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ENVIRONMENTAL LEVELS OF RADIOACTIVITY IN THE VICINITY OF THE LAWRENCE LIVERMORE LABORATORY 1973 ANNUAL REPORT

W. J. Silver, C. L. Lindeken, J. W. Meadows,
W. H. Hutchin, and D. R. McIntyre

March 4, 1974

Prepared for U.S. Atomic Energy Commission under contract No. W-7405-Eng-48

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MS. date: March 4, 1974

Foreword

This report is prepared for the U.S. Atomic Energy Commission by the Environmental Evaluations Group of the Hazards Control Department at the Lawrence Livermore Laboratory. Data are obtained through the combined efforts of the Radiochemistry Division, the Bio-Medical Division and the Hazards Control Department.

Contents

ENVIRONMENTAL LEVELS OF RADIOACTIVITY IN THE VICINITY OF THE LAWRENCE LIVERMORE LABORATORY 1973 ANNUAL REPORT

Abstract

The Lawrence Livermore Laboratory continuously monitors the levels of radioactivity within the Livermore Valley and Site 300. Results of analyses performed during 1973 for gross radioactivity and for specific radionuclides of interest in a variety of environmental samples are presented in this report. In all cases, the levels of activity observed during 1973 were found to be below the appropriate concentration guide values in AEC Manual Chapter 0524.

Particulate air filters showed gross beta activities lower than those observed during 1972, reflecting a reduction in global fallout in the atmosphere. Gamma spectral measurements on Laboratory perimeter air filters also showed lower activities of global fallout gamma emitters. These perimeter air samples were analyzed for ^{239}Pu, ^{238}Pu, ^{90}Sr, ^{235}U, and ^{238}U. With the exception of one sampling location, the annual average ^{239}Pu concentration was 1.3×10^{-17} μCi/ml, typical of global fallout.

Air samples taken within Site 300 were analyzed for uranium. These analyses showed a lower than normal ratio of ^{235}U/^{238}U. This is due to "depleted" uranium (uranium which is specially processed to lower the ^{235}U content) used at the Site. Airborne uranium concentrations were well below the standards set by the AEC.

Soil samples collected in the off-site vicinity of LLL perimeter boundaries and at Site 300 were analyzed for plutonium, uranium, and gamma emitting radionuclides. Traces of plutonium above global background levels were detected in two off-site samples near the east perimeter of the Laboratory. Sediment samples collected in surface drainage pathways from LLL showed that the plutonium in these sediments was in the same range observed in soil samples collected in the Livermore Valley.

Site 300 soil samples indicate depleted levels of ^{235}U near firing bunkers, but ^{235}U/^{238}U ratios approach that of natural uranium at site perimeters. These data indicate no apparent change from that observed in 1972.

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

Gamma spectral analyses of vegetation samples revealed no gamma-emitting radionuclides other than those present naturally or in global fallout. The vegetation samples collected in areas generally downwind from the Livermore Laboratory revealed tritium activities 10 to 100 times higher than those collected in areas where

the Laboratory's contribution should be minimal. However, if the vegetation were a regular part of one's diet, the annual whole body radiation dose from tritium would be less than 1 mrem.

The off-site radiation exposure rates measured by thermoluminescent dosimeters were in the range to be expected from the naturally occurring radionuclides in the soil and from local cosmic radiation.

Assessment of the radiation doses to an individual from the observed environmental activities listed in this report indicates the contribution from artificially produced radionuclides is small in comparison with the approximately 100 mrem yr dose received from natural sources.

Introduction

The Lawrence Livermore Laboratory is located about 50 miles southeast of San Francisco in the Livermore Valley. Shielded from the ocean by the western hills, the valley has a warm, dry climate. Annual rainfall is about 14 in. and occurs primarily during the winter months in connection with Pacific storms. Surface water drainage from the valley is from east to west through various arroyos, with outflow 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 occur almost as frequently as those from the west and southwest.

The Livermore Laboratory occupies an area of one sq mi and is situated approximately three mi east of Livermore. The Laboratory plays an integral part in the nation's nuclear weapons development program and makes diversified researches into controlled thermonuclear reactions, industrial applications of nuclear explosives, and the effects of radiation on the biosphere.

Much of the materials testing and high-explosive diagnostic work of the Laboratory is carried on at Site 300, a 10-sq mi area located about 13 mi southeast of Livermore in the sparsely populated hills of the Diablo Range which separates the Livermore and San Joaquin Valleys.

In order to carry out these programs, the Laboratory handles a variety of potentially hazardous radioactive materials. A strict effluent control program, which places maximum emphasis on controlling the effluents at the source, has been in continuous existence since the Laboratory began operation. An environmental surveillance program is conducted to ensure that this effluent control program is indeed restricting the release of radioactivity from the Livermore Laboratory and Site 300 to concentrations well below the standards set forth by the U. S. Atomic Energy Commission. This program employs techniques with sensitivities usually capable of detecting radioactivity below environmental background levels. The program includes the collection of airborne particulates, soil, water, sewer effluent, vegetation, and milk samples. These samples are analyzed for gross radioactivities as well as for the activity of specific radionuclides of interest. In addition, environmental background radiation is measured at numerous locations in the vicinity of the Livermore Laboratory by means of thermoluminescent detectors.

The results of the analyses are provided in this report. When appropriate, maximum, minimum, and average concentrations are given. Error limits, when included, reflect the uncertainties in the analyses at the 95% confidence level due to counting statistics. Unless otherwise stated, the limit of detection of these measurements is assumed to have been reached when the 2 σ error is ±100%. An attempt has been made to assess the impact from the observed environmental activity levels of artificially and naturally produced radionuclides by calculating the whole body or critical organ doses delivered to an adult by the various radionuclides of interest.

Environmental Levels of Radioactivity — Livermore Laboratory

ATMOSPHERIC RADIOACTIVITY

Concentrations of various airborne radionuclides were measured at 17 sampling stations situated throughout the Livermore Valley. Their locations are shown in Figs. 1 and 2. The six samplers located on the Laboratory perimeter use 80-in.^{2} Whatman-41 filters. The average sampling rate was 25 cfm. The remaining samplers, located off-site, used 36-in.^{2} HV-70 (cellulose-asbestos) filters and were operated at an average flow rate of 4 cfm. Air filters are changed weekly.

Air samplers are situated in such a manner that they provide a reasonable assurance that a significant release of airborne particulate radioactivity from the Laboratory would be detectable regardless of the local meteorology at the time of the release.

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 counting system. Monthly composites of the perimeter filters are also counted for specific gamma-emitting radionuclides by means of a Ge(Li) detector equipped with a Compton suppression system. Following gamma counting filters are subdivided into monthly composites by sampling location (Fig. 2). Then radiochemical separations of ^{239}Pu, ^{238}Pu, ^{241}Am, and ^{90}Sr are made. Isotopic uranium analyses are performed by mass spectrometry on portions of these samples.

The gross beta activities (averaged over six month periods) and the annual average activities are listed for each sample location in Table 1, where they may be compared with the appropriate Radioactivity Concentration Guide (RCG) of the AEC Manual Chapter 0524. In addition, the weekly average gross beta activities on the air filters from all Livermore Valley stations are shown in Fig. 3.

We have observed a significant decrease in the level of gross beta activity in Livermore air over the past three years. In 1971 the average was 1.1×10^{-13} μCi/ml,[1] in 1972 the average was 7.3×10^{-14}

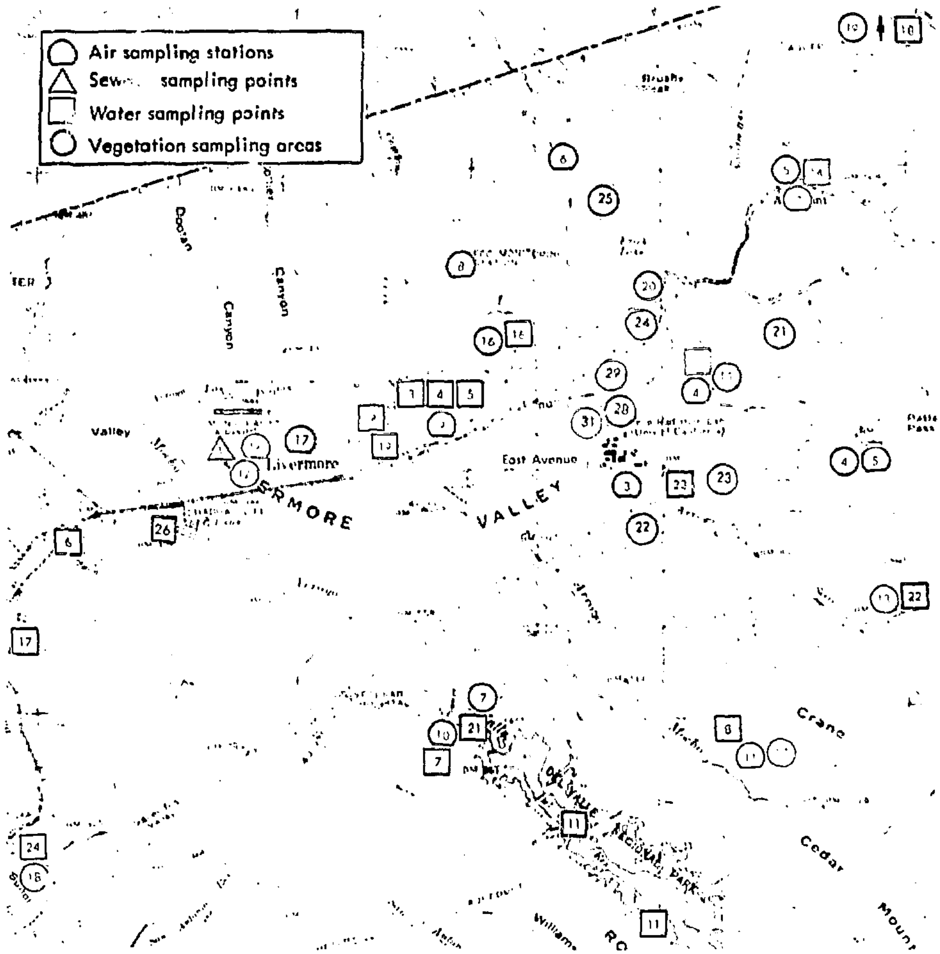


Fig. 1. Lawrence Livermore Laboratory off-site environmental sampling locations.

(Ref. 2), and in 1973 the average dropped to 2.1×10^{-14}. The gross beta activity is due to global fallout from nuclear weapons tests, to radionuclides such as ^{7}Be produced by cosmic-ray interactions with the atmosphere, and to naturally occurring radionuclides. This is shown in Table 2, which lists the activities of the more abundant gamma-emitting radionuclides in monthly composite samples collected by the six Laboratory perimeter samplers. Neither these data nor the beta activity exhibit the typical spring increase in surface air radioactivity.

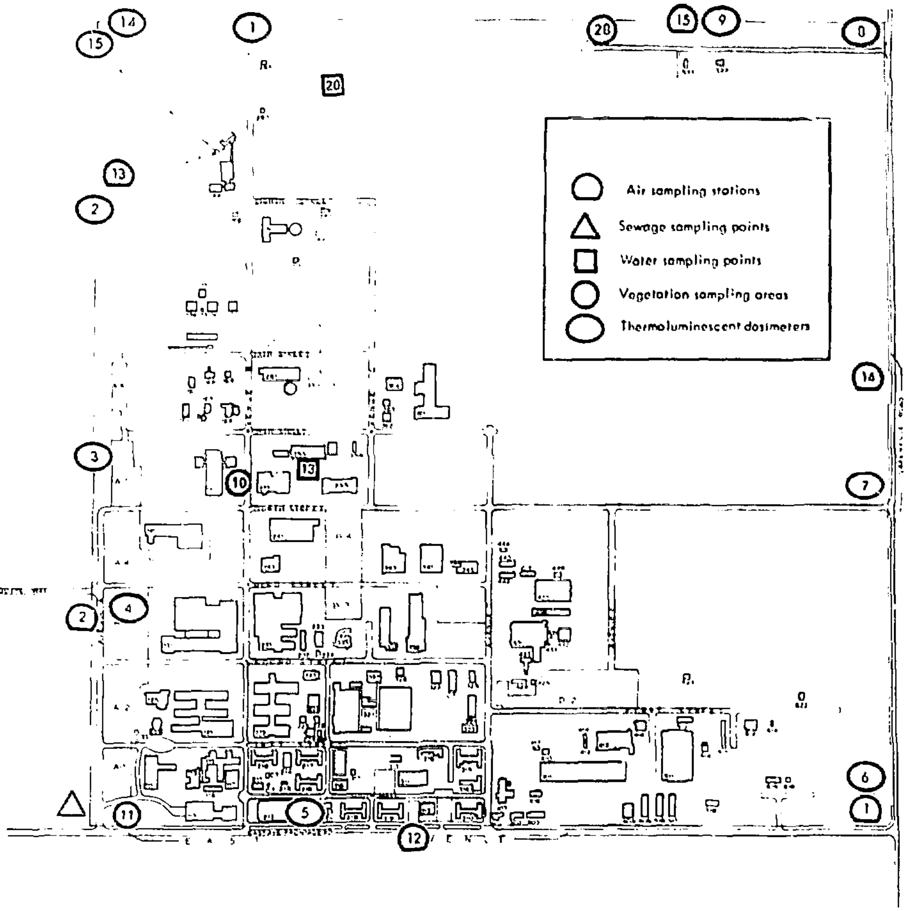


Fig. 2. Lawrence Livermore Laboratory on-site environmental sampling locations.

Table 3 shows the concentrations of airborne ^{239}Pu, ^{238}Pu, ^{241}Am, and ^{90}Sr based on the analysis of LLL perimeter air filters. With the exception of Location 14 on the east perimeter, which is normally downwind from Laboratory operations, all activities are typical of global fallout. The ^{239}Pu air concentration observed at Location 14 during April may have occurred during transfer of dry sludge from one of the solar evaporators used in volume reduction of certain low level liquid waste. These evaporators are located southwest (normally upwind — see wind rose in Fig. 4) of this sampling location. Upon recognition of this

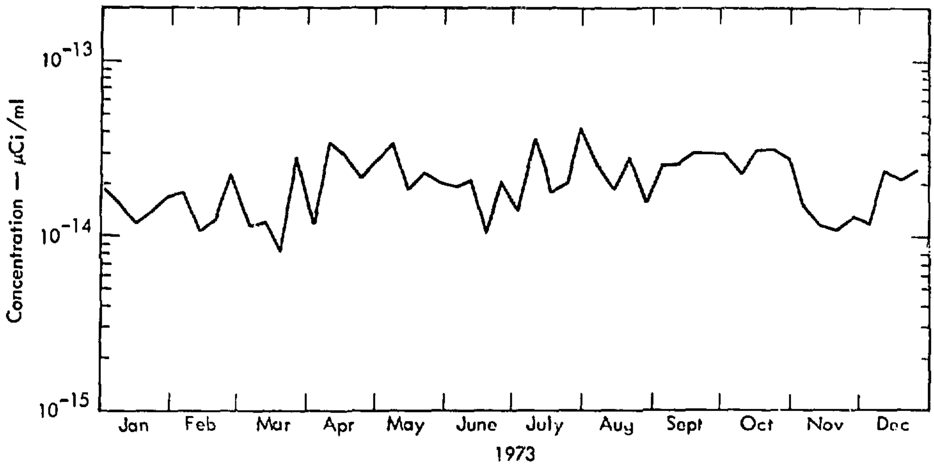


Fig. 3. Weekly average gross beta activity on air filters from Livermore Valley sampling locations.

possibility, operations were changed to minimize contact of the sludge with air.

Measurements of tritiated water (HTO) in air at LLL perimeter air sampling locations were begun in 1973. Water vapor was collected in silica gel samplers operated at about 0.5 liter per minute for one week periods. Flow control was maintained by an in-line critical orifice. The water collected was recovered by freeze drying and the HTO was measured by liquid scintillation counting. Table 4 shows the concentrations by location (see Fig. 2).

ENVIRONMENTAL IMPACT OF LLL AIRBORNE EFFLUENTS

The total curie quantities of airborne radioactivity released by Laboratory operations during 1973 are listed in this section. These data are included so that we can compare the quantities of specific radionuclides released with their apparent impact on the environment based on relevant monitoring data.

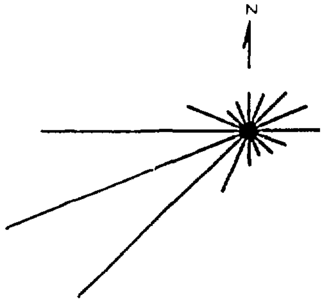
1. ^{41}Argon

An estimated total of 1300 curies of ^{41}Ar was released from the Laboratory's 3 MW pool type reactor. This led to an estimated maximum site-boundary dose of 17 mrem per year. From stack monitoring data at the source and the use of a meteorological diffusion model,[3] the following estimated man rem radiation doses were obtained within a radius of 50 miles of LLL:

During wet season (November through April) = 2.52 man rem

During dry season (May through October) = 1.35 man rem

total annual = 3.88 man rem



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

Frequency of Wind In Percent for Livermore — 1971

Mo	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	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	1.3
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. 4. Typical annual average wind pattern for Livermore, California (LLL data—1971).

The estimated population within a 50 mile radius of LLL is 4.6×10^6. Therefore, the estimated average radiation dose per person is $3.9/4.6 \times 10^6 = 8.5 \times 10^{-7}$ rem/yr (8.5×10^{-4} mrem per year). This radiation dose may be compared with the approximately 100 mrem per person annual radiation dose from naturally occurring radioactivity.

2. Tritium

The total tritium released to the atmosphere by the Laboratory from all sources is estimated to be 2510 curies. About 85% of this tritium is released at the Gaseous Chemistry Building. Assuming the entire activity were released at this location at a constant rate over the entire year, application of the appropriate X/Q values from Ref. 3 shows the concentration at the Site-boundary to be 1.6×10^{-10} μCi/ml.

The RCG for tritium (HTO) in uncontrolled areas is 2×10^{-7} μCi/ml. Environmental monitoring for HTO at the Site-boundary showed the maximum concentration to be 1.8×10^{-10} μCi/ml. The higher concentration predicted by the diffusion model is conservative, since all the tritium is assumed to be in the form of HTO. The annual whole body radiation dose to an individual at the Site-boundary who might breathe air containing 1.8×10^{-10} μCi/ml of HTO would be 0.3 mrem. This hypothetical radiation dose is small compared to the 100 mrem received from natural radioactivity.

SOIL

Analysis of soil samples collected throughout the Livermore Valley during 1971 and 1972 provided a data base for local distribution of various radionuclides deposited as a result of global fallout as well as from possible Laboratory effluents. These data were reported in annual reports for the above periods[1,2] and serve as a basis for comparing current levels of activity with those observed in the future.

In 1973, several of the earlier locations were resampled as part of a continuing surveillance program and additional samples were collected in the vicinity of LLL Site-boundaries. A group of samples was also collected in the San Joaquin Valley, since atmospheric diffusion studies show possible air movement eastward from Livermore through the Altamont Pass into this valley. In addition, sediment samples were collected along surface drainage pathways from LLL to determine if there were any releases from the Laboratory via surface drainage.

In previous years, man-made activities observed in local soil were expressed in total deposition units (μCi/m^2 or mCi/km^2) so that the data could be compared with the data of Hardy and Krey.[4] Soil cores were collected to a depth of 25 centimeters, since it is implied when using deposition units that the sample has been collected to a sufficient depth to account for essentially all the activity. While deep core sampling was still employed during 1973 when deposition data were required for purposes of comparison, greater emphasis was placed on surface sampling to a depth of one centimeter. In the case of plutonium, surface sampling is appropriate, because the situation of interest is related to airborne concentrations resulting from possible resuspension of surface activity.

All samples were dried, ground, and blended. For radiochemical analysis, 100 g aliquots were completely dissolved in acid and the radionuclides were determined using standard techniques. For gamma spectra analysis, approximately 300 g aliquots of soil were sealed in 200 cm^3, thin-walled aluminum cans and counted in a shielded Ge(Li) spectrometer equipped with a Compton suppression system.

Table 5 shows the activity levels of various radionuclides observed in Livermore Valley soil samples collected during 1973. Locations of these samples are shown in Fig. 5. Samples 253 through 294 were collected during June 1973. Sample 254, taken on the east side of Greenville Road, is located nearly due east from the solar evaporators. This specific area was not sampled in prior years. However, the area represented by Sample 319, just north of Sample 254, has been sampled annually since 1971. In October of 1972, this area (Sample 223) showed typical global fallout levels of

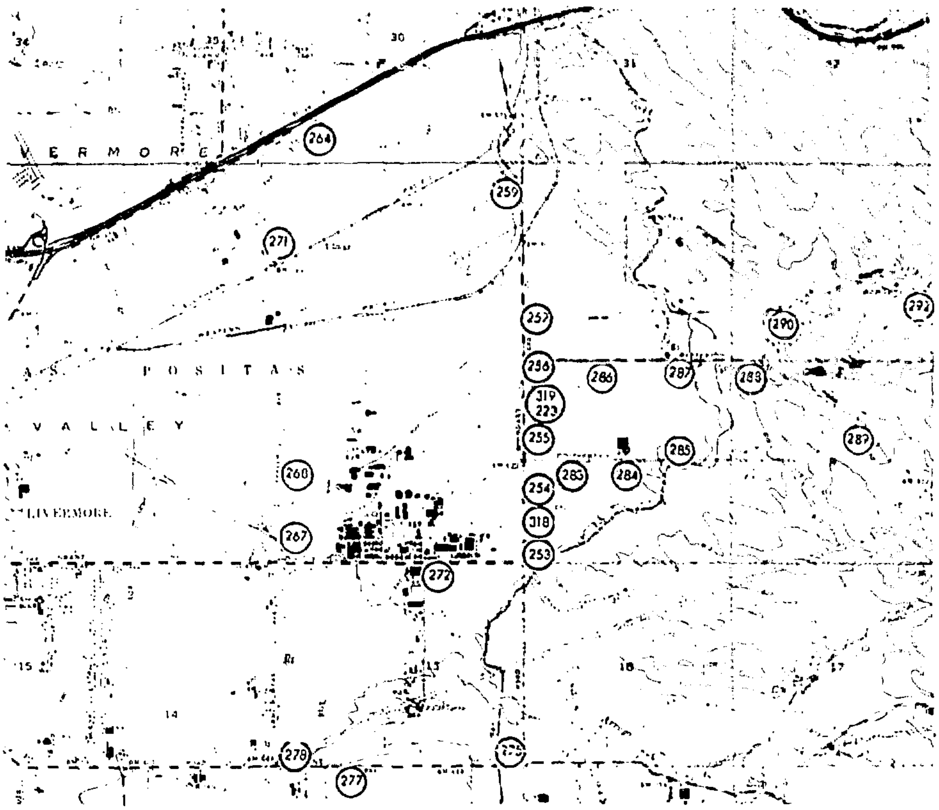


Fig. 5. Locations of soil samples collected in the vicinity of LLL.

plutonium and the small increase observed in 1973 may possibly be related to operations at the solar evaporators during the spring of 1973.

Table 6 lists the deposition values of ^{239}Pu, ^{238}Pu, and ^{137}Cs obtained from the samples collected in the San Joaquin Valley at locations shown in Fig. 6. Median deposition values of ^{239}Pu and ^{137}Cs for 25-cm deep samples were 6.5 $\times 10^{-4}$ and [illegible] $\times 10^{-2}$ $\mu Ci/M^2$, respectively. These values are typical of those attributed to global fallout in semiarid areas.[4] The table also shows the results of ^{235}U and ^{238}U analysis performed on these samples using mass spectrometry. In many cases the uranium levels are elevated over that expected for soils in this area of California.[5] Site 300, in the Diablo Range west of the San Joaquin Valley, uses uranium in high explosive experiments. This uranium is "depleted" in ^{235}U. Since the $^{235}U/^{238}U$ ratios in

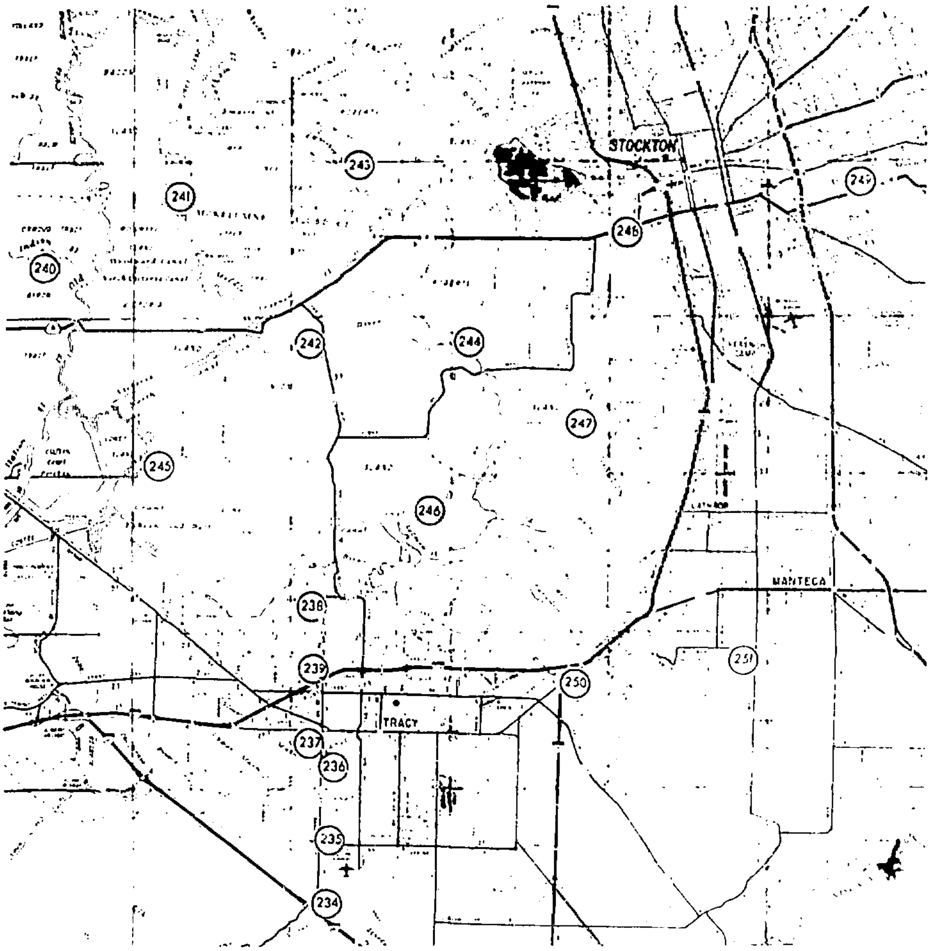


Fig. 6. Locations of soil samples collected in the San Joaquin Valley.

the San Joaquin samples correspond to those for natural uranium, Site 300 operations are not a credible source for these elevated levels.

Table 7 shows the activity levels of ^{239}Pu, ^{238}Pu, and ^{137}Cs present in ditches and arroyos which drain LLL surface water runoff. Sample locations are shown in Fig. 7. The data show that ^{239}Pu concentrations are in the range previously observed in soil within the Livermore Valley.

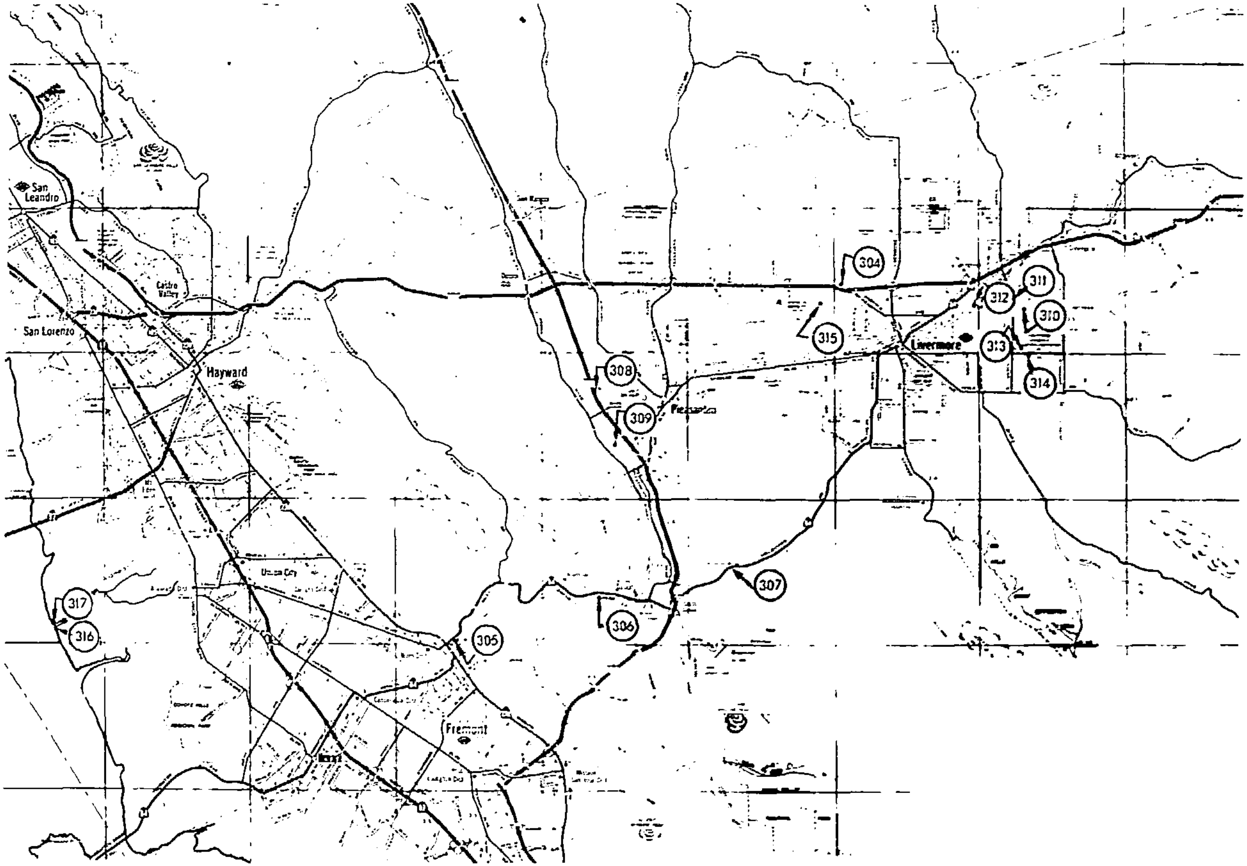


Fig. 7. Locations of sediment samples collected in ditches and arroyos into which LLL surface water drains.

LABORATORY SEWER EFFLUENT

Low level radioactive wastes from the Laboratory are discharged into the City of Livermore sanitary sewer system at the LLL outfall shown in Fig. 2. This sewage is processed at the Livermore treatment plant where liquid and sludge are separated on entering the plant. Sludge is processed in one of two digesters where it is broken down by bacterial action. Digested sludge is pumped into one of two large sludge lagoons. During the summer, a portion of this sludge is removed to drying beds. The dried sludge is used as a soil conditioner. 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.

Weekly samples were collected from each digester, the aeration tank, and the liquid effluent. Gross alpha and beta activities, as well as specific alpha emitting radionuclides, were measured in monthly composites of the weekly samples to determine if any significant buildup of radioactivity occurred 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. These data are shown in Tables 8 through 11. It is seen that most of the activity is associated with the solids (sludge) in the plant. In 1973, dried sludge from one of the lagoons showed a ^{239}Pu content of 2.6 $\times 10^{-6}$ μCi/g. This plutonium activity is related to an unintentional release to the sanitary sewer system in 1967. The activity passed through the sewage treatment plant and was retained in this sludge lagoon. The supernate from the lagoon (secondary digester supernate) is recycled through the system and, after treatment, is released as treated effluent. Since the plutonium content of the effluent is well below the RCG values for drinking water, it is clear that the Pu is being retained in the sludge as expected. Details of this release were reported in 1967 to the Atomic Energy Commission, to the City of Livermore, and to the California State Health Department.

ENVIRONMENTAL IMPACT OF LLL LIQUID EFFLUENTS

Except for low level radioactive liquid wastes, which are discharged to the Livermore sanitary sewers, the Laboratory does not release radioactive liquid wastes to the environment. During 1973, the principal radionuclides released to the sewer were 2.0 $\times 10^{-4}$ curies of ^{239}Pu and 19.0 curies of ^{3}H. Table 11 shows the concentrations of these radionuclides in the treated effluent from the Livermore Sewage Treatment Plant. The percentages of RCG (drinking water) for ^{239}Pu and ^{3}H in this effluent were 4.3 $\times 10^{-4}$ and 1.1 $\times 10^{-1}$, respectively.

WATER

Water samples were collected from various locations in the Livermore Valley shown in Figs. 1 and 2. Samples were evaporated and the residues were transferred with dilute nitric acid to counting planchets. After flaming, the planchets were counted for gross alpha and beta activities in a gas proportional counter.

No sample showed an alpha activity above the limit of sensitivity of $1.2 \times 10^{-[illegible]}$ μCi/ml. The gross beta activities are listed in Table 12. Locations 11, 15 through 17 and 21 through 24 are surface sources such as ponds, creeks, reservoirs, and aqueducts. Livermore rainfall is sampled at Location 20. The remainder of the samples represent domestic water sources. Gross beta activities are comparable to those observed during 1972. The highest activity was exhibited by the rainfall sample.

These samples were also analyzed for tritium activity. Because of the low activities, it was necessary to vacuum distill and electrolytically enrich the samples prior to internal gas counting. The results of the analyses are shown in Table 13. Inspection of the data indicates that the samples exhibit rather uniform tritium concentrations that are well below the recommended concentration guide value. The table also includes 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 liter per day and the model of Anspaugh et al.[6]

VEGETATION

Vegetation samples (usually native grasses) were collected at monthly intervals at the locations shown in Figs. 1 and 2. A portion of each sample was freeze dried and the tritium activity of the recovered water was determined by liquid scintillation counting. The balance of the samples was combined to represent a monthly composite sample. After oven drying, this composite sample was analyzed for various gamma emitting radionuclides with the Ge(Li) detector used for analyzing the airborne particulate samples.

The tritium activities, shown in Table 14, indicate significant variation from one location to another. As the prevailing wind is from the southwest, one may expect the effect of the Laboratory's operation to be minimal at Locations 4, 7, 13, 17, and 18. Tritium levels found in vegetation collected from these areas may be considered to represent normal environmental background. However, Locations 5, 28, 29, and 30, which show elevated levels, are situated in a generally downwind direction from the Laboratory. Consequently, vegetation in these areas, as well as Locations 10 and 11 (on-site), may be exposed to the low level tritium effluent released from the Gaseous Chemistry Building. The samples collected at Location 12 represent grass that has been watered by the liquid effluent from the Livermore Sewage Treatment Plant. The whole body radiation doses shown in the table were derived from the model of Anspaugh et al.,[6] assuming that the observed tritium activities were typical of those in edible vegetation grown in this area. The doses are based upon the direct daily consumption of 400 g of vegetation,[7] which is normally 80% water. It is evident that even those samples, with elevated tritium concentrations, provide rather small whole body radiation doses.

The results of the gamma spectral analyses are shown in Table 15. Again, if one makes the assumption that the observed activities are typical of those in

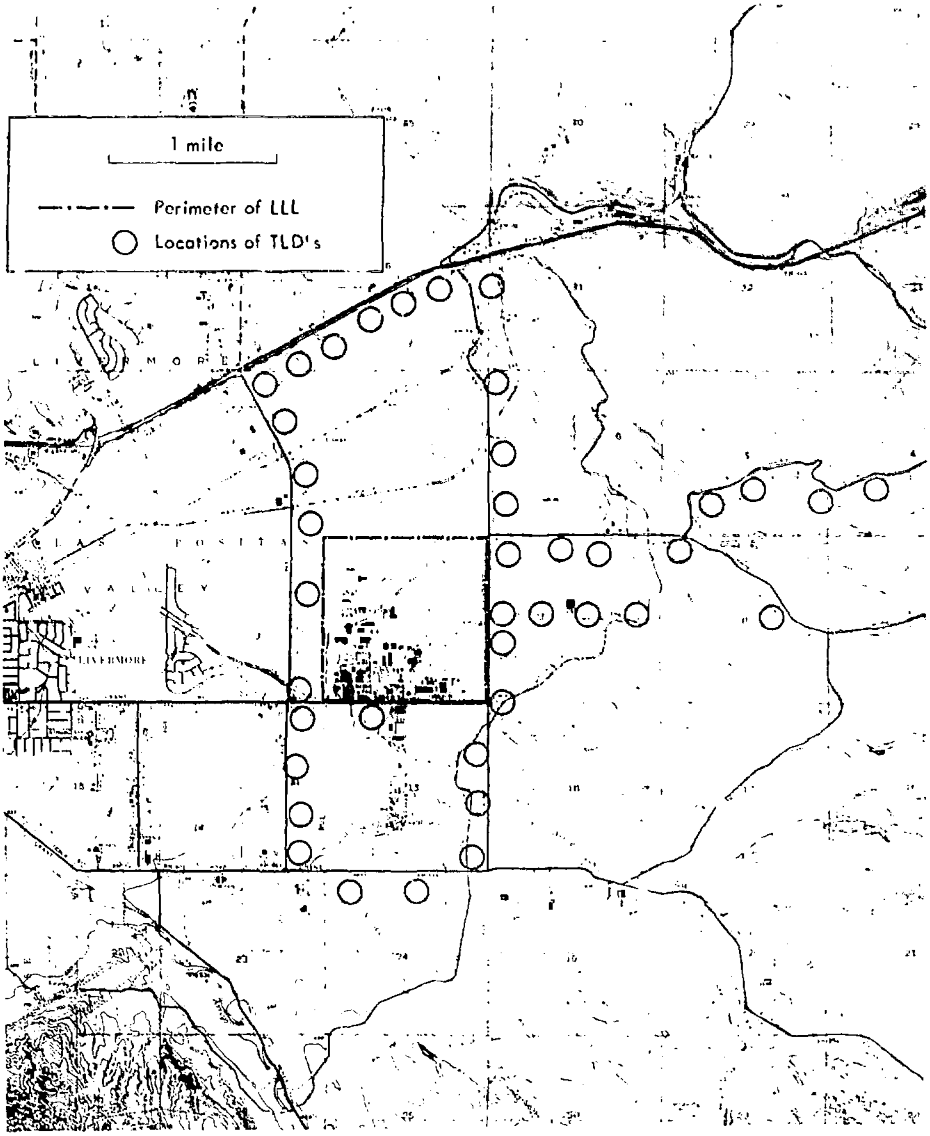


Fig. 8. Location of thermoluminescent dosimeters in the vicinity of the Lawrence Livermore Laboratory.

edible vegetation, one may calculate the annual whole body or critical organ doses to an adult resulting from the direct ingestion of these radionuclides. These calculated doses, also shown in Table 15, are based upon an adult consumption of 400 g per day of vegetation with a moisture content of 80% and the data of Ng et al.,[8] regarding the dose received per unit of radioactivity consumed under equilibrium conditions. The naturally occurring ^{40}K activity delivers about 25 mrem/yr to the whole body, while all the rest deliver appreciably less than 1 mrem/yr.

ENVIRONMENTAL RADIATION MEASUREMENTS

Environmental radiation background measurements were made at 11 Laboratory perimeter locations shown in Fig. 2, and at 41 off-site locations (shown in Fig. 8) in the vicinity of the Laboratory. These measurements were made with CaF_2:Dy (TLD-200) thermoluminescent dosimeters placed at a height of approximately 1 m above the ground. Exposure periods were 3 mo. Based on past experience, the environmental terrestrial exposure rates in the Livermore Valley vary between 3 and 7 μR/hr depending on the location; cosmic radiation, calculated from the local elevation and geomagnetic latitude according to the data of Lowder and Beck,[9] is approximately 4 μR/hr. Table 16 shows quarterly and annual dose rates in mrem derived from the observed exposure rates at perimeter locations. Above average exposure rates were observed at Locations 5, 14, and 15. Location 5 is adjacent to a cyclotron building and Locations 14 and 15 are near a linear accelerator facility. Figure 9 shows an annual frequency distribution of exposure rates measured at the 41 off-site locations. The median exposure rate of 74 mR (equivalent to 71 mrem) shown for 1973 is comparable to the off-site median of 77 mR observed from the 1972 data.

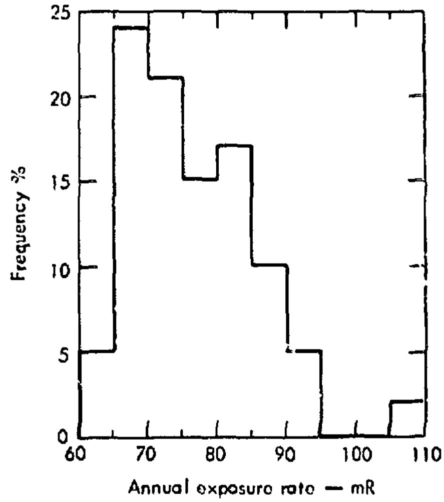


Fig. 9. Annual off-site environmental radiation exposure rates measured during 1973.

Environmental Levels of Radioactivity – Site 300

ATMOSPHERIC RADIOACTIVITY

The concentrations of various particulate radioactive substances were measured continuously at 11 air sampling locations as shown in Figs. 10 and 11. Ten of the samplers are located within the boundaries of Site 300 and the eleventh is located in Tracy, the primary population center of concern. The on-site samples were collected on 8 × 10-in. Whatman-41 filters at a flow rate of about 25 cfm. Samples in Tracy were collected on 4 × 9-in. HV-70 (cellulose-asbestos) filters at a flow rate of about 4 cfm. Filters were changed twice a week during the summer months to avoid excessive mass loading; during the balance of the year they were changed on a weekly basis. The filters were analyzed by the methods previously described for air filters used in the Livermore Valley.

No gross alpha activity above the 1×10^{-15} μCi/ml detection limit was observed on these filters. The gross beta activities, averaged over 6-mo periods, are listed in Table 17 for each sampling location. Figure 12 shows the weekly average activities deposited on air filters from all the sampling locations. These average activities are slightly higher than those measured in the Livermore Valley, but are lower than the values observed during past years. As previously noted, these reductions are due to a decrease in the level of global fallout radioactivity in the atmosphere.

Gamma spectral measurements made on monthly composite samples of the filters collected on-site reveal measurable quantities of various gamma-emitting radionuclides as may be seen in Table 18. These activity levels are essentially identical with those measured in the Livermore Valley and may readily be accounted for as being due to global fallout. The results of isotopic plutonium and uranium analyses, performed by the techniques described previously, are provided in Table 19. The relative abundance of ^{238}Pu to ^{239}Pu is approximately that expected in global fallout. The uranium, on the other hand, is appreciably depleted in ^{235}U relative to that of natural uranium because the amount used in high explosives experiments has been specially processed to lower the ^{235}U content. Although the concentrations are at times higher than those measured in air in the Livermore Valley, they are nevertheless far lower than the AEC concentration guide levels.

ECOLOGY IMPACT STUDY

An ecology study was initiated during the summer of 1973 to determine if Site 300 operations have a measurable impact on plants and animals native to this area. The work is part of the ongoing program of environmental surveillance and potential impact analysis of the site. Soils, plants, and animals are being collected from various locations on the site and analyzed for uranium and other elements of possible impact. Emphasis is being placed upon areas around the high explosive firing bunkers. For purposes of comparison, similar plants and animals are being collected from surrounding off-site locations. This work is continuing

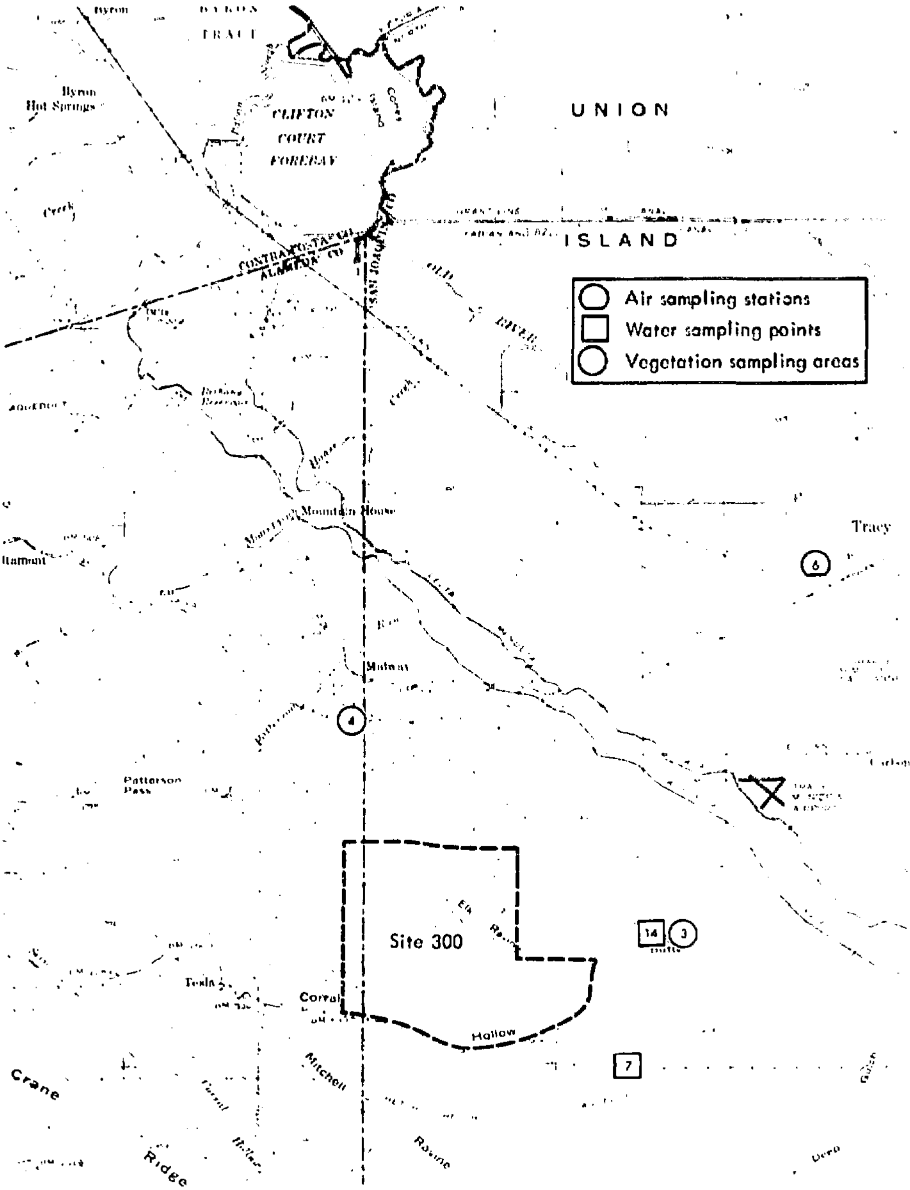


Fig. 10. Air, water, and vegetation sampling locations in the Site 300 area.

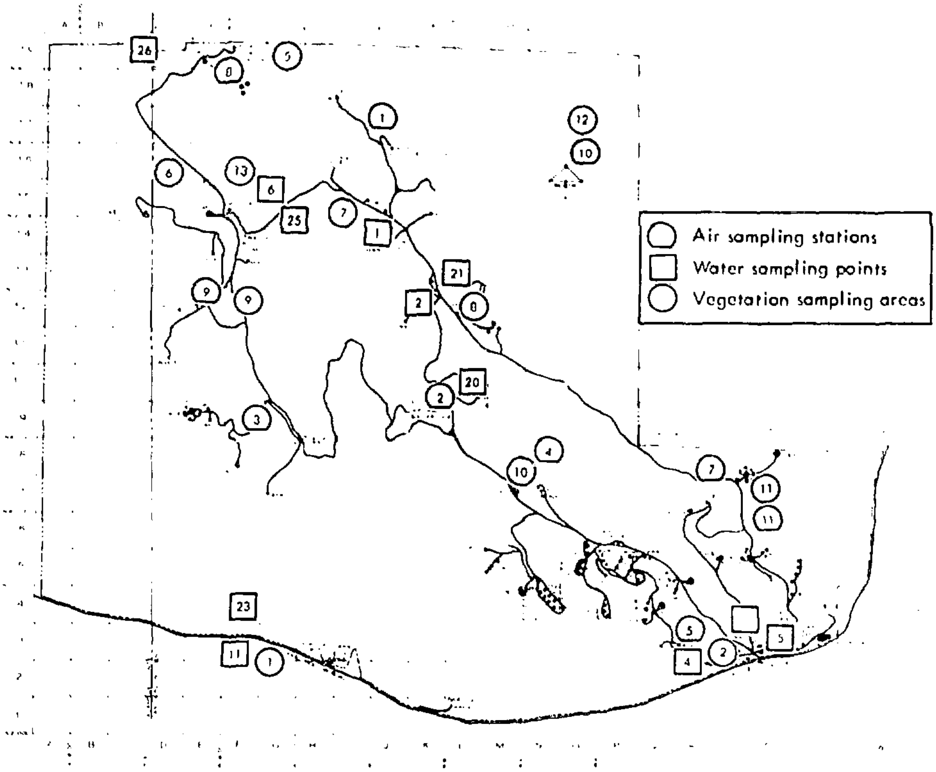


Fig. 11. Air, water, and vegetation sampling locations inside Site 300 boundary.

and will be reported in our 1974 annual report.

SOIL

High explosive tests at Site 300 often involve the use of "depleted" uranium (uranium in which the uranium is processed to reduce the ^{235}U content). In 1972, a special study was conducted to determine the extent to which the natural $^{235}U/^{238}U$ ratio in Site 300 soil was perturbed by these operations. Based on mass spectrometric isotopic uranium analysis of soils collected throughout the test site, it was found that depletion of ^{235}U was essentially restricted to areas adjacent to the firing bunkers.[2] Similar surveillance was maintained in 1973, but the number of samples was reduced to that level considered adequate to document any significant change, which might have occurred since the 1972 study. These samples were collected to a depth of one centimeter using the same sampling procedure and soil preparation technique described for Livermore Valley samples.

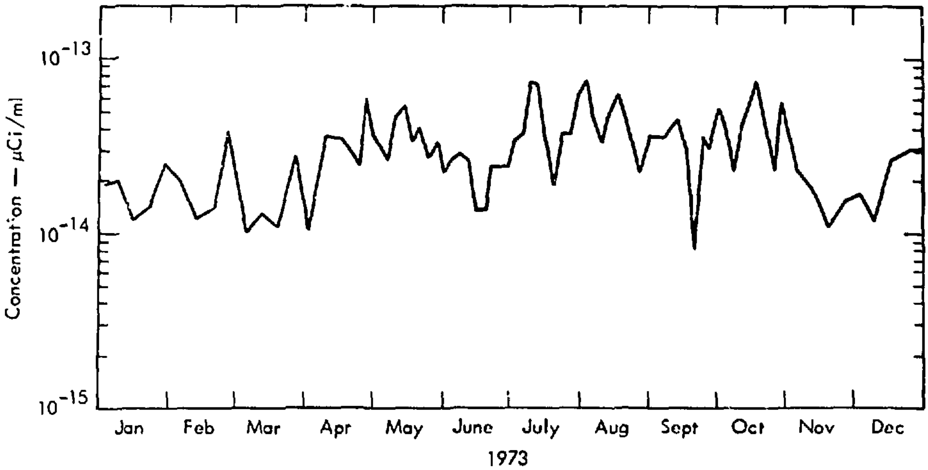


Fig. 12. Weekly average airborne gross beta activity on air filters from Site 300 sampling stations.

Sample locations are shown in Fig. 13 and the results of the isotopic uranium analyses are presented in Table 20. These data are comparable to those observed in 1972.

WATER

Samples were collected from on-site wells supplying Site 300 and from various on-site and off-site springs, ponds, and creeks. The locations of these sites are shown in Figs. 10 and 11. Locations 1 through 7 represent deep-well sources, Locations 11 and 14 are off-site creek sources, and rain water is collected at Location 20. The remaining locations are on-site ponds or springs. The samples were subjected to gross alpha and beta analyses. No samples showed a gross alpha activity above the limit of detection of 1.2×10^{-9} μCi/ml. The gross beta activities, averaged over 6-mo periods, are given in Table 21. These activities show little variation with time and location and are similar to those exhibited by the water samples collected within the Livermore Valley. The samples were also subjected to tritium analyses by electrolytic enrichment and subsequent internal gas counting. The results of the analyses are shown in Table 22. With the exception of the deep well waters, which show very little tritium, these samples contain tritium activities that are comparable with those observed in water collected within the Livermore Valley.

Table 22 also includes the calculated whole body doses to an adult consuming the water containing the listed tritium concentrations. These doses were derived in the same manner used to compute the values listed in Table 13.

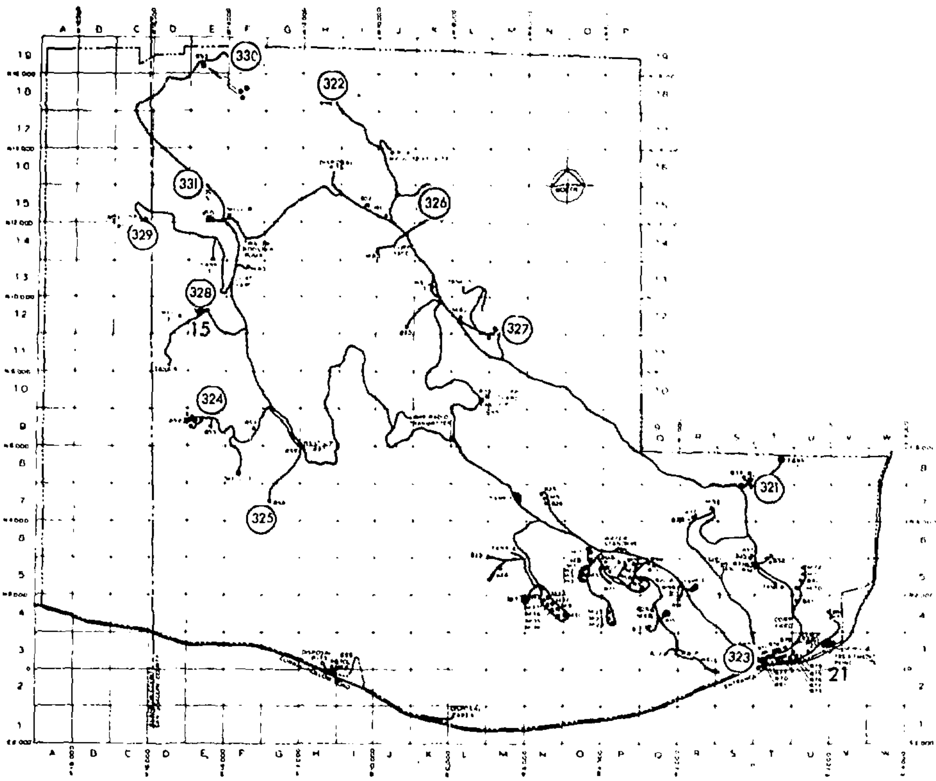


Fig. 13. Site 300 soil sampling locations during 1973.

VEGETATION

Vegetation samples were collected on a monthly basis at the 13 locations shown in Figs. 10 and 11. Dried monthly composite samples were subjected to gamma spectral analyses yielding the activities shown in Table 23. Also shown in the table are the calculated whole body or critical organ doses delivered to an adult by direct ingestion of 400 g per day of edible vegetation containing 80% water and the listed average activities. The data reveals that natural ^{40}K and ^{144}Ce from global fallout are the major contributors via this pathway.

These samples were also subjected to tritium analyses by freeze drying and scintillation counting of the resulting water. The results are shown in Table 24. The activities show little fluctuation compared with the results obtained from similar samples collected within the Livermore Valley. The table also includes the resulting whole body doses delivered to an adult by the tritium activities based upon the models referenced previously. As one would expect, these doses are insignificant.

MILK

The only dairy in the general vicinity of Laboratory operations is located about 6 mi southwest of Tracy. Periodic milk samples were collected from the dairy throughout the year. Before analysis, the samples were concentrated by means of freeze drying and the concentrates were gamma counted in a Ge(Li) counting system. In addition, each sample was analyzed for tritium activity by counting 1 ml of the water recovered from freeze drying in a liquid scintillation counting system. Activities of ^{137}Cs, ^{40}K, and ^{3}H are shown in Table 25. No 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. As expected, the only significant dose to an individual is that from naturally occurring ^{40}K.

Table 1. Airborne particulate beta radioactivity within the Livermore Valley during 1973 (μCi/ml).

Sampling location[a]	No. of samples	January-June			No. of samples	July-December			Annual average	% RCG[b]
		Maximum	Minimum	Average		Maximum	Minimum	Average		
1	22	$3.9\times10^{-14}\pm6\%$	$1.6\times10^{-15}\pm67\%$	1.6×10^{-14}	24	$3.8\times10^{-14}\pm5\%$	$1.0\times10^{-15}\pm100\%$	$<2.0\times10^{-14}$	$<1.8\times10^{-14}$	2
2	23	$4.7\times10^{-14}\pm7\%$	$6.4\times10^{-15}\pm24\%$	2.0×10^{-14}	21	$3.2\times10^{-14}\pm7\%$	$5.2\times10^{-15}\pm23\%$	2.2×10^{-14}	2.1×10^{-14}	2
3	25	$3.2\times10^{-14}\pm13\%$	$3.9\times10^{-15}\pm100\%$	$<1.6\times10^{-14}$	22	$5.6\times10^{-14}\pm9\%$	$4.1\times10^{-15}\pm100\%$	$<2.0\times10^{-14}$	$<1.8\times10^{-14}$	2
4	25	$7.5\times10^{-14}\pm7\%$	$9.9\times10^{-15}\pm34\%$	2.9×10^{-14}	21	$8.5\times10^{-14}\pm13\%$	$1.4\times10^{-14}\pm24\%$	3.7×10^{-14}	3.3×10^{-14}	3
5	26	$2.9\times10^{-14}\pm14\%$	$4.5\times10^{-15}\pm22\%$	1.5×10^{-14}	24	$4.4\times10^{-14}\pm9\%$	$4.2\times10^{-15}\pm100\%$	$<1.9\times10^{-14}$	$<1.7\times10^{-14}$	2
6	25	$4.8\times10^{-14}\pm10\%$	$4.5\times10^{-15}\pm100\%$	$<1.4\times10^{-14}$	24	$5.2\times10^{-14}\pm11\%$	$5.9\times10^{-15}\pm50\%$	2.1×10^{-14}	$<1.8\times10^{-14}$	2
7	25	[illegible]$.6\times10^{-14}\pm12\%$	$3.9\times10^{-15}\pm100\%$	$<1.7\times10^{-14}$	21	$4.6\times10^{-14}\pm19\%$	$4.2\times10^{-15}\pm100\%$	$<2.1\times10^{-14}$	$<1.9\times10^{-14}$	2
8	23	$4.8\times10^{-14}\pm10\%$	$4.5\times10^{-15}\pm100\%$	$<1.3\times10^{-14}$	26	$3.9\times10^{-14}\pm22\%$	$4.2\times10^{-15}\pm100\%$	$<1.7\times10^{-14}$	$<1.5\times10^{-14}$	2
9	26	$6.2\times10^{-14}\pm8\%$	$1.3\times10^{-15}\pm25\%$	3.0×10^{-14}	23	$9.0\times10^{-14}\pm12\%$	$1.8\times10^{-14}\pm19\%$	4.2×10^{-14}	3.6×10^{-14}	4
10	24	$1.3\times10^{-14}\pm24\%$	$4.5\times10^{-15}\pm100\%$	$<1.3\times10^{-14}$	25	$5.5\times10^{-14}\pm17\%$	$4.3\times10^{-15}\pm67\%$	1.8×10^{-14}	$<1.6\times10^{-14}$	2
11	21	$2.8\times10^{-14}\pm15\%$	$3.6\times10^{-15}\pm100\%$	$<1.3\times10^{-14}$	26	$4.4\times10^{-14}\pm20\%$	$4.2\times10^{-15}\pm100\%$	$<2.0\times10^{-14}$	$<1.7\times10^{-14}$	2
12	25	$4.2\times10^{-14}\pm7\%$	$9.5\times10^{-15}\pm15\%$	2.2×10^{-14}	25	$9.4\times10^{-14}\pm5\%$	$7.8\times10^{-15}\pm15\%$	2.7×10^{-14}	2.5×10^{-14}	3
13	23	$5.0\times10^{-14}\pm6\%$	$3.8\times10^{-15}\pm44\%$	2.1×10^{-14}	20	$3.8\times10^{-14}\pm5\%$	$4.0\times10^{-15}\pm21\%$	1.9×10^{-14}	2.0×10^{-14}	2
14	26	$3.3\times10^{-14}\pm6\%$	$7.1\times10^{-15}\pm22\%$	1.8×10^{-14}	23	$3.6\times10^{-14}\pm6\%$	$5.6\times10^{-15}\pm18\%$	2.0×10^{-14}	1.9×10^{-14}	2
15	25	$7.7\times10^{-14}\pm9\%$	$2.0\times10^{-15}\pm54\%$	2.1×10^{-14}	26	$4.1\times10^{-14}\pm5\%$	$4.7\times10^{-15}\pm20\%$	2.2×10^{-14}	2.2×10^{-14}	2
16	24	$3.6\times10^{-14}\pm6\%$	$5.9\times10^{-15}\pm22\%$	2.0×10^{-14}	20	$4.3\times10^{-14}\pm6\%$	$1.3\times10^{-14}\pm12\%$	2.5×10^{-14}	2.3×10^{-14}	2
17	10	$5.0\times10^{-14}\pm6\%$	$7.5\times10^{-15}\pm16\%$	2.2×10^{-14}	20	$5.1\times10^{-14}\pm6\%$	$9.5\times10^{-15}\pm14\%$	2.5×10^{-14}	2.4×10^{-14}	2
	Average			1.9×10^{-14}				$<2.3\times10^{-14}$	$<2.1\times10^{-14}$	2

[a] See Figs. 1 and 2 for sampling locations.

[b] The RCG (Radioactivity Concentration Guide) for airborne beta is 1×10^{-12} μCi/ml.

Table 2. Results of gamma-ray spectral measurements of Livermore Laboratory perimeter air filters during 1973 (μCi/ml).

Month	^{144}Ce	^{141}Ce[a]	^{125}Sb	^{7}Be	^{103}Ru	^{106}Ru	^{137}Cs	^{95}Zr	^{40}K
Jan.	1.7×10^{-15} ± 31%	—	4.0×10^{-16} ± 76%	6.0×10^{-14} ± 8%	—	—	5.1×10^{-16} ± 35%	7.3×10^{-16} ± 98%	—[b]
Feb.	3.0×10^{-15} ± 14%	—	2.8×10^{-16} ± 86%	1.1×10^{-13} ± 4%	—	2.7×10^{-16} ± 56%	1.0×10^{-15} ± 17%	5.9×10^{-16} ± 70%	—[b]
Mar.	3.3×10^{-15} ± 13%	9.7×10^{-17} ± 100%	4.5×10^{-16} ± 57%	1.1×10^{-13} ± 4%	1.0×10^{-16} ± 100%	1.7×10^{-16} ± 86%	1.1×10^{-15} ± 16%	5.3×10^{-16} ± 65%	—[b]
Apr.	3.6×10^{-15} ± 9%	—	4.5×10^{-16} ± 12%	1.3×10^{-13} ± 2%	2.9×10^{-17} ± 72%	2.8×10^{-15} ± 16%	1.5×10^{-15} ± 4%	7.5×10^{-17} ± 26%	7.9×10^{-16} ± 28%
May	2.4×10^{-15} ± 10%	—	3.7×10^{-16} ± 12%	1.0×10^{-13} ± 2%	—	1.8×10^{-15} ± 13%	1.3×10^{-15} ± 6%	7.2×10^{-17} ± 72%	5.7×10^{-16} ± 30%
June	1.2×10^{-15} ± 20%	—	2.1×10^{-16} ± 18%	7.4×10^{-14} ± 2%	—	1.1×10^{-15} ± 16%	7.0×10^{-16} ± 6%	2.3×10^{-17} ± 100%	8.7×10^{-16} ± 24%
July	1.4×10^{-15} ± 14%	1.2×10^{-15} ± 12%	1.8×10^{-16} ± 19%	9.3×10^{-14} ± 10%	2.3×10^{-15} ± 18%	1.4×10^{-15} ± 12%	7.2×10^{-16} ± 10%	9.6×10^{-16} ± 19%	1.6×10^{-15} ± 14%
Aug.	9.5×10^{-16} ± 19%	7.1×10^{-16} ± 14%	1.4×10^{-16} ± 30%	6.6×10^{-14} ± 10%	1.2×10^{-15} ± 11%	9.7×10^{-16} ± 24%	5.3×10^{-16} ± 8%	9.4×10^{-16} ± 6%	1.4×10^{-15} ± 22%
Sept.	7.2×10^{-16} ± 25%	4.8×10^{-16} ± 13%	1.4×10^{-16} ± 42%	5.5×10^{-14} ± 8%	1.0×10^{-15} ± 6%	5.4×10^{-16} ± 20%	3.3×10^{-16} ± 14%	8.2×10^{-16} ± 9%	1.1×10^{-15} ± 21%
Oct.	1.4×10^{-15} ± 17%	1.3×10^{-15} ± 14%	—	1.2×10^{-13} ± 7%	2.3×10^{-15} ± 20%	1.1×10^{-15} ± 23%	3.4×10^{-16} ± 6%	2.6×10^{-15} ± 3%	1.0×10^{-15} ± 31%
Nov.	1.2×10^{-15} ± 16%	7.9×10^{-16} ± 11%	9.0×10^{-17} ± 52%	6.3×10^{-14} ± 4%	1.4×10^{-15} ± 7%	7.7×10^{-16} ± 32%	1.7×10^{-16} ± 23%	2.0×10^{-15} ± 5%	7.3×10^{-16} ± 26%
Dec.	2.7×10^{-15} ± 9%	1.1×10^{-15} ± 8%	1.2×10^{-16} ± 49%	6.6×10^{-14} ± 4%	2.0×10^{-15} ± 5%	1.8×10^{-15} ± 16%	3.2×10^{-16} ± 12%	3.8×10^{-15} ± 6%	7.2×10^{-16} ± 30%
Annual av	2.0×10^{-15}	$<8.1\times10^{-16}$	2.6×10^{-16}	8.5×10^{-14}	1.3×10^{-15}	1.2×10^{-15}	7.1×10^{-16}	1.1×10^{-15}	9.8×10^{-16}
RCG	2.0×10^{-10}	5.0×10^{-9}	9.0×10^{-10}	4.0×10^{-8}	3.0×10^{-9}	2.0×10^{-10}	5.0×10^{-10}	1.0×10^{-9}	4×10^{-9}
% RCG	1.0×10^{-3}	1.6×10^{-5}	2.9×10^{-5}	2.1×10^{-4}	4.3×10^{-5}	5.8×10^{-4}	1.4×10^{-4}	1.1×10^{-4}	2.5×10^{-5}

[a] In this and other entries of this table – indicates that the radionuclide was either undetected or the probable 2σ counting error associated with the measurement exceeded 100%, which is used as our limit of detection. Increased concentrations of fission product radionuclides observed after June are largely the result of a Chinese nuclear event during the latter part of June 1973.

[b] Changed counting systems in April. Previous system had too high a ^{40}K background to detect ^{40}K in air filters.

Table 3. Plutonium, Americium, Strontium, and Uranium in air at Livermore Laboratory perimeter locations during 1973 (μCi/ml).

Month	Location	^{239}Pu	^{238}Pu	$^{238}Pu/^{239}Pu$	^{241}Am	^{90}Sr	$^{239}Pu/^{90}Sr$	Mass (mg/M^3) ^{235}U	Mass (mg/M^3) ^{238}U	$^{235}U/^{238}U$
Jan.	1	7.8×10^{-18} ± 15%	—		6.4×10^{-19} ± 34%	3.7×10^{-16} ± 12%	2.1×10^{-2}	2.2×10^{-10} ± 4%	3.5×10^{-8} ± 5%	6.3×10^{-3}
	2	9.7×10^{-18} ± 13%	—		4.5×10^{-19} ± 40%	4.3×10^{-16} ± 10%	2.3×10^{-2}	2.8×10^{-10} ± 3%	4.1×10^{-8} ± 4%	6.8×10^{-3}
	12	6.4×10^{-18} ± 13%	—		5.7×10^{-19} ± 46%	3.9×10^{16} ± 9%	1.6×10^{-2}	2.8×10^{-10} ± 3%	4.4×10^{-8} ± 4%	6.4×10^{-3}
	13	2.8×10^{-18} ± 18%	—		3.4×10^{-19} ± 43%	1.2×10^{-16} ± 16%	2.3×10^{-2}	2.0×10^{-10} ± 4%	2.8×10^{-8} ± 5%	7.1×10^{-3}
	14	2.6×10^{-17} ± 11%	9.1×10^{-18} ± 17%	3.5×10^{-1}	2.1×10^{-18} ± 56%	8.2×10^{-16} ± 16%	3.2×10^{-2}	4.8×10^{-10} ± 4%	7.6×10^{-8} ± 5%	6.3×10^{-3}
	15	8.4×10^{-18} ± 16%	7.2×10^{-19} ± 3%	8.6×10^{-2}	3.6×10^{-19} ± 58%	3.7×10^{-16} ± 16%	2.3×10^{-2}	2.6×10^{-10} ± 4%	4.1×10^{-8} ± 5%	6.3×10^{-3}
Feb.	1	4.1×10^{-17} ± 8%	3.0×10^{-18} ± 22%	7.3×10^{-2}	2.4×10^{-18} ± 32%	6.2×10^{-16} ± 9%	6.6×10^{-2}	3.7×10^{-10} ± 4%	5.4×10^{-8} ± 5%	6.9×10^{-3}
	2	1.4×10^{-17} ± 9%	1.1×10^{-18} ± 24%	7.6×10^{-2}	9.4×10^{-19} ± 39%	6.6×10^{-16} ± 7%	2.1×10^{-2}	4.2×10^{-10} ± 3%	6.1×10^{-8} ± 3%	6.9×10^{-3}
	12	1.7×10^{-17} ± 8%	2.3×10^{-18} ± 18%	1.4×10^{-1}	—	5.9×10^{-16} ± 5%	2.9×10^{-2}	3.8×10^{-10} ± 3%	5.7×10^{-8} ± 3%	6.7×10^{-3}
	13	2.1×10^{-17} ± 8%	1.7×10^{-18} ± 22%	8.1×10^{-2}	—	6.0×10^{-16} ± 6%	3.5×10^{-2}	3.4×10^{-10} ± 3%	4.8×10^{-8} ± 4%	7.1×10^{-3}
	14	1.1×10^{-16} ± 5%	4.2×10^{-18} ± 13%	3.8×10^{-2}	1.6×10^{-17} ± 10%	4.5×10^{-16} ± 7%	2.4×10^{-1}	1.7×10^{-10} ± 3%	2.5×10^{-8} ± 4%	6.8×10^{-3}
	15	1.9×10^{-17} ± 4%	1.2×10^{-18} ± 26%	6.3×10^{-2}	1.9×10^{-18} ± 24%	5.4×10^{-16} ± 6%	3.5×10^{-2}	2.9×10^{-10} ± 3%	1.1×10^{-8} ± 4%	7.1×10^{-3}
Mar.	1	1.2×10^{-17} ± 12%	1.4×10^{-18} ± 26%	1.2×10^{-1}	—	6.0×10^{-16} ± 6%	2.0×10^{-2}	2.6×10^{-10} ± 14%	3.8×10^{-8} ± 19%	6.8×10^{-3}
	2	1.3×10^{-17} ± 11%	1.7×10^{-18} ± 24%	1.3×10^{-1}	—	7.2×10^{-16} ± 6%	1.8×10^{-2}	2.1×10^{-10} ± 5%	3.0×10^{-8} ± 7%	7.0×10^{-3}
	12	1.0×10^{-17} ± 17%	8.2×10^{-19} ± 47%	8.2×10^{-2}	—	5.2×10^{-16} ± 8%	1.9×10^{-2}	3.4×10^{-10} ± 3%	4.9×10^{-8} ± 4%	6.9×10^{-3}
	13	1.4×10^{-17} ± 11%	1.3×10^{-18} ± 30%	9.3×10^{-2}	—	7.5×10^{-16} ± 6%	1.9×10^{-2}	3.1×10^{-10} ± 3%	4.3×10^{-8} ± 4%	7.2×10^{-3}
	14	1.6×10^{-17} ± 10%	1.3×10^{-18} ± 25%	8.1×10^{-2}	1.9×10^{-18} ± 36%	7.4×10^{-16} ± 6%	2.2×10^{-2}	1.9×10^{-10} ± 3%	2.8×10^{-8} ± 4%	6.8×10^{-3}
	15	1.7×10^{-17} ± 10%	2.3×10^{-18} ± 21%	1.4×10^{-1}	1.7×10^{-19} ± 37%	8.1×10^{-16} ± 5%	2.1×10^{-2}	3.4×10^{-10} ± 3%	4.9×10^{-8} ± 4%	6.9×10^{-3}
Apr.	1	4.0×10^{-17} ± 8%	3.0×10^{-18} ± 20%	7.5×10^{-2}	—	9.1×10^{-16} ± 5%	4.4×10^{-2}	4.6×10^{-10} ± 4%	6.1×10^{-8} ± 5%	7.5×10^{-3}
	2	1.8×10^{-17} ± 11%	3.0×10^{-18} ± 24%	1.7×10^{-1}	—	9.6×10^{-16} ± 6%	1.9×10^{-2}	3.7×10^{-10} ± 3%	5.0×10^{-8} ± 4%	7.4×10^{-3}
	12	2.9×10^{-17} ± 8%	2.6×10^{-18} ± 19%	9.0×10^{-2}	3.4×10^{-18} ± 23%	1.3×10^{-15} ± 6%	2.2×10^{-2}	5.2×10^{-10} ± 4%	7.6×10^{-8} ± 3%	6.8×10^{-3}
	13	2.3×10^{-17} ± 8%	2.7×10^{-18} ± 17%	1.2×10^{-1}	1.8×10^{-18} ± 22%	1.4×10^{-15} ± 10%	1.6×10^{-2}	4.8×10^{-10} ± 3%	6.7×10^{-8} ± 3%	7.2×10^{-3}
	14	8.0×10^{-14} ± 5%	2.3×10^{-17} ± 7%	2.9×10^{-4}	1.6×10^{-16} ± 8%	9.6×10^{-16} ± 6%	$8.3 \times 10^{+1}$	3.5×10^{-10} ± 3%	5.0×10^{-8} ± 3%	7.0×10^{-3}
	15	2.5×10^{-17} ± 7%	3.0×10^{-18} ± 15%	1.2×10^{-1}	1.8×10^{-18} ± 21%	1.3×10^{-15} ± 6%	1.9×10^{-2}	5.5×10^{-10} ± 2%	7.6×10^{-8} ± 3%	7.2×10^{-3}
May	1	3.8×10^{-17} ± 11%	2.4×10^{-18} ± 33%	6.3×10^{-2}	—	1.4×10^{-15} ± 11%	2.7×10^{-2}	5.3×10^{-10} 3%	7.0×10^{-8} ± 4%	7.6×10^{-3}
	2	2.6×10^{-17} ± 12%	3.8×10^{-18} ± 25%	1.5×10^{-1}	—	1.4×10^{-15} ± 15%	1.9×10^{-2}	5.0×10^{-10} ± 3%	6.5×10^{-8} ± 3%	7.6×10^{-3}
	12	2.5×10^{-17} ± 8%	2.4×10^{-18} ± 17%	1.0×10^{-1}	—	1.6×10^{-15} ± 21%	1.5×10^{-2}	6.3×10^{-10} ± 3%	8.7×10^{-8} ± 3%	7.2×10^{-3}
	13	2.8×10^{-17} ± 8%	2.6×10^{-18} ± 18%	9.3×10^{-2}	—	1.5×10^{-15} ± 15%	1.9×10^{-2}	5.1×10^{-10} ± 3%	6.6×10^{-8} ± 3%	7.7×10^{-3}
	14	4.4×10^{-15} ± 5%	1.2×10^{-16} ± 6%	2.7×10^{-2}	8.8×10^{-16} ± 7%	8.0×10^{-16} ± 7%	5.5	4.1×10^{-10} ± 3%	5.4×10^{-8} ± 3%	7.6×10^{-3}
	15	1.7×10^{-17} ± 10%	1.6×10^{-18} ± 28%	9.4×10^{-2}	—	1.1×10^{-15} ± 12%	1.5×10^{-2}	5.8×10^{-10} ± 3%	7.7×10^{-8} ± 3%	7.5×10^{-3}
June	1	1.1×10^{-17} ± 15%	4.5×10^{-19} ± 42%	4.1×10^{-2}	—	5.4×10^{-16} ± 23%	2.0×10^{-2}	5.8×10^{-10} ± 3%	7.8×10^{-8} ± 4%	7.4×10^{-3}
	2	1.2×10^{-17} ± 15%	1.5×10^{-18} ± 34%	1.3×10^{-1}	—	1.0×10^{-15} ± 41%	1.2×10^{-2}	6.2×10^{-10} ± 3%	3.3×10^{-8} ± 3%	7.5×10^{-3}
	12	5.3×10^{-17} ± 7%	3.3×10^{-18} ± 19%	6.2×10^{-2}	—	2.0×10^{-15} ± 22%	2.7×10^{-2}	7.0×10^{-10} ± 3%	9.6×10^{-8} ± 3%	7.3×10^{-3}
	13	1.2×10^{-17} ± 9%	1.8×10^{-18} ± 20%	1.5×10^{-1}	—	8.8×10^{-16} ± 30%	1.4×10^{-2}	7.1×15^{-10} ± 3%	9.6×10^{-8} ± 3%	7.4×10^{-3}

Table 3 (continued).

Month	Location	^{239}Pu	^{238}Pu	$^{238}Pu/^{239}Pu$	^{241}Am	^{90}Sr	$^{239}Pu/^{90}Sr$	Mass (mg/M^3) ^{235}U	Mass (mg/M^3) ^{238}U	$^{235}U/^{238}U$
June (con'd)	14	$1.3\times10^{-15}\pm5\%$	$4.2\times10^{-17}\pm7\%$	3.2×10^{-2}	—	$3.7\times10^{-16}\pm9\%$	3.5	$5.7\times10^{-10}\pm3\%$	$7.5\times10^{-8}\pm3\%$	7.6×10^{-3}
	15	$1.7\times10^{-17}\pm10\%$	$1.7\times10^{-18}\pm26\%$	1.0×10^{-1}	—	$8.5\times10^{-16}\pm18\%$	2.0×10^{-2}	$7.4\times10^{-10}\pm3\%$	$1.0\times10^{-7}\pm3\%$	7.4×10^{-3}
July	1	$1.1\times10^{-17}\pm14\%$	$1.5\times10^{-18}\pm34\%$	1.4×10^{-1}	—	$5.7\times10^{-16}\pm12\%$	1.9×10^{-2}	$3.7\times10^{-10}\pm3\%$	$5.2\times10^{-8}\pm4\%$	7.1×10^{-3}
	2	$1.3\times10^{-17}\pm30\%$	$6.4\times10^{-18}\pm33\%$	4.9×10^{-1}	—	$1.3\times10^{-15}\pm18\%$	1.0×10^{-2}	$9.8\times10^{-10}\pm3\%$	$1.3\times10^{-7}\pm4\%$	7.5×10^{-3}
	12	$1.1\times10^{-17}\pm16\%$	$2.4\times10^{-18}\pm46\%$	2.2×10^{-1}	—	$6.6\times10^{-16}\pm13\%$	1.7×10^{-2}	$5.5\times10^{-10}\pm2\%$	$8.1\times10^{-8}\pm4\%$	6.8×10^{-3}
	13	$8.2\times10^{-18}\pm12\%$	$1.7\times10^{-18}\pm26\%$	2.1×10^{-1}	—	$5.2\times10^{-16}\pm14\%$	1.6×10^{-2}	$4.7\times10^{-10}\pm2\%$	$6.7\times10^{-8}\pm3\%$	7.0×10^{-3}
	14	$1.1\times10^{-16}\pm6\%$	$4.6\times10^{-18}\pm14\%$	4.2×10^{-2}	—	$6.2\times10^{-16}\pm12\%$	1.8×10^{-1}	$5.9\times10^{-10}\pm2\%$	$8.2\times10^{-8}\pm3\%$	7.2×10^{-3}
	15	$1.3\times10^{-17}\pm14\%$	$6.2\times10^{-19}\pm42\%$	4.8×10^{-2}	—	$3.0\times10^{-16}\pm15\%$	4.3×10^{-2}	$1.4\times10^{-9}\pm2\%$	$2.1\times10^{-7}\pm3\%$	6.7×10^{-3}
Aug.	1	$6.7\times10^{-18}\pm18\%$	$5.7\times10^{-19}\pm52\%$	8.5×10^{-2}	—	$5.9\times10^{-16}\pm16\%$	1.1×10^{-2}	$7.5\times10^{-10}\pm4\%$	$9.9\times10^{-8}\pm5\%$	7.6×10^{-3}
	2	$6.7\times10^{-18}\pm17\%$	$7.5\times10^{-19}\pm35\%$	1.1×10^{-1}	—	$6.8\times10^{-16}\pm16\%$	9.9×10^{-3}	$6.4\times10^{-10}\pm3\%$	$8.9\times10^{-8}\pm4\%$	7.2×10^{-3}
	12	$9.2\times10^{-18}\pm16\%$	$1.1\times10^{-18}\pm50\%$	1.2×10^{-1}	—	$7.5\times10^{-16}\pm13\%$	1.2×10^{-2}	$6.2\times10^{-10}\pm3\%$	$1.1\times10^{-7}\pm3\%$	7.5×10^{-3}
	13	$1.0\times10^{-17}\pm19\%$	$1.4\times10^{-18}\pm39\%$	1.4×10^{-1}	—	$6.7\times10^{-16}\pm24\%$	1.5×10^{-2}	$8.2\times10^{-10}\pm3\%$	$1.1\times10^{-7}\pm3\%$	7.5×10^{-3}
	14	$2.8\times10^{-16}\pm5\%$	$1.2\times10^{-17}\pm11\%$	4.3×10^{-2}	—	$2.7\times10^{-16}\pm9\%$	9.6×10^{-1}	$1.9\times10^{-9}\pm3\%$	$2.7\times10^{-7}\pm4\%$	7.0×10^{-3}
	15	$7.7\times10^{-18}\pm13\%$	$9.6\times10^{-19}\pm31\%$	1.2×10^{-1}	—	$5.8\times10^{-16}\pm12\%$	1.3×10^{-2}	$1.2\times10^{-9}\pm3\%$	$1.6\times10^{-7}\pm4\%$	7.5×10^{-3}
Sept.	1	$5.3\times10^{-18}\pm15\%$	$9.2\times10^{-19}\pm33\%$	1.7×10^{-1}	—	$2.7\times10^{-16}\pm26\%$	2.0×10^{-2}	$4.9\times10^{-10}\pm3\%$	$7.0\times10^{-8}\pm4\%$	7.0×10^{-3}
	2	$4.6\times10^{-18}\pm16\%$	$1.5\times10^{-18}\pm22\%$	3.3×10^{-1}	—	$4.8\times10^{-16}\pm22\%$	9.6×10^{-3}	$6.4\times10^{-10}\pm3\%$	$8.6\times10^{-8}\pm4\%$	7.4×10^{-3}
	12	$2.2\times10^{-17}\pm8\%$	$9.4\times10^{-19}\pm28\%$	4.3×10^{-2}	—	Lost	—	$6.2\times10^{-10}\pm3\%$	$9.0\times10^{-8}\pm4\%$	6.9×10^{-3}
	13	$3.5\times10^{-18}\pm19\%$	$1.2\times10^{-19}\pm44\%$	3.4×10^{-2}	—	$3.6\times10^{-16}\pm28\%$	9.7×10^{-3}	$4.6\times10^{-10}\pm4\%$	$6.2\times10^{-8}\pm4\%$	7.4×10^{-3}
	14	$5.8\times10^{-17}\pm7\%$	$3.5\times10^{-18}\pm17\%$	6.0×10^{-2}	—	$4.5\times10^{-16}\pm27\%$	1.3×10^{-1}	$5.7\times10^{-10}\pm4\%$	$8.2\times10^{-8}\pm4\%$	7.0×10^{-3}
	15	$4.8\times10^{-18}\pm14\%$	$6.8\times10^{-19}\pm32\%$	1.4×10^{-1}	—	$4.8\times10^{-16}\pm26\%$	1.0×10^{-2}	$8.6\times10^{-10}\pm3\%$	$1.2\times10^{-7}\pm4\%$	7.2×10^{-3}
Oct.	1	$6.8\times10^{-18}\pm21\%$	$1.0\times10^{-18}\pm48\%$	1.5×10^{-1}	—	$7.0\times10^{-16}\pm17\%$	9.7×10^{-3}	$4.6\times10^{-10}\pm3\%$	$7.1\times10^{-8}\pm4\%$	6.5×10^{-3}
	2	$5.3\times10^{-18}\pm22\%$	—	—	—	$9.2\times10^{-16}\pm12\%$	5.8×10^{-3}	$6.6\times10^{-10}\pm3\%$	$1.7\times10^{-7}\pm4\%$	3.9×10^{-3}
	12	$1.6\times10^{-17}\pm12\%$	$8.5\times10^{-19}\pm41\%$	5.3×10^{-2}	—	$6.9\times10^{-16}\pm20\%$	2.3×10^{-2}	$1.0\times10^{-9}\pm3\%$	$2.6\times10^{-7}\pm4\%$	3.8×10^{-3}
	13	$5.6\times10^{-18}\pm16\%$	$6.5\times10^{-19}\pm37\%$	1.2×10^{-1}	—	$5.7\times10^{-16}\pm23\%$	9.8×10^{-3}	$5.9\times10^{-10}\pm3\%$	$1.2\times10^{-7}\pm4\%$	4.9×10^{-3}
	14	$4.3\times10^{-18}\pm10\%$	$1.5\times10^{-18}\pm35\%$	3.5×10^{-1}	—	$4.5\times10^{-16}\pm29\%$	9.9×10^{-3}	$9.2\times10^{-10}\pm3\%$	$1.6\times10^{-7}\pm4\%$	5.7×10^{-3}
	15	$1.6\times10^{-17}\pm12\%$	$9.6\times10^{-19}\pm32\%$	6.0×10^{-2}	—	$5.9\times10^{-16}\pm21\%$	2.7×10^{-2}	$9.3\times10^{-10}\pm3\%$	$1.6\times10^{-7}\pm4\%$	5.8×10^{-3}
Nov.	1	$2.1\times10^{-18}\pm29\%$	$4.2\times10^{-19}\pm49\%$	2.0×10^{-1}	—	$3.3\times10^{-16}\pm28\%$	6.4×10^{-3}	$1.7\times10^{-10}\pm4\%$	$2.1\times10^{-8}\pm6\%$	8.1×10^{-3}
	2	$2.3\times10^{-18}\pm30\%$	$6.0\times10^{-20}\pm100\%$	2.6×10^{-2}	—	$6.4\times10^{-16}\pm16\%$	3.6×10^{-3}	$1.9\times10^{-10}\pm5\%$	$2.7\times10^{-8}\pm7\%$	7.0×10^{-3}
	12	$3.4\times10^{-18}\pm28\%$	$4.8\times10^{-19}\pm61\%$	1.4×10^{-1}	—	$6.1\times10^{-16}\pm21\%$	5.6×10^{-3}	$2.6\times10^{-10}\pm4\%$	$3.9\times10^{-8}\pm5\%$	6.7×10^{-3}
	13	$2.7\times10^{-18}\pm31\%$	$1.5\times10^{-19}\pm76\%$	5.6×10^{-2}	—	$5.2\times10^{-16}\pm17\%$	5.2×10^{-3}	$2.2\times10^{-10}\pm7\%$	$3.1\times10^{-8}\pm10\%$	7.1×10^{-3}
	14	$6.7\times10^{-17}\pm8\%$	$2.2\times10^{-18}\pm24\%$	3.3×10^{-2}	—	$5.3\times10^{-16}\pm16\%$	1.3×10^{-1}	$1.9\times10^{-10}\pm5\%$	$2.7\times10^{-8}\pm7\%$	7.0×10^{-3}
	15	$2.2\times10^{-18}\pm22\%$	$2.9\times10^{-19}\pm41\%$	1.3×10^{-1}	—	$3.7\times10^{-16}\pm23\%$	5.9×10^{-3}	$2.6\times10^{-10}\pm4\%$	$5.0\times10^{-8}\pm6\%$	5.2×10^{-3}
Dec.	1	$3.4\times10^{-18}\pm22\%$	$6.4\times10^{-19}\pm45\%$	1.9×10^{-1}	—	$8.1\times10^{-16}\pm16\%$	4.2×10^{-3}	$3.2\times10^{-10}\pm5\%$	$1.1\times10^{-7}\pm6\%$	2.9×10^{-3}
	2	$4.1\times10^{-18}\pm28\%$	$4.5\times10^{-19}\pm64\%$	1.1×10^{-1}	—	$8.2\times10^{-16}\pm22\%$	5.0×10^{-3}	$8.0\times10^{-10}\pm4\%$	$3.5\times10^{-7}\pm5\%$	2.3×10^{-3}

Table 3 (continued).

Month	Location	^{239}Pu	^{238}Pu	$^{238}Pu/^{239}Pu$	^{241}Am	^{90}Sr	$^{239}Pu/^{90}Sr$	Mass (mg/m^3) ^{235}U	^{238}U	$^{235}U/^{238}U$
Dec. (cont'd)	12	$5.2\times10^{-18} \pm 26\%$	$1.9\times10^{-19} \pm 71\%$	3.7×10^{-2}	—	$7.2\times10^{-16} \pm 21\%$	7.2×10^{-3}	$4.1\times10^{-10} \pm 6\%$	$1.1\times10^{-7} \pm 9\%$	3.7×10^{-3}
	13	$4.0\times10^{-18} \pm 31\%$	$3.4\times10^{-19} \pm 71\%$	8.5×10^{-2}	—	$8.6\times10^{-16} \pm 21\%$	4.7×10^{-3}	$1.8\times10^{-10} \pm 7\%$	$2.[illegible]\times10^{-8} \pm 9\%$	6.2×10^{-3}
	14	$5.8\times10^{-18} \pm 16\%$	$3.7\times10^{-19} \pm 42\%$	6.4×10^{-2}	—	$1.0\times10^{-15} \pm 14\%$	5.8×10^{-3}	$7.0\times10^{-10} \pm 4\%$	$3.1\times10^{-7} \pm 6\%$	2.3×10^{-3}
	15	$3.4\times10^{-18} \pm 26\%$	$1.9\times10^{-19} \pm 64\%$	5.6×10^{-2}	—	$7.2\times10^{-16} \pm 14\%$	4.7×10^{-3}	$3.8\times10^{-10} \pm 4\%$	$1.5\times10^{-7} \pm 5\%$	$2.[illegible]\times10^{-3}$

Annual averages

Location	^{239}Pu µCi/ml	% RCG[a]	^{238}Pu µCi/ml	% RCG	^{235}U, mg/m^3	% RCG	^{238}U, mg/m^3	% RCG
1	1.5×10^{-17}	1.5×10^{-3}	$<1.4\times10^{-18}$	$<1.4\times10^{-4}$	4.1×10^{-10}	2.2×10^{-5}	6.3×10^{-8}	4.2×10^{-4}
2	1.1×10^{-17}	1.1×10^{-3}	$<1.5\times10^{-18}$	$<1.5\times10^{-4}$	5.3×10^{-10}	2.8×10^{-5}	9.9×10^{-8}	6.6×10^{-4}
12	1.7×10^{-17}	1.7×10^{-3}	$<1.6\times10^{-18}$	$<1.6\times10^{-4}$	5.4×10^{-10}	2.8×10^{-5}	9.2×10^{-8}	6.1×10^{-4}
13	1.1×10^{-17}	1.1×10^{-3}	1.3×10^{-18}	1.3×10^{-4}	4.4×10^{-10}	2.3×10^{-5}	6.4×10^{-8}	4.3×10^{-4}
14	7.2×10^{-15}	7.2×10^{-1}	1.9×10^{-17}	1.9×10^{-3}	5.9×10^{-10}	3.1×10^{-5}	1.0×10^{-7}	6.7×10^{-4}
15	1.3×10^{-17}	1.3×10^{-3}	1.2×10^{-18}	1.2×10^{-4}	5.6×10^{-10}	2.9×10^{-5}	1.0×10^{-7}	6.7×10^{-4}

[a]RCG 1×10^{-12} µCi/ml for Pu in the insoluble form.

Table 4. Tritium (HTO) in air at Laboratory perimeters in 1973 (µCi/ml).

Location[a]	No. of samples	January-June Maximum	Minimum	Average	No. of samples	July-December Maximum	Minimum	Average	Annual average[c]	RCG[b]	Calculated annual adult whole body [illegible]
1	2	$7.0\times10^{-12} \pm 20.3\%$	$6.5\times10^{-12} \pm 8.1\%$	$6.[illegible]\times10^{-12}$	23	$6.7\times10^{-11} \pm 3.2\%$	$6.9\times10^{-12} \pm 25.7$	3.0×10^{-11}	2.8×10^{-11}	1.4×10^{-2}	$4.[illegible]\times10^{-3}$
2	0				10	$6.9\times10^{-11} \pm 3.2\%$	$1.7\times10^{-11} \pm 3.1\%$	4.5×10^{-11}	$4.[illegible]\times10^{-11}$	$1.[illegible]\times10^{-2}$	$5.6\times10^{[illegible]}$
12	0				15	$1.9\times10^{-10} \pm 1.5\%$	$8.7\times10^{-12} \pm 14.8\%$	6.2×10^{-11}	6.3×10^{-11}	3.1×10^{-2}	$9.[illegible]\times10^{-2}$
13	0				12	$4.0\times10^{-11} \pm 4.3\%$	$8.6\times10^{-12} \pm 15.0\%$	2.4×10^{-11}	2.4×10^{-11}	1.2×10^{-2}	$3.[illegible]\times10^{-2}$
14	3	$3.7\times10^{-11} \pm 4.0\%$	$1.4\times10^{-11} \pm 6.7\%$	2.8×10^{-11}	23	$1.2\times10^{-10} \pm 2.6\%$	$3.[illegible]\times10^{-11} \pm 8.3\%$	6.6×10^{-11}	6.2×10^{-11}	3.1×10^{-2}	$1.0\times10^{[illegible]}$
15	3	$1.2\times10^{-11} \pm 9.7\%$	$7.5\times10^{-12} \pm 10.4\%$	1.0×10^{-11}	20	$4.8\times10^{-11} \pm 4.4\%$	$5.4\times10^{-12} \pm 46.8\%$	2.1×10^{-11}	2.0×10^{-11}	9.9×10^{-3}	1.2×10^{-2}

[a]See Fig. 2 for locations.

[b]RCG for HTO in air 2×10^{-7} µCi/ml.

[c]Based on July-December data.

Table 5. Activity levels of various radionuclides observed in Livermore soils during 1973 (μCi/g).

Location[a]	^{239}Pu	^{238}Pu	^{137}Cs	^{214}Bi(U)	^{212}Pb(Th)	^{40}K
S-253	6.3×10^{-9} ± 6%	3.7×10^{-10} ± 16%	3.5×10^{-7} ± 14%	6.1×10^{-7} ± 8%	6.0×10^{-7} ± 9%	9.8×10^{-6} ± 9%
S-254	6.7×10^{-8} ± 6	7.7×10^{-10} ± 8%	4.8×10^{-7} ± 12%	5.3×10^{-7} ± 10%	5.3×10^{-7} ± 11%	9.1×10^{-6} ± 9%
S-255	4.6×10^{-9} ± 6%	5.0×10^{-10} ± 14%	1.7×10^{-7} ± 22%	[illegible] $\times 10^{-7}$ ± 8%	5.0×10^{-7} ± 9%	9.6×10^{-6} ± 8%
S-256	4.1×10^{-9} ± 9%	2.6×10^{-10} ± 26%	1.9×10^{-7} ± 24%	6.3×10^{-7} ± 9%	6.2×10^{-7} ± 9%	1.2×10^{-5} ± 8%
S-257	4.3×10^{-9} ± 7%	1.8×10^{-10} ± 21%	2.2×10^{-7} ± 18%	6.0×10^{-7} ± 8%	6.3×10^{-7} ± 9%	1.1×10^{-5} ± 8%
S-259	3.9×10^{-9} ± 7%	2.2×10^{-10} ± 19%	2.3×10^{-7} ± 19%	5.6×10^{-7} ± 8%	5.9×10^{-7} ± 9%	1.3×10^{-5} ± 7%
S-264	2.3×10^{-9} ± 11%	1.4×10^{-10} ± 30%	1.2×10^{-7} ± 34%	6.2×10^{-7} ± 7%	7.2×10^{-7} ± 7%	1.2×10^{-5} ± 8%
S-267	3.7×10^{-9} ± 9%	2.2×10^{-10} ± 13%	2.4×10^{-7} ± 19%	5.8×10^{-7} ± 8%	6.6×10^{-7} ± 8%	1.1×10^{-5} ± 5%
S-268	3.4×10^{-9} ± 8%	2.7×10^{-10} ± 24%	2.2×10^{-7} ± 20%	5.7×10^{-7} ± 8%	5.9×10^{-7} ± 9%	1.3×10^{-5} ± 8%
S-271	9.5×10^{-9} ± 7%	4.4×10^{-10} ± 20%	5.1×10^{-7} ± 10%	6.1×10^{-7} ± 7%	6.7×10^{-7} ± 7%	1.4×10^{-5} ± 6%
S-272	5.4×10^{-9} ± 10%	7.7×10^{-10} ± 20%	2.0×10^{-7} ± 20%	6.0×10^{-7} ± 7%	7.3×10^{-7} ± 7%	[illegible] $\times 10^{-5}$ ± 7%
S-275	7.7×10^{-9} ± 11%	5.1×10^{-10} ± 32%	4.6×10^{-7} ± 11%	5.0×10^{-7} ± 8%	6.2×10^{-7} ± 9%	9.2×10^{-6} ± 9%
S-277	3.9×10^{-9} ± 27%	3.2×10^{-10} ± 27%	1.8×10^{-7} ± 18%	4.1×10^{-7} ± 9%	5.1×10^{-7} ± 9%	5.9×10^{-6} ± 10%
S-278	4.1×10^{-9} ± 12%	1.7×10^{-10} ± 38%	3.5×10^{-7} ± 12%	3.5×10^{-7} ± 11%	4.4×10^{-7} ± 11%	6.4×10^{-6} ± 10%
S-283	2.6×10^{-8} ± 6%	1.8×10^{-9} ± 10%	3.0×10^{-7} ± 15%	6.6×10^{-7} ± 6%	8.0×10^{-7} ± 7%	1.2×10^{-5} ± 7%
S-284	2.8×10^{-9} ± 9%	1.7×10^{-10} ± 29%	6.9×10^{-8} ± 50%	4.7×10^{-7} ± 9%	6.4×10^{-7} ± 9%	7.9×10^{-6} ± 9%
S-285	9.0×10^{-9} ± 7%	9.8×10^{-10} ± 13%	4.2×10^{-7} ± 10%	3.8×10^{-7} ± 9%	4.9×10^{-7} ± 9%	9.1×10^{-6} ± 9%
S-286	2.7×10^{-9} ± 11%	2.2×10^{-10} ± 28%	1.5×10^{-7} ± 24%	6.5×10^{-7} ± 8%	[illegible] $\times 10^{-7}$ ± 9%	1.2×10^{-5} ± 7%
S-287	2.0×10^{-8} ± 6%	1.0×10^{-9} ± 14%	2.4×10^{-7} ± 17%	5.4×10^{-7} ± 12%	5.4×10^{-7} ± 13%	1.2×10^{-5} ± 10%
S-288	4.0×10^{-9} ± 10%	3.5×10^{-10} ± 27%	2.2×10^{-7} ± 18%	6.4×10^{-7} ± 11	6.1×10^{-7} ± 11%	1.2×10^{-5} ± 7%
S-289	8.2×10^{-9} ± 8%	5.6×10^{-10} ± 21%	4.1×10^{-7} ± 12%	5.9×10^{-7} ± 9%	7.2×10^{-7} ± 9%	1.2×10^{-5} ± 7%
S-290	9.3×10^{-9} ± 9%	4.8×10^{-10} ± 24%	4.1×10^{-7} ± 8%	6.1×10^{-7} ± 6%	6.2×10^{-7} ± 8%	1.2×10^{-5} ± 5%
S-292	1.0×10^{-8} ± 8%	5.5×10^{-10} ± 21%	4.7×10^{-7} ± 11%	5.5×10^{-7} ± 8%	5.6×10^{-7} ± 9%	1.2×10^{-5} ± 7%
S-318	5.9×10^{-9} ± 14%	1.9×10^{-10} ± 48%	2.4×10^{-7} ± 12%	2.4×10^{-7} ± 7%	5.7×10^{-7} ± 9%	1.0×10^{-5} ± 7%
S-319	1.8×10^{-7} ± 7%	5.5×10^{-9} ± 9%	2.8×10^{-7} ± 12%	6.4×10^{-7} ± 7%	7.2×10^{-7} ± 10%	1.2×10^{-5} ± [illegible]
S-320	1.4×10^{-8} ± 7%	9.5×10^{-10} ± 17%	6.1×10^{-7} ± 5%	5.7×10^{-7} ± 4%	5.7×10^{-7} ± 7%	1.4×10^{-5} ± 4%
S-223	9.6×10^{-9} ± 12%	8.5×10^{-10} ± 31%	– collected in 1972 at same location as 319			
S-225	6.8×10^{-9} ± 11%	5.4×10^{-10} ± 28%	– collected in 1972 at same location as 318			
Median value	5.9×10^{-9}	4.8×10^{-10}	2.8×10^{-7}	5.8×10^{-7}	6.2×10^{-7}	1.1×10^{-5}

[a]See Fig. 5 for sample locations. All samples were taken at a depth of 0-1 cm.

Table 6. Various radionuclides observed in San Joaquin Valley soils during 1973.

Location[a]	Deposition values, $\mu Ci/M^2$			Uranium $\mu g/g$ dry soil		
	^{239}Pu	^{238}Pu	^{137}Cs	^{235}U	^{238}U	$^{235}U/^{238}U$[b]
S-234	8.9×10^{-4} ± 9%	2.6×10^{-5} ± 39%	1.7×10^{-2} ± 5%	1.4×10^{-2} ± 2%	1.9 ± 3%	7.3×10^{-3}
S-235	2.0×10^{-4} ± 20%	5.1×10^{-6} ± 67%	6.7×10^{-3} ± 10%	1.3×10^{-2} ± 2%	1.9 ± 3%	7.3×10^{-3}
S-236	6.2×10^{-4} ± 11%	2.6×10^{-5} ± 41%	2.8×10^{-2} ± 15%	1.3×10^{-2} ± 2%	1.8 ± 3%	7.2×10^{-3}
S-237	6.0×10^{-4} ± 9%	2.2×10^{-5} ± 34%	2.7×10^{-2} ± 19%	2.1×10^{-2} ± 2%	2.9 ± 3%	7.2×10^{-3}
S-238	4.7×10^{-4} ± 15%	1.8×10^{-5} ± 54%	2.9×10^{-2} ± 22%	6.4×10^{-2} ± 2%	9.1 ± 3%	7.2×10^{-3}
S-239	6.0×10^{-4} ± 12%	1.7×10^{-5} ± 52%	3.0×10^{-2} ± 18%	1.7×10^{-2} ± 2%	2.4 ± 3%	7.2×10^{-3}
S-240	5.9×10^{-4} ± 10%	2.6×10^{-5} ± 35%	6.0×10^{-2} ± 17%	7.2×10^{-2} ± 2%	10.1 ± 3%	7.3×10^{-3}
S-241	1.1×10^{-3} ± 12%	2.1×10^{-5} ± 50%	—	1.8×10^{-2} ± 2%	2.6 ± 3%	7.2×10^{-3}
S-242	1.6×10^{-4} ± 15%	6.4×10^{-6} ± 60%	1.5×10^{-3} ± 27%	1.2×10^{-1} ± 2%	17.0 ± 3%	7.3×10^{-3}
S-243	9.9×10^{-4} ± 9%	3.2×10^{-5} ± 30%	1.0×10^{-2} ± 11%	7.3×10^{-2} ± 2%	10.1 ± 3%	7.3×10^{-3}
S-244	6.5×10^{-4} ± 14%	2.8×10^{-5} ± 58%	2.9×10^{-3} ± 16%	5.5×10^{-2} ± 2%	7.6 ± 3%	7.3×10^{-3}
S-245	4.7×10^{-4} ± 15%	1.4×10^{-5} ± 48%	3.9×10^{-3} ± 21%	6.3×10^{-2} ± 2%	8.8 ± 3%	7.3×10^{-3}
S-246	8.5×10^{-4} ± 14%	2.3×10^{-5} ± 58%	3.2×10^{-2} ± 15%	4.2×10^{-2} ± 2%	5.9 ± 3%	7.3×10^{-3}
S-247	9.6×10^{-4} ± 13%	3.0×10^{-5} ± 49%	5.0×10^{-2} ± 10%	5.5×10^{-2} ± 2%	7.8 ± 3%	7.2×10^{-3}
S-248	1.2×10^{-3} ± 10%	8.0×10^{-5} ± 32%	6.0×10^{-2} ± 9%	4.0×10^{-2} ± 2%	5.6 ± 3%	7.2×10^{-3}
S-249	1.1×10^{-3} ± 10%	2.2×10^{-5} ± 37%	5.3×10^{-2} ± 9%	1.4×10^{-2} ± 2%	2.0 ± 3%	7.3×10^{-3}
S-250	2.4×10^{-4} ± 23%	4.1×10^{-5} ± 38%	1.9×10^{-3} ± 41%	4.1×10^{-2} ± 2%	5.7 ± 3%	7.2×10^{-3}
S-251	8.3×10^{-4} ± 11%	5.6×10^{-5} ± 38°	4.0×10^{-2} ± 13%	1.5×10^{-2} ± 2%	2.1 ± 3%	7.4×10^{-3}
Median value	6.5×10^{-4}	2.6×10^{-5}	2.8×10^{-2}	4.0×10^{-2}	5.6	7.3×10^{-3}

[a] See Fig. 6 for sample locations. All samples were taken at a depth of 0-25 cm.

[b] Ratios are atomic ratios; the isotopic atomic ratio of natural uranium is 7.25×10^{-3}.

Table 7. Activity levels of various radionuclides in surface drainage ditches and creeks ($\mu Ci/g$).

Location	Depth (cm)	^{239}Pu	^{238}Pu	^{137}Cs
S-304	0-1	$4.9 \times 10^{-9} \pm 7\%$	$2.6 \times 10^{-10} \pm 7\%$	$1.7 \times 10^{-8} \pm 56\%$
S-305	S[a]	$2.6 \times 10^{-9} \pm 8\%$	$1.6 \times 10^{-10} \pm 24\%$	$1.1 \times 10^{-7} \pm 24\%$
S-306	S	$8.1 \times 10^{-10} \pm 20\%$	$3.5 \times 10^{-11} \pm 71\%$	$3.8 \times 10^{-8} \pm 32\%$
S-307	S	$1.5 \times 10^{-9} \pm 14\%$	$6.5 \times 10^{-10} \pm 19\%$	$7.0 \times 10^{-6} \pm 2\%$
S-308	S	$6.2 \times 10^{-10} \pm 22\%$	$3.8 \times 10^{-11} \pm 44\%$	$2.9 \times 10^{-8} \pm 60\%$
S-309	S	$3.2 \times 10^{-9} \pm 15\%$	$5.0 \times 10^{-10} \pm 30\%$	$1.1 \times 10^{-6} \pm 7\%$
S-310	0-1	$2.2 \times 10^{-8} \pm 5\%$	$1.5 \times 10^{-9} \pm 8\%$	$3.2 \times 10^{-8} \pm 36\%$
S-310	0-25	$2.0 \times 10^{-8} \pm 7\%$	$1.3 \times 10^{-10} \pm 21\%$	$3.6 \times 10^{-9} \pm 100\%$
S-311	0-1	$1.3 \times 10^{-8} \pm 5\%$	$8.8 \times 10^{-10} \pm 9\%$	$1.7 \times 10^{-8} \pm 70\%$
S-311	0-25	$1.4 \times 10^{-9} \pm 8\%$	$8.8 \times 10^{-11} \pm 24\%$	—
S-312	0-1	$6.8 \times 10^{-8} \pm 5\%$	$4.1 \times 10^{-9} \pm 8\%$	$5.7 \times 10^{-8} \pm 40\%$
S-312	0-25	$9.6 \times 10^{-9} \pm 7\%$	$7.7 \times 10^{-10} \pm 15\%$	$1.4 \times 10^{-8} \pm 100\%$
S-313	0-1	$4.8 \times 10^{-8} \pm 10\%$	$6.5 \times 10^{-10} \pm 22\%$	$1.4 \times 10^{-7} \pm 17\%$
S-313	0-25	$1.3 \times 10^{-9} \pm 13\%$	$9.8 \times 10^{-11} \pm 41\%$	$5.7 \times 10^{-8} \pm 33\%$
S-314	0-1	$1.1 \times 10^{-9} \pm 13\%$	$1.7 \times 10^{-10} \pm 29\%$	$4.4 \times 10^{-8} \pm 35\%$
S-315	0-1	$4.9 \times 10^{-9} \pm 9\%$	$9.2 \times 10^{-10} \pm 16\%$	$9.9 \times 10^{-8} \pm 16\%$
S-315	0-25	$7.6 \times 10^{-9} \pm 8\%$	$5.9 \times 10^{-10} \pm 20\%$	$7.5 \times 10^{-8} \pm 17\%$
S-316	S	$1.8 \times 10^{-9} \pm 8\%$	$1.3 \times 10^{-10} \pm 25\%$	$5.3 \times 10^{-8} \pm 21\%$
S-317	S	$2.7 \times 10^{-9} \pm 6\%$	$1.6 \times 10^{-10} \pm 20\%$	$5.2 \times 10^{-8} \pm 17\%$

[a]S = Sediment sample representing a wet sample taken from the bottom of a running stream or creek. These samples were dried and activity is per gram of dry sample. All other samples were from dry ditch or creek beds.

Table 8. Livermore sewage treatment plant sampling results during 1973.

Month	No. of samples	Gross alpha activity (μCi/ml) Digesters Maximum	Digesters Minimum	Digesters Average	No. of samples	Aeration tank Maximum	Aeration tank Minimum	Aeration tank Average
Jan.	10	$7.4 \times 10^{-7} \pm 34\%$	$1.7 \times 10^{-7} \pm 43\%$	4.3×10^{-7}	5	$1.1 \times 10^{-7} \pm 27\%$	$1.4 \times 10^{-8} \pm 30\%$	7.7×10^{-8}
Feb.	8	$5.3 \times 10^{-7} \pm 30\%$	$4.7 \times 10^{-8} \pm 41\%$	2.6×10^{-7}	4	$7.9 \times 10^{-8} \pm 36\%$	$1.2 \times 10^{-8} \pm 30\%$	5.1×10^{-8}
Mar.	8	$3.2 \times 10^{-7} \pm 32\%$	$1.6 \times 10^{-7} \pm 41\%$	2.1×10^{-7}	4	$1.2 \times 10^{-7} \pm 24\%$	$6.8 \times 10^{-8} \pm 34\%$	9.7×10^{-8}
Apr.	8	$4.1 \times 10^{-7} \pm 29\%$	$1.2 \times 10^{-7} \pm 41\%$	2.1×10^{-7}	4	$7.7 \times 10^{-7} \pm 10\%$	$9.2 \times 10^{-8} \pm 29\%$	2.7×10^{-8}
May	10	$2.7 \times 10^{-7} \pm 28\%$	$1.2 \times 10^{-7} \pm 40\%$	2.1×10^{-7}	5	$9.0 \times 10^{-8} \pm 27\%$	$7.4 \times 10^{-8} \pm 34\%$	8.4×10^{-8}
June	8	$5.3 \times 10^{-7} \pm 25\%$	$1.3 \times 10^{-7} \pm 34\%$	2.9×10^{-7}	4	$1.2 \times 10^{-7} \pm 24\%$	$7.8 \times 10^{-8} \pm 30\%$	9.2×10^{-8}
July	10	$3.2 \times 10^{-7} \pm 31\%$	$2.6 \times 10^{-8} \pm 36\%$	2.0×10^{-7}	5	$1.7 \times 10^{-7} \pm 22\%$	$6.1 \times 10^{-8} \pm 32\%$	9.3×10^{-8}
Aug.	8	$8.6 \times 10^{-7} \pm 28\%$	$2.3 \times 10^{-7} \pm 29\%$	4.5×10^{-7}	4	$1.1 \times 10^{-7} \pm 26\%$	$4.8 \times 10^{-8} \pm 38\%$	6.9×10^{-8}
Sept.	8	$8.2 \times 10^{-7} \pm 17\%$	$2.1 \times 10^{-7} \pm 32\%$	3.3×10^{-7}	4	$5.9 \times 10^{-8} \pm 30\%$	$4.1 \times 10^{-8} \pm 43\%$	4.7×10^{-8}
Oct.	10	$6.8 \times 10^{-7} \pm 27\%$	$1.8 \times 10^{-7} \pm 54\%$	3.4×10^{-7}	5	$6.0 \times 10^{-8} \pm 33\%$	$2.7 \times 10^{-8} \pm 30\%$	4.9×10^{-8}
Nov.	8	$3.0 \times 10^{-7} \pm 32\%$	$1.6 \times 10^{-7} \pm 37\%$	2.1×10^{-7}	4	$6.2 \times 10^{-8} \pm 36\%$	$3.4 \times 10^{-8} \pm 44\%$	4.9×10^{-8}
Dec.	8	$4.5 \times 10^{-7} \pm 21\%$	$1.3 \times 10^{-7} \pm 39\%$	2.5×10^{-7}	4	$6.7 \times 10^{-8} \pm 32\%$	$2.5 \times 10^{-8} \pm 59\%$	4.4×10^{-8}

Table 9. Livermore sewage treatment plant sampling results during 1973.

Month	Gross beta activity (μCi/ml)											
	No. of Samples	Digester			No. of Samples	Aeration tank			No. of Samples	Effluent		
		Maximum	Minimum	Average		Maximum	Minimum	Average		Maximum	Minimum	Average	% RCG[a]
Jan.	10	4.6×10^{-7} ± 15%	2.1×10^{-7} ± 15%	3.3×10^{-7}	5	5.5×10^{-8} ± 7%	4.2×10^{-8} ± 8%	4.8×10^{-8}	12	2.1×10^{-8} ± 32%	7.2×10^{-9} ± 100%	1.3×10^{-8}	13
Feb.	8	2.3×10^{-7} ± 6%	1.5×10^{-7} ± 16%	2.1×10^{-7}	4	5.0×10^{-8} ± 7%	4.4×10^{-8} ± 8%	4.7×10^{-8}	8	2.5×10^{-8} ± 30%	9.8×10^{-9} ± 64%	1.8×10^{-8}	18
Mar.	8	5.4×10^{-7} ± 9%	1.8×10^{-7} ± 14%	3.1×10^{-7}	4	5.5×10^{-8} ± 7%	4.2×10^{-8} ± 8%	5.0×10^{-8}	12	2.5×10^{-8} ± 30%	7.0×10^{-9} ± 100%	1.4×10^{-8}	14
Apr.	8	1.3×10^{-6} ± 6%	1.5×10^{-7} ± 17%	3.6×10^{-7}	4	5.8×10^{-8} ± 7%	4.8×10^{-8} ± 8%	5.3×10^{-8}	10	2.9×10^{-8} ± 28%	8.1×10^{-9} ± 100%	1.7×10^{-8}	17
May	10	4.3×10^{-7} ± 13%	1.7×10^{-7} ± 14%	2.4×10^{-7}	5	5.3×10^{-8} ± 8%	3.8×10^{-8} ± 9%	4.5×10^{-8}	8	3.1×10^{-8} ± 28%	1.1×10^{-8} ± 59%	1.9×10^{-8}	19
June	8	4.1×10^{-7} ± 12%	1.8×10^{-7} ± 14%	3.0×10^{-7}	4	5.3×10^{-8} ± 8%	4.4×10^{-8} ± 9%	4.9×10^{-8}	13	3.1×10^{-8} ± 27%	7.3×10^{-9} ± 100%	1.7×10^{-8}	17
July	10	4.2×10^{-7} ± 13%	2.1×10^{-7} ± 12%	3.1×10^{-7}	5	1.2×10^{-7} ± 5%	4.6×10^{-8} ± 9%	6.7×10^{-7}	9	2.8×10^{-8} ± 30%	1.4×10^{-8} ± 47%	1.7×10^{-8}	17
Aug.	8	1.2×10^{-6} ± 12%	3.7×10^{-7} ± 10%	6.1×10^{-7}	4	1.1×10^{-7} ± 5%	7.1×10^{-8} ± 7%	8.6×10^{-8}	12	6.8×10^{-8} ± 17%	8.3×10^{-9} ± 100%	2.5×10^{-8}	25
Sept.	8	6.1×10^{-7} ± 10%	2.9×10^{-7} ± 13%	3.8×10^{-7}	4	5.3×10^{-8} ± 8%	3.9×10^{-8} ± 9%	4.7×10^{-8}	12	3.6×10^{-8} ± 26%	7.9×10^{-9} ± 100%	1.9×10^{-8}	19
Oct.	10	5.1×10^{-7} ± 14%	2.4×10^{-7} ± 14%	3.5×10^{-7}	5	4.9×10^{-8} ± 7%	3.1×10^{-8} ± 9%	4.1×10^{-8}	11	1.8×10^{-8} ± 39%	8.1×10^{-9} ± 100%	1.2×10^{-8}	12
Nov.	8	3.6×10^{-7} ± 16%	1.9×10^{-7} ± 18%	2.5×10^{-7}	4	3.9×10^{-8} ± 9%	3.3×10^{-8} ± 10%	3.5×10^{-8}	8	1.8×10^{-8} ± 40%	7.8×10^{-9} ± 100%	1.2×10^{-8}	12
Dec.	8	3.4×10^{-7} ± 18%	1.5×10^{-7} ± 24%	2.1×10^{-7}	4	3.4×10^{-8} ± 9%	2.8×10^{-8} ± 11%	3.0×10^{-8}	12	2.1×10^{-8} ± 35%	1.1×10^{-8} ± 54%	1.4×10^{-8}	14

[a]RCG = 1×10^{-7} μCi/ml.

Table 10. Transuranium elements observed in the Livermore Sewage Treatment Plant during 1973 ($\mu Ci/ml$).

Month	Sample	^{239}Pu	^{238}Pu	^{241}Am	^{244}Cm
Jan.	Digester #1	$9.9 \times 10^{-9} \pm 7\%$	$3.2 \times 10^{-9} \pm 7\%$		
	Digester #2	$9.6 \times 10^{-9} \pm 8\%$	$1.1 \times 10^{-8} \pm 8\%$	$1.1 \times 10^{-9} \pm 18\%$	$2.7 \times 10^{-10} \pm 27\%$
	Aerator	$1.3 \times 10^{-9} \pm 7\%$	$5.9 \times 10^{-10} \pm 8\%$	$1.7 \times 10^{-10} \pm 24\%$	
	Effluent	$1 \times 10^{-11} \pm 21\%$	$3.4 \times 10^{-12} \pm 32\%$	$2.2 \times 10^{-12} \pm 27\%$	$5.6 \times 10^{-12} \pm 18\%$
Feb.	Digester #1	$6.3 \times 10^{-9} \pm 6\%$	$2.2 \times 10^{-9} \pm 7\%$	$7.5 \times 10^{-10} \pm 21\%$	$1.8 \times 10^{-9} \pm 19\%$
	Digester #2	$5.5 \times 10^{-9} \pm 7\%$	$1.7 \times 10^{-9} \pm 7\%$	$1.8 \times 10^{-9} \pm 11\%$	$2.0 \times 10^{-9} \pm 10\%$
	Aerator	$1.1 \times 10^{-9} \pm 7\%$	$6.9 \times 10^{-10} \pm 8\%$	$1.3 \times 10^{-10} \pm 37\%$	$1.8 \times 10^{-10} \pm 33\%$
	Effluent	$1.3 \times 10^{-11} \pm 10\%$	$6.5 \times 10^{-12} \pm 13\%$		
Mar.	Digester #1	$8.3 \times 10^{-9} \pm 6\%$	$3.6 \times 10^{-9} \pm 7\%$		
	Digester #2	$8.4 \times 10^{-9} \pm 6\%$	$4.2 \times 10^{-9} \pm 7\%$	$7.6 \times 10^{-10} \pm 9\%$	$7.2 \times 10^{-10} \pm 9\%$
	Aerator	$2.3 \times 10^{-9} \pm 7\%$	$1.3 \times 10^{-9} \pm 7\%$		
	Effluent	$1.8 \times 10^{-11} \pm 8\%$	$1.2 \times 10^{-11} \pm 9\%$		
Apr.	Digester #1	$7.8 \times 10^{-9} \pm 7\%$	$3.0 \times 10^{-9} \pm 8\%$		
	Digester #2	$6.4 \times 10^{-9} \pm 8\%$	$3.2 \times 10^{-9} \pm 8\%$		
	Aerator	$1.6 \times 10^{-9} \pm 7\%$	$8.5 \times 10^{-10} \pm 8\%$		
	Effluent	$2.8 \times 10^{-11} \pm 8\%$	$1.2 \times 10^{-11} \pm 10\%$		
May	Digester #1	$6.8 \times 10^{-9} \pm 6\%$	$2.5 \times 10^{-9} \pm 7\%$		
	Digester #2	$5.6 \times 10^{-9} \pm 6\%$	$2.5 \times 10^{-9} \pm 6\%$		
	Aerator	$9.1 \times 10^{-10} \pm 7\%$	$4.3 \times 10^{-10} \pm 8\%$		
	Effluent	$7.5 \times 10^{-12} \pm 13\%$	$3.0 \times 10^{-12} \pm 19\%$		
June	Digester #1	$1.2 \times 10^{-8} \pm 4\%$	$2.3 \times 10^{-9} \pm 5\%$		
	Digester #2	$7.2 \times 10^{-9} \pm 4\%$	$2.5 \times 10^{-9} \pm 5\%$		
	Aerator	$1.8 \times 10^{-9} \pm 5\%$	$5.8 \times 10^{-10} \pm 6\%$		
	Effluent	$1.2 \times 10^{-11} \pm 13\%$	$7.2 \times 10^{-12} \pm 16\%$		
July	Digester #1	$7.4 \times 10^{-9} \pm 5\%$	$1.9 \times 10^{-9} \pm 5\%$		
	Digester #2	$6.0 \times 10^{-9} \pm 7\%$	$1.9 \times 10^{-9} \pm 7\%$		
	Aerator	$1.1 \times 10^{-9} \pm 7\%$	$3.9 \times 10^{-10} \pm 9\%$		
	Effluent	$7.5 \times 10^{-12} \pm 15\%$	$3.8 \times 10^{-12} \pm 15\%$		
Aug.	Digester #1	$8.9 \times 10^{-9} \pm 9\%$	$2.2 \times 10^{-9} \pm 10\%$	$1.4 \times 10^{-9} \pm 8\%$	$2.5 \times 10^{-10} \pm 6\%$
	Digester #2	$9.5 \times 10^{-9} \pm 5\%$	$1.9 \times 10^{-9} \pm 5\%$	$2.2 \times 10^{-9} \pm 7\%$	$2.3 \times 10^{-10} \pm 9\%$
	Aerator	$5.4 \times 10^{-10} \pm 6\%$	$2.1 \times 10^{19} \pm 7\%$	$1.0 \times 10^{-10} \pm 14\%$	$8.3 \times 10^{-12} \pm 36\%$
	Effluent	$4.4 \times 10^{-12} \pm 15\%$	$1.1 \times 10^{-12} \pm 27\%$	$9.7 \times 10^{-13} \pm 44\%$	$1.3 \times 10^{-13} \pm 90\%$
Sept.	Digester #1	$3.6 \times 10^{-9} \pm 5\%$	$8.7 \times 10^{-10} \pm 5\%$		
	Digester #2	Lost	Lost		
	Aerator	$9.8 \times 10^{-11} \pm 8\%$	$8.7 \times 10^{-11} \pm 13\%$		
	Effluent	$4.8 \times 10^{-11} \pm 6\%$	$4.0 \times 10^{-12} \pm 8\%$		
Oct.	Digester #1	$5.4 \times 10^{-9} \pm 5\%$	$8.9 \times 10^{-10} \pm 5\%$		
	Digester #2	$6.3 \times 10^{-9} \pm 5\%$	$1.1 \times 10^{-9} \pm 5\%$		
	Aerator	$4.2 \times 10^{-10} \pm 6\%$	$1.1 \times 10^{-10} \pm 8\%$		
	Effluent	$9.5 \times 10^{-12} \pm 15\%$	$1.8 \times 10^{-10} \pm 29\%$		
Nov.	Digester #1	$4.2 \times 10^{-9} \pm 7\%$	$6.3 \times 10^{-10} \pm 9\%$		
	Digester #2	$3.2 \times 10^{-9} \pm 6\%$	$5.7 \times 10^{-10} \pm 7\%$		
	Aerator	$3.2 \times 10^{-10} \pm 9\%$	$4.6 \times 10^{-11} \pm 19\%$		
	Effluent	$2.1 \times 10^{-12} \pm 33\%$	$2.7 \times 10^{-13} \pm 58\%$		
Dec.	Digester #1	$6.8 \times 10^{-9} \pm 7\%$	$6.7 \times 10^{-10} \pm 9\%$		
	Digester #2	$3.7 \times 10^{-9} \pm 8\%$	$4.8 \times 10^{-10} \pm 10\%$		
	Aerator	$3.3 \times 10^{-10} \pm 12\%$	$5.6 \times 10^{-11} \pm 23\%$		
	Effluent	$3.2 \times 10^{-12} \pm 28\%$	$1.2 \times 10^{-12} \pm 43\%$		

Table 11. Comparison of various radionuclides in LLL and Livermore treatment plant effluents during 1973 (μCi/ml).

Month	^{239}Pu		^{90}Sr		Tritium	
	LLL	Treatment plant	LLL	Treatment plant	LLL	Treatment plant
Jan.	5.1×10^{-10}	1.1×10^{-11}	1.9×10^{-9}	3.0×10^{-10}	8.5×10^{-5}	3.6×10^{-6}
Feb.	8.7×10^{-10}	1.3×10^{-11}	7.0×10^{-10}	7.0×10^{-10}	1.1×10^{-5}	2.8×10^{-6}
Mar.	9.0×10^{-10}	1.8×10^{-11}	1.8×10^{-9}	6.6×10^{-9}	1.3×10^{-5}	3.3×10^{-6}
Apr.	7.2×10^{-10}	2.8×10^{-11}	1.5×10^{-9}	7.2×10^{-10}	1.1×10^{-4}	7.0×10^{-6}
May	3.6×10^{-10}	7.5×10^{-12}	Lost	6.0×10^{-10}	1.2×10^{-5}	1.3×10^{-6}
June	5.9×10^{-10}	1.2×10^{-11}	3.6×10^{-9}	4.0×10^{-10}	4.0×10^{-5}	4.6×10^{-6}
July	2.7×10^{-10}	7.5×10^{-12}	1.9×10^{-9}	7.0×10^{-10}	2.3×10^{-5}	1.8×10^{-6}
Aug.	4.1×10^{-10}	4.4×10^{-12}	1.3×10^{-12}	9.0×10^{-10}	2.7×10^{-5}	3.3×10^{-6}
Sept.	1.8×10^{-10}	4.8×10^{-11}	6.4×10^{-9}	5.0×10^{-11}	3.5×10^{-5}	3.3×10^{-6}
Oct.	2.0×10^{-11}	9.5×10^{-12}	1.2×10^{-9}	5.0×10^{-10}	2.0×10^{-4}	3.2×10^{-6}
Nov.	1.6×10^{-10}	2.1×10^{-12}	1.3×10^{-9}	2.0×10^{-10}	1.1×10^{-5}	1.8×10^{-6}
Dec.	1.4×10^{-11}	3.2×10^{-12}	7.0×10^{-9}	1.1×10^{-9}	1.8×10^{-5}	3.8×10^{-6}
Annual Av	4.1×10^{-10}	1.3×10^{-11}	2.1×10^{-9}	1.1×10^{-9}	4.9×10^{-5}	3.3×10^{-6}
RCG	3×10^{-5}	3×10^{-5}	3×10^{-7}	3×10^{-7}	3×10^{-3}	3×10^{-3}
% RCG	1.4×10^{-3}	4.3×10^{-4}	7.0×10^{-1}	3.7×10^{-1}	1.6	1.1×10^{-1}

Table 12. Gross beta activities in Livermore water samples (μCi/ml).

Location	No. of samples	January-June Maximum	January-June Minimum	January-June Average	No. of samples	July-December Maximum	July-December Minimum	July-December Average	Annual average	% RCG[a]
11	6	$4.1\times10^{-9}\pm34\%$	$1.6\times10^{-9}\pm100\%$	2.5×10^{-9}	6	$3.4\times10^{-9}\pm41\%$	$1.8\times10^{-9}\pm100\%$	2.7×10^{-9}	2.6×10^{-9}	8
13	6	$6.0\times10^{-9}\pm28\%$	$1.5\times10^{-9}\pm100\%$	3.0×10^{-9}	6	$2.7\times10^{-9}\pm49\%$	$1.5\times10^{-9}\pm100\%$	1.8×10^{-9}	2.4×10^{-9}	8
15	6	$5.9\times10^{-9}\pm28\%$	$2.3\times10^{-9}\pm54\%$	4.2×10^{-9}	6	$3.1\times10^{-9}\pm47\%$	$1.7\times10^{-9}\pm74\%$	2.5×10^{-9}	3.3×10^{-9}	11
16	6	$6.6\times10^{-9}\pm24\%$	$3.0\times10^{-9}\pm47\%$	4.5×10^{-9}	6	$4.0\times10^{-9}\pm38\%$	$1.8\times10^{-9}\pm100\%$	2.9×10^{-9}	3.7×10^{-9}	12
17	6	$4.3\times10^{-9}\pm34\%$	$1.6\times10^{-9}\pm69\%$	2.8×10^{-9}	6	$6.9\times10^{-9}\pm27\%$	$2.0\times10^{-9}\pm68\%$	4.0×10^{-9}	3.4×10^{-9}	11
18	3	$5.0\times10^{-9}\pm29\%$	$3.9\times10^{-9}\pm35\%$	4.6×10^{-9}	–[b]					
19	3	$4.3\times10^{-9}\pm32\%$	$1.6\times10^{-9}\pm100\%$	2.5×10^{-9}	6	$4.8\times10^{-9}\pm35\%$	$1.4\times10^{-9}\pm75\%$	2.4×10^{-9}	2.5×10^{-9}	8
20	4	$6.8\times10^{-9}\pm25\%$	$1.6\times10^{-9}\pm64\%$	4.5×10^{-9}	3	$5.7\times10^{-9}\pm27\%$	$3.6\times10^{-9}\pm39\%$	4.7×10^{-9}	4.6×10^{-9}	15
21	6	$5.0\times10^{-9}\pm29\%$	$2.4\times10^{-9}\pm52\%$	3.4×10^{-9}	6	$5.0\times10^{-9}\pm32\%$	$1.9\times10^{-9}\pm60\%$	3.6×10^{-9}	3.5×10^{-9}	12
22	3	$1.0\times10^{-8}\pm14\%$	$8.7\times10^{-9}\pm20\%$	9.6×10^{-9}	–[b]					
24	6	$8.6\times10^{-9}\pm20\%$	$1.6\times10^{-9}\pm72\%$	4.7×10^{-9}	6	$7.0\times10^{-9}\pm26\%$	$3.0\times10^{-9}\pm49\%$	2.5×10^{-9}	3.6×10^{-9}	12
26	6	$7.7\times10^{-9}\pm20\%$	$1.6\times10^{-9}\pm76\%$	4.0×10^{-9}	6	$3.8\times10^{-9}\pm36\%$	$2.4\times10^{-9}\pm57\%$	3.0×10^{-9}	3.5×10^{-9}	12

[a]RCG (beta activity) = 3.0×10^{-8}.

[b]No samples collected.

Table 13. Tritium in water samples from Livermore Valley 1973 ($\mu Ci/ml$).

Location	No. of samples	January-June Maximum	January-June Minimum	January-June Average	No. of samples	July-December Maximum	July-December Minimum	July-December Average	Annual average	% RCG[a]	Calculated annual adult whole body dose (mrem)
11	6	$1.5 \times 10^{-7} \pm 5.6\%$	$1.1 \times 10^{-7} \pm 6.5\%$	1.2×10^{-7}	5	$1.8 \times 10^{-7} \pm 6.3\%$	$1.1 \times 10^{-7} \pm 8.7\%$	1.4×10^{-7}	1.3×10^{-7}	4.3×10^{-3}	5.2×10^{-3}
15	6	$2.0 \times 10^{-7} \pm 5.2\%$	$1.6 \times 10^{-7} \pm 5.6\%$	1.7×10^{-7}	5	$1.6 \times 10^{-7} \pm 6.9\%$	$1.2 \times 10^{-7} \pm 6.8\%$	1.4×10^{-7}	1.6×10^{-7}	5.3×10^{-3}	6.4×10^{-3}
16	6	$2.8 \times 10^{-7} \pm 3.7\%$	$2.4 \times 10^{-7} \pm 4.4\%$	2.6×10^{-7}	5	$2.4 \times 10^{-7} \pm 5.3\%$	$1.4 \times 10^{-7} \pm 7.5\%$	1.9×10^{-7}	2.3×10^{-7}	7.7×10^{-3}	9.2×10^{-3}
17	6	$1.6 \times 10^{-7} \pm 10.2\%$	$1.1 \times 10^{-7} \pm 7.3\%$	1.3×10^{-7}	5	$1.2 \times 10^{-7} \pm 7.2\%$	$8.9 \times 10^{-8} \pm 9.9\%$	1.0×10^{-7}	1.2×10^{-7}	4.0×10^{-3}	4.8×10^{-3}
19	6	$1.4 \times 10^{-7} \pm 6.0\%$	$5.8 \times 10^{-8} \pm 11.7\%$	1.1×10^{-7}	5	$2.1 \times 10^{-7} \pm 5.6\%$	$5.2 \times 10^{-8} \pm 17.5\%$	1.1×10^{-7}	1.1×10^{-7}	3.7×10^{-3}	4.4×10^{-3}
20	5	$8.4 \times 10^{-7} \pm 2.7\%$	$3.1 \times 10^{-7} \pm 8.8\%$	6.2×10^{-7}	3	$2.8 \times 10^{-7} \pm 14.5\%$	$1.1 \times 10^{-7} \pm 7.5\%$	2.1×10^{-7}	4.6×10^{-7}	1.5×10^{-2}	1.8×10^{-2}
21	6	$1.6 \times 10^{-7} \pm 5.7\%$	$1.2 \times 10^{-7} \pm 7.0\%$	1.4×10^{-7}	5	$1.8 \times 10^{-7} \pm 6.5\%$	$1.3 \times 10^{-7} \pm 8.1\%$	1.5×10^{-7}	1.4×10^{-7}	4.7×10^{-3}	5.6×10^{-3}
22	3	$2.5 \times 10^{-7} \pm 4.3\%$	$1.3 \times 10^{-7} \pm 6.8\%$	1.7×10^{-7}	0						
24	6	$1.1 \times 10^{-6} \pm 2.6\%$	$1.8 \times 10^{-7} \pm 5.3\%$	6.2×10^{-7}	5	$1.1 \times 10^{-6} \pm 3.0\%$	$2.5 \times 10^{-7} \pm 4.5\%$	7.4×10^{-7}	6.7×10^{-7}	2.2×10^{-2}	2.7×10^{-2}
26	6	$2.0 \times 10^{-7} \pm 4.7\%$	$1.1 \times 10^{-7} \pm 7.4\%$	1.5×10^{-7}	5	$1.6 \times 10^{-7} \pm 7.1\%$	$1.2 \times 10^{-7} \pm 8.8\%$	1.3×10^{-7}	1.4×10^{-7}	4.7×10^{-3}	5.6×10^{-3}

[a]RCG (water) = 3×10^{-3}.

Table 14. Tritium in vegetation samples from Livermore Valley 1973 (μCi/g).

Location	No. of samples	January-June			No. of samples	July-December			Annual average	Calculated annual adult whole body does, mrem
		Maximum	Minimum	Average		Maximum	Minimum	Average		
4	6	$3.8 \times 10^{-6} \pm 26.3\%$	$4.1 \times 10^{-7} \pm 61.9\%$	1.4×10^{-6}	6	$5.2 \times 10^{-6} \pm 8.7\%$	$3.9 \times 10^{-7} \pm 100.0\%$	1.5×10^{-6}	1.5×10^{-6}	2.3×10^{-2}
5	6	$4.9 \times 10^{-5} \pm 5.1\%$	$7.9 \times 10^{-7} \pm 58.0\%$	9.6×10^{-6}	6	$5.5 \times 10^{-5} \pm 1.6\%$	$1.5 \times 10^{-6} \pm 60.7\%$	1.6×10^{-5}	1.3×10^{-5}	2.0×10^{-1}
7	4	$1.4 \times 10^{-6} \pm 51.4\%$	$2.1 \times 10^{-7} \pm 58.3\%$	6.1×10^{-7}	5	$1.1 \times 10^{-6} \pm 28.2\%$	$2.6 \times 10^{-7} \pm 100.0\%$	4.7×10^{-7}	5.3×10^{-7}	8.0×10^{-3}
10	5	$4.4 \times 10^{-5} \pm 1.4\%$	$1.1 \times 10^{-6} \pm 27.0\%$	1.1×10^{-5}	6	$1.6 \times 10^{-5} \pm 2.5\%$	$4.6 \times 10^{-7} \pm 52.3\%$	4.7×10^{-6}	7.6×10^{-6}	1.1×10^{-1}
11	5	$3.1 \times 10^{-5} \pm 1.6\%$	$1.5 \times 10^{-6} \pm 26.1\%$	8.4×10^{-6}	6	$5.9 \times 10^{-5} \pm 1.4\%$	$8.8 \times 10^{-7} \pm 35.0\%$	1.1×10^{-5}	9.9×10^{-6}	1.5×10^{-1}
12	6	$5.3 \times 10^{-6} \pm 8.8\%$	$7.3 \times 10^{-7} \pm 40.3\%$	2.4×10^{-6}	6	$1.5 \times 10^{-5} \pm 4.2\%$	$3.0 \times 10^{-6} \pm 20\%$	6.1×10^{-6}	4.2×10^{-6}	6.3×10^{-2}
13	5	$3.2 \times 10^{-6} \pm 28.8\%$	$3.2 \times 10^{-7} \pm 100.0\%$	1.1×10^{-6}	6	$3.3 \times 10^{-6} \pm 34.0\%$	$2.8 \times 10^{-7} \pm 100.0\%$	1.3×10^{-6}	1.2×10^{-6}	1.8×10^{-2}
15	6	$3.0 \times 10^{-5} \pm 3.3\%$	$2.2 \times 10^{-6} \pm 21.6\%$	1.0×10^{-5}	6	$4.6 \times 10^{-6} \pm 15.2\%$	$9.1 \times 10^{-7} \pm 62.5\%$	3.4×10^{-6}	6.8×10^{-6}	1.0×10^{-1}
16	6	$2.0 \times 10^{-6} \pm 28.7\%$	$4.1 \times 10^{-7} \pm 40.4\%$	9.5×10^{-7}	6	$1.2 \times 10^{-6} \pm 100.0\%$	$2.0 \times 10^{-7} \pm 100.0\%$	5.6×10^{-7}	7.5×10^{-7}	1.1×10^{-2}
19	6	$1.5 \times 10^{-6} \pm 58.8\%$	$1.9 \times 10^{-7} \pm 100.0\%$	7.9×10^{-7}	6	$1.4 \times 10^{-6} \pm 100.0\%$	$1.0 \times 10^{-7} \pm 100.0\%$	4.4×10^{-7}	6.2×10^{-7}	9.3×10^{-3}
20	6	$3.0 \times 10^{-5} \pm 3.4\%$	$9.8 \times 10^{-7} \pm 46.3\%$	7.6×10^{-6}	6	$9.1 \times 10^{-6} \pm 5.7\%$	$4.9 \times 10^{-7} \pm 100.0\%$	2.4×10^{-6}	5.0×10^{-6}	7.5×10^{-2}
21	6	$2.1 \times 10^{-5} \pm 6.7\%$	$2.3 \times 10^{-6} \pm 27.0\%$	6.4×10^{-6}	5	$7.1 \times 10^{-6} \pm 4.5\%$	$9.7 \times 10^{-7} \pm 32.5\%$	3.1×10^{-6}	4.9×10^{-6}	7.4×10^{-2}
22	6	$9.1 \times 10^{-6} \pm 9.6\%$	$6.4 \times 10^{-7} \pm 34.1\%$	3.5×10^{-6}	5	$1.8 \times 10^{-6} \pm 44.1\%$	$7.7 \times 10^{-8} \pm 11.9\%$	6.7×10^{-7}	2.2×10^{-6}	3.3×10^{-2}
23	6	$1.4 \times 10^{-5} \pm 6.5\%$	$9.2 \times 10^{-7} \pm 38.2\%$	6.0×10^{-6}	5	$7.3 \times 10^{-6} \pm 11.5\%$	$7.4 \times 10^{-8} \pm 10.1\%$	1.9×10^{-6}	4.1×10^{-6}	6.2×10^{-2}
24	6	$4.3 \times 10^{-5} \pm 2.8\%$	$2.6 \times 10^{-7} \pm 79.0\%$	7.9×10^{-6}	5	$7.2 \times 10^{-7} \pm 65.6\%$	$1.3 \times 10^{-7} \pm 88.5\%$	3.9×10^{-7}	4.5×10^{-6}	6.8×10^{-2}
25	6	$1.0 \times 10^{-5} \pm 10.3\%$	$6.0 \times 10^{-7} \pm 34.0\%$	2.9×10^{-6}	4	$4.0 \times 10^{-6} \pm 11.2\%$	$2.1 \times 10^{-7} \pm 81.5\%$	1.8×10^{-6}	2.5×10^{-6}	3.8×10^{-2}
28	3	$4.6 \times 10^{-5} \pm 1.6\%$	$1.3 \times 10^{-5} \pm 3.8\%$	2.9×10^{-5}	5	$2.2 \times 10^{-5} \pm 2.5\%$	$5.9 \times 10^{-6} \pm 15.0\%$	1.1×10^{-5}	1.8×10^{-5}	2.7×10^{-1}
29	3	$3.5 \times 10^{-5} \pm 2.3\%$	$2.1 \times 10^{-5} \pm 1.9\%$	2.6×10^{-5}	4	$1.8 \times 10^{-5} \pm 3.6\%$	$5.0 \times 10^{-6} \pm 9.9\%$	1.1×10^{-5}	1.8×10^{-5}	2.7×10^{-1}
30	3	$2.2 \times 10^{-5} \pm 2.7\%$	$6.5 \times 10^{-6} \pm 5.3\%$	1.6×10^{-5}	4	$1.5 \times 10^{-5} \pm 4.0\%$	$1.9 \times 10^{-6} \pm 12.3\%$	7.9×10^{-6}	1.1×10^{-5}	1.7×10^{-1}
31	3	$1.3 \times 10^{-5} \pm 3.4\%$	$8.7 \times 10^{-7} \pm 24.9\%$	5.1×10^{-6}	5	$6.9 \times 10^{-6} \pm 8.9\%$	$1.7 \times 10^{-7} \pm 100.0\%$	2.3×10^{-6}	3.4×10^{-6}	5.1×10^{-2}

Table 15. Activities of various radionuclides in Livermore vegetation samples (μCi/g dry weight).

Radionuclide	Maximum	Minimum	Annual average	Calculated annual dose via direct ingestion (mrem)	Critical organ
^{7}Be	8.3×10^{-6}	3.7×10^{-7}	2.1×10^{-6}	0.10	Lower large intestine
^{40}K	2.6×10^{-5}	8.2×10^{-6}	1.8×10^{-5}	25	Whole body
^{95}Zr	1.7×10^{-7}	1.5×10^{-8}	3.5×10^{-8}	0.08	Lower large intestine
^{103}Ru	1.8×10^{-7}	1.6×10^{-8}	8.4×10^{-8}	0.09	Lower large intestine
^{137}Cs	8.8×10^{-8}	1.3×10^{-8}	4.7×10^{-3}	0.08	Whole body
^{141}Ce	1.5×10^{-7}	1.9×10^{-8}	6.2×10^{-8}	0.06	Lower large intestine
^{144}Ce	8.1×10^{-7}	3.0×10^{-8}	2.5×10^{-8}	0.20	Lower large intestine

Table 16. Environmental radiation background exposure rate measurements at Lawrence Livermore Laboratory perimeters during 1973.

Location	January-March mR/hr	January-March mrem/quarter	April-June mR/hr	April-June mrem/quarter	July-September mR/hr	July-September mrem/quarter	October-December mR/hr	October-December mrem/quarter	Annual mrem/year
1	1.2×10^{-2}	25	9.4×10^{-3}	19	6.8×10^{-3}	14	—[b]	—	78[c]
2	1.3×10^{-2}	27	1.0×10^{-2}	21	7.8×10^{-3}	16	9.2×10^{-3}	19	84
3	1.1×10^{-2}	22	9.6×10^{-3}	20	7.8×10^{-3}	16	1.1×10^{-2}	22	81
4	1.1×10^{-2}	22	8.3×10^{-3}	17	6.6×10^{-3}	13	—	—	70[c]
5[a]	1.3×10^{-2}	27	1.2×10^{-2}	25	1.0×10^{-2}	21	—	—	96[c]
6	1.1×10^{-2}	22	7.6×10^{-3}	15	7.7×10^{-3}	16	8.8×10^{-3}	18	72
7	7.7×10^{-3}	16	8.0×10^{-3}	16	—[b]	—	8.8×10^{-3}	18	69[c]
8	8.8×10^{-3}	18	8.0×10^{-3}	16	—	—	8.4×10^{-3}	17	68[c]
14	1.2×10^{-2}	25	1.1×10^{-2}	22	1.0×10^{-2}	21	1.0×10^{-2}	21	89
15	1.2×10^{-2}	25	9.6×10^{-3}	20	9.0×10^{-3}	18	1.3×10^{-2}	27	90
Average	1.1×10^{-2}	22	9.4×10^{-3}	19	8.2×10^{-3}	17	9.9×10^{-3}	20	80

[a]Neutron dose measurements (using an integrating rem meter) near Location 5 indicate an additional annual dose of approximately 250 mrem.

[b]— Indicates lost data.

[c]Projected data from 3 quarters.

Table 17. Airborne particulate beta radioactivity at Site 300 during 1973 (μCi/ml).

Sampling location[a]	No. of samples	January-June			No. of samples	July-December			Annual average	% RCG[b]
		Maximum	Minimum	Average		Maximum	Minimum	Average		
1	33	9.3×10^{-14} ± 7%	7.6×10^{-15} ± 25%	2.3×10^{-14}	40	8.8×10^{-14} ± 6%	1.1×10^{-14} ± 15%	3.7×10^{-14}	3.0×10^{-14}	3
2	31	4.7×10^{-14} ± 7%	4.6×10^{-15} ± 15%	2.1×10^{-14}	40	7.2×10^{-14} ± 7%	5.5×10^{-15} ± 62%	2.9×10^{-14}	2.5×10^{-14}	3
3	34	4.9×10^{-14} ± 11%	6.7×10^{-15} ± 14%	1.9×10^{-14}	42	9.8×10^{-14} ± 8%	4.1×10^{-15} ± 60%	3.1×10^{-14}	2.5×10^{-14}	3
4	32	5.0×10^{-14} ± 9%	7.5×10^{-15} ± 18%	2.3×10^{-14}	41	6.7×10^{-14} ± 6%	5.3×10^{-15} ± 64%	3.2×10^{-14}	2.8×10^{-14}	3
5	32	4.6×10^{-14} ± 9%	6.9×10^{-15} ± 29%	1.9×10^{-14}	40	8.1×10^{-14} ± 6%	6.1×10^{-15} ± 46%	3.1×10^{-14}	2.5×10^{-14}	3
6	22	1.3×10^{-13} ± 7%	6.8×10^{-15} ± 100%	4.3×10^{-14}	20	6.8×10^{-14} ± 10%	9.9×10^{-15} ± 17%	9.1×10^{-14}	6.7×10^{-14}	7
7	31	8.1×10^{-14} ± 13%	5.7×10^{-15} ± 30%	2.4×10^{-14}	40	7.0×10^{-14} ± 7%	5.8×10^{-15} ± 6[illegible]%	3.4×10^{-14}	2.9×10^{-14}	3
8	33	1.0×10^{-13} ± 8%	1.7×10^{-14} ± 10%	4.8×10^{-14}	42	2.4×10^{-13} ± 5%	1.6×10^{-14} ± 19%	7.2×10^{-14}	6.0×10^{-14}	6
9	29	5.0×10^{-14} ± 8%	3.2×10^{-15} ± 51%	2.2×10^{-14}	42	7.1×10^{-14} ± 27%	6.0×10^{-15} ± 100%	3.3×10^{-14}	2.8×10^{-14}	3
10	35	4.4×10^{-14} ± 9%	7.4×10^{-15} ± 14%	2.1×10^{-14}	42	6.5×10^{-14} ± 7%	7.0×10^{-15} ± 12%	2.9×10^{-14}	2.5×10^{-14}	3
11	33	4.1×10^{-14} ± 9%	2.4×10^{-15} ± 100%	2.0×10^{-14}	40	7.1×10^{-14} ± 6%	4.9×10^{-15} ± 100%	3.3×10^{-14}	2.7×10^{-14}	3
Average				2.6×10^{-14}				4.1×10^{-14}	3.4×10^{-14}	4

[a]See Fig. 11 for locations.

[b]RCG for airborne gross beta activity = 1.0×10^{-12}.

Table 18. Results of gamma-ray spectral measurements of Site 300 air filters during 1973 (μCi/ml).

	^{144}Ce	^{141}Ce	^{125}Sb	^{7}Be	^{103}Ru	^{106}Ru	^{137}Cs	^{95}Zr	^{40}K
Jan.	1.7×10^{-15} ± 12%	—[a]	1.9×10^{-16} ± 14%	7.1×10^{-14} ± 4%	6.9×10^{-17} ± 50%	1.3×10^{-15} ± 15%	5.6×10^{-16} ± 4%	1.5×10^{-16} ± 19%	3.4×10^{-16} ± 23%
Feb.	2.4×10^{-15} ± 6%	—	2.9×10^{-16} ± 10%	9.1×10^{-14} ± 2%	5.4×10^{-17} ± 62%	1.8×10^{-15} ± 9%	1.4×10^{-15} ± 3%	2.0×10^{-16} ± 44%	3.7×10^{-16} ± 26%
Mar.	1.1×10^{-15} ± 5%	—	3.5×10^{-16} ± 11%	8.9×10^{-14} ± 2%	3.2×10^{-17} ± 56%	1.8×10^{-15} ± 7%	1.0×10^{-15} ± 8%	9.3×10^{-17} ± 19%	3.7×10^{-16} ± 28%
Apr.	3.4×10^{-15} ± 8%	—	5.1×10^{-16} ± 8%	1.4×10^{-13} ± 2%	3.6×10^{-17} ± 38%	2.6×10^{-15} ± 6%	1.7×10^{-15} ± 4%	9.8×10^{-17} ± 48%	5.7×10^{-16} ± 22%
May	3.2×10^{-15} ± 5%	—	4.7×10^{-15} ± 5%	1.4×10^{-13} ± 2%	—	2.6×10^{-15} ± 7%	1.6×10^{-15} ± 3%	5.5×10^{-17} ± 27%	9.9×10^{-16} ± 19%
June	1.8×10^{-15} ± 14%	—	2.6×10^{-16} ± 25%	1.0×10^{-13} ± 3%	—	1.6×10^{-15} ± 29%	1.1×10^{-15} ± 9%	3.8×10^{-17} ± 100%	1.0×10^{-15} ± 40%
July	2.3×10^{-15} ± 21%	1.6×10^{-15} ± 22%	4.2×10^{-16} ± 24%	1.5×10^{-13} ± 14%	3.0×10^{-15} ± 13%	2.0×10^{-15} ± 15%	1.4×10^{-15} ± 11%	1.5×10^{-15} ± 28%	1.0×10^{-15} ± 16%
Aug.	1.7×10^{-15} ± 20%	1.5×10^{-15} ± 17%	2.1×10^{-16} ± 30%	1.1×10^{-13} ± 11%	2.6×10^{-15} ± 11%	1.4×10^{-15} ± 25%	8.1×10^{-16} ± 9%	2.1×10^{-15} ± 6%	1.0×10^{-15} ± 31%
Sept.	9.1×10^{-16} ± 18%	5.8×10^{-16} ± 12%	1.2×10^{-16} ± 8%	7.0×10^{-14} ± 9%	1.2×10^{-15} ± 10%	8.1×10^{-16} ± 33%	4.3×10^{-16} ± 16%	1.1×10^{-15} ± 7%	1.1×10^{-15} ± 23%
Oct.	1.7×10^{-15} ± 22%	1.7×10^{-15} ± 15%	9.9×10^{-17} ± 57%	1.5×10^{-13} ± 8%	2.9×10^{-15} ± 10%	1.3×10^{-15} ± 24%	4.4×10^{-16} ± 18%	3.2×10^{-15} ± 6%	1.0×10^{-15} ± 20%
Nov.	1.2×10^{-15} ± 7%	7.8×10^{-16} ± 7%	6.9×10^{-17} ± 38%	6.1×10^{-14} ± 2%	1.4×10^{-15} ± 4%	8.3×10^{-16} ± 12%	1.9×10^{-16} ± 13%	2.1×10^{-15} ± 3%	3.5×10^{-16} ± 29%
Dec.	3.3×10^{-15} ± 10%	1.2×10^{-15} ± 11%	1.6×10^{-16} ± 18%	7.0×10^{-14} ± 7%	2.4×10^{-15} ± 11%	2.0×10^{-15} ± 6%	3.8×10^{-16} ± 8%	4.5×10^{-15} ± 2%	3.9×10^{-16} ± 21%
Annual av	2.1×10^{-15}	$<1.2\times10^{-15}$	2.6×10^{-16}	1.0×10^{-13}	$<1.4\times10^{-15}$	1.7×10^{-15}	9.2×10^{-16}	$<1.3\times10^{-15}$	7.1×10^{-16}
RCG	2×10^{-10}	5×10^{-9}	9×10^{-10}	4×10^{-8}	3×10^{-9}	2×10^{-10}	5×10^{-10}	1×10^{-9}	4×10^{-9}
% RCG	1.0×10^{-3}	$<2.5\times10^{-5}$	2.9×10^{-5}	2.5×10^{-4}	$<4.7\times10^{-5}$	8.5×10^{-4}	1.8×10^{-4}	$<1.3\times10^{-4}$	1.8×10^{-5}

[a] — undetected. We consider our detection limit to be reached whenever the 2σ error (counting error) is equal to ±100%. Data with errors exceeding this limit are reported as undetected (—) and in either case the annual average is reported as < the arithmetic average. The increases in fission product radionuclides after June reflects activity from a Chinese nuclear event in June 1973.

Table 19. Plutonium and uranium concentrations on air filters from Site 300 during 1973.

Month	Activity (μCi/ml) ^{239}Pu	^{238}Pu	$^{238}Pu/^{239}Pu$	Mass (mg/m^3) ^{235}U	^{238}U	$^{235}U/^{238}U$ [b]
Jan.	$8.0 \times 10^{-18} \pm 7\%$	$1.0 \times 10^{-18} \pm 12\%$	1.3×10^{-1}	$1.4 \times 10^{-9} \pm 2\%$	$7.2 \times 10^{-7} \pm 5\%$	1.9×10^{-3}
Feb.	$1.8 \times 10^{-17} \pm 6\%$	$1.7 \times 10^{-18} \pm 11\%$	9.4×10^{-2}	$4.6 \times 10^{-10} \pm 2\%$	$1.6 \times 10^{-7} \pm 5\%$	2.9×10^{-3}
Mar.	$1.5 \times 10^{-17} \pm 6\%$	$1.8 \times 10^{-18} \pm 11\%$	1.2×10^{-1}	$1.5 \times 10^{-10} \pm 3\%$	$3.6 \times 10^{-8} \pm 3\%$	4.2×10^{-3}
Apr.	$2.5 \times 10^{-17} \pm 7\%$	$2.6 \times 10^{-18} \pm 10\%$	1.0×10^{-1}	$4.4 \times 10^{-10} \pm 2\%$	$1.0 \times 10^{-7} \pm 4\%$	4.4×10^{-3}
May	$2.3 \times 10^{-17} \pm 7\%$	$2.9 \times 10^{-18} \pm 10\%$	1.3×10^{-1}	$1.5 \times 10^{-9} \pm 2\%$	$4.3 \times 10^{-7} \pm 4\%$	3.5×10^{-3}
June	$5.6 \times 10^{-17} \pm 6\%$	$3.0 \times 10^{-18} \pm 10\%$	5.4×10^{-2}	$7.4 \times 10^{-10} \pm 2\%$	$1.7 \times 10^{-7} \pm 4\%$	4.4×10^{-3}
July	$1.9 \times 10^{-17} \pm 8\%$	$2.4 \times 10^{-18} \pm 12\%$	1.3×10^{-1}	$6.5 \times 10^{-10} \pm 3\%$	$1.1 \times 10^{-7} \pm 4\%$	5.9×10^{-3}
Aug.	$6.7 \times 10^{-18} \pm 18\%$	$5.7 \times 10^{-19} \pm 52\%$	8.5×10^{-2}	$1.2 \times 10^{-9} \pm 2\%$	$3.3 \times 10^{-7} \pm 4\%$	3.6×10^{-3}
Sept.	$9.0 \times 10^{-18} \pm 8\%$	$8.4 \times 10^{-19} \pm 16\%$	9.3×10^{-2}	$1.3 \times 10^{-9} \pm 2\%$	$3.7 \times 10^{-7} \pm 4\%$	3.5×10^{-3}
Oct.	$1.3 \times 10^{-17} \pm 11\%$	$1.2 \times 10^{-18} \pm 11\%$	9.2×10^{-2}	$9.4 \times 10^{-10} \pm 2\%$	$2.2 \times 10^{-7} \pm 3\%$	4.3×10^{-3}
Nov.	$6.5 \times 10^{-18} \pm 8\%$	$4.0 \times 10^{-19} \pm 19\%$	6.1×10^{-2}	$4.5 \times 10^{-10} \pm 4\%$	$1.5 \times 10^{-7} \pm 5\%$	3.0×10^{-3}
Dec.	$7.1 \times 10^{-18} \pm 8\%$	$5.5 \times 10^{-19} \pm 17\%$	7.7×10^{-2}	$1.8 \times 10^{-10} \pm 3\%$	$6.2 \times 10^{-8} \pm 5\%$	2.9×10^{-3}
Annual av	1.7×10^{-17}	1.6×10^{-18}	9.4×10^{-2}	7.8×10^{-10}	2.4×10^{-7}	
RCG [a]	1.0×10^{-12}	1.0×10^{-12}		1.9×10^{-3}	1.5×10^{-2}	
% RCG	1.7×10^{-3}	1.6×10^{-4}		4.1×10^{-5}	1.6×10^{-3}	

[a] Assumes Pu to be in an insoluble form.

[b] $^{235}U/^{238}U$ atomic ratio in natural uranium is 7.25×10^{-3}.

Table 20. Concentrations of uranium in Site 300 soils ($\mu g/g$ of dry soil).

Sampling[a] location	Depth (cm)	^{234}U	^{235}U	^{236}U	^{238}U	$^{235}U/^{238}U$ [b]	Total uranium	Total natural uranium	Total depleted uranium
S-321	0-1	1.08×10^{-4} ± 8%	1.56×10^{-2} ± 2%	6.26×10^{-6} ± 50%	2.22 ± 2%	7.0×10^{-3}	2.24 ± 2%	2.18 ± 5%	6.00×10^{-2} ± 100%
S-322	0-1	8.00×10^{-5} ± 24%	1.21×10^{-2} ± 3%	3.15×10^{-5} ± 38%	2.21 ± 4%	5.5×10^{-3}	2.22 ± 4%	1.52 ± 4%	7.00×10^{-1} ± 18%
S-323	0-1	7.89×10^{-5} ± 8%	1.07×10^{-2} ± 2%	1.08×10^{-5} ± 20%	1.64 ± 3%	6.5×10^{-3}	1.65 ± 3%	1.46 ± 5%	1.85×10^{-1} ± 35%
S-324	0-1	7.65×10^{-5} ± 9%	1.22×10^{-2} ± 2%	2.16×10^{-5} ± 15%	2.14 ± 3%	5.7×10^{-3}	2.15 ± 3%	1.58 ± 6%	5.73×10^{-1} ± 18%
S-325	0-1	9.55×10^{-5} ± 8%	1.41×10^{-2} ± 2%	1.26×10^{-5} ± 20%	2.27 ± 3%	6.2×10^{-3}	2.28 ± 3%	1.88 ± 6%	4.03×10^{-1} ± 26%
S-326	0-1	6.43×10^{-5} ± 10%	1.11×10^{-2} ± 2%	3.6×10^{-5} ± 11%	2.39 ± 4%	4.8×10^{-3}	2.40 ± 4%	1.28 ± 6%	1.13 ± 11%
S-327	0-1	1.13×10^{-3} ± 5%	2.96×10^{-1} ± 2%	4.0×10^{-3} ± 3%	150 ± 5%	2.0×10^{-3}	150 ± 5%	5.47 ± 9%	1.45×10^{-2} ± 7%
S-328	0-1	1.44×10^{-4} ± 6%	3.12×10^{-2} ± 2%	3.45×10^{-4} ± 4%	11.9 ± 5%	2.6×10^{-3}	11.9 ± 5%	1.89 ± 8%	1.00×10^{1} ± 8%
S-329	0-1	8.73×10^{-5} ± 8%	1.46×10^{-2} ± 2%	3.83×10^{-5} ± 11%	3.07 ± 4%	4.8×10^{-3}	3.08 ± 4%	1.70 ± 6%	1.38 ± 11%
S-330	0-1	9.56×10^{-5} ± 8%	1.40×10^{-2} ± 2%	1.01×10^{-5} ± 11%	2.19 ± 3%	6.4×10^{-3}	2.20 ± 3%	1.90 ± 6%	3.04×10^{-1} ± 34%
S-331	0-1	1.34×10^{-4} ± 7%	2.03×10^{-2} ± 2%	1.94×10^{-5} ± 15%	3.28 ± 3%	6.2×10^{-3}	3.30 ± 3%	2.71 ± 6%	5.85×10^{-1} ± 26%

[a] See Fig. 13 for sample locations within Site 300.

[b] $^{235}U/^{238}U$ atomic ratio of natural uranium is 7.25×10^{-3}.

Table 21. Gross beta activity in Site 300 water samples ($\mu Ci/ml$).

Location	No. of samples	January-June Maximum	January-June Minimum	January-June Average	No. of samples	July-December Maximum	July-December Minimum	July-December Average	Annual average	RCG[a]
1	6	$6.0 \times 10^{-9} \pm 32\%$	$1.6 \times 10^{-9} \pm 74\%$	3.9×10^{-9}	6	$4.9 \times 10^{-9} \pm 30\%$	$1.7 \times 10^{-9} \pm 72\%$	3.7×10^{-9}	3.8×10^{-9}	13
2	6	$7.6 \times 10^{-9} \pm 24\%$	$5.1 \times 10^{-9} \pm 30\%$	6.3×10^{-9}	6	$6.9 \times 10^{-9} \pm 26\%$	$2.8 \times 10^{-9} \pm 47\%$	5.2×10^{-9}	5.8×10^{-9}	19
3	6	$7.1 \times 10^{-9} \pm 23\%$	$5.4 \times 10^{-9} \pm 31\%$	6.2×10^{-9}	6	$7.5 \times 10^{-9} \pm 24\%$	$2.8 \times 10^{-9} \pm 49\%$	4.6×10^{-9}	5.4×10^{-9}	18
4	6	$7.6 \times 10^{-9} \pm 24\%$	$3.0 \times 10^{-9} \pm 48\%$	4.6×10^{-9}	6	$6.4 \times 10^{-9} \pm 26\%$	$3.3 \times 10^{-9} \pm 39\%$	4.8×10^{-9}	4.7×10^{-9}	16
5	6	$6.0 \times 10^{-9} \pm 27\%$	$4.2 \times 10^{-9} \pm 37\%$	4.9×10^{-9}	6	$8.7 \times 10^{-9} \pm 23\%$	$3.7 \times 10^{-9} \pm 39\%$	5.9×10^{-9}	5.4×10^{-9}	18
6	6	$5.4 \times 10^{-9} \pm 31\%$	$3.4 \times 10^{-9} \pm 41\%$	4.4×10^{-9}	6	$6.1 \times 10^{-9} \pm 27\%$	$3.0 \times 10^{-9} \pm 46\%$	4.3×10^{-9}	4.4×10^{-9}	15
7	6	$6.8 \times 10^{-9} \pm 24\%$	$4.7 \times 10^{-9} \pm 34\%$	6.0×10^{-9}	6	$6.0 \times 10^{-9} \pm 26\%$	$3.7 \times 10^{-9} \pm 39\%$	4.9×10^{-9}	5.2×10^{-9}	17
11	6	$1.1 \times 10^{-8} \pm 18\%$	$4.6 \times 10^{-9} \pm 32\%$	8.2×10^{-9}	6	$8.3 \times 10^{-9} \pm 21\%$	$4.9 \times 10^{-9} \pm 32\%$	6.6×10^{-9}	7.4×10^{-9}	27
14	6	$5.9 \times 10^{-9} \pm 27\%$	$1.8 \times 10^{-9} \pm 62\%$	4.0×10^{-9}	2	$6.4 \times 10^{-9} \pm 26\%$	$4.6 \times 10^{-9} \pm 33\%$	5.5×10^{-9}	4.8×10^{-9}	16
20	—[b]				2	$9.7 \times 10^{-9} \pm 20\%$	$1.7 \times 10^{-9} \pm 100\%$	5.7×10^{-9}		
21	3	$1.1 \times 10^{-8} \pm 18\%$	$9.6 \times 10^{-9} \pm 19\%$	$1.0 \quad 10^{-8}$	4	$8.4 \times 10^{-9} \pm 21\%$	$3.9 \times 10^{-9} \pm 38\%$	7.0×10^{-9}	8.5×10^{-9}	28
25	4	$3.9 \times 10^{-9} \pm 34\%$	$1.6 \times 10^{-9} \pm 100\%$	2.3×10^{-9}	—[b]					
26	3	$9.2 \times 10^{-9} \pm 18\%$	$5.7 \times 10^{-9} \pm 27\%$	7.0×10^{-9}	—[b]					

[a] RCG (beta activity) is 3.0×10^{-8} $\mu Ci/ml$.

[b] No sample taken.

Table 22. Tritium in water samples from Site 300 1973.

Location	No. of samples	January-June			No. of samples	July-December			Annual average	% RCG[a]	Calculated annual adult whole body dose (mrem)
		Maximum	Minimum	Average		Maximum	Minimum	Average			
1	6	2.1×10^{-8} ± 30.0%	6.2×10^{-9} ± 78.9%	1.1×10^{-8}	5	2.9×10^{-8} ± 25.3%	4.8×10^{-10} ± 50.1%	1.3×10^{-8}	1.2×10^{-8}	4.0×10^{-4}	4.8×10^{-3}
2	6	8.0×10^{-8} ± 10.2%	7.1×10^{-9} ± 86.4%	2.6×10^{-8}	5	3.5×10^{-8} ± 22.1%	1.4×10^{-8} ± 63.6%	2.1×10^{-8}	2.4×10^{-8}	8.0×10^{-4}	9.6×10^{-3}
3	6	5.2×10^{-8} ± 12.7%	4.9×10^{-9} ± 100.0%	2.0×10^{-8}	5	1.8×10^{-8} ± 44.8%	[illegible].1 × 10^{-9} ± 100.0%	1.1×10^{-8}	1.6×10^{-8}	5.3×10^{-4}	6.4×10^{-3}
4	6	8.5×10^{-8} ± 9.7%	5.8×10^{-9} ± 100.0%	3.0×10^{-8}	5	7.1×10^{-8} ± 10.8%	1.2×10^{-8} ± 62.2%	2.8×10^{-8}	2.9×10^{-8}	9.7×10^{-4}	1.2×10^{-2}
5	6	8.3×10^{-8} ± 8.3%	1.4×10^{-8} ± 45.5%	4.2×10^{-8}	5	4.9×10^{-8} ± 14.4%	2.0×10^{-8} ± 38.8%	3.6×10^{-8}	3.9×10^{-8}	1.3×10^{-3}	1.6×10^{-2}
6	6	2.5×10^{-8} ± 22.4%	5.5×10^{-9} ± 100.0%	1.2×10^{-8}	5	2.9×10^{-8} ± 25.8%	6.2×10^{-9} ± 100.0%	1.7×10^{-8}	1.4×10^{-8}	4.7×10^{-4}	5.6×10^{-3}
7	6	9.1×10^{-8} ± 8.5%	2.7×10^{-8} ± 25.9%	4.9×10^{-8}	5	5.0×10^{-8} ± 17.4%	6.8×10^{-9} ± 100.0%	2.4×10^{-8}	3.8×10^{-8}	1.3×10^{-3}	1.5×10^{-2}
11	6	1.3×10^{-7} ± 6.5%	6.5×10^{-9} ± 95.0%	5.3×10^{-8}	5	2.3×10^{-8} ± 31.4%	7.8×10^{-9} ± 100.0%	1.4×10^{-8}	3.6×10^{-8}	1.2×10^{-3}	1.4×10^{-2}
14	5	1.6×10^{-7} ± 7.0%	1.1×10^{-7} ± 7.2%	1.3×10^{-7}	2	1.5×10^{-7} ± 7.3%	1.4×10^{-7} ± 7.2%	1.5×10^{-7}	1.4×10^{-7}	4.3×10^{-4}	5.2×10^{-2}
20	4	1.2×10^{-7} ± 6.6%	7.8×10^{-8} ± 10.0%	1.0×10^{-7}	1	6.1×10^{-8} ± 13.0%	6.1×10^{-8} ± 13.0%	6.1×10^{-8}	9.4×10^{-8}	3.1×10^{-3}	3.8×10^{-2}
21	3	6.4×10^{-8} ± 11.7%	3.3×10^{-8} ± 18.8%	4.4×10^{-8}	3	5.5×10^{-8} ± 14.1%	4.1×10^{-8} ± 17.3%	4.6×10^{-8}	4.5×10^{-8}	1.5×10^{-3}	1.8×10^{-2}
25[b]	4	8.5×10^{-4} ± 2.0%	5.2×10^{-4} ± 2.0%	6.9×10^{-4}	0						
26	2	1.8×10^{-8} ± 38.2%	1.0×10^{-8} ± 67.7%	1.4×10^{-8}	0				1.4×10^{-8}	4.6×10^{-4}	5.6×10^{-2}

[a] RCG (HTO) = 3×10^{-3} μCi/ml.

[b] Water source at Location 25 unavailable for sampling after April 1973.

Table 23. Activities of various radionuclides in Site 300 vegetation samples (μCi/g).

Radionuclide	Maximum	Minimum	Annual average	Calculated annual dose via direct ingestion (mrem)	Critical organ
^{7}Be	6.5×10^{-6}	3.3×10^{-7}	2.2×10^{-6}	0.1	Lower large intestine
^{40}K	$[illegible].0 \times 10^{-5}$	1.2×10^{-5}	2.3×10^{-5}	33.5	Whole body
^{95}Zr	2.4×10^{-7}	2.9×10^{-8}	1.3×10^{-7}	0.3	Lower large intestine
^{103}Ru	3.0×10^{-7}	2.3×10^{-8}	9.8×10^{-8}	0.1	Lower large intestine
^{137}Cs	1.5×10^{-7}	1.7×10^{-8}	5.5×10^{-8}	0.1	Whole body
^{141}Ce	1.1×10^{-7}	1.4×10^{-8}	5.0×10^{-8}	0.05	Lower large intestine
^{144}Ce	3.3×10^{-7}	2.4×10^{-8}	1.5×10^{-7}	1.2	Lower large intestine

Table 24. Tritium in vegetation samples from Site 300 1973 ($\mu Ci/g$).

Location	No. of samples	Maximum	Minimum	Average
1	6	$1.2 \times 10^{-6} \pm 76.5\%$	$1.4 \times 10^{-7} \pm 100.0\%$	5.0×10^{-7}
2	6	$1.2 \times 10^{-6} \pm 37.8\%$	$3.0 \times 10^{-7} \pm 100.0\%$	7.1×10^{-7}
3	6	$8.5 \times 10^{-7} \pm 63.9\%$	$2.6 \times 10^{-7} \pm 74.0\%$	5.1×10^{-7}
4	6	$1.3 \times 10^{-6} \pm 37.2\%$	$4.7 \times 10^{-7} \pm 100.0\%$	7.3×10^{-7}
5	5	$1.1 \times 10^{-6} \pm 71.1\%$	$4.0 \times 10^{-7} \pm 100.0\%$	7.7×10^{-7}
6	5	$1.6 \times 10^{-4} \pm 31.7\%$	$4.2 \times 10^{-6} \pm 15.2\%$	4.2×10^{-5}
7	6	$9.1 \times 10^{-7} \pm 42.8\%$	$2.4 \times 10^{-7} \pm 99.3\%$	5.3×10^{-7}
8	5	$6.3 \times 10^{-7} \pm 89.1\%$	$2.3 \times 10^{-7} \pm 100.0\%$	4.2×10^{-7}
9	5	$2.3 \times 10^{-6} \pm 18.1\%$	$4.0 \times 10^{-7} \pm 100.0\%$	1.4×10^{-6}
10	6	$1.1 \times 10^{-6} \pm 34.2\%$	$2.6 \times 10^{-7} \pm 83.5\%$	6.6×10^{-7}
11	6	$8.9 \times 10^{-7} \pm 70.4\%$	$3.6 \times 10^{-7} \pm 100.0\%$	6.8×10^{-7}
12	1	$1.5 \times 10^{-6} \pm 29.2\%$	$1.5 \times 10^{-6} \pm 29.2\%$	1.5×10^{-6}
13	5	$2.7 \times 10^{-4} \pm 77.6\%$	$7.9 \times 10^{-6} \pm 4.5\%$	7.4×10^{-5}

Location	No. of samples	Maximum	Minimum	Average	Annual average	Calculated annual adult whole body dose (mrem)
1	6	$1.9 \times 10^{-6} \pm 100.0\%$	$7.0 \times 10^{-8} \pm 100.0\%$	6.0×10^{-7}	5.5×10^{-7}	8.3×10^{-3}
2	6	$3.2 \times 10^{-6} \pm 17.6\%$	$2.1 \times 10^{-7} \pm 100.0\%$	1.0×10^{-6}	8.7×10^{-7}	1.3×10^{-2}
3	6	$2.4 \times 10^{-6} \pm 35.5\%$	$2.6 \times 10^{-7} \pm 87.9\%$	3.4×10^{-7}	6.8×10^{-7}	1.0×10^{-2}
4	6	$1.7 \times 10^{-6} \pm 29.5\%$	$2.8 \times 10^{-7} \pm 87.9\%$	7.7×10^{-7}	7.5×10^{-7}	1.1×10^{-2}
5	6	$1.0 \times 10^{-6} \pm 38.1\%$	$5.3 \times 10^{-8} \pm 100.0\%$	4.8×10^{-7}	6.1×10^{-7}	9.2×10^{-3}
6	6	$8.4 \times 10^{-5} \pm 1.4\%$	$3.3 \times 10^{-6} \pm 7.0\%$	4.3×10^{-5}	4.3×10^{-5}	6.5×10^{-1}
7	6	$1.3 \times 10^{-5} \pm 9.1\%$	$2.3 \times 10^{-7} \pm 100.0\%$	2.6×10^{-6}	1.5×10^{-6}	2.3×10^{-2}
8	5	$9.6 \times 10^{-6} \pm 11.5\%$	$1.8 \times 10^{-7} \pm 100.0\%$	2.2×10^{-6}	1.3×10^{-6}	2.0×10^{-2}
9	6	$1.9 \times 10^{-6} \pm 14.4\%$	$6.4 \times 10^{-7} \pm 28.7\%$	1.1×10^{-6}	1.2×10^{-6}	1.8×10^{-2}
10	6	$2.1 \times 10^{-6} \pm 33.4\%$	$1.4 \times 10^{-7} \pm 100.0\%$	6.5×10^{-7}	6.6×10^{-7}	1.0×10^{-2}
11	6	$3.2 \times 10^{-6} \pm 25.5\%$	$1.5 \times 10^{-7} \pm 100.0\%$	1.3×10^{-6}	9.9×10^{-7}	1.5×10^{-2}
12	6	$1.2 \times 10^{-6} \pm 61.9\%$	$1.4 \times 10^{-7} \pm 63.8\%$	5.0×10^{-7}	6.5×10^{-7}	9.8×10^{-3}
13	6	$2.8 \times 10^{-5} \pm 2.7\%$	$2.8 \times 10^{-7} \pm 100.0\%$	8.4×10^{-6}	3.8×10^{-5}	5.7×10^{-1}

Table 25. Radionuclides observed in milk during 1973 (μCi/ml).

Radio-nuclide	No. of samples	Maximum	Minimum	Average	Calculated annual adult radiation dose (mrem)	Critical organ
^{137}Cs	12	$2.4\times10^{-9}\pm35\%$	$1.1\times10^{-9}\pm62\%$	1.6×10^{-9}	9.5×10^{-3}	Whole body
^{3}H	12	$2.5\times10^{-7}\pm54\%$	$1.1\times10^{-7}\pm100\%$	1.7×10^{-7}	5.2×10^{-4}	Whole body
^{40}K	12	$1.3\times10^{-6}\pm5\%$	$1.2\times10^{-6}\pm5\%$	1.3×10^{-6}	5.8	Whole body

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Appendix – Environmental Activity 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:

1. Air (controlled area)	6×10^{-12} μCi/ml
2. Air (uncontrolled area)	2×10^{-14} μCi/ml
3. Water (controlled area)	4×10^{-7} μCi/ml
4. Water (uncontrolled area)	3×10^{-8} μCi/ml

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

5. Air (controlled area)	3×10^{-11} μCi/ml
6. Air (uncontrolled area)	1×10^{-12} μCi/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 area)	1×10^{-7} μCi/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}I, ^{227}Ac, ^{226}Ra, and ^{228}Ra are not present in the samples, the annual average gross beta activities of the samples may not exceed the activities listed under points 5 through 8 above. The assumption that ^{129}I, ^{227}Ac, ^{226}Ra, and ^{228}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 3×10^{-3} μCi/ml.

Since analysis for ^{129}I, ^{226}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 1×10^{-7} μCi/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.