Los Alamos Environmental Restoration Recording Facility

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ENVIRONMENTAL SURVEILLANCE OF LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT AREAS AT LOS ALAMOS DURING 1986

Environmental Science Group
Environmental Surveillance Group
Health and Environmental Chemistry Group
Waste Management Group

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SUMMARY

This report documents environmental monitoring data from 1986 for one active and eleven inactive radioactive-waste management areas at Los Alamos National Laboratory. Monitoring results are presented for soil, sediment, air, external radiation and meteorological measurements. The report includes the results of detailed surveys of Areas K and T, and reconnaissance surveys of the other waste management sites. All environmental data presented here were collected within Laboratory boundaries. Data collected outside Laboratory boundaries are referenced here as presented in the Laboratory's annual environmental surveillance report for 1986.

These data are used to evaluate the integrity of the waste management areas, measure possible effluents, and detect any on-going and long-range trends in site performance. This monitoring program is coordinated with an on-going remedial action program that uses environmental data collected here to improve site performance.

Maximum radiation doses to the public from operations at radioactive waste management areas are estimated to be less than 0.3 mrem to the bone surface, less than 0.4% of the Environmental Protection Agency's air emission standard of 75 mrem/year to any organ.

INTRODUCTION

This report was compiled from information generated by the Waste Management, Environmental Surveillance, Health and Environmental Chemistry and Environmental Science Groups as a part of the DOE-sponsored radioactive waste site surveillance program at Los Alamos National Laboratory. The report is intended, primarily, as a source document for data collected in FY86.

This report contains information on one active (Area G) and 11 inactive (Areas A, B, C, E, F, K, T, U, V, W and X) radioactive waste management areas at Los Alamos (Fig. 1). Sections are included on:

- use history and data base for the TA-21 waste site,
- surface reconnaisance survey of all sites,
- meteorological and radiological monitoring measurements,
- surface reconnaisance survey of all sites,
- results of perimeter surveillance activities at Areas C and G,
- results of detailed surveillance activities at Areas T and K, and
- a dose evaluation based on waste site and Laboratory environmental surveillance data.

General information on waste site history was reported in last year's annual waste site surveillance report (ESG et al. 1986). The following information on the TA-21 waste sites is an update on the chronology of use, the historical monitoring data base and current status of these sites. The information was obtained from a report being prepared by the Laboratory for the Comprehensive Environmental Assessment and Response Program (Reynolds et al. 1987).

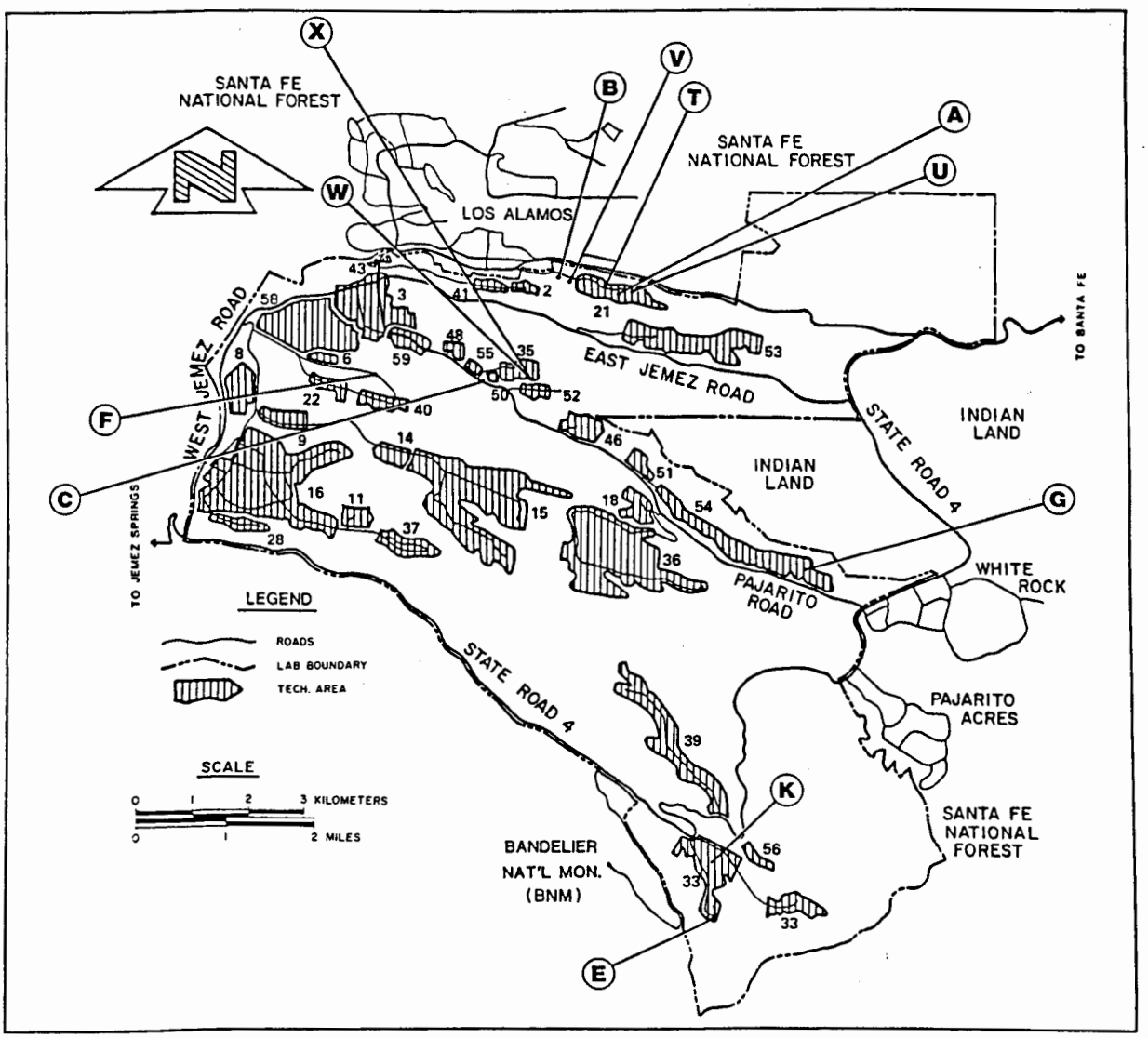

Figure 1. Location of technical areas and materials disposal areas at Los Alamos National Laboratory.

UPDATED SITE HISTORY AND DATA BASE FOR AREAS A, B, T, U AND V AT TA-21

Area A

Inactive Material Disposal Area A was opened in 1945 and last received waste in 1978 (Table 1). A major remedial action was completed in 1985 with the addition of cover material. The planning for completing the interim stabilization of this site was completed in early 1987. A comprehensive summary of special monitoring studies that have been conducted at Area A are summarized in Appendix A-1.

Area B

The Area B waste site was opened in 1944 and was last used for waste disposal in 1952 (Table 2). A major remedial action on the unpaved portion of the site occurred in 1982. The site is currently being used for a DOE Interim Operations funded closure demonstration project. The project goal is to demonstrate a site closure technology for Los Alamos that controls the potential water related problems of erosion and deep percolation (Barnes et al. 1985). A chronology of the special monitoring studies and type of data collected at Area B appears in Appendix A-2.

Area T

Area T was opened in 1945 and received waste until 1983 (Table 3). This site has been subject to intensive remedial action since 1983. An interim stabilization plan was completed in 1987 and implementation of the plan has begun. The chronology of special monitoring studies and the type of data collected at Area T are summarized in Appendix A-3.

Area U

This site was used from 1945 to 1968 (Table 4). Surface stabilization was implemented in 1985 and a plan for interim stabilization was completed in 1987. The chronology of special studies and type of data collected at Area U is summarized in Appendix A-4.

TABLE 1. CHRONOLOGY OF EVENTS AT AREA A AT TA-21

Year	Activity
1945	Construction of four pits on eastern end of Area A (125 ft x 18 ft x 12 ft deep).
1945	Construction of two storage tanks (General's Tanks: 12 ft in diameter and 62 ft 10 in long) and placement underground at west end of Area A.
1946	4 pits on eastern end of Area A closed.
1946	Last addition of liquids to General's Tanks.
1960	Hundreds of drums of radioiodide waste, which were previously stored within Area A, were removed.
1969	Large pit constructed in the center of Area A (150 ft x 40 ft x 22 ft deep).
1969-1972	Building debris from demolition work at TA-21 added to large pit in center of Area A.
1972	Large pit in center of Area A enlarged to bury building materials from the demolition of building TA-21-12 (172 ft x 134 ft x 22 ft deep).
1975	Liquids in one of General's Tanks removed for processing at TA-21-257.
1972-1978	Waste materials added to large pit in center of Area A.
1978	Large pit in center of Area A covered over.
1983	Liquids in General's Tanks removed for processing.
1985	Site stabilization activities in sealing and covering openings in the General's Tanks, removing surface contamination, adding cover material and recontouring and reseeding Area A.
1987	Planning completed for interim stabilization of site. Implementation contingent on funding.

TABLE 2. CHRONOLOGY OF EVENTS AT AREA B AT TA-21

Year	Activity
1944-1952	Construction of pit(s) and disposal of solid waste. Exact dimensions and number of pits not known.
1948	On May 3, fire occurred in 60% of the open pit. Fire extinguished within two hours. Hog wire fence was replaced with chain link fence.
1966	Western two-thirds of the area paved with asphalt and then leased to the County of Los Alamos for the storage of RV type vehicles.
1981	A decontamination crew removed some ^{233}U and $^{239,240}Pu$ contaminated soil from the eastern one third to Area G.
1982	The surface of the unpaved eastern area was renovated by moving the fence outward ten feet, removing the vegetation, adding a compacted soil and reseeding.
1986	A small, unpaved area on the southwestern corner of Area B was renovated by applying clean overburden, contouring, and reseeding with native grasses.
1982-1987	A series of experiments were initiated and implemented on the unpaved portion to evaluate trench cap design on moisture and vegetative penetration into buried waste.

TABLE 3. CHRONOLOGY OF EVENTS AT AREA T AT TA-21

Year	Activity
1945	Construction of four absorption beds completed (115 ft long x 20 ft wide x 4 ft deep).
1945-1952	Untreated liquid wastes released to absorption beds from Buildings 2, 3, 4, 5, and 12. + 150
1952	Building TA-21-35 (first liquid waste treatment plant) installed to treat liquid wastes from DP West and DP East before they were released to DP Canyon. Small amounts of liquid wastes were added to absorption beds from TA-21-35.
1952-1967	Treated liquid waste treatment plant effluent additions to absorption beds and to DP Canyon outfall from TA-21-35.
1967	Building TA-21-257 built and replaces building TA-21-35.
1968-1976	Treated wastes from TA-21-257 mixed with cement and pumped down 62 15 to 68 ft-deep, asphalt-coated disposal shafts, located principally between absorption beds 2 and 4.
1975-1983	Retrievable Waste Storage Area, located between absorption beds 1 and 3, used to store treated waste-cement mixtures in CMPs (corrugated metal pipes with a diameter of 30 in and a length of 20 ft).
1984-1986	CMPs relocated from Area T to Area G.
1967-1986	Treated liquid waste additions to DP Canyon from TA-21-257 (same outfall pipe as when effluents originated from TA-21-35).
1986	Effluent from TA-21-257 transferred via pipeline to TA-50 for discharge into Mortandad Canyon (Area T now an inactive waste disposal site).
1987	Interim surface stabilization of Area T initiated, as well as measures to control runoff intrusion from paved portions around Area T into the site.

TABLE 4. CHRONOLOGY OF EVENTS AT AREA U AT TA-21

Year	Activity
1945	2 Absorption beds constructed within Area U (supposedly similar to Area T: 115 ft long x 20 ft wide x 4 ft deep).
1945-1968	Absorption beds received ^{210}Po and ^{227}Ac from filter building effluents. (DP-153)
1968	Area U becomes an inactive site.
1984	Gate installed on west end of Area U.
1985	Piping from the absorption beds removed, and a trench (20 ft wide, 100 ft long, 4-13 ft deep) was dug across both beds in an effort to sample soil contaminated with Ac. Surface stabilization was conducted to remedy several drainage problems.
1987	Planning completed for interim stabilization of the site. Implementation of the stabilization plan begun.

Area V

Area V was used to dispose of waste water from the laundry (Bldg. 20) at TA-21 from 1945-1961 (Table 5). A new cap was applied to the site in 1985. Recommendations for completing the interim stabilization were made in 1987. The chronology of special studies and the type of data collected are summarized in Appendix A-5.

SURFACE RECONNAISANCE OF WASTE SITE INTEGRITY

A surface reconnaisance survey of all 12 LLW sites was completed during the summer of 1986 to note the general condition of the trench cover and perimeter fencing. A summary of needed actions by site and status of implementing the action is presented in Table 6.

PERIMETER AND DETAILED MONITORING STUDIES

Materials and Methods

Data collected during the perimeter surveys at Area G and C and the detailed surveys at Area T and K included:

- various meteorological parameters
- external radiation doses as measured with thermoluminescent dosimeters
- external penetrating radiation doses as measured with field instruments, and
- radionuclide concentrations in air, soil, sediment and vegetation

Most of the sampling and analytical methods used in the survey are described in Appendices A-D in Los Alamos National Laboratory reports, LA-10992-ENV (Environmental Surveillance Group, 1987a) and LA-UR-87-1076

TABLE 5. CHRONOLOGY OF EVENTS AT AREA V AT TA-21

Year	Activity
1945-1961	Construction of three absorption beds and disposal of waste water from the laundry (Bldg. 20) at TA-21. Absorption beds are reported to be similar to those at Area T. The surface area of the three beds is approximately 15,000 ft^2.
1984	Chain link fence constructed around waste area.
1985	A new cap was applied on the disposal area. However, the cap was not stabilized with vegetation.
1987	Plans completed for finishing interim stabilization of site. Implementation of plan begun.

TABLE 6. SUMMARY OF NEEDED REMEDIAL ACTIONS ON LOW LEVEL RADIOACTIVE WASTE SITES AT LOS ALAMOS BASED ON THE SURFACE RECONNAISANCE SURVEY CONDUCTED DURING THE SUMMER OF 1986

AREA	NEEDED ACTION	STATUS OF ACTION
A	correct parking lot drainage to site, revegetate with current technology	completed
B	none needed at this time	
C	erosion control along perimeter on north side fence; runoff control from TA-50 and TA-55,	planning begun
	revegetate SE corner	completed
E	none needed at this time	
F	none needed at this time	
G	none needed at this time	
K	fence and mark site or remove sumps	removal of sumps planned
T	correct parking lot drainage from south side into site	pending
	revegetate site	completed
U	none needed at this time	
V	none needed at this time	
W	none needed at this time	
X	install sign marking site	completed

(Quality Assurance Project Plans; ESG, 1987b). The field radiation survey was conducted with combinations of 2 different types of instruments to provide qualitative data on the presence or absence of external penetrating radiation and alpha emittors. The phoswich (phosphor sandwich) instrument consists of a thin sodium iodide crystal backed by a cesium iodide crystal coupled to an anti-coincidence circuit. The detector gives low-background count rates for photons in the 5-150 keV range and is used primarily to detect low energy x-rays from decay of transuranic materials. The discriminator was set at full window position. The instrument was calibrated before each field use with an ^{241}Am source and counting time was 100 seconds. The property number of the detector used in the Area C, G and K studies was PN 346298 (serial number was 108006). The serial number of the phoswich instrument used in the Area T study in 1986 was 004005. The RASCAL survey instrument consists of a 5 x 5 cm NaI(TI) detector couple to a single channel ESP-1 Eberline Scaler/rate meter. The instrument was operated in the scaler mode and calibrated to a ^{137}Cs source with a window setting encompassing the ^{137}Cs photopeak (~0.625-0.690 MeV). The instrument used had a property number of PN 347222 and a serial number of 005901. Counting time was 120 seconds.

A soil sample was collected with a 7.5 cm diameter by 5 cm deep coring tool at each sampling point. Samples were sieved through a 50 μm mesh screen and the fine fraction was processed and analyzed following procedures outlined in Appendix B of ESG, 1987a. Vegetation samples consisted of new growth green foliage and the species comprising the sample were identified prior to analysis for radionuclide content.

Specific sampling locations for the various measurements made at Area C, G, K and T are identified in the figures depicting the results. The locations at Areas C and G were around the perimeter exclusion fence although the

meteorological measurements at Areas G and C were made within the sites. A sampling grid, with 10 m grid intersections, was established at Area T. Soil samples were taken at 73 locations, vegetation at 67, and Phoswich and RASCAL measurements at 107. At Area K, 37 soil and vegetation samples and 37 Phoswich and RASCAL measurements were collected.

Background data for the Phoswich and RASCAL survey instruments and for various radionuclides in soil and vegetation are summarized in Table 7. Background survey instrument data were obtained during the actual field survey. Background radionuclide concentration data were obtained from the annual environmental surveillance report for 1986 (ESG 1987a).

RESULTS

Meteorological Monitoring at Area G

A 10.5 meter meteorological tower is located in the northeastern section of Area G. The parameters measured and the measurement levels are presented in Table 8.

Fifteen minute average data are recorded by a data acquisition system. A 24-hour summary is also recorded, including maximum and minimum temperature and relative humidity, maximum wind gust, average wind speed, total solar radiation, and total precipitation.

Temperature

Average daily temperatures during 1986 at Area G are presented in Table 9. The length of the data record at Area G is not long enough to develop long term averages for comparison, however, the range of values is consistent with long term averages measured at TA-59.

The predominant temperature feature during 1986 was the very warm January. The average temperature was 2.3^{o}C (36.2^{o}F) compared with -3.2^{o}C (26.2^{o}F) during 1985.

TABLE 7. SURVEY INSTRUMENT AND RADIONUCLIDE CONCENTRATION BACKGROUND DATA FOR THE WASTE SITE SURVEILLANCE EFFORT IN 1986

Area	Type Sample	Phoswich c/100 sec	RASCAL c/120 sec	^{3}H(pCi/l)[1]	Total U (μg/g)	^{137}Cs (pCi/g)	^{238}Pu (pCi/g)	$^{239,240}Pu$ (pCi/g)	^{241}Am (pCi/g)
C	soil	7156(415)	2180(173)	2300(1100)[2]	4.4(1.0)	0.43(0.33)	0.002(0.002)	0.016(0.019)	---
	veg.			200(300)	1.4(4.1)	0.24(0.91)	0.00003(0.00006)	0.00007(0.00008)	---
G	soil	6743(508)	2235(48)						
T	soil	385(32)	1418(118)						
K		5142(80)	1816(26)						

[1]Radionuclide background data is applicable to all waste sites.
[2]Mean ± 1 standard deviation.

TABLE 8. METEOROLOGICAL MEASUREMENTS AT AREA G

Parameters	Ht. of Measurement
wind speed, direction, and standard deviations	1.2 m, 3.5 m, 10.5 m
temperature	0.08 m, 1.2 m, 10.5 m
solar radiation	3 m,
relative humidity	1.2 m
precipitation	1.2 m

TABLE 9. AVERAGE DAILY TEMPERATURES AT AREA G

	Maximum		Minimum	
	°C	(°F)	°C	(°F)
January	9.2	(48.6)	-4.6	(23.8)
April	15.9	(60.6)	2.6	(36.7)
July	26.3	(79.3)	12.9	(55.2)
October	15.8	(60.5)	1.4	(34.6)

Nine days during 1986 exceeded 30°C (86°F); the highest temperature recorded was 31.7°C (89°F) on July 29. The coldest temperature recorded was -17.2°C (-1.0°F) on February 10. The low temperatures on 31 days were below -7°C (20°F).

Precipitation

The 1986 precipitation data for Area G are incomplete, however, rainfall estimates on days with no data were made based on data from TA-59 and White Rock. The estimated 1986 monthly precipitation totals for Area G are presented in Table 10.

Precipitation totals during 1986 were well above normal, due to a very wet spring and early summer followed by heavy rains and wet snows from September through November. The total of 47.88 cm (18.85 in) of precipitation at Area G is compared to the estimated long term average precipitation total of 33.95 cm (13.37 in).

Wind

Wind roses for Area G are presented in Figures 2, 3, and 4, representing the distribution of wind speed and direction for daytime hours, nighttime hours, and all hours.

The predominant wind direction (Fig. 2) is from the south-southwest, reflecting the channeling effect of the Rio Grande Valley. The frequent occurrence of weak, synoptic-scale pressure gradients allows differential solar heating of terrain surrounding Los Alamos to produce a large diurnal variation of winds at the site.

The daytime wind rose (Fig. 3) shows a maximum frequency of occurrence from the south-southwest, indicating wind flow up the Rio Grande Valley. A secondary maximum is present from the north-northeast through northeast. These are down valley winds which develop over the Rio Grande drainage during

TABLE 10. 1986 PRECIPITATION AT AREA G

	cm	(in)
Jan	0	0
Feb	2.31	0.91
Mar	2.06	0.81
Apr	3.71	1.46
May	3.51	1.38 (estimated)
Jun	8.76	3.45 (estimated)
Jul	5.56	2.19
Aug	2.84	1.12 (estimated)
Sep	5.94	2.34 (estimated)
Oct	5.33	2.10 (estimated)
Nov	6.22	2.45
Dec	1.63	0.64

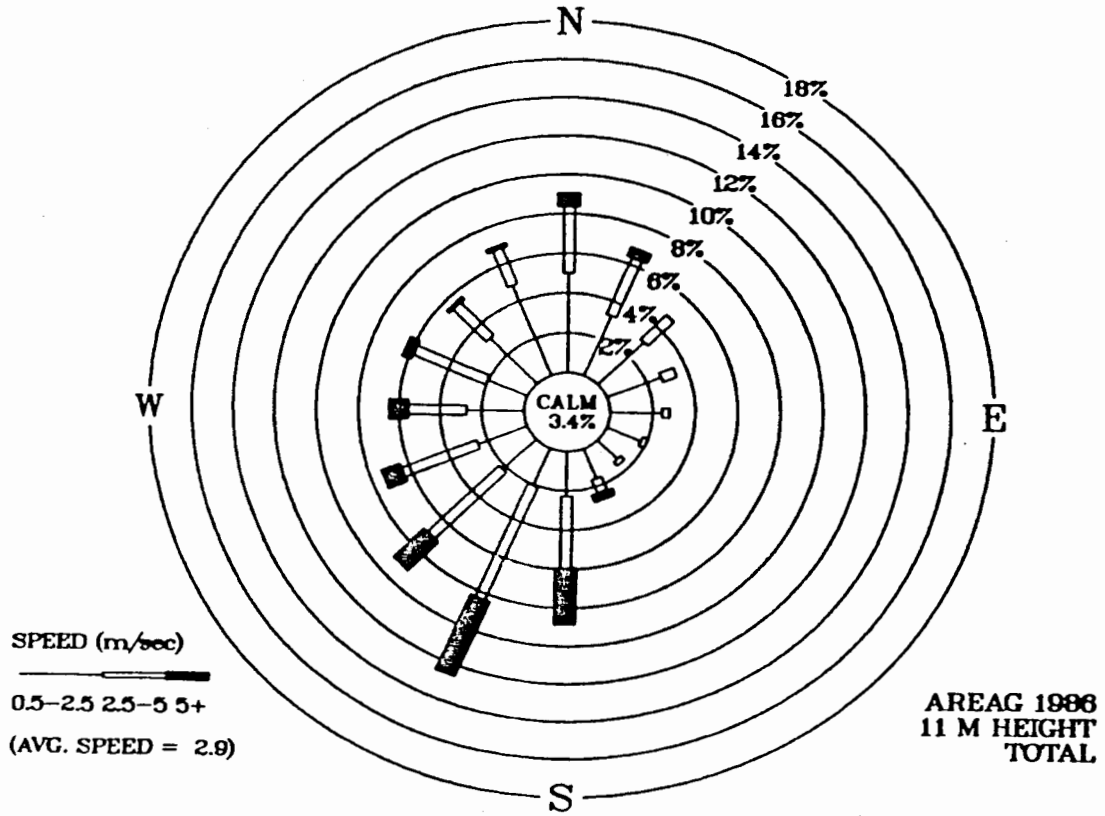

Figure 2. Average wind rose at Area G during 1986.

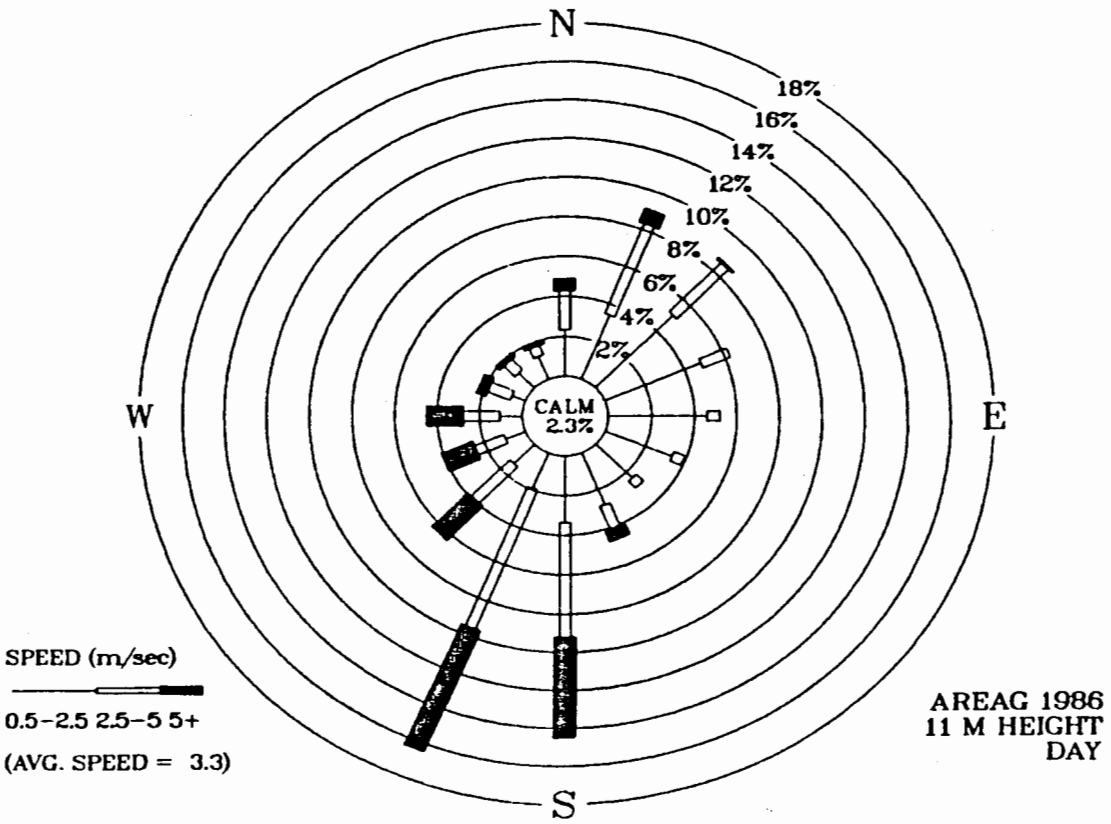

Figure 3. Average daytime wind rose at Area G during 1986.

the night and continue past sunrise due to thermal inertia. At night (Fig. 4), the predominant features are light winds flowing down the Pajarito Plateau, which slopes from the west-northwest and northwest to the east-southeast and southeast. The large component of northerly winds may be caused by the interaction of down plateau winds from the northwest and down Rio Grande winds from the northeast.

Los Alamos is a light wind site; the annual average wind speed at Area G is 2.9 m/sec, with over 40% of wind speeds less than 2.5 m/sec. High wind speeds are observed in the spring months, however, when large scale low pressure systems move out of the Rocky Mountains onto the Great Plains. Wind gusts of 31 m/sec (70 miles per hour) have been recorded during these storms.

Meteorological Monitoring at Area C

A 91 meteorological tower is located in Area C. The meteorological variables measured and the measurement levels are presented in Table 11. Similar to the Area G tower, fifteen minute average data are recorded and a 24-hour summary.

Precipitation and surface (1 meter) temperature were not measured at Area C. However, measurements at TA-59, 1500 meters west of Area C, provide a good estimate of temperature and precipitation at Area C.

Temperature

Average daily temperatures during 1986 at TA-59 are presented in Table 12. The predominant temperature feature during 1986 was the very warm January. The average daily maximum temperature was 6.3^{o}C (11.4^{o}F) higher than the 30-year normal. The average daily minimum temperature was 3.1^{o}C (5.6^{o}F) higher than the 30-year normal.

A temperature of -19.1^{o}C (-2.4^{o}F) was recorded on February 10, the coldest temperature during 1986. Low temperatures on six days during 1986

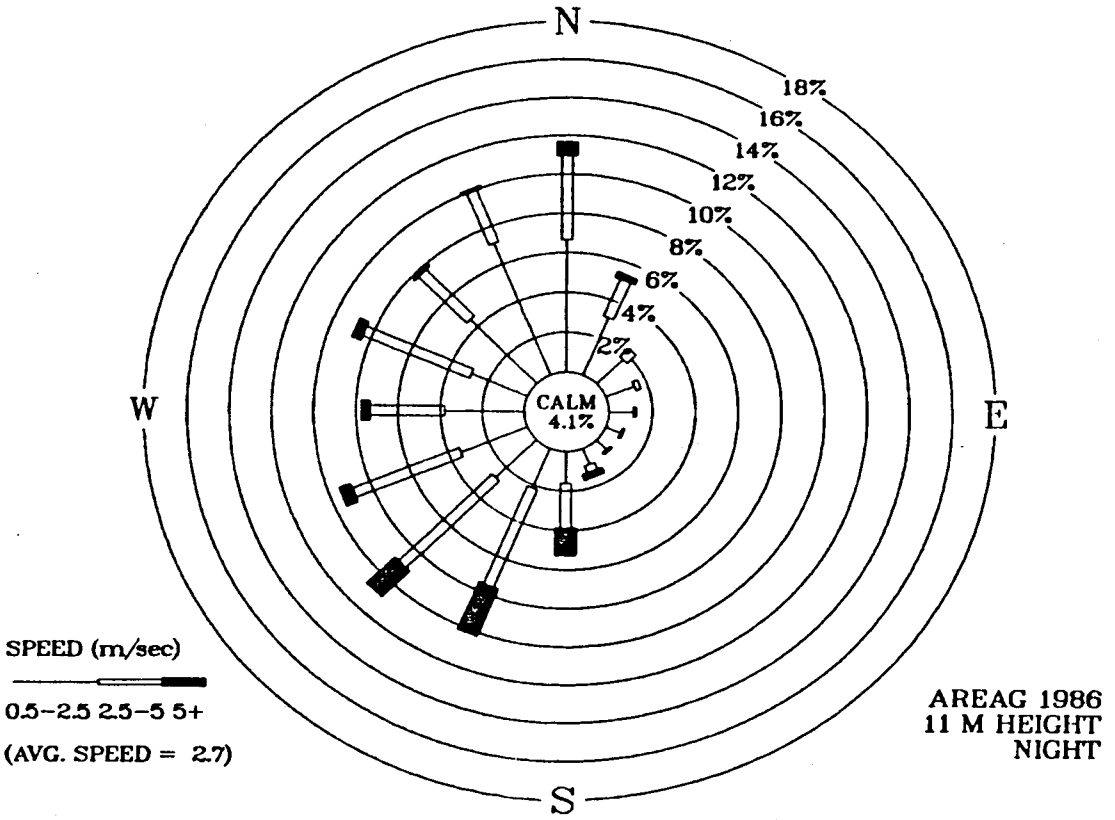

Figure 4. Average nighttime wind rose at Area G during 1986.

TABLE 11. METEOROLOGICAL MEASUREMENTS MADE AT AREA C DURING 1986

Measurement Variable	Height of Measurement Above Ground (m)
wind speed and direction	11.4, 22.9, 45.7, 91.4
temperature	11.4, 22.9, 45.7, 91.4

TABLE 12. AVERAGE DAILY TEMPERATURES AT TA-59

	Maximum		Minimum	
	(°C)	(°F)	(°C)	(°F)
January	10.6	51.1	-4.4	24.1
April	15.8	60.5	1.5	34.7
July	26.6	79.9	11.8	53.3
October	14.4	58.0	1.5	34.7

were below -12.2°C (10°F). The highest temperature, 32.3 (90°F) was recorded on July 30. The temperature exceeded 30°C (86°F) on fifteen days during 1986.

Precipitation

The precipitation at Area C is approximated as 90% of the total at TA-59. The estimated 1986 monthly precipitation totals for Area C are presented in Table 13.

Precipitation totals during 1986 were well above normal, due to a very wet spring and early summer followed by heavy rains and wet snows from September through November. The total of 55.13 cm (21.71 in) of precipitation at Area C is compared to the estimated long-term average precipitation total of 40.74 cm (16.04 in).

Wind

Wind roses for Area C are presented in Figures 5, 6, and 7, representing the distribution of wind speed and direction for daytime hours, nighttime hours, and all hours.

The predominant wind directions at Area C are from the south through the northwest. These directions reflect 1) the channeling effect of the Rio Grande Valley and 2) the diurnal wind cycle caused by differential solar heating of terrain surrounding Los Alamos.

The daytime wind rose (Fig. 6) shows a maximum frequency of occurrence from the south, indicating wind flow up the Rio Grande Valley. Light winds, less than 2.5 m/sec, from the east and north east represent winds moving up the slope of the Pajarito Plateau in the morning hours.

The dominant aspect of the nighttime wind rose (Fig. 7) is the west northwest wind. This represents a drainage wind off the Jemez Mountains down across the Pajarito Plateau, which slopes from the west northwest to east southeast.

TABLE 13. 1986 PRECIPITATION AT AREA C (ESTIMATED FROM TA-59 DATA)

	cm	in
Jan	0	0
Feb	2.31	0.91
Mar	1.78	0.70
Apr	4.23	1.67
May	3.75	1.48
Jun	12.96	5.10
Jul	5.00	1.97
Aug	7.57	2.98
Sep	4.64	1.83
Oct	6.77	2.66
Nov	5.09	2.01
Dec	1.01	0.40
Total	55.13	21.71

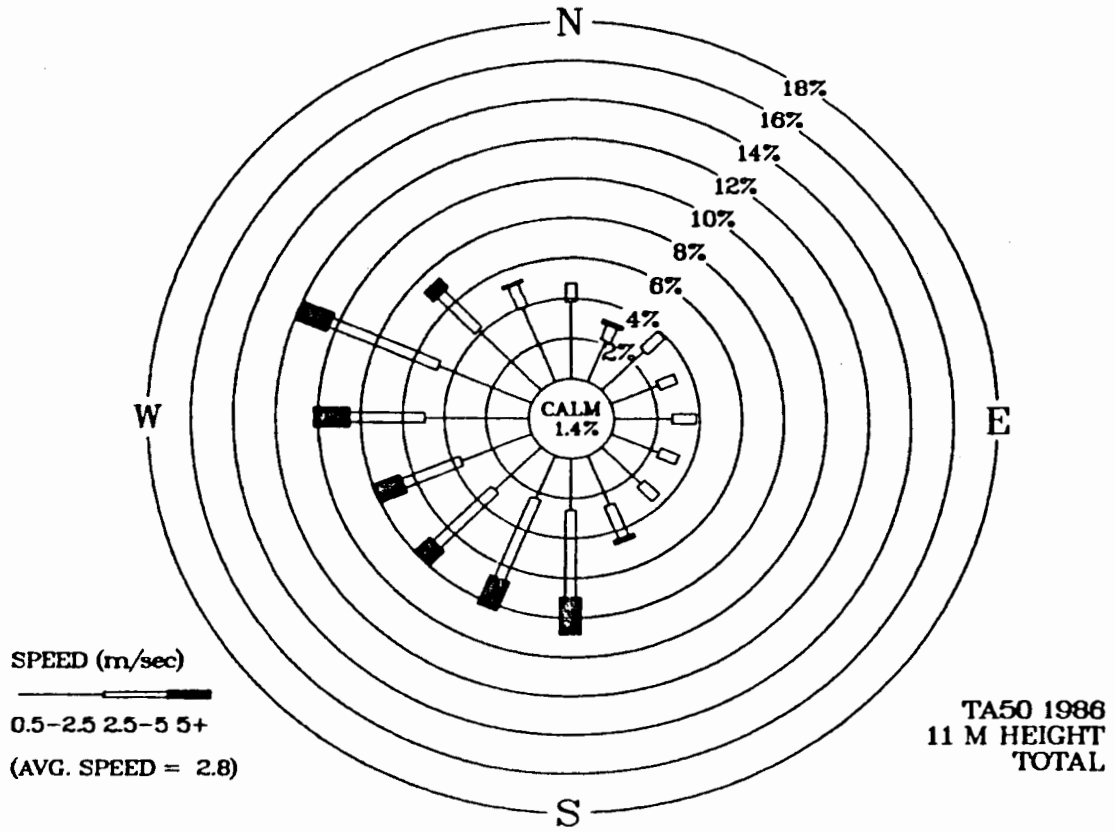

Figure 5. Average wind rose at Area C during 1986.

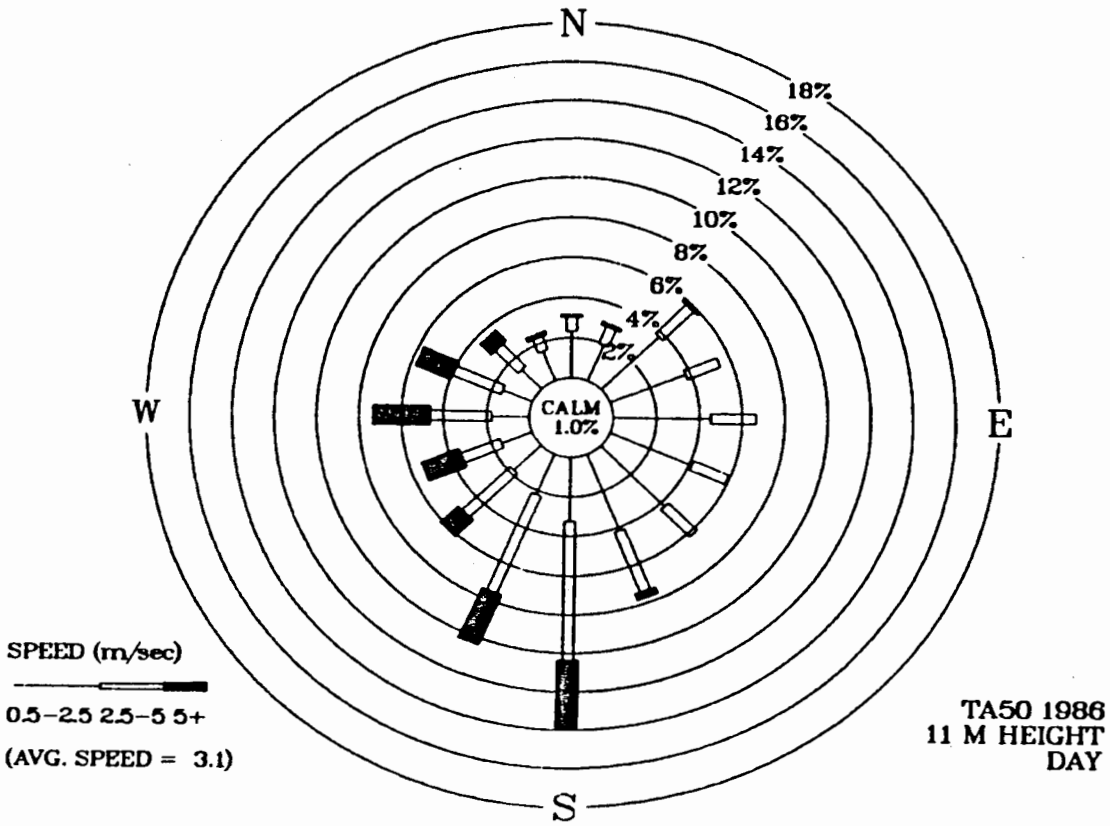

Figure 6. Average daytime wind rose at Area C during 1986.

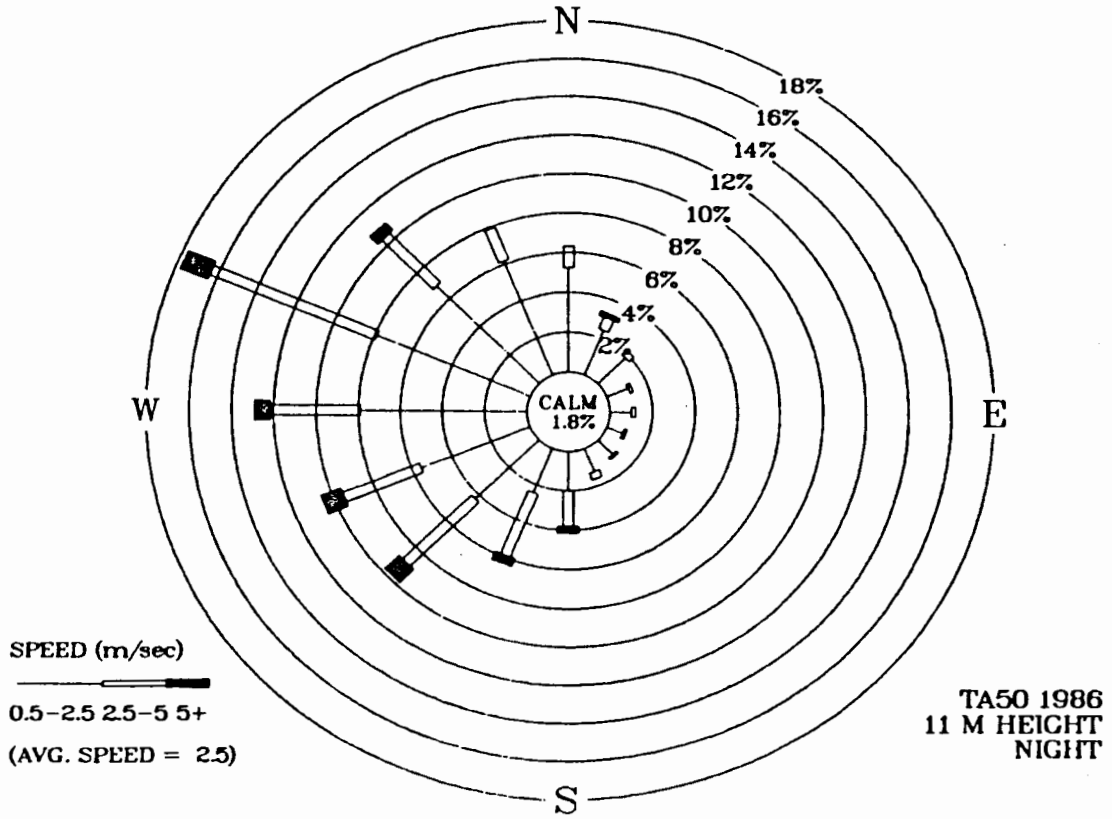

Figure 7. Average nighttime wind rose at Area C during 1986.

RADIONUCLIDES IN AIR

One (#22) of the 26 air sampling stations operated for the routine Laboratory air monitoring network is located in Area G. Four additional stations have been operated in and around Area G since 1984 (Fig. 8). Annual average air concentrations, (based on monthly values), of H-3, total U, Pu-238, and Pu-239 were measured at all stations including Area G.

Concentrations of plutonium, uranium, and tritium exceeding background in air were measured in at least one of the five sampling locations at Area G (Table 14). All of these locations are well within the Laboratory boundary. In general, concentrations of plutonium and uranium were elevated in the samples collected around the Area G site perimeter. Tritium concentrations exceeded background at all Area G locations but especially at sampler G-2, adjacent to the pits and shafts on the south-central perimeter of the site (Fig. 8). While some concentrations of the four radionuclides exceeded background, the levels were less than 0.1% of the Department of Energy's Concentration Guides for controlled areas.

TLD NETWORK FOR LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT AREAS

This network of 91 locations monitors radiation levels at 1 active and 10 inactive low-level radioactive waste management areas. These waste management areas are controlled-access areas and are not accessible to the general public. Active and inactive waste areas are monitored for external penetrating radiation with arrays of TLDs (Table 15). Averages at all sites but Area X were higher than average perimeter values. However, the ranges at most sites were similar to the range of values found at perimeter and regional stations. The extremes at Area G, the active radioactive waste area, and Area T, an inactive waste area, have been noted in previous years. Concentrations

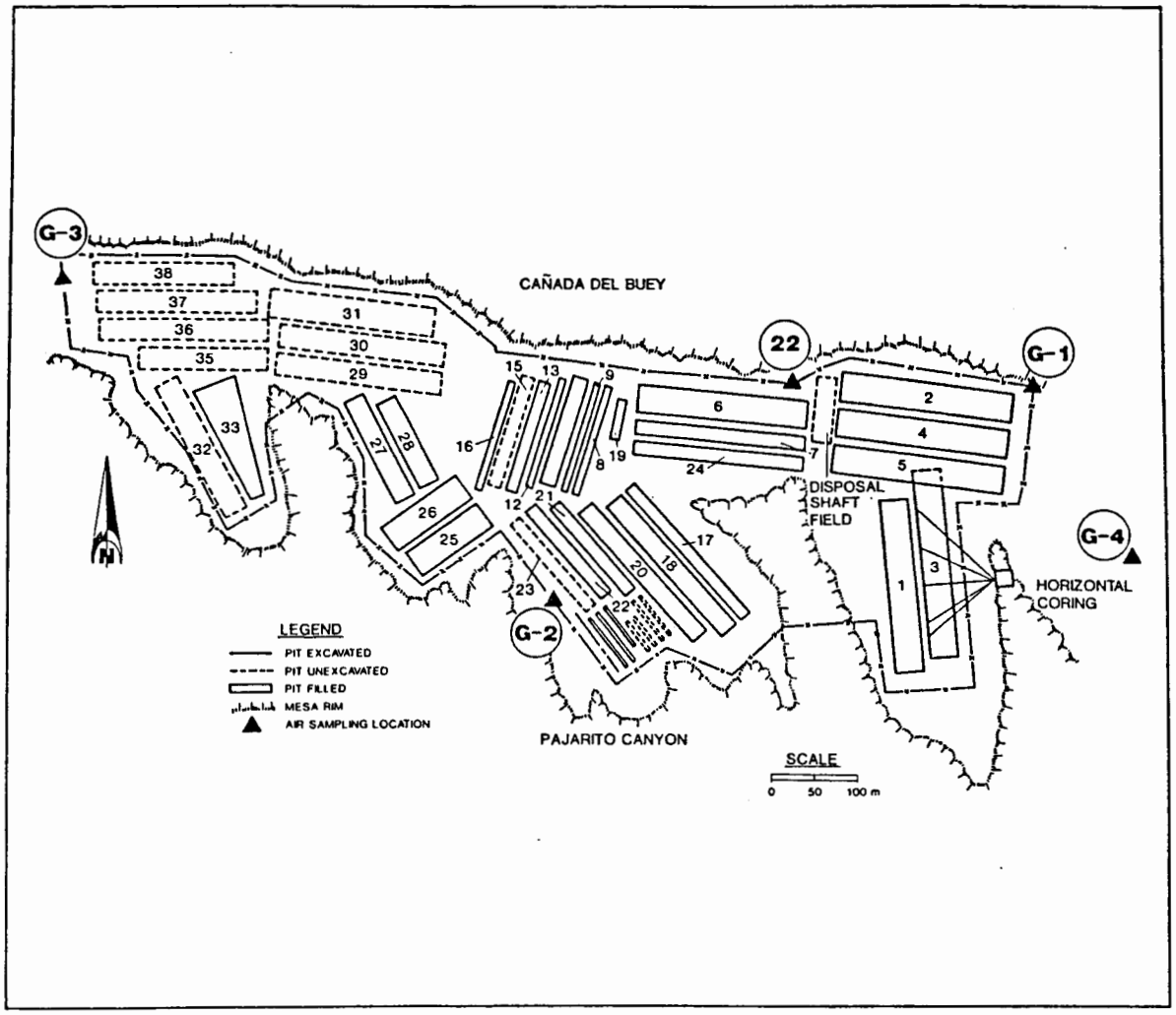

Figure 8. Air sampling network at Area G in 1986.

Table 14. Average annual concentrations of radionuclides in air samples from Area G in 1986

	max[1]	min[1]	mean[1]	mean as % of CG[2]
Pu-238 (aCi/m^3)				
station 22	70± 5	8.8±1.8	25±30	<0.1
G-1	792±109	54±4	307±330	<0.1
G-2	23±1.0	0.4±0.5	6.6±11	<0.1
G-3	27±2.6	2.7±0.8	14±11	<0.1
G-4	12±1.6	-0.5±0.8	3.3±5.8	<0.1
Regional	1.6±0.7	0.2±0.4	0.6±0.5	<0.1
Pu-239,240 (aCi/m^3)				
station 22	37±3.2	7.8±1.5	23±12	<0.1
G-1	30±22	1.2±0.8	9.8±13.4	<0.1
G-2	1.7±0.7	0.0±0.5	0.8±0.7	<0.1
G-3	358±21	1.2±0.6	91±78	<0.1
G-4	1.8±0.8	0.8±0.5	1.2±0.4	<0.1
Regional	3.8±1.0	0.2±0.5	1.5±1.2	<0.1
Uranium (pg/m^3)				
station 22	93±9.2	33±3.3	62±28	<0.1
G-1	256±25	39±3.9	121±94	<0.1
G-2	42±4.2	13±1.3	30±13	<0.1
G-3	14±15	40±4.0	75±49	<0.1
G-4	26±2.6	13±1.2	19±6.5	<0.1
Regional	105±11	22±2.2	60±24	<0.1
H-3 (mCi/m^3)				
station 22	50± 10	2 ±1	28± 16	<0.1
G-1	45± 9	1.6±0.3	17± 14	<0.1
G-2	2900±500	4.5 ±1	1053±1137	<0.1
G-3	24± 4	1.9±0.9	6.7±6.7]	<0.1
G-4	70± 10	2.6±0.5	14± 18	<0.1
Regional	46± 9	- 2 ±1	5.0± 12	<0.1

[1]Uncertainties are ± 1σ. Averages of 1985 air concentrations at three regional locations, Espanola, Pojoaque, and Santa Fe, have been included for comparison (see Environmental Surveillance Group, 1986).

[2]Controlled Area DOE Concentrations Guides are

Pu-238	2,000,000	aCi/m
Pu-239,240	2,000,000	aCi/m
U	200,000,000	pg/m
H-3	5,000,000	pCi/m

TABLE 15. DOSES (MREM) MEASURED BY TLDS AT ONSITE WASTE AREAS DURING 1986

Area	Number of TLDS	Mean	Minimum	Maximum
A	5	129	121	147
B	14	128	117	141
C	10	128	116	140
E	4	129	123	131
F	4	126	118	135
G	27	160	131	227
T	7	173	131	304
U	4	128	123	132
V	4	130	121	134
W	3	124	107	133
X	1	112	---	---

of radionuclides in air samples from offsite areas (ESG 1986), were all less than 0.1% of the DOE Derived Concentration Guides for offsite areas. Possible radiation doses, which are low and well below the DOE Radiation Protection Standard, are discussed in the Dose Assessment Section at the end of this report.

Radionuclide Transport in Sediments and Run-Off of an Active Radioactive Waste Management Area (Area G)

Radionuclides transported by surface run-off have an affinity for attachment to sediment particles by ion exchange or adsorption. Thus, radionuclides in surface run-off tend to concentrate in sediments. Nine sampling stations were established in 1982 outside the perimeter fence at Area G (TA-54) to monitor possible transport of radionuclides by storm run-off from the waste storage and disposal area (Fig. 9).

Cesium and gross gamma radioactivity in sediments from nine stations were below background levels (Table 16). Uranium at station 8 was slightly elevated when compared to background. The ^{238}Pu concentration at stations 6 through 9 and the $^{239,240}Pu$ concentrations at stations 6 and 7 were above background levels. The concentrations are low and do not pose any health or environmental problems. The presence of the plutonium in the sediment indicates that there is transport of surface contamination.

Two run-off samples were collected and analyzed for radionuclides in solution and plutonium in suspended sediments (Table 16). The event of 6/9/86 carried a trace of ^{238}Pu in solution while tritium was slightly above background for both events. The event of 6/26/86 also carried low amounts of ^{238}Pu in the suspended sediments.

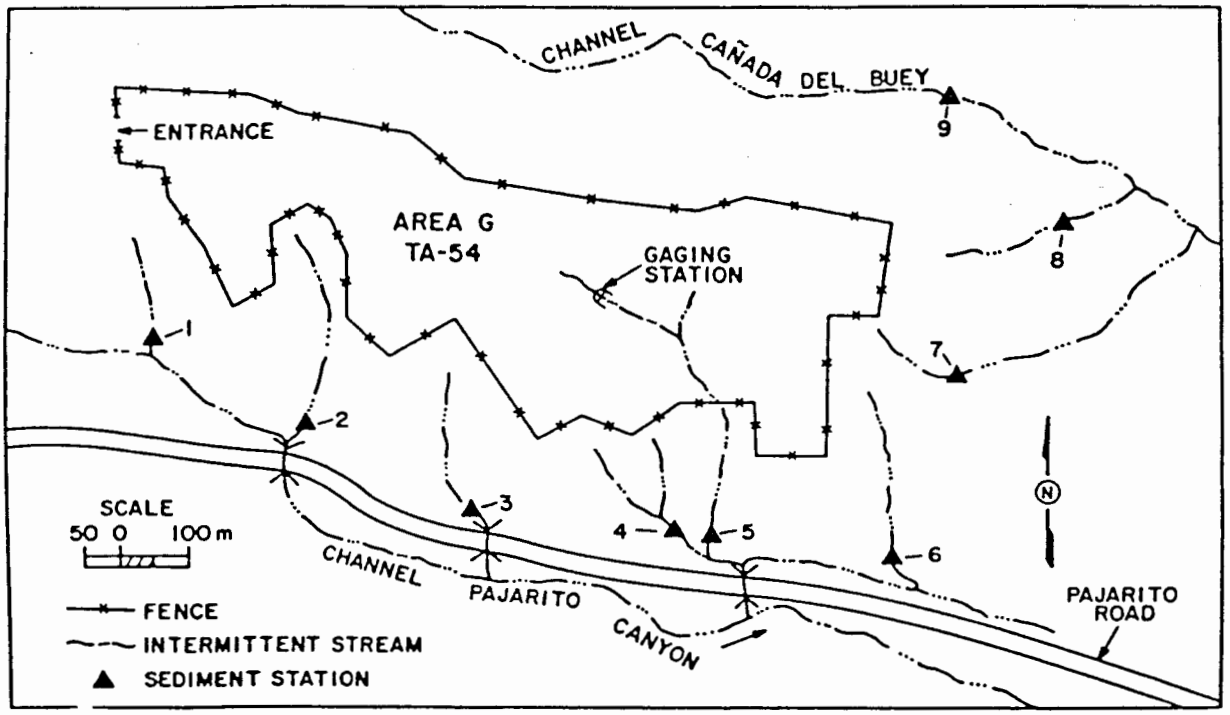

Figure 9. Surface water gaging station in Area G (TA-54) and sediment sampling stations adjacent to Area G.

TABLE 16. RADIOCHEMICAL ANALYSES OF SEDIMENTS AND RUN-OFF, AREA G, TA-54

	Sediments, October 21, 1986				
Station	^{137}Cs (pCi/g)	Total U (ug)	^{238}Pu (pCi/g)	$^{239,240}Pu$ (pCi/g)	Gross Gamma (Counts/min/g)
1	0.22 (0.6)[a]	2.7 (0.3)	0.001 (0.001)	0.002 (0.001)	-3.5 (0.7)
2	0.44 (0.11)	2.7 (0.3)	0.003 (0.001)	0.004 (0.002)	-4.3 (0.7)
3	0.08 (0.08)	2.1 (0.2)	0.003 (0.002)	0.003 (0.002)	-5.4 (0.8)
4	0.16 (0.17)	2.4 (0.3)	0.002 (0.001)	0.009 (0.002)	-1.9 (0.6)
5	0.09 (0.07)	1.9 (0.2)	0.002 (0.001)	0.008 (0.002)	-3.7 (0.7)
6	0.04 (0.06)	1.5 (0.2)	0.010 (0.001)	0.048 (0.005)	-5.9 (0.8)
7	0.09 (0.07)	1.5 (0.2)	0.091 (0.007)	0.051 (0.005)	-4.6 (0.7)
8	0.26 (0.09)	4.6 (0.5)	0.027 (0.004)	0.022 (0.003)	0.0 (0.6)
9	0.11 (0.07)	1.8 (0.2)	0.015) (0.002)	0.006 (0.001)	-5.9 (0.8)
Back-ground[b]	1.18	3.5	0.005	0.036	7.1
Limits of Detection	0.1	0.7	0.003	0.002	0.1

TABLE 16 (cont)

In Run-off Solution

Date	3H (10^{-6} Ci/mL)	^{137}Cs 10^{-9} Ci/mL)	Total U (μg/mL)	^{238}Pu (10^{-9} Ci/mL)	$^{239,240}Pu$ (10^{9} Ci/mL)	Gross Gamma (counts/min/L)
6/9/86	2.2 (0.5)	-46 (28)	0.7 (0.3)	0.031 (0.04)	-0.005 (0.016)	-120 (60)
6/26/86	3.0 (0.5)	-91 (22)	0.3 (0.1)	-0.004 (0.04)	0.004 (0.012)	-70 (100)
Back- c ground	1.0	26	3.1	0.022	0.018	243
Limits of Detection	0.7	40	1	0.009	0.03	50

TABLE 16 (cont)

Suspended Sediments in Run-off

Date	^{238}Pu (pCi/g)	$^{239,240}Pu$ (pCi/g)
6/9/86	0.021 (0.003)	0.109 (0.008)
6/26/86	0.346 (0.05)	0.197 (0.036)
Back- d ground	0.026	0.741
Limits of Detection	0.003	0.002

[a]Counting uncertainties in parentheses.

[b]x + 2s (Purtymun 1986).

[c]Surface Water Rio Grande and Rio Chama, 1986 (12 analyses; x + s)

[d]Suspended Sediments Pajarito Canyon, 1986 (8 analyses; x + s).

Perimeter Surveys

Area C

A total of 18 sampling locations were established in and around Area C (Fig. 10). Measurements with the Phoswich and RASCAL survey instruments (Table 17) reflect the same distribution patterns that were observed in 1985 (ESG et al. 1986) in that the highest instrument responses were associated with the north-east corner of the site. However, even the highest values observed are well within the background counts (see Table 7) observed with the two instruments during the survey.

Concentrations of selected radionuclides in soil and vegetation are also presented in Table 17. Tritium levels in soils exceeded background at most perimeter locations. Concentrations from 10-20 times background were measured along the south side of the site and in the vicinity of the disposal shafts located near sampling locations 12 and 13. Tritium levels in vegetation samples were generally below detection limits.

Cesium-137 concentrations in soil were at or below background (Table 17). Slightly elevated levels were measured in about half of the vegetation samples primarily along the east and south side of the site. Slightly elevated ^{238}Pu and $^{239,240}Pu$ concentrations were also measured in most soil and vegetation samples. The perimeter locations enclosing the eastern half of Area C (sampling locations 4-12) appeared to have consistently higher ^{239}Pu and ^{238}Pu concentrations in both soil and vegetation. Americium-241 concentrations in soil samples ranged from about 0.1-1.5 pCi/g within the range of or slightly exceeding background for Los Alamos soils (ESG 1987a). The data for ^{241}Am in vegetation were lost due to counting instrument failure.

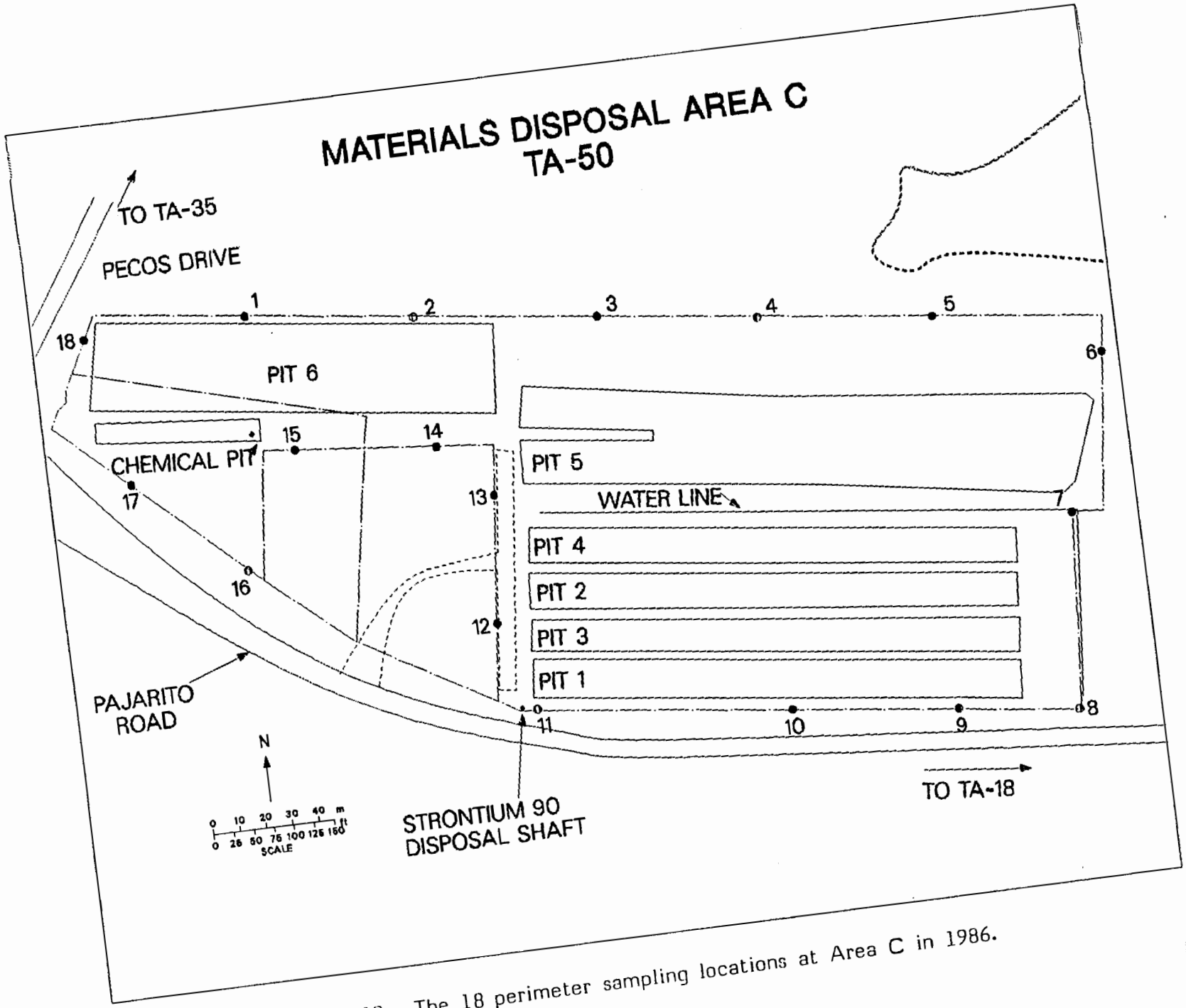

Figure 10. The 18 perimeter sampling locations at Area C in 1986.

TABLE 17. FIELD INSTRUMENT AND RADIOCHEMICAL SURVEY OF AREA C IN SEPTEMBER 1986

SOIL

Grid Loc.	H^3(pCi/L)	Am-241(pCi/g)	Cs-137(pCi/g)	Pu-238(pCi/g)	Pu-239(pCi/g)	Phoswich c/100 sec	RASCAL c/120 sec
1	11000.0	0.72	0.12	0.007	0.34	5319	1656
2	13000.0	0.78	0.21	0.006	0.60	6070	1649
3	3200.0	1.18	0.05	0.007	0.20	5986	1902
4	3400.0	0.29	0.07	0.030	0.80	6141	1755
5	7000.0	1.48	0.38	0.004	0.60	6736	2202
6	4000.0	1.07	0.28	0.096	7.30	6856	2139
7	7700.0	0.08	0.55	0.091	10.40	6333	1755
8	29000.0	1.36	N.D.	0.022	2.35	6458	1510
9	21000.0	0.39	0.09	0.005	0.36	5508	1625
10	41000.0	1.12	0.30	0.032	2.26	6169	1923
11	39000.0	1.10	0.13	0.070	15.10	5698	1474
12	21000.0	0.11	0.22	0.084	1.62	5488	1945
13	50000.0	1.21	0.03	0.0004	0.01	5887	1853
14	30000.0	0.22	0.03	0.003	0.06	4544	1208
15	23000.0	1.11	0.14	0.008	0.15	4391	1324
16	33000.0	0.19	0.30	0.011	0.13	5361	1440
17	44000.0	1.22	0.26	0.014	0.60	5272	1512
18	43000.0	1.31	0.07	0.013	0.78	4877	1554

VEGETATION

Grid Loc.	H^3(pCi/L)	Am-241(pCi/g)	Cs-137(pCi/g)	Pu-238(pCi/g)	Pu-239(pCi/g)
1	400.0	samples lost	N.D.	0.002	0.012
2	N.D.		N.D.	0.005	0.069
3	N.D.		0.35	0.014	0.203
4	N.D.		0.25	0.012	0.078
5	N.D.		1.97	0.004	0.040
6	N.D.		1.87	0.002	0.333
7	N.D.		1.83	0.005	0.450
8	1000.0		0.20	0.006	0.259
9	1800.0		N.D.	0.018	0.187
10	2100.0		N.D.	0.003	0.057
11	N.D.		0.02	0.014	0.174
12	N.D.		0.69	0.007	0.059
13	3400.0		3.73	0.002	0.011
14	N.D.		0.08	0.022	0.121
15	500.0		1.06	0.004	0.028
16	300.0		1.75	0.003	0.026
17	N.D.		0.83	0.006	0.248
18	N.D.		0.45	0.005	0.022

Area G

Soil and vegetation samples and survey instrument measurements were taken at the same 16 locations that were used during the perimeter survey in 1985 (Fig. 11). Results of the field instrument survey (Table 18) were similar to last years (ESG et al. 1986) in that counts up to 50% higher than background counts (see Table 7) were obtained on the south side perimeter locations. A phoswich count of about 2.5 times background was recorded at sampling location 7 (Table 18) which is adjacent to buried waste from the Los Alamos Meson Physics Facility.

Tritium concentrations in soil and vegetation samples (Table 18) were generally within a factor of two of background although both soil and vegetation from sampling locations 10 and 16 were 50-100 times background. The mostly non-detectable levels of tritium in vegetation may be related to the fact that much of the vegetation on Area G had matured when the samples were collected in September, 1986 and thus, had low moisture content. Concentrations of ^{137}Cs, ^{241}Am, ^{238}Pu and $^{239,240}Pu$ in soil and vegetation were not unusual although slightly elevated levels of both isotopes of plutonium were measured in soil and plant samples from the north-east corner of the site similar to observations made in 1985 (ESG et al. 1986).

Perimeter Survey Summary

Overall major changes in the radionuclide concentrations in perimeter samples from 1985 and 1986 were not apparent. Slightly elevated levels of most radionuclides were detected in some soil and vegetation samples from both sites but even the concentrations that were elevated were generally within a few percent of background. An exception was tritium in soils from both sites, where concentrations were as much as 50 times background.

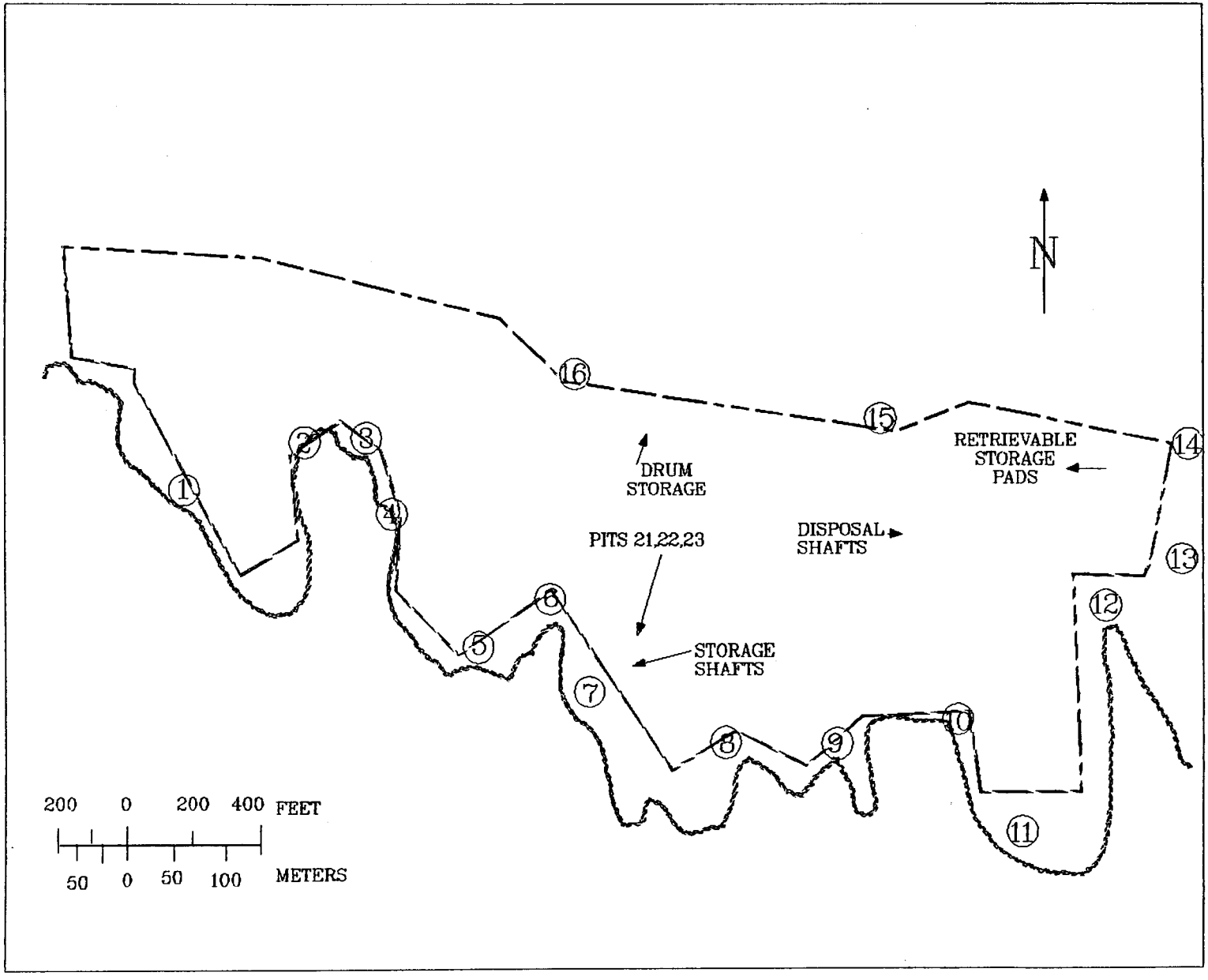

Figure 11. The 16 perimeter sampling locations at Area G in 1986.

TABLE 18. FIELD INSTRUMENT AND RADIOCHEMICAL DATA FROM THE PERIMETER SURVEY OF AREA G IN SEPTEMBER 1986

SOIL

Grid Loc.	H (pCi/l)	Am-241(pCi/g)	Cs-137(pCi/g)	Pu-238(pCi/g)	Pu-239(pCi/g)	Phoswich c/100 sec	RAS/AL c/120 sec
1	5100.0	0.86	0.82	0.003	0.030	7601	2537
2	2100.0	0.51	0.81	0.002	0.050	7348	2516
3	3200.0	0.89	1.80	0.010	0.083	7397	2481
4	2200.0	0.62	0.80	0.005	0.024	6063	2365
5	2600.0	0.87	0.64	0.006	0.020	8390	2676
6	2000.0	0.54	0.72	0.003	0.020	9650	2515
7	3500.0	1.02	0.24	0.000	0.010	17700	2507
8	4300.0	0.64	0.62	0.002	0.024	7530	2424
9	2900.0	0.22	0.55	0.007	0.027	8543	2201
10	97000.0	0.65	0.80	0.014	0.200	6288	2243
11	7000.0	0.29	0.22	0.002	0.010	7098	2467
12	6800.0	0.71	0.01	0.014	0.018	7562	2173
13	3800.0	N.D.	0.52	0.090	2.440	7942	2247
14	3800.0	0.85	0.57	1.200	3.100	7482	2197
15	4900.0	0.63	0.13	0.612	0.180	8087	1815
16	74000.0	0.74	0.10	0.620	0.911	7582	1834

VEGETATION

Grid Loc.	H (pCi/L)	Am-241(pCi/g)	Cs-137(pCi/g)	Pu-238(pCi/g)	Pu-239(pCi/g)
1	N.D.	samples lost	0.23	0.107	0.346
2	N.D.		2.11	0.230	0.088
3					
4	N.D.		1.21	0.107	0.346
5	N.D.		1.78	0.096	0.077
6	N.D.		1.02	0.055	0.094
7	N.D.		0.93	0.110	0.685
8	N.D.		1.55	0.015	0.023
9	N.D.		0.77	0.020	0.015
10	140000.0		0.060	0.013	0.016
11	N.D.		2.60	0.006	0.065
12	N.D.		1.87	0.045	0.046
13	N.D.		1.03	0.090	0.929
14	N.D.		0.36	1.350	0.270
15	N.D.		1.91	0.718	0.110
16	120000.0		1.17	0.449	0.143

Intensive Surveys

Sampling grids, with 10 m intersections, were established on Area T and K in order to provide a detailed picture of radionuclide distribution in surface soils and vegetation. The location of each grid relative to the waste site is given in the figures showing the results from each site.

Area T

The results of the field survey are presented in Figs. 12 and 13 for the Phoswich and Figs. 14 and 15 for the RASCAL. Most of the Phoswich counts exceeded the Area T background counts averaging 385 c/100 sec (Table 7). One location, on the drainage from two large storage tanks located adjacent to building 257, had a phoswich response of over 20,000 c/100 sec. (Fig. 12). It appears that there is some radionuclide contamination outside the Area T fence on the south rim of DP-Canyon. The contamination probably originated from the waste site proper, however, the existence of the building 257 radioactive liquid waste effluent outfall on the south rim of DP-Canyon precludes any definitive statement about source of the radionuclides outside the Area T fence.

The RASCAL data (Fig. 14 and 15) show very similar patterns to that observed with the Phoswich. Many of the RASCAL counts slightly exceeded the background of 1418 c/120 sec. (Table 7) and relatively higher counts (up to 5 times background) were measured on the drainage from the two storage tanks adjacent to building 257.

Most of the ^{137}Cs concentrations in soil (Figs. 16 and 17) that exceeded the background of about 0.5 pCi/g were associated with sampling locations outside the fence (Fig. 16). A maximum of 42 pCi/g soil was observed downslope from the storage tanks adjacent to Building 257. Cesium-137 concentrations in vegetation (Figs. 18 and 19) often exceeded those measured

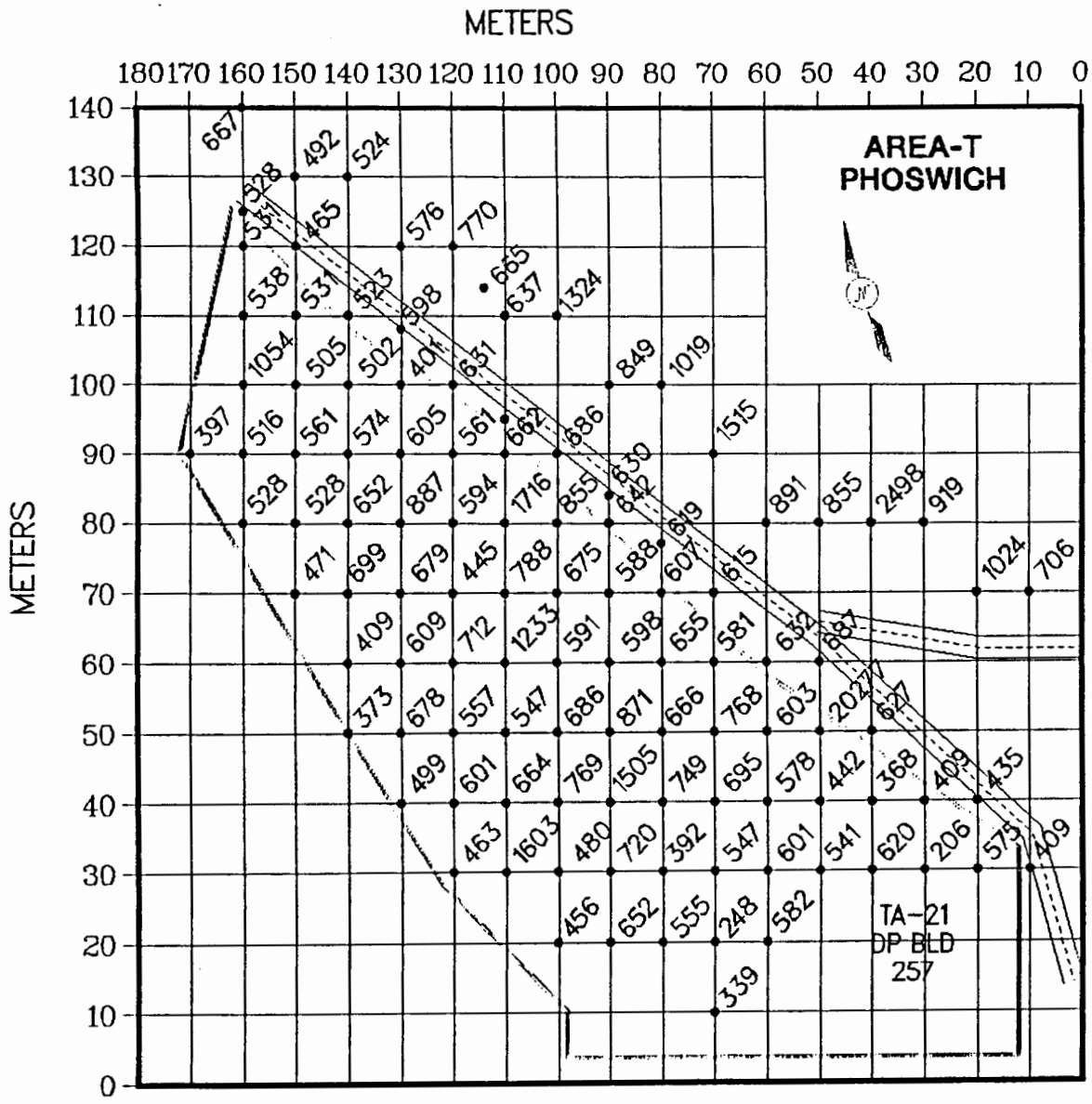

Figure 12. Phoswich counts per 100 seconds on Area T sampling grid in 1986.

AREA T PHOSWICH (SOIL)

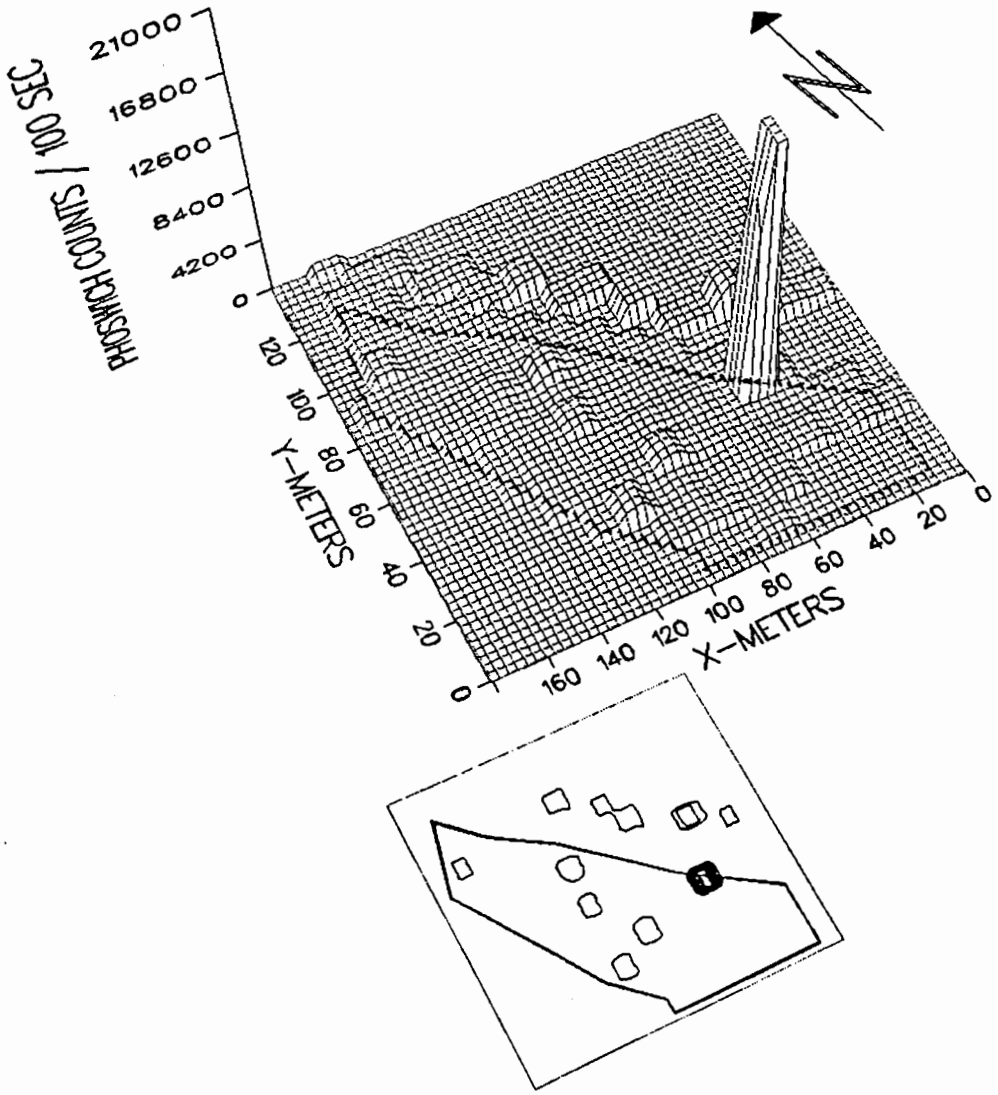

Figure 13. Three dimensional and contour plots of Phoswich counts on Area T in 1986.

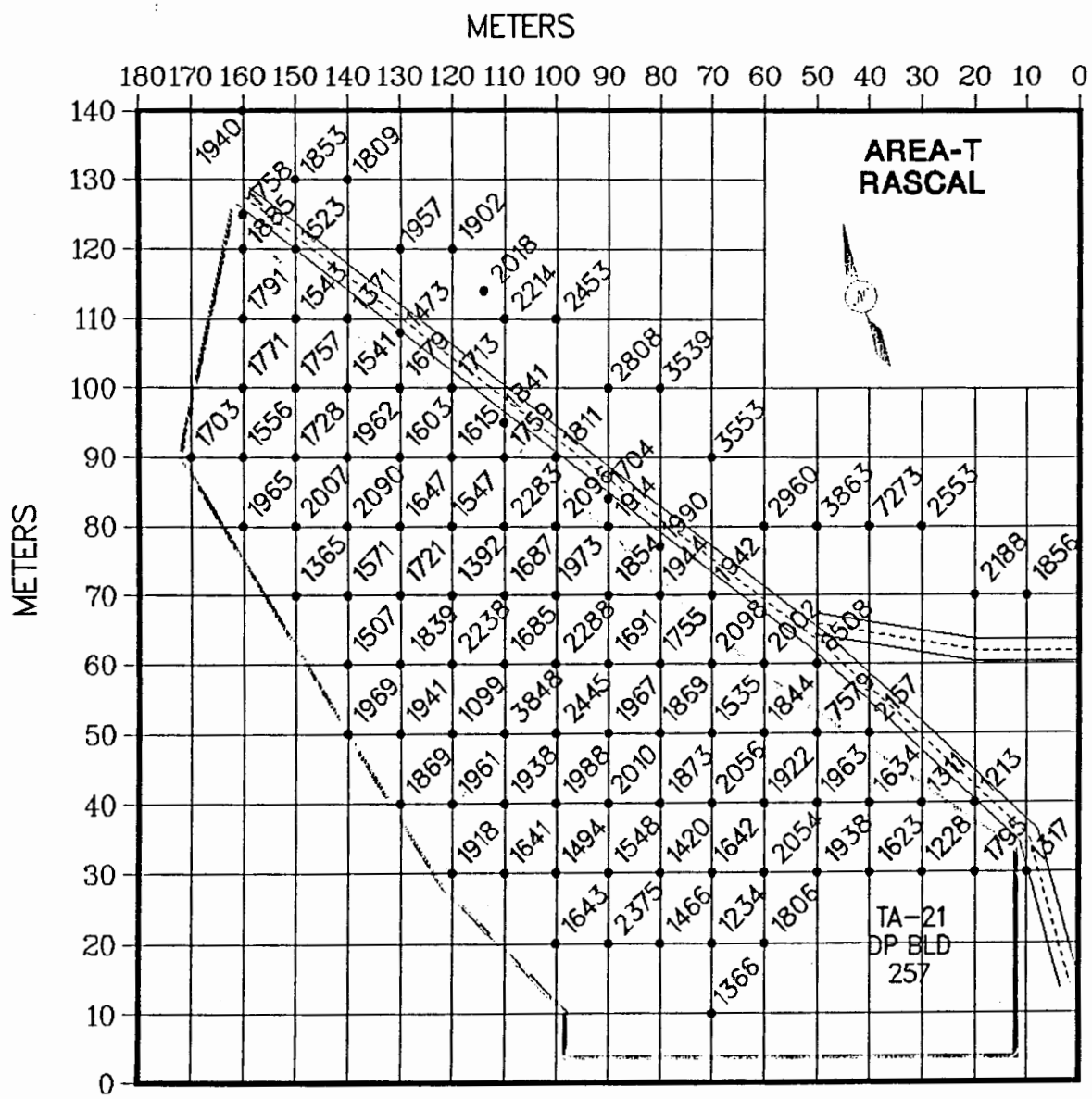

Figure 14. RASCAL counts per 120 seconds on the Area T sampling grid in 1986.

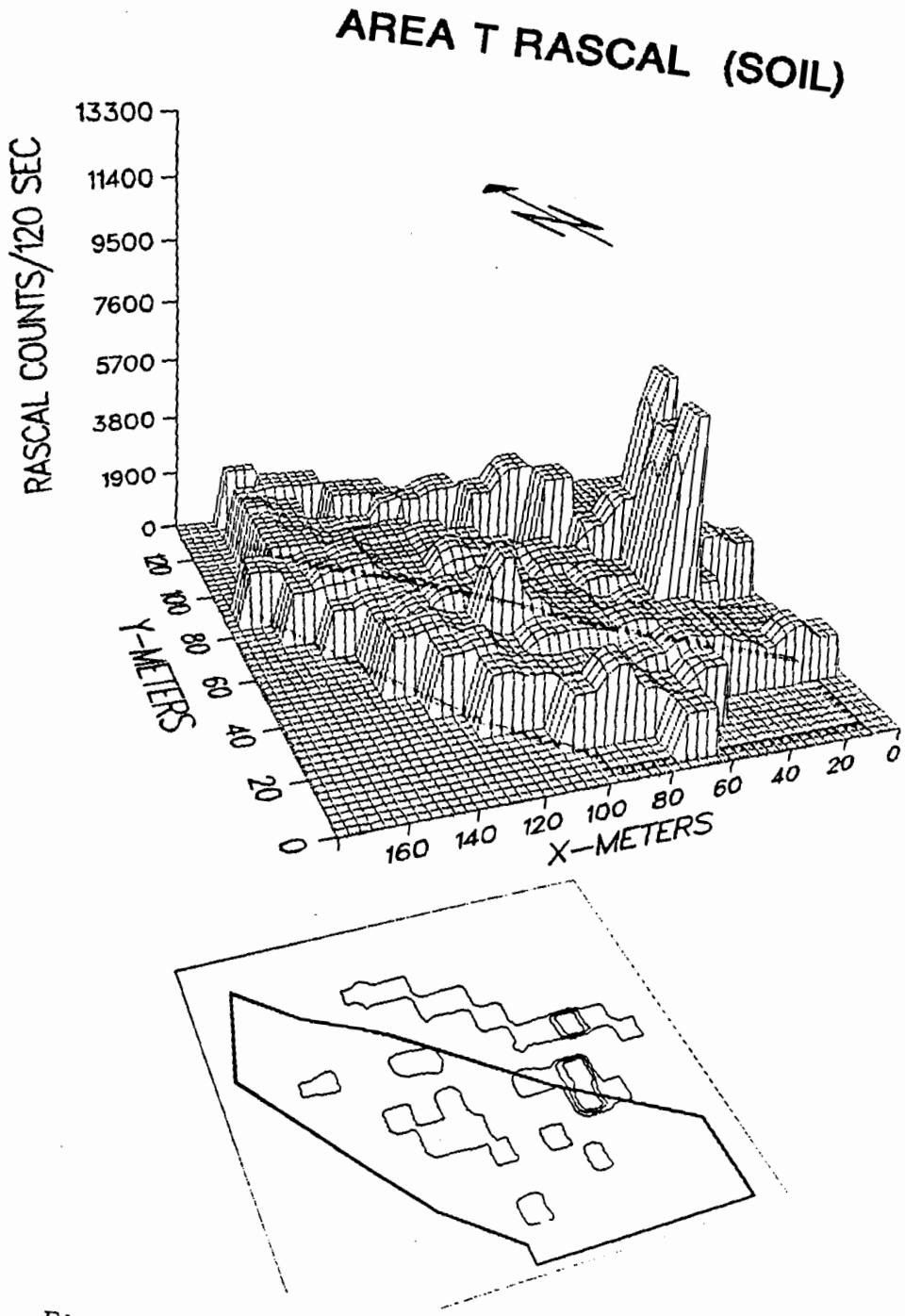

Figure 15. Three dimensional and contour plots of RASCAL counts per 120 sec on Area T in 1986.

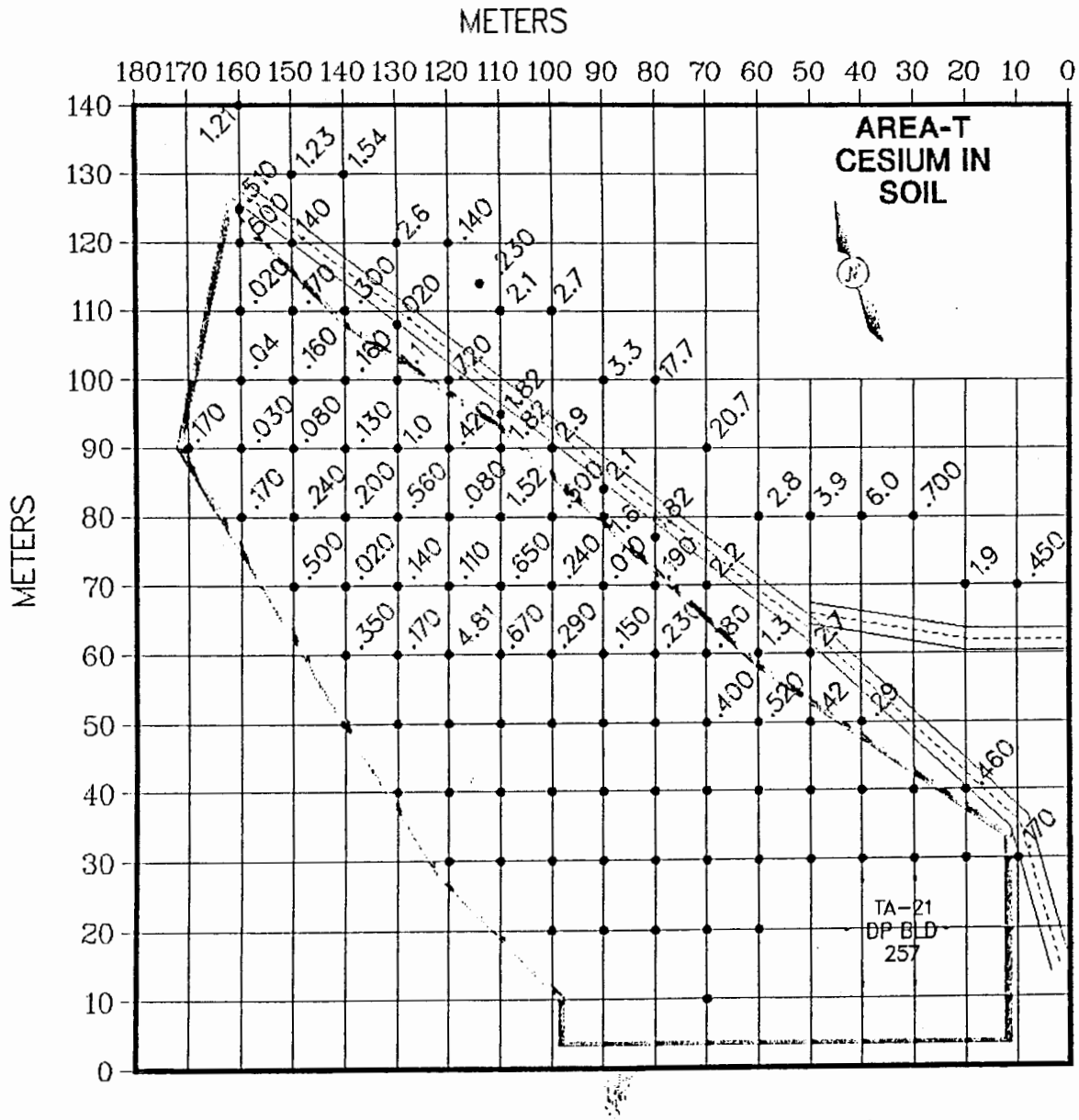

Figure 16. Cesium-137 concentrations (pCi/g dry wt.) in soil from Area T in 1986.

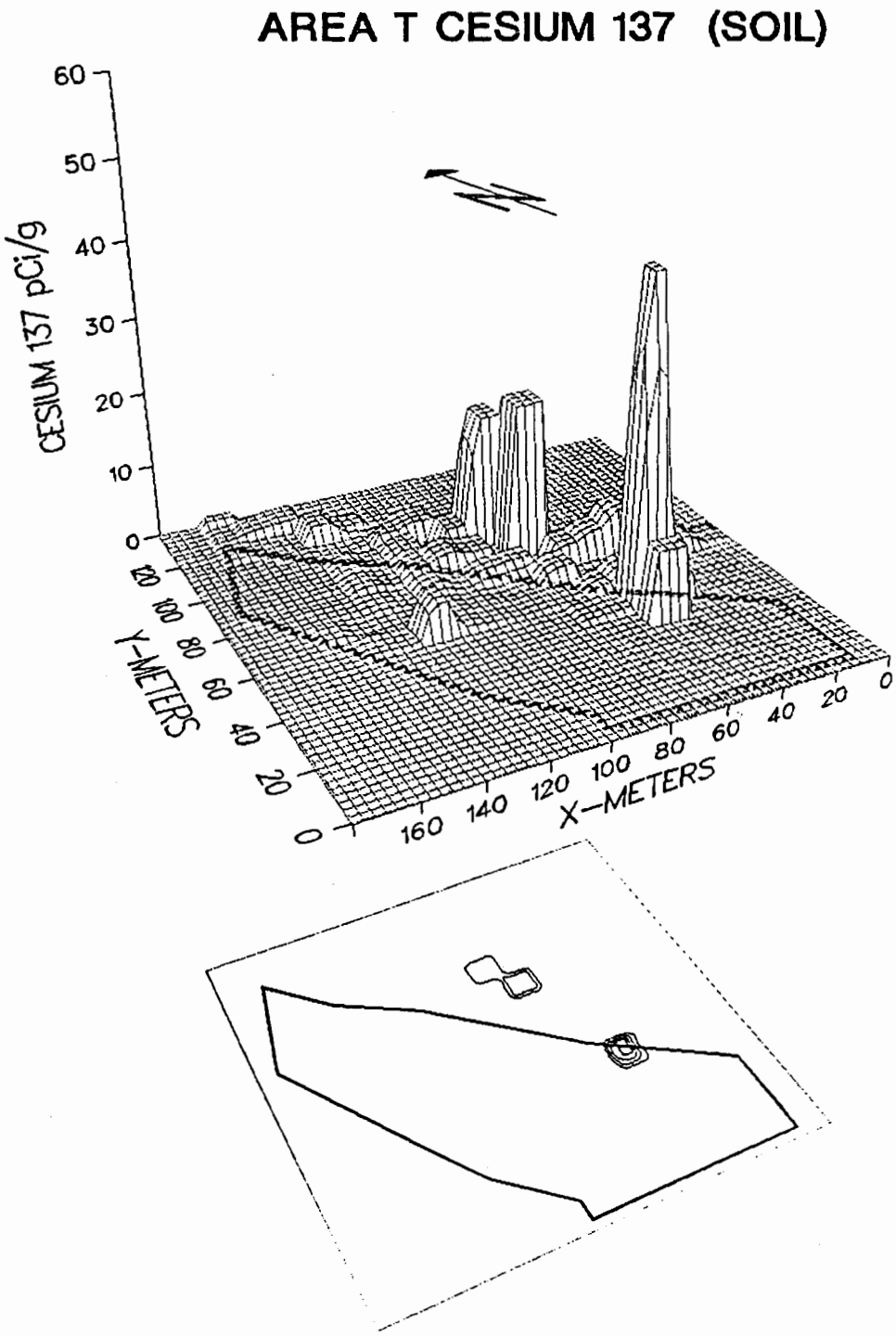

Figure 17. Three dimensional and contour plots of Cesium-137 concentrations (pCi/g dry wt.) in soil from Area T in 1986.

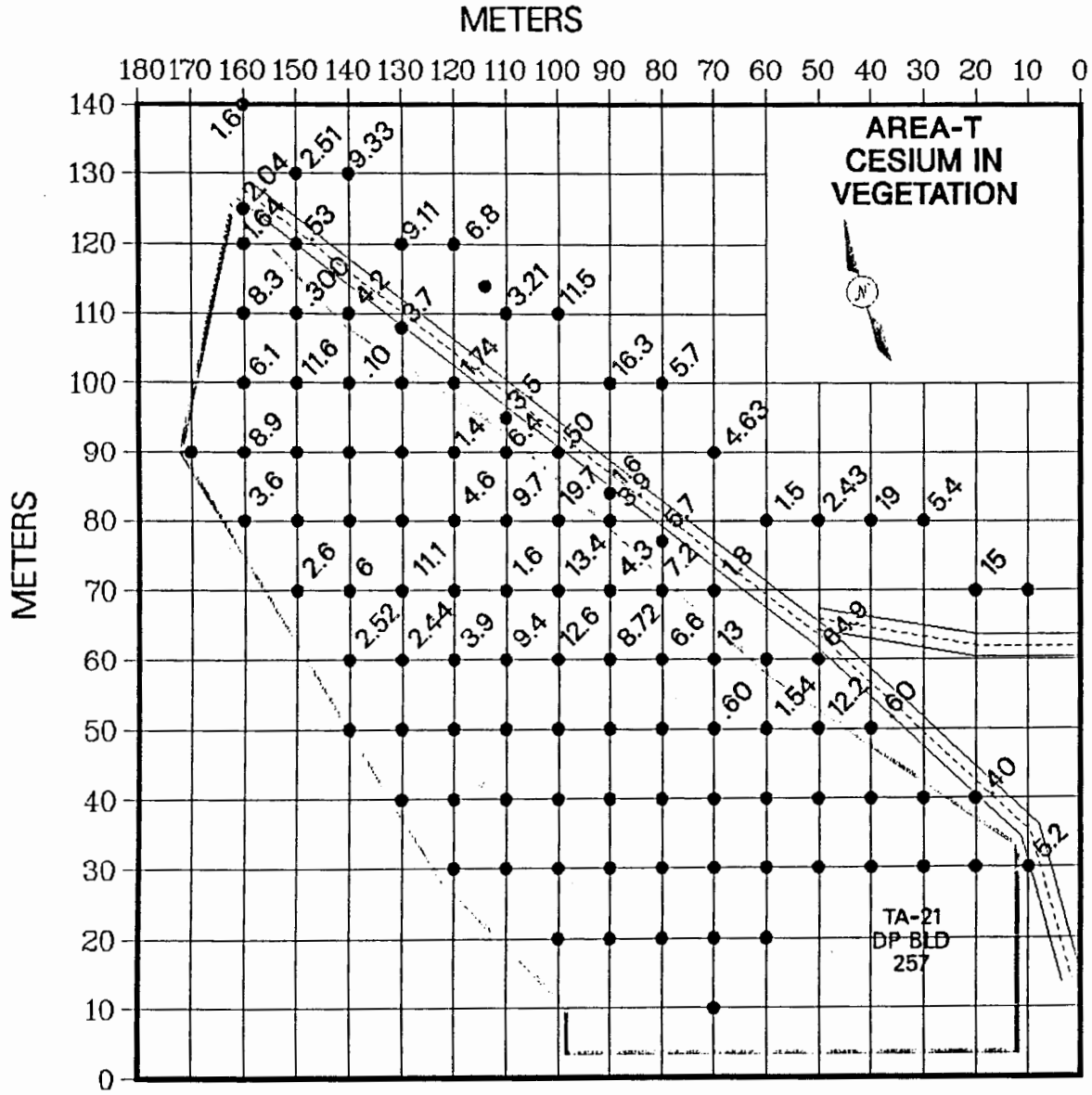

Figure 18. Cesium-137 concentrations (pCi/g dry wt.) in vegetation from Area T in 1986.

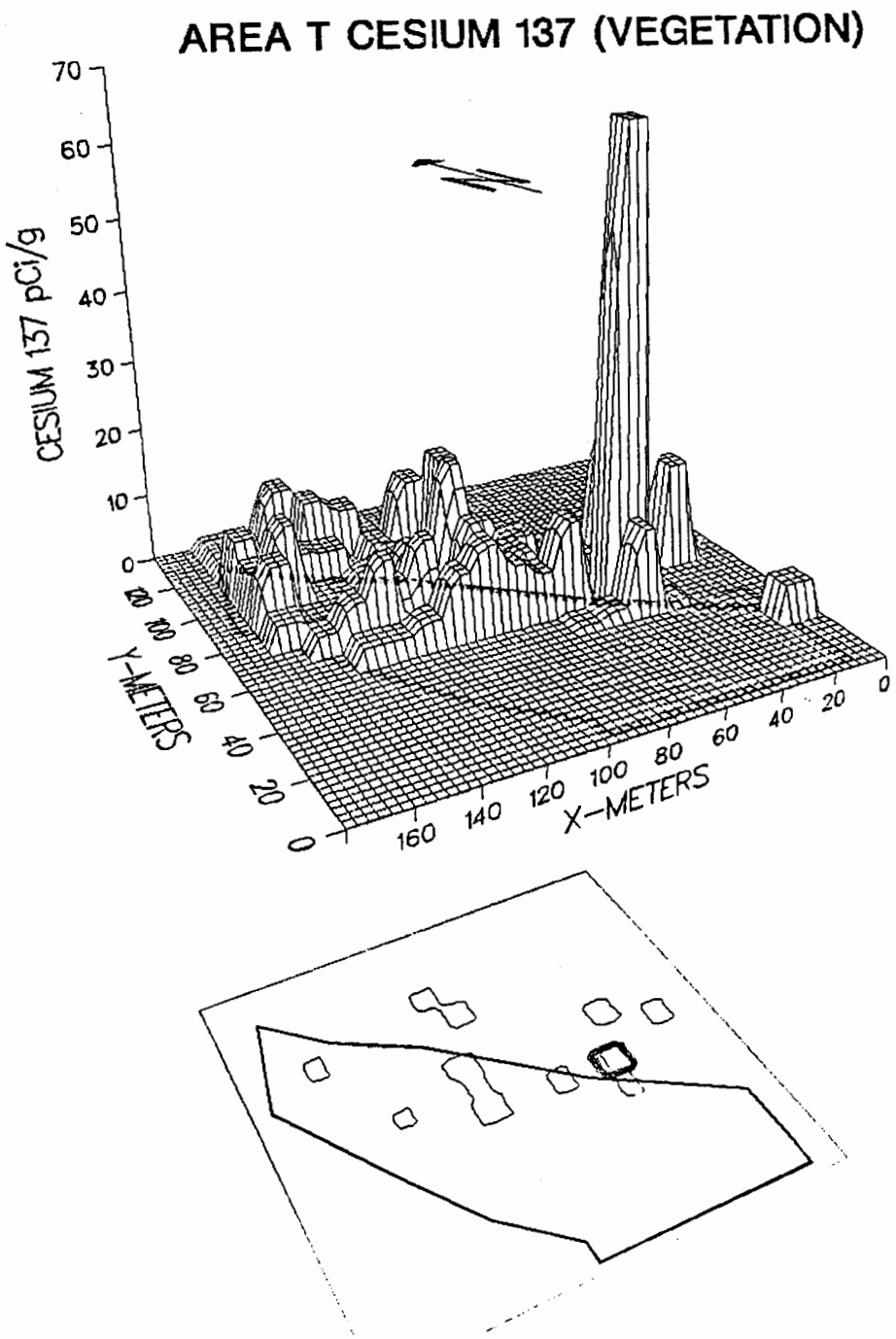

Figure 19. Three dimensional and contour plots of Cesium-137 concentrations (pCi/g dry wt.) in vegetation from Area T in 1986.

in soil from corresponding locations. Maximum ^{137}Cs concentrations in vegetation were about 65 pCi/g.

Plutonium-238, $^{239,240}Pu$, and ^{241}Am concentrations in soil and vegetation generally exceeded background levels reflecting a widespread, low level, source of these nuclides on the surface of Area T (Figs. 20-31). Concentrations in soil ranged from background up to 35 pCi ^{238}Pu/g, 70 pCi $^{239,240}Pu$/g. and 260 pCi ^{241}Am/g. These maxima all occurred within the site fence. As with previous data, a source of contamination exists outside the fenced area adjacent to DP-Canyon (see Figs. 20, 22, 24, 26, 28, 30).

In summary, the field instrument and radio-chemical analyses show that Area T and the downslope area to the rim of DP-Canyon contains radionuclides on or near the ground surface. On an activity per gram of soil or vegetation basis, ^{241}Am concentrations were 3-10 times higher than the other three radionuclides. All of the radionuclides were transported into the vegetation component of the system at levels predictable based on concentration ratio data in the published literature (White and Hakonson 1979).

Area K

The results of the Phoswich (Figs. 32 and 33) and RASCAL (Figs. 34 and 35) survey suggest little in the way of a radiation sources to which these instruments respond (see Area K background data in Table 7). The two areas where a slightly elevated instrument response (PN 346298, serial number 108006) was obtained was at x, y grid location 10, 60 near building TA-33-86 and along the intermittant stream channel downslope from Area K. The uranium concentration data for soil (Figs. 36 and 37) and vegetation (Figs. 38 and 39) were at background (Table 7) for all samples.

In contrast, tritium concentrations in soil (Figs. 40 and 41) and vegetation (Figs. 42 and 43) measured into the μCi/L range, reflecting the

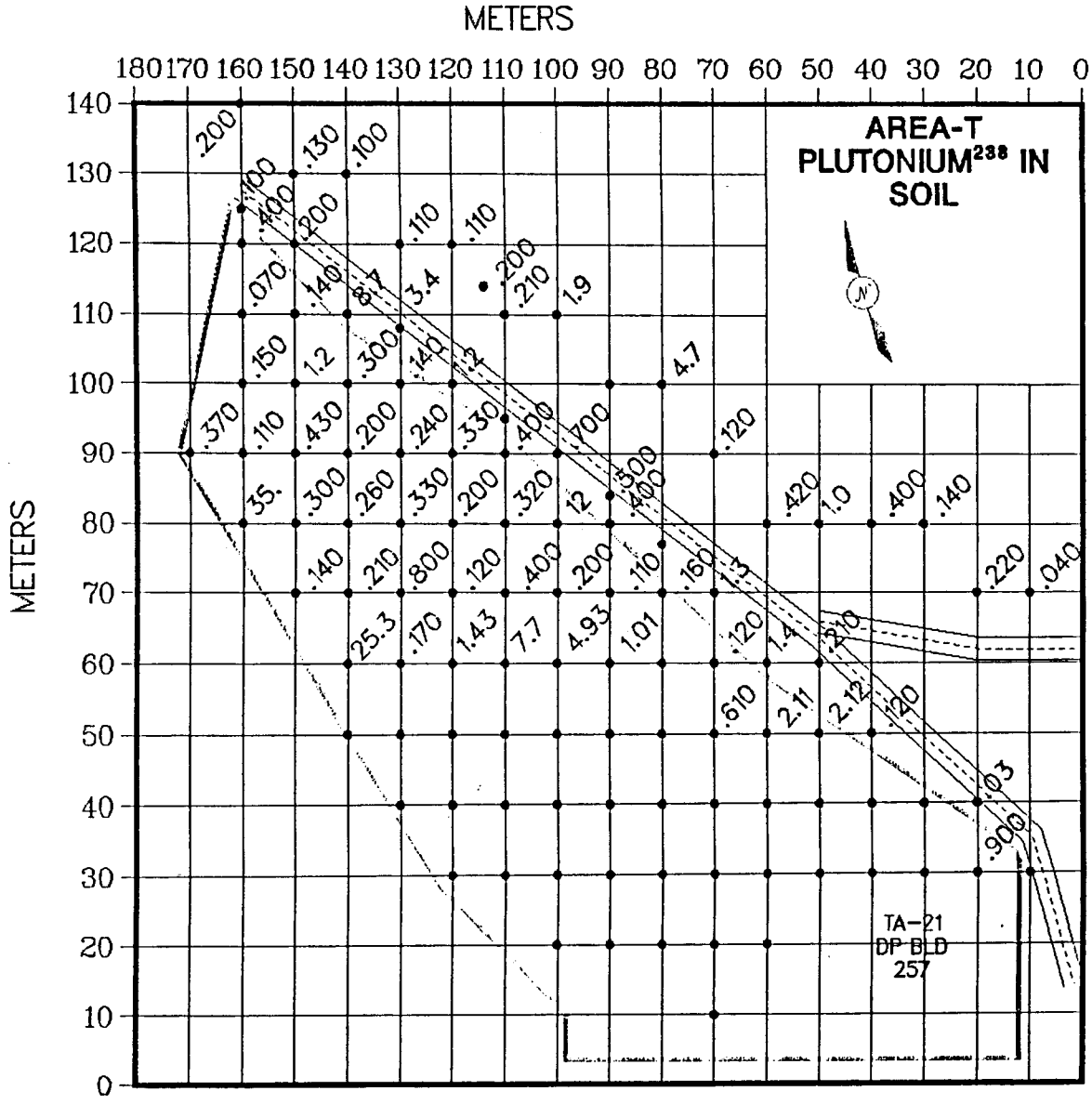

Figure 20. Plutonium-238 concentrations (pCi/g dry wt.) in soil from Area T in 1986.

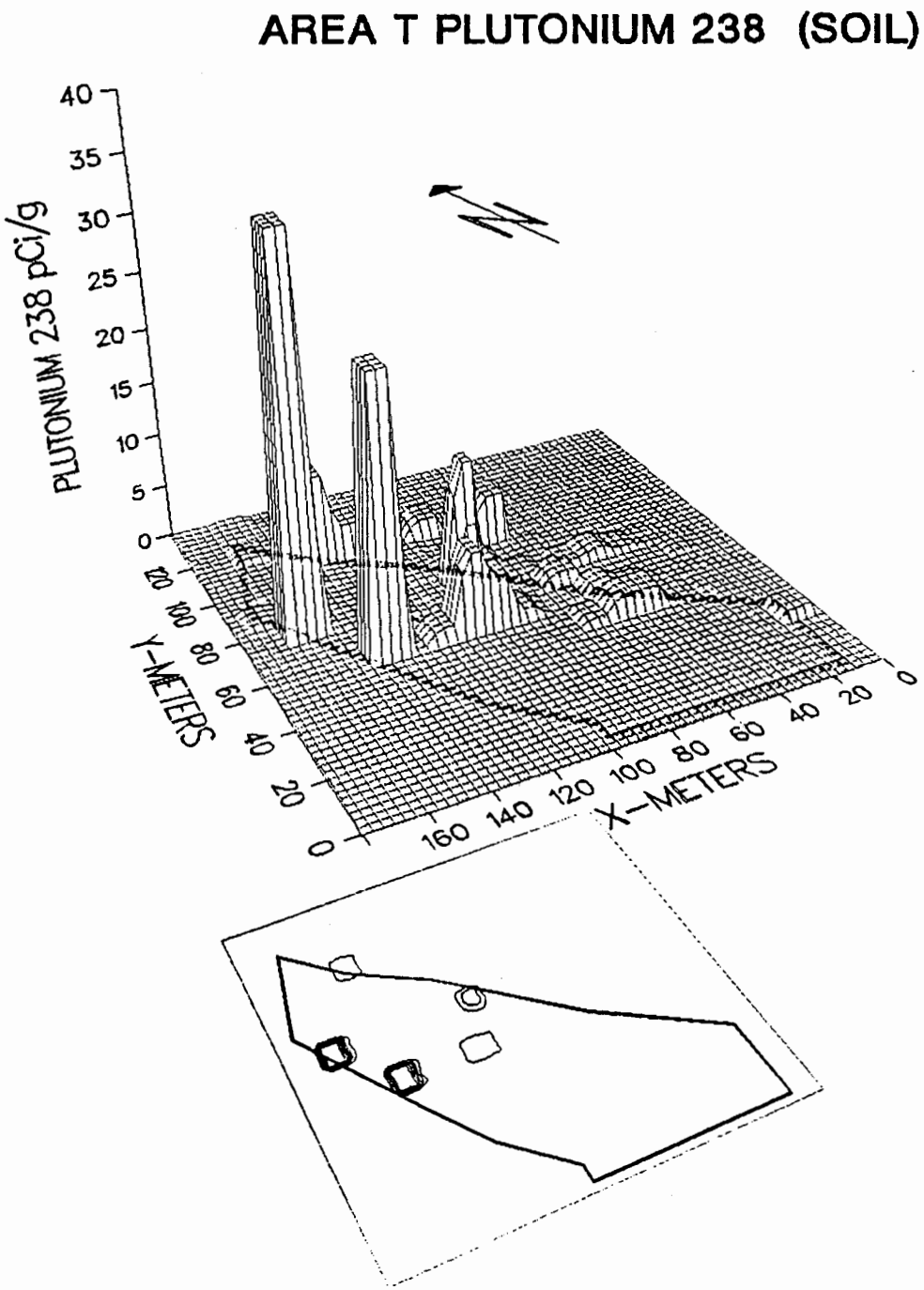

Figure 21. Three dimensional and contour plots of plutonium-238 concentrations (pCi/g dry wt.) in soil for Area T in 1986.

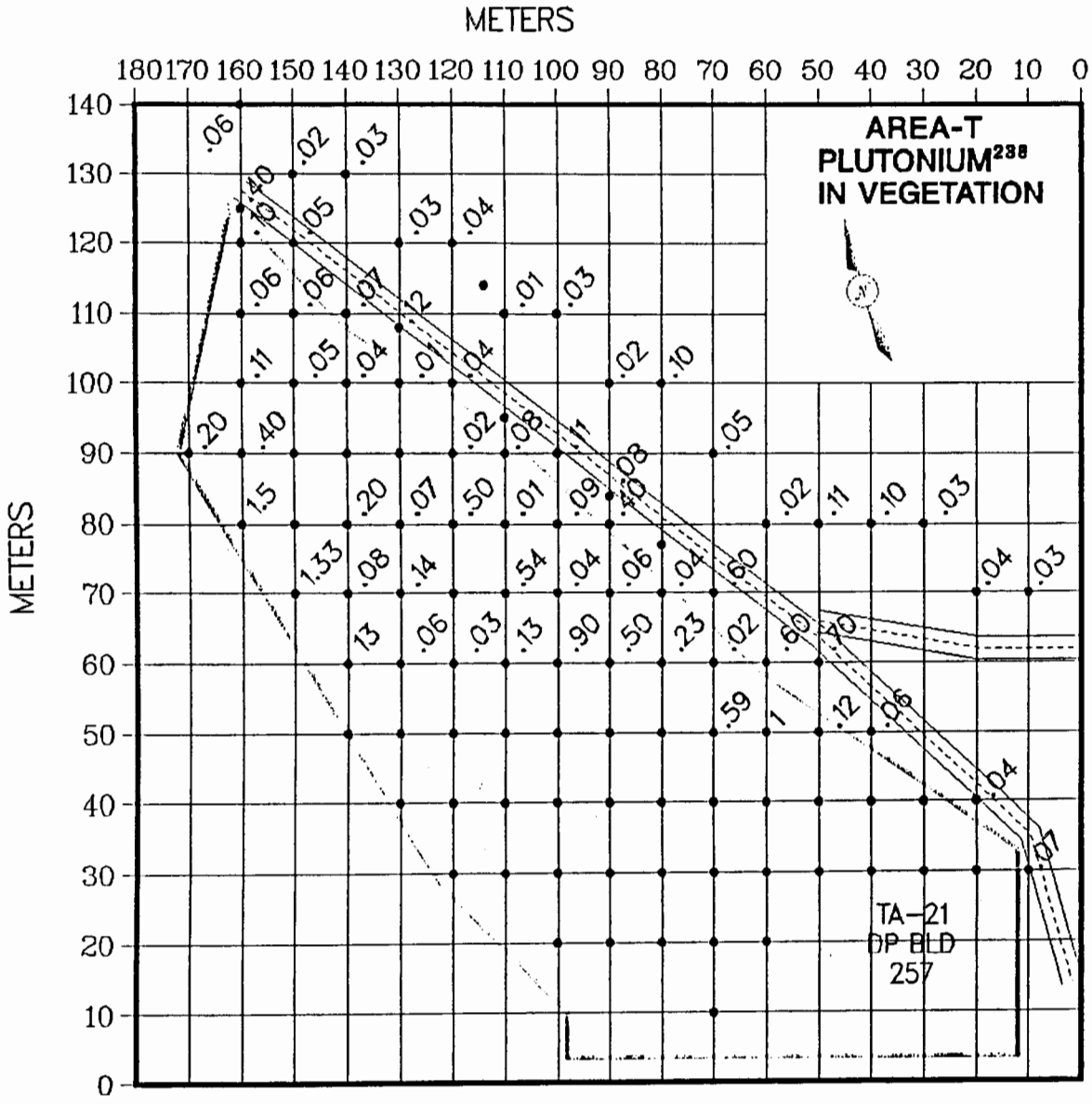

Figure 22. Plutonium-238 concentrations (pCi/g dry wt.) in vegetation from Area T in 1986.

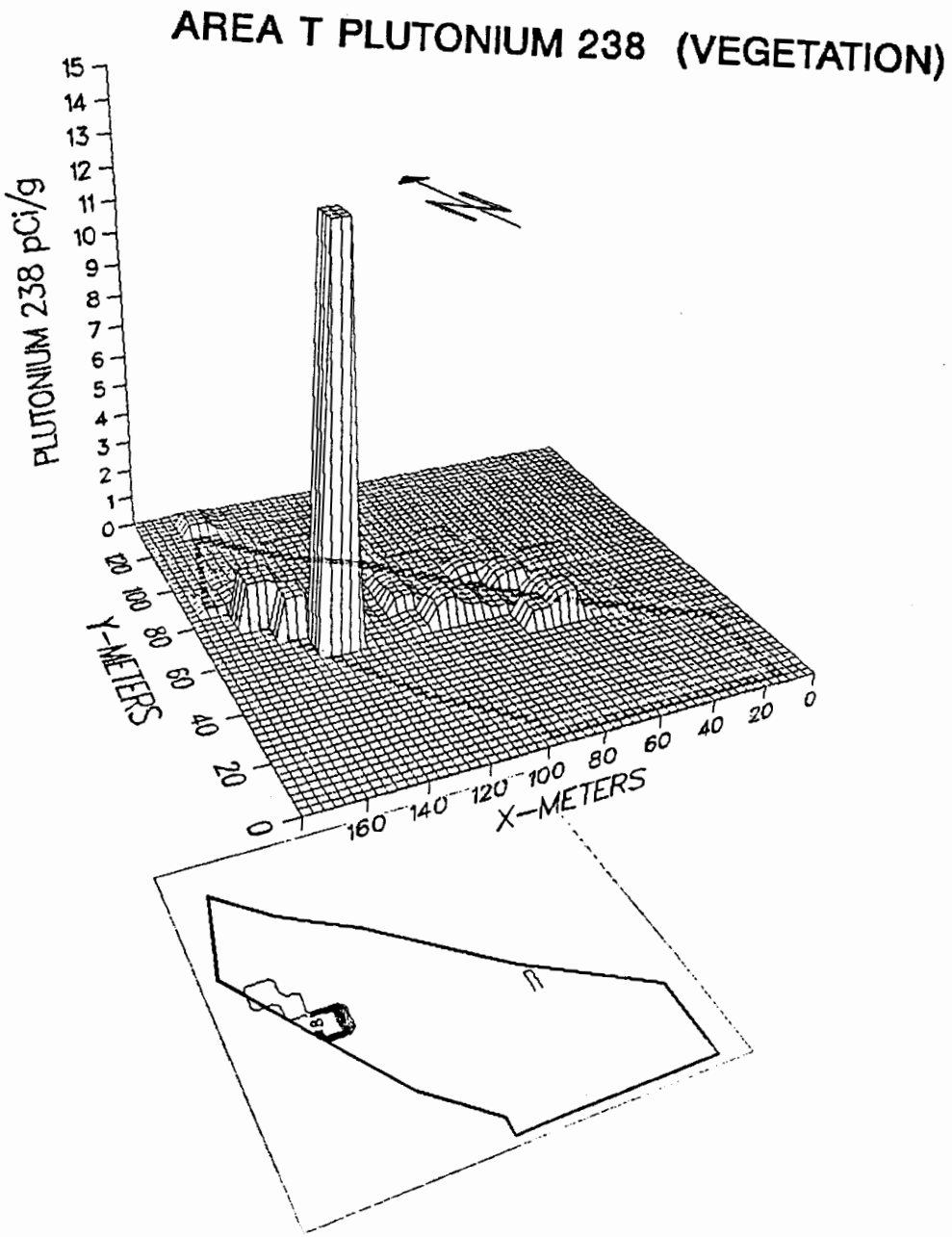

Figure 23. Three dimensional and contour plots of plutonium-238 concentrations (pCi/g dry wt.) in vegetation from Area T in 1986.

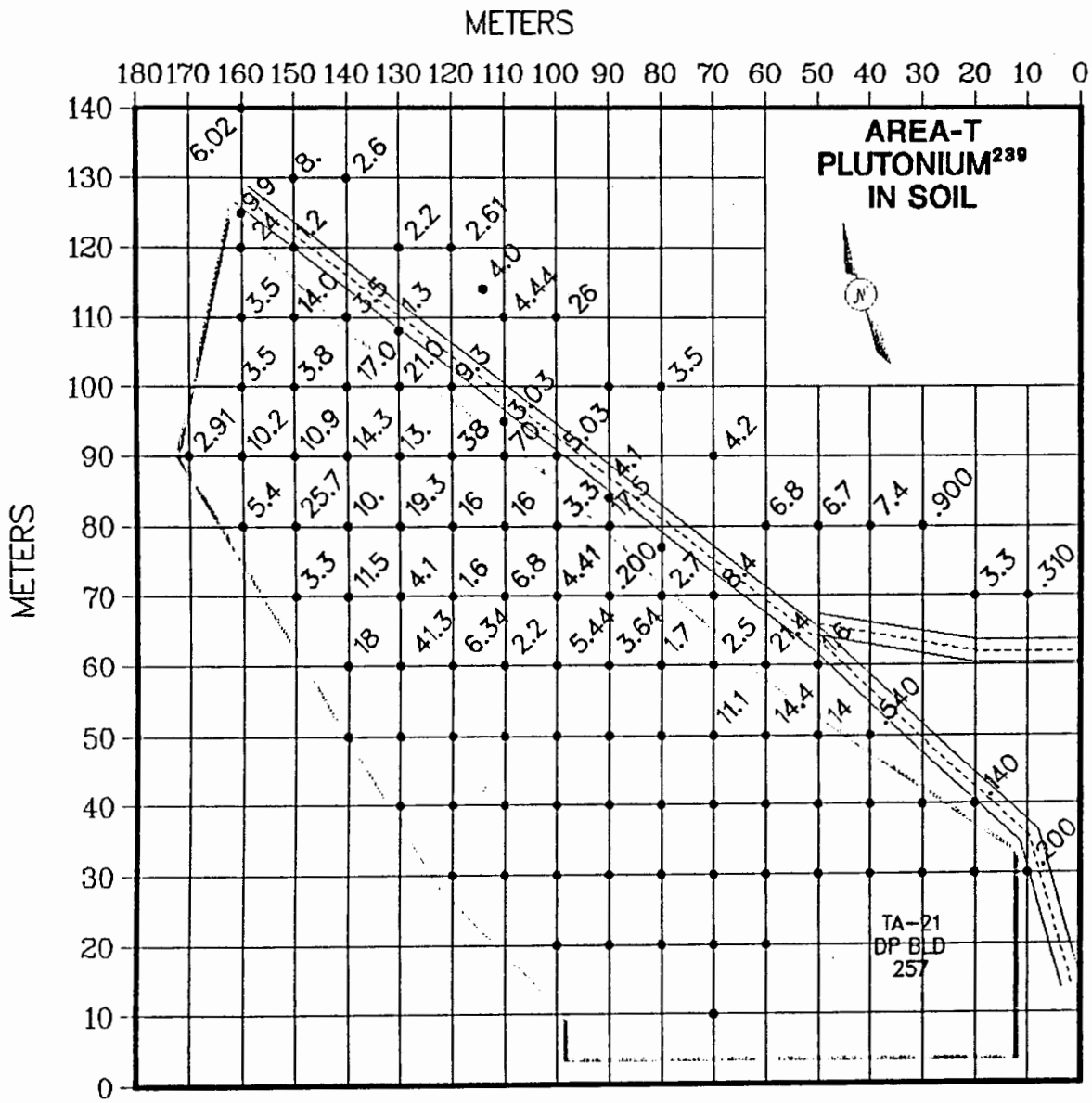

Figure 24. Plutonium-239,240 concentrations (pCi/g dry wt.) in soil from Area T in 1986.

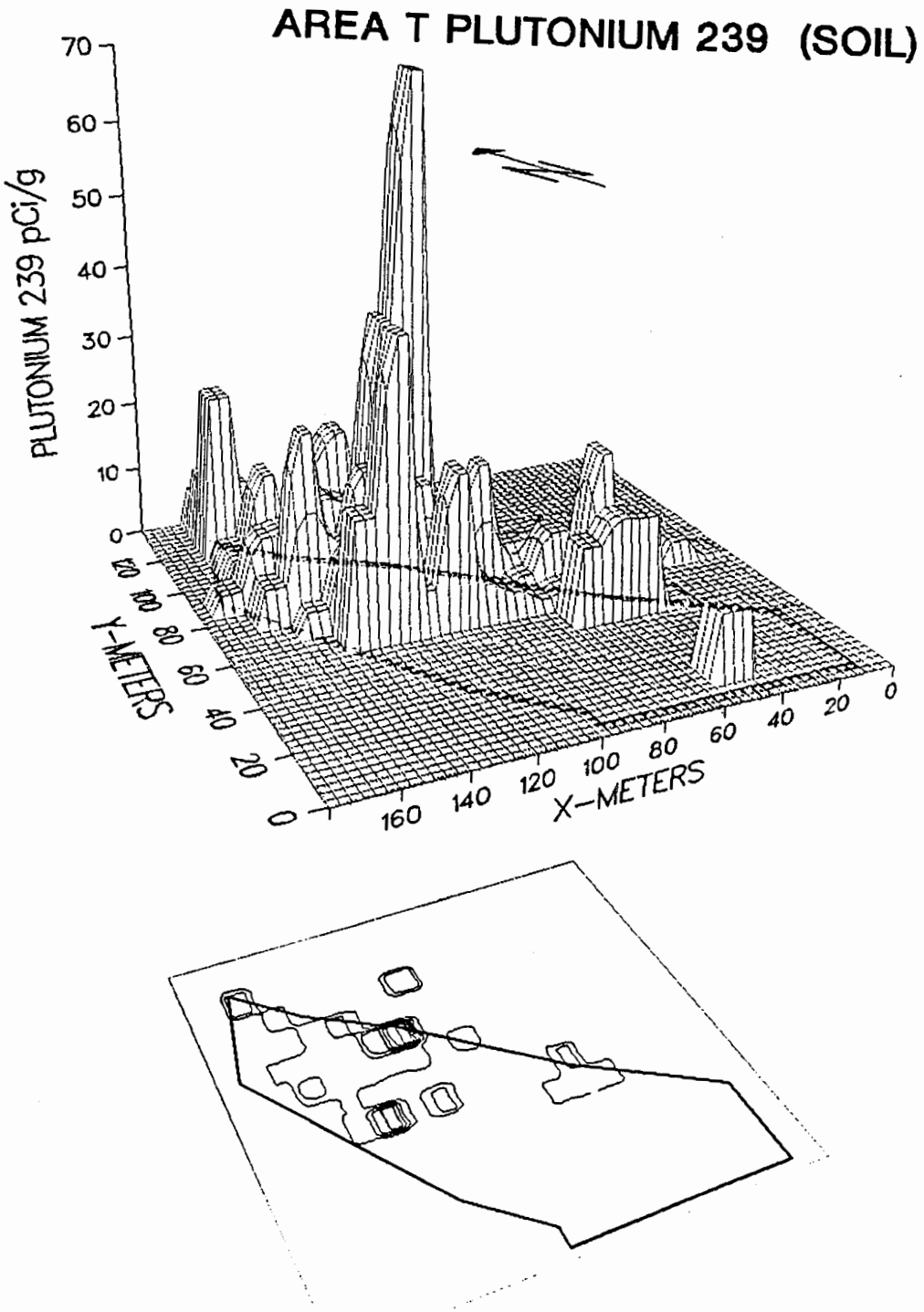

Figure 25. Three dimensional and contour plots of plutonium-239,240 concentrations (pCi/g dry wt.) in soil from Area T in 1986.

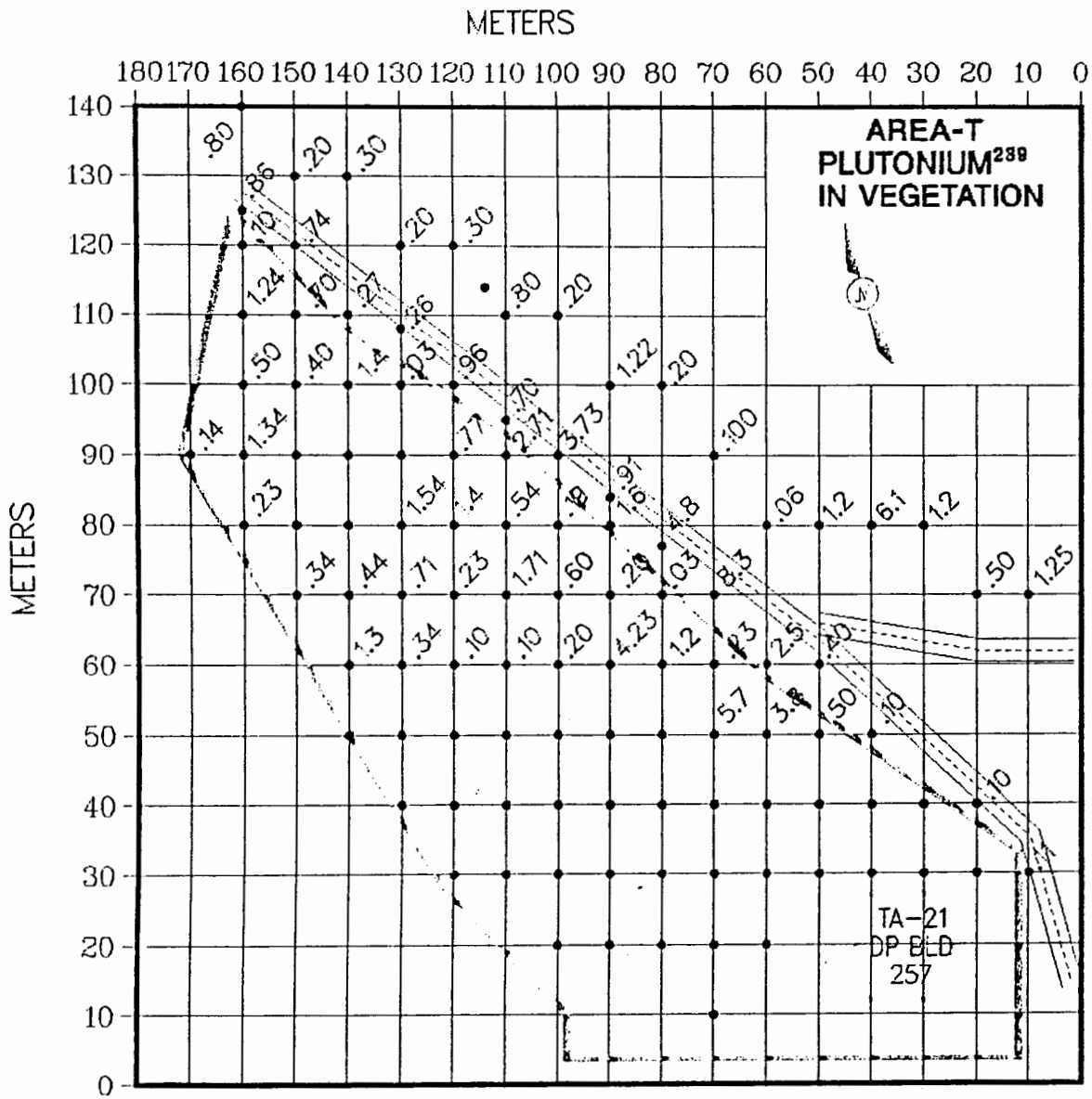

Figure 26. Plutonium-239,240 concentrations (pCi/g dry wt.) in vegetation from Area T in 1986.

AREA T PLUTONIUM 239 (VEGETATION)

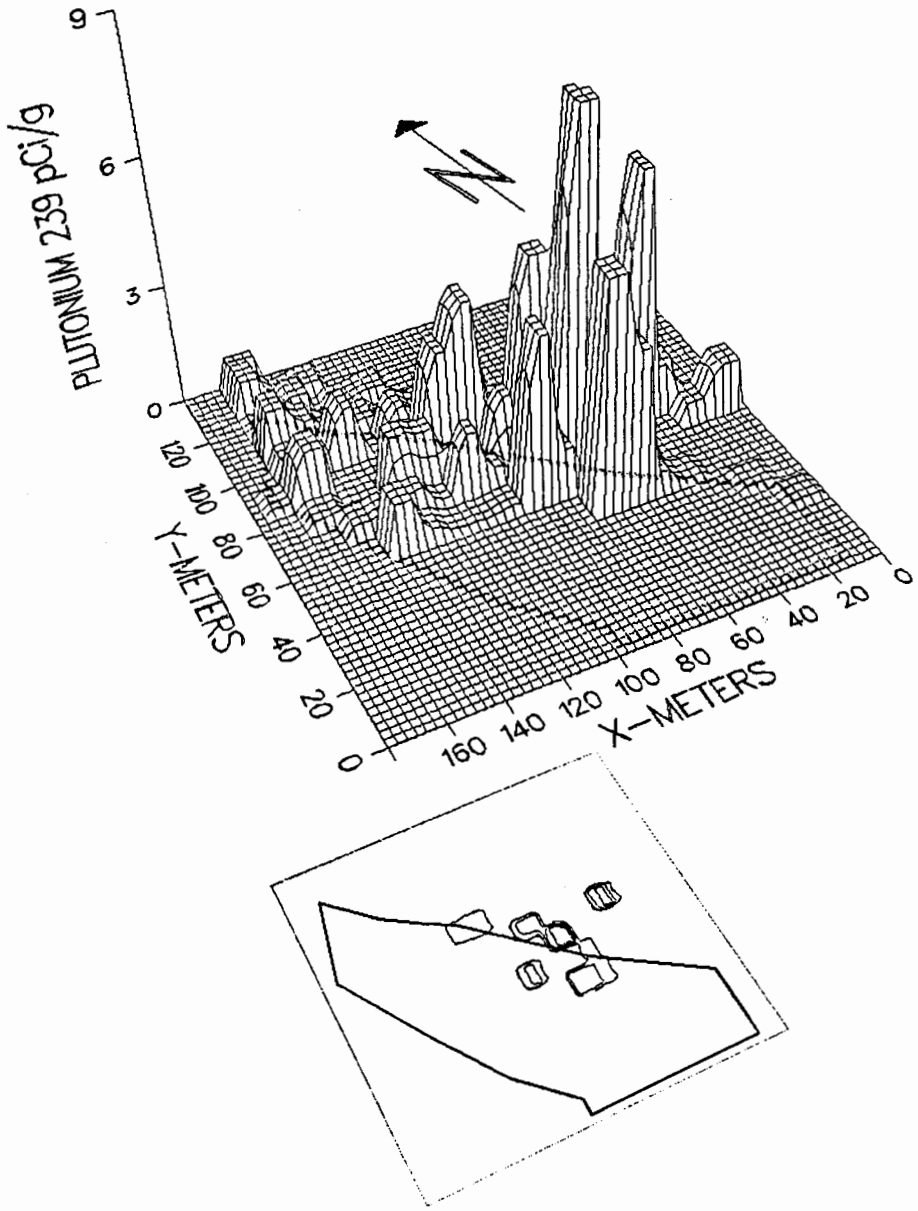

Figure 27. Three dimensional and contour plots of plutonium-239,240 concentrations (pCi/g dry wt.) in vegetation from Area T in 1986.

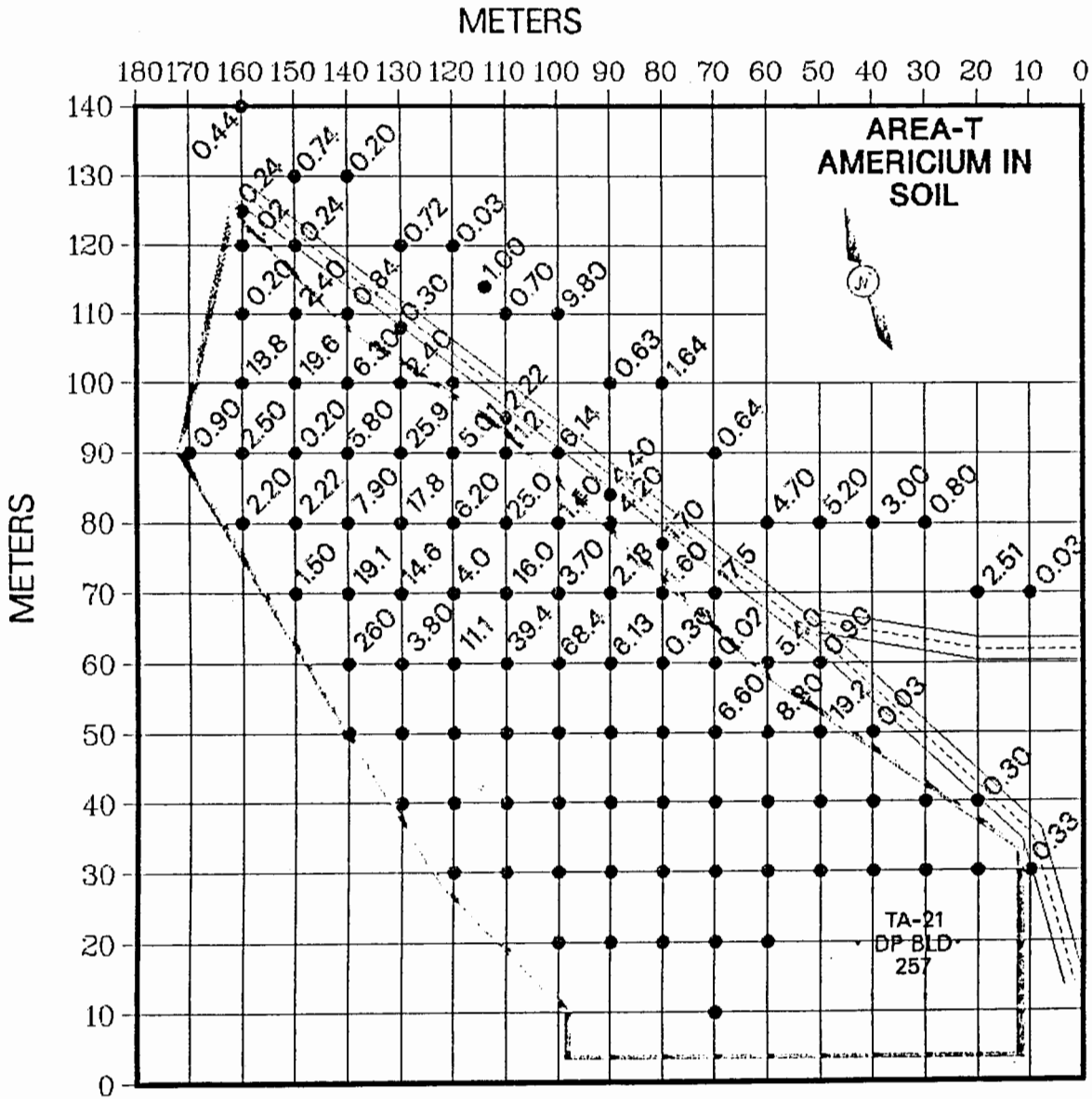

Figure 28. Americium-241 concentrations (pCi/g dry wt.) in soil from Area T in 1986.

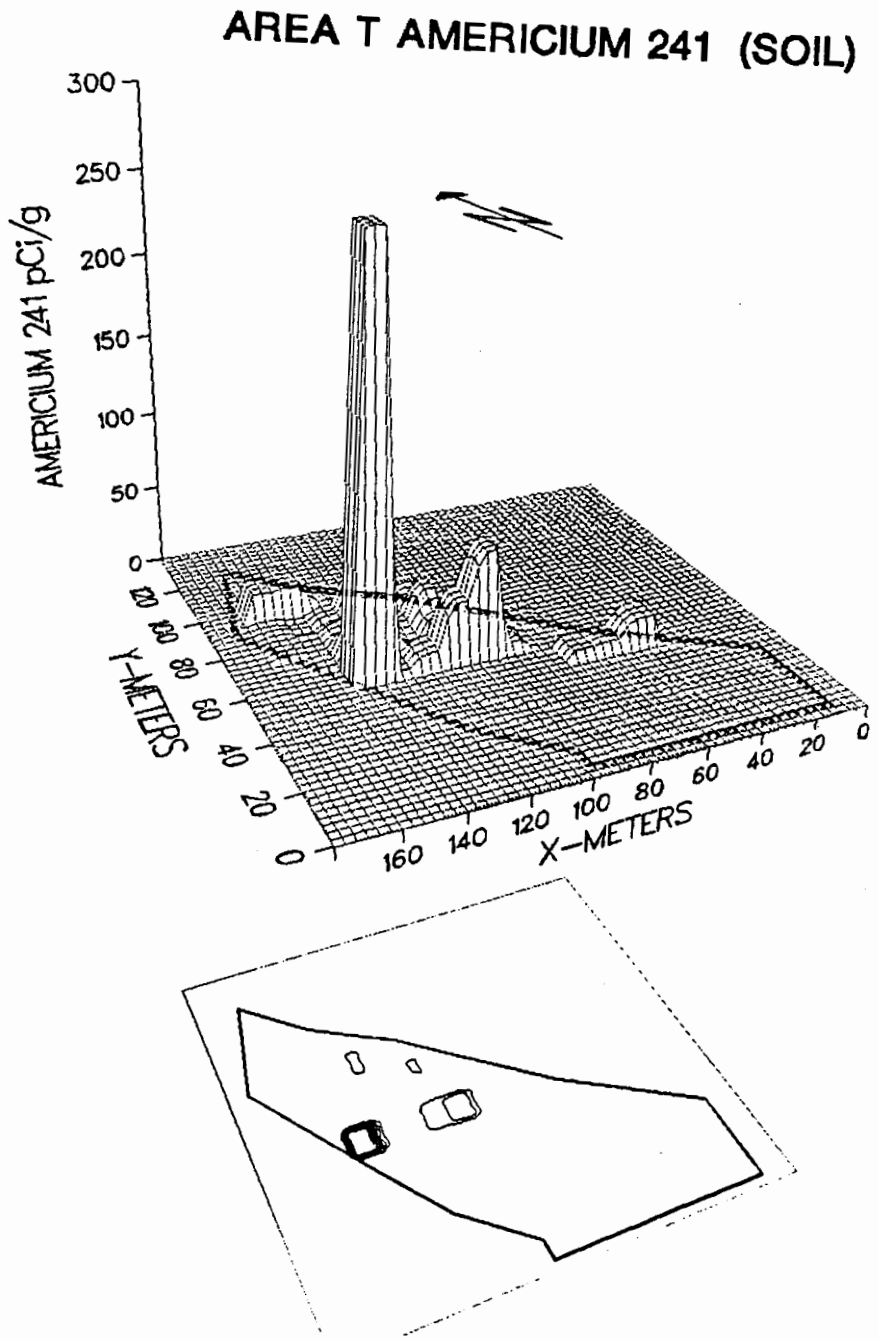

Figure 29. Three dimensional and contour plots of Americium-241 concentrations (pCi/g dry wt.) in soil from Area T in 1986.

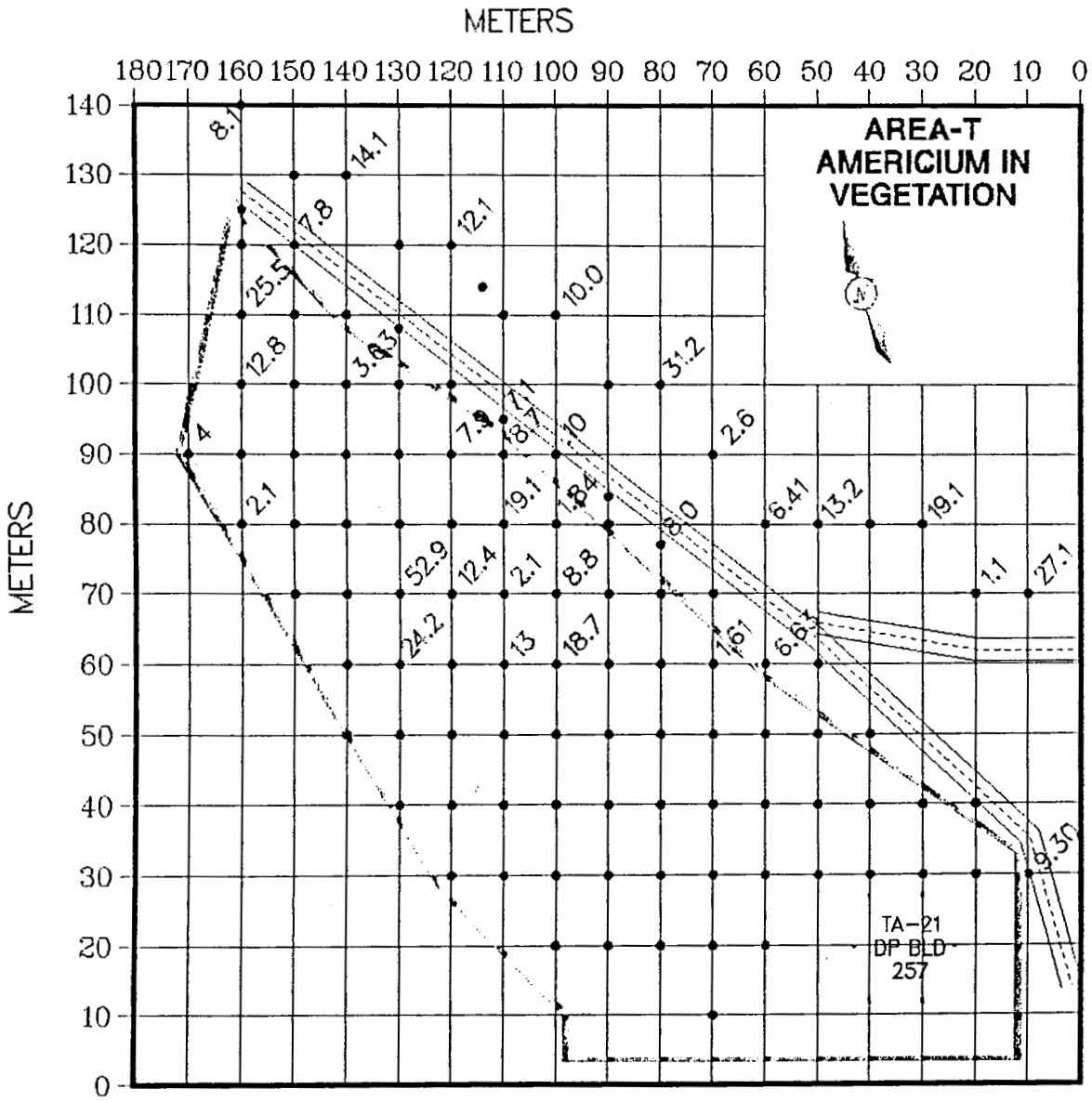

Figure 30. Americium-241 concentrations (pCi/g dry wt.) in vegetation from Area T in 1986.

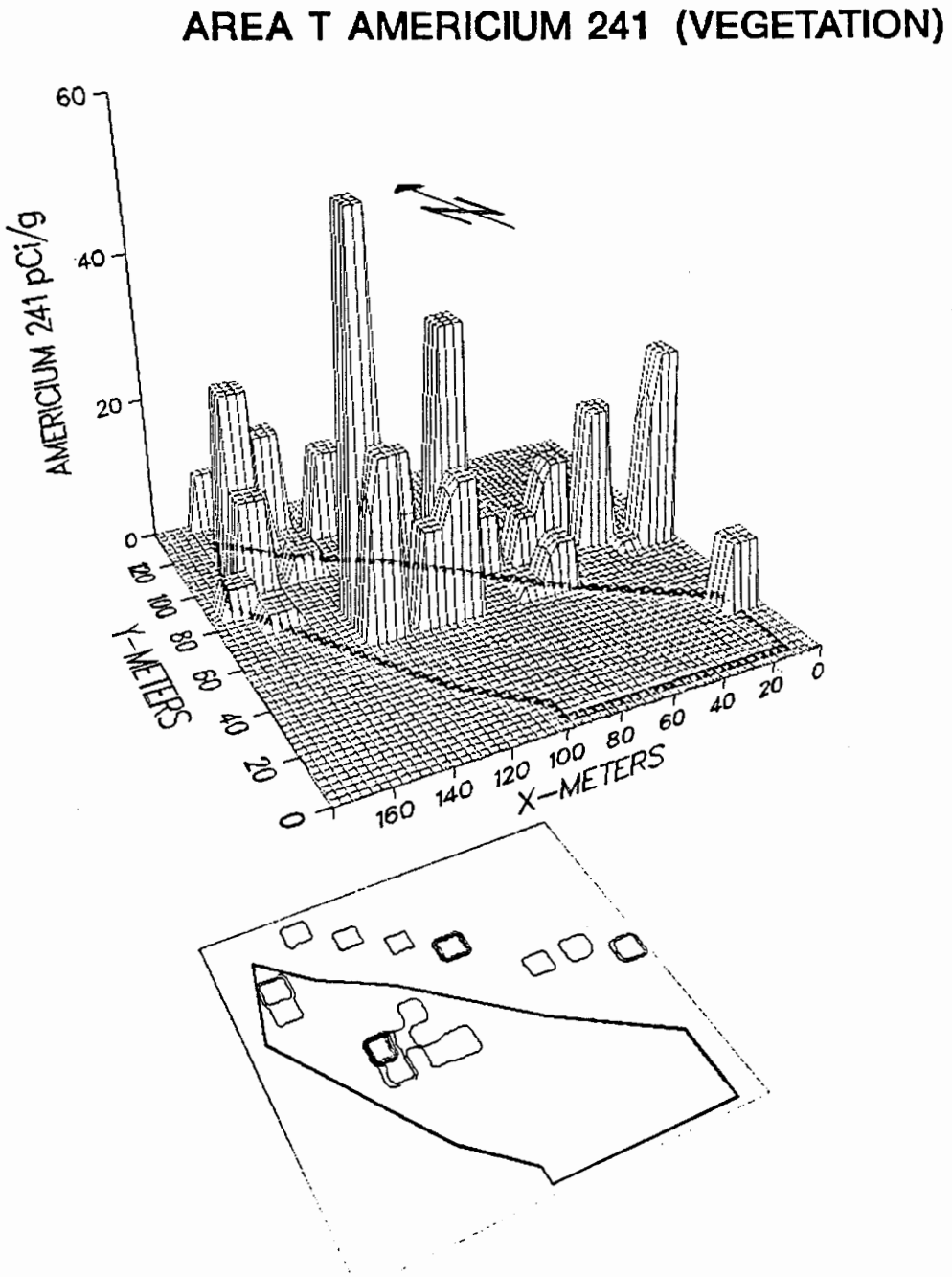

Figure 31. Three dimensional and contour plots of Americium-241 concentrations (pCi/g dry wt.) in vegetation from Area T in 1986.

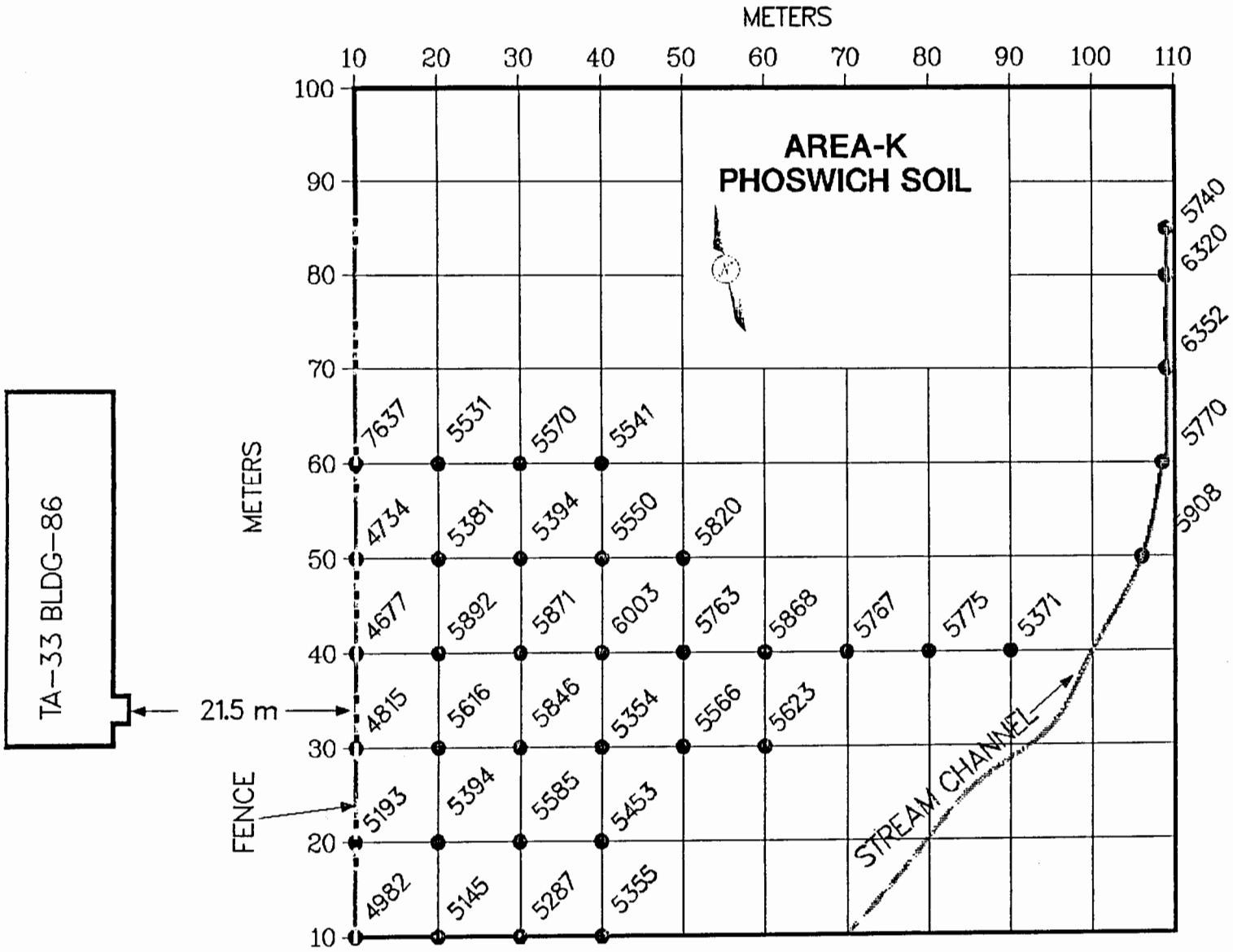

Figure 32. Phoswich counts per 100 seconds on the Area K sampling grid in 1986.

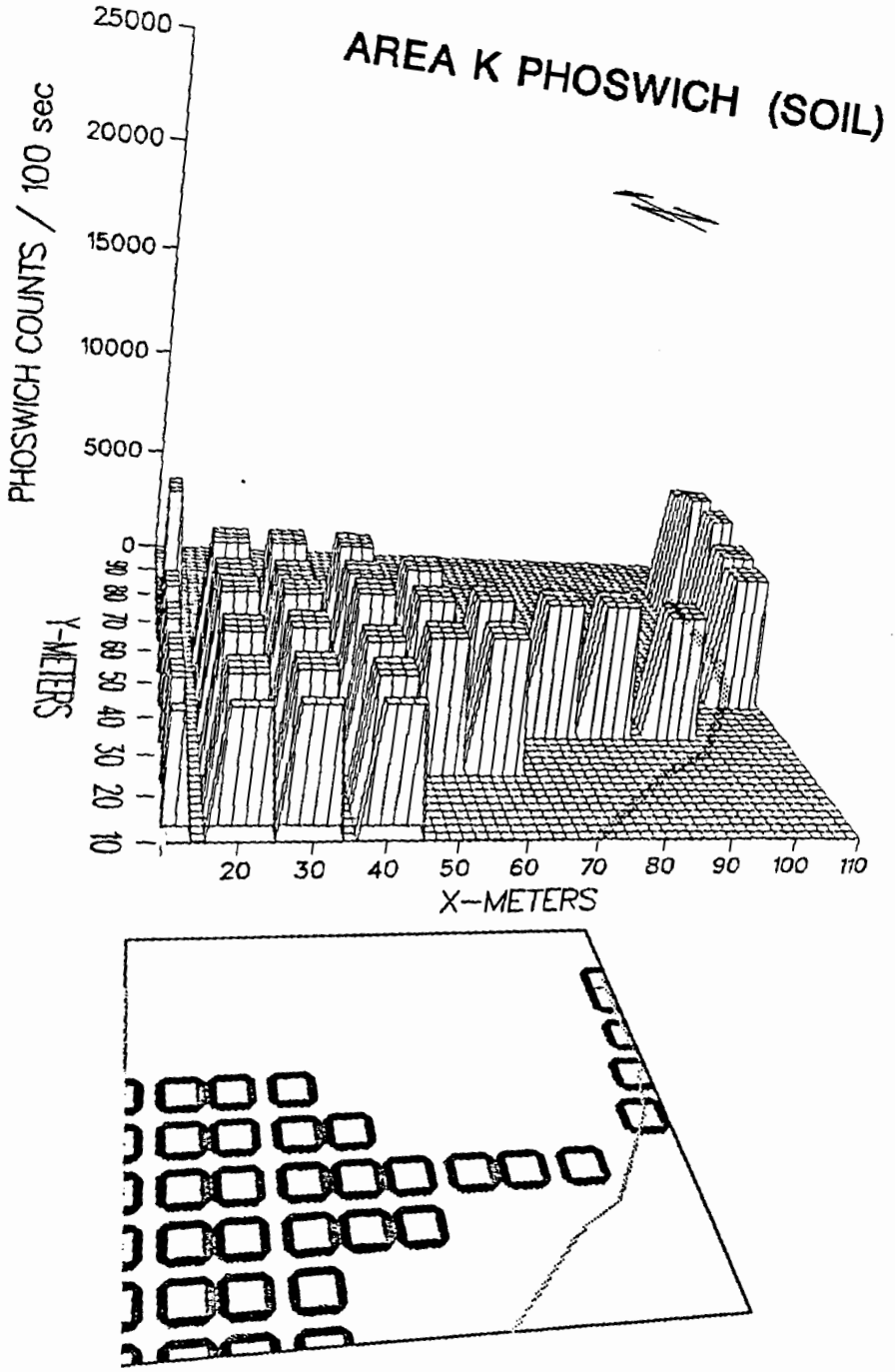

Figure 33. Three dimensional and contour plots of phowsich counts per 100 secs on Area K in 1986.

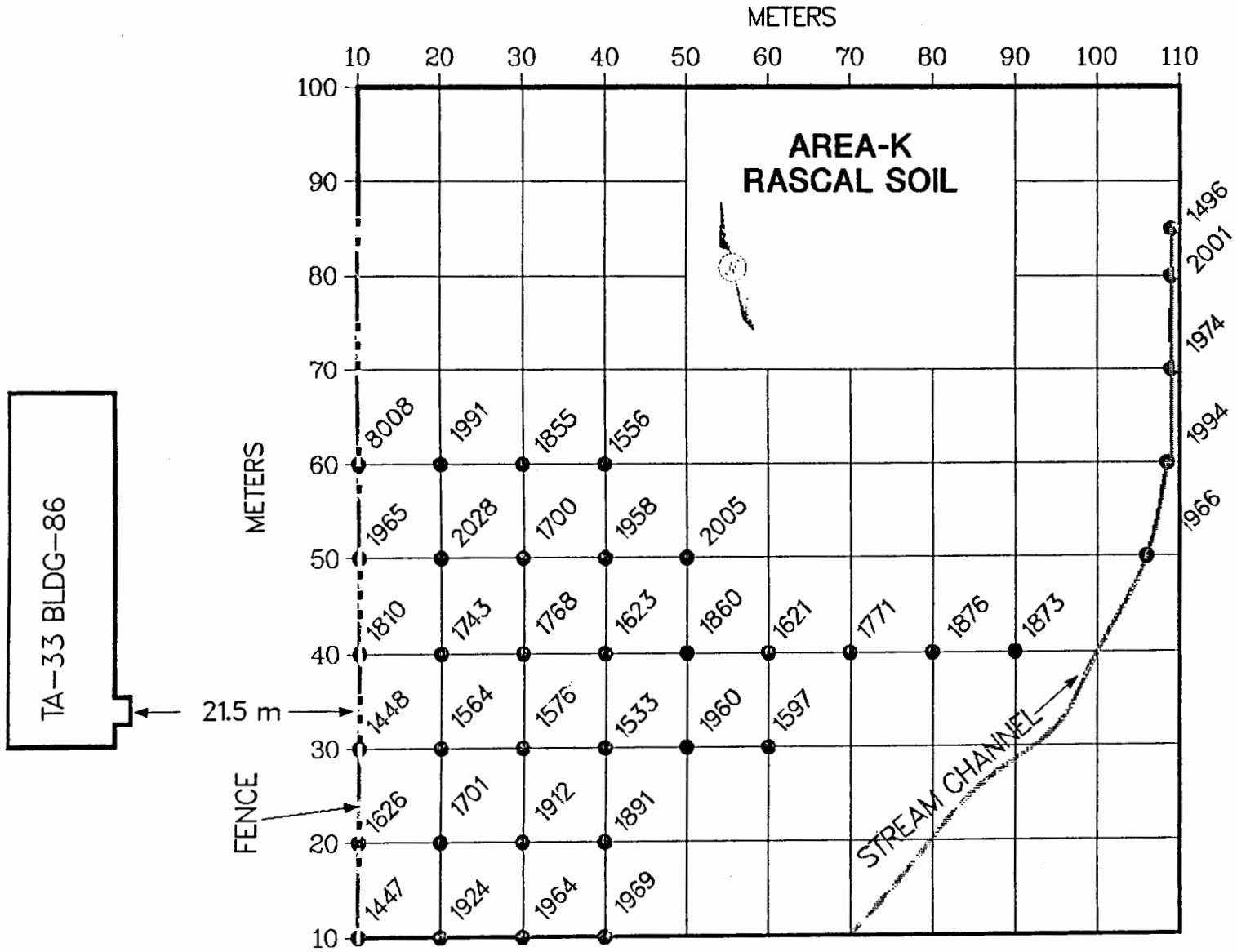

Figure 34. RASCAL counts per 120 seconds on the Area K sampling grid in 1986.

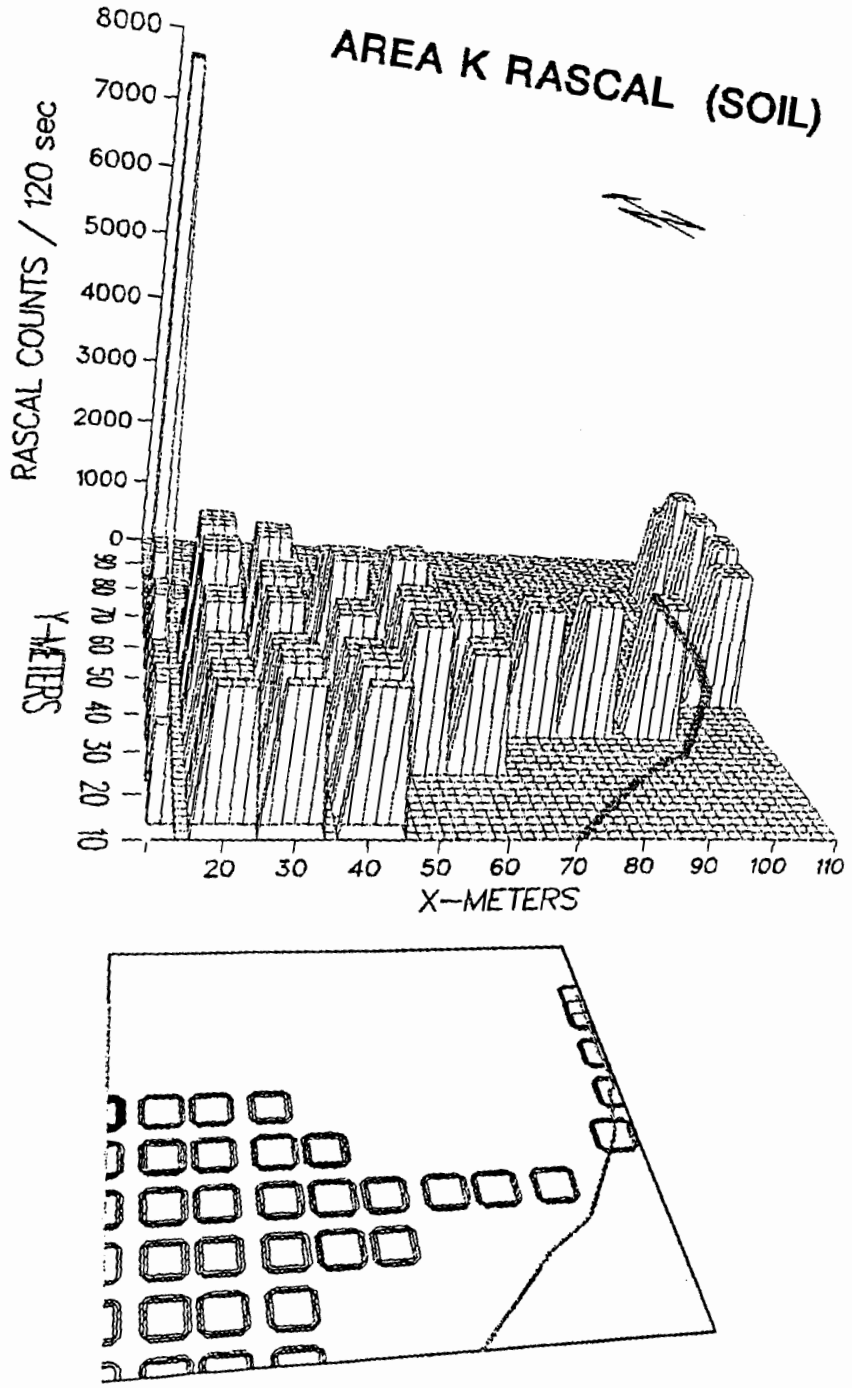

Figure 35. Three dimensional and contour plots of RASCAL counts on Area K in 1986.

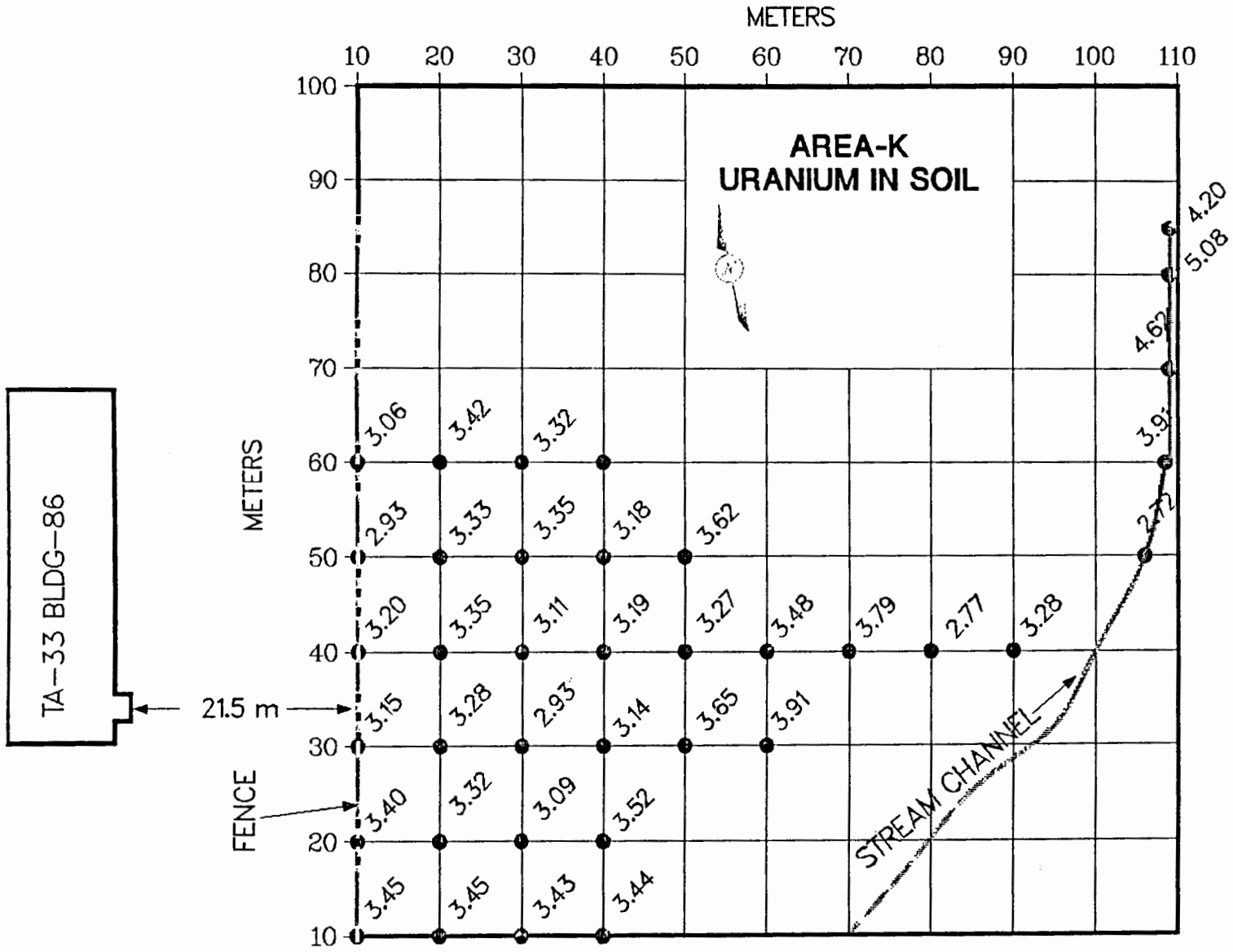

Figure 36. Total uranium concentrations (ppm) in soil from Area K in 1986.

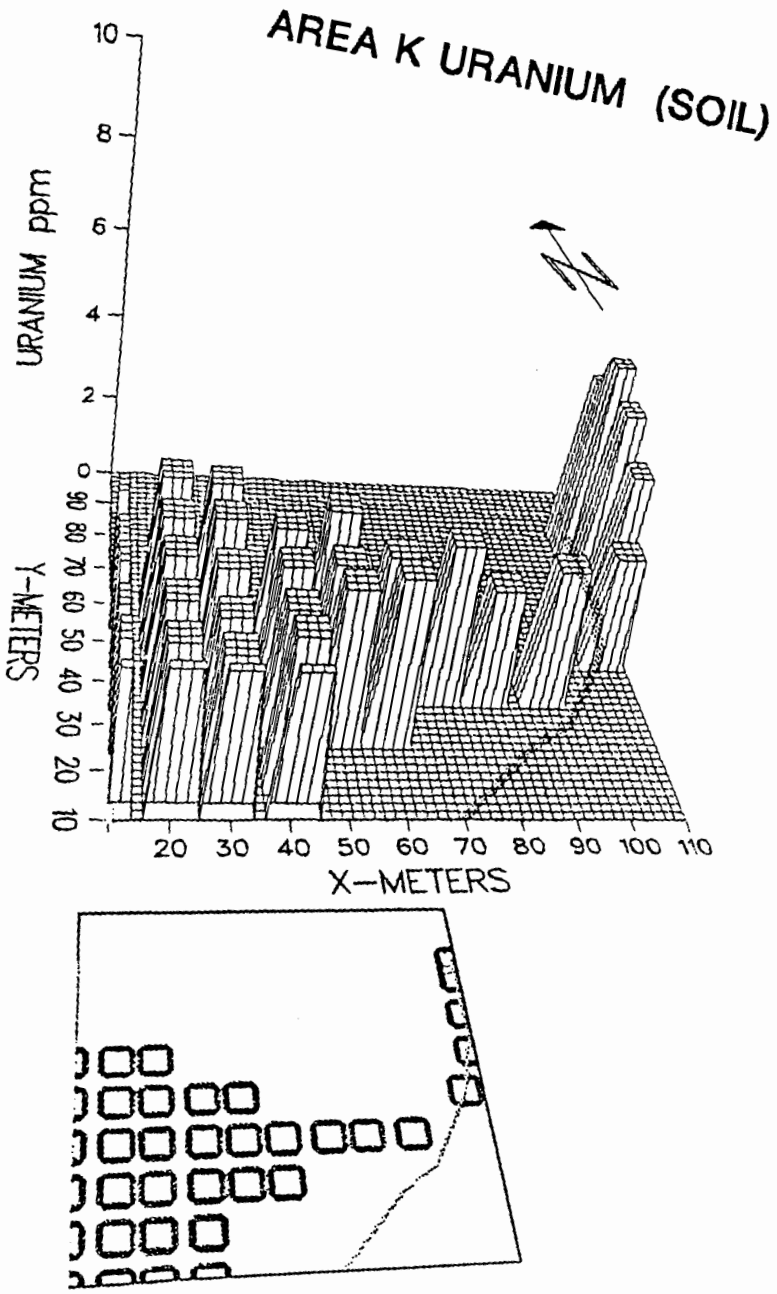

Figure 37. Three dimensional and contour plots of total uranium (ppm) in soil from Area K in 1986.

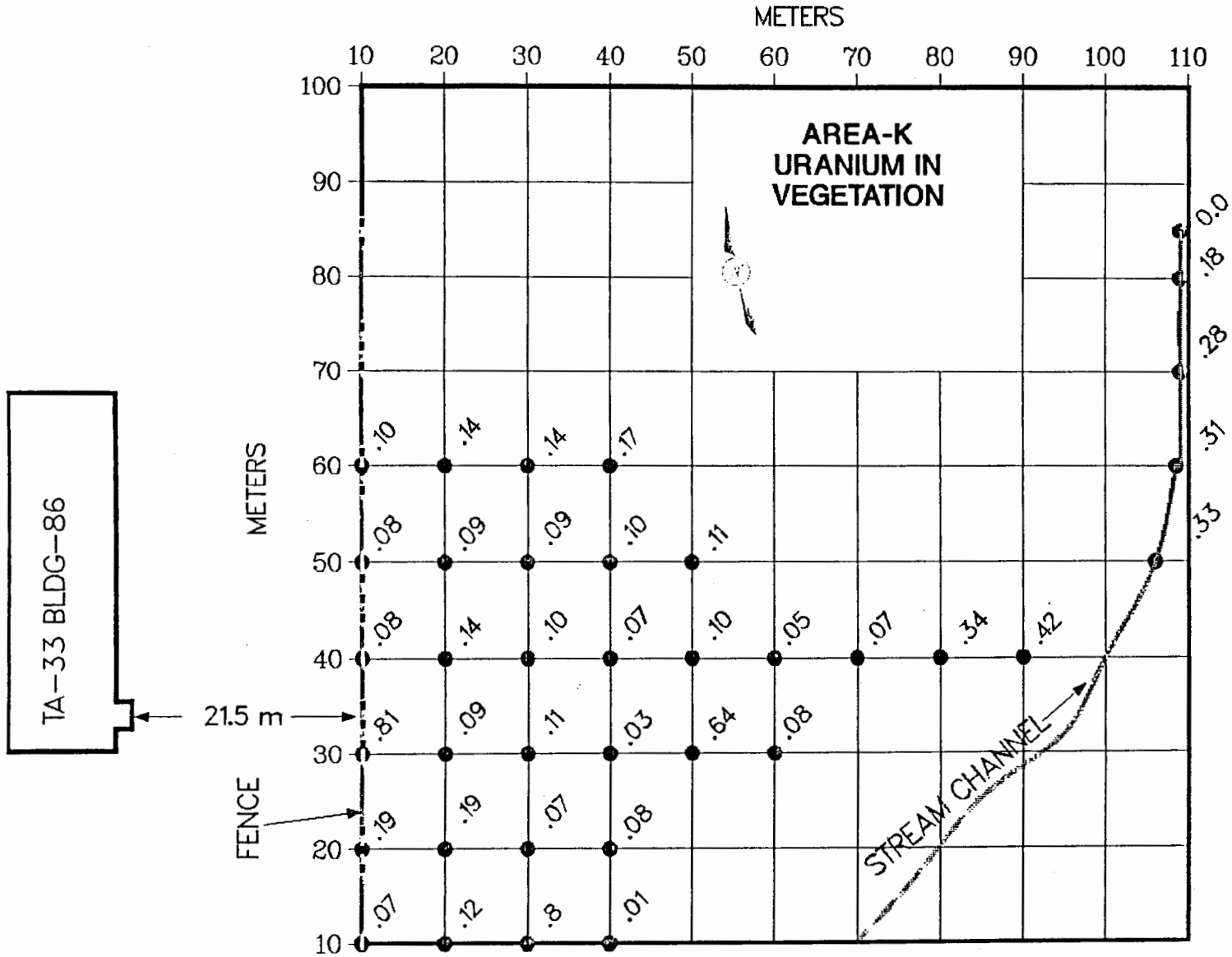

Figure 38. Total uranium concentrations (ppm) in vegetation from Area K in 1986.

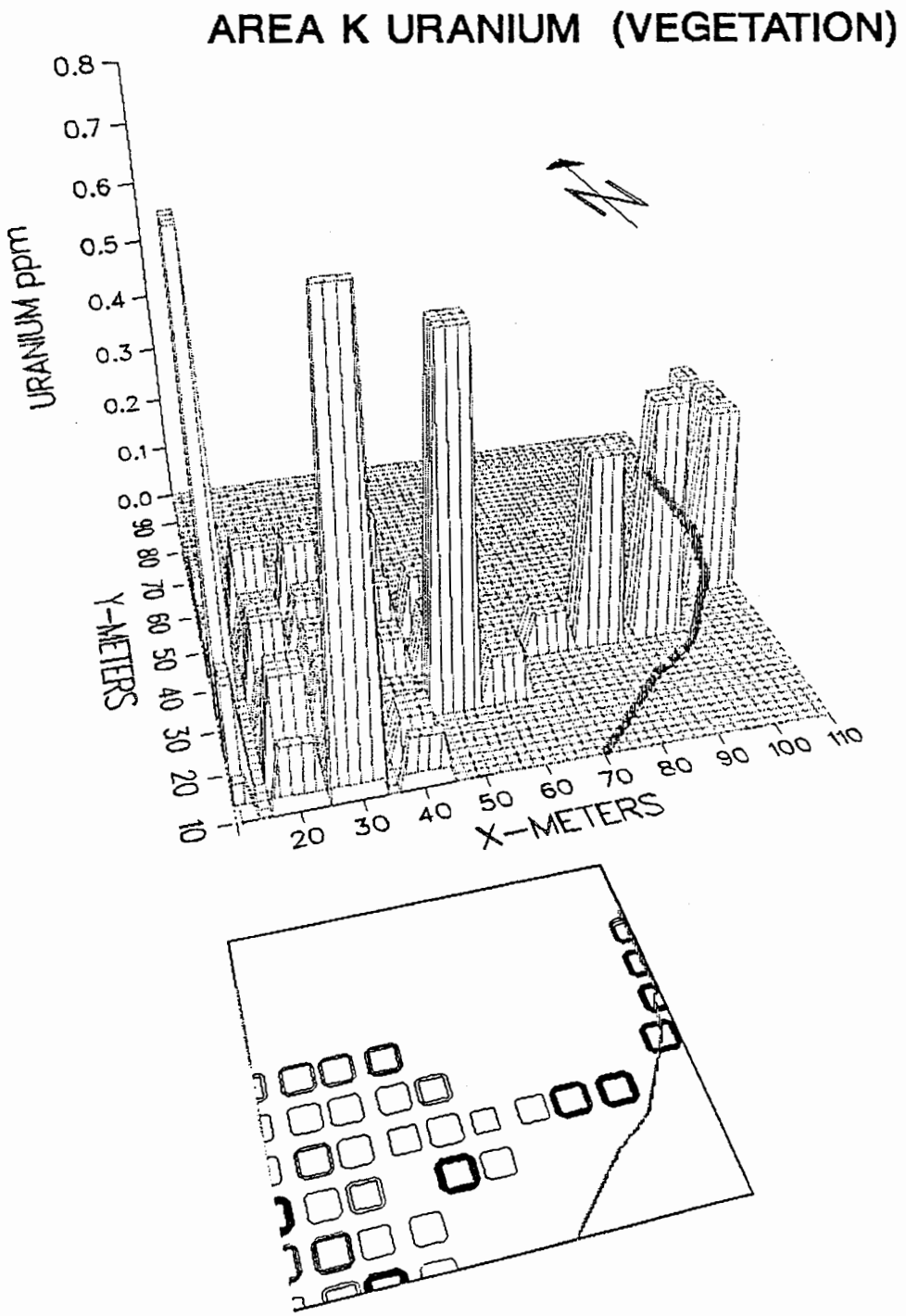

Figure 39. Three dimensional and contour plots of total uranium concentrations (ppm) in vegetation from Area K in 1986.

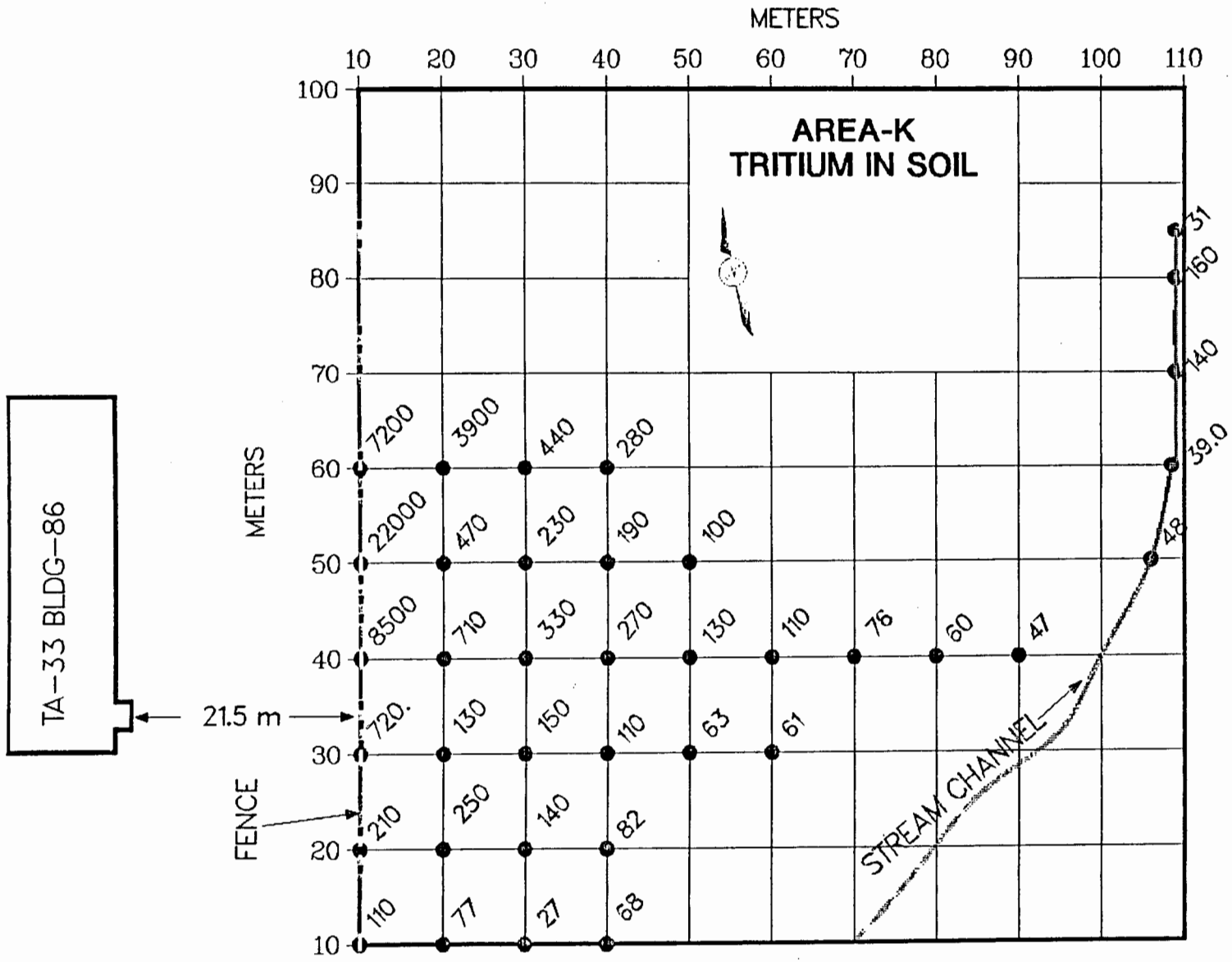

Figure 40. Tritium concentrations (pCi/) in soil from Area K in 1986.

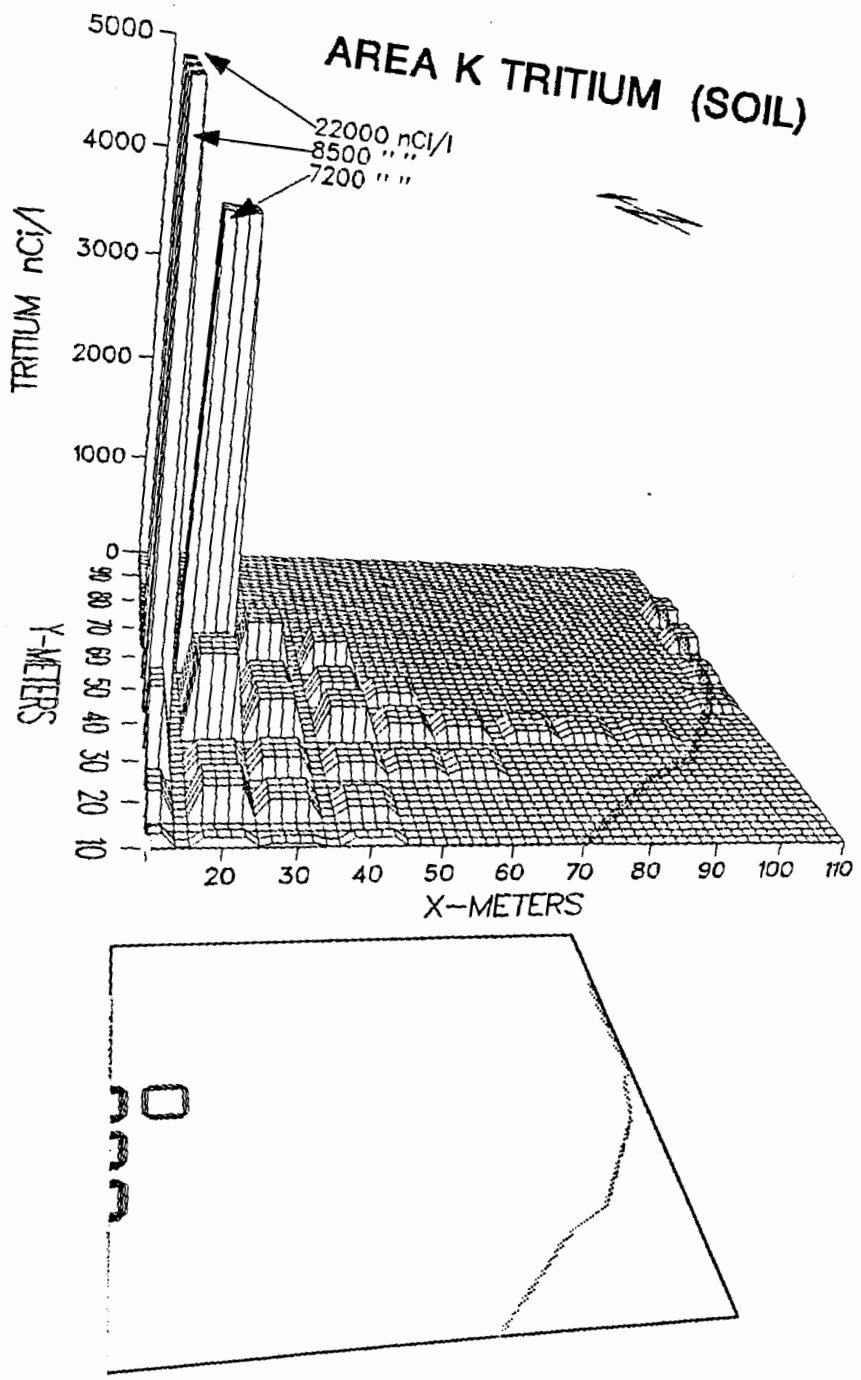

Figure 41. Three dimensional and contour plots of tritium concentrations (nCi/) in soil from Area K in 1986.

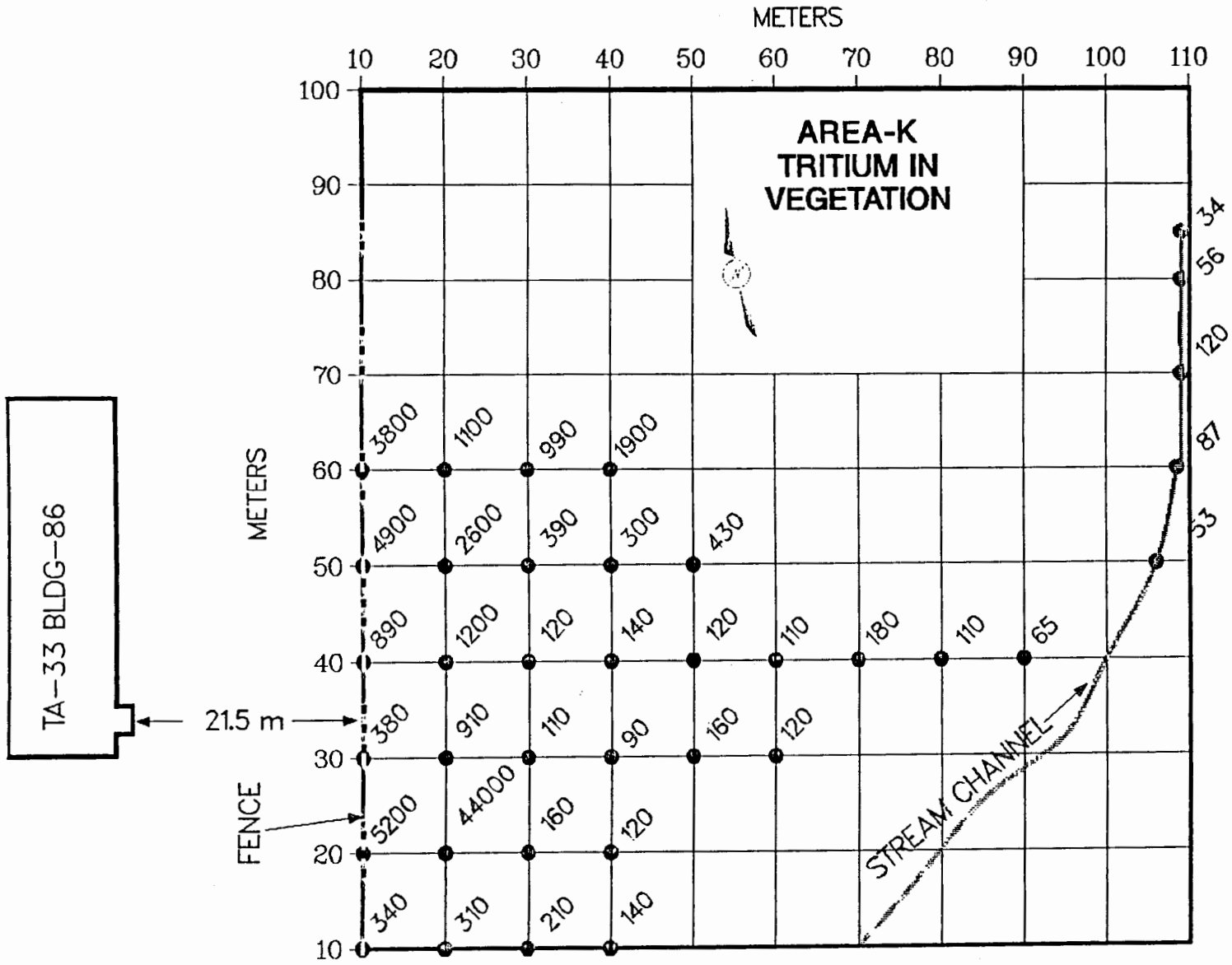

Figure 42. Tritium concentrations (pCi/) in vegetation from Area K in 1986.

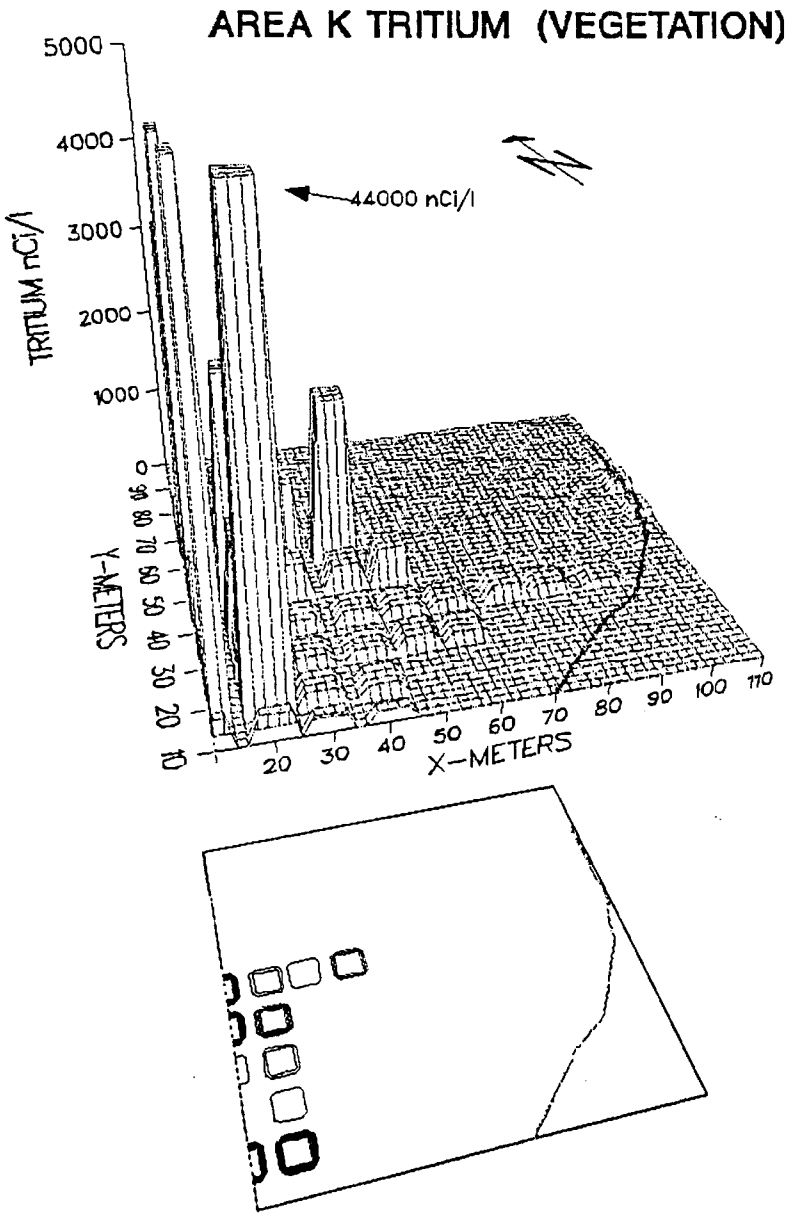

Figure 43. Three dimensional and contour plots of tritium concentrations (nCi/) in vegetation from Area K in 1986.

technical activities at TA-33-86. Concentrations were highest near the building sumps and fell off rapidly within distance downslope. As is typical of the behavior of tritium in ecosystems, levels in plants (Figs. 42 and 43) were within the same range as was measured in soil.

DOSE ASSESSMENT

While the monitoring data from Areas C, G, K, and T indicate the presence of radionuclides on and near the ground surface, both within and outside the perimeter fence, the levels measured are low. Dose estimates to members of the public, based on the monitoring data from the waste sites and general Laboratory area, were made for 1986 and are reported in the annual Environmental Surveillance Report (1987).

Based upon the inhalation pathway and the air monitoring data, the maximum 50 year dose committment relative to the DOE Radiation Protection Standard for the public, is less than 0.29 mrem/yr to the bone surface. That dose is 0.4% of the EPA's radiation limit of 75 mrem/yr to any organ by the inhalation pathway. It also represents the worst case dose based on all possible pathways.

Possible ingestion doses resulting from Laboratory (and waste) operations were estimated to be less than 0.15% of the DOE's 100 mrem/yr Radiation Protection Standard, which applies to all pathways, including ingestion (Environmental Surveillance Group 1987). There is currently no evidence of any radionuclides in drinking water that could be attributed to Laboratory (and waste) operations.

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Environmental Science Group, Environmental Surveillance Group, Health and Environmental Chemistry Group. 1986. Environmental surveillance of low-level radioactive waste management areas at Los Alamos during 1985. Los Alamos National Laboratory report, LA-UR-87-139.

Environmental Surveillance Group. 1987a. Environmental surveillance at Los Alamos during 1985, Los Alamos National Laboratory report, LA-10992-ENV.

Environmental Surveillance Group. 1987b. Quality assurance project plans. Los Alamos National Laboratory report, LA-UR-87-1076.

Reynolds, C., Polzer, W. L. and J. W. Nyhan. 1987. Site specific sampling plan for the TA-21 waste sites at Los Alamos on the Comprehensive Environmental Assessment and Response Program (In draft stage).

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APPENDIX A

TA-21 Waste Site

Special Studies

Data Base

APPENDIX A-1. DESCRIPTION OF AREA A ENVIRONMENTAL MONITORING AND SPECIAL STUDY RESEARCH DATA

Date	Location	Reference	Data Collected
Early 1950s up to June 1952	General's Tanks liquids at Area A (designated as site 6-2-SL in report)	Unpublished 1963 USGS Report cited in LA-6848-MS	Gross alpha assays on liquid contents
1973, 1975	General's Tanks liquids	Memo No. H7-76-PEM-162	Gross alpha, ^{238}Pu, ^{239}Pu, ^{241}Am, and nitrate assays on grab samples
May 1974	Four locations immediately east and west of General's Tanks	Los Alamos report LA-6848-MS, 1976 H-8 memo H8-WS-610	4 holes were augered to a depth of 35 feet and one composite sample collected from each 5 foot segment. Gross alpha and beta assays performed
5/20/80-6/2/80	2 locations within Area A and 1 outside Area A	A411 Project File	Soil samples collected from the 0-1 cm, 1-10 cm, and 10-30 cm depths at each locations, as well as a total of six vegetation samples, and analyzed for tritium, total U, and $^{239,240}Pu$
1980	31 locations outside of Area A, 24 locations along Area A fence, and 10 locations inside of Area A	A411 Project File	Phoswich and μR meter field surveys
1980	Area A site visit	A411 Project File	Overall qualitative evaluation of site surface condition
4th quarter 1982	5 locations on perimeter of Area A	Los Alamos Notebook 23820 notes, 1983 Los Alamos report LA-9762-ENV	TLD data

10/6/82	Site visit	A411 Project File	Overall qualitative evaluation of site condition, μR meter survey. No soil and vegetation samples
4 quarters 1983	5 locations on perimeter of Area A	Los Alamos Notebook 23820, 1984 Los Alamos report LA-10100-ENV	TLD data
1983	Surface soils from 15 locations within Area A and 5 locations outside of Area A	1984 Los Alamos report LA-10100-ENV	Soil samples from 0-1 cm, 1-10 cm and 10-30 cm depths assayed for tritium, total U, and $^{239,240}Pu$
1983	6 locations adjacent to and surrounding the General's Tanks at Area A	A411 Project File	Soil samples collected at 3 foot intervals to a depth of 30 feet in each hole using Purtymun's drill rig (auger samples). Samples assayed for tritium, uranium, ^{238}Pu, $^{239,240}Pu$, and ^{137}Cs
1984	15 locations within Area A and 5 locations outside of Area A	1985 July A411 monthly report, memo HSE8-85-909	Soil samples collected at 0-1, 1-10 and 10-30 cm sampling depths at each of 20 locations and analyzed for tritium, total U and $^{239,240}Pu$
4 quarters 1984	5 locations on perimeter of Area A	Los Alamos Notebook 23820 notes, 1986 Los Alamos report LA-UR-86990, 1985 Los Alamos report LA-10421-ENV	TLD data
May 1984	16 locations outside Area A fence and 21 locations inside fence	A411 Project File	Phoswich and μR meter surveys

July-August 1984	16 locations outside Area A fence and 21 locations inside fence	A411 Project File	Phoswich and μR meter surveys
May-July 1984	33 locations around Area A	A411 Project File	Vegetation samples assayed for tritium, total U and $^{239,240}Pu$
4 quarters 1985	5 locations around Area A perimeter	Los Alamos Notebook 23820 notes	TLD data
6/85	Site visit	A411 Project File	Overall qualitative evaluation of site conditions before and after stabilization
1st quarter 1985	7 locations within and outside of Area A	A411 Project File	Gamma spectrum analysis of soils at 1-10 cm and 10-30 cm depths
4 quarters 1986	5 locations around Area A perimeter	Los Alamos report LA-10992-ENV	TLD data
7/86	Surface reconnaissance	A411 Project File	Qualitative evaluations of site conditions

APPENDIX A-2. DESCRIPTION OF AREA B ENVIRONMENTAL MONITORING AND SPECIAL STUDY RESEARCH DATA

Date	Location	Reference	Data Collected
1953 (June)	Area B In caisson down-gradient of Area B	LA-6848-MS Vol. I, 1963 USGS Administrative Release	Gross alpha in soil
1966 (February)	Area B	USGS Open File Report, LA-68-48-MS Vol. I	Moisture Content, Uranium Plutonium, Gross Alpha, Gross Beta-Gamma
September		LA-6848-MS Vol. I	Beta-Gamma Survey (Geiger counter)
1971 (November)	Area B	LA-6848-MS Vol. I	Gross alpha (alpha counter) Gross beta-gamma (beta-gamma counter)
1976 (August)	Area B (asphalt portion)	LA-68-48-MS Vol. I	Visual observation for maintenance and repair measures
1977	Area B (unpaved portion)	Unpublished data (Discussed in report that is in preparation)	Surface phoswich gamma survey surface soil samples (Uranium, Plutonium, Gross alpha, Gross beta, and tritium)
1979	Area B 5 sampling locations plus background Depth: 0-1, 1-10, and 10-30 cm	Los Alamos Notebook A411 Files	^{3}H, ^{238}Pu, ^{239}Pu, ^{241}Am, ^{137}Cs, ^{226}Ac, ^{90}Sr, ^{226}Ra, and total U in soils (surface)
1980	Area B 5 sampling locations	Los Alamos Notebook A411 Files	^{3}H, ^{235}U, $^{235}U/^{238}U$, ^{238}Pu, ^{239}Pu in plants
	One location, Depth: 0-1, 1-10, and 10-30 cm		Gross gamma in soil

1981	Area B Peaches (1 location) location not identified	Los Alamos Notebook A411 Files	^{3}H, ^{238}Pu, ^{239}Pu, and ^{90}Sr in peels, pulp, and pits of peaches
	Exact location not identified (excavation samples) new sewer ditch Depth: 110-120; 100-130; 90-113 etc.		Moisture content, U, and ^{239}Pu in soil from new sewer ditch
	12 locations Depths not identified nor location identified		^{3}H, ^{238}Pu, ^{239}Pu, and Gross gamma in soil
1982	Area B 4 locations for soil Depths: 0-1, 1-10, 10-30 cm	Los Alamos Notebook A411 Files	^{3}H, U, ^{238}Pu, ^{239}Pu in soil (surface)
	Location not identified		Gamma spectrum analysis in peels, pulp, and pits of peaches
	23 locations	Los Alamos Notebook No. 23820	TLD
	Research Plots	LA-10573-MS	Soil Moisture
1983	Area B Sampling depths: 0-1, 1-10, and 10-30 cm; Sampling location-special grid	Los Alamos Notebook A411 Files	Soil Special grid ^{3}H, U, ^{238}Pu, ^{239}Pu and Sc
	Locations: B1 and B2 subsurface, Depths: 0-3, 3-8, 8-13, 13-18 etc. feet)		Soil (B1 and B2) ^{3}H, total U, $^{235}U/^{238}U$ ^{238}Pu, ^{239}Pu, ^{137}Cs
	Location: Baseline Depths: 0-1, 1-10, 10-30 cm		Soil ^{3}H, U, ^{238}Pu, ^{239}Pu, ^{137}Cs

			Animal pelt and shelter ^{238}Pu, ^{239}Pu
	23 locations	Los Alamos Notebook No. 23820	TLD
	Research Plots	LA-10573-MS	Soil moisture
1984	Area B 3 locations B1, B2, B3, soil depths 01-, 1-10, 10-14, 10-18, 10-25 cm	Los Alamos Notebook A411 Files	Vegetation ^{3}H, U, ^{238}Pu, gamma spectrum Soil (surface) ^{3}H, ^{238}Pu, ^{239}Pu gamma spectrum Field survey: Gamma uR-meter, Phoswich
	Research Plots	LA-10573-MS	Soil moisture
	21 locations, soil subsurface	Los Alamos Notebook A411 Files	Soil (subsurface) (B1 and B2), ^{238}Pu, ^{239}Pu
	23 locations	Los Alamos Notebook No. 23820	TLD
1985	Area B	Los Alamos Notebook A411 Files	Annual Site Inspection Breach of confinement Condition of cap Intrusion Other
	Research Plots	LA-10573-MS	Soil moisture
	23 locations	Los Alamos Notebook No. 23820	TLD
1986	Area B	Los Alamos Notebook	Surface Reconnaissance
	23 locations	Los Alamos Report LA-10992-ENV	TLD

APPENDIX A-3. DESCRIPTION OF AR T ENVIRONMENTAL MONITORING AND SPECIAL STUDY RESEARCH DATA

Date	Location	Reference	Data Collected
Jul-Nov 1946	Absorption beds 1 & 2 at Area T	1947 Los Alamos Report LAMS-516	Two soil and water samples from beds 1 & 2 for Pu and Po
Aug-Sept 1953	5 holes drilled in and around the Area T Absorption beds	Unpublished 1954 USGS Report cited in LA-6848-MS	Pu assays performed on samples collected to a depth of 20 feet Geologic descriptions of core
1959-1960	Absorption bed 1 of Area T	Unpublished 1963 USGS Report cited in LA-6848-MS, 1962 US Dept. Commerce Report TID-7628	Hundreds of samples collected in a series of horizontal holes originating in a 9.1 m-deep caisson next to Absorption bed 1. Tuff samples and soil solution samples assayed for Pu and soil chemistry parameters. Neutron moisture gauge data collected in several locations near and under Absorption bed 1 to depths of 100 ft, before and after addition of about 11 m of water to the bed
Jan 1967	Area between Absorption bed 1 and 3 at Area T	Los Alamos Report LA-6848-MS	Soil solution samples and a tuff sample neutron moisture gauge data collected to 100 ft
March 1974	10 sampling locations over Absorption beds 1 and 3 and between these two beds	Los Alamos Report LA-6848-MS	Pu and Am surface contamination/ external radiation survey (FIDLER and ionization chamber data)
April 17 & 18 1974	7 holes augered beween Adsorption beds 1 and 3	Los Alamos Report LA-6848-MS	Samples collected at 2.5 foot intervals to 40 feet and assayed for water content, gross alpha, gross beta, ^{137}Cs and tritium

October 1974	Retrievable waste storage area pit between Absorption beds 1 and 3	Los Alamos Report LA-6848-MS	23 samples collected from walls of pit and assayed for tritium, Pu and and Ludlum alpha counts
March 1976	4 holes in Absorption beds 3 and 4	Los Alamos Report LA-6848-MS and Nevada Operations Office Report NVO-178	Samples collected to a maximum depth of 240 inches and assayed for plutonium with a ZnS detector
4/13/78 and 4/17/78	Survey of Area T: 10 locations inside fence and 5 locations outside Area T	Los Alamos Notebook 20652	Phoswich and ZnS surveys with soil samples at 15 locations assayed for Pu and Am
6/14/78 and 6/18/78	Survey of asphalt ditch area southwest of Building SM-257	Los Alamos Notebook 20652	10 soil samples assayed for Pu and Am
3/17/78-10/5/78	Absorption beds 1 and 2 at Area T	Los Alamos Report LA-10159-LLWM, July 1984, Journal of Environ. Quality 14:501-509	Over 800 tuff samples collected in 4 100-ft holes and assayed for Pu, Am, and soil water content. Geologic characteristics published in a log of each hole. Hydrologic research done in the past used to evaluate migration of water and radionuclides
2/28/80	23 locations around perimeter of Area T and 11 locations inside Area T	Los Alamos Notebook in A411 Project File	Phoswich and μR meter survey
Sometime before 5/20/80 (assay date)	2 locations inside Area T and 2 locations north and east of Area T	Los Alamos Notebook in A411 Project File	Soil samples from 3 depths assayed for tritium, total uranium, Pu, gamma emittors (Cs-137)

Sometime before 6/10/80 (Assay date)	1 location inside Area T and 2 locations north and east of Area T	Los Alamos Notebook in A411 Project File	7 vegetation samples assayed for tritium, total uranium, u-235, u-238, Pu
Sometime in 1982	Several locations around Area T	A411 Project File	Qualitative observations on fencing and erosion from Area T R meter measurements at 6-7 broad locations within Area T. Phoswich monitoring along Area T fence 9 soil samples collected from 3 locations (3 depths/location) outside of Area T and assayed for tritium, total U, Pu, and gamma spectrometer assays
4th quarter 1982	7 locations on perimeter of Area T	Los Alamos Notebook 23820 notes, 1983 Los Alamos report LA-9762-ENV	TLD data
Sometime in 1983	North of paved road immediately north of Area T (generally north of Absorption bed 4)	A411 Project File	18 samples collected from 0 to 88 feet and assayed for tritium total uranium, Pu, and Cs-127, as well as gamma spectrometry assays
4 quarters 1983	7 locations on perimeter of Area T	Los Alamos Notebook 23820 notes, 1984 Los Alamos report LA-10100-ENV	TLD data
7/12/84-8/15/84	19 sampling locations inside and 19 sampling locations outside Area T on a grid pattern	A411 Project File	Phoswich survey of locations

6/14/84-7/19/84	19 sampling locations inside and 19 sampling locations outside Area T on a grid pattern	A411 Project File	HPIC survey of locations
6/20/84	" "	" "	Soil samples collected from 0-1 cm, 1-10 cm, and 10-30 cm depths at all locations and assayed for tritium, total uranium, Pu-238, Pu-239, gamma spectrometry assays
6/20/84-	" "	" "	15 vegetation samples identified and assayed for tritium, uranium, Pu-238 and gamma spectrometry assay
4 quarters 1984	7 locations on perimeter of Area T	Los Alamos Notebook 23820 notes, 1985 Los Alamos report LA-10421-ENV	TLD data
6/13/85	Area T Annual Site Inspection	A411 Project File	Field observations on breach of confinement, condition of cap, intrusion
4 quarters 1985	7 locations around Area T perimeter	Los Alamos Notebook 23820 notes	TLD data
10/30/86	12 locations in CMP Pit at Area T	Los Alamos Notebook R-4251 notes	12 samples collected to an average depth of 15 inches and assayed for tritium and with ZnS detector for gross alpha
April 1986	7 locations outside of and north of Area T	LANL Memo HSE8-86-1094	Soil (tritium, Pu, Cs-137; Sr-90, total U and Am) and phoswich radiation survey
6/86-8/86	108 locations surveyed (75 inside Area T and 33 outside Area T)	A411 Project File	108 Phoswich and Rascal measurements 73 soil samples and 67 vegetation samples assayed for Pu, Am, Cs-137

4 quarters 1986	7 locations around Area T perimeter	Los Alamos report LA-10992-ENV	TLD data

APPENDIX A-4. DESCRIPTION OF AREA U ENVIRONMENTAL MONITORING AND SPECIAL STUDY RESEARCH DATA

Date	Location	Reference	Data Collected
December 1975	3 locations within Area U and 8 locations outside of Area U (north and west of the western pit)	Group H8 memo no. H8-6-71, 1/7/76	Soil samples and surface water samples assayed for gross alpha
Early 1980	1 location outside of Area U and 2 inside Area U	A411 Project File, memo HSE-8-85-271, 3/27/85	Soil samples collected at 0-1, 1-10, and 10-30 cm depths and assayed for tritium, total U, and $^{239,240}Pu$. Six vegetation samples assayed for tritium and $^{239,240}Pu$. Phoswich and uR meter surveys performed at many locations inside and outside of Area U
4th quarter 1982	2 locations on perimeter of Area U	Los Alamos Notebook 23820 notes, 1983 Los Alamos report LA-9762-ENV	TLD data
4 quarters 1983	2 locations on perimeter of Area U	Los Alamos Notebook 23820 notes, 1984 Los Alamos report LA-10100-ENV	TLD data
1983	Surface soils from 1 location within Area U and 1 location outside Area U	1984 Los Alamos report LA-10100-ENV, A411 Project File	Soil samples from 0-1 cm, 1-10 cm and 10-30 cm depths assayed for tritium, total U, and $^{239,240}Pu$
1983	2 locations between north fence of Area A and road	A411 Project File, memo HSE-8-85-271, 3/27/85	Subsurface samples collected in various depth increments to a depth of about 17.6 m and assayed for ^{137}Cs, ^{239}Pu and total U
4 quarters 1984	2 locations on perimeter of Area U	Los Alamos Notebook 23820 notes, 1986 Los Alamos report LA-UR-86990, 19[illegible] Los Alamos report LA-10421-ENV	TLD data

6/14/84-7/19/84	19 sampling locations inside and 19 sampling locations outside Area T on a grid pattern	A411 Project File	HPIC survey of locations
6/20/84	" "	" "	Soil samples collected from 0-1 cm, 1-10 cm, and 10-30 cm depths at all locations and assayed for tritium, total uranium, Pu-238, Pu-239, gamma spectrometry assays
6/20/84-	" "	" "	15 vegetation samples identified and assayed for tritium, uranium, Pu-238 and gamma spectrometry assay
4 quarters 1984	7 locations on perimeter of Area T	Los Alamos Notebook 23820 notes, 1985 Los Alamos report LA-10421-ENV	TLD data
6/13/85	Area T Annual Site Inspection	A411 Project File	Field observations on breach of confinement, condition of cap, intrusion
4 quarters 1985	7 locations around Area T perimeter	Los Alamos Notebook 23820 notes	TLD data
10/30/86	12 locations in CMP Pit at Area T	Los Alamos Notebook R-4251 notes	12 samples collected to an average depth of 15 inches and assayed for tritium and with ZnS detector for gross alpha
April 1986	7 locations outside of and north of Area T	LANL Memo HSE8-86-1094	Soil (tritium, Pu, Cs-137; Sr-90, total U and Am) and phoswich radiation survey
6/86-8/86	108 locations surveyed (75 inside Area T and 33 outside Area T)	A411 Project File	108 Phoswich and Rascal measurements 73 soil samples and 67 vegetation samples assayed for Pu, Am, Cs-137

APPENDIX A-5. DESCRIPTION OF AREA V ENVIRONMENTAL MONITORING AND SPECIAL STUDY RESEARCH DATA

Date	Location	Reference	Data Collected
1980	Area V 3 sampling locations	Los Alamos Notebook A411 Files	Vegetation ^{3}H, U, ^{238}U, $^{235}U/^{238}U$, ^{238}Pu, ^{239}Pu
			Soil (surface) $^{239,240}Pu$, ^{3}H, U
			Gamma scan
			Areal Survey Phoswich, Gamma uR-meter
1982	Area V	Los Alamos Notebook A411 Files	Soil (surface) ^{3}H, U, ^{238}Pu, ^{239}Pu
		Los Alamos Notebook No. 23820	TLD
1983	Area V On location	Los Alamos Notebook A411 Files	Soil (subsurface) ^{3}H, U, $^{235}U/^{238}U$, ^{238}Pu, ^{239}Pu, ^{137}Cs
		Los Alamos Notebook No. 23820	TLD
1984	Area V	Los Alamos Notebook A411 Files	Soil (subsurface) ^{238}Pu, ^{239}Pu
			Vegetation ^{137}Cs
		Los Alamos Notebook No. 23820	TLD
			Soil (surface) ^{3}H, U, ^{239}Pu

1985	Area V	Los Alamos Notebook A411 Files	Annual Site Inspection Breach of confinement Condition of cap Intrusion Others Soil (surface) Gamma spectrum
		Los Alamos Notebook No. 23820	TLD
1986	Area V	Los Alamos Notebook A411 Files	Surface Reconnaissance Erosion Type of Vegetation Cover Animal Intrusion Condition of Exclusion Fence Other Surface Features Sampling Grid
		Los Alamos Report LA-10992-ENV	TLD

4 quarters 1986	7 locations around Area T perimeter	Los Alamos report LA-10992-ENV	TLD data

APPENDIX A-4. DESCRIPTION OF AREA U ENVIRONMENTAL MONITORING AND SPECIAL STUDY RESEARCH DATA

Date	Location	Reference	Data Collected
December 1975	3 locations within Area U and 8 locations outside of Area U (north and west of the western pit)	Group H8 memo no. H8-6-71, 1/7/76	Soil samples and surface water samples assayed for gross alpha
Early 1980	1 location outside of Area U and 2 inside Area U	A411 Project File, memo HSE-8-85-271, 3/27/85	Soil samples collected at 0-1, 1-10, and 10-30 cm depths and assayed for tritium, total U, and $^{239,240}Pu$. Six vegetation samples assayed for tritium and $^{239,240}Pu$. Phoswich and uR meter surveys performed at many locations inside and outside of Area U
4th quarter 1982	2 locations on perimeter of Area U	Los Alamos Notebook 23820 notes, 1983 Los Alamos report LA-9762-ENV	TLD data
4 quarters 1983	2 locations on perimeter of Area U	Los Alamos Notebook 23820 notes, 1984 Los Alamos report LA-10100-ENV	TLD data
1983	Surface soils from 1 location within Area U and 1 location outside Area U	1984 Los Alamos report LA-10100-ENV, A411 Project File	Soil samples from 0-1 cm, 1-10 cm and 10-30 cm depths assayed for tritium, total U, and $^{239,240}Pu$
1983	2 locations between north fence of Area A and road	A411 Project File, memo HSE-8-85-271, 3/27/85	Subsurface samples collected in various depth increments to a depth of about 17.6 m and assayed for ^{137}Cs, ^{239}Pu and total U
4 quarters 1984	2 locations on perimeter of Area U	Los Alamos Notebook 23820 notes, 1986 Los Alamos report LA-UR-86990, 1985 Los Alamos report LA-10421-ENV	TLD data

1984	12 locations within Area U and 9 locations outside of Area U	A411 Project File, memo HSE-8-85-271, 3/27/85	Soils collected at 3 locations within Area U and 8 locations outside of Area U from the 0-1, 1-10 and 10-30 cm depths and at all other locations from just the 0-1 cm depth. 14 vegetation samples assayed for tritium, and ^{239}Pu
1984	Several locations within and outside of Area U	Memo HSE-8-85-271, 3/27/85	Phoswich and high pressure ion chamber measurements collected within Area U
4 quarters 1985	2 locations around Area U perimeter	Los Alamos Notebook 23820	TLD data
6/12/85	Area A trench cap	A411 Project File	Annual site inspection of opened trench cap
4 quarters 1986	2 locations around Area U perimeter	Los Alamos report LA-10992-ENV	TLD data
7/18/86	Surface of Area A	A411 Project File	Surface reconnaissance survey remarking on general conditions of cover