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OFF-SITE ENVIRONMENTAL MONITORING REPORT FOR THE NEVADA TEST SITE AND OTHER TEST AREAS USED FOR UNDERGROUND NUCLEAR DETONATIONS

January through December 1978

by

Nuclear Radiation Assessment Division
Environmental Monitoring Systems Laboratory
U.S. ENVIRONMENTAL PROTECTION AGENCY
Las Vegas, Nevada 89114

October 1979

This work performed under a Memorandum of
Understanding No. EY-76-A-08-0539
for the
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PREFACE

The Atomic Energy Commission (AEC) used the Nevada Test Site (NTS) from January 1951 through January 19, 1976, for conducting nuclear weapons tests, nuclear rocket-engine development, nuclear medicine studies, and miscellaneous nuclear and non-nuclear experiments. Beginning on January 19, 1976, these activities became the responsibility of the newly-formed U.S. Energy Research and Development Administration (ERDA), which was later merged with other energy-related agencies to form the U.S. Department of Energy on October 1, 1977. Atmospheric nuclear tests were conducted periodically from January 27, 1951 through October 30, 1958, at which time a testing moratorium was imposed until September 1, 1961. After 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.

The U.S. Public Health Service (PHS), from 1954 through 1970, and the U.S. Environmental Protection Agency (EPA), from 1970 to the present, have maintained facilities at the NTS or in Las Vegas, Nevada, to provide an Off-Site Radiological Safety Program for nuclear testing. In addition, off-site surveillance has been provided by the PHS or EPA for nuclear explosives tests at places other than the NTS. Prior to 1954, the surveillance program was performed by the Los Alamos Scientific Laboratory and U.S. Army personnel.

Since 1954, the objective of this surveillance program has been to measure levels and trends of radioactivity in the off-site 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 deploying routine sampling networks for milk, water, and air; a dosimetry network; and a special sampling of food crops, soil, etc., when required. To implement protective actions, provide immediate radiation monitoring, and obtain environmental samples rapidly after any release of radioactivity, personnel with mobile monitoring equipment are also placed in areas downwind from the NTS or other test areas prior to each test.

Published reports covering specific test series or test projects include the analytical results for radioactivity originating from nuclear tests at the NTS. Beginning in 1959 for reactor tests, and in 1962 for weapons tests, surveillance data for each individual test which resulted in off-site radioactivity was reported separately. Commencing in January 1964, and continuing through December 1970, these individual reports for nuclear tests

were also summarized and reported every 6 months. Individual analytical results for all routine and special milk samples were also included in these semiannual summary reports.

In 1971, the AEC implemented a requirement, now referred to as the DOE Manual, Chapter 0513, that each contractor or agency involved in major nuclear activities provides a comprehensive radiological monitoring report. The entry of these reports into the general literature provide a data base for the environmental impact of nuclear activities.

To provide rapid dissemination of data, all analytical results of all air data collected since July 1971, and all milk and water samples collected since January 1972 were published in Radiation Data and Reports, a monthly publication of the EPA that was discontinued at the end of 1974. During the years 1976 and 1977, air and milk data were reported in quarterly interim reports and distributed to State, Federal, and other organizations interested in the information. Dosimetry data were also included beginning in the third quarter of 1976. In 1978 the interim quarterly reports were discontinued.

Since 1962, PHS or EPA aircraft have also been used during nuclear tests to provide rapid monitoring and sampling for releases of radioactivity. Aircraft monitoring data obtained immediately after a test are used to position mobile radiation monitoring personnel on the ground. The results of airborne sampling are used to quantify the inventories, diffusion, and transport of the radionuclides released. Beginning in 1971, all analytical data from monitoring and aerial sampling have been reported in effluent monitoring data reports in accordance with the DOE Manual, Chapter 0513.

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ACKNOWLEDGMENT

I would like to acknowledge the contribution of Ms. Jaci L. Hopper for the section of this report pertaining to the Dosimetry Network, of James W. Mullins for his contribution to the Quality Assurance Section, and of Robert G. Patzer for his preparation of the section on whole-body counting.

INTRODUCTION

Under Memorandum of Understanding No. EY-76-A-08-0539* with the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), Environmental Monitoring and Support Laboratory-Las Vegas (EMSL-LV), continued its Off-Site Radiological Safety Program within the environment surrounding the Nevada Test Site (NTS) and at other sites designated by the DOE during calendar year 1978. This report, prepared in accordance with the DOE Manual, Chapter 0513, contains summaries of the EMSL-LV dosimetry and sampling methods and analytical procedures, and the analytical results from environmental samples collected in support of the DOE nuclear testing activities. Where applicable, dosimetry and sampling data are compared to appropriate guides for external and internal exposures of humans to ionizing radiation. In addition, a brief summary of pertinent, and demographical, features of the NTS and the NTS environs is presented for background information.

DESCRIPTION OF NEVADA TEST SITE

The major programs conducted at the NTS in the past have been nuclear weapons development, proof-testing and weapons safety, testing of peaceful uses of nuclear explosives (Project Plowshare), reactor-engine development for nuclear rocket and ram-jet applications (Projects Pluto and Rover), basic high-energy nuclear physics research, and seismic studies (Vela Uniform). During this report period, these programs were continued with the exception of Project Pluto, discontinued in 1964; Project Rover, terminated in January 1973; Project Plowshare nuclear tests terminated in 1970; and Vela Uniform studies ceased in 1973. All nuclear weapons tests since 1962 were conducted underground to minimize the possibility of the release of fission products to the atmosphere.

Site Location

The Nevada Test Site (Figures 1 and 2) is located in Nye County, Nevada, with its southeast corner about 90 km northwest of Las Vegas. The NTS has an area of about 3500 km^2 and varies from 40-56 km in width (east-west) and from 64-88 km in length (north-south). This area consists of large basins or flats about 900-1200 m above mean sea level (MSL) surrounded by mountain ranges rising to 1800-2100 m above MSL.

The NTS is surrounded on three sides by exclusion areas collectively named the Nellis Air Force Range. The Range, particularly to the north and east, provides a buffer zone between the test areas and public lands. This buffer zone varies from 24-104 km between the test area and land that is open to the

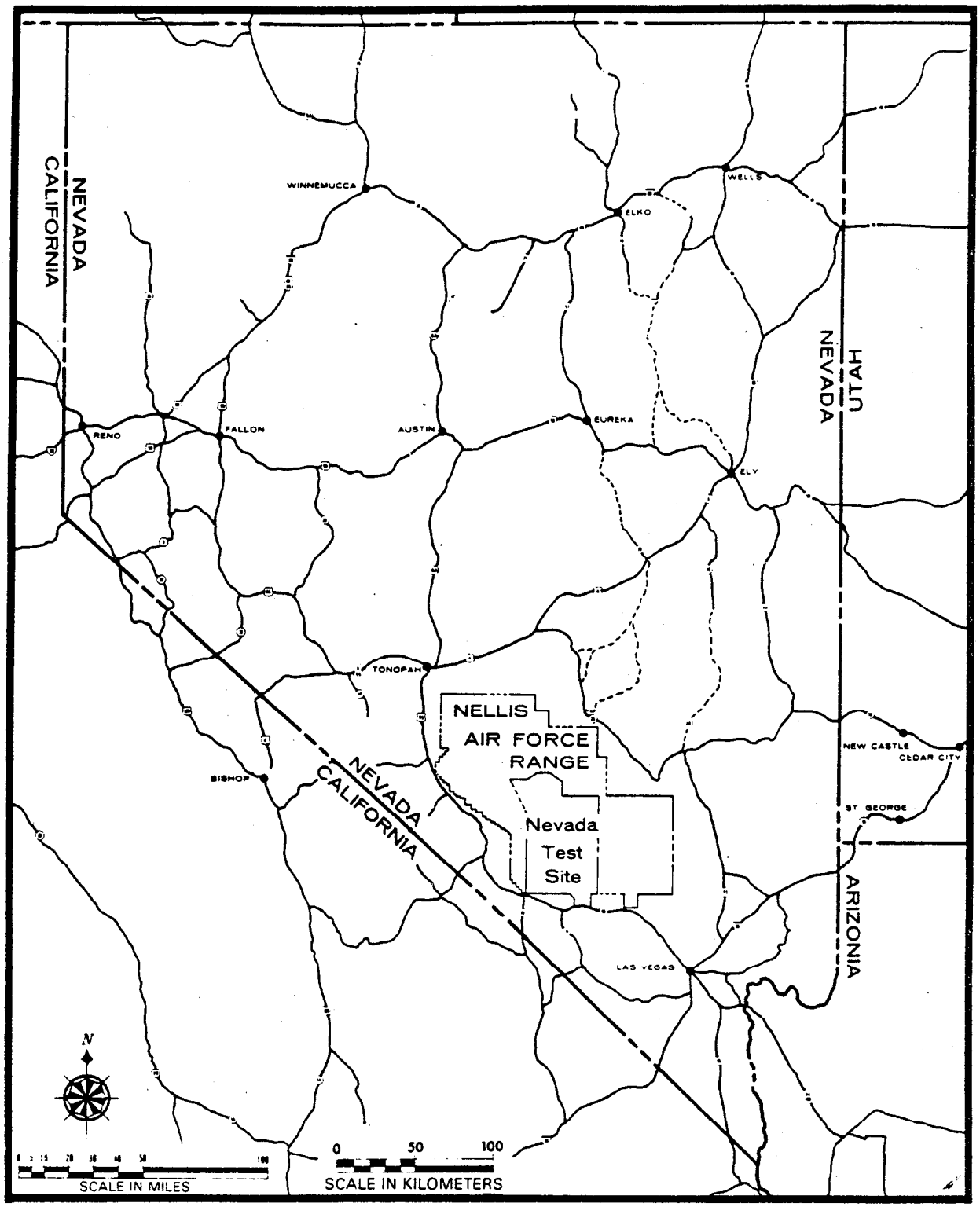

Figure 1. Nevada Test Site Location.

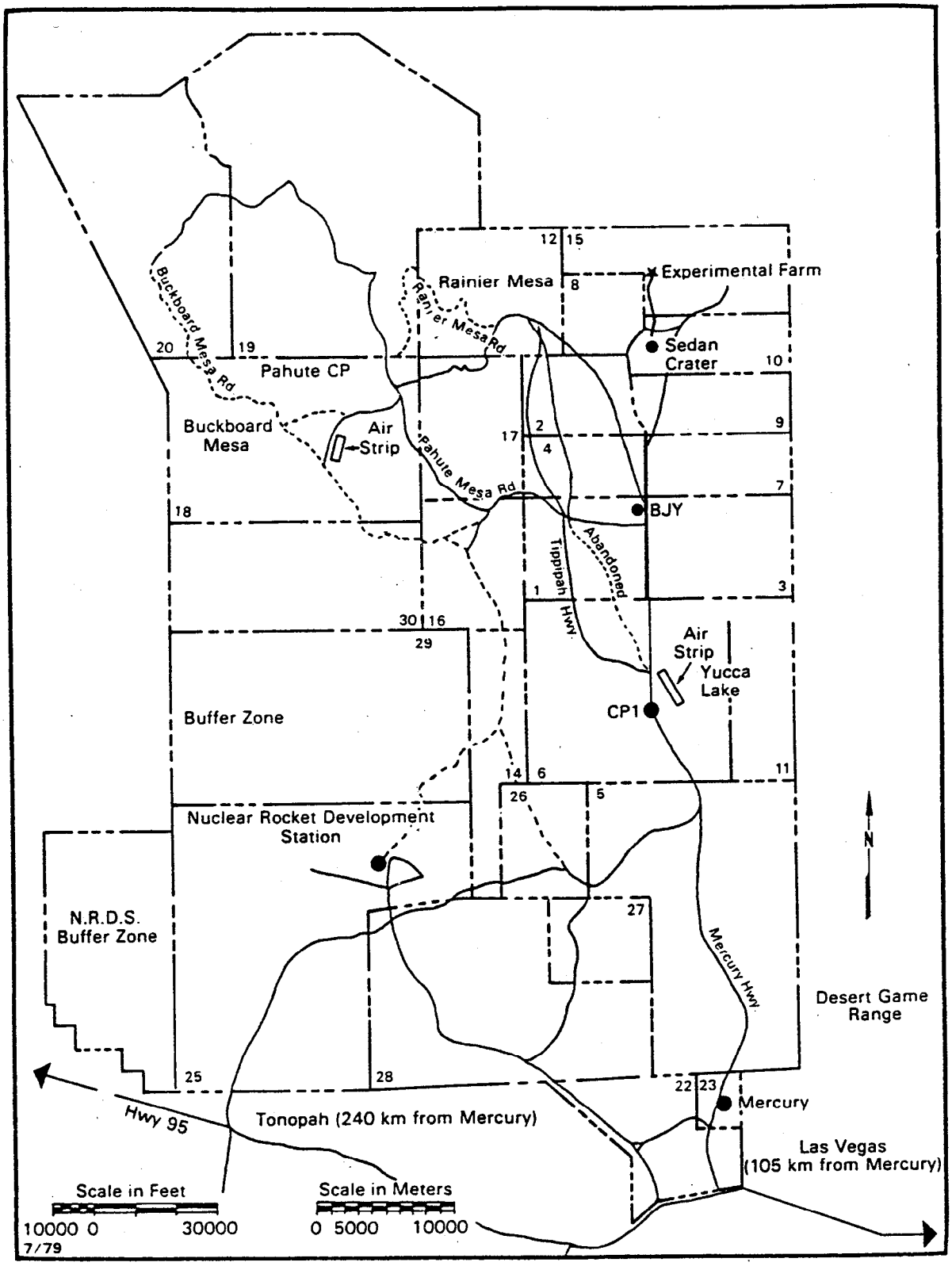

Figure 2. Nevada Test Site Road and Facility Map.

public. Depending upon wind speed and direction within the accepted range of testing criteria, this provides a delay of from 1/2 to more than 6 hours before any accidental release of airborne radioactivity could pass over public lands.

Climate

The climate of the NTS and surrounding area is variable, primarily due to altitude and the rugged terrain. Generally, the climate is referred to as Continental Arid. Throughout the year, there is insufficient water to support tree or crop growth without irrigation.

The climate may be classified by the types of vegetation which grow under these conditions. According to Houghton et al. (1975), this method, developed by Koppen's classification of dry conditions, is further subdivided on the basis of temperature and severity of drought. Table 1, from Houghton et al., summarizes the different characteristics of these climatic types in Nevada.

As pointed out by Houghton et al., 90 percent of Nevada's population lives in areas with less than 25 cm of rain per year or in areas which would be classified as mid-latitude steppe to low-latitude desert regions.

According to Quiring (1968), the NTS average annual precipitation ranges from about 10 cm at the 900-m altitude to around 25 cm on the plateaus. During the winter months, the plateaus may be snow-covered for periods 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 50° (25°) F in January and 95° (55°) F in July, with extreme daily averages of 110° F and -15° F. Corresponding temperatures on the plateaus are 35° (25°) F in January and 80° (65°) F in July with extremes of 100° and -20° F. Temperatures as low as -30° F and higher than 115° F have been observed at the NTS.

The wind directions, as measured on a 30-m tower at an observation station about 9 km NNW of Yucca Lake (Table 2), is predominantly northerly except during the months of May through August when winds from the south-southwest predominate. Because of the prevalent mountain/valley winds in the basins, south to southwest winds predominate during daylight hours during 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 (Quiring, 1968).

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, including subsurface studies of numerous boreholes, the surface and underground geological and hydrological characteristics for much of the NTS are known in considerable detail. This is particularly true for those areas in which underground experiments are conducted. A comprehensive summary of the geology and hydrology of the NTS was edited and published by Eckel (1968).

TABLE 1. CHARACTERISTICS OF CLIMATIC TYPES IN NEVADA

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

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

TABLE 2. NTS STATION 6 SURFACE WIND SUMMARY*
2.8 km SE BJY, NTS

Wind Direction	Observed Frequency	Percent Frequency	Percent Frequency Within ±10°	Average Wind Speed (m/s)
360	1778	5.9	17.9	3.7
350	2066	6.8	18.7	3.4
340	1825	6.0	16.7	3.3
330	1188	3.9	12.5	3.5
320	768	2.5	7.9	2.8
310	456	1.5	5.2	2.5
300	354	1.2	3.5	2.3
290	258	0.9	2.8	2.4
280	244	0.8	2.3	2.3
270	198	0.7	2.2	2.1
260	220	0.7	2.3	2.4
250	281	0.9	2.8	2.6
240	354	1.2	4.2	3.7
230	627	2.1	6.1	4.5
220	862	2.8	8.4	5.2
210	1055	3.5	10.4	5.4
200	1225	4.0	12.2	5.6
190	1415	4.7	12.9	5.5
180	1280	4.2	12.9	5.0
170	1219	4.0	11.5	4.1
160	993	3.3	9.9	3.4
150	800	2.6	8.1	3.0
140	678	2.2	6.6	2.6
130	529	1.7	5.3	2.2
120	414	1.4	4.3	2.0
110	356	1.2	3.8	2.2
100	388	1.3	3.6	2.4
90	358	1.2	3.6	2.5
80	361	1.2	3.6	2.3
70	374	1.2	3.8	2.5
60	415	1.4	4.7	2.6
50	649	2.1	6.2	2.7
40	813	2.7	8.4	3.0
30	1080	3.6	10.9	4.5
20	1414	4.7	13.5	5.0
10	1600	5.3	15.8	4.3

*All readings are taken 30 m above the surface, which is at an elevation of 1225 m above sea level (Quiring, 1979).

There are two major hydrologic systems on the NTS (Figure 3). Groundwater in the northwestern part of the NTS or in the Pahute Mesa area has been reported to travel somewhere between 2 and 180 m per year to the south and southwest toward the Ash Meadows discharge area in the Amargosa Desert (ERDA-1551, September 1977). It is estimated that the groundwater to the east of the NTS moves from north to south at a rate of not less than 2 nor greater than 220 m per year. Carbon-14 analyses of this eastern groundwater indicate that the lower velocity is nearer the true value. At Mercury Valley, in the extreme southern part of the NTS, the groundwater flow direction shifts to the southwest toward the Ash Meadows discharge area in the southeastern Amargosa Valley.

The water levels below the NTS vary from depths of about 100 m beneath the surface at valleys in the southeastern part of the site to more than 600 m beneath the surface at highlands to the north. Although much of the valley fill is saturated, downward movement of water is extremely slow. The primary aquifer in these formations is the Paleozoic carbonates which underlie the more recent tuffs and alluviums.

Land Use of NTS Environs

Figure 4 is a map of the off-NTS area showing general land use. A wide variety of uses, such as farming, mining, grazing, camping, fishing, and hunting, exist due to the variable terrain. For example, within a 300-km radius west of the NTS, elevations range from below sea level in Death Valley to 4420 m above MSL in the Sierra Nevada Range. Additionally, parts of two valleys of major agricultural importance (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 small-scale but intensive farming of a variety of crops by irrigation. 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-related activity is grazing of both cattle and sheep. Only areas of minor agricultural importance, primarily the growing of alfalfa hay, are found in this portion of the State within a distance of 300 km.

In the summer of 1974, a brief survey of home gardens around the NTS showed that a majority of the residents grow or have access to locally grown fruits and vegetables. Approximately two dozen of the surveyed gardens within 30-80 km of the NTS boundary were selected for sampling. These gardens produce a variety of root, leaf, seed, and fruit crops (Andrews and Vandervort, 1978).

The only industrial enterprises within the immediate off-NTS area are 31 active mines and mills, two oil fields at Trap Springs and Eagle Springs, as shown in Figure 4, and several chemical processing plants located near Henderson, Nevada (about 23 km south of Las Vegas). The number of employees for these operations varies from one person at several small mines to several hundred workers for the oil fields north of NTS and the chemical plants at Henderson. Most of the individual mining operations involve less than 10 workers per mine; however, a few operations employ 100-250 workers.

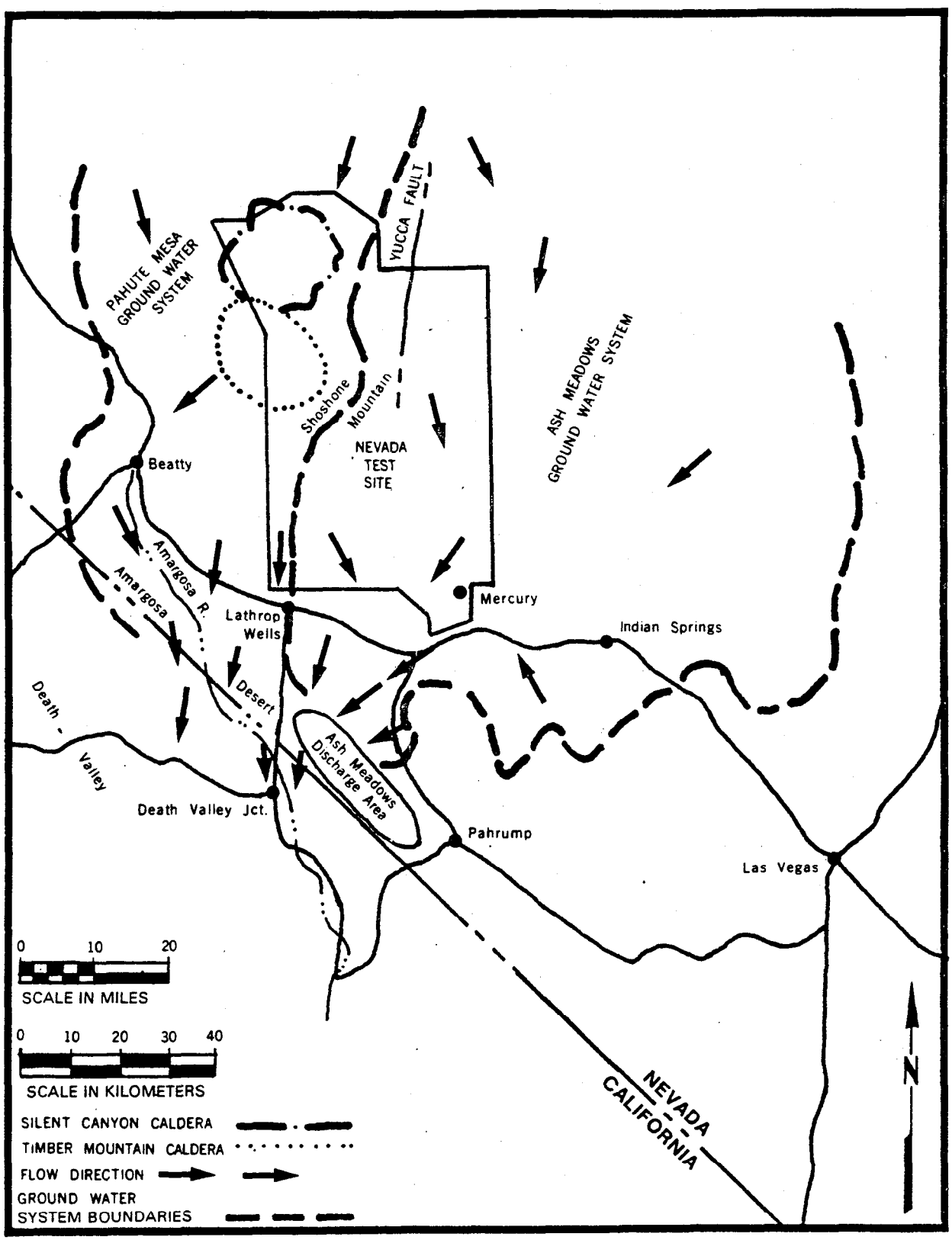

Figure 3. Groundwater Flow Systems - Nevada Test Site.

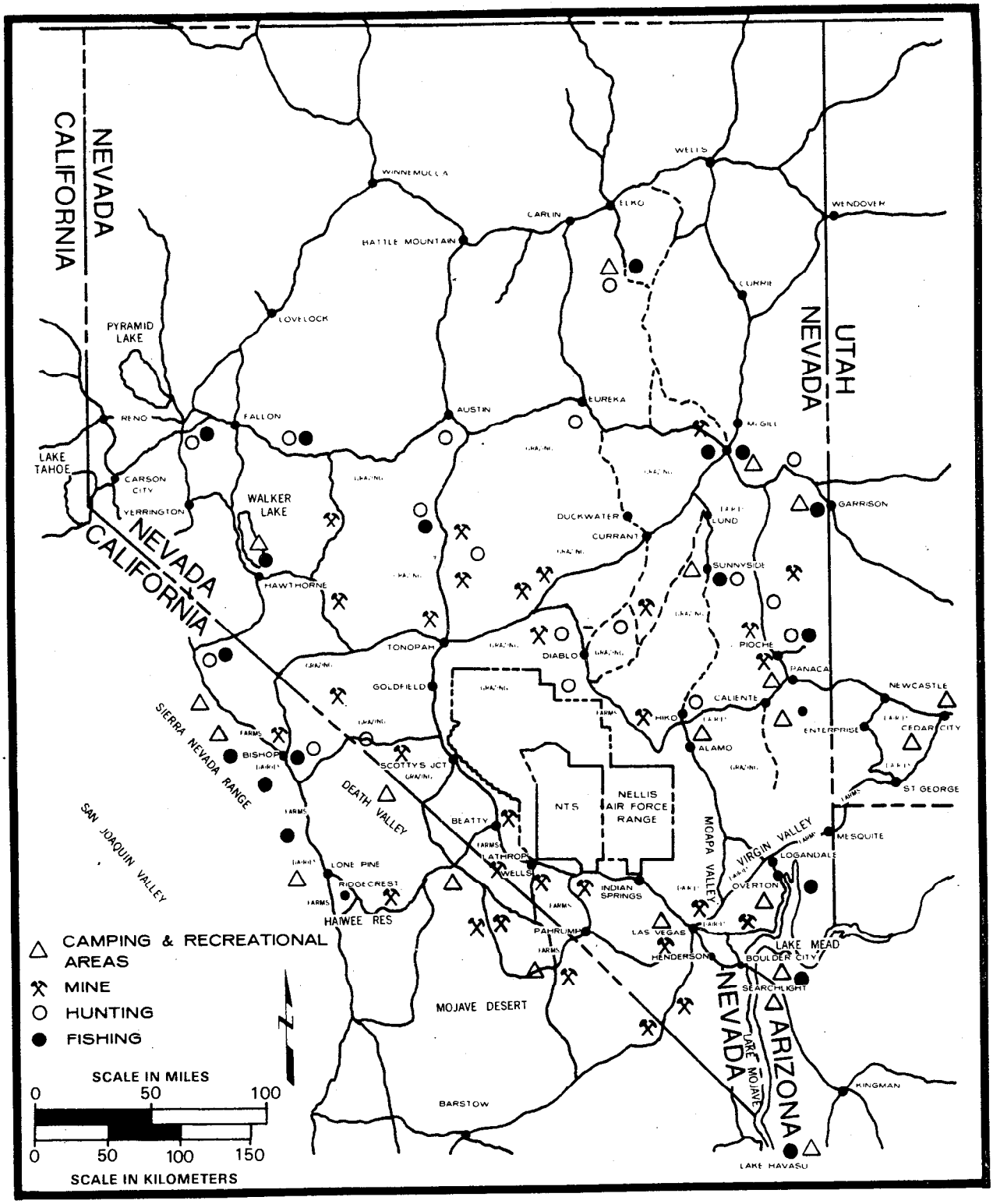

Figure 4. General Land Use, Nevada Test Site Vicinity.

The major body of water close to the NTS is Lake Mead (100 km southeast) a man-made 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, and a portion of the water is used by southern California. Smaller reservoirs and lakes located in the area are primarily for irrigation and for livestock. In California, the Owens River and Haiwee Reservoir feed into the Los Angeles Aqueduct and are the major sources of domestic water for the Los Angeles area.

As indicated in Figure 4, there are many places scattered in all directions from the NTS where such recreational activities as hunting, fishing, and camping are enjoyed by both local residents and tourists. 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 with the most extensive activities occurring during all months except the hot summer months. All hunting is generally restricted to various times during the last 6 months of the year.

Dairy farming is not extensive within the 300-km-radius area under discussion. A survey of milk cows during the summer of 1977 showed 8800 dairy cows, 419 family milk goats, and 464 family milk cows in the area. The family cows and goats are distributed in all directions around the test site (Figure 5), whereas the dairy cows (Figure 6) are primarily located southeast of the test site (Moapa River Valley, Nevada; Virgin River Valley, Nevada; and Las Vegas, Nevada), northeast (Lund area), and southwest (near Barstow, California).

Grazing of beef cattle and sheep is the most common use of the land in this area. Approximately 350,000 beef cattle and 160,000 sheep (Utah Dept. of Agriculture, 1978) were produced within the 300-km radius surrounding the test site during this report period. The distribution of the beef cattle and sheep by county are shown in Figures 7 and 8, respectively.

Population Distribution

The populated area of primary concern around the NTS which is sampled and monitored by surveillance networks is shown in Figure 9 as the area within a 300-km radius of the NTS Control Point (CP-1), except for the areas west of the Sierra Nevada Mountains and in the southern portion of San Bernardino County. Based upon the projections for the year 1977 by the U.S. Bureau of the Census and the 1978 projections for Washoe and Clark Counties by the University of Nevada (Reno), Figure 9 shows the current population of counties in Nevada and pertinent portions of the States of Arizona, California, and Utah. Las Vegas and vicinity is the only major population center within the inscribed area of Figure 9. With the assumption that the total populations of the counties bisected by the 300-km radius lie within the inscribed area, there is a population of about 548,100 people living within the area of primary concern, about 70 percent of which lives in the Las Vegas urbanized area. If the urbanized area is not considered in determining population density, there are about 1.5 persons per mi^2. For comparison, the United States (50 states, 1970 census) has a population density of 57 persons per

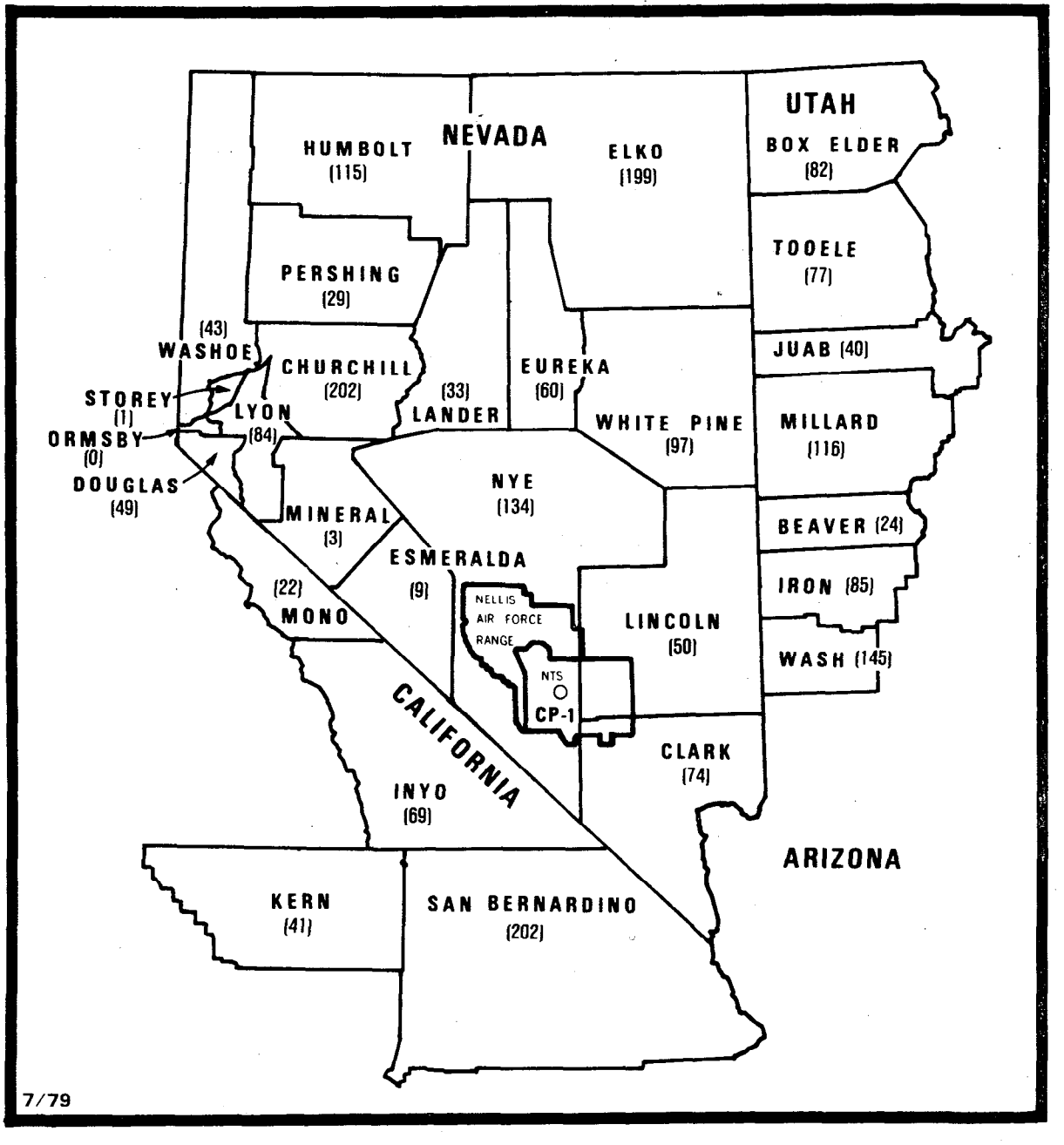

Figure 5. Location and Number of Family Milk Cows and Goats.

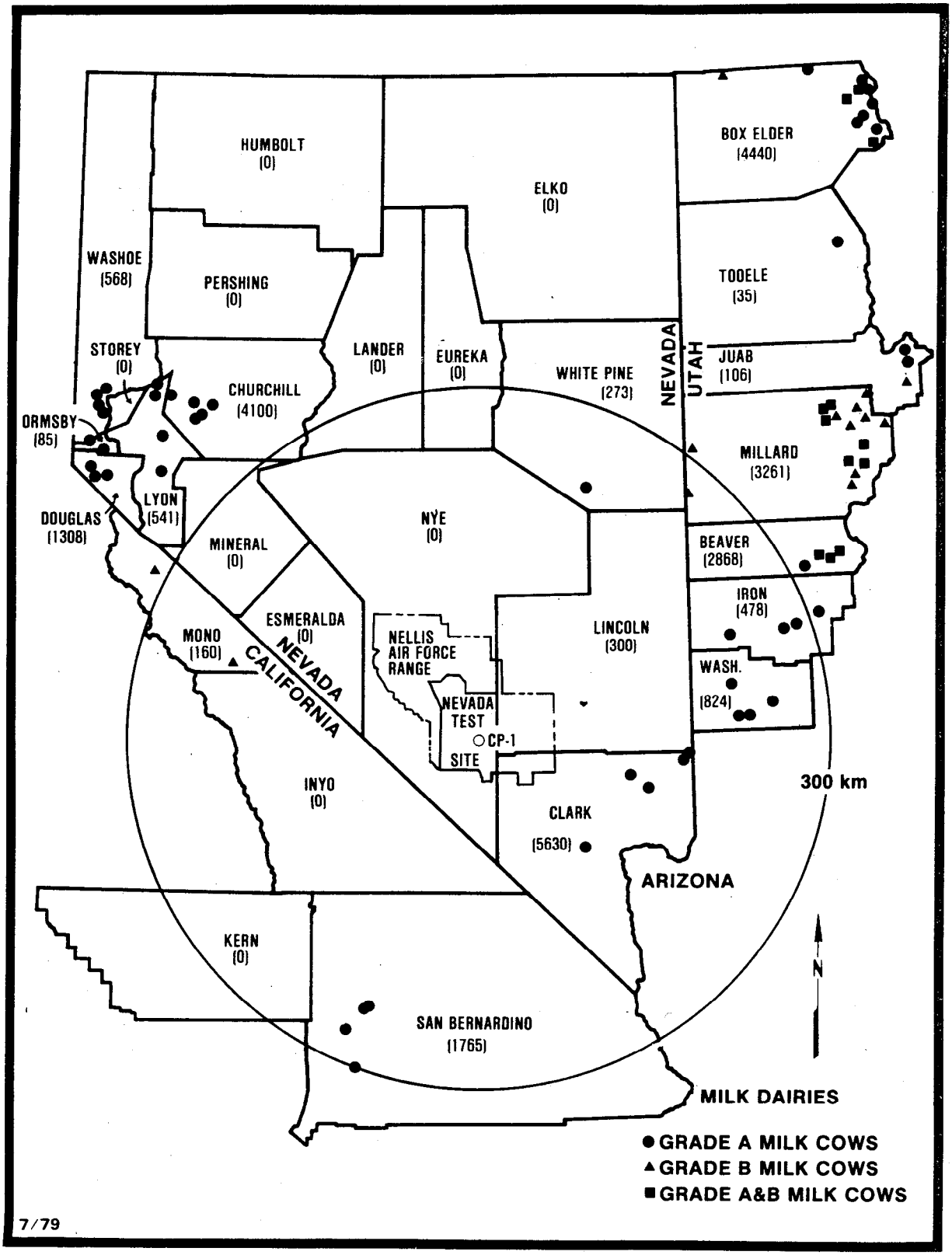

Figure 6. Location and Number of Dairy Cows.

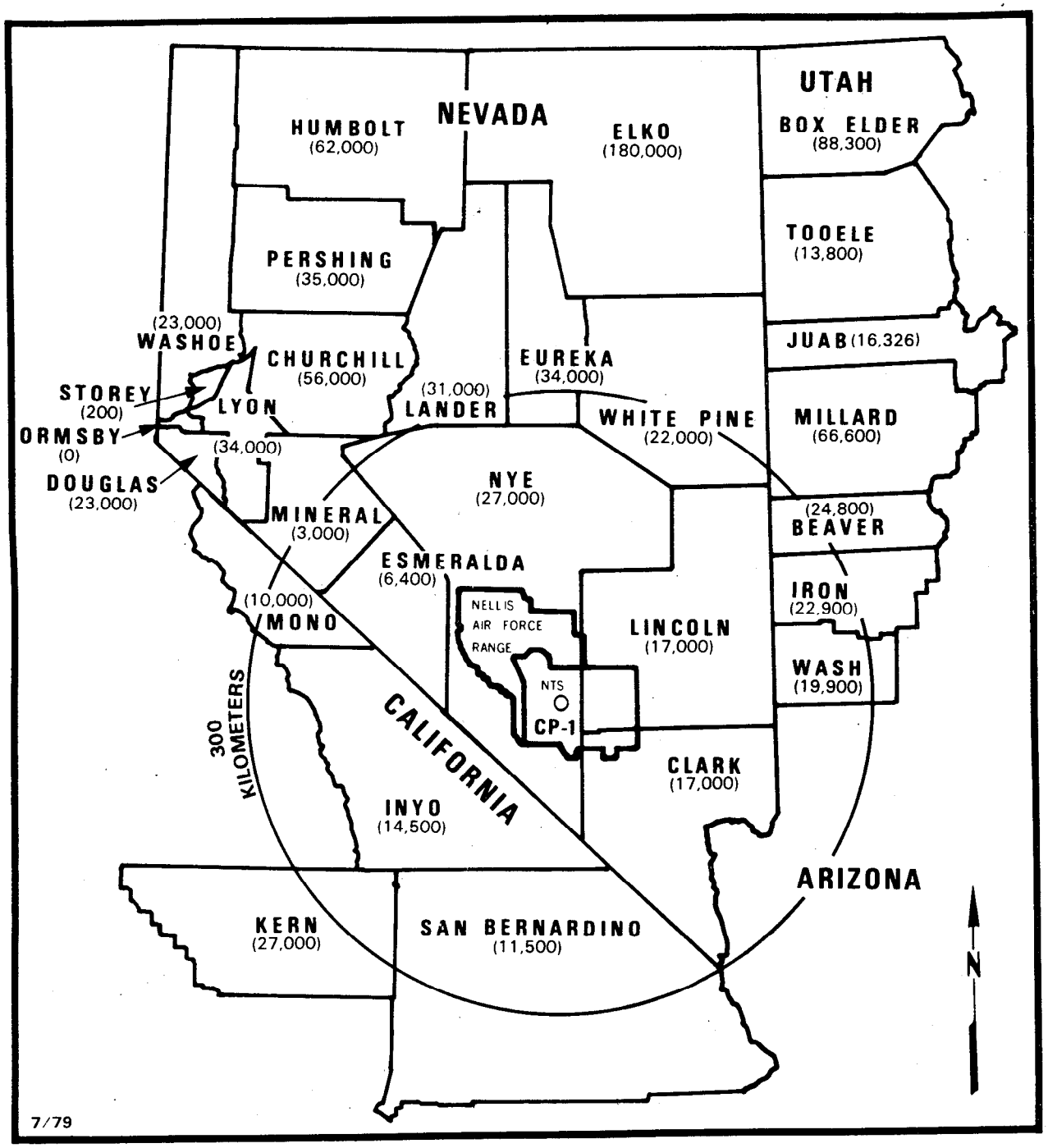

Figure 7. Distribution of Beef Cattle by County.

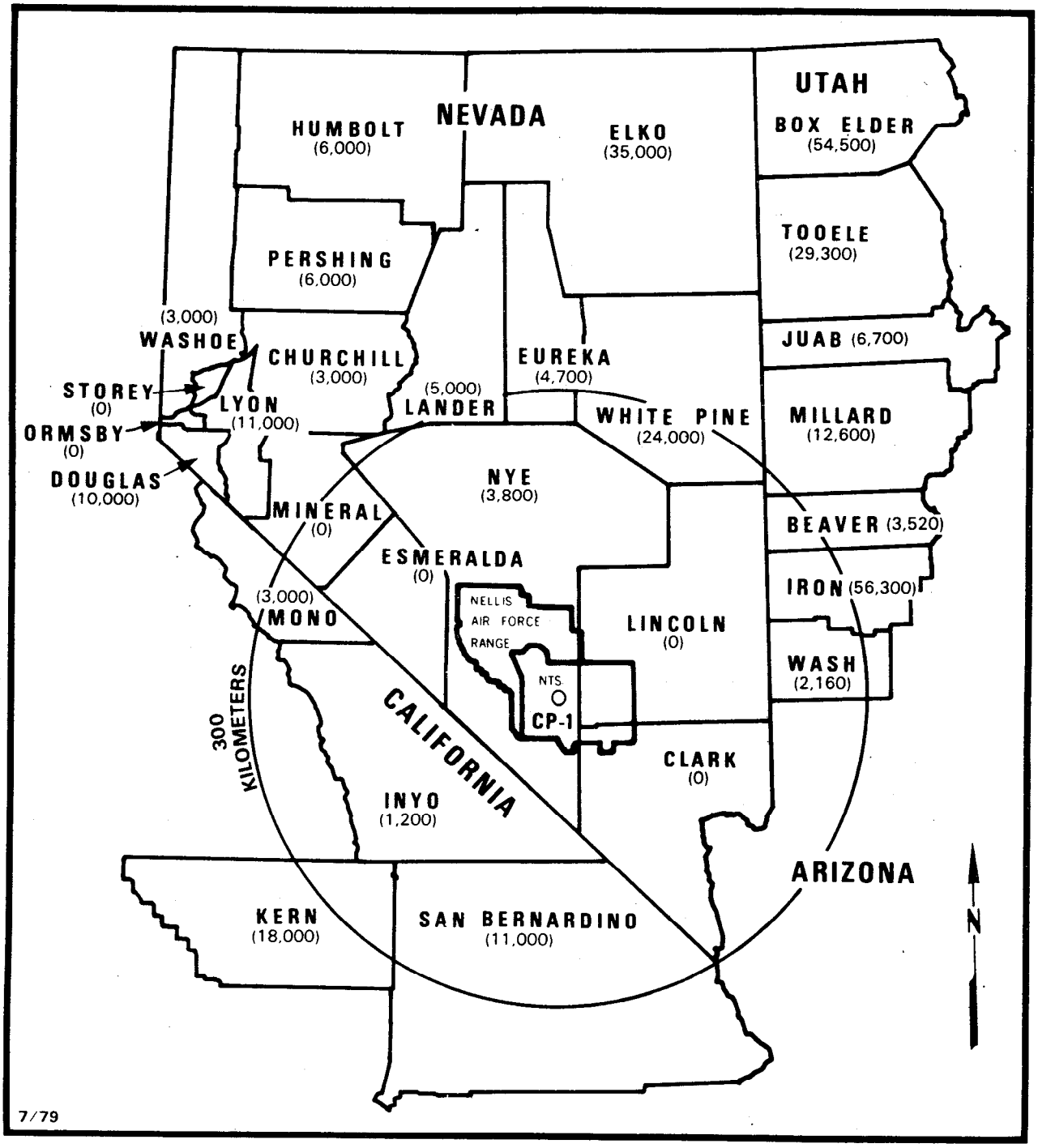

Figure 8. Distribution of Sheep by County.

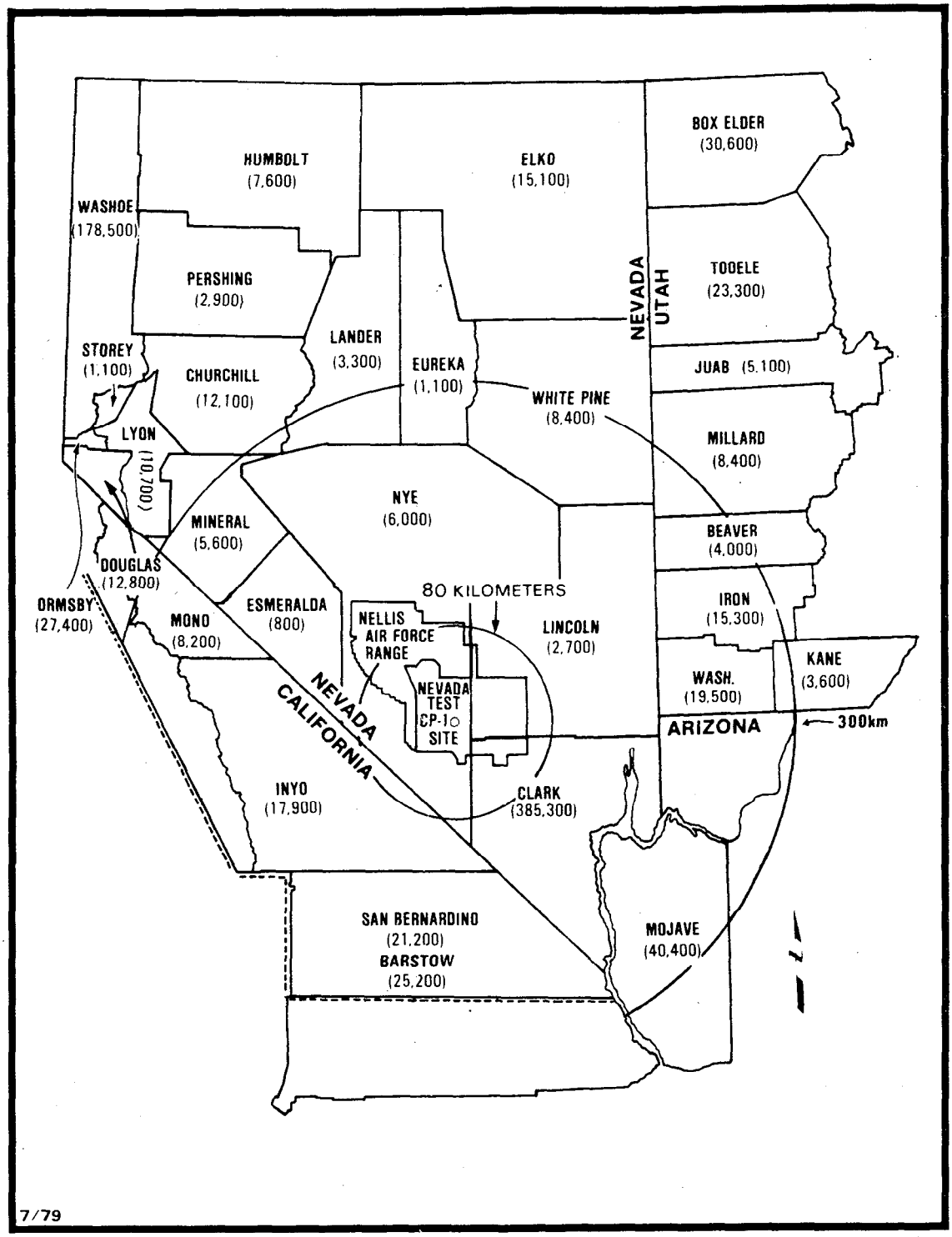

Figure 9. Population of Arizona, California, Nevada, and Utah Counties Near the Nevada Test Site.

square mile, and the overall Nevada average from the 1977 estimate is 6.2 persons per mi^2.

The off-site areas within about 50 mi of the NTS are 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 3600, is located about 45 mi south of the NTS CP-1. The Amargosa Farm area has a population of about 1000 and is located about 31 mi southwest of CP-1. The Spring Meadows Farm area, located about 35 mi southwest of CP-1, consists of approximately 4000 square miles with a total population of about 15. The largest town in the near off-site area is Beatty with a population of about 600; it is located about 65 km to the west of CP-1.

In the adjacent states, the Mojave Desert of California, which includes Death Valley National Monument, lies along the southwestern border of Nevada. According to the California Population Research Unit (1979), the population within the Monument boundaries varies considerably from season to season from a minimum of 1400 permanent residents in the area during the summer months to as many as 15,000 tourists and campers in the area on any particular day during the major holiday periods in the winter months. The largest town and contiguous populated areas in this general area is Barstow, located 265 km south-southwest of the NTS, with a population of about 25,200. The next largest populated area is the Ridgecrest-China-Lake area (20,000), 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 5300 including contiguous populated areas.

The extreme southwestern region of Utah is more developed than the adjacent part of Nevada. The largest town, Cedar City, with a population of 10,711, is located 280 km east-northeast of the NTS. The next largest community is St. George, located 220 km east of the NTS, with a population of 9051.

The extreme northwestern region of Arizona is mostly undeveloped range land with the exception of that portion in the Lake Mead Recreation Area.

Several small retirement communities are found along the Colorado River, primarily at Lake Mojave and Lake Havasu. The largest town in the area is Kingman, located 280 km southeast of the NTS, with a population of about 8000.

AIRBORNE RELEASES OF RADIOACTIVITY AT THE NTS DURING 1978

During this report period, only underground nuclear detonations were conducted. All detonations were contained. However, during re-entry drilling operations, occasional low level releases of airborne radioactivity, primarily radioxenon, did occur. According to information provided by the Nevada Operations Office, DOE, the following quantities of radionuclides were released into the atmosphere during CY 1978:

TABLE 3. TOTAL AIRBORNE RADIONUCLIDE RELEASES AT THE NEVADA TEST SITE

Radionuclide	Quantity Released (Ci)
^{3}H	90.470
^{85}Kr	15.000
^{131}I	0.0001
^{133}Xe	8.213
^{133}Xe	1.44
^{133}Xe	0.369
Total	115.4921

There is a continuous low-level release of tritium and krypton-85 on the NTS. Tritium is released primarily from the Sedan crater and by evaporation from ponds formed by drainage of water from tunnel test areas in the Rainier Mesa. Krypton-85 slowly seeps to the surface from underground test areas. The quantity of radioactive seepage has not been quantified, but has been detected at on-site sampling locations and occasionally at off-NTS locations.

DESCRIPTION OTHER TEST SITES

Table A-1 lists the names, dates, locations, yields, depths, and purposes of all underground nuclear tests conducted at locations other than the NTS. No off-NTS nuclear tests were conducted during this report period.

For the purpose of this report a large body of data and ancillary information which is too bulky for inclusion in the report has been placed in the Appendices. Where possible this information has been summarized either in some of the text tables or is discussed directly in the report. In some instances, for the convenience of readers who require the more detailed information, references to the appendices will be included in the text.

SUMMARY

During 1978, the monitoring of gamma radiation levels in the environs of the NTS was continued through the use of an off-site network of radiation dosimeters and gamma-rate recorders. Concentrations of radionuclides in pertinent environmental media were also continuously or periodically monitored by established air, milk, and water sampling networks. Before each underground nuclear detonation, mobile radiation monitors, equipped with radiation monitoring instruments and sampling equipment, were on standby in off-NTS locations to respond to any accidental release of airborne radioactivity. An airplane was airborne near the test area at detonation time to track and sample any release which might occur.

All radioactivity from the underground nuclear tests was contained except for a total of about 115 curies (Ci) of radioactivity which was reported by DOE/NV as being released intermittently throughout the year by post-shot drilling operations, and small undetermined amounts of radioxenon, tritium, and krypton-85 which slowly seep to the surface from the underground test areas.

The only off-NTS indication of this radioactivity was xenon-133 (concentration, 6.5×10^{-11} µCi/ml) in an air sample collected at Diablo, Nevada, during the period April 19 to 26 and tritiated hydrogen (HT) in two air samples collected at Indian Springs, Nevada, during the periods November 13 to 20 (2.4×10^{-11} µCi/ml) and November 27 to December 4 (1.8×10^{-11} µCi/ml). The estimated whole-body dose equivalents estimated to a hypothetical receptor at these locations were estimated to be 6.2 microrem (µrem) at Diablo and 5.8 microrem (µrem) at Indian Springs. Based upon the respective populations at these locations, 6 persons and 1500 persons, the dose commitment(*) was estimated to be 0.000037 person-rem at Diablo and 0.0087 person-rem at Indian Springs. As Diablo is beyond the 80 km-radius of the NTS Control Point, the 80-km dose commitment would be 0.0087 person-rem.

All other measurements of radioactivity made by the Off-Site Radiological Safety Program were attributed to naturally occuring radioactivity or worldwide fallout and not related to underground nuclear test operations during this report period. Radioactivity from the atmospheric nuclear tests by the People's Republic of China on March 15, 1978, at 0100 hours, EST, and December 14, at 0100 hours, EST, was detected on filter samples of the Air Surveillance Network collected in March, April, and December. The tests resulted in increases of airborne radioactivity and the specific radionuclides identified by the Air Surveillance Network were zirconium-95, moloybdenum-99, ruthenium-103, iodine-131, tellurium-132, cesium-137, barium-140, cerium-141, and curium-144.

(*) Product of estimated average dose equivalent and population.

The Long-Term Hydrological Monitoring Program used to monitor radionuclide concentrations in surface and groundwaters which are down the hydrologic gradient from sites of past underground nuclear tests was continued for the NTS and eight other sites located elsewhere in Nevada, Alaska, Colorado, New Mexico, and Mississippi.

Radioactivity from past underground nuclear tests was observed only in surface or well water samples at the Project Dribble site near Baxterville, Mississippi, and at the Project Long Shot site on Amchitka Island, Alaska. At Project Dribble site, the water sample collected from the Half Moon Creek Overflow had a tritium concentration (2.7×10^{-6} µCi/ml) that was higher than background. A special survey for tritium in subsurface soil moisture, at this site during the periods September 12 to 19, 1977, and April 18 to 27, 1978, revealed significant tritium contamination below the ground surface; the highest tritium concentration found was 1.0×10^{-3} µCi/ml in soil moisture at a depth of 10 ft in a drilled hole 25 ft southeast of surface ground zero. This value is 30 percent of the Concentration Guide (3.0×10^{-3} µCi/ml) for an individual in a controlled or uncontrolled area and is 50 times the maximum permissible level for tritium set by the EPA Drinking Water Regulations (2.0×10^{-5} µCi/ml), although the ground water in this area is not used for drinking.

The source of tritium is believed to be the residual from the post-shot drilling operations and not from leakage of radioactivity from the detonation cavity at a depth of 2700 ft. All of the tritium contamination was confined to the subsurface. None was detected in any surface water other than the Half Moon Creek Overflow nor in any of the off-site well samples. No off-site residents are suspected of being exposed to the waterborne tritium. The nearest populated area to the site is a residence, which is about 1 mile south-southwest of surface ground zero.

The above background concentrations of tritium found in several water samples collected from shallow wells and surface waters at the Project Long Shot site on Amchitka Island, Alaska, ranged from 2.8×10^{-7} µCi/ml to 7.3×10^{-6} µCi/ml. This range in concentrations is comparable to that found in samples collected during 1977 by EPA and during previous years by the U.S. Geological Survey and the University of Washington. The highest tritium concentration was found to be only 0.24 percent of the Concentration Guide. This water is not used for drinking purposes, therefore this tritium contamination was found to pose no radiological hazard.

MONITORING DATA COLLECTION, ANALYSIS, AND EVALUATION

The major portion of the Off-Site Radiological Safety Program for the NTS consisted of continuously operated dosimetry and air sampling networks and scheduled collections of milk and water samples at locations surrounding the NTS. Before each nuclear test, mobile monitoring personnel were positioned in the off-site areas most likely to be exposed to a possible release of radioactive material. These monitors, equipped with radiation survey instruments, gamma exposure-rate recorders, thermoluminescent dosimeters (TLD's), portable air samplers, and supplies for collecting environmental samples, were prepared to conduct a monitoring program directed from the NTS Control Point (CP-1) via two-way radio communications. In addition, for each event at the NTS, a U.S. Air Force aircraft with two Reynolds Electrical and Engineering Company monitoring personnel equipped with portable radiation survey instruments was airborne near surface ground zero to detect and track any radioactive effluent. One EMSL-LV cloud sampling and tracking aircraft was also available to obtain in-cloud samples, assess total cloud volume, and provide long-range tracking in the event of a release of airborne radioactivity.

This report contains descriptions for each surveillance network and interpretations of the analytical results. These analytical results are summarized (maximum, minimum, and arithmetic average concentrations) in Appendix A. Where appropriate, the arithmetic averages in the tables are compared to the applicable DOE Concentration Guides (CG's) listed in Appendix B. Unless specifically stated otherwise, all concentration averages are arithmetic averages.

For "grab" type samples, radionuclide concentrations were corrected for radioactive decay by extrapolating to the appropriate collection date. Concentrations determined over a period of time were extrapolated to the mid-point of the collection period. Beginning in 1978, concentration averages were calculated from each measured concentration including those less than the minimum detectable concentration (MDC). During prior years, concentration averages were calculated assuming that each concentration less than the MDC was equal to the MDC. Due to the large number of radionuclides that can be present below the MDC in air, those concentrations less than the MDC were assumed to be zero for the computation of concentration averages, and only those radionuclides detected during the year were averaged by the above new method and reported.

Beginning in 1978, the definition of the minimum detectable concentration for all analyses was redefined as the total counting error resulting from the sum of a 5 percent Type I error (accepting the presence of radioactivity when none is present) and a 5 percent Type II error (failure to recognize the

presence of radioactivity when it is present). This essentially increased the MDC's about a factor of two compared with the MDC values used in prior years, defined as the two-sigma counting error for determinations that were equal to or less than the two-sigma error.

QUALITY ASSURANCE

The quality assurance program for laboratory analyses consists of a combination of instrumental quality control procedures, the analysis of replicate samples to measure precision, and the analysis of cross-check samples from an independent laboratory to measure the accuracy of analyses.

The instrumental quality control procedures consist of calibration, background quality control, and reference standard quality control.

The counting systems are calibrated by using a standard radionuclide solutions obtained from the Quality Assurance Branch at EMSL-LV or in some cases directly from the National Bureau of Standards. These standards are then made up into the appropriate counting standards; several different geometries for gamma counting, planchets with varying thickness of solids for gross alpha-beta and strontium analyses by gas proportional counting, liquid scintillation vials with the appropriate scintillant for liquid scintillation counting, and electroplated sources for alpha spectroscopy. These standards are used to determine the counting efficiency of the various detectors using the same conditions used to count the samples.

The dosimetry system used for measuring external gamma radiation exposures with thermoluminescent dosimeters (TLD's) is calibrated by exposing TLD's to a known amount of radiation and reading them out at timed intervals for comparison with any given batch of TLD's being read out under normal operating conditions. The TLD's exposed to a known quantity of radiation defines the linear relationship between the exposure measured in mR and TLD thermoluminescence in nanocoulombs. The known radiation exposure used to calibrate the TLD's is determined from the theoretical estimate of the gamma field from the radiation source and actual measurements of the gamma field by using an ion chamber. Both the radiation source and the ion chamber are calibrated by an independent organization in accordance with procedures that are traceable to the National Bureau of Standards.

Background quality control for all laboratory systems is maintained by the periodic background measurements for each system. The backgrounds are plotted on control charts to check trends and to determine whether individual measurements are within required limits. Background quality control is especially important on instruments such as alpha spectrometers and germanium diodes where the backgrounds are extremely low.

Quality control for reference standards is basically the same for all laboratory instruments although the details of application are different. A reference standard is one which produces a consistent response for the instrument with which it is used. The idea is to plot on a quality control chart the reproducibility (within limits) of instrument response versus time.

The response for planchet and liquid scintillation counters is a count rate of the standard. For gamma and alpha spectrometers several responses are plotted, i.e., count rate, energy for each peak location from a multi-peaked standard, difference(s) in energy between peaks, and resolution of the peaks. For the dosimetry system, the response is the luminescence, measured in coulombs, from a constant light source.

The precision of the laboratory analyses as influenced by sampling, analytical errors, and counting errors, is estimated through a program of replicate analysis and sampling. About 10 percent of the routine samples are split, and the pairs are both analyzed individually to obtain an estimate of the analytical and counting errors combined. The total error, the above errors plus any sampling error, is estimated from replicate sampling. About 10 percent of the sampling workload is collected in duplicate, except for the dosimetry network, in which six replicate exposures are assessed for each location. The results of the replicate sampling program (Appendix C) are then used to identify those results that are significantly different than those obtained in the past.

Accuracy checks are made by the analyzing laboratory intercomparison samples provided by the Quality Assurance Branch, EMSL-LV (EPA 1979). These intercomparison samples are simulated environmental samples containing known amounts of one or more radionuclides. The intercomparison samples are analyzed by the laboratory and the results are sent to the Quality Assurance Branch for statistical analysis and comparison with the known value and analytical values obtained by other participating laboratories. The intercomparisons are performed bimonthly, quarterly, and semiannually, depending upon the type of sample. A report and a control chart for each type of analysis are returned to each participant. The identities of the participants are coded with each participant knowing his own code, but not those of the other participants. The report sent to each participant lists the individual results (analyses are done in triplicate), the mean and the experimental standard deviation of the three results, the mean range plus the standard deviation of the range, the known value, and the number of standard deviations of each participant's mean value from the grand average of all results and from the known value.

In general, the 1978 analyses were within acceptable limits, except for the strontium-89 and strontium-90 analyses in milk and water. However, none of the analytical results were different from the known values by more than 25 percent. Intercomparison results for 1978 are summarized in the Appendix (Table A-3).

AIR SURVEILLANCE NETWORK

The Air Surveillance Network (ASN) was operated by the EMSL-LV to monitor environmental levels of radioactivity and to detect any airborne release of radioactivity from NTS operations. The Network consisted of 49 active and 73 standby sampling stations located in 21 Western States (Figures 10 and 11). Samples of airborne particulates were collected at each active station on 10-cm diameter, glass-fiber filters from air volumes totaling 500 to 1200 m^3

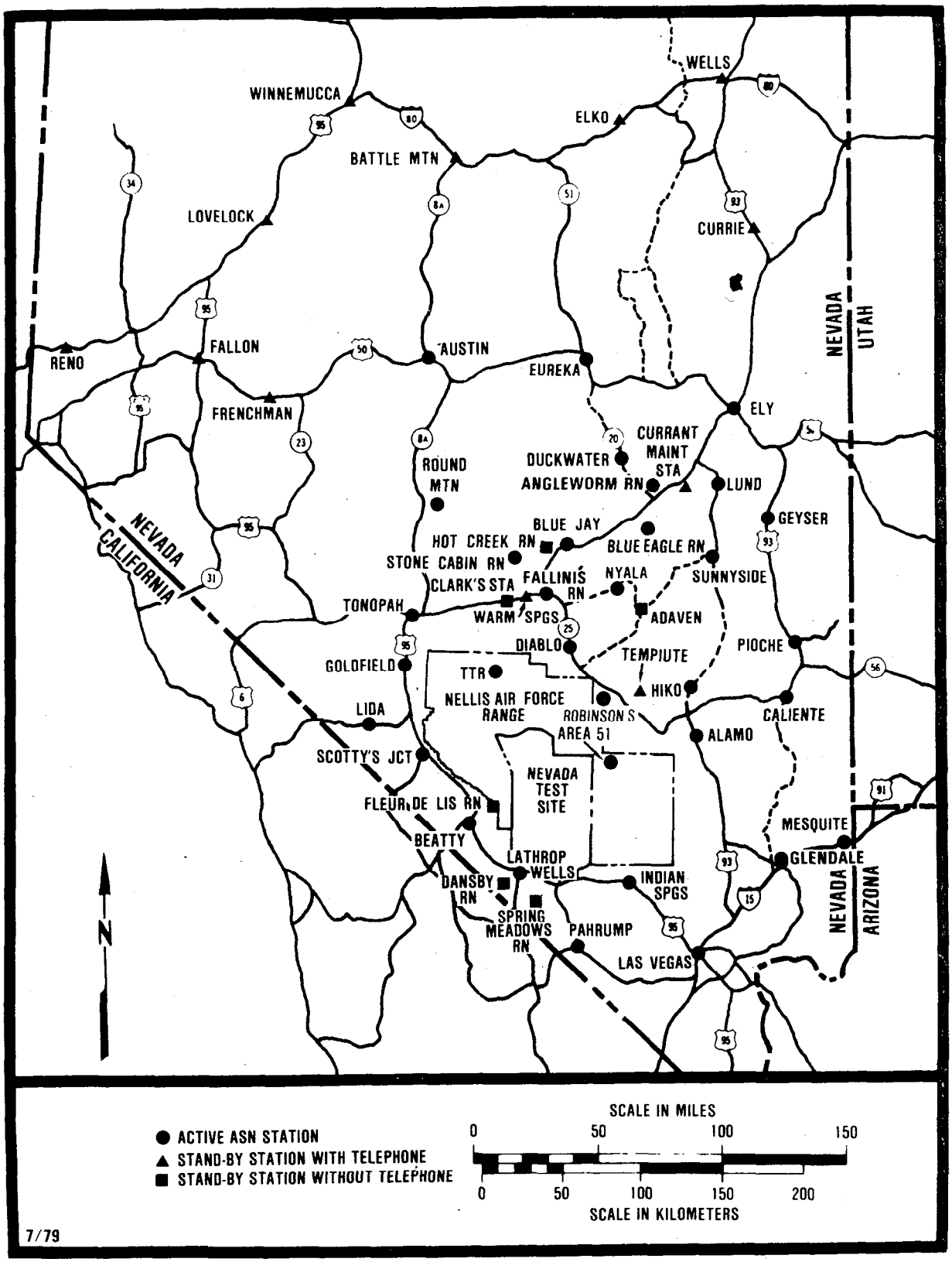

Figure 10. Air Surveillance Network - Nevada.

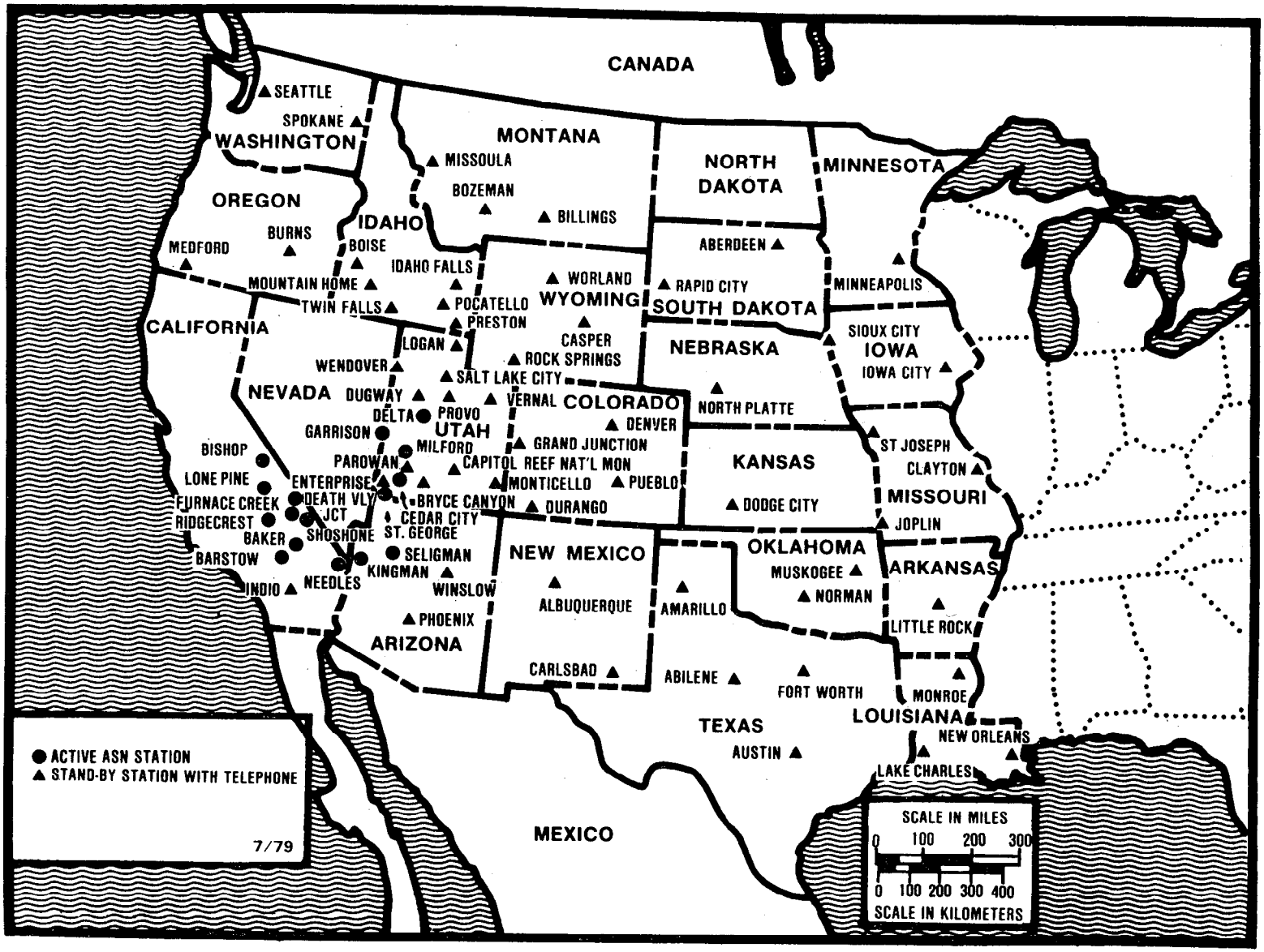

Figure 11. Air Surveillance Network - Outside Nevada.

of air at standard pressure. The filters, which are 99.9 percent efficient for particles $\leq$0.3 μm in diameter, were collected three times per week, resulting in 48- or 72-hour samples from each active station. Activated charcoal cartridges directly behind the glass-fiber filters were used regularly for the collection of gaseous radioiodines at 21 stations near the NTS. Charcoal cartridges could have been added to all other stations and all standby stations could have been activated, if necessary, by telephone request to station operators or by field personnel. All air samples (filters and cartridges) were mailed to the EMSL-LV for analysis. Special retrieval could have been arranged at selected locations in the event of a radioactive release.

During the year, the standby stations were activated quarterly to check the operation of the samplers and to maintain the expertise of Network station operators. In anticipation of airborne radioactivity from the atmospheric nuclear tests by the People's Republic of China on March 15, 1978, at 0100 hours and on December 14, 1978, at 0100 EST, 66 of the standby stations were activated with filters and charcoal cartridges during the periods March 17 through April 7 and December 15, 1978, through January 5, 1979.

During this report period, no airborne radioactivity related to the underground nuclear testing program at the Nevada Test Site was detected on any sample from the ASN. However, radioactivity from the nuclear tests by the People's Republic of China was detected on the filters and charcoal cartridges. Appendix D summarizes the analytical results of those samples containing radioactivity from Chinese tests.

NOBLE GAS AND TRITIUM SURVEILLANCE NETWORK

The Noble Gas and Tritium Surveillance Network, which was first established in April 1972, monitors the airborne levels of radiokrypton, radioxenon, and three forms of tritium (^3H)--tritiated hydrogen (HT), tritiated water (HTO), and tritiated methane (CH_3T). The Network consists of four stations on and seven off-NTS shown in Figure 12. Area 51, which appears to be off NTS, is considered to be on NTS as it is an access-controlled area with radiological safety support provided by NTS personnel.

The equipment used in this Network is composed of two separate systems, a compressor-type air sampler and a molecular sieve sampler. The compressor-type equipment continuously samples air over a 7-day period and stores it in two pressure tanks. The tanks together hold approximately 2 cubic meters of air at atmospheric pressure. They are replaced weekly and returned to the EMSL-LV where the contents of the tanks are analyzed for krypton-85, radioxenons, and tritiated methane by gas chromatography and liquid-scintillation counting techniques (Table A-2).

A molecular sieve is used to collect water samples from air. A prefilter is used to remove the particulates prior to passage of the air through a series of molecular sieve columns. Approximately 5 cubic meters of air are passed through each sampler over a 7-day sampling period. The HTO absorbed on the first molecular sieve column is recovered and the concentration of tritium in μCi/ml of sampled air is determined by liquid-scintillation counting

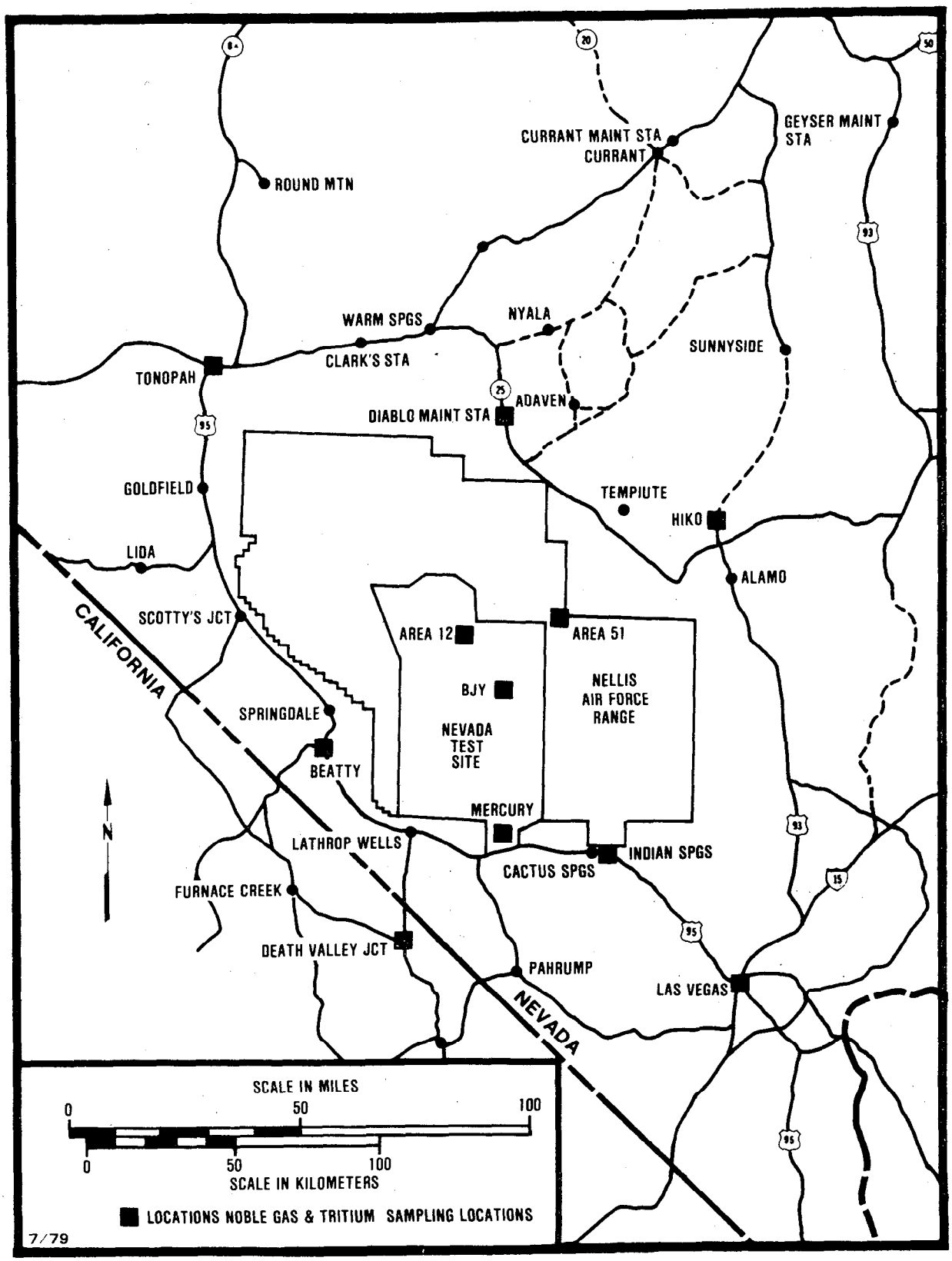

Figure 12. Noble Gas and Tritium Surveillance Network.

techniques. The tritium which passes through the first column as free hydrogen (HT) is oxidized to water and collected on the last molecular sieve column. The HT concentration is calculated from the tritium concentration in the oxidized tritium (water) recovered from the last column.

Table A-4 summarizes the results of this Network by listing the maximum, minimum, and average concentrations for krypton-85, xenon-133, and tritium as methane, as tritiated water or as tritiated hydrogen. The annual average concentrations for each station were calculated over the time period sampled using all values less than the MDC. All concentrations of krypton-85, xenon-133, tritium as tritiated methane, tritium as tritiated water, and tritium as HT are expressed in the same unit, μCi/ml of air. Since the tritium concentration in air may vary by factors of 15-20 while the concentration in μCi/ml of atmospheric water varies by factors up to about 7, the tritium concentration in μCi/ml of atmospheric moisture is also given in the table as a more reliable indicator in cases when background concentrations of HTO are exceeded.

As shown in Table 4, the average concentration of krypton-85 for the year at all stations was the same (2.0×10^{-11} μCi/ml), except for BJY (2.2×10^{-11} μCi/ml), which is significantly different than the Network average at the 95% and 99% confidence levels. The average concentration at this station has been the highest in the Network more often than at any other station. This probably results from its central location on the NTS where seepage of the noble gases from past underground nuclear detonations is suspected. As shown in Table 4 and Figure 13, the average concentration of krypton-85 for the whole Network has gradually increased since sampling was initiated in

TABLE 4. ANNUAL AVERAGE KRYPTON-85 CONCENTRATIONS IN AIR, 1972-1978

	Concentration, 10^{-11} μCi/ml						
Locations	1972	1973	1974	1975	1976	1977	1978
Death Valley Jct., Calif.	1.6	1.5	1.8	1.7	2.0	2.0	2.0
Beatty, Nev.	1.6	1.6	1.7	1.9	2.0	2.0	2.0
Diablo, Nev.	1.6	1.6	1.7	1.8	1.9	1.9	2.0
Hiko, Nev.	1.6	1.6	1.7	1.7	1.7	1.9	2.0
Indian Springs, Nev.	-	-	-	2.0	2.0	2.0	2.0
Las Vegas, Nev.	1.6	1.6	1.7	1.8	1.8	2.0	2.0
Mercury, NTS, Nev.	1.6	1.6	1.8	1.8	1.9	2.0	2.0
Area 51, NTS, Nev.	1.6	1.6	1.7	1.8	2.0	1.9	2.0
BJY, NTS, Nev.	1.7	1.8	1.9	1.9	2.0	2.1	2.2
Area 12, NTS, Nev.	1.6	1.6	1.8	1.8	2.0	1.9	2.0
Tonopah, Nev.	1.6	1.6	1.8	1.7	1.9	1.9	2.0
Network Average	1.62	1.61	1.76	1.81	1.93	1.96	2.02

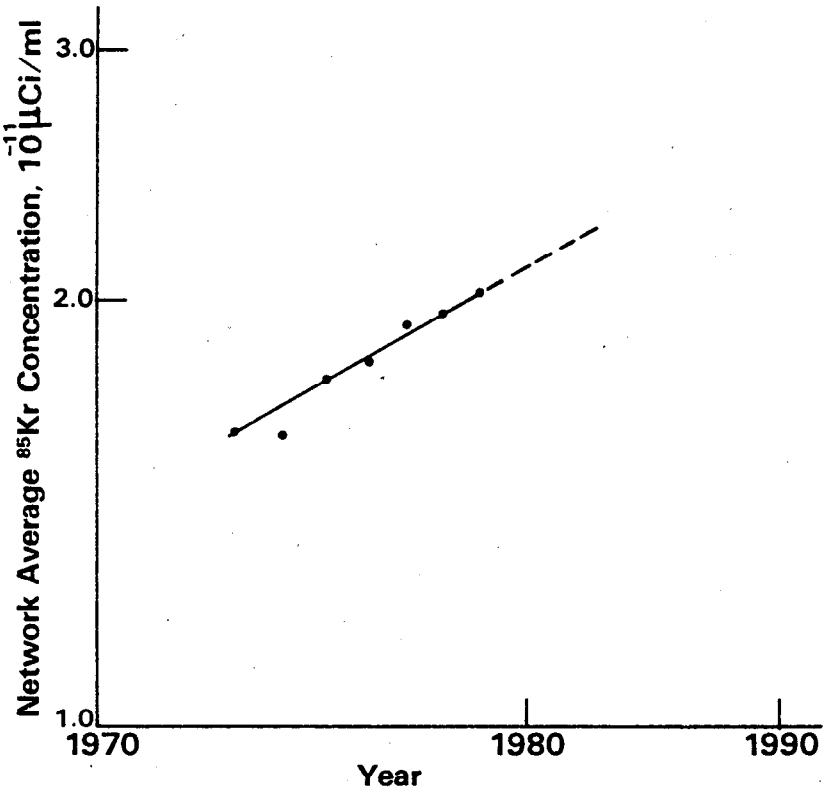

Figure 13. Trend in Annual Network Concentrations of Krypton-85 1972-1978.

1972. This increase observed at all stations probably reflects the worldwide increase in ambient concentrations resulting from the proliferation of nuclear technology.

The maximum concentration of krypton-85 for all stations ranged from 2.4 x 10^{-11} µCi/ml to 2.9 x 10^{-11} µCi/ml (Table A-4). As shown by the Figure 14, these higher concentrations and all the other concentrations for the Network stations combined followed a log-normal distribution with a geometric mean of 2.01 x 10^{-11} µCi/ml and a geometric standard deviation of 1.1. As the expected geometric standard deviation of the krypton-85 measurements attributed to sampling/analytical/counting errors was determined to be 1.2 from the duplicate sampling program (Appendix C), the variation in the krypton-85 concentrations throughout the Network appears to be caused primarily by the errors in its measurement.

Xenon-133 was detected above its MDC of about 4 x 10^{-12} µCi/ml at the locations, during the periods, and at the concentrations shown in the following table:

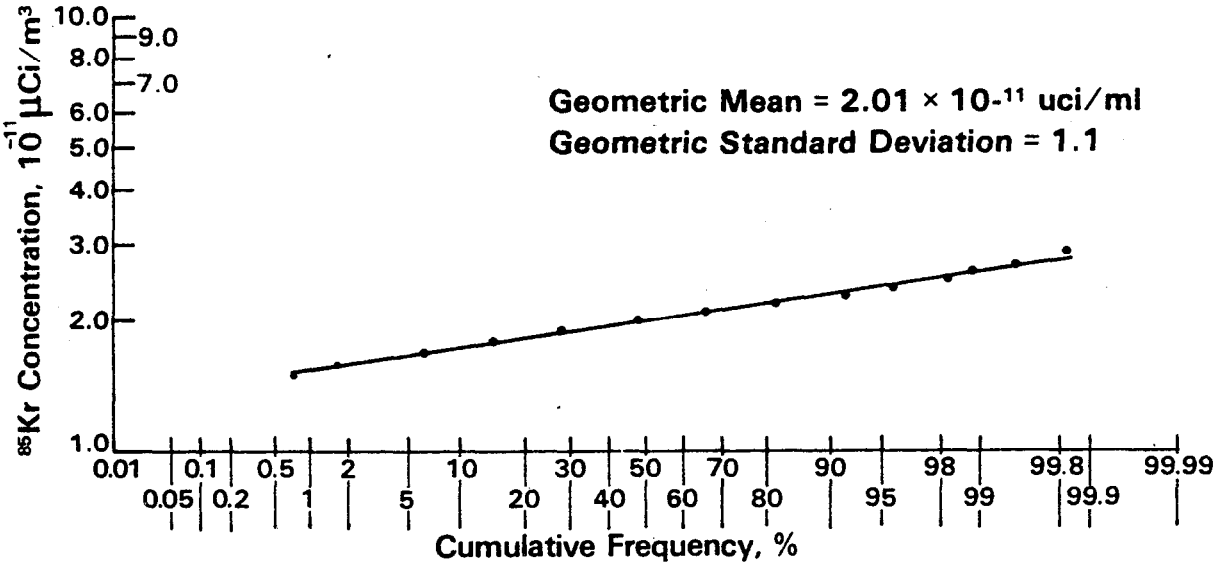

Figure 14. Distribution of Network Concentrations of Krypton-85.

TABLE 5. CONCENTRATIONS OF AIRBORNE XENON-133 DETECTED ON AND OFF NTS

Location	Sampling Period	Xenon-133 Concentration ± 2 Sigma Counting Error ($X10^{-12}$ µCi/ml)
Diablo, Nev.	4/19-26	65 ± 4.0
Mercury, NTS, Nev.	2/27-3/6	29 ± 5.4
	5/8-15	170 ± 3.0
Area 51, NTS, Nev.	2/21-27	45 ± 5.2
	2/27-3/6	16 ± 4.4
BJY, NTS, Nev.	2/21-27	14,000 ± 30*
	2/27-3/6	100 ± 5.4
	4/3-10	26 ± 4.2
	5/1-8	10 ± 3.8

* This high value resulted from post-shot drilling operations.

As shown in Table 5, xenon-133 was detected on the NTS and at only one location off the NTS, namely Diablo, NV. This concentration measured at Diablo, if it had persisted throughout the year, would have been only 0.065 percent of the CG (Appendix B).

As in the past, tritium as HTO in atmospheric moisture samples was generally at background concentrations, below the MDC of 3 to 4 x 10^{-6} µCi/ml at all off-NTS stations and at the on-NTS stations at Mercury and

Area 51. Occasional increases in concentrations appear to be a part of the normal fluctuations in background. The on-NTS stations at BJY and Area 12 continued to have concentrations consistently above background; the concentration averages for these stations were factors of 7 to 15 times the averages for all off-NTS stations.

The average concentrations of trituim as HT (Table A-4) at the off-NTS stations were comparable to those observed in 1977. During 1978 the averages ranged from $<6 \times 10^{-13}$ µCi/ml to 1.8×10^{-12} µCi/ml, whereas in 1977 the averages ranged from $<6 \times 10^{-13}$ µCi/ml to $<2 \times 10^{-12}$ µCi/ml. From a review of the cumulative frequency distributions of the data for each station, two samples collected at Indian Springs had concentrations of 2.4×10^{-11} µCi/ml and 1.8×10^{-11} µCi/ml during the respective periods November 13 to 20 and November 27 to December 4, which did not appear to be a part of the background. If the highest of these concentrations had persisted for the year, the exposure of off-NTS residents would have been 0.036 percent of the CG.

The concentrations of tritium as tritiated methame were generally below the MDC of 4×10^{-12} µCi/ml at all locations as normally observed. Detectable concentrations were observed in two samples collected at Beatty, Nevada; however, based upon the cumulative frequency distribution for the tritiated methane concentrations for the total Network, the concentrations appeared to be part of the background.

DOSIMETRY NETWORK

The Dosimetry Network is comprised of thermoluminescent dosimeters placed at 78 locations and gamma exposure rate recorders placed at 31 locations around the NTS for the purpose of measuring environmental background levels of gamma radiation (Figure 15). From an accurate measurement of the environmental background radiation rate at each monitoring location, any exposure in excess of background due to NTS testing operations can be determined.

Thermoluminescent Dosimeters

At locations within a 270-km radius of the center of the NTS, thermoluminescent dosimeters were placed at inhabited and uninhabited locations. Each Dosimetry Network station was equipped with three Harshaw Model 2271-G2 (TLD200) dosimeters, which were routinely exchanged on a quarterly basis. Within the general area covered by the dosimetry stations, 25 cooperating off-site residents each wore a dosimeter, which was exchanged at the same time as the station dosimeters.

The Model 2271-G2 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

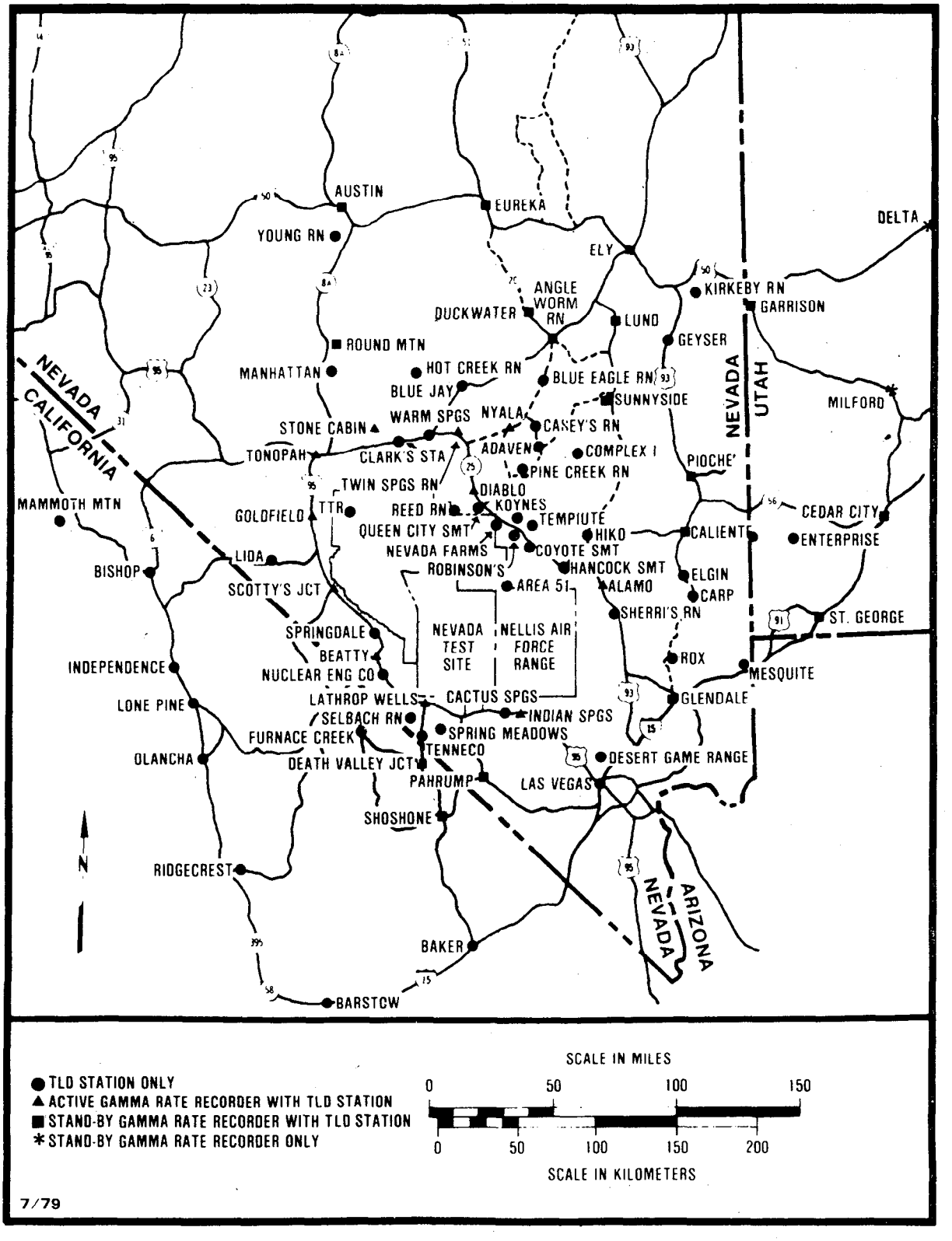

Figure 15. Dosimetry Network.

dosimeters are placed in a secured, rugged plastic housing 1 meter above ground level at each station to standardize the exposure geometry.

After appropriate corrections were made for background exposure accumulated during shipment between the laboratory and the monitoring location, the dosimeter readings for each station were averaged. The average value for each station was then compared to the value for the past year to determine whether the new value was within the range of previous background values for that station. Any values significantly greater than previous values would have led to net exposure calculations. Values significantly less than the previous year would have been examined to determine possibility of reading or handling errors. The results from each of the personnel dosimeters were compared to the background value of the nearest station to determine whether a net exposure had occurred.

The smallest exposure in excess of background radiation which may be determined from these dosimeter readings depends primarily on variations in the natural background exposure rate at the particular station. In the absence of other independent exposure rate measurements, it is necessary to compare the present exposure rate with past data which have been accepted as representing the natural background. Typically, the smallest net exposure observable for a 90-day monitoring period would be 5 to 15 mR in excess of background, which ranges from 15 to 35 mR depending on location. The term "background," as used in this context, refers to naturally occurring radioactivity plus a contribution from residual man-made fission products.

Table A-5 lists the maximum, minimum, and average dose equivalent rate (mrem/day) measured at each station in the Network during 1978 due to penetrating gamma radiation. No allowance was made for the small additional dose due to the neutron component of the cosmic ray spectrum. As shown by Table A-4, no station exhibited an exposure in excess of background, which under present criteria is defined as the 99 percent upper confidence limit of the environmental background.

Station changes were made in the Network due to unusually high background levels found at Caliente and Stone Cabin as shown in Table A-5. A cesium-137 calibration source for an LSI recorder was discovered near the Caliente TLD station. The station was moved away from the recorder so that the TLD's were no longer exposed to the calibration source. A radiation survey was performed at Stone Cabin Ranch, which had the highest dose rate in 1977, and it was determined that the stone building contributed significantly to the exposure of the TLD's. When this station was moved away from the cabin, the background rate decreased substantially. The station at Desert Oasis was abandoned at the end of first quarter 1978 and a new station at Glendale was established 3 miles east of the Desert Oasis location. The Pine Creek station could not be reached during January 1979 due to unusually heavy snowfall; the TLD's will remain on station until the first quarter exchange in April 1979.

Table 6 shows the average annual dose rate for the Dosimetry Network to be consistent with the Network average established in 1975 with the exception of the 1977 average. Mechanical problems in readout procedures during the second quarter of 1977 caused a high bias in the data which increased the Network

TABLE 6. DOSIMETRY NETWORK SUMMARY
FOR THE YEARS 1971-1978

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

average. The data for second quarter 1977, could not be adjusted to compensate for these problems. The general decreasing trend from 1971 to 1975 and the leveling off since 1975 shown by the Network average is indicative of the trend exhibited by individual stations.

Gamma Exposure Rate Recorders

A network of 13 full-time and 18 standby stationary gamma exposure rate recorders (Figure 15) was also used at selected air sampling locations to document any changes in the ambient exposure rate. The detector consists of a 2.5 by 30.5 cm constant-current ionization chamber (filled with methane) and operates on either 115 V a.c. or a self-contained battery pack. Data are recorded on a paper strip chart. These instruments have a range from 0.004 mR/h to 40 mR/h with an accuracy of about ±10 percent. The standby recorders were activated on a routine quarterly basis to ensure the recorders were functional. No increase in exposure rates attributable to current NTS operations was detected by the routine recorders.

MILK SURVEILLANCE NETWORK

Milk is only one source for the dietary intake of environmental radioactivity. However, it is a very convenient indicator of the general population's intake of biologically significant radionuclide contaminants. For this reason it is monitored on a routine basis. Few fission product radionuclides become incorporated into the milk as a result of the selective metabolism of the cow. However, those that are incorporated are very important from a radiological health standpoint and are a very sensitive measure of their concentrations in the environment. The six most common fission product radionuclides which can occur in milk are tritium, strontium-89, strontium-90, iodine-131, cesium-137 and barium-140. A seventh radionuclide, potassium-40, also occurs in milk at a reasonably constant concentration of about 1.2×10^{-6} μCi/ml. Since this is a naturally occurring radionuclide, it has not been included in the analytical results summarized in this section.

The milk surveillance networks operated by the EMSL-LV were the routine Milk Surveillance Network (MSN) and the Standby Milk Surveillance Network (SMSN). The MSN, during 1978 (Figure 16), consisted of 23 different locations where 3.8-liter milk samples were collected to represent family cows, commercial pasteurized milk producers, Grade A raw milk intended for pasteurization, and Grade A raw milk for local consumption. In the event of a release of activity from the NTS, intensive sampling would have been conducted in the affected area within a 480-km radius of CP-1, NTS, to assess the radionuclide concentrations in milk, the radiation doses that could result from the ingestion of the milk, and the need for protective action. Samples are collected from milk suppliers and producers beyond 480 km within the SMSN.

During 1978, 75 milk samples were collected from the MSN on a quarterly collection schedule. As samples of milk could not be collected at the Manzanie Ranch, another sampling location is being sought. Samples could not be collected at all of the other locations due to the unavailability of milk or cows.

Each MSN milk sample was analyzed for gamma-emitters, strontium-89, and strontium-90. Samples collected at six locations from the MSN were also analyzed for tritium. Table A-2 lists the general analytical procedures and detection limits for these analyses.

The SMSN consisted of about 150 Grade A milk processing plants in all States west of the Mississippi River. Managers of these facilities could be requested by telephone to collect raw milk samples representing milk sheds supplying milk to the plants. Since there were no releases of radioactivity from the NTS or other test locations, this network was not activated except to request one sample from most of the locations to check the readiness and reliability of the network. During the months of May and June, 120 milk samples were collected and analyzed by gamma spectrometry. Samples selected from each of the Western States were also analyzed for tritium, strontium-89, and strontium-90.

The analytical results of milk samples collected from the MSN during 1978 are summarized in Table A-6, where the maximum, minimum, and average concentrations of the tritium, strontium-89, strontium-90, iodine-131, and cesium-137 in samples collected during the year are shown for each sampling location. As shown in Table 7, the average radionuclide concentrations for the whole Network are comparable to those for the SMSN, if not slightly lower. As mentioned in the Quality Assurance Section, the strontium-90 analyses for both networks were found to be biased low by 25 percent.

LONG-TERM HYDROLOGICAL MONITORING PROGRAM

During this reporting period, EMSL-LV personnel continued the collection and analysis of water samples from wells, springs, and spring-fed surface water sources which are down the hydrologic gradient of the ground water at the NTS and at off-NTS sites of underground nuclear detonations to monitor for any migration of test-related radionuclides through the movement of ground water. The water samples were collected from wellheads or spring discharge

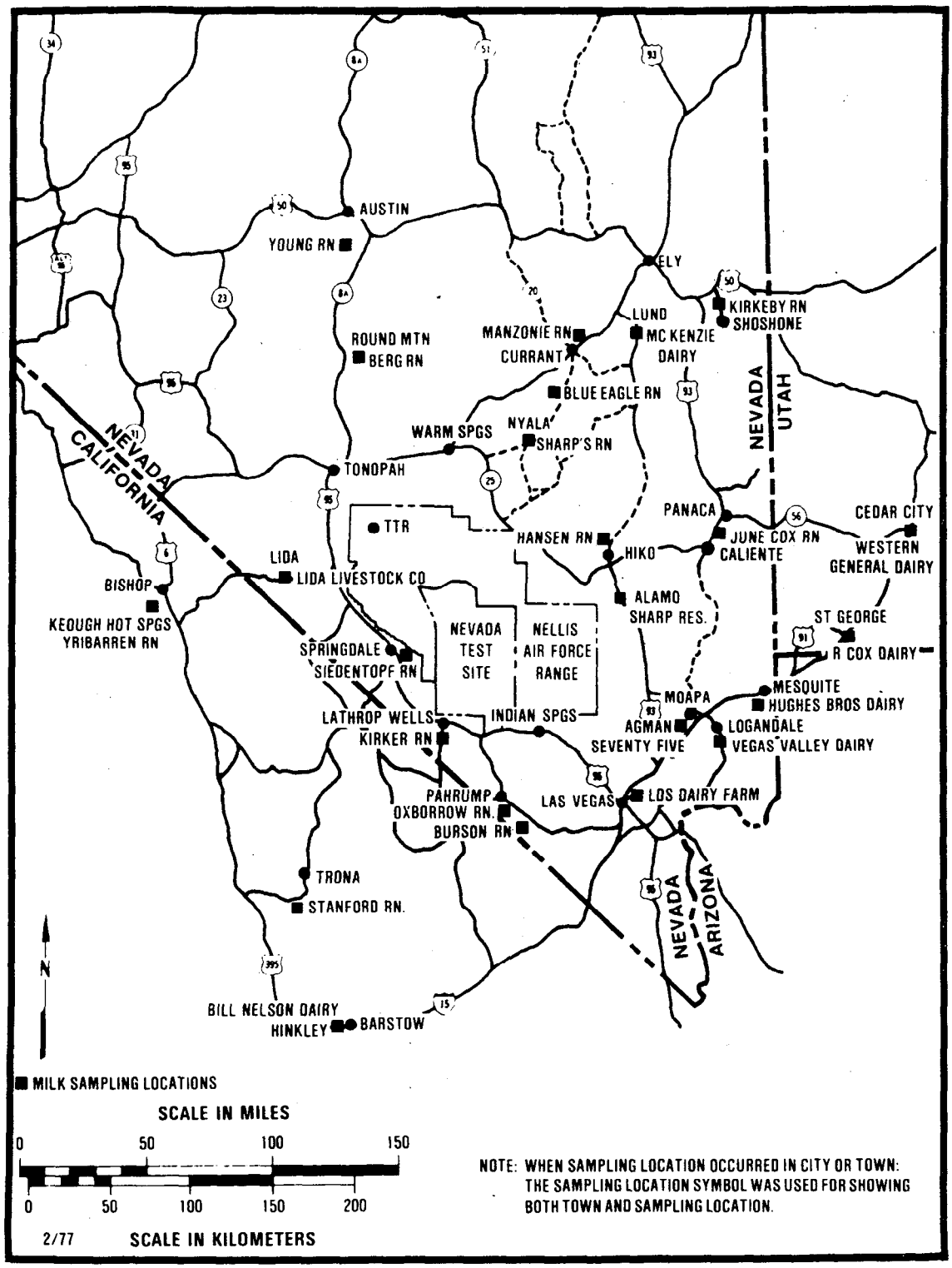

Figure 16. Milk Surveillance Network.

TABLE 7. SUMMARY OF RADIONUCLIDE CONCENTRATIONS FOR MILK SURVEILLANCE NETWORK AND STANDBY SURVEILLANCE NETWORK

Network	Radionuclide	No. of Samples	Concentrations (10^{-9} µCi/ml) C_{Max}	C_{Min}	C_{Avg}
MSN	^{3}H	24	1400	<400	<400
	^{89}Sr	75	< 6	< 3	< 3
	^{90}Sr	75	4.0	< 1	1.2
	^{137}Cs	75	16	2.9	< 3
SMSN	^{3}H	21	700	<400	390
	^{89}Sr	21	4.3	< 2	1.6
	^{90}Sr	21	5.9	< 2	2.6
	^{137}Cs	108	20	< 3	4.9

points wherever possible. Prior to each sampling at a wellhead, water was pumped from the aquifer to assure the collection of representative samples. If pumps were not available, an electrical-mechanical water sampler capable of collecting 3-liter samples at depths to 1800 m was used.

Nevada Test Site

For the NTS, attempts were made to sample 10 locations monthly and 20 locations semi-annually (Figures 17 and 18). Additionally, samples were collected annually from 12 locations. Not all stations could be sampled with the desired frequency because of inclement weather conditions or inoperative pumps.

For each sampled location, samples of raw water, filtered water, and filtered and acidified water were collected. The raw water samples were analyzed for tritium. Portions of the filtered and acidified samples were given radiochemical analyses by the criteria summarized in Table A-7. Table A-2 summarizes the analytical techniques used. Each filter was also analyzed by gamma spectrometry.

The analytical results for all samples collected and analyzed during this reporting period are shown in Appendix A and were compared with the CG's in Appendix B. The analyses for strontium-89, strontium-90, radium-226, uranium-234, uranium-235, uranium-238, plutonium-238, and plutonium-239, which were normally done at least once during the year on a sample from each location, were not made unless the levels of gross alpha and gross beta radioactivity in any sample showed an unexpected increase (See Table A-7). No increases were observed in the gross alpha and gross beta radioactivity during the year; therefore, no additional analyses were required. The ranges in radioactivity were $<2 \times 10^{-9}$ µCi/ml to 1.6×10^{-8} µCi/ml and $<4 \times 10^{-9}$

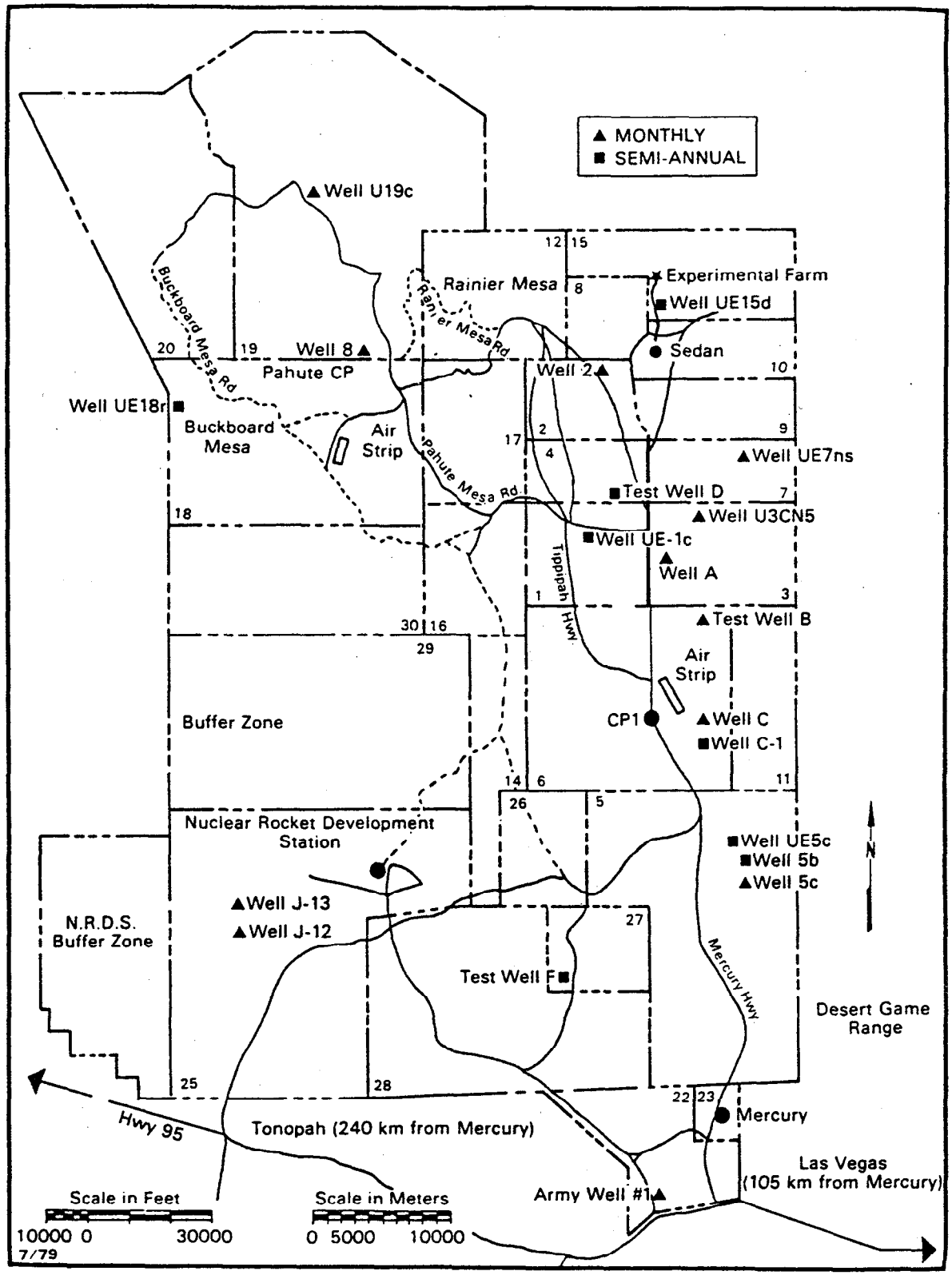

Figure 17. On-Site Long-Term Hydrological Monitoring Program, Nevada Test Site.

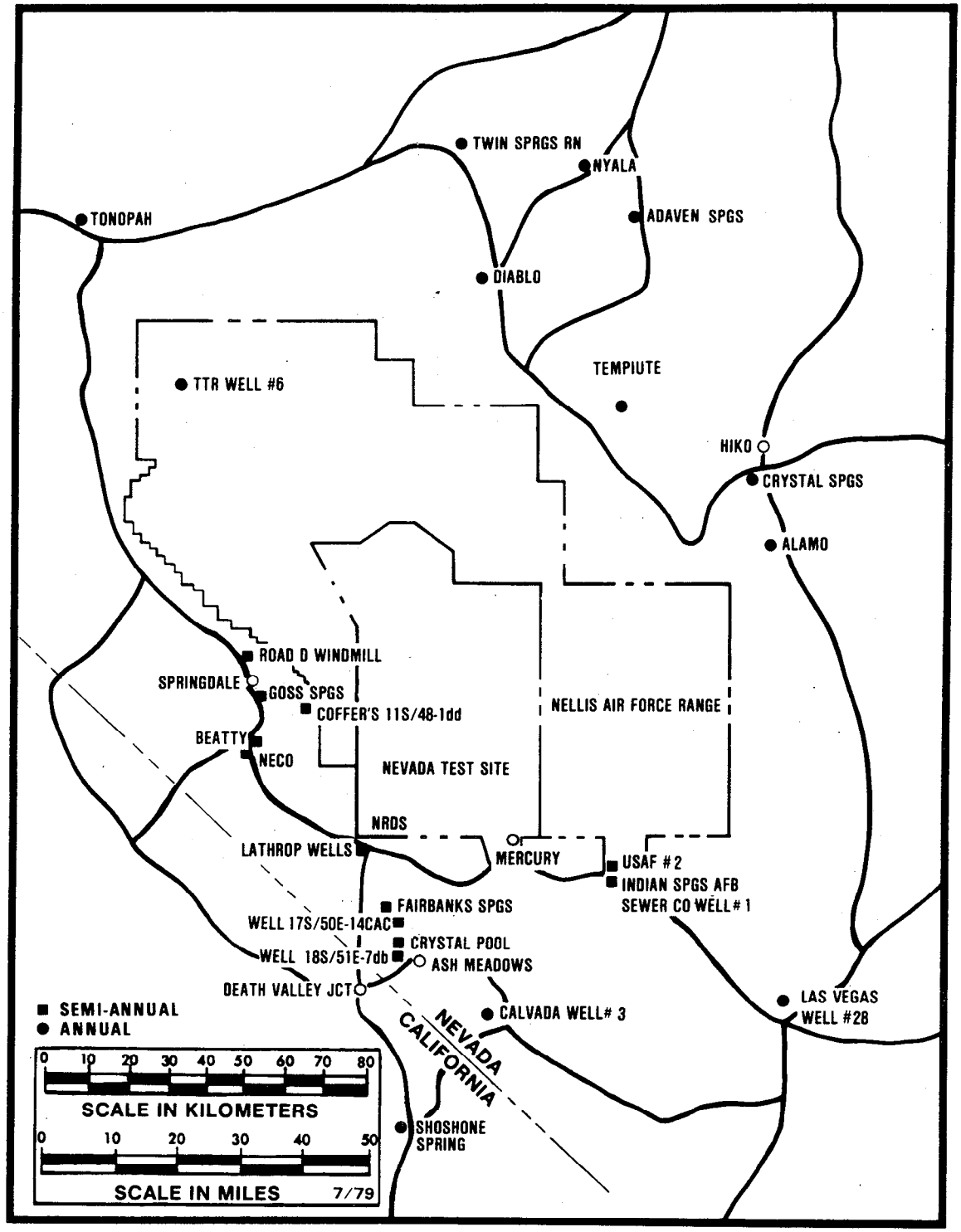

Figure 18. Off-Site Long-Term Hydrological Monitoring Program, Nevada Test Site.

μCi/ml to 4.6 x 10^{-8} μCi/ml, respectively. (See Appendix Tables A-7, A-10 and Appendix B).

As shown in previous years, the tritium detected in NTS Wells C and C-1 is attributed to tracer experiments conducted prior to the commencement of this surveillance program. All tritium concentrations were below 0.01 percent of the Concentration Guide for an occupationally exposed person. (See Appendix Tables A-8 and A-9).

The concentrations of tritium in the water samples collected from Well U3CN-5 (ranged from <9 x 10^{-9} μCi/ml to 2.8 x 10^{-7} μCi/ml), Well B (ranged from 1.7 x 10^{-7} μCi/ml to 2.5 x 10^{-7} μCi/ml), Sharp Ranch (1.8 x 10^{-7} μCi/ml) and Adaven Spring (1.2 x 10^{-7} μCi/ml) were greater than the concentration range of all the other sampled wells on and around the NTS (<9 x 10^{-9} μCi/ml to 4.7 x 10^{-8} μCi/ml). As the higher tritium concentrations were comparable to the range in concentrations observed in surface water, which can be a possible contaminant of ground water, no further investigation was warranted. The concentration of tritium in a major surface water in Southern Nevada, the Colorado River, as reported by the EPA Office of Radiation Programs, ranged from 5 x 10^{-7} μCi/ml to 7 x 10^{-7} μCi/ml.

Other Test Sites

The annual collection and radiological analysis of water samples were continued for this program at all off-NTS sites of underground nuclear detonations. The project sites at which samples were collected are Project Gnome near Carlsbad, New Mexico; Project Faultless in Central Nevada; Project Shoal near Fallon, Nevada; Project Gasbuggy in Rio Arriba County, New Mexico; Project Rulison near Rifle, Colorado; Project Dribble at Tatum Dome, Mississippi; Project Rio Blanco near Meeker, Colorado; and Projects Long Shot/Milrow/Cannikin on Amchitka Island, Alaska. Figures 17 through 31 identify the sampling locations, and Table A-1 lists additional information on the location of each site and tests performed at these locations. The sampling locations at these project sites remained the same except for the Project Milrow site and the background locations on Amchitka Island, Alaska. At the Project Milrow site, Wells W-4, W-7, W-13, and W-18 were added to the sampling schedule. For the background locations, the sampling location Army Well No. 1 was added and Mile 27 Stream and the Base Camp Maintenance Building were omitted.

All samples were analyzed in accordance with the same criteria (Table A-7) as for samples collected on and around the NTS. The results of all analyses are listed or summarized in Table A-11 and compared to the appropriate CG's (Appendix B). As the special analyses (strontium-89 and -90, radon-226, uranium-234,- 235 and -238, plutonium-238 and -239) on samples from Project Rio Blanco were not completed in time for last year's report, the results for these analyses are listed in Table A-12. The only radioactivity detected by these analyses was the naturally occurring isotopes of uranium and strontium-90 (1.7 x 10^{-9} μCi/ml) in the surface water sample collected from Fawn Creek, 8400 ft Downstream. The strontium-90 was attributed to worldwide atmospheric fallout.

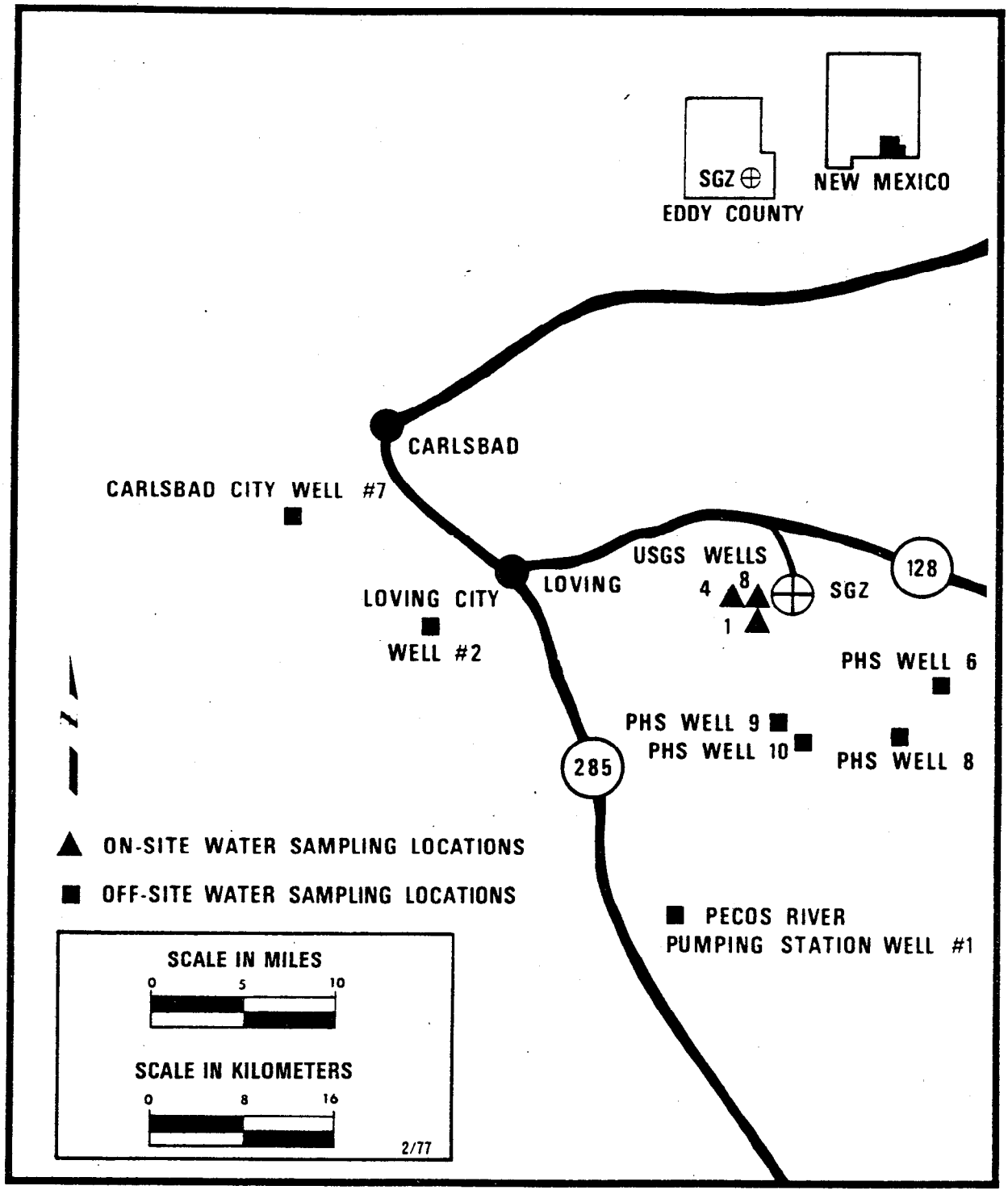

Figure 19. Long-Term Hydrological Monitoring Program, Project Gnome/Coach, Carlsbad, New Mexico.

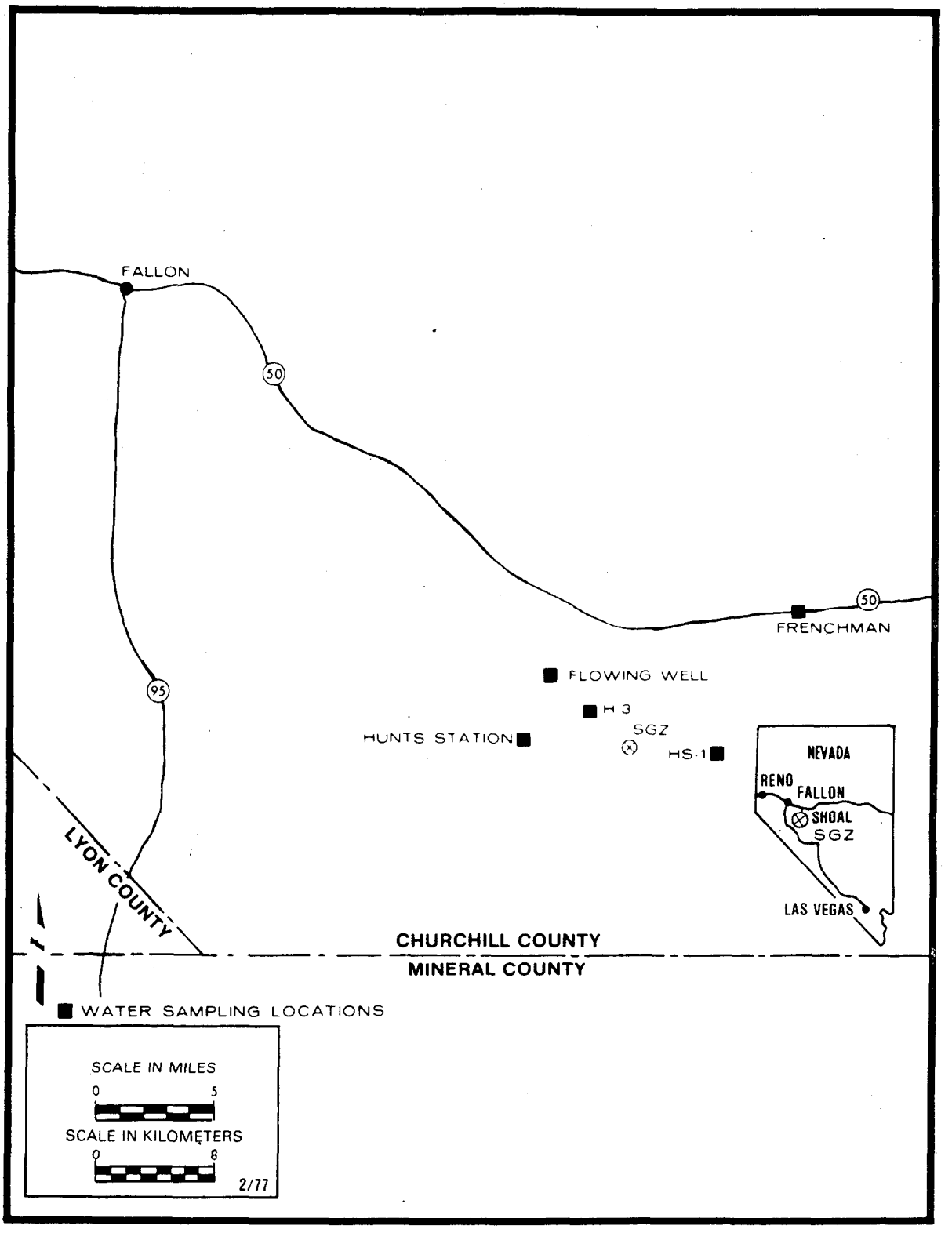

Figure 20. Long-Term Hydrological Monitoring Program, Project Shoal, Fallon, Nevada.

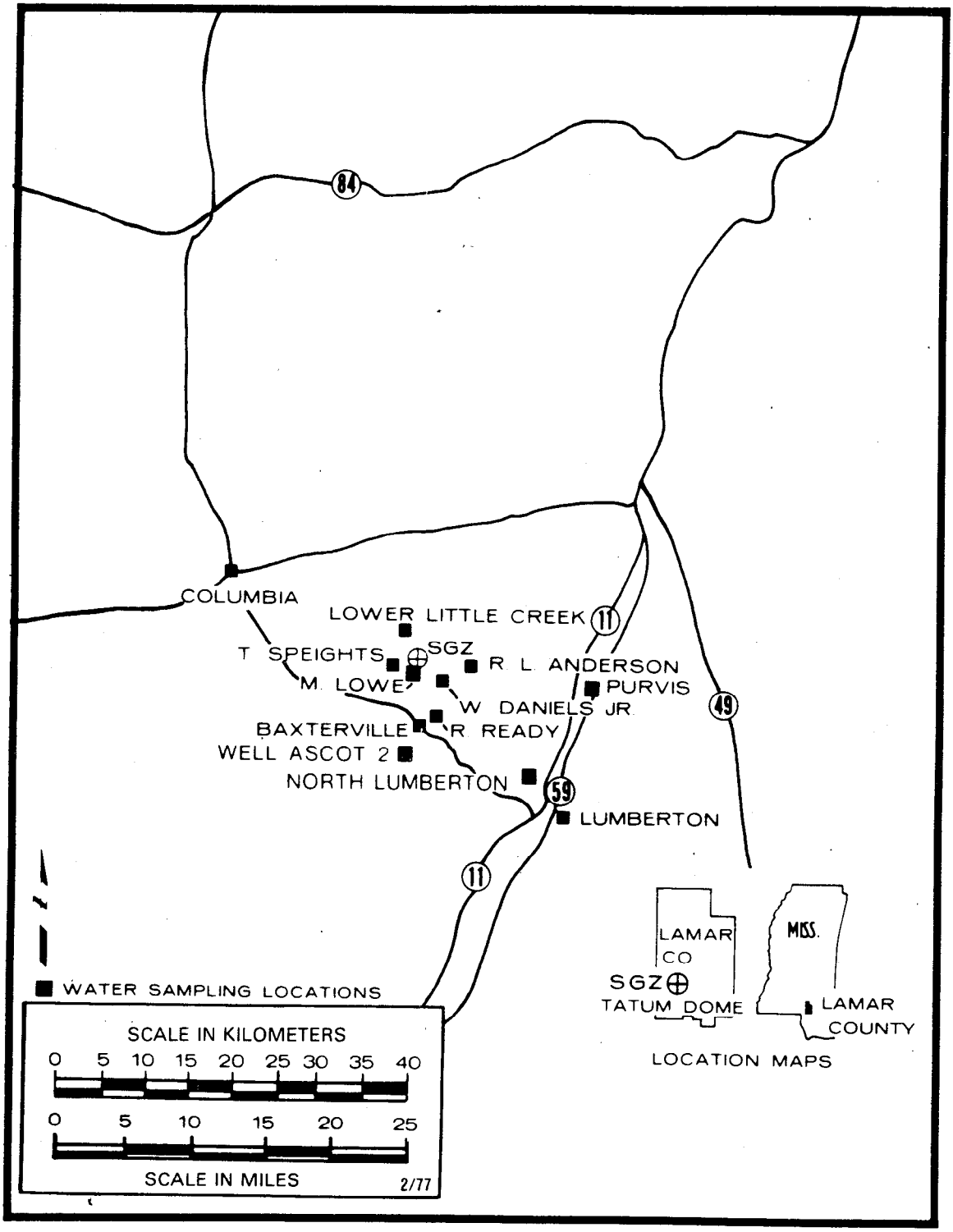

Figure 21. Long-Term Hydrological Monitoring Program, Project Dribble/Miracle Play, Vicinity of Tatum Salt Dome, Mississippi.

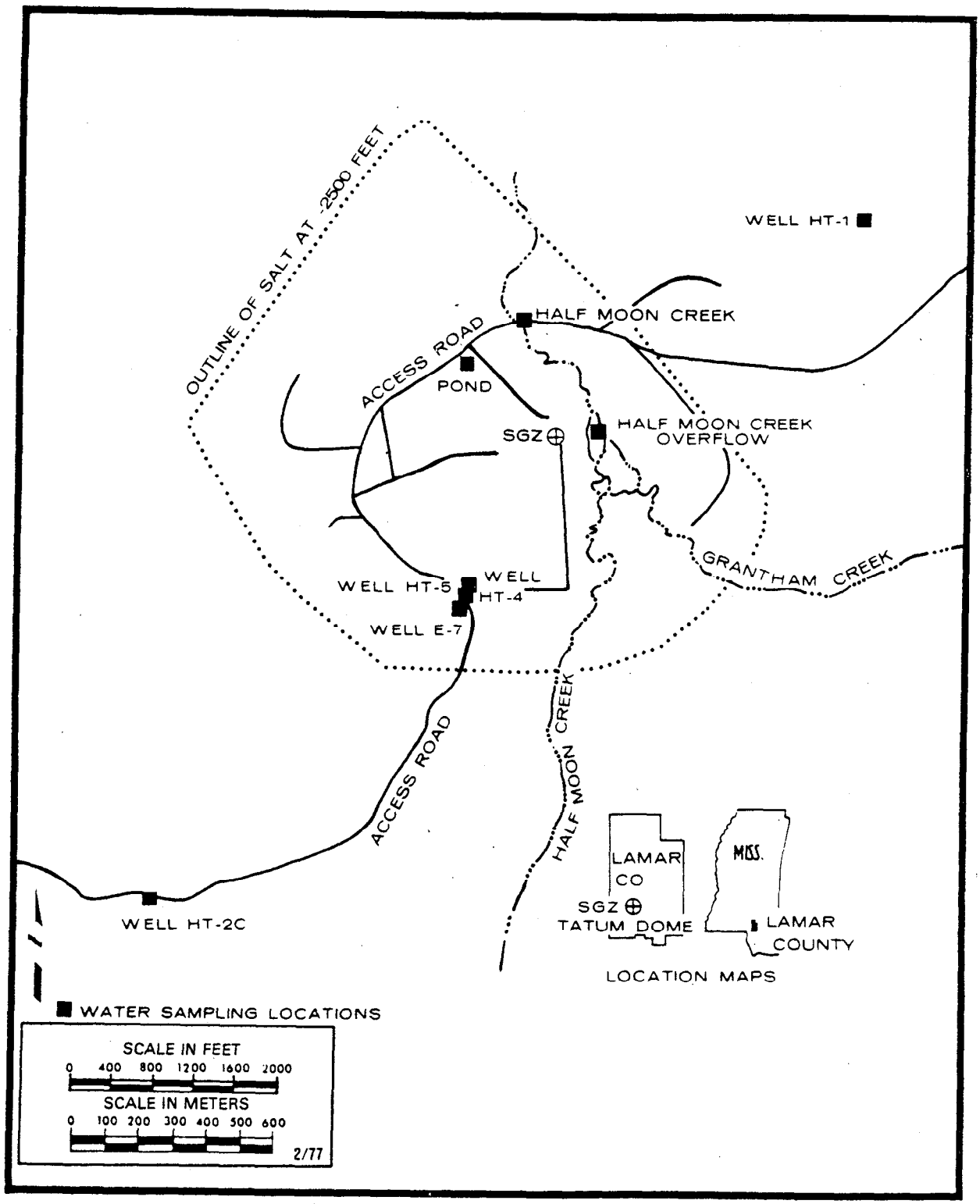

Figure 22. Long-Term Hydrological Monitoring Program, Project Dribble/Miracle Play, Tatum Salt Dome, Mississippi.

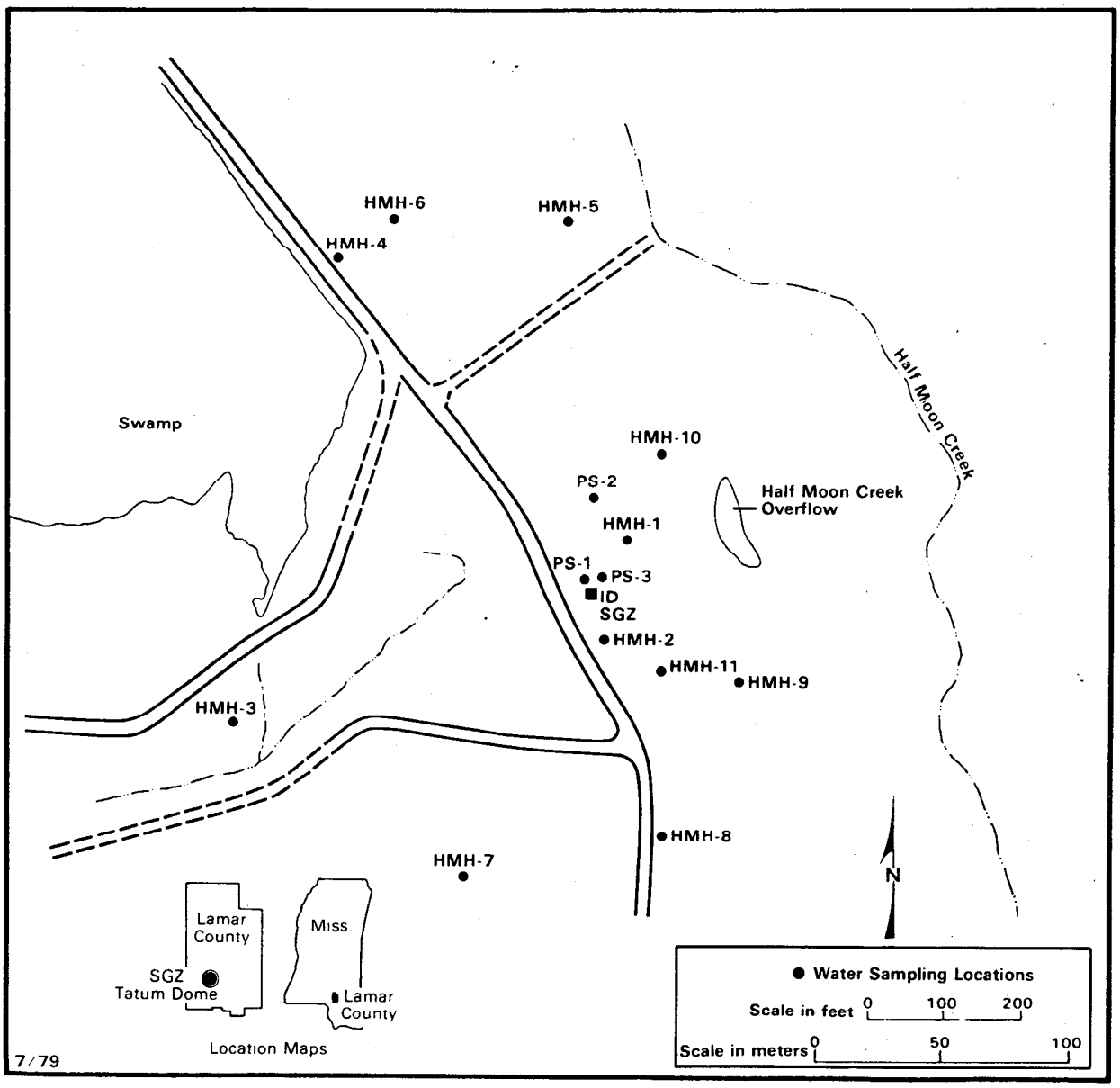

Figure 23. Long-Term Hydrological Monitoring Program, Project Dribble/Miracle Play, Tatum Dome, Mississippi.

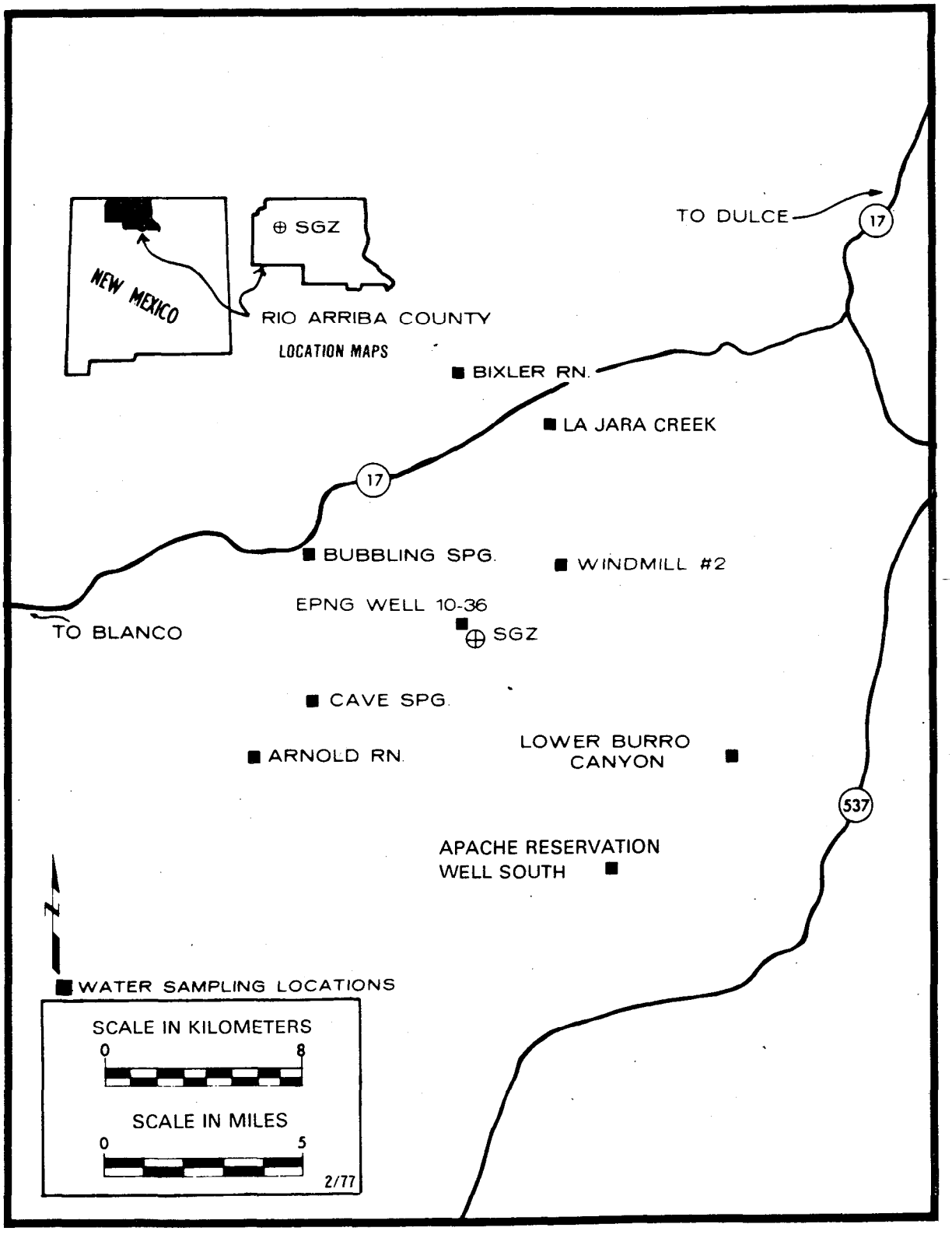

Figure 24. Long-Term Hydrological Monitoring Program, Rio Arriba County, New Mexico, Project Gasbuggy.

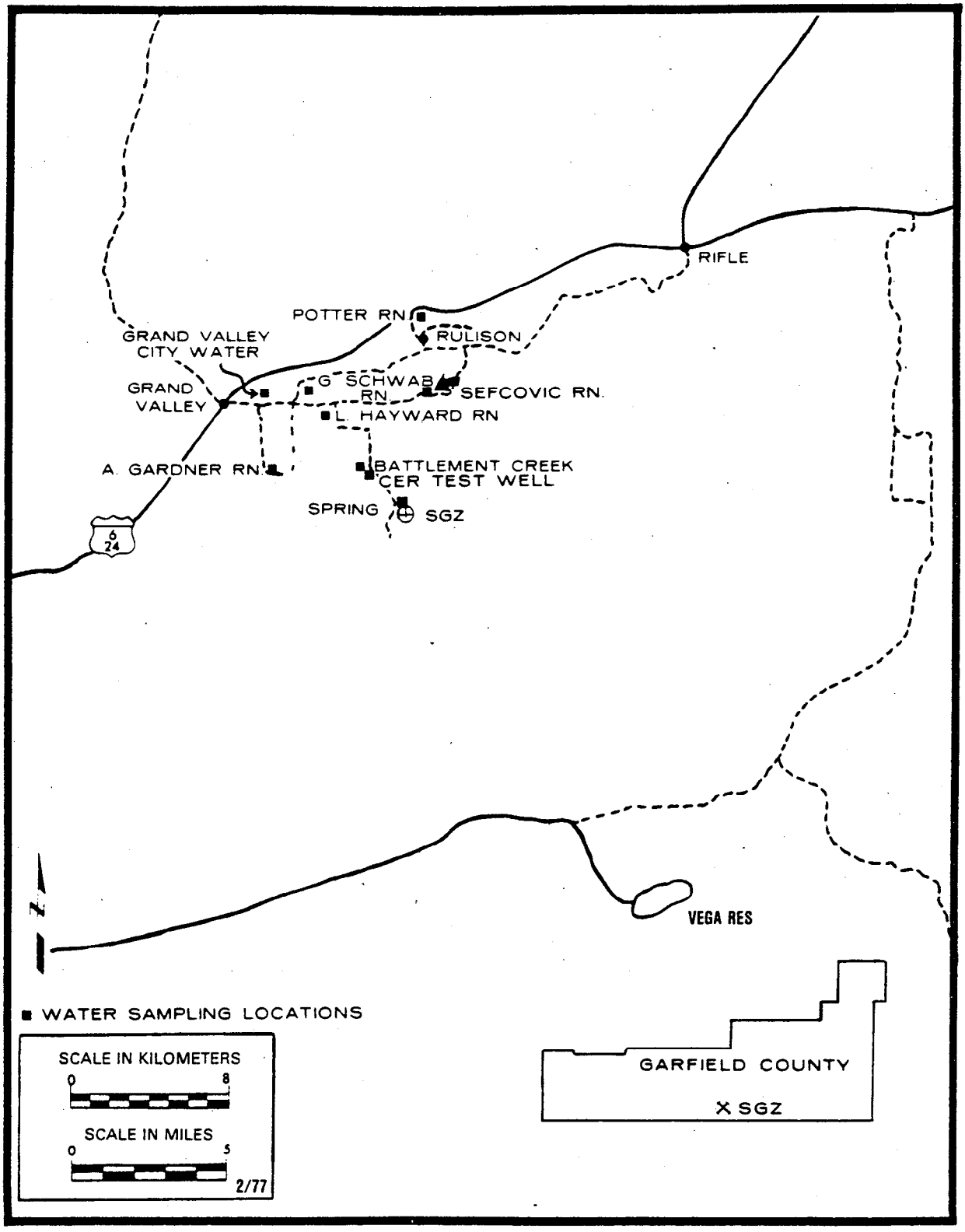

Figure 25. Long-Term Hydrological Monitoring Program, Project Rulison, Rulison, Colorado.

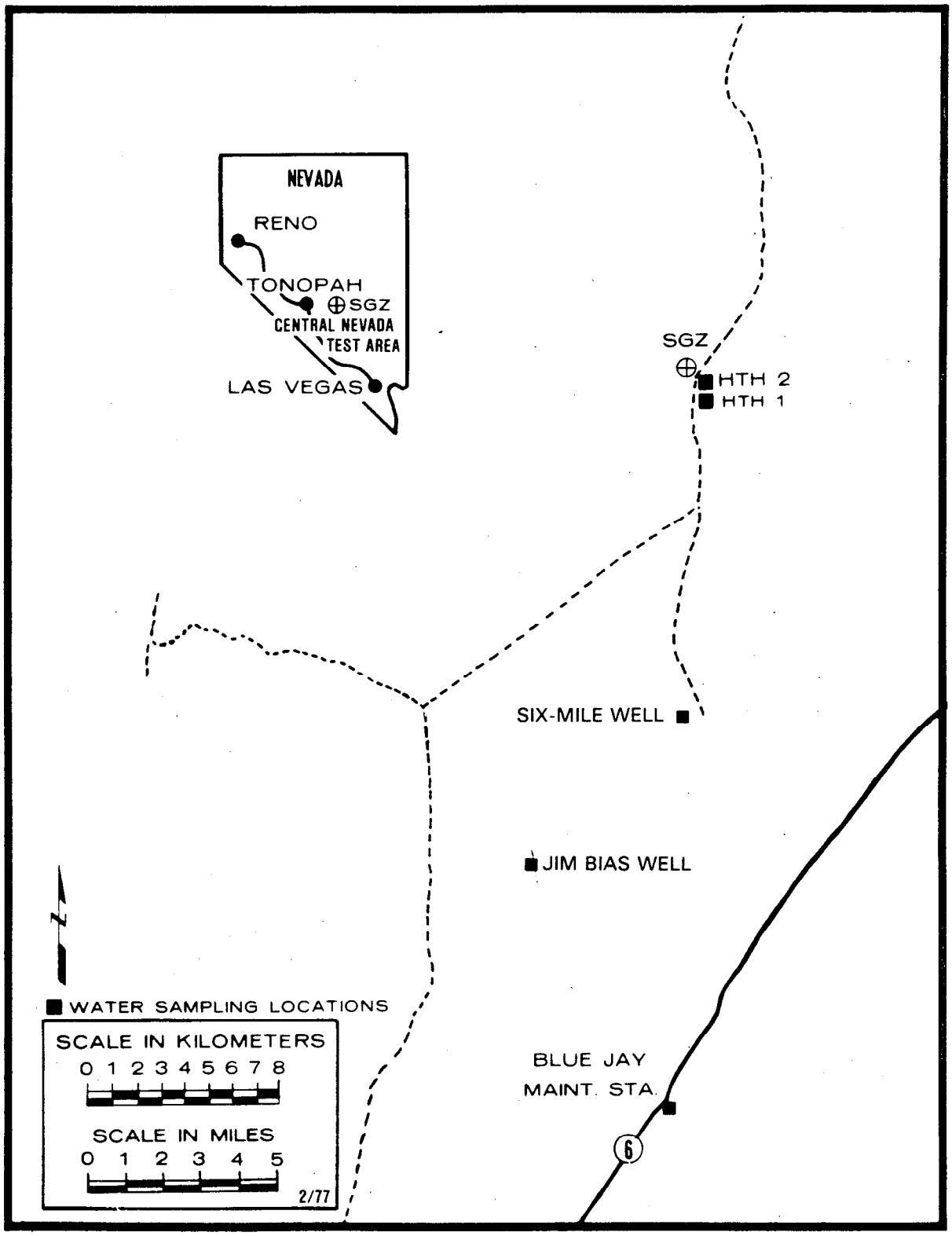

Figure 26. Long-Term Hydrological Monitoring Program, Faultless Event, Central Nevada Test Area.

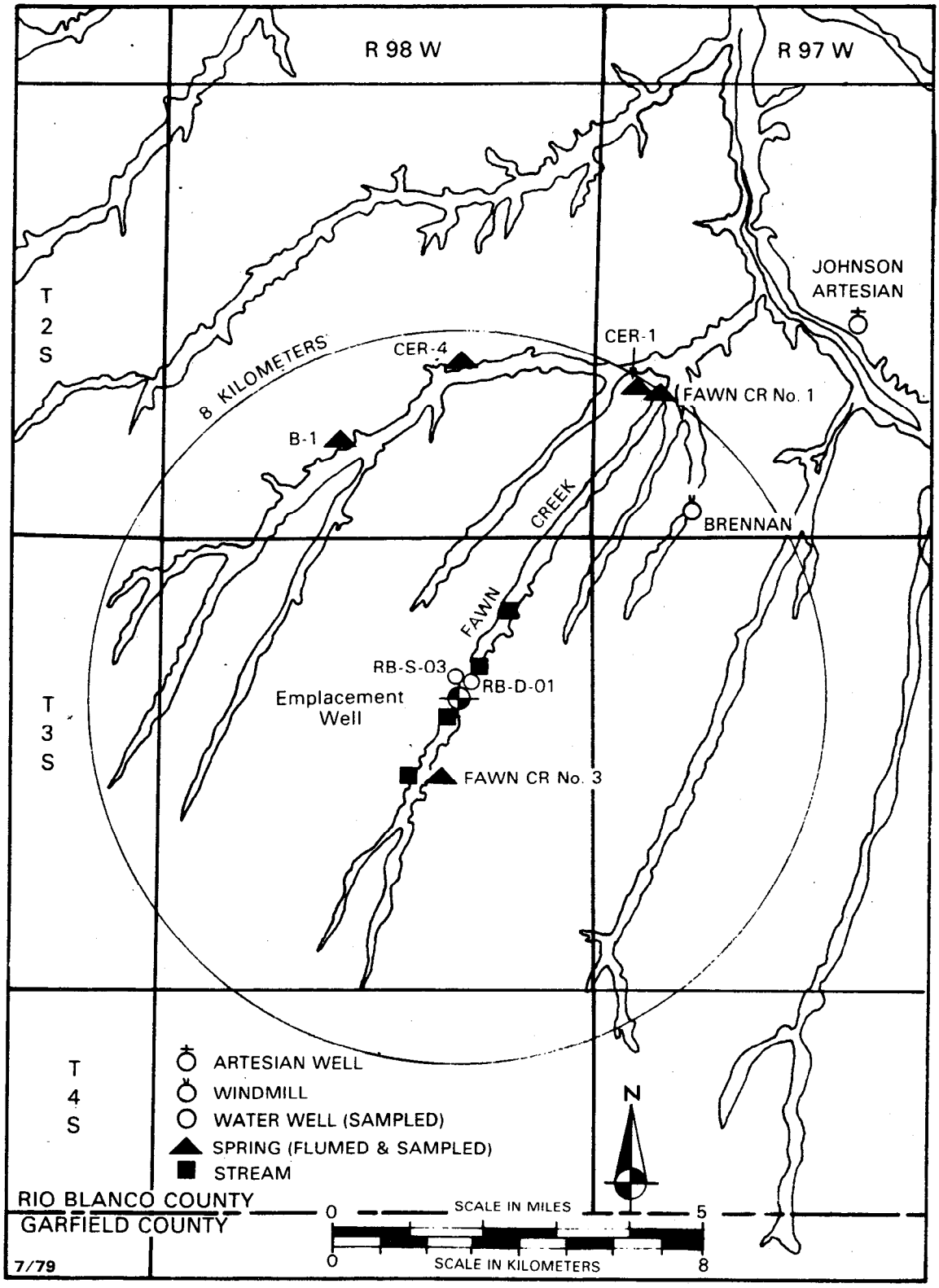

Figure 27. Long-Term Hydrological Monitoring Program, Project Rio Blanco, Rio Blanco County, Colorado.

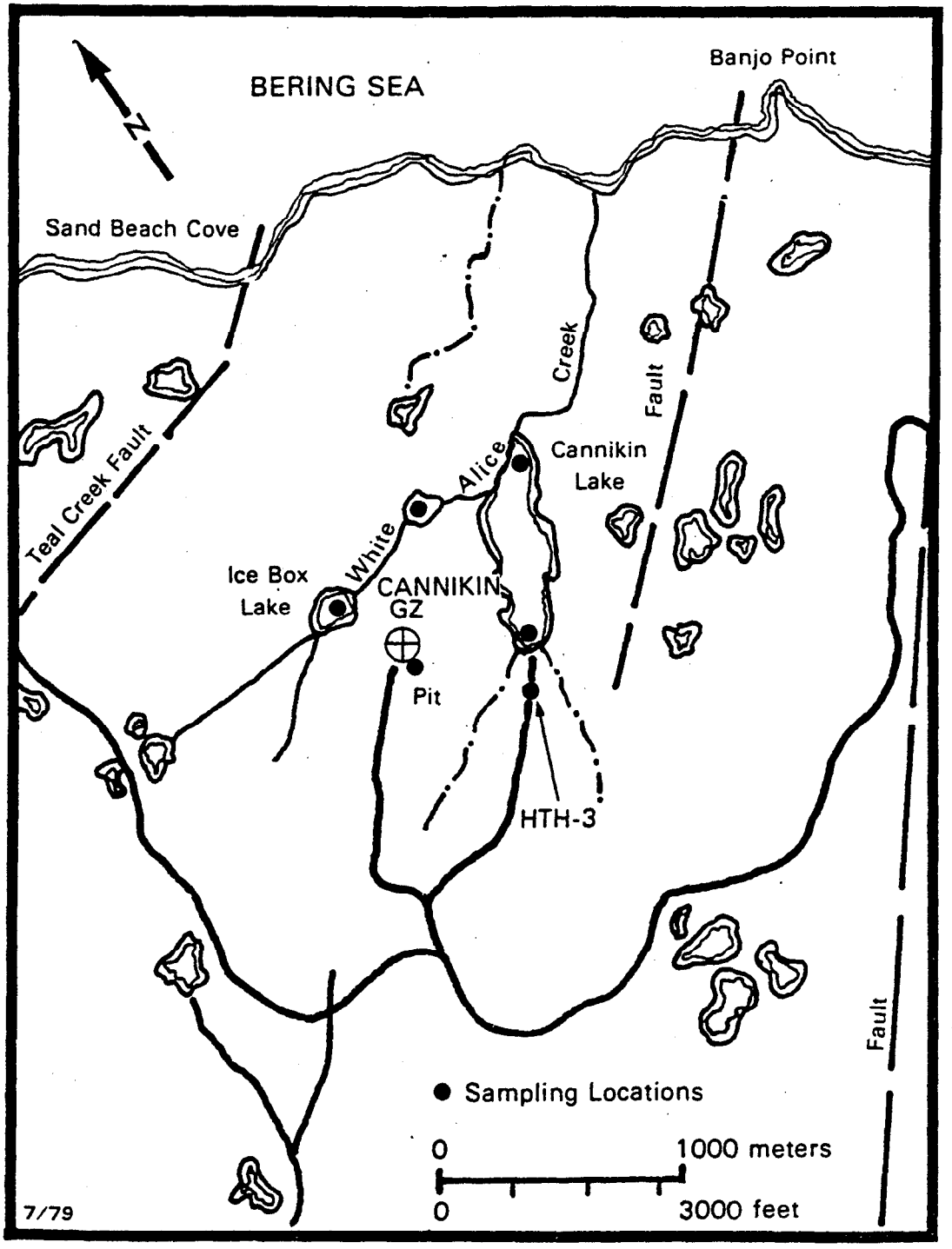

Figure 28. Long-Term Hydrological Monitoring Program, Project Cannikin, Amchitka Island, Alaska.

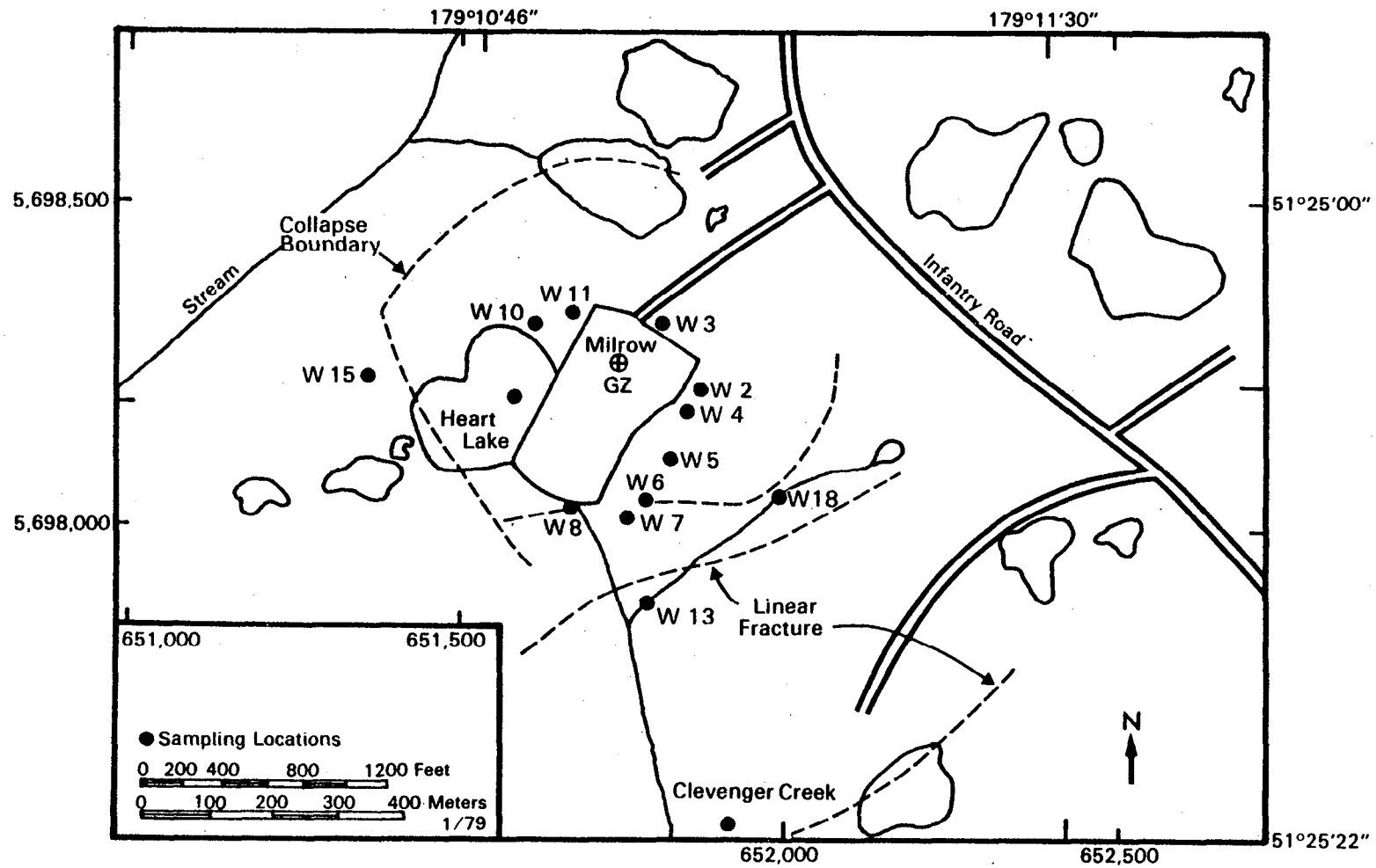

Figure 29. Long-Term Hydrological Monitoring Program, Project Milrow, Amchitka Island, Alaska.

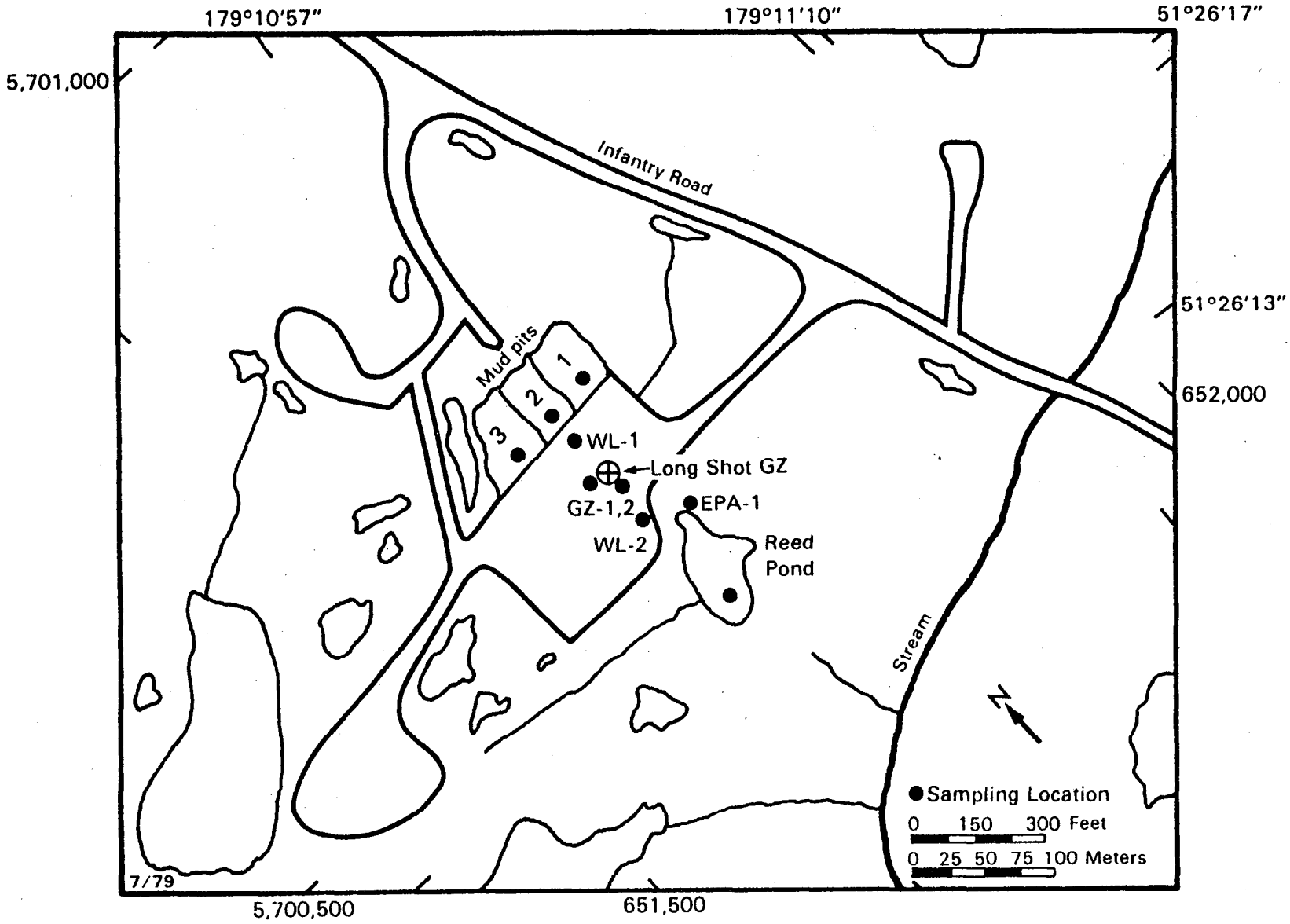

Figure 30. Long-Term Hydrological Monitoring Program, Project Long Shot, Amchitka Island, Alaska.

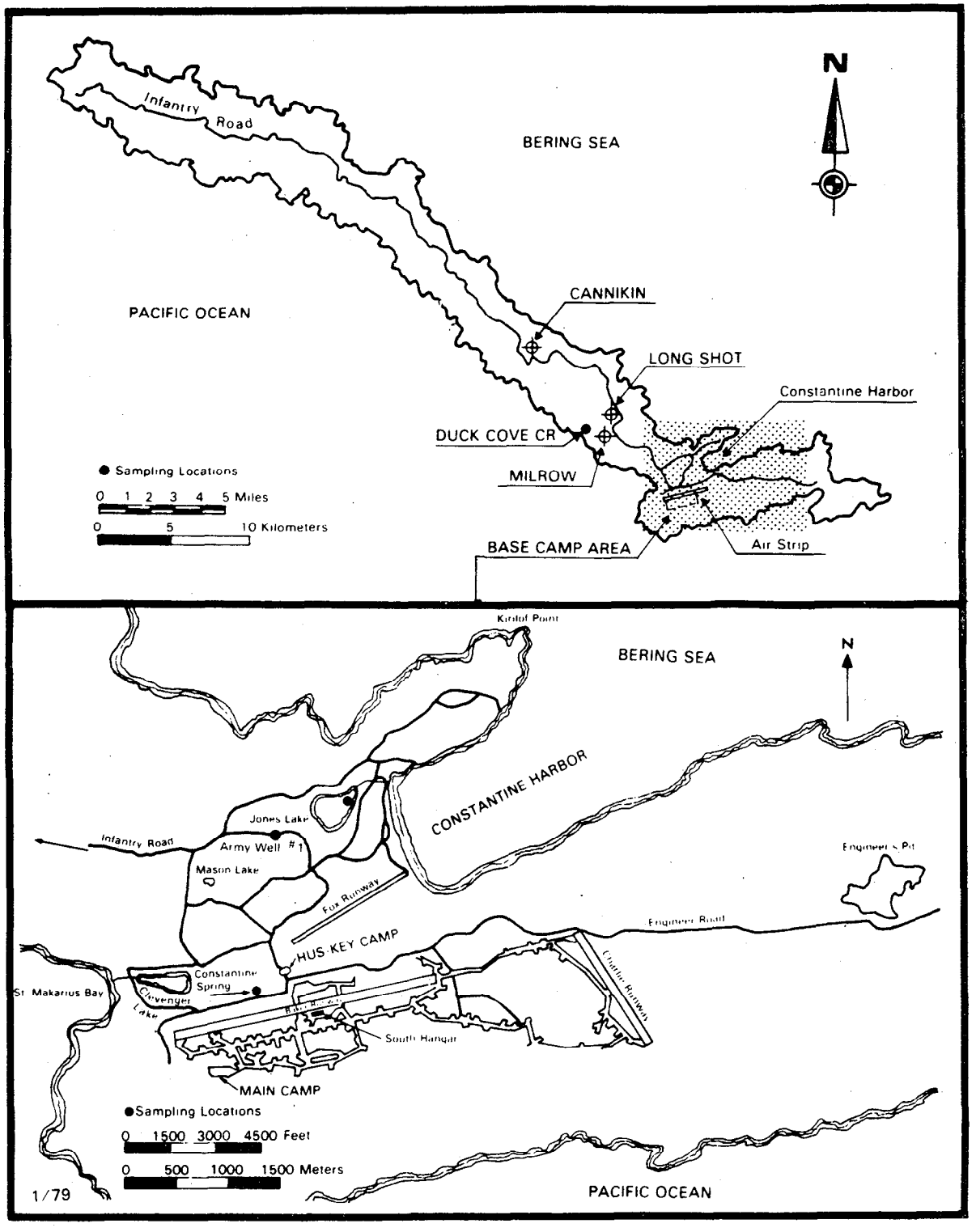

Figure 31. Long-Term Hydrological Monitoring Program, Background Sampling, Amchitka Island, Alaska.

As reported in previous annual reports, concentrations of radioactivity above background levels were observed in samples collected from USGS Wells 4 and 8 near Malaga, New Mexico (Table A-11, Project Gnome). These wells, which are fenced, posted, and locked to prevent their use by unauthorized personnel, were contaminated by the injection of higher concentrations of tritium, strontium-90 and cesium-137 (USGS Well 8 only) for a tracer study.

All of the other sampled wells showed no unexplained increase in gross alpha or gross beta radioactivity. The water sample collected at Flowing Well near Frenchman, Nevada, (Table A-11, Project Shoal) had a higher than normal beta concentration of 1.6×10^{-7} µCi/ml; however, the gamma spectrometry analysis on this sample identified naturally occurring potassium-40 and radon-222 daughter products as the sources of radioactivity. Except for the anomalous low gross beta concentration in 1976 ($<5 \times 10^{-9}$ µCi/ml), the gross beta concentration in the annual samples collected from this location since 1972 have ranged from 3.8×10^{-8} µCi/ml to 9.4×10^{-8} µCi/ml. With the exclusion of the Flowing Well sample, the gross alpha and gross beta concentration ranges for all the off-NTS sites were, respectively, $<2 \times 10^{-9}$ µCi/ml to $<4.0 \times 10^{-8}$ µCi/ml and $<6 \times 10^{-9}$ µCi/ml to 4.5×10^{-8} µCi/ml.

The concentrations of tritium in samples collected at all locations were similar to those observed in samples collected in the past. The concentration of tritium (2.7×10^{-6} µCi/ml) in the surface water sample collected from the Half Moon Creek Overflow at the Project Dribble site, Tatum Dome, Mississippi, was again higher than background levels observed in Off-site surface water samples (6.2×10^{-8} µCi/ml to 7.6×10^{-8} µCi/ml). Exploratory surveys in April 1977 found the tritium to be coming from subsurface soil contaminated with tritium which was suspected to be the residual from post-shot drilling operations following two underground nuclear detonations, Salmon in 1964 and Sterling in 1966.

To determine the extent to which the subsurface soil was contaminated, soil and water samples were collected from four-inch-diameter holes augered to the water table on 25-, 50-, and 100-foot grids around surface ground zero. Each sample was analyzed on-site for conductivity, pH, and tritium. The results of this investigation, conducted during the September 12 to 19, 1977, and April 18 to 27, 1978, were reported in detail (DOE, 1978). As cited in this report (DOE, 1978), the area contaminated by tritium at the water table measures about 1,225 ft north to south and 960 ft east to west. The surface ground zero is located slightly east of the center of the contaminated area. Within the contaminated area, there are five areas (totalling 2 acres) that had tritium concentrations in soil moisture or ground water that were equal to or exceeded 2.0×10^{-5} µCi/ml.

The highest concentration of tritium observed, 10^{-3} µCi/ml, was obtained from soil moisture recovered from a soil sample collected in Hole 67, at a depth of 10 ft. This hole was located approximately 25 ft southeast of Well PS-1 (Figure 23), which was sealed during post-shot drilling operations. Although this water is not used as drinking water, this concentration is 30 percent of the CG for an individual in a controlled or uncontrolled area and 50 times the maximum contaminant level at the EPA Drinking Water Regulations (Appendix B).

To determine the distribution of tritium with depth to the water table, a well (PS-3) was drilled and sampled to 142 ft; however, the water table was never reached (DOE, 1978). As the soil moisture samples collected from the upper 43 ft of the formation overlying Tatum Dome in this well contained all of the tritium contamination (2.5×10^{-5} µCi/ml to 9.7×10^{-4} µCi/ml), except for a few low level samples (5.0×10^{-7} µCi/ml to 9.0×10^{-6} µCi/ml) collected at depths between 93 ft and 142 ft, the source of the tritium is believed to be from drilling operations and is not suspected to be caused by upward leakage of radioactivity from the event cavity at a depth of 2700 ft (DOE 1978).

For the purpose of monitoring the tritium concentrations in the on-site subsurface soil moisture, 11 holes 4 inches in diameter were augered by EPA personnel at the locations shown in Figure 23, lined with 4-inch-diameter plastic casing, and capped above the ground surface. Beginning in April 1978, water samples from these locations will be collected and analyzed for tritium quarterly for 1 year. If no significant increase in radioactivity concentration is observed in samples collected at any of the locations, the locations will be sampled annually. The analytical results for the samples collected from the HMH locations and Well PS-3 are listed in Appendix A-13. As shown by the table, the highest tritium concentration was 4.5×10^{-4} µCi/ml in the sample collected from HMH-1. All of the tritium contamination was confined to the subsurface. None was detected in any surface water or offsite well other than the on-site Half-Moon Creek Overflow. No off-site residents are suspected of being exposed to the waterborne tritium. As mentioned earlier, the nearest populated area is a single residence which is about 1 mile south-southwest of surface ground zero. To make certain that the subsurface tritium contamination had not entered an aquifer which is used by off-site residents, arrangements are being made between representatives of the Department of Energy, Nevada Operations Office, the State of Mississippi and the EPA to extend Well PS-3 to the local aquifer and to implement further changes to the environmental surveillance program for the Project Dribble site.

The concentration of tritium in several water samples collected from shallow wells and surface waters at the Project Long Shot site on Amchitka Island, Alaska, were also above background levels. These samples, which had tritium concentrations ranging from 2.8×10^{-7} µCi/ml to 7.3×10^{-6} µCi/ml, were collected from every location at the project site except for Reed Pond (Table A-11). The observed concentrations are comparable to those reported earlier by the U.S. Geological Survey (Ballance, 1974; Thordarson and Ballance, 1976) and the University of Washington (Nelson and Seymour, 1977). The highest tritium concentration was found to be only 0.24 percent of the CG. The water in this area is not used for drinking purposes, therefore the contamination was found to pose no radiological hazard.

WHOLE-BODY COUNTING

Eighteen families consisting of 59 residents from 12 locations near the NTS were examined twice during the year to determine individual body burdens of radioactivity for each individual and to monitor for any physical changes

attributable to the effects of acute or chronic exposure to radiation or radioactivity. When possible, all members of a family were included in the examinations. The home locations of these individuals were Pahrump, Lund, Beatty, Pioche, Nyala, Round Mountain, Ely, Tempiute, Goldfield, Lathrop Wells, Tonopah, and Spring Meadow Farms, Nevada.

Each examination consisted of a measurement of the body burden of radioactivity using the whole-body counting facility described previously (NERC-LV, 1974), a complete hematological examination, and a thyroid profile. A urine sample was also collected from each individual for tritium analysis, and a composite of urine samples from each family was analyzed for plutonium-238 and plutonium-239.

From the results of the whole-body counting, the fission product cesium-137 was detected above the detection limit in 86 out of 97 measurements. The maximum, minimum, and average body burdens for this radionuclide were 3.4×10^{-8}, $<5 \times 10^{-9}$, and 1.3×10^{-8} μCi/g body weight, respectively, which were similar to last year's concentrations (maximum of 3.9×10^{-8} μCi/g; minimum of $<5 \times 10^{-9}$; and average of 1.4×10^{-8} μCi/g body weight).

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.

The concentrations of plutonium-238 and plutonium-239 in all composite urine samples were below the minimum detectable concentration of 2×10^{-10} μCi/ml, which was higher than the MDC reported in Table A-2. (4 to 8×10^{-11} μCi/l) due to the fact that the composite urine sample from each family was often less than the desired one liter.

As the concentration of plutonium-238 and plutonium-239 in the urine of individuals exposed only to worldwide atmospheric fallout would not result in a concentration in urine above the MDC, the five composite urine samples reported last year to contain plutonium-238 or plutonium-239 above the MDC were re-evaluated. From the evaluation, all four of the composites having plutonium-238 were calculated to have a concentration less than the MDC. The composites were calculated in accordance with the new definition, which allows for both Type I and Type II decision errors at the 95% confidence level. The plutonium-239 concentration reported in the fifth composite ($2.9 \times 10^{-11} \pm 1.8 \times 10^{-11}$ μCi/ml) was found to be above the newly defined MDC; however, this is believed to be a statistical anomally, because no plutonium was detected in the 1978 composite of urine samples collected from members of this same family.

DOSE ASSESSMENT

The only radioactivity which was detected off-NTS and ascribed to test operations was xenon-133 detected in an air sample collected at Diablo, Nevada, during the period April 19-26 and tritiated hydrogen (HT) in air samples collected at Indian Springs, Nevada, during the periods November 13 to 20 and November 27 to December 4.

The estimated dose equivalent to the whole body of a hypothetical receptor at Diablo from the exposure to the airborne xenon-133 would be

$$\frac{(6.5 \times 10^{-11}\ \mu Ci/ml)\ (7\ days)\ (500\ mrem/year)}{(10^{-7}\ \mu Ci/ml)\ (365\ days/year)\ (1\ mrem/1000\ \mu rem)} = 6.2\ \mu rem$$

Based upon an estimated population of six people, the dose commitment at Diablo was estimated to be 0.000037 person-rem.

At Indian Springs, the concentrations of HT in air minus an ambient HT concentration of 7.6×10^{-13} μCi/ml, estimated from all other off-NTS, resulted in a calculated dose equivalent of

$$\frac{[2.4 \times 10^{-11}\ \mu Ci/ml] + [1.8 \times 10^{-11}\ \mu Ci/ml] - [(2)(7.6 \times 10^{-13}\ \mu Ci/ml)(7\ d)(500\ mrem/y)]}{[(6.7 \times 10^{-8}\ \mu Ci/ml)(365\ d)(1\ mrem/1000\ \mu rem)]} = 5.8\ \mu rem$$

Based upon a population of 1500 at Indian Springs, the estimated dose commitment for the area would be 0.0087 person-rem.

As Diablo is beyond 80 km of the center of the NTS, the 80 km dose commitment would be 0.0087 person-rem. Due to the greater population density within the Las Vegas area, the highest dose commitment (0.36 person-rem) was for this area, which is approximately 100 km from the NTS. This dose commitment is small compared to the 26,000 person-rem, which residents of Las Vegas and nearby communities received from natural background radiation during this report period.

TABLE 8. ESTIMATED DOSE COMMITMENT FROM XENON-133 CONCENTRATIONS

Location	Population	Estimated Dose Equivalent (μrem)	Dose Commitment (person-rem)	Dose Commitment With in 80km (person-rem)
Beatty, Nev.	500	2.5	0.0013	0.0013
Diablo, Nev.	6	1.2	0.0000072	0.0
Hiko, Nev.	60	1.1	0.000066	0.0
Las Vegas, Nev.	370,500*	0.96	0.36	0.0
Tonopah, Nev.	2,000	1.4	0.0028	0.0
Total			0.36	0.0013

*Population is for Las Vegas and nearby communities within Clark County.

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APPENDIX A. TABLES

TABLE A-1. UNDERGROUND TESTING CONDUCTED OFF THE NEVADA TEST SITE

Name of Test, Operation or Project	Date	Location	Yield[4] (kt)	Depth m (ft)	Purpose of the event[4,5]
Project/Gnome Coach[1]	12/10/61	48 km (30 mi) SE of Carlsbad, N. Mex.	3.1[6]	360 (1184)	Multi-purpose experiment.
Project Shoal[2]	10/26/63	45 km (28 mi) SE of Fallon, Nev.	12	366 (1200)	Nuclear Test detection research experiment.
Project Dribble[2] (Salmon Event)	10/22/64	34 km (21 mi) SW of Hattiesburg, Miss.	5.3	823 (2700)	Nuclear test detection research experiment.
Operation Long Shot[2]	10/29/65	Amchitka Island, Alaska	80	716 (2350)	DOD nuclear test detection experiment.
Project Dribble[2] (Sterling Event)	12/03/66	34 km (21 mi) SW of Hattiesburg, Miss.	0.38	823 (2700)	Nuclear test detection research experiment.
Project Gasbuggy[1]	12/10/67	88 km (55 mi) E of Farmington, N. Mex.	29	1292 (4240)	Joint Government-Industry gas stimulation experiment.
Faultless Event[3]	01/19/68	Central Nevada Test Area 96 km (60 mi) E of Tonopah, Nev.	200-1000	914 (3000)	Calibration test.
Project Miracle Play (Diode Tube)[3]	02/02/69	34 km (21 mi) SW of Hattiesburg, Miss.	Non-nuclear explosion	823 (2700)	Detonated in Salmon/Sterling cavity. Seismic studies.
Project Rulison[1]	09/10/69	19 km (12) SW of Rifle, Colo.	40	2568 (8425)	Gas Stimulation experiment.
Operation Milrow[3]	10/02/69	Amchitka Island, Alaska	1000	1219 (4000)	Calibration test.
Project Miracle[1] Play (Humid Water)[2]	04/19/70	34 km (21 mi) SW of Hattiesburg, Miss.	Non-nuclear explosion	823 (2700)	Detonated in Salmon/Sterling cavity. Seismic studies.
Operation Cannikin[3]	11/06/71	Amchitka Island, Alaska	<5000	1829 (6000)	Test of warhead for Spartan missile.
Project Rio Blanco[1]	05/17/73	48 km (30 mi) SW of Meeker, Colo.	3x30	1780 to 2040 (5840 to 6690)	Gas stimulation experiment.

[1]Plowshare Events
[2]Vela Uniform Events
[3]Weapons Tests
[4]Information from "Revised Nuclear Test Statistics," dated September 20, 1974, and "Announced United States Nuclear Test Statistics," dated June 30, 1976, distributed by David G. Jackson, Director, Office of Public Affairs, Energy Research Administration, Nevada Operations Office, Las Vegas, Nevada.
[5]News release Al-62-50, ABC Albuquerque Operations Office, Albuquerque, New Mexico. December 1, 1961.
[6]"The Effects of Nuclear Weapons," Rev. Ed. 1964.

TABLE A-2. SUMMARY OF ANALYTICAL PROCEDURES

Type of Analysis*	Analytical Equipment	Counting Period (Min)	Analytical Procedures	Sample Size (Liter)	Approximate Detection Limit**
NaI(Tl) Spectrometry	Gamma spectrometer with 10-cm-thick by 10-cm-diameter NaI detector calibrated at 10 keV per channel (0-2 MeV range).	100 min for milk, water, Long-Term Hydro, suspended solids; 10 min. for air charcoal cartridges and air filters.	Radionuclide concentrations quantified from gamma spectral data by computer using a least squares technique.	3.5 for routine milk and water samples; 800-1200 m^3 for air filter samples; 7.3 for Long-Term Hydro. Water suspended solids. Composite air filters ~15000 m^3	For routine milk and water generally, $1x10^{-8}$ µCi/ml for most common fallout radionuclides in a simple spectrum. For air filters, $4x10^{-14}$µCi/ml. For Long-Term Hydro. suspended solids, $6.0x10^{-9}$µCi/ml.
Ge(Li) gamma Spectrometry	Gamma spectrometer with Ge(Li) detector calibrated at 1/2 keV/channel (0-2 MeV range) individual isotopic efficiencies ranging from ~15% - 22%.	Individual air filters 30 min air filter composites. ~1200 min.	Radionuclide concentration quantified from gamma spectral data by on-line computer program. Radionuclides in air filter composite samples are identified only.	Same as above.	Same as above
89-90Sr	Low-background thin-window, gas-flow proportional counter with a 5.7-cm diameter window (80 µg/cm^2).	50	Chemical separation by ion exchange. Separated sample counted successively; activity calculated by simultaneous equations.	1.0	$^{89}Sr = 5x10^{-9}$ µCi/ml $^{90}Sr = 2x10^{-9}$ µCi/ml.
^3H	Automatic liquid scintillation counter with output printer.	200	Sample prepared by distillation.	0.005	$4x10^{-7}$ µCi/ml
^3H Enrichment (Long-Term Hydrological Samples)	Automatic scintillation counter with output printer.	200	Sample concentrated by electrolysis followed by distillation.	0.25	$1x10^{-8}$ µCi/ml
238,239Pu 234,235,238U	Alpha spectrometer with 450 mm^2, 300-µm depletion depth, silicon surface barrier detectors operated in vacuum chambers.	1000-1400	Sample is digested with acid, separated by ion exchange, electroplated on stainless steel planchet and counted by alpha spectrometer.	1.0	$^{238}Pu = 8x10^{-11}$ µCi/ml ^{239}Pu, ^{234}U, ^{235}U, ^{238}U = $4x10^{-11}$ µCi/ml

(continued)

TABLE A-2. (Continued)

Type of Analysis*	Analytical Equipment	Counting Period (Min)	Analytical Procedures	Sample Size (Liter)	Approximate Detection Limit**
^{226}Ra	Single channel analyzer coupled to P.M. tube detector.	30	Precipitated with Ba, converted to chloride. Stored for 30 days for ^{222}Rn ^{226}Ra to equilibrate. Radon gas pumped into scintillation cell for alpha scintillation counting.	1.5	$2x10^{-10}$ µCi/ml
Gross alpha Gross beta in liquid samples	Low-background thin-window, gas-flow proportional counter with a 5.7-cm-diameter window (80 µg/cm^2).	50	Sample evaporated; residue weighed and counted; corrected for self-attenuation.	0.2	$\alpha = 6x10^{-9}$ µCi/ml $\beta = 4x10^{-9}$ µCi/ml
Gross beta on air filters	Low-level end window, gas flow proportional counter with a 12.7-cm-diameter window (100 mg/cm^2).	20	Filters counted at 7 and 14 days after collection; two counts can be used to extrapolate concentration to mid-collection time assuming $T^{-1.2}$ decay or using experimentally derived decay.	10-cm diameter glass fiber filter; sample collected from 500-1200m^3.	$4x10^{15}$µCi/ml
^{85}Kr, ^{133}Xe CH^3T	Automatic liquid scintillation counter with output printer.	200	Physical separation by gas chromatography; dissolved in toluene "cocktail" for counting.	400-1000	$^{85}Kr = 4x10^{-12}$ µCi/ml $^{133}Xe = 4x10^{-12}$ µCi/ml $CH3T = 4x10^{-12}$ µCi/ml

*Johns, F. B., P. B. Hahn, D. J. Thome, and E. W. Bretthauer. Radiochemical Analytical Procedures for Analyses of Environmental Samples, EMSL-LV-0539-17, U.S. Environmental Protection Agency, EMSL-LV, Las Vegas. 1979.

**The detection limit for all samples received after January 1, 1978 is defined as 3.29 sigma where sigma equals the counting error of the sample and Type I error = Type II error = 5 percent. (Corley, J. P., D. H. Denham, D. E. Micheles, A. R. Olsen and D. A. Waite, "A Guide for Environmental Radiological Surveillance at ERDA Installations," ERDA 77-24 pp. 3.19-3.22, March, 1977, Energy Research and Development Administration, Division of Safety, Standards and Compliance, Washington, D.C.)

TABLE A-3. 1978 QUALITY ASSURANCE INTERCOMPARISONS

Analysis	Month	Mean of Replicate Analyses ±/σ (10^{-9} µCi/ml)	Mean Range + Standard Error of Range	Known Value (10^{-9} µCi/ml)	Normalized Deviation from Grand Avg.	Normalized Deviation from Conc.
Gross α in water	Jan.	7 ± 0	0.0	7	-0.1	0.0
	Mar.	21 ± 1	0.12	20	1.4	0.5
	May	13 ± 1	0.24	13	-0.0	0.0
	July	20 ± 1	0.20	22	1.0	-0.5
	Sept.	6 ± 1	0.24	5	0.1	0.3
Gross β in water	Jan.	31 ± 1	0.24	39	-2.1	-2.7
	Mar.	34 ± 1	0.24	29	1.6	1.8
	May	20 ± 3	0.59	18	-0.1	-0.7
	July	25 ± 2	0.35	30	-2.5	-1.8
^{3}H in water	Feb.	1800 ± 100	0.35	1680	0.3	0.6
	Apr.	2230 ± 149	0.47	2220	0.2	0.0
	June	2300 ± 400	1.67	2270	0.2	0.1
	Aug.	1178 ± 219	0.76	1230	-0.4	-0.3
^{239}Pu in water	Jan.	1.5 ± 0.1	0.30	1.7	0.1	-2.0
	July	3.1 ± 0.2	0.47	3.6	0.4	-1.5
^{90}Sr in water	Jan.	35 ± 1	0.74	31	5.6	4.3
	May	23 ± 1	0.39	27	-0.6	-4.2
	Sept.	12 ± 1	0.39	16	-3.8	-4.2
^{89}Sr in water	Jan.	27 ± 1	0.24	25	1.0	0.8
	May	12 ± 2	0.47	16	-2.4	-1.4
	Sept.	14 ± 4	0.83	19	-0.1	-1.8
^{226}Ra in water	Mar.	4.8 ± 0.1	0.15	5.5	0.1	-1.5
	June	3.8 ± 0.4	0.79	3.7	0.5	0.3
^{3}H in urine	Mar.	760 ± 26	0.09	1050	-1.2	-1.5
	June	3767 ± 153	0.43	4150	-0.4	-1.6
	Sept.	930 ± 214	0.74	1120	-1.3	-1.0

(continued)

TABLE A-3. (Continued)

Analysis	Month	Mean of Replicate Analyses ±/σ (10^{-9} µCi/ml)	Mean Range + Standard Error of Range	Known Value (10^{-9} µCi/ml)	Normalized Deviation from Grand. Avg.	Normalized Deviation from Conc.
^{137}Cs in water	Feb.	< 3	-	0	-	-
	Apr.	< 4	-	0	-	-
	June	29 ± 3	0.71	30	-1.0	-0.5
	Aug.	16 ± 2	0.35	15	-0.0	0.3
	Oct.	123 ± 5	0.89	125	-1.2	-0.7
^{131}I in milk	Apr.	82 ± 3	0.59	82	0.0	-0.1
	July	< 3	-	0	-	-
^{137}Cs in milk	Apr.	24 ± 2	0.47	23	-0.5	-0.2
	July	54 ± 1	0.12	53	-0.0	0.2
^{140}Ba in milk	Apr.	< 2	-	0	-	-
	July	< 3	-	0	-	-
^{90}Sr in milk	Apr.	7 ± 1	0.79	9	-1.8	-1.9
	July	38 ± 1	0.24	49	-5.5	-7.9
^{89}Sr in milk	Apr.	78 ± 1	0.24	101	-4.8	-7.9
	July	50 ± 5	1.35	41	5.1	3.1
K in milk	Apr.	1529 ± 6	0.09	1500	-0.3	-0.7
	July	1527 ± 28	0.39	1560	-0.4	-0.7
Gross β on air filters	Mar.	38 ± 2	0.47	38	-0.5	0.1
	June	36 ± 3	0.59	36	-0.9	0.0
^{137}Cs on air filters pCi/filter	Mar.	25 ± 2	0.35	22	0.6	1.0
	June	17 ± 1	0.24	18	-1.2	-0.3

TABLE A-4. 1978 SUMMARY OF ANALYTICAL RESULTS FOR THE NOBLE GAS AND TRITIUM SURVEILLANCE NETWORK

Sampling Location	No. Days Sampled	Radionuclide	Units	Radioactivity Concentrations C_{Max}	C_{Min}	C_{Avg}	% of Conc. Guide*
				(μCi/ml air)			
Death Valley Jct., Calif.	342.6	^{85}Kr	10^{-12} μCi/ml air	24 x 10^{-12}	17 x 10^{-12}	20	0.02
	342.6	^{133}Xe	10^{-12} μCi/ml air	<20	< 3	< 3	< 0.01
	308.9	^{3}H as HT	10^{-6} μCi/ml water	0.93	< 0.3	< 0.3	--
	342.6	^{3}H as CH_3T	10^{-12} μCi/ml air	<20	< 2	< 2	
	308.9	^{3}H as HTO	10^{-12} μCi/ml air	4.9	< 0.6	1.4	< 0.01
	285.7	^{3}H as HT	10^{-12} μCi/ml air	4.1	< 0.3	0.77	
Beatty, Nev.	343.6	^{85}Kr	10^{-12} μCi/ml air	25	17	20	0.02
	343.6	^{133}Xe	10^{-12} μCi/ml air	< 30	< 3	< 3	< 0.01
	296.7	^{3}H as HTO	10^{-6} μCi/ml water	1.9	< 0.3	0.29	--
	343.6	^{3}H as CH_3T	10^{-12} μCi/ml air	<20	< 2	< 2	
	296.7	^{3}H as HTO	10^{-12} μCi/ml air	13	< 0.3	1.5	< 0.01
	295.7	^{3}H as HT	10^{-12} μCi/ml air	< 3	< 0.5	< 0.5	
Diablo, Nev.	344.7	^{85}Kr	10^{-12} μCi/ml air	26	17	20	0.02
	336.7	^{133}Xe	10^{-12} μCi/ml air	65	< 2	3.1	< 0.01
	322.9	^{3}H as HTO	10^{-6} μCi/ml water	1.4	< 0.3	< 0.3	--
	344.7	^{3}H as CH_3T	10^{-12} μCi/ml air	<20	< 2	< 2	
	322.9	^{3}H as HTO	10^{-12} μCi/ml air	8.6	< 1	1.5	< 0.01
	307.0	^{3}H as HT	10^{-12} μCi/ml air	6.0	< 0.6	0.97	
Hiko, Nev.	357.7	^{85}Kr	10^{-12} μCi/ml air	26	14	20	0.02
	357.7	^{133}Xe	10^{-12} μCi/ml air	<20	< 3	< 3	< 0.01
	321.8	^{3}H as HTO	10^{-6} μCi/ml water	0.75	< 0.3	< 0.3	--
	357.7	^{3}H as CH_3T	10^{-12} μCi/ml air	<20	< 2	< 2	
	321.8	^{3}H as HTO	10^{-12} μCi/ml air	< 5	< 0.8	0.73	< 0.01
	293.0	^{3}H as HT	10^{-12} μCi/ml air	4.0	< 0.4	0.94	
Indian Springs, Nev.	344.4	^{85}Kr	10^{-12} μCi/ml air	25	16	20	0.02
	363.6	^{133}Xe	10^{-12} μCi/ml air	< 5	< 3	< 3	< 0.01
	334.6	^{3}H as HTO	10^{-6} μCi/ml water	0.85	< 0.4	< 0.4	--
	356.5	^{3}H as CH_3T	10^{-12} μCi/ml air	20	< 2	< 2	
	334.6	^{3}H as HTO	10^{-12} μCi/ml air	< 4	< 0.8	0.83	< 0.01
	300.5	^{3}H as HT	10^{-12} μCi/ml air	24	< 0.5	1.8	
Las Vegas, Nev.	329.7	^{85}Kr	10^{-12} μCi/ml air	24	16	20	0.02
	336.6	^{133}Xe	10^{-12} μCi/ml air	<20	< 3	< 3	< 0.01
	321.6	^{3}H as HTO	10^{-6} μCi/ml water	1.1	< 0.3	0.29	--
	336.7	^{3}H as CH_3T	10^{-12} μCi/ml air	<30	< 2	< 2	
	321.6	^{3}H as HTO	10^{-12} μCi/ml air	< 7	< 0.7	1.6	< 0.01
	285.7	^{3}H as HT	10^{-12} μCi/ml air	7.9	< 0.6	0.89	

(continued)

Table A-4 (Continued)

Sampling Location	No. Days Sampled	Radionuclide	Units	Radioactivity Concentrations C_{Max}	C_{Min}	C_{Avg}	% of Conc. Guide*
				(μCi/ml air)			
NTS, Nev.	350.5	^{85}Kr	10^{-12} μCi/ml air	28	15	20	< 0.01
Mercury	363.5	^{133}Xe	10^{-12} μCi/ml air	170	< 3	5.7	< 0.01
	323.6	^{3}H as HTO	10^{-6} μCi/ml water	2.3	< 0.3	0.33	--
	356.5	^{3}H as CH_3T	10^{-12} μCi/ml air	<20	< 2	< 2	
	323.6	^{3}H as HTO	10^{-12} μCi/ml air	32	< 0.7	1.8	< 0.01
	303.7	^{3}H as HT	10^{-12} μCi/ml air	6.4	< 0.6	0.8	
NTS, Nev.	363.5	^{85}Kr	10^{-12} μCi/ml air	27	16	20	< 0.01
Area 51 #	363.5	^{133}Xe	10^{-12} μCi/ml air	45	< 3	3.4	< 0.01
	356.5	^{3}H as HTO	10^{-6} μCi/ml water	3.2	< 0.3	0.29	--
	363.5	^{3}H as CH_3T	10^{-12} μCi/ml air	<20	< 2	< 2	
	356.5	^{3}H as HTO	10^{-12} μCi/ml air	20	< 0.7	1.2	< 0.01
	349.5	^{3}H as HT	10^{-12} μCi/ml air	< 3	< 0.7	< 0.7	
NTS, Nev.	335.6	^{85}Kr	10^{-12} μCi/ml air	29	19	22	< 0.01
BJY	356.5	^{133}Xe	10^{-12} μCi/ml air	14,000	< 2	240	< 0.01
	329.6	^{3}H as HTO	10^{-6} μCi/ml water	12	0.32	2.2	--
	356.5	^{3}H as CH_3T	10^{-12} μCi/ml air	<20	< 2	< 2	
	329.6	^{3}H as HTO	10^{-12} μCi/ml air	110	1.2	13	< 0.01
	322.6	^{3}H as HT	10^{-12} μCi/ml air	37	< 0.2	2.7	
NTS, Nev.	363.6	^{85}Kr	10^{-12} μCi/ml air	25	17	20	< 0.01
Area 12	363.5	^{133}Xe	10^{-12} μCi/ml air	<10	< 3	< 3	< 0.01
	329.8	^{3}H as HTO	10^{-6} μCi/ml water	17	< 0.5	4.5	--
	363.6	^{3}H as CH_3T	10^{-12} μCi/ml air	<20	< 2	< 2	
	329.8	^{3}H as HTO	10^{-12} μCi/ml air	120	1.9	18	< 0.01
	322.8	^{3}H as HT	10^{-12} μCi/ml air	57	< 0.2	6.9	
Tonopah,	336.6	^{85}Kr	10^{-12} μCi/ml air	27	15	20	0.02
Nev.	349.6	^{133}Xe	10^{-12} μCi/ml air	<20	< 4	< 3	< 0.01
	329.7	^{3}H as HTO	10^{-6} μCi/ml water	0.73	< 0.3	< 0.3	--
	349.6	^{3}H as CH_3T	10^{-12} μCi/ml air	<20	< 2	< 2	
	329.7	^{3}H as HTO	10^{-12} μCi/ml air	4.2	< 0.9	1.1	< 0.01
	315.5	^{3}H as HT	10^{-12} μCi/ml air	<20	< 0.5	0.5	

*Concentration Guides used for NTS Stations are those applicable to exposures to radiation workers. Those used for off-NTS stations are for exposure to a suitable sample of the population in an uncontrolled area. See Appendix B for Concentration Guides.

#Also known as Groom Lake.

TABLE A-5. 1978 SUMMARY OF RADIATION DOSES FOR THE DOSIMETRY NETWORK

Station Location	Measurement Period	Dose Equivalent Rate (mrem/d) Max.	Min.	Avg.	Annual Adjusted Dose Equivalent (mrem/y)
Adaven, Nev.	01/10/78 - 01/07/79	0.39	0.33	0.36	130
Alamo, Nev.	01/09/78 - 01/08/79	0.29	0.26	0.28	100
Area 51-NTS, Nev.	01/09/78 - 01/08/79	0.20	0.19	0.20	72
Austin, Nev.	01/11/78 - 01/09/79	0.43	0.40	0.41	150
Baker, Calif.	01/09/78 - 01/08/79	0.24	0.23	0.23	84
Barstow, Calif.	01/09/78 - 01/08/79	0.27	0.27	0.27	96
Beatty, Nev.	01/31/78 - 01/03/79	0.28	0.32	0.30	100
Bishop, Calif.	01/10/78 - 01/10/79	0.28	0.27	0.28	100
Blue Eagle Ranch, Nev.	01/11/78 - 01/09/79	0.21	0.17	0.19	67
Blue Jay, Nev.	01/10/78 - 01/11/79	0.35	0.34	0.34	120
Cactus Springs, Nev.	01/16/78 - 01/02/79	0.18	0.17	0.18	60
Caliente, Nev.	01/10/78 - 01/09/79	0.38	0.31	0.34	120
Carp, Nev.	01/10/78 - 01/09/79	0.31	0.30	0.30	110
Casey's Ranch, Nev.	01/11/78 - 01/10/79	0.22	0.20	0.20	77
Cedar City, Utah	02/01/78 - 01/16/79	0.23	0.22	0.22	77
Clark Station, Nev.	01/10/78 - 01/14/79	0.33	0.32	0.33	120
Complex I, Nev.	01/10/78 - 01/10/79	0.30	0.29	0.29	110
Coyote Summit, Nev.	01/09/78 - 01/12/79	0.35	0.34	0.34	130
Currant, Nev.	01/11/78 - 01/09/79	0.31	0.29	0.30	110
Death Valley Jct., Calif.	01/12/78 - 01/11/79	0.23	0.22	0.22	81
Desert Game Range, Nev.	01/16/78 - 01/02/79	0.16	0.15	0.16	55
Desert Oasis, Nev.[1]	01/31/78 - 03/27/79	0.17	0.17	0.17	5
Diablo Maint. Sta., Nev.	01/12/78 - 01/11/79	0.38	0.36	0.37	130
Duckwater, Nev.	01/11/78 - 01/09/79	0.33	0.29	0.30	110
Elgin, Nev.	01/10/78 - 01/09/79	0.35	0.35	0.35	130
Ely, Nev.	01/11/78 - 01/25/79	0.23	0.21	0.22	83
Enterprise, Utah	02/01/78 - 01/10/79	0.30	0.27	0.29	96
Eureka, Nev.	01/11/78 - 01/10/79	0.34	0.31	0.33	120
Furnace Creek, Calif.	01/12/78 - 01/11/79	0.19	0.18	0.18	67
Garrison, Utah	01/09/78 - 01/08/79	0.22	0.20	0.21	76
Geyser Maint. Sta., Nev.	01/09/78 - 01/08/79	0.32	0.30	0.31	110
Glendale, Utah[2]	03/27/78 - 01/15/79	0.17	0.17	0.17	50
Goldfield, Nev.	01/09/78 - 01/08/79	0.27	0.25	0.26	95
Hancock Summit, Nev.	01/09/78 - 01/12/79	0.42	0.39	0.41	150
Hiko, Nev.	01/09/78 - 01/08/79	0.22	0.22	0.22	80
Hot Creek Ranch, Nev.	01/10/78 - 01/11/79	0.27	0.26	0.26	96
Independence, Calif.	01/10/78 - 01/09/79	0.29	0.27	0.27	100
Indian Springs, Nev.	01/16/78 - 01/02/79	0.19	0.16	0.18	61
Kirkeby Ranch, Nev.	01/09/78 - 01/08/79	0.24	0.21	0.23	82
Koynes, Nev.	01/12/78 - 01/12/79	0.27	0.24	0.26	95
Las Vegas (Airport), Nev.	02/06/78 - 01/19/79	0.15	0.14	0.15	51

(continued)

TABLE A-5. (Continued)

Station Location	Measurement Period	Dose Equivalent Rate (mrem/d) Max.	Min.	Avg.	Annual Adjusted Dose Equivalent (mrem/y)
Las Vegas (Placak), Nev.	02/06/78 - 01/19/79	0.15	0.14	0.15	51
Las Vegas (USDI), Nev.	02/06/78 - 01/19/79	0.18	0.17	0.17	60
Lathrop Wells, Nev.	01/16/78 - 01/03/79	0.28	0.25	0.26	93
Lida, Nev.	01/09/78 - 01/08/79	0.29	0.28	0.28	100
Lone Pine, Calif.	01/10/78 - 01/09/79	0.28	0.26	0.27	99
Lund, Nev.	01/10/78 - 01/10/79	0.25	0.23	0.24	88
Mammoth Mtn., Calif.	01/11/78 - 01/10/79	0.38	0.24	0.29	100
Manhattan, Nev.	01/10/78 - 01/09/79	0.34	0.24	0.31	110
Mesquite, Nev.	01/31/78 - 01/15/79	0.18	0.18	0.18	64
Nevada Farms, Nev.	01/12/78 - 01/12/79	0.34	0.32	0.33	120
Nuclear Eng. Co., Nev.	01/31/78 - 01/03/79	0.47	0.35	0.39	130
Nyala, Nev.	01/11/78 - 01/10/79	0.24	0.23	0.23	85
Olancha, Calif.	01/10/78 - 01/09/79	0.26	0.25	0.26	94
Pahrump, Nev.	01/17/78 - 01/02/79	0.19	0.18	0.18	64
Pine Creek Ranch, Nev.[3]	01/10/78 - 10/05/78	0.33	0.31	0.32	77
Pioche, Nev.	01/11/78 - 01/10/79	0.25	0.24	0.24	88
Queen City Summit, Nev.	01/09/78 - 01/12/79	0.39	0.37	0.38	140
Reed Ranch, Nev.	01/09/78 - 01/11/79	0.32	0.30	0.31	110
Ridgecrest, Calif.	01/10/78 - 01/09/79	0.24	0.23	0.23	85
Robinson's Tr. Park, Nev.	01/12/78 - 01/12/79	0.33	0.33	0.33	120
Round Mountain, Nev.	01/10/78 - 01/09/79	0.32	0.30	0.31	110
Rox, Nev.	01/31/78 - 01/15/79	0.28	0.26	0.27	95
Scotty's Junction, Nev.	01/09/78 - 01/08/79	0.31	0.28	0.29	100
Selbach Ranch, Nev.	01/31/78 - 01/03/79	0.34	0.31	0.32	110
Sherri's Bar, Nev.	01/09/78 - 01/08/79	0.22	0.21	0.21	77
Shoshone, Calif.	01/12/78 - 01/11/79	0.30	0.28	0.29	110
Springdale, Nev.	02/01/78 - 01/03/79	0.35	0.31	0.33	110
Spring Meadows, Nev.	01/17/78 - 01/02/79	0.20	0.17	0.18	65
St. George, Utah	02/02/78 - 01/16/79	0.19	0.19	0.19	66
Stone Cabin Ranch, Nev.	01/11/78 - 01/12/79	0.48	0.31	0.39	140
Sunnyside, Nev.	01/10/78 - 01/10/79	0.22	0.20	0.21	76
Tempiute, Nev.	01/12/78 - 01/12/79	0.34	0.28	0.31	110
Tenneco, Nev.	01/17/78 - 01/02/79	0.30	0.29	0.29	100
Tonopah, Nev.	01/09/78 - 01/08/79	0.33	0.30	0.31	110
Tonopah Test Range, Nev.	01/10/78 - 01/09/79	0.30	0.27	0.29	100
Twin Springs Ranch, Nev.	01/12/78 - 01/11/79	0.32	0.31	0.31	120
Warm Springs, Nev.	01/11/78 - 01/11/79	0.33	0.32	0.32	120
Young's Ranch, Nev.	01/10/78 - 01/09/79	0.26	0.25	0.25	92

[1]Monitoring at this location discontinued after first quarter 1978.
[2]Station established second quarter 1978.
[3]Fourth quarter 1978 exchange not possible due to weather conditions.

TABLE A-6. 1978 SUMMARY OF ANALYTICAL RESULTS FOR THE MILK SURVEILLANCE NETWORK

Sampling Location	Sample Type[1]	No. of Samples	Radio-nuclide	Radioactivity Conc. (10^{-9} µCi/ml) C_{Max}	C_{Min}	C_{Avg}
Hinkley, Calif. Bill Nelson Dairy	12	4	^{89}Sr	< 5	< 3	< 3
		4	^{90}Sr	< 2	< 2	< 2
		4	^{137}Cs	4.0	< 3	< 3
Keough Hot Spgs., Calif. Yribarren Ranch	13	4	^{89}Sr	< 5	< 2	2.0
		4	^{90}Sr	2.0	< 2	< 2
		4	^{137}Cs	6.0	< 3	< 3
Trona, Calif. Stanford Ranch	13	3	^{89}Sr	< 6	< 3	< 3
		3	^{90}Sr	< 2	< 2	< 2
		3	^{137}Cs	5.5	< 3	< 3
Alamo, Nev. A. J. Sharp	14	3	^{89}Sr	< 3	< 2	< 2
		3	^{90}Sr	< 2	< 2	< 2
		3	^{137}Cs	7.1	< 3	5.2
Austin, Nev. Young's Ranch	14	4	^{3}H	620	<400	<400
		4	^{89}Sr	< 3	< 2	< 2
		4	^{90}Sr	2.3	1.3	1.8
		4	^{137}Cs	< 5	< 4	< 4
Caliente, Nev June Cox Ranch	13	4	^{89}Sr	< 3	< 2	< 2
		4	^{90}Sr	1.6	< 2	< 2
		4	^{137}Cs	< 4	< 3	< 3

(continued)

TABLE A-6. (Continued)

Sampling Location	Sample Type[1]	No. of Samples	Radio-nuclide	Radioactivity Conc. (10^{-9} µCi/ml) C_{Max}	C_{Min}	C_{Avg}
Currant, Nev. Blue Eagle Ranch	13	3	^{89}Sr	< 3	< 2	< 2
		3	^{90}Sr	3.5	< 2	2.0
		3	^{137}Cs	16	< 4	7.1
Currant, Nev. Manzonie Ranch	13	0	^{89}Sr	--	--	--
			^{90}Sr	--	--	--
			^{137}Cs	--	--	--
Hiko, Nev. Darrel Hansen Ranch	13	4	^{3}H	<600	<400	<400
		4	^{89}Sr	< 4	< 2	< 2
		4	^{90}Sr	< 2	< 2	< 2
		4	^{137}Cs	5.9	< 4	< 4
Las Vegas, Nev. LDS Dairy Farm	12	4	^{3}H	<600	<400	<400
		4	^{89}Sr	< 3	< 2	< 2
		4	^{90}Sr	< 2	< 2	< 2
		4	^{137}Cs	5.4	< 3	< 3
Lathrop Wells, Nev. Kirker Ranch	13	3	^{89}Sr	< 3	< 2	< 2
		3	^{90}Sr	< 2	< 2	< 2
		3	^{137}Cs	< 5	< 4	< 4
Lida, Nev. Lida Livestock Co.	13	1	^{89}Sr	< 2	< 2	< 2
		1	^{90}Sr	< 2	< 2	< 2
		1	^{137}Cs	8.9	8.9	8.9

(continued)

TABLE A-6. (Continued)

Sampling Location	Sample Type[1]	No. of Samples	Radio-nuclide	Radioactivity Conc. (10^{-9} µCi/ml) C_{Max}	C_{Min}	C_{Avg}
Logandale, Nev. Vegas Valley Dairy	12	4	^{89}Sr	< 4	< 2	< 2
		4	^{90}Sr	< 2	< 1	< 1
		4	^{137}Cs	< 5	< 3	< 3
Lund, Nev. McKenzie Dairy	12	4	^{3}H	<600	<400	<400
		4	^{89}Sr	< 4	< 2	< 2
		4	^{90}Sr	< 3	< 2	< 2
		4	^{137}Cs	4.9	2.9	< 3
Mesquite, Nev. Hughes Bros. Dairy	12	4	^{3}H	1400	<400	450
		4	^{89}Sr	< 4	< 2	< 2
		4	^{90}Sr	< 2	< 1	< 1
		4	^{137}Cs	4.9	3.8	< 4
Moapa, Nev. Agman Seventy-Five, Inc.	12	4	^{89}Sr	< 3	< 2	< 2
		4	^{90}Sr	1.5	< 2	< 2
		4	^{137}Cs	< 5	< 4	< 4
Nyala, Nev. Sharp's Ranch	13	4	^{3}H	<600	<400	<400
		4	^{89}Sr	< 3	< 2	< 2
		4	^{90}Sr	1.7	< 2	< 2
		4	^{137}Cs	< 5	< 3	< 3

(continued)

TABLE A-6. (Continued)

Sampling Location	Sample Type[1]	No. of Samples	Radio-nuclide	Radioactivity Conc. (10^{-9} µCi/ml) C_{Max}	C_{Min}	C_{Avg}
Pahrump, Nev. Oxborrow Ranch	13	3	^{89}Sr	< 3	< 2	< 2
		3	^{90}Sr	< 2	< 2	< 2
		3	^{137}Cs	5.2	< 4	< 4
Round Mountain, Nev. Berg Ranch	13	1	^{89}Sr	< 2	< 2	< 2
		1	^{90}Sr	4.0	4.0	4.0
		1	^{137}Cs	< 4	< 4	< 4
Shoshone, Nev. Kirkeby Ranch	13	4	^{89}Sr	< 3	< 2	< 2
		4	^{90}Sr	2.8	1.6	1.9
		4	^{137}Cs	7.3	< 3	3.8
Springdale, Nev. Boiling Pot Ranch	13	2	^{89}Sr	< 3	< 3	< 3
		2	^{90}Sr	1.4	< 2	< 2
		2	^{137}Cs	< 4	< 3	< 3
Cedar City, Utah Western General Dairy	12	4	^{89}Sr	< 4	< 2	< 2
		4	^{90}Sr	2.8	< 2	< 2
		4	^{137}Cs	< 5	< 3	< 3
St. George, Utah R. Cox Dairy	12	4	^{89}Sr	< 4	< 2	< 2
		4	^{90}Sr	< 2	< 1	< 1
		4	^{137}Cs	5.7	< 4	< 4

[1]12 = Raw Milk from Grade A Producer(s)
13 = Raw Milk from family cow(s)
14 = Other than Grade A Producer (Raw)

TABLE A-7. ANALYTICAL CRITERIA FOR LONG-TERM HYDROLOGICAL MONITORING PROGRAM SAMPLES

Gross alpha	All samples
Gross beta	All samples
Gamma scan	All samples
^{3}H*	All samples
$^{89,90}Sr$	Only samples collected at locations for the first time during CY78.
^{226}Ra	Only samples collected at locations for the first time during CY78 if gross alpha exceeded 3×10^{-9} µCi/ml.
U	Only samples collected at locations for the first time during CY78.
$^{238,239}Pu$	Only samples collected at locations for the first time during CY78.

*All samples were first analyzed by the more rapid conventional technique (MDC of about 4×10^{-7} µCi/ml). Those samples having tritium concentrations <MDC were then analyzed by the enrichment technique (MDC of about 1×10^{-8} µCi/ml).

TABLE A-8. 1978 SUMMARY OF ANALYTICAL RESULTS FOR THE NTS MONTHLY LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	No. Samples Collected[1]	No. Samples Analyzed	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml) Max	Min	Avg	% of Conc. Guide[2]
NTS	10	10	Gross α	< 4	< 2	< 2	--
Well 8		10	Gross β	< 6	< 4	< 4	--
		10	^{3}H	<20	< 9	< 9	<0.01
NTS	11	11	Gross α	9.0	< 3	4.9	--
Well U3CN-5		11	Gross β	10	< 6	< 6	--
		11	^{3}H	280	< 9	45	<0.01
NTS	11	11	Gross α	13	< 3	5.7	--
Well A		11	Gross β	7.2	< 6	< 6	--
		11	^{3}H	21	< 9	< 9	<0.01
NTS	11	11	Gross α	27	< 6	11	--
Well C		11	Gross β	12	< 6	6.8	--
		11	^{3}H	100	38	56	<0.01
NTS	11	11	Gross α	11	< 5	6.1	--
Well 5c		11	Gross β	46	< 6	5.8	--
		11	^{3}H	<30	< 9	< 9	<0.01
NTS	11	11	Gross α	5.8	< 4	3.8	--
Army Well		11	Gross β	< 6	4.9	< 5	--
No. 1		11	^{3}H	<16	< 9	< 9	<0.01
NTS	10	10	Gross α	7.6	< 3	2.6	--
Well 2		10	Gross β	< 6	4.1	< 5	
		10	^{3}H	47	< 9	< 9	<0.01
NTS	7	7	Gross α	< 5	< 3	< 3	--
Test Well B		7	Gross β	< 6	< 4	< 4	--
		6	^{3}H	250	170	190	<0.01
NTS	10	10	Gross α	6.1	< 3	< 3	--
Well J-13		10	Gross β	< 6	< 4	< 4	--
		10	^{3}H	16	< 9	< 9	<0.01
NTS	1	1	Gross α	< 3	< 3	< 3	--
Well J-12			Gross β	< 6	< 6	< 6	--
(Alternate for J-13			^{3}H	<13	<20	< 3	<0.01
NTS	9	9	Gross α	< 3	< 2	< 2	--
Well U19c		9	GRoss β	< 6	< 4	< 4	--
		9	^{3}H	<17	< 9	< 9	<0.01

[1]Samples could not be collected every month due to weather conditions or inoperative pumps.

[2]Concentration Guides for drinking water at on-NTS locations are the same as those for off-NTS locations. See Appendix B for Concentration Guides.

TABLE A-9. 1978 ANALYTICAL RESULTS FOR THE NTS SEMI-ANNUAL LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
NTS Well UE15d	2/02		23	Gross α	9.2	--
				Gross β	10	--
				^{3}H	<20	<0.01
NTS Well UE15d	7/19		23	Gross α	10	--
				Gross β	8.6	--
				^{3}H	<30	<0.01
NTS Test Well D	1/31	571	23	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
NTS Test Well D	7/20	571	23	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
NTS Well UE1c	2/02	500	23	Gross α	3.9	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
NTS Well UE1c	7/20	500	23	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
NTS Well C-1	2/02		23	Gross α	5.8	--
				Gross β	7.5	--
				^{3}H	24	<0.01
NTS Well C-1	7/19		23	Gross α	8.7	--
				Gross β	9.4	--
				^{3}H	<20	<0.01
NTS Well UE5C	2/01		23	Gross α	3.8	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
NTS Well UE5C	8/01		23	Gross α	8.6	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
NTS Well UE18r[4]	2/02	507	23	Gross α	7.8	--
				Gross β	< 6	--
				^{3}H	<20	<0.01

(continued)

TABLE A-9. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
NTS Well 5B	2/01		23	Gross α	< 4	--
				Gross β	5.7	--
				^{3}H	<20	<0.01
NTS Well 5B	7/18		23	Gross α	5.7	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
NTS Test Well F	2/03	1006	23	Gross α	13	--
				Gross β	10	--
				^{3}H	<20	<0.01
NTS Test Well F	7/21	1006	23	Gross α	11	--
				Gross β	7.8	--
				^{3}H	<20	<0.01
Ash Meadows, Nev. Crystal Pool	1/04		27	Gross α	15	--
				Gross β	10	--
				^{3}H	<20	<0.01
Ash Meadows, Nev. Crystal Pool	7/27		27	Gross α	7.0	--
				Gross β	12	--
				^{3}H	<20	<0.01
Ash Meadows, Nev. Well 18S/51E-7DB	1/04		23	Gross α	5.4	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
Ash Meadows, Nev. Well 18S/51E-7DB	7/27		23	Gross α	4.1	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
Ash Meadows, Nev. Well 17S/50E-14CAC	1/04		23	Gross α	8.9	--
				Gross β	19	--
				^{3}H	<20	<0.01
Ash Meadows, Nev. Well 17S/50E-14CAC	7/27		23	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	<20	<0.01

(continued)

TABLE A-9. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Ash Meadows, Nev. Fairbanks Springs	1/04		27	Gross α	< 4	--
				Gross β	< 6	--
				^3H	<20	<0.01
Ash Meadows, Nev. Fairbanks Springs	7/27		27	Gross α	< 4	--
				Gross β	< 6	--
				^3H	<20	<0.01
Beatty, Nev. City Supply	1/05		23	Gross α	16	--
				Gross β	< 6	--
				^3H	<20	<0.01
Beatty, Nev. City Supply	8/02		23	Gross α	9.3	--
				Gross β	< 6	--
				^3H	<20	<0.01
Beatty, Nev. Nuclear Engineering Co.	1/03		23	Gross α	8.3	--
				Gross β	5.9	--
				^3H	<20	<0.01
Beatty, Nev. Nuclear Engineering Co.	8/02		23	Gross α	8.1	--
				Gross β	< 6	--
				^3H	<20	<0.01
Beatty, Nev. Coffers Well	1/05		23	Gross α	9.4	--
				Gross β	< 6	--
				^3H	<20	<0.01
Beatty, Nev. Coffers Well	8/01		23	Gross α	11	--
				Gross β	< 6	--
				^3H	16	<0.01
Indian Springs, Nev. USAF No. 2	1/03		23	Gross α	< 5	--
				Gross β	< 6	--
				^3H	<20	<0.01
Indian Springs Nev. USAF No. 2	8/01		23	Gross α	< 5	--
				Gross β	< 6	--
				^3H	25	<0.01

(continued)

TABLE A-9. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Indian Springs, Nev. Sewer Co. Inc. Well No. 1	1/03		23	Gross α	5.5	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
Indian Springs, Nev. Sewer Co. Inc. Well No. 1	8/01		23	Gross α	< 4	--
				Gross α	< 6	--
				^{3}H	<20	<0.01
Lathrop Wells, Nev. City Supply	1/03		23	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
Lathrop Wells, Nev. City Supply	8/02		23	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
Springdale, Nev. Goss Springs	1/05		27	Gross α	< 5	--
				Gross β	6.0	--
				^{3}H	<20	<0.01
Springdale, Nev. Goss Springs	8/02		27	Gross α	< 5	--
				Gross β	< 6	--
				^{3}H	<20	<0.01
Springdale, Nev. Road D Windmill	1/05		23	Gross α	< 5	--
				Gross β	< 6	--
				^{3}H	<20	<0.01

[1]If depth not shown, water was collected at surface

[2]23 - Well
27 - Spring

[3]Concentration Guides for drinking water at on-NTS locations are the same as those for off-NTS locations. See Appendix B.

[4]Second sample during the year could not be collected.

TABLE A-10. 1978 ANALYTICAL RESULTS FOR THE NTS ANNUAL LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	Date	Sample Type[1]	Type of Radio-activity	Radioactivity Conc. (10^{-9} μCi/ml)	% of Conc. Guide[2]
Shoshone, Calif. Shoshone Spring	7/27	27	Gross α	< 6	--
			Gross β	12	--
			^{3}H	<20	<0.01
Hiko, Nev. Crystal Springs	6/19	27	Gross α	6.2	--
			Gross β	< 6	--
			^{3}H	<20	<0.01
Alamo, Nev. City Supply	6/19	23	Gross α	< 5	--
			Gross β	6.0	--
			^{3}H	<20	<0.01
Warm Springs, Nev. Twin Springs Ranch	6/19	27	Gross α	7.7	--
			Gross β	< 6	--
			^{3}H	<20	<0.01
Diablo, Nev. Highway Maint. Station	6/19	23	Gross α	< 4	--
			Gross β	< 6	--
			^{3}H	<20	<0.01
Nyala, Nev. Sharp Ranch	6/20	23	Gross α	< 5	--
			Gross β	< 6	--
			^{3}H	180	<0.01
Adaven, Nev. Adaven Spring	6/20	27	Gross α	< 3	--
			Gross β	< 6	--
			^{3}H	120	<0.01
Pahrump, Nev. Calvada Well 3	6/21	23	Gross α	< 5	--
			Gross β	< 6	--
			^{3}H	<20	<0.01
Tonopah, Nev. City Supply	6/21	23	Gross α	< 3	--
			Gross β	< 6	--
			^{3}H	<30	--
Clark Station, Nev. Tonopah Test Range Well 6	6/20	23	Gross α	< 4	--
			Gross β	< 6	--
			^{3}H	<20	<0.01
Las Vegas, Nev. Water District Well No. 28	6/22	23	Gross α	< 3	--
			Gross β	< 6	--
			^{3}H	<20	<0.01
Tempiute, Nev. Union Carbide Well	6/19	23	Gross α	< 3	--
			Gross β	< 6	--
			^{3}H	<20	<0.01

[1]23 - Well
27 - Spring
[2]See Appendix B for Concentration Guides.

TABLE A-11. 1978 ANALYTICAL RESULTS FOR THE OFF-NTS LONG-TERM HYDROLOGICAL MONITORING PROGRAM

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
			PROJECT GNOME			
Malaga, N. Mex. USGS Well No. 1	5/20	161	23	Gross α	<10	--
				Gross β	< 8	--
				^3H	<20	< 0.01
Malaga, N. Mex. USGS Well No. 4	5/20	148	23	Gross α	14	--
				Gross β	19,000	--
				^3H	640,000	21
Malaga, N. Mex. USGS Well No. 8	5/20	144	23	Gross α	< 9	--
				Gross β	21,000	--
				^3H	710,000	21
Malaga, N. Mex. PHS Well No. 6			23	Gross α	(not collected due to broken pump)	
				Gross β		
				^3H		
Malaga, N. Mex. PHS Well No. 8	5/21		23	Gross α	< 9	--
				Gross β	< 7	--
				^3H	<20	< 0.01
Malaga, N. Mex. PHS Well No. 9	5/21		23	Gross α	< 3	--
				Gross β	< 6	--
				^3H	<20	< 0.01
Malaga, N. Mex. PHS Well No. 10	5/21		23	Gross α	<20[4]	--
				Gross β	<20[4]	--
				^3H	<20	< 0.01
Malaga, N. Mex. Pecos River Pumping Stations	5/21		23	Gross α	< 7	--
				Gross W	< 6	--
				^3H	<20	<0.01

(continued)

TABLE A-11. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Loving, N. Mex. City Well No. 2	5/21		23	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01
Carlsbad, N. Mex. City Well No. 7	5/22		23	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01
PROJECT SHOAL						
Frenchman, Nev. Frenchman Station	3/01		23	Gross α	22	--
				Gross β	11	--
				^{3}H	<20	< 0.01
Frenchman, Nev. Well HS-1	3/02		23	Gross α	3.9	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01
Frenchman, Nev. Well H-3	3/01		23	Gross α	< 7	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01
Frenchman, Nev. Flowing Well	3/01		23	Gross α	<20[4]	--
				Gross β	160[5]	--
				^{3}H	<20	< 0.01
Frenchman, Nev. Hunts Station	3/02		23	Gross α	< 5	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01
PROJECT DRIBBLE						
Baxterville, Miss. City Supply	4/12		23	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	77	< 0.01

(continued)

TABLE A-11. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Baxterville, Miss. Lower Little Creek	4/12		22	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	63	< 0.01
Baxterville, Miss. Well HT-1	4/10	378	23	Gross α	< 5	--
				Gross W	< 6	--
				^{3}H	15	< 0.01
Baxterville, Miss. Well HT-2c	4/10	108	23	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	24	< 0.01
Baxterville, Miss. Well HT-4	4/14	122	23	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01
Baxterville, Miss. Well HT-5	4/14	183	23	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01
Baxterville, Miss. Well E-7	4/10	280	23	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01
Baxterville, Miss. Well Ascot No. 2	4/17	651	23	Gross α	<40[4]	--
				Gross β	<30[4]	--
				^{3}H	<20	< 0.01
Baxterville, Miss. Half Moon Creek	4/17		22	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	62	< 0.01
Baxterville, Miss. Half Moon Creek Overflow	4/14		22	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	2700	0.09

(continued)

TABLE A-11. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Baxterville, Miss. T. Speights Residence	4/13		23	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	99	< 0.01
Baxterville, Miss. R. L. Anderson Residence	4/13		23	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	55	< 0.01
Baxterville, Miss. Mark Lowe Residence	4/13		23	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	55	< 0.01
Baxterville, Miss. R. Ready Residence	4/12		23	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	46	< 0.01
Baxterville, Miss. W. Daniels Residence	4/13		23	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	38	< 0.01
Lumberton, Miss. City Supply Well No. 2	4/11		23	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01
Purvis, Miss. City Supply	4/11		23	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01
Columbia, Miss. City Supply	4/12		23	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01

(continued)

TABLE A-11. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Lumberton, Miss. North Lumberton City Supply	4/11		23	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	<20	--
Baxterville, Miss. Pond W of GZ	4/11		21	Gross α	< 2	--
				Gross β	< 2	--
				^{3}H	76	< 0.01
PROJECT GASBUGGY						
Gobernador, N. Mex. Arnold Ranch	5/18		27	Gross α	< 9	--
				Gross β	< 7	--
				^{3}H	<20	< 0.01
Gobernador, N. Mex. Apache Reservation Well South	5/18		23	Gross α	< 7	--
				Gross β	< 6	--
				^{3}H	67	--
Gobernador, N. Mex. Lower Burro Canyon	5/18		23	Gross α	< 8	--
				Gross β	< 7	--
				^{3}H	<20	< 0.01
Gobernador, N. Mex. Fred Bixler Ranch	5/18		23	Gross α	< 6	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01
Gobernador, N. Mex. Cave Springs	5/18		27	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	<20	--
Gobernador, N. Mex. Windmill No. 2	5/16		23	Gross α	< 7	--
				Gross β	< 7	--
				^{3}H	<20	--

(continued)

TABLE A-11. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Gobernador, N. Mex. Bubbling Springs	5/16		27	Gross α	< 6	--
				Gross β	< 6	--
				^{3}H	120	< 0.01
Gobernador, N. Mex. La Jara Creek	5/16		22	Gross α	< 8	--
				Gross β	< 7	--
				^{3}H	170	--
Gobernador, N. Mex. EPNG Well 10-36	5/17	1097	23	Gross α	<40[4]	--
				Gross β	45	--
				^{3}H	16	< 0.01
PROJECT RULISON						
Rulison, Colo. Lee L. Hayward Ranch	5/19		23	Gross α	12	--
				Gross β	< 6	--
				^{3}H	710	0.02
Rulison, Colo. Glen Schwab Ranch	5/19		23	Gross α	4.8	--
				Gross β	< 6	--
				^{3}H	690	0.02
Grand Valley, Colo. Albert Gardner Ranch	5/19		23	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	650	0.02
Grand Valley, Colo. City Water Supply	5/19		27	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	<20	< 0.01
Grand Valley Colo. Spring 300 Yds. NW of GZ	5/20		27	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	730	0.02

(continued)

TABLE A-11. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Rulison, Colo. Felix Sefcovic Ranch	5/19		23	Gross α	< 3	--
				Gross β	< 6	--
				^3H	880	0.03
Grand Valley, Colo. Battlement Creek	5/20		22	Gross α	< 3	--
				Gross β	< 6	--
				^3H	850	0.03
Grand Valley, Colo. CER Well	5/20		23	Gross α	< 3	--
				Gross β	< 6	--
				^3H	580	0.02
Rulison, Colo. Potter Ranch	5/18		27	Gross α	3.7	--
				Gross β	< 6	--
				^3H	680	0.02
PROJECT FAULTLESS						
Blue Jay, Nev. Highway Maint. Station	6/14		23	Gross α	3.9	--
				Gross β	< 6	--
				^3H	<20	< 0.01
Blue Jay, Nev. Sixmile Well	6/15		23	Gross α	< 4	--
				Gross β	< 6	--
				^3H	<20	--
Blue Jay, Nev. Jim Bias Well	6/19		27	Gross α	7.5	--
				Gross β	< 6	--
				^3H	<20	< 0.01
Blue Jay, Nev. Well HTH-1	6/12	259	23	Gross α	< 4	--
				Gross β	< 6	--
				^3H	<20	< 0.01

(continued)

TABLE A-11. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Blue Jay, Nev. Well HTH-2	6/12	184	23	Gross α	3.4	--
				Gross β	< 6	--
				^3H	<20	< 0.01
PROJECT RIO BLANCO						
Rio Blanco, Colo. Fawn Creek 6800 ft Upstream	5/17		22	Gross α	< 6	--
				Gross β	< 6	--
				^3H	80	< 0.01
Rio Blanco, Colo. Fawn Creek 500 ft Upstream			22	Gross α	(Sample not collected)	
				Gross β		
				^3H		
Rio Blanco, Colo. Fawn Creek 500 ft Downstream	5/17		22	Gross α	< 6	--
				Gross β	< 6	--
				^3H	63	< 0.01
Rio Blanco, Colo. Fawn Creek 8400 ft Downstream	5/17		22	Gross α	< 6	--
				Gross β	< 6	--
				^3H	49	< 0.01
Rio Blanco, Colo. Fawn Creek No. 1	5/17		27	Gross α	< 6	--
				Gross β	< 6	--
				^3H	51	< 0.01
Rio Blanco, Colo. Fawn Creek No. 3	5/17		27	Gross α	< 6	--
				Gross β	< 6	--
				^3H	48	< 0.01
Rio Blanco, Colo. CER No. 1 Black Sulphur	5/18		27	Gross α	< 6	--
				Gross β	< 6	--
				^3H	67	< 0.01

(continued)

TABLE A-11. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Rio Blanco, Colo. CER No. 4 Black Sulphur	5/18		27	Gross α	< 6	--
				Gross β	< 6	--
				^3H	590	0.02
Rio Blanco, Colo. B-1 Equity Camp	5/18		27	Gross α	< 5	--
				Gross β	< 6	--
				^3H	130	< 0.01
Rio Blanco, Colo. Brennan Windmill	5/16		23	Gross α	7.5	--
				Gross β	< 6	--
				^3H	<20	< 0.01
Rio Blanco, Colo. Johnson Artesian Well	5/16		23	Gross α	< 7	--
				Gross β	< 7	--
				^3H	<20	< 0.01
Rio Blanco, Colo. Well RB-D-01			23	Gross α Gross β ^3H	(Sample not collected due to inoperative pump)	
Rio Blanco, Colo. Well RB-S-03			23	Gross α Gross β ^3H	(Sample not collected due to inoperative pump)	
PROJECT CANNIKIN						
Amchitka, Alas. South End of Cannikin Lake	8/20		21	Gross α	< 4	--
				Gross β	< 6	--
				^3H	64	< 0.01
Amchitka, Alas. North End of Cannikin Lake	8/20		21	Gross α	< 5	--
				Gross β	< 6	--
				^3H	68	< 0.01
Amchitka, Alas. Well HTH-3	8/20	42.7	23	Gross α	< 4	--
				Gross β	< 6	--
				^3H	84	< 0.01

(continued)

TABLE A-11. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} μCi/ml)	% of Conc. Guide[3]
Amchitka, Alas. Ice Box Lake	8/20		21	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	100	< 0.01
Amchitka, Alas. White Alice Creek	8/20		22	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	95	< 0.01
Amchitka, Alas. Pit South of Cannikin GZ	8/20		21	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	96	< 0.01
PROJECT MILROW						
Amchitka, Alas. Heart Lake	8/21		21	Gross α	2.0	--
				Gross β	< 6	--
				^{3}H	89	< 0.01
Amchitka, Alas. Well W-5	8/21	0.83	23	^{3}H	120	< 0.01
Amchitka, Alas. Well W-6	8/21	0.94	23	^{3}H	110	< 0.01
Amchitka, Alas. Well W-8	8/21	1.6	23	^{3}H	210	< 0.01
Amchitka, Alas. Well W-15	8/21	1.1	23	^{3}H	88	< 0.01
Amchitka, Alas. Well W-10	8/21	2.0	23	^{3}H	75	< 0.01
Amchitka, Alas. Well W-11	8/21	1.5	23	^{3}H	110	< 0.01

(continued)

TABLE A-11. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Amchitka, Alas. Well W-3	8/21	1.1	23	^{3}H	100	< 0.01
Amchitka, Alas. Well W-2	8/21	0.30	23	^{3}H	130	< 0.01
Clevenger Creek	8/22		22	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	99	< 0.01
Amchitka, Alas. Well W-4[6]	8/21	0.46	23	^{3}H	100	< 0.01
Amchitka, Alas. Well W-7[6]	8/21	0.31	23	^{3}H	96	< 0.01
Amchitka, Alas. Well W-13[6]	8/22	0.74	23	^{3}H	70	< 0.01
Amchitka, Alas. Well W-18[6]	8/22	0.20	23	^{3}H	91	< 0.01
PROJECT LONG SHOT						
Amchitka, Alas. Well WL-2	8/22	3.5	23	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	1000	0.03
Amchitka, Alas. EPA Well-1	8/22	7.7	23	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	280	< 0.01
Reed Pond	8/22		21	Gross α	< 2	--
				Gross β	< 6	--
				^{3}H	97	< 0.01

(continued)

TABLE A-11. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Well GZ No. 1	8/22	27.4	23	Gross α	< 4	--
				Gross β	< 6	--
				^{3}H	7300	0.24
Well GZ No. 2	8/22	12.2	23	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	900	0.03
Well WL-1	8/22	1.7	23	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	400	--
Mud Pit No. 1	8/22		21	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	1800	0.06
Mud Pit No. 2	8/22		21	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	2300	0.08
Mud Pit No. 3	8/22		21	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	2300	0.08
AMCHITKA BACKGROUND SAMPLES						
Amchitka, Alas. Constantine Spring	8/20		27	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	110	< 0.01
Amchitka, Alas. Army Well No. 1	8/21	36.6	23	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	110	< 0.01
Amchitka, Alas. Jones Lake	8/20		21	Gross α	< 3	--
				Gross β	< 6	--
				^{3}H	85	< 0.01

(continued)

TABLE A-11. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Duck Cove Creek	8/25		22	^{3}H	110	< 0.01

[1]If depth not shown, water was collected at surface

[2]21 - Pond, lake, reservoir, stock tank, or stock pond
22 - Stream, river, or creek
23 - Well
26 - Rain
27 - Spring

[3]Concentration Guides (CG) for drinking water at on-site locations are the same as those for off-site locations. See Appendix B for Concentration Guides. As gross α and gross β radioactivity concentrations were used only for identifying gross radioactivity concentration increases and as more complete radionuclide analyses were made in the past, the calculation of % CG's was not considered appropriate.

[4]High MDC due to high concentration of dissolved solids.

[5]Based upon gamma spectrometry analysis, the source of this radioactivity was naturally occurring ^{40}K and daughter products of ^{222}Rn. Actual quantities could not be determined due to complex gamma spectra.

[6]These sampling locations were added during this year. The samples collected from these locations are to be analyzed only for ^{3}H.

TABLE A-12. 1978 SPECIAL ANALYTICAL RESULTS FOR THE OFF-NTS LONG-TERM HYDROLOGICAL MONITORING PROGRAM - PROJECT RIO BLANCO

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
			PROJECT RIO BLANCO			
Rio Blanco, Colo. Fawn Creek 6800 ft Upstream	5/17		22	^{89}Sr	<40	<2
				^{90}Sr	< 0.7	< .30
				^{234}U	1.7	< .01
				^{235}U	0.084	< .01
				^{238}U	1.2	< .01
				^{238}Pu	< 0.05	< .01
				^{239}Pu	< 0.03	< .01
Rio Blanco, Colo. Fawn Creek 500 ft Upstream	5/17		22	^{89}Sr	<50	<2
				^{90}Sr	< 0.7	< .30
				^{234}U	1.2	< .01
				^{235}U	0.024	< .01
				^{238}U	0.77	< .01
				^{238}Pu	< 0.04	< .01
				^{239}Pu	< 0.030	< .01
Rio Blanco, Colo. Fawn Creek 500 ft Downstream	5/17		22	^{89}Sr	<50	<2
				^{90}Sr	< 0.7	< .30
				^{234}U	1.4	< .01
				^{235}U	0.022	< .01
				^{238}U	0.76	< .01
				^{238}Pu	< 0.03	< .01
				^{239}Pu	< 0.02	< .01
Rio Blanco, Colo. Fawn Creek 8400 ft Downstream	5/17		22	^{89}Sr	< 2	< .07
				^{90}Sr	1.7	.56
				^{234}U	1.5	< .01
				^{235}U	0.032	< .01
				^{238}U	0.91	< .01
				^{238}Pu	< 0.03	< .01
				^{239}Pu	< 0.02	< .01

(continued)

TABLE A-12. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Rio Blanco, Colo. Fawn Creek No. 1	5/18		27	^{89}Sr	<40	<2
				^{90}Sr	< 0.6	<0.2
				^{234}U	1.8	< .01
				^{235}U	0.043	< .01
				^{238}U	0.91	< .01
				^{238}Pu	< 0.04	< .01
				^{239}Pu	< 0.03	< .01
Rio Blanco, Colo. Fawn Creek No. 3	5/17		27	^{89}Sr	<40	<2
				^{90}Sr	< 0.7	<0.3
				^{234}U	1.4	<0.01
				^{235}U	0.029	<0.01
				^{238}U	0.77	<0.01
				^{238}Pu	< 0.04	<0.01
				^{239}Pu	< 0.03	<0.01
Rio Blanco Colo. CER No. 1 Black Sulphur	5/18		27	^{89}Sr	<40	<2
				^{90}Sr	< 0.61	<0.20
				^{234}U	3.0	0.01
				^{235}U	0.067	<0.01
				^{238}U	1.8	0.036
				^{238}Pu	< 0.04	<0.01
				^{239}Pu	< 0.04	<0.01
Rio Blanco Colo. CER No. 4 Black Sulphur	5/18		27	^{89}Sr	<45	<2
				^{90}Sr	< 0.7	<0.30
				^{234}U	2.2	<0.01
				^{235}U	0.043	<0.01
				^{238}U	1.4	0.028
				^{238}Pu	< 0.03	<0.01
				^{239}Pu	< 0.03	<0.01
Rio Blanco Colo. B-1 Equity Camp	5/18		27	^{89}Sr	< 2.1	<0.10
				^{90}Sr	< 0.6	<0.2
				^{234}U	2.0	<0.01
				^{235}U	0.054	<0.01
				^{238}U	1.2	<0.01
				^{238}Pu	< 0.03	<0.01
				^{239}Pu	< 0.02	<0.01

(continued)

TABLE A-12. (Continued)

Sampling Location	Date	Depth (m)[1]	Sample Type[2]	Type of Radio-activity	Radioactivity Conc. (10^{-9} µCi/ml)	% of Conc. Guide[3]
Rio Blanco, Colo. Brennan Windmill	5/18		23	^{89}Sr	<35	<2
				^{90}Sr	< 0.6	<0.2
				^{226}Ra	0.24	-
				^{234}U	9.9	<0.01
				^{235}U	0.16	<0.01
				^{238}U	3.9	<0.01
				^{238}Pu	< 0.04	<0.01
				^{239}Pu	< 0.03	<0.01
Rio Blanco, Colo. Johnson Artesian Well	5/18		23	^{89}Sr	< 2.1	<0.01
				^{90}Sr	< 0.6	<0.2
				^{234}U	0.044	< .01
				^{235}U	< 0.008	< .01
				^{238}U	0.022	< .01
				^{238}PU	< 0.04	< .01
				^{239}Pu	< 0.04	< .01
Rio Blanco Colo. Well RB-D-01	5/18		23	^{89}Sr	<40	<2
				^{90}Sr	< 0.7	<0.30
				^{234}U	0.67	<0.01
				^{235}U	0.015	<0.01
				^{238}U	0.30	<0.01
				^{238}Pu	< 0.03	<0.01
				^{239}Pu	< 0.02	<0.01
Rio Blanco Colo. Well RB-S-03	5/18		23	^{89}Sr	<41	<2
				^{90}Sr	< 0.7	<0.30
				^{234}U	< 0.03	<0.01
				^{235}U	< 0.01	<0.01
				^{238}U	< 0.02	<0.01
				^{238}Pu	< 0.03	<0.01
				^{239}Pu	< 0.02	<0.01

[1]If depth not shown, water was collected at surface.
[2]22 - Stream, river, or creek
23 - Well
27 - Spring
[3]Concentration Guide (CG) for drinking water at on-site locations are the same as those for off-site locations.
See Appendix B for CG's.

TABLE A-13. SPECIAL ANALYTICAL RESULTS FOR THE LONG-TERM HYDROLOGICAL MONITORING PROGRAM - PROJECT DRIBBLE[1]

Sampling Location	Date	(m)	^{3}H Concentration (10^{-9} μCi/ml)	% CG
HMH-1	4/27	3.5	450,000	
	7/13		12,000	
	10/11		86,000	
HMH-2	4/27	3.4	230,000	
	7/13		190,000	
	10/11		190,000	
HMH-3	4/27	2.7	330	
	7/13	2.7	1,100	
	10/11	2.7	510	
HMH-4	4/27	1.5	58	
	7/13		120	
	10/11		66	
HMH-5	4/27	2.4	4,100	
	7/13		2,000	
	10/11		5,000	
HMH-6	4/27	1.5	260	
	7/13		340	
	10/11		1,800	
HMH-7	4/26	1.8	4,200	
	7/13		330	
	10/11		1,300	
HMH-8	4/27	2.7	98	
	7/13		67	
	10/11		69	

(continued)

TABLE A-13. (Continued)

Sampling Location	Date	(m)	^{3}H Concentration (10^{-9} µCi/ml)	% CG
HMH-9	4/27	1.5	50	
	7/13		61	
	10/11		79	
HMH-10	4/27	2.4	640	
	7/13		96	
	10/11		150	
HMH-11	4/27	2.4	98,000	
	7/13		3,700	
	10/11		78,000	
PS-3	4/[2]	33.4	--	
	7/13		75	
	10/11		420	

[1]Each sample was also analyzed by gamma spectrometry. No gamma-emitting radionuclides were detected above the MDC of 1×10^{-8} µCi/ml.

[2]Sample was not collected in April.

APPENDIX B. RADIATION PROTECTION STANDARDS FOR EXTERNAL AND INTERNAL EXPOSURE

APPENDIX B. RADIATION PROTECTION STANDARDS FOR EXTERNAL AND INTERNAL EXPOSURE

TABLE B-1. DOE ANNUAL DOSE COMMITMENT[1]

Type of Exposure	Dose Limit to Critical 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

[1]"Radiation Protection Standards," DOE Manual, Chapter 0524.

TABLE B-2. DOE CONCENTRATION GUIDES (CG'S)[1]

Network or Program	Sampling Medium	Radionuclide	CG (μCi/ml)	Basis of Exposure
Air Surveillance Network	air	^{7}Be	1.1×10^{-8}	Suitable sample of the exposed population in uncontrolled area.
		^{95}Zr	3.3×10^{-10}	
		^{131}I	3.3×10^{-11}	
		^{132}Te	1.0×10^{-9}	
		^{137}Cs	1.7×10^{-10}	
		^{140}Ba	3.3×10^{-10}	
		^{144}Ce	1.0×10^{-10}	
Noble Gas and Tritium Surveillance Network, On-NTS	air	^{85}Kr	1.0×10^{-5}	Individual in controlled area.
		^{3}H	5.0×10^{-6}	
		^{133}Xe	1.0×10^{-5}	
Noble Gas and Tritium Surveillance Network, Off-NTS	air	^{85}Kr	1.0×10^{-7}	Suitable sample of the exposed population in uncontrolled area.
		^{3}H	6.7×10^{-8}	
		^{133}Xe	1.0×10^{-7}	
Long-Term Hydrological Program	water	^{3}H	3.0×10^{-3}	Individual in a controlled or an uncontrolled area.
		^{89}Sr	3.0×10^{-6}	
		^{90}Sr	3.0×10^{-7}	
		^{137}Cs	2.0×10^{-5}	
		^{226}Ra	3.0×10^{-8}	
		^{234}U	3.0×10^{-5}	
		^{235}U	3.0×10^{-5}	
		^{238}U	4.0×10^{-5}	
		^{238}Pu	5.0×10^{-6}	
		^{239}Pu	5.0×10^{-6}	

[1]"Radiation Protection Standards," DOE Manual, Chapter 0524.

EPA DRINKING WATER REGULATIONS FOR RADIONUCLIDES[1]

Maximum Contaminant Levels for Beta Particles and Photon Radioactivity from Man-Made Radionuclides in Community Water Systems[2]

(a) The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/yr.

(b) Except for the radionuclides listed in Table B-3, the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents shall be calculated on the basis of a 2-liter per day drinking water intake using the 168 hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69 as amended August 1963, U.S. Department of Commerce. If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 millirem/year.

TABLE B-3. AVERAGE ANNUAL CONCENTRATION ASSUMED TO PRODUCE A TOTAL BODY OR ORGAN DOSE OF 4 MREM/YR

Radionuclide	Critical Organ	pCi per liter
Tritium	Total body	20,000
Strontium-90	Bone marrow	8

[1] "Drinking Water Regulations Radionuclides." Title 40 Code of Federal Regulations, Chapter 1, Part 141. Federal Register, Vol. 41, No. 133. U.S. Government Printing Office, Washington, D. C. July 9, 1976.

[2] Community water system is a public water system which serves a population of which 70 percent or greater are residents. A public water system is a system for the provision to the public of piped water for human consumption, if such system has at least 15 service connections or regularly serves an average of 25 individuals daily at least 3 months out of the year.

APPENDIX C. REPLICATE SAMPLING PROGRAM

APPENDIX C. REPLICATE SAMPLING PROGRAM

Purpose

The program was initiated for the purpose of routinely assessing the errors due to sampling replication and analytical/counting associated with the collection and analysis of samples obtained from the surveillance networks maintained around the Nevada Test Site and other sites designated by the Nevada Operations Office, Department of Energy.

Procedure

The program involved the collection and analysis of replicate samples from the Air Surveillance Network (ASN), the Noble Gas and Tritium Surveillance Network (NG & TSN), the Dosimetry Network and the Standby Milk Surveillance Network (SMSN). Due to difficulties anticipated in obtaining sufficient quantities of milk for duplicate samples from the Milk Surveillance Network, duplicate samples were collected during the annual activation of the SMSN.

At least 30 duplicate samples from each network were collected and analyzed over the report period. Since three thermoluminescent (TLD) cards consisting of two TLD chips each are used at each station of the Dosimetry Network, no additional samples were necessary. The following table summarizes the sampling information for each surveillance network.

TABLE C-1. SAMPLES AND ANALYSES FOR REPLICATE SAMPLING PROGRAM

Surveillance Network	Number of Sampling Locations	Samples Collected Per Year	Sets of Replicate Samples Collected	Number of Replicates Per Set	Sample Analysis
ASN	121	8,300	533	2	Gross β γ Spectrometry
NG & TSN	11	572	52	2	^{85}Kr, ^{3}H, HTO, HT, H_2O
Dosimetry	78	312	312	4-6	External γ
SMSN	150	150	~30	2	^{40}K
LTHMP	134	254	~35	2	Gross α, Gross β, ^{3}H

There were other analyses for air, milk and water samples that could not be included in this evaluation due to the fact that there were not a sufficient number of analytical results available at the time of this report. Since the sampling distributions of each sample type appeared to be log-normal from the review of cumulative frequency plots of the results, the variance of each set of replicate sample results was estimated from the logarithms of the results in each set.

The variance, s^2, of each set of replicate TLD results (n=6) was estimated from the logarithms of the results by the standard expression,

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

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 logarithms of the duplicate sample results. For small sample sizes, this estimate of the variance is statistically efficient (1) and certainly more convenient in calculating than the standard expression.

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 confidence interval of the expected population geometric variance for each type of sample analysis. The expressions used are as follows:(2)

$$\tilde{s}^2 = \sum_{i=1}^{n} (n_i - 1)s^2 / \sum_{i=1}^{n} (n_i - 1)$$

$$\text{Lower Confidence Limit (LCL)} = \sum_{i=1}^{n} (n_i - 1)\ (\tilde{s}^2)/\chi^2\{0.995, \sum_{i=1}^{n} (n_i - 1)\}$$

$$\text{Upper Confidence Limit (UCL)} = \sum_{i=1}^{n} (n_i - 1)\ (\tilde{s}^2)/\chi^2\{0.005, \sum_{i=1}^{n} (n_i - 1)\}$$

$LCL \leq \sigma^2 \leq UCL$

where σ^2 = the true value of the population geometric variance

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

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

$\tilde{s}^2$ = the best estimate of sample geometric variance derived from the variance estimates of all replicate samples (the expected value of $\tilde{s}^2$ is σ^2).

The 99% upper confidence limit for the total error (sampling + analytical/counting errors) of the geometric mean of any group of samples collected from a given network was then determined as the geometric mean $+2.57\tilde{s}$.

The following table lists the expected geometric standard deviation and its 99% upper confidence limit (UCL) for most analyses.

TABLE C-2. UPPER CONFIDENCE LIMITS OF SAMPLING AND ANALYTICAL/COUNTING ERRORS

Surveillance Network	Analysis	Sets of Replicate Samples Evaluated	Expected Geometric Stnd. Dev. $\tilde{s}$	99% UCL of Total Error
ASN	Gross β	533	2.03	6.2
	^{7}Be	86	1.46	2.6
	^{131}I	23	1.48	2.8
	^{132}Te	13	1.53	3.0
	^{140}Ba	28	1.50	2.8
	^{144}Ce	21	1.52	2.9
NG & TSN[1]	^{85}Kr	44	1.088	1.2
	^{3}H	51	1.42	2.4
	HTO	20	2.29	8.4
	HT	21	2.84	15
Dosimetry	γ (TLD)	331	1.044	1.1
SMSN	^{40}K	32	1.086	1.2
LTHMP	Gross α	38	1.55	3.1
	Gross β	27	1.29	1.9
	^{3}H (conv.)	36	1.12	1.3
	^{3}H (enrich.)	50	1.34	2.1

[1]Snedecor, G. W. and W. G. Cochran. Statistical Methods. The Iowa State University Press, Ames, Iowa. 6th ed. 1967. pp. 39-47.

APPENDIX D. DETECTION OF AIRBORNE RADIOACTIVITY FROM ATMOSPHERIC NUCLEAR TESTS BY THE PEOPLE'S REPUBLIC OF CHINA

Following the atmospheric nuclear tests by the People's Republic of China on March 15, 1978, at 0100 hours EST and on December 14, 1978, at 0100 EST, samples of airborne radioactivity within the Western United States were obtained from the Air Surveillance Network. Samples were collected to determine the effect of the Chinese test on the ambient levels of airborne radioactivity, which are routinely monitored around the Nevada Test Site in support of underground nuclear tests. From the concentration of radioiodine observed in the air samples, an estimate of the radiation dose equivalent to the thyroid gland of a hypothetical infant receptor via inhalation at each sampling location was calculated. The following is a summary of the procedures and results.

Procedure

In addition to the 49 active stations of the Air Surveillance Network (ASN), 67 of the 73 standby stations were activated for the periods March 17 through April 7, 1978, and December 15 through January 5, 1979. All operators of the active and standby stations were requested to use a charcoal cartridge behind the particulate filter.

The particulate filters were counted for gross beta radioactivity at 7 days and 14 days after collection to allow for the decay of naturally occurring radioactivity and for the purpose of extrapolating the concentration to the midtime of collection. Those samples having a gross beta count greater than 50 cpm ($\sim 1.0 \times 10^{-11}$ µCi/ml) were analyzed by gamma spectrometry.

Immediately upon receipt and about five days after collection, the filters selected from 14-21 stations running along a north and south line in the Network were analyzed for gamma-emitting radionuclides by gamma spectrometry techniques. The charcoal cartridges were initially counted for gross gamma radioactivity; those cartridges having a count rate greater than 300 cpm were then quantified for specific radionuclides.

Results

The airborne concentrations of gross beta radioactivity resulting from the March Chinese test was more significant than the December Chinese test. Typical time series plots of the gross beta radioactivity concentrations in air are shown in Figures D-1 and D-2 for Pueblo, Colorado, and Bishop, California. The standby station at Pueblo had the highest concentration (1.70×10^{-10} µCi/ml) within the Network. The continuously operating

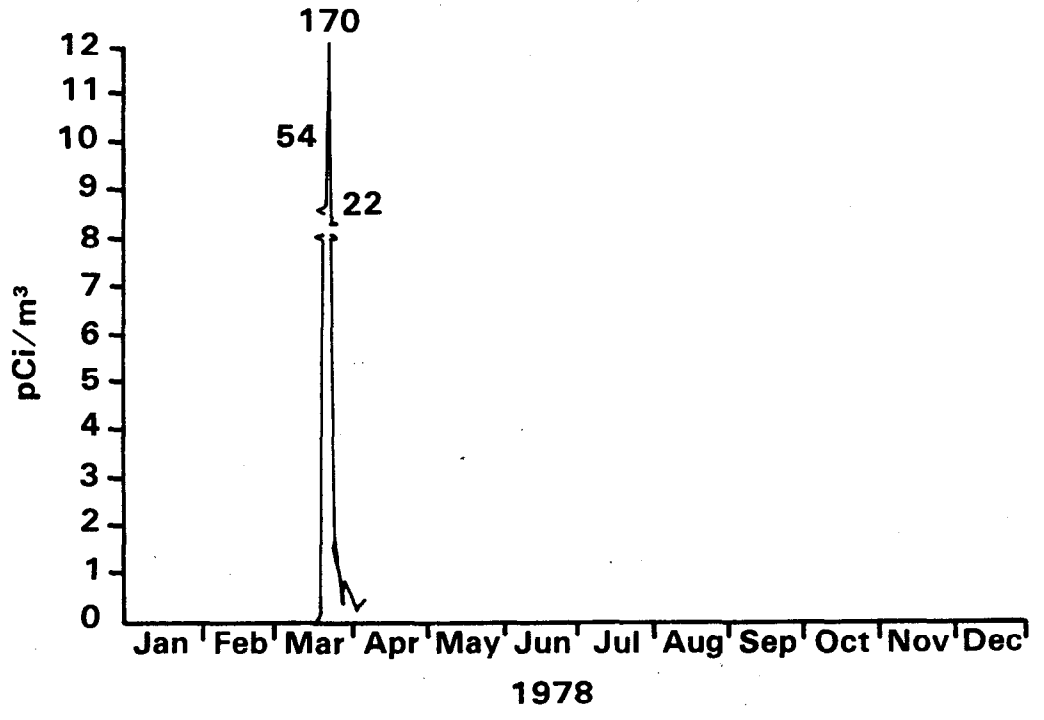

Figure D-1. Gross Beta Radioactivity Concentrations in Air at Pueblo, Colorado.

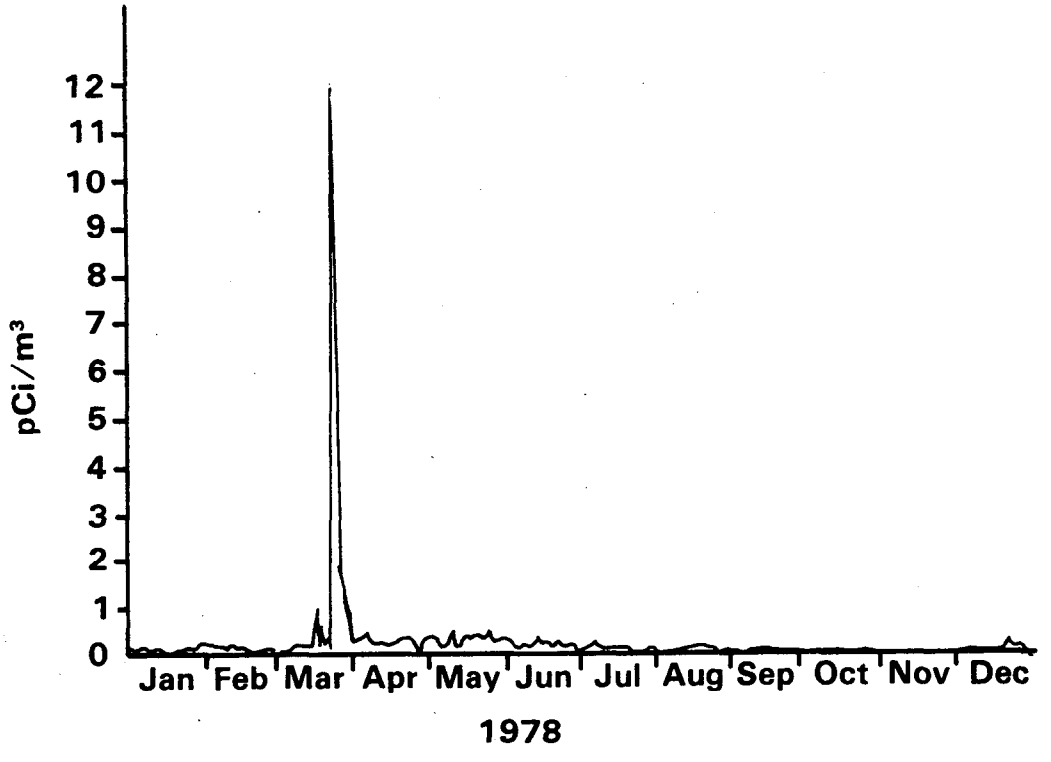

Figure D-2. Gross Beta Radioactivity Concentrations in Air at Bishop, California.

station with the highest gross beta radioactivity concentration (1.2×10^{-11} µCi/ml) within the Network was at Bishop, California.

As indicated by the results of gamma spectrometry on air samples, fresh fission products (^{95}Zr, ^{99}Mo, ^{103}Ru, ^{131}I, ^{132}Te, ^{137}Cs, ^{140}Ba, ^{141}Ce, and ^{144}Ce) and naturally occurring ^{7}Be were detected in various combinations on the filters. Only ^{131}I was detected on the charcoal cartridges. Due to interferences within the gamma spectra, only the radionuclides ^{7}Be, ^{95}Zr, ^{131}I, ^{132}Te, ^{137}Cs, ^{140}Ba, and ^{144}Ce were quantified. Tables D-2 and D-3 summarize the radionuclide concentrations detected in samples collected at all sampling locations during the year. The locations and sampling periods during which the maximum concentration of each radionuclide was detected are shown in the following table:

TABLE D-1. AIR SAMPLING STATIONS HAVING DETECTABLE RADIONUCLIDE CONCENTRATIONS

Location	Sampling Period	Radionuclide	Half-Life (days)	Maximum Conc. (10^{-12} µCi/ml)	Average Conc. (10^{-12} µCi/ml)	% CG*
Worland, Wyo.	3/21-22	^{95}Zr	65	2.1	0.036	0.01
Casper, Wyo.	3/20-21	^{131}I	8.04	37	1.2	4
Casper Wyo.	3/20-21	^{132}Te	3.3	71	1.8	0.2
Seligman, Ariz.	5/10-12	^{137}Cs	30.1(y)	0.32	0.013	0.008
Casper, Wyo.	3/20-21	^{140}Ba	13	29	0.84	0.3
Tonopah, Nev.	5/31-6/2	^{144}Ce	284	0.61	0.028	0.03

*Percent of the Concentration Guide (CG), as specified in DOE Manual, Chapter 0524, for a suitable sample of the exposed population. See Appendix B.

The dates on which these maximum concentrations occurred are indicative that the ^{137}Cs and the ^{144}Ce concentrations in the troposphere were probably affected more by the annual increase in airborne radioactive fallout concentrations resulting from the mixing that occurs at the boundary of the stratosphere and troposphere during the spring season.

From the concentrations of ^{131}I and ^{132}Te determined in the samples from each air sampling location, the radiation dose equivalent (D.E.) to the thyroid gland of an hypothetical, 1-year-old infant receptor was calculated

TABLE D-2. 1978 SUMMARY OF ANALYTICAL RESULTS FOR AIR SURVEILLANCE NETWORK ACTIVE STATIONS

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Kingman, Ariz.	312.0	^{7}Be	0.60	0.15	0.19
	75.9	^{95}Zr	0.16	0.014	0.0067
	6.2	^{131}I	0.26	0.057	0.0029
	7.2	^{132}Te	0.21	0.059	0.0029
	30.0	^{137}Cs	0.035	0.010	0.0015
	13.2	^{140}Ba	0.034	0.017	0.0046
	47.0	^{144}Ce	0.38	0.083	0.022
Seligman, Ariz.	75.0	^{7}Be	0.70	0.22	0.01
	63.0	^{95}Zr	0.10	0.021	0.0074
	7.0	^{131}I	0.12	0.032	0.0019
	5.0	^{132}Te	0.16	0.12	0.0024
	23.0	^{137}Cs	0.32	0.013	0.0035
	10.0	^{140}Ba	0.30	0.044	0.0043
	21.0	^{144}Ce	0.35	0.025	0.014
Baker, Calif.	120.0	^{7}Be	0.52	0.078	0.084
	77.1	^{95}Zr	0.071	0.011	0.0067
	7.1	^{131}I	0.16	0.050	0.0021
	6.0	^{132}Te	0.24	0.068	0.0024
	27.9	^{137}Cs	0.023	0.010	0.0013
	17.2	^{140}Ba	0.26	0.027	0.0054
	48.9	^{144}Ce	0.23	0.031	0.019
Barstow, Calif.	58.9	^{7}Be	0.47	0.11	0.042
	67.9	^{95}Zr	1.2	0.013	0.013
	7.0	^{131}I	0.18	0.029	0.0024
	6.0	^{132}Te	0.24	0.077	0.0035
	13.0	^{137}Cs	0.023	0.010	<0.001
	9.0	^{140}Ba	0.30	0.036	0.0041
	20.0	^{144}Ce	0.26	0.062	0.0094
Bishop, Calif.	112.0	^{7}Be	0.61	0.15	0.10
	85.9	^{95}Zr	0.077	0.019	0.0082
	13.9	^{131}I	1.4	0.026	0.0086
	5.0	^{132}Te	1.6	0.065	0.0079
	35.0	^{137}Cs	0.033	0.012	0.0021
	16.9	^{140}Ba	1.9	0.028	0.012
	53.0	^{144}Ce	0.32	0.083	0.026

(continued)

TABLE D-2. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Death Valley Jct., Calif.	132.2	^{7}Be	0.59	0.12	0.097
	91.9	^{95}Zr	0.094	0.012	0.0074
	13.0	^{131}I	0.19	0.02	0.0020
	6.0	^{132}Te	0.32	0.078	0.0027
	43.9	^{137}Cs	0.035	0.012	0.0021
	17.0	^{140}Ba	0.26	0.026	0.0043
	32.8	^{144}Ce	0.35	0.077	0.016
Furnace Creek, Calif.	159.1	^{7}Be	0.52	0.071	0.10
	51.3	^{95}Zr	0.043	0.012	0.0036
	9.0	^{131}I	0.17	0.021	0.0025
	6.0	^{132}Te	0.12	0.077	0.0020
	28.8	^{137}Cs	0.017	0.013	0.0012
	11.0	^{140}Ba	0.17	0.043	0.0036
	36.9	^{144}Ce	0.26	0.069	0.016
Lone Pine, Calif.	56.9	^{7}Be	0.79	0.11	0.11
	44.0	^{95}Zr	0.11	0.017	0.0096
	2.0	^{131}I	1.2	1.2	0.016
	6.0	^{132}Te	0.73	0.12	0.013
	32.0	^{137}Cs	0.060	0.010	0.0036
	6.0	^{140}Ba	0.88	0.050	0.013
	33.0	^{144}Ce	0.29	0.065	0.032
Needles, Calif.	84.4	^{7}Be	0.51	0.12	0.061
	48.5	^{95}Zr	0.063	0.014	0.0039
	8.2	^{131}I	0.16	0.032	0.0023
	6.1	^{132}Te	0.18	0.076	0.0023
	22.1	^{137}Cs	0.023	0.010	<0.001
	13.1	^{140}Ba	0.30	0.024	0.0038
	26.6	^{144}Ce	0.19	0.043	0.010
Ridgecrest, Calif.	93.4	^{7}Be	0.57	0.11	0.078
	71.9	^{95}Zr	0.066	0.014	0.0066
	7.0	^{131}I	0.3	0.074	0.0034
	3.0	^{132}Te	0.32	0.14	0.0023
	27.9	^{137}Cs	0.028	0.011	0.0016
	10.0	^{140}Ba	0.54	0.037	0.0072
	42.9	^{144}Ce	0.36	0.063	0.019

(continued)

TABLE D-2. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Shoshone, Calif.	79.6	^{7}Be	0.52	0.11	0.072
	51.1	^{95}Zr	0.079	0.019	0.0055
	7.0	^{131}I	0.35	0.082	0.0033
	6.0	^{132}Te	0.21	0.11	0.0025
	23.0	^{137}Cs	0.033	0.010	0.0013
	15.2	^{140}Ba	0.35	0.040	0.0063
	33.5	^{144}Ce	0.23	0.78	0.014
Alamo, Nev.	111.5	^{7}Be	0.59	0.12	0.10
	95.2	^{95}Zr	0.089	0.016	0.0086
	8.0	^{131}I	0.34	0.024	0.0022
	5.0	^{132}Te	0.22	0.13	0.0022
	28.3	^{137}Cs	0.026	0.010	0.0014
	16.3	^{140}Ba	0.20	0.030	0.0038
	46.9	^{144}Ce	0.40	0.065	0.020
Austin, Nev.	95.9	^{7}Be	0.73	0.19	0.15
	54.0	^{95}Zr	0.055	0.013	0.0058
	4.0	^{131}I	0.65	0.070	0.0030
	4.9	^{132}Te	0.70	0.090	0.0041
	28.0	^{137}Cs	0.036	0.012	0.0023
	6.9	^{140}Ba	0.75	0.055	0.0049
	41.0	^{144}Ce	0.33	0.074	0.0026
Beatty, Nev.	119.6	^{7}Be	0.59	0.12	0.10
	81.9	^{95}Zr	0.054	0.014	0.0063
	7.0	^{131}I	0.37	0.023	0.0022
	3.0	^{132}Te	0.37	0.096	0.0017
	30.7	^{137}Cs	0.036	0.013	0.0017
	12.0	^{140}Ba	0.30	0.045	0.0036
	47.7	^{144}Ce	0.31	0.065	0.022
Blue Eagle Ranch, Nev.	121.8	^{7}Be	0.82	0.12	0.14
	73.9	^{95}Zr	0.11	0.013	0.0077
	9.9	^{131}I	0.13	0.031	0.0020
	5.9	^{132}Te	0.60	0.061	0.0034
	35.0	^{137}Cs	0.036	0.014	0.0022
	10.0	^{140}Ba	0.36	0.021	0.0030
	39.0	^{144}Ce	0.39	0.11	0.021

(continued)

TABLE D-2. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Blue Jay, Nev.	102.2	^{7}Be	1.0	0.16	0.097
	87.9	^{95}Zr	0.089	0.016	0.0084
	4.0	^{131}I	0.23	0.094	0.0015
	3.0	^{132}Te	0.34	0.11	0.0020
	15.0	^{137}Cs	0.026	0.014	<0.001
	9.2	^{140}Ba	0.26	0.041	0.0030
	34.1	^{144}Ce	0.41	0.093	0.020
Caliente, Nev.	121.6	^{7}Be	0.78	0.15	0.11
	80.6	^{95}Zr	0.061	0.017	0.0070
	4.0	^{131}I	0.061	0.034	<0.001
	5.0	^{132}Te	0.055	0.043	<0.001
	27.9	^{137}Cs	0.031	0.014	0.0018
	13.5	^{140}Ba	0.19	0.018	0.0020
	22.9	^{144}Ce	0.27	0.086	0.011
Currant Ranch, Nev.	117.0	^{7}Be	0.87	0.15	0.14
	79.3	^{95}Zr	0.073	0.019	0.0085
	4.8	^{131}I	0.15	0.10	0.0018
	2.9	^{132}Te	0.24	0.13	0.0014
	42.0	^{137}Cs	0.036	0.012	0.0025
	13.0	^{140}Ba	0.36	0.045	0.0050
	55.1	^{144}Ce	0.45	0.087	0.032
Diablo, Nev.	101.3	^{7}Be	0.96	0.16	0.095
	84.2	^{95}Zr	0.14	0.014	0.0081
	9.1	^{131}I	0.18	0.061	0.0028
	5.2	^{132}Te	0.089	0.080	0.0013
	36.9	^{137}Cs	0.047	0.010	0.0022
	15.1	^{140}Ba	0.34	0.064	0.0055
	31.5	^{144}Ce	0.28	0.091	0.016
Duckwater, Nev.	105.7	^{7}Be	0.55	0.12	0.099
	62.9	^{95}Zr	0.083	0.017	0.0073
	4.0	^{131}I	0.17	0.049	<0.001
	6.0	^{132}Te	0.20	0.075	0.0028
	27.0	^{137}Cs	0.046	0.012	0.0015
	18.0	^{140}Ba	0.16	0.031	0.0047
	31.0	^{144}Ce	0.26	0.078	0.015

(continued)

TABLE D-2. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Ely, Nev.	108.3	^{7}Be	1.1	0.15	0.12
	60.1	^{95}Zr	0.088	0.020	0.0075
	9.0	^{131}I	0.25	0.030	0.0026
	6.0	^{132}Te	0.28	0.10	0.0026
	38.7	^{137}Cs	0.045	0.016	0.0029
	11.0	^{140}Ba	0.46	0.035	0.0055
	35.0	^{144}Ce	0.33	0.096	0.016
Eureka, Nev.	110.0	^{7}Be	0.84	0.16	0.13
	81.6	^{95}Zr	0.080	0.015	0.0089
	9.0	^{131}I	0.090	0.028	0.0014
	5.0	^{132}Te	0.11	0.055	0.0011
	25.0	^{137}Cs	0.052	0.014	0.0018
	14.0	^{140}Ba	0.19	0.053	0.0045
	56.0	^{144}Ce	0.54	0.076	0.030
Fallini's Ranch, Nev.	122.0	^{7}Be	0.74	0.17	0.14
	82.2	^{95}Zr	0.10	0.016	0.0089
	11.0	^{131}I	0.17	0.018	0.0020
	4.0	^{132}Te	0.22	0.15	0.0020
	43.9	^{137}Cs	0.032	0.011	0.0021
	12.1	^{140}Ba	0.24	0.063	0.0043
	37.9	^{144}Ce	0.40	0.095	0.019
Geyser Ranch, Nev.	31.6	^{7}Be	1.0	0.19	0.087
	74.0	^{95}Zr	0.14	0.017	0.014
	7.0	^{131}I	0.29	0.031	0.0043
	3.0	^{132}Te	0.32	0.14	0.0037
	18.0	^{137}Cs	0.035	0.014	0.0023
	4.0	^{140}Ba	0.35	0.10	0.0054
	17.0	^{144}Ce	0.39	0.12	0.022
Glendale, Nev.	91.5	^{7}Be	0.81	0.13	0.096
	55.2	^{95}Zr	0.062	0.012	0.0056
	7.9	^{131}I	0.21	0.024	0.0023
	7.1	^{132}Te	0.21	0.039	0.0031
	38.9	^{137}Cs	0.039	0.012	0.0027
	17.1	^{140}Ba	0.24	0.023	0.0052
	38.8	^{144}Ce	0.23	0.069	0.020

(continued)

TABLE D-2. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Goldfield, Nev.	114.3	^{7}Be	0.71	0.15	0.098
	71.9	^{95}Zr	0.092	0.016	0.0064
	5.1	^{131}I	0.16	0.029	<0.001
	0.9	^{132}Te	0.13	0.13	<0.001
	30.0	^{137}Cs	0.062	0.013	0.0022
	11.5	^{140}Ba	0.26	0.023	0.0019
	37.1	^{144}Ce	0.23	0.079	0.017
Area 51, NTS, Nev.[1]	121.6	^{7}Be	0.64	0.17	0.14
	64.1	^{95}Zr	0.52	0.014	0.0067
	2.9	^{131}I	0.19	0.10	0.0015
	2.0	^{132}Te	0.25	0.19	0.0016
	18.9	^{137}Cs	0.041	0.012	0.0016
	2.9	^{140}Ba	0.21	0.099	0.0017
	26.3	^{144}Ce	0.30	0.087	0.014
Hiko, Nev.	95.7	^{7}Be	0.53	0.13	0.084
	100.0	^{95}Zr	0.072	0.013	0.0085
	9.0	^{131}I	0.16	0.022	0.0016
	3.0	^{132}Te	0.16	0.096	<0.001
	32.0	^{137}Cs	0.038	0.010	0.0018
	8.0	^{140}Ba	0.29	0.031	0.0027
	31.0	^{144}Ce	0.30	0.10	0.014
Indian Springs, Nev.	117.4	^{7}Be	0.79	0.14	0.11
	86.0	^{95}Zr	0.10	0.014	0.0090
	8.0	^{131}I	0.53	0.030	0.0033
	6.1	^{132}Te	0.53	0.036	0.0032
	30.0	^{137}Cs	0.040	0.010	0.0016
	11.0	^{140}Ba	0.42	0.032	0.0049
	33.0	^{144}Ce	0.19	0.090	0.014
Las Vegas, Nev.	71.7	^{7}Be	0.88	0.12	0.060
	81.0	^{95}Zr	0.17	0.012	0.0072
	8.0	^{131}I	0.41	0.028	0.0046
	8.0	^{132}Te	0.40	0.066	0.0044
	21.0	^{137}Cs	0.021	0.011	0.0010
	8.0	^{140}Ba	0.49	0.067	0.0056
	38.9	^{144}Ce	0.20	0.070	0.014

(continued)

TABLE D-2. (Continued)

Sampling Location	No. Days Detected	Type of Radioactivity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Lathrop Wells, Nev.	92.0	^{7}Be	0.51	0.14	0.083
	81.0	^{95}Zr	0.070	0.015	0.0075
	7.0	^{131}I	0.17	0.028	0.0013
	5.0	^{132}Te	0.19	0.048	0.0018
	26.0	^{137}Cs	0.027	0.012	0.0015
	7.0	^{140}Ba	0.28	0.029	0.0033
	29.0	^{144}Ce	0.37	0.082	0.016
Lida, Nev.	111.9	^{7}Be	0.66	0.17	0.12
	82.0	^{95}Zr	0.19	0.018	0.0084
	9.0	^{131}I	0.15	0.086	0.0030
	7.0	^{132}Te	0.18	0.068	0.0027
	30.0	^{137}Cs	0.032	0.011	0.0018
	11.0	^{140}Ba	0.22	0.070	0.0054
	31.0	^{144}Ce	0.33	0.12	0.014
Lund, Nev.	107.9	^{7}Be	1.8	0.11	0.12
	87.5	^{95}Zr	0.064	0.015	0.0087
	5.0	^{131}I	0.29	0.036	0.0018
	2.0	^{132}Te	0.22	0.11	<0.001
	30.9	^{137}Cs	0.034	0.011	0.0019
	8.9	^{140}Ba	0.42	0.034	0.0034
	35.7	^{144}Ce	0.30	0.11	0.018
Mesquite, Nev.	132.0	^{7}Be	0.69	0.14	0.11
	61.0	^{95}Zr	0.34	0.013	0.0072
	4.0	^{131}I	0.11	0.057	0.0011
	3.0	^{132}Te	0.14	0.11	0.0012
	7.0	^{137}Cs	0.021	0.011	<0.001
	7.0	^{140}Ba	0.19	0.024	0.0019
	17.0	^{144}Ce	0.20	0.069	0.0071
Moapa, Nev.	1.9	^{7}Be	0.41	0.41	0.072
	9.0	^{95}Zr	0.043	0.014	0.018
	0.0	^{131}I	--	--	--
	0.0	^{132}Te	--	--	--
	0.0	^{137}Cs	--	--	--
	0.0	^{140}Ba	--	--	--
	0.0	^{144}Ce	--	--	--

(continued)

TABLE D-2. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Nyala, Nev.	94.0	^{7}Be	0.96	0.17	0.010
	61.0	^{95}Zr	0.094	0.018	0.0062
	6.0	^{131}I	0.15	0.076	0.0017
	5.0	^{132}Te	0.27	0.069	0.0019
	24.0	^{137}Cs	0.032	0.011	0.0014
	6.0	^{140}Ba	0.16	0.075	0.0023
	15.0	^{144}Ce	0.34	0.11	0.0076
Pahrump, Nev.	140.3	^{7}Be	0.62	0.12	0.12
	84.4	^{95}Zr	0.078	0.014	0.0071
	6.0	^{131}I	0.41	0.096	0.0034
	6.0	^{132}Te	0.45	0.16	0.0042
	54.2	^{137}Cs	0.028	0.010	0.0027
	12.0	^{140}Ba	0.43	0.030	0.0057
	47.6	^{144}Ce	0.31	0.091	0.019
Pioche, Nev.	88.8	^{7}Be	0.71	0.13	0.11
	86.8	^{95}Zr	0.068	0.016	0.0092
	8.0	^{131}I	0.12	0.032	0.0019
	8.0	^{132}Te	0.20	0.070	0.0025
	30.0	^{137}Cs	0.035	0.013	0.0021
	8.2	^{140}Ba	0.25	0.067	0.0034
	31.0	^{144}Ce	0.29	0.068	0.016
Round Mountain, Nev.	98.3	^{7}Be	1.0	0.091	0.10
	78.9	^{95}Zr	0.12	0.016	0.0086
	8.9	^{131}I	0.36	0.033	0.0032
	3.9	^{132}Te	0.40	0.13	0.0023
	35.4	^{137}Cs	0.047	0.013	0.0022
	7.9	^{140}Ba	0.31	0.026	0.0028
	43.5	^{144}Ce	0.30	0.12	0.22
Scotty's Junction, Nev.	114.8	^{7}Be	0.53	0.13	0.096
	79.7	^{95}Zr	0.080	0.013	0.0068
	7.1	^{131}I	0.18	0.062	0.0027
	7.1	^{132}Te	0.25	0.081	0.0031
	17.0	^{137}Cs	0.031	0.014	0.0010
	10.0	^{140}Ba	0.31	0.054	0.0047
	31.1	^{144}Ce	0.27	0.066	0.013

(continued)

TABLE D-2. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Stone Cabin Ranch, Nev.	94.6	^{7}Be	0.99	0.19	0.11
	82.4	^{95}Zr	0.080	0.018	0.0095
	4.9	^{131}I	0.18	0.086	0.0018
	4.0	^{132}Te	0.46	0.18	0.0035
	39.9	^{137}Cs	0.041	0.016	0.0027
	12.8	^{140}Ba	0.39	0.049	0.0052
	37.9	^{144}Ce	0.42	0.097	0.022
Sunnyside, Nev.	99.7	^{7}Be	0.78	0.21	0.12
	95.5	^{95}Zr	0.083	0.013	0.0093
	9.0	^{131}I	0.10	0.030	0.0014
	4.0	^{132}Te	0.14	0.053	0.0011
	35.5	^{137}Cs	0.045	0.013	0.0023
	12.0	^{140}Ba	0.23	0.052	0.0037
	49.7	^{144}Ce	0.38	0.11	0.026
Tempiute, Nev.	80.8	^{7}Be	0.64	0.096	0.10
	52.7	^{95}Zr	0.057	0.015	0.0067
	7.8	^{131}I	0.13	0.038	0.0023
	4.0	^{132}Te	0.53	0.094	0.0039
	19.7	^{137}Cs	0.051	0.010	0.0014
	10.6	^{140}Ba	0.26	0.074	0.0058
	19.5	^{144}Ce	0.36	0.081	0.013
Tonopah, Nev.	96.0	^{7}Be	0.83	0.071	<0.1
	88.8	^{95}Zr	0.15	0.017	0.0094
	7.0	^{131}I	0.15	0.032	0.0015
	3.0	^{132}Te	0.30	0.25	0.0023
	52.0	^{137}Cs	1.040	0.011	0.0034
	10.0	^{140}Ba	0.24	0.051	0.0033
	46.0	^{144}Ce	0.61	0.11	0.029
Tonopah Test Range, Nev.	107.2	^{7}Be	1.2	0.10	0.14
	71.0	^{95}Zr	0.11	0.016	0.0077
	10.1	^{131}I	0.15	0.025	0.0023
	4.3	^{132}Te	0.096	0.071	0.0013
	36.6	^{137}Cs	0.041	0.012	0.0027
	18.3	^{140}Ba	0.23	0.022	0.0057
	36.2	^{144}Ce	0.34	0.094	0.024

(continued)

TABLE D-2. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Cedar City, Utah	109.7	^{7}Be	0.82	0.15	0.13
	66.0	^{95}Zr	0.087	0.018	0.0073
	4.0	^{131}I	0.091	0.042	<0.001
	1.0	^{132}Te	0.21	0.21	<0.001
	21.9	^{137}Cs	0.032	0.014	0.0013
	4.0	^{140}Ba	0.098	0.036	<0.001
	26.1	^{144}Ce	0.29	0.098	0.012
Delta, Utah	67.3	^{7}Be	2.6	0.19	0.12
	68.3	^{95}Zr	0.16	0.012	0.013
	3.0	^{131}I	0.076	0.076	<0.001
	3.0	^{132}Te	0.13	0.13	0.0016
	25.2	^{137}Cs	0.034	0.010	0.0020
	5.5	^{140}Ba	0,13	0.10	0.0026
	39.3	^{144}Ce	0.51	0.075	0.030
Garrison, Utah	129.0	^{7}Be	0.63	0.14	0.14
	80.0	^{95}Zr	0.12	0.014	0.0095
	6.0	^{131}I	0.15	0.053	0.0014
	4.0	^{132}Te	0.15	0.060	<0.001
	24.0	^{137}Cs	0.026	0.013	0.0013
	10.0	^{140}Ba	0.24	0.039	0.0031
	41.0	^{144}Ce	0.27	0.092	0.020
Milford, Utah	53.6	^{7}Be	0.99	0.12	0.13
	53.7	^{95}Zr	0.073	0.017	0.012
	7.6	^{131}I	0.11	0.059	0.0035
	10.2	^{132}Te	0.17	0.041	0.0054
	13.2	^{137}Cs	0.028	0.010	0.0013
	10.2	^{140}Ba	0.14	0.047	0.0058
	17.2	^{144}Ce	0.51	0.15	0.024
St. George, Utah	119.0	^{7}Be	0.74	0.13	0.11
	88.5	^{95}Zr	0.079	0.016	0.0078
	9.0	^{131}I	0.12	0.050	0.0018
	4.9	^{132}Te	0.25	0.055	0.0015
	33.8	^{137}Cs	0.081	0.012	0.0025
	14.0	^{140}Ba	0.19	0.040	0.0037
	47.3	^{144}Ce	0.32	0.081	0.023

[1]Also known as Groom Lake.

TABLE D-3. 1978 SUMMARY OF ANALYTICAL RESULTS FOR AIR SURVEILLANCE NETWORK STANDBY STATIONS

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-3} µCi/ml) Max	Min	Avg
Phoenix, Ariz.	13.9	^{7}Be	0.40	0.16	0.060
	19.1	^{95}Zr	0.061	0.014	0.011
	9.0	^{131}I	0.23	0.038	0.020
	7.0	^{132}Te	0.19	0.097	0.017
	0.0	^{137}Cs	--	--	--
	7.0	^{140}Ba	0.33	0.14	0.031
	0.0	^{144}Ce	--	--	--
Winslow, Ariz.	8.7	^{7}Be	0.51	0.19	0.041
	6.4	^{95}Zr	0.074	0.046	0.0062
	8.0	^{131}I	0.15	0.038	0.011
	3.0	^{132}Te	0.24	0.17	0.0095
	0.0	^{137}Cs	--	--	--
	8.0	^{140}Ba	0.33	0.035	0.020
	0.0	^{144}Ce	--	--	--
Little Rock, Ark.	8.8	^{7}Be	0.77	0.18	0.059
	7.1	^{95}Zr	0.083	0.037	0.0068
	9.1	^{131}I	7.9	0.10	0.23
	8.1	^{132}Te	9.8	0.047	0.29
	4.0	^{137}Cs	0.030	0.013	0.0012
	9.1	^{140}Ba	5.8	0.046	0.18
	0.0	^{144}Ce	--	--	--
Indio, Calif.	8.0	^{7}Be	0.45	0.068	0.037
	15.4	^{95}Zr	0.12	0.018	0.011
	7.0	^{131}I	0.31	0.056	0.018
	7.0	^{132}Te	0.31	0.074	0.022
	5.1	^{137}Cs	0.019	0.011	0.0013
	10.0	^{140}Ba	0.84	0.025	0.029
	2.0	^{144}Ce	0.12	0.12	0.0046
Denver, Colo.	12.0	^{7}Be	0.82	0.23	0.084
	8.0	^{95}Zr	0.094	0.035	0.0075
	14.0	^{131}I	18	0.051	0.61
	8.0	^{132}Te	25	0.093	0.81
	0.0	^{137}Cs	--	--	--
	22.0	^{140}Ba	18	0.021	0.60
	0.0	^{144}Ce	--	--	--

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Durango, Colo.	8.9	^{7}Be	1.2	0.24	0.081
	9.9	^{95}Zr	0.13	0.022	0.011
	6.4	^{131}I	0.90	0.043	0.022
	1.9	^{132}Te	1.8	0.29	0.036
	2.4	^{137}Cs	0.013	0.013	<0.001
	6.4	^{140}Ba	1.4	0.077	0.041
	3.2	^{144}Ce	0.087	0.087	0.0051
Grand Junction, Colo.	14.1	^{7}Be	0.35	0.21	0.061
	4.1	^{95}Zr	0.052	0.043	0.0031
	8.0	^{131}I	0.15	0.030	0.0092
	2.9	^{132}Te	0.14	0.12	0.0059
	0.0	^{137}Cs	--	--	--
	8.0	^{140}Ba	0.14	0.055	0.011
	0.0	^{144}Ce	--	--	--
Pueblo, Colo.	3.0	^{7}Be	1.6	0.28	0.046
	4.1	^{95}Zr	0.095	0.027	0.0040
	8.0	^{131}I	21	0.071	0.74
	8.0	^{132}Te	34	0.12	1.1
	0.0	^{137}Cs	--	--	--
	9.2	^{140}Ba	18	0.13	0.66
	0.0	^{144}Ce	--	--	--
Boise, Idaho	13.1	^{7}Be	0.50	0.16	0.069
	7.0	^{95}Zr	0.070	0.022	0.0043
	2.0	^{131}I	0.037	0.037	0.0014
	0.0	^{132}Te	--	--	--
	0.0	^{137}Cs	--	--	--
	5.0	^{140}Ba	0.18	0.074	0.0089
	0.0	^{144}Ce	--	--	--
Idaho Falls, Idaho	14.1	^{7}Be	0.46	0.13	0.073
	14.9	^{95}Zr	0.13	0.020	0.013
	9.3	^{131}I	0.33	0.022	0.019
	4.0	^{132}Te	0.83	0.11	0.022
	2.3	^{137}Cs	0.021	0.021	<0.001
	11.2	^{140}Ba	0.40	0.065	0.028
	0.0	^{144}Ce	--	--	--

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Mountain Home, Idaho	12.0	^{7}Be	0.42	0.23	0.062
	8.0	^{95}Zr	0.041	0.014	0.0040
	9.8	^{131}I	0.25	0.046	0.015
	9.8	^{132}Te	0.36	0.080	0.022
	5.0	^{137}Cs	0.017	0.016	0.0014
	13.9	^{140}Ba	0.29	0.055	0.028
	0.0	^{144}Ce	--	--	--
Pocatello, Idaho	15.8	^{7}Be	0.72	0.13	0.11
	16.4	^{95}Zr	0.088	0.022	0.012
	7.0	^{131}I	0.082	0.048	0.0080
	4.9	^{132}Te	0.11	0.058	0.0073
	2.0	^{137}Cs	0.023	0.023	<0.001
	12.0	^{140}Ba	0.15	0.035	0.020
	3.0	^{144}Ce	0.094	0.094	0.0054
Preston, Idaho	15.0	^{7}Be	0.45	0.22	0.076
	8.0	^{95}Zr	0.053	0.047	0.0072
	8.1	^{131}I	0.048	0.038	0.0065
	2.0	^{132}Te	0.056	0.056	0.0020
	2.0	^{137}Cs	0.017	0.017	<0.001
	9.1	^{140}Ba	0.097	0.065	0.014
	0.0	^{144}Ce	--	--	--
Twin Falls, Idaho	3.0	^{7}Be	0.26	0.26	0.012
	15.0	^{95}Zr	0.036	0.018	0.0068
	13.0	^{131}I	0.47	0.028	0.017
	9.0	^{132}Te	0.11	0.063	0.011
	0.0	^{137}Cs	--	--	--
	20.0	^{140}Ba	0.12	0.029	0.018
	3.0	^{144}Ce	0.092	0.092	0.0043
Iowa City, Iowa	8.0	^{7}Be	0.26	0.11	0.028
	2.7	^{95}Zr	0.077	0.031	0.0023
	8.9	^{131}I	0.59	0.022	0.030
	4.0	^{132}Te	0.90	0.044	0.030
	3.0	^{137}Cs	0.013	0.013	<0.001
	10.9	^{140}Ba	0.56	0.027	0.032
	3.0	^{144}Ce	0.076	0.076	0.0044

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Sioux City, Iowa	10.8	^{7}Be	0.39	0.14	0.065
	6.0	^{95}Zr	0.027	0.022	0.0028
	12.0	^{131}I	1.9	0.014	0.055
	5.0	^{132}Te	3.3	0.084	0.078
	2.0	^{137}Cs	0.019	0.019	<0.001
	12.0	^{140}Ba	2.1	0.025	0.058
	0.0	^{144}Ce	--	--	--
Dodge City, Kans.	24.0	^{7}Be	0.37	0.16	0.088
	6.0	^{95}Zr	0.11	0.030	0.0044
	12.0	^{131}I	1.6	0.045	0.054
	12.0	^{132}Te	0.24	0.042	0.063
	0.0	^{137}Cs	--	--	--
	17.0	^{140}Ba	1.5	0.027	0.053
	2.0	^{144}Ce	0.16	0.16	0.0051
Lake Charles, La.	9.3	^{7}Be	0.33	0.19	0.046
	17.1	^{95}Zr	0.038	0.016	0.0094
	9.9	^{131}I	0.29	0.045	0.026
	7.9	^{132}Te	0.24	0.046	0.020
	0.0	^{137}Cs	--	--	--
	11.9	^{140}Ba	0.42	0.022	0.04
	2.9	^{144}Ce	0.093	0.093	0.0056
Monroe, La.	22.9	^{7}Be	0.59	0.13	0.085
	11.8	^{95}Zr	0.032	0.018	0.0046
	9.5	^{131}I	3.6	0.027	0.065
	6.8	^{132}Te	4.1	0.069	0.073
	2.0	^{137}Cs	0.016	0.016	0.00051
	12.0	^{140}Ba	3.1	0.045	0.074
	0.0	^{144}Ce	--	--	--
New Orleans, La.	5.1	^{7}Be	0.22	0.15	0.019
	13.7	^{95}Zr	0.11	0.013	0.012
	11.0	^{131}I	0.84	0.027	0.046
	8.9	^{132}Te	0.93	0.031	0.037
	2.0	^{137}Cs	0.014	0.014	<0.001
	17.8	^{140}Ba	0.73	0.034	0.058
	2.0	^{144}Ce	0.12	0.12	0.0050

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Minneapolis, Minn.	9.0	^{7}Be	0.29	0.19	0.037
	1.0	^{95}Zr	0.059	0.059	0.0010
	4.8	^{131}I	1.1	0.055	0.027
	1.9	^{132}Te	1.9	0.28	0.037
	0.0	^{137}Cs	--	--	--
	7.8	^{140}Ba	1.0	0.021	0.026
	0.0	^{144}Ce	--	--	--
Clayton, Mo.	14.2	^{7}Be	0.37	0.10	0.051
	19.0	^{95}Zr	0.033	0.019	0.0088
	13.0	^{131}I	2.7	0.030	0.093
	5.0	^{132}Te	2.8	0.053	0.0086
	0.0	^{137}Cs	--	--	--
	17.0	^{140}Ba	2.1	0.034	0.074
	3.0	^{144}Ce	0.060	0.060	0.0030
Joplin, Mo.	13.0	^{7}Be	1.7	0.18	0.92
	7.0	^{95}Zr	0.064	0.040	0.0066
	12.9	^{131}I	11	0.062	0.020
	6.3	^{132}Te	10	0.085	0.25
	0.0	^{137}Cs	--	--	--
	11.1	^{140}Ba	8.2	0.13	0.24
	4.9	^{144}Ce	0.10	0.096	0.0097
St. Joseph, Mo.	13.4	^{7}Be	0.45	0.11	0.039
	9.1	^{95}Zr	0.16	0.025	0.010
	14.1	^{131}I	0.64	0.054	0.052
	11.1	^{132}Te	1.1	0.061	0.045
	0.0	^{137}Cs	--	--	--
	13.1	^{140}Ba	0.92	0.095	0.075
	3.0	^{144}Ce	0.068	0.068	0.0027
Billings, Mont.	0.0	^{7}Be	--	--	--
	1.9	^{95}Zr	0.046	0.046	0.0035
	1.9	^{131}I	0.062	0.062	0.0046
	0.0	^{132}Te	--	--	--
	2.0	^{137}Cs	0.025	0.025	0.0020
	1.9	^{140}Ba	0.092	0.092	0.0069
	0.0	^{144}Ce	--	--	--

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Bozeman, Mont.	5.1	^{7}Be	0.35	0.010	0.017
	7.7	^{95}Zr	0.032	0.020	0.0034
	13.0	^{131}I	9.2	0.073	0.29
	7.1	^{132}Te	6.9	0.043	0.21
	2.0	^{137}Cs	0.016	0.016	<0.001
	12.1	^{140}Ba	2.3	0.079	0.12
	0.0	^{144}Ce	--	--	--
Missoula, Mont.	16.1	^{7}Be	0.39	0.23	0.076
	12.3	^{95}Zr	0.055	0.026	0.0058
	14.0	^{131}I	4.1	0.029	0.12
	9.8	^{132}Te	5.0	0.032	0.11
	0.0	^{137}Cs	--	--	--
	17.0	^{140}Ba	2.9	0.048	0.089
	0.0	^{144}Ce	--	--	--
North Platte, Nebr.	13.0	^{7}Be	0.31	0.16	0.060
	11.1	^{95}Zr	0.032	0.020	0.0056
	14.0	^{131}I	12	0.030	0.28
	8.0	^{132}Te	14	0.057	0.33
	0.0	^{137}Cs	--	--	--
	14.0	^{140}Ba	8.2	0.032	0.21
	0.0	^{144}Ce	--	--	--
Battle Mountain, Nev.	16.1	^{7}Be	0.42	0.37	0.12
	6.0	^{95}Zr	0.062	0.042	0.0052
	4.0	^{131}I	0.058	0.054	0.0040
	1.9	^{132}Te	0.040	0.040	0.0013
	3.1	^{137}Cs	0.016	0.016	<0.001
	12.9	^{140}Ba	0.15	0.050	0.019
	0.0	^{144}Ce	--	--	--
Currant Maint. Sta., Nev.	2.3	^{7}Be	0.56	0.56	0.041
	17.2	^{95}Zr	0.092	0.026	0.025
	8.0	^{131}I	0.14	0.067	0.024
	5.0	^{132}Te	0.23	0.11	0.030
	0.0	^{137}Cs	--	--	--
	8.0	^{140}Ba	0.28	0.057	0.035
	0.0	^{144}Ce	--	--	--

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Currie, Nev.	5.9	^{7}Be	0.51	0.14	0.028
	16.4	^{95}Zr	0.085	0.013	0.012
	8.0	^{131}I	0.053	0.023	0.0056
	6.0	^{132}Te	0.13	0.050	0.011
	3.0	^{137}Cs	0.012	0.012	<0.001
	7.0	^{140}Ba	0.15	0.034	0.012
	7.0	^{144}Ce	0.15	0.080	0.016
Elko, Nev.	7.0	^{7}Be	0.27	0.21	0.036
	15.9	^{95}Zr	0.073	0.024	0.015
	4.9	^{131}I	0.16	0.049	0.011
	1.9	^{132}Te	0.11	0.11	0.0048
	0.0	^{137}Cs	--	--	--
	8.1	^{140}Ba	0.22	0.084	0.026
	0.0	^{144}Ce	--	--	--
Fallon, Nev.	16.8	^{7}Be	0.47	0.23	0.092
	14.0	^{95}Zr	0.042	0.018	0.0066
	7.2	^{131}I	0.21	0.035	0.011
	5.2	^{132}Te	0.25	0.091	0.012
	0.0	^{137}Cs	--	--	--
	5.2	^{140}Ba	0.27	0.098	0.015
	2.0	^{144}Ce	0.13	0.13	0.0043
Frenchman Sta., Nev.	17.9	^{7}Be	0.70	0.21	0.12
	11.8	^{95}Zr	0.082	0.020	0.0086
	8.0	^{131}I	0.24	0.063	0.014
	6.9	^{132}Te	0.32	0.081	0.019
	2.9	^{137}Cs	0.013	0.013	<0.001
	12.9	^{140}Ba	0.29	0.046	0.025
	0.0	^{144}Ce	--	--	--
Lovelock, Nev.	28.7	^{7}Be	0.61	0.18	0.15
	11.3	^{95}Zr	0.13	0.023	0.0077
	6.0	^{131}I	0.18	0.060	0.0092
	4.1	^{132}Te	0.15	0.11	0.0072
	3.5	^{137}Cs	0.015	0.015	<0.001
	7.0	^{140}Ba	0.32	0.11	0.017
	2.0	^{144}Ce	0.16	0.16	0.0043

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Reno, Nev.	12.0	^{7}Be	0.42	0.18	0.10
	0.0	^{95}Zr	--	--	--
	0.0	^{131}I	--	--	--
	0.0	^{132}Te	--	--	--
	0.0	^{137}Cs	--	--	--
	0.0	^{140}Ba	--	--	--
	0.0	^{144}Ce	--	--	--
Warm Springs, Nev.	3.0	^{7}Be	0.52	0.28	0.021
	17.2	^{95}Zr	0.092	0.028	0.015
	6.0	^{131}I	0.19	0.046	0.011
	3.0	^{132}Te	0.24	0.090	0.011
	0.0	^{137}Cs	--	--	--
	13.8	^{140}Ba	0.24	0.021	0.026
	0.0	^{144}Ce	--	--	--
Wells, Nev.	19.0	^{7}Be	1.0	0.037	0.16
	9.0	^{95}Zr	1.1	0.033	0.024
	5.0	^{131}I	0.36	0.12	0.016
	3.0	^{132}Te	0.22	0.10	0.0074
	0.0	^{137}Cs	--	--	--
	11.0	^{140}Ba	1.1	0.067	0.052
	3.0	^{144}Ce	0.10	0.10	0.0053
Winnemucca, Nev.	12.1	^{7}Be	2.7	0.21	0.14
	10.0	^{95}Zr	0.052	0.026	0.0077
	1.0	^{131}I	0.089	0.089	0.0018
	0.0	^{132}Te	--	--	--
	5.0	^{137}Cs	0.016	0.014	0.0015
	1.0	^{140}Ba	0.21	0.21	0.0041
	0.0	^{144}Ce	--	--	--
Albuquerque, N. Mex.	13.1	^{7}Be	1.2	0.18	0.060
	14.9	^{95}Zr	0.10	0.014	0.0086
	5.9	^{131}I	0.12	0.033	0.0046
	6.1	^{132}Te	0.19	0.054	0.0071
	0.0	^{137}Cs	--	--	--
	16.0	^{140}Ba	0.35	0.024	0.019
	0.0	^{144}Ce	--	--	--

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Carlsbad, N. Mex.	14.2	^{7}Be	0.41	0.10	0.062
	16.6	^{95}Zr	0.094	0.016	0.013
	10.8	^{131}I	0.33	0.027	0.026
	12.8	^{132}Te	0.25	0.056	0.023
	0.0	^{137}Cs	--	--	--
	9.7	^{140}Ba	0.31	0.036	0.036
	0.0	^{144}Ce	--	--	--
Muskogee, Okla.	28.7	^{7}Be	0.34	0.081	0.094
	16.0	^{95}Zr	0.16	0.019	0.012
	15.0	^{131}I	8.9	0.028	0.19
	10.0	^{132}Te	11	0.12	0.22
	0.0	^{137}Cs	--	--	--
	18.0	^{140}Ba	6.9	0.026	0.17
	0.0	^{144}Ce	--	--	--
Norman, Okla.	7.0	^{7}Be	0.25	0.23	0.041
	14.1	^{95}Zr	0.069	0.024	0.014
	14.9	^{131}I	4.5	0.041	0.14
	9.0	^{132}Te	4.0	0.097	0.14
	0.0	^{137}Cs	--	--	--
	15.9	^{140}Ba	3.2	0.061	0.16
	0.0	^{144}Ce	--	--	--
Burns, Oreg.	18.0	^{7}Be	1.3	0.078	0.11
	7.0	^{95}Zr	0.070	0.034	0.0050
	6.0	^{131}I	0.083	0.073	0.0073
	3.0	^{132}Te	0.22	0.11	0.0072
	0.0	^{137}Cs	--	--	--
	5.0	^{140}Ba	0.17	0.068	0.011
	2.0	^{144}Ce	0.12	0.12	0.0037
Medford, Oreg.	9.1	^{7}Be	0.37	0.020	0.038
	14.7	^{95}Zr	0.049	0.027	0.0073
	3.0	^{131}I	0.035	0.035	0.0014
	0.0	^{132}Te	--	--	--
	0.0	^{137}Cs	--	--	--
	3.0	^{140}Ba	0.055	0.055	0.0022
	0.0	^{144}Ce	--	--	--

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Aberdeen, S. Dak.	18.0	^{7}Be	0.53	0.14	0.068
	5.0	^{95}Zr	0.11	0.026	0.0036
	4.0	^{131}I	0.50	0.058	0.016
	2.0	^{132}Te	1.0	0.61	0.024
	0.0	^{137}Cs	--	--	--
	5.0	^{140}Ba	0.62	0.039	0.017
	0.0	^{144}Ce	--	--	--
Rapid City, S. Dak.	7.7	^{7}Be	0.69	0.16	0.035
	16.7	^{95}Zr	0.082	0.018	0.0081
	13.6	^{131}I	12	0.027	0.30
	5.9	^{132}Te	13	0.15	0.30
	0.0	^{137}Cs	--	--	--
	9.5	^{140}Ba	7.7	0.054	0.19
	0.0	^{144}Ce	--	--	--
Abilene, Tex.	13.2	^{7}Be	0.42	0.094	0.045
	11.9	^{95}Zr	0.15	0.022	0.011
	13.0	^{131}I	5.2	0.14	0.14
	12.0	^{132}Te	6.0	0.13	0.15
	3.1	^{137}Cs	0.010	0.010	<0.001
	18.1	^{140}Ba	3.9	0.043	0.15
	0.0	^{144}Ce	--	--	--
Amarillo, Tex.	20.8	^{7}Be	0.72	0.13	0.13
	12.0	^{95}Zr	0.068	0.018	0.0078
	7.0	^{131}I	1.9	0.095	0.180
	7.0	^{132}Te	1.5	0.086	0.064
	0.0	^{137}Cs	--	--	--
	7.0	^{140}Ba	1.3	0.063	0.057
	0.0	^{144}Ce	--	--	--
Austin, Tex.	16.3	^{7}Be	0.39	0.16	0.064
	18.7	^{95}Zr	0.11	0.025	0.013
	12.0	^{131}I	0.46	0.087	0.047
	8.0	^{132}Te	0.36	0.18	0.027
	3.7	^{137}Cs	0.020	0.015	<0.001
	17.0	^{140}Ba	0.71	0.065	0.069
	1.7	^{144}Ce	0.088	0.088	0.0020

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Fort Worth, Tex.	13.0	^{7}Be	0.27	0.18	0.070
	6.0	^{95}Zr	0.036	0.018	0.0032
	3.0	^{131}I	3.8	0.092	0.17
	3.0	^{132}Te	7.2	0.12	0.27
	0.0	^{137}Cs	--	--	--
	5.9	^{140}Ba	4.4	0.040	0.17
	0.0	^{144}Ce	--	--	--
Bryce Canyon, Utah	16.1	^{7}Be	0.41	0.30	0.14
	3.0	^{95}Zr	0.053	0.053	0.0041
	5.0	^{131}I	0.11	0.053	0.011
	5.0	^{132}Te	0.12	0.091	0.014
	0.0	^{137}Cs	--	--	--
	5.0	^{140}Ba	0.30	0.18	0.029
	0.0	^{144}Ce	--	--	--
Capitol Reef, Utah	28.8	^{7}Be	0.55	0.28	0.16
	11.0	^{95}Zr	0.082	0.028	0.0092
	6.0	^{131}I	0.30	0.056	0.014
	4.0	^{132}Te	0.18	0.060	0.0061
	2.0	^{137}Cs	0.035	0.035	0.0011
	10.0	^{140}Ba	0.28	0.048	0.016
	0.0	^{144}Ce	--	--	--
Dugway, Utah	4.0	^{7}Be	0.39	0.33	0.045
	13.7	^{95}Zr	0.096	0.024	0.017
	5.0	^{131}I	0.13	0.028	0.0078
	2.5	^{132}Te	0.058	0.058	0.0042
	0.0	^{137}Cs	--	--	--
	10.5	^{140}Ba	0.20	0.075	0.031
	0.0	^{144}Ce	--	--	--
Enterprise, Utah	21.0	^{7}Be	0.85	0.18	0.15
	12.0	^{95}Zr	0.12	0.050	0.014
	5.0	^{131}I	0.12	0.058	0.0077
	2.0	^{132}Te	0.13	0.13	0.0041
	0.0	^{137}Cs	--	--	--
	9.0	^{140}Ba	0.29	0.12	0.025
	0.0	^{144}Ce	--	--	--

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Logan, Utah	13.2	^{7}Be	0.49	0.23	0.08
	14.0	^{95}Zr	0.068	0.021	0.011
	7.9	^{131}I	0.10	0.033	0.0091
	2.9	^{132}Te	0.13	0.071	0.0046
	0.0	^{137}Cs	--	--	--
	13.0	^{140}Ba	0.19	0.076	0.025
	3.0	^{144}Ce	0.079	0.079	0.0041
Monticello, Utah	9.2	^{7}Be	0.82	0.19	0.063
	9.8	^{95}Zr	0.099	0.030	0.0093
	5.0	^{131}I	0.13	0.053	0.0086
	1.0	^{132}Te	0.13	0.13	0.0025
	0.0	^{137}Cs	--	--	--
	7.0	^{140}Ba	0.23	0.049	0.013
	0.0	^{144}Ce	--	--	--
Parowan, Utah	15.1	^{7}Be	0.45	0.12	0.097
	5.0	^{95}Zr	0.091	0.021	0.0034
	0.0	^{131}I	--	--	--
	0.0	^{132}Te	--	--	--
	0.0	^{137}Cs	--	--	--
	2.0	^{140}Ba	0.068	0.068	0.0027
	0.0	^{144}Ce	--	--	--
Provo, Utah	15.1	^{7}Be	0.87	0.36	0.095
	12.0	^{95}Zr	0.094	0.094	0.0080
	3.8	^{131}I	0.13	0.083	0.0036
	0.0	^{132}Te	--	--	--
	6.1	^{137}Cs	0.025	0.013	0.0014
	6.8	^{140}Ba	0.25	0.075	0.014
	2.0	^{144}Ce	0.180	0.180	0.0043
Salt Lake City, Utah	17.1	^{7}Be	0.70	0.28	0.13
	7.8	^{95}Zr	0.67	0.025	0.0075
	7.1	^{131}I	0.15	0.053	0.011
	0.0	^{132}Te	--	--	--
	0.0	^{137}Cs	--	--	--
	9.0	^{140}Ba	0.13	0.041	0.018
	0.0	^{144}Ce	--	--	--

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} µCi/ml) Max	Min	Avg
Vernal, Utah	9.9	^{7}Be	0.86	0.20	0.085
	19.0	^{95}Zr	0.083	0.026	0.015
	3.0	^{131}I	0.52	0.11	0.014
	3.0	^{132}Te	1.4	0.75	0.056
	0.0	^{137}Cs	--	--	--
	9.0	^{140}Ba	0.51	0.064	0.035
	0.0	^{144}Ce	--	--	--
Wendover, Utah	15.5	^{7}Be	1.9	0.21	0.18
	6.9	^{95}Zr	0.16	0.049	0.011
	3.0	^{131}I	0.12	0.078	0.0045
	1.9	^{132}Te	0.13	0.13	0.0041
	0.0	^{137}Cs	--	--	--
	6.0	^{140}Ba	0.20	0.078	0.016
	0.0	^{144}Ce	--	--	--
Seattle, Wash.	9.0	^{7}Be	0.36	0.081	0.026
	8.9	^{95}Zr	0.026	0.013	0.0028
	12.0	^{131}I	0.38	0.023	0.012
	4.0	^{132}Te	0.26	0.046	0.0066
	0.0	^{137}Cs	--	--	--
	13.0	^{140}Ba	0.21	0.041	0.014
	0.0	^{144}Ce	--	--	--
Spokane, Wash.	13.0	^{7}Be	0.44	0.090	0.041
	8.0	^{95}Zr	0.040	0.015	0.0030
	13.0	^{131}I	0.51	0.016	0.0021
	5.0	^{132}Te	0.54	0.010	0.021
	0.0	^{137}Cs	--	--	--
	13.0	^{140}Ba	0.35	0.025	0.019
	0.0	^{144}Ce	--	--	--
Casper, Wyo.	10.0	^{7}Be	0.76	0.18	0.080
	10.0	^{95}Zr	0.052	0.026	0.0079
	10.0	^{131}I	37	0.081	1.2
	10.0	^{132}Te	71	0.062	1.8
	3.0	^{137}Cs	0.011	0.011	<0.001
	15.0	^{140}Ba	29	0.083	0.084
	0.0	^{144}Ce	--	--	--

(continued)

TABLE D-3. (Continued)

Sampling Location	No. Days Detected	Type of Radio-activity	Radioactivity Concentration (10^{-9} μCi/ml) Max	Min	Avg
Rock Springs, Wyo.	7.0	^{7}Be	0.82	0.20	0.065
	6.0	^{95}Zr	0.090	0.025	0.0054
	6.0	^{131}I	0.92	0.063	0.046
	6.0	^{132}Te	1.8	0.078	0.063
	8.1	^{137}Cs	0.024	0.013	0.0029
	12.0	^{140}Ba	0.79	0.045	0.056
	0.0	^{144}Ce	--	--	--
Worland, Wyo.	20.7	^{7}Be	0.73	0.11	0.081
	11.0	^{95}Zr	2.1	0.023	0.036
	15.0	^{131}I	27	0.030	0.47
	6.0	^{132}Te	43	0.12	0.70
	0.0	^{137}Cs	--	--	--
	20.0	^{140}Ba	20	0.019	0.36
	5.0	^{144}Ce	0.17	0.11	0.0099

for each sampling location*. The calculated D.E.'s for each sampling location are shown in Figures D-3 and D-4 with isopleth lines for the D.E.'s of 0.01 mrem and 0.1 mrem. The highest infant thyroid dose equivalent was estimated to be 4.0 mrem for the samples collected at Casper, Wyoming. This dose is 0.8 percent of the Radiation Protection Standard of 500 mrem for the general population, as specified by the DOE Manual, Chapter 0524.

*Calculational procedures were the same as those specified in Appendix B, "Final Report of Off-Site Surveillance for the Baneberry Event," Report No. SWRHL-107r. Available from National Technical Information Service, U.S. Dept. of Commerce, Springfield, VA 22161. Feb. 1972.

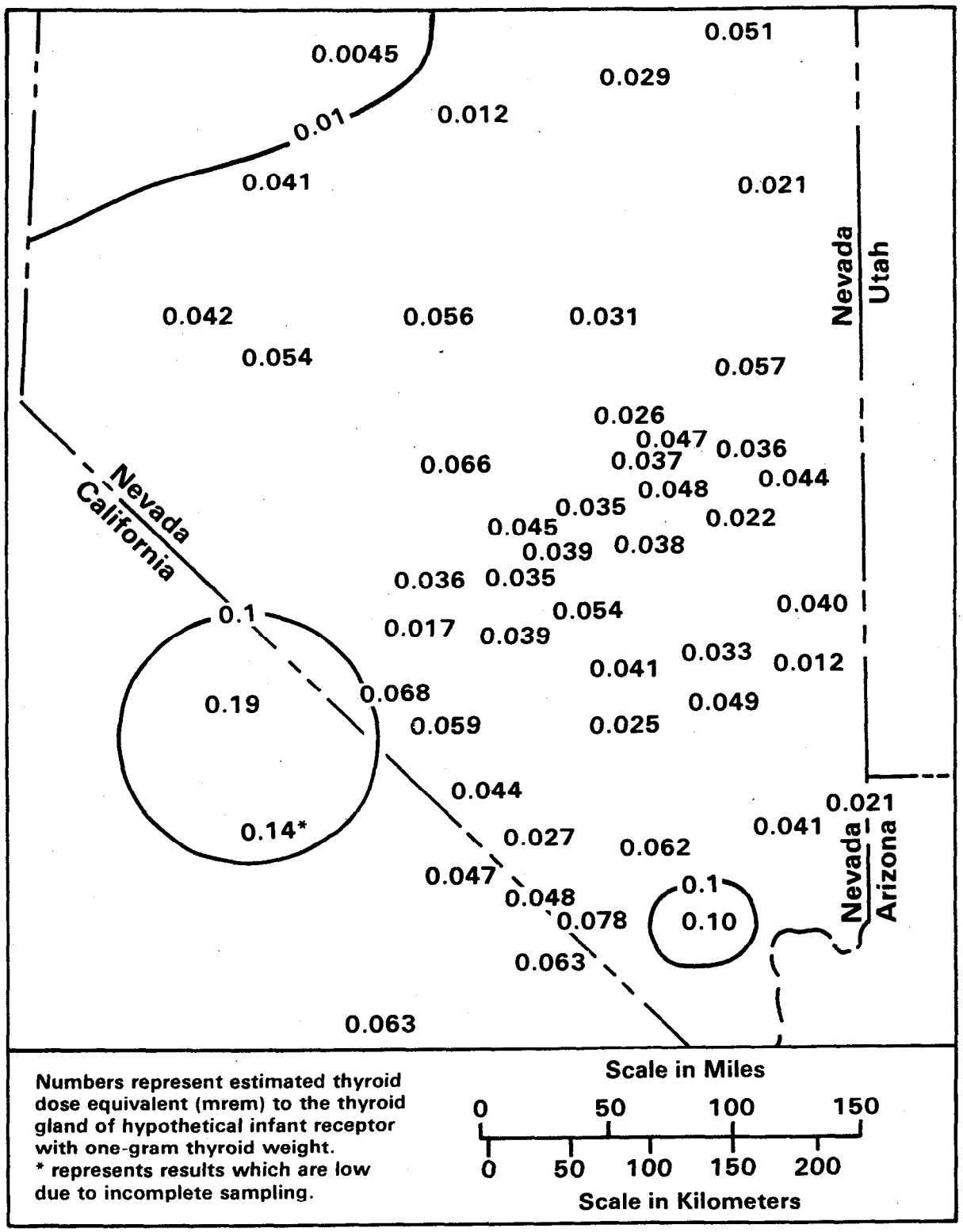

Figure D-3. Infant Thyroid Dose Equivalents (mrem) Estimated from Air Sampling Results of Air Surveillance Network, (Nevada), March-April 1978.

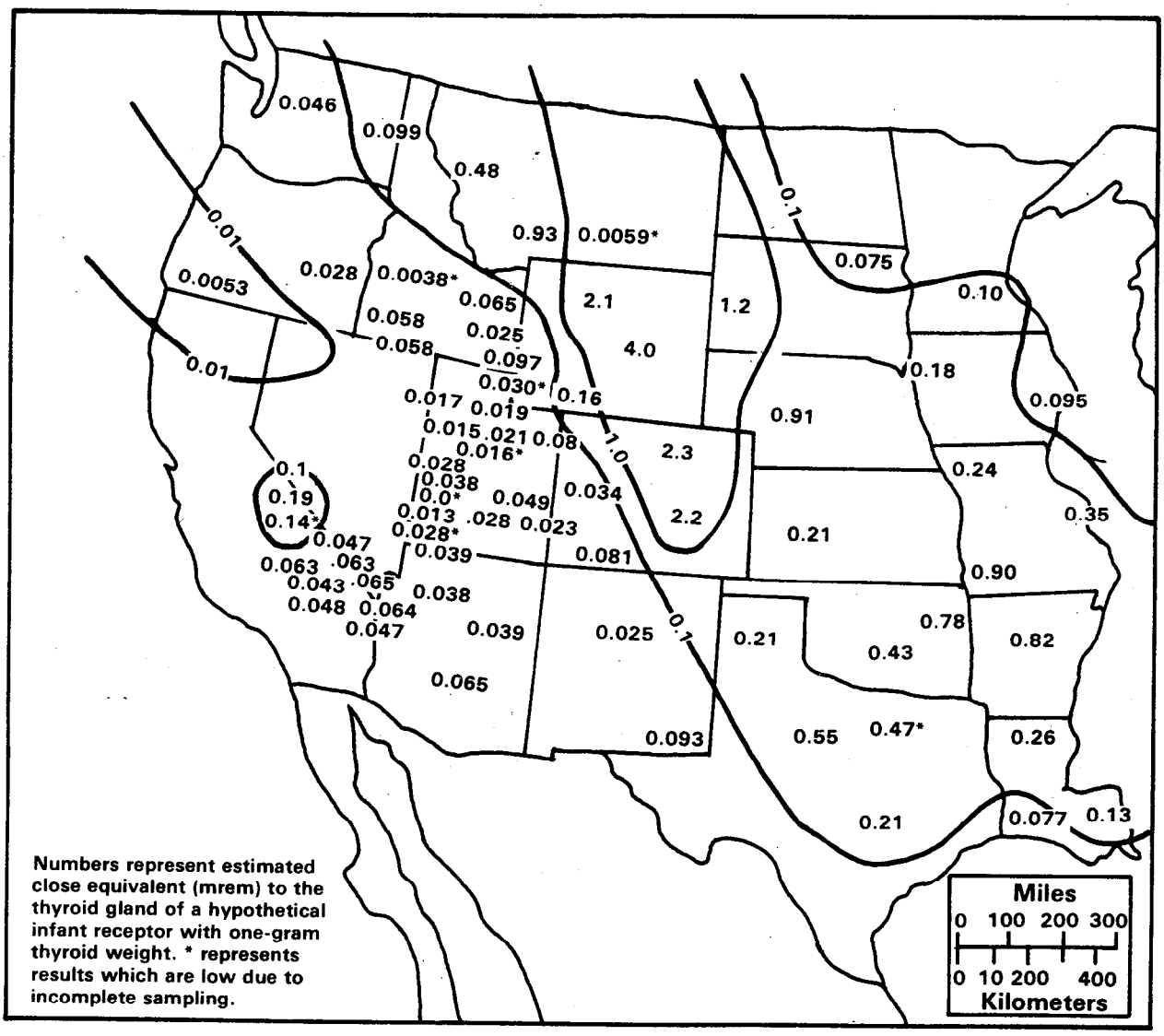

Figure D-4. Infant Thyroid Dose Equivalents (mrem) Estimated from Air Sampling Results of Air Surveillance Network (Western United States), March-April 1978.

APPENDIX E. LIST OF ABBREVIATIONS AND SYMBOLS

µm	micrometer
µrem	micro-rotgen-equivalent-man
µCi/g	microcurie per gram
µCi/ml	microcurie per milliliter
AEC	Atomic Energy Commission
ASN	Air Surveillance Network
C	temperature in Celsius
CG	Concentration Guide
Ci	Curie
cm	centimeter
CP-1	Control Point One
CY	Calendar Year
D.E.	Dose Equivalent
DOE	U.S. Department of envergy
EMSL-LV	Environmental Monitoring and Support Laboratory-Las Vegas
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Administration
ERDA/NV	Energy Research and Development Administration/ Nevada Operations Office
ft	feet
GZ	Ground Zero
h	hour
kg	kilogram
km	kilometer
kt	kiloton
LCL	lower confidence limit
LLL	Lawrence Livermore Laboratory
LTHMP	Long-Term Hydrological Monitoring Program
m	meter
MDC	minimum detectable concentration
mm	millimeter
mrem/y	milli-röntgen-equivalent-man per year
mrem/d	milli-röntgen-equivalent-man per day
mR	milli-röntgen
mR/h	milli-röntgen per hour
MSL	Mean Sea Level
MSM	Milk Surveillance Network
nCi	nanocurie
NTS	Nevada Test Site

PHS	Public Health Service
pCi	picocurie
SMSN	Standby Milk Surveillance Network
TLD	thermoluminescent dosimeter
UCL	Upper Confidence Limit
USGS	United States Geological Survey
WSN	Water Surveillance Network
y	year
^{3}H	tritium or hydrogen-3
HT	tritiated hydrogen
HTC	tritiated water
CH_3T	tritiated methane
Ba	barium
Be	berylium
Cs	cesium
I	iodine
K	potassium
Kr	krypton
Pu	plutonium
Ra	radium
Ru	ruthenium
Sr	strontium
Te	tellurium
U	uranium
Xe	xenon
Zr	zirconium

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