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ENVIRONMENTAL MONITORING AT THE LAWRENCE LIVERMORE LABORATORY 1975 ANNUAL REPORT

W. J. Silver

C. L. Lindeken

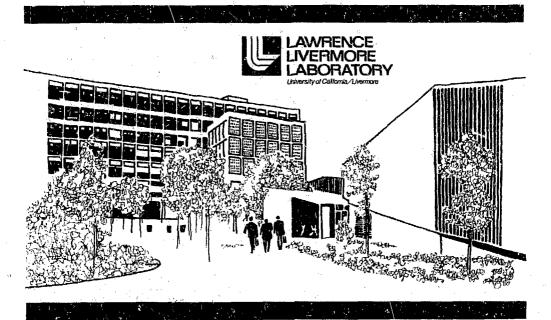
J. W. Meadows

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April 15, 1976

Prepared for U.S. Energy Research & Development Administration under contract No. W-7405-Eng-48



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LAWRENCE LIVERMORE LABORATORY

University of California Livermore, California 94550

UCRL-50027-75

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W. J. Silver, C. L. Lindeken, J. W. Meadows, E. H. Willes and D. R. Mc Intyre

MS. date: April 15, 1976

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Foreword

This report is prepared for the U. S. Energy Research & Development Administration by the Environmental Evaluations Croup of the Hazards Control Department, Lawrence Livermore Laboratory. Data are obtained through the combined efforts of the Radiochemistry Division, the Bio-Medical Division and the Hazards Control Department. In addition to the authors listed, the following personnel made significant contributions to this report:

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Lawrence Livermore Laboratory (Looking From Southeast)

- LLL
 Sandia
 South Bay Aqueduct
 Arroyo Seco
 Arroyo Las Positas
 Nearest residential r

 - Nearest residential area
- Vasco Raad
- East Avenue
- Greenville Road
- Lupin Way
 - Interstate 580

ENVIRONMENTAL MONITORING AT THE LAWRENCE LIVERMORE LABORATORY 1975 ANNUAL REPORT

Introduction

The Lawrence Livermore Laboratory (LLL) is located about 64 km (40 mi) east of San Francisco in the Livermore Valley in southern Alameda County, approximately 5 km (3 mi) east of the city of Livermore, California.

The site occupies an area of 2.54 km² (627 acres, approximately 1 mi²). Open agricultural areas surround the Laboratory on the north, east, west, and part of the south side. Sandia Laboratories — Livermore occupies a portion of the adjoining property on the south.

Established in 1952, the Laboratory is operated for the Energy
Research and Development Administration by the University of California under contract number W-7405-Eng-48 and currently employs approximately 5900 people. Although nuclear weapons research and development has always been the prime mission of LLL, additional programs include controlled thermonuclear research, peaceful uses of nuclear explosives, biomedical studies and laser fusion research. Most recently, major programs to develop non-nuclear energy tech-

nologies have been established at Livermore.

Much of the materials testing and high-explosive diagnostic work of the Laboratory is carried on at Site 300, about 16 km (10 mi) southeast of Livermore. This site, located in the sparsely populated hills of the Diablo Range, covers an area of 27 km² (7000 acres).

The Livermore Valley has a climate characterized by mild, rainy winters and warm, dry summers. Annual rainfall averages about 360 mm (14 in.); rains occur predominantly between November and April, usually in connection with Pacific storms. Surface water drainage from the Valley is from east to west through various arroyos, with the outfall near Sunol in the southwestern corner of the valley. Prevailing winds are from the west and southwest during April through September. During the remainder of the year, the winds from the east and northeast often occur as frequently as those from the west and southwest.

The Livermore site is developed on a northwesterly sloping alluvial flood plain bordering the low hills of the Livermore Uplands to the south. Lithology of the area consists of a series of unconsolidated marine and continental sedimentary units such as sandstones, gravels, silts, and clays overlaying the interbedded sandstones of the Franciscan Formation. The hilly terrain surrounding the Valley is used for cattle and sheep pasture. Principal agricultural products in the vicinity of LLL are grapes and wine, cattle, poultry and eggs.

Water bodies adjacent to the Laboratory include the South Bay Aqueduct, which runs from northeast to southwest at a closest distance of 1.8 km (1.1 mi) to the southeast, the Patterson Pass water treatment facility about 2 km (1.3 mi) east of LLL; and Frick Lake 4 km (2.5 mi) north of LLL (Frick Lake is dry most of the year). LLL normally receives all of its treated water from the Hetch Hetchy Aqueduct (which supplies San Francisco), located 11 km (7 mi) southwest of Livermore. Laboratory storm water is channeled through storm sewers designed to accommodate a ten-year flow. Open ditches are used in undeveloped areas of the site. Two arroyos traverse LLL. Arroyo Seco crosses at the southwest corner of the project, and Arroyo Las

Positas originally crossed the northeast section of the site, entering from the east at a point on Greenville Road between Patterson Pass Road and Lupin Way. However, in 1965, as part of an erosion control program the arroyo was channeled north to the northeast corner of the site, and then west along the north perimeter to an outlet at the northwest corner. This outlet, which also constitutes the principal pathway for the Laboratory's surface drainage (storm and irrigation), runs north in a 5.7 \times 10⁻³ km² (1.4 acre) easement zone to the Western Pacific tracts, then westward where it joins Arroyo Seco.

The total present population within 80 km (50 mi) of the Laboratory is approximately 4.3×10^6 , distributed as indicated in Fig. 1. The population of the city of Livermore is approximately 50,000, and the nearest residential area is 0.8 km (0.5 mi) from the Laboratory's west perimeter.

A strict effluent control program, which places maximum emphasis on controlling effluents at the source, has been in continuous existence within the Laboratory since it began operation. An environmental surveillance program is conducted to ensure that this control program is indeed restricting the release of effluents from the

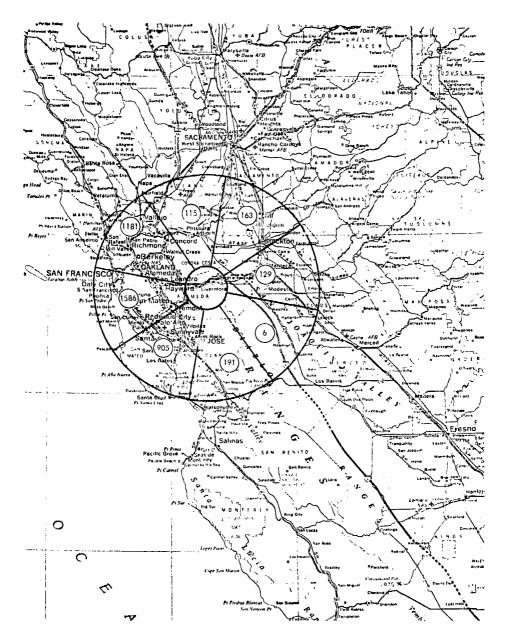


Fig. 1. Estimated population distribution within 80 km (50 mi) of I.L. These figures are rounded to nearest 1000; the total population shown is $4\ 276\ 000$.

Livermore Laboratory and Site 300 to concentrations well below applicable standards. This program employs techniques with sensitivities usually capable of detecting radioactive and non-radioactive pollutants below environmental background levels. The program includes the collection and analysis of air, soil, water, sewer affluent, vegetation, and milk samples. Environmental background radiation is measured at numerous locations in the vicinity of the Livermore Laboratory by means of thermoluminescence dosimeters.

Results of these analyses are provided in this report. Appendix A contains all data in tabular form. To facilitate interpretation, graphical presentation techniques have been employed in the body of the report. When appropriate, the tabulated data contain maximum,

minimum, and average values. Error limits, when accompanying these data. reflect the uncertainties in the analyses at the 95% confidence level. Unless otherwise stated, the minimum detection limit of these measurements is assumed to have been reached when the 20 error is ±100%. In the case of radioactivity, an attempt has been made to assess the impact from the observed environmental activity levels of artificially produced radionuclides by calculating the whole body or critical organ doses delivered to an adult by the various radionuclides of interest. For proper evaluation, these radiation doses, which are typically less than 1 mrem per year, should be compared with doses of approximately 100 mrem received locally each year from natural sources.

Summary

In 1975, the average annual gross beta activity on air filters was about half of that observed during 1974. There were corresponding decreases in specific fission product radionuclides, reflecting the reduction in fallout of nuclear debris from the large-yield Chinese atmospheric nuclear explosion in 1973. Airborne 238 U concentrations at Site 300 were

higher than those at Laboratory perimeters because of the use of "depleted" uranium (a byproduct of 235 U enrichment) at the Site. These uranium concentrations were well below the standards set by ERDA.

Soil samples collected in the off-site vicinity of the Laboratory and at Site 300 were analyzed for plutonium. There were negligible

changes from the levels previously reported.

Water samples collected within the Livermore Valley and Site 300 exhibited normal background gross beta and tritium activities.

Vegetation samples collected in areas generally downwind from the Laboratory contained tritium activities generally higher than those collected in areas where the Laboratory's contribution should be minimal. Tritium levels in Site 300 vegetation were essentially unchanged from those observed in 1974.

The median annual gamma radiation dose rate at the Laboratory perimeter was 62 mrem compared with 59 mrem as the median background dose rate in the off-site vicinity. Operation of a 14-MeV neutron generator near the south Site perim-

eter continues to be a source of elevated radiation.

Both Laboratory perimeter and Site 300 annual average airborne beryllium concentrations were less than 0.002% of the appropriate standard.

Releases of heavy metals to the Livermore sanitary sewer system conformed to the discharge regulations of the city of Livermore.

No Laboratory effluent resulted in an estimated radiation dose to the nearest resident exceeding 1 mrem. Assessment of the radiation doses to an individual from the environmental activities listed in this report demonstrates that the dose contribution from Laboratory operations in 1975 was very small compared with the approximately 100-mrem/year dose locally received from natural sources.

Monitoring Data - Collection, Analysis and Evaluation

RADIOACTIVE MONITORING

Airborne Radioactivity

Concentrations of various airborne radionuclides were measured at Laboratory perimeters, in the offsite vicinity of the Laboratory and at Site 300. Sampling locations are shown in Figs. 2, 3, 4, and 5, respectively. The six samplers on the Laboratory perimeter and the ten

samplers at Site 300 use 5.2 × 10⁻² m² (80-in.²) Whatman 41 cellulose filters. These samplers are operated at an average flow rate of 700 l/m (25 cfm). Laboratory perimeter and Site 300 air filters are also analyzed for beryllium as part of our nonradioactive monitoring program. An easily dissolved filter and a low trace metal background are requirements for these analyses. Whatman 41 represents a

balance between such requirements and particulate collection efficiency. 1 Off-site samplers throughout the Livermore Valley use $4.56 \times 10^{-3} \text{m}^{2}$ $(7.07-\text{in.}^{2})$ glass fiber filters (Flanders F-700) and are operated at 80 L/m (3 cfm). All air filters are changed weekly. Perimeter and Site 300 filters are cut in half, and half of each filter is retained for

beryllium analysis (see Non-Radioactive Monitoring).

After a four-day delay for the decay of radon-thoron daughters, gross alpha and beta activities on the filters are determined using an automatic gas flow proportional counter. Monthly composites of the Laboratory perimeter and Site 300 filters are also counted for specific

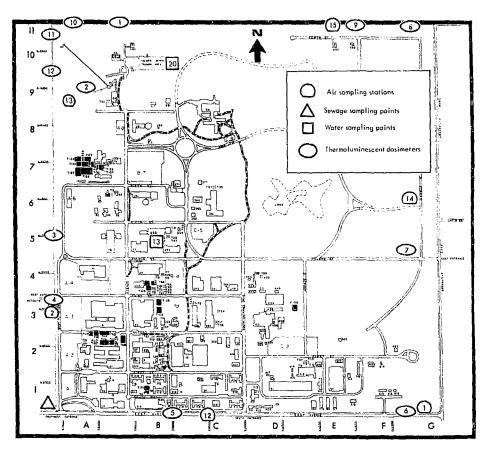


Fig. 2. LLL on-site environmental sampling locations.

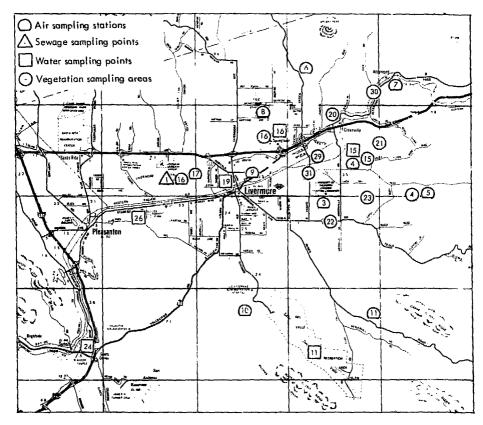


Fig. 3. LLL off-site environmental sampling locations.

gamma-emitting radionuclides by means of a Ge(Li) detector equipped with Compton suppression. Following gamma counting, the monthly composite of the Laboratory perimeter filters is divided according to sampling locations. These samples and the Site 300 composite are analyzed for 239 Pu, 238 Pu, 90 Sr. 235 V. and 238 U.

Tables 1 and 2 in Appendix A show airborne gross alpha and gross beta activities on the Livermore Valley samples. Table 3 shows the corresponding activities for Site 300. Average annual gross beta activity in both Livermore and Site 300 air samples was about half that observed during 1974, 3 reflecting the reduction in fallout of nuclear debris which was introduced into the stratosphere by the large-yield Chinese atmospheric explosion in 1973. Figure 6 is a plot of the weekly average beta activities at the two

sites. Tables 4 and 5 list the activities of the more abundant gamma-emitting radionuclides which contribute to the beta activity in Livermore and Site 300 samples. Tables 6 and 7 show the concentrations of airborne ²³⁹Pu, ²³⁸Pu, ⁹⁰Sr, ²³⁵U, and ²³⁸U in Livermore perimeter and Site 300 air samples. The higher concentration of ²³⁸U at Site 300 is due to the use of "depleted" uranium (a byproduct of ²³⁵U enrichment) at

the site. As noted, however, the uranium concentrations correspond to less than 0.01% of the Concentration Guides of ERDAM Chapter 0524. Both sets of data show plutonium and strontium levels that are lower than last year. Figure 7, which compares 1974 and 1975 monthly levels of airborne 239 Pu, shows that the usual spring peak in fallout activity is less pronounced in 1975 — a condition also indicated by the

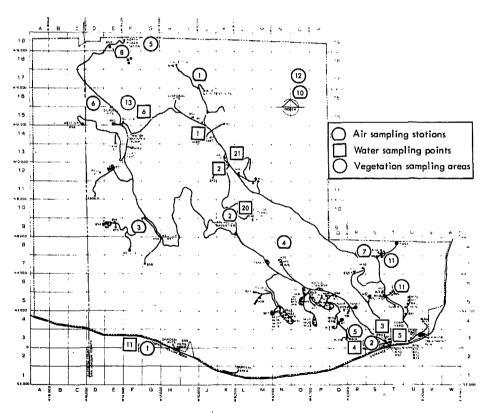


Fig. 4. Air, water and vegetation sampling locations inside Site 300 boundary.

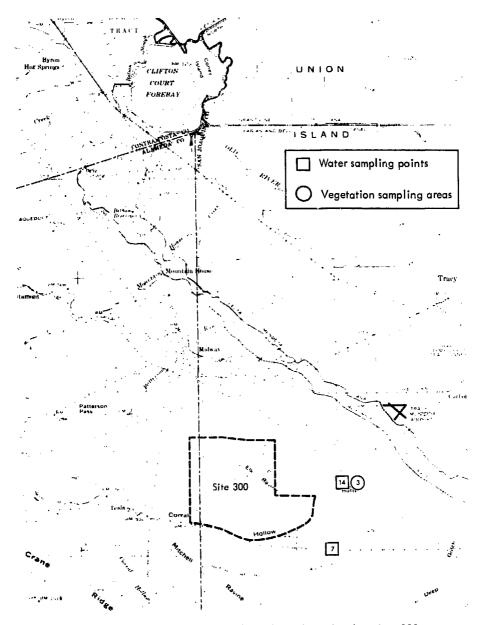


Fig. 5. Water and vegetation sampling locations in the Site 300 area.

relatively constant gross beta activity.

Although elemental gaseous tritium (HT) may often be present in the airborne effluent, Laboratory site boundary measurements are restricted to those of tritiated water (HTO) because of its greater hazard to man.4 Airborne tritiated water (HTO) concentrations were determined at each of the LLL perimeter sampling locations shown in Fig. 2. Water vapor was collected on silica gel samplers operated at about 0.5 l/min for 1-week periods. The collected water was recovered by vacuum-drying at 150°C, and the HTO

was measured by liquid scintillation Table 8 shows maximum. counting. minimum, and average concentrations observed at each location. average annual concentration for the set is 4.7×10^{-11} uCi/ml. which is the same value observed for the average during 1974. The highest HTO concentration was observed at Location 2 at the west Site boundary during the month of November. As noted, during the late fall and winter, the winds are from the east and northeast almost as frequently as from the west and southwest, the latter being the prevailing wind directions in the Livermore Valley.

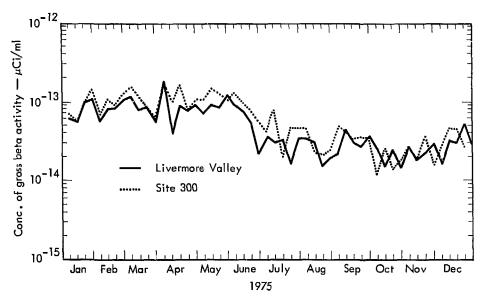


Fig. 6. Weekly average gross beta activity on air filters from Livermore Valley and Site 300 sampling locations.

It should also be pointed out that Location 12 shows the highest annual average concentration, probably because it is downwind from one source (gaseous chemistry) in the winter and downwind from another (14-MeV neutron generator) during

the other seasons. However, it is of interest that even the highest concentration at the Site boundary $(4.1\times10^{-10}~\mu\text{Ci/ml})$ is less than 0.3% of the Concentration Guide of $2.0\times10^{-7}~\mu\text{Ci/ml}$ specified by ERDA Manual Chapter 0524.

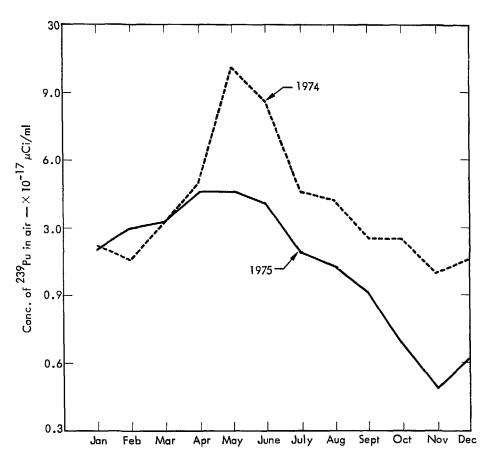


Fig. 7. Concentration of 239 Pu in LLL perimeter air filters during 1974 and 1975.

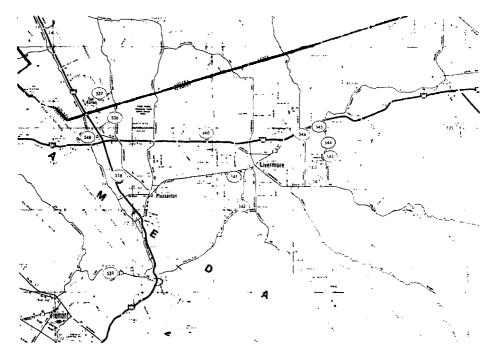


Fig. 8. Locations of soil samples collected in the vicinity of LLL.

Radioactivity in Soil

An intensive soil sampling program in 1971 and 1972 has provided a data base for the concentration range of various radionuclides in soils in the vicinity of the Laboratory and at Site 300. Since 1972, soil sampling in the vicinity of LLL and at Site 300 has been part of a continuing surveillance program to document any changes in environmental levels of radioactivity that may have occurred and to evaluate any increase that might be due to Laboratory operations. During 1975, twenty locations in the

vicinity of LLL were resampled.
Fifteen of these locations were
chosen by a random selection process
from the group of over 200 locations
that were sampled as part of the
1971-72 survey. Five samples were
collected east of Greenville Road at
the same locations that have been
sampled annually since 1973. Figure
8 shows the location of the random
sample group, and Figure 9 shows locations of the east of Greenville Road
group. Figure 10 indicates the locations at Site 300 where annual samples
have been collected since 1973.

All samples were collected to a depth of 1 cm, and include five separate 15-cm-diam (6-in.) samples at each location. All samples were dried, ground, and blended. For radiochemical analysis 100-g aliquots were completely dissolved, and 239 Pu and 238 Pu were determined using standard radiochemical techniques. For gamma spectra analysis, approxi-

mately 300-g aliquots of soil were sealed in 200-cm³, thin-walled aluminum cans and counted in the Ge(Li) spectrometer previously referenced. The results of the gamma spectra analysis of the Livermore Valley soil samples are shown in Table 9. Figure 11 shows a distribution plot of ²³⁹Pu activities in all soil samples collected in the Livermore Valley

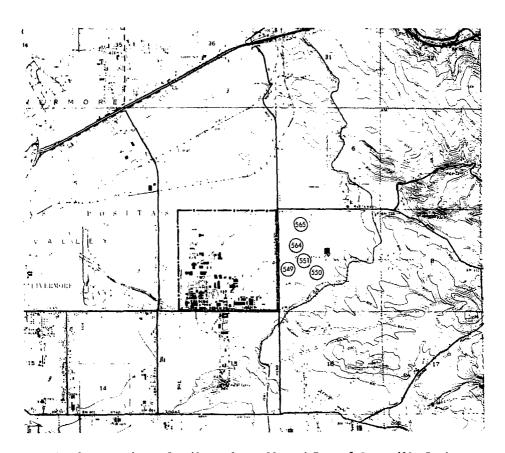


Fig. 9. Locations of soil samples collected East of Greenville Road.

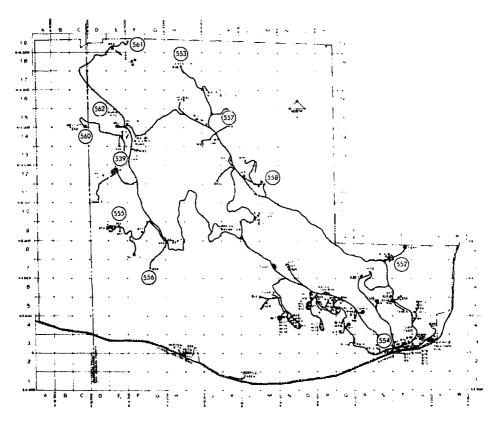


Fig. 10. Locations of soil samples collected inside Site 300 boundary.

during 1975. The six samples with the highest activities all come from the same geographical area (Figs. 8 and 9), and as previously reported, probably reflect low-level releases from solar evaporation of liquid wastes. These operations have been discontinued. Table 10 compares the plutonium levels in soil samples from this area with those collected at the same locations during 1974. No significant changes were observed,

with the exception of Sample 564. In 1973, the sample collected at this same location showed a plutonium content in agreement with the 1975 data. Accordingly, this anomaly is being investigated.

High-explosive tests at Site 300 often involve the use of depleted uranium. Accordingly, soil samples are taken annually to determine the extent to which the natural ²³⁵U/²³⁸U ratio of the soil is perturbed

by these operations. To date the analyses have indicated that isotopic perturbation is essentially restricted to areas adjacent to the firing bunkers. A direct measurement of 238 U was employed using the 63-keV

transition gamma from 234 Th, the first daughter of 238 U. 7 Besides providing essentially a direct measurement of 238 U, gamma spectroscopy has the additional advantage that the 235 U and 238 U data are obtained simultaneously

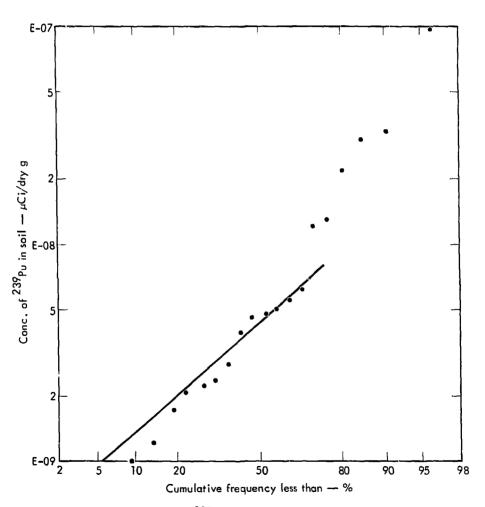


Fig. 11. Distribution plot of ²³⁹Pu in soil samples from the Livermore Valley during 1975.

with the measurement of other gamma-emitting radionuclides in soil. The isotopic uranium data, shown in Table 11, are comparable to those observed during 1974. Plutonium and 137 Cs levels are also in the range which were present in Site 300 soils in 1974.

Radioactivity in Sewage

Liquid radioactive wastes are treated to reduce activity levels to as low as practicable and well below standards set by ERDAM Chapter 0524. Following this treatment, the liquid waste is released to the city of Livermore's sanitary sewer system at the LLL outfall shown in Fig. 2. This effluent is continuously monitored for pH and radioactivity.

The Livermore water reclamation plant is a 200 l/s (5 000 000 gal/day) secondary treatment sewage plant serving the residential, commercial, and industrial users in Livermore. Sanitary sewage from LLL contributes about 13 l/s (300 000 gal/day), which is about 6% of the total input to the plant. Sewage entering the plant flows into the primary settling tanks where most solids drop out and grease floats to the surface. Next, the sewage is pumped over two trickling filter units where aerobic bacteria growing on filter rock oxidize organic matter in the sewage. The sewage then enters an activated

sludge aeration tank where microbes suspended in the sewage further oxidize organics to purify the waste. After aeration, the sewage flows to the final sedimentation tank where the suspended microbes settle out. The purified sewage is chlorinated to kill pathogenic bacteria before release from the plant since the treated waste is used to recharge ground-water supplies. Treated water (the plant effluent) is used for irrigating the Livermore Municipal Golf Course. lawns of the Livermore Airport, and nearby agricultural land: the excess is discharged into Arroyo Las Positas.

Solids from the settling tanks are pumped to anaerobic digesters where bacteria break down the organics to yield stablized sludge and methane. This sludge is then pumped into one of two large lagoons. During the summer, a portion of this sludge is removed to drying beds. The dried sludge is primarily used by the city of Livermore as a soil conditioner.

Weekly samples are collected from each digester, the aeration tank, and the liquid effluent. Gross alpha and beta activities, as well as specific alpha-emitting radionuclides, are measured in monthly composites of the weekly samples to determine if any significant buildup of radioactivity occurs within the plant. In addition, the
activity levels of certain radionuclides in the LLL effluent are
compared with those in the effluent
from the Livermore treatment plant.
The data in Tables 12 through 14 are
comparable to those observed in 1974.
These measurements indicate no
buildup of radioactivity within the
plant.

Radioactivity in Water

Water samples are collected from various locations in the Livermore Valley and at Site 300 as shown in Figs. 2 through 5. These samples are analyzed for gross alpha and beta activities using a gas proportional counter. There were no samples with an alpha activity above the minimum detection limit of 1.2×10^{-9} uCi/ml. The gross beta activities for the Livermore Valley samples are listed in Table 15. Locations 11. 16, and 24 are surface sources such as ponds, creeks, and reservoirs. Livermore rainfall is sampled at Location 20. The balance are domestic water sources. Annual average gross beta activity in Livermore waters in 1975 were essentially unchanged from that observed in 1974. Gross beta activities in Site 300 water samples are shown in Table 16. These samples are collected from onsite wells supplying Site 300 (Locations 1 through 7) and off-site creek sources (Locations 11 and 14). The Location 20 represents Site 300 rainwater. Location 21 is a springfed pond near Bunker 812. Annual average gross beta activity of Site 300 water during 1975 was also unchanged from 1974. With the exception of rainwater and the two off-site creek sources, the Site 300 samples came primarily from deep wells and springs.

These samples are also analyzed for tritium activity. Because of the low activities, it was necessary to distill and electrolytically enrich the samples prior to liquid scintillation counting. Tables 17 and 18 show the data for Livermore and Site 300 samples, respectively. Inspection of the data indicates that the samples exhibit concentrations that are well below the recommended concentration guide value. tables also include an estimate of the annual dose that may be delivered to an adult consuming water containing the listed tritium concentrations. The doses, which are typically less than 0.1 mrem, are based upon a daily water consumption of 1 l/day and the model of Anspaugh et al.8

Radioactivity in Vegetation

Vegetation samples (usually native grasses) are collected at monthly intervals throughout the Livermore Valley, at Site 300, and in the off-site vicinity of Site 300 at the locations shown in Figs. 3. 4, and 5. These samples are freezedried, and the tritium activity in the recovered water is determined by liquid scintillation counting. Table 19 shows the tritium data on vegetation collected in the Livermore Valley. The whole-body radiation doses shown in the table were derived from the model of Anspaugh et al.,8 assuming that the observed activities were typical of edible vegetation grown in this area. The possible doses, which are less than 1 mrem per year, are based upon the direct daily consumption of 400 g of vegetation, 9 normally 80% water.

Table 20 shows the tritium data for Site 300. With the exception of Locations 6 and 13, the tritium levels of Site 300 vegetation are lower and show less fluctuation than do the Livermore Valley samples. Location 6 is adjacent to an area containing tritium-contaminated debris from a firing table. Under the influence of seasonal rains, the tritium has apparently entered an aquifer whose outflow is in the area where Sample 13 is routinely collected.

Radioactivity in Milk

During 1975, milk samples were obtained at monthly intervals from

two sources. One was a farm located on North Livermore Avenue in the Livermore Valley, and the other was a dairy Located about 10 km southwest of Tracy in the San Joaquin Valley. Before analysis, the samples are concentrated by means of freeze-drving and the concentrates are gamma-counted in a Ge(Li) counting system. In addition, each sample is analyzed for tritium activity by counting the vacuum distilled sample in a liquid scintillation counting system. Activities of ¹³⁷Cs. ⁴⁰K. and ³H are shown in Table 21. other radionuclides were detected. Also shown are the calculated annual adult whole-body or critical organ radiation dose delivered to man via the milk pathway. These calculations are based on a daily intake of 260 g/day and the models previously referenced. The only dose to an individual above 1 mrem is that from naturally occuring 40 K.

Environmental Radiation Measurements

Environmental radiation measurements are made at 12 LLL perimeter locations shown in Fig. 2 and at 41 off-site locations shown in Fig. 12, in the vicinity of the Laboratory. These measurements are obtained with thermoluminescence dosimeters using a procedure published elsewhere. 10 Exposure periods are three months. Based on past measurements, 11 the

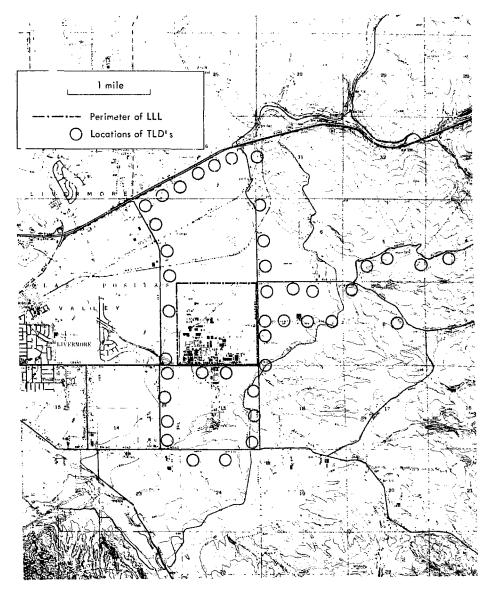


Fig. 12. Location of TLDs in the vicnity of LLL.

environmental terrestrial exposure rates in the Livermore Valley vary between 3 and 7 uR/hr; cosmic radiation, calculated from the local elevation and geomagnetic latitude according to the data of Lowder and Beck. 12 is approximately 4 µR/hr. Table 22 shows quarterly and annual doses in millirem derived from the measured exposure rates at perimeter locations. Operation of a 14-MeV neutron generator located adjacent to the south boundary fence has been responsible for elevated dose rates at Location 5.3,5 During 1975, TLD measurements were also made at a point on the Site boundary directly opposite this facility since maximum exposure rates are observed there. This perimeter monitoring location, identified in Table 22 as Location 5a. is about 25 m west of Location 5 (see Fig. 2). It has been estimated that during 1975 the maximum radiation dose to an individual from this source was less than one-tenth the radiation protection standard of ERDA Manual Chapter 0524. Locations 10, 11, and 12 are near a linear accelerator facility. Figure 13 shows an annual frequency distribution of environmental dose rates observed at the 41 off-site locations. The dosimeters recording the highest doses (213 and 73 mrem) are near an off-site industrial plant where radiography is frequently performed.

The median off-site dose rate of 59 mrem is comparable to the 66 mrem observed during 1974. The median perimeter dose rate was 62 mrem, compared with 69 mrem observed for 1974. Figure 14 is a dose distribution plot combining Laboratory perimeter and off-site measurements. The six doses above those typical of environmental background have each been identified either in Table 22 or i "he comments above."

NON-RADIOACTIVE MONITORING

Airborne Beryllium

Beryllium monitoring, both of inplant air and at or near the property boundaries, has always been a part of the LLL safety program. Each

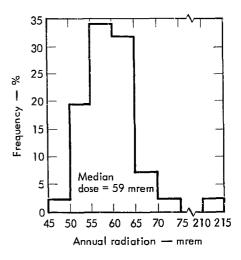


Fig. 13. Annual off-site radiation background (mrem) for 1975.

month half of each LLL perimeter and Site 300 filter is composited by sampling location, wet digested, and the beryllium content of the solutions is determined by atomic absorption analysis.

Tables 23 and 24 show monthly average airborne beryllium concentrations for LLL perimeter and Site 300

sampling locations, respectively. There appears to be no difference between the levels at Site 300 where beryllium is frequently expended in high-explosive experiments and those observed at Livermore. The concentrations, which are 3 to 4 orders of magnitude below the emission standard, can be accounted for by resuspension

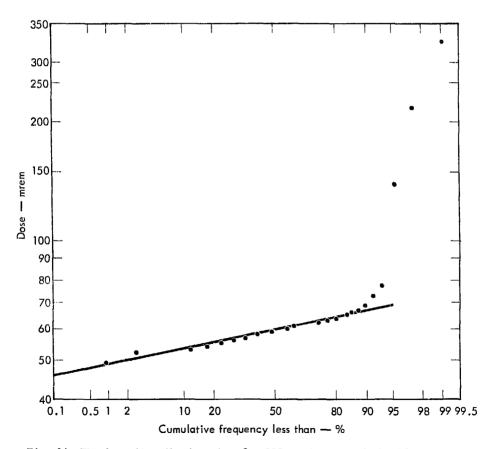


Fig. 14. TLD dose distribution plot for LLL perimeter and the Livermore Valley in 1975.

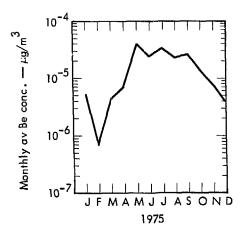


Fig. 15. Concentration of beryllium in LLL site perimeter air filters during 1975.

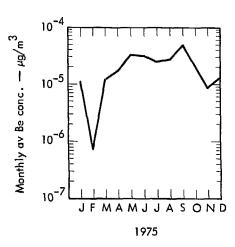


Fig. 16. Concentration of beryllium in Site 300 air filters during 1975.

of surface soil containing naturally occurring beryllium. Local soils contain approximately 1 ppm of beryllium. Livermore's air typically contains $10-100~\mu g$ of particulates per cubic metre. Using a value of $50~\mu g/m^3$ for an average dust load and 1 ppm for the beryllium content of this dust would give an airborne beryllium concentration of $5.0 \times 10^{-5}~\mu g/m^3$, in agreement with the data in the tables. These concentrations are highest during the dry dusty summers as shown in Figs. 15 and 16.

Heavy Metals Released to Livermore Sanitary Sewer

As noted in the previous section, sanitary sewage from the Laboratory is treated at the Livermore Municipal Water Reclamation Plant, a 200 l/sec (5 000 000 gal/day) secondary treatment sewage plant serving the residential, commercial, and industrial users in Livermore. The LLL sewage effluent is continuously monitored for pH and radioactivity prior to entering the Livermore system.¹³ In addition, composites of sewage representative of daily flow are collected and analyzed for copper and chromium using atomic absorption analyses. These daily samples are also composited on a weekly basis and analyzed for the balance of metals shown in Table 25. The data in this table, however, represent monthly averages based on such weekly measurements. concentrations meet the requirements

for discharges of industrial wastes specified by the city of Livermore (see Appendix B).

Physical and Chemical Analysis of LLL and Site 300 Sewage

A 24-hr sample of Laboratory sewage effluent is collected at quarterly intervals throughout the These samples are subjected to a variety of analyses including biochemical oxygen demand, ammonia, nitrate, total nitrogen content, alkalinity and total solids. Table 26 shows typical data for 1975 which are well below the discharge requirements of the Livermore City Code Section 18.63 (see Appendix B). Table 27 shows results obtained on similar quarterly samples collected from the sewage settling pond at Site 300.

Noise Pollution

As noted elsewhere in this report, the Laboratory's high-explosive diagnostic work is carried out at Site 300. Because of the remoteness of this site, these experiments can be performed with minimal off-site impact from annoying noises or damaging overpressures. Based on meteorological measurements made twice daily, a limit is set on the weight of high explosives that can be detonated without impact in populated areas. To monitor the

correctness of these limits, four microbarograph sensors are maintained in or near Tracy. The probability of overpressure is greatest in this area because of the direction of the prevailing winds. Microbarograph data indicate no excessive overpressures during 1975. Also, there were no complaints of damage or noise irritation during the past year. Indeed, there have been no complaints since the high-explosive weight limit program was formalized in 1966.

Pesticide Monitoring

Our nonradioactive environmental surveillance program was expanded in 1975 to include pesticide monitoring. At Livermore, pesticide use includes herbicides, fungicides and insecticides, and while a wide variety of these materials is employed, none has shown a regular pattern of heavy use.

The most probable way pesticides used at LLL could be transported to the off-site environment is via entrainment in surface run-off water. Most of this surface drainage leaves the Site in a ditch at the northwest corner of the property. Quarterly samples have been collected from this ditch at the Site boundary. During the winter and spring, run-off water samples were obtained; during the summer and fall the samples consisted of drainage sediments.

Samples were extracted with hexane and ether and the extracts were analyzed in a Finnigan 3000 D gas chromatograph/mass spectrometer.

Data obtained were compared with those from pesticides known to have been used at LLL, which included Bromacil, Carbaryl, Chlordane, Dicofol, Diuron, Folpet, Malathion and 2,4-D. Samples collected during 1975 showed no residues of pesticides exceeding the limits of detection.

Details of the analytical technique have been published. 14

ENVIRONMENTAL IMPACT OF LLL EFFLUENTS

Radioactive Airborne Effluents

During 1975, radioactive airborne effluents consisted of an estimated 600 Ci of 41 Ar from Building 281 (reactor); combined tritium releases from Buildings 212 (14-MeV neutron generator) and 331 (gaseous chemistry) totaled 3380 Ci, and a total of approximately 1200 Ci of 1502-13N2 was released from Building 194 (electron-positron linear accelerator). With the exception of tritium, all these radionuclides are short-lived. Comparative releases in 1974 were 700 Ci of 41 Ar, 1900 Ci of tritium, and 1300 Ci of $^{15}O_2 - ^{13}N_2$. Except for tritium, the levels of radioactive airborne effluents during 1975 are

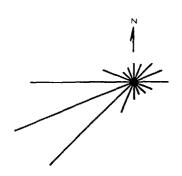
essentially the same as those observed during 1974. Increased operations at the 14-MeV neutron generator is partly responsible for the additional release of tritium in 1975. However, improved sensitivity in stack monitoring at the Gaseous Chemistry facility is responsible for most of the increase reported. Table 28 contains estimates of the radiation dose to the public from Laboratory airborne effluents, indicating that the total dose to the nearest resident from these effluents is less than 1 mrem. The following three dose reference points were employed: (1) the "fence post" dose at the location on the Site boundary where the maximum exposure rates exist. (2) the dose to mearest resident and (3) the man-rem dose within a radius of 80 km (50 mi). Dose calculations are based on the use of a continuous point source computer code. 15 This code provides estimates of concentration at distances between 0.1 and 100 km from the point of release. The code is based upon meteorologically typical data derived from wind direction, speed, and variability observations taken at 1/2-hr intervals. Concentration contour plots are provided at various probability levels. Source terms for those calculations were based on data from continuously operating stack monitoring equipment. Tritium

doses are conservative, since it is assumed that all tritium is in the form of tritiated water. The difference in man-rem doses between wet and dry seasons is due to difference in prevailing wind direction during these periods and is not related to "rainout." At Livermore, the wet season normally extends from November through April. Figure 17 shows that the annual average winds are predominantly from the south-

west. During the wet season, the winds tend to be reversed. Since population is not distributed uniformly, there are accompanying seasonal man-rem dose differences.

Radioactive Liquid Effluents

Except for low-level radioactive liquid wastes which are discharged to the Livermore sanitary sewers, LLL does not release radioactive liquids to the environment. During



Wind rose shows relative frequency of wind direction (by the length of the line) obtained from the tabulated phonal data below.

Frequency of Wind In Percent for Livermore - 1971

Mo	N	NNE	NE	ENE	E	ESE	SE	SSE	ś	ssv.	5 V•	wsw	w	WNW	NW.	NNW	Calm
Jan	2.7	2.2	7.2	12.1	17.8	6.8	6.2	2.2	3.9	3.8	4.9	7.0	9,7	7.6	2.0	2.6	1.5
feb	2.2	2.5	6.9	12.9	14.8	7.2	5.1	2.8	3.5	3.0	4.9	8.0	11.2	8.5	3.4	2.0	1.4
Mar	2.1	2.2	6.4	12.3	13.5	6.9	4.9	2.7	3.3	2.6	4.6	10.5	12.2	9.1	3.1	1.8	1.7
April	2.1	2.3	4.6	8.7	9.4	5.1	3.2	2.1	3.0	4.8	10.8	16.1	13.9	7.4	2.2	1.8	2.3
May	2.2	1,9	3.8	6.5	7.1	4.0	2.4	1.7	2.4	4.7	15.3	17.7	16.7	6.0	1.9	1.9	3.8
June	2.1	1.7	3.4	5.6	6.2	3.5	2.1	1.4	2.2	4.6	16.9	19.8	17.7	5.4	1.7	1.6	3.9
July	1.7	1.4	2.8	4.6	5.1	2.9	1.8	1.3	2.0	5.3	19.5	22.9	17.2	4.6	1.4	1.4	4.0
Aug	1.6	1.4	2.7	4.5	5.0	2.8	1.7	1.3	2,1	5.3	19.8	23.5	17.0	4.5	1.4	1.4	4.1
Sept	1.9	1.4	2.5	4.0	4.4	2.5	1.6	1.3	2.2	5.4	21.1	23.3	17.3	4.7	1.4	1.2	3.7
Oct	2.4	1.6	2.7	4.1	4.5	2.7	1.6	1.3	2.2	5.7	20.6	22.5	16.3	4.6	1.5	2.2	3.5
Nov	2.6	2.5	3.4	4.5	4.9	2.7	1,9	1.9	2.6	5.4	19.2	20.5	15.5	4.7	2.0	2.3	3.3
Dec	2.8	3.0	3.9	4.6	5.3	3.0	2.6	2.2	2.7	5.1	17.7	19.2	15.3	4.8	2.1	2.4	3.1
Annual Average	2.2	2.0	4.2	7.0	8.2	4.2	2.9	1.8	2.7	4.7	14.6	17.6	15.0	6.0	2.0	1.9	3.0

Fig. 17. Typical annual average wind pattern for Livermore (LLL data - 1971).

1975, the principal radionuclides released to the sewer were 2.1×10^{-4} Ci 239 Pu and 38 Ci of HTO. Table 14 shows the concentration of these radionuclides in the treated effluent from the Livermore Water Reclamation Plant to be 9.8×10^{-11} and 9.3×10^{-6} μ Ci/ml for 239 Pu and HTO, respectively. These concentrations represent 3.3×10^{-4} % and 0.3% of the ERDAM Chapter 0524 drinking water standard for 239 Pu and HTO, respectively. In addition, during 1975 the average annual gross beta activity of the LLL sewage effluent

was $1.9 \times 10^{-8}~\mu\text{Ci/ml}$. It is assumed that this activity is due to betagamma emitters, which are released to the sewer system in accordance with ERDAN Chapter 0524. Analysis of samples collected at the point of discharge show the presence of 13^4 Cs, 13^7 Cs, 6^5 Zn, 5^6 Mn, 6^0 Co, 9^5 Zr, 9^5 Nb, 12^5 Sb, and 110 Ag. Even if any of these radionuclides were assumed to be the sole source of the 1.9 $\times~10^{-8}~\mu\text{Ci/ml}$, Table 29 shows that none would account for over 0.3% of the CG of E'. Manual Chapter 0524.

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Appendix A Tables

Table 1. Gross alpha activity in air filters in the Livermore Valley during 1975 ($\mu Ci/m1$).

	No. of		January-June		No. of		July-December		Annua1	λ,
Location	namples	MaxImum	Mintmum	Average	samples	Maximum	Minimum	Average	Average	CG
10	25	1.4 E - 15 : 37%	2.4 E - 16 : 100Z	4.7 E - 16	27	2,0 E - 15 + 322	2.6 E - 16 + 100%	6.8 E - 16	5.8 E - 16 ± 622°	2.8
2	25	2.1 E - 15 : 34%	2.6 E - 16 ± 1002	5.6 E - 16	21	2.1 E - 15 : 542	2.2 E - 16 · 100%	7.7 E - 16	6.6 E - 16 ± 70%	3.3
3	18	1.8 E - 15 ± 412	2.4 E - 16 : 100%	8.5 E - 16	24	2.6 E - 15 : 432	3.9 E - 16 : 1002	7.1 E - 16	7.8 E - 16 : 53%	3.9
4	23	4.2 E - 15 ± 29%	7.0 E - 17 · 1002	1.2 E - 15	23	2.5 E ~ 15 ± 35%	3.9 E - 16 · 100%	1.0 E ~ 15	1.1 E - 15 ± 61%	5.5
5	22	2.2 E - 15 : 38%	4.0 E - 17 ' 100%	9,3 E - 16	25	2.4 E - 15 1 36%	3.9 E - 16 ' 100%	9.5 E ~ 16	9.4 E - 16 + 53%	4.7
6	23	1.8 E - 15 : 417	4.0 E - 17 : 100%	7.8 E - 16	16	1.7 E - 15 : 392	4.2 E - 16 : 1002	7.5 E ~ 16	7.6 E - 16 ± 53%	3.8
7	23	2.3 E - 15 ± 39%	8.0 E - 17 ± 100%	8.0 E - 16	25	2.0 E - 15 : 18%	3.9 E - 16 · 100%	9.0 E - 16	8.5 E - 16 ± 51%	4.3
8	20	4.0 E - 15 . 317	5.0 E = 17 t 100%	1.2 E - 35	26	1.9 E - 15 : 38%	3.9 E - 16 1 100%	9.2 E ~ 16	1.0 E - 15 : 79%	5.0
9	17	1.7 E - 15 : 412	5.0 E - 17 · 1002	7.8 E - 16	22	2.0 F - 15 · 372	3.9 E - 16 · 100%	8.7 E - 16	8.3 E - 16 ± 49%	4.2
10	20	2.1 E - 15 ± 402	2.9 E - 16 : 100Z	7.0 E - 16	27	9.3 E - 16 + 48%	2.9 E - 16 · 100%	6.0 E - 16	6.5 E - 16 ± 56%	3.3
11	22	2.9 E - 15 ± 64%	8.0 E - 17 1 1002	6.9 E - 16	24	1.4 E - 15 : 50%	3.9 E - 16 · 1002	9.3 E - 16	8.1 E - 16 ± 42%	4.1
12	25	1.8 E - 15 ± 382	2.7 E - 16 ± 1002	7.1 E - 16	27	1.6 E - 15 · 43%	2.9 E - 16 : 1007	7.0 E - 16	7.1 E - 16 ± 542	3.6
13	25	2.2 E - 15 ± 322	2.4 E - 16 ± 100%	5.3 E - 16	24	1.3 E - 15 ± 42%	2.4 E - 16 · 109%	4.7 E ~ 16	5.0 E - 16 ± 682	2.5
14	25	2.9 E - 15 : 30%	2.6 E - 16 ! 100Z	7.2 E - 26	27	1.6 E - 15 : 40%	2.6 E - 16 ± 100%	6.7 E - 16	7.0 E - 16 ± 692	3.5
15	25	1.8 E - 15 ± 362	2.5 E - 16 : 1002	5.7 E - 16	27	1.0 E - 15 ± 48%	2.8 E - 16 : 100%	5.7 E - 16	5.7 E - 16 ! 51%	2.9
16	20	4.5 E - 15 ± 302	2.8 E - 16 ± 100%	1.2 E - 15	26	5.7 E - 15 · 49	2.4 E - 16 : 1002	1.2 E - 15	1.2 E - 15 : 99%	6.0
									7.9 E - 16 ± 252 ^d	

See Figures 2 and 3 for sampling locations.

 $^{^{}b}Concentration Guide for gross alpha in air is 2.0 E - 14 <math display="inline">\mu C1/mI$.

 $^{^{\}rm c}$ lm all tables these limits represent the range of the data on which the average is based.

d_{In all tables} these limits represent the range of the averages on which this average is based.

Table 2. Gross beta activity in air filters in the Livermore Valley during 1975 (pCi/ml).

Location	No. of Samples	Maximum	January-June Minizum	Average	No. of Samples	Maximum	'uly-December Minimum	Average	Annual Average	çab
1ª	25	2.0 E - 13 - 3%	1.8 E - 14 · 92	8.5 E - 14	27	5.1 E = 14 + 61	9_8 F = 15 = 11°	2.3 E - 14	1.4 E - 14 : 76.	5.4
2	25	1.9 5 - 1 1 32	1.9 E - 14 · 8t	9.4 F - 14	27	5.6 E - 14 · 81	7.5 F = 15 1 125	2.1 E + 14	5.9 E = 14 1 687	5.9
3	18	9.1 E - 14 ± 5%	2.7 E - 14 : 9t	6.4 E - 14	24	3.9 E - 14 · 87	1.6 F - 14 * 10%	2.1 F - 14	4.2 E + 14 * 521	4
4	23	2.5 E - 13 : 3%	1.0 E - 14 · 47	1.2 E - 13	24	8.8 E = 14 * 55	1.4 E = 14 = 11°	3.9 1 - 14	7.9 E - 14 · 69%	7.1
5	22	2.0 E - 13 ± 4%	7.3 E - 15 · 5%	8.9 E - 14	25	5.0 E - 14 · 7	1.8 E = 14 × 10°	1.0 E - 14	3.9 F - 14 : 657	5.4
6	23	1.5 E - 13 ± 42	5.1 E - 15 · 67	6.6 E - 14	17	5.4 E - 14 · 7	1.2 8 - 14 - 12*	3.2 € ≈ 14	4.9 E - 14 · 61%	4.9
7	23	1.8 E - 13 : 4%	6.8 E - 15 + 5%	7.1 E - 14	25	4.5 E - 14 · 7	1.5 E = 14 × 115	2.5 E - 14	4.8 E - 14 : 6m?	4.8
8	20	1.9 E - 13 · 4%	6.5 E - 15 · 62	7.4 E - 14	25	5.1 E - 14 · 7	1.9 5 - 14 + 101	2.7 E - 14	5.1 E - 14 1 n2%	5.1
9	17	1.9 E - 13 : 4%	7.7 E - 15 · 5%	7.4 E - 14	23	5.7 E + 14 · 67	1.5 E = 14 + 10°	2.9 1 - 10	3 2 E - 14 t 65%	5.2
10	20	1.9 E - 13 : 37	1.7 E - 14 : 92	8.6 E - 14	27	6.5 E - 14 · HT	1.1 E - 14 · 11	2.2 E - 14	5.4 E - 14 · 89%	5.4
11	22	1.4 E - 13 ± 42	5.1 E - 15 : 6%	6.8 E - 14	24	4.3 E - 14 · 72	1.4 E - 14 + 10%	2.8 8 - 14	4.8 E - 14 · 58%	4.8
12	25	1.5 E - 13 ± 4%	2.4 E - 14 · 82	9,6 F - 14	27	6.5 E - 14 · 63	1.0 E - 14 · 12*	2.n E - 14	6.1 E - 14 * 69%	6.1
13	25	1.4 E - 13 ± 32	1.7 E - 14 ± 9%	8.4 % - 14	24	4.9 E - 14 - 62	8.4 E - 15 · 111	2.4 E - 14	5.4 F - 14 1 732	5.4
14	25	2.0 E - 13 ± 4%	2.0 E - 14 · 92	9.4 f 14	27	3.9 E - 14 · 75	9.1 8 - 15 - 12"	2.1 : - 14	5.8 E - 14 · 748	5,8
15	25	2.0 E - 13 ± 3%	1.9 E - 14 ± 9%	8.7 E - 14	27	4.5 E - 14 · 67	8.0 E - 15 · 12	2.1 F = 14	5.4 E - 14 · 752	5.4
16	20	2.0 E - 13 ± 32	1.0 E - 14 ± 187	9.2 E - 14	25	5.3 E - 14 · 92	9.1 E - 15 · 115	1.9 E - 14	5.5 E - 14 · 82%	5.5
Annua	laverage								5.5 E - 14 · 152	5,5

^aSee Figures 2 and 3 for sampling locations.

^bConcentration Guide for gross beta in air is 1.0 E - 12 µCi/ml.

Table 3. Gross alpha and gross beta activities in air filters at Site 300 during 1975 (μ Ci/ml).

			Gross Alpha Acti	vity		Gross Beta Activity					
Location	No. of Samples	Maximum	Minimum	Annual Average	хссь	Maximum	Minimum	Annual Average	%CG ^E		
ıa	44	1.9 E - 15 ± 37%	8.0 E - 17 + 100%	6.7 E - 16 ! 64%	3.4	3.2 E - 13 + 3%	1.0 E - 14 ± 1%	7.0 E - 14 ± 86%	7.0		
2	49	3.2 E - 15 ± 55%	2.2 E - 16 ! 100%	6.2 E - 16 ± 75%	3.1	2.5 E - 13 · 3%	1.1 E - 14 + 4%	7.4 E - 14 ± 69%	7.4		
3	50	3.5 E - 15 ± 34%	1.7 E - 16 ± 100%	5.8 E - 16 ± 88%	2.9	1.7 E - 13 ± 3%	9.3 E - 15 ± 10%	5.8 E - 14 ± 66%	5.8		
4	45	1.8 E - 15 ± 39%	2.0 E - 16 ± 100%	6.8 E - 16 ± 51%	3.4	4.1 E - 13 + 2%	1.7 E - 14 ± 6%	8.0 E - 14 ± 88%	8.0		
5	48	1.6 E - 15 ± 51%	1.8 E - 16 ± 100%	7.0 E - 16 ± 54%	3.5	1.7 E - 13 t 32	9.5 E - 15 ± 11%	6.5 E - 14 ± 60%	6.5		
7	50	1.5 E - 15 ± 41%	2.0 E - 16 ± 100%	6.5 E - 16 ! 59%	3.3	1.8 E - 13 ± 3%	9.9 E - 15 ± 11%	6.8 E - 14 ± 67%	6.8		
8	49	2.5 E - 15 ± 32%	2.3 E - 16 ± 100%	6.9 E - 16 ± 57%	3.5	2.4 E - 13 t 3%	8.8 E - 15 ± 12%	8.9 E - 14 ± 82%	8.9		
9	50	1.1 E - 15 ± 44%	2.6 E - 16 ± 61%	5.5 E - 16 ± 42%	2.8	1.9 E - 13 ± 3%	7.9 E - 15 ± 13%	6.0 E - 14 ± 69%	6.0		
10	41	5.9 E - 15 ± 32%	1.6 E - 16 ± 100%	8.1 E - 16 ± 100%	4.1	2.0 E - 13 ± 2%	1.1 E - 14 ± 12%	7.5 E - 14 ± 73%	7.5		
11	47	1.5 E - 15 ± 39%	1.5 E - 16 ± 100%	6.0 E - 16 ± 66%	3.0	2.0 E - 13 ± 2%	2.9 E - 15 ± 17%	6.8 E - 14 ± 68%	6.8		
Annual	average			6.6 E - 16 ± 11%				7.1 E - 14 ± 13%			

^aSee Figure 4 for sampling locations.

 $[^]b Concentration Guide for gross alpha in air is 2.0 E - 14 <math display="inline">\mu \text{Ci/ml}$

Concentration Guide for gross beta in air is 1.0 E - 12 µCi/ml.

Table 4. Results of gamma-ray spectral measurements of (LLL) perimeter air filters during 1975 (µCi/ml).

Month	144 _{Ce}	¹⁴¹ Ce	125 _{Sb}	7 _{Be}	103 _{Ru}	10ь _{Ки}	137 _{Ce}	95 ₂ r	$^{10}\mathrm{K}$
Jan	1.8 E - 14 = 5%	2.9 E - 15 ± 6).	8.8 E - 16 ± 13%	1.1 E - 13 ± 2%	4.8 E - 15 : 42	8.5 E ~ 15 ± 77	1.6 E = 15 ± 47	1.5 F = 14 + 30	1.6 8 - 16 - 100)
Feb	2.5 E - 14 ± 3%	2.3 E - 15 ± 9%	1.3 E - 15 ± 132	1.1 E - 13 ± 3%	4.8 E - 15 : 5%	1.3 E - 1+ · 47	2.5 E - 15 + 52	1.4 E - 14 1 2%	<1.0 E - 16 1 1003
Mar	2.5 E - 14 ± 3%	1.5 E - 15 ± 15%	1.5 E - 15 ± 11%	9.1 E - 14 ± 3%	J.3 E - 15 : 8%	1.3 E - 44 4 4%	2.7 E - 15 · 4%	1.3 E = 14 ± 2%	<pre><1.0 E = 16 ± 100%</pre>
Apr	2.7 E - 14 ± 8%	8.5 E - 16 ± 15%	1.7 E - 15 ± 8%	1.1 E - 13 ± 32	2.3 E - 15 : H%	1.5 E - 14 : 3%	3.2 E - 15 + 42	1.1 c = 15 x 25	2.3 F = 16 + 86%
May	2.7 E - 14 ± 47	5.4 E - 16 ± 17%	1.9 E - 15 ± 8%	1.4 E - 13 · 22	1.6 E - 15 ± 9%	1.6 E - 14 * 5%	3.7 E - 15 + 3%	8.4 6 - 15 1 53	6.1 E - 16 · 49
June	1.5 E - 14 ± 3%	2.0 E - 16 ± 30%	1.1 E - 15 ± 9%	1.1 E - 13 + 2%	5.4 E - 16 + 172	8,5 E - 15 4 42	2.3 8 - 15 * 48	3. 5 E - 15 + 44	0.6 E - 16 * Po.
July	5.8 E - 15 ± 5%	<1.0 E - 17 ± 1002	4.5 E - 16 ± 13%	7.0 E - 14 ± 22	1.1 E - 16 ± 591	3.3 E - 15 * 9%	9.3 E - 16 ± 5%	1.1 E - 15 ' 8Z	3.6 E - 16 + 48°
Aug	3.6 E - 15 ± 7%	<1.0 E - 17 ± 100%	2.7 E - 16 ± 19%	8.0 E - 14 ± 2%	5,3 E - 17 ± 51%	2.0 E - 15 * 82	6.6 E - 16 · 67	5.0 E - 16 1 12%	5.2 E = 16 · 383
Sept	3.0 E - 15 ± 10%	<1.0 E - 17 ± 100%	2.6 E - 16 ± 20%	1.3 E - 13 . 2%	3.0 E - 17 : 96%	1.7 1 - 15 1 98	5.8 F - 1n + 72	3.0 E - 16 ! 16%	6.1 E - 16 2 47
Oct	1.4 E - 15 ± 14%	<1.0 E - 17 ± 1007	1.1 E - 16 ± 252	1.0 E - 13 ± 27	<1.0 E - 17 ± 100%	8,2 L = 16 - 17%	2.8 E = 16 = 117	1.3 E = 16 ± 30%	2.3 E - 15 · 925
Nov	9.8 E - 16 ± 14%	<1.0 E - 17 ± 100%	8.2 E - 17 ± 28%	7.8 E - 14 t 2%	<1.0 E = 17 ± 100%	5.8 E - 16 · 18%	2.2 E - 16 + 8	6.4 E - 17 ± 27%	1.3 E = 16 ± 99°
Dec	1.3 E - 15 ± 17%	<1.0 E ~ 17 ± 100%	1.4 E - 16 ± 38%	1.1 E - 13 + 2%	<1.0 E - 17 ± 100%	7.6 E - 16 · 14%	3.5 E = 16 ± 12%	6.1 E - 17 1 392	2.8 E - 16 + 99%
Annual <i>a</i> vg	1.3 E - 14 ± 87%	<7.0 E - 16 ± 100%	8.1 E - 16 ± 83%	1.9 E = 13 + 20%	<1,5 E - 15 ± 100%	6.9 E - 15 · 88%	1.6 E = 15 + 79%	5.8 E - 15 ± 1002	<pre><a.1 95"<="" e="16" pre="" ±=""></a.1></pre>
CC	2.0 E - 10	5.0 E - 09	9.0 E - 10	4.0 E - 08	3.0 E - 09	2.0 E - 10	5.0 E - 10	1.0 E - 09	4.0 E - 09
XCG	6.5 E - 03	1.4 E - 05	9.0 E - 05	2.5 E - 04	5.0 E - 05	3.5 E - 03	3.2 E - 04	5.8 E - 04	1.3 E - 05

Table 5. Results of gamma-ray spectral measurements of Site 300 air filters during 1975 (µCi/ml).

Month	144 _{Ce}	141 _{Ce}	125 _{Sb}	7 _{Be}	103 _{Ru}	106 _{Ru}	117 _{C3}	95 2r	⁴⁰ R
Jan	1.7 E - 14 ± 3%	3.0 E - 15 ± 112	9,1 E - 16 ± 102	1.0 E - 13 ± 2%	4.8 E - 15 + 52	8.3 E ~ 15 1 4º	1.6 E - 15 + 4%	1.4 E - 14 * 2%	1.6 E - 16 + 97%
Feb	2.3 E - 14 ± 3%	2.1 E - 15 ± 7%	1.3 E - 15 ± 8%	1.1 E - 13 + 2%	4.5 E - 15 ± 3%	1.2 E ~ 14 1 37	2.3 E - 15 + 42	1.5 E - 14 2 3%	1.4 E - 16 + 100%
Mar	4.1 E 14 ± 37	2.3 E - 15 ± 8%	2.4 E - 15 ± 62	1.7 E - 13 ± 2%	5.4 E - 15 ± 42	2.1 E ~ 14 · 2%	4.3 E - 15 + 1%	2.1 E - 14 · 2%	3.1 E - 16 · 61°
Apr	2.3 E - 14 ± 42	7.4 E - 16 ± 112	1.5 E - 15 ± 7%	9.9 E - 14 + 2%	1.9 E - 15 + IZ	1,3 E ~ 14 ± 3%	2.8 E - 15 1 3%	9.1 E - 15 t 2%	1.4 E - 16 ± 92%
May	3.1 E - 14 ± 62	6.3 E - 16 ± 10Z	2,2 E - 15 ± 6%	1.6 E - 13 + 2%	1.6 E - 15 + 82	1.7 E ~ 14 ± 2%	4.1 E = 15 + 22	9.4 E = 15 ± 22	2.9 E - 16 + 50%
June	1.8 E - 14 t 3Z	2.2 E - 16 ± 23%	1.3 E - 15 1 72	1.6 E - 13 ± 2%	6.1 E = 16 ± 12%	1.0 E - 14 1 32	2.7 E - 15 t 3%	4.3 E = 15 1 3%	5.8 E = 16 ± 32%
July	7.7 E - 15 ± 3%	1.1 E - 17 ± 92%	6.4 E - 16 ! 9%	1.2 E - 13 ± 2%	1.8 E - 16 + 36%	4.2 E ~ 15 1 4%	1.3 E - 15 1 5%	1.4 E - 15 · 5%	2.8 E - 16 : 46%
Λug	5.2 E - 15 ± 6%	<1.0 E - 17 ± 100%	4.4 E - 16 : 11Z	1,3 E + 13 ± 2%	1.0 E - 16 ± 51%	2.9 E - 15 ! 62	9.8 E - 16 ± 5%	7.2 E - 16 * B%	3.1 E - 16 / 56%
Sept	3.4 E - 15 ± 6%	<1.0 E - 17 1 100%	3.0 E - 16 ± 182	1.9 E - [3 ± 2%	2.8 E - 17 t 65%	2.0 E - 15 4 6%	6.7 E - 16 ± 52	3.7 E - 16 ! 11%	J. 3 E - 16 ± 43%
Uct	1.9 E - 15 ± 8%	<1.0 E - 17 ± 100%	1.8 E - 16 ± 12%	1.4 E - 13 t 2%	1.1 E - 17 t 95%	1.1 E - 15 ' 82	3.9 E - 16 ± 4%	1.5 E = 16 / 16%	3.6 E - 16 1 125
Nov	1.1 E - 15 ± 10%	<1.0 E - 17 ! 1007	8.7 E - 17 + 232	8.1 E - 14 1 2%	<1.0 E - 17 + 100%	6.3 F - 16 / 14Z	2.5 E - 16 · 74	6.8 E - 17 : 18%	1.6 E - 16 + 99%
Dec	1.6 E - 15 ± 10%	<1.0 E - 17 ± 100%	1.7 E - 16 1 21%	1,3 E - 13 + 2%	<1.0 E = 17 ± 1007	8.7 E - 16 + 22%	4.1 E = 16 ± 7%	8.7 E - 17 3 22%	1.4 E - 16 t 982
Annual avg	1.4 E - 14 : 91%	<7.5 E - 16 ± 1002	9.5 E - 16 ± 832	1,3 E - 13 ± 25%	<1,6 E - 15 ± 100%	7.8 E - 15 + 89Z	1.8 E - 15 + 782	6.3 E - 15 + 1002	2.7 E - 16 + 491
IG.	2.0 E - LO	5.0 E - 09	9.0 E - 10	4.0 E - 08	3.0 E - 09	2.0 E - 10	5.0 E = 10	1.0 E - 09	4.6 E - 09
ZCC:	7.0 E - 03	1.5 E - 05	1.1 E - 04	3.3 E - 04	5,3 E - 05	3.9 E - 03	3.6 E - 04	6.3 E - 04	6.8 E - 0s

Table 6. Plutonium, strontium, and uranium in air at LLL perimeter location during 1975.

		Activity	(µCi/ml)		Activity (pCi/ml)		Mase (μg/m ³)	
ionth	Locationa	239 _{Pu} b	238 _{Pu}	238 _{Pu} /239 _{Pu}	90 _{Sr}	²³⁹ Pu/ ⁹⁰ Sr	2 35 _U	238 _U	²³⁵ u/ ²³⁸ u
an	1	2.0 E - 17 ± 11%	1.4 E - 18 ± 29%	7.0 E - 02	1.2 E - 15 ± 20%	1.7 E - 02	1.1 E - 07 ± 2%	1.7 E - 05 ± 3%	6.5 E - 0
	2	1.8 E - 17 ± 12%	1.1 E - 18 ± 35%	6.1 E - 02	1.3 E - 15 ± 24%	1.4 E - 02	1.5 E - 07 ± 2%	2.3 E - 05 ± 3%	6.5 E - 0
	12	2.3 E ~ 17 ± 12%	1.4 E - 18 = 37%	6.1 E - 02	2.5 E - 15 ± 18%	9.2 E - 03	3.0 E - 07 1 2%	5.0 E - 05 1 3%	6.0 E - 0
	13	I.8 E - 17 ± 11%	8.1 E - 19 ± 39%	4.5 E - 02	1.5 E - 15 ± 26%	1.2 E - 02	1.6 E - 07 ± 2%	2.2 E - 05 ± 3%	7.3 E - 0
	14	2.1 E - 17 ± 11%	1.3 E - 18 ± 36%	6.2 E - 02	2.5 E - 15 ± 14%	8.4 E - 03	1.9 E - 07 ± 2%	2.7 E - 05 ± 3%	7.0 E - 0
	15	2.2 E - 17 ± 13%	1.4 E - 18 ± 412	6.4 E - 02	2.0 E ~ 15 + 16%	1.1 E - 02	1.3 E - 07 ± 2%	1.8 £ - 05 ± 3%	7.2 E - 03
eb	1	3.0 E - 17 ± 9%	3.0 E - 19 ± 100%	1.0 E - 02	3.1 E - 15 ± 14%	1.0 E - 02	1.3 E - 07 ± 2%	2.0 E - 05 ± 37	6.5 E - 03
	2	3.0 E - 17 ± 9%	6.1 E - 19 ± 40%	2.0 E - 02	3.3 E - 15 * 17%	9.1 E - 03	1.7 E - 07 ± 2%	2.6 E - 05 ± 3%	6.5 E - 03
	12	2.5 E - 17 ± 10%	6.1 E - 19 ± 45%	2.4 E - 02	1.9 E - 15 ± 17%	1.3 E - 02	2.3 E - 07 ± 2%	3.6 E - 05 ± 3%	6.4 E - 03
	13	2.4 E - 17 ± 9%	8.4 E - 19 ± 37%	3.5 E - 02	2.3 E - 15 ± 14%	1.0 E - 02	1.4 E - 07 ± 2%	2.0 E - 05 ± 3%	7.0 E - 03
	14	2.9 E - 17 ± 10%	8.3 E - 19 ± 37%	2.9 E - 02	2.7 E - 15 ± 11%	1.1 E - 02	1.3 E - 07 ± 2%	1.8 E - 05 ± 3%	7.2 E - 03
	15	4.1 E - 17 ± 8%	1.7 E - 18 ± 26%	4.1 E - 02	2.5 E - 15 t 12%	1.6 E - 02	1.4 E - 07 ± 2%	2.0 E - 05 ± 3%	7.0 E - 03
ат	1	3.0 E - 17 ± 8%	7.9 E - 19 ± 34%	2.6 E ~ 02	2.5 E - 15 ± 16%	1.2 E - 02	1.4 E - 07 ± 2%	3.0 E - 05 ± 3%	4.7 E - 03
	2	3.2 E - 17 ± 8%	1.2 E - 18 ± 28%	3.8 E - 02	3.0 E - 15 ± 15%	1.1 E - 02	2.0 E - 07 ± 2%	2.3 E ~ Q5 ± 2%	8.7 E - 03
	12	3.5 E - 17 ± 8%	4.5 E - 19 ± 41%	1.3 E - 02	4.0 E - 15 ± 16%	8.8 E - 03	3.4 E - 07 ± 2%	6.2 E - 05 ± 3%	5.5 E - 03
	13	2.8 E - 17 ± 8%	4.2 E - 19 ± 38%	1.5 E - 02	3.0 E - 15 ± 17%	9.3 E - 03	1.5 E - 07 ± 2%	2.4 E - 05 ± 3%	6.3 E - 03
	14	3.9 E - 17 ± 9%	1.6 E - 18 ± 29%	4.1 E - 02	3.1 E - 15 ± 17%	1.3 E - 02	2.0 E - 07 t 2%	4.0 E - 05 ± 3%	5.0 E - 03
	15	3.1 E - 17 ± 11%	7.4 E - 19 ± 49%	2.4 E - 02	3.0 E - 15 ± 18%	1.0 E - 02	1.8 E - 07 ± 2%	3.2 E - 05 ± 3%	5.6 E - 03
pr	1	4.1 E - 17 ± 7%	1.2 E - 18 ± 23%	2.9 E ~ 02	2.3 E - 15 ± 6%	1.6 E - 02	1.9 E - 07 ± 2%	2.8 E - 05 ± 3%	6.8 E - 03
	2	4.1 E - 17 ± 6%	1.2 E - 18 ± 23%	2.9 E - 02	2.2 E - 15 ± 6%	1.9 E - 02	1.6 E - 97 ± 2%	2.2 E - 05 ± 2%	7.3 E - 03
	12	4.6 E - 17 ± 8%	6.3 E - 19 ± 40%	1.4 E - 02	2.6 E - 15 ± 6%	1.8 E - 02	4.7 E - 07 ± 2%	6.9 E - 05 ± 2%	6.8 E - 03
	13	3.7 E - 17 ± 8%	9.5 E - 19 ± 33%	2.6 E - 02	2.2 E ~ 15 ± 5%	1.7 E - 02	1.9 E - 07 ± 2%	2.7 E - 05 ± 2%	7.0 E - 03
	14	6.7 E - 17 ± 6%	2.5 E - 19 ± 17%	3.7 E - 02	2.5 E - 15 ± 5%	2.7 E - 02	4.2 E - 07 ± 2%	6.1 E - 05 ± 2%	6.9 E ~ 03
	15	4.2 E - 17 ± 7%	1.2 E - 18 ± 27%	2.9 E - 02	2.4 E - 15 ± 5%	1.8 E - 02	2.1 E ~ 07 ± 2%	3.2 E - 05 ± 3%	6.6 E - 03

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Month	Locationa	220 %			Activity (µCi/ml)		Mass (ng/m /	
		239 _{Pu} b	238 _{Pu}	238 _{Pu} /239 _{Pu}	90 _{Sr}	²³⁹ Pu/ ⁹⁰ Sr	235 _t ,	²³⁸ u	235 _{U/} 238 _U g
May	1	4.4 E - 17 ± 12%	2,4 E - 13 ± 30%	5.5 E - 02	2.2 E - 15 ± 6%	2.0 E - 02	3.5 E - 07 ± 2%	4.8 E - 05 ± 3%	7.3 E - 02
	2	4.2 E - 17 ± 9%	5.2 E - 19 ± 32%	1.2 E - 02	2.2 E - 15 ± 6%	1.9 E - 02	3.3 E - 07 ' 2%	4.7 E - 05 ± 3%	7.0 E ~ 02
	12	5.2 E - 17 ± 13%	3.8 E - 18 ± 37%	7.3 E - 02	2.9 E - 15 ± 7%	1.8 E - 02	6.1 E - 07 ± 2%	9.3 E - 05 ± #5	6.6 E - 02
	13	4.5 E - 17 ± 9%	1.5 E ~ 18 ± 28%	3.3 E - 02	2.2 E - 15 ± 5%	2.0 E - 02	7.0 E - 07 ± 2%	9.8 E - 05 ± 2%	7.1 E - 02
	14	3.7 E - 17 ± 12%	1.4 E ~ 17 ± 26%	3.8 E - 02	2.2 E - 15 ± 6%	1.4 E - 02	4.8 E - 07 ± 2%	6.7 E - 05 ± 3%	7.2 E - 02
	15	5.3 E - 17 ± 10%	8.1 E - 19 ± 36%	1.5 E - 02	2.2 E ~ 15 ± 6%	2.4 E - 02	4.1 E - 07 ± 4%	5.7 E - 05 ± 2%	7.2 E - 02
Jun	1	2.7 E - 17 ± 10%	5.7 E - 19 ± 50%	2.1 E - 02	1.5 E - 15 ± 9%	1.8 E - 02	5.7 E - 07 ± 2%	8.1 E - 05 ± 3%	7.0 E - 02
	2	2.8 E - 17 ± 14%	4.2 E - 19 ± 30%	1.5 E - 02	1.3 E - 15 ± 8%	2.2 E - 02	3.7 E - 07 t 2%	5.1 E - 05 ± 37	7.3 E - 02
	12	3.3 E - 17 ± 16%	1.3 E - 18 ± 47%	3.9 E - 02	1.7 E - 15 ± 10%	1.9 E - 02	8.4 E - 07 ± 2%	1.2 E - 04 ± 3%	7.0 E - 02
	13	2.4 E - 17 ± 18%	5.1 E ~ 19 ± 76%	2.1 E - 02	1.5 E - 15 ± 9%	1.6 E - 02	6.0 E - 07 ± 2%	8.2 E - 05 ± 2%	7.3 E - 02
	14	1.0 E - 16 ± 16%	8.0 E - 18 ± 34%	8.0 E - 02	1.6 E - 15 ± 16%	6.3 E - 02	7.6 E - 07 t 2%	1.1 E - 04 ± 2%	6.9 E - 03
	15	3.2 E - 17 ± 17%	1.4 E - 18 ± 47%	4.4 E - 02	1.5 E - 15 ± 10%	2.1 E - 02	5.9 E - 07 ± 2%	8.2 E - 05 ± 2%	7.2 E - 03
Ju1y	1	2.3 E - 17 ± 8%	7.9 E - 19 ± 31%	3.4 E - 02	9.2 E - 16 ± 27%	2.5 E - 02	2.9 E - 07 ± 2%	4.2 E - 05 ± 3%	6.9 E - 03
	2	1.4 E ~ 17 * 15%	5.3 E - 19 ± 48%	3.8 E - 02	I.4 E - 15 + 24%	1.0 E - 02	2.3 E - C7 ± 2%	3.3 E - 05 + 3%	7.0 E - 03
	12	2.0 E - 17 ± 43%	1.0 E - 19 ± 100%	5.0 E - 03	Lost sample	-	5.0 E - 07 t 2%	6.9 E - 05 ± 3%	7.2 E - 03
	13	1.1 E - 17 ± 10%	5.5 E - 19 ± 31%	5.0 E ~ 02	1.1 E - 15 ± 27%	1.0 E - 02	2.5 E - 07 ± 2%	3.5 E - 05 ± 3%	7.1 E ~ 03
	14	3.0 E - 17 ± 8%	1.2 E - 19 ± 27%	4.0 E - 03	1.3 E - 15 ± 19%	2.3 E ~ 02	3.6 E - 07 ± 2%	5.1 E - 05 ± 3%	7.1 E - 03
	15	1.6 E - 17 ± 10%	1.1 E - 18 ± 25%	6.9 E - 02	1.6 E ~ 15 ± 35%	1.0 E - 02	6.1 E - 07 * 2%	8.7 E - 05 ± 3%	7.0 E - 03
Aug	1	8.9 E - 18 2 12%	5.1 E ~ 19 ± 39%	5.7 E - 02	6.7 E - 16 ! 29%	1.3 E - 02	3.6 E - 07 ± 2%	5.3 E - 05 ± 3%	6.8 E - 03
	2	5.9 E - 18 ± 18%	4.1 E - 19 ± 49%	6.9 € - 02	5.5 E - 16 : 39%	1.1 E - 02	2.9 E - 07 ± 1%	4.1 E - 05 2 3%	7.1 E ~ 03
	12	1.2 E - 17 ± 14%	3.9 E - 19 ± 56%	3.3 E - 02	Lost sample	-	5.3 E - 07 ± 2%	7.4 E - 05 ± 3%	7.2 E - 03
	13	8.9 E - 18 ± 15%	2.5 E - 19 ± 100%	2.8 E - 02	Lost sample	_	2.8 E - 07 ± 2%	4.0 E - 05 ± 3%	7.0 E - 03
	14	3.6 E - 17 ± 7%	2.0 E - 18 ± 21%	5.6 E - 02	Lost sample	-	6.9 E - 07 ± 22	9.9 E - 05 ± 3%	7.0 E - 03
	15	8.4 E - 18 ± 122	4.2 E - 19 ± 39%	5.0 E - 02	Lost sample	_	4.4 E - 07 ± 2%	6.2 E - 05 ± 3%	7.1 E - 03

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		Activity	(µCi/m1)		Activity (μC1/m1)		Mass (ıg/m³)	
Month	Locationa	239 _{Pu} b	238 _{Pu}	238 _{Pu} /239 _{Pu}	90 Sr	239 _{Pu} /90 _{Sr}	235 _U	∠38 _U	²³⁵ U/ ²³⁸ UB
Sept	1	9.3 E - 18 ± 182	8.5 E - 19 ± 54%	9.1 E - 02	4.8 E - 16 ± 19%	1.9 E - 02	4.3 E - 07 ± 2%	6.4 E - 05 ± 3%	6.7 E - 03
	2	5.9 E - 18 ± 26%	1.5 E - 19 ± 39%	2.5 E - 02	4.5 E - 16 ± 28%	1.3 E - 02	3.2 E - 07 ± 9%	4.6 E - 05 ± 12%	7.0 E - 03
	12	1.1 E - 17 ± 162	9.0 E - 19 ± 42%	8.2 E - 02	Lost sample	_	6.8 E - 07 ± 2%	9.9 E - 05 ± 3%	6.9 E - 03
	13	7.4 E - 18 ± 19%	4.1 E - 19 ± 100%	5.5 E - 02	6.0 E - 16 ± 23%	1.2 E - 02	3.6 E - 07 ± 2%	5.1 E - 05 ± 3%	7.1 E - 03
	14	1.4 E - 17 ± 12%	5.1 E - 19 ± 50%	3.6 E - 02	Lost sample	-	1.3 E - 06 ± 2%	1.8 E - 04 ± 3%	7.2 E - 03
	15	7.6 E - 18 ± 16%	5.0 E - 19 ± 47%	6.6 E - 02	2.7 E - 16 ± 21%	2.8 E - 02	5.3 E - 07 ± 2%	7.5 E - 05 1 3%	7.1 E - 03
0ct	1	5.0 E - 18 ± 14%	5.9 E - 19 ± 31%	1.2 E - 01	2.1 E - 16 ± 61%	2.4 E - 02	2.9 E - 07 ± 28%	3.9 E - 05 ± 39%	7.4 E - 03
	2	4.3 E - 18 ± 14%	3.0 E - 19 ± 31%	7.0 E - 02	3.6 E - 16 ± 47%	1.2 E - 02	2.4 E - 07 ± 4%	3.4 E - 05 ± 5%	7.1 E - 03
	12	7.5 E - 18 ± 21%	6.9 E - 19 ± 35%	9.2 E - 02	1.4 E - 16 ± 96%	5.4 E - 02	5.9 E - 07 ± 8%	9.5 E - 05 ± 10%	6.2 E - 03
	13	4.4 E - 18 ± 21%	1.0 E - 18 ± 30%	2.2 E - 01	3.2 E - 16 ± 56%	1.4 E - 02	2.2 E - 07 ± 12%	3.0 E - 05 ± 16%	7.3 E - 03
	14	1.6 E - 17 ± 13%	1.7 E - 19 ± 29%	1.1 E - 02	1.6 E - 16 ± 79%	1.0 E - 01	6.2 E - 07 ± 3%	8.6 E - 05 ± 4%	7.2 E - 03
	15	3.6 E - 18 2 23%	3.7 E - 19 ± 40%	1.0 E - 01	1.7 E - 16 ± 63%	2,1 E - 02	3.7 E - 07 ± 3%	5.2 E - 05 ± 4%	7.1 E - 03
Nov	1	4.1 E - 18 ± 16%	8.0 E - 19 ± 29%	2.0 E - 01	1.7 E - 16 ± 17%	2.4 E - 02	1.5 E - 07 ± 2%	2.2 E ~ 05 ± 3%	6.8 E - Q3
	2	3.9 E - 18 ± 162	2.1 E - 19 ± 43%	5.4 E - 02	1.1 E - 16 ± 20%	3.5 E - 02	1.5 E - 07 ± 2%	2.1 E - 05 ± 3%	7.1 E - 03
	12	5.2 E - 18 ± 15%	2.7 E - 19 ± 56%	5.2 E - 02	1.4 E - 16 ± 14%	3.7 E - 02	3.5 E - 07 * 2%	5.2 E - 05 ± 3%	6.7 E - 03
	13	5.0 E - 18 ± 16%	9.6 E - 19 ± 27%	1.9 E - 01	1.3 E - 16 ± 16%	3.8 E - 02	1.7 E - 07 ± 2%	2.4 E - 05 ± 3%	7.1 E - 03
	14	5.6 E - 18 ± 14%	4.2 E - 19 ± 36%	7.5 E - 02	1.5 E - 16 ± 182	3,7 E - 02	1.7 E - 07 ± 2%	2.4 E - 05 : 3%	7.1 E - 03
	15	5.3 E - 18 ± 147	2.5 E - 19 ± 38%	4.7 E - Q2	1.4 E - 16 ± 16%	3.8 E - 02	1.7 E - 07 ± 2%	2.3 E - 05 1 3%	1.4 E - 03
)ec	1	4.6 E - 18 ± 232	1.5 E - 19 ± 82%	J. J E - 02	5.4 E - 16 ± 22%	8.5 E - 03	4.9 E - 07 : 2%	7.0 E - 05 · 3%	7.0 E - 03
	2	4.9 E - 18 ± 30%	3.9 E - 19 ± 76%	8.0 E - 02	5.0 E - 16 ± 162	9.8 E - 03	5.1 E - 07 : 2%	7.3 E - 05 ± 3%	7.0 E - 03
	12	6.8 E - 18 ± 21%	6.0 E - 19 ± 672	8.8 E - 02	7.4 E - 16 ± 182	9.2 E - 03	8.4 E - 07 ± 2%	1.2 E - 04 : 32	7.0 E - 03
	13	4.0 E - 18 ± 222	7.0 E - 19 : 43%	1.8 E - 0;	5.6 E - 16 : 12%	7.1 E - 03	4.2 E - 07 ± 2%	6.1 E - 05 : 3%	6.9 E - 03
	14	1.2 E - 17 ± 25%	1.1 E - 18 ± 45%	9.2 E - 02	5.7 E - 16 : 18%	2.1 E - 02	5.0 E - 07 : 2%	7.1 E - 05 ± 3%	7.0 E - 03
	15	4.6 E - 18 ± 25%	4.8 E - 19 ± 56%	1.0 E - 01	8.6 E - 16 : 15%	5.3 E - 03	4.8 E - 07 ± 2%	6.9 E - 05 : 32	7.0 E - 03

Table 6. (continued)

Annual ave Location	rages ²³⁹ Pu (µCi/ml)	, ₁₃ , c	238 _{Pu (µCi/mi)}	zec^d	235 _{(c. g/m} 3)	:cn ^e	23H _{(' (ug/m³)}	*CGf
1	2.1 E - 17 ± 69%	3.5 F - 02	8.6 E ~ 19 · 697	1.2 E - 01	2.9 E = 07 + 52"	1.5 F - 85	4.3 E - 05 · 49%	2.8 F = 04
2	1.9 E - 17 ± 77%	3.2 E - 02	5.9 E - 19 · 64%	8.4 E - 03	2.6 E - 07 + 421	1.4 E - 05	3.6 E = 05 + 457	2.4 F = 34
12	2.3 E - 17 ± 68%	3.8 E - 02	9.5 E - 19 · 1032	1,4 E = 01	5.2 E - 07 + 38%	2.7 E - 05	7.7 E = 05 ± 37	5.1 E - 04
13	1.8 E - 17 ± 76%	3.0 E - 02	7.4 E - 19 ± 46%	1.1 E - 03	3.0 E - 07 · 617	1.6 F - 05	4.3 E - 05 ! 59%	2.9 E - 04
14	3.4 E - 17 ± 78%	5.7 E - 02	1.9 E - 19 · 2002	2.7 E - 01	4.9 E = 07 ± 683	2.6 F - 05	7.0 E - 05 ± 66%	4.7 F = 03
15	2.2 E - 17 ± 77%	3.7 E - 02	8.6 E - 19 : 56%	1.2 E - D3	3.6 E - 07 · 512	1.9 E - 05	5.1 E = 05 · 492	3.4 F = 04

See Fig. 2 for sampling locations.

bactivity listed as 239 Pu includes activity due to the 240 Pu isotope.

CCG = 6.0 E - 14 µC1/ml for 239 Pu in the soluble form.

 $^{^{}d}$ CG = 7.0 E - 14 μ Ci/ml for 238 Pu in the soluble form.

 $e_{CG} = 1.90 \text{ mg/m}^3$ for ^{235}U in the insoluble form.

 $f_{CG} = 15.0 \text{ µg/m}^3$ for ^{238}U in the insoluble form. $g_{\text{The ratio of }}^{235}\text{U/}^{228}\text{U}$ is 7.25 E - 03 in natural uranium.

Table 7. Plutonium, strontium, and uranium concentrations in air at Site 300 during 1975.

	Activity	(µC1/ml)		Activity (µCi/ml)		Mass	(μg/m ³)	
Month	239 _{Pu}	238 _{Pu}	²³⁰ Pu/ ²³⁹ Pu	90 _{Sr}	²³⁹ Pu/ ⁹⁰ Sr	235 _U	238 _U	²³⁵ u/ ²³⁸ u ^a
Jan	2.3 E - 17 ± 12%	4.B E - 19 ± 52%	2,1 E ~ 02	1.1 E - 15 ± 6%	2.1 E - 02	1.5 E - 07 + 2%	3.1 E - 05 ± 3%	4.8 E - 03
Feb	3.4 E - 17 ± 12%	2.9 E - 19 ± 442	8.5 E - 03	1.7 E - 15 ± 6%	2.0 E - 02	1.7 E - 07 · 22	3.3 E - 05 ± 32	5.1 E - 03
Mar	5.5 E - 17 ± 9%	1.5 E - 18 ± 192	2.7 R ~ 02	2.9 E - 15 ± 47	1.9 E - 02	4.1 E - 07 ± 2%	1.3 E - 04 + 4%	3.2 E - 03
Apr	4.1 E - 17 ± 14%	8.1 E - 19 ± 342	2.0 E ~ 0?	2.2 E - 15 ± 5%	1.9 E - 02	1.5 E - 07 + 2%	3.4 E - 05 + 3%	4.4 E - 03
May	5.6 E - 17 ± 8%	1.4 E - 18 ± 187	2.5 E ~ 02	3.1 E - 15 ± 5%	1.8 E - 02	4.6 E - 07 + 27	9.3 E - 05 · 3X	4.9 E - 03
June	5.0 E - 17 ± 132	1.8 E - 18 ± 28%	3,6 E ~ 02	3.1 E - 15 ± 62	1.6 E - 92	1.4 E - 07 + 27	5.0 E - 04 ± 37	2.8 E - D4
July	1.1 E - 17 ± 5%	1.1 E - 18 ± 12%	1.0 E ~ 01	1.2 E - 15 : 117	9.1 E - 03	4.3 E - 07 + 2%	7.2 E - 95 ± 2%	6.0 E - 03
Aug	1.8 E - 17 ± 72	8.6 E - 19 + 29%	4.8 E ~ 02	9.8 E - 16 * 152	1.8 E - 02	8.0 E - 07 + 2Z	2.8 E - 04 + 32	2.9 E - 03
Sept	1.3 E - 17 ± 62	8.3 E - 19 ± 182	6.4 E ~ 02	5.8 E - 16 ± 142	2.2 E - 02	5.1 E - 07 · 22	1.6 E - 04 ± 32	3.2 E - 03
Oct	2.1 E - 17 ± 62	9.5 E - 19 ± 12%	4.5 E ~ 02	3.0 E - 16 ± 25%	7.0 E - 02	3.8 E - 07 ± 3%	6.1 E - 05 ± 47	6.2 E - 03
Nov	6.7 E - 18 ± 62	7.0 E - 19 ± 162	4.5 E ~ 02	1.4 E - 16 ± 72	4.8 E - 02	1.8 E - 07 ± 2%	2.7 E - 05 + 2Z	6.7 E - 03
Dec	1.0 E - 17 ± 8%	5.3 E - 19 ± 21%	5.3 E ~ 02	7.5 E - 16 ± 92	1.3 E - 02	3.7 E - 07 ± 27	9.9 E - 05 ± 32	3.7 E - 03
Annual								
Avg	2.8 F - 17 ± 65%	9.0 E - 19 ± 53%	4.1 E ~ 02	1.5 E - 15 ± 72%	1.9 E - 02	3.5 E - 07 · 582	1.3 E - 04 · 100z	4.3 E - 03
CG	6.0 E - 14 (sol)	7.0 E - 14 (sol)		3.0 E - 11 (sol)		1.9 (insol)	1.5 E + 01 (insol)	
ZCG	4.7 E - 02	1.3 E - 03		5.0 E - 03		1.8 E - 05	9.7 E - 04	

^aThe ratio of 235 U/ 238 U is 7.25 E - 03 in natural uranium.

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Table 8. Tritium (MTO) in air at LLL perimeter locations during 1975 (µCi/ml).

		Janua	January ~ June				- December				Calculated
Locatio	Number of na samples	Maximum	Minimun	Average	Number of samples	Maxlmum	Minimum	Netare	Annual	-c. 1-	annual iduli whole-body dose (mrem)
1	26	1.0 E - 10 ± 27	1.0 E - 11 · 82	1.3 E - 11	25	1, 5 E - 10 + 27	1.6 E - 11 · 16'	. 0 E - 11	3.5 1 - 11	1.8 (- 0.7	5.6 F = 35
2	26	8.6 E - 11 + 22	5,2 E - 12 1 257	3.2 E = 11	25	4.1 E - 10 1 1	1.2 E - 11 1 161	6.7 E - 11	4.9 F - 11	2.5 8 00	7.8 F - 01
12	25	2.9 E - 10 : 172	1.4 5 - 11 : 67	7.8 E - 11	22	2.6 E = 10 * 12	3.8 F = 11 + 47	1.0 E - 10	8.8 F - 11	4.5 F = 82	1.4 F - 01
13	26	5.4 F - 11 ± 42	8.5 E - 12 1 112	2.0 E - 11	22	8.7 E = 11 + 27	1.3 E = 11 1 15"	1.0 F - 11	2.5 E = 11	1.2 r = 02	4.0 F - 03
14	25	1.4 E - 10 ± 27	1.1 E - 11 / 72	4.8 E - 11	25	1.5 E - 10 + 2%	1.9 E = 11 + 5"	1.1 E - 11	5.0 F - 11	2,5 F - 02	$s_* o_* r + o_*$
15	26	6.7 E - 11 : 32	7.6 E - 12 : 102	2.8 E - 11	25	1.2 F = 40 + 45	1.2 % = 11 × 193	4.2 F - 11	4.5 F - 11	1.8 1 - 02	5,6 8 - 02
Annual .	average								4-71 - 11	2.4 F = 02	7.5 8 - 02

⁴See Fig. 2 for sampling locations.

bConcentration guide for tritium (HTO) in air is 2.0 E = 07 LCI/ml.

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Table 9. Concentrations of various radionuclides in Livermore Valley soil samples during 1975.

	Sampling		Activity (µCi/dry g)		Mass (µg/dry g)	
Location ^a	Depth (cm)	239 _{Pu}	40 _K	137 _{Cs}	232 _{Th}	235 _U	238 _U
535	0 - 1	5.0 E - 09 ± 5Z	1.5 E - 05 1 11%	2.6 E - 07 ± 9%	6.4 E - 00 ± 13%	1.9 E - 02 + 95%	1.9 E - 00 ± 972
536	0 - 1	1.7 E - 09 ± 7%	1.2 E - 05 ± 9%	7.6 E - 08 ± 16%	6.2 E - 00 ± 14%	8.0 E - 03 ± 30%	2.2 E - 00 ± 647
537	0 - 1	2.3 E - 09 ± 9%	9.7 E - 06 + 11X	1.1 E - 07 · 172	5.9 E ~ 00 + 167	1.4 E - 02 ± 627	2.3 E - 00 1 80%
538	0 - 1	9.9 E - 10 ± 10%	6.9 E - 06 ± 11%	1.8 E - 07 ± 117	3.4 E - 00 + 17%	1.0 E - 02 ± 627	1.6 E - 00 ± 27%
539	0 - 1	9.9 E - 10 + 16%	7.8 E - 06 ± 9%	3.9 E - 08 ± 39%	2.9 E - 00 → 22%	6.7 E - 03 ± 95%	-
540	0 - 1	1.2 E - 09 + 9%	1.0 E - 05 ± 11%	5.4 E - 08 ± 24%	4.8 E - 00 1 18Z	1.2 E - 02 + 82%	1.6 E - 00 + 31%
541	0 - 1	5.5 E - 09 ± 7%	8.3 E - 06 + 11%	4.0 E - 08 ± 56%	4.6 E ~ 00 + 9%	1.8 E - 02 ± 79%	1.7 E - 00 ± 907
542	0 - 1	6.2 E - 09 ± 14%	9.3 E - 06 + 92	3.5 E - 07 · 8%	4.6 E ~ 00 + 18%	1.6 E - 02 ± 90%	2.3 E - 00 ± 55%
543	0 - i	1.3 E - 08 ± 6%	1.2 E - 05 ± 9%	2.7 E - 07 ± 21%	5.5 E ~ 00 • 182	1.7 E - 02 + 93%	2.1 E - 00 + 967
544	0 - 1	4.7 E - 09 ± 92	1.3 E - 05 ± 10%	2.4 E - 07 ± 11%	4.9 E - 00 + 172	1.3 E - 02 + 99%	1.9 E - 00 ± 95%
545	0 - 1	4.5 E - 09 ± 6%	1.2 E - 05 ± 82	2.3 E - 07 ± 10%	5.5 E - 00 + 142	1.7 E - 02 ± 90%	1.6 E - 90 ± 67%
546	0 - 1	2.8 E - 09 ± 72	1.1 E - 05 ± 9%	1.5 E - 07 ± 21%	3.5 E - 00 + 23%	1.1 E - 02 ± 99%	1.5 E - 00 + 95%
547	0 - 1	2.1 E - 09 ± 8%	7.1 E - 06 ± 11%	1.2 E - 07 ± 14%	3.9 E ~ 00 ± 162	1.2 E - 02 ! 99%	1.9 E - 00 ± 80%
548	0 - 1	3.9 E - 09 ± 6%	1.2 E - 05 + 10%	2.3 E - 07 + 15%	5.0 E ~ 00 * 20%	1.2 E - 02 · 992	2.2 E - 00 ± 39%
549	0 - 1	3.0 E - 08 ± 52	1.1 E - 05 ± 9%	3.8 E - 07 + 112	5.2 E - 00 ± 187	9.0 E - 03 ± 99%	2.2 E - 00 + 76%
550	0 - 1	2.2 E - 08 + 5%	1.1 E - 05 ± 9%	2.4 E - 07 ± 102	5.4 E - 00 + 17%	7.4 E - 03 ± 99%	2.3 E - 00 + 657
551	0 - 1	3.3 E - 08 ± 5%	1.3 E - 05 ± 10%	2.0 E - 07 · 17%	5.0 E - 00 ± 242	1.0 E - 02 + 99%	2.1 E - 90 ± 957
563	0 - 1	2.2 E - 09 ± 6%	1.1 E - 05 ± 15%	1.3 E - 07 ± 242	4.8 E - 00 · 247	1.5 E - 02 · 99%	2.6 E - 00 + 827
564	0 - 1	9.9 E - 08 ± 5%	1.3 E - 05 + 10%	2.3 E - 07 · 15%	5.7 E ~ 00 * 182	1.2 E - 02 ! 99%	1.4 E - 00 : 997
565	0 - 1	1.2 E - 08 ± 6%	1.4 E - 05 + 72	3,6 E - 07 · 82	3.9 E ~ 00 172	8.1 E - 03 · 997	1.5 E - 00 ± 957

See Figs. 9 and 10 for soil sampling locations.

Table 10. Comparison of plutonium concentrations in off-site samples during 1974 and 1975 (MCi/dry g).

			1975		1974				
Depth (cui)	Location ^a	230 Pa	238 _{Pit}	$238_{\rm pu}/239_{\rm pu}$	Location	? 19 _{Pu}	238 _{Pu}	$238_{ m Pu}/239_{ m Po}$	
0 - 1	549	3.0 E = 08 · 52	3.6 E - 09 + 87	1.2 E - 01	519	3.7 F = 08 · 21"	4.3 E - 09 · 347	1.2 E - 01	
0 - 1	550	2.2 F - 08 * 3"	3.5 F = 09 + 55	1.6 E - 01	520	4.8 F - 08 + 6"	5.6 F - 09 + 9"	1.2 E - 01	
0 - 1	551	3.3 E = 08 - 5"	1.4 E = 09 × 8	1.0 E = 01	522	$8.7 E = 08 \pm 60$	$8.2 E - 09 + 9^{\circ}$	9.4 E = 02	
0 - 1	564	9.9 E = 08 + 5%	4.2 E = 09 + 71	4.2 E - 02	524	1.1 E - 08 * 5°	8.4 E - 10 ± 13°	7.6 E - 02	
0 - 1	565	1.2 F - 08 ± 62	4.6 E - 10 ± 167	3.8 F - 02	526	1.2 E = 08 + 5°	5.5 E - 10 + 157	4.6 E - 02	

aSee Fig. 10 for sampling locations.

Table 11. Plutonium, cesium, and uranium concentrations in Site 300 soil samples during 1975.

			tivity (µCi/dry g)		Activity (pCI/dry g)		Mass (ag/dry g)	
Location ^a	Depth (cm)	239 _{Pu}	238 _{Pu}	$^{238}_{Pu}/^{239}_{Pu}$	137 _{Cs}	235 _U	238 _t ,	$^{235}v/^{238}v$
552	0-1	2.2 E - OR ± 6%	9.5 E - 10 ! 142	4.3 E - 02	8.4 E - 07 ± 57	1.4 E - 02 · 997	3.3 E - 00 + 462	4.2 E - 01
553	0-1	9.6 E - 09 ± 6%	4.4 E - 10 ± 15Z	4.6 E - 02	5.5 E - 07 ± 132	2.0 E - 02 · 991	1.7 E - 00 + 632	5.4 E - 03
554	0-1	2.6 E ~ 08 · 52	9.5 E - 10 t 14Z	3.7 E - 02	1.6 E - 06 · 4"	9.2 E - 03 4 90%	1.8 E - 00 + 727	5.1 E = 03
555	0-1	5.8 E - 09 : 62	3.2 E - 10 ± 16%	5.5 E - 02	3.0 E - 07 · 122	2.8 E - 02 · 99%	3.5 E - 00 + 51%	8.0 E = 03
556	0-1	7.4 E ~ 09 ± 6%	3.8 E - 10 ± 162	5.1 E - 02	5. 1 E - 07 ± 67	1.1 E - 02 · 99%	3.3 E - 00 · 412	3.3 E - 03
557	0-1	7.2 E - 09 ± 6%	2.7 E - 10 : 172	3.8 E - 02	3.5 E - 07 ± 12%	3.1 E - 02 · 992	3.6 E - 00 · 47	8.6 E - 03
558	0-1	5.6 E - 09 ± 72	2.7 E - 10 ± 22%	4.8 E - 02	2.5 E - 07 + 152	2.7 E - 02 · 992	1.1 E - 01 t 29%	2.5 E - 03
559	0-1	7.3 E - 09 t 6Z	3.5 E - 10 ± 15%	4.8 E - 02	2.9 E - 07 ± 9%	1.5 E - 02 · 990	2.4 E - 00 · 70%	6.3 E - 03
560	01	9.6 E - 10 : 13Z	5.9 E - 11 ± 41%	6.1 E - 02	4.1 E - OH / 65%	1.8 E = 02 · 99%	4.9 E - 00 ± 54%	3.7 E - 03
561	0-1	3.6 E - 09 ± 7%	2.3 E - 10 * 21%	6.4 E - 02	2.4 E - 07 ± 112	3,5 E - 01 + 82	1.9 E - 02 ! 9%	1.8 E - 03
562	0-1	3.1 E ~ 09 ± 102	1.2 E - 10 ± 35%	3.9 E - 02	1.3 E - 07 ± 15%	1.3 E - 02 * 992	3.2 E - 00 ± 69%	4.1 E - 03
575 ^b	0-1	6.3 E - 09 ± 82	2.0 E - 10 · 112	3.2 E - 02				
576 ^b	0-1	2.4 E - 08 ± 62	8.2 E - 10 · 142	3.4 E - 02				

a See Fig. 11 for sampling locations.

bSamples 575 and 576 are replicates of samples 554 and 552, respectively.

Table 12. Gross alpha activity in Livermore Water Reclamation Plant samples during 1975 ($\mu \text{Ci/ml}$).

		Di	gesters		Aeration Tank				
Month	Number of Samples	Maximum	Minimum	Average	Number of Samples	Ma:imum	Minimum	Average	
January	8	1.4 E - 08 : 19Z	5.1 E - 09 + 1002	8.4 E - 09	4	5.6 E - 08 + 467	3.2 E - 08 + 627	4.3 E - 08	
February	8	2.9 E - 09 : 452	1.6 E - 09 · 60%	2.1 E - 09	4	3.0 E - 09 - 457	1.3 E = 99 · 100%	2.1 E - 09	
March	5	6.4 E - 09 ± 592	4.3 E - 09 · 757	5.4 E - 09	4	5.6 E - 08 · 457	2.0 E - 08 + 100X	3.8 E - 08	
Apvil	5	1.6 E - 08 ± 38Z	7.1 E - 09 + 592	1.2 E - 08	5	4.4 E - 08 · 482	2.1 E = 08 + 1002	3.4 F 08	
Hay	8	2.4 E - 08 + 362	1.1 E - 08 · 457	1.7 E - 08	4	4.6 E = 08 · 557	2.1 E - 08 + 597	3.3 E - 08	
June	g	1.8 E - 08 ± 482	6.3 E - 09 ! 100%	1.3 E - 08	4	4.5 E - 08 · 577	1.1 E - 08 · 1007	2.7 E - 08	
July	10	1.8 E - 08 : 65%	6.3 E - 09 + 1007	1.1 E - 08	5	5.5 E - 08 + 15%	1.9 E = 08 · 812	3.8 E - 08	
August	8	1.6 E - 08 : 372	9.5 E - 09 · 427	1.3 E = 08	4	5.0 E - 08 1 197	2.9 E - 08 + 45?	3.9 E ~ 08	
September	10	1.5 E - 08 ± 53%	7.1 E - 09 * 437	1.0 E = 08	5	5.1 F = 08 · 417	2.0 E = 08 + 482	3.3 E - 08	
October	8	2.7 E - 08 + 35%	6.7 E - 09 · 42%	1.3 E - 08	4	3.7 E - 08 · 397	2.0 E - 08 + 55%	2.6 E - 08	
November	В	1.2 E - 08 ± 32%	3.2 E - 09 * 60%	8.5 E = 09	4	3.9 E = 08 + 377	1,9 E - 08 + 51%	2.6 F - 08	
December	10	1.1 E - 08 ± 402	3.5 E - 09 1 57%	7.0 E = 09	5	3.0 E - 08 - 367	1.8 E - 08 + 547	2.3 E = 08	

Table 13. Gross beta activity in Livermore Water Reclamation Plant samples during 1975 ($\mu CI/mI$).

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Table 14. Comparison of various radionuclides in LLL and Livermore Water Reclamation Plant effluents during 1975 (µCi/ml).

	2.39	Pu	94	Sr	Triti	<u> </u>
Month	LLI.	LWRP	1.1.1.	LNRP	I,LI.	LWRP
Lim	4,9 1 10 - 5"	7.2 E - 11 - 342	3.7 E - 10	2.6 E - 09	3.1 E - 04	2.3 E - 05
Feb	apr 1, - 10 - 31	8.3 E - 11 - 14%	9.5 E - 10	7.9 E - 10	1.0 E - 04	6.1 E - 06
Mar	1.2 E - 10 1 3	1.6 E - 11 · 13'	9.0 E - 10	9.1 E - 10	2.7 E - 05	5.1 E - 06
Apr	1.9 E = 00 - 4.	1.7 L - 11 + 7%	6.3 E - 10	3,2 E = 09	1.1 E - 04	1.1 E - 05
May	1.5 F = 10 × 45	4.6 E - 10 / 165	1.5 E = 09	1.2 E - 09	4.7 E - 04	1.7 E - 05
lune	W.9 F ~ 10 * 4	2.4 E = 10 ± 271	2.7 E - 09	2.8 E - 09	1.9 E - 05	5.8 E - 06
July	4.3 E = 10 + 5.	5.7 E - 12 = 22	9.2 E = 10	1.2 E - 10	5.2 E - 05	6.0 E - 06
Aug	1.7 h - 10 · 5	1.8 E - 11 · 122	1.2 E - 09	2.3 E - D+	5.2 5 - 05	3.4 E = 06
nept	3,9 1 - 10 - 42	7.6 E + 12 + 11.	1.1 E - 09	1.1 E = 09	2.3 E - 05	2.2 E + 00
i i e t	9.9 L = 10 ± 42	1.2 E - 10 · 105	8:9 % - 10	2.6 E - 10	1.2 E - 05	1.4 5 - 06
Nov	3.3 E = 10 f 6%	5.2 E - 11 1 211	8.6 E - 10	7.5 E - 10	6.8 E - 05	5.6 E - 06
bec	1.2 E = 09 × 41	1.7 E - 11 : 31	1.9 L - 09	.1 E - 10	7,1 E - 05	4.6 E - 06
Annual avg	6.3 L = 10	9.4 E - 11	1.2 E = 09	1.4 E - 09	1.1 E = 04	9.3 E - 06
CG.	1.0 E - 05	3.0 K - 05	3.0 E - 07	3.0 E - 07	3.0 E - 03	3.0 E - 03
acq.	2.1 E - 03	3.1 E - 04	4.0 E - 01	4.7 E - 91	3.7 E - 00	3.1 E - 01

Table 15. Gross beta activity in water samples from the Livermore Valley during 1975 (µCi/ml).

Locatio	Number of samples	Maximum	Minimum	Annual average	, CG
11	4	3.3 E - 09 ± 100%	2.3 E - 09 : 1007	2.7 E - 09 · 10*	ģ
13	12	5.0 E - 09 : 100%	2.0 E - 09 ± 100%	2.8 E - 09 - 31"	i,
15	4	4.0 E = 09 ± 332	2.3 E - 09 1 1005	3.0 E = 09 · 265	10
16	4	3.3 E - 09 ± 35%	2.3 E - 09 1 100%	3.0 E - 09 · 16"	10
19	4	3.3 E = 09 ± 100Z	2.3 E = 09 ± 100%	2.7 E = 89 · 36"	9
20	6	1.5 E - 08 ± 19%	4.7 E = 09 * 301	9.3 E + 09 - 47%	31
24	4	5.7 E = 09 ± 28%	3.3 E - 09 : 100%	4.6 E = 09 1 221	1.7
26	4	3.3 E - 09 · 100%	2.3 E - 09 - 100%	2.8 E - 09 - 15'	٠,
Annual	average			3.9 E - 09 - 59.	1 i

^aSee Figs. 2 and 3 for sampling locations.

^bConcentration Guide for gross beta activity in water is 3.0 E - 08 LCi/ml.

Table 16. Gross beta activity in water samples from Site 300 during 1975 (uCi/ml).

Locationa	Number of samples	Maximum	Min imum	Annual average	,,,b
1	11	6.2 E - 09 ± 20%	2.5 E - 09 / 350	. F = 00 ' = 1'	: '
2	3	7.1 E - 09 : 25%	5.2 E - 09 · 297	$6.4 \pm 0.0 \pm 16$.1.
3	3	8.7 E - 09 ± 24%	4.9 E - 09 / 30°	$n_{*+} = 1 - m^{\alpha} = 3^{\alpha}$	
4	3	1.1 E - 08 ± 21%	6.0 E - 09 · 28%	8.1 F = 09 + Q	
5	3	5.4 E - 09 ± 230	3.2 E - 09 · 355	4.6 T = 36 - 26	
6	11	6.3 E - 09 ± 21%	3.2 E - 09 · 1000	$4.9 \text{ E} = 99 \times 21$	1.
7	3	5.9 E - 09 ± 28%	5.0 E - 09 : 29°	5.4 E = 09 + 81	
11	5	7.7 E - 09 ± 25%	3.9 E - 09 · 269	6.4 F = 09 24	1
14	5	6.1 E - 09 ± 26%	3.9 E - 09 · 31	5.0 [- 64 - 75	٠,
20	3	8.1 E - 09 ± 25%	6.6 E - 09 ± 267	7.21 - 69 - 11	
21	5	8.2 E - 09 ± 17%	3.7 E - 09 ± 31°	6.1 E - 99 211	1.1
Annual ave	erage			5.9 E - 09 19	

^aSee Figs. 4 and 5 for sampling locations.

Table 17. Tritium in water samples from Livermore Valley during 1975 (μ C1/m1).

Locationa	Number of samples	Maximum	Minimur	Therape	. _e . +	Calculated adult while Ends were sprent
111	4	1.3 E - 07 = 103	1.0 E - 07 = 10"	1,1 E - 97	3,9 E - 1	4.5 % - 33
15	4	1.8 E - 07 : 12%	1.5 E + 07 ± 60	1.7 E - 97	5.5 5 - 93	5.8 E = 3
16	4	3.2 E - 07 : 7%	2.1 E - 07 ± 62	2.7 E - 07	9,0 E = 03	1.1 E = 92
19	4	1.7 E - 07 : 11%	6.7 E - 08 : 105	1.2 E - 07	3.9 E - 03	4.8 E - 03
20	5	5.3 E - 07 = 8%	1.3 E - 07 : 9%	3.1 E - 07	1.0 E - 02	1.2 E - 02
24	4	2.0 E - 06 ± 2%	2.9 E - 07 : 4%	1,1 E - 06	3.8 E = 02	4.4 E = 02
26	4	2.8 E - 06 ± 2%	2.6 E - 07 : 5%	9.1 E - 07	3.0 E - 02	3.6 E - 02
Annual ave	erage			4.3 E - 07	1.4 E - 02	1.7 E - 02

a See Figs. 2 and 3 for sampling locations.

^bConcentration Guide for beta activity in water is 3.0 E - 08 LCI/ ϵ 1.

^{*}Concentration Guide (CG) for tritium in water is 3.0 E = 01 GCI/ml.

Table 18. Tritium in water samples from Site 300 during 1975 ($\mu \text{Ci/ml}$).

Locat jond	Number of samples	Маж і тип	Minimum	Average	xcc_{μ}	Calculated adult whole body dose (mrem)
1	<u> </u>	6.7 E - QE ± 9%	7.5 E - 09 ± 100%	2.2 E - 98	7.3 E - 54	8.R E - 04
2	2	1.8 E - 98 - 42%	1.7 E ~ 08 : 100%	1.8 E - 08	5,8 E ~ 04	7.2 E - 04
1	2	1.6 E = 08 : 100%	7.1 E - 09 · 100%	1.1 E = 08	3.8 E + 04	4.4 E - 04
4	2	2.9 E - 08 · 29%	1.3 E = 98 ± 60%	2.1 E - 08	6.9 E - 04	8.4 E - 04
1	2	4.8 E - 08 · 201	2.3 E = 0a : 327	3.5 E - 08	1.2 E - 03	1.4 E - 63
13	q	5,4 E + 08 t 8*	6.7 E - 09 : 1007	2.5 F = 08	8.4 E = 04	1.0 E - 03
7	2	3.0 E - 08 : 337	1.1 E = 08 : 61%	2.1 F - On	6.9 E - 04	8.4 E - 04
11	4	7.2 E = 08 ± 11%	6.5 E - 69 - 100°	2.9 E - 09	9.7 E - 04	1.1 E - 03
1.	4	1.3 E - 07 : 101	1.2 E = 67 · 7:	1.3 E - 07	4.3 E - 03	5.3 E - 63
20	7	3.2 E - 07 - 5"	7.9 E - OB : 10%	1.5 E - 07	5.1 E - 63	6.0 F - 03
21	•	4.5 E = 08 ± 22°	2.1 E - 98 - 457	3.2 # - 0p	1.1 E = 03	1.2 E - 03
Annua, aze	erage			4.5 E - 08	1.5 E - 95	1.8 E - 03

[&]quot;See Figs. 4 and 5 for sampling locations.

Table 19. Tritium in Livermore Valley vegetation during 1975 (μ Ci/dry g).

Location ^a	Number of samples	Max imum	Minimum	Average	Calculated adult whole body dose (mrem)
4	7	1.6 E - D6 + 49%	1.1 E - 07 · 89	9.1 E - 07	1.3 E - 02
15	8	1.6 E - 05 * 9%	2.8 E - 06 ± 27%	9.3 E - 96	1.4 E - 01
16	8	1.8 E - 06 ± 397	1.4 E - 07 : 10%	9.3 E - 0:	1.4 E - 02
20	8	2.6 F - 06 ± 117	1.8 E - 07 · 4.5"	1.4 E - 06	2.1 E - 02
21	В	6.8 E - 06 ± 11%	6.1 E - 07 - 37"	3.4 E - 06	5.1 E - 02
22	В	4.1 E - 06 * 12%	1.3 E - 06 + 54°	2.7 E - 06	4.1 E - 02
23	8	6.9 E - 06 ± 117	3. E - 07 + 45	4,2 E - 06	6.3 E - 02
200	8	2.0 E - 05 ± 5%	3.3 E - 06 ± 5"	9.9 E - 06	1.5 E - 01
30	8	6.9 E - 06 ± 12%	1.2 E - 06 : 71%	4.5 E - 06	6.8 E - 02
31	8	2.4 E - 05 ± 5%	1.1 E - 06 ± 247	8.5 E ~ 06	1.3 E - 02
Annual ave	erage			4.6 E - 06	6.9 E - 02

^aSee Fig. 3 for sampling locations.

 $^{^{\}rm h}_{\rm Concentration~Guide}$ (CG) for tritium in water is 3.0 E = 4.3 LCi/m1.

Table 20. Tritium in Site 300 vegetation during 1975 ($\mu Ci/dry$ g).

I.ocation ^a	א mber יי samples	Maximum	Minimum	Average	Calculated annual adult whole body dose (mrem)
1	8	1.1 E - 06 ± 73%	7.7 E - 08 ± 100%	1.2 E - 07	1.8 E - 03
2	8	1.1 E - 06 ± 77%	1.7 E - 07 ± 100%	3.3 E - 07	4.8 E - 03
3	8	8.2 E - 07 ± 74%	3.7 E - 07 ± 100%	4.7 E - 07	6.9 E - 03
5	8	8.0 E - 07 ± 50%	1.1 E - 07 ± 100%	2.3 E - 07	3.4 E - 03
6	8	4.1 E - 05 ± 3%	2.3 E - 07 ± 100%	8.2 E - 06	1.2 E - 01
11	8	7.4 E - 07 ± 100%	1.6 E - 07 ± 100%	1.6 E - 07	2.3 E - 03
12	6	5.9 E - 07 ± 52%	1.5 E - 07 ± 100%	2.9 E - 07	4.2 E - 03
13	8	3.3 E - 04 ± 1%	6.7 E - 07 ± 100%	5.2 E - 05	7.9 E - 01
Annual ave	erage			7.7 E - 06	1.1 E - 01

^aSee Figs. 4 and 5 for sampling location.

Table 21. Radionuclides observed in milk samples during 1975 (µCi/ml).

Radio- nuclide	Number of samples	Maximum	Minimum	Average	Calculated aunual adult dose (mrem)	Critical organ
San Joaqu	ir Valley					
3 _H	1.2	5.4 E - 07 ± 39%	1.4 E - 07 ± 100%	2.4 E - 07 ± 57%	7.9 E - 04	Whole body
⁴⁰ K	12	1.4 E - 06 ± 4%	1.2 E - 06 ± 4%	1.3 E - 06 ± 4%	5.8 E - 00	Whole body
137 _{Cs}	12	2.0 E - 09 ± 27%	3.1 E - 10 ± 100%	1.0 E - 09 ± 60%	6.0 E - 03	Whole body
Livermore	Valley					
3 _H	9	3.4 E - 07 ± 45%	2.6 E - 08 ± 100%	1.8 E - 07 ± 47%	5.5 E ~ 04	Whole body
⁴⁰ K	10	4.5 E - 06 ± 3%	9.8 E - 07 ± 3%	1.3 E - 06 ± 17%	5.8 E - 00	Whole body
137 _{Cs}	10	4.1 F - 09 ± 13%	5.2 E - 10 ± 100%	1,6 E - 09 ± 63%	9.6 E - 03	Whole body

Table 22. Environmental radiation measurements at the Lawrence Livermore Laboratory perimeter during 1975 (mrems).

Locationa	January-March	April-June	July-September	October-December	Annua1 ^b
1	18 ± 0.7	15 ± 1.1	12 ± 1.4	17 ± 3.7	62
2	17 ± 1.7	14 ± 1.6	12 ± 1.4	17 ± 3.2	60
3	17 ± 4.8	14 ± 2.2	15 ± 2.1	16 ± 5.0	62
4	18 * 0.7	13 ± 1.5	13 ± 1.0	15 ± 1.5	59
5	53 ± 3.0	29 ± 3.3	34 ± 5.2	23 ± 5.6	139
5a	80 ^c	70 ^c	100	67	317 ^d
6	17 ± 1.1	Lost	14 ± 2.8	17 ± 3.3	64
7	15 ± 1.1	12 ± 1.4	12 ± 1.4	16 ± 13.5	55
8	15 ± 3.6	Lost	11 ± 2.5	14 ± 5.2	53
9	16 ± 2.2	13 ± 0.8	13 ± 2.4	13 ± 5.2	55
10	17 ± 1.8	15 ± 2.2	Lost	18 ± 4.0	67
11	18 ± 1.9	16 ± 1.3	14 ± 1.7	21 ± 5.6	69
12	15 ± 3.6	16 ± 1.4	15 ± 1.5	31 ± 4.8	77
Average	24.3	20.6	22.1	22.2	88

^aSee Fig. 2 for dosimeter locations.

^bTLD measurements in the off-site vicinity of the Laboratory (Fig. 13) show a median annual background of 59 mrem. However, subtracting this number from the data above to estimate the contribution from Laboratory operations yields several "negative" contributions, which demonstrate that the background at the various perimeter locations cannot be represented by a single value.

^CGamma doses during the first two quarters are estimates based on neutron/gamma ratios observed during the last two quarters.

 $^{^{\}text{d}}\text{Neutron}$ dose measurements at Location 5a indicate an additional annual dose of approximately 700 mrem.

Table 23. Concentration of beryllium in LLL perimeter air filters during 1975 ($\mu g/m^3$).

Locat ion ^a	January	February	March	April	May	June	July	August	September	October	November	December	Annual average
1	6.0 E - 06	6.3 E - 07	6.3 E - 06	1.6 E - 05	3.3 E - 05	2.9 E - 05	2.4 E - 05	2.6 E - 05	3.9 E - 05	1.7 E - 05	7.9 E - 06	1.1 E - 05	1.8 E - 05
2	3.9 E - 06	7.6 E - 07	<5.0 E - 07 ^b	1.7 E - 05	2.4 E - 05	1.6 E - 05	1.3 E - 05	1.9 E - 05	2.9 E - 05	1.1 E - 05	<5.0 E - 07	9.9 E - 06	<1.2 E - 05
12	2.4 E - 05	8,3 E - 07	4.5 E - 05	4.8 E - 05	5,7 E ~ 05	4.5 E - 05	2.1 E - 05	3.6 E - 05	4.8 E - 05	3.2 E - 05	3.0 E - 05	2.6 E - 05	3.5 E - 05
13	1.3 E - 05	6.3 E - 07	<5,0 E - 07	1.0 E - 05	3.2 E - 05	3.9 E - 05	2.6 E - 05	1.1 E - 05	1,9 E - 05	6.7 E - 06	6.2 E - 06	1.1 E - 05	<1.5 E - 05
14	3.8 E - 06	7.3 E - 07	<5,0 E - 07	6.0 E - 06	2,4 E - 05	3.6 E - 05	3.0 E - 05	5.1 E - 05	1,2 E - 04	3,2 E - 05	4.6 E - 0ú	6.2 E - 06	<2.6 E - 05
15	1.4 E - 05	7.2 E - 07	1,4 E - 05	5.8 E - 06	2.8 E - 05	2.8 E - 05	3.5 E - 05	2.0 E - 05	4.1 E - 05	2,5 E - 05	4.3 E - 06	1.3 E - 05	1.9 E - 05
Monthly average	1.1 E - 05	7.2 E - 07	<1.2 E - 05	1.7 E - 0S	3,3 E - 05	3.2 E - 05	2.5 E - 05	2.7 E ~ 05	4.9 E - 05	2,1 E - US	<8.9 E - 06	1.3 E - 05	<2.1 E - 05
% ntandard ^C	5.5 E - 04	3.6 E - 05	6.0 E - 04	8.5 E - 04	1.7 E - 03	1.6 E - 03	1.3 E - 03	1.4 E - 03	2.5 E ~ 03	1,0 E - 03	4.5 E - 04	6.5 E - 04	1.1 E - 03

See Fig. 2 for sampling locations.

Table 24. Concentration of beryllium in Site 300 air filters during 1975 ($\mu g/m^3$).

Location	January	February	March	Vbrij	May	June	July	August	September	Getober	No vembe r	December	Annual average
1	1.6 E - 05	5,8 E - 07	<5.0 E - D7	<5.0 E - 07	3.0 E - 05	1, - 1 - 05	1.6 E - 05	1.2 E - 05	2.3 E - 05	1,1 E ~ 05	1.9 E - 06	<5.0 E − 07	<1.0 E - 05
2	1.1 E - 05	6,3 E - 07	<5.0 E - 07	5.6 E ~ 06	3.6 F - 05	1,1 E - 05	8.0 E - g6	1.1 E - 05	2.3 E - 05	1.5 E ~ 05	3.0 E - 06	5.0 E - 06	<1.1 E - 05
3	9,9 E - 06	5,3 E - 07	5.0 E - 06	4,1 E - 06	3.6 E - 05	2,1 E - 05	1.9 E - 05	3.2 E - 05	3.1 2 - 05	1.4 E ~ 05	7.8 E - 06	9.8 E - 06	1,6 E - 05
4	<5.0 E - 07 ^b	7.6 E - 07	<5.0 E - 07	1,5 E - 05	6.4 E - 05	4.1 E - 05	3.9 E - 05	2.9 E - 05	1.9 E - 05	2.9 E ~ 05	1.1 E ~ 05	6.1 E - 05	<2.1 E - 05
5	<5.0 F - 07	<5.0 E - 07	5, 2 E - C6	1.5 E ~ 05	2,9 E = 05	2,6 F = 05	4.3 E - 05	2. 3 E - 05	5.1 E - 05	1.3 E ~ 05	1.8 t - D5	1,5 E ~ 05	<2.0 E - 05
,	7.7 E - 06	5.4 E - 07	1.0 E - 05	3.9 E - 06	3,1 E - 05	1.1 E - 05	3.3 E - 05	8,2 E - 06	2.8 E - 05	1.5 E ~ 05	1.2 E ~ 05	<5.0 E - 07	<1.3 E ~ 05
8	<5.0 E - 07	7.5 E - 07	<5.0 E - 07	5.4 E - 06	4, 1 E - 05	7.9 E = 06	4.5 E - 05	<5.0 E - 07	2.9 E - 05	8.0 E - 06	1,0 E - U5	<5.0 E - 07	<1.3 E - 05
9	7.7 E - 06	8.0 E - D7	<5.0 E - 07	1.1E - 05	3,9 E - 05	4,7 F - 06	3.0 E - 05	<5.0 E - 07	1.5 E - 05	8. 1 E - 194	2.5 E - 06	<5.0 E - 07	<1.0 E - 05
10	<5.0 E - 07	1.2 E - 06	1.6 E - 05	1,9 E - 06	7. 1 L - 05	1.1 E - 04	7.9 E - 05	9,9 E ~ 05	2.4 E - 05	1.1 E - D5	1.1 E - 05	<5.0 E - 07	<3,6 E = 05
11	<5.0 E - 07	5.6 E - 07	5.1 E - U6	4.5 E - 06	4.1 E - 05	4.3 E - 06	2.8 E - 05	2.7 £ - 05	2.3 E - 05	1,3 E - 05	5.5 E - 06	<5.0 E - 07	<1.3 E - 05
Honthly average	<5.5 E = 06	<6.9 E - 07	<4.4 E - 06	<7.1 E - 06	4.2 E - 05	2.5 E ~ 05	3.4 E - 05	<2.4 E ~ 05	2.7 E = 05	1.4 E ~ 05	8.3 E ~ 06	<3.9 E - 06	<1.6 E - 05
	<2.8 E - 0%	-											

[&]quot;See Fig. 4 for sampling locations.

blints of sensitivity is 5.0 E - 07 µg/m³.

^CEmission standard is 2 µg/m³ as reported in Federal Register, April 6, 1973.

blimit of sensitivity is 5.0 E - 07 mg/m³.

**Emission standard is 2 mg/m³ as reported in Federal Register, April 6, 1971.

Table 25. Monthly average concentrations of various elements in LLL sewage effluent during 1975 (mg/1).

Month	Cd	Cr	Cu	Fe	Pb	Ni	Ag	Zn	Fa
January	0.01	0.13	2.10	2.04	0.22	0.20	0.16	0.65	_
February	0.01	0.17	1.63	2.43	0.08	0.13	0.18	0.44	_
March	0.01	0.13	2.51	2.98	0.15	0.22	0.25	0.49	-
April	0.01	0.15	1.51	2.72	0.12	0.12	0.23	0.68	0.60
May	0.02	0.19	3.42	4.53	0.73	0.24	0.25	1.12	0.72
June	0.02	0.26	5.41	8.44	0.37	0.22	0.37	1.12	0.32
July	0.01	0.08	1.01	1.07	0.07	0.06	0.14	0.36	0.27
August	0.01	0.09	2.48	3.03	0.14	0.08	0.18	0.50	0.17
September	0.01	0.15	1.53	4.36	0.22	0.08	0.10	0.56	0.19
October	0.01	9.18	0.57	2.00	0.04	0.05	0.07	0.44	0.21
November	0.01	0.23	0.80	1.70	0.04	0.09	0.04	0.40	0.22
December	0.02	0.58	2.96	4.87	0.23	0.14	0.21	1.00	0.24
Annual average	0.01	0.20	2.16	3.35	0.20	0.14	0.18	0.65	0.33

^aMonthly fluoride measurements on sewage effluent began in April.

Table 26. Physical and chemical examination of LLL sewage effluent during 1975.

	S	1	4	- Annual				
Analysis	1st Quarter	2nd Quarter	3rd Quarter	4th Quarte				
воръ	78	31	37	44	48	÷	447	
COD	220	133	120	178	163	±	287	
Total nitrogen	25	22	24	38	27	÷	26*	
Ammonia nitrogen	16	12	18	5.3	13	÷	46%	
Nitrate nitrogen	1.2	1.5	0.10	10	3.2	ż	144"	
0il & grease	51	5	15	68	35	ŧ	86"	
Sulfate	56	_	42	59	52	•	170	
Arsenic	0.030	0.006	0.004	<.001	<.01			
Boron	0.42	0.4	0.4	1.1	0.58	<u>+</u>	60%	
Cyanide	0.25	0.011	0.09	0.29	0.16	•	81%	
Mercury	0.0170	0.0010	0.0011	0.0019	0.007	±.	1007	
Selenium	0.006	0.003	0.004	0.007	0.005	<u>+</u>	40?	
Settleable matter ^C	2.0	<0.1	<0.1	0.2	0.9	±	67%	
Total solids	248	200	239	355	261	Ť	25%	
Solids, dissolved	216	165	206	325	228	1	30%	
Solids, suspended	25	27	15	32	25	±	28%	
Total alkalinity ^d	100.0	91.4	79	130	100	±	22%	
Total phosphorus	2.5	1.9	2.8	4.4	2.9	±	38%	

^aData obtained from a composite of samples collected over a 24 hr period in each quarter.

Biochemical oxygen demand (5 day @ 20°C).

^CSettleable matter, m1/1/hr.

 $^{^{\}rm d}$ Alkalinity (mg/l CaCO $_{3}$).

Table 27. Physical and chemical examination of Site 300 sewage settling pond during 1975.

		24 hr Comp	osite, mg/l ^a			
Analysis	lst Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annua avera	
BODb	65	35	36	20	39	± 49%
COD	400	357	650	420	457	± 29%
Total nitrogen	18	15	31	20	21	± 33%
Ammonia nitrogen	<0.05	0.22	<0.05	0,11	0,11	± 73%
Nitrate nitrogen	0.04	0.14	0.45	0.10	0,15	± 93%
Oil and Grease	27	63	13	63	42	± 60%
ulfate	346	470	420	490	432	± 15%
Arsenic	0.002	0,006	0.003	0.014	0.006	± 83ኢ
Boron	4.3	4.7	1.4	5.8	4.1	± 46%
Cyanide	<0.001	0.001	0,005	0.003	0.003	± 67%
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	<0.000	1
Selenium	0.001	0,015	0.015	0.008	0,010	± 70%
Settleable matter ^C	<0.1	<0.1	<0.1	<0,1	<0.1	
Total solids	2158	2765	3370	3026	2830	± 18%
Solids, dissolved	1756	2667	2338	2893	2414	± 21%
Solids, suspended	182	64	184	98	132	± 46%
Solids, volatile	445	451	836	422	539	± 37%
Total alkalinity ^d	750	994	1199	1085	1007	± 19%
Total phosphorus	0.7	7.5	10.1	10.9	7,3	± 63%

^aData obtained from a composite of samples collected over a 24 hr period in each.

Table 28. Estimated radiation dose to public from LLL radioactive airborne effluents in 1975.

Nuclide	Facility	Curies released	Dose at site boundary (mrem)	Dose to nearest downwind resident (mrem)	Season	Dose within 80 km radius of LLL (man rem)
⁴¹ Ar	Bldg 281 - Livermore Pool type reactor	595	5.1	0.67	Wet Dry Annual	1.1 0.6 1.7
3 _{H2}	Bldg 331 - Gaseous Chemistry	2167	0,20	0.017	Wet Dry Annuel	0.14 0.07 0.21
3 _H 2	Bldg 212 - insulating core transformer accelerator	1217	1.63	0.020	Wet Dry Annual	0.11 0.07 0.18
13 _{N2} -15 ₀₂	Bldg 194 - Electron positron linear accelerator	1185	0.0051	0.0013		

bBiochemical oxygen demand (5 day @ 20°C).

CSettleable matter, ml/l/hr.

dAlkalinity (mg/1 CaCO₂).

Table 29. Percent of concentration guide of radionuclides detected in discharges to Livermore city severs.

Radionuclide	CG ^b (µCi/ml)	% CG
134 _{Cs}	9 E - 06	2.1 E - 01
137 _{Cs}	2 E - 05	9.5 E - 02
110 _{Ag}	3 E - 05	6.3 E - 02
¹²⁵ Sb	1 E - 04	1.9 E - 02
95 _{Nb}	1 E - 04	1.9 E - 02
56 _{Mn}	1 E - 04	1.9 E - 02
65 Zn	1 E - 04	1.9 E - 02
95 _{Zr}	8 E - 04	2.4 E - 03
60 _{Co}	3 E - 03	6.3 E - 04

^aAssuming each of the radionuclides was the sole source of the 1.9 E - 08 μ Ci/ml annual average gross beta activity in the dishcarge.

bERDAM 0524, Annex A, Table II.

Appendix B

Discharge Limits to the Sanitary Sewer Systems of the City of Livermore

The Code of the City of Livermore (1959) states the discharge requirements to its sanitary sewer system in Section 18.63. These limits are as follows:

Sec. 18.63.

No person shall discharge, or cause to be discharged, except for salt waste discharge from water softener units of any kind or description installed and in operation on or before January 31, 1966, which are regenerated by the owner thereof at the place of use of such units, any of the following described water or wastes to any public sewer unless the customer obtains a permit from the city in accordance with section 18.65.

- (a) Any liquor or vapor having a temperature higher than one hundred fifty degrees Fahrenheit.
- (b) Any waters or wastes which contain more than two hundred ppm of fat, oil or grease that is petroleum ether soluble.
- (c) Any gasoline, benzene, naphtha, fuel oil or other inflammable or explosive liquid, solid or gas.
- (d) Any garbage, except properly ground with a mechanical garbage grinder. Specifically excluded from the sewers are waste products resulting from the handling, storage and sale of fruits and vegetables from other than retail produce establishments, or other foods not intended primarily for immediate consumption.
- (e) Any ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, coal tar, asphalt, cement, plastics, woods, paunch manure or any other solid viscous substance capable of causing obstruction to the flow in sewers or other interferences with the proper economical operation of the sewage works.
- (f) Any wastes or water with a pH lower than six and eight-tenths or higher than eight.
- (g) Any waters or wastes containing total dissolved solids increments greater than three hundred and twenty-five ppm, nor chloride increment greater than seventy-five ppm, increase during a single cycle use of the water supply.

- (h) Any water or wastes having a B.O.D. greater than three hundred ppm (the average B.O.D. for residential users).
- (i) Any waters or wastes containing more than three hundred ppm of suspended solids (the average suspended solids for residential users).
- (j) Any waters intended to be used or used to dilute waste discharge to avoid violation of the above limitation. (Ord. No. 586. par 1.)

Sec. 18.66

No person shall discharge or cause to be discharged any radioactive wastes into any public sewers, except where:

- A. The waste is discharged in strict conformity with current atomic energy commission recommendations for safe disposal of radioactive wastes.
- B. The discharging of radioactive waste will not cause injury to personnel or damage to the sewage works. Any person discharging a radioactive waste to a public sewer in accordance with the provisions of the preceding paragraph shall submit to the council such report as the council may deem necessary.

In the event of any accidental spill of any radioactive material into the public sewer, the person responsible shall (a) immediately notify the plant superintendent, and (b) render such technical or other assistance to the department of public works within his power to prevent the sewage works from becoming contaminated with radioactivity. (Ord. No. 586, par 1.)

Appendix C

Environmental Activity Concentration Guide Levels

The Standards for Radiation Protection (AEC Manual Chapter 0524, issued 11/8/68) state that if there is a mixture in air and water of radionuclides whose identity and concentrations are unknown, the average activity should not exceed the following values:

		_12
1.	Air (controlled area)	6 × 10 ⁻¹² µCi/m1
2.	Air (uncontrolled area)	$2 \times 10^{-14} \mu \text{Ci/ml}$
3.	Water (controlled area)	$4 \times 10^{-7} \mu \text{Ci/ml}$
4.	Water (uncontrolled area)	$3 \times 10^{-8} \mu \text{Ci/m1}$

If it is known that alpha emitters and ²²⁷Ac are not present, the following guide values may be used to determine the permissible average activity:

5.	Air (controlled area)	$3 \times 10^{-11} \mu \text{Ci/ml}$
6.	Air (uncontrolled area)	$1 \times 10^{-12} \mu \text{Ci/ml}$

If it is known that ^{129}I , ^{226}Ra , and ^{228}Ra are not present, the following values may be used:

7.	Water	(controlled area)	3	×	10 ⁻⁶	μCi/ml
8.	Water	(uncontrolled are	a) 1	×	10-7	uCi/ml

The air and water samples are subjected to gross alpha and gross beta measurements. The average annual alpha activities may not exceed those listed under points 1 through 4 above. Since the alpha emitters have been accounted for in the gross alpha measurements, and the assumption is made that $^{129}\mathrm{I}$, $^{227}\mathrm{Ac}$, $^{226}\mathrm{Ra}$, and $^{228}\mathrm{Ra}$ are not present in the samples, and annual average gross beta activities of the samples may not exceed the activities listed under points 5 through 8 above. The assumption that $^{129}\mathrm{I}$, $^{227}\mathrm{Ac}$, $^{226}\mathrm{Ra}$, and $^{228}\mathrm{Ra}$ are not present in air and water samples is reasonable in view of the minute quantities of these radionuclides available at the Laboratory. AEC Manual Chapter 0524 also states that the average tritium activities in off-site water samples may not exceed 3 \times 10 $^{-3}$ $\mu\mathrm{Ci/ml}$.

Since analysis for 129 I, 126 Ra, and 228 Ra activities is made on samples collected from the Laboratory's sewage effluent at the point of discharge into the Livermore city sanitary sewer system, the gross alpha and beta activities

in the samples collected from the effluent discharged from the Livermore sewage treatment plant should not exceed the 1 \times 10 $^{-7}$ $\mu\text{Ci/ml}$ listed under point 8 above.

The annual external whole-body radiation dose to workers in controlled areas may not exceed 5 rem; while that to an individual in an uncontrolled area may not exceed 500 mrem. An average annual dose of 170 mrem may not be exceeded for a group of individuals in an uncontrolled area.