 between packers 3 and 5 (Bullfrog and upper Tram formations) with 100 to 140 gpm production out of C#3 (also Bullfrog and upper Tram). Staff was interpreting the iodide test as the data became available for the purposes of planning a reactive tracer test using lithium bromide. The results to date indicate that it will not be possible to conduct a lithium bromide test between C#2 and C# because lithium concentrations would not exceed half the background concentration in the ground-water (60-70 ppb), even if 40 kg of lithium bromide were injected. However, the pilot test was conducted by injecting only 180 gallons of tracer solution into a packed-off interval exceeding 2000 gallons in volume, and there was no attempt to chase the tracer solution out of the borehole. The next test, involving injection of pentafluorobenzoic acid into C#2, will be conducted with a 5 gpm water chase for an extended period of time, and it is hoped that the chase will accomplish two things: (1) flush tracer out of the borehole more quickly, and (2) reduce tracer residence times in the formation by pushing tracer into more conductive pathways in the vicinity of the injection borehole. A second conservative tracer (a pyridone derivative) will be injected into C#1 during the next test, so staff will also have the opportunity to assess tracer response between C#1 and C#3 before conducting a reactive tracer test. It should be noted that predictions

based on the iodide pilot test between C#2 and C#3 cannot be used to predict tests conducted between C#1 and C#3. This information will be presented next month in a milestone report. No details of the analyses are provided in this monthly report because the test is not yet complete, and the iodide data have not yet been officially released.

Modeling to Support Tracer Test Interpretations. A Laplace transform transfer function model was developed to assist in the interpretation of tracer tests conducted at the C-holes. The model contains transfer functions for the injection pulse, the injection borehole, the formation, and the production borehole. These transfer functions are multiplied by each other to achieve a convolution in the time domain. The transfer function for the formation is a Laplace transform solution for transport in a dual-porosity medium with flow in fractures and diffusion into the porous matrix. Parameters in the model can be varied to obtain a best fit to a data set by minimizing the sum of squares of differences between the data and the model. The adjustable parameters include (1) the mean fluid residence time in the formation, (2) the dispersivity in the formation, (3) a time constant for how long tracer spends in the injection borehole, (4) the average fracture aperture (which controls the amount of matrix diffusion), and (5) the fraction of tracer participating in the test. Application of this model to "fit" the iodide breakthrough curve from the pilot tracer test has led to two preliminary conclusions:

- It is possible to fit the iodide data assuming any amount of matrix diffusion by adjusting the fraction of tracer assumed to participate in the test. This result suggests a need to use more than one tracer in a tracer test to better determine the formation parameters (mean residence time and dispersivity) and the amount of matrix diffusion occurring in the formation.

- It would greatly help in the interpretation of a tracer test to eliminate or minimize the uncertainty associated with how quickly tracer leaves the injection borehole by flushing tracer out of the borehole. This would decrease the number of adjustable parameters in the model, and it may also result in more tracer participating in the test.

In addition to the transfer function model, a 2-D finite-difference model was developed to conduct simulations of steady-state flow and tracer transport in a heterogeneous formation. When using this model, a hydraulic conductivity distribution for the formation is generated stochastically using a specified variance, covariance function, and correlation length(s). A flow field in the heterogeneous conductivity field resulting from pumping a single production well is then calculated and used for tracer transport calculations. An injection/ recirculation well can also be included in the calculations. Tracer transport is simulated using particle-tracking techniques. Some preliminary results from this model indicate that partial recirculation can reduce tracer travel times in a heterogeneous formation by over an order of magnitude if the injection borehole happens to be in a low conductivity zone where little flow occurs as a result of the production well. In this case, the recirculation serves to "push" tracer out of the low

conductivity zone and into conductive pathways where it can then quickly move to the production well. Thus, the model suggests that recirculation has the potential to dramatically reduce tracer travel times at the C-holes. However, it is also possible that recirculation may have little or no effect on travel times. Project scientists are hoping that recirculation enhances tracer recoveries enough between C#2 and C#3 that it is possible to conduct a lithium tracer test between these two holes.

Lithium Bromide Column Experiments . Staff continued to analyze lithium transport experiments conducted last year.

WBS 1.2.3.4.1.1 Ground-water Chemistry Model. Modeling of ground-water chemistry reactions in the soil zone on Yucca Mountain is ongoing.

WBS 1.2.3.4.1.2.1 Batch Sorption Studies. Staff completed section I of the sorption summary report. To date, they have completed sections I., III., and IV., A. of this report.

Outline for the sorption report:

I. Ground-water Chemistry (and its effects on sorption)

II. Mineralogy Variability (and its effects on sorption)

III. Sorption Data (determined by batch experiments)

- A. Sorption of Simple Cations
- B. Sorption of Simple Anions
- C. Sorption of Actinides

IV. Models that can explain the measured sorption data

- A. Ion Exchange
- B. Surface Complexation

V. Recommended sorption data for PA

WBS 1.2.3.4.1.2.2 Biological Sorption and Transport. Staff was preparing for the upcoming International High-Level Waste Management Meeting in Las Vegas. Four papers will be presented at the "Microbiological Research at Yucca Mountain" session. In addition, all the individuals who analyzed the ESF samples will have the opportunity for a first-time in-depth discussion of their results and further publication objectives. Larry Hersman will collect all data for submission to the Project.

Work continued on the summary and synthesis report, specifically describing chelated transport studies. Paul Reimus and Larry Hersman were rewriting a previously approved report titled "Desferrioxamine B-Enhanced Transport of Iron in Volcanic Tuff During Unsaturated Conditions" to include Reimus' modelling input.

WBS 1.2.3.4.1.3 Speciation/Solubility. Staff continued database collection and data analysis. Data analysis includes using the SIT formalism to check for outlying data points from different sources.

WBS 1.2.3.4.1.4.1 Transport. Staff completed the summary of the solid-rock column data under unsaturated conditions (see section I., C of the transport outline). They completed section I of the transport summary and synthesis report.

Transport Report Outline

I. Assessment of Validity of Kd under Advective Conditions
- A. Crushed Rock Columns
  - 1. Using Water from the J-13 Well
    - a. Vitric Tuff
    - b. Zeolitic Tuff
    - c. Devitrified Tuff
  - 2. Using Water from the UE-25 p# 1 Well
    - a. Vitric Tuff
    - b. Zeolitic Tuff
    - c. Devitrified Tuff
- B. Saturated Solid Rock Columns
  - 1. Using Water from the J-13 Well
  - 2. Using Water from the UE-25 p# 1 Well
- C. Unsaturated Solid Rock Columns
  - 1. Zeolitic Tuff
  - 2. Devitrified Tuff

II. Radionuclide Transport through Fractures
- A. Conservative Radionuclides (tritium and pertechnetate)
- B. Sorbing Radionuclides

III. Colloid-Facilitated Radionuclide Transport
- A. Colloid Stability in Natural Ground-waters
- B. Sorption of Radionuclides onto Colloids
- C. Elution of Colloids through Fractures
  - 1. Saturated Systems
  - 2. Unsaturated Systems

Radionuclide Transport through Fractures. Staff collected data describing the elution of tritiated water, pertechnetate, and neptunium through five natural fractures at Yucca Mountain. Initial findings indicate the following: (1) It appears that diffusion from the fracture into the matrix can take place even at relatively fast flow rates. (2) Np can be significantly retarded, even during a fracture-flow scenario.

Neptunium retardation in fractures could be due to both diffusion into the matrix and sorption onto the minerals lining the fracture walls. (3) Contrary to previous assumptions about the role of fractures in radionuclide retardation, preliminary results from this experiment indicate that fracture flow does not necessarily result in a fast pathway for actinide migration through fractures.

Staff received twenty naturally fractured core samples from the USGS core library in Mercury, Nevada. The cores were chosen for transport, hydrodynamics, matrix diffusion, and sorption studies of naturally fractured rocks. (The cores were determined to be natural because of the presence of secondary mineral coatings.) Many of the cores can be reassembled, producing a fractured core of up to 2-4 feet in length. The samples were chosen from NTS UE12N#15, UE20C, and UE18T bore holes. Cores UE12N#15 and UE18T are 2 1/2 inch diameter cores similar to the columns we have all ready used for our experiments, whereas core UE20C is a 4-inch-diameter core.

Staff also summarized the results of the tuff-wafer experiments (see section II. A. in the diffusion outline) and sections IA and IB #2 of the diffusion report (describing diffusion studies using rock beakers). To date, they completed sections I and II. A. of the diffusion report.

Diffusion Report Outline

I. Diffusion of Conservative Radionuclides through Saturated Tuff
- A. Tritiated Water
  - 1. Diffusion Cells
  - 2. Rock Beakers
- B. Pertechnetate
  - 1. Diffusion Cells
  - 2. Rock Beakers

II. Diffusion of Sorbing Radionuclides through Saturated Tuff
- A. Tuff Wafers
- B. Diffusion Cells
- C. Rock Beakers

III. Diffusion of Radionuclides through Unsaturated Tuff

WBS 1.2.3.4.1.5.1 Retardation Sensitivity Analysis. ***Site-Scale Transport Modeling.*** Evaluation of recent ESF samples for Cl-36 (^{36}Cl). A flow and transport model using the FEHM code was used to simulate transport of ^{36}Cl into the ESF tunnel. These modeling results show that observed ^{36}Cl signals are consistent with existing site conceptual models and parameter estimates. Base-case parameters (material properties and infiltration rates) predict Pleistocene-aged water (i.e., older than 10 ky) in the ESF, while parameter estimates consistent with increased fracturing of the PTn unit (as might be associated with fault zones) lead to predictions of a small component of bomb-pulse ^{36}Cl in the ESF fractures. These modeling

results show that the new ^{36}Cl data from the ESF (Fabryka-Martin et al., 1996) do not require a major reevaluation of previous work.

The ESF ^{36}Cl data cited above show $^{36}Cl/Cl$ ratios for systematic and feature-based samples up to station 35 in the ESF. The systematic samples were collected every 200 meters in the stretch of the ESF. The feature-based samples were collected only in distinct faults or fractures. Of these samples, no bomb pulse ^{36}Cl was found in the systematic samples. At five locations, bomb-pulse ^{36}Cl was found in the feature-based samples. Each of these five distinct locations is associated with extensions and/or projections of mapped surface structural features, such as Bow Ridge Fault, Drill Hole Wash Fault, western limit of Imbricate Fault Zone, and Sundance Fault.

Using a representative stratigraphic column at station 35 (a station at which bomb-pulse ^{36}Cl was found) extracted from the 3-D site-scale stratigraphic model of Robinson et al. ("An Unsaturated Zone Flow and Transport of Yucca Mountain," [milestone 3468, 1995]), simulations were performed to model the transport of ^{36}Cl, first assuming no faulting and then assuming structural modification of the PTn fractures due to faulting. With base-case properties, transport of bomb-pulse ^{36}Cl through the entire PTn could not be simulated. Modification of PTn properties based on the assumption that in a fault zone, fracture densities and apertures may increase as well as the net infiltration rate, yielded simulations which predict bomb-pulse ^{36}Cl arrivals at the ESF due to the ability of the modified PTn to sustain fracture flow.

Also included in this analysis is the incorporation of a time varying ^{36}Cl source function at ground surface over the last one-million years. Simulations using this function demonstrate that the $^{36}Cl/Cl$ ratios measured in the ESF, which are higher than current $^{36}Cl/Cl$ ratios in rainwater but not obviously bomb-pulse, indicate samples of Pleistocene water, a time period in which the $^{36}Cl/Cl$ ratio was about twice as high as it is now. This consideration is important so that $^{36}Cl/Cl$ ratios somewhat above present-day background are not misinterpreted as bomb-pulse.

Radionuclide Migration Calculations. Calculations of the transport of Pu and U in the unsaturated zone were initiated. For the sorption values currently expected for these radionuclides, migration velocities are extremely slow for Pu. Staff was analyzing the available batch and column sorption data for plutonium to assess the validity of the sorption K_d values used. U travels somewhat more rapidly, but it still poses no threat of breaking through to the water table in one-million years at 0.1 mm/y uniform infiltration rate. Higher infiltration rates will be considered in future calculations.

Other. Staff met with DOE representatives to discuss planning issues and progress on deliverables due this FY.

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 were underway using the mapping gantry.

Staff continued to assemble 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.

Staff generated test management progress reports to ensure test requirements were met and issues identified. ESF TCO staff continued to support both the Field Change Control Board and the Baseline Change Control Board (level III) on a weekly basis.

WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes. Staff continued testing of the multiple node module of FEHM for fault and fracture modeling.

Grid Generation. Notable among the many grids generated during this reporting period were refined site-scale saturated-zone models and 3-D cannister-scale models. The site-scale models were higher resolution models of several units; the grids contained about 100k and 300k nodes. Staff was working in collaboration with John Czarnecki and Claudia Faunt of the USGS to reduce the number on grid points. The cannister scale 3-D grid was developed for and in collaboration with Brian Dunlap of the M&O.

Repository fluxes for liquid and vapor were being transferred to David Sevougian of the M&O. To date the following has been transferred: 2-D fluxes for several repository locations, two different flow rates, and both fracture and matrix values. The transfer of 3-D fluxes was being processed.

WBS 1.2.5.3.5 Technical Database Input. The following ATDT records packages were sent to the Los Alamos Records Processing Center (RPC):

- "Geochemical Data for Basalts of the Yucca Mountain Region," DTN LAFP831851AQ95.001.
- "Ar Isotopic Ratios for Basalt Samples from the Yucca Mountain Region," DTN LAFP831851AQ95.002.
- "Age Calculations for Basalts of the Yucca Mountain Region," DTN LAFP831851DQ.95.003.

The following TDB record package was sent to the Los Alamos RPC:

- "Thermodynamic Analysis of Calorimetric Measurement of the Enthalpy of Hydration of Clinoptilolite."

WBS 1.2.6.1.1 Exploratory Studies Facility (ESF) Management, Planning and Technical Assessments. Staff attended weekly design and construction meetings. Staff participated in discussions with DOE and the design team to merge future design activities into the existing 2C design package. Staff provided design input to support field changes related to the thermal test alcove construction. Staff developed weekly and monthly administrative management reports for testing activities and facilitated job package record development. Staff provided field test coordination and administrative support for ESF north ramp main and alcove construction.

WBS 1.2.6.1.2/3 Quality Assurance and Safety Analysis. Staff attended weekly design and construction meetings and routinely observed ESF field testing activities. Staff 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 weekly design and construction meetings. Staff supported development of weekly and monthly administrative management reports for testing activities; staff facilitated job package record development. Staff provided field test coordination and administrative support for ESF north ramp main and alcoves construction.

WBS 1.2.6.8.4 Integrated Data and Control System (IDCS). The design team was notified that the IDCS has been placed on indefinite hold because of budgetary constraints. The IDCS data acquisition equipment received in FY 1995 continued to be configured and deployed as temporary portable data acquisition stations. The ESF TCO completed the Draft Field Work Plan (FWP) document titled "ESF Data Collection Systems" to direct the QA configuration, deployment, calibration, and operation of the data acquisition systems in the ESF. This FWP will direct the data collection of the ESF testing organizations in FY 1996 and 1997.

WBS 1.2.11.2/.3/.5 Quality Assurance. ***Program Development.*** Staff continued to place QPs & QP forms, as well as DPs on line. They continued to be involved in planning activities, trying to identify where cuts can best be absorbed and functions still remain viable and determining how to streamline processes without severely impacting technical work.

Procedure Revisions. QPs-06.1 & 06.2 were distributed for formal review. QPs-02.12, 04.6, 18.2, & 08.3 were identified as needing editorial changes and can be placed on-line when QP-06.1 & 06.2 are approved. All other procedures were being reviewed for process improvement and consolidation. P. Gillespie continued to evaluate QARD changes with respect to the RTN matrix. Updating the RTN matrix has been a major undertaking in FY96. Staff prepared to discuss the possibility of allowing Los Alamos to establish their own database.

M&TE. The Los Alamos standards and calibration group (ESH-9) is now conducting calibration activities for Los Alamos YMP researchers.

Audits and Surveys. The audit schedule was being prepared. RTN activities were taking up survey time.

DR-YMQAD-95-D-015 was issued by the YMSCO. This deficiency concerns one of our vendors (SIMCO), and is currently open. DR-YMQAD-96-D-033, a YMSCO- issued DR, was assigned to the TCO office for a field work package. Discussions were being conducted as to why this DR should not have been issued against Los Alamos continued.

Quality Engineering. B. Gundlach continued to work with investigators on FEHMN certification issues. He is also re-engineered the draft homepage on which we hope to make QA documents available on line.

(b) Deliverables Completed

Milestone 3664, "Electronic Submission of 3-D Mineralogy Data to Framework Model" Included in this data set are results from the analysis of USW NRG-6 that were previously unpublished.

Milestone 3783, "Summary report of chlorine-36 studies: systematic sampling of porewater for chlorine-36 in the ESF"

(c) Problem Areas

WBS 1.2.3.2.1.1.1 Mineralogy of Transport Pathways. Progress in meeting planned milestones is being impacted by requests to assist in analysis for silica-mineral health-hazard issues in the ESF. Requests for help on this issue continue to be made and the extent of impact on FY96 milestones is not yet known.

Min-Pet personnel continued to evaluate the samples held in the Los Alamos sample storage facility because sufficient funds are not available to continue to support the facility. Samples needed for future programmatic work will be stored in individual PI's offices or laboratories. Samples that are no longer needed will be shipped back to the SMF, and the Los Alamos sample-storage facility will be vacated.

WBS 1.2.3.3.1.3.1 Reactive Tracer Testing. Potential problems or issues that may adversely affect performance during future reporting periods include: (1) the pending layoff of drilling crews to support C-holes activities, which could cause serious delays if there is a need to pull equipment out of the holes after the layoff occurs, and (2) the possibility that partial recirculation will not improve the recovery of conservative tracer between C#2 and C#3 plus the possibility of low tracer recoveries between C#1 and C#3, the combination of which would make it very unlikely that a successful reactive tracer test could be conducted using lithium as tracer. To hedge against the possibility that lithium cannot be used as a reactive tracer, staff was compiling a list of additional potential reactive tracers for a permit application.

(2) Personnel Changes

WBS 1.2.3.4.1.5.1 Retardation Sensitivity Analysis. Jake Turin, a Los Alamos hydrogeochemist, has begun contributing to the ^{36}Cl modeling effort, in addition to working on the C-Wells reactive tracer task.

(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 Mineralogy of Transport Pathways. The question how to prioritize staff effort—for either completion of planned milestones (see below) or for addressing the immediate concerns over silica-mineral health hazards in the ESF—will need to be resolved soon.

WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes.
A meeting was held with M&O on 29 March in Los Alamos. This meeting was intended for planning PA work scope for FY 96, but no work scope discussions took place. Considerable discussion was held regarding the results of FY95 Los Alamos deliverables.

(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 to provide input to mineralogic models for site transport evaluations and (2) support the project in preparation of synthesis and summary reports.

WBS 1.2.3.2.1.1.2 Alteration History. Staff will continue writing the Alteration History portion of the Mineralogy of Transport Pathways Summary and Synthesis report, in support of a site investment analysis. Sections on mineral dehydration and rehydration will be prepared for inclusion in the report. The work in support of the FY96 Thermal Loading Study Report will continue through April and will also be included in the Alteration History Summary and Synthesis Report.

WBS 1.2.3.2.1.2.2 Stability of Minerals and Glasses. Summary and synthesis report writing will continue, and study plan comments will continue to be addressed.

WBS 1.2.3.2.5 Volcanism. Synthesis of Volcanism activities will continue.

WBS 1.2.3.3.1.2.2 Water Movement Test. Staff will obtain final ^{36}Cl results for samples submitted for analysis since December 1995. Staff will process critical ESF samples for chlorine-36. Staff will continue acquisition of halide data for boreholes to replace old data discarded as unreliable. Staff will continue acquisition of halide data for chlorine-36 samples already submitted for isotope analysis. Staff will participate in planning activities for sample collection from ESF and boreholes Prepare for DOE audit scheduled for June 1996.

WBS 1.2.3.3.1.3.1 Reactive Tracer Testing. Staff will continue to work on 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 conduct a reactive tracer test (using lithium bromide and polystyrene microspheres as tracers) immediately after the next round of conservative tracer tests involving injection into both C#1 and C#2 are completed. The first reactive tracer test will be conducted by injecting into whichever hole shows the highest recovery of conservative tracer.

WBS 1.2.3.4.1.2.1 Batch Sorption Studies. Staff will complete section IV., B of the sorption report.

WBS 1.2.3.4.1.1 Ground-Water Chemistry Model. Staff will continue development of 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 implementation of laboratory experiments designed to evaluate controls on ground water compositions in the unsaturated and saturated zones at Yucca Mountain.

WBS 1.2.3.4.1.2.2 Biological Sorption and Transport. Staff will continue summary and synthesis report. Staff will continue to prepare for IHLWM meeting.

WBS 1.2.3.4.1.3. Solubility/Speciation. Staff will continue work described above.

WBS 1.2.3.4.1.5.1 Retardation Sensitivity Analysis. Staff will continue code development on reduced-degree-of-freedom methods and transport model improvements, including the incorporation of a longitudinal and transverse dispersion model option. Staff will continue simulations on the impact of repository waste heat on far-field radionuclide transport for Tc, Np, Pu, Se, and Np. Staff will continue grid development for saturated-zone transport calculations.

WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes. Continue work described above.

WBS 1.2.11.2/.3/.5 Quality Assurance Program Development, Verification, and Engineering. Staff will continue to establish a surveillance schedule. Staff will continue discussions with the M&O to allow each AO to implement their own RTN Matrix using Microsoft Access software as the preferred database. Staff will continue efforts on the QA homepage as we continue to examine options for putting forms and QA procedures on line in an effort to address electronic document control. Staff will be placing two prototypical QPs on the homepage; these will be followed by four additional QPs. Staff will provide the laboratory lead with monthly status reports on Software QA activities and 1994 and 1995 QA-related statistics.

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WBS: 1.2.9.1
QA: N/A.

June 5, 1996

LA-EES-13-06-96-003

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 May 1996 (SCPB:NA)

Attached is the Los Alamos Monthly Management Analysis Report for May 1996. 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.

The 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/cmv

Attachment: a/s

Enclosure 4

Los Alamos Monthly Management Analysis Report for May 1996

(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 Contractor work scope consolidation meetings.

WBS 1.2.3.2.1.1.1 Transport Pathways. ***Quantitative X-ray Diffraction Studies.*** Staff completed collecting X-ray diffraction data and continued data reduction for samples from the lower Topopah vitrophyre to the water table in USW SD-7, SD-9, and SD-12. These data will be used in milestone 4240, "Analysis of the Vitric-to-Zeolitic Transition and of Zeolite Abundances in SD-7, 9, and 12," and they are needed to provide defensible transport models for the site. Preliminary analysis of data for bulk-rock samples at the top of the lower Topopah Spring Tuff vitrophyre and at the top of the zeolitized horizon in the Calico Hills Formation has revealed the presence of the zeolite chabazite. Chabazite has previously been identified at Yucca Mountain only in a limited number of fracture samples. The occurrence of chabazite in SD-7 once again emphasizes that we lack a complete understanding of mineral distributions at Yucca Mountain, even in close proximity to the host rock, and that "surprises" will still be encountered.

Chabazite in SD-7 occurs both above the lower Topopah Spring Tuff vitrophyre and within the nonwelded Calico Hills Formation. In a thermodynamic modeling study of the zeolites found at Yucca Mountain, S. Chipera modeled stability fields for erionite, phillipsite, and chabazite; these zeolites were stable phases only in groundwater compositions that were significantly more potassic than present Yucca Mountain groundwater. Decreases in aqueous silica and sodium activities and increases in temperature also enhanced the stability field for chabazite.

Preliminary results for USW SD-7 also indicate that the top of the abundantly zeolitized zone at the southern end of the exploration block is significantly higher than in the center of the exploration block. If this observation persists as the data are finalized, then the data will have important implications for transport modeling and particularly in providing more accurate site-performance calculations.

Calcite Studies. A paper titled "Paleo-transport of Lanthanides and Strontium Recorded in Calcite Compositions from Tuffs at Yucca Mountain, Nevada" (D. Vaniman and S. Chipera) was accepted for publication in the journal *Geochimica et Cosmochimica Acta*. This paper describes the evidence, recorded in calcite trace-element compositions, for the strong influence of trace minerals on groundwater chemistry at Yucca Mountain. In

particular, calcite compositions provide evidence that trace amounts of Mn oxides along fractures effectively modify the composition of UZ waters along all flowpaths greater than a few tens of meters. These results provide direct evidence that any radioactive wastes released in the UZ will encounter highly sorptive trace minerals. A presentation on this topic was made this month to the Los Alamos Earth and Environmental Sciences Division's external review committee; committee members who focus on the geosciences include H. Yoder (Carnegie Institution of Washington, Geophysical Laboratory) and L. Silver (California Institute of Technology).

Microautoradiography. Microautoradiography experiments will be completed this year on critical rock types, water compositions, and actinide species. Using electron microprobe analysis of Ag in the radiographic emulsions, test exposures to measure saturation limits and linearity of the emulsion used (Kodak NTB2 radiographic emulsion) in the microautoradiography experiments were completed. This experiment was only partially successful, because light scattering within the thin-section used partially exposed all of the test strips simultaneously. The experiment will be repeated with multiple, individually-exposed slides. The information from this work will be used to limit or to compensate for any nonlinearities in the response of the emulsions to exposure signals, thus allowing more quantitative measurements of mineral/mineral actinide distribution coefficients. These distribution coefficients for actinides are important data, and they will be used in the site transport models.

Summary and Synthesis Report. Work continued in data analysis and writing for the Mineralogy of Transport Pathways Summary and Synthesis Report.

Planning Activities. Staff participated in a teleconference with S. Nelson, A. Meijer, R. Henning, and B. Thompson to discuss combined activities at one of three drill holes (WT-17, WT-1, or USW H-3) near the southern end of Yucca Mountain. The Project does have access to some existing mineralogical data for WT-1 and H-3, although sample spacings in those two drill holes were relatively large. Because there is only a small amount of mineralogical information on the southeastern portion of Yucca Mountain, Min-Pet staff felt that, of the three holes discussed, additional effort would be best concentrated on WT-17 for FY97. Min-Pet staff also discussed the value of analyzing cuttings from WT-17 using X-ray powder diffraction methods; accurate mineralogic data for this hole would help define the mineralogy down-gradient away from Yucca Mountain. This data would also be used to provide "edge" information for the flow and transport site models. In addition, actual mineralogical data measured from cuttings would provide important ground truth for well-log information.

WBS 1.2.3.2.1.1.2 Alteration History. Staff expanded sections of the summary and synthesis report dealing with zeolitization from outline form. Preliminary versions of the data tables for zeolite chemical analyses were compiled. General considerations related to the definition of the vitric-zeolitic transition were described in this section. The boundary may be defined differently depending on the intended use for information about the

transition. The variety of possible uses includes paleohydrologic and other petrologic studies and mapping of sorptive, hydraulic, and thermal properties.

A report summarizing alteration history studies of Yucca Mountain natural self-analog studies, Yellowstone analog studies, and thermodynamic studies of zeolite stability and dehydration, pertinent to the evaluation of thermal loading goals, was completed.

WBS: 1.2.3.2.1.2. Kinetics and Thermodynamics of Mineral Evolution at Yucca Mountain. B. Carey continued analyzing thermodynamic data for clinoptilolite. His results this month include thermodynamic models for the energetics of cation-exchange, which allow the several thermodynamic measurements of the Gibbs free energy of formation of clinoptilolite to be evaluated for consistency. The models indicate that there is significant difference between calorimetric and solubility determinations of the Gibbs free energy of formation, and the calorimetric values are believed to be more reliable. In addition, Carey obtained accurate thermodynamic values (to within 0.1%) for both clinoptilolite and heulandite, allowing a single model for these structural pairs. The models also permit the calculation of the Gibbs free energy of formation of any compositional end-member with an improved and more quantifiable accuracy. These results will be included in the summary and synthesis reports.

B. Carey gave a presentation to the Los Alamos Earth and Environmental Sciences Division's external review committee on the potential for mineral reactions to occur at Yucca Mountain following emplacement of high-level radioactive waste. The talk focused on the mineral clinoptilolite and included a summary of the experiments characterizing the equilibrium and energetics of hydration and dehydration. These results were used in simulations that illustrated the effects of hydration and dehydration of clinoptilolite on saturation, temperature evolution, and the stability of clinoptilolite at Yucca Mountain. Other potential mineral reactions at Yucca Mountain including those involving clays, the silica polymorphs, and volcanic glass were briefly discussed. The external review committee made some suggestions for future work that included experiments designed to determine the water content of clinoptilolite at elevated pressure and experiments on the dissolution and precipitation behavior of minerals to better define the potential for redistribution of material at Yucca Mountain.

B. Carey, S. Chipera, and D. Bish prepared for presentations at the annual Clay Minerals Society meeting, which will be held 17-20 June in Gatlinburg, TN. The titles of the presentations are "X-ray Powder Diffraction And Thermogravimetric Analysis Of Clinoptilolite Dehydration Behavior" and "Hydration/Rehydration Hysteresis in Smectite: Equilibrium or Kinetic Effect?" Both talks will focus on kinetic and thermodynamic aspects of hydration in smectite and clinoptilolite, with a goal of accurately predicting the behavior of both minerals as a function of temperature and partial pressure of water.

A paper titled "Equilibrium Modeling of Clinoptilolite-Analcime Equilibria at Yucca Mountain, Nevada," was accepted for publication in the journal *Clays and Clay Minerals*. The authors were addressing reviewer and editorial comments before final submittal.

WBS 1.2.3.2.5 Volcanism. ***Probability Studies.*** Chapter 3, "Tectonic Settings of the Yucca Mountain Region: Relationship to Episodes of Basaltic Volcanism," of the summary and synthesis report was being edited and reviewed by co-authors at the USGS and Stanford University. Participants from the tectonics program at University of Nevada, Reno, have agreed to write sections on seismicity and teleseismic studies.

Staff continued to revise chapter 7, "Probabilistic Volcanic Hazard Assessment," of the summary and synthesis report.

Golder Associates was preparing results of their studies on simulation modeling of the probability of magmatic disruption of the Yucca Mountain site to be included in chapter 7.

Staff assessed all results to date on simulation modeling of the disruption probability. These results indicate that the uncertainty in the location of zone boundaries can be modeled for many zone boundaries by examining the disruption probability for different assumed values of the mean and standard deviation of dike lengths.

Staff evaluated the revised chronology data for the Lathrop Wells and Sleeping Center. This revised data indicate that the minimum repose interval for the Pliocene and Quaternary is 320,000 years, which is longer than the 200,000 years minimum repose interval estimated in the volcanism status report (Crowe et al. 1995). It is still, however, the shortest repose interval during the Pliocene and Quaternary.

Geochemistry of Eruptive Sequences. Staff focused on preparing for a DOE audit scheduled 3-7 June. The audit was later postponed indefinitely. Synthesis activities continued.

Subsurface Effects. Staff focused on preparing for a DOE audit scheduled 3-7 June. The audit was later postponed indefinitely. Other work included completion of a first draft of a mineral alteration study at the Paiute Ridge analog site and continued preparation of a manuscript on work at Grants Ridge site.

WBS 1.2.3.3.1.2.2 Water Movement Test. Staff collected 18 samples from the ESF tunnel for chlorine-36 analysis. Nine of these were associated with locations at which elevated chlorine-36 signals had previously been determined, near stations 2, 12, 21, and 26. At two of these locations, a single sample had previously been found to have elevated chlorine-36, and the objective was to resample these sites to confirm the earlier result as well as to determine the width of the zones with elevated chlorine-36. The remaining samples collected on this trip were systematic and feature-based samples from Alcoves 2 and 3 and from the main drift, between stations 41 and 50. Staff also participated in the collection of about 15 ESF samples for tritium analysis.

An alternative hypothesis to account for the elevated chlorine-36 in the ESF samples is natural production by cosmic rays impinging on calcite in surface soils. To test this concept, several soil samples were collected from YMP trenches and surface exposures this month.

The accelerator mass spectrometer used to analyze YMP samples for chlorine-36 has been inoperative for the past month, creating a backlog of approximately 70 samples. Staff continued processing additional ESF samples for chlorine-36 analysis.

Staff began processing a test suite of six samples for technetium-99, cesium-137, and plutonium, all of which are present as global fallout from atmospheric testing of nuclear devices in the 1950s and 1960s. The objective is to test the feasibility of using one of these nuclides as an independent indicator of fast paths, to corroborate the chlorine-36 results. Gamma-counting of raw sample material was insufficiently sensitive to detect cesium-137 in borehole and ESF samples containing bomb-pulse chlorine-36 (including an ESF sample from the Bow Ridge Fault) although cesium-137 was easily measured in surface soil samples. To improve sensitivity, chemical processing of these samples is necessary to isolate the cesium-137 as well as any plutonium from the matrix. However, it is likely that detectable levels of these elements will not be observed at depth, given their propensity to sorb strongly onto soil components.

WBS 1.2.3.3.1.3.1 Reactive Tracer Testing. A conservative tracer test involving injection of pentafluorobenzoic acid (PFBA) into well C#2 while producing water out of well C#3 was initiated on 15 May. The purpose of this test is to determine conservative tracer travel times, peak concentrations, and recoveries under partial recirculating (weak dipole) flow conditions in the most transmissive interval at the C-holes (the middle to lower Bullfrog unit). The results of the test are allowing project scientists to determine whether a reactive tracer test can be conducted in the same interval under the same conditions.

Ten kilograms of PFBA was injected as a 250 gallon slug (~10000 ppm) at ~5 gallons per minute (gpm) into the middle to lower Bullfrog formation in well C#2 at a depth of about 2290 ft below surface at 12:20 pm on 15 May. The linear distance between C#2 and C#3 is approximately 30 m, or 100 ft. The injection interval was 308 ft. long, extending down to 2598 ft. below surface. Tracer-free water produced from C#3 had been injected into C#2 at ~5 gpm starting at 3:45 pm on 14 May so that a steady-state weak dipole flow field was established prior to introducing tracer. The tracer solution was introduced without any disruption in the flow field, and water from C#3 was pumped at ~5 gpm into C#2 behind the tracer so as to maintain a steady flow field throughout the test. Water has been produced from C#3 at a nearly constant rate of 154 gpm since 8 May. As of 31 May, an upper bound for the mass of PFBA that has been reinjected into C#2 since the beginning of the test was about 80 g, or 0.8% of the total mass. This amount of reinjected mass should have no measurable effect on the breakthrough curve, although project scientists will ultimately account for this when doing the final interpretation of the test.

Fig. 1 shows the preliminary breakthrough curve as of about noon on 31 May (~385 hours since injection on 15 May). The curve contains nearly 500 data points representing analyses conducted in the field by UNLV and Los Alamos scientists. These data should be considered preliminary and should not be used outside the project until appropriate quality checks and reviews have been conducted. Over 800 samples have been collected during the test at intervals ranging from 15 minutes at the beginning of the test to 2 hours at the present time. The concentration of PFBA peaked at about 340-350 ppb on 25 and 26 May and has slowly declined since. The total recovery of PFBA at 385 hours since injection was about 25%. The apparent discontinuity in concentrations at about 350 hours in Fig. 1 is believed to be a problem associated with the field analyses and not an actual dip in concentrations. Samples collected near that time will be reanalyzed during the first week of June to test this hypothesis.

While the test results to date are still being analyzed, the preliminary results have indicated that, before proceeding with a reactive tracer test, it would be prudent to inject a conservative tracer into C#1 while pumping C#3 to determine if tracer response times and recoveries are shorter and higher, respectively, than from C#2. Modeling analyses have suggested that a reactive tracer test involving a 40 kg injection of lithium bromide (the current environmental permit limit) into C#2 would have a marginal chance of resulting in lithium concentrations that are significantly above background concentrations (70-80 ppb). Although C#1 is over two-and-a-half times the distance from C#3 than C#2, the possibility that the former well may yield a better tracer response cannot be ruled out. The pressure draw down in C#1 resulting from pumping C#3 is almost as great as the drawdown in C#2, and borehole videotapes indicate that fractures tend to be oriented more in the C#1-C#3 direction than the C#2-C#3 direction. Thus, the current plan is to inject 15 kg of sodium iodide into C#1 to determine if higher concentrations can be obtained from injections into this borehole. Staff was prepared to proceed with this injection during the last week of May, but the necessary approvals had not yet been obtained. Lithium bromide will ultimately be injected into whichever borehole (C#1 or C#2) results in a higher recovery/peak concentration of conservative tracer. In the meantime, approval for an 80 kg injection of lithium bromide is being pursued with the State of Nevada environment department in the event that C#1 does not have a significantly better tracer response than C#2. This approval would increase the chances of seeing a quantifiable lithium response from either C#1 or C#2.

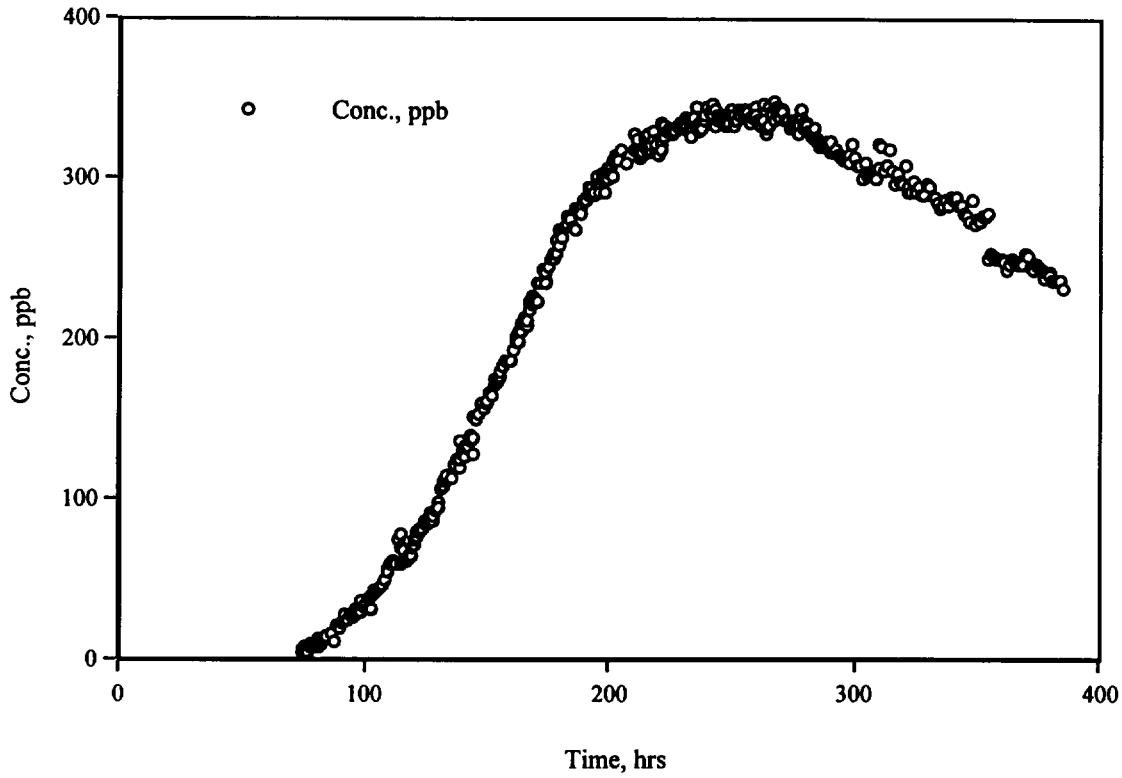

Fig. 1. Preliminary PFBA Breakthrough Curve (through 31 May 1996).

WBS 1.2.3.4.1.1 Groundwater Chemistry Model

Continued development of ground water chemistry model. Submitted estimates of long-term water compositions to sorption task for use in experiments on potential backfill materials.

WBS 1.2.3.4.1.2.1 Batch Sorption Studies. Staff completed summarizing the surface complexation work in the literature involving Np and relevant minerals and groundwater compositions at Yucca Mountain. This summary has been added to section IV, B. To date, staff completed sections I, III, and IV, A of this report and were currently working on section IV, B.

Outline for summary and synthesis report

I. Groundwater Chemistry (and its effects on sorption)

II. Mineralogy Variability (and its effects on sorption)

III. Sorption Data (determined by batch experiments)

- A. Sorption of Simple Cations
- B. Sorption of Simple Anions
- C. Sorption of Actinides

IV. Models that can explain the measured sorption data

A. Ion Exchange

B. Surface Complexation

V. Recommended sorption data for PA

WBS 1.2.3.4.1.2.2 Biological Sorption and Transport. Staff continued writing the summary and synthesis report. The following sections have been completed:

Introduction (approximately 40 pages, 135 references)

Appendix - Colloidal Agglomeration

Siderophore Production

Siderophore/Plutonium Chelation

Siderophore promoted hematite dissolution Siderophore/Iron transport

WBS 1.2.3.4.1.3 Speciation/Solubility. Staff focused on data analysis and began writing the milestone. Data analysis includes using the SIT formalism to check for outlying data points from different sources.

WBS 1.2.3.4.1.4.1 Transport. Staff completed the summary and synthesis section on colloid stability in natural waters (see section III A of the transport outline). To date, they have completed sections I and III A of this report

Transport Report

I. Assessment of Validity of K_d under Advective Conditions
- A. Crushed Rock Columns
  - 1. Using Water from the J-13 Well
    - a. Vitric Tuff
    - b. Zeolitic Tuff
    - c. Devitrified Tuff
  - 2. Using Water from the UE-25 p# 1 Well
    - a. Vitric Tuff
    - b. Zeolitic Tuff
    - c. Devitrified Tuff
- B. Saturated Solid Rock Columns
  - 1. Using Water from the J-13 Well
  - 2. Using Water from the UE-25 p# 1 Well
- C. Unsaturated Solid Rock Columns
  - 1. Zeolitic Tuff
  - 2. Devitrified Tuff

II. Radionuclide Transport through Fractures
- A. Conservative Radionuclides (tritium and pertechnetate)
- B. Sorbing Radionuclides

III. Colloid-Facilitated Radionuclide Transport
- A. Colloid Stability in Natural Groundwaters
- B. Sorption of Radionuclides onto Colloids
- C. Elution of Colloids through Fractures
  - 1. Saturated Systems
  - 2. Unsaturated Systems

Staff also summarized the results of diffusion cells experiments (see Section II B in the diffusion outline). To date, they have completed sections I, II, A and II, B of the diffusion report.

Diffusion Report

I. Diffusion of Conservative Radionuclides through Saturated Tuff
- A. Tritiated Water
  - 1. Diffusion Cells
  - 2. Rock Beakers
- B. Pertechnetate
  - 1. Diffusion Cells
  - 2. Rock Beakers

II. Diffusion of Sorbing Radionuclides through Saturated Tuff
- A. Tuff Wafers
- B. Diffusion Cells
- C. Rock Beakers

III. Diffusion of Radionuclides through Unsaturated Tuff

WBS 1.2.3.4.1.5.1 Retardation Sensitivity Analysis. ***Drift-Scale Flow and Transport Calculations.*** A flow and transport model at the drift scale is being developed to simulate the movement of water and radionuclides in the vicinity of an emplacement drift and waste canister. Two- and three-dimensional finite-element grids were developed based on the latest designs proposed for the waste package/emplacement drift system. The calculations assume that the system has returned to the ambient hydrologic conditions (i.e., that the radioactive decay waste heat has dissipated). The hydrologic parameters of the system are based on measured properties of the Topopah Springs rock and recently measured unsaturated flow properties of the proposed backfill and invert materials. Measurements of the transport properties of the invert material (sorption coefficients) will be incorporated into the transport calculations when they are available.

Initial flow-model results indicate that a capillary barrier, which diverts water around the drifts, is set up at low infiltration rates. Consequently, the radionuclides must diffuse through the backfill and invert before migrating downward by advection with the flowing groundwater. However, at higher infiltration rates, advection occurs through the drift, increasing the rate of transport away from the drift area. The computational results will be compiled in the form of a time-dependent source term for radionuclide release, which will be used as input to site-scale radionuclide transport models.

Environmental Isotope Studies. A series of one- and two-dimensional calculations were initiated to explore the limits of applicability of certain model assumptions used in site-scale UZ transport calculations of ^{36}Cl. The first set of runs is to test the applicability of the dual-permeability model to simulate the interaction of fractures and matrix. The question addressed is whether the pressure gradients into the rock matrix from the fractures can be adequately represented using the dual-permeability approach, which effectively assumes a single pressure in the matrix for the reason of computational efficiency. The limits of this approach will be identified in this study. The other aspect of this work relates to the assumption of steady state, constant infiltration to represent what is, in effect, a series of rapid infiltration events, followed by periods of little or no infiltration. The transport response

of the system to periodic infiltration is being studied in this task as well. The results will be used to better interpret the isotopic measurements, including ^{36}Cl background and bomb-pulse data.

Grid Generation. Over the last 3 months, we have worked to produce a computational grid of the SZ for the USGS flow model (John Czarnecki) and the LANL flow and transport model. This has been an iterative process and to date, we have investigated 4 different versions of the Stratamodel SFM. A preliminary grid was produced for each of these Stratamodel's until a final version was identified and delivered April 4, 1996. Our close collaboration with the USGS has enabled us to quickly come to resolution on a model with the correct area of interest (AOI) and described by a computational grid of modest size (30,000 nodes) which allows the USGS to proceed with its flow calculations. We are now producing a computational grid for FEHM calculations.

The steps that have been carried out are as follows:

1) Conversion of the Stratamodel SFM to a hexahedral grid.
2) Removal of zero volume hexahedral elements which are part of Stratamodel.
3) Conversion of each hexahedral element to 24 tetrahedral elements.
4)Removal of all elements in bottom layer of model.
5) Addition of 465 nodes to grid the locations of water well water table measurements.
6)Identification and output of lists of nodes situated on the top, bottom, and four sides of the Stratamodel for application of boundary conditions.
7) Testing of the grid on simple heat flow and saturated flow problems prior to delivery to the USGS.
8) Addition of 239 nodes around the model perimeter to match water level of larger regional model. This step requires that the perimeter nodes as provided by USGS be translated 750m to the south and 750m to the west.

With the exception of the last item, all of these steps have been completed. We are working to modify the grid generation code to accomplish this last step. At this point 96 of the 239 nodes required have been added and a computational grid has been delivered to USGS. Computed flow solutions on the preliminary and final grids, complete with perimeter nodes will be delivered shortly.

This process has involved direct and efficient communication between the USGS and LANL to understand and develop SZ model requirements. New software was developed to handle some of the special cases that are part of this work. Stratamodel continues to be somewhat unreliable and does not always produce the expected geometries. For this reason, a completely new algorithm was implemented to identify and output the outside nodes for boundary condition inputs. We have also added the option of pinching out very thin layers that persist artificially in Stratamodel.

Code Development. The transport model options have been improved to include two new options. First, the diffusion coefficient can now be specified as a function of fluid saturation, in keeping with the experimental

measurements of Conca using the unsaturated flow apparatus. Second, a model consisting of a longitudinal and transverse dispersion has now been added. The former feature is being used for drift-scale transport calculations, and the latter will be useful in the SZ transport simulations to be performed later this year.

WBS 1.2.3.9.7 Special Studies: ESF Test Coordination. Staff provided multiple-shift field coordination and PI support for ESF north ramp, main, and alcove tests. Test installation for the single-element heater portion of the Thermal Test Program was in progress and planning for the FY97 heated room test continued. Geologic mapping and consolidated sampling activities were continuing using the mapping gantry.

Staff continued to assemble field records files for test activities conducted in the north ramp, main drift, and test alcoves. This effort includes the maintenance of an administrative database that identifies sample locations and their corresponding photo identifiers.

Administrative test management progress reports were generated to ensure that test requirements and issues are identified. Staff continued to support the Field Change Control Board and the Baseline Change Control Board.

Staff submitted a progress report (LA-EES-13-LV-05-96-007) on ESF testing activities for April 1996 to S.B. Jones and R.L. Craun.

WBS 1.2.5.7 Investment Decision Integration/Technical Evaluation. Staff attended the NWTRB meeting in Austin, TX, 30 AprilÐ1 May.

Staff attended a PR 14 review meeting in Las Vegas, NV.

Staff attended the 7th International meeting on Accelerator Mass Spectrometry in Tucson, AZ, 20–25 May.

Charles Harrington was appointed as a member of the committee that will prepare a new draft of the Waste Isolation Strategy. In connection with this responsibility, he attended a meeting in Las Vegas and participated in several teleconference calls. He also rewrote sections of the draft.

WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes. Staff extended the reduced-degree-of-freedom algorithms to dual-permeability simulations with air-water-heat. This extension should allow the first-time solution of mountain-scale simulations with this physics and fracture representation. The initial test results were very promising.

Staff continued testing of thermal problems using multiply-defined nodes. This technology allows excellent resolution near interfaces with coarser resolution than was required without this technique. Staff was currently also using it for drift calculations.

Grid Generation. Many grids were developed this month. They included drift-scale grids with multiply-defined interfaces and a new saturated-zone grid for John Czarnecki. The new saturated-zone grid contained additional points for observations, additional layers in the vertical direction, and new boundary nodes.

Carl Gable and Terry Cherry attended an X3D Workshop (on grid generation) at Los Alamos.

WBS 1.2.5.3.5 Technical Database Input. The following automated technical data tracking (ATDT) system submissions were completed:

- Stable chlorine isotope ratios measured for soils at Yucca Mountain, DTN LAJF831222AQ95.001
- Stable chlorine isotope ratios measured for USW UZ-1 rock cuttings, DTN LAJF831222AQ95.002
- Halide and chlorine-36 analyses of ground-waters from USW UZ-1, UE#25-P1, and UE25 UZN#2, DTN LAJF831222AQ95.004
- Halide and chlorine-36 analyses of soils from the UE25 NRG#5 drill pad, DTN LAJF831222AQ95.005
- Halide and chlorine-36 analyses of soils from Test Cell C, NTS Area 25, DTN LAJF831222AQ95.007
- Halide analyses of Topopah Spring tuff from UE25 UZ#16 (1111 ft), DTN LAJF831222AQ95.008
- Halide and chlorine-36 analyses of cuttings from borehole USW UZ-14, DTN LAJF831222AQ95.015
- Halide analyses of Paintbrush tuffs from Yucca Mountain, DTN LAJF831222AQ95.016
- Halide and chlorine-36 analyses of pore waters, groundwaters and surface runoff from Yucca Mountain and vicinity, DTN LAJF831222AQ95.017
- Halide and chlorine-36 analyses of drill core from USW UZ-N55, DTN LAJF831222AQ95.018

The following ATDT records packages have been transmitted to the Los Alamos Records Processing Center:

- Halide analyses of surface soils collected within the Perimeter Drift Boundary, DTN LA000000000063.002
- Halide and chlorine-36 analyses of ground-waters from the saturated zone, DTN LA000000000064.001
- Halide and chlorine-36 analyses of Rocks from the North Starter Tunnel, DTN LA000000000065.001

Staff continued to compare records transmitted to the RPC with the actual entries of the DTN database to verify that all entries were complete.

WBS 1.2.6.1.1 Exploratory Studies Facility (ESF) Management, Planning and Technical Assessments. Staff attended weekly design and construction meetings. Staff continued to participate in discussions with DOE and the design team to merge future design activities into the existing 2C design package. Staff provided design

input to support field changes related to the thermal test alcove and north Ghost Dance Fault alcove construction Staff provided design input to support field changes related to the thermal test alcove construction. Staff developed weekly and monthly administrative management reports for testing activities and facilitated job package record development. Staff provided field test coordination and administrative support for ESF north ramp main drift and alcove activities.

WBS 1.2.6.1.2/3 Quality Assurance and Safety Analysis. Staff attended weekly design and construction meetings and routinely observed ESF field testing activities. Staff reviewed test planning records and test-related field change requests for compliance with QA and safety concerns. Staff developed and implemented a respirator program for scientific personnel working underground that meets Project requirements. Staff continued to coordinate all scientific tunnel access with the construction manager.

WBS 1.2.6.1.6 Exploratory Studies Facility (ESF) Test Management. Staff attended weekly design and construction meetings. Staff supported development of weekly and monthly administrative management reports for testing activities; staff facilitated job package record development. Staff provided field test coordination and administrative support for ESF north ramp, main drift, and alcove activities. Staff provided input for an M&O-initiated change in the WBS assignment for this effort from WBS 1.2.6.1 management category to WBS 1.2.6.14 performance category.

WBS 1.2.6.8.4 Integrated Data and Control System (IDCS). The design team was notified that the IDCS has been placed on indefinite hold because of budgetary constraints. The IDCS data acquisition equipment received in FY 1995 continued to be configured and deployed as temporary portable data acquisition stations. The ESF TCO completed the Draft Field Work Plan (FWP) document titled "ESF Data Collection Systems" to direct the QA configuration, deployment, calibration, and operation of the data acquisition systems in the ESF. This FWP will direct the data collection of the ESF testing organizations in FY 1996, 1997, and 1998.

WBS 1.2.11.2/.3/.5 Quality Assurance Program Development, Verification, and Engineering. ***Program Development.*** Staff continued to place QPs, QP forms, and DPs on-line. They were also trying to identify the areas in which cuts can best be absorbed and functions still remain viable. Staff was also trying to determine areas in which to streamline processes without severely impacting technical areas. Staff was updating the RTN matrix and sent a prototype to the M&O. Paul Gillespie is heading this function. The matrix is now completely functional; it should be completely updated by 30 June.

Procedure Revisions. QPs-06.1, 06.2, 06.3, and 18.2 were placed on-line. QPs-02.5, 02.7, 02.11, 02.12, 02.15, 03.25, and 04.6 were approved; the next step will be to get these latest approved procedures to Document Control for distribution to file and WEB pages. The remaining QPs are in different stages of revision and review and are were being reviewed for process improvement and consolidation. P. Gillespie continued evaluation of QARD changes with respect to the RT matrix.

Travel. M. Clevenger and P. Gillespie attened QA managers meetings in Albuquerque on 22 and 23 May at which the Qualified Suppliers List Workshop was discussed.

M&TE. The Los Alamos standards and calibration group (ESH-9) is now conducting calibration activities for Los Alamos YMP researchers. QP-12.3, which describes control of M&TE, is presently being revised to eliminate the M&TE Coordinator activities.

Audits and Surveys. A performance-based audit of Post-closure Tectonics, which was scheduled for June 3, 1996, was canceled. It has been re-scheduled for the September 16, 1996. The compliance-based audit is still scheduled the last week of June and is currently focused on Cl-36 activities. RT Matrix and procedure revision activities were taking up local survey time.

Deficiencies. DR-YMQAD-95-D-015, which was issued by YMSCO and concerns one of our vendors (SIMCO), was still open. YMSCO is evaluating our revised resolution, and they will rule on closure by the end of May 1996.

Quality Engineering. B. Gundlach continued to work with investigators on FEHMN certification issues. He is also reengineered the draft home page on which we hope to make QA documents available on line.

(b) Deliverables Completed

Milestone T6545, "Users Manual for the FEHMN Application"

(c) Problem Areas

WBS 1.2.3.2.5 Volcanism. Digital terrain data for the Sleeping Butte center was previously archived with EG&G, which is no a longer participant in the YMP. The data cannot be retrieved with current volcanism resources. The revised Sleeping Butte geologic mapping is completed but cannot to transferred to a topographic base without access to the EG&G data.

WBS 1.2.11.2/.3/.5 Quality Assurance Program Development, Verification, and Engineering. Budget reduction is causing surveillance personnel to work on things other than conducting surveys. Conversion of QPs from WordPerfect to Word is still having a major impact to the timeliness of procedure revision.

(2) Personnel Changes

NA

(3) Unusual Costs and Possible Financial Performance Problems

NA

WBS 1.2.3.2.1.1.1 Mineralogy of Transport Pathways. The Peña Blanca study was approved on 3 April 1996. Because of problems at the TRW level, we have not been authorized to begin. According to the C/SCR, this work was supposed to have started on 1 March, and the draft report is due to TRW by 30 August. We have already lost several months, and further delays will jeopardize our ability to deliver the draft report by 30 August.

(4) Programmatic Issues that may Impact the Overall CRWMS M&O Effort

WBS 1.2.3.2.1.1.1 Mineralogy of Transport Pathways. The possibly favorable impact of the occurrence of abundantly zeolitized rocks over 200 m above the water table in USW SD-7 is important. The occurrence of very thick UZ zeolitic sequences impinging on the southern end of the exploration block will have a significant impact on repository performance.

WBS 1.2.3.2.1.2.2 Stability of Minerals and Glasses. Staff now has thermodynamic models for the energetics of cation exchange in clinoptilolite. These models allow the several thermodynamic measurements of the Gibbs free energy of formation of clinoptilolite to be evaluated for consistency, showing that the calorimetric values are most reliable. The models also allow calculation of the Gibbs free energy of formation for any compositional end-member of clinoptilolite with an improved and more quantifiable accuracy, allowing more accurate thermodynamic models of mineral evolution under the thermal influence of a repository at Yucca Mountain.

WBS 1.2.11.2/.3/.5 Quality Assurance Program Development, Verification, and Engineering. Communication between DOE and the M&O has been difficult. Staff has had to duplicate effort to satisfy both entities.

WBS 1.2.5.4.9 Development and Verification of Flow and Transport Codes. Staff was evaluating new fracture relative-permeability data made available by the USGS and using this data to help determine the applicability of dual-permeability models in a broad range of YMP applications.

(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 to provide input to mineralogic models for site transport evaluations and (2) support the project in preparation of synthesis and summary reports.

WBS 1.2.3.2.1.1.2 Alteration History. Staff will continue writing the Alteration History portion of the Mineralogy of Transport Pathways summary and synthesis report, in support of a site suitability analysis.

Sections on mineral dehydration and rehydration will be prepared for inclusion in the report. The work in support of the FY96 Thermal Loading Study Report will continue at a low level, mainly to provide guidance to the modelers, and will also be included in the Alteration History Summary and Synthesis report.

WBS 1.2.3.2.1.2.2 Stability of Minerals and Glasses. Summary and synthesis report writing will continue, and study plan comments will continue to be addressed. Several presentations related to kinetics and thermodynamics will be given at the annual meeting of the Clay Minerals Society.

WBS 1.2.3.2.5 Volcanism. Continue work described above.

WBS 1.2.3.3.1.2.2 Water Movement Test. Staff will process samples of surface calcite in order to evaluate this as an alternative source for the elevated ^{36}Cl levels seen in ESF samples. Staff will evaluate feasibility of alternative methods for corroborating the presence of bomb-pulse ^{36}Cl in subsurface samples. Staff will process critical ESF samples for ^{36}Cl. Staff will continue acquisition of halide data for bore holes to replace old data discarded as unreliable. Staff will continue acquisition of halide data for ^{36}Cl samples already submitted for isotope analysis. Staff will participate in activities for sample collection from ESF and bore holes. Staff will prepare for DOE audit scheduled for June 1996.

WBS 1.2.3.4.1.1 Groundwater 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 1.2.3.4.1.2.1 Batch Sorption Studies. Staff will complete section IV B of the sorption report.

WBS 1.2.3.4.1.2.2 Biological Sorption and Transport. For the appendix section of the summary and synthesis report, staff will write a paper on bacterial growth on hematite and coordinate with Tom Kieft (NM Tech) and David White (U Tenn) for their contributions to the summary and synthesis report. Staff will also write the summary section of the report, which will discuss all of the information presented in the appendix.

WBS 1.2.3.4.1.3. Solubility/Speciation. Efforts in database collection and evaluation will continue.

WBS 1.2.3.4.1.4.1 Transport. Staff will complete Section III B of the transport report and section II C of the diffusion report.

WBS 1.2.3.4.1.5.1 Study: Retardation Sensitivity Analysis. Staff will continue code development on reduced-degree-of-freedom methods. Staff will continue drift-scale transport calculation study. Staff will complete a transient infiltration model study. Staff will continue grid development for UZ and SZ flow and transport calculations.

WBS 1.2.3.9.7 Special Studies: ESF Coordination. Staff will continue support of ESF test coordination site characterization activities in response to Project programmatic requirements.

WBS 1.2.5.3.5 Technical Database Input. Staff will continue to evaluate which technical data needs to be entered into the ATDT and/or the TDB (GENISES). Staff will continue to work the backlog of data submissions to the ATDT system.

WBS 1.2.6.1.1 ESF Management, Planning, and Technical Assessments. Staff will support finalizing of Title II Design Packages for the north portal surface facility and ESF excavations to meet the DOE's "temporary facility" guidance. Staff will continue field test coordination for construction monitoring, geologic mapping, consolidated sampling, perched water, radial boreholes, hydrologic properties of major faults, hydrochemistry, and thermal test facility activities being conducted in the north ramp, ESF main, and test alcoves.

WBS 1.2.6.1.6 ESF Test Management. Staff will continue management and implementation of test planning and field test activities.

WBS 1.2.6.8.4 Integrated Data and Control System. Staff will 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. Formal reports on surveys conducted in May will be issued at the end of June. Staff will continue placing Quality Administrative and Detailed Technical procedures on-line in an effort to address electronic document control. Staff will continue revising the remaining 18 QPs before working on the DPs. Staff will continue to provide the Los Alamos lab lead with monthly status of Software QA activities.

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

May 13, 1996

Wayne Kozai
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, 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
Robert W. Craig
Technical Project Officer
Yucca Mountain Project Branch
U.S. Geological Survey

Enclosure:
cc: S. Hanauer, DOE/Forrestal
R. Dyer, DOE,Las Vegas
C. Fox, DOE, Las Vegas
A. Gil, DOE,Las Vegas
T. Hill, DOE, Las Vegas
S. Jones, DOE,Las Vegas
R. Patterson, DOE,Las Vegas
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L. Hayes, M&O/TRW, Las vegas
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W. Day, USGS, Denver
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Enclosure 5

W. Dudley, USGS, Denver
D. Gillies, USGS,Denver
D. Hoxie, USGS, Las Vegas
R. Keefer, USGS,Denver
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B. Parks, USGS,Denver
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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		

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,P1and 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

Yucca Mtn. Site Char. Project-Planning & Control System
PACS Participant Work Station (PPWS)
WBS Status Sheet (WBS02)

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					FY1996 Cumulative to Date					FY1996 at Completion		
Id	Description	BCWS	BCWP	ACWP	SV	CV	BCWS	BCWP	ACWP	SV	CV	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

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
Date Prepared 05/13/96 08:04

MONTHLY COST/FTE REPORT

Fiscal Month/Year APRIL 1996

	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
0G311196B	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
0G31296B2	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	0.6
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. Flts 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	49.3
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	265.7
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	24.4
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	49.8
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

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
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	50.5
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	504.3
*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
0G52496B2	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
0G53596B	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
0G54196B	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
0G54696B	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
0G55396B		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	0.3
0G5796B	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
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
0G82596B	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
0G84596B	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

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
**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
0G92296B 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
0GC52196B 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	43.9
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
0GF2396B1 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
0GF2396B2 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
0GF2396B3 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
0GF2396B4 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
0GF2396B5 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
0GF396B 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	8333.5
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	16.0
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