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Off-Site Environmental Monitoring Report

Radiation Monitoring Around United States Nuclear Test Areas, Calendar Year 1984

prepared for the
U.S. Department of Energy
under Interagency Agreement
Number DE-A108-76DP00539

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OFF-SITE ENVIRONMENTAL MONITORING REPORT
Radiation monitoring around United States nuclear test areas, calendar year 1984

compiled by

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ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
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NOTICE

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PREFACE

The U.S. Atomic Energy Commission (AEC) used the Nevada Test Site (NTS) from January 1951 through January 19, 1975, for conducting nuclear weapons tests, nuclear rocket-engine development, nuclear medicine studies, and other nuclear and non-nuclear experiments. Beginning January 19, 1975, these activities became the responsibility of the newly formed U.S. Energy Research and Development Administration (ERDA). On October 1, 1977 the ERDA was merged with other energy-related agencies to form the U.S. Department of Energy (DOE). Atmospheric nuclear tests were conducted periodically from January 27, 1951, through October 30, 1958, after which a testing moratorium was in effect until September 1, 1961. Since September 1, 1961, all nuclear detonations have been conducted underground with the expectation of containment, except for four slightly above-ground or shallow underground tests of Operation Dominic II in 1962 and five nuclear earth-cratering experiments conducted under the Plowshare program between 1962 and 1968.

Prior to 1954, an off-site surveillance program was performed by the Los Alamos Scientific Laboratory and the U.S. Army. From 1954 through 1970 the U.S. Public Health Service (PHS), and from 1970 to the present the U.S. Environmental Protection Agency (EPA) have provided an Off-Site Radiological Safety Program under an Interagency Agreement. The PHS or EPA has also provided off-site surveillance for U.S. nuclear explosive tests at places other than the NTS.

Since 1954, an objective of this surveillance program has been to measure levels and trends of radioactivity, if present, in the environment surrounding testing areas to ascertain whether the testing is in compliance with existing radiation protection standards. Off-site levels of radiation and radioactivity are assessed by sampling milk, water, and air; by deploying dosimeters; and by sampling food crops, soil, etc., as required. Personnel with mobile monitoring equipment are placed in areas downwind from the test site prior to each test in order to implement protective actions, provide immediate radiation monitoring, and obtain environmental samples rapidly after any release of radioactivity. Since 1962, aircraft have also been deployed to rapidly monitor and sample releases of radioactivity during nuclear tests. Monitoring data obtained by the aircraft crew immediately after a test are used to position mobile radiation monitoring personnel on the ground. Data from airborne sampling are used to quantify the amounts, diffusion, and transport of the radionuclides released.

Beginning with Operation Upshot-Knothole in 1953, a report was published by the PHS summarizing the surveillance data for each test series. In 1959 for reactor tests, and in 1962 for weapons and Plowshare tests, such data were published for those tests that released radioactivity detectable off the NTS.

The reporting interval was changed again in 1964 to semi-annual publication of data for each 6-month period which also included the data from the individual reports.

In 1971, the AEC implemented a requirement, now incorporated into DOE Order 5484.1, that each contractor or agency involved in major nuclear activities provide a comprehensive annual radiological monitoring report. This is the thirteenth annual report in this series; it summarizes the off-site activities of the EPA during CY 1984.

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ABBREVIATIONS, SYMBOLS AND CONVERSIONS

a	annum (year)
ASN	Air Surveillance Network
CG	Concentration Guide
Ci	Curie
CP-1	Control Point One
CY	Calendar Year
d	day
DOE	U.S. Department of Energy
DOE/NV	Department of Energy, Nevada Operations Office
EMSL-LV	Environmental Monitoring Systems Laboratory, Las Vegas
EPA	U.S. Environmental Protection Agency
eV	electron volt
g	gram
GZ	Ground Zero
h	hour
HTO	tritiated water
L	liter
LTHMP	Long-Term Hydrological Monitoring Program
m	meter
MDC	Minimum Detectable Concentration
MSL	Mean Sea Level
MSN	Milk Surveillance Network
NGTSN	Noble Gas and Tritium Surveillance Network
NTS	Nevada Test Site
Pa	Pascal - unit of pressure
R	Roentgen
rad	unit of absorbed dose, 100 ergs/g
rem	the rad adjusted for biological effect
TLD	thermoluminescent dosimeter

PREFIXES

a	atto	$= 10^{-18}$
f	femto	$= 10^{-15}$
p	pico	$= 10^{-12}$
n	nano	$= 10^{-9}$
μ	micro	$= 10^{-6}$
m	milli	$= 10^{-3}$
k	kilo	$= 10^{3}$
M	Mega	$= 10^{6}$

CONVERSIONS

Multiply	By	To Obtain
<u>Concentration Guides</u>		
μCi/mL	10^{9}	pCi/L
μCi/mL	10^{12}	pCi/m^3
<u>SI Units</u>		
rad	10^{-2}	Gray (Gy = 1 Joule/kg)
rem	10^{-2}	Sievert (Sv)
pCi	0.037	Becquerel

SECTION 1

SUMMARY

PURPOSE

It is U.S. Environmental Protection Agency policy to protect the general public and the environment from pollution caused by human activities. This includes radioactive contamination of the biosphere and concomitant radiation exposure of the population. To this end and in concordance with U.S. Department of Energy policy of keeping radiation exposure of the general public as low as reasonably achievable, the EMSL-LV conducts an Off-site Radiological Safety Program centered on the DOE's Nevada Test Site. This program is conducted under an Interagency Agreement between EPA and DOE.

A principal activity of the Off-site Radiological Safety Program is routine environmental monitoring for radioactive materials in various media and for radiation in areas which may be affected by nuclear tests. It is conducted to document compliance with standards, to identify trends, and to provide information to the public. This report summarizes these activities for CY 1984.

Locations

Most of the radiological safety effort is applied in the areas around the Nevada Test Site in south-central Nevada. The principal activity at the NTS is testing of nuclear devices, though other related projects are also conducted. This portion of Nevada is sparsely settled, 0.5 person/km^2, and has a continental arid climate. The largest town in the near off-site area is Beatty, located about 65 km west of the NTS with a population of about 800.

Underground tests have been conducted in several other States for various purposes. At these sites in Alaska, Colorado, New Mexico, and Mississippi, a long-term hydrological monitoring program (LTHMP) is conducted to detect any possible contamination of potable water and aquifers near these sites.

Pathways Monitoring

The pathways leading to human exposure to radionuclides, namely air, water, and food, are monitored by networks of sampling stations. The networks are designed not only to detect radiation from DOE/NV nuclear test areas but also to detect increases in population exposure from other sources.

In 1984 the air surveillance network (ASN) consisted of 29 continuously operating stations surrounding the NTS and 85 standby stations (operated 1 or 2 weeks each quarter) in all States west of the Mississippi. Other than naturally occurring beryllium-7, the only activity detected by this network was plutonium-239 from worldwide fallout.

The noble gas and tritium sampling network (NGTSN) consisted of 16 stations off site (off the NTS and exclusion areas) in 1984. No NTS-related radioactivity was detected at any off-site station. Tritium concentrations in air remained below MDC levels and krypton-85 concentration continued the upward trend which started in 1960, reflecting the worldwide increase in the use of nuclear technology.

The long-term hydrological monitoring of wells and surface waters near sites of nuclear tests showed only background tritium and other radionuclide concentrations except for those wells that enter the test cavity or those that were previously spiked with radionuclides for hydrological tests.

The milk surveillance network (MSN) consisted of 28 sampling locations within 300 km of the NTS and about 86 standby locations in the Western U.S. The tritium concentration in milk was at background levels, and strontium-90 from worldwide fallout continued the slow downward trend observed in recent years.

Other foods analyzed have been mainly meat from domestic or game animals and garden vegetables. The radionuclide most frequently found in the edible portion of the sampled animals is cesium-137. However, its concentration has been near the MDC since 1968. Meat from deer that reside on the NTS has not had markedly higher concentrations of radionuclides than meat from deer that reside in other areas of Nevada.

External Exposure

External exposure is monitored by a network of TLD's at 86 locations surrounding the NTS and by TLD's worn by 49 off-site residents. In a few cases, small exposures of a few mrem above the average for the person or location were measured. Except for several occupational exposures, all such net exposures were very low and were not related to NTS activities. The range of exposures measured, varying with altitude and soil constituents, is similar to the range of such exposures found in other areas of the U.S.

Internal Exposure

Internal exposure is assessed by whole-body counting supplemented by phoswich detectors to measure lung burdens of radioactivity. In 1984, counts were made on 70 off-site residents, as well as on 226 other individuals for occupational or other reasons. Natural potassium-40 was found as expected, but no nuclear test related radioactivity was detected. In addition, physical examinations of the off-site residents revealed only a normally healthy population consonant with the age and sex distribution of that population.

Community Monitoring Stations

The 15 Community Monitoring Stations became operational in 1982. Each station is operated by a resident of the community who is trained to collect samples and interpret some of the data. Each station is an integral part of the ASN, NGTSN and TLD networks and is also equipped with a pressurized ion chamber system and recording barograph. Samples and data from the stations are analyzed by EMSL-LV and are also interpreted and reported by the Desert Research Institute, University of Nevada. Data from these stations are reported herein as part of the networks in which they participate.

Dose Assessment

Doses were calculated for an average adult living in Nevada based on the Kr-85, Sr-90, Cs-137 and Pu-239 detected by the monitoring networks. Using conservative assumptions, the estimated dose would have been less than 0.6 mrem per year, a small fraction of the variation of 10 mrem per year due to the natural radionuclide content of the body. Since no radioactivity originating on the NTS was detectable off site, no dose assessment related to NTS activities could be made. However, atmospheric dispersion calculations, based on known emissions from the NTS, indicate that the population dose within 80 km of CP-1 was about 1×10^{-3} person-rem for 1984.

SECTION 2

INTRODUCTION

The EMSL-LV operates an Off-site Radiological Safety Program around the NTS and other sites as requested by the Department of Energy (DOE) under an Interagency Agreement between DOE and EPA. This report, prepared in accordance with the guidelines in DOE/EP-0023 (DOE 1981a), covers the program activities for calendar year 1984. It contains descriptions of pertinent features of the NTS and its environs, summaries of the EMSL-LV dosimetry and sampling methods, analytical procedures, and the analytical results from environmental measurements. Where applicable, dosimetry and sampling data are compared to appropriate guides for external and internal exposures of humans to ionizing radiation.

SECTION 3

DESCRIPTION OF THE NEVADA TEST SITE

Historically, the major programs conducted at the NTS have been nuclear weapons development, proof-testing and weapons safety and effects, testing peaceful uses of nuclear explosives (Plowshare Program), reactor engine development for nuclear rocket and ramjet applications (Projects Rover and Pluto), high-energy nuclear physics research, seismic studies (Vela Uniform), and studies of high-level waste storage. During 1984, nuclear weapons development, proof-testing and weapons safety, nuclear physics programs, and studies of high-level waste storage were continued at the NTS. Project Pluto was discontinued in 1964; Project Rover was terminated in January 1973; Plowshare tests were terminated in 1970; Vela Uniform studies ceased in 1973. All nuclear weapons tests since 1962 have been conducted underground. More detail and pertinent maps for the portions of this section are included in Appendix A. Only selected information is presented in this Section.

SITE LOCATION

The NTS is located in Nye County, Nevada, with its southeast corner about 90 km northwest of Las Vegas (Figure 1). It has an area of about 3,500 square km and varies from 40 to 56 km in width (east-west) and from 64 to 88 km in length (north-south). This area consists of large basins or flats about 900 to 1,200 m above mean sea level (MSL) surrounded by mountain ranges rising 1,800 to 2,300 m above MSL.

The NTS is surrounded on three sides by exclusion areas, collectively named the Nellis Air Force Range, which provide a buffer zone between the test areas and public lands. This buffer zone varies from 24 to 104 km between the test area and land that is open to the public. Depending upon wind speed and direction at the time of testing, from 2 to more than 6 hours will elapse before any release of airborne radioactivity could pass over public lands.

CLIMATE

The climate of the NTS and surrounding area is variable, due to its variations in altitude and its rugged terrain. Generally, the climate is referred to as continental arid. Throughout the year, there is insufficient precipitation to support the growth of common food crops without irrigation.

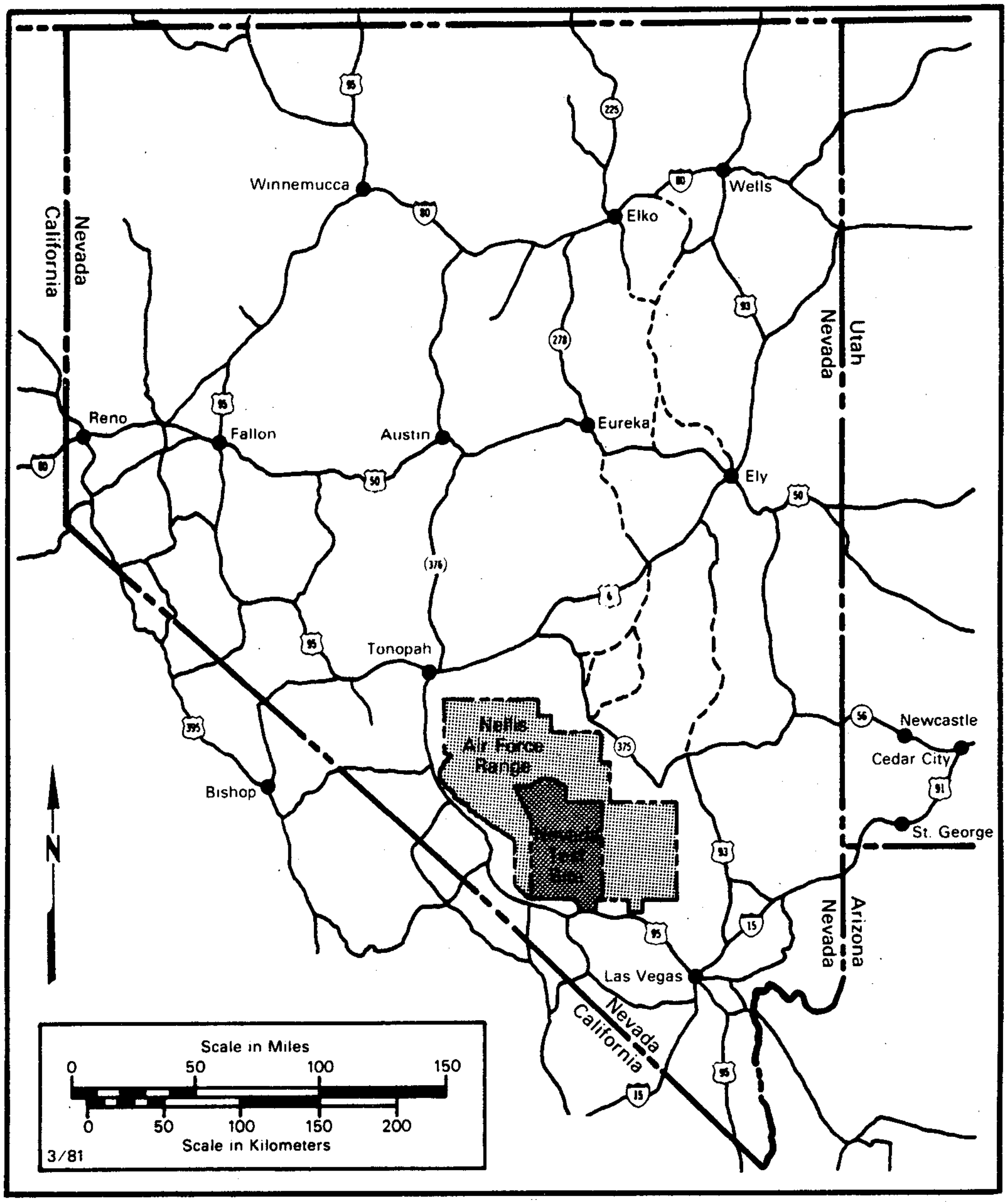

Figure 1. Location of the Nevada Test Site (NTS).

As Houghton et al. (1975) point out, 90 percent of Nevada's population lives in areas with less than 25 cm of rainfall per year or in areas that would be classified as mid-latitude steppe to low-latitude desert regions.

The wind direction, as measured on a 30 m tower at an observation station about 9 km NNW of Yucca Lake near CP-1, is predominantly northerly except during May through August when winds from the south-southwest predominate (Quiring 1968). Because of the prevalent mountain/valley winds in the basins, south to southwest winds predominate during daylight hours of most months. During the winter months southerly winds have only a slight edge over northerly winds for a few hours during the warmest part of the day. These wind patterns are often quite different at other locations on the NTS because of local terrain effects and differences in elevation.

GEOLOGY AND HYDROLOGY

Geological and hydrological studies of the NTS have been in progress by the U.S. Geological Survey and various other organizations since 1956. Because of this continuing effort, the surface and underground geological and hydrological characteristics for much of the NTS are known in considerable detail (see Figure A-1). This is particularly true for those areas in which underground experiments are conducted. A comprehensive summary of the geology and hydrology of the NTS by Winograd and Thordarson was published in 1975.

The aquifers underlying the NTS vary in depths from about 200 m beneath the surface of valleys in the southeastern part of the site to more than 500 m beneath the surface of highlands to the north. Although much of the valley fill is saturated, downward movement of water is retarded by various tuffs and is extremely slow. The primary aquifer in these formations consists of Paleozoic carbonates that underlie the more recent tuffs and alluviums.

LAND USE OF NTS ENVIRONS

Industry within the immediate off-NTS area includes approximately 40 active mines and mills, oil fields in the Railroad Valley area, and several industrial plants in Henderson, Nevada. The number of employees for these operations may vary from one person at several of the small mines to several hundred workers for the oil fields north of the NTS and the industrial plants in Henderson. Most of the individual mining operations involve less than 10 workers per mine; however, a few operations employ 100 to 250 workers.

The major body of water close to the NTS is Lake Mead (120 km southeast, Figure A-2), a manmade lake supplied by water from the Colorado River. Lake Mead supplies about 60 percent of the water used for domestic, recreational, and industrial purposes in the Las Vegas Valley. Some Lake Mead water is used in Arizona, southern California, and Mexico. Smaller reservoirs and lakes located in the area are used primarily for irrigation, for watering livestock, and for wildlife refuges.

Dairy farming is not extensive within 300 km of the NTS. A survey of milk cows during the summer of 1983 showed 78,000 dairy cows, 757 family milk cows and 847 family milk goats in the area (Figures A-4 and A-5). The family cows and goats are distributed in all directions around the NTS, whereas most dairy cows are located to the southeast (along the Muddy and Virgin River valleys and in Las Vegas, Nevada), northeast (Lund), and southwest (near Barstow, California).

Grazing is the most common land use within 300 km of the site. Approximately 560,000 cattle and 150,000 sheep are distributed within the area as shown in Figures A-6 and A-7, respectively. The estimates are based on information supplied by the California Crop and Livestock reporting service, from 1984 agricultural statistics supplied by the Nevada Department of Agriculture and 1984 estimates based on 1982 census information supplied by the Utah Department of Agriculture.

POPULATION DISTRIBUTION

Excluding Clark County, the major population center (approximately 463,000 in 1980), the population density within a 150 km radius of CP-1 on the NTS is about 0.5 persons per square kilometer. For comparison, the 48 contiguous states (1980 census) had a population density of approximately 29 persons per square kilometer. The estimated average population density for all of Nevada in 1980 was 2.8 persons per square kilometer.

The off-site area within 80 km of the NTS (the area in which the dose commitment must be determined for the purpose of this report) is predominantly rural, Figure A-3. Several small communities are located in the area, the largest being in the Pahrump Valley. This growing rural community, with an estimated population of about 5,500, is located about 72 km south of the NTS CP-1. The Amargosa Farm Area, which has a population of about 1,500, is located about 50 km southwest of CP-1. The largest town in the near off-site area is Beatty, which has a population of about 800 and is located approximately 65 km to the west of CP-1.

AIRBORNE RELEASES OF RADIOACTIVITY AT THE NTS DURING 1984

All nuclear detonations during 1984 were conducted underground and were contained, although occasional releases of low-level radioactivity occurred during re-entry drilling or seepage, through fissures in the soil. Table 1 shows the total quantities of radionuclides released to the atmosphere, as reported by the DOE Nevada Operations Office (1985). Because these releases occurred throughout the year, and because of the distance from the points of releases to the nearest sampling station, none of the radioactive nuclides listed in this table were detected off site.

TABLE 1. TOTAL AIRBORNE RADIONUCLIDE EMISSIONS AT THE NTS DURING 1984

Radionuclide	Half-Life (days)	Quantity Released (Ci)
Tritium	4,500	197
Argon-37	35.1	9.6
Krypton-83m	0.08	21.3
Krypton-85m	0.19	34
Krypton-87	0.05	0.8
Xenon-133	5.24	160
Xenon-133m	2.2	8.5
Xenon-135	0.38	1297
Xenon-135m	0.00018	156

SECTION 4

QUALITY ASSURANCE

GOALS

The goals of the EMSL-LV quality assurance program are to assure the collection and analysis of environmental samples with the highest degree of accuracy and precision obtainable with state-of-the-art instrumentation and to achieve the best possible completeness and comparability given the extent and type of networks from which samples are collected. To meet these goals, it is necessary to devote strict attention to both the sample collection and sample analysis procedures.

SAMPLE COLLECTION

The collection of samples is governed by a detailed set of Standard Operating Procedures (SOP's). These SOP's prescribe the frequency and method of collection, the type of collection media, sample containment and transport, sample preservation, sample identification and labeling, and operating parameters for the instrumentation. Sample control is an important segment of these activities as it enables tracking from collection to analysis for each sample and governs the selection of duplicate samples for analysis and the samples chosen for replicate analysis.

These procedures provide assurance that sample collection, labeling and handling are standardized to minimize sample variability due to inconsistency among these variables.

SAMPLE ANALYSIS

All of the networks operated by the EMSL-LV have individual Quality Assurance Project Plans that assure the results of analysis will be of known quality and will be comparable to results obtained elsewhere with equivalent procedures. These Plans are summarized in the following sections.

External QA

External QA provides the data from which the accuracy of analysis (a combination of bias and precision) can be determined. Bias is assessed from the results obtained on intercomparison study samples and on samples "spiked" with known amounts of radionuclides. The Off-site Radiological Safety Program participates in Intercomparison Study Programs that include environmental sample analysis, TLD dosimetry, and whole-body counting. Also, samples which are undisclosed to the analyst are spiked by adding known amounts of radionuclides and entered then into the normal chain of analysis.

Data for precision are collected from duplicate and replicate analyses. At least 10 percent of all samples are collected in duplicate. When analyzed, the data indicate the precision of both sample collection and analysis. Replicate counting of at least 10 percent of all samples yield data from which the precision of counting can be determined.

If the bias and precision data are of sufficient quality (i.e., normalized deviation in Table C-3 is less than 3), then comparability, i.e., comparison of the data with those of other analytical laboratories, can be assessed with confidence. The results of external QA procedures are shown in Appendix C.

Internal QA

Internal QA consists of those procedures used by the analyst to assure proper sample preparation and analysis. The principal procedures used are the following:

- Instrument background counts
- Blank and reagent analyses
- Instrument calibration with known nuclides
- Laboratory control standards analysis
- Performance check-source analysis
- Maintenance of control charts for background and check-source data
- Scheduled instrument maintenance

These procedures ensure that the instrumentation is not contaminated, that calibration is correct, and that standards carried through the total analytical procedure are accurately analyzed.

VALIDATION

After the results are produced, supervisory personnel examine the data to determine whether or not the analysis is valid. This includes checking all procedures from sample receipt to analytical result with particular attention to the internal QA data and comparison of the results with previous data from similar samples at the same location.

Any variant result or failure to follow internal QA procedures during sample analysis will trigger an internal audit of the analytical procedures and/or a re-analysis of the sample or its duplicate.

AUDITS

All analytical data are reviewed by personnel of the Dose Assessment Branch for completeness and consistency. Investigations are conducted to resolve any inconsistencies and corrective actions are taken if necessary. SOP's and QA project plans are revised as needed following review of procedures and methodology. The EMSL-LV QA Officer audits the operations periodically.

SECTION 5

RADIOLOGICAL SAFETY ACTIVITIES

The radiological safety activities of the EMSL-LV are divided into two major areas: special test support and routine environmental surveillance. Both of these activities are designed to detect any increase in environmental radiation which might cause exposure to individuals or population groups so that protective actions may be taken, to the extent feasible. These activities are described in the following portions of this report.

SPECIAL TEST SUPPORT

Before each nuclear test, mobile monitoring personnel are positioned in the off-site areas most likely to be affected should a release of radioactive material occur. They ascertain the locations of residents, work crews and animal herds and obtain information relative to controllability of residents in communities and remote areas. These monitors, equipped with radiation survey instruments, gamma exposure-rate recorders, thermoluminescent dosimeters (TLD's), portable air samplers, and supplies for collecting environmental samples, are prepared to conduct a monitoring program as directed from the NTS Control Point (CP-1) via two-way radio communications.

For those tests which might cause ground motion detectable off site, EPA monitors are stationed at locations where hazardous situations might ensue. At these locations, occupants are notified of potential hazard so they can take precautionary measures.

Professional EPA personnel serve as members of the Test Controller's Advisory Panel to provide advice on possible public and environmental impact of each test and feasible protective actions in case accidental releases of radioactivity should occur.

An EG&G cloud sampling and tracking aircraft is always flown over the NTS to obtain samples, assess total cloud volume, and provide long-range tracking in the event of a release of airborne radioactivity. A second aircraft is also flown to gather meteorological data and to perform cloud tracking. Information from these aircraft can be used in positioning the radiation monitors.

During CY 1984 none of the tests conducted at the NTS released radioactivity that was detected off site.

PATHWAYS MONITORING

The off-site radiation monitoring program includes pathways monitoring consisting of air, water and milk surveillance networks surrounding the NTS and a limited animal sampling project. These are explained in detail below.

Air Surveillance Network (ASN)

Network Design--

The ASN monitors an important route of human exposure to radionuclides: inhalation of airborne materials. Not only the concentration but also the source must be determined if appropriate corrective actions are to be taken. The ASN is designed to cover the areas within 200 km of the NTS with some concentration of stations in the prevailing downwind direction (Figure 2). The coverage is constrained to those locations having available electrical power and a resident willing to operate the equipment. This continuously operating network is reinforced by a standby network which covers the contiguous States west of the Mississippi River, (Figure 3).

Methods--

During 1984 the ASN consisted of 29 continuously operating sampling stations and 85 standby stations. The air sampler at each station was equipped to collect both particulate radionuclides and reactive gases.

Samples of airborne particulates were collected at each active station on 5-cm diameter glass-fiber filters at a flow rate of about 81 m^3 per day. Filters were changed after sampler operation periods of 2 or 3 days (160 to 240 m^3). Activated charcoal cartridges placed directly behind the filters to collect gaseous radioiodine were changed at the same time as the filters. The standby network was activated for 1 to 2 weeks per quarter at most locations. The samplers are identical to those used in the ASN and are operated by State and municipal health department personnel or by local residents. All air filters and charcoal cartridges were analyzed by the EMSL-LV.

Results--

Throughout the network, beryllium-7 was the only nuclide detected by gamma spectroscopy. The principal means of beryllium-7 production is from spallation of oxygen-16 and nitrogen-14 in the atmosphere by cosmic rays. Appendix Tables E-1 and E-2, summarize the data from the ASN samples. All time-weighted averages (Avg in the tables) are less than 1 percent of the Concentration Guide (Appendix D) for exposure to the general public, however, these guides do not apply to naturally-occurring radionuclides.

During 1984, no airborne radioactivity related to nuclear testing at the NTS was detected on any sample from the ASN.

A plot of the logarithm of the individual concentrations of beryllium-7 for all stations during the year versus probits indicates that the air data are approximately lognormally distributed. The distribution for the individual

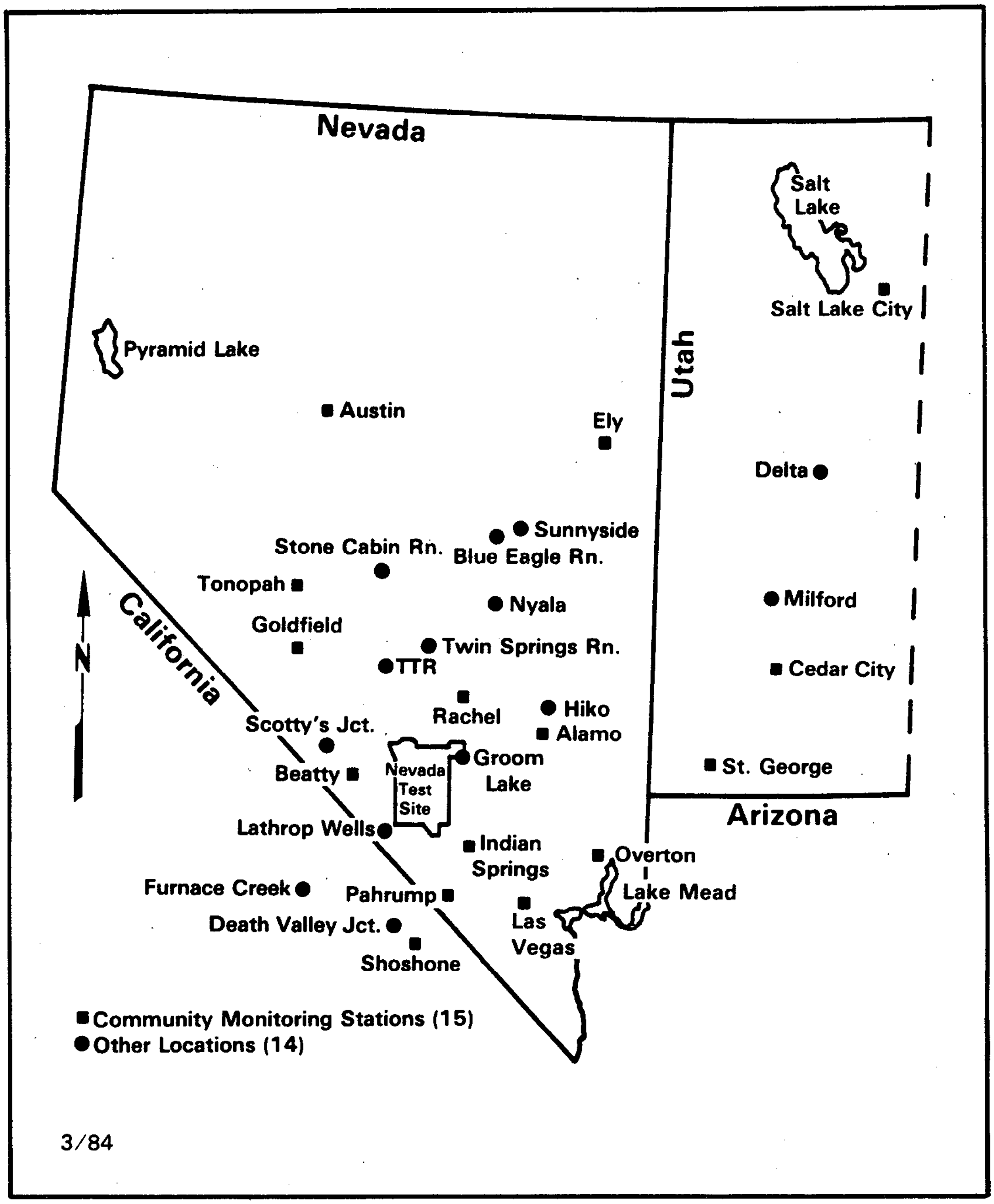

Figure 2. Air Surveillance Network stations (1984).

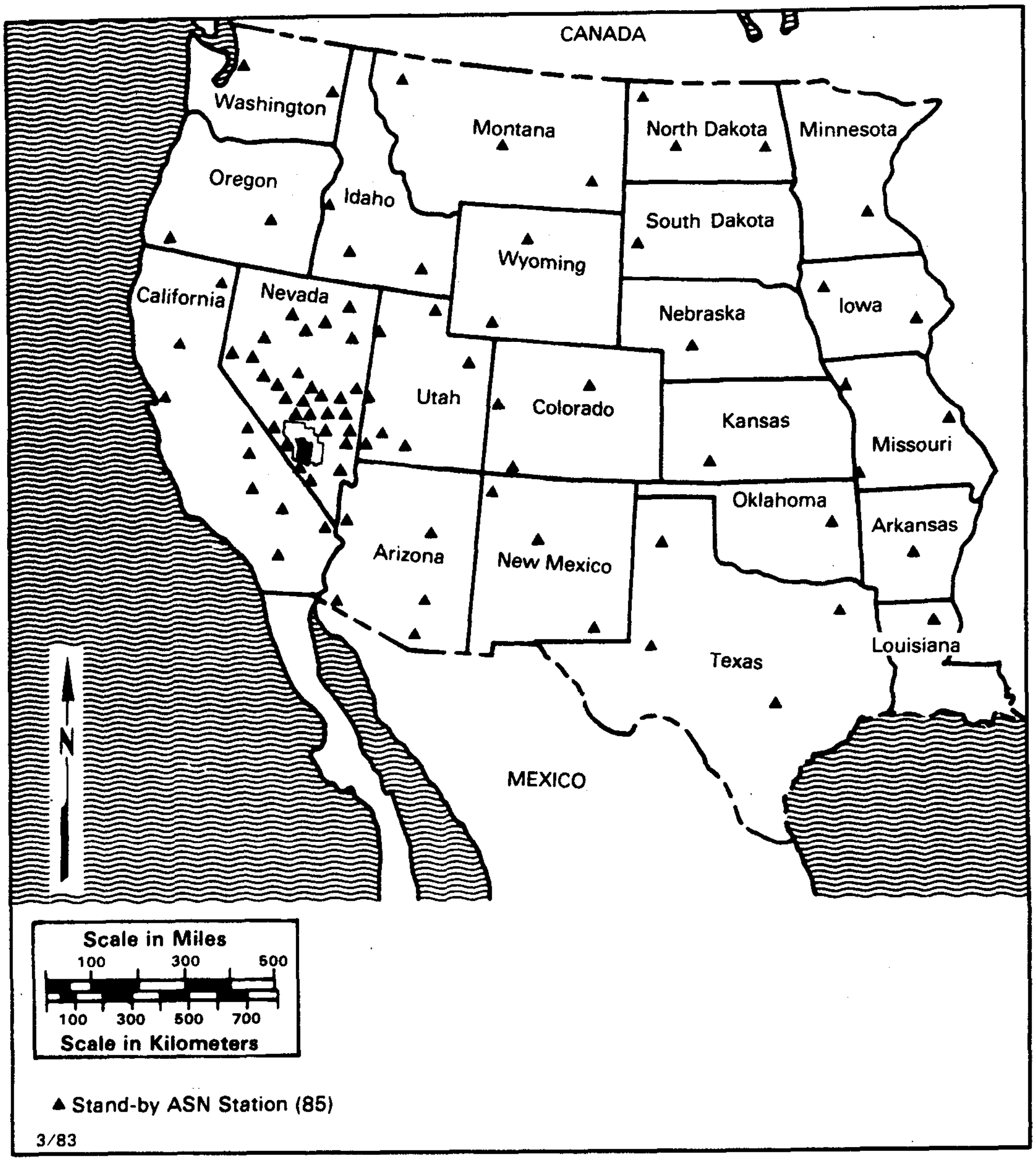

Figure 3. Standby Air Surveillance Network stations (1984).

nuclide that was detected indicated that there was a single source, assumed to be worldwide, because all stations were affected similarly.

Two special studies are performed on the samples from the ASN: a gross beta analysis of the filters from 5 stations, and plutonium-238 and plutonium-239 analysis of composited filters from 15 States. The results from the plutonium-239 analyses are shown in Appendix Table E-4; plutonium-238 results were <MDC.

The gross beta analysis is used to detect trends in atmospheric radioactivity more quickly than is possible with gamma spectrometry. For this study, three stations north and east of the NTS, and two stations south and west of the NTS are used. The three filters per week from each station are analyzed for gross beta activity after a 7-day delay to decrease the contribution from thoron daughter activity. The data suggest little significant difference among stations and indicate a relatively stable concentration compared to previous years (Figure 4). The maximum concentration measured was 0.064 pCi/m^3, the minimum was <0.006 pCi/m^3, and the arithmetic average was 0.012 pCi/m^3. A summary of the data is shown in Appendix Table E-3. The gross beta analysis was reinstated in July 1981 after its termination in 1979.

Noble Gas and Tritium Surveillance Network

Network Design--

There are several sources for the radionuclides monitored by this network. Noble gases are emitted from nuclear power plants, propulsion reactors, reprocessing facilities and nuclear explosions. Tritium is emitted from the same sources and is also produced naturally. The monitoring network will be affected by all these sources, but must be able to detect NTS emissions. For this purpose some of the samplers are located close to the NTS and particularly in drainage-wind channels leading from the test areas. In 1984 this network consisted of 16 stations as shown in Figure 5.

Methodology--

Samples of air are collected by either of two methods; by directly compressing or by liquefying air using cryogenic techniques. Either type of equipment continuously samples air over a 7-day period and stores approximately 1 cubic meter of air in pressure tanks. The tanks are exchanged weekly and returned to the EMSL-LV where their contents are analyzed. Analysis starts by condensing the samples at liquid nitrogen temperature and using gas chromatography to separate the gases. The separate fractions of radioxenon and radiokrypton are dissolved in scintillation cocktails and counted in a liquid scintillation counter (see Appendix B).

For tritium sampling, a molecular sieve column is used to collect water from air. A prefilter is used to remove particles before air passes through the molecular sieve column. Up to 10 cubic meters of air are passed through each column over a 7-day sampling period. Water adsorbed on the molecular sieve is recovered, and the concentration of tritium in the water (HTO) is determined by liquid scintillation counting techniques (see Appendix B).

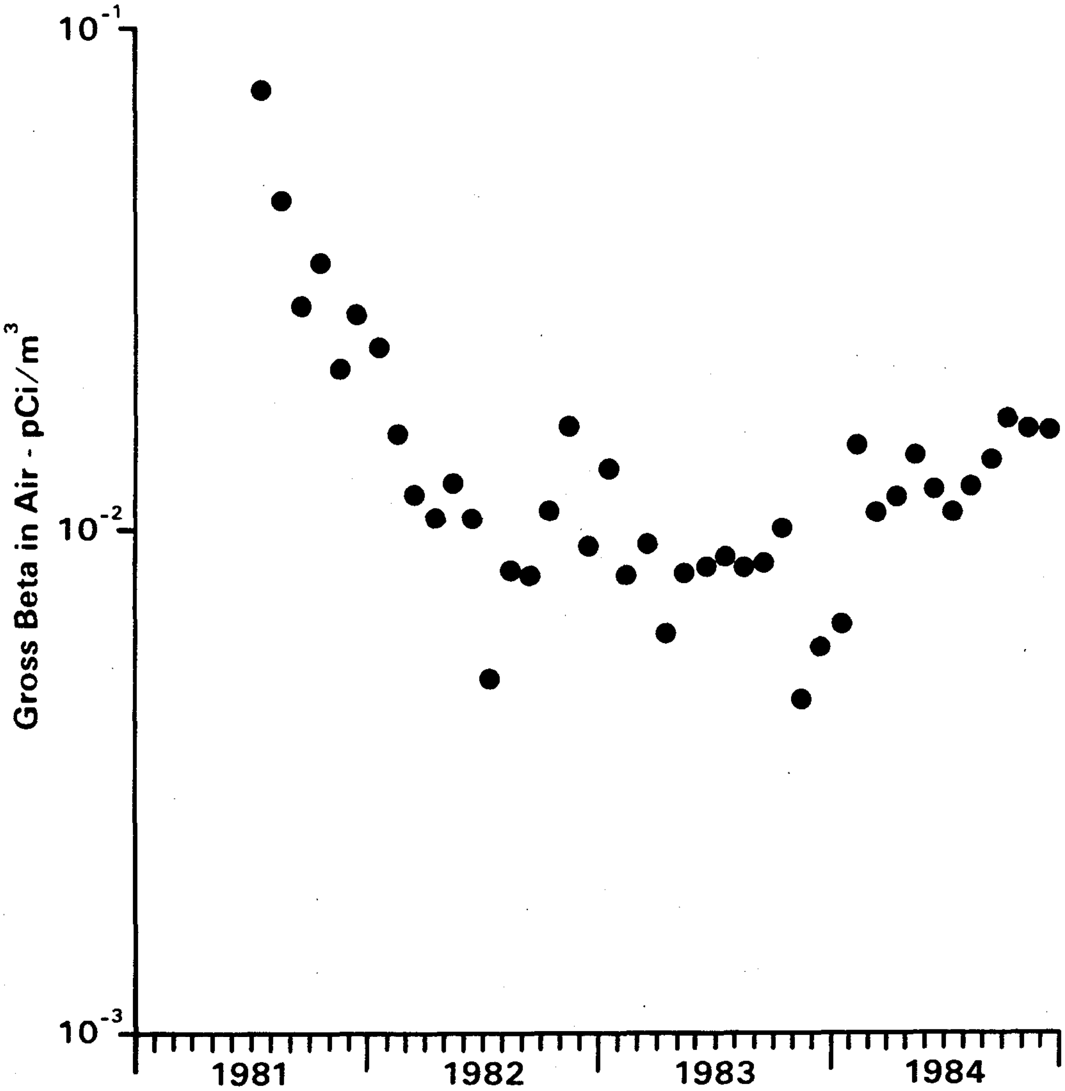

Figure 4. Monthly average gross beta in air samples, 1981-84.

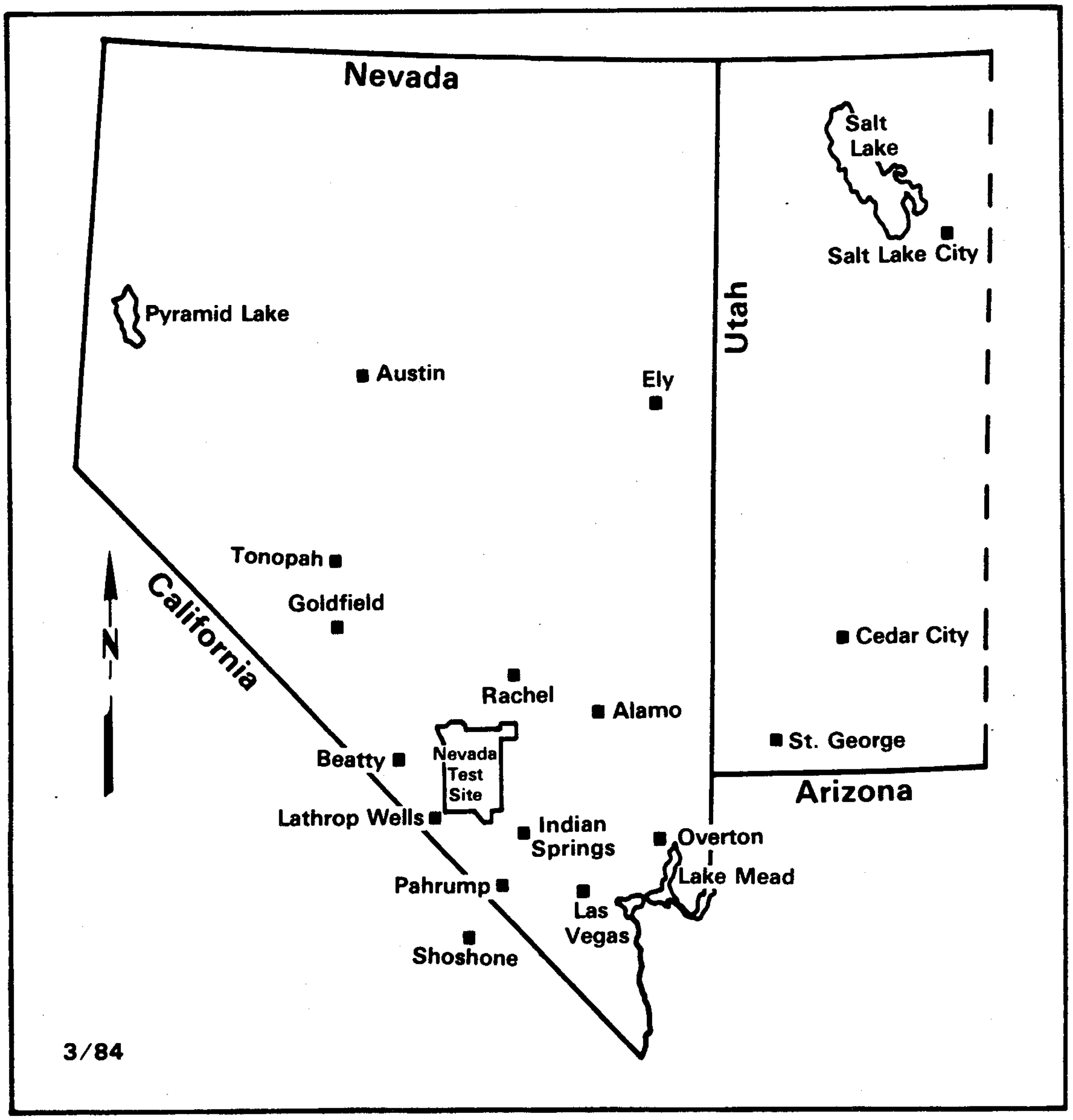

Figure 5. Noble Gas and Tritium Surveillance Network sampling locations.

Results--

All results are shown in Appendix Table E-5 as the maximum, minimum and average concentration for each station. These data indicate that no radioactivity from NTS tests was detected off site by the Noble Gas and Tritium Surveillance Network during 1984. The average concentrations of krypton-85 at all network stations ranged from 25 to 29 pCi/m^3 (as shown in Figure 6).

The concentrations of krypton-85 within the whole network appeared to have a skewed distribution. The lognormal distribution had a geometric mean of 26 pCi/m^3 and a geometric standard deviation of 1.16.

As shown in Figure 7 and Table 2, the average concentration of krypton-85 for the whole network has gradually increased since sampling began in 1972. This increase, observed at all stations, reflects the worldwide increase in ambient concentrations resulting from the increased use of nuclear technology. The increase in ambient krypton-85 concentration was projected by Bernhardt, et al., (1973). However, the measured network average in 1984 is only about 13% percent of the 210 pCi/m^3 predicted by Bernhardt. Since nuclear fuel reprocessing is the primary source of krypton-85, the decision of the United States to defer fuel reprocessing may be one reason why krypton-85 levels have not increased as fast as predicted.

Using published data for krypton-85 concentration in air (NCRP 1975) and the data from our network (Table 2), the change over time was plotted as shown in Figure 7. Linear correlation analysis indicates that the krypton concentration/time relation is pCi/m^3 = 5.4 + 0.85t where t is number of years after 1960. The correlation coefficient, R, is 0.986.

As in the past, tritium concentrations in atmospheric moisture samples from the off-NTS stations were generally below the minimum detectable concentration (MDC) of about 400 pCi/L water (Appendix Table E-5). The tritium concentrations observed at off-NTS stations were considered to be representative of environmental background. The geometric mean of the tritium concentrations for all off-site stations was evaluated as 0.018 pCi/mL of moisture, which is below the minimum detectable concentration of about 0.4 pCi/mL. The geometric standard deviation for the mean was determined to be 1.5.

Long-term Hydrological Monitoring Program

Network Design--

A major pathway for the transport of radionuclides to individuals is via potable water. This program monitors possible radioactive contamination of potable water sources. The design is for a system to monitor the aquifers underlying, and surface waters on or near, sites where nuclear explosions have occurred. For aquifers, monitoring is limited by the availability of wells that tap those sources. For the sites considered herein, a suitable number of wells is present so that sufficient monitoring data are obtained.

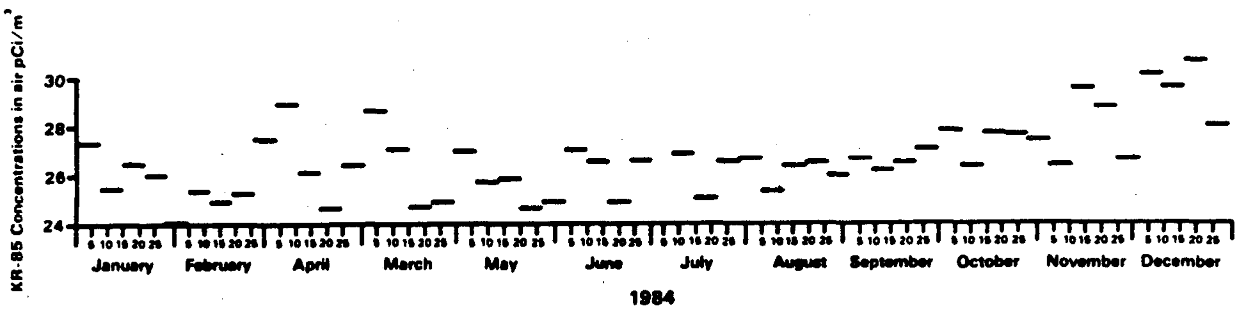

Figure 6. Weekly averaged krypton-85 concentration in air, 1984 data.

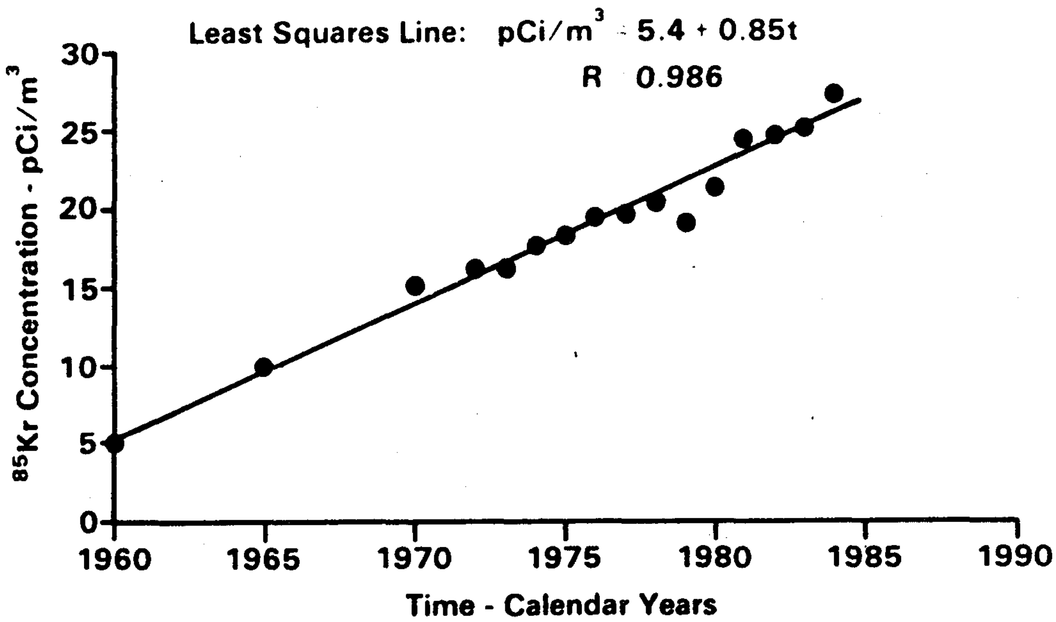

Figure 7. Trend in annual average krypton-85 concentration.

TABLE 2. ANNUAL AVERAGE KRYPTON-85 CONCENTRATIONS IN AIR, 1975-1984

Sampling Locations	Kr-85 Concentrations (pCi/m^3)									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Alamo, NV	--	--	--	--	--	--	27	24	25	28
Austin, NV	--	--	--	--	--	--	--	24	25	27
Beatty, NV	19	20	20	20	19	21	24	25	24	26
Diablo and Rachel, NV**	18	19	19	20	19	21	24	26	24	26
Ely, NV	--	--	--	--	--	--	--	24	25	26
Goldfield, NV*	--	--	--	--	--	--	--	25	24	28
Hiko, NV*	17	17	19	20	19	21	24	26	--	--
Indian Springs, NV	20	20	20	20	19	21	24	24	25	25
NTS, Mercury, NV*	18	19	20	20	19	21	23	--	--	--
NTS, Area 51, NV*	18	20	19	20	19	21	24	--	--	--
NTS, BJY, NV*	19	20	21	22	21	23	26	--	--	--
NTS, Area 12, NV*	18	20	19	20	19	21	24	--	--	--
Tonopah, NV	17	19	19	20	18	21	25	24	25	26
Las Vegas, NV	18	18	20	20	--	--	24	24	24	27
Death Valley Jct., CA*	17	20	20	20	19	--	--	--	--	--
NTS, Area 15, NV*	--	--	--	--	19	21	25	--	--	--
NTS, Area 400, NV*	--	--	--	--	18	21	23	--	--	--
Lathrop Wells, NV	--	--	--	--	19	22	24	24	26	26
Pahrump, NV	--	--	--	--	--	--	23	24	24	27
Overton, Nev.	--	--	--	--	--	--	26	24	25	26
Cedar City, Ut.	--	--	--	--	--	--	--	25	24	26
St. George, Ut.	--	--	--	--	--	--	--	24	25	26
Salt Lake City, Ut.	--	--	--	--	--	--	--	25	25	29
Shoshone, CA	--	--	--	--	--	--	--	25	25	26
NETWORK AVERAGE	18	19	20	20	19	21	24	24	25	27

*Stations discontinued
**Station at Diablo was moved to Rachel in March 1979.

The monitored locations for the NTS and nearby off-site areas are shown in Figures 8 and 9. For Projects Cannikin, Longshot and Milrow in Alaska; for Projects Rio Blanco and Rulison in Colorado; for Projects Dribble and Miracle Play in Mississippi; for Projects Faultless and Shoal in Nevada; and for Projects Gasbuggy and Gnome in New Mexico, the sampling locations are shown in Figures E-1 through E-12 in Appendix E.

Methods--

At each sampling location, four samples are collected. Two samples are collected in 500-mL glass bottles; one is used for tritium analysis and the other stored for use as a duplicate sample or to replace the original sample if it is lost in analysis. Two 3.5-L samples are filtered through 10 cm diameter membrane filters into cubitainers and acidified with HNO_3. One sample and the filter are gamma-scanned, the other sample is stored for duplicate analysis or for reanalysis as required.

Beginning in July 1984, this procedure was modified for the locations around the NTS which were sampled semi-annually and annually. At these locations, the sampling frequency was changed to monthly and the above sampling procedure was used only twice a year. During the other months, only a 3.5-L sample was collected for analysis by gamma spectrometry.

The tritium and gamma spectrometric analyses are described in Appendix B. If the tritium concentration detected by the conventional analysis is less than 700 pCi/L, then the sample is reanalyzed using the enrichment method.

Results--

Table 3 lists the locations at which water samples were found to contain man-made radioactivity. Radioactivity in samples collected at most of these locations has been reported in previous years, the data for all samples analyzed are compiled in Appendix Tables E-6 and E-7 together with the percent of the relevant concentration guide listed in Appendix D. No man-made gamma-emitting radionuclides were detected in any of the other water samples analyzed.

None of the radionuclide concentrations found at the locations listed in Table 3 are expected to result in measurable radiation exposures to residents in the areas where the samples were collected. Well UE7NS and Test Well B are located on the NTS, and are not used as sources of domestic water.

USGS Wells 4 and 8, which were contaminated with the reported nuclides during tracer studies years ago, are on private land at the Project Gnome site in New Mexico and are closed and locked to prevent their use. Well LRL-7 was used for the disposal of contaminated soil and salt. As a result, this well is expected to produce contaminated water.

The Project Dribble wells in Mississippi are about 1 mile from the nearest residence and are not sources of drinking water.

The shallow wells at the Project Long Shot site on Amchitka Island in Alaska are in an isolated location and are not sources of drinking water.

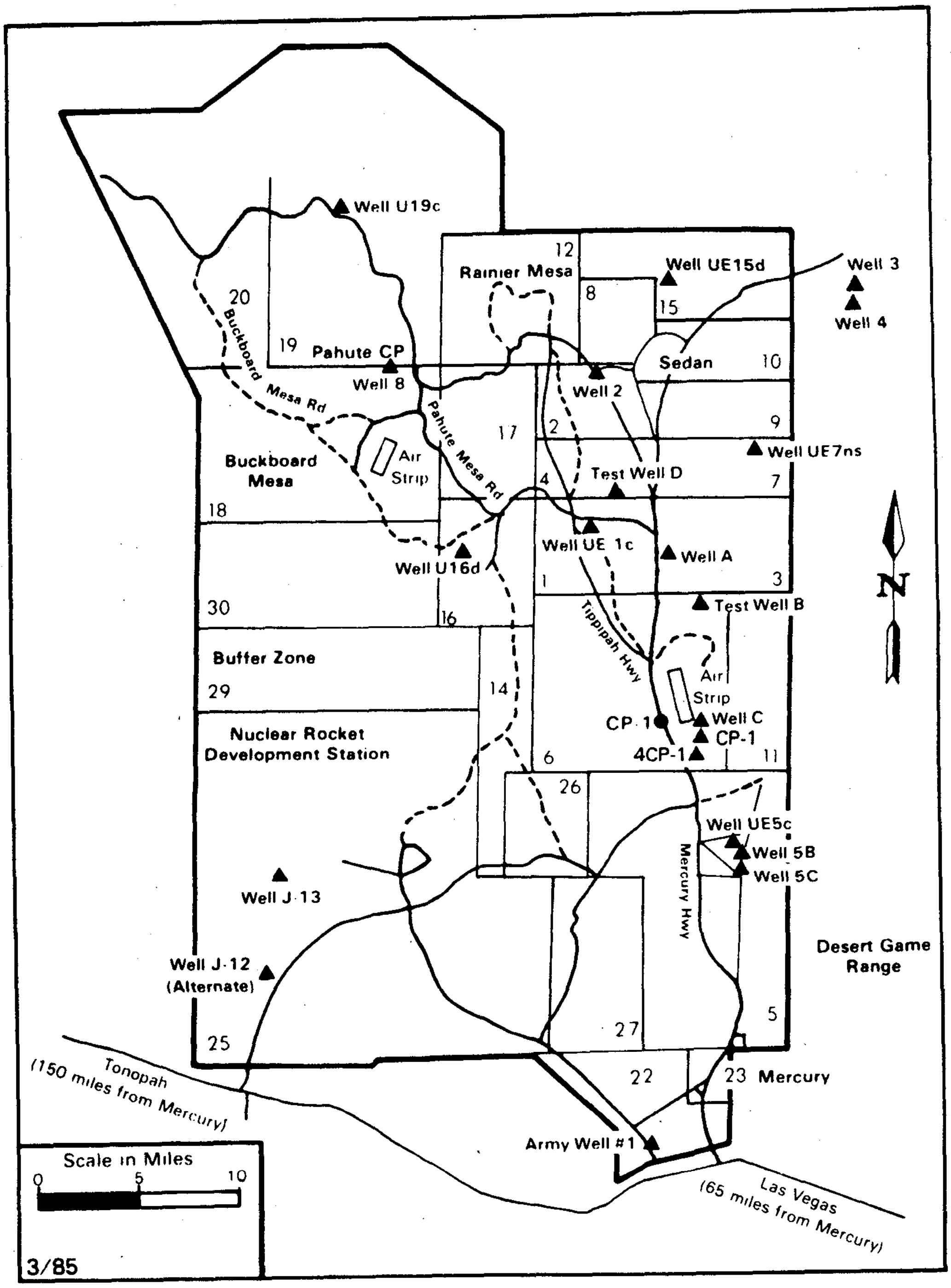

Figure 8. LTHMP sampling locations on the NTS.

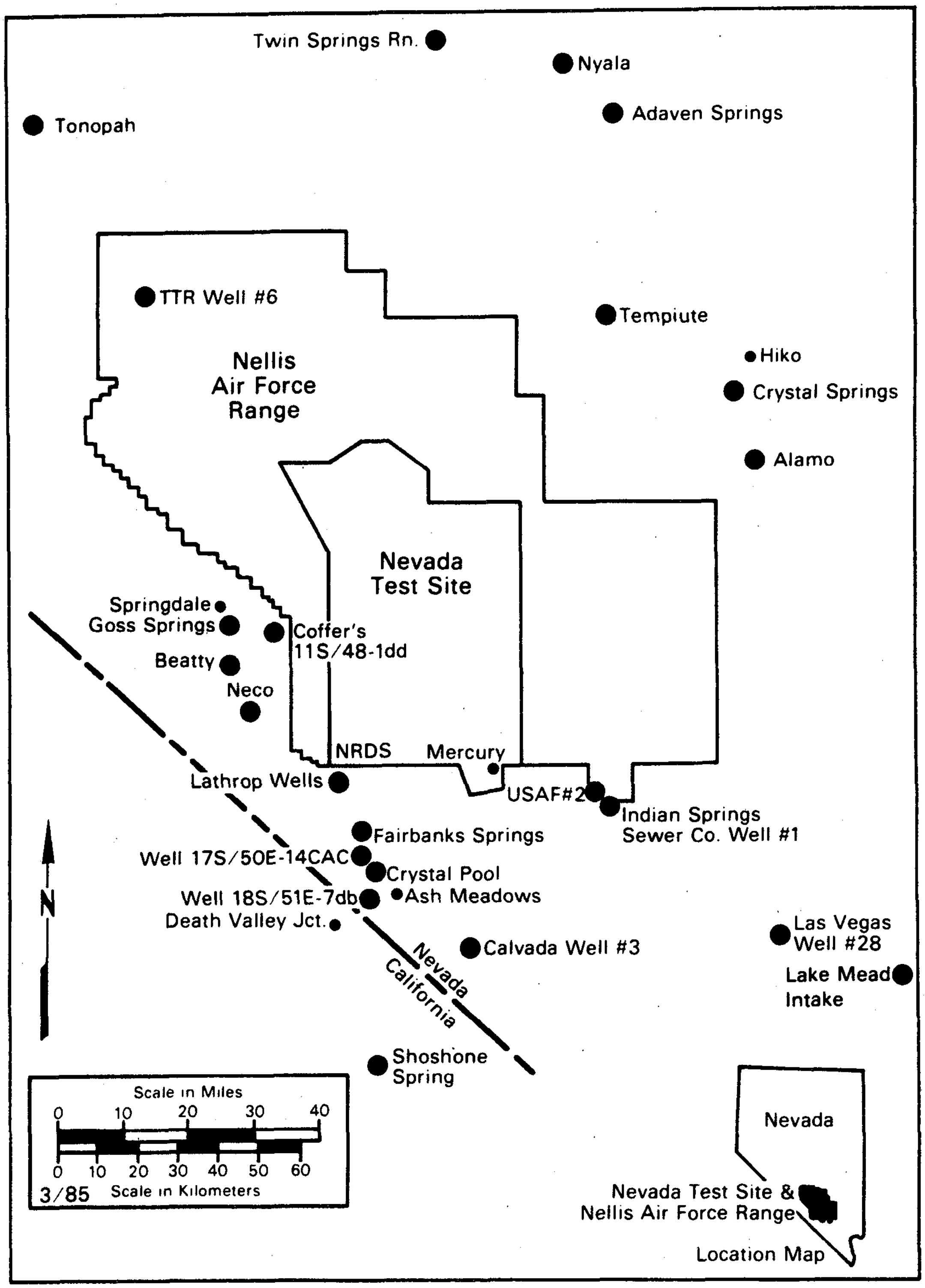

Figure 9. LTHMP sampling locations near the NTS.

TABLE 3. WATER SAMPLING LOCATIONS WHERE SAMPLES CONTAINED MAN-MADE RADIOACTIVITY - 1984

Sampling Location	Type of Radioactivity	Concentration (pCi/L)
NTS, NV		
Test Well B	Hydrogen-3	6-190
Well UE7NS	Hydrogen-3	990-4600
PROJECT GNOME, NM		
USGS Well 4	Hydrogen-3	330,000
	Strontium-90	9,000
USGS Well 8	Hydrogen-3	260,000
	Strontium-90	5,700
	Cesium-137	95
Well LRL-7	Hydrogen-3	23,000
	Strontium-90	13
	Cesium-137	210
PROJECT DRIBBLE, MS		
Well HMH-1 through 11	Hydrogen-3	26-5,800
Well HM-S	Hydrogen-3	18,000
Well HM-L	Hydrogen-3	1,400
REECo Pit Drainage-B	Hydrogen-3	800
REECo Pit Drainage-C	Hydrogen-3	510
Half Moon Creek Overflow	Hydrogen-3	280
PROJECT LONG SHOT, AK		
Well WL-2	Hydrogen-3	710
Well GZ, No. 1	Hydrogen-3	3,200
Well GZ, No. 2	Hydrogen-3	220
Mud Pit No. 1	Hydrogen-3	490
Mud Pit No. 2	Hydrogen-3	580
Mud Pit No. 3	Hydrogen-3	710
Stream East of Long Shot	Hydrogen-3	660

Milk Surveillance Network (MSN)

Network Design--

An important pathway for transport of radionuclides to humans is the air-forage-cow-milk chain. This pathway is monitored by EMSL-LV through analysis of milk. The design of the network is based on collections from areas likely to be affected by accidental releases from the NTS as well as from areas unlikely to be so affected. Additional considerations are: 1) a complete ring of stations to cover any eventuality, 2) samples from major milksheds as well as from family cows, and 3) availability of milk cows.

Methods--

The network consists of two major portions, the MSN at locations within 300 km of the NTS from which samples are collected quarterly or monthly (Figure 10) and the standby network (SMSN) at locations in all major milksheds west of the Mississippi River from which samples are collected annually. One exception to the latter portion of the network is Texas; the State Health Department performs the surveillance of the milksheds in that State. Beginning in August, the locations that were sampled quarterly are now sampled monthly.

The quarterly/monthly raw milk samples are collected by EPA monitors in 4-liter plastic containers (cubitainers) and preserved with formaldehyde. The annual milk samples are also collected in cubitainers and preserved with formaldehyde but they are collected by contacting State Food and Drug Administration Representatives, after notification of the Regional EPA offices by telephone, and mailed to EMSL-LV for analysis.

All the milk samples are analyzed first for gamma-emitting nuclides by high-resolution gamma spectrometry and then for strontium-89 and strontium-90 by the methods outlined in Appendix B, after a portion of milk is set aside for tritium analysis. Occasionally a milk sample will sour, thus preventing its passage through the ion exchange column and its subsequent strontium analysis. However, the other analyses can generally be performed satisfactorily. Beginning in August, 1984 strontium analyses are done quarterly.

Results--

The analytical results from the 1984 milk samples are summarized in Appendix Table E-8 and Table E-9 where the maximum, minimum, and average concentrations of tritium, strontium-89 and strontium-90 are shown for each sampling location. As shown in Table 4, the average concentrations of tritium and strontium-90 for the whole network are similar to the network averages for previous years.

Other than naturally occurring potassium-40, radionuclides were not detected by gamma spectrometry in any of the samples from the MSN.

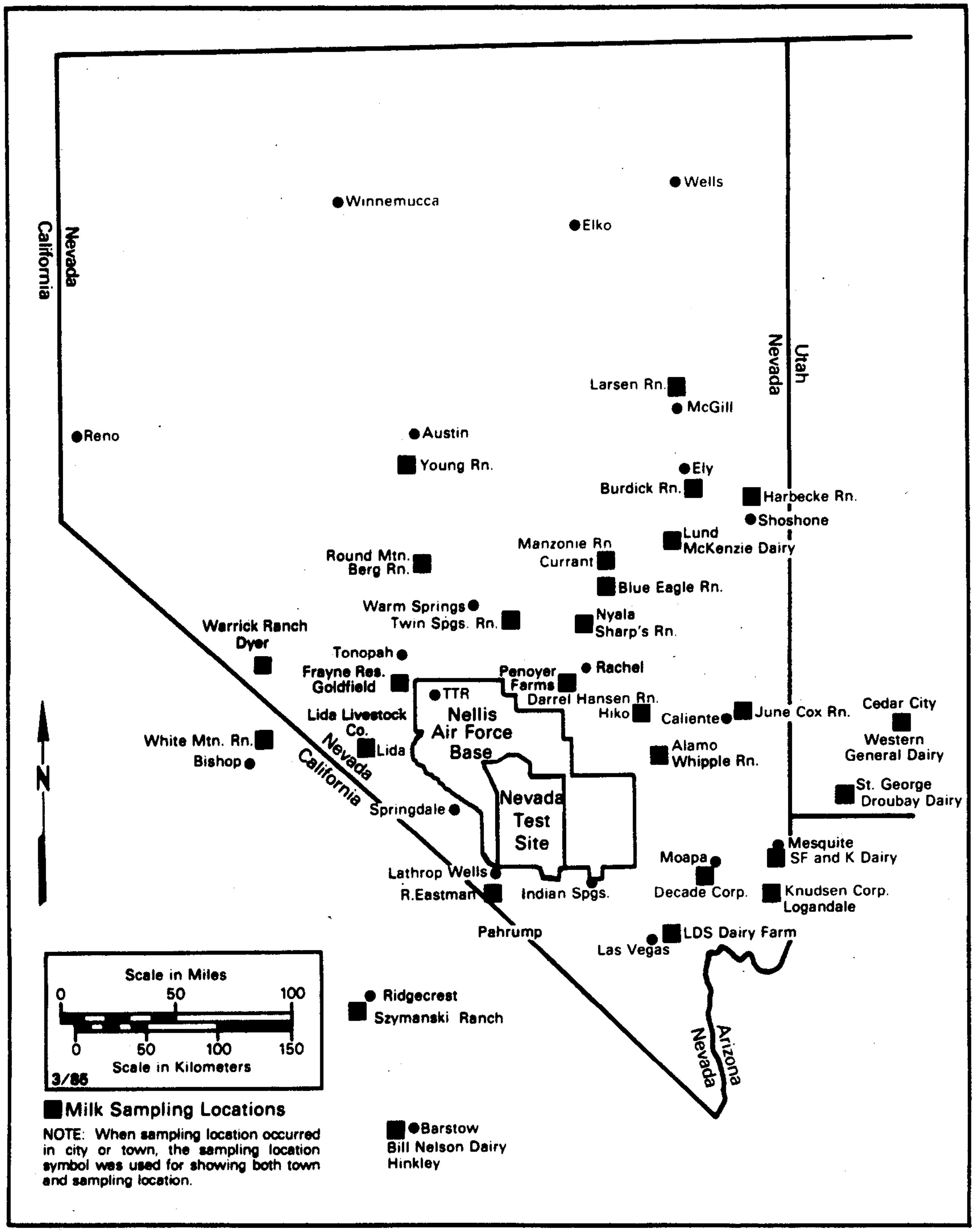

Figure 10. Milk sampling locations within 300 km of the NTS.

TABLE 4. NETWORK ANNUAL AVERAGE CONCENTRATIONS OF TRITIUM AND STRONTIUM-90 IN MILK, 1975 - 1984

	Average Concentrations - pCi/L	
Year	H-3	Sr-90
1975	<400	<3
1976	<400	<2
1977	<400	<2
1978	<400	1.2
1979	<400	<3
1980	<400	<2
1981	<400	1.9
1982	<400	1.2
1983	<400	0.8
1984	<400	0.5

The tritium and strontium-90 concentrations for the whole milk network were plotted versus probits. The tendency of the data to fit one straight line indicates that the data represent a single source, which appears to be atmospheric deposition. The consistently higher results from New Orleans reflect the higher rainfall in that area. These results are consistent with the results obtained for the Pasteurized Milk Network shown in Figure 11. This network is operated by the Eastern Environmental Radiation Facility in Montogmery, Alabama.

Biomonitoring Program

Objective--

The pathways for transport of radionuclides to man include air, water, and food. Monitoring of air, water, and milk are discussed above. Meat is a food component that may be a potential route of exposure to off-site residents.

Methods--

Samples of muscle, lung, liver, kidney, blood, and bone are collected periodically from cattle purchased from a commercial herd that grazes areas northeast of the NTS. These samples are analyzed for gamma emitters, tritium, strontium, and plutonium. Also, each November and December, bone and kidney samples from desert bighorn sheep collected throughout southern Nevada (see Figure 12) are donated by licensed hunters and are analyzed. These kinds of samples have been collected and analyzed for up to 27 years to determine long term trends.

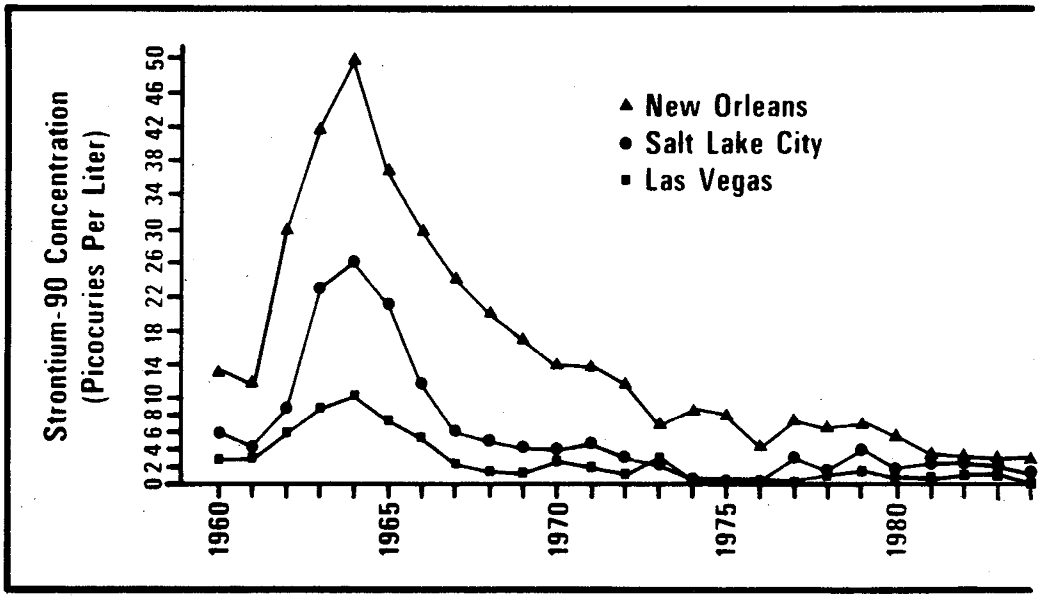

Figure 11. Strontium-90 concentration in Pasteurized Milk Network samples.

Results--

Analytical data from bones and kidneys collected from desert bighorn sheep during 1984 are presented in Table 5. Gamma-emitting radionuclides, other than the naturally occurring potassium-40, were not detected in any of the kidneys. Tritium was detected in the kidneys of two animals (500 ± 280 and 650 ± 280 pCi/l of tissue water). Strontium-90 levels in the bones (average 2.02 pCi/g ash) are consistent with the reports in recent years (Figure 13). Counting errors exceeded the reported concentrations of plutonium-238 and -239 in all samples of bone ash.

Analytical data for samples collected from eight beef cattle are presented in Table 6. These cattle grazed the Orin Nash Ranch, which is northeast of the NTS. Other than the naturally occurring potassium-40, the only gamma-emitting radionuclide detected, was cesium-137 in one muscle sample (22 ± 12 pCi/kg). Tritium was not detected in blood from any of these animals. Plutonium analysis has been completed only in the first four animals sampled. Positive values of plutonium-239 in soft tissues analyzed (muscle, lungs, and liver) ranged from 0.011 to 0.18 pCi/kg and in bone ash from 0.00 to 0.028 pCi/g of ash. Plutonium-238 was not detected. The analytical data for the October sampling will be reported in the next annual report. Strontium-90 detected in the bones averaged 2.1 pCi/g of ash which is consistent with concentrations reported in recent years (Figure 13).

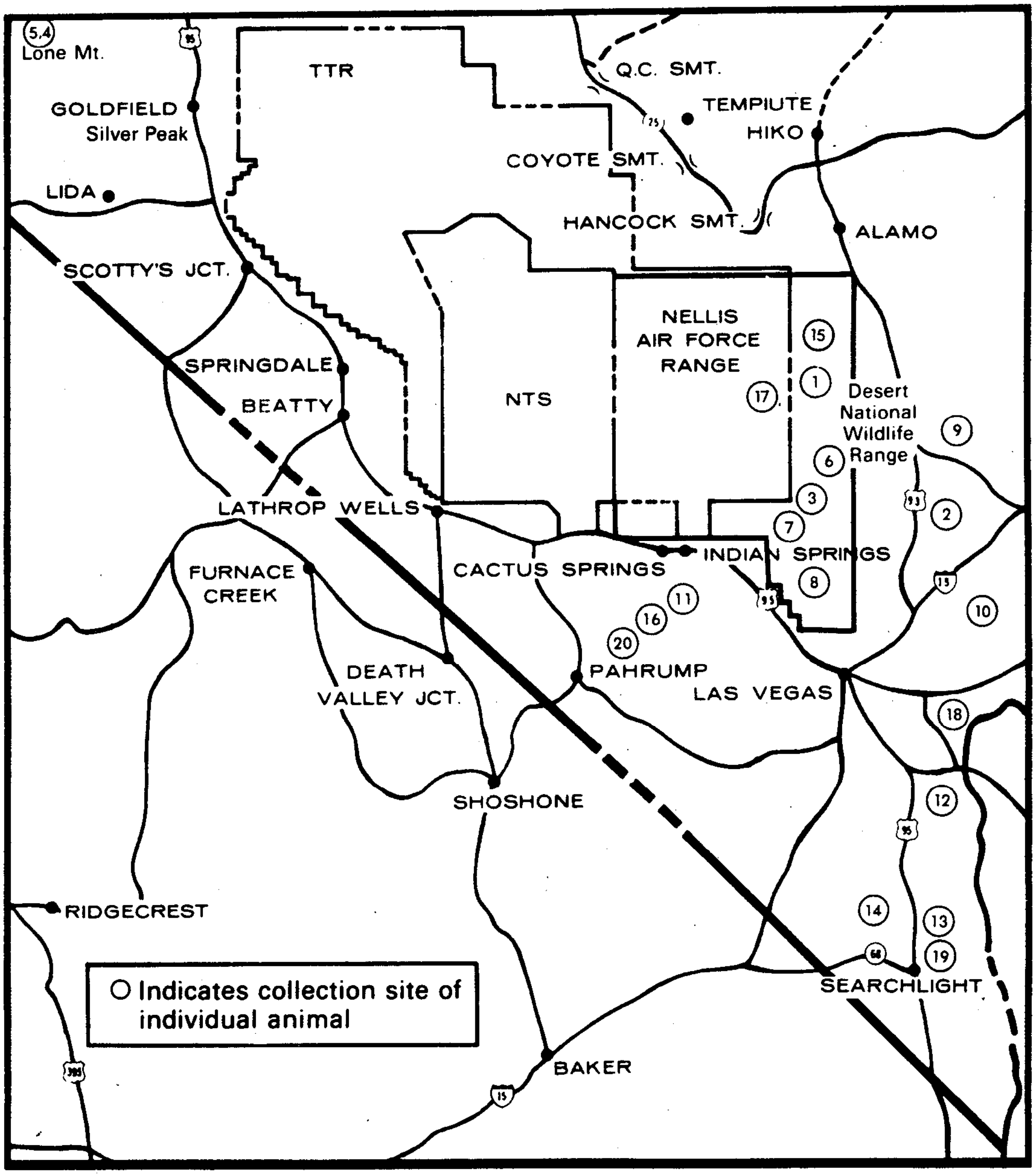

Figure 12. Collection sites for bighorn sheep samples.

TABLE 5. RADIONUCLIDE CONCENTRATIONS IN DESERT BIGHORN SHEEP SAMPLES - 1983

Bighorn Sheep (Collected Winter 1983)	Bone 90 Sr (pCi/g Ash)	Bone 238 Pu (pCi/g Ash)	Bone 239 Pu (pCi/g Ash)	Kidney K(g/kg)* 137Cs(pCi/kg)* 3H(pCi/l)‡
1	3.5 ± 0.1	0.00023**	0.00**	2.1 ± 0.3 <36 <440
2	1.4 ± 0.1	-0.00054**	-0.0006**	2.0 ± 0.4 <30 <440
3	2.4 ± 0.1	-0.0606**	0.0006**	3.8 ± 0.4 <30 650 ± 280
4	3.2 ± 0.1	0.00047**	0.00**	4.5 ± 0.7 <74 <440
5	1.8 ± 0.1	-0.00051**	-0.00025**	3.6 ± 0.4 <39 500 ± 280
6	2.2 ± 0.1	-0.00053**	-0.0011**	4.7 ± 0.8 <75 <460
7	2.1 ± 0.1	-0.0012**	0.0011**	5.0 ± 0.5 <40 <460
8	1.2 ± 0.1	-0.0007**	0.00027**	2.3 ± 0.6 <68 <460
9	2.2 ± 0.1	-0.0011**	0.00049**	2.1 ± 0.4 <29 <460
10	1.9 ± 0.1	0.00048**	-0.00044**	2.3 ± 0.4 <40 <460
11	1.5 ± 0.1	0.00023**	0.00**	2.3 ± 0.4 <36 <470

(continued)

TABLE 5. Continued

Bighorn Sheep (Collected Winter 1983)	Bone 90 Sr (pCi/g Ash)	Bone 238 Pu (pCi/g Ash)	Bone 239 Pu (pCi/g Ash)	Kidney K(g/kg)* 137Cs(pCi/kg)* 3H(pCi/l)‡
11 (duplicate)	1.8 ± 0.1	-0.0019**	0.00063**	NS
12	0.95 ± 0.1	-0.00022**	-0.00044**	4.1 ± 0.9 <85 <470
13	0.87 ± 0.1	-0.00051**	-0.001**	6.9 ± 0.8 <73 <470
14	1.1 ± 0.1	0.00**	0.00026**	NS
15	4.3 ± 0.2	0.0016**	0.005 ± 0.0035	3.8 ± 0.4 <33 <410
15 (duplicate)	3.9 ± 0.2	0.00059**	0.0013**	NS
16	2.2 ± 0.1	-0.00031**	0.00092**	2.0 ± 0.3 <32 <470
17	3.2 ± 0.2	-0.00065**	-0.00032**	2.8 ± 0.3 <24 <470
18	1.0 ± 0.1	0.0009**	-0.0018**	2.8 ± 0.4 <32 <470
18 (duplicate)	0.8 ± 0.1	-0.0019**	-0.0063**	NS
19	1.2 ± 0.1	-0.00078**	0.0012**	3.1 ± 0.5 <43 <470
20	1.8 ± 0.1	-0.0019**	0.00**	2.4 ± 0.4 <33 <470

(continued)

TABLE 5. Continued

Bighorn Sheep (Collected Winter 1983)	Bone 90 Sr (pCi/g Ash)	Bone 238 Pu (pCi/g Ash)	Bone 239 Pu (pCi/g Ash)	Kidney K(g/kg)* 137Cs(pCi/kg)* 3H(pCi/l)‡
Median	1.8	-0.0019**	0.00**	2.8 <36 <470
Range	0.8 ± 4.3	-0.00078** - 0.0016**	-0.00044** - 0.005	2.0 ± 6.9 <24 ± <85 <410 - 650

*Wet weight.
**Counting error exceeds reported activity.
‡Aqueous Portion of Kidney Tissue.
NS Not sampled.

Two reports Black and Smith (1984) and Smith and Black (1984) on radionuclide uptake studies conducted at the NTS Experimental Dairy Farm from 1963 to 1981 and the Animal Investigation Program from 1957 to 1981, respectively, were published during the year. Giles (1985) presented a paper at the Nevada Chapters of the Wildlife Society and the Society for Range Management describing the migration patterns of the NTS mule deer herd as observed during the years 1977 to 1981.

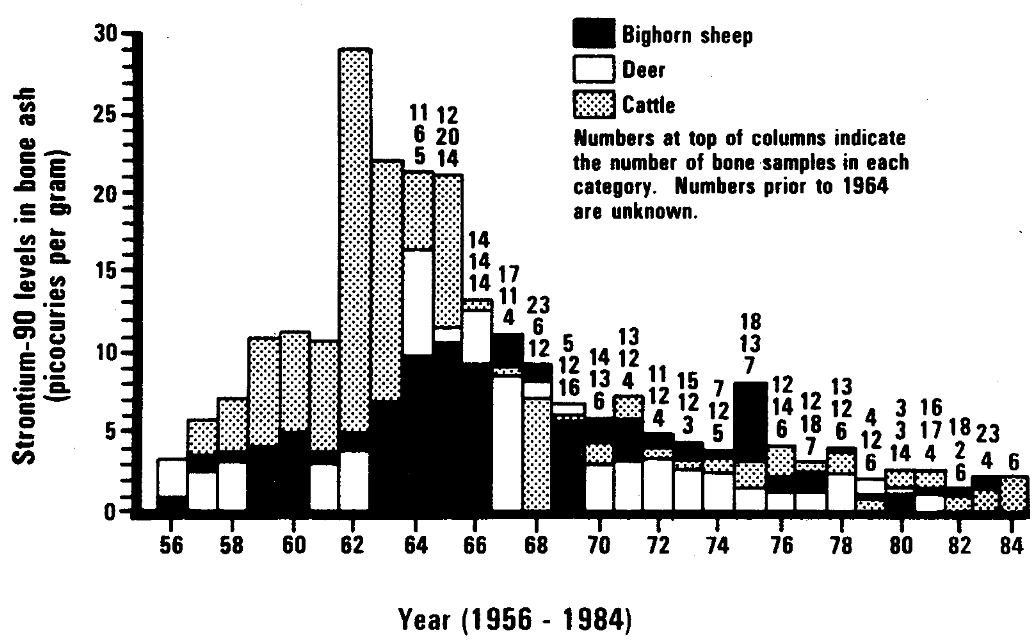

Figure 13. Average strontium-90 concentration in animal bone.

TABLE 6. RADIONUCLIDE CONCENTRATIONS IN CATTLE TISSUE SAMPLES - 1984

	MUSCLES K(g/kg*) 239Pu(pCi/kg*)	LUNGS K(g/kg*) 239Pu(pCi/kg*)	LIVER K(g/kg*) 239Pu(pCi/kg*)	BLOOD 3H(pCi/l)	BONE 90Sr(pCi/g ash) 239Pu(pCi/g ash)
MAY - 1984					
BOV-1	4.0 ± 0.3 0.020 ± 0.028**	7.1 ± 1.0 0.086 ± 0.059	4.2 ± 0.4 0.066 ± 0.041	<260	1.8 ± 0.2 0.013 ± 0.006
DUPLICATE BOV-1	NC	NC	***		1.8 ± 0.2 0.084 ± 0.005
BOV-2	3.5 ± 0.3 0.075 ± 0.03	4.7 ± 0.6 0.043 ± 0.041	4.0 ± 0.4 0.11 ± 0.051	<490	2.7 ± 0.2 0.00 ± 0.003**
DUPLICATE BOV-2	NC	NC	4.1 ± 0.4 0.086 ± 0.036		2.5 ± 0.2 0.028 ± 0.009
BOV-3	4.7 ± 0.3 0.18 ± 0.05	5.0 ± 0.5 0.066 ± 0.049	3.9 ± 0.4 0.095 ± 0.035	<490	2.2 ± 0.2 0.028 ± 0.006
BOV-4	4.2 ± 0.4 0.011 ± 0.021**	1.9 ± 0.5 0.055 ± 0.053	4.1 ± 0.3 0.023 ± 0.034**	<490	1.6 ± 0.2 0.0072 ± 0.0046
OCTOBER 1984					
BOV-5	5.7 ± 0.4 NR	5.7 ± 0.6 NR	4.5 ± 0.4 NR	<260	NR
BOV-6	3.8 ± 0.4 NR	4.8 ± 0.6 NR	4.7 ± 0.4 NR	<260	NR

(continued)

TABLE 6. (Continued)

	MUSCLES K(g/kg*) 239Pu(pCi/kg*)	LUNGS K(g/kg*) 239Pu(pCi/kg*)	LIVER K(g/kg*) 239Pu(pCi/kg*)	BLOOD 3H(pCi/l)	BONE 90Sr(pCi/g ash) 239Pu(pCi/g ash)
BOV-7	5.9 ± 0.4 NR	2.8 ± 0.6 NR	4.8 ± 0.3 NR	<260	NR
BOV-8	5.4 ± 0.4 NR	3.7 ± 0.5 NR	4.8 ± 0.3 NR	<260	NR

*Wet weight.
**Counting error exceeds reported activity.
***Lost in chemistry.
NC Not collected
NR Not reported, analysis not completed.

EXTERNAL EXPOSURE MONITORING

Thermoluminescent Dosimetry Network

External radiation exposure of people is due primarily to medical sources and to natural sources such as cosmic radiation and naturally occurring radioactivity in soil. Radioactivity from fallout generated by past atmospheric nuclear testing causes approximately 0.6 percent of a person's total exposure. Until 1965, film badges were used to document external exposure, but TLD's gradually replaced film as the measurement instrument because of their greater sensitivity and precision. From 1970 to 1974 the EMSL-LV used the TLD-12 dosimeter but changed to the TLD-200 in 1975.

Network Design--

The TLD network is designed to measure environmental radiation exposure at a location rather than to an individual because of the many uncertainties associated with personnel monitoring. Several individuals, some residing within and some residing outside of estimated fallout zones from past nuclear tests at the NTS, have been monitored so that any correlations that may exist between personnel and environmental monitoring could be obtained. The network consists of 86 monitored locations encircling the NTS with some concentration in the area of the estimated fallout zones (Figure 14). This arrangement permits an estimate of average background exposure; yet any increase due to NTS activities can be detected.

Methods--

In 1984 the TLD Network consisted of 86 stations at both inhabited and uninhabited locations within a 300-km radius of the CP-1. Each station is equipped with three Harshaw thermoluminescent dosimeters (TLD's) to measure gamma exposures resulting from environmental background as well as accidental releases of gamma-emitting radioactivity. Within the area covered by the Network, 49 off-site residents wore dosimeters during 1984. All TLD's were exchanged quarterly with personnel TLD's being changed to monthly in July.

The Harshaw Model 2271-G2 (TLD-200) dosimeter consists of two small "chips" of dysprosium-activated calcium fluoride mounted in a window of Teflon plastic attached to a small aluminum card. An energy compensation shield of 1.2-mm thick cadmium metal is placed over the card containing the chips, and the shielded card is then sealed in an opaque plastic card holder. Three of these dosimeters are placed in a secured, rugged, plastic housing 1 meter above ground level at each station to standardize the exposure geometry. One dosimeter is issued to each of 49 off-site residents who are instructed in its proper wearing.

After appropriate corrections were made for exposure accumulated during shipment between the laboratory and the monitoring location, and for the response factor, the six TLD chip readings for each station were averaged. The average value for each station was then compared to the values obtained during the previous four quarters at that station to determine whether the new value was within the range of previous background values for that station. The

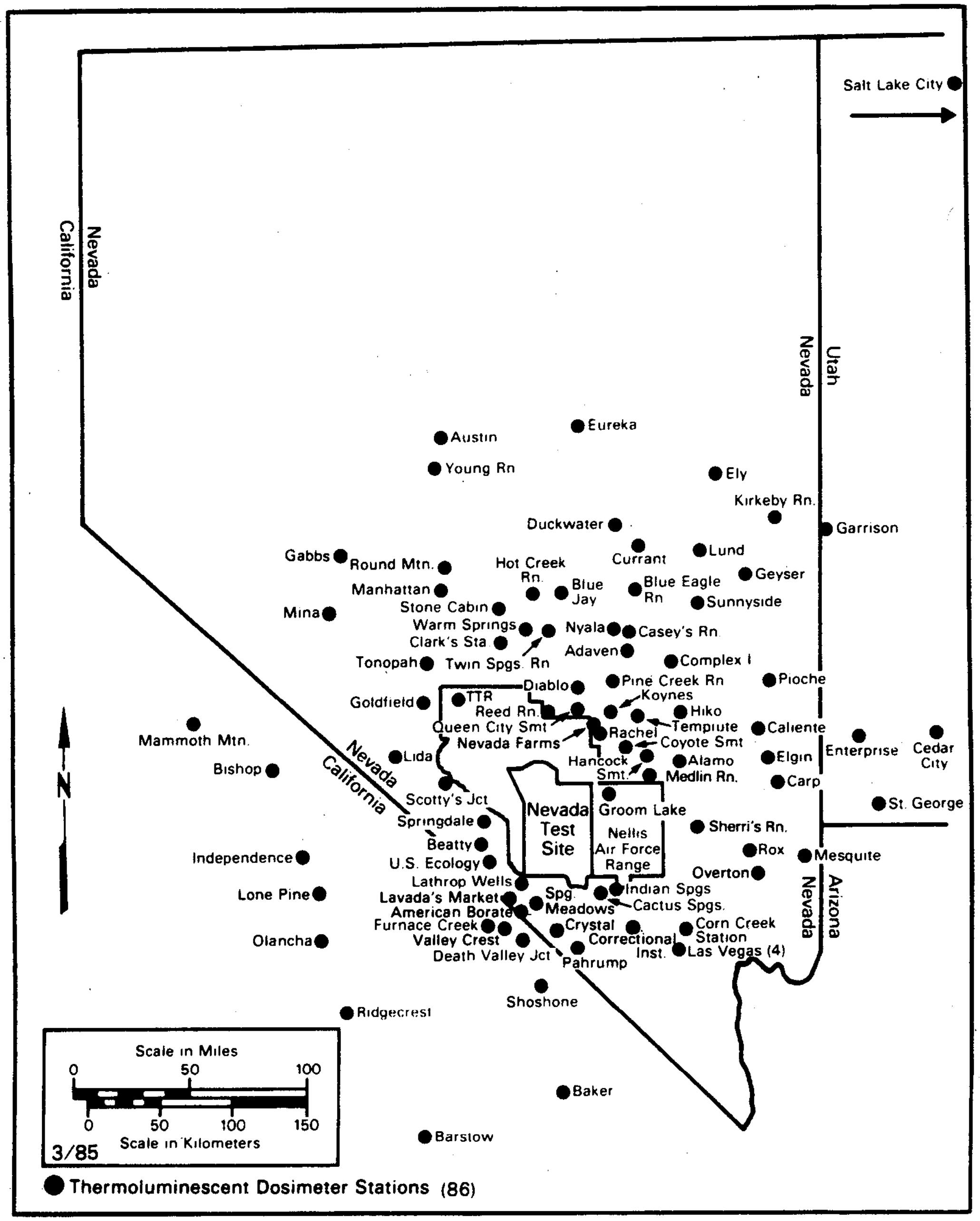

Figure 14. Locations monitored with TLD's.

result from each of the personnel dosimeters was compared to the average background value measured at the nearest fixed station over the previous four quarters.

The smallest exposure above background radiation that can be determined from these TLD readings depends primarily on the magnitude of variations in the natural background exposure rate at the particular station. In the absence of other independent exposure rate measurements, the present exposure rate is compared with valid prior measurements of natural background. Typically, the smallest net exposure detectable at the 99 percent confidence level for a 90-day exposure period would be 1 to 5 mR above background.

Depending on location, the background ranges from 15 to 35 mR per quarter. The term "background," as used in this context, refers to naturally occurring radioactivity plus a contribution from residual manmade fission products, such as worldwide fallout.

Results--

Appendix Table E-10 lists the maximum, minimum, and average dose equivalent rate (mrem/day) and the annual adjusted dose equivalent rate (average in mrem/day times the number of days in the year) measured at each station in the Network during 1984. No allowance was made for the small additional exposure due to the neutron component of the cosmic ray spectrum. No station exhibited an exposure in excess of background during 1984.

Appendix Table E-11 lists the personnel number; associated background station; the maximum, minimum, and average dose equivalent rate (mrem/d); and the annual dose equivalent (mrem) measured for each off-site resident monitored during 1984. Twelve dosimeters worn by residents exhibited exposures in excess of background. These exposures are attributed to higher background levels in the residence than at the background station location or to occupational exposure (Nos. 45, 49, 52, 57). Usually, the average dose equivalent rates of the off-site residents is lower than their background stations due to the shielding provided by their homes or places of work.

Table 7 shows that the average annual dose rate for the Dosimetry Network is consistent with the Network average established in 1975. Annual doses decreased from 1971 to 1975 with a leveling trend since 1975, except for a high bias in the 1977 results attributed to mechanical readout problems. The trend shown by the Network average is indicative of the trend exhibited by individual stations, although this average is also affected by the mix of stations at different altitudes (note Figure 15).

Because of the great range in the results, 35 to 133 mrem, an average for the whole area monitored may be inappropriate for estimating individual exposure. This would be particularly true if the exposure of a particular resident were desired. Since environmental radiation exposure can vary markedly with both altitude and the natural radioactivity in the soil, and since the altitude of the TLD station location is relatively easy to obtain, the measured dose rates for 1975 to 1984 were plotted as a function of altitude. As most of Nevada lies between 2,000 and 6,000 feet above mean sea level, this range was used and

TABLE 7. DOSIMETRY NETWORK SUMMARY FOR THE YEARS 1971 - 1984

Environmental Radiation Dose Rate (mrem/y)			
Year	Maximum	Minimum	Average
1971	250	102	160
1972	200	84	144
1973	180	80	123
1974	160	62	114
1975	140	51	94
1976	140	51	94
1977	170	60	101
1978	150	50	95
1979	140	49	92
1980	140	51	90
1981	142	40	90
1982	139	42	88
1983	140	42	87
1984	133	35	85

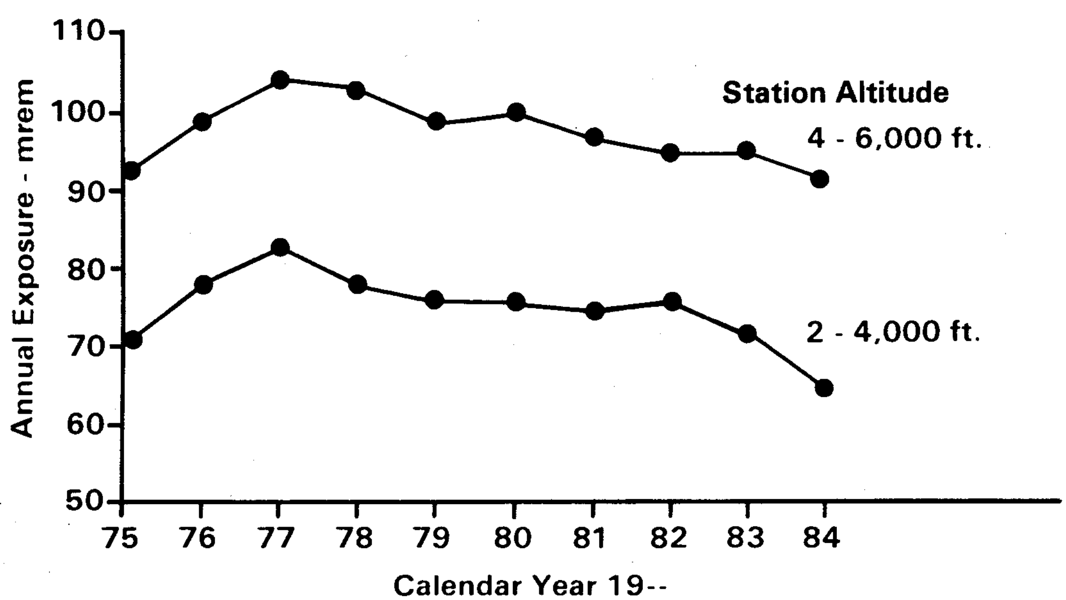

Figure 15. Average annual TLD exposure as a function of station altitude.

was split into two sections for plotting purposes. The results, shown in Figure 15, indicate that the average exposure at altitudes between 4,000 and 6,000 feet is about 20 mrem/a higher than that at altitudes between 2,000 and 4,000 feet, although both curves follow the same trend as the overall averages listed in Table 7. Thus, if an individual does not live near a monitored location, an estimate of exposure could be based on the altitude of his residence rather than on the average for the whole area monitored.

Pressurized Ion Chamber Network (PIC)

This network is located at the 15 Community Monitoring Stations identified on Figure 2 plus stations at Complex I, Furnace Creek, Nyala, Stone Cabin Ranch, Tikaboo Valley, Twin Springs, and Lathrop Wells. The PIC used is manufactured by Reuter-Stokes. The output is displayed on both a paper tape and a digital readout, so the station manager can observe the response. All data is stored on cassette tapes which are read into a computer at EMSL-LV each week. The computer output consists of a table containing hourly, daily, and weekly summaries of the maximum, minimum, average, and standard deviation of the gamma exposure rate.

The data for 1984 are displayed in Table 8 as the average μR/hr and annual mR from each station. When these data are compared to the TLD results for the same 22 stations, it is found that the PIC response is about 34% higher than the TLD response. This is attributed, primarily, to the difference in energy response (plateau) of the two instruments.

INTERNAL EXPOSURE MONITORING

Internal exposure is caused by ingested or inhaled radionuclides that remain in the body either temporarily or for longer times because of storage in tissues. At EMSL-LV two methods are used to detect such body-burdens: whole-body counting and urinalysis.

The whole-body counting facility has been maintained at EMSL-LV since 1966 and is equipped to determine the identity and quantity of gamma-emitting radioactive materials which may have been inhaled or ingested into the body. A single thallium-activated sodium iodide crystal, 28 x 10 centimeters, is used to measure gamma radiation having energies ranging from 0.1 to 2.5 MeV. Two phoswich detectors are available and can be placed on the chest to measure low-energy radiation - for example, 17 KeV X-rays from plutonium-239. The most likely mode of intake for most alpha-emitting radionuclides is inhalation, and the most important of these radionuclides also emit low-energy X-rays which can be detected in the lungs by the phoswich detectors. An additional phoswich detector is used to determine low-energy radionuclide concentrations in bone, by moving the detector around the skull.

Network Design

This activity consists of two portions, an Off-site Human Surveillance Program and a Radiological Safety Program. The design for the Off-site Human Surveillance Program is to measure radionuclide body-burdens in a representative

TABLE 8. PRESSURIZED ION CHAMBER READINGS - μR/HOUR

STATION LOCATION	MEASUREMENT PERIOD	EXPOSURE RATE (MICRO-R/H)* MAX.	MIN.	AVG.	ANNUAL ADJUSTED EXPOSURE (MR/Y)
ALAMO, NV	01/01/84-12/30/84	19.6	7.2	14.08	123
AUSTIN, NV	01/01/84-12/30/84	25.0	14.3	17.82	156
BEATTY, NV	01/01/84-12/30/84	22.2	8.2	16.13	141
CEDAR CITY, UT	01/01/84-12/30/84	15.4	8.8	10.41	91
COMPLEX 1, NV	01/03/84-12/30/84	23.4	10.0	18.38	161
ELY, NV	01/04/84-12/27/84	17.8	10.1	12.01	105
FURNACE CREEK, CA	01/01/84-12/30/84	17.6	1.0	10.21	89
GOLDFIELD, NV	01/01/84-12/30/84	20.0	11.3	14.35	126
INDIAN SPRINGS, NV	01/01/84-12/30/84	14.1	2.0	7.89	69
LAS VEGAS, NV (UNLV)	01/01/84-12/30/84	14.6	3.4	7.12	62
LATHROP WELLS, NV	01/01/84-12/30/84	19.0	9.1	13.28	116
NYALA, NV	01/01/84-12/30/84	17.7	5.8	12.58	110
OVERTON, NV	01/05/84-12/30/84	13.5	2.3	8.18	72
PAHRUMP, NV	01/01/84-12/30/84	12.8	6.7	7.71	67
RACHEL, NV	01/01/84-12/30/84	21.3	13.3	16.72	146
SALT LAKE CITY, UT	01/01/84-12/30/84	16.1	1.4	11.17	98
SHOSHONE, CA	01/01/84-12/30/84	16.8	9.7	11.19	98
ST. GEORGE, UT	01/04/84-12/30/84	13.0	7.2	8.77	77
STONE CABIN RNCH, NV	01/01/84-12/30/84	22.1	9.6	16.57	145
TIKABOO VALLEY, NV	01/01/84-12/30/84	21.3	12.8	15.75	138
TONOPAH, NV	01/01/84-12/30/84	22.3	15.2	17.58	154
TWIN SPRGS RANCH, NV	01/01/84-12/30/84	21.2	14.1	17.13	150

*The MAX and MIN values are obtained from the instantaneous readings.

number of families who reside in areas that were subjected to fallout during the early years of nuclear weapons tests. A few families who reside in areas not affected by such fallout were also selected for comparative study. The principal constraint to the program is the cooperation received from the people in the area of study.

The Radiological Safety Program portion requires all employees who may be exposed to radioactive materials in the course of their work to undergo a periodic whole-body count. Some DOE contractor employees are also included in this program.

Methods

The Off-Site Human Surveillance Program was initiated in December 1970 to determine levels of radioactive nuclides in some of the families residing in communities and ranches surrounding the Nevada Test Site. Biannual counting is performed in the spring and fall. This program started with 34 families (142 individuals). In 1984, 16 of these families (37 individuals) were still active in the program. The geographical locations of the families which participated in 1984 are shown in Figure 16.

These persons travel to the Environmental Monitoring Systems Laboratory where a whole-body count of each person is made to determine the body burden of gamma-emitting radionuclides. A urine sample is collected for analysis and a short medical history, complete blood count, thyroid profile and physical examinations are obtained on each participant at one of the visits. Results of the whole-body count are available before the families leave the facility and are discussed with the subjects. The results of the blood and urine tests are sent to the families, along with a letter of explanation from the examining physician.

In 1982, 15 new families were added to the surveillance program. These people are in charge of the community monitoring stations described in the following section. In 1984, three long-time residents in the off-site area, with their families, were added. As with the first group of families, each person receives a whole-body count, medical history, complete blood count, thyroid profile, etc.

In addition to the above off-site families, counts are performed routinely on EPA and other contractor's employees as a part of the health monitoring programs. Counts on other individuals in the general population from Las Vegas and other cities are used for comparison.

Results

During 1984, a total of 409 NaI(Tl) and 800 phoswich spectra were obtained from individuals, of which 130 were from persons participating in the Off-site Human Surveillance Program. Also, about 1,600 spectra for calibrations and background were generated. Cesium-137 is generally the only fission product detected though none was found in the persons counted this year. Body burdens of Cs-137 in the off-site population detected in previous years were similar to those in other U.S. residents from California to New York. All spectra collected in 1984 were representative of normal background for people and showed only natural potassium-40. No plutonium was detected in any of the phoswich spectra.

The concentration of tritium in urine samples from the off-site residents varied from 0 to 1,650 pCi/L with an average value of 210 pCi/L. Nearly all the concentrations measured were in the range of background levels measured in water and reflect only natural exposure. The source for the high values (Salt Lake City residents) is unknown but is not attributed to NTS activities. The tritium concentration in urines from EPA employees had a mean of 214 pCi/L and a range of 0 to 1080 pCi/L.

As reported in previous years, medical examination of the off-site families revealed a generally healthy population. In regard to the hematological examinations and thyroid profiles, no abnormal results were observed which could be attributed to past or present NTS testing operations.

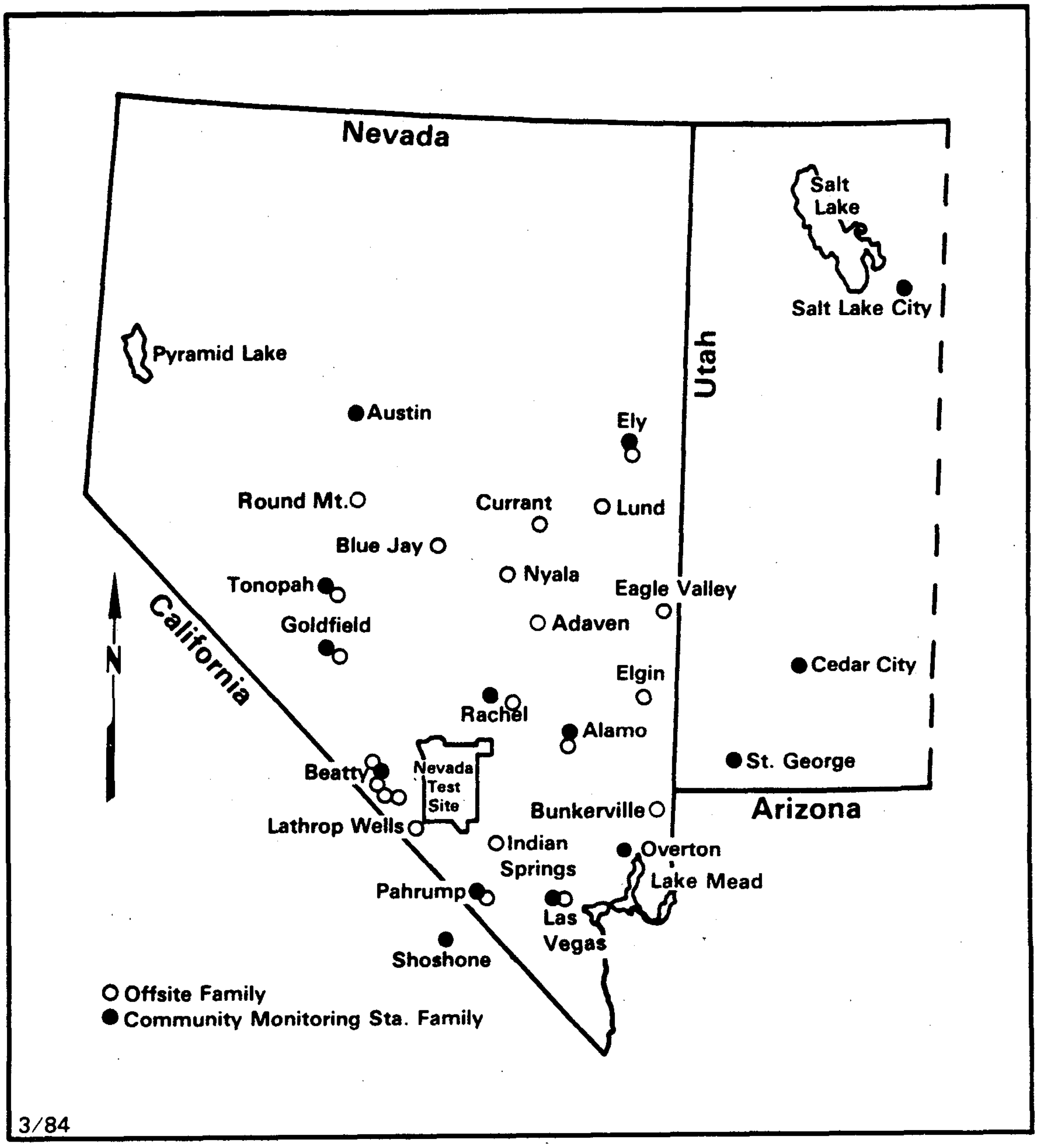

Figure 16. Location of families in the Human Surveillance Program.

COMMUNITY MONITORING STATIONS

In order to increase public knowledge about and participation in radiological surveillance activities as conducted by DOE and EPA; the DOE, through an Interagency Agreement with EPA and contracts with the Desert Research Institute (DRI) of the University of Nevada, and the University of Utah, has established a network of 15 Community Monitoring Stations in the off-NTS areas. Each station is operated by a local resident, in most cases a science teacher, who is trained in radiological surveillance methods by the University of Utah. The stations are equipped and maintained, and samples are collected and analyzed by EMSL-LV. DRI provides data interpretation to the communities involved and pays the station operators for their services.

Each station contains one of the samplers for the ASN, NGTSN and Dosimetry networks discussed earlier, plus a pressurized ion chamber (PIC) and recorder for immediate readout of external gamma exposure, and a recording barograph. All of the equipment is mounted on a stand at a convenient location in each community so the residents are aware of the surveillance and, if interested, can have ready access to the data. The station locations are those indicated in Figure 2.

The data from these stations are included in the tables in Appendix E with the other data from the appropriate networks. Table 8 contains a summary of the PIC data.

CLAIMS INVESTIGATIONS

One of the public service functions of the EMSL-LV is to investigate claims of injury allegedly due to radiation originating from NTS activities. A physician and a veterinarian, qualified by education or experience in the field of radiobiology, investigate claims of radiation injury to determine whether or not radiation exposure may be involved.

Investigation of claims from people involves determining the type of illness, from examining physicians records and diagnoses, and determining the possibility of radiation exposure through residence history and examination of historical radiation surveillance data. These investigations can be conducted by the Medical Liaison Officers Network (MLON) or by the EMSL-LV physician, depending on where the claim is made. The MLON is composed of physicians, one from each state, who are trained in radiobiology.

The EMSL-LV veterinarian conducts similar investigations for claims of injury to domestic animals. In most cases the injuries investigated have been due to common causes such as bacterial infections or unusual events such as feeding on halogeton, a poisonous plant. No such claims were made in 1984.

PUBLIC INFORMATION PROGRAM

An important function of the Off-site Program has been to create and maintain, to the extent possible, public confidence that all reasonable safeguards are being employed to preserve public health and property from possible hazards resulting from nuclear testing. Much of this responsibility is carried out through personal contact with off-site residents by the radiation monitors who advise the residents of program developments and answer questions about test activities.

For any test where ground motion may be perceptible off site, monitors visit remote locations and active mines beforehand to advise operators of possible problems. They also stand by on test day to advise of schedule changes. Mine operators are reimbursed for time lost due to these activities. After the test, monitors inform all their contacts that the test is over and whether or not any radiation was detected off site.

The series of "town hall" meetings,initiated during Fiscal Year 1982 near community monitoring stations was continued for CY 1984. The meetings were organized to familiarize the local citizenry with the NTS nuclear testing and related activities, to show how the surveillance networks function, and to answer questions or expressed concerns of the attending public. During CY84, meetings were held according to the following schedule:

January 12, 1984	Mesquite, NV	July 18, 1984	Amargosa Valley, NV
February 14, 1984	Eureka, NV	August 22, 1984	Kanab, UT
March 22, 1984	Searchlight,, NV	August 23, 1984	Fredonia, AZ
April 19, 1984	Bullhead City, AZ	October 17, 1984	Kingman, AZ
May 26, 1984	Currant, NV	November 27, 1984	Silver Peak, NV
June 13, 1984	Enterprise, UT	November 28, 1984	Bishop, CA
June 14, 1984	Milford, UT		

Other activities included arranging NTS tours for business and community leaders from Beatty, Death Valley, Amargosa Valley and Pahrump; for the Community Monitoring Station managers, and for members of the Medical Liaison Officers Network. Talks on the Off-site Program were given at Twin Springs school and to civic and professional organizations in Reno, Carson City, Tonapah and Las Vegas in June, August, October, and November. A complete Community Monitoring Station was exhibited at the Southern Arizona State Fair in Fredonia during September.

With the continued population growth in the off-site area in recent years and the continuing concern for keeping radiation exposures as low as reasonably achievable, the EMSL-LV realized that it would need local government assistance to implement all protective actions that could be needed to protect close-in population centers should an underground nuclear test accidently vent. EMSL-LV staff discussed the kinds of assistance needed with the Nevada State Division of Emergency Management, and obtained the State's concurrence with its plan to work with County emergency management officials to develop modifications or additions to their adopted emergency response plans. These changes would specify protective actions and procedures for implementing them and would serve as formal agreements on Federal and local government responsibilities and authorities.

During fiscal year 1984, an Appendix to the Radiological Defense Annex of the Lincoln County and Nye County (Nevada) emergency plans was approved by

Federal, State, and County agency officials and was signed. This Appendix is expected to serve as a model for developing similar agreements with officials of Clark, Esmeralda, and possibly White Pine counties. The County plans, with their new appendices, will be annexed to the master plan DOE is developing for off-site emergency response for an accidental venting or seepage at the Nevada Test Site.

DOSE ASSESSMENT

Dose assessment calculations for NTS-related radioactivity are not possible because detectable levels of radioactivity from the 1984 nuclear testing program at the NTS were not observed off site by any of the monitoring networks. However, an exposure can be calculated by using atmospheric dispersion and reported releases of radioactivity from the NTS (Table 1). This calculation is shown below. Residual radioactivity was observed in waters from wells in other nuclear testing areas known to be contaminated during past nuclear tests at the Project Dribble Site near Hattiesburg, Mississippi; Project Gnome near Malaga, New Mexico; and at the Project Long Shot Site on Amchitka Island, Alaska. However, the waters from these contaminated wells are not used for drinking purposes.

An estimate of exposure of an average adult in Nevada due to worldwide radioactivity can be made based on the data from the monitoring networks. The principal data are strontium-90 in milk (0.27 pCi/L) from previous atmospheric tests; krypton-85 in air (26 pCi/m^3) from power reactors and reprocessing plants; and plutonium-239 in air (24 aCi/m^3) from previous atmospheric tests.

Assumptions:
1) Breathing rate = 7,300 m^3/a
2) Water intake = 438 L/a, milk = 1/2 of water or 219 L/a
3) 8,766 hr/a

From DOE/EP-0023 Appendix B (DOE 1981a); first-year Dose Factors are:
1) Kr-85 (immersion) 2,200 mrem/hr per µCi/mL, whole body (µCi/mL = 10^{12} pCi/m^3),
2) Sr-90 (ingestion) 45 mrem/µCi intake, whole body, and
3) Pu-239 (inhalation) 48,000 mrem/µCi to lung.

Calculated annual dose:

Kr-85: $$2{,}200 \text{ mrem/hr} \times 8{,}760 \text{ hr/a} \times \frac{26 \text{ pCi/m}^3}{10^{12} \text{ pCi/m}^3} = 5.01 \times 10^{-4} \text{ mrem/a}$$

Sr-90: $45 \text{ mrem/µCi} \times 10^{-6} \text{ µCi/pCi} \times 0.27 \text{ pCi/L} \times 219 \text{ L/a} = 0.0027 \text{ mrem/a}$

Pu-239: $4.8 \times 10^{4} \text{ mrem/µCi} \times 24 \text{ aCi/m}^3 \times 10^{-12} \text{ µCi/aCi} \times 7{,}300 \text{ m}^3\text{/a} = 0.0084 \text{ mrem/a}$

The highest postulated annual dose estimate to man, from the results of the 1984 Biomonitoring Program, was calculated to be 0.58 mrem. This would result from the Pu-239 content of liver from the cattle sample if an individual ate 0.5 kg per day for the whole year and if the liver tissue had the maximum measured plutonium.

Therefore, the total maximized annual dose to an adult in Nevada from worldwide radioactivity (assuming the above conditions) as detected by EMSL-LV monitoring networks is the sum of the above amounts or 0.59 mrem. Natural radioactivity in the body (K-40, C-14, Ra-226, etc.) results in annual internal doses ranging from 26 to 36 mrem per year (FRC 1960), and the calculated internal dose is only 5.9 percent of this 10 mrem variation.

The external exposures to Nevadans range from 35 to 133 mrem/a as measured by the TLD network. In the U.S., reported external exposures range from 63 to 200 mrem/a, depending on elevation (sea coast or Rocky Mountains) and on the natural radioactivity in the soil (NCRP 1971). The exposures measured by the TLD's compare favorably with that range as the TLD station's altitude varies from 500 to over 7,000 feet above MSL and the uranium content in soil probably also varies markedly among stations.

No radioactivity released at the NTS was measured off site, therefore, the dose to the off-site population from these releases was calculated by using average weather data and atmospheric diffusion equations. Wind direction and speed data were available for a 12-year period as were 25,000 hourly observations of Pasquill stability class. Based on the releases shown in Table 1, the estimated population dose to the 8500 people within 80 km of CP-1 was 1×10^{-3} person-rem. The highest estimated dose was 2.6×10^{-4} mrem/yr to an individual living in Indian Springs, with lesser amounts to individuals in Amargosa, Beatty, Lathrop Wells, Pahrump, and Rachel. Both results were higher than last year due to an increased seepage of short-lived noble gases and to a doubling of the population in the affected area.

SECTION 6

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APPENDIX A. SITE DATA

SITE DESCRIPTION

A summary of the uses of the NTS and its immediate environs is included in Section 3 of this report. More detailed data and descriptive maps are contained in this Appendix.

Location

The NTS is located in Nye County, Nevada, with its southeast corner about 90 km northwest of Las Vegas (Figure 1 in main report). It has an area of about 3,500 square km and varies from 40 to 56 km in width (east-west) and from 64 to 88 km in length (north-south). This area consists of large basins or flats about 900 to 1,200 m above mean sea level (MSL) surrounded by mountain ranges rising 1,800 to 2,300 m above MSL.

The NTS is surrounded on three sides by exclusion areas, collectively named the Nellis Air Force Range, which provide a buffer zone between the test areas and public lands. This buffer zone varies from 24 to 104 km between the test area and land that is open to the public. Depending upon wind speed and direction, from 2 to more than 6 hours will elapse before any release of airborne radioactivity could pass over public lands.

Climate

The climate of the NTS and surrounding area is variable, due to its variations in altitude and its rugged terrain. Generally, the climate is referred to as continental arid. Throughout the year, there is insufficient water to support the growth of common food crops without irrigation.

Climate may be classified by the types of vegetation indigenous to an area. According to Houghton et al. (1975), this method of classification of dry condition, developed by Doppen, is further subdivided on the basis of temperature and severity of drought. Table A-1 (Houghton et al. 1975) summarizes the characteristics of climatic types for Nevada.

According to Quiring (1968), the NTS average annual precipitation ranges from about 10 cm at the lower elevations to around 25 cm on the higher elevations. During the winter months, the plateaus may be snow-covered for a period of several days or weeks. Snow is uncommon on the flats. Temperatures vary considerably with elevation, slope, and local air currents. The average daily high (low) temperatures at the lower altitudes are around 50F (25F) in January and 95F (55F) in July, with extremes of 110F and -15F. Corresponding temperatures on the plateaus are 35F (25F) in January and 80F (65F) in July with ex-115F have been observed.

TABLE A-1. CHARACTERISTICS OF CLIMATIC TYPES IN NEVADA (from Houghton et al. 1975)

Climate Type	Mean Temperature °C (°F) Winter	Mean Temperature °C (°F) Summer	Annual Precipitation cm (inches) Total*	Annual Precipitation cm (inches) Snowfall	Dominant Vegetation	Percent of Area
Alpine tundra	-18° to -9° (0° to 15°)	4° to 10° (40° to 50°)	38 to 114 (15 to 45)	Medium to heavy	Alpine meadows	--
Humid continental	-12° to -1° (10° to 30°)	10° to 21° (50° to 70°)	64 to 114 (25 to 45)	Heavy	Pine-fir forest	1
Subhumid continental	-12° to -1° (10° to 30°)	10° to 21° (50° to 70°)	30 to 64 (12 to 25)	Moderate	Pine or scrub woodland	15
Mid-latitude steppe	-7° to 4° (20° to 40°)	18° to 27° (65° to 80°)	15 to 38 (6 to 15)	Light to moderate	Sagebrush, grass, scrub	57
Mid-latitude desert	-7° to 4° (20° to 40°)	18° to 27° (65° to 80°)	8 to 20 (3 to 8)	Light	Greasewood, shadscale	20
Low-latitude desert	-4° to 10° (40° to 50°)	27° to 32° (80° to 90°)	5 to 25 (2 to 10)	Negligible	Creosote bush	7

*Limits of annual precipitation overlap because of variations in temperature which affect the water balance.

The wind direction, as measured on a 30 m tower at an observation station about 9 km NNW of Yucca Lake, is predominantly northerly except during the months of May through August when winds from the south-southwest predominate (Quiring 1968). Because of the prevalent mountain/valley winds in the basins, south to southwest winds predominate during daylight hours of most months. During the winter months southerly winds have only a slight edge over northerly winds for a few hours during the warmest part of the day. These wind patterns may be quite different at other locations on the NTS because of local terrain effects and differences in elevation.

Geology and Hydrology

Two major hydrologic systems shown in Figure A-1 exist on the NTS (ERDA 1977). Ground water in the northwestern part of the NTS or in the Pahute Mesa area has been reported to flow at a rate of 2 m to 180 m per year to the south and southwest toward the Ash Meadows Discharge Area in the Amargosa Desert. It is estimated that the ground water to the east of the NTS moves from north to south at a rate of not less than 2 m nor greater than 220 m per year. Carbon-14 analyses of this eastern ground water indicate that the lower velocity is nearer the true value. At Mercury Valley in the extreme southern part of the NTS, the eastern ground water flow shifts southwestward toward the Ash Meadows Discharge Area.

Land Use of NTS Environs

Figure A-2 is a map of the off-NTS area showing a wide variety of land uses, such as farming, mining, grazing, camping, fishing, and hunting within a 300-km radius of the NTS. For example, west of the NTS, elevations range from 85 m below MSL in Death Valley to 4,420 m above MSL in the Sierra Nevada Range. Parts of two major agricultural valleys (the Owens and San Joaquin) are included. The areas south of the NTS are more uniform since the Mojave Desert ecosystem (mid-latitude desert) comprises most of this portion of Nevada, California, and Arizona. The areas east of the NTS are primarily mid-latitude steppe with some of the older river valleys, such as the Virgin River Valley and Moapa Valley, supporting irrigation for small-scale but intensive farming of a variety of crops. Grazing is also common in this area, particularly to the northeast. The area north of the NTS is also mid-latitude steppe, where the major agricultural activity is grazing of cattle and sheep. Minor agriculture, primarily the growing of alfalfa hay, is found in this portion of the State within 300 km of the NTS Control Point-1 (CP-1). Many of the residents grow or have access to locally grown fruits and vegetables.

Many recreational areas, in all directions around the NTS (Figure A-2) are used for such activities as hunting, fishing, and camping. In general, the camping and fishing sites to the northwest, north, and northeast of the NTS are utilized throughout the year except for the winter months. Camping and fishing locations to the southeast, south, and southwest are utilized throughout the year. The hunting season is from September through January.

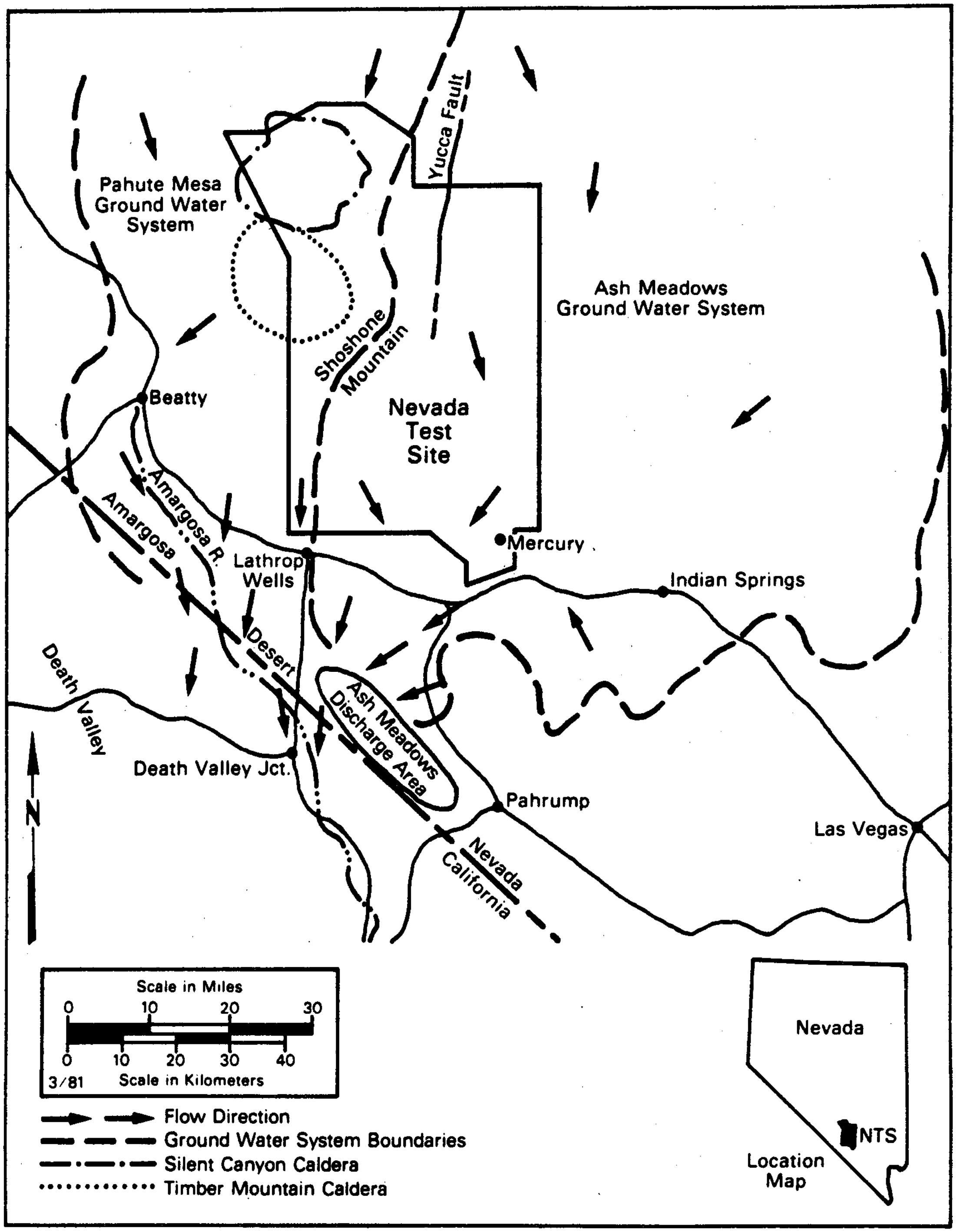

Figure A-1. Ground-water flow systems around the Nevada Test Site.

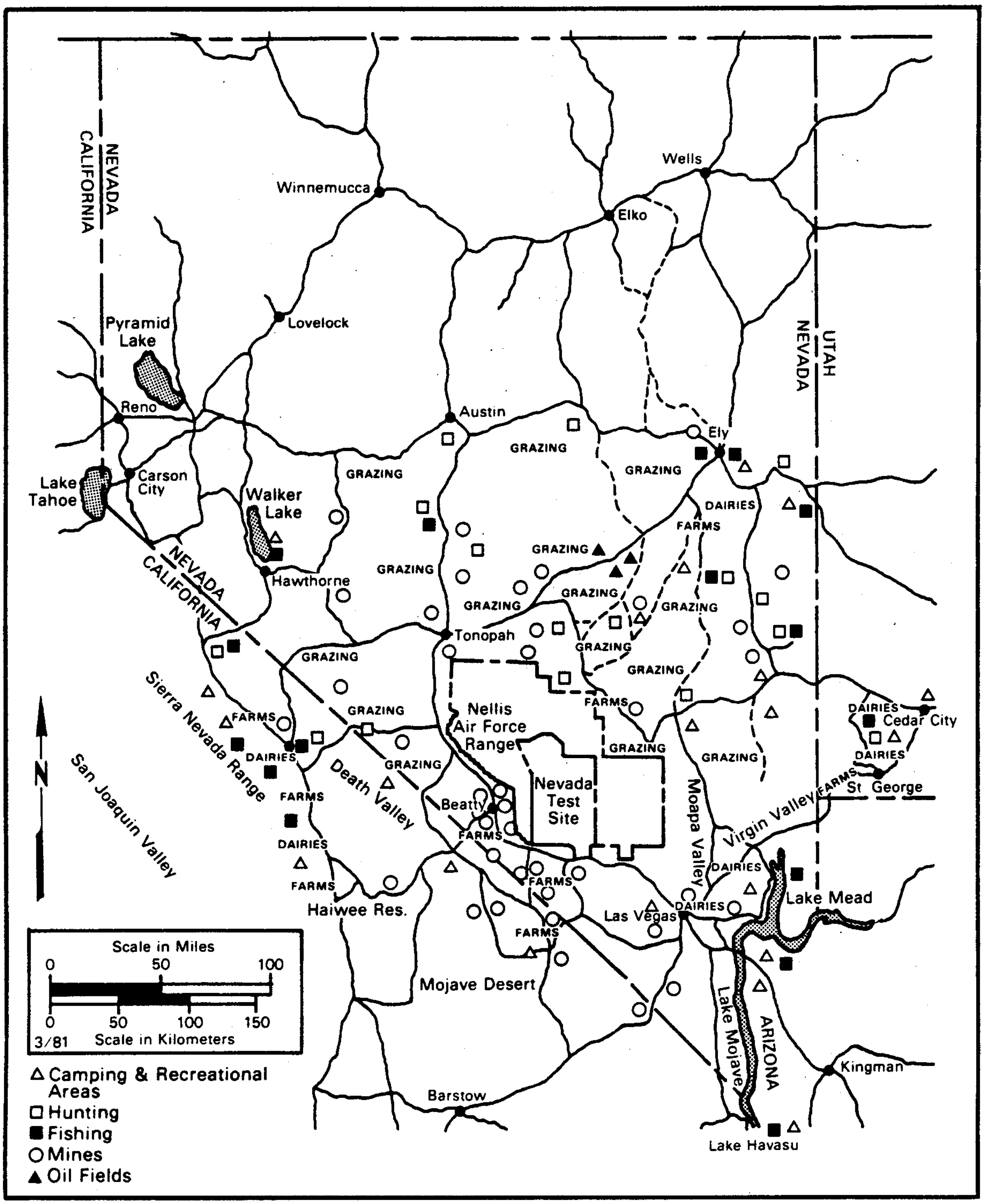

Figure A-2. General land use within 300 km of the Nevada Test Site.

Population Distribution

Figure A-3 shows the current population of counties surrounding the NTS based on 1980 census figures. Excluding Clark County, the major population center (approximately 463,000 in 1980), the population density within a 150 km radius of the NTS is about 0.5 persons per square kilometer. For comparison, the 48 contiguous states (1980 census) had a population density of approximately 29 persons per square kilometer. The estimated average population density for Nevada in 1980 was 2.8 persons per square kilometer.

The off-site area within 80 km of the NTS (the area in which the dose commitment must be determined for the purpose of this report) is predominantly rural. Several small communities are located in the area, the largest being in the Pahrump Valley. This growing rural community, with an estimated population of about 5,500, is located about 72 km south of the NTS CP-1. The Amargosa Farm Area, which has a population of about 1,500, is located about 50 km southwest of CP-1. The largest town in the near-offsite area is Beatty, which has a population of about 800 and is located approximately 65 km to the west of CP-1. A report by Smith and Coogan was published in 1984 which summarizes the population distribution within selected rural areas out to 200 kilometers from the Control Point on the NTS.

The Mojave Desert of California, which includes Death Valley National Monument, lies along the southwestern border of Nevada. The National Park Service (1980) estimates that the population within the Monument boundaries ranges from a minimum of 200 permanent residents during the summer months to as many as 5,000 tourists and campers on any particular day during the major holiday periods in the winter months, and as many as 30,000 during "Death Valley Days" in the month of November. The largest town and contiguous populated area (about 40 square miles) in the Mojave Desert is Barstow, located 265 km south-southwest of the NTS, with a 1983 population of about 36,000. The next largest populated area is the Ridgecrest-China Lake area, which has a current population of about 25,000 and is located about 190 km southwest of the NTS. The Owens Valley, where numerous small towns are located, lies about 50 km west of Death Valley. The largest town in Owens Valley is Bishop, located 225 km west-northwest of the NTS, with a population of about 5,300 including contiguous populated areas.

The extreme southwestern region of Utah is more developed than the adjacent part of Nevada. The largest community is St. George, located 220 km east of the NTS, with a population of 11,300. The next largest town, Cedar City, with a population of 10,900, is located 280 km east northeast of the NTS.

The extreme northwestern region of Arizona is mostly range land except for that portion in the Lake Mead Recreation Area. In addition, several small communities lie along the Colorado River. The largest town in the area is Kingman, located 280 km southeast of the NTS, with a population of about 9,300. Figures A-4 through A-7 show the domestic animal populations in the counties near the NTS.

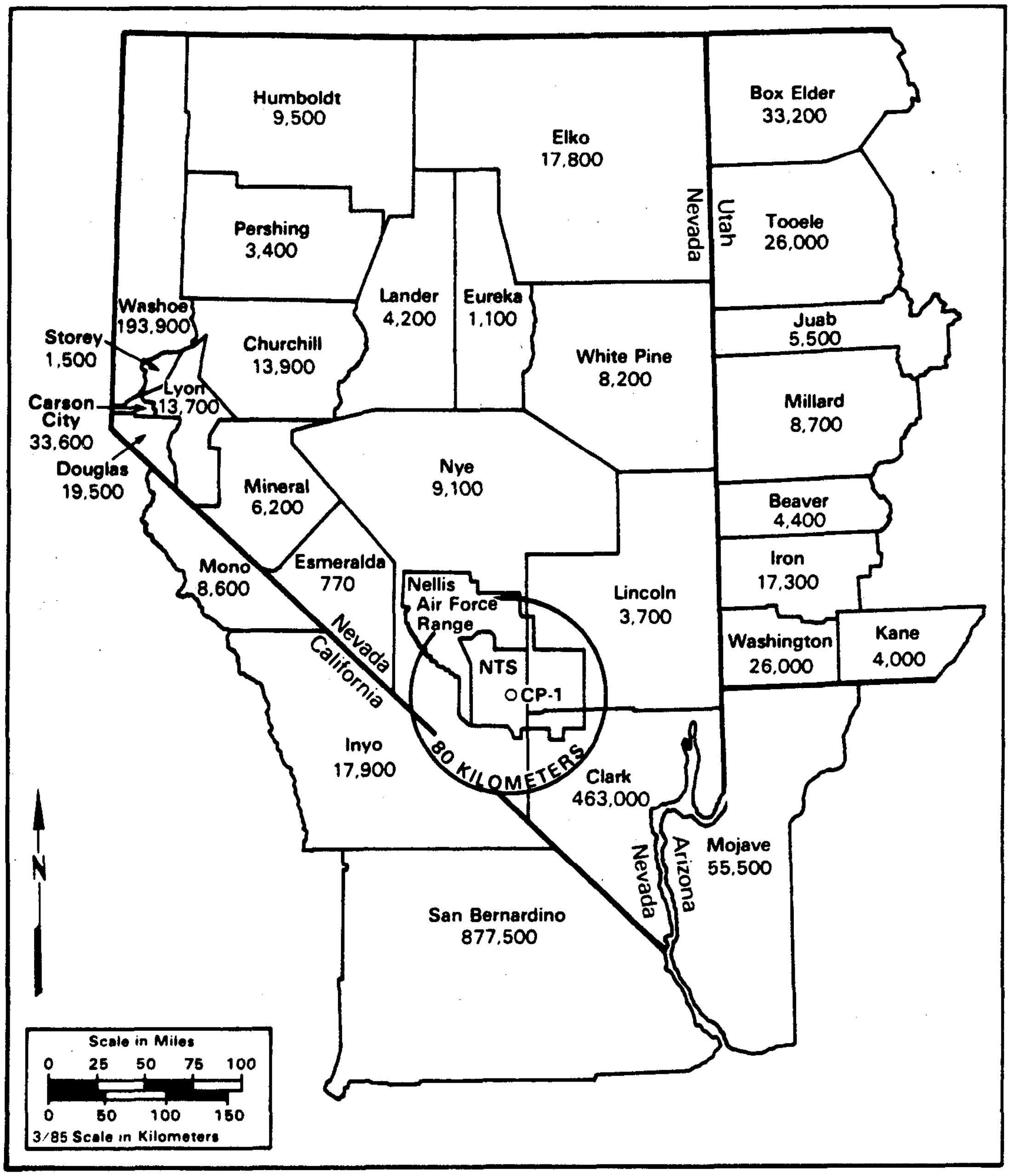

Figure A-3. Population of Arizona, California, Nevada, and Utah counties near the Nevada Test site (1980).

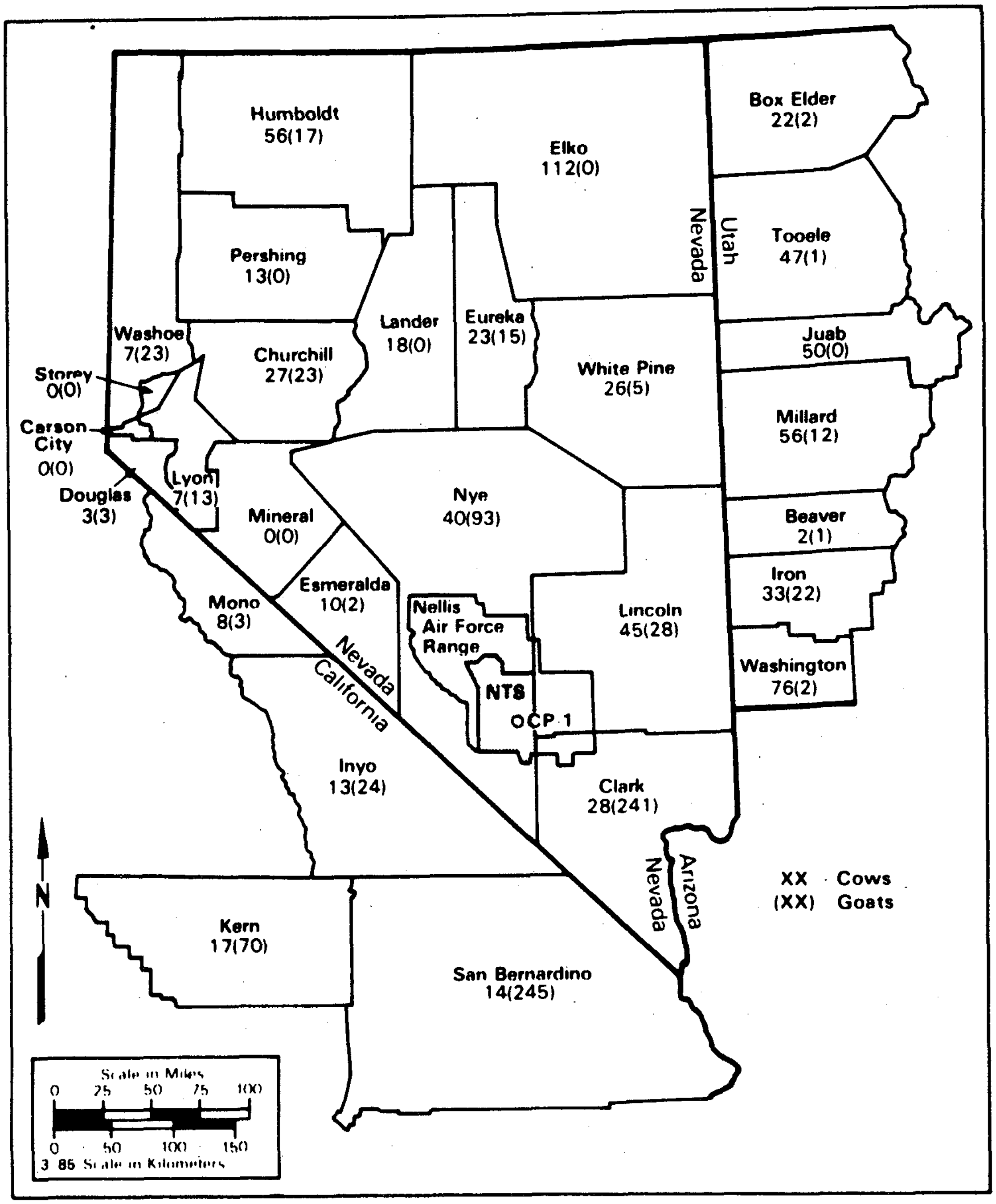

Figure A-4. Distribution of family milk cows and goats, by county (1984).

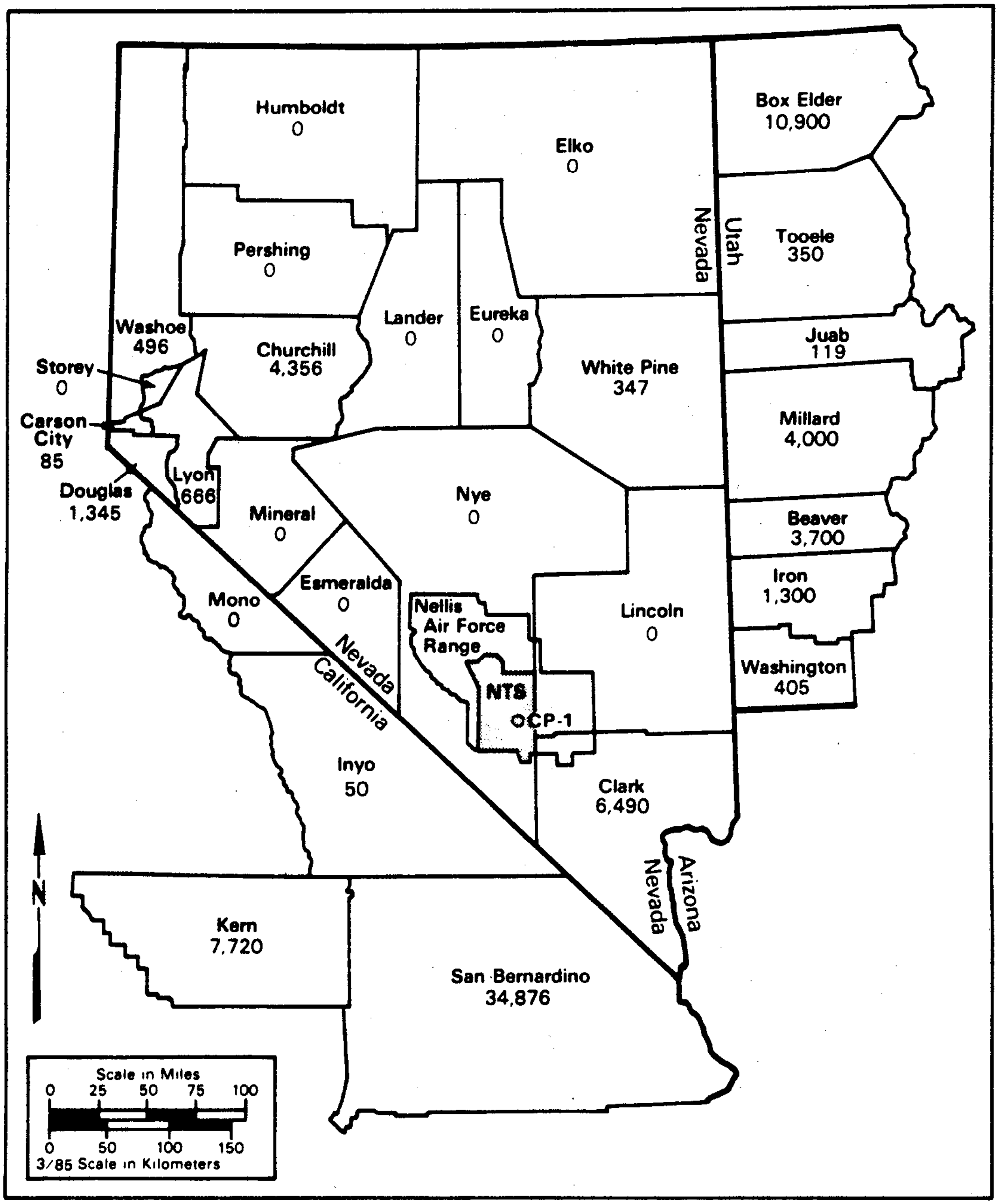

Figure A-5. Distribution of dairy cows, by county (1984).

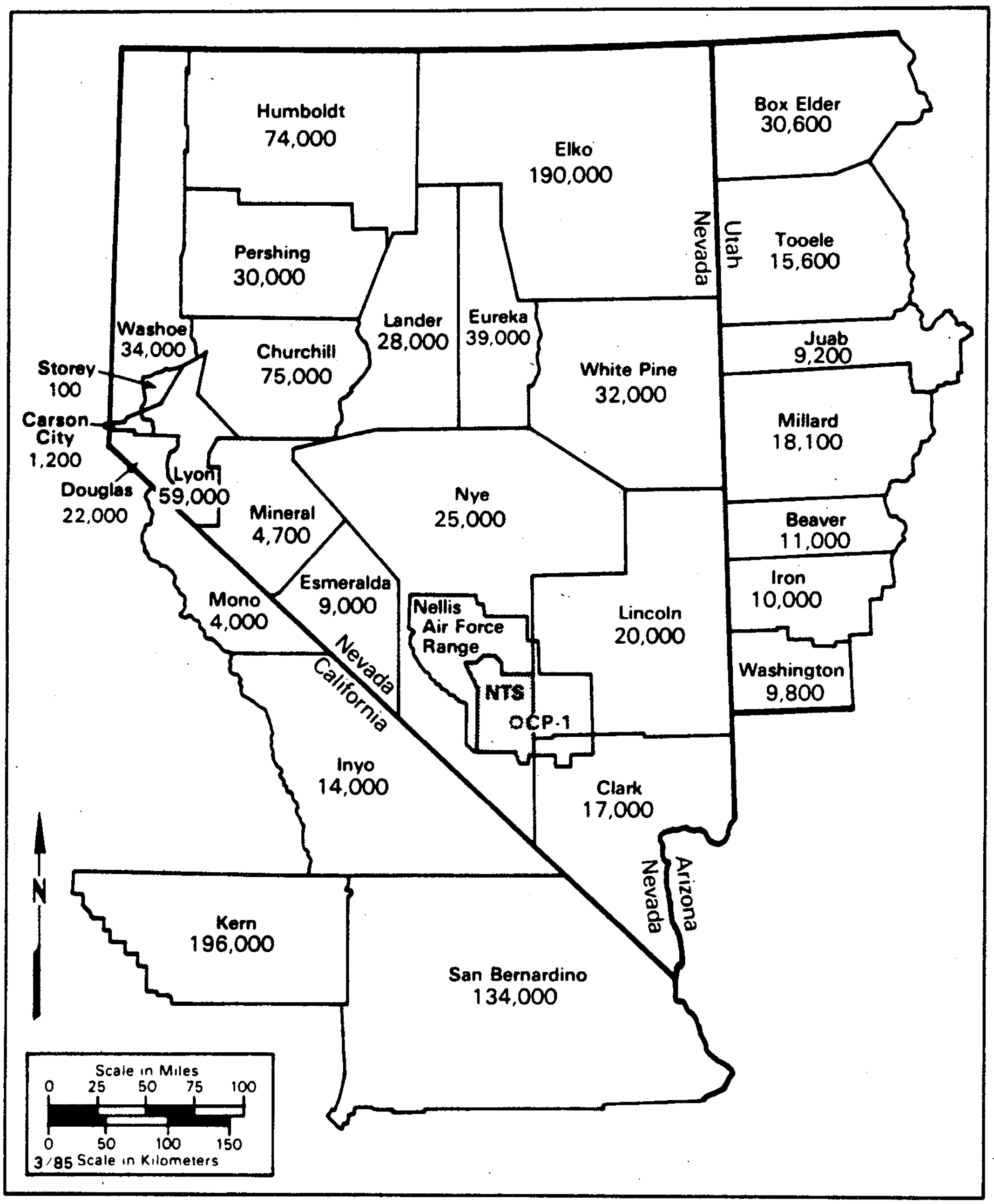

Figure A-6. Distribution of beef cattle, by county, 1984.

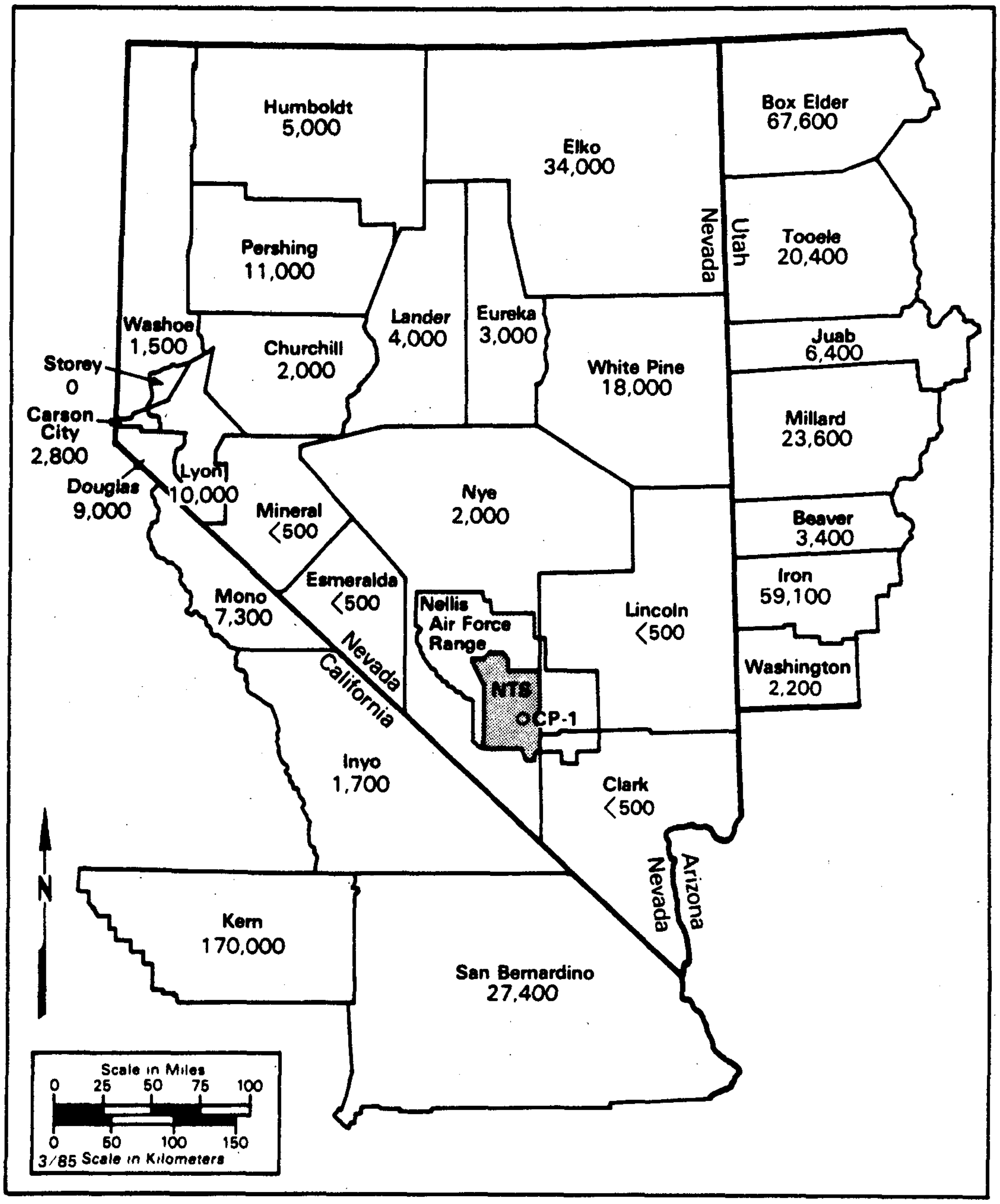

Figure A-7. Distribution of sheep, by county, 1984.

APPENDIX B. SAMPLE ANALYSIS PROCEDURES

ANALYTICAL PROCEDURES

The procedures for analyzing samples collected for offsite surveillance are described by Johns et al. in "Radiochemical Analytical Procedures for Analyses of Environmental Samples" (EMSL-LV-0539-17, 1979) and are summarized in Table B-1.

TABLE B-1. SUMMARY OF ANALYTICAL PROCEDURES

Type of Analysis	Analytical Equipment	Counting Period (min)	Analytical Procedures	Sample Size	Approximate Detection Limit*
IG Ge(Li) Gamma Spectrometry**	IG or Ge(Li) detector calibrated at 0.5 keV/channel (0.04 to 2 MeV range) individual detector efficiencies ranging from 15% to 35%.	Air charcoal cartridges and individual air filters, 30 min; air filter composites, 1200 min. 100 min for milk, water, suspended solids.	Radionuclide concentration quantified from gamma spectral data by on-line computer program. Radionuclides in air filter composite samples are identified only.	120-300 m^3 for air filters; and charcoal cartridges; 3-1/2 liters for milk and water.	For routine milk and water generally, 5 pCi/L for most common fallout radionuclides in a simple spectrum. Filters for LTHMP suspended solids, 6 pCi/L. Air filters and charcoal cartridges, 0.04 pCi/m^3.
Gross beta on air filters	Low-level end window, gas flow proportional counter with a 12.7 cm diameter window (80 $\mu g/cm^2$)	30	Samples are counted after decay of naturally-occuring radionuclides and, if necessary, extrapolated to midpoint of collection in accordance with $t^{-1.2}$ decay or an experimentally-derived decay.	120-300 m^3	0.5 pCi/sample.

(continued)

TABLE B-1. (Continued)

Type of Analysis	Analytical Equipment	Counting Period (min)	Analytical Procedures	Sample Size	Approximate Detection Limit*
Sr-89-90	Low-background thin-window, gas-flow proportional counter.	50	Chemical separation by ion exchange. Separated sample counted successively; activity calculated by simultaneous solution of equations.	1.0 liter for milk or water. 0.1-1 kg for tissue.	Sr-89 = 5 pCi/L Sr-90 = 2 pCi/L.
H-3	Automatic liquid scintillation counter with output printer.	200	Sample prepared by distillation.	4 ml for water	400 pCi/L.
H-3 Enrichment (Long-Term Hydrological Samples)	Automatic scintillation counter with output printer.	200	Sample concentrated by electrolysis followed by distillation.	250 ml for water	10 pCi/L.
Pu-238,239	Alpha spectrometer with 450 mm, 300-μm depletion depth, silicon surface barrier detectors operated in vacuum chambers.	1000-1400	Water sample or acid-digested filter or tissue samples separated by ion exchange, electro-plated on stainless steel planchet.	1.0 liter for water; 0.1-1 kg for tissue; 5,000-10,000 m^3 for air.	Pu-238 = 0.08 pCi/L Pu-239 = 0.04 pCi/L for water. For tissue samples, 0.04 pCi per total sample for all isotopes; 5-10 aCi/m^3 for plutonium on air filters.
Kr-85, Xe-133, Xe-135	Automatic liquid scintillation counter with output printer.	200	Separation by gas chromatography; disolved in toluene "cocktail" for counting	0.4-1.0 m^3 for air	Kr-85, Xe-133, Xe-135 = 4 pCi/m^3.

*The detection limit is defined as 3.29 sigma where sigma equals the counting error of the sample and Type I error = Type II error = 5 percent. (J. P. Corley, D. H. Denham, R. E. Jaquish, D. E. Michels, A. R. Olsen, D. A. Waite, A Guide for Environmental Radiological Surveillance at U.S. Dept. of Energy Installations, July 1981, Office of Operational Safety Report DOE/EP-0023, U.S. DOE, Washington, D. C.)

**Gamma Spectrometry using either an intrinsic germanium (IG), or lithium-drifted germanium diode (Ge(Li)) detector.

APPENDIX C. QUALITY ASSURANCE PROCEDURES

PRECISION OF ANALYSIS

The duplicate sampling program was initiated for the purpose of routinely assessing the errors due to sampling, analysis, and counting of samples obtained from the surveillance networks maintained by the EMSL-LV.

The program consists of the analysis of duplicate or replicate samples from the ASN, the NGTSN, the LTHMP, and the Dosimetry Network. As the radioactivity concentration in samples collected from the LTHMP and the MSN are below detection levels, most duplicate samples for these networks are prepared from spiked solutions. The NGTSN samples are generally split for analysis.

At least 30 duplicate samples from each network are normally collected and analyzed over the report period. Since three TLD cards consisting of two TLD chips each are used at each station of the Dosimetry Network, no additional samples were necessary. Table C-1 summarizes the sampling information for each surveillance network.

To estimate the precision of a methodology, the standard deviation of replicate results is needed. Thus, for example, the variance, s^2, of each set

TABLE C-1. SAMPLES AND ANALYSES FOR DUPLICATE SAMPLING PROGRAM, 1984

Surveillance Network	Number of Sampling Locations	Samples Collected This Year	Sets of Duplicate Samples Collected	Number Per Set	Sample Analysis
ASN	114	4,533	469	2	Gross beta, γ Spectrometry
NGTSN	16	835 (NG) 833 (H3)	27 32	2	Kr-85, H-3, H_2O, HTO
Dosimetry	86	344	344	4-6	Effective dose from gamma
MSN	31	98	25	2	K-40, Sr-89, Sr-90
LTHMP	134	254	125	2	H-3

of replicate TLD results (n=6) was estimated from the results by the standard expression,

$$s^2 = \sum_{i=1}^{k} (x_i - \overline{x})^2 / (k - 1)$$

where k = number of sets of replicates.

Since duplicate samples were collected for all other sample types, the variances, s^2, for these types were calculated from $s^2 = (0.886R)^2$, where R is the absolute difference between the duplicate sample results. For small sample sizes, this estimate of the variance is statistically efficient* and certainly more convenient to calculate than the standard expression. The standard deviation is obtained by taking the square root.

The principle that the variances of random samples collected from a normal population follow a chi-square distribution (χ^2) was then used to estimate the expected population standard deviation for each type of sample analysis. The expression used is as follows:**

$$s = \left[\sum_{i=1}^{k} (n_i - 1)s_i^2 / \sum_{i=1}^{k} (n_i - 1) \right]^{1/2}$$

where n_i-1 = the degrees of freedom for n samples collected for the ith replicate sample

s_i^2 = the expected variance of the ith replicate sample

s = the best estimate of sample standard deviation derived from the variance estimates of all replicate samples (the expected value of s^2 is σ^2).

For expressing the precision of measurement in common units, the coefficient of variation ($s/\overline{x}$) was calculated for each sample type. These are displayed in Table C-2 for those analyses for which there were adequate data.

To estimate the precision of counting, approximately 10 percent of all samples are counted a second time. These are unknown to the analyst. Since all such replicate counting gave results within the counting error, the precision data in Table C-2 represents errors principally in analysis.

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*Snedecor, G. W., and W. G. Cochran. Statistical Methods. The Iowa State University Press, Ames, Iowa. 6th Ed. 1967. pp. 39-47.
**Freund, J. E. Mathematical Statistics. Prentice Hall, Englewood, New Jersey. 1962. pp 189-235.

TABLE C-2. SAMPLING AND ANALYTICAL PRECISION - 1984

Surveillance Network	Analysis	Sets of Replicate Samples Evaluated	Coefficient of Variation (%)
ASN	Gross β	39	55
	Be-7 (1982)	9	37
NGTSN	Kr-85	26	15
	HTO	*	26
	H_2O	29	24
Dosimetry	(TLD)	344	4.1
MSN	K-40	55	11
	Sr-89	33	11
	Sr-90	34	16
LTHMP	H-3	41	9.7
	H-3	56	19

*Estimate of precision was calculated from the errors in the H-3 conventional analysis and the measurement of atmospheric moisture (H_2O).

ACCURACY OF ANALYSIS

Data from the analysis of intercomparison samples are statistically analyzed and compared to known values and values obtained from other participating laboratories. A summary of the statistical analysis is given in Table C-3, which compares the mean of three replicate analyses with the known value. The normalized deviation is a measure of the accuracy of the analysis when compared to the known concentration. The determination of this parameter is explained in detail separately (Jarvis and Siu). If the value of this parameter (in multiples of standard normal deviate, unitless) lies between control limits of -3 and +3, the precision or accuracy of the analysis is within normal statistical variation. However, if the parameters exceed these limits, one must suspect that there is some cause other than normal statistical variations that contributed to the difference between the measured values and the known value. As shown by this table, all analyses were within the control limit.

To measure the performance of the contractor laboratory for analysis of animal tissues, a known amount of activity was added to several samples. The reported activity is compared to the known amount in Table C-4. The average bias for Sr-90 was -22 percent and for Pu-239 was -19 percent.

TABLE C-3. QUALITY ASSURANCE INTERCOMPARISON RESULTS - 1984

Analysis	Month	Mean of Replicate Analyses (pCi/L)	Known Value (pCi/L)	Normalized Deviation from: Known Conc.
H-3 in water	Feb	2333	2383	-0.2
	Apr	2389	3508	-0.6
	Jun	2917	3081	-0.6
	Aug	2746	2817	-0.3
	Oct	2640	2810	-0.8
	Dec	3022	3182	-0.8
H-3 in urine	Mar	3927	4496	-2.6
	Jun	2183	2319	-0.7
	Nov	2011	2012	0.0
Cr-51 in water	Feb	41	40	0.5
	Jun	<60	66	---
	Oct	<40	40	---
Co-60 in water	Feb	9	10	-0.2
	Jun	30	31	-0.5
	Oct*	19	20	-0.2
	Oct*	16	14	0.6
Zn-65 in water	Feb	49	50	-0.5
	Jun	59	63	-1.4
	Oct	147	147	-0.1
Ru-106 in water	Feb	44	61	-6.0
	Jun	32	29	1.2
	Oct	45	47	-0.8
I-131 in water	Apr	<10	6	---
	Aug	34	34	-0.1
	Dec.	36	36	-0.1
Cs-134 in water	Feb	25	31	-2.0
	Jun	43	47	-1.4
	Oct*	31	31	0.0
	Oct*	<3	2	---
Cs-137 in water	Feb	15	16	-0.3
	Jun	35	37	-0.8
	Oct*	24	24	-0.1
	Oct*	15	14	0.2

(continued)

TABLE C-3. (Continued)

Analysis	Month	Mean of Replicate Analyses (pCi/L)	Known Value (pCi/L)	Normalized Deviation from: Known Conc.
Sr-89 in milk	June	25	25	0.0
	Oct	23	22	0.3
Sr-90 in milk	June	17	17	0.0
	Oct	16	16	0.0
I-131 in milk	June	Not reported - excessive decay		
	Oct	41	42	0.3
Cs-137 in milk	June	33	35	-0.7
	Oct	32	32	0.0
Cs-137 in air filters (pCi/filter)	Aug	10	15	-1.8
	Nov	7	10	-0.9

*In October 1984, two intercomparison studies were conducted for Co-60, Cs-134, and Cs-137 in water.

QUALITY ASSURANCE-DOSIMETRY

Radioanalytical counting systems and TLD systems are calibrated using radionuclide standards that are traceable to the National Bureau of Standards (NBS). These standards are obtained from the Quality Assurance Division at EMSL-LV or from NBS. Each standard source used for TLD calibrations is periodically checked for accuracy in accordance with procedures traceable to NBS.

To determine accuracy of the data obtained from the TLD systems, dosimeters are submitted to the international intercomparison of environmental dosimeters. Dosimeters were submitted to the Sixth International Intercomparison in July 1981 (Table C-5). All TLD measurements are performed in conformance with standards proposed by the American National Standards Institute (ANSI 1975).

TABLE C-4. QUALITY ASSURANCE RESULTS FOR THE BIOENVIRONMENTAL PROGRAM - 1984

Sample Type and Shipment Number	Nuclide	Activity Added pCi/g Bone Ash	Activity Reported pCi/g Bone Ash	% Bias+ or Precision‡
		Spiked Samples		
Bone Ash				
Ash 24	239Pu	0.20	0.13	-35
52	90Sr	9.76	8.97	-25
Ash 25	239Pu	0	0.00024**	-
52	90Sr	0	1.6	-
Ash 26	239Pu	0.19	0.14	-26
52	90Sr	9.1	8.9	-21
Ash 27	239Pu	0	0.00029**	-
52	90Sr	0	1.6	-
Ash 7	239Pu	0.13	0.11	-15
55	90Sr	1.2	2.8	-12
Ash 8	239Pu	0	0.00037**	-
55	90Sr	0	1.7	-
Ash 9	239Pu	0.13	0.13	0
55	90Sr	1.2	2.5	-31
Ash 10	239Pu	0	0.003**	-
55	90Sr	0	1.98	-
Duplicate Samples				
Bov 11 Bone	90Sr	0	1.5	-0.16
Bov 11 Bone	90Sr	0	1.8	
BHS 15 Bone	90Sr	0	4.3	0.086
BHS 15 Bone Dup	90Sr	0	3.9	
BHS 18 Bone	90Sr	0	1.0	0.19
BHS 18 Bone Dup	90Sr	0	0.8	
BOV 1 Bone	239Pu	0	0.013	-1.3
	90Sr	0	1.8	0
BOV 1 Bone Dup	239Pu	0	0.084	
	90Sr	0	1.8	
BOV 2 Bone	239Pu	0	0.00	-1.7
	90Sr	0	2.7	0.07
BOV 2 Bone Dup	239Pu	0	0.02	
	90Sr	0	2.5	

+ Bias (B) = Recovery -1; where recovery is $\frac{x_1}{u}$

and x_1 = net activity reported
u = activity added

‡ Precision $(C_v) = 2\left(\frac{x_1 - x_2}{x_1 + x_2}\right) \times \frac{1}{1.128}$ where x_1 = first value, x_2 = second value

**Counting error exceeds reported activity

TABLE C-5. SUMMARY RESULTS OF THE SIXTH INTERNATIONAL INTERCOMPARISON OF ENVIRONMENTAL DOSIMETERS

Quantity	Mean	Standard Deviation	Comments
Summary of Laboratory Results (mR):			
EMSL-LV Dosimeters	146	11	EMSL-LV results 2% lower than all dosimeters and 8% lower than the calculated exposure.
All Dosimeters	149	21	
Calculated Exposure	158	8	
Summary of Field (Pre-irradiated) Results (mR):			
EMSL-LV Dosimeters	191	14	EMSL-LV results 0% lower than all dosimeters and 5% lower than the calculated exposure.
All Dosimeters	191	30	
Calculated Exposure	202	10	
Summary of Field Results (mR):			
EMSL-LV Dosimeters	43.1	3.2	EMSL-LV results 4.2% lower than all dosimeters and 0.9% lower than the calculated exposure.
All Dosimeters	45.0	16.4	
Calculated Exposure	43.5	2.2	

APPENDIX D. RADIATION PROTECTION STANDARDS FOR EXTERNAL AND INTERNAL EXPOSURE

DOE ANNUAL DOSE COMMITMENT

The annual dose commitment tabulated below is from "Basic Radiation Protection Criteria" in NCRP Report No. 39.

Type of Exposure	Dose Limit to Individuals in Uncontrolled Area at Points of Maximum Probable Exposure (rem)	Dose Limit to Suitable Sample of the Exposed Population in an Uncontrolled Area (rem)
Whole body, gonads, or bone marrow	0.5	0.17
Other organs	1.5	0.5

DOE CONCENTRATION GUIDES

The concentration guides (CG's) in Table D-1 are from the DOE Order 5480.1, Chapter XI, "Requirements for Radiation Protection." All values are annual average concentrations. The Concentration Guides are based on a suitable sample of the exposed population in an uncontrolled area. The final column lists the Minimum Detectable Concentration from Appendix B as a percent of the CG.

EPA CONCENTRATION GUIDE

In 1976 the Environmental Protection Agency published concentration guides for drinking water (Part 141, CFR 40, Amended) which included 20,000 pCi/L for tritium. This concentration would result in 4 mrem/a to an individual from continuous exposure.

TABLE D-1. DOE CONCENTRATION GUIDES

Network or Program	Sampling Medium	Radio-nuclide	CG	MDC as % of CG
			(pCi/m^3)	
Air Surveillance Network	air	Be-7	1.3×10^4	3.1×10^{-4}
		Zr-95	3.3×10^2	1.2×10^{-2}
		Nb-95	1.0×10^3	4.0×10^{-3}
		Mo-99	2.3×10^3	1.7×10^{-3}
		Ru-103	1.0×10^3	4.0×10^{-3}
		I-131	3.3×10^1	1.2×10^{-1}
		Te-132	1.3×10^3	3.1×10^{-3}
		Cs-137	1.7×10^2	2.4×10^{-2}
		Ba-140	3.3×10^2	1.2×10^{-2}
		La-140	1.3×10^3	3.1×10^{-3}
		Ce-141	1.7×10^3	2.4×10^{-3}
		Ce-144	6.7×10^1	6.0×10^{-2}
		Pu-239	2.0×10^{-2}	5.0×10^{-2}
Noble Gas and Tritium Surveillance Network	air	Kr-85	1.0×10^5	4.0×10^{-3}
		H-3	6.7×10^4	6.0×10^{-1}
		Xe-133	1.0×10^5	4.0×10^{-3}
		Xe-135	3.3×10^4	1.2×10^{-2}
			(pCi/L)	
Long-Term Hydrological Program	water	H-3	1.0×10^6	1.0×10^{-3}
		Sr-89	1.0×10^3	5.0×10^{-1}
		Sr-90	1.0×10^2	2.0×10^{-0}
		Cs-137	6.7×10^3	1.5×10^{-1}
		Ra-226	1.0×10^1	
		U-234	1.3×10^3	
		U-235	1.3×10^3	
		U-238*	2.0×10^2	
		Pu-238	1.7×10^3	4.7×10^{-3}
		Pu-239	1.7×10^3	2.4×10^{-3}
Milk Surveillance Networks	milk	H-3	1.0×10^6	1.0×10^{-3}
		Cs-137	6.7×10^3	1.5×10^{-1}
		Sr-89	1.0×10^3	5.0×10^{-1}
		Sr-90	1.0×10^2	2.0×10^{-0}

*Concentration based on chemical toxicity.

APPENDIX E. DATA SUMMARY FOR THE MONITORING NETWORKS

TABLE E-1. SUMMARY OF ANALYTICAL RESULTS FOR AIR SURVEILLANCE NETWORK CONTINUOUSLY OPERATING STATIONS - 1984

SAMPLING LOCATION	NO. DAYS DETECTED /SAMPLED	RADIO- NUCLIDE	RADIOACTIVITY CONC. (PCI/M3) MAX	MIN	AVG*
DEATH VALLEY JCT, CA	13.0/367.0	7BE	0.75	0.31	0.018
FURNACE CREEK, CA	26.9/364.5	7BE	0.60	0.25	0.029
SHOSHONE, CA	21.7/319.5	7BE	0.43	0.16	0.020
ALAMO, NV	15.0/362.5	7BE	0.59	0.43	0.021
AUSTIN, NV	7.2/349.4	7BE	0.29	0.29	0.0060
BEATTY, NV	4.0/345.9	7BE	0.58	0.48	0.0061
STONE CABIN RANCH, NV	12.9/342.6	7BE	0.98	0.44	0.024
CURRANT, NV - BLUE EAGLE RANCH	5.0/360.4	7BE	0.81	0.47	0.0084
GOLDFIELD, NV	7.9/364.2	7BE	0.64	0.39	0.011
GROOM LAKE, NV	21.7/317.1	7BE	0.58	0.29	0.028
HIKO, NV	5.0/363.2	7BE	0.36	0.33	0.0048
INDIAN SPRINGS, NV	11.7/362.7	7BE	0.89	0.29	0.018
LAS VEGAS, NV	8.5/357.0	7BE	0.54	0.33	0.010
LATHROP WELLS, NV	15.9/350.9	7BE	0.81	0.33	0.021
OVERTON, NV	16.9/356.9	7BE	0.90	0.21	0.021
PAHRUMP, NV	21.0/353.1	7BE	0.71	0.37	0.029

(continued)

TABLE E-1. Continued

SAMPLING LOCATION	NO. DAYS DETECTED /SAMPLED	RADIO-NUCLIDE	RADIOACTIVITY CONC. (PCI/M3) MAX	MIN	AVG*
SCOTTY'S JCT, NV	11.0/365.3	7BE	0.58	0.25	0.014
SUNNYSIDE, NV	5.0/363.9	7BE	0.55	0.53	0.0074
RACHEL, NV - ROBINSON TRAILER	9.0/344.5	7BE	0.69	0.20	0.012
TONOPAH, NV	2.0/365.9	7BE	0.62	0.62	0.0033
TTR, NV	42.4/360.1	7BE	0.52	0.19	0.039
FALLINI'S (TWIN SPGS) RANCH, NV	4.0/360.6	7BE	0.79	0.44	0.0068
CEDAR CITY, UT	8.0/349.3	7BE	0.92	0.55	0.015
DELTA, UT	3.7/199.1	7BE	0.48	0.48	0.0088
MILFORD, UT	24.7/303.9	7BE	0.50	0.13	0.017
ST GEORGE, UT	15.0/336.3	7BE	0.61	0.27	0.022
SALT LAKE CITY, UT	53.1/355.3	7BE	0.57	0.22	0.043

*AVG MEANS TIME-WEIGHTED AVERAGE OVER TOTAL SAMPLING TIME.

THE FOLLOWING STATIONS HAD NEGLIGIBLE GAMMA-SPECTRA:

ELY, NV
NYALA, NV

TABLE E-2. SUMMARY OF ANALYTICAL RESULTS FOR AIR SURVEILLANCE NETWORK STANDBY STATIONS - OPERATED 1 OR 2 WEEKS PER QUARTER - 1984

SAMPLING LOCATION	NO. DAYS DETECTED /SAMPLED	RADIO-NUCLIDE	RADIOACTIVITY CONC. (PCI/M3) MAX	MIN	AVG
KINGMAN, AZ	2.0/28.1	7BE	0.48	0.48	0.034
INDIO, CA	3.0/20.8	7BE	0.39	0.39	0.055
CLAYTON, MO	2.0/28.0	7BE	0.56	0.56	0.040
LUND, NV	3.0/27.2	7BE	0.69	0.69	0.076
RENO, NV	2.0/28.1	7BE	0.45	0.45	0.031
MEDFORD, OR	3.1/20.7	7BE	0.50	0.50	0.076
BRYCE CANYON, UT	2.0/28.9	7BE	0.77	0.77	0.054

THE FOLLOWING STATIONS HAD NEGLIGIBLE GAMMA-SPECTRA:

GLOBE, AZ
TUCSON, AZ
WINSLOW, AZ
YUMA, AZ
LITTLE ROCK, AR
ALTURAS, CA
BAKER, CA
BISHOP, CA
CHICO, CA
LONE PINE, CA
NEEDLES, CA
RIDGECREST, CA
SANTA ROSA, CA
CORTEZ, CO
DENVER, CO
GRAND JUNCTION, CO
MOUNTAIN HOME, ID
NAMPA, ID
POCATELLO, ID
FORT DODGE, IA
IOWA CITY, IA
DODGE CITY, KS
MONROE, LA

MINNEAPOLIS, MN
JOPLIN, MO
GREAT FALLS, MT
KALISPELL, MT
MILES CITY, MT
NORTH PLATTE, NE
BATTLE MOUNTAIN, NV
BLUE JAY, NV
CALIENTE, NV
CURRANT, NV - ANGLE WORM RANCH
CURRIE, NV
ELKO, NV
EUREKA, NV
FALLON, NV
FRENCHMAN STATION, NV
GEYSER RANCH, NV
LOVELOCK, NV
MESQUITE, NV
PIOCHE, NV
ROUND MOUNTAIN, NV
WARM SPRINGS, NV
WELLS, NV
WINNEMUCCA, NV

ALBUQUERQUE, NM
CARLSBAD, NM
SHIPROCK, NM
BISMARK, ND
FARGO, ND
WILLISTON, ND
MUSKOGEE, OK
BURNS, OR
RAPID CITY, SD
AMARILLO, TX
AUSTIN, TX
MIDLAND, TX
TYLER, TX
ENTERPRISE, UT
GARRISON, UT
LOGAN, UT
PAROWAN, UT
VERNAL, UT
WENDOVER,UT
SEATTLE, WA
SPOKANE, WA
ROCK SPRINGS, WY
WORLAND, WY

TABLE E-3. SUMMARY OF GROSS BETA ANALYSES FOR AIR SURVEILLANCE NETWORK - 1984

SAMPLING LOCATION	NO. DAYS SAMPLED	RADIOACTIVITY CONC. (PCI/M3) MAX	MIN	AVG
SHOSHONE, CA	324.7	0.035	-0.0032	0.013
LAS VEGAS, NV	353.9	0.027	-0.011	0.011
DELTA, UT	199.1	0.064	0.0016	0.014
MILFORD, UT	303.9	0.040	-0.0042	0.012
ST GEORGE, UT	331.3	0.032	0.0	0.013

TABLE E-4. PLUTONIUM-239 CONCENTRATION IN COMPOSITED AIR SAMPLES* - 1984

Sampling Location	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Annual Average
WINSLOW, AZ	25.2	25.2	-11.9**	29.1	16.9
BISHOP, CA	--	153	--	22.5	87.5
MT HOME, ID	31.6	31.6	--	--	31.6
IOWA CITY, IA	9.28	11.5	711***	--	210
MONROE, LA	5.62**	6.78**	7.65**	--	6.8**
JOPLIN, MO	7.05**	7.05**	--	47**	17.6**
LAS VEGAS, NV	-0.6**	5.6**	14.4	9.0**	5.4**
LATHROP WELLS, NV	24.4	34.4**	58.9	5.55**	31.2
RACHEL, NV	42.8	42.1	3.54**	14.2**	25.6
ALBUQUERQUE/CARLSBAD, NM	494	438	42.7	2.81**	256
MUSKOGEE, OK	0**	0**	305	3.63**	94.1
MEDFORD/BURNS, OR	3.14**	3.51**	2.68**	15.0**	4.7**
RAPID CITY, SD	5.93**	5.77**	67.7**	19.8**	24.9**
AUSTIN, TX	1.26**	1.26**	47.1**	--	16.2**
VERNAL, UT	11.0**	--	67.6	4.27**	30.4
SALT LAKE CITY, UT	41.5	38.5	5.39**	-3.95**	24.6
SEATTLE/SPOKANE, WA	-1.47**	-1.47**	70.7	0**	17.1**
WORLAND, WY	0**	0**	-19.8**	--	0**

*All data expressed in aCi/m^3.
**Result is less than 2 x counting error. MDC varied from 10 to 50 aCi/m^3.
***Insufficient sample, concentration is inaccurate.

TABLE E-5. SUMMARY OF ANALYTICAL RESULTS FOR THE NOBLE GAS AND TRITIUM SURVEILLANCE NETWORK - 1984

SAMPLING LOCATION	NO. SAMPLES POSITIVE/ NEGATIVE	RADIONUCLIDE	RADIOACTIVITY CONC. (PCI/M3)* MAX	MIN	AVG	PERCENT CONC. GUIDE±
SHOSHONE, CA	47/6	85KR	38	18	26	0.03
	41/12	133XE	27	-9.3	5.3	<0.01
	52/0	3H IN ATM. M.*	0.40	-0.22	0.043	-
	52/0	3H AS HTO IN AIR	2.5	-1.4	0.31	<0.01
ALAMO, NV	44/7	85KR	34	21	28	0.03
	43/8	133XE	37	-6.6	7.7	<0.01
	52/0	3H IN ATM. M.*	0.40	-0.28	0.055	-
	52/0	3H AS HTO IN AIR	4.5	-1.3	0.43	<0.01
ALAMO, (SHERRI'S) NV	1/0	85KR	33	33	33	0.03
	1/0	133XE	6.8	6.8	6.8	<0.01
AUSTIN, NV	50/2	85KR	34	20	27	0.03
	45/7	133XE	32	-14	5.5	<0.01
	52/0	3H IN ATM. M.*	0.46	-0.34	0.021	-
	52/0	3H AS HTO IN AIR	2.5	-1.6	0.15	<0.01
BEATTY, NV	46/5	85KR	34	19	26	0.03
	39/12	133XE	31	-19	6.0	<0.01
	51/1	3H IN ATM. M.*	0.30	-0.19	0.064	-
	51/1	3H AS HTO IN AIR	2.1	-1.7	0.34	<0.01
ELY, NV	48/4	85KR	34	19	26	0.03
	42/10	133XE	23	-13	4.9	<0.01
	49/2	3H IN ATM. M.*	0.50	-0.25	0.061	-
	49/2	3H AS HTO IN AIR	2.3	-1.3	0.40	<0.01
GOLDFIELD, NV	48/4	85KR	40	18	28	0.03
	43/9	133XE	30	-14	5.2	<0.01
	51/0	3H IN ATM. M.*	0.43	-0.25	0.021	-
	51/0	3H AS HTO IN AIR	2.3	-2.3	0.063	<0.01
INDIAN SPRINGS, NV	46/6	85KR	34	20	25	0.03
	41/11	133XE	33	-19	5.3	<0.01
	53/0	3H IN ATM. M.*	0.45	-0.25	0.052	-
	53/0	3H AS HTO IN AIR	4.1	-0.96	0.30	<0.01
LAS VEGAS, NV	47/6	85KR	35	19	27	0.03
	43/10	133XE	35	-7.9	6.5	<0.01
	50/3	3H IN ATM. M.*	0.67	-0.16	0.079	-
	50/3	3H AS HTO IN AIR	3.3	-1.1	0.45	<0.01

(continued)

TABLE E-5. Continued

SAMPLING LOCATION	NO. SAMPLES POSITIVE/ NEGATIVE	RADIONUCLIDE	RADIOACTIVITY CONC. (PCI/M3)* MAX	MIN	AVG	PERCENT CONC. GUIDE±
LATHROP WELLS, NV	49/3	85KR	36	20	26	0.03
	43/9	133XE	51	-21	7.1	<0.01
	50/2	3H IN ATM. M.*	0.37	-0.22	0.077	-
	50/2	3H AS HTO IN AIR	4.0	-1.1	0.46	<0.01
OVERTON, NV	42/12	85KR	35	19	26	0.03
	39/15	133XE	20	-18	5.8	<0.01
	48/4	3H IN ATM. M.*	0.48	-0.28	0.015	-
	48/4	3H AS HTO IN AIR	4.3	-1.6	0.13	<0.01
PAHRUMP, NV	45/8	85KR	34	18	27	0.03
	41/12	133XE	29	-16	5.9	<0.01
	52/1	3H IN ATM. M.*	0.45	-0.21	0.052	-
	52/1	3H AS HTO IN AIR	2.4	-2.4	0.22	<0.01
RACHEL, NV	48/4	85KR	32	21	26	0.03
	47/5	133XE	38	-16	6.2	<0.01
	50/2	3H IN ATM. M.*	0.44	-0.33	0.050	-
	50/2	3H AS HTO IN AIR	3.0	-1.4	0.33	<0.01
TONOPAH, NV	48/4	85KR	34	18	26	0.03
	43/9	133XE	41	-11	6.5	<0.01
	52/0	3H IN ATM. M.*	0.48	-0.25	0.026	-
	52/0	3H AS HTO IN AIR	2.3	-1.6	0.14	<0.01
CEDAR CITY, UT	49/4	85KR	34	18	26	0.03
	46/7	133XE	33	-58	5.7	<0.01
	50/2	3H IN ATM. M.*	0.29	-0.35	0.0074	-
	50/2	3H AS HTO IN AIR	1.9	-2.3	0.056	<0.01
ST GEORGE, UT	41/11	85KR	33	19	26	0.03
	39/13	133XE	31	-8.8	5.7	<0.01
	52/1	3H IN ATM. M.*	0.35	-0.28	0.038	-
	52/1	3H AS HTO IN AIR	4.0	-2.4	0.29	<0.01
SALT LAKE CITY, UT	38/12	85KR	35	20	29	0.03
	32/18	133XE	60	-9.8	12	0.01
	39/12	3H IN ATM. M.*	0.36	-0.26	0.068	-
	39/12	3H AS HTO IN AIR	3.6	-2.0	0.56	<0.01

* CONCENTRATIONS OF TRITIUM IN ATMOSPHERIC MOISTURE (ATM. M.) ARE EXPRESSED AS PCI PER ML OF WATER COLLECTED.

± CONCENTRATION GUIDES USED ARE FOR EXPOSURE TO A SUITABLE SAMPLE OF THE POPULATION IN AN UNCONTROLLED AREA.

TABLE E-6. SUMMARY OF TRITIUM RESULTS FOR THE NTS MONTHLY LONG-TERM HYDROLOGICAL MONITORING PROGRAM - 1984

SAMPLING LOCATION	NO. SAMPLES	TRITIUM CONCENTRATION (PCI/L) MAX	MIN	AVG	PERCENT CONC. GUIDE
WELL 2	12	5.1	-1.9	1.4	<0.01
WELL 3	12	8.3	-1.3	4.6	<0.01
WELL 4	12	15	-2.3	3.0	<0.01
WELL 4 CP-1	5	0.0	-6.0	-2.4	<0.01
WELL 5C	12	6.7	-8.5	-0.54	<0.01
WELL 8	12	4.8	-6.6	0.65	<0.01
WELL A	12	20	0.0	3.8	<0.01
TEST WELL B	11	190	5.6	150	0.02
WELL C	12	34	19	27	<0.01
WELL J-13	12	2.9	-14	-0.77	<0.01
WELL U19C	8	2.0	-49	-6.6	<0.01
WELL UE7NS	8	4600	990	2200	0.2
WELL ARMY 1	12	3.3	-6.1	-1.2	<0.01

TABLE E-7. TRITIUM RESULTS FOR THE LONG-TERM HYDROLOGICAL MONITORING PROGRAM - 1984

SAMPLING LOCATION	COLLECTION DATE 1984	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
SHOSHONE, CA			
SHOSHONE SPRING	01/11	-100 ± 180*	<0.01
ADAVEN SPRING, NV	10/01	59 ± 130*	<0.3
ALAMO, NV			
CITY WELL 4	09/06	65 ± 120*	<0.3
ASH MEADOWS, NV			
CRYSTAL POOL	01/16	5.6 ± 5.2*	<0.03
	06/27	-58 ± 120*	<0.01
FAIRBANKS SPRINGS	01/16	25 ± 18	0.1
	08/08	2.9 ± 4.5*	<0.01
WELL 17S-50E-14CAC	01/16	4.1 ± 5.2*	<0.02
	06/28	NC	
	08/08	2.0 ± 4.2*	<0.01
WELL 18S-51E-7DB	01/16	7.1 ± 5.0*	<0.01
	06/27	-53 ± 120*	<0.01
BEATTY, NV			
CITY SUPPLY 12S-47E-7DB	01/17	2.6 ± 5.4*	<0.01
	08/07	7.5 ± 4.0	0.04
COFFERS WELL 11S/48/1DD	01/17	0.25 ± 7.9*	<0.01
	06/26	-100 ± 120*	<0.01
USECOLOGY	01/03	-0.22 ± 4.7*	<0.01
BOULDER CITY, NV			
LAKE MEAD INTAKE	01/16	170 ± 8	0.9
	08/13	62 ± 5	0.3
	09/04	220 ± 110	1
CLARK STATION, NV			
TTR WELL 6	10/04	200 ± 110	1
HIKO, NV			
CRYSTAL SPRINGS	09/06	77 ± 120*	<0.4

(continued)

TABLE E-7. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
INDIAN SPRINGS, NV			
SEWER CO. INC. WELL 1	01/16	9.9 ± 4.9	0.05
USAF WELL 2	01/16	14 ± 5	0.07
LAS VEGAS, NV			
WELL 28	01/22	-17 ± 180*	<0.01
LATHROP WELLS, NV			
CITY 15S-50E-18CDC	01/17	10 ± 5	0.5
NTS, NV			
WELL 5B	01/09	1.7 ± 7.6*	<0.01
	07/18	-0.99 ± 5.9*	<0.01
	08/06	4.7 ± 4.6*	<0.02
WELL C-1	01/10	11 ± 8	0.05
	07/18	11 ± 5	0.05
	08/07	15 ± 4	0.08
TEST WELL D	01/18	0.33 ± 7.5*	<0.01
	07/19	5.2 ± 5.6*	<0.03
	08/08	-59 ± 110*	<0.01
WELL U3CN-5	07/05	NC	
	08/06	NC	
WELL U16D	01/10	3.9 ± 7.5*	<0.01
	07/18	-2.2 ± 5.5*	<0.01
WELL UE1C	01/18	0.92 ± 7.5*	<0.01
	07/19	4.1 ± 5.8*	<0.02
	08/08	-51 ± 110*	<0.01
WELL UE5C	01/09	3.7 ± 7.7*	<0.02
	07/18	1.0 ± 5.6*	<0.01
	08/06	0 ± 4.5*	<0.01
WELL UE15D	01/10	63 ± 7	0.3
	07/13	4.1 ± 6.0*	<0.02
	08/07	29 ± 4	0.1

(continued)

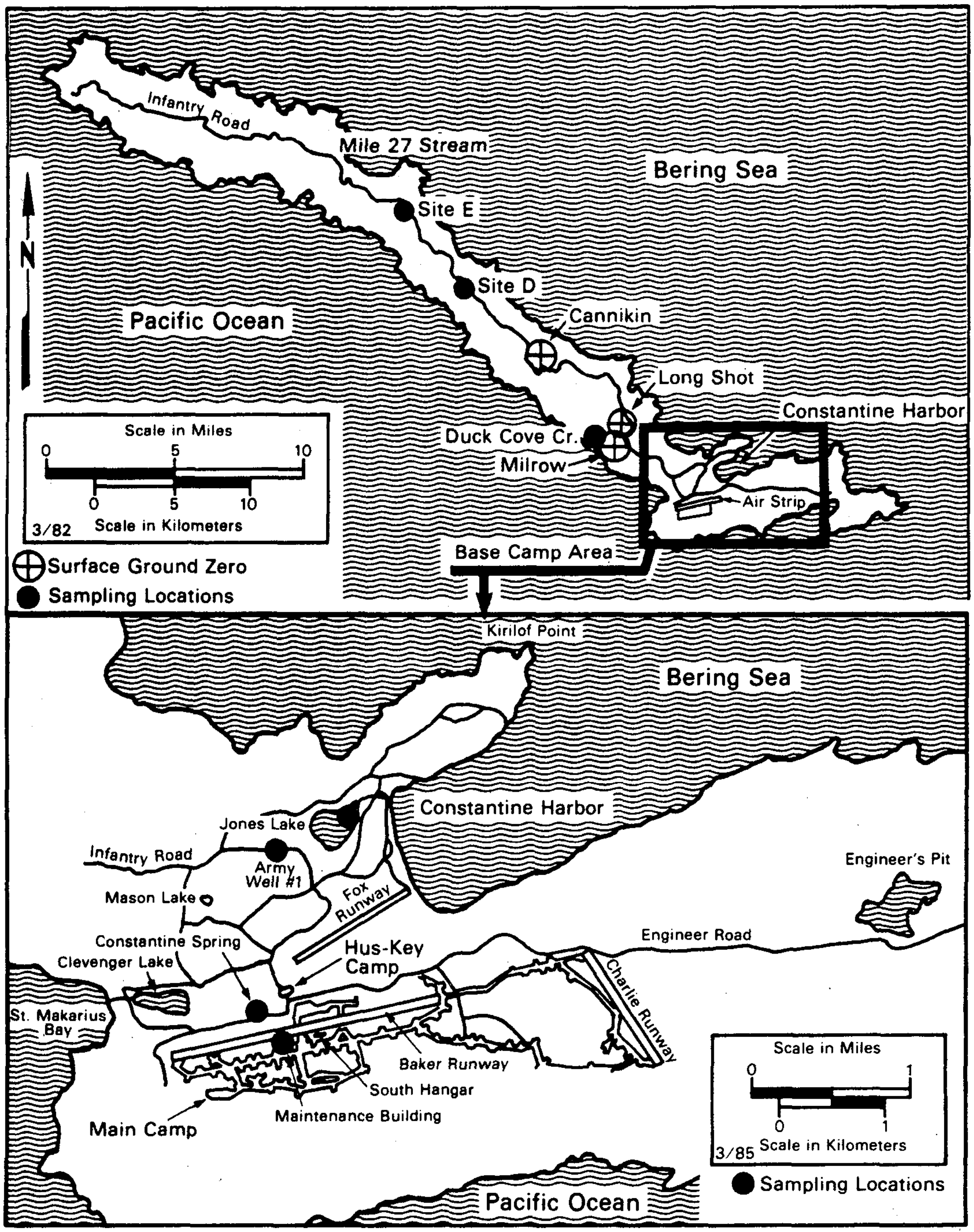

Figure E-1. Amchitka Island and background sampling locations for the LTHMP.

TABLE E-7. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
NYALA, NV			
SHARP'S RANCH	10/04	18 ± 130*	<0.09
OASIS VALLEY, NV			
GOSS SPRINGS	01/17	8.0 ± 4.5	0.04
	08/07	3.7 ± 4.6*	<0.02
PAHRUMP, NV			
CALVADA WELL 3	10/04	36 ± 130*	<0.2
TEMPIUTE, NV			
UNION CARBIDE WELL	10/03	70 ± 130*	<0.3
TONOPAH, NV			
CITY WELL	10/05	18 ± 130*	<0.09
WARM SPRINGS, NV			
TWIN SPRINGS RANCH	10/04	57 ± 130*	<0.3
AMCHITKA, AK - BACKGROUND SAMPLES			
ARMY WELL 1	05/03	46 ± 5	0.2
ARMY WELL 2	05/02	26 ± 5	0.1
ARMY WELL 3	05/02	62 ± 5	0.3
ARMY WELL 4	05/02	59 ± 5	0.3
CONSTANTINE SPRING	05/03	65 ± 5	0.3
DUCK COVE CREEK	05/03	29 ± 4	0.1
JONES LAKE	05/03	33 ± 5	0.2
RAIN SAMPLE	05/03	35 ± 5	0.2
	05/08	22 ± 5	0.1
	05/09	31 ± 5	0.2

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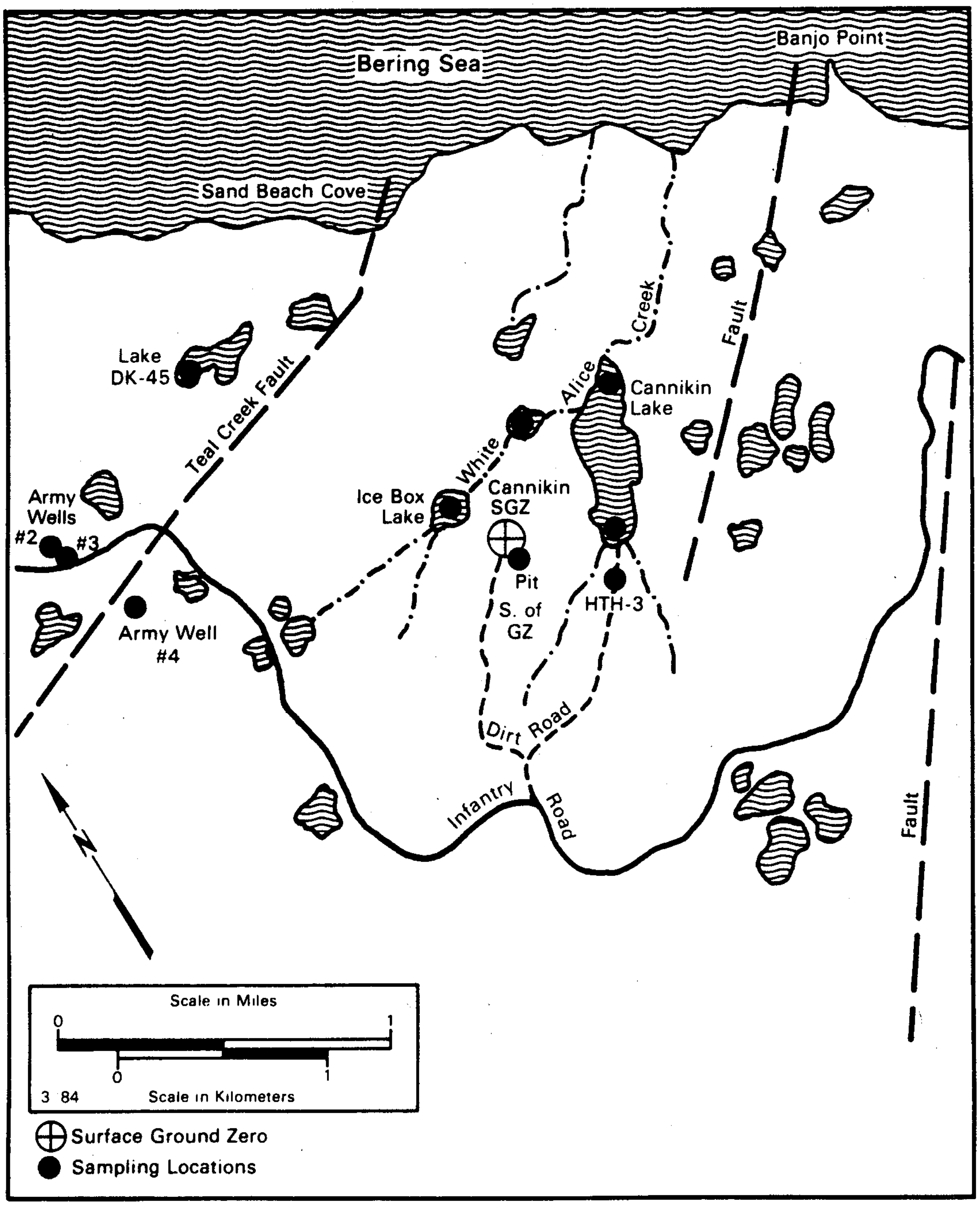

Figure E-2. LTHMP sampling locations for Project Cannikin.

TABLE E-7. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
SITE D HYDRO EXPLOR HOLE	05/02	73 ± 5	0.4
SITE E HYDRO EXPLOR HOLE	05/02	140 ± 6	0.7
<u>PROJECT CANNIKIN - AMCHITKA, AK</u>			
NORTH END CANNIKIN LAKE	05/02	40 ± 5	0.2
SOUTH END CANNIKIN LAKE	05/02	49 ± 5	0.2
DK-45 LAKE†	05/03	42 ± 5	0.2
ICE BOX LAKE	05/02	45 ± 5	0.2
PIT S OF CANNIKIN GZ	05/02	18 ± 4	0.09
WELL HTH-3	05/02	48 ± 5	0.2
WHITE ALICE CREEK	05/02	38 ± 5	0.2
STREAM EAST OF LONG SHOT‡	05/05	660 ± 11	3
<u>PROJECT LONG SHOT - AMCHITKA, AK</u>			
EPA WELL-1	05/05	5.6 ± 4.8*	<0.03
LONG SHOT POND 1	05/05	23 ± 4	0.1
LONG SHOT POND 2	05/05	26 ± 4	0.1
LONG SHOT POND 3	05/05	56 ± 5	0.3
MUD PIT 1	05/05	490 ± 9	2
MUD PIT 2	05/05	580 ± 8	3
MUD PIT 3	05/05	710 ± 9	4
REED POND	05/05	59 ± 5	0.3
WELL GZ 1	05/05	3200 ± 140	20
WELL GZ 2	05/05	220 ± 6	1

(continued)

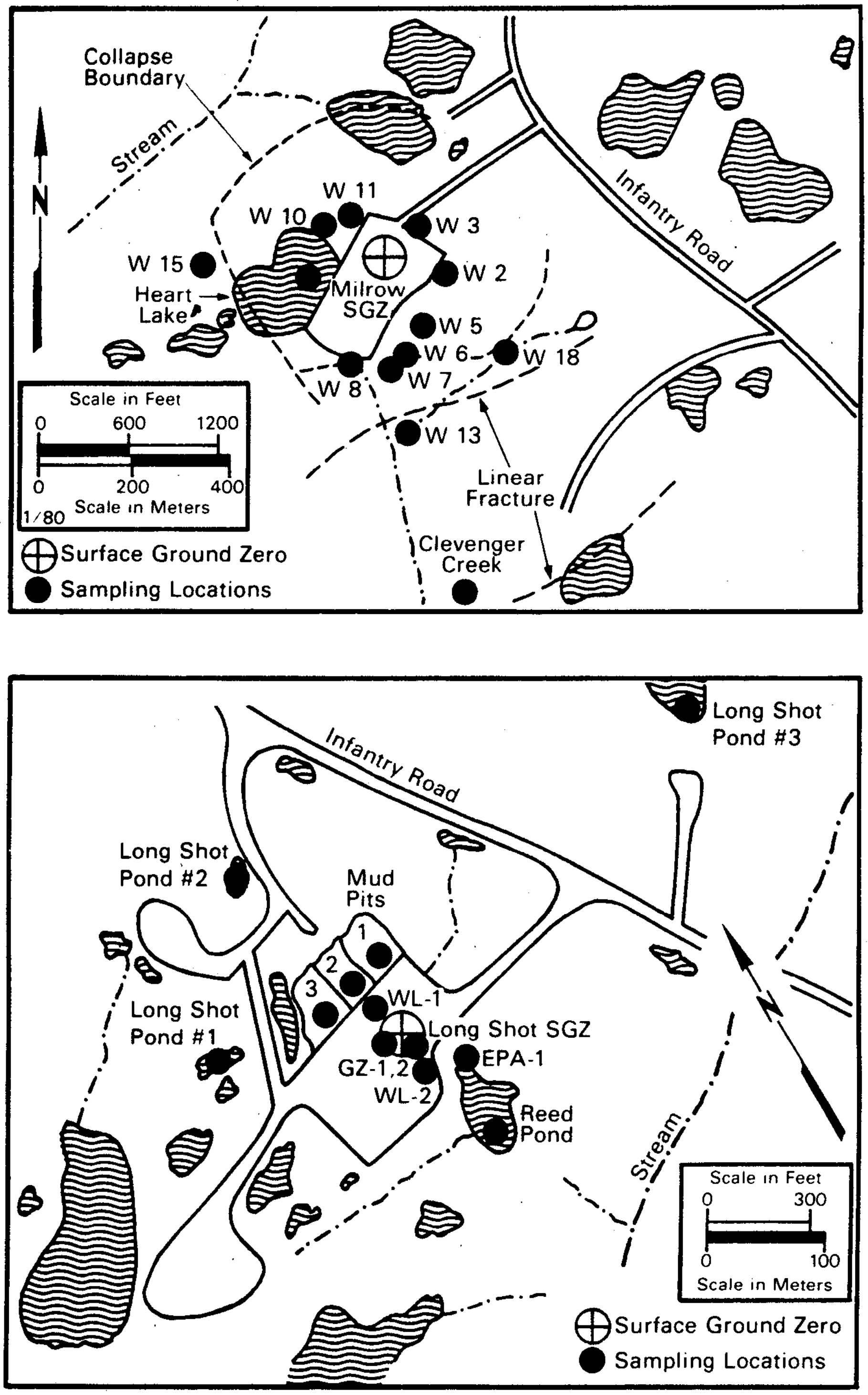

Figure E-3. LTHMP sampling locations for Projects Milrow and Long Shot.

TABLE E-7. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
WELL WL-1	05/05	53 ± 5	0.3
WELL WL-2	05/05	710 ± 9	4
PROJECT MILROW - AMCHITKA, AK			
CLEVENGER CREEK	05/04	47 ± 5	0.2
HEART LAKE	05/04	23 ± 5	0.1
WELL W-2	05/04	33 ± 4	0.2
WELL W-3	05/04	32 ± 5	0.2
WELL W-4	05/04	NC	
WELL W-5	05/04	22 ± 4	0.1
WELL W-6	05/04	22 ± 5	0.1
WELL W-7	05/04	17 ± 4	0.09
WELL W-8	05/04	30 ± 4	0.1
WELL W-9	05/04	NC	
WELL W-10	05/04	43 ± 4	0.2
WELL W-11	05/04	110 ± 5	0.5
WELL W-12	05/04	NC	
WELL W-13	05/04	54 ± 4	0.3
WELL W-14	05/04	38 ± 4	0.2
WELL W-15	05/04	20 ± 4	0.1
WELL W-16	05/04	NC	
WELL W-17	05/04	27 ± 5	0.1
WELL W-18	05/04	54 ± 5	0.3
WELL W-19	05/04	NC	

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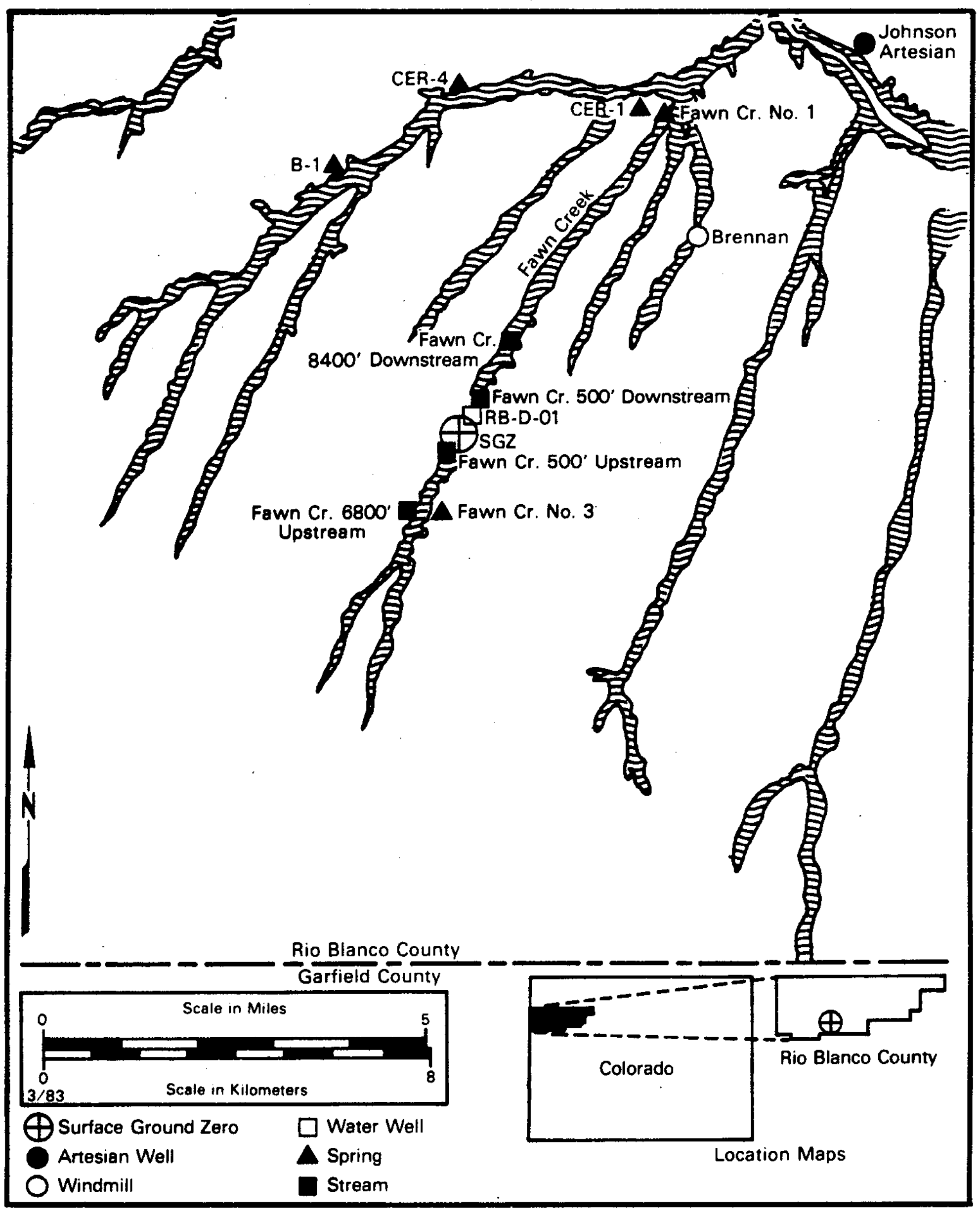

Figure E-4. LTHMP sampling locations for Project Rio Blanco.

TABLE E-7. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
PROJECT RIO BLANCO - COLORADO			
RIO BLANCO, CO			
B-1 EQUITY CAMP	06/22	100 ± 5	0.5
BRENNAN WINDMILL	06/22	45 ± 4	0.2
CER 1 BLACK SULPHUR	06/22	78 ± 5	0.4
CER 4 BLACK SULPHUR	06/22	110 ± 5	0.6
FAWN CREEK 1	06/22	51 ± 5	0.3
FAWN CREEK 3	06/22	63 ± 5	0.3
FAWN CREEK 6800FT UPSTR	06/22	69 ± 5	0.3
FAWN CREEK 500FT UPSTR	06/22	79 ± 5	0.4
FAWN CREEK 500FT DNSTR	06/22	74 ± 5	0.4
FAWN CREEK 8400FT DNSTR	06/22	75 ± 4	0.4
JOHNSON ARTESIAN WELL	06/22	-0.93 ± 4.2*	<0.01
WELL RB-D-01	06/22	13 ± 4	0.07
PROJECT RULISON - COLORADO			
GRAND VALLEY, CO			
CITY SPRING	06/20	3.3 ± 5.0*	<0.02
ALBERT GARDNER RANCH	06/21	200 ± 6	1
RULISON, CO			
LEE HAYWARD RANCH	06/21	310 ± 7	2
POTTER RANCH	06/21	160 ± 6	0.8
G. SCHWAB RANCH (R.SEARCY)	06/21	180 ± 6	0.9
FELIX SEFCOVIC RANCH	06/21	240 ± 7	1

(continued)

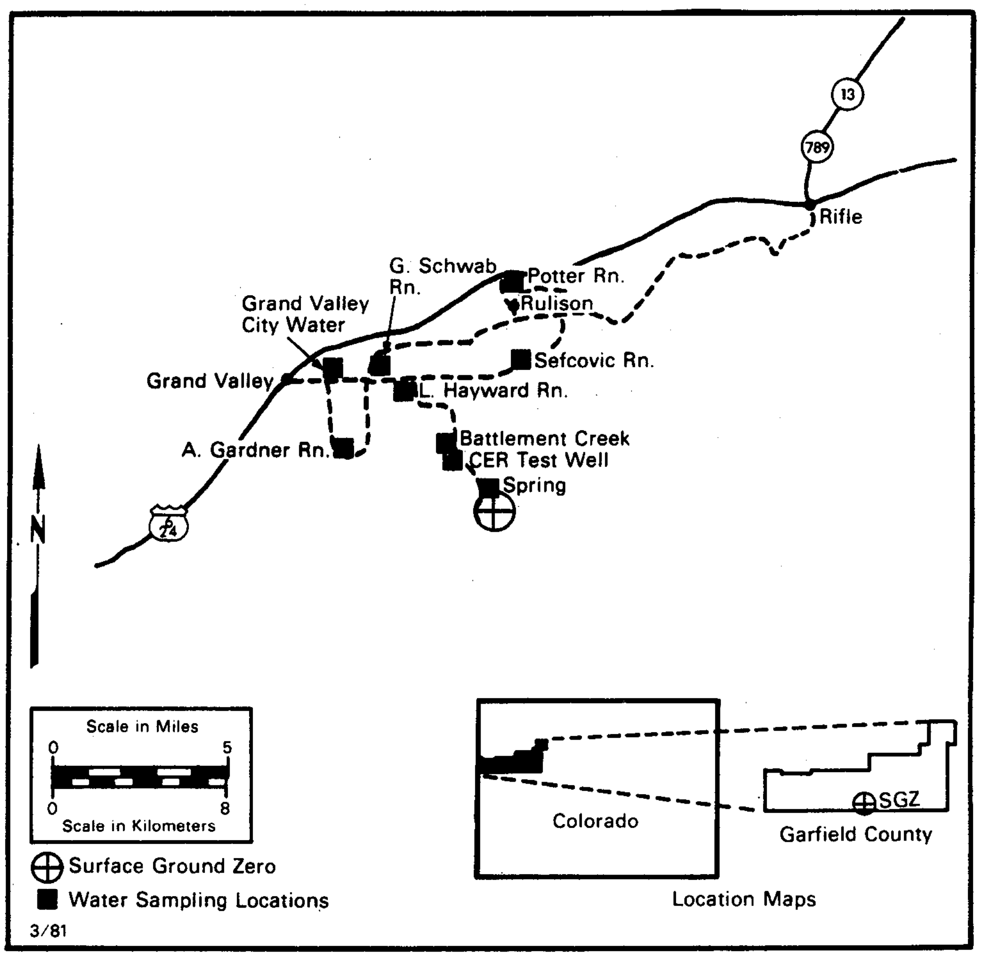

Figure E-5. LTHMP sampling locations for Project Rulison.

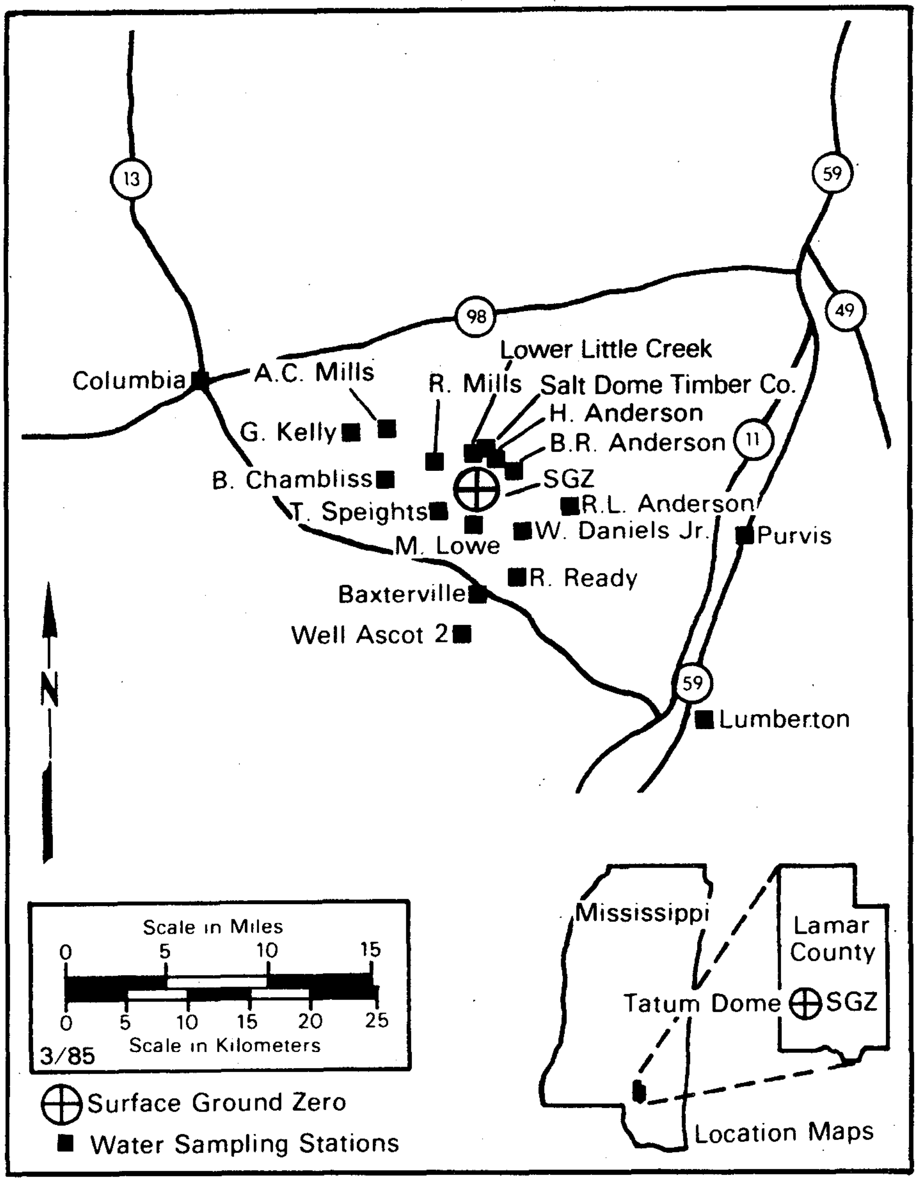

Figure E-6. LTHMP sampling locations for Project Dribble - towns and residences.

TABLE E-7. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
GRAND VALLEY, CO			
BATTLEMENT CREEK	06/20	120 ± 5	0.6
SPRING 300 YRDS NW OF G	06/20	130 ± 6	0.6
CER TEST WELL	06/20	110 ± 6	0.6
PROJECT DRIBBLE - MISSISSIPPI			
BAXTERVILLE, MS			
BAXTERVILLE CITY WELL	04/17	63 ± 5	0.3
COLUMBIA, MS			
CITY WELL 64B	04/17	10 ± 5	0.05
LUMBERTON, MS			
CITY WELL 2	04/16	2.4 ± 5.8*	<0.01
PURVIS, MS			
CITY SUPPLY	04/16	-0.22 ± 5.0*	<0.01
BAXTERVILLE, MS			
HALF MOON CREEK	04/16	50 ± 5	0.3
LOWER LITTLE CREEK	04/17	50 ± 5	0.3
B R ANDERSON	04/16	50 ± 5	0.3
H ANDERSON	04/16	44 ± 5	0.2
R L ANDERSON	04/16	53 ± 5	0.3
B CHAMBLISS	04/16	3.5 ± 5.1*	<0.02
W DANIELS JR	04/16	42 ± 5	0.2
G KELLY	04/16	1.1 ± 4.8*	<0.01

(continued)

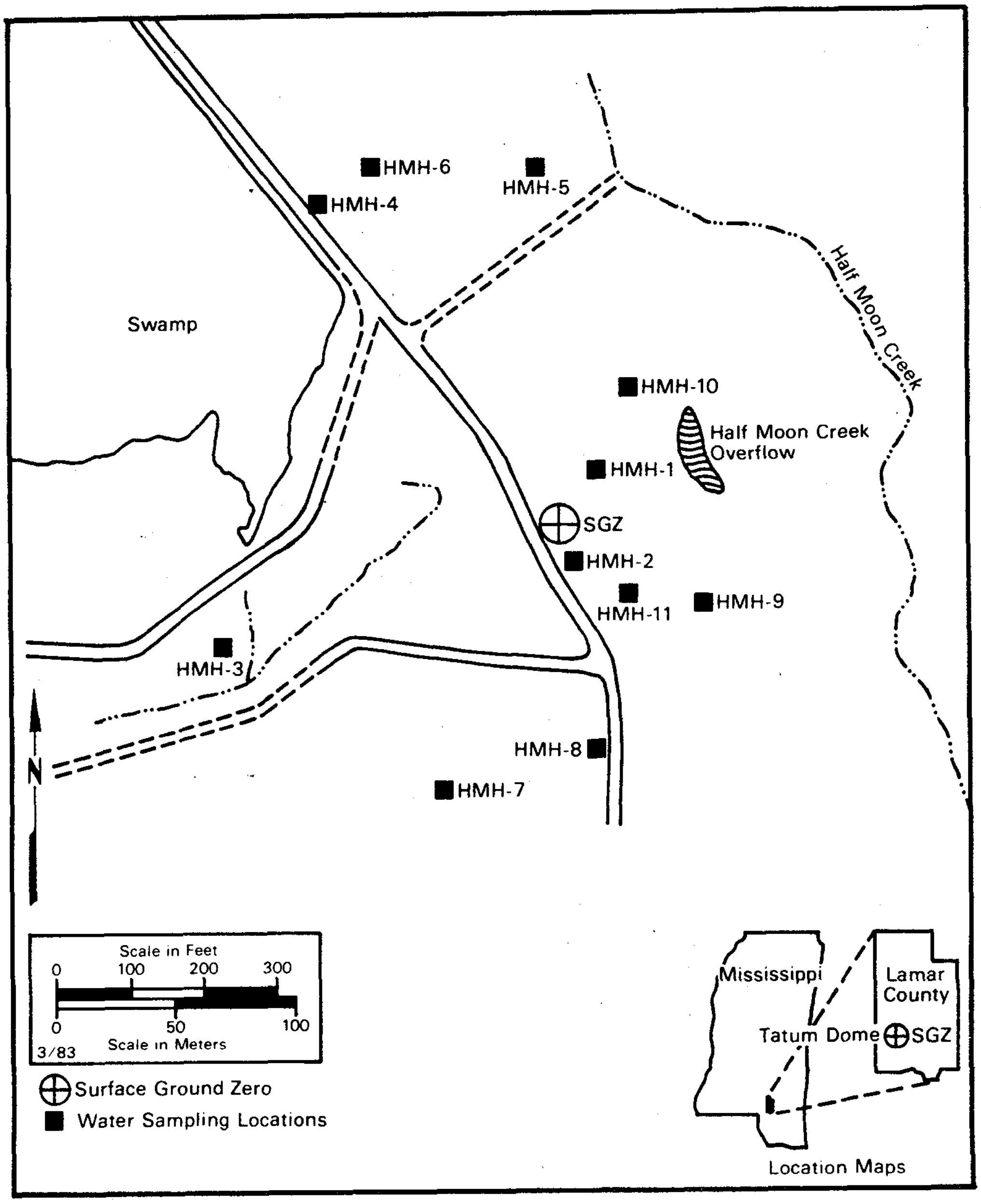

Figure E-7. LTHMP sampling locations for Project Dribble - near GZ.

TABLE E-7. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
M LOWE	04/16	39 ± 5	0.2
A C MILLS	04/16	0.74 ± 4.9*	<0.01
R MILLS	04/16	39 ± 5	0.2
R READY	04/16	90 ± 5	0.4
T SPEIGHTS	04/17	74 ± 5	0.4
WELL ASCOT 2	04/18	15 ± 5	0.07
HALF MOON CREEK OVRFLW	04/16	280 ± 7	1
WELL E-7	04/17	9.0 ± 4.4	0.04
WELL HM-1	04/16	1.3 ± 4.9*	<0.01
WELL HM-2A	04/16	4.5 ± 4.9*	<0.02
WELL HM-2B	04/16	1.1 ± 4.8*	<0.01
WELL HM-3	04/16	1.1 ± 5.6*	<0.01
WELL HMH-1	04/16	5800 ± 170	30
WELL HMH-2	04/16	1800 ± 130	9
WELL HMH-3	04/16	110 ± 6	0.5
WELL HMH-4	04/16	32 ± 5	0.2
WELL HMH-5	04/16	2600 ± 140	10
WELL HMH-6	04/16	610 ± 9	3
WELL HMH-7	04/16	290 ± 7	1
WELL HMH-8	04/16	30 ± 5	0.2
WELL HMH-9	04/16	28 ± 5	0.1
WELL HMH-10	04/16	26 ± 6	0.1
WELL HMH-11	04/16	820 ± 120	4

(continued)

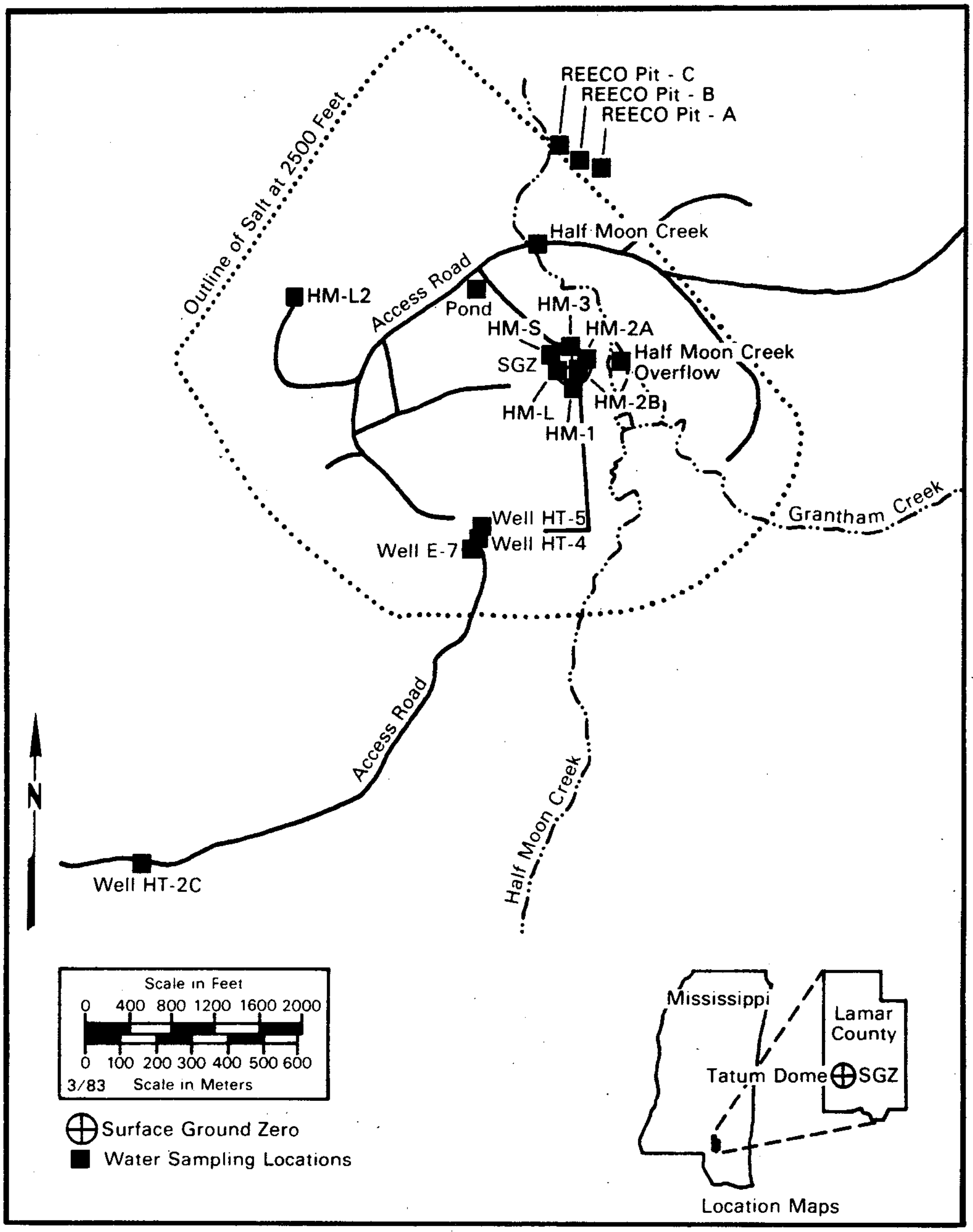

Figure E-8. LTHMP sampling locations for Project Dribble - near salt dome.

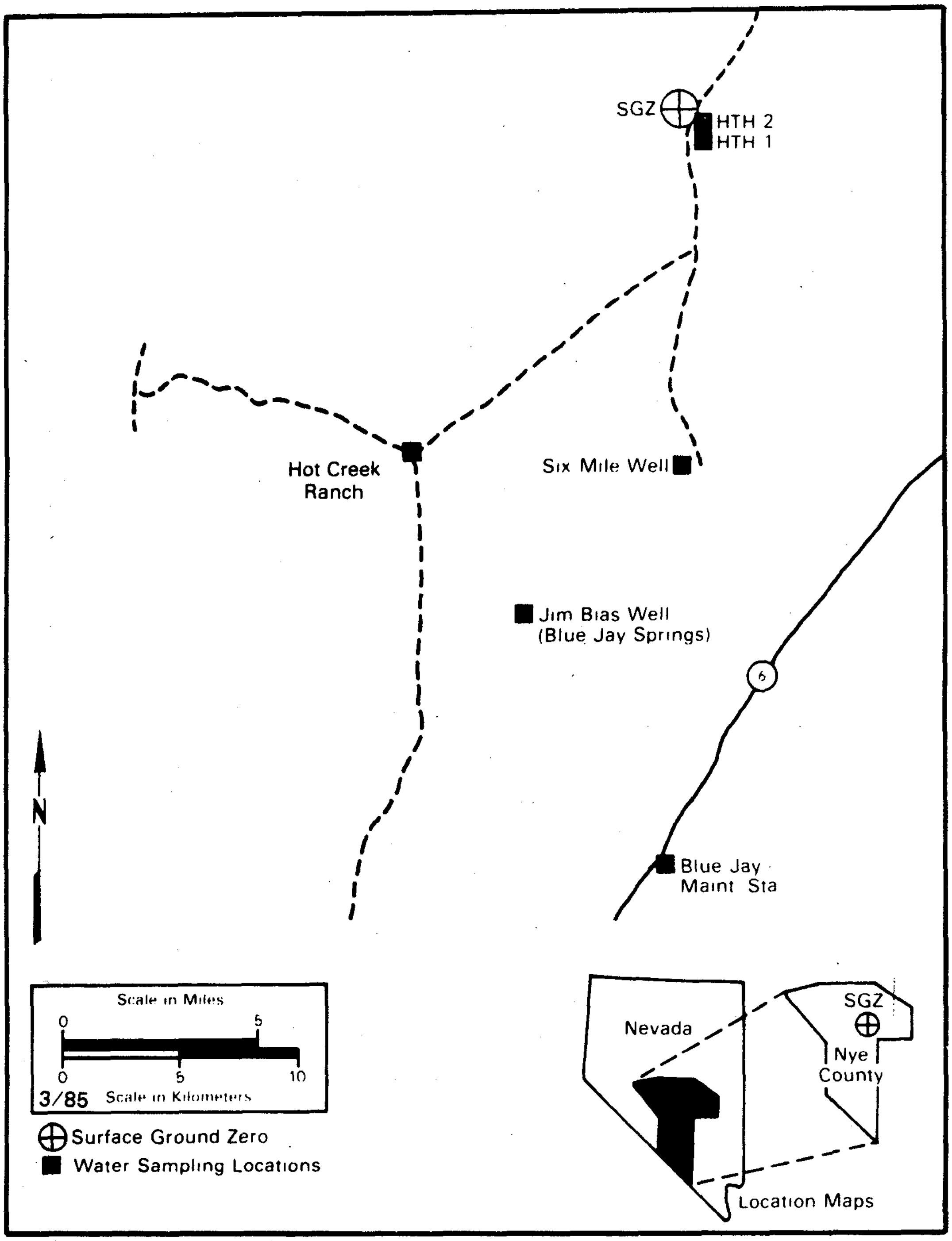

Figure E-9. LTHMP sampling locations for Project Faultless.

TABLE E-7. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
BAXTERVILLE, MS			
WELL HM-L	04/16	1400 ± 130	7
WELL HM-L2	04/16	2.1 ± 5.1*	<0.01
WELL HM-S	04/16	18000 ± 270	90
HT-2C	04/17	32 ± 5	0.2
WELL HT-4	04/17	8.7 ± 4.4	0.04
WELL HT-5	04/17	5.4 ± 4.9*	<0.03
POND WEST OF GZ	04/16	27 ± 5	0.1
REECO PIT DRAINAGE-A	04/16	38 ± 5	0.2
REECO PIT DRAINAGE-B	04/16	800 ± 10	4
REECO PIT DRAINAGE-C	04/16	510 ± 9	3
SALT DOME TIMBER CO	04/16	47 ± 5	0.2
PROJECT FAULTLESS - NEVADA			
BLUE JAY, NV			
BIAS WELL	07/23	-4.1 ± 5.0*	<0.01
HOT CREEK RANCH SPRING	07/25	3.2 ± 5.6*	<0.02
MAINTENANCE STATION	07/24	-9.2 ± 4.7*	<0.01
SIX MILE WELL	07/25	NC	
HTH-1 WELL	07/25	1.1 ± 5.6*	<0.01
HTH-2 WELL	07/25	-2.2 ± 5.5*	<0.01
PROJECT SHOAL - NEVADA			
FRENCHMAN STATION, NV			
HUNTS STATION	02/22	-1.7 ± 8.5*	<0.01
FLOWING WELL	02/22	0 ± 8.7*	<0.01

(continued)

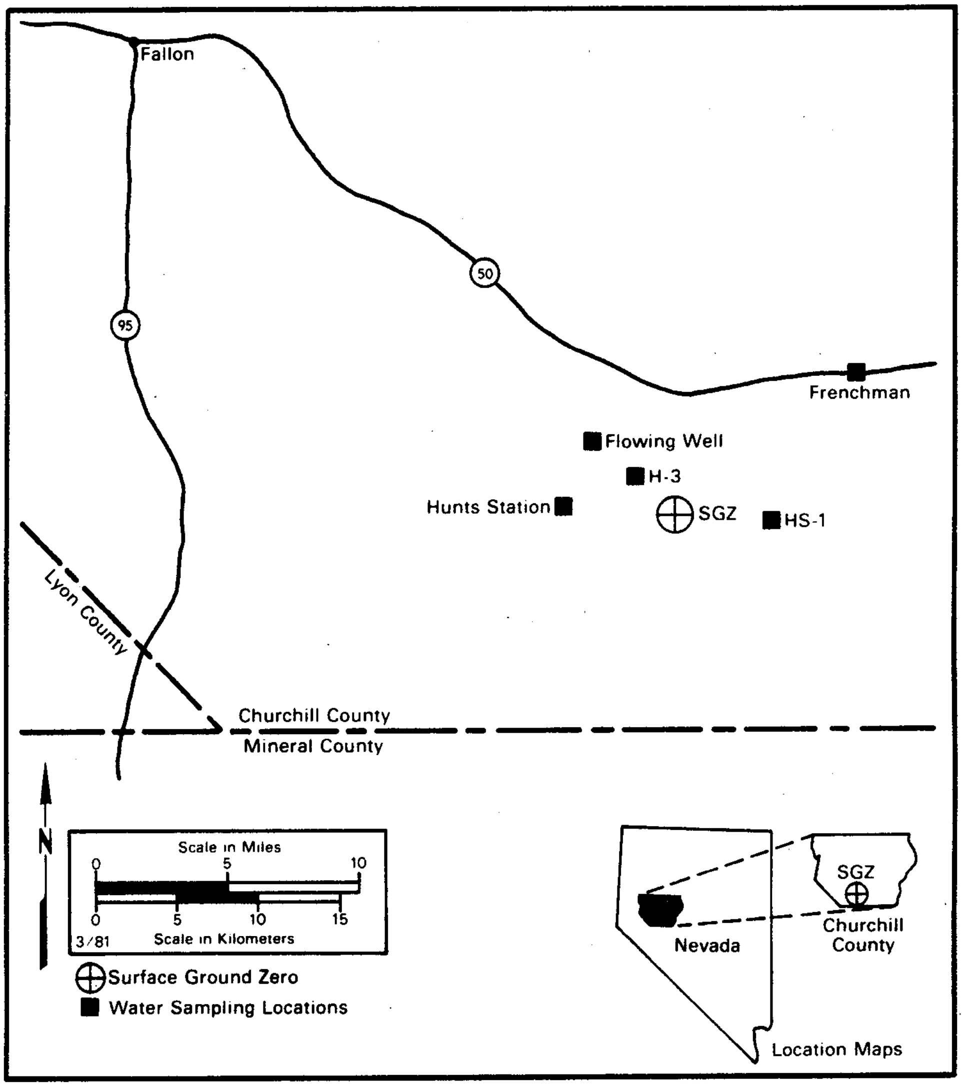

Figure E-10. LTHMP sampling locations for Project Shoal.

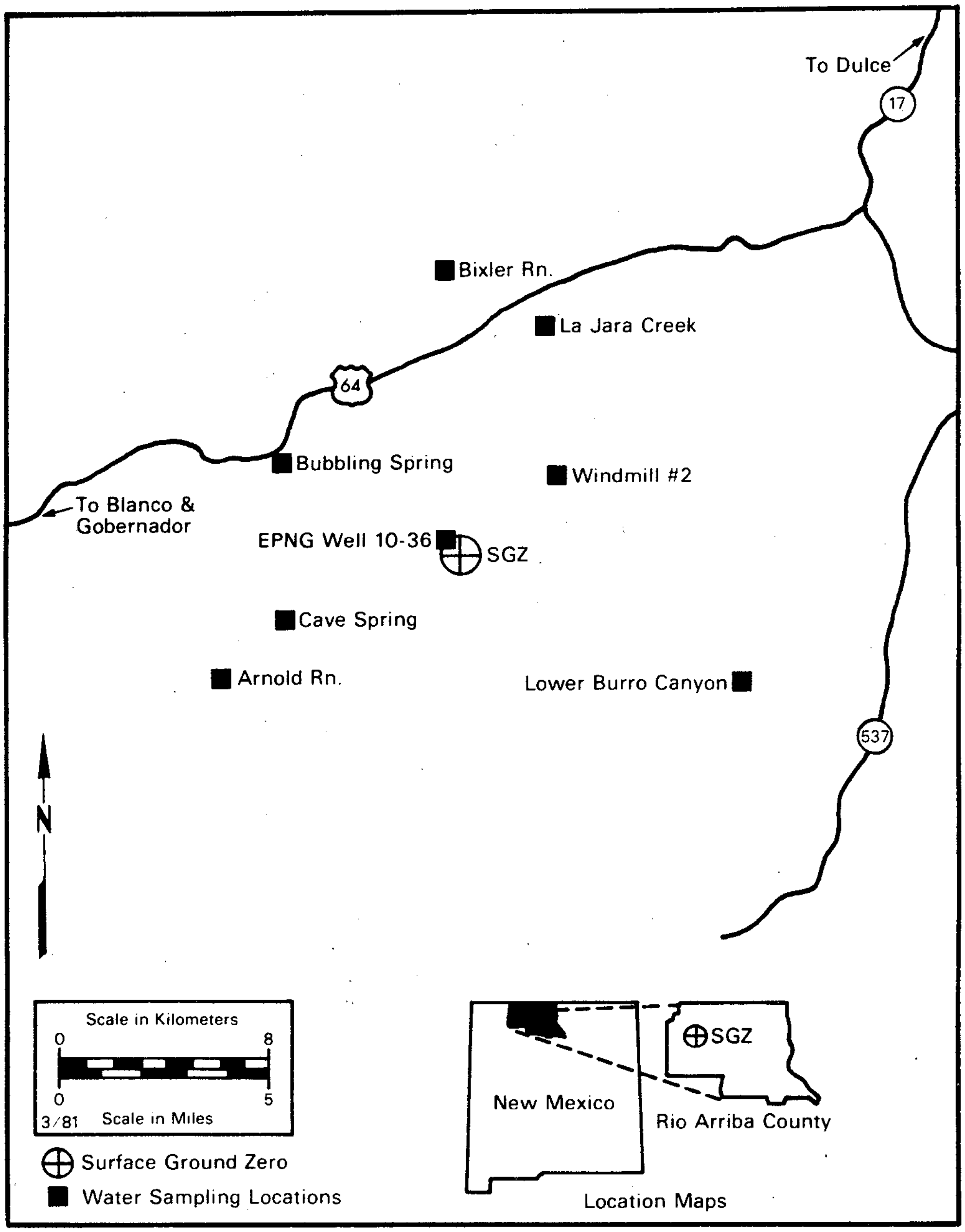

Figure E-11. LTHMP sampling locations for Project Gasbuggy.

TABLE E-7. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
FRENCHMAN STATION	02/22	-10 ± 8*	<0.01
WELL H-3	02/22	NC	
WELL HS-1	02/23	-11 ± 8*	<0.01
PROJECT GASBUGGY - NEW MEXICO			
GOBERNADOR, NM			
ARNOLD RANCH	06/06	5.4 ± 4.6*	<0.03
BIXLER RANCH	06/06	13 ± 4	0.06
BUBBLING SPRINGS	06/06	84 ± 5	0.4
CAVE SPRINGS	06/07	68 ± 5	0.3
LA JARA CREEK	06/07	64 ± 5	0.3
LOWER BURRO CANYON	06/06	NA	
WELL 28.3.33.233 SOUTH	06/07	NC	
WELL 30.3.32.343 NORTH	06/07	NC	
JICARILLA WELL 1	06/06	11 ± 4	0.05
WINDMILL 2	06/07	NC	
EPNG WELL 10-36	06/07	400 ± 8	2
PROJECT GNOME - NEW MEXICO			
CARLSBAD, NM			
CARLSBAD CITY WELL 7	05/31	8.5 ± 3.9	0.04
LOVING, NM			
CITY WATER WELL 2	05/31	7.1 ± 4.2	0.04

(continued)

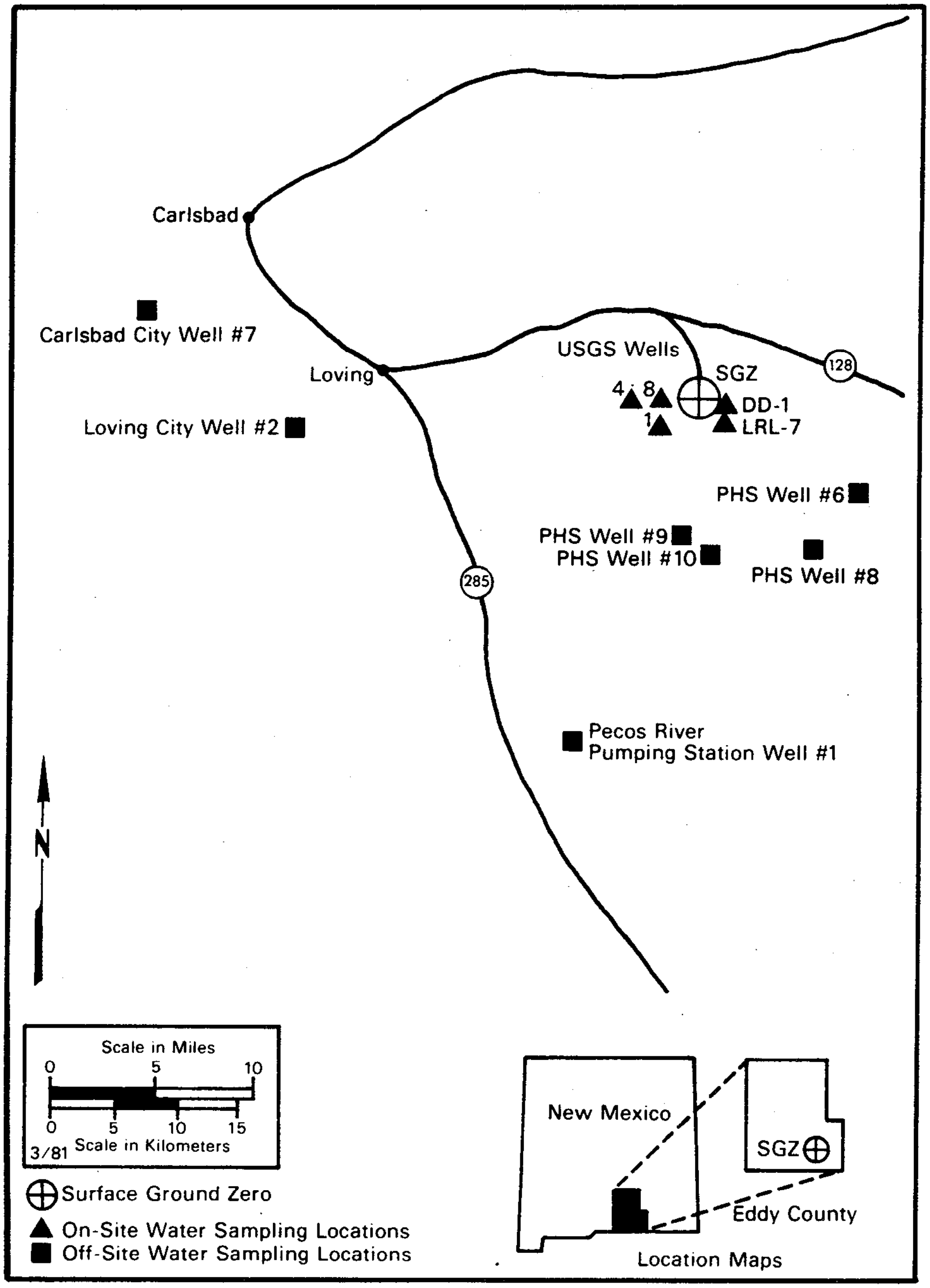

Figure E-12. LTHMP sampling stations for Project Gnome.

TABLE E-7. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	CONC. ± 2 SIGMA TRITIUM (PCI/L)	PCT OF CONC. GUIDE
MALAGA, NM			
PECOS PUMPING STATION	05/31	1.3 ± 4.6*	<0.01
PHS WELL 6	06/02	80 ± 5	0.4
PHS WELL 8	06/02	19 ± 4	0.09
PHS WELL 9	06/02	2.4 ± 4.4*	<0.01
PHS WELL 10	06/02	18 ± 4	0.09
USGS WELL 1	06/01	2.9 ± 4.5*	<0.01
USGS WELL 4	06/01	280000 ± 960	1000
USGS WELL 8§	06/01	200000 ± 810	1000
WELL LRL-7#	06/02	18000 ± 260	90

FOOTNOTES	ANALYSIS	RESULT	2 SIGMA	UNITS
†DK-45 LAKE	238PU	0.066	0.059*	pCi/M3
	239PU	0.024	0.035*	pCi/M3
‡STR. E. LONG SHOT	238PU	-0.0048	0.023*	pCi/L
	239PU	0		pCi/L
§USGS WELL 8	137Cs	95	11	pCi/L
#WELL LRL-7	137Cs	210	16	pCi/L

NC - No sample collected - pump out/gate locked/dry well, etc.

* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC)

TABLE E-8. SUMMARY OF ANALYTICAL RESULTS FOR THE MILK SURVEILLANCE NETWORK - 1984

SAMPLING LOCATION	SAMPLE TYPE	NO. OF SAMPLES	RADIO-NUCLIDE	RADIOACTIVITY CONC. (PCI/L) MAX	MIN	AVG
BISHOP, CA	13	2	3H	200	49	130
WHITE MOUNTAIN RANCH		2	89SR	-1.5	-10	-5.8
		2	90SR	3.1	1.4	2.2
HINKLEY, CA	12	5	3H	210	-12	85
BILL NELSON DAIRY		2	89SR	0.097	-3.6	-1.7
		4	90SR	2.8	-0.57	1.3
RIDGECREST, CA	10	5	3H	170	3.8	73
CEDARSAGE FARM		3	89SR	2.2	-3.0	-0.67
		3	90SR	2.9	-0.74	1.1
KEOUGH HOT SPGS, CA	13	2	3H	50	8.7	29
YRIBARREN RANCH		2	90SR	-0.48	-6.4	-3.4
ADAVEN, NV	13	1	3H	39	39	39
UHALDE RANCH		1	89SR	1.8	1.8	1.8
		1	90SR	-1.9	-1.9	-1.9
ALAMO, NV	13	3	3H	120	21	81
WHIPPLE RANCH		1	89SR	2.0	2.0	2.0
		1	90SR	-1.8	-1.8	-1.8
RACHEL, NV	10	2	3H	320	-160	81
FALLIS RANCH		1	89SR	-2.7	-2.7	-2.7
		2	90SR	3.2	-1.9	0.66
RACHEL, NV	13	2	3H	160	130	140
JAMES MOODY		2	89SR	1.6	0.0090	0.80
		2	90SR	0.14	-0.13	0.0035
AUSTIN, NV	13	4	3H	260	160	220
YOUNG'S RANCH		4	89SR	2.1	-1.8	0.44
		4	90SR	5.1	-1.5	1.2
CURRANT, NV	13	4	3H	220	-74	39
BLUE EAGLE RANCH		5	89SR	1.8	-7.4	-1.0
		5	90SR	5.6	-0.84	1.4
CURRANT, NV	13	3	3H	280	26	190
MANZONIE RANCH		2	89SR	1.2	-0.69	0.23
		3	90SR	0.69	-3.0	-1.3

(continued)

TABLE E-8. Continued

SAMPLING LOCATION	SAMPLE TYPE	NO. OF SAMPLES	RADIO-NUCLIDE	RADIOACTIVITY CONC. (PCI/L) MAX	MIN	AVG
DYER, NV	13	2	3H	250	69	160
ROTHROCK RANCH		1	89SR	-5.5	-5.5	-5.5
		1	90SR	4.5	4.5	4.5
GOLDFIELD, NV	10	2	3H	220	120	170
FRAYNE RANCH		1	89SR	-3.4	-3.4	-3.4
		1	90SR	2.6	2.6	2.6
LAS VEGAS, NV	12	5	3H	350	11	160
LDS DAIRY FARMS		4	89SR	2.0	-2.1	0.87
		4	90SR	0.63	-0.19	0.27
LATHROP WELLS, NV	10	1	3H	180	180	180
LOGANDALE, NV	12	5	3H	120	-49	43
KNUDSEN DAIRY		2	89SR	1.6	-1.6	0.020
		3	90SR	1.8	-1.4	0.16
LUND, NV	12	5	3H	200	-150	47
MCKENZIE DAIRY		3	89SR	2.2	0.23	1.0
		3	90SR	0.50	-1.1	-0.47
MCGILL, NV	13	3	3H	310	11	160
LARSEN RANCH		1	89SR	-1.1	-1.1	-1.1
		2	90SR	1.4	-4.4	-1.5
MESQUITE, NV	12	5	3H	170	1.0	83
SF AND K DAIRY		3	89SR	3.0	0.79	2.2
		3	90SR	0.23	-2.1	-0.84
MOAPA, NV	12	5	3H	350	-45	110
DECADE CORP		2	89SR	-1.8	-4.2	-3.0
		3	90SR	1.6	-4.5	-0.63
NYALA, NV	13	2	3H	320	84	200
SHARP'S RANCH		1	89SR	-1.0	-1.0	-1.0
		1	90SR	1.5	1.5	1.5
CALIENTE, NV	13	5	3H	350	-60	180
JUNE COX RANCH		2	89SR	3.0	0.89	2.0
		3	90SR	0.64	-0.18	0.25
ROUND MT, NV	13	1	89SR	0.55	0.55	0.55
BERG'S RANCH		1	90SR	2.8	2.8	2.8

(continued)

TABLE E-8. Continued

SAMPLING LOCATION	SAMPLE TYPE	NO. OF SAMPLES	RADIO-NUCLIDE	RADIOACTIVITY CONC. (PCI/L) MAX	MIN	AVG
SHOSHONE, NV	13	3	3H	230	160	180
HARBECKE RANCH		5	89SR	0.94	-16	-4.7
		5	90SR	5.7	0.69	3.3
WARM SPRINGS, NV	13	3	3H	130	-140	-12
TWIN SPRINGS RANCH		2	89SR	0.19	-2.8	-1.3
		2	90SR	4.5	2.0	3.2
CEDAR CITY, UT	12	4	3H	71	-51	4.1
WESTERN GEN DAIRIES		2	89SR	0.86	-0.39	0.24
		3	90SR	1.2	-4.3	-0.91
ST GEORGE, UT	12	1	89SR	-2.5	-2.5	-2.5
GENTRY DAIRY		1	90SR	1.6	1.6	1.6
ST GEORGE, UT	12	4	3H	170	2.5	85
DROUBAY DAIRY		1	89SR	-0.62	-0.62	-0.62
		3	90SR	1.4	-4.7	-0.84

TABLE E-9. ANALYTICAL RESULTS FOR THE STANDBY MILK SURVEILLANCE NETWORK - 1984

SAMPLING LOCATION	COLLECTION DATE 1984	CONC. ± 2 SIGMA 89SR (PCI/L)	CONC. ± 2 SIGMA 90SR (PCI/L)
		GAMMA SPECTRAL AND STRONTIUM ANALYSES**	
KINGMAN, AZ CANYON FARMS	07/23	2.3 ± 2.1*	0.0022 ± 2.2*
TUCSON, AZ SHAMROCK DAIRY, PIMA CO	07/23	-0.49 ± 2.1*	0.99 ± 2.2*
BAKERSFIELD, CA CARNATION DAIRY	07/23	1.8 ± 2.1*	-0.69 ± 2.2*
SANTA ROSA, CA GLEN OAKS FARM	07/23	-2.7 ± 1.7*	2.0 ± 1.8*
WILLOWS, CA FOREMOST FOODS COMPANY	07/23	1.4 ± 1.9*	-0.59 ± 2.0*
PUEBLO, CO HYDE PARK DAIRY CO.	07/09	-0.69 ± 1.7*	-0.17 ± 1.8*
FLENSBURG, MN FLENSBURG CO-OP CMRY	05/22	NA	NA
ATOKA, OK MUNGLE DAIRY	07/10	NA	NA

(continued)

TABLE E-9. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	SAMPLING LOCATION	COLLECTION DATE 1984
	GAMMA SPECTRAL ANALYSES ONLY**		
PIMA, AZ SMITH HUNT DAIRY	07/23	OXNARD, CA CHASE BROS DAIRY	07/23
TAYLOR, AZ SUNRISE DAIRY	07/23	PALO ALTO, CA PENINSULA CREAMERY	03/05
TEMPE, AZ UNITED DAIRYMEN OF AZ	07/23	REDDING, CA MCCOLL'S DAIRY PROD	07/23
YUMA, AZ GOLDEN WEST DAIRY	07/24	SAN LUIS OBISPO, CA CAL STATE POLY	07/23
FAYETTEVILLE, AR UNIVERSITY OF AR	06/25	SAUGUS, CA WAYSIDE HONOR RANCH	07/23
LITTLE ROCK, AR BORDENS	06/25	SMITH RIVER CA COUNTRY MAID DAIRY	07/23
PARAGOULD, AR FOREMOST FOODS INC	06/26	SOLEDAD, CA CTF DAIRY	07/23
RUSSELLVILLE, AR ARKANSAS TECH UNIV	06/26	TRACY, CA DEUEL VOC INST	07/23
HELENDALE, CA OSTERKAMP DAIRY NO 2	07/23	WEED, CA MEDO-BEL CREAMERY	08/28 09/05
CHINO, CA CALIF INST FOR MEN	07/24	COLORADO SPGS, CO SINTON DAIRY CO	07/09
FERNBRIDGE, CA HUMBOLDT CREAMERY	03/05 07/23	DELTA, CO ARDEN MEADOW GOLD DAIRY	07/11
HOLTVILLE, CA SCHAFFNERSON DAIRY	07/23	FT COLLINS, CO POUDRE VALLEY DAIRY	07/09
LEMON GROVE, CA MILLER DAIRY	08/23	GRAND JCT, CO COLORADO WEST DAIRIES	07/09
MANTECA, CA DEJAGER DAIRY NO 2 NORTH	07/23	BOISE, ID MEADOW GOLD DAIRIES	08/13

TABLE E-9. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	SAMPLING LOCATION	COLLECTION DATE 1984
	GAMMA SPECTRAL ANALYSES ONLY**		
TWIN FALLS, ID YOUNGS DAIRY	08/13	LAFAYETTE, LA UNIV SOUTHWESTERN LA	06/25
CALDWELL, ID DCA RECEIVING STA	08/13	RUSTON, LA TECH UNIV DAIRY	06/25
IDAHO FALLS, ID WESTERN GENERAL DAIRY	08/13	DALTON, MN DALTON CO-OP CREAMERY	05/23
LEWISTON, ID GOLDEN GRAIN DAIRY PROD	08/13	FLENSBURG, MN+ FLENSBURG CO-OP CMRY	05/22
POCATELLO, ID ROWLAND'S DAIRY	08/13	FOSSTON, MN LAND O' LAKES INC	05/21
DAVENPORT, IA SWISS VALLEY FARMS CO	02/29 03/02	NICOLLET, MN WALTER SCHULTZ FARM	05/16
KIMBALLTON, IA AMPI RECEIVING STA	02/29	ROCHESTER, MN ASSC MILK PRODUCERS	05/21
LAKE MILLS, IA LAKE MILLS COOP CRMY	02/29	AURORA, MO MID-AMERICA DIARY INC	06/04
LEMARS, IA WELLS DAIRY	02/29	CHILLICOTHE, MO MID-AMERICA DAIRYMEN	06/05
GARDEN CITY, KS MYERS MILK PROD	06/04	JACKSON, MO MID-AMERICA DAIRYMEN INC	06/04
ELLIS, KS MID-AMERICA DAIRY	06/04	JEFFERSON CITY, MO CENTRAL DAIRY CO	06/05
TOPEKA, KS THE DAIRY CO	06/04	BOZEMAN, MT DARIGOLD FARMS	07/09
BATON ROUGE, LA LA STATE UNIV	06/25	GREAT FALLS, MT MEADOW GOLD DAIRY	08/24
HAMMOND, LA SOUTHEASTERN LA COLLEGE	06/27	HAVRE, MT VITA-RICH DAIRY	08/22

TABLE E-9. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	SAMPLING LOCATION	COLLECTION DATE 1984
	GAMMA SPECTRAL ANALYSES ONLY**		
KALISPELL, MT EQUITY SUPPLY CO	07/06	MCALESTER, OK OKLA ST PENITENTIARY	07/09
NORTH PLATTE, NE MID-AMERICA DAIRYMEN	06/04	STILLWATER, OK OSU DAIRY	07/09
FALLON, NV CREAMLAND DAIRY	07/23	CORVALLIS, OR SUNNY BROOK DAIRY	08/14
LAS VEGAS, NV ANDERSON DAIRY	07/23	EUGENE, OR ECHO SPRINGS DAIRY	08/13
ALBUQUERQUE, NM BORDEN'S VALLEY GOLD	07/09	GRANTS PASS, OR VALLEY OF ROGUE DAIRY	08/13
LA PLATA, NM ROTHLISBERGER DAIRY	07/12	KLAMATH FALLS, OR NEDO BEL CREAMERY	08/24
BISMARCK, ND BRIDGEMENS CREAMERY	07/23	MEDFORD, OR DAIRYGOLD FARMS	08/13
DEVILS LAKE, ND LAKE VIEW DAIRY	07/18	MYRTLE POINT, OR SAFEWAY STORES INC	08/13
FARGO, ND CASSCLAY CREAMERY	07/19	PORTLAND, OR DARIGOLD FARMS	08/13
GRAND FORKS, ND MINNESOTA DAIRY	07/18	REDMOND, OR EBERHARD'S CREAMERY INC	08/11
JAMESTOWN, ND COUNTRY BOY DAIRY	07/18	TILLAMOOK, OR TILLAMOOK CO CRMY	08/14
WILLISTON, ND PETERSONS CREAMERY	07/17	MITCHELL, SD CULHANES DAIRY	07/09
ATOKA, OK‡ MUNGLE DAIRY	07/10	SIOUX FALLS, SD TERRACE PARK DAIRY	07/09
CLAREMORE, OK SWAN BROS DAIRY	07/09	VOLGA, SD LAND O'LAKES INC	07/09

TABLE E-9. Continued

SAMPLING LOCATION	COLLECTION DATE 1984	SAMPLING LOCATION	COLLECTION DATE 1984
	GAMMA SPECTRAL ANALYSES ONLY**		
BEAVER, UT CACHE VALLEY DAIRY	07/09	MOSES LAKE, WA SAFEWAY STORES INC.	08/13
PROVO, UT BYU DAIRY PRODUCTS LAB	07/16	SPOKANE, WA CONSOLIDATED DAIRY	08/13
CEDAR CITY, UT WESTERN GEN DAIRIES	07/09	POWELL, WY CREAM OF THE VALLEY DAIRY	07/09
SMITHFIELD, UT CACHE VALLEY DAIRY	07/10	RIVERTON, WY ALBERTSON'S PLANT	07/09

* CONCENTRATION IS LESS THAN THE MINIMUM DETECTABLE CONCENTRATION (MDC).
** POTASSIUM-40 WAS THE ONLY GAMMA-EMITTER DETECTED EXCEPT FOR THE RESULTS BELOW:

	ANALYSIS	RESULT	2SIGMA	UNITS
+	137CS	11	7	PCI/L
‡	137CS	3.2	1.8	PCI/L

TABLE E-10. SUMMARY OF RADIATION DOSE EQUIVALENTS FROM TLD DATA - 1984

STATION LOCATION	MEASUREMENT PERIOD ISSUE	COLLECT	DOSE EQUIVALENT RATE (MREM/D) MAX.	MIN.	AVG.	ADJUSTED DOSE EQUIVALENT (MREM/Y)
ADAVEN, NV	01/06/84	01/09/85	0.32	0.29	0.31	112
ALAMO, NV	01/06/84	01/09/85	0.23	0.21	0.23	82
AMERICAN BORATE, NV	01/04/84	01/10/85	0.27	0.24	0.25	91
AUSTIN, NV	01/05/84	01/17/85	0.34	0.32	0.33	119
BAKER, CA	01/03/84	01/07/85	0.23	0.19	0.21	76
BARSTOW, CA	01/03/84	01/07/85	0.28	0.24	0.26	94
BEATTY, NV	01/04/84	01/07/85	0.32	0.26	0.29	104
BISHOP, CA	01/04/84	01/08/85	0.27	0.23	0.26	93
BLUE EAGLE RANCH, NV	01/05/84	01/08/85	0.19	0.16	0.18	64
BLUE JAY, NV	01/05/84	01/15/85	0.32	0.28	0.30	110
CACTUS SPRINGS, NV	01/03/84	01/07/85	0.16	0.14	0.15	55
CALIENTE, NV	01/09/84	01/10/85	0.29	0.26	0.27	100
CARP, NV	04/04/84	01/10/85	0.28	0.24	0.26	95
CASEY'S RANCH, NV	01/04/84	01/15/85	0.21	0.17	0.19	69
CEDAR CITY, UT	01/05/84	01/08/85	0.21	0.17	0.19	68
CLARK STATION, NV	01/05/84	01/16/85	0.30	0.27	0.29	104
COALDALE, NV	01/04/84	01/16/85	0.28	0.24	0.27	97
COMPLEX 1, NV	01/06/84	01/09/85	0.32	0.28	0.31	111
CORN CREEK, NV	01/03/84	01/07/85	0.12	0.11	0.12	42
COYOTE SUMMIT, NV	01/03/84	01/15/85	0.32	0.27	0.30	111
CRYSTAL, NV	01/04/84	01/07/85	0.19	0.16	0.18	66
CURRANT,NV	01/03/84	01/08/85	0.28	0.24	0.27	97
DEATH VALLEY JCT, CA	01/06/84	01/10/85	0.20	0.16	0.18	66
DIABLO MAINT. STA., NV	01/04/84	01/16/85	0.34	0.27	0.32	115
DUCKWATER, NV	01/03/84	01/08/85	0.27	0.22	0.26	93
ELGIN, NV	01/09/84	01/10/85	0.33	0.28	0.31	112
ELY, NV	01/04/84	01/08/85	0.23	0.20	0.22	80
ENTERPRISE, UT	01/05/84	01/09/85	0.33	0.27	0.30	110
EUREKA, NV	01/05/84	01/17/85	0.29	0.26	0.28	101
FURNACE CREEK, CA	01/06/84	01/10/85	0.18	0.14	0.16	58
GABBS, NV	01/04/84	01/16/85	0.20	0.18	0.19	68
GARRISON, UT	01/04/84	01/07/85	0.20	0.18	0.19	70
GEYSER RANCH, NV	01/04/84	01/07/85	0.28	0.24	0.26	95
GOLDFIELD, NV	01/03/84	01/15/85	0.25	0.23	0.24	87
GROOM LAKE-NTS, NV	01/03/84	01/15/85	0.19	0.15	0.18	64
HANCOCK SUMMIT,NV	01/03/84	01/15/85	0.39	0.32	0.37	133
HIKO, NV	01/10/84	01/09/85	0.20	0.19	0.19	69
HOT CK RNCH, NV	01/05/84	01/21/85	0.24	0.19	0.23	82
INDEPENDENCE, CA	01/04/84	01/08/85	0.25	0.21	0.23	82
INDIAN SPRINGS, NV	01/03/84	01/07/85	0.14	0.12	0.13	48
KIRKEBY RANCH, NV	01/04/84	01/07/85	0.22	0.19	0.21	74
KOYNES RANCH, NV	01/04/84	01/15/85	0.27	0.19	0.24	86
LAS VEGAS, NV (AIRPT)	01/03/84	01/02/85	0.14	0.12	0.13	48

(continued)

TABLE E-10. Continued

STATION LOCATION	MEASUREMENT PERIOD ISSUE	COLLECT	DOSE EQUIVALENT RATE (MREM/D) MAX.	MIN.	AVG.	ADJUSTED DOSE EQUIVALENT (MREM/Y)
LAS VEGAS, NV (PLACAK)	01/03/84	01/02/85	0.14	0.12	0.13	48
LAS VEGAS, NV (UNLV)	01/03/84	01/02/85	0.12	0.10	0.11	41
LAS VEGAS, NV (USDI)	01/03/84	01/02/85	0.17	0.14	0.16	57
LATHROP WELLS, NV	01/03/84	01/07/85	0.25	0.22	0.23	85
LAVADA'S MARKET, NV	01/04/84	01/09/85	0.24	0.20	0.22	81
LIDA, NV	01/03/84	01/15/85	0.26	0.24	0.25	90
LONE PINE, CA	01/04/84	01/08/85	0.24	0.20	0.22	80
LUND, NV	01/03/84	01/10/85	0.24	0.20	0.22	81
MAMMOTH MOUNTAIN, CA	01/05/84	01/09/85	0.35	0.22	0.27	97
MANHATTAN, NV	01/05/84	01/17/85	0.35	0.32	0.33	121
MESQUITE, NV	01/04/84	01/07/85	0.18	0.13	0.16	57
MINA, NV	01/04/84	01/16/85	0.27	0.23	0.25	92
MOAPA, NV	01/03/84	01/07/85	0.20	0.14	0.17	62
NYALA, NV	01/04/84	01/16/85	0.23	0.18	0.21	77
OLANCHA, CA	01/04/84	01/08/85	0.26	0.22	0.24	87
OVERTON, NV	01/04/84	01/07/85	0.17	0.12	0.14	52
PAHRUMP, NV	01/04/84	01/07/85	0.14	0.00	0.10	35
PENOYER FARMS, NV	01/04/84	01/16/85	0.31	0.26	0.29	105
PINE CREEK RANCH, NV	01/06/84	01/10/85	0.34	0.30	0.32	117
PIOCHE, NV	01/09/84	01/09/85	0.21	0.20	0.21	75
QUEEN CITY SMT, NV	01/04/84	01/15/85	0.35	0.30	0.33	121
RACHEL, NV	01/04/84	01/15/85	0.29	0.25	0.28	101
REED RANCH, NV	01/04/84	01/15/85	0.30	0.25	0.28	103
RIDGECREST, CA	01/04/84	01/07/85	0.23	0.20	0.21	76
ROUND MT, NV	01/05/84	01/17/85	0.31	0.29	0.30	109
S.DESERT COR CENTR,NV	01/03/84	01/07/85	0.14	0.13	0.13	47
SALT LAKE CITY, UT	01/04/84	01/04/85	0.24	0.18	0.21	77
SCOTTY'S JCT, NV	01/03/84	01/15/85	0.29	0.26	0.27	100
SHERI'S RANCH, NV	01/10/84	01/11/85	0.25	0.21	0.23	85
SHOSHONE, CA	01/06/84	01/11/85	0.20	0.16	0.18	66
SPRINGDALE, NV	01/03/84	01/08/85	0.30	0.26	0.28	102
ST. GEORGE, UT	01/04/84	01/07/85	0.18	0.12	0.15	53
STONE CABIN RANCH, NV	01/05/84	01/15/85	0.30	0.24	0.28	101
SUNNYSIDE, NV	01/03/84	01/09/85	0.16	0.14	0.15	56
TEMPIUTE, NV	01/03/84	01/15/85	0.29	0.25	0.28	102
TIKABOO VALLEY, NV	01/03/84	01/15/85	0.29	0.25	0.27	100
TONOPAH TEST RNG, NV	01/04/84	01/16/85	0.28	0.25	0.27	97
TONOPAH, NV	01/04/84	01/15/85	0.32	0.29	0.31	111
TWIN SPRGS RNCH, NV	01/04/84	01/16/85	0.30	0.26	0.28	104
USECOLOGY, NV	01/03/84	01/07/85	0.30	0.27	0.28	103
VALLEY CREST, CA	01/06/84	01/10/85	0.15	0.13	0.14	51
WARM SPRINGS, NV	01/05/84	01/16/85	0.32	0.28	0.31	112
YOUNG'S RANCH, NV	01/05/84	01/17/85	0.25	0.23	0.24	87

TABLE E-11. SUMMARY OF RADIATION DOSES FOR OFFSITE RESIDENTS - 1984

RES-I-DENT NO.	BACKGROUND STATION LOCATION	MEASUREMENT PERIOD ISSUE	COLLECT	DOSE EQUIVALENT RATE (MREM/D) MAX.	MIN.	AVG.	NET EXPOSURE (MREM)
2	CALIENTE, NV	01/09/84	01/10/85	0.30	0.26	0.29	0.0
3	BLUE JAY, NV	04/12/84	06/29/84	0.28	0.28	0.28	0.0
6	INDIAN SPRINGS, NV	01/03/83	01/08/85	0.17	0.15	0.16	2.6
7	GOLDFIELD, NV	01/03/84	01/15/85	0.23	0.16	0.20	0.0
8	TWIN SPRINGS RANCH, NV	01/04/84	01/16/85	0.29	0.27	0.28	0.0
9	BLUE EAGLE RANCH, NV	01/05/84	01/08/85	0.17	0.16	0.17	0.0
10	COYOTE SUMMIT, NV	01/06/84	01/09/85	0.30	0.28	0.29	0.0
11	COYOTE SUMMIT, NV	01/06/84	01/09/85	0.30	0.29	0.29	0.0
13	KOYNES RANCH, NV	01/04/84	01/15/85	0.19	0.17	0.18	0.0
14	TIKABOO VALLEY, NV	01/03/84	01/15/85	0.23	0.21	0.23	0.0
15	TIKABOO VALLEY, NV	01/03/84	01/15/85	0.23	0.22	0.22	0.0
18	NYALA, NV	01/04/84	01/16/85	0.21	0.18	0.19	0.0
19	GOLDFIELD, NV	01/03/84	01/15/85	0.25	0.19	0.21	0.0
21	BEATTY, NV	01/04/84	01/08/85	0.25	0.22	0.24	0.0
22	ALAMO, NV	01/06/84	01/09/85	0.18	0.18	0.18	0.0
24	LAS VEGAS, NV (USDI)	01/03/84	01/04/85	0.15	0.13	0.14	0.0
25	CORN CREEK, NV	01/03/84	01/02/85	0.15	0.14	0.15	2.7
27	PAHRUMP, NV	01/04/84	06/27/84	0.19	0.17	0.18	7.5
28	HOT CREEK RANCH, NV	01/05/84	01/15/85	0.28	0.26	0.26	0.0
29	STONE CABIN RANCH, NV	01/05/84	01/15/85	0.28	0.25	0.27	0.0
30	RACHEL, NV	01/03/84	01/21/85	0.25	0.25	0.25	0.0
33	LATHROP WELLS, NV	01/04/84	01/09/85	0.22	0.17	0.20	0.0

(continued)

TABLE E-11. Continued

RES-I-DENT NO.	BACKGROUND STATION LOCATION	MEASUREMENT PERIOD ISSUE	COLLECT	DOSE EQUIVALENT RATE (MREM/D) MAX.	MIN.	AVG.	NET EXPOSURE (MREM)
34	FURNACE CREEK, CA	01/06/84	01/10/85	0.17	0.13	0.16	0.0
35	DEATH VALLEY JCT., CA	01/06/84	01/10/85	0.21	0.17	0.19	0.0
36	PAHRUMP, NV	01/03/84	01/08/85	0.14	0.12	0.13	0.0
37	INDIAN SPRINGS, NV	01/03/84	01/10/85	0.21	0.16	0.18	9.1
38	BEATTY, NV	01/04/84	01/08/85	0.32	0.25	0.30	0.9
40	GOLDFIELD, NV	01/03/84	01/15/85	0.24	0.21	0.22	0.0
41	AUSTIN, NV	01/05/84	12/11/84	0.30	0.26	0.26	0.0
42	TONOPAH, NV	01/04/84	01/15/85	0.28	0.24	0.26	0.0
44	CEDAR CITY, UT	01/05/84	01/08/85	0.22	0.19	0.21	0.0
45	ST. GEORGE, UT	01/04/84	01/07/85	0.51	0.15	0.25	35.5
47	ELY, NV	01/04/84	01/08/85	0.26	0.21	0.24	3.2
49	LAS VEGAS, NV (UNLV)	01/03/84	01/02/85	0.20	0.18	0.19	26.5
50	HOT CREEK RANCH, NV	01/05/84	01/15/85	0.28	0.26	0.27	0.0
51	TONOPAH, NV	01/04/84	01/16/85	0.34	0.22	0.26	0.0
52	SALT LAKE CITY, UT	01/06/84	01/04/85	0.89	0.22	0.57	86.1
54	RACHEL, NV	01/04/84	01/15/85	0.28	0.20	0.26	0.0
55	RACHEL, NV	01/04/84	01/21/85	0.26	0.25	0.25	0.0
56	CORN CREEK STATION, NV	01/03/84	01/02/85	0.14	0.13	0.14	0.0
57	OVERTON, NV	01/03/84	01/07/85	0.37	0.19	0.26	41.2
59	CEDAR CITY, UT	01/05/84	01/08/85	0.28	0.21	0.24	12.3
60	SHOSHONE, CA	01/06/84	01/18/85	0.20	0.14	0.18	0.0

(continued)

TABLE E-11. Continued

RES-I-DENT NO.	BACKGROUND STATION LOCATION	MEASUREMENT PERIOD		DOSE EQUIVALENT RATE (MREM/D)			NET EXPOSURE
		ISSUE	COLLECT	MAX.	MIN.	AVG.	(MREM)
223	LAS VEGAS, NV (USDI)	01/04/84	01/02/85	0.13	0.12	0.12	0.0
232	HIKO, NV	04/03/84	01/09/85	0.23	0.20	0.22	3.6
233	ELY, NV	05/24/84	11/05/84	0.23	0.15	0.18	0.0
234	ALAMO, NV	05/24/84	09/06/84	0.21	0.20	0.20	0.0
235	CALIENTE, NV	05/24/84	01/10/85	0.27	0.17	0.21	0.0
239	TONOPAH, NV	09/12/84	10/04/84	0.28	0.28	0.28	0.0

ADDENDUM

NON-RADIOLOGICAL SUPPLEMENT TO THE NTS ENVIRONMENTAL MONITORING REPORT

Prepared by:

Industrial Hygiene
Reynolds Electrical and Engineering Co., Inc.

Report Period: Calendar Year, 1984

INTRODUCTION

Environmental compliance activities which are the subject of this report are regulated under Chapter 445 of the state of Nevada Administrative Codes. Chapters 445.131, 445.361, and 445.401 respectively address water pollution control, public water systems, and air pollution. There are a total of 16 facilities which have current State of Nevada operating permits or approval. For common information including site description, geology, land use, etc., reference the EPA Annual Report.

SUMMARY

Water Pollution

No effluent monitoring is required.

Air Pollution

There were no violations of the 14 State air pollution operating permits. No effluent monitoring is required and none was performed. The allowable emissions are established by State-determined operating constraints which were not exceeded.

Ground-water Monitoring

Composite quarterly samples were taken from two wells to monitor changes in nitrate concentration.

MONITORING DATA COLLECTION, ANALYSIS, AND EVALUATION

Air Pollution Control

a. Area 1 Shaker Plant--
Operating restrictions to Permits 922 and 923 were not violated during this period. The facilities were not operated in excess of the allowable hours and an annual production report will be forwarded to the State by April 15, 1985.

b. Area 12 Concrete Batch Plant--
The plant did not exceed the permit restriction of 8 hours per day, nor more than 296 hours per year. An annual report will be forwarded to the State by April 15, 1985.

c. Area 3 Aggregate Plant--
The restrictions to Operating Permit 919 were not exceeded. The plant did not operate in excess of 8 hours per day, nor more than 280 hours per year. An annual production report will be submitted by April 15, 1985.

d. Area 5 Aggregate Plant--
The restrictions to Operating Permit 920 were not exceeded. The plant did nnot operate in excess of 8 hours per day, nor more than 650 hours per year. An annual production report will be submitted by April 15, 1985.

e. Area 5 Surface Area Disturbance--
The restrictions to Permit 921 were not exceeded. A final fugitive dust control plan will be submitted at least six months prior to abandonment of the site.

f. Area 2 Stemming Systems--
The restrictions to Operating Permits 957 and 958 were not exceeded.

g. NTS 4,000,000 BTU/hour or Greater Boiler Permits--
The restrictions to Permits 509 through 513 and 925 were not exceeded. The boilers were not operated in excess of 8,400 hours per year. All boilers used Number 2 fuel oil. An annual analysis of fuel for sulfur and BTU content will be submitted by October 1, 1985.

Ground-water Monitoring

Monthly ground-water samples were collected from Wells Ue5C and Ue5B and composited into calendar year quarterly samples to monitor changes in nitrate concentration. The sample from Well Ue5B was 21.0 milligrams of nitrates per liter (mg/l) and the sample from Well Ue5C was 11.3 mg/l.

TECHNICAL REPORT DATA *(Please read Instructions on the reverse before completing)*		
1. REPORT NO. DOE/DP/0539-055	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE OFFSITE ENFIRONMENTAL MONITORING REPORT Radiation Monitoring Around U.S. Nuclear Test Areas, Calendar Year 1984		5. REPORT DATE 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) G. D. Potter, S. C. Black, R. F. Grossman, R. G. Patzer, and D. D. Smith		8. PERFORMING ORGANIZATION REPORT NO. EPA 600/4-85-035
9. PERFORMING ORGANIZATION NAME AND ADDRESS Environmental Monitoring Systems Laboratory Office of Research and Development U. S. Environmental Protection Agency Las Vegas, Nevada 89114		10. PROGRAM ELEMENT NO. X6EH10 11. CONTRACT/GRANT NO. IAG DE-A108-76DP00539
12. SPONSORING AGENCY NAME AND ADDRESS U. S. Department of Energy Nevada Operations Office P. O. Box 14100 Las Vegas, NV 89114		13. TYPE OF REPORT AND PERIOD COVERED Response - 1984 14. SPONSORING AGENCY CODE EPA 600/07

15. SUPPLEMENTARY NOTES

Prepared for the U. S. Department of Energy under Interagency Agreement No. DE-A108-76DP00539

16. ABSTRACT

This report covers the routine radiation monitoring activities conducted by the Environmental Monitoring Systems Laboratory-Las Vegas in areas which may be affected by nuclear testing programs of the Department of Energy. This monitoring is conducted to document compliance with standards, to identify trends in environmental radiation, and to provide such information to the public. It summarizes these activities for calendar year 1984.

No radioactivity attributable to NTS activities was detectable offsite by the monitoring networks. Using recorded wind data and Pasquill stability categories, atmospheric dispersion calculations based on reported radionuclides releases yield an estimated dose of $1X10^{-3}$ person-rem to the population within 80 km of the Nevada Test Site during 1983. World-wide fallout of Kr-85, Sr-90, Cs-137, and Pu-239 detected by the monitoring networks would cause maximum exposure to an individual of less than 0.6 mrem per year. Plutonium in air was still detectable along with krypton-85, which continued its gradual increase, as has been reported previously. Cesium and strontium in air were near their detection limits. An occasional net exposure to offsite residents has been detected by the TLD network. On investigation, the cause of such net exposures has been due to personal habits or occupational activities, not to NTS activities.

17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
18. DISTRIBUTION STATEMENT RELEASE TO THE PUBLIC	19. SECURITY CLASS *(This Report)* UNCLASSIFIED 20. SECURITY CLASS *(This page)* UNCLASSIFIED	21. NO. OF PAGES 136 22. PRICE

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