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RADIOLOGICAL SURVEY FOLLOWING DECONTAMINATION ACTIVITIES NEAR THE TA-45 SITE

by

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ABSTRACT

Three areas at the site of a former radioactive liquid waste treatment plant at Los Alamos National Laboratory were decontaminated during 1982 by Bechtel Corporation, with health physics support provided by Eberline Instrument Corporation, under the Department of Energy's Formerly Utilized Sites Remedial Action Program (FUSRAP). Before decontamination, there were above-background concentrations of gross alpha, gross beta, ^{238}Pu, $^{239,240}Pu$, ^{241}Am, ^{90}Sr, and ^{137}Cs in the surface soils. These combined concentrations were above operational decontamination guidelines for surface soil contamination. After cleanup operations, radionuclide concentrations in surface soils at all three sites were within decontamination guidelines.

I. INTRODUCTION

This evaluation of current radiological conditions at the site of a former radioactive liquid waste treatment plant [Technical Area 45 (TA-45)] at Los Alamos National Laboratory is based on analyses of soil samples taken from TA-45. The study was undertaken to supplement the Formerly Utilized Sites Remedial Action Program (FUSRAP) sponsored by the U.S. Department of Energy (DOE). FUSRAP is designed to evaluate the public health aspects of and need for remedial action at sites used by the former U.S. Army Corps of Engineers Manhattan Engineer District (MED) and U.S. Atomic Energy Commission (AEC).

II. BACKGROUND

Liquid radioactive wastes were generated by research with nuclear materials at Los Alamos, New Mexico, for the World War II MED atomic bomb project starting in 1943 and, subsequently, by work conducted for the AEC. Untreated effluents were discharged into Acid Canyon from 1944 until 1951. A treatment plant at TA-45 was constructed on the rim of Acid Canyon (Fig. 1) and discharged treated effluents from 1951 until 1964.

The radioactive liquid waste treatment plant was decommissioned in late 1966, and decontamination work in Acid Canyon continued into 1967. By June 1967, the treatment plant site and Acid Canyon were deemed sufficiently free of contamination to be released from AEC control without restriction. The treatment plant site, Acid Canyon, and part of Pueblo Canyon were transferred to Los Alamos County by quitclaim deed on July 1, 1967. Radiation surveys during the period of use and after decommissioning and decontamination indicated that there were some low-level residual contaminants, especially in the water-runoff channels. These have been monitored over the years as part of the routine environmental surveillance programs conducted by the Los Alamos National Laboratory (ESG 1982).

Early in 1976, the Energy Research and Development Administration (ERDA) identified Acid and Pueblo Canyons and the site of the former radioactive liquid waste treatment plant above Acid Canyon in Los Alamos as locations once used in, or affected by, operations of the U.S. Army MED and/or AEC. The areas were subsequently resurveyed in 1976-77 for residual contamination as part of FUSRAP under the auspices of ERDA and its successor agency, DOE (ESG 1981).

Under FUSRAP, Bechtel Corporation, with health physics support provided by Eberline Instrument Corporation, decontaminated an untreated radioactive waste-line discharge area southwest of the former TA-45 site during July, August, and October 1982 (Figs. 1, 2, and 3). In August and November of 1982, the Los Alamos National Laboratory's Environmental Surveillance Group (H-8) surveyed these decontaminated areas for above-background radionuclide soil concentrations to document postdecontamination conditions.

At the time of the cleanup (July, August, and October 1982), soil guidelines covering decontamination at FUSRAP sites had not been issued. To provide an operational framework for this decontamination, soil guidelines for the Acid and Pueblo Canyons cleanup project were used [(FBD 1981) and (Ferenbaugh 1982)]. These guidelines are listed in Table I.

In March 1983, general guidelines governing above-background concentrations of radionuclides in soils at the FUSRAP sites were published by the DOE (ORO 1983). These "FUSRAP guidelines," listed in Table II, are approximately the same as those in Table I. The $^{238}U/^{234}U$ limit of 40 pCi/g (Table I) differs from the natural uranium FUSRAP limit of 75 pCi/g (Table II). The

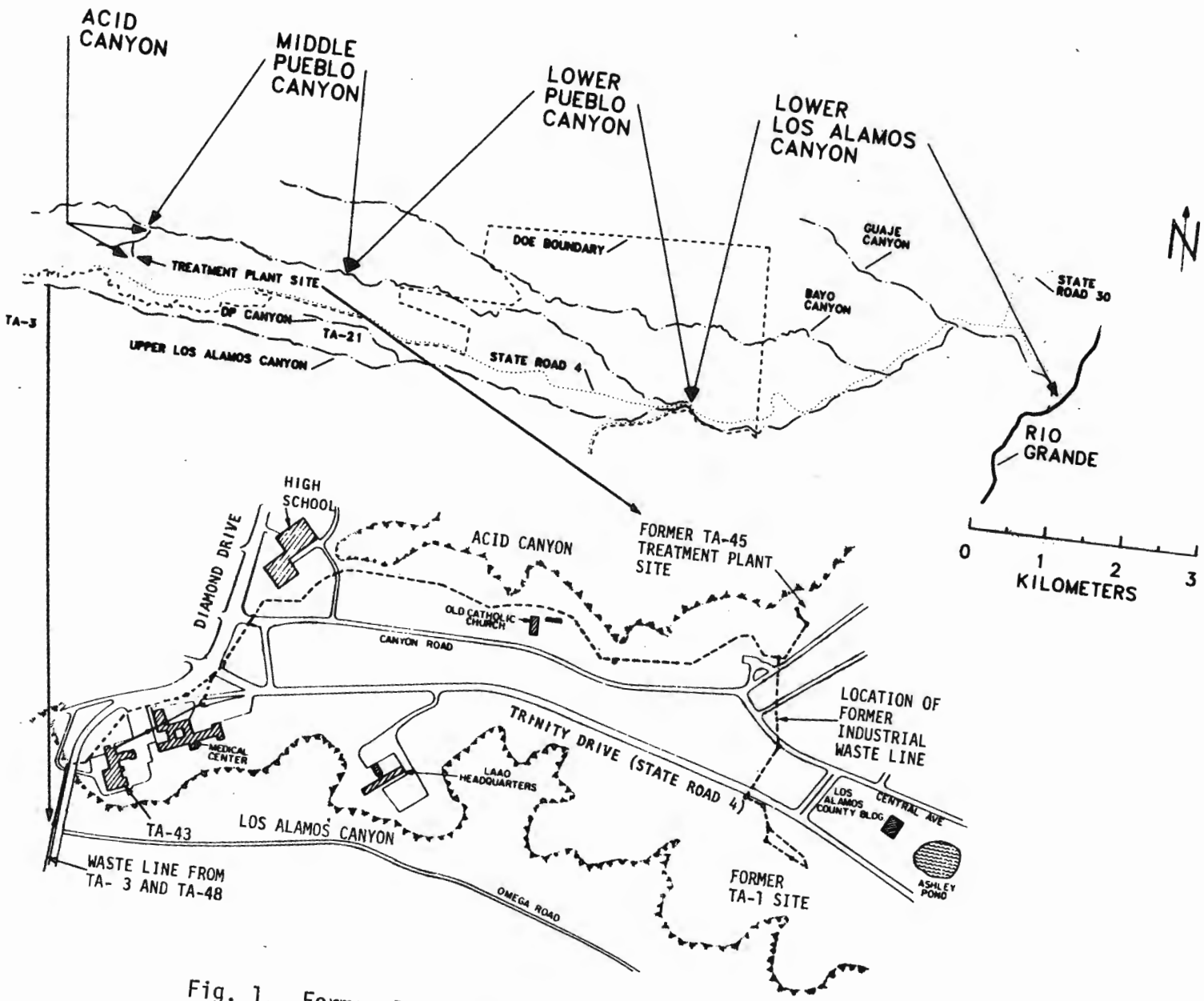

Fig. 1. Former liquid waste-handling facilities and relation to effluent receiving canyons.

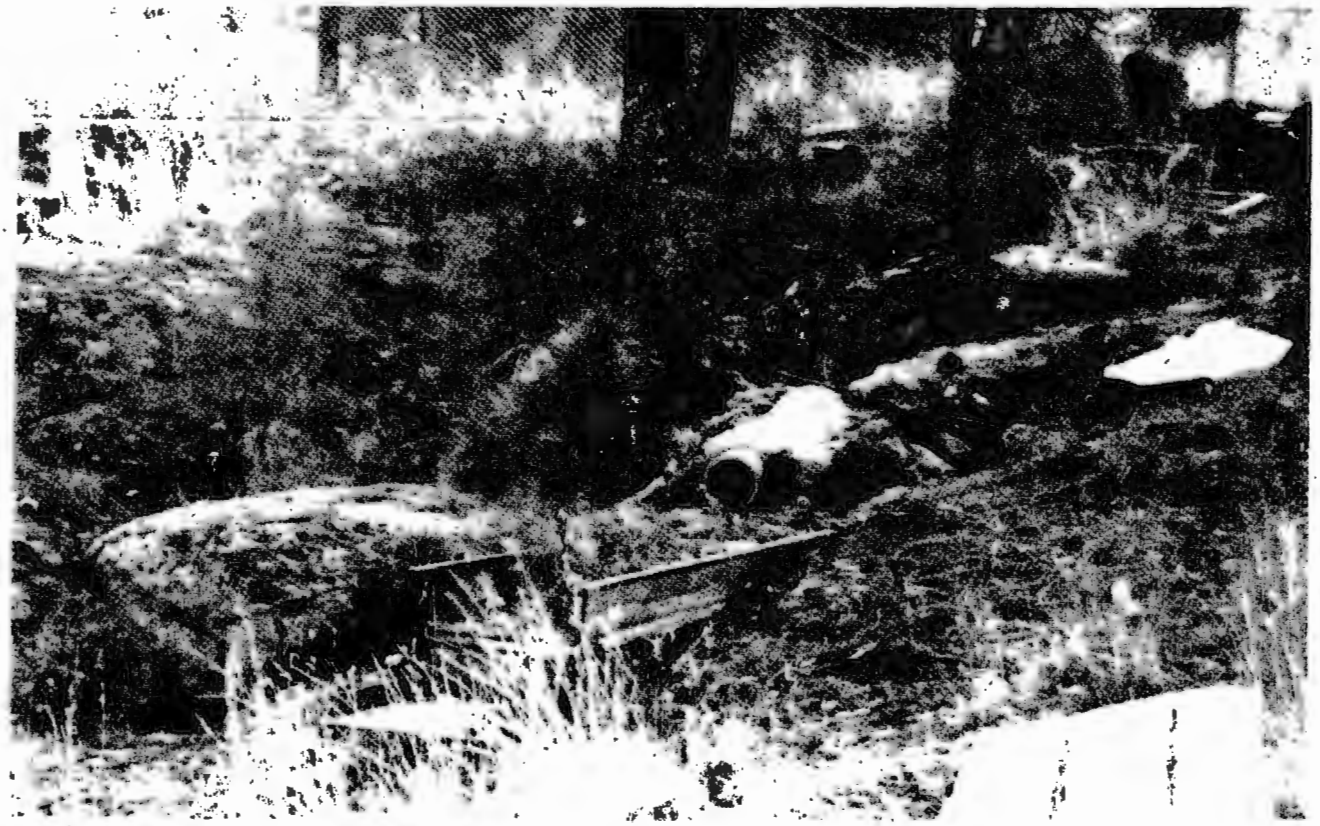

Fig. 2. Untreated radioactive waste-line discharge point.

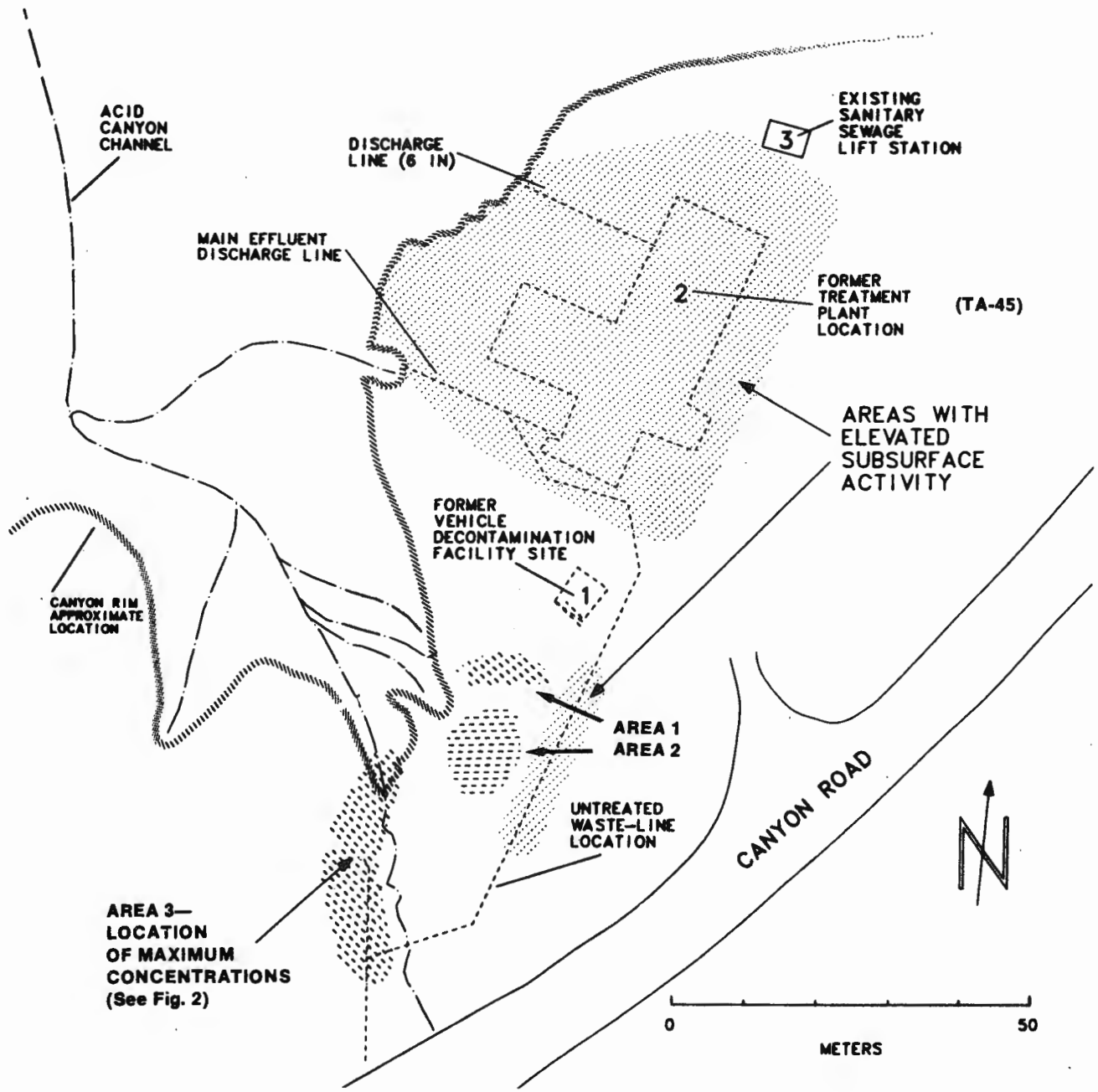

Fig. 3. Locations of Areas 1, 2, and 3 in vicinity of former liquid waste-handling facility (TA-45).

TABLE I

PROPOSED CRITERIA FOR SOIL CLEANUP ACTION

Radionuclide	Concentration (pCi/g above background)
^{241}Am	20
^{239}Pu	100
^{238}Pu	100
$^{238}U/^{239}U$	40
^{232}Th	20
^{230}Th	280
^{228}Th	50
^{137}Cs	80
^{90}Sr	100

TABLE II

SURFACE SOIL FUSRAP GUIDELINES
(ORO 1983 and Gilbert 1983)

Radionuclide	Radionuclide Soil Guideline (RSG) (pCi/g above background)
^{241}Am[a]	20
^{241}Pu[a]	800
$^{239,240}Pu$[a]	100
^{238}Pu[a]	100
Natural uranium[b]	75
^{238}U[b]	75
^{230}Th[b]	300
^{226}Ra[b]	15
^{137}Cs[a]	80
^{90}Sr[a]	100
^{3}H (pCi/mℓ) soil moisture[a]	5200

[a]These guidelines are based on radiation exposure from a 100- by 100-m contamination area. The guidelines are the average radionuclide concentrations from the 100- by 100-m area.

[b]Guidelines for the radionuclides in the ^{238}U decay series are based on the assumption that a 140- by 140- by 1.5-m homogeneous waste field is exposed at the ground surface. The guidelines are the average radionuclide concentrations from the 140- by 140- by 1.5-m area.

40 pCi/g limit refers only to the ^{238}U, but the ^{238}U is assumed to be in equilibrium with ^{234}U (Healy 1979). If both the ^{238}U and ^{234}U were to be included in the limit, it would be 80 pCi/g (40 pCi/g of ^{238}U and 40 pCi/g of ^{234}U), which is approximately the same as the 75 pCi/g FUSRAP guideline.

We decided to use the more general FUSRAP guidelines (Table II) in this report, even though they only became available after the cleanup was completed. These guidelines will also be applied at other FUSRAP sites. The two sets of soil guidelines are approximately the same numerically, but the FUSRAP limits differ from the previous guidelines, because they specify the area over which radionuclide concentrations can be averaged. The previous guidelines did not fix the area size but left this as a decision for the on-site health physics management.

Survey results reported here have been evaluated to determine if radionuclide concentrations in soil, after decontamination, conform to these FUSRAP guidelines. In these surveys, the soil was not sampled in the 100- by 100-m area specified in the FUSRAP guidelines but was done only in the zones designated for decontamination and in the immediately surrounding areas. The reason for this difference in the sizes of the areas sampled is that, as previously indicated, sampling was performed several months before the final FUSRAP guidelines were available. In addition, the previous FUSRAP survey showed that above-background radionuclide soil concentrations were minimal outside the areas designated for cleanup (ESG 1981). Radionuclide soil concentrations averaged over the designated areas are higher than those averaged over a larger 100- by 100-m area, so application of the FUSRAP guidelines to these smaller areas is conservative.

III. SURFACE SOIL REMEDIAL ACTION GUIDELINES AND CONDITIONS BEFORE DECONTAMINATION

The guidelines for cleaning up residual contamination at FUSRAP sites are in two DOE reports [(ORO 1983) and (Gilbert 1983)]. Table II gives these FUSRAP guidelines for surface soil contamination, which apply to soil samples averaged over a 100- by 100-m area. The guideline in Table II for each radionuclide applies if that radionuclide is the only one at above-background concentratrations. If more than one radionuclide is present, the guideline requires that the sum of the ratios of the soil concentration (C_i) of each radionuclide (i) to the radionuclide soil guideline (RSG_i) must be less than 1, that is,

$$\Sigma\ [(C_i)/(RSG_i)]\ .$$

The predominant radionuclides that were released in the effluent from TA-45 were ^{3}H, ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{238}Pu, $^{239,240}Pu$ (ESG 1981) and trace amounts of ^{241}Pu (a beta-emitting radionuclide that is important because it decays into ^{241}Am). Radionuclide soil concentrations before cleanup have been reported previously (ESG 1981). When the procedure for applying the FUSRAP guidelines to several radionuclides was used, we found that the FUSRAP guidelines were exceeded by these reported concentrations. The most contaminated area (Area 3, see Fig. 3) was approximately 325 times the FUSRAP ratio guideline. [This number is probably an overestimate, because the sampling program described in ESG 1981 was not specifically designed for application of the FUSRAP guidelines, which were published several years after the original sampling took place. Also, inclusion of uncontaminated areas in the Area 3 sampling to cover a 100- by 100-m area would lower the overall average concentrations. However, almost certainly, the FUSRAP guideline would still have been exceeded in this area.]

IV. SURVEY RESULTS AND COMPARISON WITH SOIL CLEANUP GUIDELINES

Group H-8 conducted a radiological surface soil survey on 16 August 1982 of the untreated radioactive waste-line discharge area (Fig. 4). This first survey was conducted after the initial decontamination by Bechtel and Eberline Corporations. Surface soil samples were collected from three areas (Fig. 4) where Bechtel and Eberline had removed contaminated soil. The soil samples were counted for gross-alpha and gross-beta activities, which were used in screening high-level samples. Because of their relatively long half-lives and their dosimetric importance, analyses for ^{90}Sr, ^{137}Cs, ^{238}Pu, $^{239,240}Pu$, and ^{241}Am were done on selected soil samples using radiochemistry techniques (ESG 1982).

Results of this first survey after cleanup are shown in Table III. Radionuclide concentrations were greatly reduced as a result of the decontamination program. Several samples with high gross-alpha readings also had elevated $^{239,240}Pu$ and ^{241}Am concentrations. Samples with no detectable above-background gross-alpha activity also had relatively low levels of ^{238}Pu, $^{239,240}Pu$, and ^{241}Am. This correlation confirmed the usefulness of the gross-alpha procedure in screening soil samples to determine which samples had relatively higher levels of radioactivity; it also agreed with past experience at Los Alamos National Laboratory (ESG 1981). Four of the $^{239,240}Pu$ samples exceeded the 100-pCi/g FUSRAP guideline; however, the average $^{239,240}Pu$ concentration was determined by averaging soil concentrations separately, over Areas 1, 2, and 3, to approximate the 100- by 100-m areal average procedure, and this concentration was below the FUSRAP guideline.

Summing the ratios of each radionuclide soil concentration to the respective RSG checked for compliance with the FUSRAP ratio guideline of 1. Soil concentrations of ^{241}Pu, ^{234}U, and ^{235}U (which were not measured in this

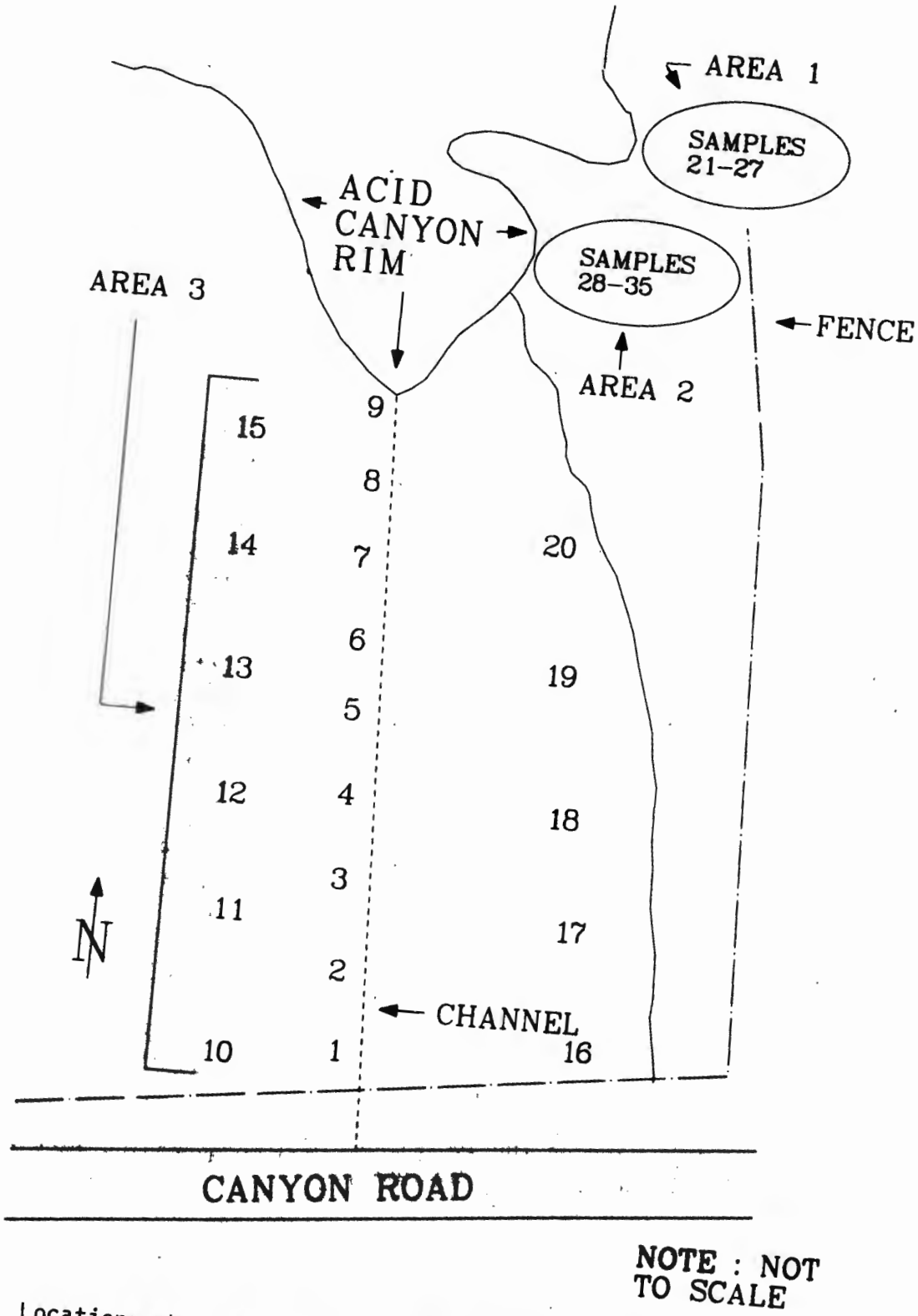

Fig. 4. Locations where surface soil samples were taken on 16 August 1982 radiological survey.

TABLE III

RESULTS OF RADIOLOGICAL SURFACE SOIL SURVEY DONE ON AUGUST 16, 1982

Sample Number (Fig. 4)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	^{238}Pu (pCi/g)	$^{239,240}Pu$ (pCi/g)	^{241}Am (pCi/g)	^{90}Sr (pCi/g)	^{137}Cs (pCi/g)
Minimum Detectable Limit	25	8	0.002	0.002	0.01	0.01	0.01
				AREA 3			
Typical Background[a]	10 ± 13		0.003 ± 0.007	0.028 ± 0.058	-	0.29 ± 0.33	0.44 ± 0.89
1	-	-					
2	-	-	0.001 ± 0.002	0.23 ± 0.02	0.5 ± 0.2		0.003 ± 0.001
3	-	-	0.004 ± 0.004	0.48 ± 0.04	0.7 ± 0.2		0.003 ± 0.001
4	-	-					
5	-	-					
6	-	-					
7	230 ± 40	-	0.51 ± 0.06	133 ± 12	8.2 ± 0.4		0.04 ± 0.009
8	270 ± 60	-	0.47 ± 0.04	130 ± 6	4.5 ± 0.3		0.004 ± 0.001
9	230 ± 60	-	0.52 ± 0.04	120 ± 6	2.8 ± 0.2		0.002 ± 0.001
10	-	-					
11	-	-					
12	-	-					
13	-	-					
14	400 ± 70	-	0.32 ± 0.03	77 ± 4	2.2 ± 0.2		0.004 ± 0.001
15	-	-					
16	-	-					
17	-	-					
18	-	-					
19	-	-					
20	-	-					
				AREA 1			
21	-	-					
22	-	-					
23	-	-					
24	-	-					
25	-	-					
26	-	-					
27	-	-					
				AREA 2			
28	-	212 ± 12				88 ± 6	17 ± 1
29	-	258 ± 14				101 ± 8	5.3 ± 0.5
30	-	106 ± 10				46 ± 4	5.5 ± 0.4
31	-	106 ± 10				59 ± 4	3.5 ± 0.3
32	-	60 ± 10				26 ± 1	2.0 ± 0.3
33	-	212 ± 12					
34	-	-					
35	-	-					

[a]Reference ESG 1982, p. 135. Typical background radionuclide concentrations in soils are averages of samples taken at six regional sampling locations in northern and central New Mexico during 1981.

Notes: (1) Gross-beta counting system was only calibrated for ^{90}Sr.
(2) Results reported with ± two standard deviations.
(3) - Means sample activity was less than the minimum detectable limit. No entry means no analysis was made on the sample.
(4) The ^{238}Pu, $^{239,240}Pu$, ^{241}Am, ^{90}Sr, and ^{137}Cs analyses were done using chemical dissolution and instrumental counting techniques. The gross-alpha and gross-beta analyses were counted with ZnS and plastic scintillator counting systems, respectively, on dried soil samples.

survey) were estimated from radionuclide activity ratios based on other soil sampling results (ESG 1981). The sum of the ratios for Area 3 was 0.4 ± 0.2. No above-background radioactivity was detected in Area 1. The sum of the ratios for Area 2 was 0.6 ± 0.1. However, this area had a relatively small size.

To further clean up isolated hot spots in Area 3, Bechtel and Eberline conducted a second decontamination effort during October 1982. On 1 November 1982, Group H-8 did a second radiological survey of the untreated radioactive waste-line discharge area (Fig. 5).

Results of the resurvey in Table IV and Fig. 5 show that of 34 surface soil samples taken in the untreated radioactive waste-line discharge area, 5 samples (410-, 120-, 410-, 100-, and 120-pCi/g gross alpha) were above the 100-pCi/g FUSRAP guideline for $^{239,240}Pu$ (assuming that the majority of the alpha activity came from $^{239,240}Pu$). Again, this 100-pCi/g FUSRAP guideline refers to the average $^{239,240}Pu$ concentration in surface soil from a 100- by 100-m area. The average of all 34 samples was 60-pCi/g gross alpha, which is less than the 100-pCi/g FUSRAP guideline. (The gross-alpha measurement, which is a crude field-screening technique, overestimates alpha activity. From Table III, we see that the gross-alpha measurement tends to be approximately double the total alpha activity in the sample.)

The ratio $\Sigma(C_i)/(RSG_i)$ was calculated again and compared with the FUSRAP ratio guidelines of 1. Radionuclide soil concentrations were calculated from the measured gross-alpha results and the previously measured radionuclide concentrations. The ratios were summed at 0.3 ± 0.2, indicating that the second cleanup reduced the radionuclide concentrations in soil. Because of the uncertainties involved in the analyses, this reduction was not significant statistically. Nevertheless, the radionuclide concentrations were still below the FUSRAP guidelines.

V. SUMMARY

Three areas at the site of a former radioactive liquid waste treatment plant (TA-45) were decontaminated during 1982 by Bechtel Corporation, with health physics support provided by Eberline Instrument Corporation, under the DOE's FUSRAP activity. Before decontamination, there were above-background concentrations of gross alpha, gross beta, ^{238}Pu, $^{239,240}Pu$, ^{241}Am, ^{90}Sr, and ^{137}Cs in the surface soils. The combination of these concentrations was above the FUSRAP guidelines for surface soil contamination. After cleanup operations, radionuclide concentrations in surface soils at all three sites were within the FUSRAP decontamination guidelines.

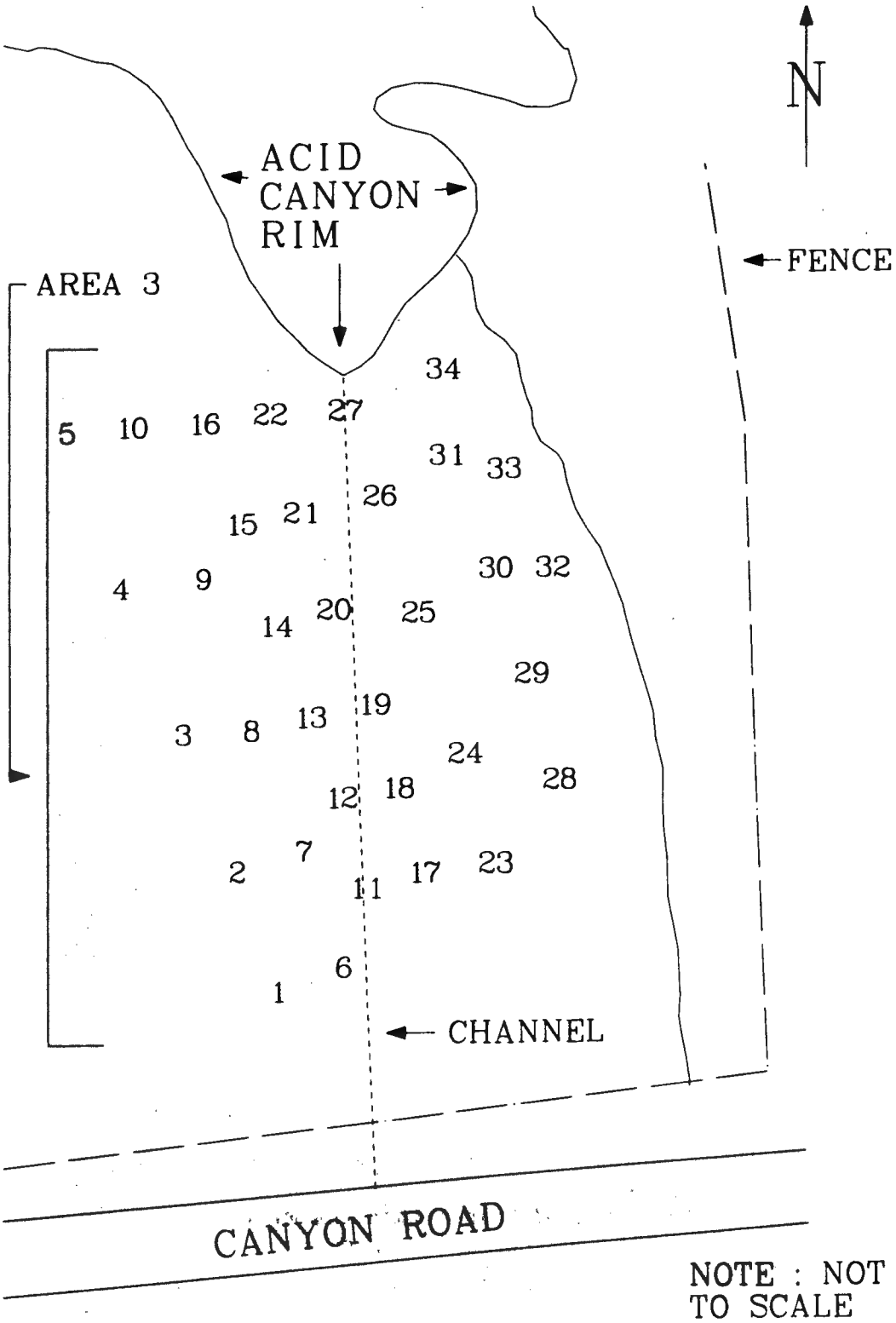

Fig. 5. Locations where surface soil samples were taken on 1 November 1982 radiological survey.

TABLE IV

RESULTS OF RADIOLOGICAL SURFACE SOIL SURVEY DONE ON NOVEMBER 1, 1982

Untreated Waste Line Discharge Area

Sample Number	Gross Alpha (pCi/g)
1	a
2	a
3	120 ± 40[b]
4	a
5	--
6	70 ± 50
7	a
8	a
9	a
10	a
11	100 ± 50
12	a
13	a
14	a
15	a
16	a
17	65 ± 38
18	a
19	a
20	a
21	46 ± 48
22	a
23	a
24	a
25	65 ± 38
26	a
27	a
28	a
29	410 ± 60
30	120 ± 60
31	a
32	a
33	410 ± 60
34	53 ± 49
35	a

[a]Sample activity is less than the minimum detectable limit of about 25 pCi/g.
[b]All results reported as X ± 2s.

NOTE: All samples analyzed for gross-beta activity were less than minimum detectable limit, except for Sample Number 33, which had a gross beta concentration of 23 ± 2 pCi/g.

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