University of California
LOS ALAMOS SCIENTIFIC LABORATORY
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May 30, 1980

ISCS Report

Mr. John Peel
Idaho Operations Office
550 2nd St.
Idaho Falls, ID 83404

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Dear John:

Enclosed are the April 1980 Monthly Reports on those projects under your low-level waste program.

Sincerely,

James G. Steger
LS-6 Alternate Group Leader
Environmental Science Group

JGS:tj

Enc: Monthly Report
Distribution List

8004

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MONTHLY PROGRAMS REPORT

March 1980

AL 3.5.1
Solid Radioactive Waste Disposal Studies

AL 3.5.4
Shallow Land Burial Technology

AL 3.10.1
Alternative Systems Study

LOS ALAMOS SCIENTIFIC LABORATORY
ENVIRONMENTAL SCIENCE GROUP LS-6

Work performed for

DIVISION OF WASTE MANAGEMENT
US DEPARTMENT OF ENERGY

University of California

LOS ALAMOS SCIENTIFIC LABORATORY

PROGRAM STATUS REPORT

Title: Solid Radioactive Waste Disposal Studies BR&C NO.: AR-05-15-15

FO/Contractor: AL/LASL WEP NO.: AL 3.5.1

Manager: James G. Steger Annual Budget: $300k

Principal Investigator: M. A. Rogers Date: May 1980

Month Covered: April 1980

Task Description:

The purpose of this task is to develop methods for environmental monitoring and surveillance of low-level waste disposal facilities. The approach taken will be to assess the migration of radionuclides from wastes buried during the last 35 years at LASL in order to determine waste/soil interactions and radionuclide movement in a semi-arid environment. Potentially significant pathways will be identified and modeled. A method of monitoring radionuclide movement along these pathways will be developed along with identifying the constraints that must be imposed upon disposal site operating practices and waste forms.

Highlights and Significant Accomplishments:

The trace element data was put through discriminant analysis three times and cluster analysis twice this month by Dick Beckman, S-1. U, Fe, Th, and Cs will correctly classify 82.7% of known units in the Tshirege. For all of the trace elements (Zn, U, W, Th, Cs, Rb, Co, Ta, Fe, Ba, Sb, As, and Mo) the percentage of correctly classified is 78.6. Using U, Fe, Th, and Cs the percentage correctly classified for individual units is:

Unit A - 100%
Unit B - 91.3%
Unit C - 100%
Unit D - 94.7%
Unit E - 41.2%
Unit F - 73.3%

The University of Colorado graduate classes in volcanology, igneous petrology, and mineral deposits with professors Bill Atkinson, economic geology; Ed Larsen, volcanology; and Charles Stern, igneous petrology visited April 7th. I conducted a fieldtrip that covered exposures of the entire section of the Bandelier Tuff on the Pajarito Plateau.

The "glass" samples sent back to us by CMB-6 and tuff samples for the Tshirege were taken to Dave Mann, G-6 to be thin-sectioned. CMB-6 had said that the "glasses" contained crystals at a temperature of 1750°C; therefore I took them to be sectioned in preparation for microprobe analysis. The other thin sections are to round out our collection for descriptive work which will be in the geology report in support of the map.

The soil temperature probes have been calibrated and the thermograph has been checked to see if internal heating of the thermograph resulted in an altering of the readings. It did not. To further decrease that possibility and to protect the thermograph from rain and dust, an aluminum cover was constructed that fit over the thermograph. The aluminum has the property of practically eliminating the "greenhouse effect" present due to the existence of glass windows. The cover should consequently diminish the temperature fluctuations in the thermograph which, in turn, might potentially influence the soil temperature readings.

Adapters have been made for the heat flow sensors to fit the "multimeter" which, after calibration, will convert the voltage measurements in heat flow expressed in KWm^{-2}. The holes for the temperature probes and the heat flow sensors have been drilled about 10 m from GS-150 ("the Tritium shaft"), so that the influence of temperature gradient and heat flow on tritiated water emanation can be verified.

Literature review concerning the "maximum credible case" of climate change is quite an awesome task. Available data on tree-ring indices in Los Alamos was compared with the existing climatic data. For all trees studied, the tree-ring index decreases with temperature and increases with precipitation, but the multiple

correlation coefficients were 0.50 for Douglas Fir, 0.51 for Ponderosa Pine, and 0.57 for Piñon. Only for Piñon is the test significant at the 1% level. On the other hand, the interrelationship between tree-rings indices (Douglas Fir, Ponderosa Pine, and Piñon) is extremely significant with R = 0.95.

In April the volcano assessment was completed and a memo report was submitted for consideration. There are two distinct source areas for volcanic rocks in the Jemez Mountains: a mantle source for mafic rocks (basalts, andesites, etc.) and a crustal source for felsic rocks (rhyolites, ash flows, etc.). Stratigraphy and age dates indicate that there is a cause and effect relationship between the two types of volcanism, such that felsic events are dependent upon major mafic activity. Geophysical studies in the Valles Caldera suggest that the source area for the Bandelier Tuff is now a cooling granitic mass and may be considered inactive. There is a thin balsaltic magma at ∿15km beneath this part of the Rio Grande Rift, but it appears to be unable to induce significant melting of the overlying crustal rocks at this time. Estimates for continued activity in the Jemez area are:

1. $3 \times 10^{-6} yr^{-1}$ for eruptions of any kind.
2. $7 \times 10^{-6} yr^{-1}$ for pyroclastic and doming events, which becomes important only after major mafic activity has begun, activating crustal sources.
3. $1 \times 10^{-11} yr^{-1}$ for new volcanoes, unrelated to present rift structures, erupting through LASL disposal sites. This is the only volcanic mechanism by which waste inventories can be released into the environment.

Recent geological evidence from a portion of the Española Basin suggests that the trend of volcanic centers may move away from the immediate LASL area in the future. However, we will be unable to verify this hypothesis for several hundred thousand years.

After meeting with Vern Rogers, Vern Rogers and Associates, it was decided to attempt to develop a land-use evaluation scheme for the LASL area. Initially

we will be looking at Area C, Area F, and White Rock. A generalized soil evaluation was reported in Jack Nyhan's soil survey, LA-6779-MS. Some of the results are rather interesting. About half of White Rock is totally unsuited for housing, and Area C (a former bean field) appears to be only marginally capable to support farming. We will shortly be getting in touch with the Soil Conservation Service to get a site-specific detailed soil analysis in the study areas. Vern Rogers is currently developing a set of general criteria for land-use evaluation. We will need to correlate the theoretically determined suitibility of these sites with past and current land use.

Budget Variance:

None

Milestone Variance:

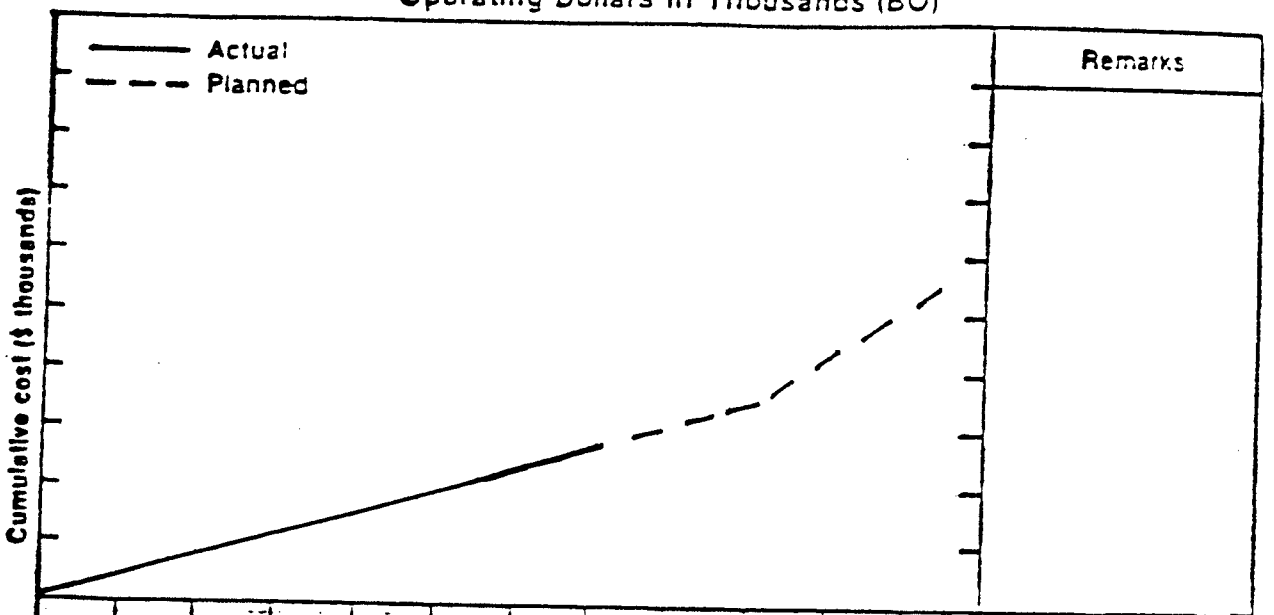
None

Problems and Issues:

None

Title	Radioactive Waste Disposal Studies	B&RC No.	AR 05-15-15
FO/Contractor	AL/LASL	FY 80	WEP No. AL 3.5.1

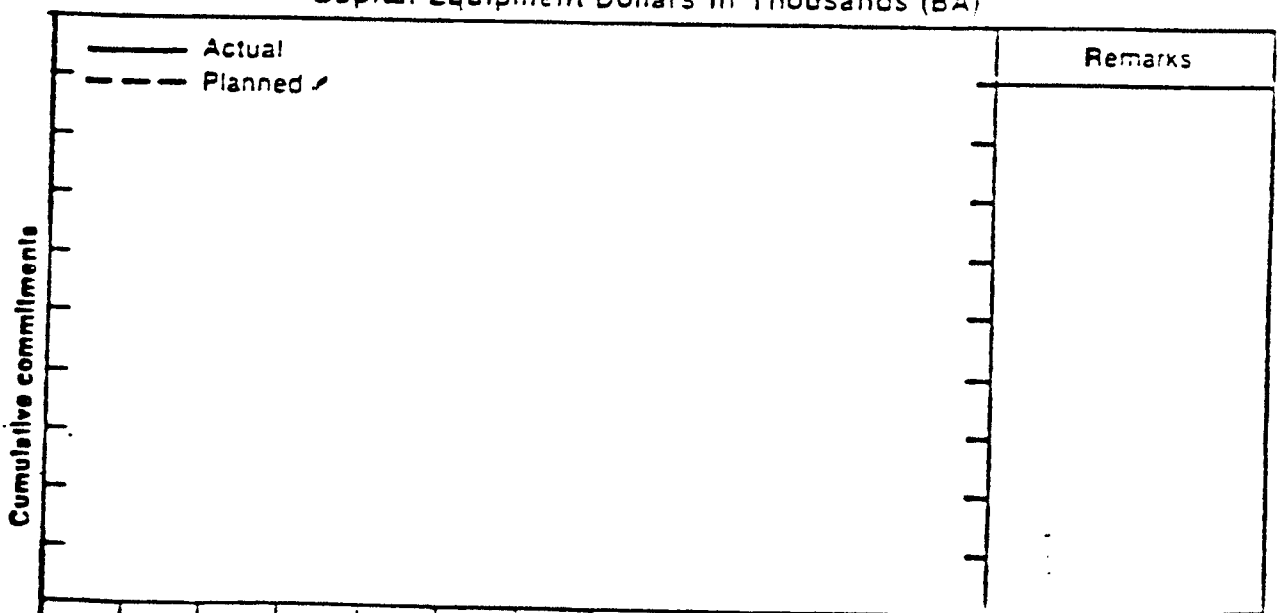
Operating Dollars in Thousands (BO)



	O	N	D	J	F	M	A	M	J	J	A	S	
Planned	23	46	70	94	117	126	147	169	191	235	279	323	
Actual	23	46	67	89	109	128	152						
Variance (over)	0	0	3	5	8	(2)	(5)						

Month

Capital Equipment Dollars in Thousands (BA)



	O	N	D	J	F	M	A	M	J	J	A	S	
Planned												40	
Actual													
Variance (over)													

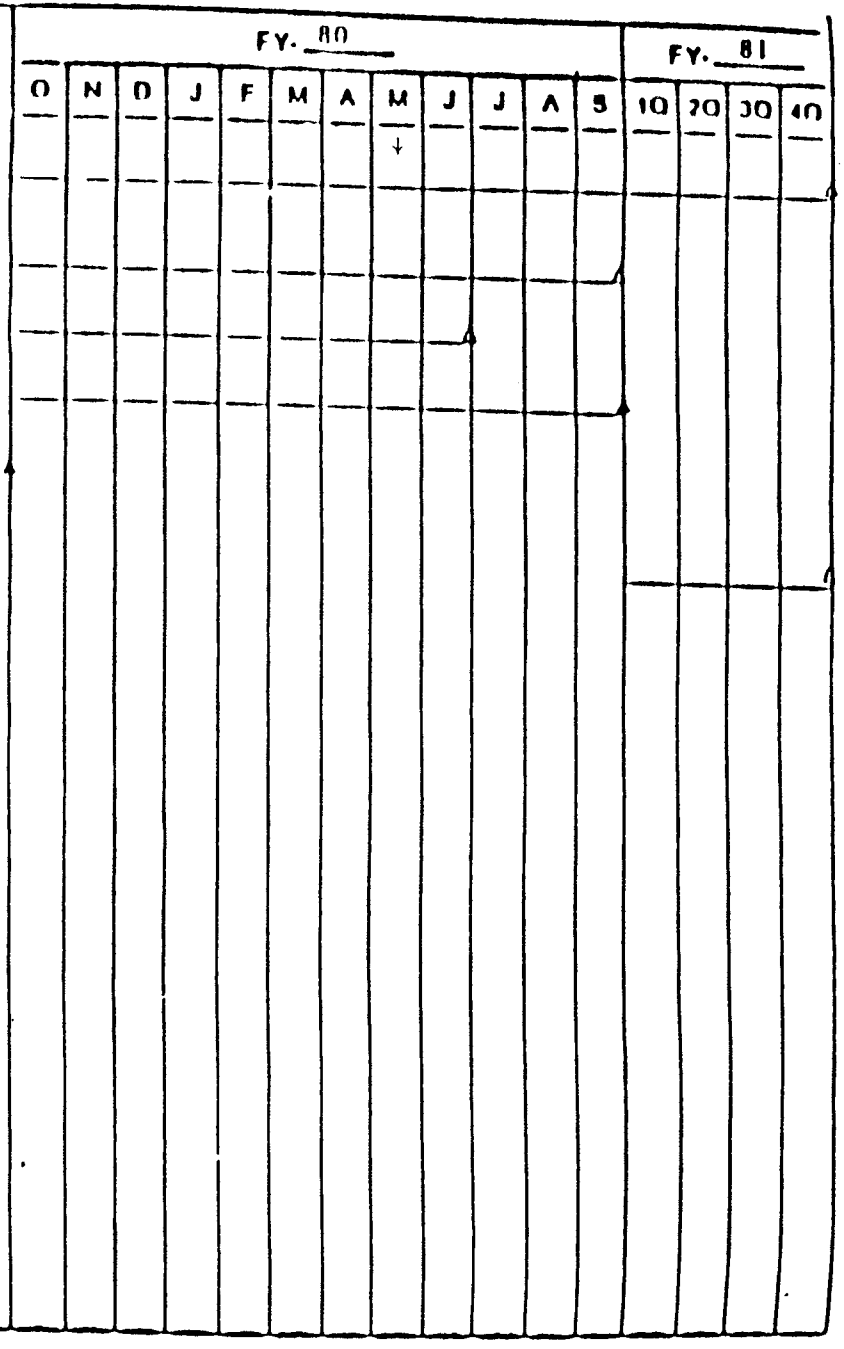
Milestone Schedule

Milestone No.	Milestone	FY. 80 O	N	D	J	F	M	A	M	J	J	A	S	FY. 81 1Q	2Q	3Q	4Q
1.1	Summary Report on Source Term								↓								
1.2	Field Sampling Completed																
2.1A	Summary Report on Hydrology																
2.1B	Summary Report on Geology																
2.2A	Feasibility of Coupling PNL/LASL Surface Models Determined																
2.2B	PNL/LASL Surface Models for TRU Adopted to LLW																

Solid Radioactive Waste Disposal Studies

BIFC No. AR-05-15-15

WEF No. 81 3 5 1



☆ Level 0 - Department Controlled Milestone

☆ Level 1 - LTW - Controlled Milestone

☆ Level 2 - LTW P - Controlled Milestone

△ Level 3 - Lead Field Office - Controlled Milestone

Level 4 - Other Milestones

- - - ◊ Scheduled Deviation for ☆ or △

——— Activity Line

↓ Time Now

PROGRAM STATUS REPORT

Title: Shallow Land Burial Technology

BR&C NO.: AR-05-15-15

FO/Contractor: AL/LASL

WBS NO.: AL 3.5.4

Manager: James G. Steger

Annual Budget: $400K

Principal Investigator: John W. Nyhan

Date: May 1980

Month Covered: April 1980

Task Description:

To improve the technology related to the shallow land burial of radioactive waste by examining radionuclide mobilization and migration mechanisms, by developing monitoring techniques around burial sites, by developing engineering methods to improve waste containment, and by the construction of an experimental engineered waste burial facility.

Highlights/Significant Accomplishments:

We have continued to process a group of 800 tuff samples collected under an old liquid waste disposal pit at LASL in an effort to examine radionuclide mobilization/migration mechanisms. About 260 of these samples are currently ready to be assayed using ATASS for transuranics and fission products previously added to these pits.

A major effort was expended in characterizing the ATASS system's sensitivity to plutonium using the plutonium in tuff standards. In order to determine the ATASS sensitivity to plutonium very precisely, we examined the influence of tuff sample homogenization on plutonium sensitivity. Five of the high concentration plutonium tuff standards were opened and thoroughly homogenized. Before the tuff samples were homogenized, approximately 1 to 2 grams of cold tuff was added to each of the samples to fill any void space within the sample which occurred from previous sample handling. All work was done under a hood, inside a paper lined 20" x 24" plastic photo tray.

After adding the cold tuff, the sample was placed on a 12" x 12" clean sheet of paper. Homogenization began by taking one corner of the paper, folding it over in the direction of the opposite corner, thus, mixing the sample in a rolling motion. This was done several times allowing a thorough blending of each sample. The samples were placed back in the containers, reweighed, resealed and wiped clean before recounting. An attempt to place all samples back into their original containers was made, however, in some cases, not possible. Samples one and two were placed in their original containers, samples three and four required new lids, and sample five was put in an entirely new container. The sensitivity data of the samples after homogenization is presented in Table I. Sensitivities ranged from 0.000920 to 0.001183. Table II shows the sensitivity from the same five samples before homogenization, which ranged from 0.001398 to 0.001845. A comparison of the data presented in these tables showed that the homogenization of the samples apparently resulted in a lower sensitivity with a lower variation. However, a statistical analysis of the sensitivity data was performed (Table III), which showed no significant statistical differences in sensitivities at the three sigma confidence level.

These preliminary results were so interesting, we decided to homogenize the rest of the plutonium tuff standards. The low and medium concentration plutonium tuff standards were opened, homogenized, resealed, and recounted. Tables IV, and V present sensitivity data of the standards before and after homogenization, with a statistical analysis of the sensitivity data in Table VI. In Experiment I the low concentration standards ranged from 0.0009233 to 0.001279, considerably lower than that of the same standards before homogenization, in which the sensitivities ranged from 0.002337 to 0.003140. After homogenization, not only were the sensitivities lower, but also the coefficient of variation was lower: 12.76% before homogenization and 11.36% after homogenization. In Experiment II the sensitivities were also quite a bit lower, ranging from 0.001126 to 0.001189, after homogenization

and 0.001794 to 0.002790 before homogenization. However, the coefficient of variation in this experiment was considerably lower than that of Experiment I before homogenization, 14.2% and 2.1% after homogenization. This clearly indicates that we must throughly homogenize the plutonium standards before establishing a count rate in order to determine concentrations of plutonium in soils.

In order to quantitatively assess the contribution of americium to the counts in the plutonium L x-ray region of the spectrum, we determined the ratios of the 59.537 keV ^{241}Am gamma ray to the americium L x-rays in the americium tuff standards (Tables VII, and VIII, and IX). This was determined by using least squares regression analysis of the L x-ray and americium gamma-ray counting data. Since the three L x-rays are in the same energy range as those emitted from plutonium, this calibration was necessary in order for us to assay for both americium and plutonium simultaneously. A regression analysis of the data is presented in Table IX, which shows that the y intercept values (^{241}Am L x-ray count rate) ranged from -.04707 to .07767 in experiment II, and -.02866 to .04106 in experiment III and also include a total of the three L x-ray count rates. In experiment II when the individual L x-ray count rates were used, slope values (L x-ray count rate/^{241}Am gamma ray count rate) ranged from .06113 to .05075, but when the total of the L x-rays was used as the y variable in the analysis, the slope had a value of .28005. In experiment III the values of the slope ranged from .06113 to .04954 for individual L x-rays and had a slope value of .2926. The standard error estimate of the y intercept ranged from .0511 to .1525 in experiment II and .04168 to .1688 in experiment III. The standard error of the regression coefficient estimate of the slope ranged from .00231 to .00702 in experiment II and .00172 to .00678 in experiment III, resulting in a variation cf slope estimates of only 2.12% to 3.62% in experiment II and 2.21% to 2.28% in experiment III. The latter observation shows that the americium L x-ray count rates can be estimated very accurately from the americium gamma-ray count rates.

Several other project-related accomplishments were made. John Umbarger of LASL Group H-1, who is responsible for developing the ATASS system in our project, gave a seminar on April 17, 1980 entitled "Instrumentation for low-level transuranic and radionuclide measurements applied to waste management and environmental monitoring programs." A final draft of the manuscript describing the ATASS system was completed and is currently undergoing typesetting.

A major effort was expended in planning for the design of our Experimental Engineered Waste Burial Facility (EEWBF). Gerald DePoorter (Engineer in Charge) and John Nyhan (Project Principal Investigator) visited several field burial operation sites throughout South Carolina and Tennessee (4/28 - 5/1) collecting information on how wastes were buried in the field and who was doing field research in this area. Scientists involved in this type of research were informed that we plan to hold a workshop to evaluate experiments to be performed at the LASL EEWBF in September and then wrote a short document about the EEWBF, which is also included in this month's report ("Design considerations and preliminary design for experimental waste burial facility" by G. L. DePoorter).

Budget Variance Analysis

None

Milestone Variance Analysis

None

Problems and Issues

- The method of using vanadium as a radionuclide mimic was suggested by John Umbarger, H-1, as probably the best means of studying accelerating weathering. We would like to investigate this, and an additional $90k for FY80 would be of considerable help.

Table I. Sensitivity Data of Plutonium Standards After Homogenization

Sample #	Count Time (Sec)	Total Counts (Area) C	Counts per sec	Calculated Concentration pCi/g	Actual Added Concentration pCi/g	Sensitivity Cps/pCi/g
PuH1H	9000	11257	1.25	382.290±3%	1057	.001183
PuH3H	9000	10325	1.15	346.208±3%	1071	.001074
PuH4H	9000	9909	1.10	331.890±3%	1060	.001038
PuH5H	10000	10806	1.08	323.060±3%	1071	.001008
PuH6H	10000	9675	.968	292.756±3%	1052	.000920

Table II. Sensitivity Data of Plutonium Standards Before Homgenization

Sample #	Count Time (Sec)	Total Counts (Area) C	Counts per sec	Calculated Concentration pCi/g	Actual Added Concentration pCi/g	Sensitivity Cps/pCi/g
PuH1	6000	12583	2.097	700.528±3%	1057	0.001984
PuH3	6000	11755	1.959	649.628±3%	1071	0.001829
PuH4	7000	12607	1.801	605.583±3%	1060	0.001699
PuH5	8000	11981	1.497	484.839±3%	1071	0.001398
PuH6	7000	13584	1.941	363.691±3%	1052	0.001845

Table III. Statistical Analysis of Plutonium Data Given in Table I and II Before and After Sample Homogenization

After Homogenization		
$\bar{x}$	S^a	CV^b
.001044	.0000960	9.19

Before Homogenization		
$\bar{x}$	S	CV
.001751	.000221	12.66

[a] Standard deviation

[b] Coefficient of variation ($s \times 100/\bar{x}$)

Table IV. Plutonium Low Standards Before and After Homogenization

Sample #	Count Time (Sec)	Total Counts (Area) C	Counts per sec	Calculated Concentration pCi/g	Actual Added Concentration pCi/g	Sensitivity Cps/pCi/g
PuL-1	15,000	2408	0.1605	55.47 ±4%	53.02	0.003027
PuL-2	16,000	2019	0.1261	43.667±5%	53.74	0.002346
PuL-3	15,000	2224	0.1482	50.989±5%	53.15	0.002788
PuL-4	16,000	1997	0.1248	43.672±5%	53.41	0.002337
PuL-5	15,000	2538	0.1692	62.012±5%	53.88	0.003140
PuL-6	16,000	3195	0.1371	46.155±4%	53.78	0.002549
PuL-1H	16,000	1044	.06525	22.022±7%	53.02	0.001230
PuL-2H	16,000	931	.05819	19.616±8%	53.74	0.001082
PuL-3H	16,000	906	.05819	15.670±9%	53.15	0.001094
PuL-4H	16,000	789	.04931	15.412±9%	53.41	0.00099233
PuL-5H	16,000	926	.05788	19.233±8%	53.88	0.001074
PuL-6H	16,000	1102	.0688	21.348±7%	53.78	0.001279

Table V. Plutonium Medium Standards Before and After Homogenization

Sample #	Count Time (Sec)	Total Counts (Area) C	Counts per sec	Calculated Concentration pCi/g	Actual Added Concentration pCi/g	Sensitivity Cps/pCi/g
PuM-1	13,000	9654	0.7426	194.912±3%	266.2	0.002790
PuM-2	12,000	7600	0.6333	224.809±3%	269.0	0.002354
PuM-3	12,000	7858	0.6548	236.039±3%	266.2	0.002460
PuM-4	14,000	6634	0.4738	162.322±3%	264.1	0.001794
PuM-5	12,000	7987	0.6658	236.282±3%	265.3	0.002509
PuM-6	11,000	7670	0.6972	244.141±3%	262.0	0.002661
PuM-1H	14,000	4433	.31664	99.363±3%	266.2	0.001189
PuM-2H	14,000	4240	.3028	94.999±4%	269.0	0.001126
PuM-3H	14,000	4364	.3117	99.875±5%	266.2	0.001171
PuM-4H	14,000	4220	.3014	96.479±3%	264.1	0.001141
PuM-5H	14,000	4380	.3128	93.239	265.3	0.001179
PuM-6H	14,000	4309	.3077	101.496	262.0	0.001175

Table VI. Statistical Analysis of Plutonium Tuff Standards Before and After Homogenization

EXPERIMENT I

$\tilde{x}$	S[a]	C.V.[b]
Before Homogenization		
0.002697	0.0003429	12.71%
After Homogenization		
0.001113	0.0001265	11.36%

EXPERIMENT II

$\tilde{x}$	S	C.V.
Before Homogenization		
0.002428	0.0003465	14.27%
After Homogenization		
0.001164	0.00002446	2.10%

[a] Standard Deviation

[b] Coefficient of Variation

Table VII. Count Rates of ^{241}Am Gamma-ray and L x-rays from Experiment II

Sample #	^{241}Am γ-ray Count rate (cps)	Lα x-ray Count rate (cps)	Lα x-ray ratio*	Lβ x-ray Count rate (cps)	Lβ x-ray ratio**	Lγ x-ray Count rate (cps)	Lγ x-ray ratio***	Total (cps)	Ratio
AML-1	2.170	.1233	.05685	.3160	.1456	.09700	.04470	.5363	.2471
AML-2	1.965	.1160	.05907	.3140	.1598	.09367	.04769	.5236	.2664
AML-3	2.270	.1431	.06321	.3729	.1642	.1140	.05028	.6303	.2776
AML-4	2.112	.1310	.06203	.3442	.1630	.1033	.04895	.5785	.2739
AML-5	2.161	.1515	.07013	.3971	.1837	.1095	.05071	.6581	.3045
AML-6	1.957	.1170	.05981	.3209	.1639	.1015	.05189	.5394	.2756
AMM-1	10.65	.6880	.06464	1.806	.1695	.5472	.05139	3.041	.2855
AMM-2	10.64	.6497	.06109	1.692	.1591	.5345	.05025	2.876	.2703
AMM-3	11.22	.5280	.04706	1.582	.1410	.5046	.04498	2.614	.2329
AMM-4	10.86	.5930	.05461	1.693	.1559	.5340	.04919	2.820	.2596
AMM-5	10.90	.6060	.05562	1.652	.1516	.5082	.04664	2.766	.2537
AMM-6	12.52	.5180	.04139	1.532	.1223	.4994	.03989	2.549	.2035
AMH-1									
AMH-2	38.08	2.278	.05984	6.092	.1600	1.837	.04826	10.20	.2678
AMH-3	37.17	2.632	.07082	6.479	.1743	1.974	.05313	11.08	.2980
AMH-4	37.24	2.242	.06020	5.942	.1595	1.811	.04864	9.995	.2683
AMH-5	37.78	2.569	.06803	6.589	.1745	2.042	.05405	11.20	.2964
AMH-6	40.07	2.287	.05708	6.260	.1562	1.944	.04852	10.49	.2617

* Lα x-ray cps/^{241}Am γ-ray cps

** Lβ x-ray cps/^{241}Am γ-ray cps

*** Lγ x-ray cps/^{241}Am γ-ray cps

Table VIII. Count Rates of ^{241}Am Gamma-ray and L X-rays from Experiment III

Sample #	^{241}Am γ-ray Count rate (cps)	Lα x-ray Count rate (cps)	Lα x-ray ratio*	Lβ x-ray Count rate (cps)	Lβ x-ray ratio**	Lγ x-ray Count rate (cps)	Lγ x-ray ratio***	Total (cps)	Ratio
AML-1	2.043	.1108	.05426	.3134	.1534	.0878	.04299	.5120	.2506
AML-2	1.905	.1113	.05848	.2972	.1560	.0874	.4591	.4949	.2603
AML-3	2.224	.1508	.06784	.3672	.1651	.1076	.04843	.6256	.2812
AML-4	2.208	.1246	.05647	.3472	.1572	.1050	.04757	.5768	.2612
AML-5	2.107	.1481	.07032	.3720	.1765	.1107	.05258	.6308	.2993
AML-6	1.876	.1091	.05821	.3043	.1622	.0869	.04728	.5003	.2666
AMM-1	10.73	.6662	.06211	1.751	.1632	.5242	.04888	2.941	.2740
AMM-2	10.38	.6612	.06373	1.757	.1694	.5445	.05247	2.962	.2853
AMM-3									
AMM-4	10.83	.5670	.05236	1.661	.1533	.5275	.04871	2.755	.2543
AMM-5	11.03	.6167	.05593	1.725	.1564	.5185	.04701	2.860	.2592
AMM-6	12.73	.5220	.04102	1.579	.1240	.5040	.03960	2.605	.2046
AMH-1	41.31	2.575	.06234	6.691	.1620	2.139	.05179	11.40	.2759
AMH-2	39.91	2.252	.05764	6.056	.1549	1.867	.04778	10.17	.2548
AMH-3	40.60	2.554	.06293	6.940	.1709	2.117	.05216	11.61	.2859
AMH-4	37.49	2.064	.05507	5.720	.1525	1.647	.04394	9.431	.2515
AMH-5	38.23	2.537	.06640	6.628	.1734	2.055	.05376	11.22	.2934
AMH-6	39.64	2.404	.06068	6.213	.1567	1.849	.04666	10.46	.2638

* Lα x-ray cps/^{241}Am γ-ray cps

** Lβ x-ray cps/^{241}Am γ-ray cps

*** Lγ x-ray cps/^{241}Am γ-ray cps

Table IX. Regression Analysis of ^{241}Am Tuff Standard Counting

Experiment II

y	x	y Intercept (L x-ray cps)	Slope (L x-ray cps/^{241}Am γ-ray cps)	Standard error of estimate of y on x (L x-ray cps)	Standard error of the regression coefficient estimate of the y intercept (L x-ray cps)	Standard error of the regression coefficient estimate of the slope (L x-ray cps/^{241}Am γ-ray cps)
Lα x-ray cps	^{241}Am γ-ray cps	-.04707	.06366	.1411	.05011	.00231
Lβ x-ray cps	^{241}Am γ-ray cps	.07767	.1657	.2264	.08041	.00370
Lγ x-ray cps	^{241}Am γ-ray cps	-.01969	.05075	.06597	.02343	.00108
Total L x-ray cps	^{241}Am γ-ray cps	-.1441	.28005	.4296	.1525	.00702

Experiment III

Lα x-ray cps	^{241}Am γ-ray cps	-.02866	.06113	.11576	.04168	.00172
Lβ x-ray cps	^{241}Am γ-ray cps	.04106	.16190	.24208	.08715	.00359
Lγ x-ray cps	^{241}Am γ-ray cps	-.01425	.04954	.09306	.03350	.00138
Total	^{241}Am γ-ray	-.09310	.2726	.4547	.1688	.00678

WASTE BURIAL FACILITY

by

Gerald L. DePoorter

The purpose of this report is to present design considerations for the experimental waste burial facility and to suggest a possible working design. A working design is needed so we can start negotiations to obtain the site to build the facility, start detailed engineering, do preliminary environmental monitoring of the chosen site, and plan and hold the design review with the contractors and other interested people in the low-level waste management community. Having a working design will enable us to be more specific on the experiments we want to do, which will also help in the planning. In other words, we have to start someplace, soon, or the facility will never meet the strict time schedule we now find ourselves under. This working design will be just that - something we can discuss and hopefully improve while some of the other things that must be done to build the facility can get started.

The basic approach I am taking is that the purpose of the experimental waste burial facility is to prove, on an appropriate scale, the effectiveness of some of the suggested solutions to problems that have been associated with shallow land burial, and to evaluate other improvements to shallow land burial. The results of experiments in the field will be used to support any suggested improvements.

POTENTIAL PROBLEMS WITH SHALLOW LAND BURIAL OF LOW-LEVEL RADIOACTIVE WASTE

There are several general problem areas associated with shallow land burial of low-level radioactive wastes. In general terms, besides improper operation, poor packaging, and intrusion there are problems associated with:

waste settlement,

the interaction of water with the wastes,

the generation of gases in the waste,

uptake of radioactive contamination by plants and animals.

The problem areas that are probably the most serious and are closely related to each other are waste settlement and interaction of water with the wastes. Water, either from surface infiltration or groundwater encroachment, can do two things. It can leach the waste, mobilizing the radioactive materials, and can lead to settlement of the fill and the waste. Settlement leads to cracking and deterioration in the cap material, which subsequently allows more water from the surface to infiltrate into the buried wastes. In the absence of water, the settlement problem could probably be overcome by careful packing of the fill material, by the use of containers when appropriate, and compaction of the waste forms prior to burial.

GENERAL WASTE MANAGEMENT PHILOSOPHIES

Since the primary mode of radioactive contamination from a properly operated low-level waste burial facilities has been through leaching and transport of radionuclides by water, waste management philosophies can be conveniently discussed in terms of the effects of water on the system. There are two ways to look at this: in terms of possible effluent from the burial facility and in terms of the possible modes by which water can get into the burial pit. The general waste management philosophies expressed in both terms are outlined in Table I.

Expressing the waste management philosophies in these two ways clarifies both the problems and the possible solutions. One expression is negative, i.e., solve the problem once it happens, and the other expression is positive, i.e., do what you can to prevent the problem in the first place. Since we are concerned with an experimental burial facility whose purpose is to demonstrate and substantiate new techniques, preventing problems is probably better than solving a problem once you have it. However, it is important that we keep both aspects in mind. We must think in terms of both preventing the problem and in terms of knowing what to do if the problem occurs.

The guaranteed 100% safe philosophy is unrealistic from a technical and cost viewpoint, but may have some political advantages. Planned dispersion, from a

general political point of view, is probably not acceptable. However, if recovery of transuranics from the burial pit by intruders is a concern, then this may not be a bad idea. State of the art containment is probably the best approach from all viewpoints. It is the most honest approach because it is probably impossible to guarantee 100% containment or absolute isolation from water under all conditions. By understanding migration properties, based on quantitative experimental results, this approach can also be made politically acceptable. This is consistent with the draft of 10 CRF part 61. State of the art containment combined with engineered channeling of the effluent is the waste management philosophy we shall use in the design of the experimental waste burial facility. However, provision will be made to work on either of the other two philosophies.

In looking at the problems described above and in trying to solve them, it is instructive to consider worst case conditions, guaranteed 100% secure conditions, and what I will call optimum conditions. Worst case conditions would be when the leaching is the fastest and contaminated leachate solution gets out of the pit into the surroundings. Whether this occurs with saturated or unsaturated conditions will be determined in our experiments. The worst case conditions are intolerable and will not be considered further. Guaranteed 100% safe conditions are when the burial pit is completely tight and no water gets into the pit and there is no pit effluent. As was the case with the guaranteed 100% safe waste management philosophy, the guaranteed 100% secure conditions are very difficult to achieve. The optimum conditions are when we recognize that water is going to get into the burial pit and engineer the pit so that the water getting into the pit goes where we determine it will, and if that is not completely successful, any effluent leaves through an engineered failure point. In designing the burial pit, we minimize the conditions under which surface infiltration or groundwater encroachment can occur.

SOLUTIONS TO POTENTIAL PROBLEMS WITH SHALLOW LAND BURIAL OF LOW-LEVEL RADIOACTIVE WASTE

Based on the literature, on the summaries of the literature by the subcontractors, and on discussions here at LASL and elsewhere, solutions to the above problems that are practical and cost effective can be proposed. Given the fact that we can not guarantee under all conceivable conditions that no water will get into the burial pit due to either surface infiltration or groundwater encroachment during the expected lifetime of the pit, we will design the experimental burial pit based on the following hypotheses

1. We can control the movement of any water that gets into the burial pit by an appropriate combination of liners and drain systems in the cap, walls, and bottom of the burial pit.
2. We know how the water will interact with the waste forms and how any leachate formed will interact with the fill material or the liner or cap.
3. We can collect and passively treat any leachate that forms.
4. We can channel, collect, and passively treat any gases that come from the burial pit.
5. The effects of waste settlement on cap integrity can be controlled by the design of the cap and waste placement.
6. The trench cap can be designed to prevent intrusion by burrowing animals and pick up of contamination by plants.
7. We can control the settlement of the waste and fill in the burial pit.

The purpose of the experimental waste burial facility will be to substantiate the above hypotheses and to prove under field conditions that some of the newer concepts for low-level shallow land burial are effective, practical, and reliable.

THE EXPERIMENTAL WASTE BURIAL FACILITY

The purposes of the experimental waste burial facility are listed in Table II. The items listed in the table are quite general, because the experimental facility

is intended to provide information useful for the disposal of both low-level radioactive wastes and hazardous chemical waste, which may be mixed with the radioactive waste in any environment.

Because of the complexity of the combination of hydrological, chemical, and mechanical aspects of waste burial, experiments should be carried out on at least three scales. These three scales and illustrative experiments for each scale are shown in Table III. The isolated variable experiments are designed to provide good experimental data on important phenomena on a field scale that can be directly applied to a full scale facility. Although the isolated variable experiments are quite chemical in nature, the intermediate scale experiments are designed to provide information on mechanical effects and on a combination of mechanical and chemical effects. The leachate-liner-fill interactions have both a mechanical and chemical nature while the gas channeling and collection and the burial pit drainage systems are more mechanical in nature. The integrated experiments will address such large scale mechanical problems as pit settlement, cap cracking, and the effects of the pit filling operation and backfilling and capping cn the liner and drain systems. The isolated variable experiments can best be done in a specialized pit design while the intermediate and integrated experiments should be done in burial pits that closely resemble actual burial facilities. Having near-full-scale burial pits that are capped will also be useful for experiments on the effects of burrowing animals and plant uptake of material from the pit.

The key to any of these experiments is the monitoring of what goes on in the buria pit in the field. To discuss this, we must consider what we will actually be putting into these experimental facilities, regardless of the scale. Some possiilities are listed in Table IV. To get the most information without problems related to putting radionuclides into the environment, the use of nonradioactive waste forms combined with mimics for some of the radioactive elements such as plutonium is probably the best way to go. By not using radioactive materials, more options are available relative to waste forms, placement methods, and possible leach solutions.

EXPERIMENTAL BURIAL PITS FOR ISOLATED VARIABLE STUDIES

A possible experimental burial pit is shown conceptually in Figure 1. Plan and side views are shown in the top of the figure, and a detail drawing of the experiment cluster is shown in the bottom of the figure. The heart of the experimental pit is the experiment cluster, which consists of six experimental caissons clustered around a central access and instrument caisson. The insturment and access caisson should be about 9 to 10 ft (about 3 m) in diameter. The experimental caissons can be any size up to the same size as the central caisson or can be larger if used in place of two smaller caissons, depending on what experiments are done in each one. The access caisson will allow samples to be taken in a horizontal direction in any of the experimental caissons at any elevation and without disturbing the surface of the caisson or allowing access by water to the packing material in the vertical direction. Each caisson will be instrumented to provide the information indicated in Table I.

This design philosophy for the experimental burial pit was taken for the following reasons. The use of multiple experimental caissons arourd a central instrument and access caisson will allow a large number of separate experiments per pit. The caissons provide isolation of the experimental areas and also prevent the horizontal influx of water, allowing more precise control of the environment in each of the experimental areas.

The individual caissons give a large degree of flexibility in the experiments that can be performed. Any type of fill material can be used in these caissons. The arrangement of the experiment clusters in the experimental pit is only a suggestion. The relatively large distance is left between them so that not all of the clusters have to be installed at once. The experiment clusters could be arranged in a hexagonal array similar to the arrangement of the experimental clusters themselves. Further input and discussion is probably necessary before the final arrangement can be decided.

This arrangement will also be a good way to evaluate design, emplacement procedures, and operation of the instruments that will be required to monitor the burial

pits. This information will be used for the instrumentation of the intermediate and full scale burial pits.

Burial Pits for Intermediate Scale and Integrated Experiments

Scaling factors that can be used to extrapolate and compare for the design of full scale burial pits must be obtained from these experiments. Therefore, intermediate scale burial pits and full scale burial pits must also be included in the facility. Although the chemical effects on the liners can be determined in the experimental pits, the mechanical effects on the liners such as the effects of filling the pits and settling of the material in the pits must be determined in the intermediate or full scale burial pit.

The term full scale is probably a bit misleading. To me, full scale means about the same depth and width as an actual pit, but probably no longer than about 50 ft. It is probably good enough just to have the length equal to or greater than the width of the burial pit.

The intermediate scale burial pits will have instrument and access caissons by them, as will the pits for the isolated variable studies. For this scale experiment, it will be useful to be able to sample on a horizontal plane without providing vertical access from the surface of the pit.

To summarize, the experimental waste burial facility should consist of experimental burial pits, intermediate size burial pits, and full scale burial pits. The basic information will be obtained from the experimental pits on leachate chemistry, leachate-liner interactions, effect of biological activity on leachate mobility, and the effects of waste form on the leachate. Some of the mechanical variables related to gas collection and channeling and burial pit drainage systems will be evaluated in the intermediate scale burial pits. The more mechanical parameters such as cap performance and liner performance will be determined in the full scale pits.

PRELIMINARY DESIGN FOR THE EXPERIMENTAL WASTE BURIAL FACILITY

A possible physical layout for the experimental waste burial facility is shown in Figure 2. This consists of experiment clusters, intermediate scale burial pits, and full scale burial pits. The general experiments that would be done in this facility are listed in Table V. These experiments would test the hypotheses described earlier. In addition to testing these hypotheses, this facility would allow for many other types of experiments that wil lead to a better understanding of the phenomena that occur in burial pits, either for low-level radioactive waste or hazardous waste.

Explicit details of these experiments have been left out here. These details can be added after more discussion here in the group and in discussions with others and after the design conference to be held with the contractors and others. The purpose now is to decide on a particular general plan for the facility so that the planning and detailed engineering can begin. Also, cost estimates must be made in order to see how much we can do with the money we have available. We also need to find a site for the facility here at LASL, start the preliminary tests, and determine the environmental impact of the facility.

TABLE I. GENERAL WASTE MANAGEMENT PHILOSOPHIES

GRARANTEED 100% SAFE

Engineer waste disposal facility so that all hazardous materials are kept in the burial pit.

or

Engineer waste disposal facility so that water cannot reach the emplaced waste thereby eliminating the possibility of contaminants being mobilized. Water from waste degradation will be channeled, collected, and passively treated.

STATE OF THE ART CONTAINMENT COMBINED WITH ENGINEERED CHANNELING OF THE EFFLUENT

Use disposal practices based on sound experimental evidence combined with suitable engineering so that the effluent can be collected and properly passively treated.

or

Recognize that some water is going to get into the burial pit. Design the pit so that this water is diverted and collected before it can reach the emplaced wastes. As a backup, engineer the system so that if effluent is formed, it can be collected and properly treated with a passive system.

PLANNED DISPERSION TO PREVENT FUTURE ACCESS BY INTRUDERS

Allows for leaching of hazardous materials and disperses these materials in a controlled manner to the immediate environment of the burial pit.

or

Provides specific access channels for the water so that the leaching can be controlled to disperse the hazardous materials as desired.

TABLE II. GENERAL PURPOSES OF EXPERIMENTAL WASTE BURIAL FACILITY

TEST METHODS FOR CONSTRUCTING AND OPERATING WASTE DISPOSAL FACILITIES

- Evaluate Burial Pit Design
  - Determine need for liners.
  - Evaluate burial pit liner systems, if needed.
  - Evaluate burial pit cap systems.
  - Evaluate backfill materials.
  - Evaluate burial pit drain systems.
- Evaluate Burial Pit Operations
  - Test burial procedures.
  - Test different waste forms.
  - Test placement methods.

DEVELOP AND TEST MONITORING SYSTEMS TO MEASURE BURIAL PIT PERFORMANCE

- Measure infiltration rate of water into the burial pit.
- Measure leach rate and leachate composition in burial pit.
- Measure water and leachate movement out of the burial pit.
- Measure gas generation, movement, and composition in the burial pit.
- Measure movement of solids in the burial pit.
- Monitor heat flow into and out of the burial pit.
- Measure evaporation and transpiration of water from the pit.

CONTROL CLIMATIC CONDITIONS AT THE BURIAL PIT

- Simulate rainfall.
- Simulate freeze-thaw cycles in the caps.
- Control evaporation and transportation.

DETERMINE EFFECT OF BIOLOGICAL ACTIVITY ON MATERIAL CONTAINED IN THE BURIAL PIT

DETERMINE SCALING FACTORS TO BE USED IN BURIAL PIT DESIGN

TABLE III. TYPES OF EXPERIMENTS TO DETERMINE BURIAL PIT PERFORMANCE

ISOLATED VARIABLE EXPERIMENTS

1. Interaction of infiltrating solutions with the waste forms and the transport of these solutions through the compacted fill.
2. Chemical and hydrological effects of leachate solutions on liner materials.

INTERMEDIATE SCALE EXPERIMENTS

3. Gas channeling and collection.
4. Burial pit drainage systems.
5. Leachate-liner-fill interactions.

INTEGRATED EXPERIMENTS

6. Total effects of liner systems.
7. Total effects of cap systems.

TABLE IV. WHAT WILL BE PLACED IN THE EXPERIMENTAL BURIAL PITS?

SIMULATED WASTE

Non-radioactive.
Non-radioactive plus tracers.
Non-radioactive plus mimics.

ACTUAL WASTES

Low-level radioactive waste.
Hazardous chemical waste.

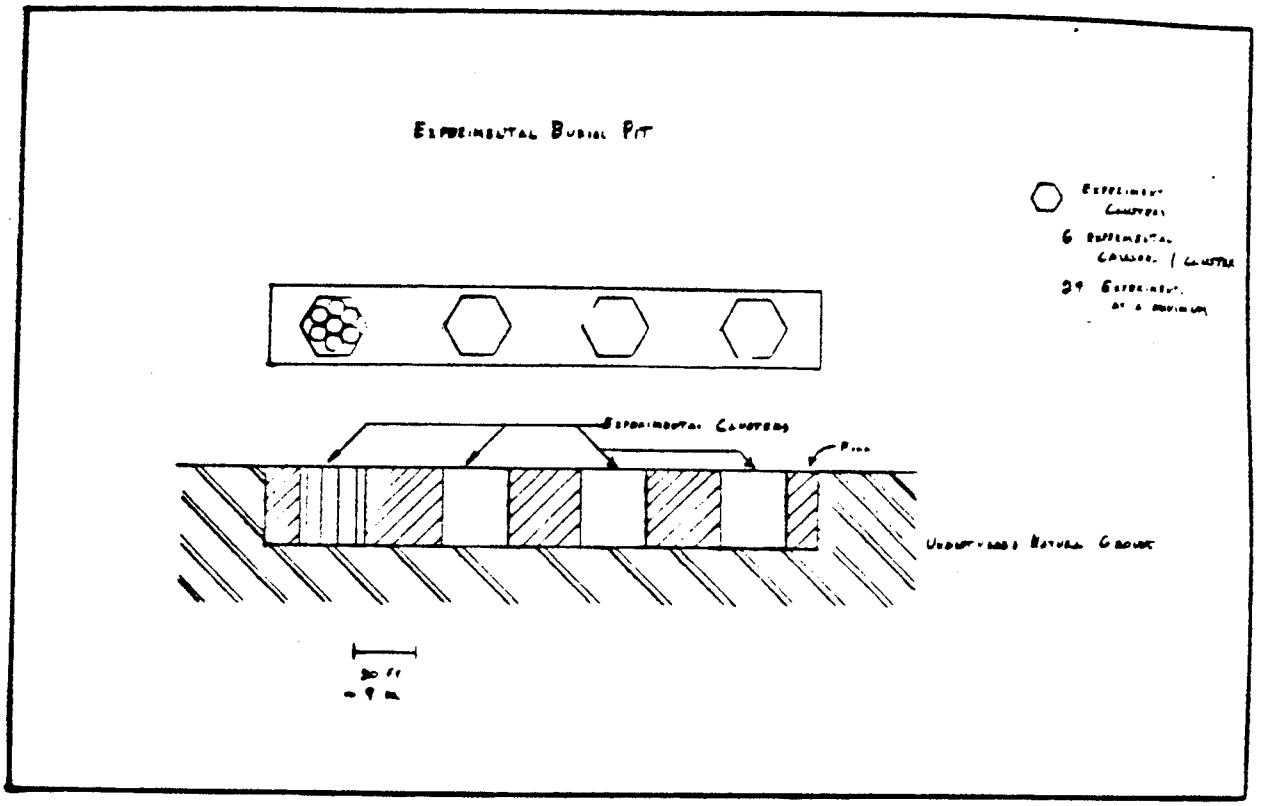
NOTE:

To get the most and best information from the experimental burial pit, simulated waste is probably the best to use. For analytical purposes, tracers would be useful, but probably not necessary. If the burial pits are to be stressed, that is, made to leak, it probably would be best not to leak too much radioactive material into the environment.

TABLE V. SUMMARY OF INITIAL EXPERIMENTS AND THEIR SCALE

EXPERIMENT	EXPERIMENT SCALE		
	EXPERIMENTAL	INTERMEDIATE	FULL SCALE
Leachate interaction with waste forms and liners	X	X	
Leachate collection and treatment	X	X	
Water movement in and surrounding pit	X	X	
Effect of waste settlement on cap integrity			X
Burrowing animal intrusion and plant uptake of contaminants			X
Total effects of drain system and liners			X
Gas channeling and collection		X	
Effects of microbiological activity on mobility of waste forms	X	X	

FIGURE 1. EXPERIMENTAL BURIAL PIT



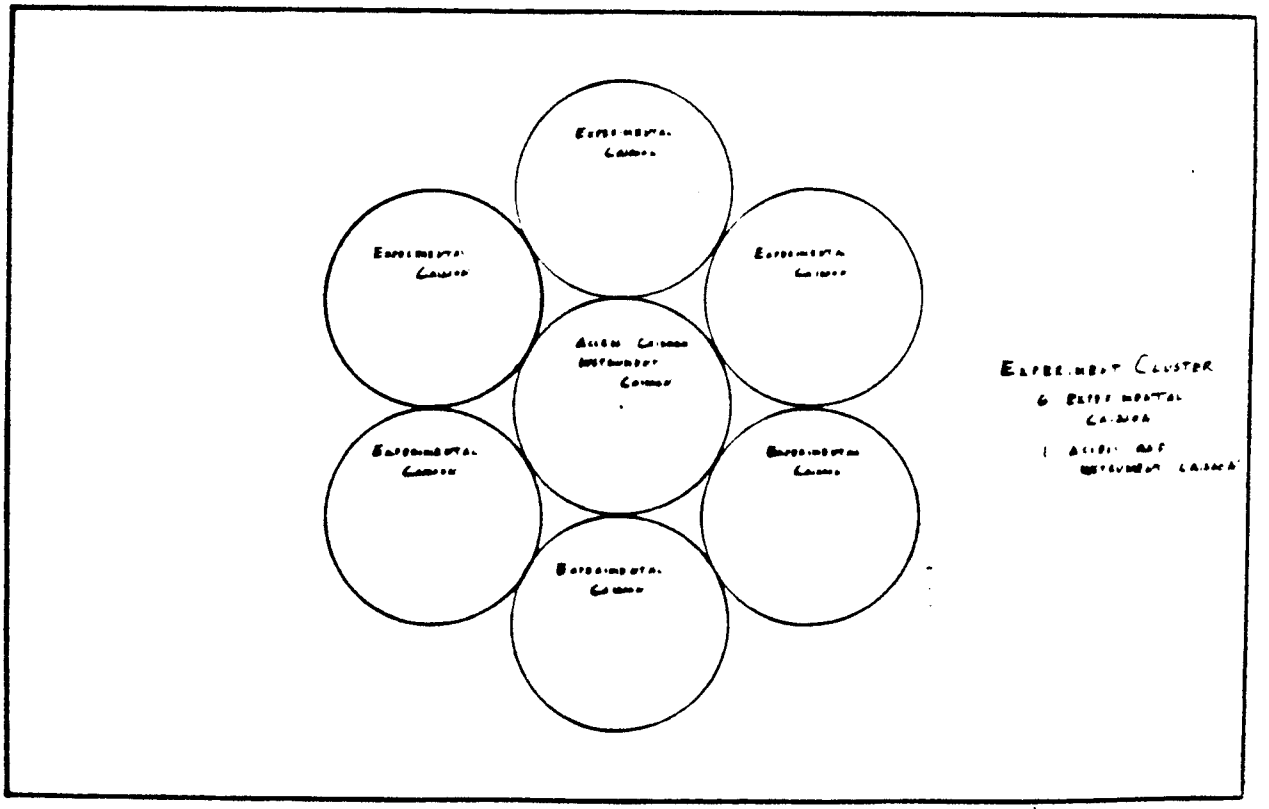
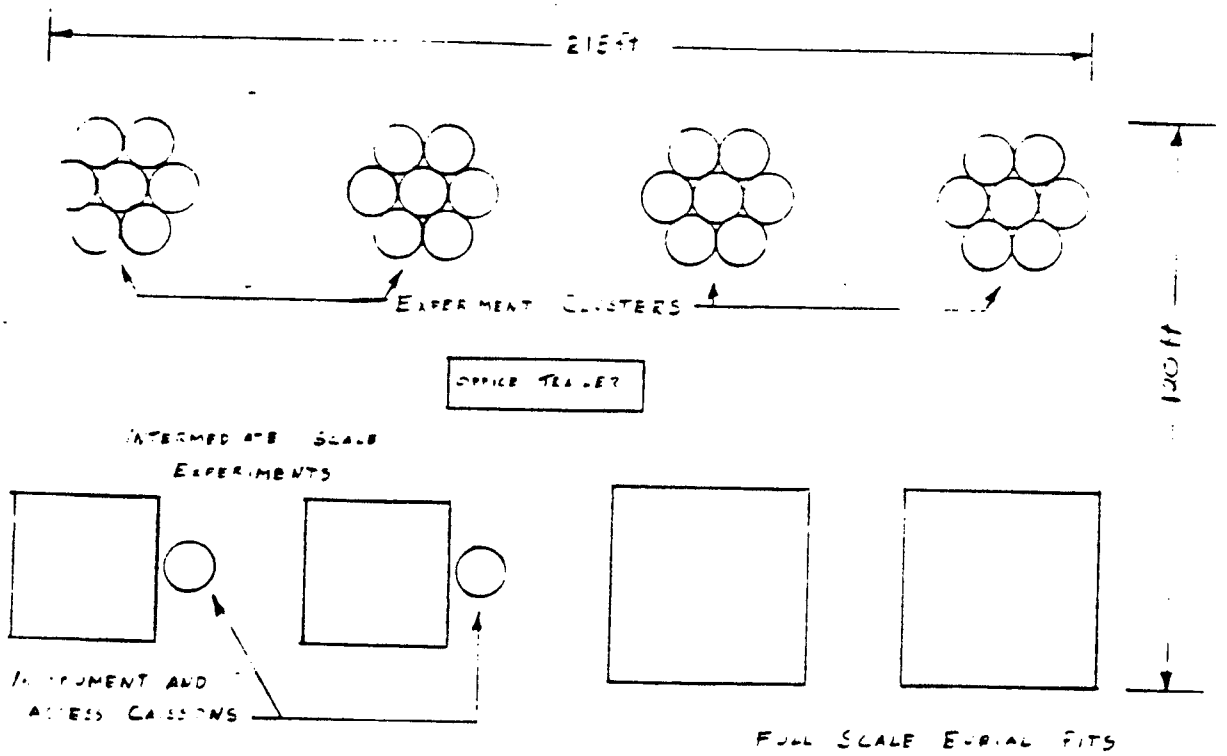


FIGURE 2. PRELIMINARY DESIGN FOR EXPERIMENTAL WASTE BURIAL FACILITY



EXPERIMENTAL WASTE BURIAL FACILITY

PHASE I 26,000 SQ FT 0.6 ACRE

POSSIBLE VARIATIONS

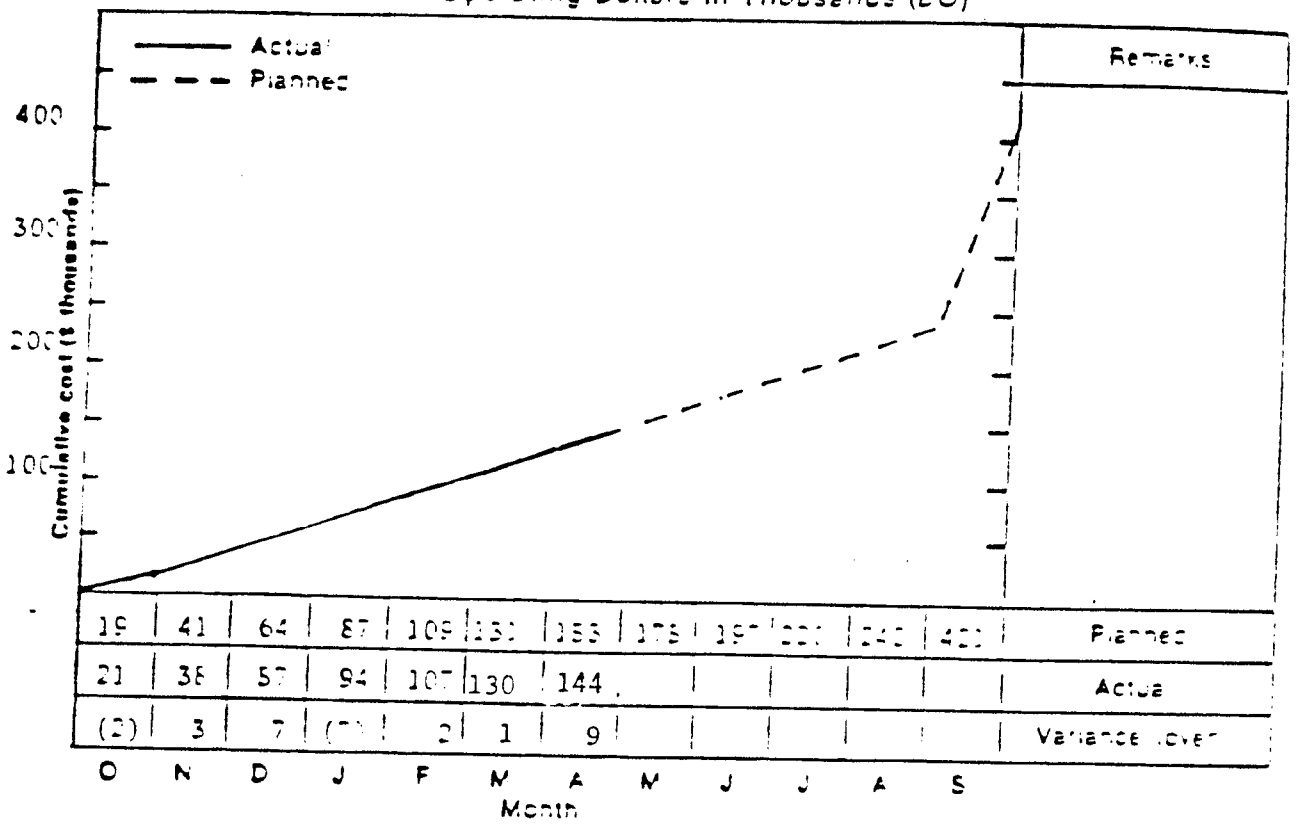
A. 3 EXPT CLUSTERS, 3 INT SCALE, 2 FULL SCALE

B 2 EXPT CLUSTERS, 4 INT SCALE 2 FULL SCALE

Title Shallow Land Burial Technology B&RC No. AF 05-15-15

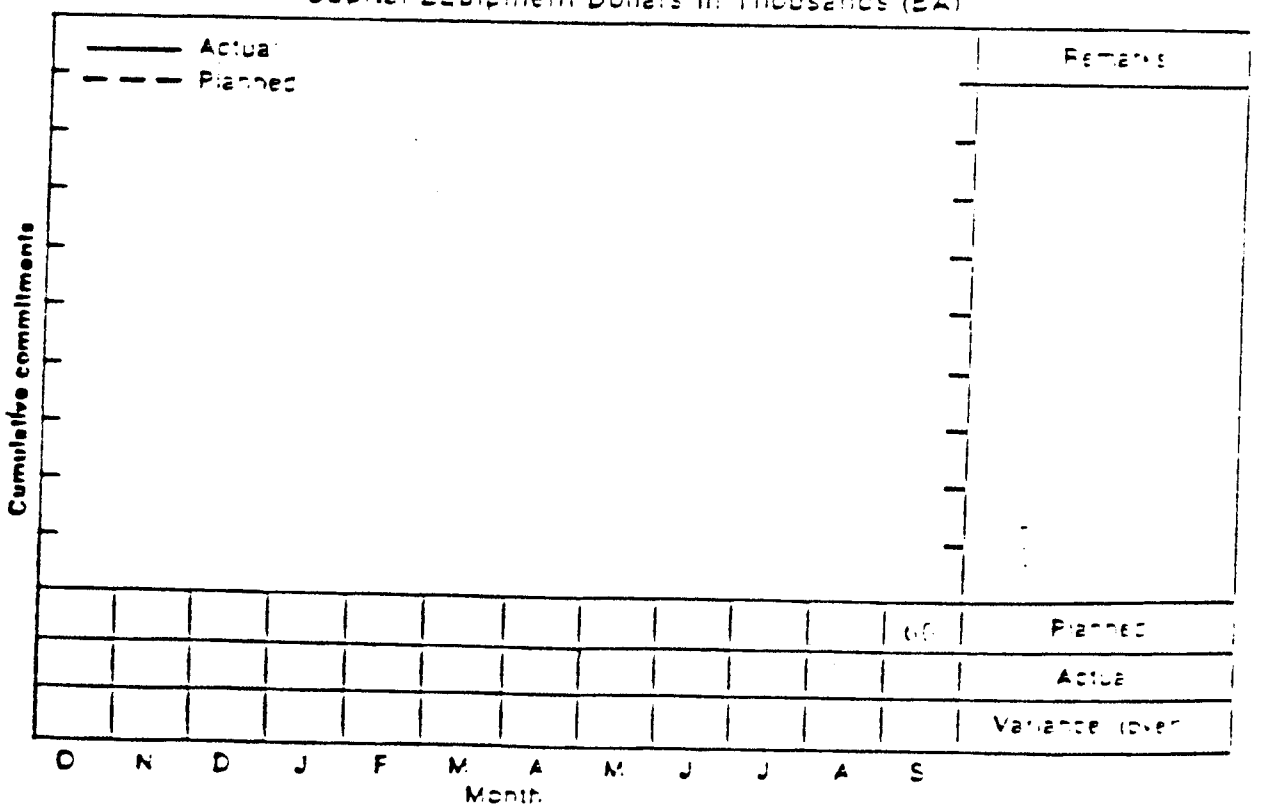
FO/Contractor AL/LASL FY 80 WEF No AL 3.5.4

Operating Dollars in Thousands (BO)



	O	N	D	J	F	M	A	M	J	J	A	S	
Planned	19	41	64	87	109	131	153	175	197	221	242	421	
Actual	21	38	57	94	107	130	144						
Variance (over)	(2)	3	7	(7)	2	1	9						

Capital Equipment Dollars in Thousands (EA)



	O	N	D	J	F	M	A	M	J	J	A	S	
Planned												68	
Actual													
Variance (over)													

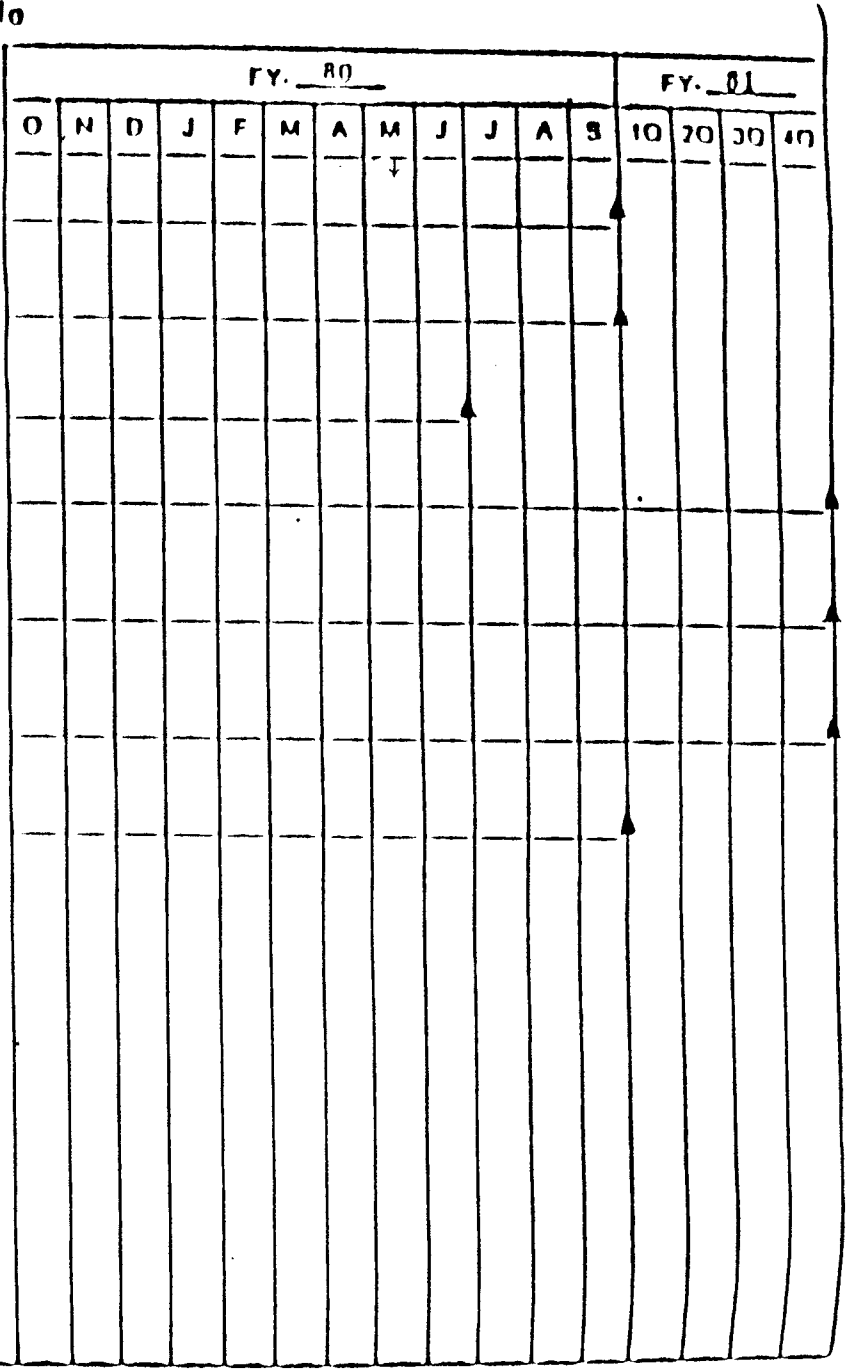
Milestone Schedule

Milestone No.	Milestone	FY. 80 O	N	D	J	F	M	A	M	J	J	A	S	FY. 81 1Q	2Q	3Q	4Q
1	Evaluation of manmade barriers.																
3	Literature survey on influence of waste materials & environmental factors on engineered barriers.																
6	Analysis of tuff samples collected under a previously-used liquid radioactive waste disposal bed.																
7	Technology & modeling of water flow through unsaturated materials.																
8	Completion of LASL lab studies on saturated and unsaturated flow of radioactive waste solutions in tuff.																
9	Report on NMSU lab studies on stable element solute retention by soils & tuff.																
12	Development of neutron activation tracers & field equipment for monitoring tracer migration.																

Shallow Land Burial Technology

BLRC No. AR-05-15-15

WEP No. AL 3.5.4



Level 0 - Department Controlled Milestone

Level 1 - E1W - Controlled Milestone

Level 2 - E1W P - Controlled Milestone

Scheduled Deviation for ☆ or △

Activity Line

Time Now

PROGRAM STATUS REPORT

Title: Alternative Systems Study

BR&C NO.: AR-05-15-15

FO/Contractor: AL/LASL

WEP NO.: AL 3.10.1

Manager: James G. Steger

Annual Budget: $300k

Principal Investigator: Merlin Wheeler

Date: May 1980

Month Covered: April 1980

Task Description:

The overall goals of the proposed work are to gather information pertinent to analyzing Alternative Disposal Methods and to generate a management plan for a program to evaluate selected alternatives to shallow land burial for the disposal of low level radioactive waste. The work will be structured so as to take maximum advantage of all applicable ongoing and proposed work within DOE and other organizations. In particular, close cooperation will be sought between this work and the High Level Waste disposal work coordinated by ONWI.

Highlights/Significant Accomplishments:

Data on characteristics of both commercial and DOE LLW have been compiled, describing major waste types, radionuclide types and concentrations, and relative volumes. The dominant mechanisms leading to the environmental release of radionuclides from the various disposal alternatives have been described. In concert, this information is being used to analyze the specific reasons why alternative disposal concepts may be required.

Discussions with ONWI have identified several areas of mutual advantage. In addition to the direct benefits to LLW of the geologic disposal investigations,

common interest exists regarding sea bed disposal, modeling, licensing requirements, and state interactions. Possible areas of common interest may also exist between the LLW and the TRU program.

Budget Variance:

None

Milestone Variance:

None

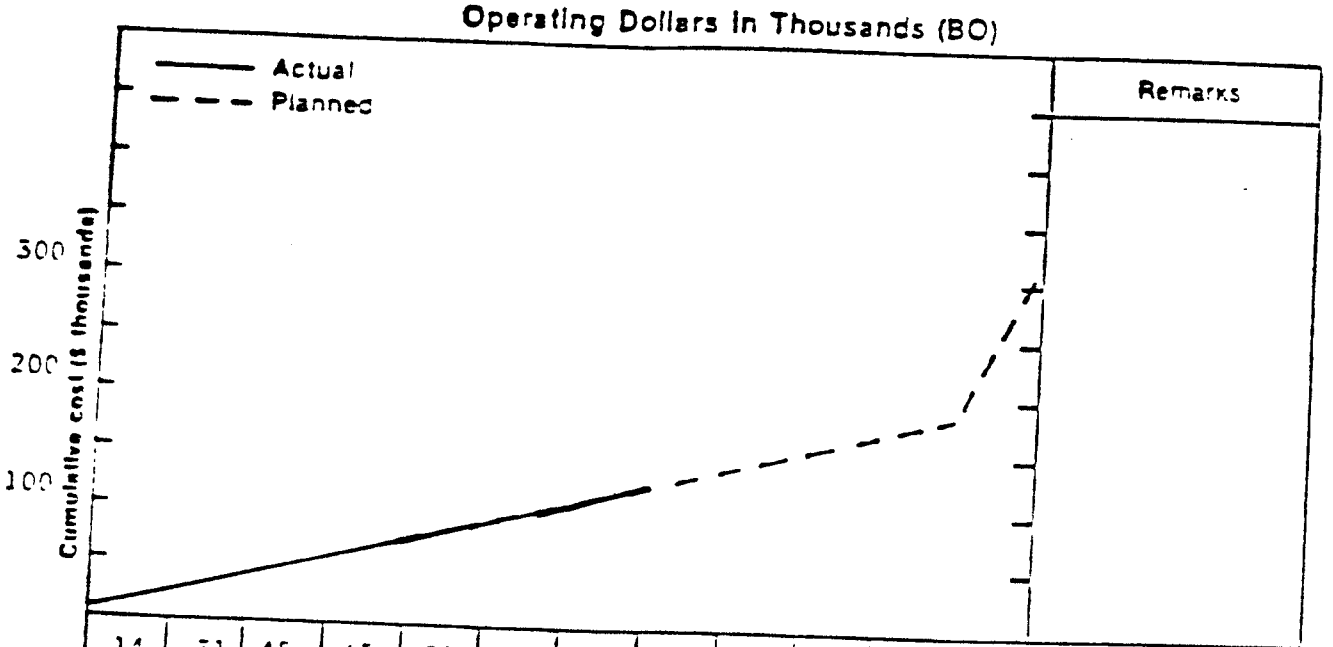
Problems and Issues:

None

Title Alternative Systems Study B&RC No. AP 05-15-15

FO/Contractor AL/LASL FY 80 WEP No. AL 3.10.1

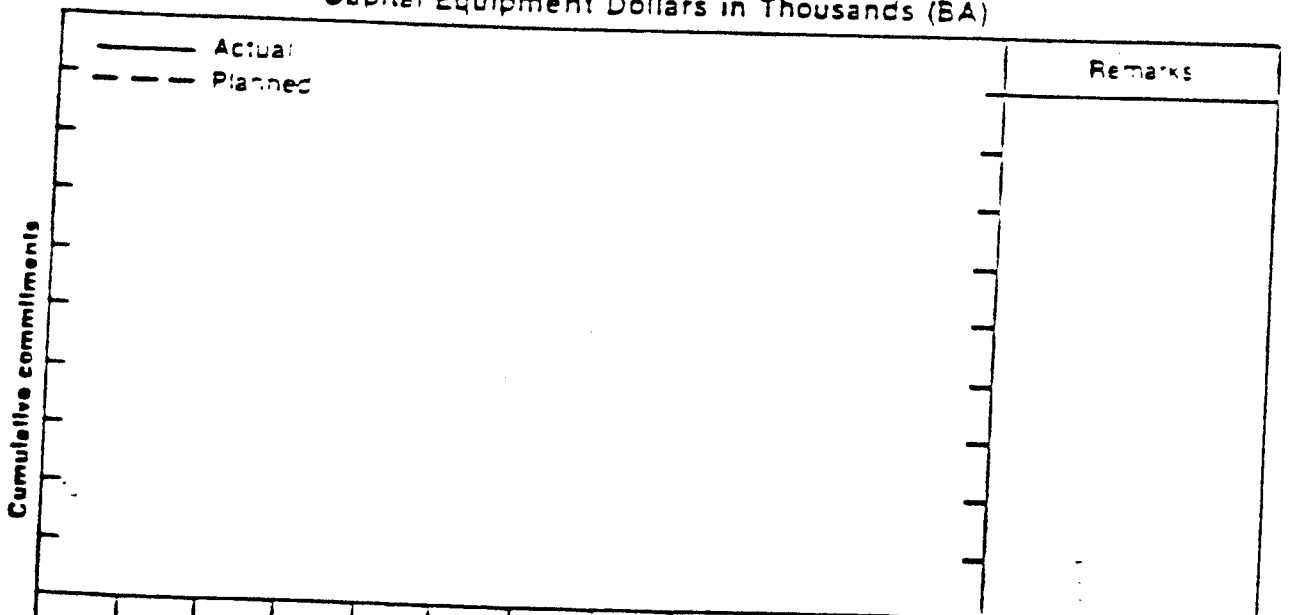
Operating Dollars in Thousands (BO)



	O	N	D	J	F	M	A	M	J	J	A	S	
Planned	14	31	48	65	82	99	115	132	150	166	183	318	
Actual	16	29	43	71	81	99	114						
Variance (over)	(2	2	5	(6)	1	0	1						

Month

Capital Equipment Dollars in Thousands (BA)

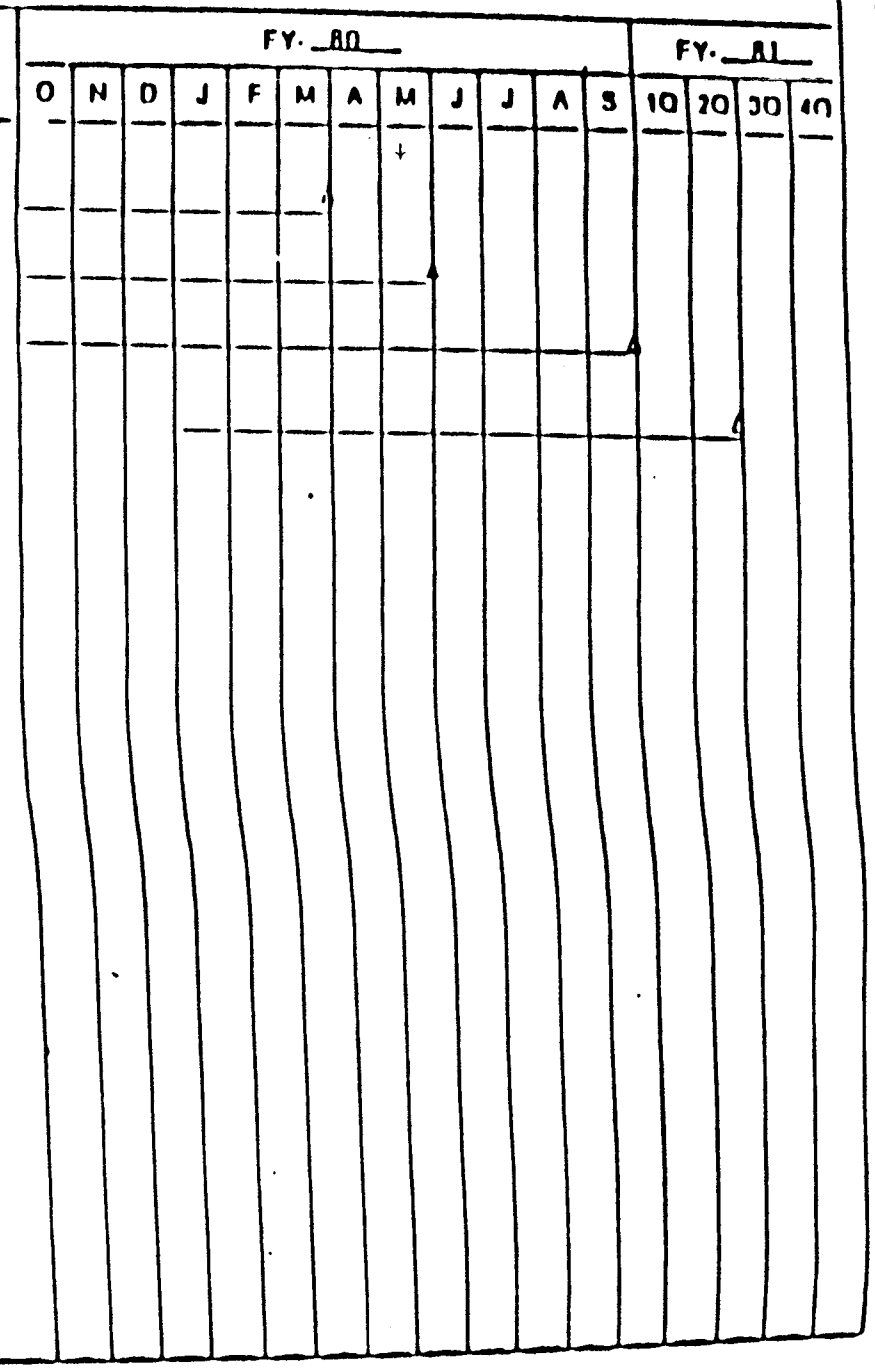


	O	N	D	J	F	M	A	M	J	J	A	S	
Planned												0	
Actual													
Variance (over)													

Month

Milestone Schedule

Milestone No.	Milestone	FY 80 O	N	D	J	F	M	A	M	J	J	A	S	FY 81 1Q	2Q	3Q	4Q
1.	Input waste characterized																
2.	Alternative Options Catalogued																
3.	Report on assessment of technical issues																
4.	Issue Development Plan																



Level 0 - Department Controlled Milestone
Level 1 - ETW - Controlled Milestone
Level 2 - ETW P - Controlled Milestone

Scheduled Deviation for ☆ or △
Activity Line
Time Now

Alternative Systems Study

BADC No. AR-05-15-15
WEP No. AL 3.10.1

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