United States
Environmental Protection
Agency

Office of Radiation Programs
Las Vegas Facility
P.O. Box 15027
Las Vegas NV 89114

ORP/LV-79-2
January 1979

Radiation

EPA

Ambient Airborne Radioactivity Measurements in the Vicinity of the Jackpile Open Pit Uranium Mine New Mexico

Technical Note
ORP/LV-79-2

AMBIENT AIRBORNE RADIOACTIVITY MEASUREMENTS IN THE VICINITY OF THE JACKPILE OPEN PIT URANIUM MINE NEW MEXICO

Gregory G. Eadie*
C. William Fort*
Mala L. Beard**

January 1979

*Office of Radiation Programs-Las Vegas Facility
U.S. Environmental Protection Agency
Las Vegas, Nevada 89114

**District Sanitarian, Indian Health Service
A.C.L. Hospital
P.O. Box 130
San Fidel, New Mexico 87049

DISCLAIMER

This report has been reviewed by the Office of Radiation Programs Las Vegas Facility, U. S. Environmental Protection Agency, and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for their use.

PREFACE

The Office of Radiation Programs of the U.S. Environmental Protection Agency carries out a national program designed to evaluate population exposure to ionizing and nonionizing radiation, and to promote development of controls necessary to protect the public health and safety. This report describes several field studies which were conducted to evaluate the ambient airborne radioactivity levels for locations in the vicinity of the Jackpile Open Pit Uranium Mine in New Mexico. Readers of this report are encouraged to inform the Office of Radiation Programs of any omissions or errors. Comments or requests for further information are also invited.

Donald W. Hendricks
Director, Office of
Radiation Programs, LVF

TABLE OF CONTENTS

	Page
LIST OF FIGURES	vii
LIST OF TABLES	viii
ACKNOWLEDGMENTS	ix
INTRODUCTION	1
SUMMARY	2
STUDY AREA	3
RADIATION SURVEYS	4
RADIUM IN SOIL AND WATER SAMPLES	6
METEOROLOGY	7
AMBIENT OUTDOOR RADON-222 CONCENTRATIONS	9
Sampling System and Analytical Methods	9
Results and Discussion	9
Interlaboratory Comparisons	14
INDOOR RADON PROGENY LEVELS	16
Sampling System and Analytical Methods	16
Results and Discussion	16
Radon and Progeny Equilibrium Ratios	21
Regulations and Guidelines	23
Log-Probability Distribution of Indoor Radon Progeny Levels	24
AIRBORNE PARTICULATE SAMPLING	29
System Description	29
Gross Versus Net Results	29
Results and Discussion	31
Log-Probability Distribution of Ambient Airborne Particulate Radioactivity	37
DOSE ESTIMATES	42
RADIOACTIVITY IN FOOD	44

Page

REFERENCES 46

APPENDICES

A - Ambient Outdoor Radon-222 Concentrations 48
B - Composited Monthly Ambient Air Sampling Results in pCi/m^3 60
C - Composited Monthly Ambient Air Sampling Results in pCi/g 66
D - Air Sampling Results for Locations in the Vicinity of the Jackpile Open Pit Uranium Mine (in pCi/m^3) 72
E - Air Sampling Results for Locations in the Vicinity of the Jackpile Open Pit Uranium Mine (in pCi/g) 78

LIST OF FIGURES

Number		Page
1	Sampling locations and summary of radon and progeny measurements in the vicinity of the Jackpile Open Pit Mine, New Mexico	3
2	Ambient indoor radon progeny working levels during 1976	22
3	Log-probability plot of ambient indoor radon progeny levels at Laguna	26
4	Log-probability plot of ambient indoor radon progeny levels at Jackpile Housing	27
5	Log-probability plot of ambient indoor radon progeny levels at Paguate	28
6	Average monthly airborne radium-226 concentration (pCi/m^3) for locations in the vicinity of the Jackpile Open Pit Uranium Mine	34
7	Average monthly airborne total uranium concentration (pCi/m^3) for locations in the vicinity of the Jackpile Open Pit Uranium Mine	35
8	Average monthly airborne thorium-230 concentration (pCi/m^3) for locations in the vicinity of the Jackpile Open Pit Uranium Mine	36
9	Log-probability plot of the composited monthly ambient radium-226 radioactivity concentrations for the five locations in the vicinity of the Jackpile Open Pit Uranium Mine	38
10	Log-probability plot of the composited monthly ambient total uranium radioactivity concentrations for the five locations in the vicinity of the Jackpile Open Pit Uranium Mine	39
11	Log-probability plot of the composited monthly ambient thorium-230 radioactivity concentrations for the five locations in the vicinity of the Jackpile Open Pit Uranium Mine	40

LIST OF TABLES

Number		Page
1	Gamma Radiation Surveys and Soil and Water Sample Results	5
2	Ambient Outdoor Radon-222 Concentrations During June 1976 in the Vicinity of the Jackpile Open Pit Mine, New Mexico	10
3	Representative Background Radon Levels in the Vicinity of the Jackpile Mine	12
4	Exposure Limits for Radon-222 and Radon Progeny	13
5	Replicate Analysis Between Two Laboratories	15
6	Ambient Indoor Radon Progeny Levels at Laguna Tribal Building	18
7	Ambient Indoor Radon Progeny Levels at Jackpile Housing (#16 House)	19
8	Ambient Indoor Radon Progeny Levels at Paguate Community Building	20
9	Radon and Progeny Equilibrium Indications	21
10	Blank Microsorban Filter Radioactivity Contents	30
11	Volume Weighted Annual Average Airborne Radionuclide Concentration (in pCi/m^3)	33
12	Mass Weighted Annual Average Airborne Radionuclide Concentration (in pCi/g)	33
13	Comparison of Means	41
14	Average Annual Lung Dose (mrem/year) for Insoluble Radionuclides	43
15	Radioactivity in Food	45

ACKNOWLEDGMENTS

The authors would like to extend their grateful appreciation to The Anaconda Company and Mr. William E. Gray for their cooperation during this study.

INTRODUCTION

Starting in December 1975, a one-year study was conducted in the vicinity of the Jackpile Open Pit Uranium Mine to measure the ambient airborne concentrations of natural radioactive materials such as uranium, radium and thorium. Radon progeny levels (expressed as Working Levels [WL]) were also determined at several indoor locations in nearby communities. During June 1976, a special study was conducted to measure the ambient outdoor radon-222 levels in the area. This report discusses the results of these radiological surveys.

SUMMARY

This report discusses the results of several radiological surveys conducted in the vicinity of the Jackpile Open Pit Uranium Mine in New Mexico. During June 1976, ambient radon-222 concentrations were measured at eleven locations, seven of which appear to have been at representative background radon levels - averaging 0.50 ± 0.033 pCi/l. The other four locations had average radon levels in excess of this typical background level; however, the highest measured radon concentration was 2.7 pCi/l. The arithmetic average ambient radon progeny working level obtained indoors at the Laguna Tribal Building appeared to be at a representative background level of 0.0049 ± 0.00045 WL. The arithmetic average ambient working levels obtained at the Paguate Community Center and the Jackpile Housing were 0.035 ± 0.0038 and 0.015 ± 0.0025 WL, respectively. Ambient airborne particulate radioactivity concentrations measured outdoors at Old Laguna appear to be at typical background levels; however, other locations exhibited higher annual average concentrations for the naturally-occurring radionuclides.

STUDY AREA

Figure 1 shows the study area and sampling locations. The Anaconda Company operates the Jackpile-Paguate Mine which is the world's largest open pit uranium mine. About 5500 tons of uranium ore are produced each day. Roughly one-half of the daily production is sent via railway for processing at the Anaconda Mill at Bluewater; the remaining ore is stockpiled at the mine.

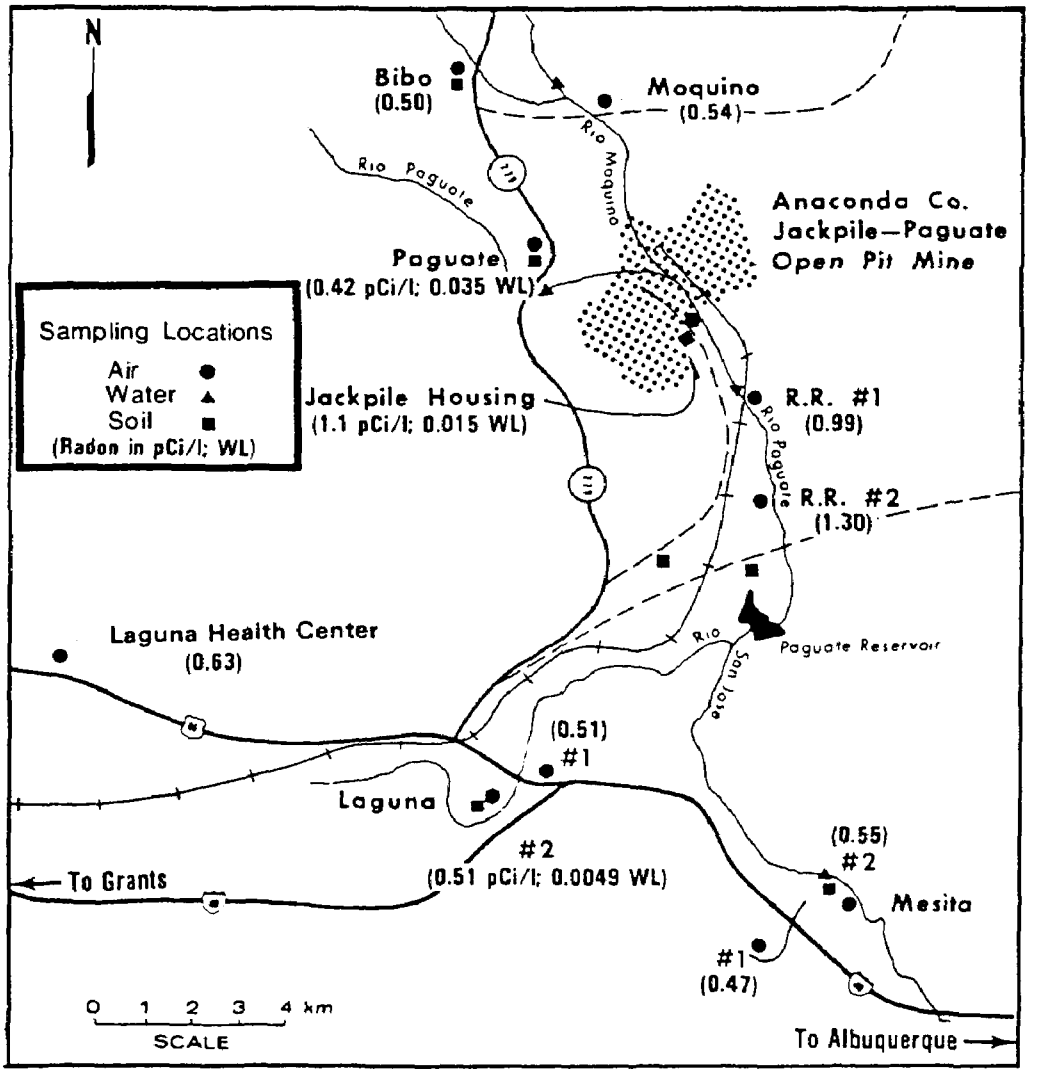

Figure 1. Sampling locations and summary of radon and progeny measurements in the vicinity of the Jackpile Open Pit Mine, New Mexico

RADIATION SURVEYS

Upon selection of a site as a suitable air sampling location, gamma radiation surveys were completed. These surveys were done to evaluate whether the sampling location was constructed upon an area of elevated terrestrial radioactivity, or if some uranium ore or other radioactive material was present inside the structure. Such conditions could have biased the ambient outdoor radon levels and/or the indoor working level determinations.

A pressurized ionization chamber (PIC - Reuter Stokes, Model RSS-111 Environmental Radiation Monitor) was used to measure the radiation exposure rate in units of microroentgen per hour (μR/h). The PIC was calibrated using a "shadow shield" method employing a cobalt-60 source calibrated by the National Bureau of Standards. The PIC was then inter-calibrated to respond to a radium-226 gamma spectrum. The PIC measures both the cosmic and terrestrial gamma source exposure rates. All PIC measurements were made at a height of one meter above ground surface. For the indoor measurements, the PIC determination was made in about the center of the room in which the indoor radon progeny air sampler was located.

Radiation surveys were also made using a portable gamma scintillator survey meter (Baird-Atomic, Type NE148A - Gamma Scintillator Ratemeter). This instrument was calibrated with a radium-226 standard and measured the relative gamma radiation exposure rate in units of μR/h. Table 1 presents the radiation exposure rates measured at each location (indoor and outdoor) for both types of detectors.

TABLE 1. GAMMA RADIATION SURVEYS AND SOIL AND WATER SAMPLE RESULTS

Location	Outdoor PIC (μR/h)	Outdoor Scintillator (μR/h)	Indoor Pic (μR/h)	Indoor Scintillator (μR/h)	Ra-226 in Soil Top 5 cm* (pCi/g)	Ra-226 in Water (Total)* (pCi/l)
Laguna (#2)	11.5	5	14.1	8	0.62 ± 0.15	-
Bibo	14.3	7	-	-	0.86 ± 0.18	-
Mesita (#1)	11.0	5	-	-	-	-
Mesita (#2)	12.0	7	-	-	0.78 ± 0.17	0.37 ± 0.097
Moquino	11.9	5	-	-	-	0.15 ± 0.064
Paguate	13.1	7	14.5	11	1.1 ± 0.19	0.65 ± 0.12
Jackpile Housing	15.9	14	17.0	14	3.9 ± 0.36	-
Railroad Trestle	13.4	9	-	-	1.7 ± 0.24	4.7 ± 0.32

*Result ± Two-Sigma Counting Error

RADIUM IN SOIL AND WATER SAMPLES

In addition to the radiation survey, a soil sample was also collected at several of the outdoor air sampling locations. Each soil sample was obtained at the same location as were the outdoor radiation measurements. The results of analyses for radium-226 content are also reported in Table 1. A standardized sampling procedure, which utilized a steel scoop, 5-cm deep and 100-cm^2 in surface area, was established to obtain a standard soil sample of 500 cm^3, representing the average activity in the top five centimeters of soil. The highest radium content in soil (3.9 pCi/g) was at the Jackpile Housing Area. The soil content at the Railroad Trestle was also high at 1.7 pCi/g. Both of these areas showed elevated radon levels, as discussed later. The background location at Laguna (#2) had the lowest radium in soil content of 0.62 pCi/g.

Four non-potable water samples were collected from nearby streams and these results are also shown in Table 1. Radium-226 in the total water sample (both dissolved and suspended components) was measured, ranging from a low of 0.15 pCi/l at the Rio Moquino to a high value of 4.7 pCi/l for a stream near the railroad trestle.

METEOROLOGY*

Surface winds are monitored continuously at the Jackpile-Paguate mine by the Anaconda Company using a Bendix Aerovane wind transmitter located on the roof of the maintenance shop. The approximate height of the instrument is 60 feet above ground level. Wind speed and direction are recorded on analog recorders and later reduced to hourly averages by Anaconda personnel.

Surface winds at the mine occur primarily from the east and west. The nocturnal wind (1800-0600 MST) is characterized by light, westerly flow influenced by drainage from nearby terrain. During the early morning period (0000-0600 MST) westerly flow accounts for 41.5 percent of all occurrences; 27.4 percent are less than 5 mph. During the late evening (1800-2400 MST), flow is also westerly, although wind speeds average slightly higher.

The daytime wind (0600-1800 MST) is characterized by light to moderate flow distributed primarily between the eastern and western sectors. The influence of drainage winds from the west can be seen to diminish during this time as wind speeds in these sectors increase. In the morning period (0600-1200 MST) light to moderate winds still account for the majority of occurrences although they are increasingly associated with easterly flow. By afternoon (1200-1800 MST) light winds account for only a small fraction of occurrences in either the western or eastern sectors; moderate to strong winds predominate in both.

Wind speeds at the mine exemplify the early morning effect of drainage winds, which are replaced later in the day by strong westerly flow. Wind speeds in the early morning average 5.6 mph and increase to an average of 10.6 mph during 1200-1800 MST. Although winds are more frequent from the east during this period, the stronger winds are associated with westerly flow; wind speeds in this sector average 13.5 mph between 1200-1800 MST.

---

* This section provided by The Anaconda Company (1976).

Wind speeds at the mine are generally of light to moderate intensity with wind speeds greater than 15 mph accounting for less than 11 percent of all occurrences. Average wind speeds range from 5.3 mph from the east to 11.6 mph from the west-northwest. The strongest winds generally occur from the WNW although the frequency of their occurrence is extremely small. Maximum hourly average wind speeds are most prevalent during the afternoon hours (1200-1800 MST); ranging from 18.0 mph from the ENE to 45 mph from the WNW.

Wind speeds and directions recorded by Anaconda at the maintenance shop provide a general indication of surface winds in the area but, because of the irregular terrain, should not be considered representative of any other specific location at the mine.

AMBIENT OUTDOOR RADON-222 CONCENTRATIONS

SAMPLING SYSTEM AND ANALYTICAL METHODS

A continuous, low-volume, 110-volt AC sampling system was used to obtain the ambient outdoor sample (U.S. Public Health Service, 1969). This sampling technique consisted of pumping filtered air via a small, low-volume air pump (less than 10 ml/min sampling rate) into a 30-liter Tedlar bag*. The air intake was about one meter above the ground surface. Usually a continuous 48-hour air sample was collected in the Tedlar bag which was then transported to the laboratory facility for radon content analysis.

Radon analyses were completed at the Eberline Instrument Corporation, in Albuquerque, New Mexico. Eberline flow thru cells (volume of 0.51 liters), similar to the radon scintillation flasks described by George (1976), were used for radon analysis. The cells were counted on the Eberline SAC R-5 counting system for a 100 minute counting period. The minimum detectable activity (MDA)** achieved for these particular cells and counting system was 0.12 pCi/l. Replicate analysis was also completed at the Environmental Monitoring and Support Laboratory in Las Vegas (EMSL), as discussed in another section.

RESULTS AND DISCUSSION

Table 2 summarizes the results of this study. Ambient radon concentrations ranged from the minimum detectable activity (MDA - also shown as less than or as < in the following tables) of 0.12 pCi/l to the highest level observed for 2.7 pCi/l. These summary results are also shown on Figure 1. Basic data for each sampling location are presented in Appendix A, Tables A-1 to A-11. The lowest average radon concentration measured (0.42 ± 0.14 pCi/l)*** was at the Paguate

---

* Air Sample Bag made of 0.002 inch (2 mil) thick Du Pont Tedlar (T.M.) poly vinyl fluoride (PVF) material; from Environmental Measurements, Inc., San Francisco, CA.

** MDA was defined as that sample net activity which was equal to the total counting error term (due to both sample and instrument background) at the 95 percent confidence level.

*** The error term associated with average determinations is two times the standard deviation of the sample population divided by the square root of the number of samples.

TABLE 2. AMBIENT OUTDOOR RADON-222 CONCENTRATIONS (in pCi/l)* DURING JUNE 1976 IN THE VICINITY OF THE JACKPILE OPEN PIT MINE, NEW MEXICO

Location, Description	Maximum Concentration*	Minimum Concentration*	Average Concentration**
Old Laguna-(#1)	1.3 ± 0.18	0.20 ± 0.10	0.51 ± 0.28
Laguna-Training Bldg. (#2)	1.5 ± 0.39	0.14 ± 0.07	0.51 ± 0.29
IHS-Laguna Health Center	1.6 ± 0.19	0.22 ± 0.11	0.63 ± 0.36
Bibo-Wellhouse	1.4 ± 0.29	Less than 0.12	0.50 ± 0.23
Mesita-Industrial Plant (#1)	0.89 ± 0.33	0.18 ± 0.05	0.47 ± 0.31
Mesita-Community Building (#2)	1.7 ± 0.22	Less than 0.12	0.55 ± 0.49
Moquino-Private Residence	1.4 ± 0.23	Less than 0.12	0.54 ± 0.31
Paguate-Community Building	0.74 ± 0.06	Less than 0.12	0.42 ± 0.14
Jackpile Mine-Company Housing Area	1.8 ± 0.23	0.25 ± 0.10	1.1 ± 0.34
Railroad Trestle (#1) Below Jackpile housing area	2.1 ± 0.26	Less than 0.12	0.99 ± 0.54
(Location #2)-One mile south of Railroad Trestle (#1)	2.7 ± 0.24	0.44 ± 0.05	1.3 ± 0.50

* Source of Analyses: Eberline Instrument Corporation, Albuquerque, New Mexico
Result ± Two-Sigma Counting Error Terms

** Average Result ± Two-Standard Error Terms (i.e., standard deviation of the sample population divided by the square root of the number of samples)

Community Building (Table A-8), which is directly west and roughly within two kilometers of the border of the active open pit mining area. Six other locations appear to have average ambient radon concentrations which fluctuate within the two-standard error terms about the Paguate results. Therefore, these seven locations have been considered as representative background areas and the ambient radon levels measured at these locations are listed in Table 3. In summary, ambient radon levels at representative background locations ranged from less than 0.12 pCi/l to a maximum measured value of 1.7 pCi/l. The grand average radon level for the seven background locations was 0.50 ± 0.033 pCi/l. For comparison, a background radon level of 0.72 ± 0.42 pCi/l (average ± two-standard error of the mean) was observed during November 1975 at five locations in the Ambrosia Lake area of active uranium mining and milling (Eadie, et al., 1976).

The remaining four sampling locations showed ambient radon levels in excess of this typical background level (i.e., greater than 0.50 ± 0.033 pCi/l). The Jackpile Housing Area (Table A-9) is obviously in immediate proximity to the ore body and mining activities. The two sampling stations near the railroad (Tables A-10 and A-11) showed elevated radon levels possibly due to ore spillage or the use of mine overburden material along the right-of-way. Ambient radon levels measured at the IHS-Laguna Health Center (Table A-3) are only slightly elevated compared to the background locations and probably reflect the natural variability of radon emanation from uranium bearing minerals in the local geologic structure. For comparison purposes, current federal and state exposure limits for radon-222 concentrations are shown in Table 4.

TABLE 3. REPRESENTATIVE BACKGROUND RADON LEVELS (pCi/l) IN THE VICINITY OF THE JACKPILE MINE

Location	Maximum Concentration*	Minimum Concentration*	Average Concentration**
Paguate	0.74 ± 0.06	<0.12	0.42 ± 0.14
Old Laguna (#1)	1.3 ± 0.18	0.20 ± 0.10	0.51 ± 0.28
Laguna (#2)	1.5 ± 0.39	0.14 ± 0.07	0.51 ± 0.29
Bibo	1.4 ± 0.29	<0.12	0.50 ± 0.23
Mesita (#1)	0.89 ± 0.33	0.18 ± 0.05	0.47 ± 0.31
Mesita (#2)	1.7 ± 0.22	<0.12	0.55 ± 0.47
Moquino	1.4 ± 0.23	<0.12	0.54 ± 0.31

Summary:	Highest Maximum	1.7	Lowest Minimum	<0.12	Average	0.50 ± 0.033

* Result ± Two-Sigma Counting Error; less than shown as <

** Average Result ± Two-Standard Errors (i.e., the standard deviation of the sample population divided by the square root of the number of samples)

TABLE 4. EXPOSURE LIMITS FOR RADON-222 AND RADON PROGENY*

Regulation Source	40 hour Exposure Limits (Restricted Area Annual Average)	168 hour Exposure Limits (Unrestricted Area Annual Average)**
Nuclear Regulatory Commission (10CFR Part 20) January 29, 1976 Appendix B	30 pCi/l (0.33 Working Levels)	3 pCi/l (0.03 Working Levels)
New Mexico Environmental Improvement Agency Regulations for Governing the Health and Environmental Aspects of Radiation June 16, 1973, Part 4 Appendix A	100 pCi/l	3 pCi/l

* Concentrations Above Natural Background

** Population exposure in unrestricted area may be limited to one-third of these listed values per NRC 10CFR20, Section 20.106 (e) and/or NMEIA-Part 4-160, para. E.

INTERLABORATORY COMPARISONS

During this study, radon analyses were completed at both the Eberline Instrument Corporation and at the U.S. EPA, Environmental Monitoring and Support Laboratory in Las Vegas, Nevada (EMSL) on 18 different replicate samples (i.e., two separate sample aliquots drawn from the same Tedlar bag), as shown in Table 5.

The EMSL technique used a radon concentration apparatus (Johns, 1975) capable of analyzing a 5-liter sample and counting on a 2-inch diameter photomultiplier tube using the standard 125-ml Lucas cell. The Eberline method employed the 0.51-liter scintillation flask as described above, with no sample concentration. Therefore, considering only the counting error terms, 10 of the 18 replicates were within the two-sigma counting error terms of each other (a 56 percent agreement). On the whole, the Eberline results ranged up to a factor of 6 times the replicate results from the EMSL. For radon concentrations less than 0.11 pCi/l, the Eberline analyses averaged about four times the value as reported by EMSL. For radon levels greater than 0.11 pCi/l, the Eberline results were less than twice the EMSL determinations. Obviously, the lower sensitivity of the EMSL radon determinations (due to the larger sample size) emphasizes the limit of the scintillation flasks for completing analysis at typical background radon concentrations without enrichment of the sample. Since only six out of the total 99 samples of this study were at a radon concentration less than 0.12 pCi/l, the reported radon values from Eberline are probably within a factor of two of the "real" level and therefore, the Eberline results reported here have been considered as valid results.

TABLE 5. REPLICATE ANALYSIS BETWEEN TWO LABORATORIES
(Radon ± Two-Sigma Counting Error Term, pCi/l)

Eberline*	EMSL**	Factor***
0.26 ± 0.10	0.049 ± 0.018	5.3
0.20 ± 0.10	0.090 ± 0.028	2.2
<0.41	0.090 ± 0.022	4.6
0.32 ± 0.10	0.18 ± 0.033	1.8
0.44 ± 0.12	0.071 ± 0.025	6.2
<0.12	0.041 ± 0.019	2.9
0.50 ± 0.12	0.18 ± 0.033	2.8
0.32 ± 0.10	0.065 ± 0.020	4.9
<0.35	0.090 ± 0.024	3.9
0.19 ± 0.13	0.11 ± 0.010	1.7
<0.12	0.056 ± 0.020	2.1
0.48 ± 0.12	0.12 ± 0.029	4.0
0.36 ± 0.10	0.11 ± 0.026	3.3
<0.34	0.31 ± 0.043	1.1
0.25 ± 0.10	0.20 ± 0.035	1.3
<0.12	0.14 ± 0.029	0.86
0.82 ± 0.06	0.53 ± 0.055	1.6
0.84 ± 0.17	0.84 ± 0.077	1.0

* Eberline Instrument Corporation. Less than values shown as <

** Environmental Monitoring and Support Laboratory

*** Factor = $\frac{\text{Eberline Result}}{\text{EMSL Result}}$; less than values considered as real numbers

INDOOR RADON PROGENY LEVELS

SAMPLING SYSTEM AND ANALYTICAL METHODS

The indoor radon progeny levels were measured using a Type II, TLD-Radon Progeny Integrating Sampling Unit (RPISU) (Schiager, 1971). This sampling unit uses thermoluminescent dosimeter disks (TLD) to absorb the alpha particle emissions from the radon progeny collected on a membrane filter through which the sampled air has passed.

The measurement of stored energy in the exposed TLD disk was obtained with a Harshaw Model 2000-TLD reader. The reader gave a readout (in nanocoulombs) which was converted to a working level (WL) value by utilizing a working level-liter per nanocoulomb (WL-l/nC) conversion factor which was obtained through calibration tests in known radon progeny atmospheres. All WL determinations were completed at the Office of Radiation Programs-Las Vegas Facility (ORP-LVF).

RESULTS AND DISCUSSION

Three locations were selected for conducting the indoor radon progeny level determinations - the Laguna Tribal Building (#2), the Paguate Community Center, and the Jackpile Housing (#16 House). This study ran for one year from December 1975 to December 1976 and all sample results (i.e., ambient values uncorrected for background level) are shown in Tables 6 to 8. Samples indicated as "NV" are not valid due to some type of operational error associated with the sample collection. For example, misreading time clock resulted in negative sample collection time, or having a non-determinable off flowrate could not permit the correct sampled volume determination. Hence, such NV samples were ignored and were not included in the averaging process.

The arithmetic average ambient working level value of 0.0049 ± 0.00045 WL (ranging from 0.0017 to 0.0094 WL) obtained at the Laguna Tribal Building (#2) (Table 6) appears to be a representative background level. For a similar

study conducted in the Grants area of active uranium mining and milling operations, a mean "background" working level of 0.0069 WL was obtained during November 1975 (Eadie et al., 1976). Therefore, for the purposes of this study, the value of 0.0049 ± 0.00045 WL is considered to be the background working level in the vicinity of the Jackpile Mine.

The arithmetic average ambient working level obtained at the Jackpile Housing was 0.015 ± 0.0025 WL (ranging from 0.0023 to 0.038 WL) (Table 7). Subtraction of the average representative background value of 0.0049 WL yields an average net value of 0.010 WL for the Jackpile Housing.

The arithmetic average ambient working level obtained at the Paguate Community Center was 0.035 ± 0.0038 WL (ranging from 0.0082 to 0.073 WL) (Table 8). Subtraction of the average representative background value of 0.0049 WL yields an average net value of 0.030 WL for the Paguate Community Center. These relatively high working levels appear to be caused by the build-up of radon progeny due to the exhalation from the natural radium content of the dirt floor and adobe block walls. Samples of the dirt floor material averaged 0.90 ± 0.18 pCi of radium-226 per gram. Soil samples outside this structure also had a similar radium content of 1.1 ± 0.19 pCi/g. Unfortunately, a sample of the adobe block could not be obtained for analysis of radium content. Also, high equilibrium concentrations of radon progeny would be expected for this structure since it was seldom occupied and had rather poor natural ventilation. For the period 6/8 to 6/30/76, the average ambient outdoor radon concentration measured at the Paguate Community Building was 0.42 pCi/l (Table A-8). At 100% equilibrium with its daughters, and assuming that the indoor level was equal to and due solely to this measured outdoor radon level, a maximum working level of only 0.0042 WL would be expected. However, for essentially the same time period (i.e., 6/4 to 7/2/76), the measured indoor working level averaged 0.033 WL (Table 8) - - over seven times greater than could be explained on the basis of the outdoor radon concentration. Therefore, since the measured indoor working levels cannot be substantiated by the observed outdoor radon levels, the build-up of radon progeny levels must be attributable to the radium content of the dirt floor and adobe block wall construction versus radon releases from nearby mining activities.

TABLE 6. AMBIENT INDOOR RADON PROGENY LEVELS AT LAGUNA TRIBAL BUILDING

DATE START	DATE FINISH	CORRECTED VOLUME (liters)	SAMPLING TIME (hours)	AMBIENT WORKING LEVEL (WL)*	
12/04/75	12/11/75	22328	155.5	.00671	
12/11/75	12/18/75	23107	159.1	.00376	
12/18/75	12/29/75	40703	264.4	.00531	
12/29/75	01/02/76	15471	100.5	.00333	
01/02/76	01/07/76	2520	23.1	.00528	
01/07/76	01/12/76	15969	115.4	.00670	
01/12/76	01/16/76	14337	97.5	.00463	
01/16/76	01/23/76	24006	171.3	.00622	
01/23/76	01/30/76	24630	167.5	.00375	
01/30/76	02/06/76	22514	166.3	.00637	
02/06/76	02/13/76	21704	169.7	.00537	
02/13/76	02/20/76	5857	50.2	.00343	
02/20/76	02/27/76	23042	170.2	.00386	
02/27/76	03/05/76	20036	168.4	.00311	
03/05/76	03/13/76	16983	150.4	.00386	
03/13/76	03/19/76	10321	91.4	.00460	
03/19/76	03/26/76	723	5.4	.00169	
04/01/76	04/09/76	5789	33.5	.00531	
04/09/76	04/19/76	40576	240.0	.00421	
04/19/76	04/23/76	11462	54.0	.00398	
04/23/76	04/30/76	31906	165.9	.00377	
04/30/76	05/07/76	6256	37.0	-.01102	NV-4
05/07/76	05/21/76	5896	31.4	.00263	
05/21/76	05/28/76	23855	141.1	.00511	
05/28/76	06/04/76	26912	170.5	.00431	
06/04/76	06/11/76	24220	165.2	.00361	
06/11/76	06/18/76	20277	168.4	.00443	
06/18/76	06/25/76	10645	70.8	.00598	
06/25/76	07/02/76	20067	156.9	.00440	
07/02/76	07/09/76	286	2.0	.00525	
07/09/76	07/16/76	3079	21.0	.00382	
07/16/76	07/23/76	23373	169.0	.00378	
07/23/76	07/30/76	4590	31.5	.00316	
07/30/76	08/06/76	7124	55.7	.00562	
08/13/76	08/20/76	39018	247.2	.00427	
08/30/76	09/03/76	1450	8.1	.00264	
09/03/76	09/10/76	22343	160.0	.00594	
09/10/76	09/17/76	17405	140.0	.00682	
09/17/76	09/24/76	27940	169.0	.00673	
09/24/76	10/01/76	12029	99.9	.00610	
10/01/76	10/08/76	4860	38.0	.00838	
10/08/76	10/15/76	27162	168.1	.00787	
10/15/76	10/22/76	25842	167.7	.00681	
10/24/76	11/08/76	40762	241.1	.00936	
11/08/76	11/12/76	8934	50.5	.00544	
11/12/76	11/22/76	28019	159.7	.00444	
11/22/76	11/29/76	520	3.1	.00437	
11/29/76	12/03/76	34433	213.1	.00446	
12/03/76	12/10/76	2488	14.5	.00589	

Total number of samples = 48 from 12/4/75 to 12/10/76

Average Working Level 0.0048 ±0.00046WL

Range of 0.0017 to 0.0094WL

* Value calculated by computer but should be rounded to two significant digits.

NV=not valid sample

TABLE 7. AMBIENT INDOOR RADON PROGENY LEVELS AT JACKPILE HOUSING (#16 HOUSE)

DATE START	DATE FINISH	CORRECTED VOLUME (liters)	SAMPLING TIME (hours)	AMBIENT WORKING LEVEL (WL)*	
12/04/75	12/11/75	34304	169.5	.02260	
12/11/75	12/19/75	12054	78.3	.01598	
12/19/75	12/29/75	34634	241.2	.01813	
12/29/75	01/02/76	14014	100.0	.01667	
01/02/75	01/12/76	1972	17.0	.01956	
01/12/76	01/16/75	0	.0	*	NV-2
01/15/76	01/23/76	28069	170.9	.02578	
01/23/76	01/30/76	25238	167.1	.02316	
01/30/75	02/06/76	24191	165.0	.02356	
02/06/76	02/13/76	23844	165.9	.01893	
02/13/76	02/20/76	774	5.5	.01679	
02/20/76	02/27/76	10128	72.0	.01915	
02/27/76	03/05/76	22194	164.6	.01615	
03/05/76	03/13/76	20185	149.1	.02102	
03/13/76	03/19/76	5714	50.0	.02299	
03/19/76	03/26/76	21652	169.3	.01151	
03/25/76	04/02/76	988	7.1	.00232	
04/07/75	04/09/76	305	2.2	.00271	NV-2
04/09/75	04/19/76	2857	20.0	.01201	
04/30/75	05/07/76	16452	93.2	.01254	
05/07/76	05/15/76	23905	121.1	.01092	
05/11/76	05/21/76	17097	92.9	.01020	
05/21/75	05/28/75	26667	144.9	.01037	
05/28/75	06/04/76	26512	164.5	.00722	
06/04/76	06/11/76	29516	179.5	.00605	
06/11/75	06/18/76	24703	164.3	.00392	
06/18/76	06/25/76	20168	167.5	.00556	
06/25/75	07/02/75	13327	126.4	.00812	
07/02/75	07/09/75	338	3.1	.00055	NV-2
07/09/75	07/16/75	10394	95.2	.00812	
07/15/76	07/23/76	5138	50.0	.00913	
09/10/76	09/17/76	29084	169.3	.00869	
09/17/75	09/24/76	30434	169.6	.01044	
09/24/76	10/01/76	24285	167.3	.00942	
10/01/75	10/08/75	21550	168.5	.00824	
10/08/76	10/15/76	28353	167.7	.01652	
10/15/75	10/22/75	29447	170.4	.01413	
10/22/75	11/05/76	31372	174.0	.01919	
11/05/75	11/16/75	2877	17.4	.03770	
11/15/76	11/22/76	9998	83.7	.00800	
11/22/76	11/29/75	-9834	-55.7	-.00135	NV-5
11/29/75	12/03/75	15791	93.4	.03053	
12/03/76	12/10/75	22435	137.7	.02641	

Total number of samples = 39 from 12/4/75 to 12/10/76

Average Working Level 0.015 ±0.0025WL

Range of 0.0023 to 0.038WL

* Value calculated by computer but should be rounded to two significant digits.

NV=not valid sample

TABLE 8. AMBIENT INDOOR RADON PROGENY LEVELS AT PAGUATE COMMUNITY BUILDING

DATE START	DATE FINISH	CORRECTED VOLUME (liters)	SAMPLING TIME (hours)	AMBIENT WORKING LEVEL (WL)*	DATE START	DATE FINISH	CORRECTED VOLUME (liters)	SAMPLING TIME (hours)	AMBIENT WORKING LEVEL (WL)*	
12/04/75	12/11/75	22543	169.2	.04991	06/04/76	06/11/76	27006	171.1	.03475	
12/11/75	12/18/75	19164	149.2	.04391	06/11/76	06/18/76	19477	123.4	.02922	
12/18/75	12/29/75	1871	34.4	.05254	06/18/76	06/25/76	25425	169.1	.03211	
12/29/75	01/02/76	862	5.0	.01204	06/25/76	07/02/76	22544	157.8	.03741	
01/02/76	01/12/76	3174	29.1	.05644	07/02/76	07/09/76	12406	78.6	.04244	
01/12/76	01/16/76	1460	9.2	.03514	07/09/76	07/16/76	15593	96.5	.03146	
01/16/76	01/23/76	911	8.1	.04251	07/16/76	07/23/76	11957	99.3	.04427	
01/23/76	01/30/76	8737	80.1	.05336	07/23/76	07/30/76	7275	42.1	.02451	
01/30/76	02/06/76	531	4.7	.03558	07/30/76	08/06/76	20253	168.2	.03398	
02/06/76	02/13/76	9862	79.5	.04532	08/06/76	08/13/76	13186	97.4	.01622	
02/13/76	02/20/76	698	5.8	.03665	08/13/76	08/20/76	22050	136.5	.02199	
02/20/76	02/27/76	13210	106.5	.03750	08/20/76	08/27/76	4597	25.5	.02732	
02/27/76	03/03/76	1212	11.1	.04108	08/27/76	09/03/76	12813	77.5	.01730	
03/03/76	03/05/76	6172	52.9	.02363	09/03/76	09/10/76	11913	105.5	.03009	
03/05/76	03/13/76	14520	119.3	.02274	09/10/76	09/17/76	27048	153.2	.03024	
03/13/76	03/19/76	8715	74.7	.01833	09/17/76	09/24/76	17083	137.5	.06290	
03/19/76	03/26/76	17401	154.1	.03621	09/24/76	10/01/76	1484	9.5	.04301	
03/25/76	04/02/76	15752	154.9	.03699	10/01/76	10/08/76	17655	126.9	.03685	
04/02/76	04/12/76	13428	115.1	.04135	10/08/76	10/15/76	16313	131.4	.07264	
04/12/76	04/19/76	3439	31.5	.02898	10/15/76	10/22/76	1987	15.2	.02827	
04/19/76	04/23/76	7511	60.5	.03794	10/22/76	10/29/76	23268	167.2	.03046	
04/23/76	04/30/76	19483	167.0	.03548	10/29/76	11/05/76	10357	75.5	.05263	
04/30/76	05/07/76	12250	112.2	.01388	11/05/76	11/18/76	19452	117.9	.01995	
05/07/76	05/14/76	4757	33.3	.00998	11/15/76	11/22/76	22745	147.5	.01615	
05/21/76	05/28/76	18064	145.5	.04389	11/22/76	11/29/76	855	4.7	.00422	
05/28/76	06/04/76	24087	168.6	.01559	11/29/76	12/03/76	150	1.0	.00875	NV-2
					12/03/76	12/10/76	17509	139.4	.02155	

Total number of samples 52 from 12/4/75 to 12/10/76

Average Working Level 0.035 ±0.0038WL

Range of 0.0082 to 0.073WL

* Value calcuted by computer but should be rounded to two significant digits.

NV=not valid sample

Figure 2 shows a plot of the ambient working level values obtained for these three sampling locations. This graphic display provides some evidence of the seasonal variation in indoor radon progeny levels, with the winter months exhibiting higher working levels than the summer months. This feature was probably the result of higher radon progeny equilibrium concentrations due to poor ventilation rates in the winter when the doors and windows were usually closed.

RADON AND PROGENY EQUILIBRIUM RATIOS

Assuming that the indoor radon concentration would be equal to the measured ambient outdoor level, the percent equilibrium of radon and its progeny may be calculated. These results are shown in Table 9. The 96 percent equilibrium calculated for results at Old Laguna (#1) indicates a rather high value but is not too unreasonable since the structure was seldom used and was unoccupied during most of the study period. The other two equilibrium values exceed 100 percent and signify that it is erroneous to assume that the indoor radon levels are equal to the measured outdoor concentrations. It should be noted that the radon levels were obtained during June; whereas, the working level determinations were averaged for an entire year. Therefore, the yearly average indoor radon levels are probably in excess of the reported 1.1 and 0.42 pCi/l for these two locations. These high equilibrium values provide further incentive to conduct monitoring over longer time periods in order to determine the seasonal variability of ambient radon concentrations and its effect on indoor radon progeny levels.

TABLE 9. RADON AND PROGENY EQUILIBRIUM INDICATIONS

Location	Average Ambient Outdoor Radon During June 1976 (pCi/l)	Yearly (1976) Average Indoor Radon Progeny (Working Level)	Percent Equilibrium*
Laguna (#2)	0.51 ± 0.29	0.0049	96
Jackpile Housing	1.1 ± 0.34	0.015	136
Paguate	0.42 ± 0.14	0.035	833

*Percent equilibrium equals the working level value divided by the ambient radon concentration divided by 100 pCi/l; since, one working level is equivalent to 100% equilibrium of 100 pCi/l radon and its progeny.

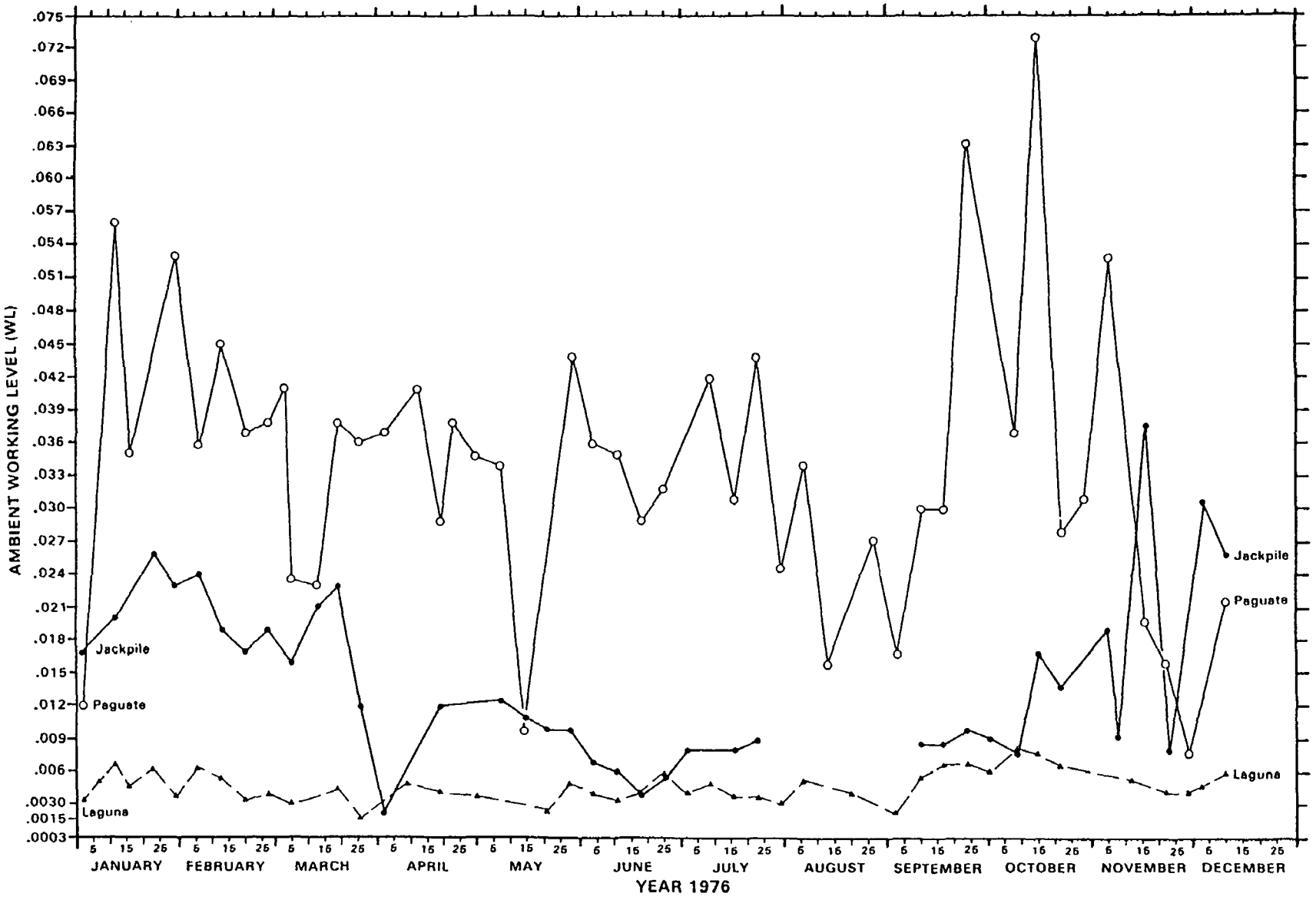

Figure 2. Ambient indoor radon progeny working levels during 1976

REGULATIONS AND GUIDELINES

Current Nuclear Regulatory Commission regulations (January, 1976) limit radon progeny levels to 0.03 working levels (above natural background) for continuous exposure in unrestricted areas (Table 4). Another guideline for continuous exposure to indoor radon progeny concentrations was established by the U.S. Surgeon General in 1970. These guides were promulgated as a result of the health hazard evaluation of the use of uranium mill tailings material for construction purposes. These guides provide remedial action recommendations for three ranges of working level values above natural background. In summary, for locations with WL values less than 0.01 WL, no remedial action is recommended. For sites exceeding 0.05 WL, remedial action to reduce WL exposure is indicated. For the range 0.01 to 0.05 WL, the need for any remedial action may be suggested after due consideration of all exposure routes and cost estimates of remedial action alternatives. These Surgeon General Guidelines have effectively been applied to the Grand Junction, Colorado remedial action program for structures incorporating tailings material. The natural background WL value for the Grand Junction area was determined to be 0.004 WL (Joint Committee on Atomic Energy, 1971).

LOG-PROBABILITY DISTRIBUTION OF INDOOR RADON PROGENY LEVELS

The following discussion is offered as a simple approach for comparison of data collected at the various sampling locations. Although it is recognized that the data may represent more than one distribution superimposed upon another, the plotted lines represent the best least squares fit of all data points for an exponential function (Brownlee, 1965). Figures 3, 4 and 5 are log-normal probability plots of the observed ambient indoor radon progeny levels, expressed as working levels (WL), for Laguna, Jackpile Housing and Paguate. The geometric mean ($\overline{X}_g$) is given by the fiftieth cumulative percent intercept. The geometric standard deviation (S_g) is indicated by the slope of the line and is usually calculated by dividing the working level value at the 84 percentile by the working level value at the 50 percentile.

The goodness of fit of the data points on these log-probability plots, as illustrated by Figures 3, 4 and 5, provides an indication that the measured indoor working levels can generally be described by the log-normal distribution. Also shown on the plots are the respective arithmetic averages ($\overline{X}$), taken from Tables 6, 7, and 8. Obviously, the best estimate of the annual average would be a time or volume weighted arithmetic average of samples collected on a continuous basis over the annual cycle; however, the collection of such samples is often difficult to achieve due to equipment or operator shortcomings. However, the arithmetic average can be estimated from the parameters of the log-normal distribution by the equation:

$$\overline{X}' = \overline{X}_g \; e^{(\ln S_g)^2/2}$$

For example, from Figure 3, using $\overline{X}_g$ = 0.0051 WL and S_g 1.35 (all data), the estimated arithmetic average ($\overline{X}'$) was calculated to be 0.0051 WL - - essentially identical to the geometric mean value. Similarly, from the log-normal parameters obtained from Figures 4 and 5, the estimated arithmetic averages ($\overline{X}'$) were calculated to be 0.019 WL and 0.040 WL, respectively. Therefore, the highest relative error between the arithmetic average ($\overline{X}$) versus the estimated average obtained from the log-normal parameters ($\overline{X}'$) was 27 percent for the data from Jackpile Housing (Figure 4).

In order to test the adequacy of conducting less frequent sampling to estimate the annual average indoor radon progeny level, data obtained during this study for the first week of each even numbered month, and also for each odd numbered month, was also plotted for each sampling location. (As shown in Figure 2, there appears to be some seasonal variability of indoor working levels, hence the proposed sampling scheme covering every-other month over a one year period should eliminate this possible sampling bias.) On the plots, the geometric mean and standard deviations are shown with sub-scripts "ge" for the even number months and similarly, "go" for the odd months. As an example, from Figure 3, the arithmetic average ($\overline{X}$) working level at Laguna was 0.0049 WL. The geometric mean ($\overline{X}_g$) obtained from the best-fit curve of all data was 0.0051 WL. The geometric mean for the first week data of even numbered months ($\overline{X}_{ge}$) was 0.0054 WL, and similarly, $\overline{X}_{go}$ was 0.0047 WL. Estimates of the annual average based on the log-normal parameters for the even and odd month sampling scheme resulted in relative errors of 16 and 1.5 percent for the Laguna data (Figure 3).

Similar statistical analysis of the data obtained at Jackpile Housing and Paguate indicate a relative error of less than 24 percent for conducting one week sampling for every-other month. Based on this limited data, it would appear that to be cost effective and to maximize equipment and manpower utilization, completion of a one week sampling period using the RPISU sampler for every other month over at least a year's duration would provide sufficient data to plot a log-probability distribution from which the annual average indoor radon progeny level could be reasonably estimated from the log-normal parameters.

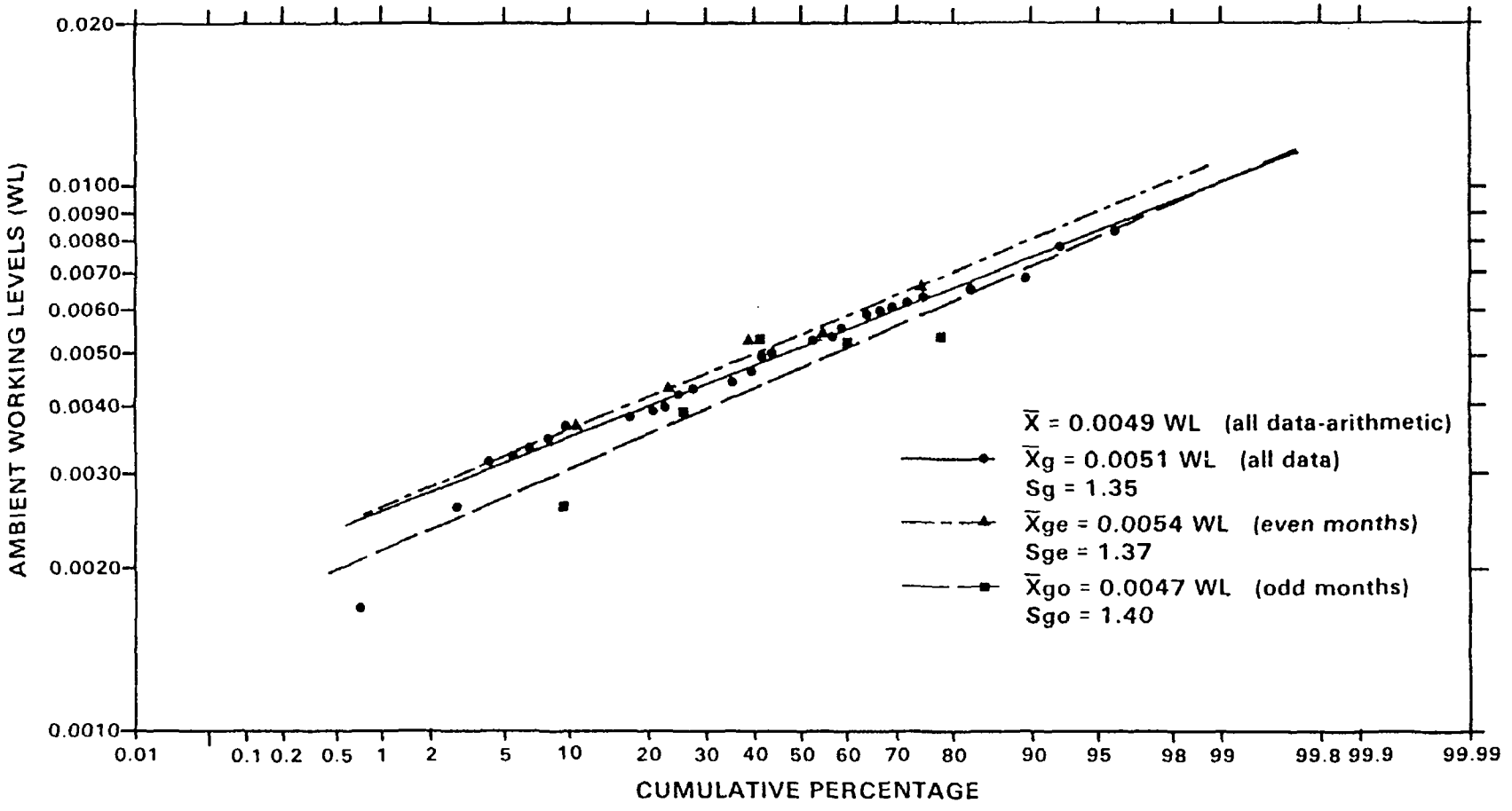

Figure 3. Log-probability plot of ambient indoor radon progeny levels at Laguna

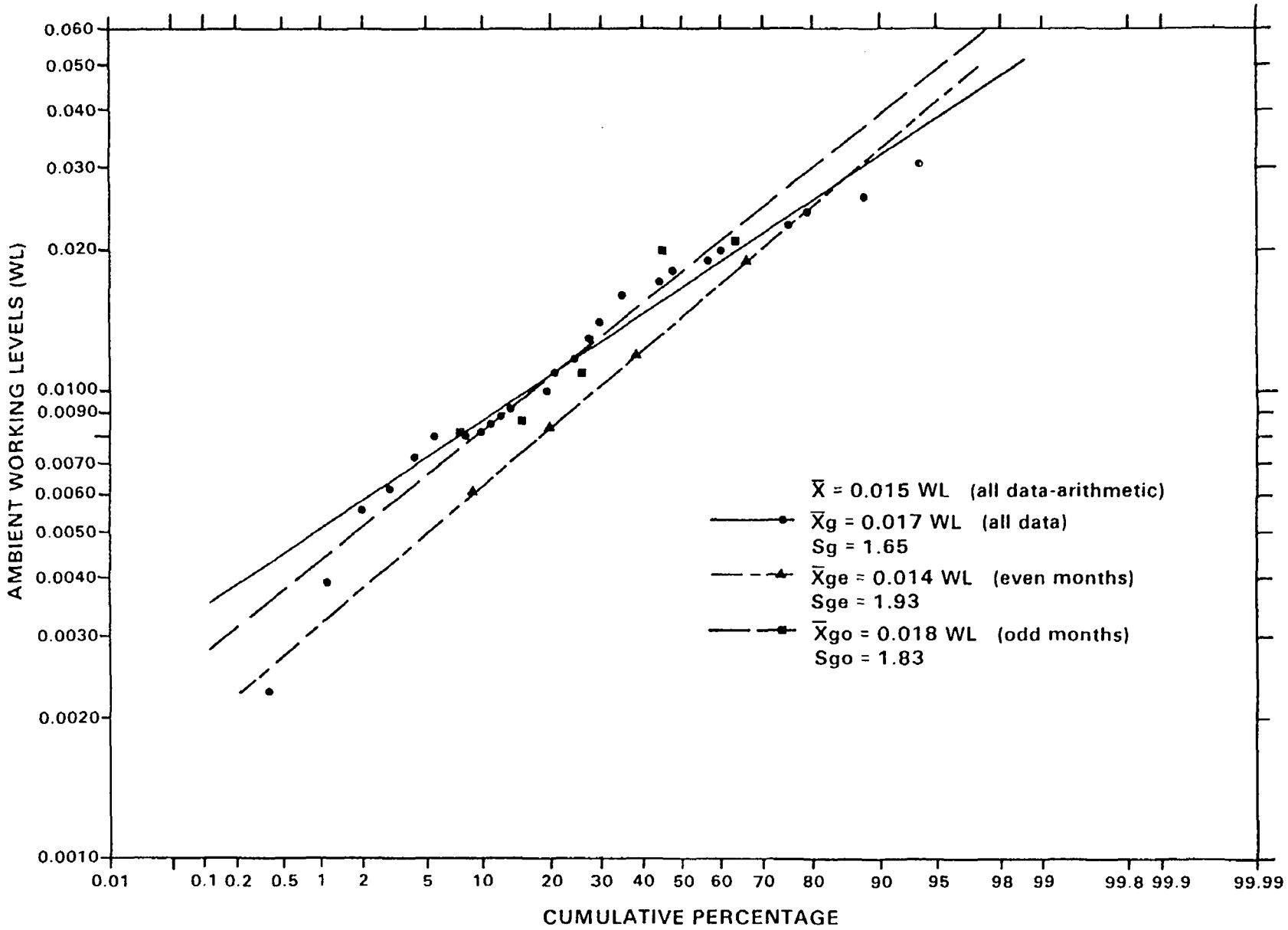

Figure 4. Log-probability plot of ambient indoor radon progeny levels at Jackpile Housing

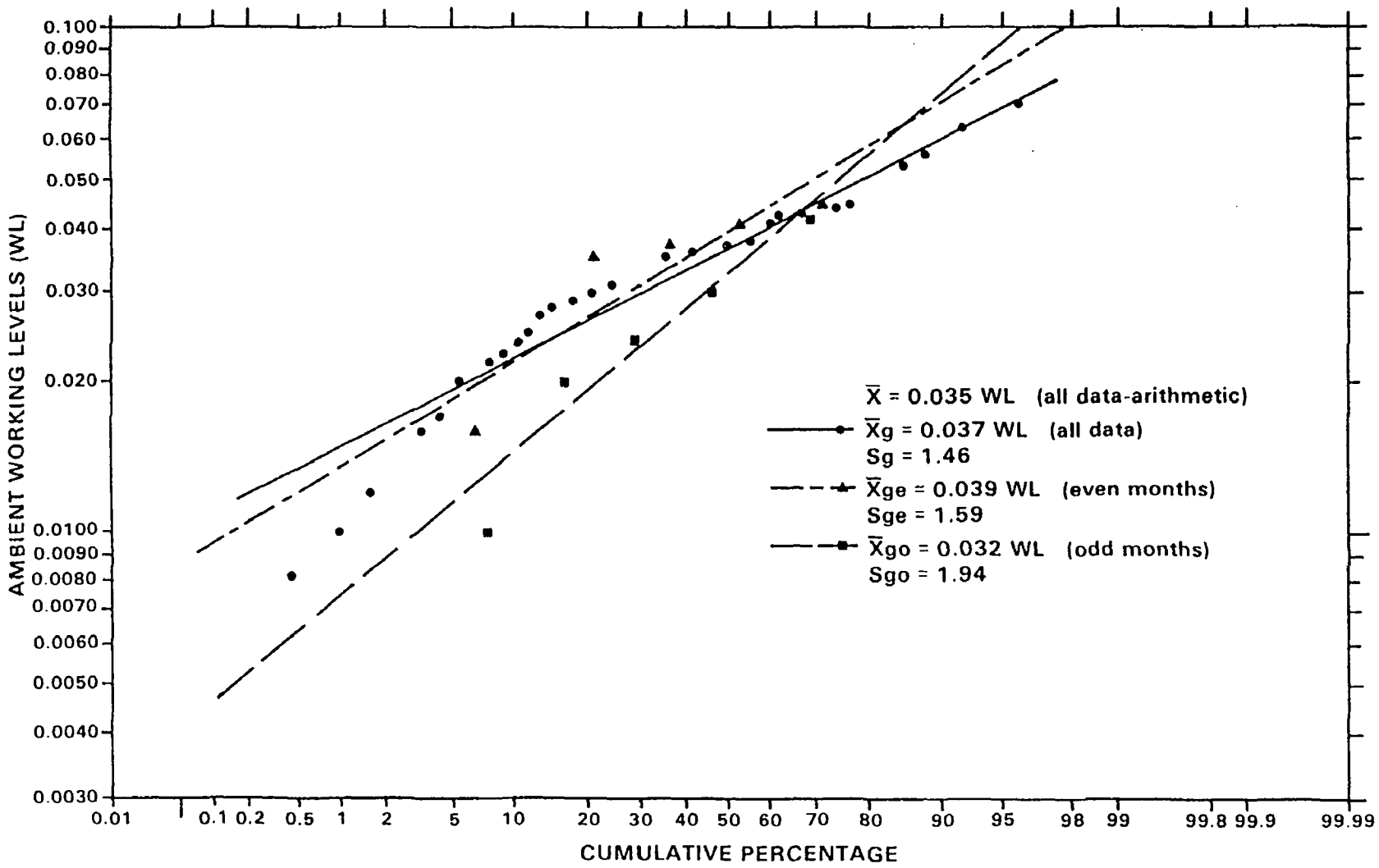

Figure 5. Log-probability plot of ambient indoor radon progeny levels at Paguate

AIRBORNE PARTICULATE SAMPLING

SYSTEM DESCRIPTION

Air particulate sampling was conducted using a heavy-duty air sampler*. This sampler has a carbon-vane pump with a 10.5 cubic feet per minute (CFM) free flow capacity. The pump was driven through a V-belt system by a 110-volt, 3/4-hp motor equipped with thermal overload protection. Each unit had a built-in vacuum gauge, and was calibrated to provide a calibration curve of air flow rate versus pressure drop. A running time meter, with readout to tenths of an hour, measured the total sampling time and could be reset to zero for each new sampling period. The air volume collected was determined from the calibration curve by averaging the "on" and "off" air flow rates and multiplying this average by the total time of sample collection. A quick change filter holder was mounted at one meter above the ground surface and was secured such that the open face of the (four-inch diameter) filter was toward the ground. For this study, Microsorban filters were used.

GROSS VERSUS NET RESULTS

Eadie and Bernhardt (1976) have reported that radiochemical analyses of blank (i.e., unused) four-inch diameter Microsorban filters indicate some low-level content of naturally-occurring radioactivity. Such activity may be due to the composition of the filter media itself, or due to contaminants in reagents, glassware, or other analytical equipment. The analytical sensitivity of the radiochemical techniques may also mask the identification of the true source of such low levels of radioactivity.

Table 10 presents data on the radioactivity content of blank Microsorban filters which were used for this study. In order to account for this radioactivity content associated with blank filter analyses, the appropriate blank filter activity (Table 10) has been subtracted from the measured gross analytical

*Heavy-Duty Air Sampler, Research Appliance Corporation, Allison Park, PA; or Tempest Air Sampler, Gelman Instrument Corporation, Ann Arbor, MI.

TABLE 10. MICROSORBAN FILTER RADIOACTIVITY CONTENT (1)

(pCi/filter ± two-sigma counting error terms)

Radium-226	Thorium-230	Thorium-232	Uranium-234	Uranium-235(2)	Uranium-238	Radium-228	Polonium-210	Lead-210
0.18 ± .07	<0.015	<0.012	0.024 ± .015	0.003 ± .001	0.067 ± .023	0.73 ± .62	0.22 ± .09	<0.071
0.15 ± .07	<0.030	<0.027	0.016 ± .012	<0.0004	<0.009	<0.67	0.16 ± .09	<2.95
0.06 ± .05	<0.032	0.047 ± .038	<0.010	<0.0003	<0.008	<0.68	0.24 ± .09	1.21 ± .75
0.05 ± .05	<0.022	<0.016	0.015 ± .013	<0.0004	<0.009	<0.62	0.19 ± .06	<0.50
0.19 ± .08	<0.021	<0.011	0.018 ± .013	<0.0006	0.018 ± .012	<0.60	0.39 ± .08	1.75 ± .42
Grand Average (3)								
0.13 ± .08	<0.024	<0.023	0.017 ± .006	<0.0009	<0.022	<0.66	0.24 ± .11	<1.30

(1). Average four-inch diameter Microsorban filter mass ± two standard deviations of 1.0960 ± 0.1510 grams; four filter composite analyzed.
(2). U-235 calculated based on natural U-235 to U-238 activity ratio of 1:21.45 (or 0.0466).
(3). Grand average of all results with standard error about this mean based on the t-distribution at the 95 percent confidence level.

result to obtain an "adjusted gross" result. Only blank radioactivity contents for isotopic uranium and radium-226 were subtracted from the gross analytical result to obtain the reported values. The reported isotopic thorium values are gross analytical results. Although air samples were also analyzed for polonium-210, lead-210 and radium-228 contents, subsequent evaluation of the analytical procedures uncovered technical problems and hence, these particular analytical results have not been reported.

RESULTS AND DISCUSSION

Air sampling was conducted at five locations - - Jackpile Housing, Paguate, Bibo, Mesita, and Old Laguna. The radioactivity concentrations of the naturally-occurring radionuclides are usually expressed as picocuries per cubic meter of ambient air (pCi/m^3). Dust loading of the air filter samples was also determined and the specific activity of the dust, expressed as pCi/g, is also given. The solubility of airborne particulate matter was not determined for this study.

The composited monthly ambient air sampling results (in pCi/m^3) are presented in Tables B-1 to B-5. These data reporting considerations are discussed in Eadie and Bernhardt (1976). Tables C-1 to C-5 contain the summary results of dust loading determinations (in pCi/g) for these same samples. Appendices D and E contain the individual adjusted ambient air sampling results in units of pCi/m^3 and pCi/g, respectively. An appropriate "normal background" value has not been subtracted from any of these reported results. Tables 11 and 12 summarize the annual average ambient air sampling radiological results in units of pCi/m^3 and pCi/g respectively, for the five locations of this study. Also shown in Table 11 are background concentrations as reported in NCRP, 1975. Comparison of these values to results from this study indicates that the airborne concentrations measured at Old Laguna appear to be at typical background levels. (This result is consistent with the observed background levels of radon and progeny which were discussed above.)

Figures 6, 7 and 8 also show the monthly average airborne concentrations (in pCi/m^3) of radium-226, total uranium and thorium-230 measured at these sampling locations for the year 1976. Comparison of these graphs indicates a seasonal variability specific to each location but having no common cycle for

all the locations. For example, at Mesita (Table B-4), the radium-226 airborne concentration ranged up to a factor of 17 between the minimum measured in August and the maximum measured in July. Similar comparison of results obtained at Bibo (Table B-3) result in only a factor of 6 between the minimum value measured in January and the maximum in June. Such incongruities with respect to month of maximum or minimum airborne concentrations may be a reflection of the level of industrial activity in that particular area or perhaps, a change in meteorological conditions. Such a situation provides further support for the need for long-term sampling schemes per specific site to evaluate the impact of the seasonal variability of airborne radioactivity.

TABLE 11. VOLUME WEIGHTED ANNUAL AVERAGE AMBIENT AIRBORNE RADIONUCLIDE CONCENTRATIONS* ± STANDARD ERROR AT THE 95% CONFIDENCE LEVEL (IN pCi/m^3)

	Radium-226	Uranium-234	Uranium-235	Uranium-238	Thorium-230	Thorium-232
Jackpile Housing	0.0024 ± 0.00086	0.0027 ± 0.00065	0.00011 ± 0.000029	0.0027 ± 0.00063	0.0028 ± 0.0022	0.000042 ± 0.000018
Paguate	0.0012 ± 0.00042	0.0012 ± 0.00041	0.000047 ± 0.000015	0.0012 ± 0.00039	0.0011 ± 0.00039	0.00012 ± 0.000047
Bibo	0.0002 ± 0.000051	0.00038 ± 0.00019	0.0000077 ± 0.0000032	0.00037 ± 0.00019	0.0003 ± 0.00016	0.000055 ± 0.000026
Mesita	0.00034 ± 0.00021	0.0003 ± 0.00012	0.000013 ± 0.0000051	0.0003 ± 0.00012	0.00018 ± 0.000079	0.000077 ± 0.000036
Old Laguna	0.00016 ± 0.000081	0.00025 ± 0.00011	0.0000091 ± 0.0000043	0.00026 ± 0.00011	0.000081 ± 0.000039	0.000024 ± 0.000017
NCRP-45 Background**	0.0001	0.00012	0.0000056	0.00012	0.000045	0.00003

* Sampling period from December 1975 to December 1976; volume weighted average per Eadie and Bernhardt (1976)
** NCRP, 1975

TABLE 12. MASS WEIGHTED ANNUAL AVERAGE AMBIENT AIRBORNE RADIONUCLIDE CONCENTRATIONS* ± STANDARD ERROR AT THE 95% CONFIDENCE LEVEL (IN pCi/g)

	Radium-226	Uranium-234	Uranium-235	Uranium-238	Thorium-230	Thorium-232
Jackpile Housing	70 ± 21	78 ± 9.1	3.0 ± 0.46	76 ± 9.3	80 ± 61	1.2 ± 12
Paguate	13 ± 4.9	13 ± 4.5	0.50 ± 0.17	13 ± 4.4	12 ± 5.4	1.3 ± 0.29
Bibo	4.6 ± 1.7	8.9 ± 5.8	0.17 ± 0.10	8.7 ± 5.8	7.0 ± 4.6	1.3 ± 0.74
Mesita	3.4 ± 2.2	2.8 ± 1.1	0.22 ± 0.24	2.8 ± 1.0	2.0 ± 1.1	0.71 ± 0.35
Old Laguna	3.0 ± 1.5	4.6 ± 2.3	0.16 ± 0.095	4.6 ± 2.5	1.5 ± 1.2	0.44 ± 0.37

* Sampling period from December 1975 to December 1976; mass weighted average per Eadie and Bernhardt (1976)

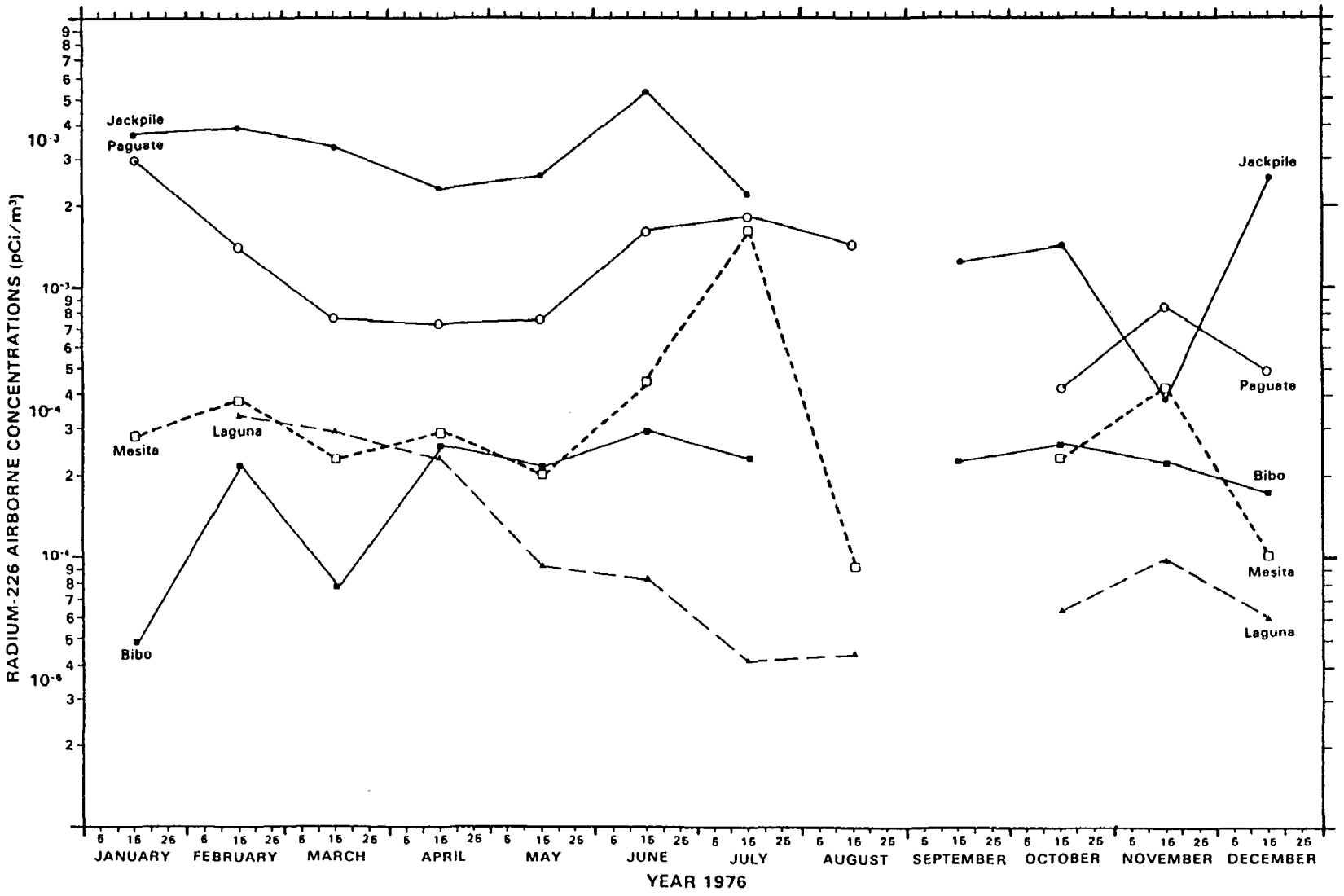

Figure 6. Average monthly airborne radium-226 concentration (pCi/m^3) for locations in the vicinity of the Jackpile Open Pit Uranium Mine

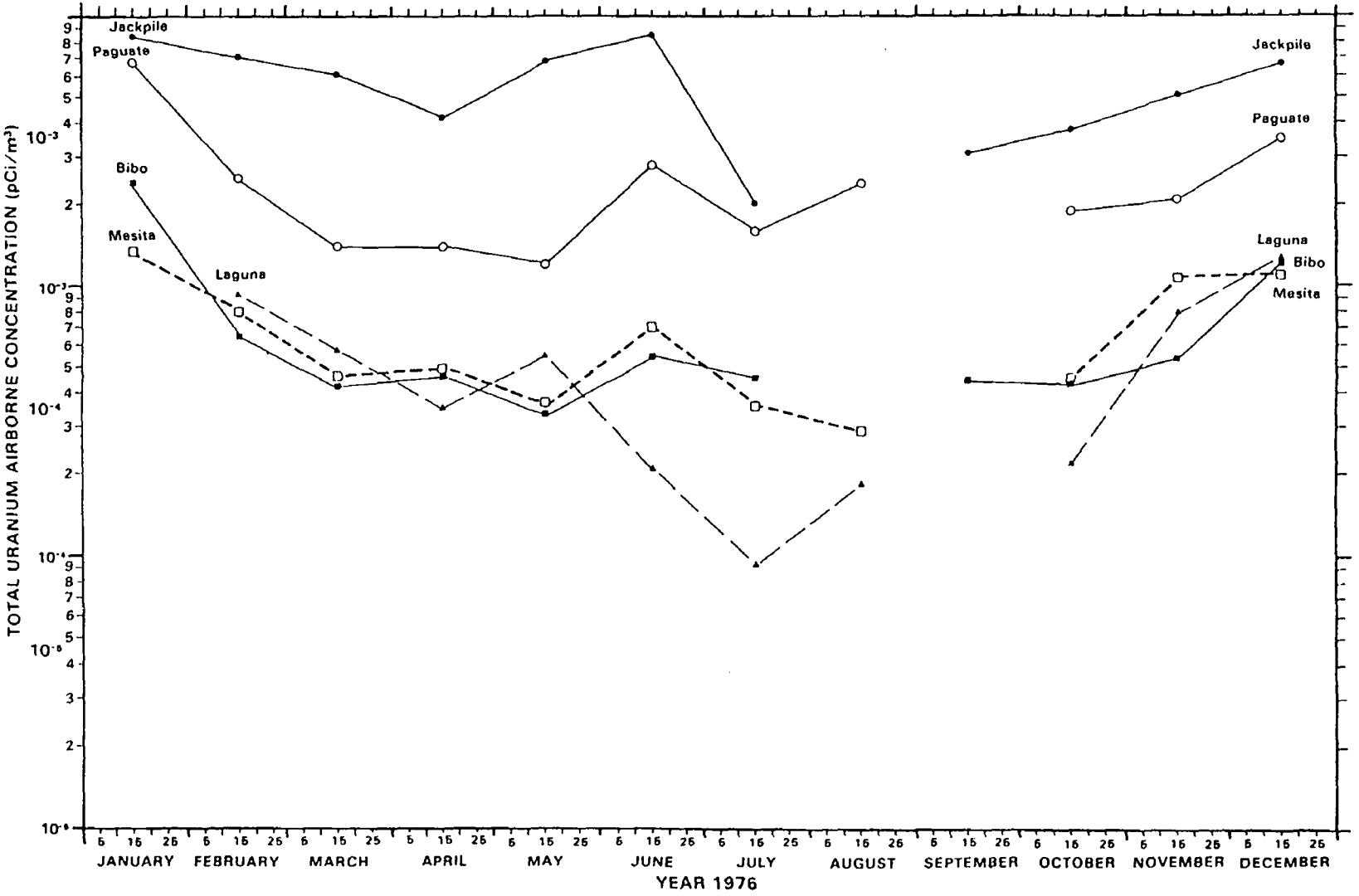

Figure 7. Average monthly airborne total uranium concentration (pCi/m^3) for locations in the vicinity of the Jackpile Open Pit Uranium Mine

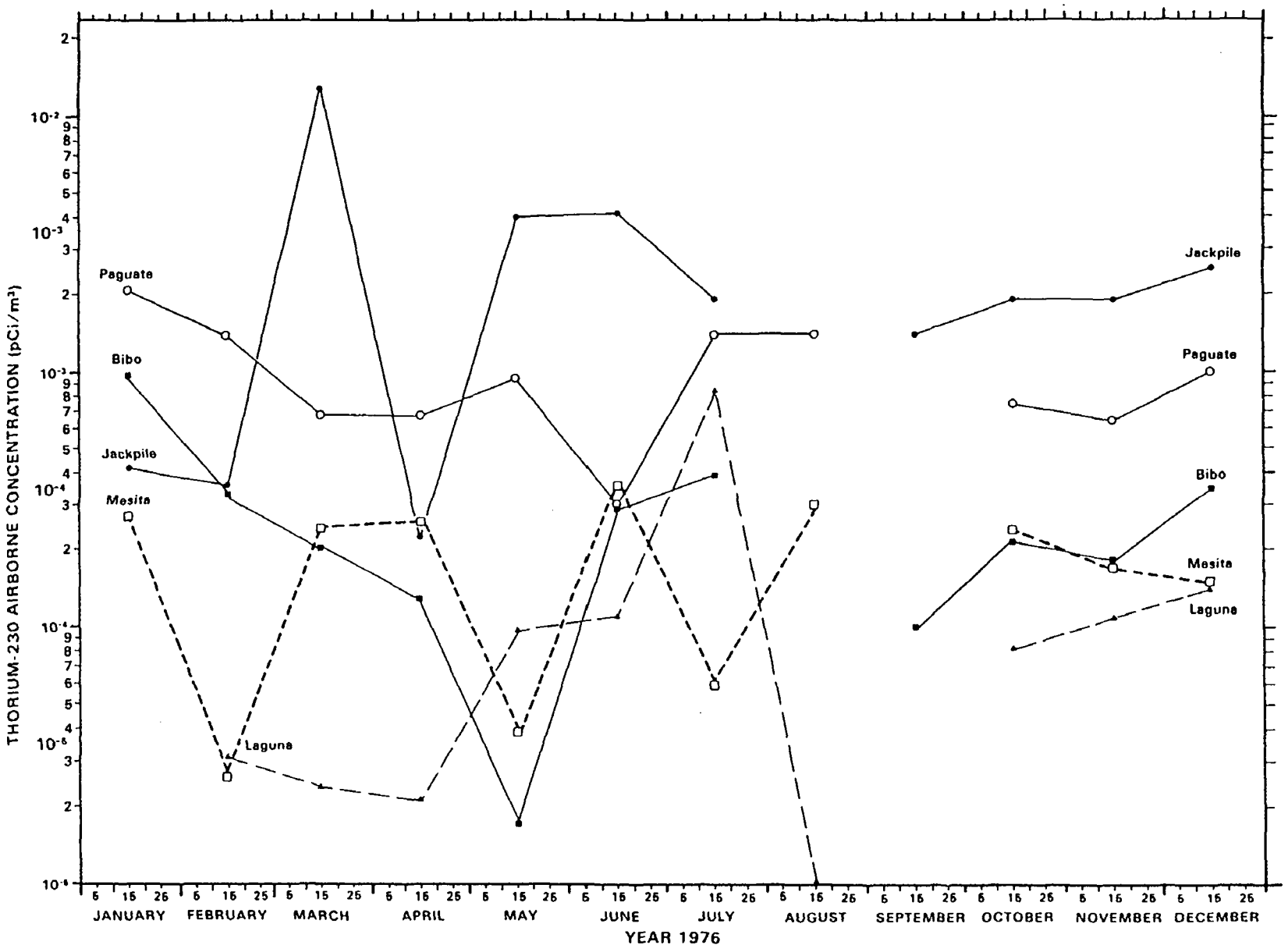

Figure 8. Average monthly airborne thorium-230 concentration (pCi/m³) for locations in the vicinity of the Jackpile Open Pit Uranium Mine

LOG-PROBABILITY DISTRIBUTION OF AMBIENT AIRBORNE PARTICULATE RADIOACTIVITY

Log-normal probability plots of the composited monthly ambient radioactivity concentrations for the five sites for radium-226, total uranium and thorium-230 are shown in Figures 9, 10 and 11, respectively. The plotted lines represent the best least squares fit of all data points for an exponential function (Brownlee, 1965). The visual inspection of these log-probability plots provides an indication that the measured ambient airborne radioactivity concentrations can generally be described by the log-normal distribution. Table 13 shows the comparison between the arithmetic average ($\overline{X}_a$), the volume weighted arithmetic average ($\overline{X}_w$), the geometric mean ($\overline{X}_g$), and the estimated average based on the log-normal parameters ($\overline{X}'$) for each sampling site. Except for the total uranium results at Mesita, $\overline{X}_g$ was always less than $\overline{X}_w$ (Table 13). This feature of the geometric mean is probably due to the equal weighting of all data points when obtaining the log-probability plots; whereas, the volume weighted arithmetic average takes into account the sample size and gives more "weight" to the larger samples. Also, the larger samples result in more accurate analytical determinations since there is more radioactivity to measure and consequently, better counting statistics are obtained as compared to analytical results from smaller samples. Obviously, simple arithmetic averaging (i.e., without weighting factors) also does not consider sample size and provides equal weight for each sample. It would therefore seem appropriate to choose the volume weighted arithmetic average as the best estimate of the annual average airborne radioactivity concentration. Considering the volume weighted arithmetic average ($\overline{X}_w$) as the best estimate of the annual average airborne radioactivity concentration, the highest relative error associated with estimating the average based on the log-normal parameters was 89 percent for the thorium-230 results at Mesita. Except for the total uranium data obtained at Mesita, the relative error between the $\overline{X}_w$ versus the $\overline{X}'$ was much less than 15 percent - - providing further support that it is reasonable to assume a log-normal distribution for the airborne particulate radioactivity and that annual averages may be reasonably estimated based on the log-normal parameters.

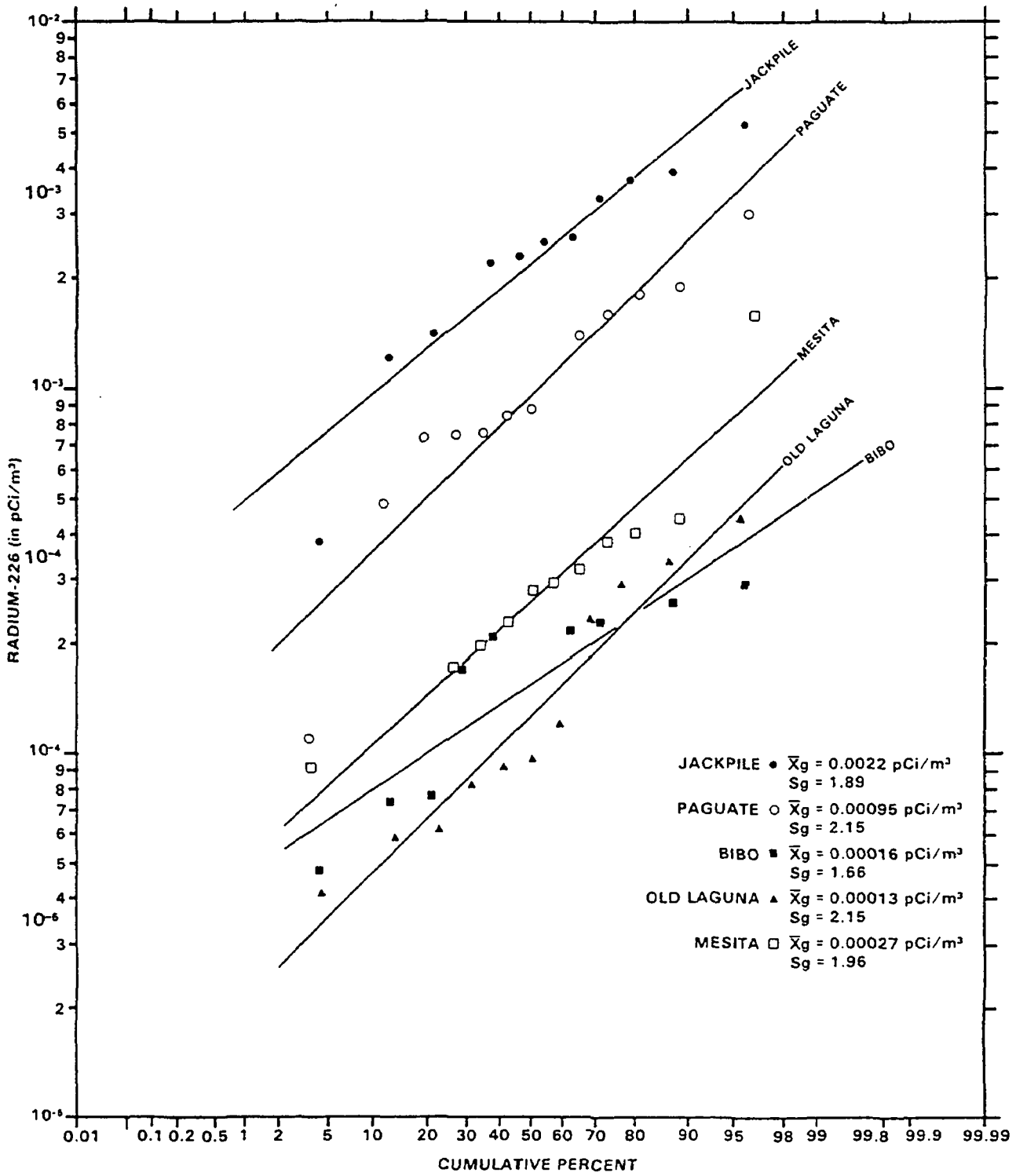

Figure 9. Log-probability plot of the composited monthly ambient radium-226 radioactivity concentrations for the five locations in the vicinity of the Jackpile Open Pit Uranium Mine

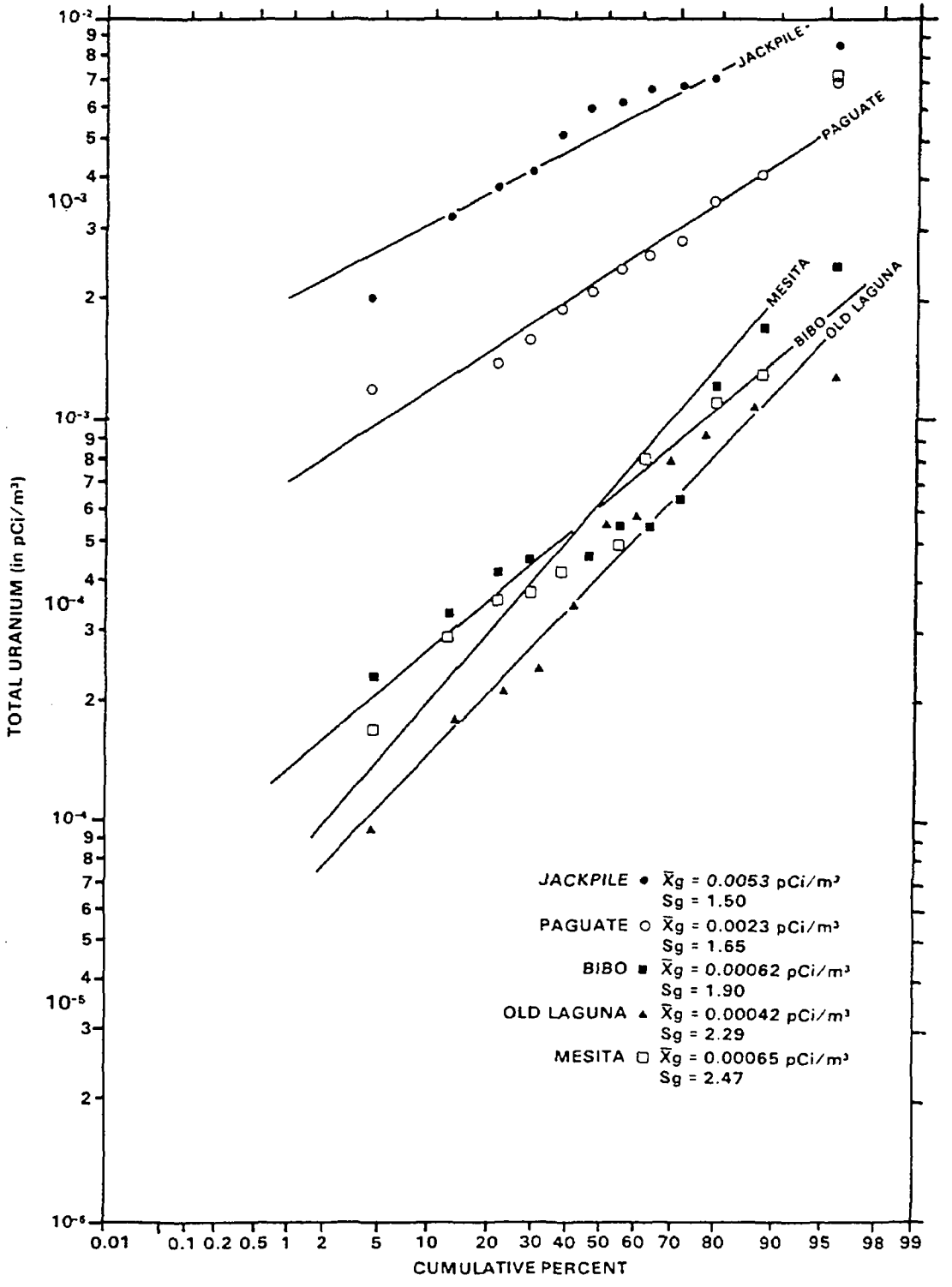

Figure 10. Log-probability plot of the composited monthly ambient total uranium radioactivity concentrations for the five locations in the vicinity of the Jackpile Open Pit Uranium Mine

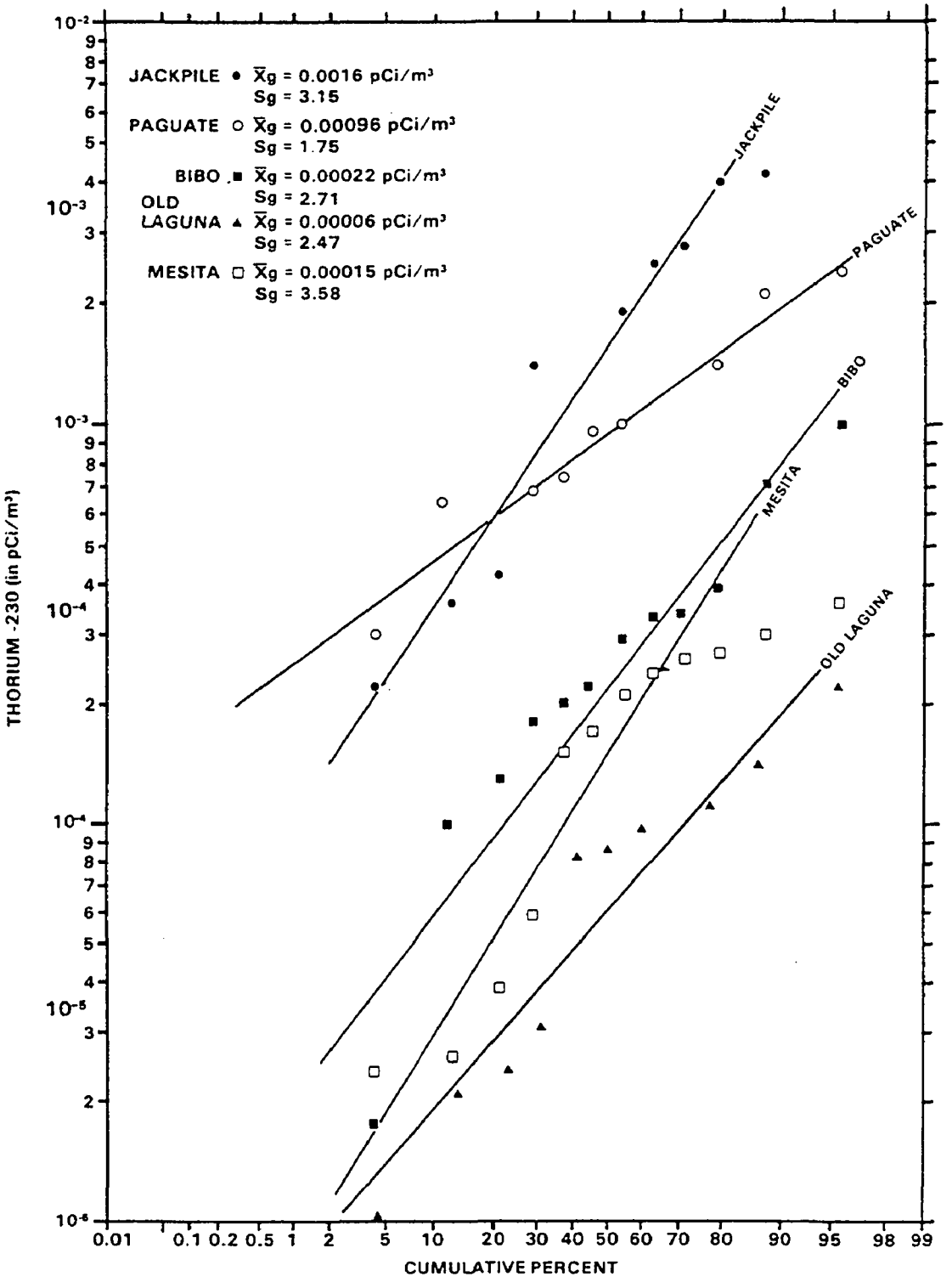

Figure 11. Log-probability plot of the composited monthly ambient thorium-230 radioactivity concentrations for the five locations in the vicinity of the Jackpile Open Pit Uranium Mine

TABLE 13. COMPARISON OF MEANS (IN pCi/m³)

Site	Radium-226				Total Uranium				Thorium-230			
	$\bar{X}_a$*	$\bar{X}_w$**	$\bar{X}_g$+	$\bar{X}'$++	$\bar{X}_a$*	$\bar{X}_w$**	$\bar{X}_g$+	$\bar{X}'$++	$\bar{X}_a$*	$\bar{X}_w$**	$\bar{X}_g$+	$\bar{X}'$++
Jackpile Housing	0.0026	0.0024	0.0022	0.0027	0.0058	0.0055	0.0053	0.0058	0.0030	0.0028	0.0016	0.0031
Paguate	0.0013	0.0012	0.00095	0.0013	0.0026	0.0025	0.0023	0.0026	0.0011	0.0011	0.00096	0.0011
Bibo	0.00019	0.0002	0.00016	0.00018	0.0008	0.00075	0.00062	0.00076	0.00032	0.0003	0.00022	0.00036
Mesita	0.00037	0.00034	0.00027	0.00034	0.00064	0.00061	0.00065	0.00098	0.00018	0.00018	0.00015	0.00034
Old Laguna	0.00017	0.00016	0.00013	0.00017	0.00058	0.00052	0.00042	0.00059	0.000085	0.000081	0.00006	0.00009

* Arithmetic average (Tables B-1 to B-5)
** Volume weighted arithmetic average (Eadie and Bernhardt, 1976)
\+ Geometric mean from log-probability plots (Figures 9 to 11)
++ Estimated average base on log-normal parameters

DOSE ESTIMATES

Listed in Table 14 are the dose conversion factors for each radionuclide measured in this study. (The doses due to polonium-210 and lead-210 have not been estimated since these radionuclides were not evaluated for this study.) This factor represents the average annual dose equivalent in rems for each year of chronic inhalation at a concentration of 1 pCi/m^3. Dose estimates have been maximized by assuming that the indoor concentration of radioactive materials would be the same as the levels measured outdoors during this study. The highest total dose of 38 millirem was calculated for an individual exposed to the annual average ambient radionuclide concentrations measured outdoors at the Jackpile Housing (assuming continuous exposure for the entire year at the volume weighted arithmetic average value reported in Table B-1). Similarly, a total dose of 2.7 millirem was calculated for an individual exposed to the annual average ambient radionuclide concentrations measured outdoors at Old Laguna - - the location having the lowest measured ambient airborne concentrations of this study. Therefore, considering Old Laguna as representative of "background" conditions, the additional dose to an individual (above background) at Jackpile Housing would be about 35 millirem for each year of exposure to the airborne radionuclide concentrations measured during this study. For comparison purposes the dose estimates for typical background concentrations of naturally occurring radioactive materials as reported for New York City and Argonne National Laboratory (NCRP, 1975) are also tabulated in Table 14.

TABLE 14. AVERAGE ANNUAL LUNG DOSE (MREM/YEAR) FOR INSOLUBLE RADIONUCLIDES

Isotope	Dose Conversion Factor*	Jackpile Housing	Paguate	Bibo	Mesita	Old Laguna	New York City (NCRP, 1975)	Argonne National Laboratory (NCRP, 1975)
U-234	3.7	10	4.4	1.4	1.1	0.93	0.93	0.44
U-235	3.4	0.34	0.16	0.024	0.044	0.031	0.04	0.023
U-238	3.2	8.6	3.8	1.2	0.96	0.83	0.80	0.38
Th-230	3.4	9.5	3.7	1.0	0.61	0.28	No data	0.15
Th-232	3.0	0.13	0.36	0.15	0.21	0.072	No data	0.09
Ra-226	3.7 (no radon+)	8.9	4.4	0.74	1.3	0.59	0.37	No data
Total Dose (mrem/year)		38	17	4.5	4.2	2.7	1.4	1.1

* Rem per year for continuous inhalation of 1 pCi/m^3 for particles of 1.0μm AMAD; using a quality factor for alpha of 10, and a pulmonary lung mass of 480 grams (U.S. EPA, 1973; Mills, 1976; Sullivan, 1977)

\+ It has been assumed that radon-222 and its progeny escape from the aerosol particle and that the only dose is due to radium-226

RADIOACTIVITY IN FOOD

During the course of this study, some concern was expressed about the possible ingestion of radioactive materials due to their uptake by food grown in the local area. Only samples of cucumbers and onions were obtained and the results of radiochemical analyses of these food are shown in Table 15. Unfortunately, samples of meat from animals which grazed on areas close to the mining activities were not available.

Previously reported analyses of vegetables indicated a radium-226 content of less than 0.002 pCi/g (Hallden et al., 1963). Welford and Baird (1967) reported a total uranium content for vegetables of roughly 0.00053 pCi/g. The radioactive content of the cucumbers from this study are essentially comparable to these reported "typical background" values with the exception of radium-226, the results for the onions are several orders of magnitude greater than the cucumber results. The fairly high radium-226 content of the cucumbers or the relatively high thorium-232 content of the onions cannot be resolved without additional sampling and further analyses. In any event, the results reported here for cucumbers and onions may be indicative of increased plant uptake from elevated radioactivity in the soil and/or plant foliage adsorption of airborne radioactive materials. Such a possibly significant exposure pathway should not be ignored in future studies of the radiological impact of uranium mining and milling activities.

TABLE 15. RADIOACTIVITY IN FOOD (CONCENTRATION ± TWO-SIGMA COUNTING ERROR, IN pCi/g)

Radionuclide	Cucumber	Onion
Radium-226	0.11 ± 0.011	0.047 ± 0.0083
Uranium-234	0.00018 ± 0.000032	0.026 ± 0.002
Uranium-235	Less than 0.000011	0.0011± 0.00034
Uranium-238	0.00013 ± 0.000027	0.027 ± 0.0021
Thorium-230	0.0032 ± 0.00049	0.035 ± 0.0052
Thorium-232	0.00042 ± 0.000091	0.039 ± 0.0057

REFERENCES

Brownlee, K. A. (1965), Statistical Theory and Methodology in Science and Engineering. John Wiley & Sons.

Eadie, G. G., R. F. Kaufmann, D. J. Markley and R. Williams (June 1976), Report of Ambient Outdoor Radon and Indoor Radon Progeny Concentrations during November 1975 at Selected Locations in the Grants Mineral Belt, New Mexico. U.S. Environmental Protection Agency, Technical Note: ORP/LV-76-4.

Eadie, Gregory G. and D. E. Bernhardt (December 1976), Sampling and Data Reporting Considerations for Airborne Particulate Radioactivity. U.S. Environmental Protection Agency, Technical Note ORP/LV-76-9.

George, A. C. (1976), Scintillation Flasks for the Determination of Low Level Concentrations of Radon. In: Proceedings of the Ninth Midyear Topical Symposium of the Health Physics Society, February 9-12, 1976.

Hallden, N. A., I. M. Fisenne and J. H. Harley (1963), Radium-226 in the Diet in three U.S. Cities. In: the Proceedings of the 7th Annual Meeting on Bioassay and Analytical Chemistry; held at Argonne National Laboratory on October 12-13, 1961.

Johns, F. B., ed. (February 1975), Handbook of Radiochemical Analytical Methods. U.S. Environmental Protection Agency, EPA-680/4-75-001.

Joint Committee on Atomic Energy (1971), Hearings on the Use of Uranium Mill Tailings for Construction Purposes. U.S. Government Printing Office, Washington, D.C., 515 pp.

Mills, William A. (September 13, 1976), Revised Dose to the Lung form UFC Particulates, letter to C. R. Porter.

(NCRP, 1975), National Council on Radiation Protection and Measurements, Natural Background Radiation in the United States, November 15, 1975 NCRP Report No. 45.

(NMEIA, 1973), New Mexico Environmental Improvement Agency-Regulation for Governing the Health and Environmental Aspects of Radiation. June 16, 1973.

(NRC, 1976), Nuclear Regulatory Commission (January, 1976), title 10 Code of Federal Regulations Part 20-Standards for Protection Against Radiation. (Federal Register, Vol. 40, No. 211-Friday, October 31, 1975 for amended radon values).

Schiager, K. J. (1971), The Evaluation of Radon Progeny Exposures in Buildings: A Report on Equipment and Techniques Colorado State University, Fort Collins, Colorado.

Sullivan, Robert E. (June 1977), Plutonium Air Inhalation Dose (PAID) - A Code for Calculating Organ Doses Due to the Inhalation and Ingestion of Radioactive Aerosols. U.S. Environmental Protection Agency, Technical Note ORP/CSD-77-4.

The Anaconda Company (1976), Mining and Reclamation Plan at the Anaconda Company's Jackpile-Paguate Uranium Mine, Valencia County, New Mexico. Dames and Moore Job No. 4010-041-06 (December, 1976).

(U.S. EPA, 1973), U.S. Environmental Protection Agency, Part I-Fuel Supply - Environmental Analysis of the Uranium Fuel Cycle, October 1973.

U.S. Public Health Service (1969), Evaluation of Radon-222 Near Uranium Tailings Piles. U.S. Department of Health, Education and Welfare, DER-69-1.

U.S. Surgeon General (1970), Recommendations of action for radiation exposure levels in dwellings constructed on or with uranium mill tailings. In: Hearings on the Use of Uranium Mill Tailings for Construction Purposes(1971), p. 51-54.

Welford, G. A. and R. Baird, December 1967, Uranium Levels in Human Diet and Biological Materials. Health Physics, Vol. 13, pp. 1321-1324.

APPENDIX A

Ambient Outdoor Radon-222 Concentrations

TABLE A-1. OLD LAGUNA-(#1)

Date/Time On	Date/Time Off	Radon Concentration* ±two-sigma counting error term, pCi/l
6/15/76 1500	6/16/76 1340	0.37 ± 0.12
6/16/76 1340	6/18/76 0850	0.23 ± 0.06
6/18/76 0850	6/20/76 0935	0.59 ± 0.16
6/20/76 0935	6/22/76 0855	1.3 ± 0.18
6/22/76 0855	6/24/76 0855	0.26 ± 0.10 (0.049 ± 0.019)**
6/24/76 0855	6/26/76 0855	0.23 ± 0.10
6/26/76 0900	6/28/76 0900	0.20 ± 0.10 (0.090 ± 0.028)**
6/28/76 0900	6/30/76 0930	0.84 ± 0.16

Summary

6/15/76 to 6/30/76 (8 Samples)

Range: 0.20 ± 0.10 to 1.3 ± 0.18

Average ± Two-Standard Error+ = 0.51 ± 0.28

* Eberline Instrument Corp. determination

** EMSL determination

\+ The standard error is defined as the standard deviation of the sample population divided by the square root of the number of samples

TABLE A-2. LAGUNA-TRAINING BUILDING (#2)

Date/Time On	Date/Time Off	Radon Concentration* ±two-sigma counting error term, pCi/l
6/8/76 1420	6/10/76 1404	1.5 ± 0.39
6/10/76 1406	6/12/76 1218	0.85 ± 0.34
6/12/76 1220	6/14/76 1010	Less than 0.41 (0.090 ± 0.022)**
6/14/76 1011	6/16/76 0935	0.50 ± 0.06
6/16/76 0935	6/18/70 1240	0.14 ± 0.07
6/18/76 1240	6/20/76 1205	0.32 ± 0.10 (0.18 ± 0.033)**
6/20/76 1205	6/22/76 1215	0.18 ± 0.18
6/22/76 1215	6/24/76 1130	0.47 ± 0.13
6/24/76 1130	6/26/76 0830	0.19 ± 0.11

Summary

6/8/76 to 6/26/76 (9 Samples)

Range: 0.14 ± 0.07 to 1.5 ± 0.39

Average ± Two-Standard Error+ = 0.51 ± 0.29

* Eberline Instrument Corp. determination

** EMSL determination

\+ The standard error is defined as the standard deviation of the sample population divided by the square root of the number of samples

TABLE A-3. IHS-LAGUNA HEALTH CENTER

Date/Time On	Date/Time Off	Radon Concentration* ±two-sigma counting error term, pCi/l
6/15/76 1430	6/16/76 1300	0.64 ± 0.14
6/16/76 1400	6/18/76 1220	0.59 ± 0.14
6/18/76 1220	6/20/76 1155	0.24 ± 0.12
6/20/76 1155	6/22/76 1200	1.6 ± 0.19
6/22/76 1200	6/24/76 1115	0.22 ± 0.11
6/26/76 1130	6/28/76 1100	0.44 ± 0.12 (0.071 ± 0.025)**
6/28/76 1100	6/30/76 1010	0.64 ± 0.16

Summary

6/15/76 to 6/30/76 (7 Samples)

Range: 0.22 ± 0.11 to 1.6 ± 0.19

Average ± Two-Standard Error+ = 0.63 ± 0.36

* Eberline Instrument Corp. determination

** EMSL determination

\+ The standard error is defined as the standard deviation of the sample population divided by the square root of the number of samples

TABLE A-4. BIBO-WELLHOUSE

Date/Time On	Date/Time Off	Radon Concentration* ±two-sigma counting error term, pCi/l
6/8/76 1207	6/10/76 1120	Less than 0.12 (0.041 ± 0.019)**
6/10/76 1120	6/12/76 1130	1.4 ± 0.29
6/12/76 1131	6/14/76 1337	Less than 0.38
6/14/76 1338	6/16/76 1020	1.1 ± 0.14
6/16/76 1021	6/18/76 1140	0.71 ± 0.17
6/18/76 1140	6/20/76 1110	0.50 ± 0.12 (0.18 ± 0.033)**
6/20/76 1110	6/22/76 1120	Less than 0.12
6/22/76 1120	6/24/76 1030	0.32 ± 0.10 (0.065 ± 0.020)**
6/24/76 1030	6/26/76 1100	0.28 ± 0.11
6/26/76 1100	6/27/76 1030	0.28 ± 0.14
6/27/76 1030	6/28/76 1015	0.37 ± 0.10
6/28/76 1015	6/30/76 1130	0.37 ± 0.13

Summary

6/8/76 to 6/30/76 (12 Samples)

Range: Less than 0.12 to 1.4 ± 0.29

Average ± Two-Standard Error+ = 0.50 ± 0.23

* Eberline Instrument Corp. determination

** EMSL determination

\+ The standard error is defined as the standard deviation of the sample population divided by the square root of the number of samples

TABLE A-5. MESITA-INDUSTRIAL PLANT (#1)

Date/Time On	Date/Time Off	Radon Concentration* ±two-sigma counting error term, pCi/l
6/8/76 1533	6/10/76 1430	0.31 ± 0.06
6/10/76 1430	6/12/76 1415	0.89 ± 0.33
6/12/76 1420	6/14/76 1455	0.49 ± 0.14
6/14/76 1456	6/15/76 1435	0.18 ± 0.05

Summary

6/8/76 to 6/15/76 (4 Samples)

Range: 0.18 ± 0.05 to 0.89 ± 0.33

Average ± Two-Standard Error+ = 0.47 ± 0.31

* Eberline Instrument Corp. determination

\+ The standard error is defined as the standard deviation of the sample population divided by the square root of the number of samples

TABLE A-6. MESITA-COMMUNITY BUILDING (#2)

Date/Time On	Date/Time Off	Radon Concentration* ±two-sigma counting error term, pCi/l
6/15/76 1445	6/16/76 1320	1.7 ± 0.22
6/16/76 1425	6/18/76 1320	0.32 ± 0.12
6/20/76 1225	6/22/76 1235	Less than 0.12
6/22/76 1235	6/24/76 1145	0.34 ± 0.05
6/24/76 1145	6/26/76 1210	0.23 ± 0.08
6/26/76 1210	6/28/76 1120	0.61 ± 0.16

Summary

6/15/76 to 6/28/76 (6 Samples)

Range: Less than 0.12 to 1.7 ± 0.22

Average ± Two-Standard Error+ = 0.55 ± 0.47

* Eberline Instrument Corp. determination

\+ The standard error is defined as the standard deviation of the sample population divided by the square root of the number of samples

TABLE A-7. MOQUINO-PRIVATE RESIDENCE

Date/Time On	Date/Time Off	Radon Concentration* ±two-sigma counting error term, pCi/l
6/8/76 1242	6/10/76 1141	1.4 ± 0.14
6/10/76 1145	6/12/76 1151	Less than 0.30
6/12/76 1155	6/14/76 1348	Less than 0.35 *(0.090 ± 0.024)***
6/14/76 1350	6/16/76 1037	1.1 ± 0.22
6/16/76 1038	6/18/76 1200	0.24 ± 0.08
6/18/76 1200	6/20/76 1125	0.19 ± 0.12
6/20/76 1125	6/22/76 1140	1.4 ± 0.23
6/22/76 1140	6/24/76 1045	Less than 0.12
6/24/76 1045	6/26/76 1110	0.23 ± 0.10
6/26/76 1110	6/28/76 1030	0.47 ± 0.14
6/28/76 1030	6/30/76 1150	Less than 0.12

Summary

6/8/76 to 6/30/76 (11 Samples) — Range: Less than 0.12 to 1.4 ± 0.23
Average ± Two-Standard Error+ = 0.54 ± 0.31

* Eberline Instrument Corp. determination
** EMSL determination
\+ The standard error is defined as the standard deviation of the sample population divided by the square root of the number of samples

TABLE A-8. PAGUATE-COMMUNITY BUILDING

Date/Time On	Date/Time Off	Radon Concentration* ±two-sigma counting error term, pCi/l
6/8/76 1125	6/10/76 1000	0.19 ± 0.13 (0.11 ± 0.010)**
6/10/76 1000	6/12/76 1100	0.57 ± 0.14
6/12/76 1102	6/14/76 1310	0.29 ± 0.11
6/14/76 1311	6/16/76 1055	0.74 ± 0.06
6/16/76 1055	6/18/76 1120	0.18 ± 0.10
6/18/76 1120	6/20/76 1050	0.36 ± 0.10 (0.11 ± 0.026)**
6/21/76 1100	6/22/76 1110	0.65 ± 0.12
6/22/76 1110	6/24/76 1010	Less than 0.12 (0.056 ± 0.020)**
6/24/76 1010	6/26/76 1045	0.31 ± 0.12
6/26/76 1045	6/28/76 1000	0.48 ± 0.12 (0.12 ± 0.029)**
6/28/76 1000	6/30/76 1110	0.73 ± 0.17

Summary

6/8/76 to 6/30/76 (11 Samples) — Range: Less than 0.12 to 0.74 ± 0.06
Average ± Two-Standard Error+ = 0.42 ± 0.14

* Eberline Instrument Corp. Determination
** EMSL determination
\+ The standard error is defined as the standard deviation of the sample population divided by the square root of the number of samples

TABLE A-9. JACKPILE MINE-COMPANY HOUSING AREA

Date/Time On	Date/Time Off	Radon Concentration* ±two-sigma counting error term, pCi/l
6/8/76 0915	6/10/76 1240	1.8 ± 0.35
6/10/76 1241	6/12/76 1025	1.6 ± 0.36
6/12/76 1025	6/14/76 1250	Less than 0.34 (0.31 ± 0.043)**
6/14/76 1251	6/16/76 1200	1.3 ± 0.17
6/16/76 1201	6/18/76 0945	0.53 ± 0.14
6/18/76 0945	6/20/76 1030	0.89 ± 0.18
6/20/76 1030	6/22/76 1050	1.5 ± 0.19
6/22/76 1050	6/24/76 0945	0.35 ± 0.10 (0.20 ± 0.035)**
6/24/76 0945	6/26/76 1030	1.4 ± 0.08
6/26/76 1030	6/28/76 0945	1.8 ± 0.23
6/28/76 0945	6/30/76 1050	1.1 ± 0.07

Summary

6/8/76 to 6/30/76 (11 Samples) — Range: 0.25 ± 0.10 to 1.84 ± 0.23
Average ± Two-Standard Error+ = 1.1 ± 0.34

* Eberline Instrument Corp. determination
** EMSL determination
\+ The standard error is defined as the standard deviation of the sample population divided by the square root of the number of samples

TABLE A-10. RAILROAD TRESTLE-BELOW JACKPILE HOUSING (#1)

Date/Time On	Date/Time Off	Radon Concentration* ±two-sigma counting error term, pCi/l
6/8/76 1025	6/10/76 1304	2.1 ± 0.26
6/10/76 1310	6/12/76 0945	1.6 ± 0.35
6/12/76 0945	6/14/76 1235	Less than 0.12 (0.14 ± 0.029)**
6/14/76 1236	6/16/76 1225	0.29 ± 0.12
6/16/76 1227	6/18/76 0930	0.41 ± 0.13
6/18/76 0930	6/20/76 1010	0.82 ± 0.06 (0.53 ± 0.055)**
6/20/76 1010	6/22/76 0935	1.3 ± 0.22
6/23/76 0935	6/24/76 0930	0.19 ± 0.10
6/24/76 0930	6/26/76 0930	2.1 ± 0.22

Summary

6/8/76 to 6/26/76 (9 Samples) Range: Less than 0.12 to 2.1 ± 0.26
Average ± Two-Standard Error+ = 0.99 ± 0.54

* Eberline Instrument Corp. determination
** EMSL determination
\+ The standard error is defined as the standard deviation of the sample population divided by the square root of the number of samples

TABLE A-11. (LOCATION #2)-ONE MILE SOUTH OF RR TRESTLE (#1)

Date/Time On	Date/Time Off	Radon Concentration* ±two-sigma counting error term, pCi/l
6/8/76 1047	6/10/76 1319	2.6 ± 0.43
6/10/76 1320	6/12/76 1035	1.2 ± 0.29
6/12/76 1038	6/14/76 1035	0.62 ± 0.14
6/14/76 1036	6/16/76 1240	1.6 ± 0.20
6/16/76 1240	6/18/76 0915	0.44 ± 0.05
6/18/76 0915	6/20/76 1000	0.59 ± 0.16
6/20/76 1000	6/22/76 0920	2.0 ± 0.11
6/22/76 0920	6/24/76 0920	0.46 ± 0.13
6/24/76 0920	6/26/76 0940	2.7 ± 0.24
6/26/76 0940	6/28/76 0930	0.84 ± 0.17 (0.84 ± 0.077)**
6/28/76 0930	6/30/76 1040	1.1 ± 0.19

Summary
6/8/76 to 6/30/76 (11 Samples)

Range: 0.44 ± 0.05 to 2.7 ± 0.24
Average ± Two-Standard Error+ = 1.3 ± 0.50

* Eberline Instrument Corp. determination
** EMSL determination
\+ The standard error is defined as the standard deviation of the sample population divided by the square root of the number of samples

APPENDIX B

Composited Monthly Ambient Air Sampling Results in pCi/m^3

TABLE B-1. COMPOSITED MONTHLY AMBIENT AIR SAMPLING RESULTS* (in pCi/m^3) AT JACKPILE HOUSING

MO/YR	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
75/12	75/12/04	75/12/29	3.00E-03	1.10E-04	3.00E-03	2.80E-03	5.40E-05	2.20E-03
			(1.40E-04)	(1.40E-05)	(1.40E-04)	(7.50E-05)	(1.00E-05)	(1.20E-04)
76/01	75/12/29	76/01/23	4.30E-03	1.90E-04	4.20E-03	4.20E-04	8.00E-06	3.70E-03
			(2.00E-04)	(1.90E-05)	(1.90E-04)	(1.20E-05)	(2.00E-06)	(1.60E-04)
76/02	76/01/30	76/02/27	3.60E-03	1.30E-04	3.50E-03	3.60E-04	6.00E-06	3.90E-03
			(1.70E-04)	(1.50E-05)	(1.60E-04)	(8.00E-06)	(1.00E-06)	(1.60E-04)
76/03	76/02/27	76/03/26	3.10E-03	1.30E-04	3.00E-03	1.40E-02	9.20E-05	3.30E-03
			(1.50E-04)	(1.60E-05)	(1.40E-04)	(2.20E-04)	(1.80E-05)	(1.50E-04)
76/04	76/03/26	76/04/30	2.10E-03	8.20E-05	2.10E-03	2.20E-04	5.00E-06	2.30E-03
			(1.00E-04)	(1.20E-05)	(1.00E-04)	(6.00E-06)	(1.00E-06)	(1.30E-04)
76/05	76/04/30	76/05/28	3.40E-03	1.10E-04	3.40E-03	4.00E-03	8.40E-05	2.60E-03
			(1.70E-04)	(1.60E-05)	(1.70E-04)	(1.50E-04)	(2.10E-05)	(1.30E-04)
76/06	76/05/28	76/06/25	4.30E-03	1.70E-04	4.20E-03	4.20E-03	6.70E-05	5.30E-03
			(2.00E-04)	(1.90E-05)	(2.00E-04)	(9.60E-05)	(1.20E-05)	(1.90E-04)
76/07	76/07/02	76/07/30	9.90E-04	4.50E-05	9.90E-04	1.90E-03	3.60E-05	2.20E-03
			(7.70E-05)	(7.50E-06)	(7.70E-05)	(6.00E-05)	(8.30E-06)	(1.30E-04)
76/09	76/07/30	76/09/24	1.57E-03	2.90E-05	1.56E-03	1.37E-03	2.73E-05	1.22E-03
			(4.51E-03)	(1.10E-05)	(4.64E-03)	(4.41E-03)	(3.71E-05)	(5.33E-03)
76/10	76/10/01	76/10/29	1.90E-03	5.90E-05	1.90E-03	1.90E-03	4.50E-05	1.40E-03
			(1.10E-04)	(1.10E-05)	(1.10E-04)	(6.00E-05)	(9.20E-06)	(9.80E-05)
76/11	76/10/29	76/11/29	2.70E-03	1.20E-04	2.40E-03	1.90E-03	5.60E-05	3.80E-04
			(4.50E-04)	(4.90E-05)	(4.20E-04)	(2.20E-04)	(1.10E-05)	(5.40E-05)
76/12	76/11/29	76/12/10	3.40E-03	1.30E-04	3.30E-03	2.50E-03	3.00E-05	2.50E-03
			(1.80E-04)	(2.30E-05)	(1.80E-04)	(2.90E-04)	(1.10E-05)	(1.80E-04)
VOLUME WEIGHTED AVERAGES			2.74E-03	1.12E-04	2.68E-03	2.82E-03	4.18E-05	2.44E-03
STD ERR MEAN * T95(N-1)			(6.45E-04)	(2.87E-05)	(6.26E-04)	(2.22E-03)	(1.77E-05)	(8.61E-04)

*Results corrected for blank filter content. Statistical considerations as discussed in Eadie and Bernhardt (1976). Results shown are volume weighted arithmetic average with values in parenthesis being the standard error at the 95 percent confidence level based on the t-distribution for (n-1) degrees of freedom.

TABLE B-2. COMPOSITED MONTHLY AMBIENT AIR SAMPLING RESULTS* (in pCi/m^3) AT PAGUATE

MO/YR	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
75/12	75/12/04	75/12/29	2.10E-03	8.30E-05	2.00E-03	2.40E-03	1.30E-04	1.90E-03
			(1.10E-04)	(1.20E-05)	(1.00E-04)	(1.00E-04)	(2.40E-05)	(1.00E-04)
76/01	75/12/29	76/01/23	3.50E-03	1.30E-04	3.30E-03	2.10E-03	2.50E-04	3.00E-03
			(1.80E-04)	(1.90E-05)	(1.70E-04)	(7.60E-05)	(2.60E-05)	(1.70E-04)
76/02	76/01/30	76/02/27	1.30E-03	5.00E-05	1.20E-03	1.40E-03	2.40E-04	1.40E-03
			(7.20E-05)	(9.20E-06)	(7.00E-05)	(6.10E-05)	(2.60E-05)	(9.30E-05)
76/03	76/02/27	76/03/26	6.90E-04	3.20E-05	7.10E-04	6.80E-04	1.90E-04	7.60E-04
			(4.40E-05)	(6.90E-06)	(4.60E-05)	(4.00E-05)	(2.20E-05)	(7.00E-05)
76/04	76/03/26	76/04/30	7.10E-04	2.80E-05	7.00E-04	6.80E-04	8.90E-05	7.30E-04
			(4.40E-05)	(6.70E-06)	(4.50E-05)	(3.90E-05)	(1.40E-05)	(7.70E-05)
76/05	76/04/30	76/05/28	6.40E-04	2.50E-05	5.90E-04	9.50E-04	1.10E-04	7.50E-04
			(4.20E-05)	(6.20E-06)	(4.10E-05)	(5.10E-05)	(1.70E-05)	(7.30E-05)
76/06	76/05/28	76/06/25	1.40E-03	5.30E-05	1.40E-03	3.00E-04	2.80E-05	1.60E-03
			(7.70E-05)	(9.50E-06)	(7.60E-05)	(3.00E-05)	(1.00E-05)	(1.00E-04)
76/07	76/07/02	76/07/30	8.30E-04	3.10E-05	7.90E-04	1.40E-03	5.80E-05	1.80E-03
			(6.40E-05)	(5.60E-06)	(6.10E-05)	(4.80E-05)	(9.90E-06)	(1.00E-04)
76/08	76/07/30	76/08/27	1.20E-03	4.70E-05	1.20E-03	1.40E-03	5.80E-05	1.40E-03
			(6.60E-05)	(8.60E-06)	(6.40E-05)	(6.30E-05)	(1.30E-05)	(9.40E-05)
76/10	76/08/27	76/10/29	9.60E-04	3.70E-05	8.90E-04	7.40E-04	1.40E-04	4.10E-04
			(6.30E-05)	(9.50E-06)	(6.10E-05)	(4.40E-05)	(1.90E-05)	(4.65E-03)
76/11	76/10/29	76/11/29	1.10E-03	3.60E-05	9.90E-04	6.40E-04	6.40E-05	8.40E-04
			(6.50E-05)	(8.00E-06)	(6.20E-05)	(4.10E-05)	(1.40E-05)	(7.10E-05)
76/12	76/11/29	76/12/10	1.70E-03	5.90E-05	1.80E-03	1.00E-03	5.40E-05	4.80E-04
			(1.10E-04)	(1.60E-05)	(1.10E-04)	(6.40E-05)	(1.60E-05)	(9.50E-05)
VOLUME WEIGHTED AVERAGES			1.24E-03	4.73E-05	1.19E-03	1.11E-03	1.16E-04	1.15E-03
STD ERR MEAN * T95(N-1)			(4.07E-04)	(1.52E-05)	(3.87E-04)	(3.87E-04)	(4.66E-05)	(4.21E-04)

*Results corrected for blank filter content. Statistical considerations as discussed in Eadie and Bernhardt (1976). Results shown are volume weighted arithmetic average with values in parenthesis being the standard error at the 95 percent confidence level based on the t-distribution for (n-1) degrees of freedom.

TABLE B-3. COMPOSITED MONTHLY AMBIENT AIR SAMPLING RESULTS* (in pCi/m^3) AT BIBO

MO/YR	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
75/12	75/12/04	75/12/29	8.50E-04	----	8.40E-04	7.10E-04	7.70E-05	7.40E-05
			(1.20E-04)		(1.20E-04)	(8.20E-05)	(2.70E-05)	(3.50E-05)
76/01	75/12/29	76/01/23	1.20E-03	----	1.20E-03	9.80E-04	1.80E-04	4.80E-05
			(3.40E-04)		(3.40E-04)	(1.90E-04)	(7.90E-05)	(3.70E-05)
76/02	76/01/30	76/02/27	3.30E-04	----	3.10E-04	3.30E-04	5.10E-05	2.20E-04
			(2.80E-05)		(2.80E-05)	(2.40E-05)	(1.00E-05)	(4.40E-05)
76/03	76/02/27	76/03/26	2.10E-04	----	2.10E-04	2.00E-04	7.20E-05	7.70E-05
			(2.10E-05)		(2.20E-05)	(1.80E-05)	(1.10E-05)	(3.60E-05)
76/04	76/03/26	76/04/30	2.40E-04	6.50E-06	2.20E-04	1.30E-04	3.20E-05	2.60E-04
			(2.10E-05)	(3.30E-06)	(2.10E-05)	(1.40E-05)	(6.90E-06)	(4.40E-05)
76/05	76/04/30	76/05/28	1.70E-04	1.50E-06	1.60E-04	1.70E-05	4.00E-06	2.10E-04
			(1.90E-05)	(1.80E-06)	(1.90E-05)	(2.00E-06)	(1.00E-06)	(4.80E-05)
76/06	76/05/28	76/06/25	2.80E-04	1.20E-05	2.70E-04	2.90E-04	3.70E-05	2.90E-04
			(2.40E-05)	(4.40E-06)	(2.50E-05)	(2.40E-05)	(7.90E-06)	(5.90E-05)
76/07	76/07/02	76/07/16	2.40E-04	9.70E-06	2.20E-04	3.90E-04	5.90E-05	2.30E-04
			(2.90E-05)	(5.90E-06)	(2.90E-05)	(5.00E-05)	(2.00E-05)	(7.00E-05)
76/09	76/08/06	76/09/03	2.30E-04	6.00E-06	2.20E-04	1.00E-04	2.30E-05	2.20E-04
			(2.10E-05)	(3.00E-06)	(2.10E-05)	(1.60E-05)	(8.00E-06)	(4.60E-05)
76/10	76/09/03	76/10/29	2.15E-04	5.45E-06	2.15E-04	2.15E-04	5.05E-05	2.55E-04
			(6.99E-04)	(1.56E-05)	(8.26E-04)	(3.18E-04)	(9.53E-05)	(4.45E-04)
76/11	76/10/29	76/11/29	2.70E-04	8.80E-06	2.70E-04	1.80E-04	4.60E-05	2.20E-04
			(2.40E-05)	(4.30E-06)	(2.50E-05)	(3.10E-05)	(1.50E-05)	(4.20E-05)
76/12	76/11/29	75/12/10	6.00E-04	2.50E-05	6.10E-04	3.40E-04	1.60E-05	1.70E-04
			(5.60E-05)	(1.10E-05)	(5.70E-05)	(3.90E-05)	(1.10E-05)	(6.50E-05)
VOLUME WEIGHTED AVERAGES			3.76E-04	7.66E-06	3.69E-04	3.02E-04	5.50E-05	1.96E-04
STD ERR MEAN * T95(N-1)			(1.90E-04)	(3.15E-06)	(1.92E-04)	(1.64E-04)	(2.63E-05)	(5.10E-05)

*Results corrected for blank filter content. Statistical considerations as discussed in Eadie and Bernhardt (1976). Results shown are volume weighted arithmetic average with values in parenthesis being the standard error at the 95 percent confidence level based on the t-distribution for (n-1) degrees of freedom.

TABLE B-4. COMPOSITED MONTHLY AMBIENT AIR SAMPLING RESULTS* (in pCi/m³) AT MESITA

MO/YR	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
75/12	75/12/04	75/12/29	8.90E-05	4.40E-06	8.10E-05	2.10E-04	4.70E-05	1.70E-04
			(1.30E-05)	(3.10E-06)	(1.50E-05)	(2.30E-05)	(1.10E-05)	(5.20E-05)
76/01	75/12/29	76/01/23	6.80E-04	2.80E-05	6.60E-04	2.70E-04	1.10E-04	2.80E-04
			(4.40E-05)	(7.00E-06)	(4.40E-05)	(2.40E-05)	(1.50E-05)	(5.80E-05)
76/02	76/01/30	76/02/13	4.00E-04	1.30E-05	4.00E-04	2.60E-05	1.20E-05	3.80E-04
			(4.10E-05)	(7.00E-06)	(4.20E-05)	(1.40E-05)	(9.00E-06)	(8.00E-05)
76/03	76/03/02	76/03/26	2.20E-04	8.30E-06	2.40E-04	2.40E-04	7.00E-05	2.30E-04
			(2.50E-05)	(4.60E-06)	(2.80E-05)	(2.40E-05)	(1.30E-05)	(6.20E-05)
76/04	76/03/26	76/04/30	2.40E-04	9.40E-06	2.50E-04	2.60E-04	1.50E-04	2.90E-04
			(2.30E-05)	(4.30E-06)	(2.60E-05)	(2.10E-05)	(1.50E-05)	(5.20E-05)
76/05	76/04/30	76/05/28	1.80E-04	6.60E-06	1.90E-04	3.90E-05	2.50E-05	2.00E-04
			(2.00E-05)	(3.90E-06)	(2.30E-05)	(9.00E-06)	(7.00E-06)	(4.90E-05)
76/06	76/05/28	76/06/25	3.40E-04	1.70E-05	3.50E-04	3.60E-04	1.40E-04	4.40E-04
			(3.20E-05)	(6.30E-06)	(3.30E-05)	(3.10E-05)	(1.90E-05)	(6.70E-05)
76/07	76/07/09	76/07/30	1.90E-04	4.80E-06	1.70E-04	5.90E-05	1.50E-04	1.60E-03
			(2.80E-05)	(5.20E-06)	(2.70E-05)	(5.00E-05)	(2.50E-05)	(1.20E-04)
76/08	76/07/30	76/08/27	1.50E-04	9.70E-06	1.40E-04	3.00E-04	1.00E-04	9.20E-05
			(1.80E-05)	(4.30E-06)	(1.90E-05)	(3.00E-05)	(1.70E-05)	(4.30E-05)
76/10	76/09/27	76/10/29	2.10E-04	9.20E-06	2.10E-04	2.40E-05	1.60E-05	2.29E-04
			(2.00E-05)	(3.70E-06)	(2.20E-05)	(3.00E-06)	(2.00E-06)	(1.35E-03)
76/11	76/10/29	76/11/29	5.20E-04	2.40E-05	5.30E-04	1.70E-04	5.10E-05	4.10E-04
			(4.20E-05)	(7.20E-06)	(4.40E-05)	(1.70E-05)	(9.90E-06)	(5.70E-05)
76/12	76/11/29	76/12/10	5.90E-04	2.20E-05	5.10E-04	1.50E-04	1.80E-05	1.00E-04
			(5.60E-05)	(1.10E-05)	(5.20E-05)	(2.80E-05)	(1.30E-05)	(6.90E-05)
VOLUME WEIGHTED AVERAGES			3.00E-04	1.27E-05	2.98E-04	1.78E-04	7.71E-05	3.44E-04
STD ERR MEAN * T95(N-1)			(1.17E-04)	(5.09E-06)	(1.15E-04)	(7.86E-05)	(3.55E-05)	(2.06E-04)

*Results corrected for blank filter content. Statistical considerations as discussed in Eadie and Bernhardt (1976). Results shown are volume weighted arithmetic average with values in parenthesis being the standard error at the 95 percent confidence level based on the t-distribution for (n-1) degrees of freedom.

TABLE B-5. COMPOSITED MONTHLY AMBIENT AIR SAMPLING RESULTS* (in pCi/m^3) AT OLD LAGUNA

MO/YR	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
75/12	75/12/04	75/12/29	5.40E-04	2.50E-05	5.40E-04	2.20E-04	8.60E-05	1.20E-04
			(3.90E-05)	(6.80E-06)	(4.00E-05)	(1.90E-05)	(1.20E-05)	(3.80E-05)
76/02	76/01/30	76/02/27	4.60E-04	1.20E-05	4.70E-04	3.10E-05	9.00E-06	3.30E-04
			(3.60E-05)	(4.70E-06)	(3.70E-05)	(2.00E-06)	(1.00E-06)	(5.90E-05)
76/03	76/02/27	76/03/26	3.00E-04	7.90E-06	2.80E-04	2.40E-05	9.00E-06	2.90E-04
			(2.60E-05)	(3.80E-06)	(2.60E-05)	(4.00E-06)	(3.00E-06)	(5.10E-05)
76/04	76/03/26	76/04/30	1.80E-04	5.80E-06	1.70E-04	2.10E-05	1.10E-05	2.30E-04
			(1.90E-05)	(3.20E-06)	(2.10E-05)	(3.00E-06)	(2.00E-06)	(5.50E-05)
76/05	76/04/30	76/05/28	2.70E-04	9.70E-06	2.80E-04	9.70E-05	3.40E-05	9.20E-05
			(2.70E-05)	(4.90E-06)	(2.90E-05)	(1.60E-05)	(9.00E-06)	(4.40E-05)
76/06	76/05/28	76/06/25	1.10E-04	6.30E-06	1.00E-04	1.10E-04	5.80E-05	8.30E-05
			(1.50E-05)	(3.60E-06)	(1.70E-05)	(1.50E-05)	(1.10E-05)	(4.80E-05)
76/07	76/07/02	76/07/30	4.60E-05	2.80E-06	4.80E-05	8.70E-05	4.10E-05	4.10E-05
			(1.20E-05)	(3.20E-06)	(1.60E-05)	(1.80E-05)	(1.20E-05)	(4.70E-05)
76/08	76/08/06	76/08/27	9.40E-05	4.40E-06	9.00E-05	1.00E-05	1.00E-06	4.40E-04
			(1.50E-05)	(3.30E-06)	(1.60E-05)	(2.00E-06)	(1.00E-06)	(7.00E-05)
76/10	76/08/27	76/10/29	1.14E-04	4.83E-06	1.26E-04	8.29E-05	1.08E-05	6.22E-05
			(4.51E-04)	(3.30E-05)	(6.73E-04)	(5.63E-05)	(2.18E-05)	(1.71E-04)
76/11	76/10/29	76/11/29	3.80E-04	9.20E-06	4.10E-04	1.10E-04	1.10E-05	9.60E-05
			(3.10E-05)	(5.10E-06)	(3.40E-05)	(1.50E-05)	(6.00E-06)	(4.60E-05)
76/12	76/11/29	76/12/10	6.10E-04	2.60E-05	6.40E-04	1.40E-04	1.50E-05	5.90E-05
			(5.70E-05)	(1.20E-05)	(5.90E-05)	(2.70E-05)	(1.10E-05)	(5.80E-05)
VOLUME WEIGHTED AVERAGES			2.53E-04	9.11E-06	2.56E-04	8.12E-05	2.44E-05	1.62E-04
STD ERR MEAN * T95(N-1)			(1.10E-04)	(4.32E-06)	(1.13E-04)	(3.90E-05)	(1.69E-05)	(8.11E-05)

*Results corrected for blank filter content. Statistical considerations as discussed in Eadie and Bernhardt (1976). Results shown are volume weighted arithmetic average with values in parenthesis being the standard error at the 95 percent confidence level based on the t-distribution for (n-1) degrees of freedom.

APPENDIX C

Composited Monthly Ambient Air Sampling Results in pCi/g

TABLE C-1. COMPOSITED MONTHLY AMBIENT AIR SAMPLING RESULTS* (in pCi/g) AT JACKPILE HOUSING

MO/YR	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
75/12	75/12/04	75/12/29	7.90E+01	2.80E+00	7.70E+01	7.30E+01	1.40E+00	5.50E+01
			(3.60E+00)	(3.60E-01)	(3.50E+00)	(1.90E+00)	(2.70E-01)	(3.20E+00)
76/01	75/12/29	76/01/23	9.70E+01	4.20E+00	9.50E+01	9.40E+00	1.80E-01	8.40E+01
			(4.50E+00)	(4.40E-01)	(4.40E+00)	(2.70E-01)	(4.50E-02)	(3.60E+00)
76/02	76/01/30	76/02/27	9.00E+01	3.20E+00	8.70E+01	8.80E+00	1.40E-01	9.70E+01
			(4.20E+00)	(3.80E-01)	(4.10E+00)	(2.10E-01)	(2.60E-02)	(4.00E+00)
76/03	76/02/27	76/03/26	7.60E+01	3.10E+00	7.20E+01	3.40E+02	2.20E+00	8.20E+01
			(3.60E+00)	(3.80E-01)	(3.50E+00)	(5.40E+00)	(4.40E-01)	(3.70E+00)
76/04	76/03/26	76/04/30	6.20E+01	2.50E+00	6.20E+01	6.50E+00	1.50E-01	7.00E+01
			(3.00E+00)	(3.40E-01)	(3.00E+00)	(1.80E-01)	(2.70E-02)	(3.80E+00)
76/05	76/04/30	76/05/28	8.40E+01	2.70E+00	8.40E+01	9.90E+01	2.10E+00	6.50E+01
			(4.20E+00)	(3.80E-01)	(4.20E+00)	(3.60E+00)	(5.10E-01)	(3.40E+00)
76/06	76/05/28	76/06/25	9.70E+01	3.90E+00	9.50E+01	9.60E+01	1.50E+00	1.20E+02
			(4.50E+00)	(4.30E-01)	(4.50E+00)	(2.20E+00)	(2.80E-01)	(4.40E+00)
76/07	76/07/02	76/07/30	4.60E+01	2.00E+00	4.50E+01	8.40E+01	1.60E+00	9.70E+01
			(3.40E+00)	(3.30E-01)	(3.40E+00)	(2.60E+00)	(3.70E-01)	(6.00E+00)
76/09	76/07/30	76/09/24	7.02E+01	1.50E+00	6.98E+01	6.20E+01	1.26E+00	5.73E+01
			(1.56E+02)	(5.70E-01)	(1.65E+02)	(1.60E+02)	(1.61E+02)	(2.15E+02)
76/10	76/10/01	76/10/29	6.40E+01	1.90E+00	6.30E+01	6.20E+01	1.50E+00	4.30E+01
			(3.50E+00)	(3.80E-01)	(3.50E+00)	(2.00E+00)	(3.00E-01)	(3.20E+00)
76/11	76/10/29	76/11/29	6.80E+01	2.90E+00	6.20E+01	4.80E+01	1.40E+00	9.90E+00
			(1.10E+01)	(1.30E+00)	(1.10E+01)	(5.70E+00)	(2.90E-01)	(1.40E+00)
76/12	76/11/29	76/12/10	9.80E+01	3.70E+00	9.50E+01	7.30E+01	8.80E-01	7.30E+01
			(5.30E+00)	(6.60E-01)	(5.20E+00)	(8.30E+00)	(3.20E-01)	(5.40E+00)
VOLUME WEIGHTED AVERAGES			7.84E+01	3.01E+00	7.62E+01	8.02E+01	1.19E+00	6.98E+01
STD ERR MEAN * T95(N-1)			(9.10E+00)	(4.62E-01)	(9.30E+00)	(6.10E+01)	(1.15E+01)	(2.12E+01)

*Results corrected for blank filter content. Statistical considerations as discussed in Eadie and Bernhardt (1976). Results shown are mass weighted arithmetic average with values in parenthesis being the standard error at the 95 percent confidence level based on the t-distribution for (n-1) degrees of freedom.

TABLE C-2. COMPOSITED MONTHLY AMBIENT AIR SAMPLING RESULTS* (in pCi/g) AT PAGUATE

MO/YR	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
75/12	75/12/04	75/12/29	2.40E+01	9.40E-01	2.30E+01	2.70E+01	1.50E+00	2.10E+01
			(1.20E+00)	(1.30E-01)	(1.20E+00)	(1.10E+00)	(2.70E-01)	(1.20E+00)
76/01	75/12/29	76/01/23	1.70E+01	6.30E-01	1.60E+01	1.00E+01	1.20E+00	1.50E+01
			(8.60E-01)	(9.20E-02)	(8.40E-01)	(3.70E-01)	(1.30E-01)	(8.30E-01)
76/02	76/01/30	76/02/27	8.80E+00	3.50E-01	8.40E+00	9.60E+00	1.70E+00	9.50E+00
			(5.00E-01)	(6.40E-02)	(4.90E-01)	(4.30E-01)	(1.80E-01)	(6.50E-01)
76/03	76/02/27	76/03/26	5.00E+00	2.20E-01	5.00E+00	4.90E+00	1.40E+00	5.40E+00
			(3.10E-01)	(4.90E-02)	(3.20E-01)	(2.90E-01)	(1.50E-01)	(4.90E-01)
76/04	76/03/26	76/04/30	1.20E+01	4.50E-01	1.10E+01	1.10E+01	1.50E+00	1.20E+01
			(7.20E-01)	(1.10E-01)	(7.30E-01)	(6.40E-01)	(2.30E-01)	(1.30E+00)
76/05	76/04/30	76/05/28	1.20E+01	4.40E-01	1.10E+01	1.70E+01	1.90E+00	1.30E+01
			(7.60E-01)	(1.10E-01)	(7.30E-01)	(9.30E-01)	(3.10E-01)	(1.30E+00)
76/06	76/05/28	76/06/25	1.60E+01	6.00E-01	1.50E+01	3.40E+00	3.10E-01	1.70E+01
			(8.70E-01)	(1.10E-01)	(8.60E-01)	(3.40E-01)	(1.10E-01)	(1.10E+00)
76/07	76/07/02	76/07/30	1.70E+01	6.40E-01	1.70E+01	2.80E+01	1.20E+00	3.70E+01
			(1.30E+00)	(1.20E-01)	(1.30E+00)	(1.00E+00)	(2.10E-01)	(2.20E+00)
76/08	76/07/30	76/08/27	3.10E+01	1.20E+00	3.00E+01	3.70E+01	1.50E+00	3.60E+01
			(1.70E+00)	(2.20E-01)	(1.70E+00)	(1.60E+00)	(3.30E-01)	(2.40E+00)
76/10	76/08/27	76/10/29	7.00E+00	2.70E-01	6.40E+00	5.40E+00	1.10E+00	4.80E+00
			(4.60E-01)	(6.90E-02)	(4.40E-01)	(3.20E-01)	(1.40E-01)	(2.58E+01)
76/11	76/10/29	76/11/29	1.20E+01	4.00E-01	1.10E+01	7.10E+00	7.10E-01	9.20E+00
			(7.20E-01)	(8.80E-02)	(6.90E-01)	(4.60E-01)	(1.60E-01)	(7.90E-01)
76/12	76/11/29	76/12/10	2.90E+01	9.70E-01	3.00E+01	1.70E+01	9.00E-01	8.10E+00
			(1.90E+00)	(2.70E-01)	(1.90E+00)	(1.10E+00)	(2.60E-01)	(1.60E+00)
VOLUME WEIGHTED AVERAGES			1.32E+01	5.00E-01	1.26E+01	1.17E+01	1.25E+00	1.27E+01
STD ERR MEAN * T95(N-1)			(4.54E+00)	(1.66E-01)	(4.35E+00)	(5.35E+00)	(2.91E-01)	(4.91E+00)

*Results corrected for blank filter content. Statistical considerations as discussed in Eadie and Bernhardt (1976). Results shown are mass weighted arithmetic average with values in parenthesis being the standard error at the 95 percent confidence level based on the t-distribution for (n-1) degrees of freedom.

TABLE C-3. COMPOSITED MONTHLY AMBIENT AIR SAMPLING RESULTS* (in pCi/g) AT BIBO

MO/YR	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
75/12	75/12/04	75/12/29	1.90E+01	----	2.00E+01	1.60E+01	1.80E+00	1.80E+00
			(2.80E+00)		(2.80E+00)	(1.90E+00)	(6.10E-01)	(8.00E-01)
76/01	75/12/29	76/01/23	4.00E+01	----	4.00E+01	3.20E+01	5.80E+00	1.60E+00
			(1.20E+01)		(1.20E+01)	(6.20E+00)	(2.60E+00)	(1.20E+00)
76/02	76/01/30	76/02/27	9.80E+00	----	9.30E+00	9.60E+00	1.50E+00	6.60E+00
			(8.20E-01)		(8.10E-01)	(7.20E-01)	(2.80E-01)	(1.30E+00)
76/03	76/02/27	76/03/26	4.80E+00	----	4.70E+00	4.50E+00	1.60E+00	1.80E+00
			(4.80E-01)		(5.10E-01)	(4.20E-01)	(2.50E-01)	(8.20E-01)
76/04	76/03/26	76/04/30	6.00E+00	1.60E-01	5.40E+00	3.20E+00	8.00E-01	6.20E+00
			(5.30E-01)	(8.10E-02)	(5.30E-01)	(3.40E-01)	(1.70E-01)	(1.10E+00)
76/05	76/04/30	76/05/28	7.80E+00	6.50E-02	7.40E+00	7.50E-01	1.60E-01	9.20E+00
			(8.10E-01)	(7.80E-02)	(8.60E-01)	(7.60E-02)	(3.50E-02)	(2.10E+00)
76/06	76/05/28	76/06/25	7.30E+00	2.90E-01	6.90E+00	7.40E+00	9.40E-01	7.50E+00
			(6.10E-01)	(1.10E-01)	(6.40E-01)	(6.10E-01)	(2.00E-01)	(1.50E+00)
76/07	76/07/02	76/07/16	2.30E+01	9.70E-01	2.10E+01	3.90E+01	5.80E+00	2.20E+01
			(2.80E+00)	(5.80E-01)	(2.80E+00)	(4.90E+00)	(2.00E+00)	(6.80E+00)
76/09	76/08/06	76/09/03	8.10E+00	2.10E-01	7.60E+00	3.50E+00	8.00E-01	7.50E+00
			(7.10E-01)	(1.10E-01)	(7.30E-01)	(5.70E-01)	(2.70E-01)	(1.60E+00)
76/10	76/09/03	76/10/29	2.78E+00	6.91E-02	2.72E+00	2.73E+00	6.46E-01	3.29E+00
			(1.89E+01)	(1.98E-01)	(1.95E+01)	(5.32E+00)	(3.31E+00)	(1.60E+01)
76/11	76/10/29	76/11/29	7.10E+00	2.30E-01	7.00E+00	4.60E+00	1.20E+00	5.80E+00
			(6.30E-01)	(1.10E-01)	(6.50E-01)	(8.00E-01)	(4.00E-01)	(1.10E+00)
76/12	76/11/29	76/12/10	1.50E+01	5.90E-01	1.50E+01	8.30E+00	4.00E-01	4.10E+00
			(1.40E+00)	(2.70E-01)	(1.40E+00)	(9.40E-01)	(2.70E-01)	(1.60E+00)
VOLUME WEIGHTED AVERAGES			8.87E+00	1.68E-01	8.73E+00	7.04E+00	1.28E+00	4.60E+00
STD ERR MEAN * T95(N-1)			(5.77E+00)	(1.04E-01)	(5.84E+00)	(4.55E+00)	(7.41E-01)	(1.65E+00)

*Results corrected for blank filter content. Statistical considerations as discussed in Eadie and Bernhardt (1976). Results shown are mass weighted arithmetic average with values in parenthesis being the standard error at the 95 percent confidence level based on the t-distribution for (n-1) degrees of freedom.

TABLE C-4. COMPOSITED MONTHLY AMBIENT AIR SAMPLING RESULTS* (in pCi/g) AT MESITA

MO/YR	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
75/12	75/12/04	75/12/29	9.00E-01	4.50E-02	8.20E-01	2.10E+00	4.80E-01	1.80E+00
			(1.40E-01)	(3.20E-02)	(1.60E-01)	(2.30E-01)	(1.10E-01)	(5.30E-01)
76/01	75/12/29	76/01/23	6.50E+00	2.70E-01	6.30E+00	2.60E+00	1.00E+00	2.70E+00
			(4.20E-01)	(6.70E-02)	(4.20E-01)	(2.30E-01)	(1.40E-01)	(5.60E-01)
76/02	76/01/30	76/02/13	3.20E+00	1.10E-01	3.20E+00	2.10E-01	1.00E-01	3.10E+00
			(3.30E-01)	(5.70E-02)	(3.40E-01)	(1.10E-01)	(7.60E-02)	(6.50E-01)
76/03	76/03/02	76/03/26	2.30E+00	8.30E-02	2.40E+00	2.40E+00	7.00E-01	2.30E+00
			(2.50E-01)	(4.60E-02)	(2.80E-01)	(2.40E-01)	(1.30E-01)	(6.20E-01)
76/04	76/03/26	76/04/30	1.70E+00	7.10E-02	1.80E+00	1.90E+00	1.10E+00	2.10E+00
			(1.70E-01)	(3.20E-02)	(1.90E-01)	(1.60E-01)	(1.20E-01)	(3.90E-01)
76/05	76/04/30	76/05/28	2.30E+00	8.30E-02	2.40E+00	4.90E-01	3.10E-01	2.50E+00
			(2.50E-01)	(4.90E-02)	(2.80E-01)	(1.10E-01)	(9.10E-02)	(6.10E-01)
76/06	76/05/28	76/06/25	2.70E+00	1.30E+00	2.70E+00	2.70E+00	1.00E+00	3.30E+00
			(2.40E-01)	(4.80E-01)	(2.60E-01)	(2.40E-01)	(1.50E-01)	(5.10E-01)
76/07	76/07/09	76/07/30	2.50E+00	6.40E-02	2.20E+00	7.70E+00	2.00E+00	2.10E+01
			(3.70E-01)	(6.90E-02)	(3.70E-01)	(6.60E-01)	(3.40E-01)	(1.70E+00)
76/08	76/07/30	76/08/27	2.00E+00	1.30E-01	1.80E+00	3.80E+00	1.30E+00	1.20E+00
			(2.30E-01)	(5.50E-02)	(2.40E-01)	(3.80E-01)	(2.20E-01)	(5.50E-01)
76/10	76/08/27	76/10/01	1.70E+00	6.80E-02	1.60E+00	1.80E-01	1.20E-01	2.40E+00
			(1.50E-01)	(2.70E-02)	(1.60E-01)	(2.10E-02)	(1.70E-02)	(4.00E-01)
76/11	76/10/29	76/11/29	3.90E+00	1.80E-01	3.90E+00	1.20E+00	3.80E-01	3.10E+00
			(3.10E-01)	(5.30E-02)	(3.30E-01)	(1.20E-01)	(7.30E-02)	(4.30E-01)
76/12	76/11/29	76/12/10	1.30E+01	4.70E-01	1.10E+01	3.20E+00	3.80E-01	2.40E+00
			(1.20E+00)	(2.40E-01)	(1.10E+00)	(5.90E-01)	(2.90E-01)	(1.50E+00)
VOLUME WEIGHTED AVERAGES			2.83E+00	2.24E-01	2.76E+00	1.98E+00	7.06E-01	3.40E+00
STD ERR MEAN * T95(N-1)			(1.08E+00)	(2.41E-01)	(1.03E+00)	(1.07E+00)	(3.45E-01)	(2.17E+00)

*Results corrected for blank filter content. Statistical considerations as discussed in Eadie and Bernhardt (1976). Results shown are mass weighted arithmetic average with values in parenthesis being the standard error at the 95 percent confidence level based on the t-distribution for (n-1) degrees of freedom.

TABLE C-5. COMPOSITED MONTHLY AMBIENT AIR SAMPLING RESULTS* (in pCi/g) AT OLD LAGUNA

MO/YR	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
75/12	75/12/04	75/12/29	5.20E+00	2.40E-01	5.30E+00	2.10E+00	8.30E-01	1.10E+00
			(3.70E-01)	(6.50E-02)	(3.80E-01)	(1.80E-01)	(1.20E-01)	(3.70E-01)
76/02	76/01/30	76/02/27	3.60E+00	8.70E-02	3.60E+00	2.40E-01	6.90E-02	2.60E+00
			(2.80E-01)	(3.70E-02)	(2.90E-01)	(1.90E-02)	(1.00E-02)	(4.60E-01)
76/03	76/02/27	76/03/26	2.50E+00	6.40E-02	2.20E+00	1.90E-01	7.40E-02	2.40E+00
			(2.10E-01)	(3.00E-02)	(2.10E-01)	(3.60E-02)	(2.20E-02)	(4.10E-01)
76/04	76/03/26	76/04/30	1.90E+00	6.20E-02	1.80E+00	2.30E-01	1.10E-01	2.40E+00
			(2.00E-01)	(3.40E-02)	(2.20E-01)	(2.80E-02)	(2.00E-02)	(5.90E-01)
76/05	76/04/30	76/05/28	1.10E+01	3.80E-01	1.10E+01	3.60E+00	1.30E+00	3.60E+00
			(1.00E+00)	(1.80E-01)	(1.00E+00)	(5.90E-01)	(3.50E-02)	(1.60E+00)
76/06	76/05/28	76/06/25	2.30E+00	1.30E-01	2.00E+00	2.40E+00	1.20E+00	1.70E+00
			(3.10E-01)	(7.40E-02)	(3.60E-01)	(3.20E-01)	(2.30E-01)	(9.90E-01)
76/07	76/07/02	76/07/30	2.50E+00	1.50E-01	2.60E+00	4.60E+00	2.10E+00	2.40E+00
			(6.60E-01)	(1.70E-01)	(8.30E-01)	(9.40E-01)	(6.40E-01)	(2.50E+00)
76/08	76/08/06	76/08/27	6.20E+00	2.80E-01	5.70E+00	6.40E-01	6.40E-02	2.80E+01
			(9.40E-01)	(2.10E-01)	(1.00E+00)	(1.30E-01)	(6.40E-02)	(4.40E+00)
76/10	76/08/27	76/10/29	7.12E+00	2.90E-01	7.69E+00	5.04E+00	6.52E-01	3.81E+00
			(1.43E+01)	(1.31E+00)	(2.49E+01)	(9.33E+00)	(2.36E+00)	(1.03E+01)
76/11	76/10/29	76/11/29	5.30E+01	1.20E+00	5.70E+01	1.50E+01	1.50E+00	1.40E+01
			(4.30E+00)	(7.10E-01)	(4.80E+00)	(2.10E+00)	(8.30E-01)	(6.30E+00)
76/12	76/11/29	76/12/10	4.30E+01	1.80E+00	4.50E+01	9.90E+00	1.10E+00	4.10E+00
			(4.10E+00)	(8.20E-01)	(4.30E+00)	(1.90E+00)	(7.70E-01)	(4.10E+00)
VOLUME WEIGHTED AVERAGES			4.64E+00	1.62E-01	4.64E+00	1.47E+00	4.40E-01	2.96E+00
STD ERR MEAN * T95(N-1)			(2.33E+00)	(9.50E-02)	(2.52E+00)	(1.20E+00)	(3.71E-01)	(1.48E+00)

*Results corrected for blank filter content. Statistical considerations as discussed in Eadie and Bernhardt (1976). Results shown are mass weighted arithmetic average with values in parenthesis being the standard error at the 95 percent confidence level based on the t-distribution for (n-1) degrees of freedom.

APPENDIX D

Air Sampling Results for Locations
in the Vicinity of the Jackpile Open Pit
Uranium Mine (in pCi/m^3)

TABLE D-1. AIR SAMPLING RESULTS* (in pCi/m³) AT JACKPILE HOUSING

SAMPLE	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
158811	75/12/04	75/12/29	3.0E-03	1.1E-04	3.0E-03	2.8E-03	5.4E-05	2.2E-03
			(1.40E-04)	(1.40E-05)	(1.40E-04)	(7.50E-05)	(1.00E-05)	(1.20E-04)
158813	75/12/29	76/01/23	4.3E-03	1.9E-04	4.2E-03	4.2E-04	8.0E-06	3.7E-03
			(2.00E-04)	(1.90E-05)	(1.90E-04)	(1.20E-05)	(2.00E-06)	(1.60E-04)
158815	76/01/30	76/02/27	3.6E-03	1.3E-04	3.5E-03	3.6E-04	6.0E-06	3.9E-03
			(1.70E-04)	(1.50E-05)	(1.60E-04)	(8.00E-06)	(1.00E-06)	(1.60E-04)
158819	76/02/27	76/03/26	3.1E-03	1.3E-04	3.0E-03	1.4E-02	9.2E-05	3.3E-03
			(1.50E-04)	(1.60E-05)	(1.40E-04)	(2.20E-04)	(1.80E-05)	(1.50E-04)
158821	76/03/26	76/04/30	2.1E-03	8.2E-05	2.1E-03	2.2E-04	5.0E-06	2.3E-03
			(1.00E-04)	(1.20E-05)	(1.00E-04)	(6.00E-06)	(1.00E-06)	(1.30E-04)
158823	76/04/30	76/05/28	3.4E-03	1.1E-04	3.4E-03	4.0E-03	8.4E-05	2.6E-03
			(1.70E-04)	(1.60E-05)	(1.70E-04)	(1.50E-04)	(2.10E-05)	(1.30E-04)
158825	76/05/28	76/06/25	4.3E-03	1.7E-04	4.2E-03	4.2E-03	6.7E-05	5.3E-03
			(2.00E-04)	(1.90E-05)	(2.00E-04)	(9.60E-05)	(1.20E-05)	(1.90E-04)
157777	76/07/02	76/07/30	9.9E-04	4.5E-05	9.9E-04	1.9E-03	3.6E-05	2.2E-03
			(7.70E-05)	(7.50E-06)	(7.70E-05)	(6.00E-05)	(8.30E-06)	(1.30E-04)
157907	76/07/30	76/09/03	1.8E-03	----	1.8E-03	1.6E-03	2.9E-05	1.5E-03
			(9.40E-05)		(9.40E-05)	(5.20E-05)	(7.00E-06)	(9.00E-05)
160525	76/09/03	76/09/24	8.2E-04	2.9E-05	7.9E-04	6.4E-04	2.2E-05	3.4E-04
			(6.70E-05)	(1.10E-05)	(6.50E-05)	(5.00E-05)	(9.90E-06)	(8.90E-05)
160529	76/10/01	76/10/29	1.9E-03	5.9E-05	1.9E-03	1.9E-03	4.5E-05	1.4E-03
			(1.10E-04)	(1.10E-05)	(1.10E-04)	(6.00E-05)	(9.20E-06)	(9.80E-05)
160531	76/10/29	76/11/29	2.7E-03	1.2E-04	2.4E-03	1.9E-03	5.6E-05	3.8E-04
			(4.50E-04)	(4.90E-05)	(4.20E-04)	(2.20E-04)	(1.10E-05)	(5.40E-05)
160535	76/11/29	76/12/10	3.4E-03	1.3E-04	3.3E-03	2.5E-03	3.0E-05	2.5E-03
			(1.80E-04)	(2.30E-05)	(1.80E-04)	(2.90E-04)	(1.10E-05)	(1.80E-04)

*Results have been corrected for blank filter content. Values in parenthesis are the two-sigma (95 percent confidence level) standard deviation based on counting errors. Statistical considerations as discussed in Eadie and Bernhardt (1976). Blanks indicate no data.

TABLE D-2. AIR SAMPLING RESULTS* (in pCi/m^3) AT PAGUATE

SAMPLE	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
158827	75/12/04	75/12/29	2.1E-03	8.3E-05	2.0E-03	2.4E-03	1.3E-04	1.9E-03
			(1.10E-04)	(1.20E-05)	(1.00E-04)	(1.00E-04)	(2.40E-05)	(1.00E-04)
158829	75/12/29	76/01/23	3.5E-03	1.3E-04	3.3E-03	2.1E-03	2.5E-04	3.0E-03
			(1.80E-04)	(1.90E-05)	(1.70E-04)	(7.60E-05)	(2.60E-05)	(1.70E-04)
158831	76/01/30	76/02/27	1.3E-03	5.0E-05	1.2E-03	1.4E-03	2.4E-04	1.4E-03
			(7.20E-05)	(9.20E-06)	(7.00E-05)	(6.10E-05)	(2.60E-05)	(9.30E-05)
158833	76/02/27	76/03/26	6.9E-04	3.2E-05	7.1E-04	6.8E-04	1.9E-04	7.6E-04
			(4.40E-05)	(6.90E-06)	(4.60E-05)	(4.00E-05)	(2.20E-05)	(7.00E-05)
158835	76/03/26	76/04/30	7.1E-04	2.8E-05	7.0E-04	6.8E-04	8.9E-05	7.3E-04
			(4.40E-05)	(6.70E-06)	(4.50E-05)	(3.90E-05)	(1.40E-05)	(7.70E-05)
158837	76/04/30	76/05/28	6.4E-04	2.5E-05	5.9E-04	9.5E-04	1.1E-04	7.5E-04
			(4.20E-05)	(6.20E-06)	(4.10E-05)	(5.10E-05)	(1.70E-05)	(7.30E-05)
158839	76/05/28	76/06/25	1.4E-03	5.3E-05	1.4E-03	3.0E-04	2.8E-05	1.6E-03
			(7.70E-05)	(9.50E-06)	(7.60E-05)	(3.00E-05)	(1.00E-05)	(1.00E-04)
157779	76/07/02	76/07/30	8.3E-04	3.1E-05	7.9E-04	1.4E-03	5.8E-05	1.9E-03
			(6.40E-05)	(5.60E-06)	(6.10E-05)	(4.80E-05)	(9.90E-06)	(1.00E-04)
157799	76/07/30	76/08/27	1.2E-03	4.7E-05	1.2E-03	1.4E-03	5.8E-05	1.4E-03
			(6.60E-05)	(8.60E-06)	(6.40E-05)	(6.30E-05)	(1.30E-05)	(9.40E-05)
157903	76/08/27	76/10/01	----	----	----	----	----	1.1E-04
								(3.50E-05)
159965	76/10/01	76/10/29	9.6E-04	3.7E-05	8.9E-04	7.4E-04	1.4E-04	8.8E-04
			(6.30E-05)	(9.50E-06)	(6.10E-05)	(4.40E-05)	(1.90E-05)	(8.30E-05)
159967	76/10/29	76/11/29	1.1E-03	3.6E-05	9.9E-04	6.4E-04	6.4E-05	8.4E-04
			(6.50E-05)	(8.00E-06)	(6.20E-05)	(4.10E-05)	(1.40E-05)	(7.10E-05)
159969	76/11/29	76/12/10	1.7E-03	5.9E-05	1.8E-03	1.0E-03	5.4E-05	4.8E-04
			(1.10E-04)	(1.60E-05)	(1.10E-04)	(6.40E-05)	(1.60E-05)	(9.50E-05)

*Results have been corrected for blank filter content. Values in parenthesis are the two-sigma (95 percent confidence level) standard deviation based on counting errors. Statistical considerations as discussed in Eadie and Bernhardt (1976). Blanks indicate no data.

TABLE D-3. AIR SAMPLING RESULTS* (in pCi/m^3) AT BIBO

SAMPLE	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
158841	75/12/04	75/12/29	8.5E-04	----	8.4E-04	7.1E-04	7.7E-05	7.4E-05
			(1.20E-04)		(1.20E-04)	(8.20E-05)	(2.70E-05)	(3.50E-05)
158843	75/12/29	76/01/23	1.2E-03	----	1.2E-03	9.8E-04	1.8E-04	4.8E-05
			(3.40E-04)		(3.40E-04)	(1.90E-04)	(7.90E-05)	(3.70E-05)
158845	76/01/30	76/02/27	3.3E-04	----	3.1E-04	3.3E-04	5.1E-05	2.2E-04
			(2.80E-05)		(2.80E-05)	(2.40E-05)	(1.00E-05)	(4.40E-05)
158847	76/02/27	76/03/26	2.1E-04	----	2.1E-04	2.0E-04	7.2E-05	7.7E-05
			(2.10E-05)		(2.20E-05)	(1.80E-05)	(1.10E-05)	(3.60E-05)
158849	76/03/26	76/04/30	2.4E-04	6.5E-06	2.2E-04	1.3E-04	3.2E-05	2.6E-04
			(2.10E-05)	(3.30E-06)	(2.10E-05)	(1.40E-05)	(6.90E-06)	(4.40E-05)
158779	76/04/30	76/05/28	1.7E-04	LT 1.5E-06	1.6E-04	1.7E-05	4.0E-06	2.1E-04
			(1.90E-05)	(1.80E-06)	(1.90E-05)	(2.00E-06)	(1.00E-06)	(4.80E-05)
158781	76/05/28	76/06/25	2.8E-04	1.2E-05	2.7E-04	2.9E-04	3.7E-05	2.9E-04
			(2.40E-05)	(4.40E-06)	(2.50E-05)	(2.40E-05)	(7.90E-06)	(5.90E-05)
157793	76/07/02	76/07/16	2.4E-04	9.7E-06	2.2E-04	3.9E-04	5.9E-05	2.3E-04
			(2.90E-05)	(5.90E-06)	(2.90E-05)	(5.00E-05)	(2.00E-05)	(7.00E-05)
157795	76/08/06	76/09/03	2.3E-04	6.0E-06	2.2E-04	1.0E-04	2.3E-05	2.2E-04
			(2.10E-05)	(3.00E-06)	(2.10E-05)	(1.60E-05)	(8.00E-06)	(4.60E-05)
157797	76/09/03	76/10/01	1.6E-04	6.5E-06	1.5E-04	2.4E-04	4.3E-05	2.2E-04
			(1.70E-05)	(3.10E-06)	(1.70E-05)	(2.50E-05)	(1.10E-05)	(4.60E-05)
159959	76/10/01	76/10/29	2.7E-04	4.4E-06	2.8E-04	1.9E-04	5.8E-05	2.9E-04
			(2.50E-05)	(3.80E-06)	(2.60E-05)	(3.30E-05)	(1.80E-05)	(4.80E-05)
159961	76/10/29	76/11/29	2.7E-04	8.8E-06	2.7E-04	1.8E-04	4.6E-05	2.2E-04
			(2.40E-05)	(4.30E-06)	(2.50E-05)	(3.10E-05)	(1.50E-05)	(4.20E-05)
159963	76/11/29	76/12/10	6.0E-04	2.5E-05	6.1E-04	3.4E-04	1.6E-05	1.7E-04
			(5.60E-05)	(1.10E-05)	(5.70E-05)	(3.90E-05)	(1.10E-05)	(6.50E-05)

*Results have been corrected for blank filter content. Values in parenthesis are the two-sigma (95 percent confidence level) standard deviation based on counting errors. Statistical considerations as discussed in Eadie and Bernhardt (1976). Blanks indicate no data.

TABLE D-4. AIR SAMPLING RESULTS* (in pCi/m^3) AT MESITA

SAMPLE	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
158797	75/12/04	75/12/29	8.8E-05	4.4E-06	8.1E-05	2.1E-04	4.7E-05	1.7E-04
			(1.30E-05)	(3.10E-06)	(1.50E-05)	(2.30E-05)	(1.10E-05)	(5.20E-05)
158799	75/12/29	76/01/23	6.8E-04	2.8E-05	6.6E-04	2.7E-04	1.1E-04	2.8E-04
			(4.40E-05)	(7.00E-06)	(4.40E-05)	(2.40E-05)	(1.50E-05)	(5.80E-05)
158801	76/01/30	76/02/13	4.0E-04	1.3E-05	4.0E-04	2.6E-05	1.2E-05	3.8E-04
			(4.10E-05)	(7.00E-06)	(4.20E-05)	(1.40E-05)	(9.00E-06)	(8.00E-05)
158803	76/03/02	76/03/26	2.2E-04	8.3E-06	2.4E-04	2.4E-04	7.0E-05	2.3E-04
			(2.50E-05)	(4.60E-06)	(2.80E-05)	(2.40E-05)	(1.30E-05)	(6.20E-05)
158805	76/03/26	76/04/30	2.4E-04	9.4E-06	2.5E-04	2.6E-04	1.5E-04	2.9E-04
			(2.30E-05)	(4.30E-06)	(2.60E-05)	(2.10E-05)	(1.50E-05)	(5.20E-05)
158807	76/04/30	76/05/28	1.8E-04	6.6E-06	1.9E-04	3.9E-05	2.5E-05	2.0E-04
			(2.00E-05)	(3.90E-06)	(2.30E-05)	(9.00E-06)	(7.00E-06)	(4.90E-05)
158809	76/05/28	76/06/25	3.4E-04	1.7E-05	3.5E-04	3.6E-04	1.4E-04	4.4E-04
			(3.20E-05)	(6.30E-06)	(3.30E-05)	(3.10E-05)	(1.90E-05)	(6.70E-05)
157781	76/07/09	76/07/30	1.9E-04	LT 4.8E-06	1.7E-04	5.9E-05	1.5E-04	1.6E-03
			(2.80E-05)	(5.20E-06)	(2.70E-05)	(5.00E-05)	(2.50E-05)	(1.20E-04)
157785	76/07/30	76/08/27	1.5E-04	9.7E-06	1.4E-04	3.0E-04	1.0E-04	9.2E-05
			(1.80E-05)	(4.30E-06)	(1.90E-05)	(3.00E-05)	(1.70E-05)	(4.30E-05)
157787	76/08/27	76/10/01	2.1E-04	9.2E-06	2.1E-04	2.4E-05	1.6E-05	3.2E-04
			(2.00E-05)	(3.70E-06)	(2.20E-05)	(3.00E-06)	(2.00E-06)	(5.30E-05)
159947	76/10/01	76/10/29	----	----	----	----	----	1.0E-04
								(4.80E-05)
159949	76/10/29	76/11/29	5.2E-04	2.4E-05	5.3E-04	1.7E-04	5.1E-05	4.1E-04
			(4.20E-05)	(7.20E-06)	(4.40E-05)	(1.70E-05)	(9.90E-06)	(5.70E-05)
159951	76/11/29	76/12/10	5.9E-04	2.2E-05	5.1E-04	1.5E-04	1.8E-05	1.0E-04
			(5.60E-05)	(1.10E-05)	(5.20E-05)	(2.80E-05)	(1.30E-05)	(6.90E-05)

*Results have been corrected for blank filter content. Values in parenthesis are the two-sigma (95 percent confidence level) standard deviation based on counting errors. Statistical considerations as discussed in Eadie and Bernhardt (1976). Blanks indicate no data.

TABLE D-5. AIR SAMPLING RESULTS* (in pCi/m^3) AT OLD LAGUNA

SAMPLE	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
158783	75/12/04	75/12/29	5.4E-04	2.5E-05	5.4E-04	2.2E-04	8.6E-05	1.2E-04
			(3.90E-05)	(6.80E-06)	(4.00E-05)	(1.90E-05)	(1.20E-05)	(3.80E-05)
158787	76/01/30	76/02/27	4.6E-04	1.2E-05	4.7E-04	3.1E-05	9.0E-06	3.3E-04
			(3.60E-05)	(4.70E-06)	(3.70E-05)	(2.00E-06)	(1.00E-06)	(5.90E-05)
158789	76/02/27	76/03/26	3.0E-04	7.9E-06	2.8E-04	2.4E-05	9.0E-06	2.9E-04
			(2.60E-05)	(3.80E-06)	(2.60E-05)	(4.00E-06)	(3.00E-06)	(5.10E-05)
158791	76/03/26	76/04/30	1.9E-04	5.8E-06	1.7E-04	2.1E-05	1.1E-05	2.3E-04
			(1.90E-05)	(3.20E-06)	(2.10E-05)	(3.00E-06)	(2.00E-06)	(5.50E-05)
158793	76/04/30	76/05/28	2.7E-04	9.7E-06	2.8E-04	9.7E-05	3.4E-05	9.2E-05
			(2.70E-05)	(4.90E-06)	(2.90E-05)	(1.60E-05)	(9.00E-06)	(4.40E-05)
158795	76/05/28	76/06/25	1.1E-04	6.3E-06	1.0E-04	1.1E-04	5.8E-05	8.3E-05
			(1.50E-05)	(3.60E-06)	(1.70E-05)	(1.50E-05)	(1.10E-05)	(4.80E-05)
157783	76/07/02	76/07/30	4.6E-05	LT 2.8E-06	4.8E-05	8.7E-05	4.1E-05	4.1E-05
			(1.20E-05)	(3.20E-06)	(1.60E-05)	(1.80E-05)	(1.20E-05)	(4.70E-05)
157789	76/08/06	76/08/27	9.4E-05	4.4E-06	9.0E-05	1.0E-05	1.0E-06	4.4E-04
			(1.50E-05)	(3.30E-06)	(1.60E-05)	(2.00E-06)	(1.00E-06)	(7.00E-05)
157791	76/08/27	76/10/01	7.9E-05	2.3E-06	7.4E-05	8.0E-05	1.2E-05	5.1E-05
			(1.10E-05)	(2.10E-06)	(1.30E-05)	(1.30E-05)	(4.50E-06)	(3.70E-05)
159953	76/10/01	76/10/29	1.5E-04	7.5E-06	1.8E-04	8.6E-05	9.5E-06	7.4E-05
			(1.80E-05)	(4.20E-06)	(2.10E-05)	(1.20E-05)	(5.20E-06)	(3.90E-05)
159955	76/10/29	76/11/29	3.8E-04	9.2E-06	4.1E-04	1.1E-04	1.1E-05	9.6E-05
			(3.10E-05)	(5.10E-06)	(3.40E-05)	(1.50E-05)	(6.00E-06)	(4.60E-05)
159957	76/11/29	76/12/10	6.1E-04	2.6E-05	6.4E-04	1.4E-04	1.5E-05	5.9E-05
			(5.70E-05)	(1.20E-05)	(5.90E-05)	(2.70E-05)	(1.10E-05)	(5.80E-05)

*Results have been corrected for blank filter content. Values in parenthesis are the two-sigma (95 percent confidence level) standard deviation based on counting errors. Statistical considerations as discussed in Eadie and Bernhardt (1976). Blanks indicate no data.

APPENDIX E

Air Sampling Results for Locations in the Vicinity of the Jackpile Open Pit Uranium Mine (in pCi/g)

TABLE E-1. AIR SAMPLING RESULTS* (in pCi/g) AT JACKPILE HOUSING

SAMPLE	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
158812	75/12/04	75/12/29	7.9E+01	2.8E+00	7.7E+01	7.3E+01	1.4E+00	5.5E+01
			(3.60E+00)	(3.60E-01)	(3.50E+00)	(1.90E+00)	(2.70E-01)	(3.20E+00)
158814	75/12/29	76/01/23	9.7E+01	4.2E+00	9.5E+01	9.4E+00	1.8E-01	8.4E+01
			(4.50E+00)	(4.40E-01)	(4.40E+00)	(2.70E-01)	(4.50E-02)	(3.60E+00)
158816	76/01/30	76/02/27	9.0E+01	3.2E+00	8.7E+01	8.8E+00	1.4E-01	9.7E+01
			(4.20E+00)	(3.80E-01)	(4.10E+00)	(2.10E-01)	(2.60E-02)	(4.00E+00)
158820	76/02/27	76/03/26	7.6E+01	3.1E+00	7.2E+01	3.4E+02	2.2E+00	8.2E+01
			(3.60E+00)	(3.80E-01)	(3.50E+00)	(5.40E+00)	(4.40E-01)	(3.70E+00)
158822	76/03/26	76/04/30	6.2E+01	2.5E+00	6.2E+01	6.5E+00	1.5E-01	7.0E+01
			(3.00E+00)	(3.40E-01)	(3.00E+00)	(1.80E-01)	(2.70E-02)	(3.80E+00)
158824	76/04/30	76/05/28	8.4E+01	2.7E+00	8.4E+01	9.9E+01	2.1E+00	6.5E+01
			(4.20E+00)	(3.80E-01)	(4.20E+00)	(3.60E+00)	(5.10E-01)	(3.40E+00)
158826	76/05/28	76/06/25	9.7E+01	3.9E+00	9.5E+01	9.6E+01	1.5E+00	1.2E+02
			(4.50E+00)	(4.30E-01)	(4.50E+00)	(2.20E+00)	(2.80E-01)	(4.40E+00)
157778	76/07/02	76/07/30	4.6E+01	2.0E+00	4.5E+01	8.4E+01	1.6E+00	9.7E+01
			(3.40E+00)	(3.30E-01)	(3.40E+00)	(2.60E+00)	(3.70E-01)	(6.00E+00)
157908	76/07/30	76/09/03	7.8E+01	----	7.8E+01	7.0E+01	1.3E+00	6.8E+01
			(4.20E+00)		(4.20E+00)	(2.30E+00)	(3.20E+01)	(4.00E+00)
160526	76/09/03	76/09/24	4.1E+01	1.5E+00	3.9E+01	3.2E+01	1.1E+00	1.7E+01
			(3.30E+00)	(5.70E-01)	(3.30E+00)	(2.50E+00)	(5.00E-01)	(4.50E+00)
160530	76/10/01	76/10/29	6.4E+01	1.9E+00	6.3E+01	6.2E+01	1.5E+00	4.3E+01
			(3.50E+00)	(3.80E-01)	(3.50E+00)	(2.00E+00)	(3.00E-01)	(3.20E+00)
160532	76/10/29	76/11/29	6.9E+01	2.9E+00	6.2E+01	4.8E+01	1.4E+00	9.9E+00
			(1.10E+01)	(1.30E+00)	(1.10E+01)	(5.70E+00)	(2.90E-01)	(1.40E+00)
160536	76/11/29	76/12/10	9.8E+01	3.7E+00	9.5E+01	7.3E+01	8.8E-01	7.3E+01
			(5.30E+00)	(6.60E-01)	(5.20E+00)	(8.30E+00)	(3.20E-01)	(5.40E+00)

*Results have been corrected for blank filter content. Values in parenthesis are the two-sigma (95 percent confidence level) standard deviation based on counting errors. Statistical considerations as discussed in Eadie and Bernhardt (1976). Blanks indicate no data.

TABLE E-2. AIR SAMPLING RESULTS* (in pCi/g) AT PAGUATE

SAMPLE	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
158828	75/12/04	75/12/29	2.4E+01	9.4E-01	2.3E+01	2.7E+01	1.5E+00	2.1E+01
			(1.20E+00)	(1.30E-01)	(1.20E+00)	(1.10E+00)	(2.70E-01)	(1.20E+00)
158830	75/12/29	76/01/23	1.7E+01	6.3E-01	1.6E+01	1.0E+01	1.2E+00	1.5E+01
			(8.60E-01)	(9.20E-02)	(8.40E-01)	(3.70E-01)	(1.30E-01)	(8.30E-01)
158832	76/01/30	76/02/27	8.8E+00	3.5E-01	8.4E+00	9.6E+00	1.7E+00	9.5E+00
			(5.00E-01)	(6.40E-02)	(4.90E-01)	(4.30E-01)	(1.80E-01)	(6.50E-01)
158834	76/02/27	76/03/26	5.0E+00	2.2E-01	5.0E+00	4.9E+00	1.4E+00	5.4E+00
			(3.10E-01)	(4.90E-02)	(3.20E-01)	(2.90E-01)	(1.50E-01)	(4.90E-01)
158836	76/03/26	76/04/30	1.2E+01	4.5E-01	1.1E+01	1.1E+01	1.5E+00	1.2E+01
			(7.20E-01)	(1.10E-01)	(7.30E-01)	(6.40E-01)	(2.30E-01)	(1.30E+00)
158838	76/04/30	76/05/28	1.2E+01	4.4E-01	1.1E+01	1.7E+01	1.9E+00	1.3E+01
			(7.60E-01)	(1.10E-01)	(7.30E-01)	(9.30E-01)	(3.10E-01)	(1.30E+00)
158840	76/05/28	76/06/25	1.6E+01	6.0E-01	1.5E+01	3.4E+00	3.1E-01	1.7E+01
			(8.70E-01)	(1.10E-01)	(8.60E-01)	(3.40E-01)	(1.10E-01)	(1.10E+00)
157780	76/07/02	76/07/30	1.7E+01	6.4E-01	1.7E+01	2.8E+01	1.2E+00	3.7E+01
			(1.30E+00)	(1.20E-01)	(1.30E+00)	(1.00E+00)	(2.10E-01)	(2.20E+00)
157800	76/07/30	76/08/27	3.1E+01	1.2E+00	3.0E+01	3.7E+01	1.5E+00	3.6E+01
			(1.70E+00)	(2.20E-01)	(1.70E+00)	(1.60E+00)	(3.30E-01)	(2.40E+00)
157904	76/08/27	76/10/01	----	----	----	----	----	2.0E+00
								(7.20E-01)
159966	76/10/01	76/10/29	7.0E+00	2.7E-01	6.4E+00	5.4E+00	1.1E+00	6.4E+00
			(4.60E-01)	(6.90E-02)	(4.40E-01)	(3.20E-01)	(1.40E-01)	(6.00E-01)
159968	76/10/29	76/11/29	1.2E+01	4.0E-01	1.1E+01	7.1E+00	7.1E-01	9.2E+00
			(7.20E-01)	(8.80E-02)	(6.90E-01)	(4.60E-01)	(1.60E-01)	(7.90E-01)
159970	76/11/29	76/12/10	2.9E+01	9.7E-01	3.0E+01	1.7E+01	9.0E-01	8.1E+00
			(1.90E+00)	(2.70E-01)	(1.90E+00)	(1.10E+00)	(2.60E-01)	(1.60E+00)

*Results have been corrected for blank filter content. Values in parenthesis are the two-sigma (95 percent confidence level) standard deviation based on counting errors. Statistical considerations as discussed in Eadie and Bernhardt (1976). Blanks indicate no data.

TABLE E-3. AIR SAMPLING RESULTS* (in pCi/g) AT BIBO

SAMPLE	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
158842	75/12/04	75/12/29	1.9E+01	----	2.0E+01	1.6E+01	1.8E+00	1.8E+00
			(2.80E+00)		(2.80E+00)	(1.90E+00)	(6.10E-01)	(8.00E-01)
158844	75/12/29	76/01/23	4.0E+01	----	4.0E+01	3.2E+01	5.8E+00	1.6E+00
			(1.20E+01)		(1.20E+01)	(6.20E+00)	(2.60E+00)	(1.20E+00)
158846	76/01/30	76/02/27	9.8E+00	----	9.3E+00	9.6E+00	1.5E+00	6.6E+00
			(8.20E-01)		(8.10E-01)	(7.20E-01)	(2.80E-01)	(1.30E+00)
158848	76/02/27	76/03/26	4.8E+00	----	4.7E+00	4.5E+00	1.6E+00	1.8E+00
			(4.80E-01)		(5.10E-01)	(4.20E-01)	(2.50E-01)	(8.20E-01)
158850	76/03/26	76/04/30	6.0E+00	1.6E-01	5.4E+00	3.2E+00	8.0E-01	6.2E+00
			(5.30E-01)	(8.10E-02)	(5.30E-01)	(3.40E-01)	(1.70E-01)	(1.10E+00)
158780	76/04/30	76/05/28	7.8E+00	LT 6.5E-02	7.4E+00	7.5E-01	1.6E-01	9.2E+00
			(8.10E-01)	(7.80E-02)	(8.60E-01)	(7.60E-02)	(3.50E-02)	(2.10E+00)
158782	76/05/28	76/06/25	7.3E+00	2.9E-01	6.9E+00	7.4E+00	9.4E-01	7.5E+00
			(6.10E-01)	(1.10E-01)	(6.40E-01)	(6.10E-01)	(2.00E-01)	(1.50E+00)
157794	76/07/02	76/07/16	2.3E+01	9.7E-01	2.1E+01	3.9E+01	5.8E+00	2.2E+01
			(2.80E+00)	(5.80E-01)	(2.80E+00)	(4.90E+00)	(2.00E+00)	(6.80E+00)
157796	76/08/06	76/09/03	8.1E+00	2.1E-01	7.6E+00	3.5E+00	8.0E-01	7.5E+00
			(7.10E-01)	(1.10E-01)	(7.30E-01)	(5.70E-01)	(2.70E-01)	(1.60E+00)
157798	76/09/03	76/10/01	1.5E+00	6.5E-02	1.5E+00	2.4E+00	4.4E-01	2.3E+00
			(1.70E-01)	(3.10E-02)	(1.80E-01)	(2.50E-01)	(1.10E-01)	(4.60E-01)
159960	76/10/01	76/10/29	4.9E+00	7.6E-02	4.8E+00	3.3E+00	1.0E+00	5.0E+00
			(4.30E-01)	(6.60E-02)	(4.50E-01)	(5.60E-01)	(3.10E-01)	(8.20E-01)
159962	76/10/29	76/11/29	7.1E+00	2.3E-01	7.0E+00	4.6E+00	1.2E+00	5.8E+00
			(6.30E-01)	(1.10E-01)	(6.50E-01)	(8.00E-01)	(4.00E-01)	(1.10E+00)
159964	76/11/29	76/12/10	1.5E+01	5.9E-01	1.5E+01	8.3E+00	4.0E-01	4.1E+00
			(1.40E+00)	(2.70E-01)	(1.40E+00)	(9.40E-01)	(2.70E-01)	(1.60E+00)

*Results have been corrected for blank filter content. Values in parenthesis are the two-sigma (95 percent confidence level) standard deviation based on counting errors. Statistical considerations as discussed in Eadie and Bernhardt (1976). Blanks indicate no data.

TABLE E-4. AIR SAMPLING RESULTS* (in pCi/g) AT MESITA

SAMPLE	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
158798	75/12/04	75/12/29	9.0E-01	4.5E-02	8.2E-01	2.1E+00	4.8E-01	1.8E+00
			(1.40E-01)	(3.20E-02)	(1.60E-01)	(2.30E-01)	(1.10E-01)	(5.30E-01)
158800	75/12/29	76/01/23	6.5E+00	2.7E-01	6.3E+00	2.6E+00	1.0E+00	2.7E+00
			(4.20E-01)	(6.70E-02)	(4.20E-01)	(2.30E-01)	(1.40E-01)	(5.60E-01)
158802	76/01/30	76/02/13	3.2E+00	1.1E-01	3.2E+00	2.1E-01	1.0E-01	3.1E+00
			(3.30E-01)	(5.70E-02)	(3.40E-01)	(1.10E-01)	(7.60E-02)	(6.50E-01)
158804	76/03/02	76/03/26	2.3E+00	8.3E-02	2.4E+00	2.4E+00	7.0E-01	2.3E+00
			(2.50E-01)	(4.60E-02)	(2.80E-01)	(2.40E-01)	(1.30E-01)	(6.20E-01)
158806	76/03/26	76/04/30	1.7E+00	7.1E-02	1.8E+00	1.9E+00	1.1E+00	2.1E+00
			(1.70E-01)	(3.20E-02)	(1.90E-01)	(1.60E-01)	(1.20E-01)	(3.90E-01)
158808	76/04/30	76/05/28	2.3E+00	8.3E-02	2.4E+00	4.9E-01	3.1E-01	2.5E+00
			(2.50E-01)	(4.90E-02)	(2.80E-01)	(1.10E-01)	(9.10E-02)	(6.10E-01)
158810	76/05/28	76/06/25	2.7E+00	1.3E+00	2.7E+00	2.7E+00	1.0E+00	3.3E+00
			(2.40E-01)	(4.80E-01)	(2.60E-01)	(2.40E-01)	(1.50E-01)	(5.10E-01)
157782	76/07/09	76/07/30	2.5E+00	LT 6.4E-02	2.2E+00	7.7E+00	2.0E+00	2.1E+01
			(3.70E-01)	(6.90E-02)	(3.70E-01)	(6.60E-01)	(3.40E-01)	(1.70E+00)
157786	76/07/30	76/08/27	2.0E+00	1.3E-01	1.8E+00	3.8E+00	1.3E+00	1.2E+00
			(2.30E-01)	(5.50E-02)	(2.40E-01)	(3.80E-01)	(2.20E-01)	(5.50E-01)
157788	76/08/27	76/10/01	1.7E+00	6.8E-02	1.6E+00	1.8E-01	1.2E-01	2.4E+00
			(1.50E-01)	(2.70E-02)	(1.60E-01)	(2.10E-02)	(1.70E-02)	(4.00E-01)
159950	76/10/29	76/11/29	3.9E+00	1.8E-01	3.9E+00	1.2E+00	3.8E-01	3.1E+00
			(3.10E-01)	(5.30E-02)	(3.30E-01)	(1.20E-01)	(7.30E-02)	(4.30E-01)
159952	76/11/29	76/12/10	1.3E+01	4.7E-01	1.1E+01	3.2E+00	3.8E-01	2.4E+00
			(1.20E+00)	(2.40E-01)	(1.10E+00)	(5.90E-01)	(2.90E-01)	(1.50E+00)

*Results have been corrected for blank filter content. Values in parenthesis are the two-sigma (95 percent confidence level) standard deviation based on counting errors. Statistical considerations as discussed in Eadie and Bernhardt (1976). Blanks indicate no data.

TABLE E-5. AIR SAMPLING RESULTS* (in pCi/g) AT OLD LAGUNA

SAMPLE	DATE ON	DATE OFF	234U	235U	238U	230TH	232TH	226RA
158784	75/12/04	75/12/29	5.2E+00	2.4E-01	5.3E+00	2.1E+00	8.3E-01	1.1E+00
			(3.70E-01)	(6.50E-02)	(3.80E-01)	(1.80E-01)	(1.20E-01)	(3.70E-01)
158788	76/01/30	76/02/27	3.6E+00	8.7E-02	3.6E+00	2.4E-01	6.9E-02	2.6E+00
			(2.90E-01)	(3.70E-02)	(2.90E-01)	(1.90E-02)	(1.00E-02)	(4.60E-01)
158790	76/02/27	76/03/26	2.5E+00	6.4E-02	2.2E+00	1.9E-01	7.4E-02	2.4E+00
			(2.10E-01)	(3.00E-02)	(2.10E-01)	(3.60E-02)	(2.20E-02)	(4.10E-01)
158792	76/03/26	76/04/30	1.9E+00	6.2E-02	1.8E+00	2.3E-01	1.1E-01	2.4E+00
			(2.00E-01)	(3.40E-02)	(2.20E-01)	(2.80E-02)	(2.00E-02)	(5.90E-01)
158794	76/04/30	76/05/28	1.1E+01	3.8E-01	1.1E+01	3.6E+00	1.3E+00	3.6E+00
			(1.00E+00)	(1.80E-01)	(1.00E+00)	(5.90E-01)	(3.50E-02)	(1.60E+00)
158796	76/05/28	76/06/25	2.3E+00	1.3E-01	2.0E+00	2.4E+00	1.2E+00	1.7E+00
			(3.10E-01)	(7.40E-02)	(3.60E-01)	(3.20E-01)	(2.30E-01)	(9.90E-01)
157784	76/07/02	76/07/30	2.5E+00	LT 1.5E-01	2.6E+00	4.6E+00	2.1E+00	2.4E+00
			(6.60E-01)	(1.70E-01)	(8.30E-01)	(9.40E-01)	(6.40E-01)	(2.50E+00)
157790	76/08/06	76/08/27	6.2E+00	2.8E-01	5.7E+00	6.4E-01	6.4E-02	2.8E+01
			(9.40E-01)	(2.10E-01)	(1.00E+00)	(1.30E-01)	(6.40E-02)	(4.40E+00)
157792	76/08/27	76/10/01	5.8E+00	1.7E-01	5.4E+00	5.9E+00	8.7E-01	3.7E+00
			(8.30E-01)	(1.50E-01)	(9.60E-01)	(9.40E-01)	(3.30E-01)	(2.70E+00)
159954	76/10/01	76/10/29	8.1E+00	3.8E-01	9.4E+00	4.4E+00	4.9E-01	3.9E+00
			(9.30E-01)	(2.10E-01)	(1.10E+00)	(6.20E-01)	(2.60E-01)	(2.00E+00)
159956	76/10/29	76/11/29	5.3E+01	1.2E+00	5.7E+01	1.5E+01	1.5E+00	1.4E+01
			(4.30E+00)	(7.10E-01)	(4.80E+00)	(2.10E+00)	(8.30E-01)	(6.30E+00)
159958	76/11/29	76/12/10	4.3E+01	1.8E+00	4.5E+01	9.9E+00	1.1E+00	4.1E+00
			(4.10E+00)	(8.20E-01)	(4.30E+00)	(1.90E+00)	(7.70E-01)	(4.10E+00)

*Results have been corrected for blank filter content. Values in parenthesis are the two-sigma (95 percent confidence level) standard deviation based on counting errors. Statistical considerations as discussed in Eadie and Bernhardt (1976). Blanks indicate no data.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. Technical Note ORP/LV-79-2	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Ambient Airborne Radioactivity Measurements in the Vicinity of the Jackpile Open Pit Uranium Mine, New Mexico		5. REPORT DATE January 1979
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Gregory G. Eadie, C. William Fort and Mala L. Beard		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Office of Radiation Programs - Las Vegas Facility U.S. Environmental Protection Agency Las Vegas, Nevada 89114		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Same as above		13. TYPE OF REPORT AND PERIOD COVERED Final
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This report discusses the results of several radiological surveys conducted in the vicinity of the Jackpile Open Pit Uranium Mine in New Mexico. During June 1976, ambient radon-222 concentrations were measured at eleven locations, seven of which appear to have been at representative background radon levels - averaging 0.50 ± 0.033 pCi/l. The other four locations had average radon levels in excess of this typical background level; however, the highest measured radon concentration was 2.7 pCi/l. The arithmetic average ambient radon progeny working level obtained indoors at the Laguna Tribal Building appeared to be at a representative background level of 0.0049 ± 0.00045 WL. The arithmetic average ambient working levels obtained at the Paguate Community Center and the Jackpile Housing were 0.035 ± 0.0038 and 0.015 ± 0.0025 WL, respectively. Ambient airborne particulate radioactivity concentrations measured outdoors at Old Laguna appear to be at typical background levels; however, other locations exhibited higher annual average concentrations for the naturally-occurring radionuclides.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Radon	Uranium Mining	1807
Natural radioactivity	Environmental Surveys	1808
Radiation	Radiation Surveys	0705
Surveys		
Airborne radioactivity		

18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 93
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

United States
Environmental Protection
Agency

Office of Radiation Programs
Las Vegas Facility
P.O. Box 15027
Las Vegas NV 89114

Official Business
Penalty for Private Use
$300

Postage and
Fees Paid
Environmental
Protection
Agency
EPA 335

U.S. MAIL

Third Class
Bulk