CEER-X-115

RADIOLOGICAL SURVEY REPORT

for

EL VERDE RESEARCH STATION

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH

HEALTH AND SAFETY DIVISION

November, 1981
Revised May, 1983

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
UNIVERSITY OF PUERTO RICO — U.S. DEPARTMENT OF ENERGY

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Prepared by:

Nimia E. Irizarry

November, 1981
Date

Antonio Vega Cruz

Revised: May, 1983

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CERTIFICATION

It is hereby certified that the areas described in this report do not represent a radiation hazard to the public nor to any person working in El Verde Research Station. From a radiation standpoint these facilities could be safely used under the conditions stated in NRC License Number 52-1934-02 of March 9, 1982 as amended on October 13, 1982. (Appendix IV)

May 1983
Date

Nimia E. Irizarry
Head, Health and Safety Division

ABSTRACT

The Radiological Survey and the Decontamination, as indicated below, of El Verde Research Station has been completed.

Areas 8, 5 and 4 were found contaminated. All contamination was removed from areas 8 and 5. Figures 12, 14 and 15.

The contamination in area 4 (Figure 16) was identified as Cs-137 and was removed down to a radiation level of 200 uR/hr. Even though this radiation level does not constitutes a hazard for the public or personnel working in the area, access to it has been controlled by a fence and appropriate warning signs. On December 1981 an NRC License was requested for the use of Cs-137 and Tritium in the forest. The Nuclear Regulatory Commission granted to CEER-UPR license No. 52-1934-02 on March 1982.

The contaminated soil that was removed from areas 3, 5 and 4 was packed in DOT approved containers and was shipped to a low level waste disposal site in Oak Ridge, Tennessee on September 1982.

INTRODUCTION

The Puerto Rico Nuclear Center was developed during the early 1960's under the sponsorship of the Atomic Energy Commission with the main goal of developing a comprehensive program for research and training in nuclear science and engineering and in the applications of nuclear energy in medicine, agriculture and industry.

As part of the projects developed in order to achieve this goal, the Terrestrial Ecology Division was started in 1963. In 1964 a memorandum of agreement was signed between the Atomic Energy Commision and the Forest Service, US Department of Agriculture, separating 156 acres in the Luquillo Experimental Forest, i.e., El Verde Rain Forest, for conducting detailed ecological studies. Figures 1 and 1-A.

The main study area is located on the "northwestern slope of the mountain" and the research station is built on the site of a former coffee plantation. Several study areas were developed just up the mountain and to the east across the Sonadora River. (9). Access to the area is controlled by means of a hog wire fence, 8 ft high. The presence of patrol dogs also aids in the security of the area.

From 1964 on, a large amount of research projects were made in El Verde. Vegetation was quantified and identified, pollen was analized, a detailed study of the climate was made, soil was studied and many other aspects of the Rain Forest were thoroughly studied. (11)

Radiotracers were used, beside other techniques, during the study of mineral cycling and forest metabolism.

In 1976 the goals and objectives of PRNC changed, PRNC became the Center for Energy and Environment Research and the AEC-ORO (then ERDA and now the Department of Energy) concurred on transferring CEER

facilities to the University of Puerto Rico and terminating the agreement with the Forest Service. CEER/UPR will continue to use this research area under a use permit from the Forest Service.

In the process, a radiological survey was planned and has been done during the last three years. The area under CEER's responsibility was thoroughly surveyed using portable survey meters. Instrumentation used for this survey is listed on page 12. During this walk-through survey, some soil plots were found fenced and marked with radiation safety signs. These areas or plots were surveyed in more detail and samples were taken and analyzed for gross beta, gamma and alpha contamination. Also spectrometric analysis was done to representative samples of each of this areas. Except for three of these plots, no other areas were found with contamination or radiation levels higher than background.

This Report summarizes the activities carried out during the radiological survey and documents the results.

HISTORICAL BACKGROUND

The Terrestrial Ecology Program was initiated on April 1963. A month later, the work at El Verde Rain Forest started with three major objectives as follows:

1. To determine the effects of gamma irradiation from a 10,000 Ci Cesium-137, sealed source, on a plot of lower montane rain forest.
2. To measure the cycles of fallout elements in the rain forest system.
3. To determine the circuits of energy flow and metabolic processes of the ecosystem in order to understand the phenomena observed. (8).

During the first year of work at El Verde, all efforts were directed towards the study of the general conditions before gamma irradiation.

There is no record of mayor tracer studies during 1963 except in August when three trees were tagged by injecting 1 mCi of ^{32}P-phosphoric acid into each of the tree stems. (9)

On September 16, 1964 an agreement was reached and a memorandum of understanding between the Atomic Energy Commission and the Forest Service, United States Department of Agriculture was signed in order to separate 156 acres of the El Verde Rain Forest for conducting detailed ecological studies of the effects of gamma radiation, (Cs-137), upon tropical forests.

Figures 1 and 1-A show the location and detail of the area included in the Agreement.

A preliminary irradiation with a 6 Ci Co-60, sealed source, was carried out on August 1964 to help predict the attenuation of gamma radiation in the forest and to verify the hazards report for the ^{137}Cs sealed source.

The 10,000 Ci cesium-137, sealed source, was installed on top of a small ridge in the Rain Forest on December 7, 1964. The area was exposed to gamma radiation for the period between January 19, 1965 to April 27, 1965. It was removed and shipped to USA during July 1966. This source had no record of leakage and therefore did not constitute a potential source of contamination to any area in the forest. (10).

It must be mentioned, though, that during the arrangements made for this irradiation project, El Verde site was fenced at radii of 80 m, 160 m and 500 m from the radiation center. These fences have been used as reference points during the radiological survey being reported at present. See Figure 2.

When the irradiation was completed and the immediate post-irradiation effects were under study, plans were developed for studying mineral cycling, cycles of fallout elements and metabolic processes. Among other methods, radioactive tracers were used in numerous experiments during this period of time.

In January 1966 tracer experiments involving the use of Strontium-85, Cesium-134 and Manganese-54 were initiated. These experiments were carried out throughout the whole year and ended in December 1966. "The objective of the experiment was to determine whether these nuclides could be transferred from litter to soil to roots of understory plants, and, if so, at what rates.

Four plots were established within a fenced enclosure on a gently sloping ridge top within El Verde contract area. These plots, which ranged from 1 to 1.5 m^2, were completely encircled with corrugated aluminum garden edging to a depth of 3 inches, and roots to this depth were cut to prevent export of nuclides to trees outside of the plots. Two of the plots were stripped of all litter and two were left intact prior to the application of nuclides. On January 6, 1966, approximately 1 mCi/m^2 of each, ^{134}Cs, ^{85}Sr and ^{54}Mn were applied to the plots, in the form of a spray from a hand-pumped garden sprayer. All plants within the plots, at this time, were covered with plastic bags and aluminum foiled to prevent contamination with spray." (3)(4)(10)

Purchase order records indicate that on May 1966, the Terrestrial Ecology Project bought 1 Curie of Tritium to be used in future experiments within the Rain Forest.

During February 1967, twenty microcuries of Tritium were diluted to 1 liter of water and the mixture was applied to the surface of a 0.94 m^2 soil plot. (5).

Later, on August 3, 1967, three tree's trunks were tagged by spraying each with 1 mCi of carrier free ^{65}Zn solution. This study was designed to evaluate the utilization by the snail Caracolus caracola, of lower plants growing on the tree trunks. (5)

On August 10, 1967, 1 mCi of ^{85}Sr and 0.8 mCi of ^{134}Cs were diluted in 2,500 ml of water and evenly applied to a small plot of soil. (5)

Tritium was repeatedly used during 1968 and 1969. Five more experiments using this radiotracer were planned and carried out.

One of the experiments consisted on injecting three trees with different amount of ^{3}H as follows:

1. Large Dacryodes excelsa ..... 20 mCi
2. Sloanea berteriana ..... 6 mCi
3. Small Dacryodes excelsa ..... 1 mCi

Another experiment, done during May 1968, consisted on evenly applying four liters of water containing 50 mCi on Tritium to a 3.7 m^2 soil plot.

Two more experiments involving the use of Tritium were reported in June 1969, but there is no record of the amounts of the isotope used. (1)

Experiments using Cesium-137, Strontium-85 and Manganese-54 continued. In September 18, 1968 a tree of the species Matayba dominguensis was injected with 0.46 mCi of ^{137}Cs and a Dacryodes excelsa was injected with 0.19 mCi of ^{85}Sr, 0.34 mCi of ^{54}Mn and 17.69 mCi of ^{86}Rb. (1).

Also during 1968 another experiment using tritiated water was reported but the amounts of the radioisotope are not mentioned.

The next reference to the use of radioisotopes was reported in June 1970. In this report, ^{32}P. ^{75}Se, ^{65}Zn and ^{59}Fe are mentioned as the radioisotopes used to study nutrient pathways and depth of nutrient uptake. This experiment apparently was carried out in plastic trays in the laboratory. (11).

Another reference to the tagging of trees using ^{32}P does not specify the date of the experiment but it is mentioned that 1 mCi of the isotope was used for injecting two trees of species Sloanea berteriana and Dacryodes excelsa. Reference to this study is made in "A Tropical

Rain Forest". (10) Since this book was published in 1970, it is assumed that this ^{32}P experiment was performed in 1969 or before.

After 1970, the Terrestrial Ecology Division reported only one event involving the use of radioisotopes, i.e., the tagging of a Giant Tree Fern, Cyathea arborea. The tree was tagged during June 1973 with unknown amounts of ^{32}P.

Based on these data, Table 1 has been prepared. It is a summary of the radioisotopes used, amounts used and date and location of the experiment.

ISOTOPE (S)	DATE AND AREA APPLIED	ORIGINAL ACTIVITY	HALF LIVES PASSED
^{3}H	Jan. 6 1967; Area 2 (Fig.9)	20mCi	1.30
^{3}H;	May 1968 Area 3 (Fig.10)	50 mCi	1.22
^{32}P	1969 "	1 mCi	357.07
^{32}P	1972 "	46 mCi	280.57
^{137}Cs	Sept.18,1968 Area 4 (Fig.11)	0.46 mCi	0.5
^{86}Rb	" " "	17.69 mCi	293.41
^{85}Sr	" " "	0.19 mCi	84.62
^{54}Mn	" " "	0.34 mCi	17.49
^{85}Sr	Aug.10, 1967 Area 5 (Fig.12)	1 mCi	90.26
^{134}Cs	" " "	0.8 mCi	7.77
^{65}Zn	Aug. 3, 1967 Area 7 (Fig.13)	3 mCi	16.99
^{134}Cs	Jan. 6, 1966 Area 8 (Fig.14)	1 mCi	8.25
^{85}Sr	" "	1 mCi	95.90
^{54}Mn	" "	1 mC	19.92

Table 1 - Summary of radioisotope usage in El Verde Rain Forest

It must be mentioned that, associated with the field activities, there is a laboratory building that was constructed in 1965.

Another laboratory, adjacent to the first one, was constructed in 1976. There is no record of radioisotope usage in the new laboratory.

On the other hand, it is assumed that some sample preparation involving the use of radiotracers was performed in the old laboratory. Figure 3 shows the laboratory area.

SUMMARY OF THE RADIOLOGICAL SURVEY

A Radiological Survey was planned and performed in order to determine the status of El Verde facilities and research areas from radioactive contamination standpoint. The survey included a survey of the radiation levels and removable contamination in the old laboratory building and a walk-through survey of the forest. Also, soil and vegetation samples were collected and analyzed.

1. Survey in the Laboratory Building:

The radiation levels within the laboratory were measured using portable Geiger Muller and Scintillation survey meters. The benches, tables, drawers, instruments, floors, walls, materials and other surfaces were scanned on contact and at 1 meter high.

Since the laboratory building is included in NRC License No. 52-1934-02, and at the time of the survey there were plans for the use of radioisotopes such as Tritium, no efforts were made to survey the drains, hoods exhaust system, sink traps, etc.

The survey for removable contamination was done using the standard smear technique. Figures 4, 5 and 6 show the areas where the smears were taken.

2. Survey of the Forest

A walk-through survey was done in the forest, starting from the laboratory area through the trails up to the radiation center where the Cs-137 source was installed on 1964. The survey was extended to three, six and twelve meters from the trails. The area within the 160 m radius was surveyed in a grid of approximately one meter.

This part of the survey was performed at ground level, and 1 meter high, using earphones in order to more precisely detect variation in radiation levels in spite of the inequality of the ground.

During the walk-through survey, six areas were found fenced with chicken wire screens and marked with radiation safety signs. These areas were marked as follows: areas 2, 3, 4, 5, 7 and 8, based on numbers already existing within the fenced plots. For the purpose of this report, these areas will be called hereinafter, area ____ as numbered. Figure 7 shows the approximate location of these areas. Each area was thoroughly surveyed, and a detailed map of the radiation levels was done. Also, soil and vegetation samples were collected in the areas.

In order to have a complete idea of the status of the surrounding grounds, soil samples were also collected outside of the fenced areas, beyond the radiation safety signs. All soil samples were collected from surface 6 inches and from next 6 inches deep in the ground.

Soil and vegetation samples, representative of each area were analyzed for radionuclide content in a Germanium Lithium drifted detector. Also, other portions were oven dried, grinded and an alliquot of 200 mg was counted in a Gas Flow Proportional Counter, for gross

alpha and beta-gamma contamination. Microcuries per gram were calculated using the following formula;

$$uCi/g = \frac{\text{net cpm}}{A\ (F)\ 2.22 \times 10^6}$$

where A= amount of sample analyzed (g)

F= efficiency factor = 50%

RESULTS OF THE RADIOLOGICAL SURVEY BEFORE DECONTAMINATION

The initial Radiological Survey for El Verde Research Areas was carried out during different intervals of time in FY 1978 through FY 1981.

The background radiation level varies from 2 uR/hr to 6 uR/hr in the laboratory area and in the forest. Figure 8 shows the detailed radiation levels in the laboratory area.

Each one of the areas was surveyed in detail. Figures 9, 10, 11, 12, 13, and 14 show the radiation levels and location of the samples taken inside and beyond the fence of each area. Samples taken beyond the fence are identified as control samples.

Based on the description and clues found in each area, spectrometric analysis of some samples and the descriptions found in the literature searched, the isotopes used in each sampling zone were identified as follows:

Area 2 - ^{3}H

Area 3 - ^{3}H, ^{32}P

Area 4 - ^{137}Cs, ^{85}Sr, ^{54}Mn, ^{86}Rb

Area 5 - ^{85}Sr, ^{134}Cs

Area 7 - ^{65}Zn

Area 8 - ^{134}Cs, ^{85}Sr, ^{54}Mn

Appendix 1 is a summary of the results of the samples analyzed for gross beta-gamma and gross alpha contamination.

Appendix 2 is a summary of the samples analyzed in the GeLi spectrometer.

Three of the areas were found with radiation levels higher than background: Areas 4, 5 and 8. See Figures 11, 12 and 14.
No contamination was found in the laboratory building.

Appendix 1A shows the results of all the smears taken in this building. No samples were taken in the new laboratory constructed in 1976.

Sc 1 samples from an area where no radioisotopes have been used, were taken and analyzed in order to establish a background level for comparison purpose. The results of these soil samples are included in Appendix 3.

INSTRUMENTS USED

1. Ludlum Measurements, Inc.

   Model 3, Pancake GM 1.5 mg/cc window

   Sweetwater, Texas

2. Scintillation Gamma Ratemeter Type 1597A

   Reactor Control Division

   Eliot Process Automation Limited

   Lewisham, London, S.E. 13

3. Nuclear Measurements Corporation

   Gas Flow Proportional Counter

   Model PCC-IIT-DS-IT Combination

   50% Eff. Ave. efficiency for gamma energies from 0.500 Mev to 1.3 Mev.

   NMC Indianapolis, Indiana

4. Nuclear Data 4410 Spectrometer

   with a GeLi Detector

   Nuclear Data Inc.

5. Liquid Scintillation Counter

   Beckman Model LS 3133T

   Beckman Inc., California

   30% Eff. for Tritium

DECONTAMINATION, PRESENT STATUS AND CONCLUSIONS

Decontamination efforts were concentrated to two of the areas: 4 and 8. The contaminated soil in area 5 was readily removed.

The contaminated soil was removed until an aluminum tray was found about 30 cm deep in area 8. Beyond this level no contamination was found. About 1,000 lb (453 kg) of soil were removed, placed in plastic bags and transported to CEER Mayaguez for proper disposal.

At the present time the radiation levels in area 8 vary from 2 uR/hr to 10 uR/hr. See figure 15 for a diagram of the radiation levels.

Two trees were found contaminated in area 4. The resin of the tree, as well as some pieces of cortex, were analyzed in the spectrometer and ^{137}Cs was found as the contaminant. No attempt was made to quantify the remaining isotope. Soil contaminated with cesium underneath the tree, was removed. Even though about 100 lb (43 kg) of soil were removed, the radiation level under the tree is still higher than background, i.e. about 200 uR/hr. Figure 16 shows the present status of this area.

The contaminated tree remains in place and the Forest service concurred with CEER that El Verde Research area should be licensed for the use of radiotracers. A license application was submitted to the Nuclear Regulatory Commission and License No. 52-1934-02 was granted on March 9, 1982.

Area 4 will remain fenced and with radiation safety signs. All other radiation safety signs have been removed.

Of the radioisotopes used in El Verde, (Table 1), tritium is the one of more concern because it could be incorporated into the human body following ingestion of HTO, by passing through skin or inhalation either

as liquid or in a gaseous form. However, this concern is lessened in view of the relatively short biological half-lifes **which are involved. For example, NCRP Report No. 62 indicates that: "It seems reasonable to conclude that one pool of tritium in exposed individuals is in the form of free body water. It has a (biological) half-life between 6 and 18 days." (6)

We conclude on the basis of the observations (Jordan 1970) that any tritium used in the area has been dissipated in the atmosphere as water vapor.

Jordan estimated the half residence time ($t_{\frac{1}{2}}$)* for tritium in the soil, in the vegetation and in the air in a tropical ecosystem such as El Verde. (2)

According to Jordan, tritium moves into the air through evaporation of the water in the litter, in such a way that, the half-residence time of the ^{3}H in the soil and litter, necessarily controls concentration in the water vapor above the spiked soil. The results in his experiments indicated that: "29 days probably is a good estimate for the $t_{\frac{1}{2}}$ of tritium in the soil as a whole." (2)

He found that for trees growing in soil spiked with tritium, the $t_{\frac{1}{2}}$ is between 41 and 55 days. For those trees (Dacryodes excelsa) where the isotope was injected, the $t_{\frac{1}{2}}$ of tritium was 6.6 days (2)

If one Curie (1 Ci) of tritium bought on 1966 was used during 1969 and experienced a half-residence time of 55 days, the amount remaining in 1983 would be 1.95×10^{-27} Ci.

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* Half residence time = is the length of time that it takes for half the activity in a compartment to be removed.

** Biological half-life = is the time required for the body to eliminate by regular process of elimination one half of a dose received of any substance

Based on the above observations, then we conclude, that biological cycling and the movement of tritium in a tropical ecosystem as El Verde is such that all tritium used in the research area has been dispersed to the atmosphere in very low levels not dangerous to either the public or to persons working in the area.

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APPENDIX 1.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date May - June - Nov '78
Technician Ramón Pérez
Sampling zone Area #2

Instrument used PCC - 11T
Background β γ 60 dpm ± 10
Background α 0 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
C-2-1A	1.35×10^{-5}	0 **	2-3A	9.0×10^{-6}	0
C-2-1B	4.05×10^{-5}	0	2-3B	4.5×10^{-6}	0
C-2-2A	2.25×10^{-5}	0	2-Lys A	4.5×10^{-5}	0
C-2-2B	4.05×10^{-6}	0	2-Lys B	$< 4.5 \times 10^{-6}$	0
C-2-3A	$< 4.5 \times 10^{-6}$	0	2-1A	$< 4.5 \times 10^{-6}$	0
C-2-3B	4.5×10^{-6}	0	2-1B	$< 4.5 \times 10^{-6}$	
C-2-4A	1.35×10^{-5}	0			
C-2-4B	$< 4.5 \times 10^{-6}$	0			
C-2-5A	4.05×10^{-5}	0			
C-2-5B	2.25×10^{-5}	0			
C-2-6A	4.50×10^{-6}	0			
C-2-6B	$< 4.50 \times 10^{-6}$	0			
C-2-7A	$< 4.5 \times 10^{-6}$	0			
C-2-7B	$< 4.50 \times 10^{-6}$	0			
C-2-8A	7.21×10^{-5}	0			
C-2-8B	4.05×10^{-5}	0			
C-2-9A	9.00×10^{-6}	0			
C-2-9B	$< 4.50 \times 10^{-6}$	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5} µ Ci/g

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

** Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date April '78

Technician Ramón Pérez

Sampling zone Area #3

Instrument used DS-1T
Background β γ 60 dpm 110
Background α 0 dpm
Sample Vol. or Wt. 200mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
3-C-A	$<4.50 \times 10^{-6}$	0**			
3-C-B	"	0			
3-C-C	"	0			
3-1A	"	0			
3-1B	"	0			
3-1C	"	0			
3-2A	"	0			
3-2B	"	0			
3-2C	2.70×10^{-5}	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5} µ Ci/g

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date: Jun - Jul '78

Technician Ramón Pérez

Sampling zone Area #3

Instrument used DS-1T
Background β γ 60 dpm ± 10
Background α 0 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
C-3-1A	3.15×10^{-5}	0**	3-1A	7.21×10^{-5}	0
C-3-1B	1.35×10^{-5}	0	3-1B	3.15×10^{-5}	0
C-3-2A	9.0×10^{-6}	0	3-2A	2.70×10^{-5}	0
C-3-2B	4.5×10^{-6}	0	3-2B	3.60×10^{-5}	0
C-3-3A	2.25×10^{-5}	0	3-3A	9.00×10^{-6}	0
C-3-3B	9.0×10^{-6}	0	3-3B	9.00×10^{-6}	0
C-3-4A	1.35×10^{-5}	0	3-4A	2.7×10^{-5}	0
C-3-4B	1.80×10^{-5}	0	3-4B	9.0×10^{-6}	0
C-3-5A	1.35×10^{-5}	0	3-5A	$< 4.50 \times 10^{-6}$	0
C-3-5B	1.80×10^{-5}	0	3-5B	$< 4.50 \times 10^{-6}$	0
C-3-6A	4.50×10^{-6}	0	3-5A Lys S.	1.80×10^{-5}	0
C-3-6B	9.0×10^{-6}	0	3-5B Lys S.	3.15×10^{-5}	0
C-3-7A	9.0×10^{-6}	0	3-6A	2.25×10^{-5}	0
C-3-7B	4.50×10^{-6}	0	3-6B	1.35×10^{-5}	0
C-3-8A	4.05×10^{-5}	0	3-7A	2.70×10^{-5}	0
C-3-8B	1.35×10^{-5}	0	3-7B	4.95×10^{-5}	0
C-3-9A	2.70×10^{-5}	0			
C-3-9B	1.35×10^{-5}	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range $\pm$ 2.3 X 10^{-5} µ Ci/g

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date Nov. '78

Technician Ramon Perez

Sampling zone Area # 4

Instrument used Rec-11T, DS-1T
Background β γ 60 dpm ± 10
Background α 0 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
4-1A	2.70×10^{-5}	0**			
4-1B	4.50×10^{-6}	0			
4-2A	1.80×10^{-5}	0			
4-2B	2.25×10^{-5}	0			
4-3A	1.35×10^{-5}	0			
4-3B	4.50×10^{-6}	0			
4-4A	4.95×10^{-5}	0			
4-4B	1.35×10^{-5}	0			
4-5A	2.25×10^{-5}	0			
4-5B	1.80×10^{-5}	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5} µ Ci/g

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date Nov. '78

Technician Ramón Pérez

Sampling zone Area #4

Instrument used DS-1T
Background β γ 60 dpm ±10
Background α 0 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
C-4-0A	$<4.50\times10^{-6}$	0**	C-4-12A	1.35×10^{-5}	0
C-4-0B	"	0	C-4-12B	4.50×10^{-6}	0
C-4-1A	"	0	C-4-13A	4.50×10^{-6}	0
C-4-1B	4.50×10^{-6}	0	C-4-13B	$<4.50\times10^{-6}$	0
C-4-2A	$<4.5\times10^{-6}$	0	C-4-14A	9.0×10^{-6}	0
C-4-2B	4.50×10^{-6}	0	C-4-14B	$<4.5\times10^{-6}$	0
C-4-3A	4.5×10^{-6}	0	C-4-15A	"	0
C-4-3B	9.00×10^{-6}	0	C-4-15B	"	0
C-4-4A	1.35×10^{-5}	0	C-4-16A	4.05×10^{-5}	0
C-4-4B	9.00×10^{-6}	0	C-4-16B	$<4.5\times10^{-6}$	0
C-4-5A	1.35×10^{-5}	0	C-4-17A	"	0
C-4-5B	1.80×10^{-5}	0	C-4-17B	9.00×10^{-6}	0
C-4-6A	$<4.50\times10^{-6}$	0	C-4-18A	3.6×10^{-5}	0
C-4-6B	1.35×10^{-5}	0	C-4-18B	4.50×10^{-6}	0
C-4-10A	1.80×10^{-5}	0	C-4-19A	$<4.50\times10^{-6}$	0
C-4-10B	1.35×10^{-5}	0	C-4-19B	4.50×10^{-5}	0
C-4-11A	1.80×10^{-5}	0	C-4-20A	$<4.50\times10^{-6}$	0
C-4-11B	$<4.50\times10^{-6}$	0	C-4-20B	"	0

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5} µ Ci/g

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date Sept. 1978

Technician Ramón Pérez

Sampling zone Area #5

Instrument used PCC-11T
Background β γ 60 dpm ± 10
Background α 0 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil + Veg.

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
C-5-1A	1.80×10^{-5}	0 **	5-3A	4.50×10^{-5}	0
C-5-1B	3.15×10^{-5}	0	5-3B	2.70×10^{-5}	0
C-5-2A	1.35×10^{-5}	0	5-4A	4.05×10^{-5}	0
C-5-2B	4.95×10^{-5}	0	5-4B	"	0
C-5-3A	9.00×10^{-6}	0	Veg. A	9.00×10^{-6}	0
C-5-3B	4.05×10^{-5}	0	Veg. B	4.50×10^{-6}	0
C-5-4A	4.50×10^{-5}	0			
C-5-4B	2.25×10^{-5}	0			
C-5-5A	4.50×10^{-5}	0			
C-5-5B	2.25×10^{-5}	0			
C-5-6A	2.25×10^{-5}	0			
C-5-6B	3.15×10^{-5}	0			
C-5-7A	4.95×10^{-5}	0			
C-5-7B	6.30×10^{-5}	0			
5-1A	4.05×10^{-5}	0			
5-1B	3.15×10^{-5}	0			
5-2A	2.25×10^{-5}	0			
5-2B	3.60×10^{-5}	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range ± 2.3×10^{-5} µ Ci/g

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

** Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date Sept. '78

Technician Ramon Perez

Sampling zone Area #7

Instrument used Pcc - 11T
Background β γ 52 dpm ±10
Background α 1 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
C-7-1A	2.25×10^{-5}	0**	7-1A	$< 4.50 \times 10^{-6}$	0
C-7-1B	"	0	7-1B	9.0×10^{-6}	0
C-7-2A	2.70×10^{-5}	0	7-2A	4.50×10^{-6}	0
C-7-2B	9.00×10^{-6}	0	7-2B	1.35×10^{-5}	0
C-7-3A	"	0	7-3A	1.80×10^{-5}	0
C-7-3B	1.80×10^{-5}	0	7-3B	4.50×10^{-6}	0
C-7-4A	2.70×10^{-5}	0	7-4A	2.70×10^{-5}	0
C-7-4B	1.80×10^{-5}	0	7-4B	9.0×10^{-6}	0
C-7-5A	2.25×10^{-5}	0	7-5A	2.25×10^{-5}	0
C-7-5B	2.70×10^{-5}	0	7-5B	3.15×10^{-5}	0
C-7-6A	9.00×10^{-6}	0	7-6A	2.25×10^{-5}	0
C-7-6B	"	0	7-6B	1.35×10^{-5}	0
C-7-7A	$< 4.50 \times 10^{-6}$	0			
C-7-7B	"	0			
C-7-8A	2.70×10^{-5}	0			
C-7-8B	1.8×10^{-5}	0			
C-7-9A	$< 4.50 \times 10^{-6}$	0			
C-7-9B	4.50×10^{-6}	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range $\pm$ 2.3 X 10^{-5} µ Ci/g

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
HEALTH AND SAFETY OFFICE

ENVIRONMENTAL SAMPLES SUMMARY REPORT

Date November 1978

Technician Ramón Pérez

Sampling zone Area # 8

Instrument used Pcc - 11T
Background β γ 50 dpm ±10
Background α 0 dpm
Sample Vol. or Wt. 200 mg
Type of sample Soil

SAMPLE NO.	Net* µCi/g β γ	Net µCi/g α	SAMPLE NO.	Net µCi/g β γ	Net µCi/g α
C-8-1A	2.70×10^{-5}	0**	8-Cont.A	$< 4.50 \times 10^{-6}$	0
C-8-1B	3.15×10^{-5}	0	8.Cont.B	"	0
C-8-2A	1.35×10^{-5}	0	8-1A	5.85×10^{-5}	0
C-8-2B	3.15×10^{-5}	0	8-1B	$< 4.50 \times 10^{-6}$	0
C-8-3A	1.80×10^{-5}	0	8-2A	9.00×10^{-5}	0
C-8-3B	9.00×10^{-6}	0	8-2B	6.30×10^{-5}	
C-8-4A	2.70×10^{-5}	0			
C-8-4B	2.25×10^{-5}	0			
C-8-5A	$< 4.50 \times 10^{-6}$	0			
C-8-5B	4.95×10^{-5}	0			
C-8-6A	$< 4.50 \times 10^{-6}$	0			
C-8-6B	2.70×10^{-5}	0			
8-3A	4.95×10^{-5}	0			
8-3B	9.00×10^{-6}	0			
8-4A	2.70×10^{-5}	0			
8-4B	"	0			
8-5A	1.80×10^{-5}	0			
8-5B	$< 4.50 \times 10^{-6}$	0			

Key: * Net Results = µCi/g sample - µ Ci/g background Error range $\pm$ 2.3×10^{-5} µ Ci/g

V= vegetation C= control

S= soil A= soil surface 6 in. B= soil sub-surface 6 in.

**Zero (0) indicates activity bellow detection limits of the Gas Flow Proportional Counter.

APPENDIX 1A

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Lab I-II
Date _____
Taken by Cintrón & Vega
Counted by Sánchez
Date counted 31 April 1978

☐ Notify _____ on ext. _____
of results. ☐ Notified.
☐ Send copy of report to:
_____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☐ BETA-GAMMA
Background 30 ±10 c/m Geometry 2π PS - 1T

Sample Number	Beta-Gamma	Alpha
1C	0 **	
2	0	
3	C	
4	C	
5	0	
6	C	
7	0	
8	C	
9	0	
10	0	
11	0	
12	C	
13	C	
14	C	

Sample Number	Beta-Gamma	Alpha
15	0	
16	0	
17	C	
18	C	
19	0	
20	C	
21	C	
22	C	
23	0	
24	C	
25	0	
26	0	
27	C	
28	C	

Identification of Samples:

Area A - Lab I-II El Verde

1A-1

Remarks: ** Zero (0) indicates counts bellow detection limits of Proportional Counter

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Lab I-II

Date

Taken by Cintrón Vega

Counted by Sanchez

Date counted 31 April 1978

☐ Notify _____ on ext. _____ of results. ☐ Notified.

☐ Send copy of report to: _____ Code _____

To be counted for

☐ ALPHA
Background _____ c/m Geometry _____

☐ BETA-GAMMA DS-1T
Background 30 ±10 c/m Geometry 2 ??

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
29	0 **	
30	0	
31	0	
32	0	
33	0	
34	0	
35	0	
36	0	
37	0	
38	0	
39	0	
40	0	
41	0	
42	0	

Sample Number	Beta-Gamma	Alpha
43	0	
44	0	
45	0	
46	0	
47	0	
48	0	
49	0	
50	0	
51	0	
52	0	
53	0	
54	0	
55	0	
56	0	

Identification of Samples:

El Verde
Area A - Lab I-II

1A-2

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Lab I-II
Date April '78
Taken by Cintrón-Vega
Counted by Jaime Vega
Date counted 31 April 1978

☐ Notify _____ on ext. _____
of results. ☐ Notified.
☐ Send copy of report to:
_____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☐ BETA-GAMMA
Background 30 c/m Geometry 2 π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
57	0**	
58	0	
59	0	
60	0	
61	0	
62	0	
63	0	
64	0	
65	0	
66	0	
67	0	
68	0	

Sample Number	Beta-Gamma	Alpha

Identification of Samples:

El Verde
Area A - Lab I-II

1A-3

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room _____
Date _____
Taken by A. Vega & Cintrón
Counted by Feliciano
Date counted April 3, 1978

☐ Notify _____ on ext. _____
of results ☐ Notified.
☐ Send copy of report to:
_____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA DS-2
Background 29 ±10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
1	0 **	
2	0	
3	0	
4	0	
5	0	
6	0	
7	0	
8	0	
9	0	
10	0	
11	0	
12	0	
13	0	
14	0	

Sample Number	Beta-Gamma	Alpha
15	0	
16	0	
17	0	
18	0	
19	0	
20	0	
21	0	

Identification of Samples:

El Verde Laboratory

Area B

1A-4

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room _____

Date _____

Taken by A. Vega + Cintron

Counted by Felicia C.

Date counted April 3, 1978

☐ Notify _____ on ext. _____ of results ☐ Notified.

☐ Send copy of report to: _____ Code _____

To be counted for

☐ ALPHA
Background _____ c/m Geometry _____

☒ BETA-GAMMA
Background 2.7 ± 10 c/m Geometry 2π

D5-2

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
22	0 **	
23	0	
24	0	
25	0	
26	0	
27	0	
28	0	
29	0	
30	0	
31	0	
32	0	
33	0	
34	0	
35	0	

Sample Number	Beta-Gamma	Alpha
36	0	
37	0	
38	0	
39	0	
40	0	
41	0	
42	0	

Identification of Samples:

El Verde Laboratory

Area B

1A-5

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room _____
Date March '78
Taken by A. Vega + Cintrón
Counted by Feliciano
Date counted April 3, 1978

☐ Notify _____ on ext. _____
of results. ☐ Notified.
☐ Send copy of report to:
_____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA DS-2
Background 29 ±10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
43	0**	
44	0	
45	0	
46	0	
47	0	
48	0	
49	0	
50	0	
51	0	
52	0	
53	0	
54	0	
55	0	
56	0	

Sample Number	Beta-Gamma	Alpha
57	0	
58	0	
59	0	
60	0	
61	0	
62	0	
63	0	
64	0	
65	0	
66	0	
67	0	
68	0	
69	0	
70	0	

Identification of Samples:

El Verde Laboratory
Area - B

1A-6

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room ____ ☐ Notify _____ on ext. _____

Date _____ of results. ☐ Notified.

Taken by A. Vega Cintrón ☐ Send copy of report to:

Counted by Feliciano _____ Code _____

Date counted April 3, 1978

To be counted for

☐ ALPHA
Background _____ c/m Geometry _____

☒ BETA-GAMMA DS-2
Background 29 ± 10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
71	0**	
72	0	
73	0	
74	0	
75	0	
76	0	
77	0	
78	0	
79	0	
80	0	
81	0	
82	0	
83	0	
84	0	

Sample Number	Beta-Gamma	Alpha
85	0	
86	0	
87	0	
88	0	
89	0	
90	0	
91	0	

Identification of Samples:

El Verde Laboratory

Area B

1A-7

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Storage Room ☐ Notify _____ on ext. _____
Date Dec. 9, 81 of results. ☐ Notified.
Taken by Yoga ☐ Send copy of report to: _____ Code _____
Counted by Yoga
Date counted DEC, 10, 81

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA
Background 30 ± 10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
1A	0**	
2A	0	
3A	0	
4A	0	
5A	0	
6A	0	
7A	0	

Sample Number	Beta-Gamma	Alpha

Identification of Samples:

El Verde Laboratory Area B
Storage Room

1A-8

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Area C-D
Date March '78
Taken by S. Gomez
Counted by Sánchez
Date counted April 3, 1978

☐ Notify _____ on ext. _____
of results. ☐ Notified.
☐ Send copy of report to:
_____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA DS-1T
Background 30±10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
1	0**	
2	0	
3	0	
4	0	
5	0	
6	0	
7	0	
8	0	
9	0	
10	0	
11	0	
12	0	
13	0	
14	0	

Sample Number	Beta-Gamma	Alpha
15	0	
16	0	
17	0	
18	0	
19	0	
20	0	
21	0	
22	0	
23	0	
24	0	
25	0	
26	0	
27	0	
28	0	

Identification of Samples:

El Verde Lab Bldng.

Area C and Shops

1A-9

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Area C-D
Date [illegible]
Taken by Santiago Gomez
Counted by Feliciano
Date counted April 3, 1978

☐ Notify _____ on ext. _____
of results. ☐ Notified.
☐ Send copy of report to:
_____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA DS - 2
Background 29 ±10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
29	0 **	
30	0	
31	0	
32	0	
33	0	
34	0	
35	0	
36	0	
37	0	
38	0	
39	0	
40	0	
41	0	
42	0	

Sample Number	Beta-Gamma	Alpha
43	0	
44	0	
45	0	
46	0	
47	0	
48	0	
49	0	
50	0	
51	0	
52	0	
53	0	
54	0	
55	0	
56	0	

Identification of Samples:

El Verde Lab building

Area C and Shops

1A-10

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Area C-D ☐ Notify _____ on ext. _____
Date March 78 of results. ☐ Notified.
Taken by S. Gomez ☐ Send copy of report to:
Counted by Feliciano _____ Code _____
Date counted April 3, 1978

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA DS-2
Background 29 ±10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
57	0**	
58	0	
59	0	
60	0	
61	0	
62	0	
63	0	

Sample Number	Beta-Gamma	Alpha

Identification of Samples:

Smears El Verde Lab. Bldng

Area C and Shops

1A-11

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Area C-D
Date March '73
Taken by S. Gomez
Counted by Sanchez
Date counted April 3, 1973

☐ Notify _____ on ext. _____ of results. ☐ Notified.
☐ Send copy of report to: _____ Code _____

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA DS-1T
Background 30 ±10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
64	0**	
65	0	
66	0	
67	0	
68	0	
69	0	
70	0	
71	0	
72	0	
73	0	
74	0	
75	0	
76	0	
77	0	

Sample Number	Beta-Gamma	Alpha
78	0	
79	0	
80	0	
81	0	
82	0	
83	0	
84	0	
85	0	
86	0	
87	0	
88	0	
89	0	
90	0	
91	0	

Identification of Samples:

El Verde Lab Building

Area C and Shops

1A-12

Remarks:

HEALTH PHYSICS ASSAY REPORT

Bldg. El Verde Room Area C D ☐ Notify _____ on ext. _____
Date _____ of results. ☐ Notified.
Taken by S. Gomez ☐ Send copy of report to: _____ Code _____
Counted by Sanchez & Feliciano
Date counted April 3, 1978

To be counted for
☐ ALPHA
Background _____ c/m Geometry _____
☒ BETA-GAMMA DS-1T
Background 30 ± 10 c/m Geometry 2π

** Zero (0) indicates counts bellow detection limits of the Proportional Counter

Sample Number	Beta-Gamma	Alpha
92	0 **	
93	0	
94	0	
95	0	
96	0	
97	0	
98	0	
99	0	
100	0	
101	0	
102	0	
103	0	
104	0	
105	0	

Sample Number	Beta-Gamma	Alpha
106	0	
107	0	
108	0	
109	0	
110	0	
111	0	
112	0	
113	0	
114	0	
115	0	

Identification of Samples:

El Verde Lab. building

Area C and Shops

1A-13

Remarks:

APPENDIX 2.

APPENDIX 2.

Soil Samples Analyzed in the Germanium Lithium Spectrometer *

VEGETATION

AREA	SAMPLE NO	CONTAMINATED	NOT CONTAMINATED
4	3	Cs-137	
2	6		X
2	5		X
8	4	X	
SOIL			
2	6 A & B		X
2	5 A & B		X
3	4 A & B		X
4	Base of tree	Cs-137	
4	Resin of tree	Cs-137	
5	5 A & B		X
5	6 A & B		X
7	7 A & B		X
7	8 A & B		X
8	1 A & B		X
8	2 A & B		X
8	6 A & B		x
8	Control 1 A & B		X

*Spectrometric analysis was made with the only purpose of detecting radioactive contaminants. No attempt was made to quantify any contaminant.

APPENDIX 3.

APPENDIX 3.

Soil Samples taken at the Experimental Station in order to establish background levels for comparison purposes.

Samples counted in the Gas Flow Proportional Counter

SAMPLE NO.	μ Ci/gm $\pm 2.3 \times 10^{-5}$
1	2.70×10^{-5}
2	5.40×10^{-5}
3	4.05×10^{-5}
4	1.80×10^{-5}

APPENDIX 4.

NRC Form 374
(12-81)

U.S. NUCLEAR REGULATORY COMMISSION

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MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter 1, Parts 30, 31, 32, 33, 34, 35, 36, 40 and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s); and to import such byproduct and source material. This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee		
1. University of Puerto Rico Center for Energy and Environmental Research 2. Caparra Heights Station San Juan, Puerto Rico 00935	3. License number	52-19434-02
	4. Expiration date	March 31, 1987
	5. Docket or Reference No.	

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
A. Hydrogen 3	A. Any	A. 4 curies
B. Cesium 137	B. Any	B. 1 millicurie

9. Authorized use

A. and B. For use in field experiments.

CONDITIONS

10. Licensed material shall be used only at Caribbean National Forest, Luquillo Forest, El Verde Research Station, Puerto Rico.

11. The licensee shall comply with the provisions of Title 10, Chapter 1, Code of Federal Regulations, Part 19, "Notices, Instructions and Reports to Workers; Inspections" and Part 20, "Standards for Protection Against Radiation."

12. Licensed material shall be used by, or under the supervision of, Jeffrey Carl Luvall.

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License number
52-19434-02
Docket or Reference number

CONDITIONS

13. Licensed material shall not be used in or on human beings or in products distributed to the public.

14. A. Individuals involved in operations which utilize, at any one time, more than 100 millicuries of Hydrogen 3 in a non-contained form, other than metallic foil, shall have bioassays performed within one week following a single operation and at weekly intervals for continuing operations.

B. (1) Tritium shall not be used in such a manner as to cause any individual to receive a radiation exposure such that urinary excretion rates exceed 28 microcuries of tritium per liter when averaged over a calendar quarter.

(2) Urinalysis shall be performed at weekly intervals on all individuals who work in the restricted areas of facilities in which tritium is used. If the average concentration of tritium in urine for any single individual during a calendar quarter is less than 10 microcuries per liter, urinalysis may be performed on that individual at monthly intervals for the following calendar quarter and may continue at monthly intervals so long as the average concentration in the calendar quarter remains below 10 microcuries per liter. The urine specimen shall be collected on the same day of the week insofar as possible.

(3) A report of an average concentration in excess of the limit specified in B(1) above for any individual shall be filed, in writing, within thirty (30) days of the end of the calendar quarter with the Office of Inspection and Enforcement, U. S. Nuclear Regulatory Commission, Washington, D. C. 20555, with a copy to the Regional Office of Inspection and Enforcement. The report shall contain the results of all urinalyses for the individual during the calendar quarter, the cause of the excessive concentrations, and the corrective steps taken or planned to assure against a recurrence.

(4) Any single urinalysis which discloses a concentration of greater than 50 microcuries per liter shall be reported, in writing, within seven (7) days of the licensee's receipt of the results, to the Office of Inspection and Enforcement, U. S. Nuclear Regulatory Commission, Washington, D. C. 20555, with a copy to the U. S. Nuclear Regulatory Commission, Region II, Office of Inspection and Enforcement, 101 Marietta Street, Suite 3100, Atlanta, Georgia 30303.

NRC Form 374A
(12-81)

U.S. NUCLEAR REGULATORY COMMISSION

License number
52-19434-02
Docket or Reference number

MATERIALS LICENSE
SUPPLEMENTARY SHEET

CONDITIONS

15. Except as specifically provided otherwise by this license, the licensee shall possess and use licensed material described in Items 6, 7, and 8 of this license in accordance with statements, representations, and procedures contained in letter dated December 20, 1981. The Nuclear Regulatory Commission's regulations shall govern the licensee's statements in applications or letters, unless the statements are more restrictive than the regulations.

For the U.S. Nuclear Regulatory Commission

Date MAR 09 1982

By Material Licensing Branch
Division of Fuel Cycle and
Material Safety
Washington, D.C. 20555

NRC Form 374A
(12-81)

U.S. NUCLEAR REGULATORY COMMISSION

MATERIALS LICENSE
SUPPLEMENTARY SHEET

PAGE 1 OF 1 PAGES

License number 52-19434-02

Docket or Reference number

Amendment No. 01

University of Puerto Rico
Center for Energy and Environmental
Research
Caparra Heights Station
San Juan, Puerto Rico 00935

In accordance with letter dated August 4, 1982, License Number 52-19434-02 is amended as follows:

Conditions 10. and 12. are amended to read:

10. Licensed material shall be used only at Caribbean National Forest, Luquillo Forest, El Verde Research Station, Puerto Rico.

12. Licensed material shall be used by, or under the supervision of, Laurence J. Tilly, Ph.D.

OCT 13 1982

Date

For the U.S. Nuclear Regulatory Commission

10-13-82

Original Signed By
Patricia C. Vacca
By Material Licensing Branch

Division of Fuel Cycle and
Material Safety
Washington, D.C. 20555

10-13-82

FIGURES

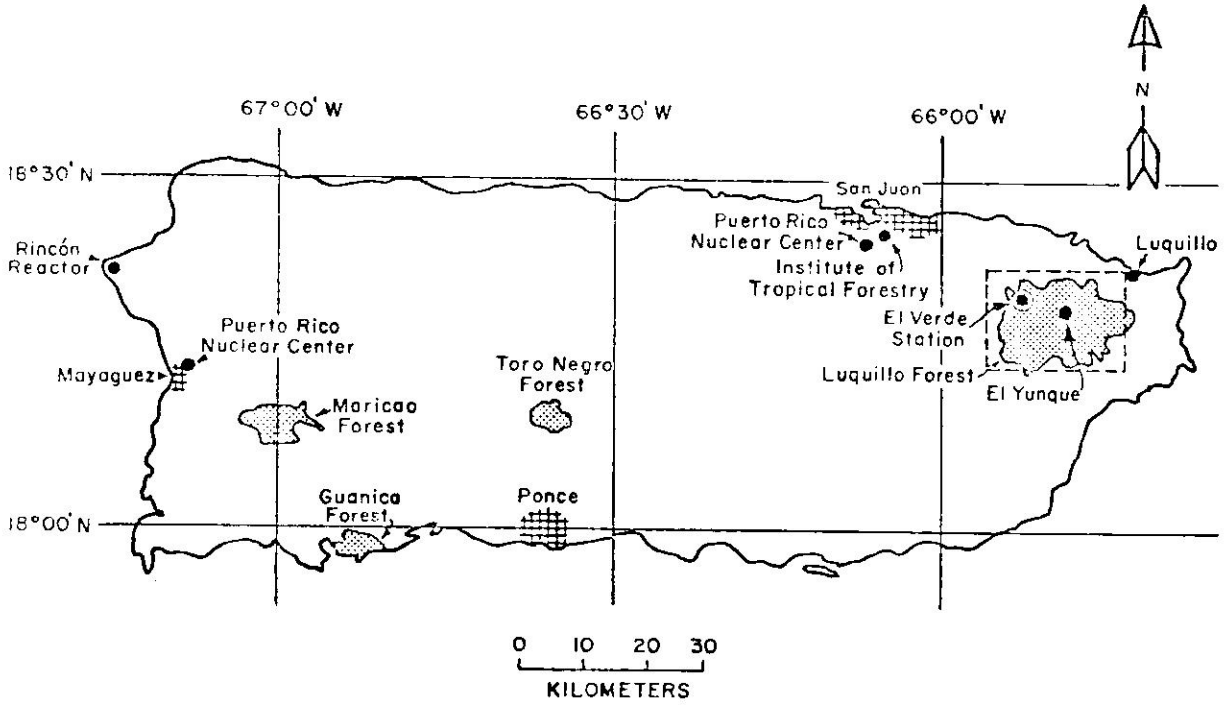


Fig. 1. Map of Puerto Rico Showing the Location of Luquillo Forest and El Verde Research Area.

Meteorological tower

Cycling and Transport study sites

U. S. Forest Service long term growth plots

AEC Experimental sites (1964-1970)

Fig. 1-A. Approximate boundary of the 156 acres under DOE-Forest Service Agreement

Fig. 2. Schematic Map of El Verde Research Area Showing the Cs-137 Radiation Center and Approximate Location of the 80m and 160m radii.

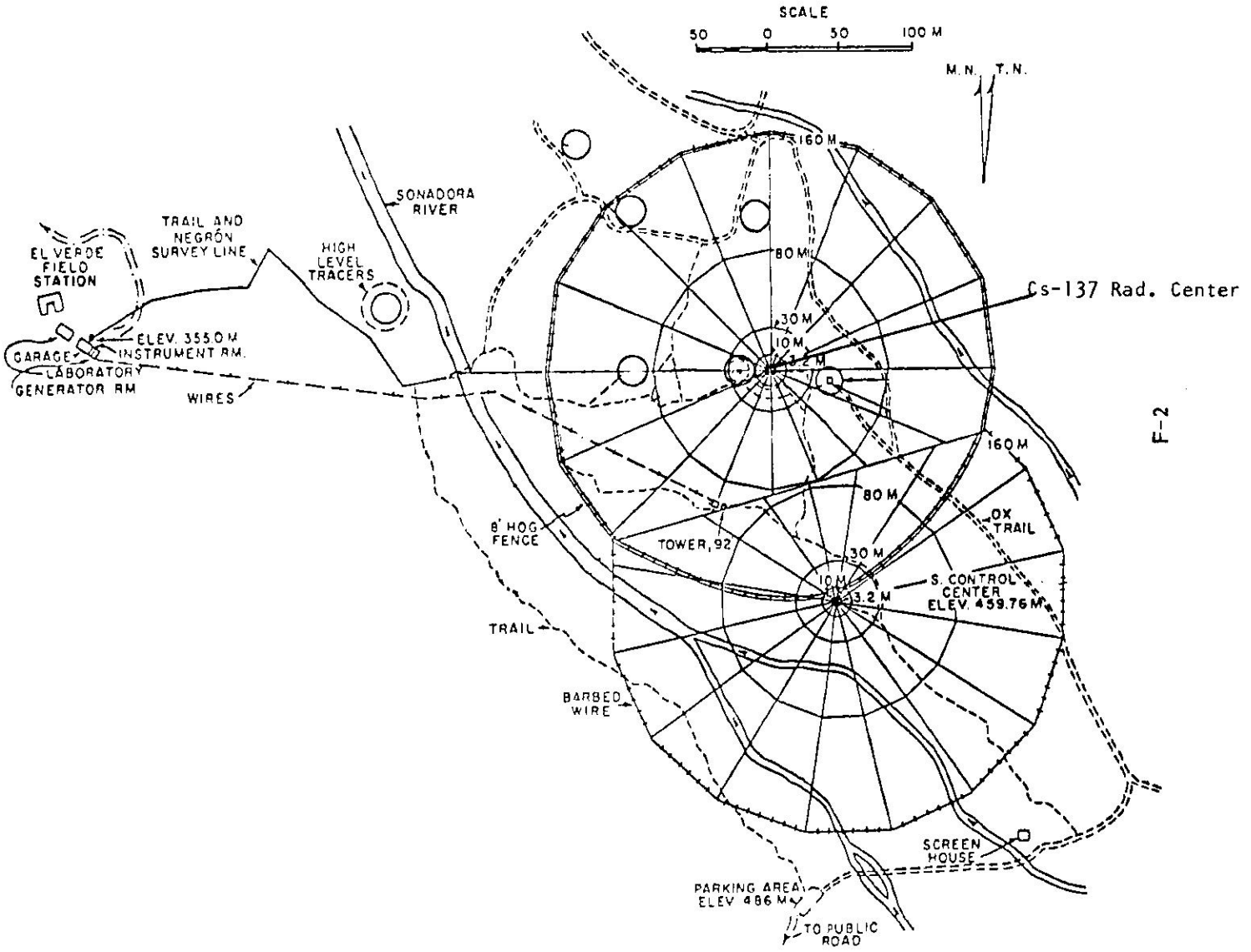


Fig. 3. Laboratory Area, El Verde Research Station.

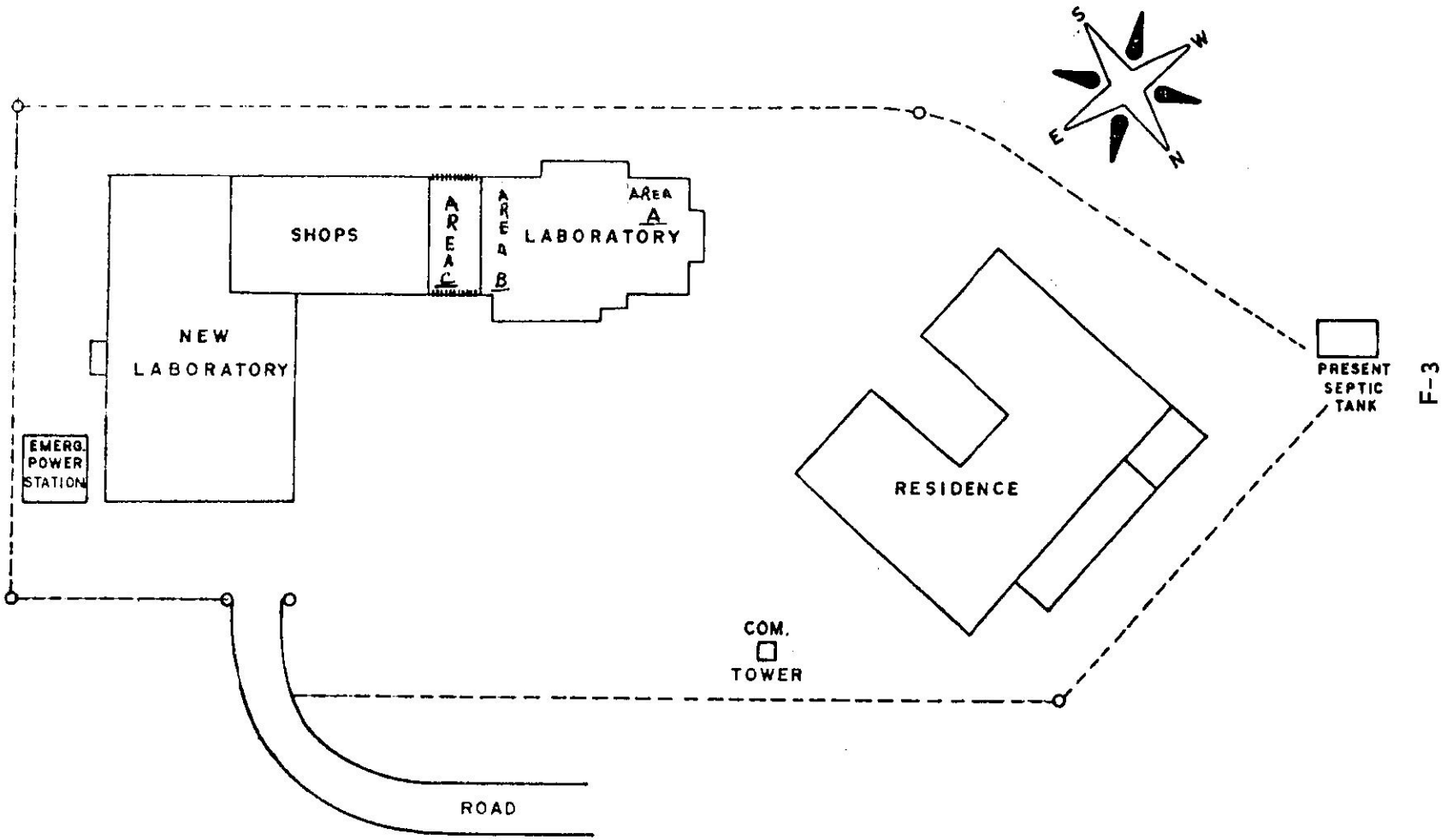


Fig. 4. Detail of Old Laboratory Building, Area A. Numbers Indicate Survey Points. See Appendix 1a for Results.

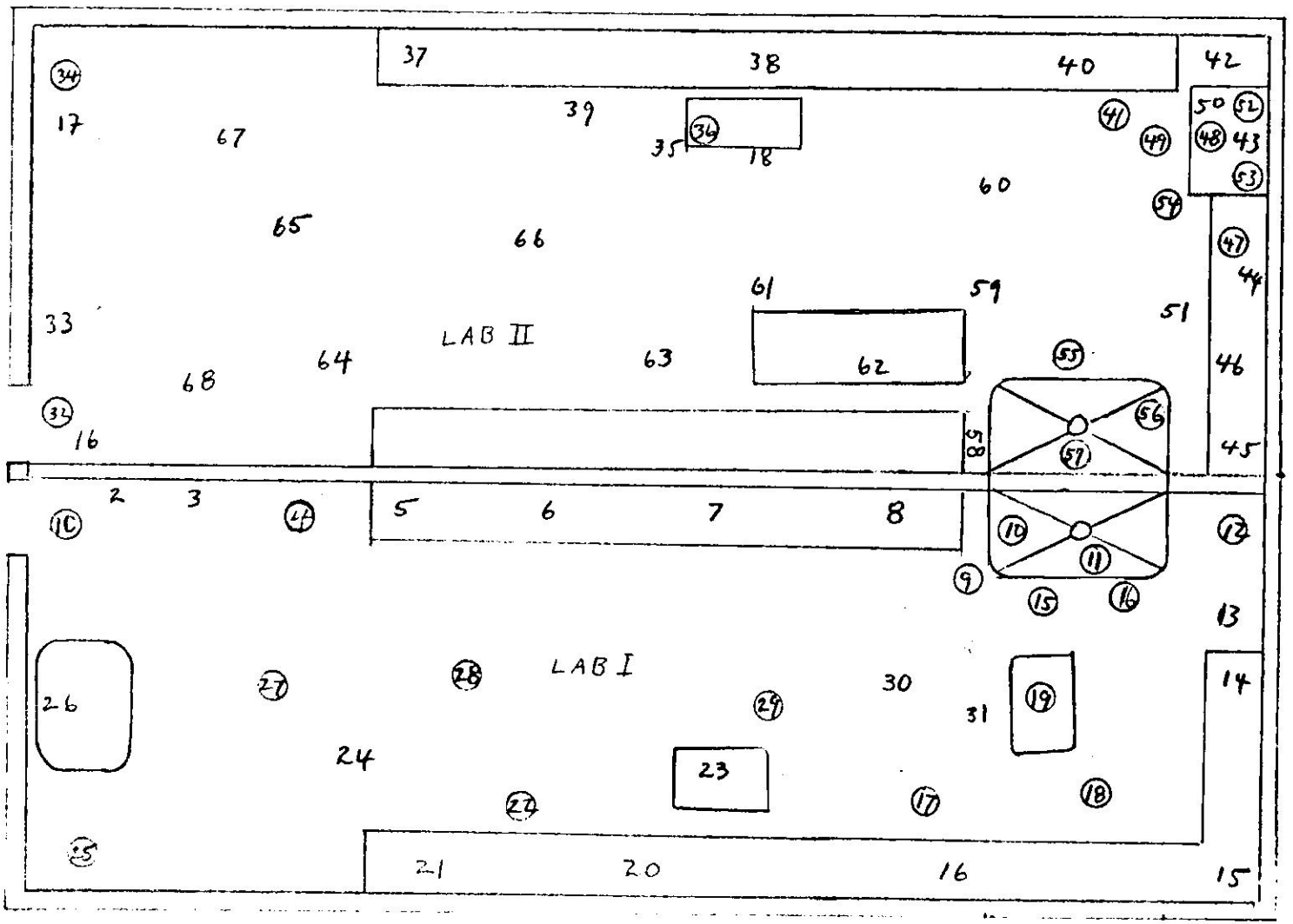


Fig. 5. Detail of Old Laboratory Building, Area B. Numbers Indicate Survey Points. See Appendix 1A for Results.

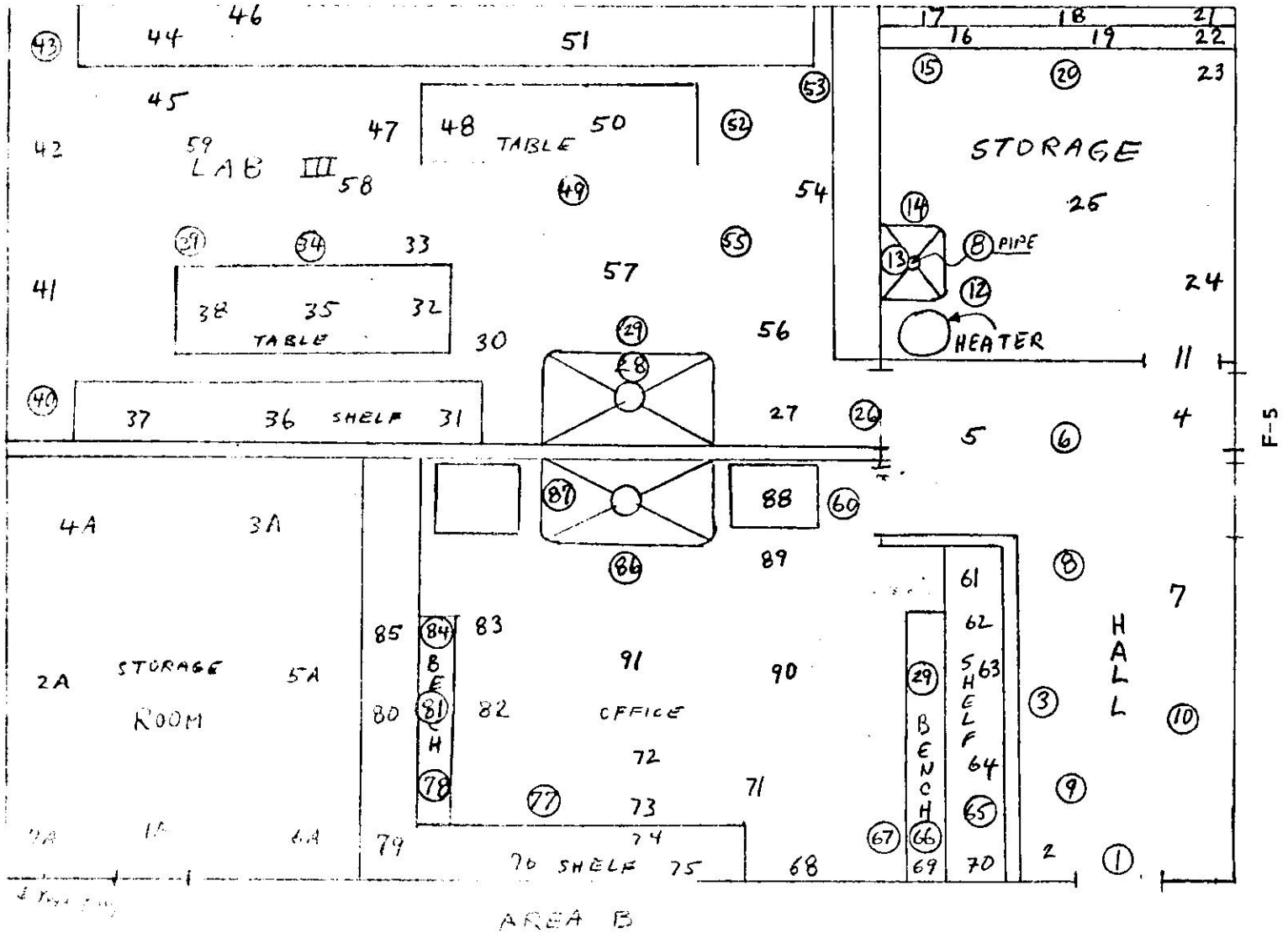


Fig. 6. Detail of Old Laboratory Building, Area C and Shops. Numbers Indicate Survey Points. See Appendix 1A for Results.

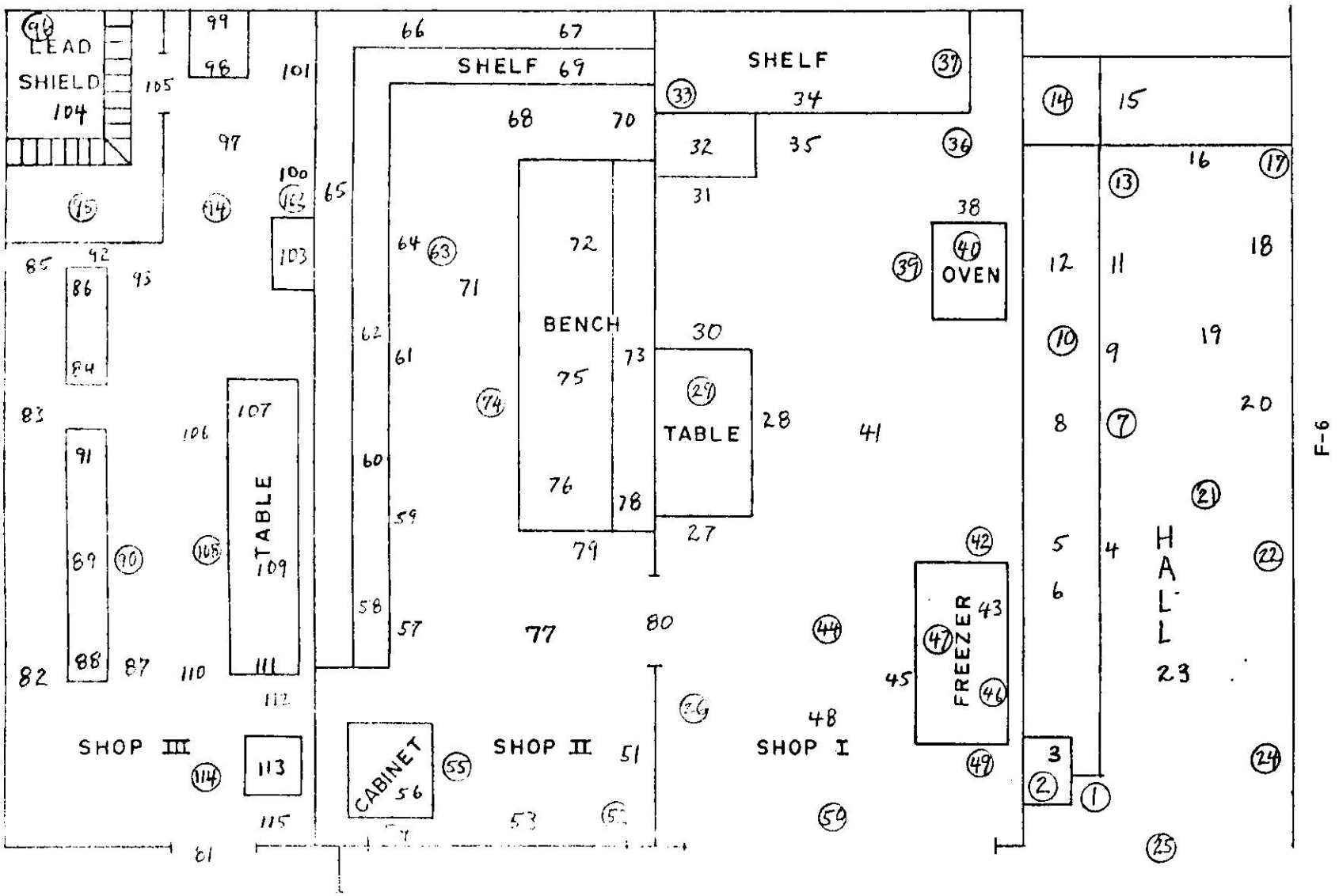


Fig. 7. Approximate Location of the Six Areas where Radiotracers were Used.

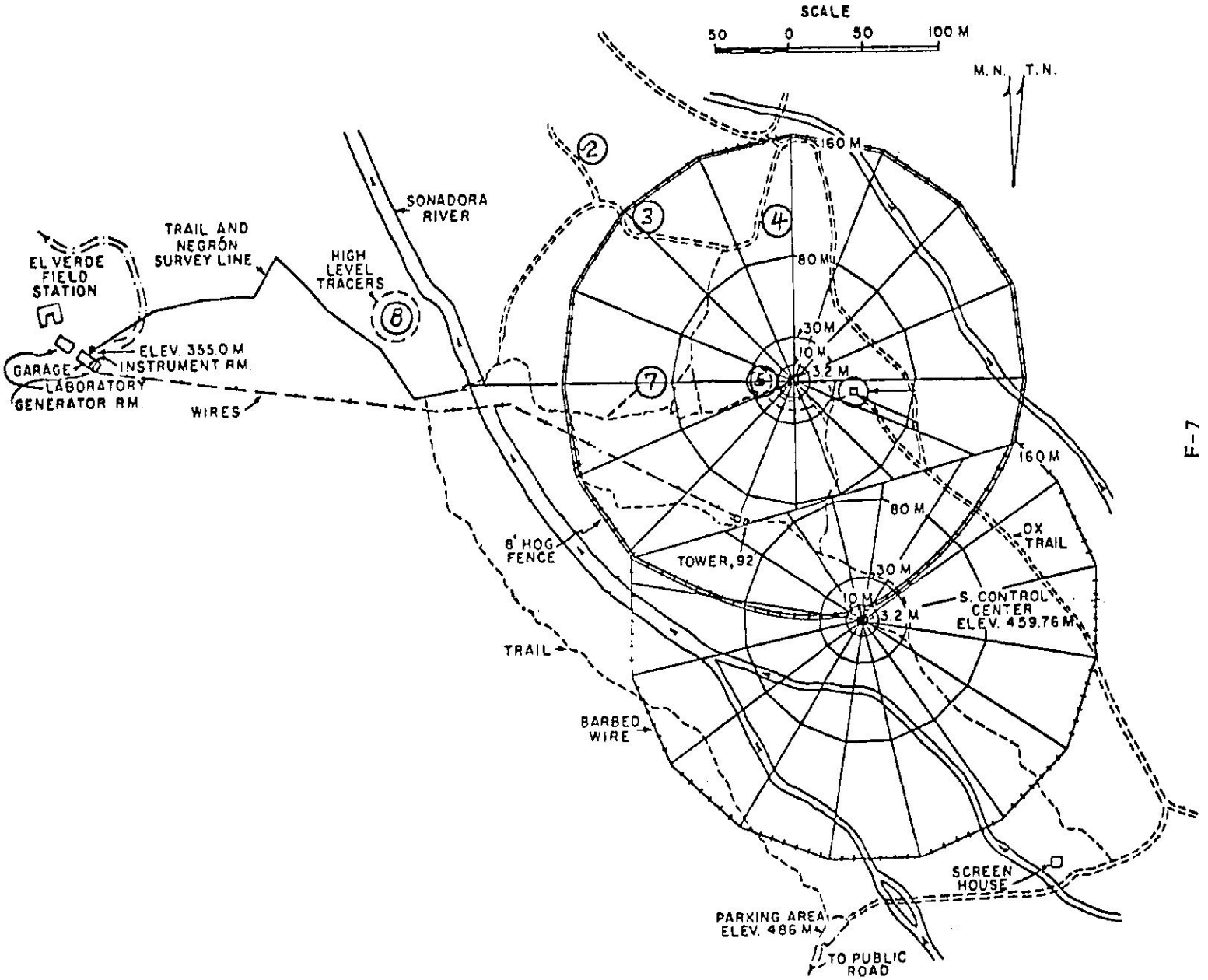


Fig. 8. Radiation Levels, Expressed in μR/hr, in the Laboratory Area.

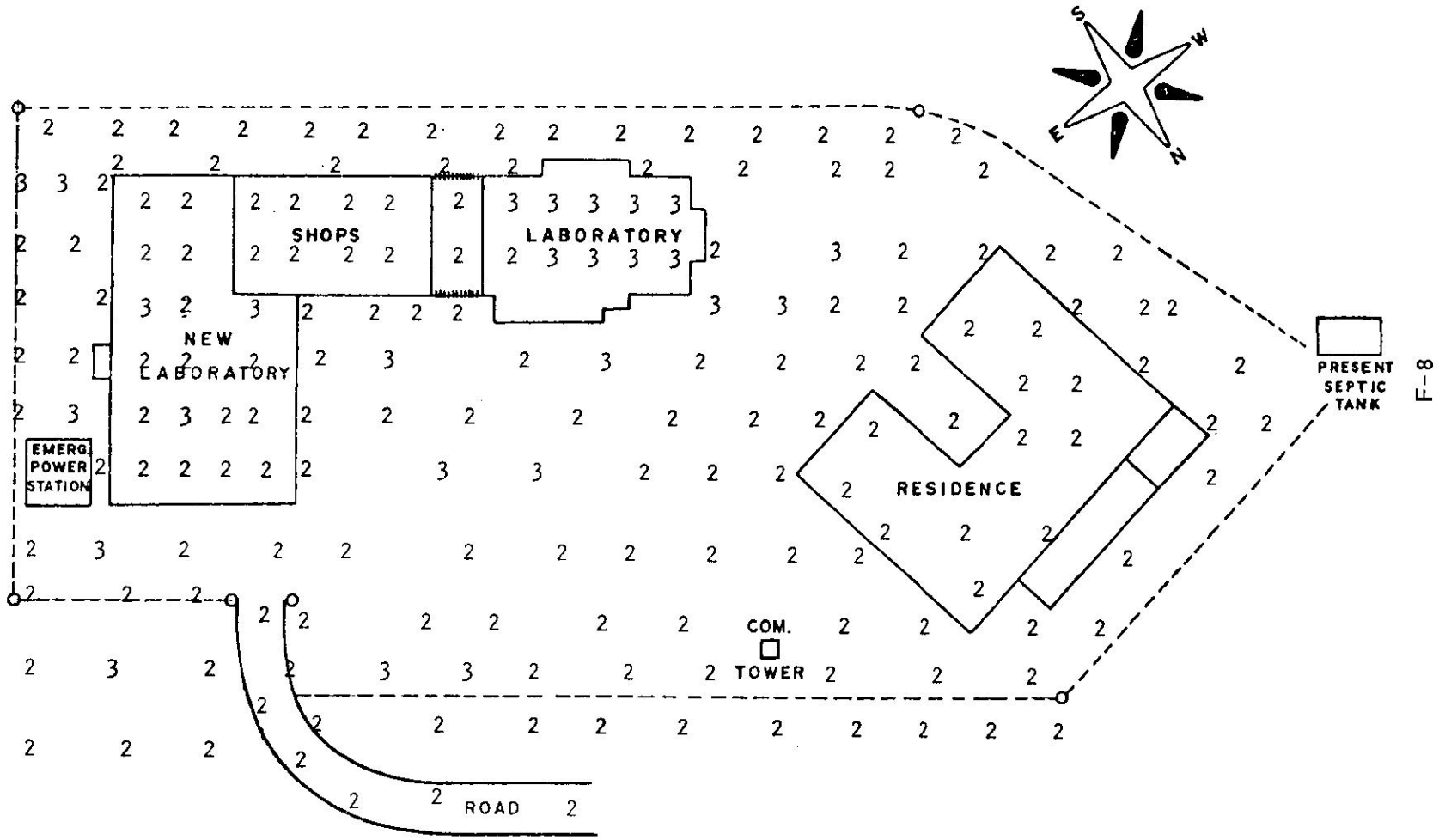
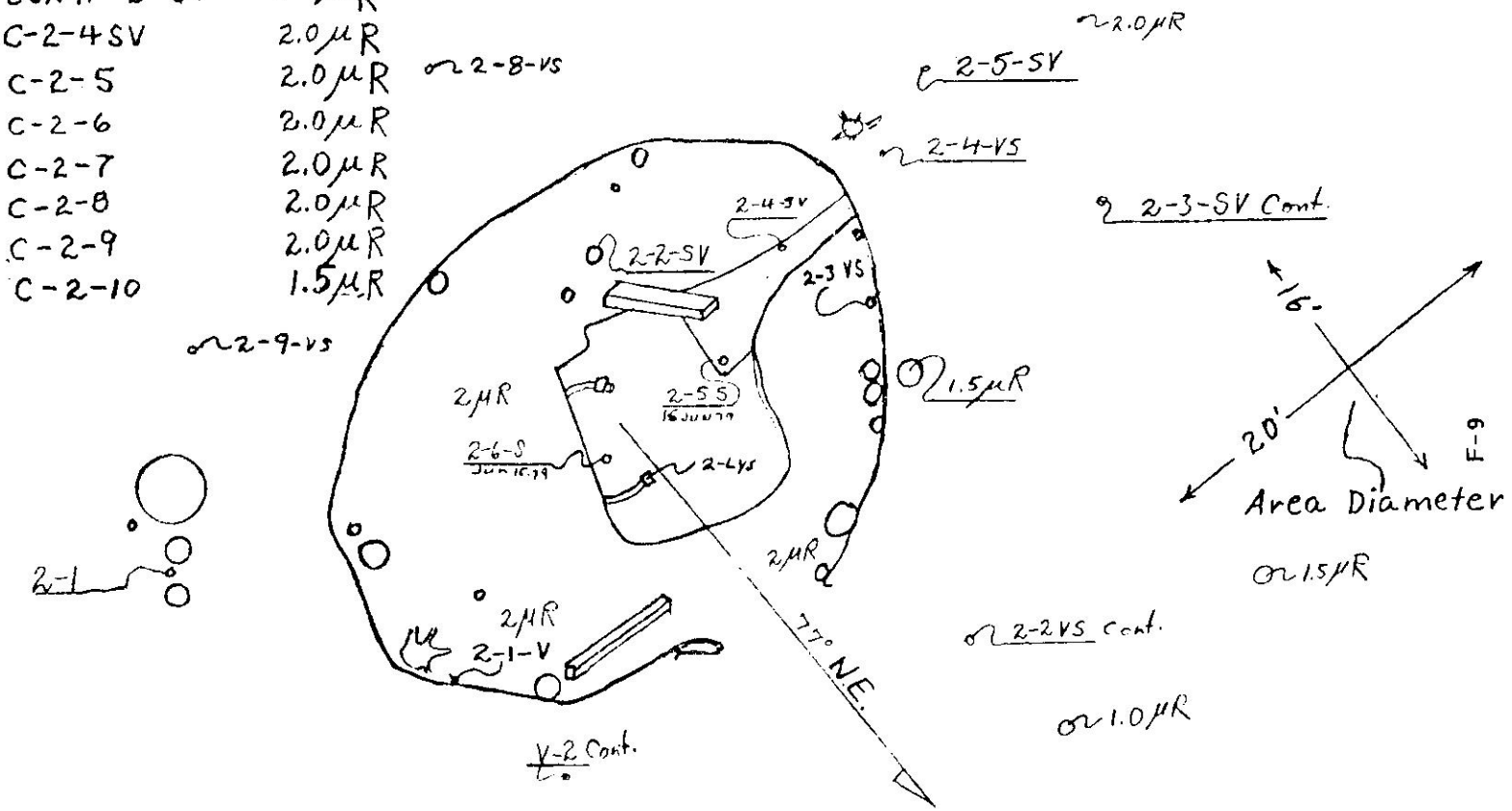


Fig. 9. Radiation Levels and Sampling Locations in Area 2. See Appendix 1 for Results of Samples Analyzed.

El Verde Rain Forest ~2-7-VS Area #2 Back Ground 2.0μR

2-6 Cont.

CONT. 2-3V	2.0μR
C-2-4SV	2.0μR
C-2-5	2.0μR
C-2-6	2.0μR
C-2-7	2.0μR
C-2-8	2.0μR
C-2-9	2.0μR
C-2-10	1.5μR



Tree #1 Connell 1.5μR
Tree #5 " 1.5μR
Soil 1.5μR

Fig. 10. Radiation Levels and Sampling Locations in Area 3.

See Appendix 1 for Results of Samples Analyzed.

Area # 3 El Verde Rain Forest

Soil 3-1 – 2.0 MR
3-2 "
3-3 "
3-4 1.5 MR
3-5 "
3-6 "
3-7 2.0 MR

1.5 MR at all trees

Control Area
3-1 1.5 MR
3-2 "
3-3 "
3-4 "
3-5 "
3-6 "
3-7 "
3-8 "
3-9 "

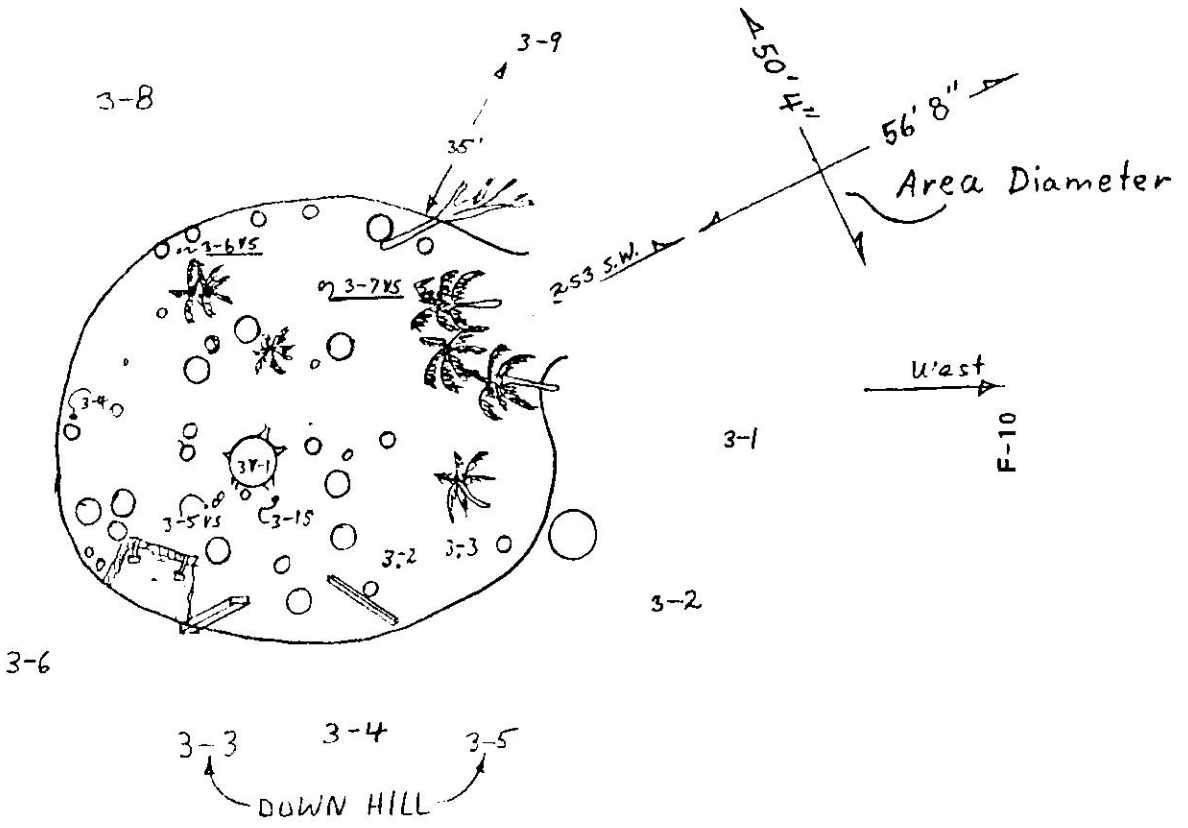
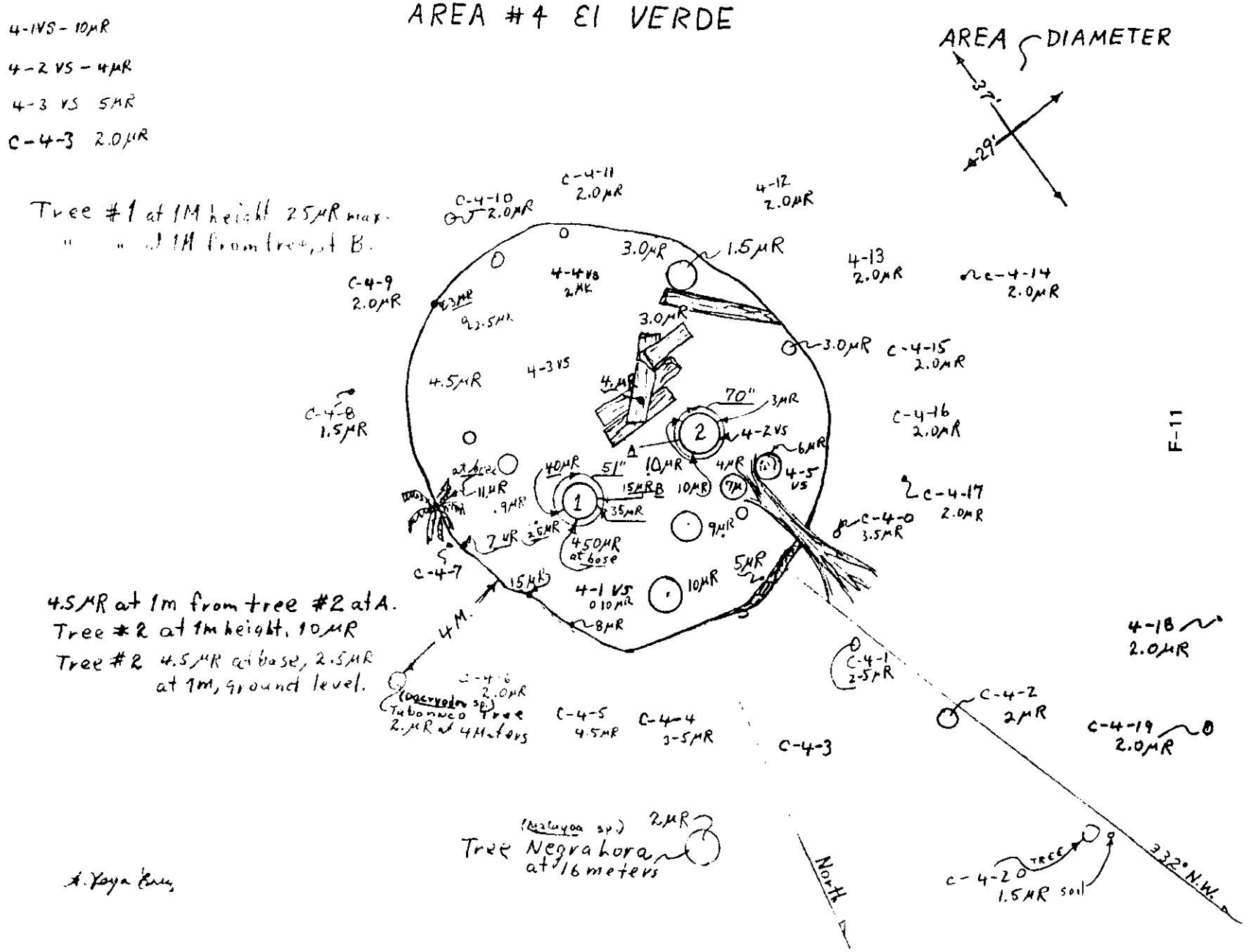


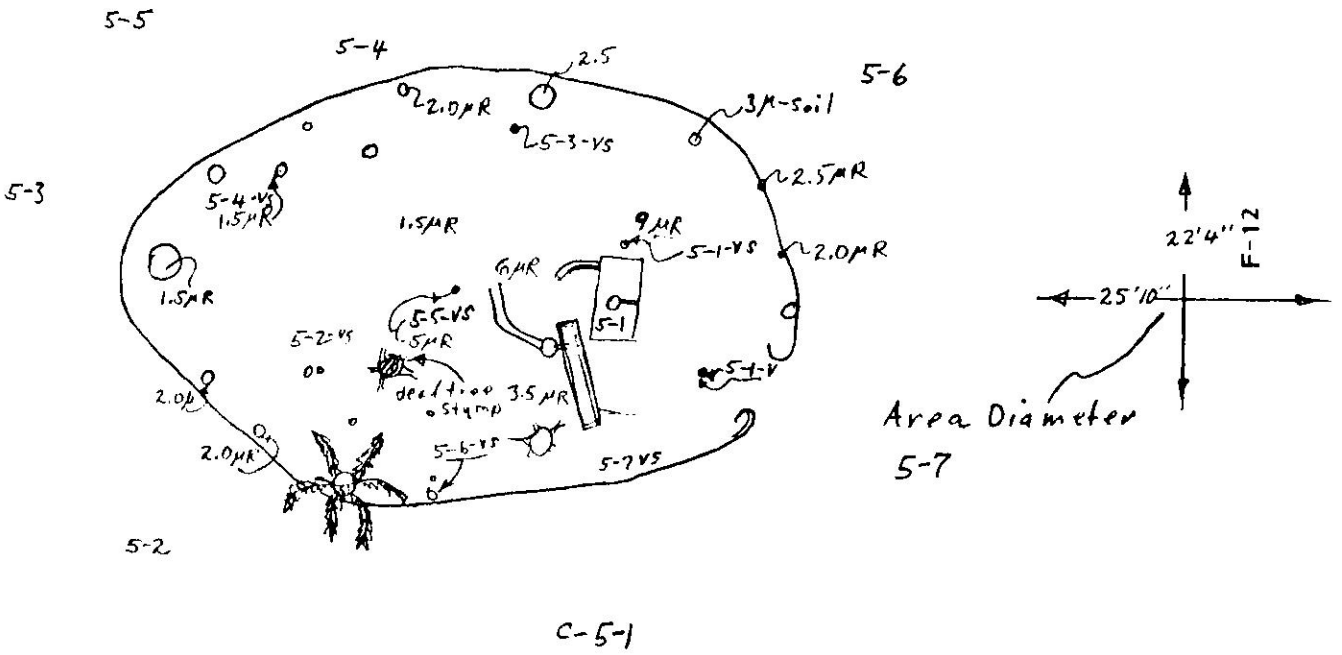
Fig. 11. Radiation Levels and Sampling Locations in Area. 4.
See Appendix 1 for Results of Samples Analyzed.



Area #5 El Verde

5-1 50μR
5-1-VS 30μR
5-2 VS 1.5μR

5-1-V 1.5μR
5-2 VS 2.0μR
5-3 VS 2.0μR
5-4 VS 2.0μR
5-5 VS 1.5μR
5-6 VS 1.5μR
5-7 VS 2.0μR



C-5-1

Fig. 12. Radiation Levels and Sampling Locations in Area 4.

See Appendix 1 for Results of Samples Analyzed.

Area #7 El Verde

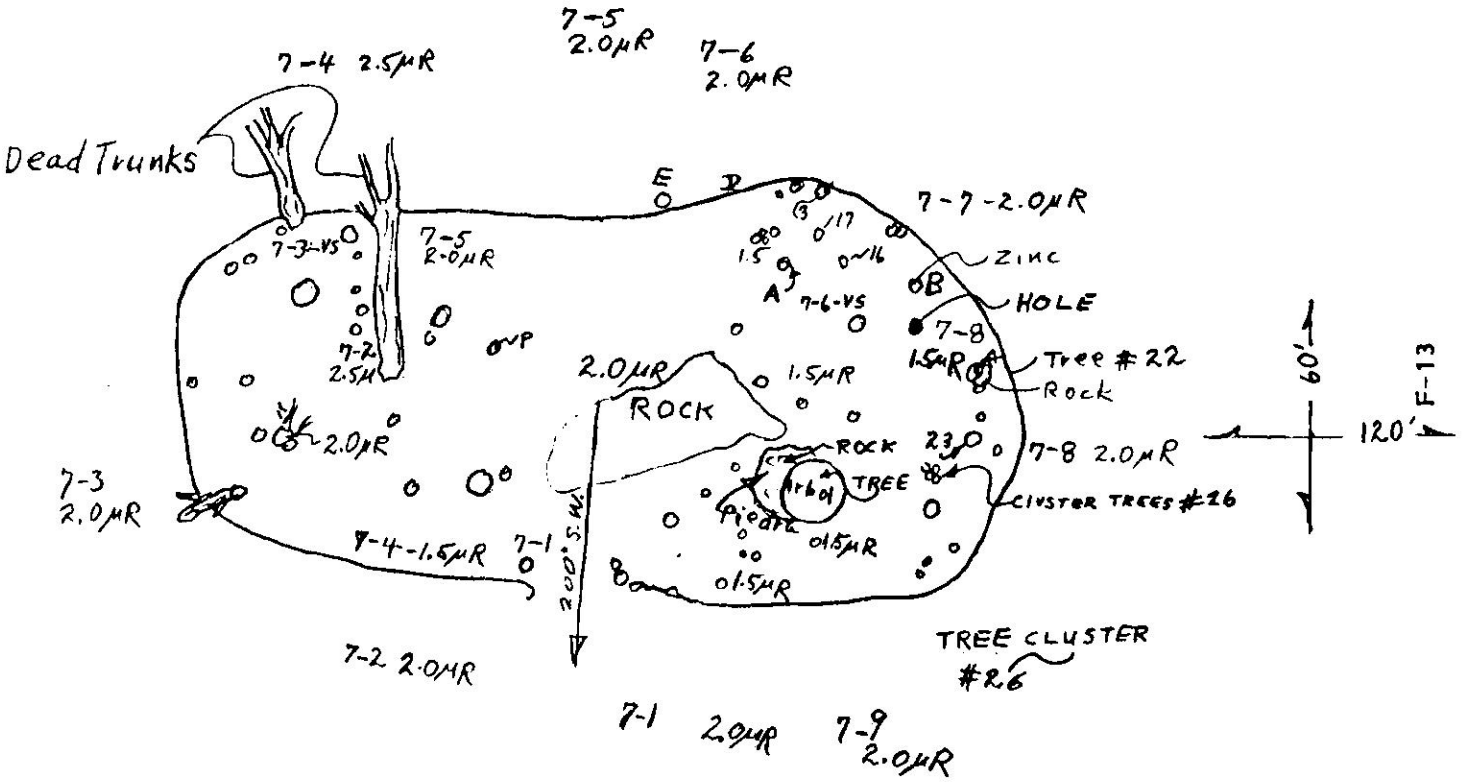


Fig. 13. Radiation Levels and Sampling Locations in Area 7.

See Appendix 1 for Results of Samples Analyzed.

A. Yago

Fig. 14. Radiation Levels and Sampling Locations in Area 8.
See Appendix 1 for Results of Samples Analyzed.

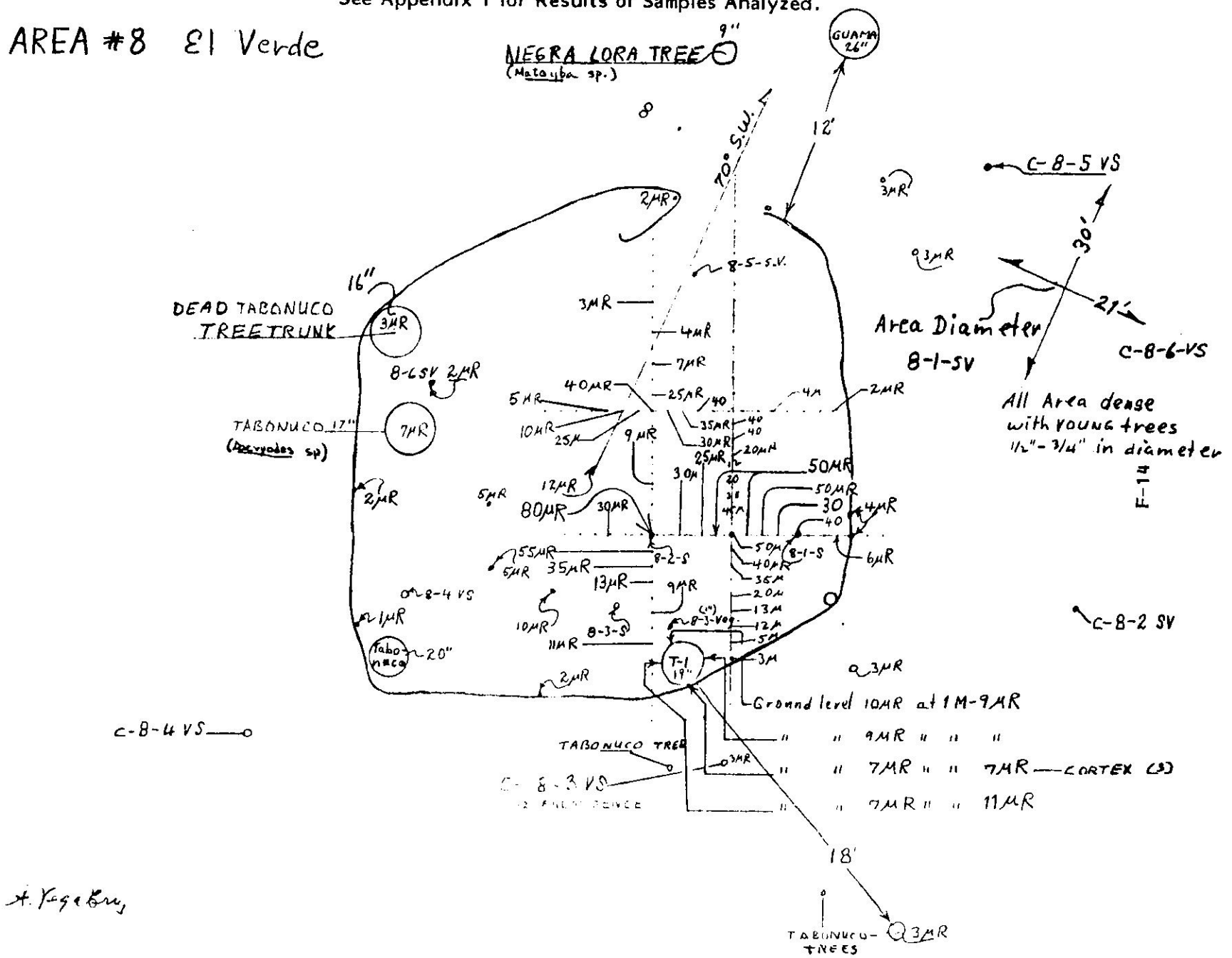


Fig. 15. Radiation Levels After Decontamination of Area 8.

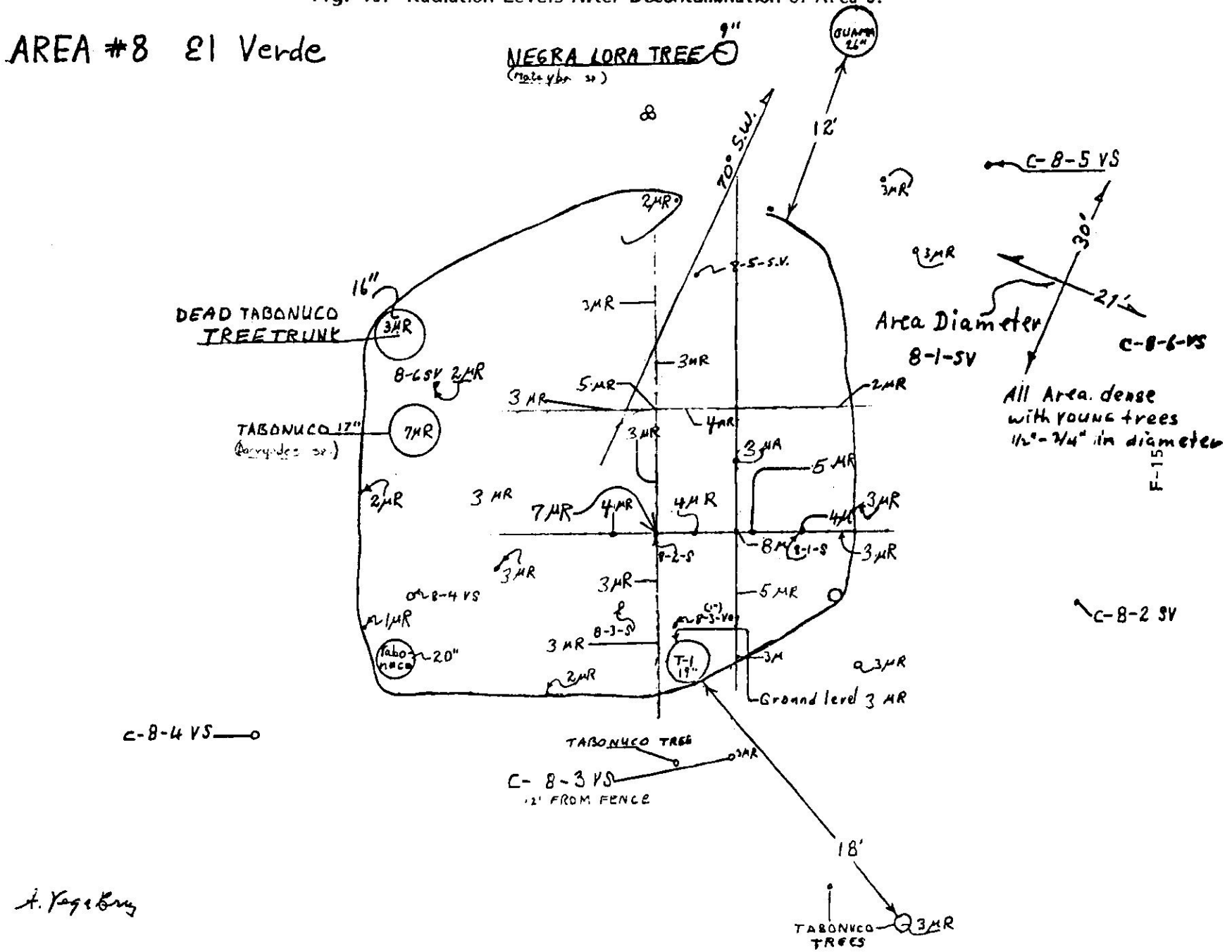


Fig. 16. Radiation Levels, at the present time, in Area 4.