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Nevada Test Site Annual Site Environmental Report for Calendar Year - 1995

Editors:
Stuart C. Black and Yvonne E. Townsend

Technical Reviewer:
Wayne M. Glines

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U.S. Department of Energy
Nevada Operations Office

Prepared by:
Bechtel Nevada
Post Office Box 98521
Las Vegas, NV 89193-8521

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AUTHORS AND CONTRIBUTORS

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Stuart C. Black, BN

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Colleen M. Beck, DRI
Stuart C. Black, BN
James W. Kesler, BN
Tim A. Lindemann, BN

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Orin L. Haworth, BN
James W. Kesler, BN
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Anita A. Mullen, EPA

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Deron Linkenheil, BN

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Theodore J. Redding, BN
Mark D. Sells, EPA

FOREWORD

Prior to 1989, annual reports of environmental monitoring and assessment results for the Nevada Test Site (NTS) were prepared in two separate parts. Onsite effluent monitoring and environmental monitoring results were reported in an onsite report prepared by the U.S. Department of Energy, Nevada Operations Office (DOE/NV). Results of the Offsite Radiological Surveillance and Long-Term Hydrological Monitoring programs conducted by the U.S. Environmental Protection Agency (EPA), Radiation Sciences Laboratory, Las Vegas, Nevada, were reported separately by that Agency.

Beginning with the 1989 Annual Site Environmental Report for the NTS, these two documents were combined into a single report to provide a more comprehensive annual documentation of the environmental protection activities conducted for the nuclear testing program and other nuclear and non-nuclear operations at the NTS. The two agencies have coordinated preparation of this seventh combined onsite and offsite report through sharing of information on environmental surveillance and releases as well as meteorological, hydrological, and other supporting data used in dose-estimation calculations.

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The skill, dedication, and perseverance of Angela L. McCurdy in word processing and desktop publishing support were crucial to the production of this report. The review and advice offered by the Environmental Protection Division, Nevada Operations Office and the EPA Radiation Sciences Laboratory, Las Vegas (RSL-LV) reviewers were invaluable. Compilation and verification of onsite data were provided by Robert F. Grossman, Balwan S. Hooda, and Orin L. Haworth. Compilation and verification of EG&G/EM's onsite and offsite data were provided by James W. Kesler. Statistical analyses of data were provided by Robert R. Kinnison. The cooperative support of Anita A. Mullen of the RSL-LV in production of this combined onsite and offsite environmental report is greatly appreciated.

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MEASUREMENT UNITS AND NOMENCLATURE

Radioactivity data in this report are expressed in curies, microcuries (one millionth of a curie), and picocuries (one millionth of a millionth). The curie (Ci) is the customary unit used to express the rate of atomic nuclei transformations that occur each second. A curie is 37 billion (37×10^9) nuclear transformations per second. The unit of becquerel is also used. A becquerel (Bq) is equal to one disintegration per second; therefore, it takes 3.7×10^{10} becquerels to equal one curie.

The roentgen (R) is the customary unit used to describe the intensity of gamma radiation at a given measurement point (in air). The radiation exposure rate to external sources of penetrating radioactivity is expressed in milliroentgens per hour (mR/h), or one-thousandth of a roentgen per hour. Radiation exposure rates in the U.S. from natural radioactivity of cosmic and terrestrial origin typically vary between 0.005 and 0.025 mR/h.

The rem (for roentgen equivalent man) is a unit describing dose equivalent, or the energy imparted to human tissue when exposed to radiation. Dose is expressed in rem, millirem (mrem), or microrem (µrem). A typical annual dose rate from natural radioactivity (excluding exposure to radon) is 100 to 130 mrem per year. The unit of sievert (Sv) is also used. One sievert is equivalent to 100 rem.

The elements and corresponding symbols used in this report are:

Element	Symbol	Element	Symbol
Argon	Ar	Lithium	Li
Arsenic	As	Nitrogen	N
Boron	B	Oxygen	O
Barium	Ba	Lead	Pb
Beryllium	Be	Plutonium	Pu
Bromine	Be	Radium	Ra
Carbon	C	Radon	Rn
Calcium	Ca	Selenium	Se
Cadmium	Cd	Sulfur	S
Chlorine	Cl	Strontium	Sr
Cobalt	Co	Technetium	Tc
Chromium	Cr	Thorium	Th
Cesium	Cs	Thulium	Tm
Copper	Cu	Tritium	^{3}H
Hydrogen	H	Uranium	U
Potassium	K	Xenon	Xe
Krypton	Kr	Zinc	Zn

LIST OF ACRONYMS AND EXPRESSIONS

ADTS	Automated Deficiency Tracking System
AEC	U.S. Atomic Energy Commission
AIRFA	American Indian Religious Freedom Act
AIHA	American Industrial Hygiene Association
ALARA	as low as reasonably achievable
ALI	Annual Limit of Intake
AMEM	Assistant Manager for Environmental Restoration and Waste Management
ANSI	American National Standard Institute
APCD	Air Pollution Control District
ARL/SORD	Air Resource Laboratory Special Operations and Research Division
ASD	REECo Analytical Services Department
ASER	Annual Site Environmental Report
ASN	Air Surveillance Network (RSL-LV)
AVO	Amador Valley Operations, EG&G/EM
BECAMP	Basic Environmental Compliance and Monitoring Program
BN	Bechtel Nevada
BOD	biochemical oxygen demand
BoFF	Bureau of Federal Facilities
CAA	Clean Air Act
CAP88-PC	EPA software program for estimating doses
CCHD	Clark County Health Department
CCSD	Clark County Sanitation District
CEDE	Committed effective dose equivalent
CEI	Compliance Evaluation Inspection
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R.	Code of Federal Regulations
CLP	Contract Laboratory Program (EPA)
CP	Control Point
CRMP	Community Radiation Monitoring Program
CWA	Clean Water Act
CX	Categorical Exclusion
DAC	Derived Air Concentration
DAF	Device Assembly Facility
DCG	Derived Concentration Guide
DDR	Data Discrepancy Report
DNA	Defense Nuclear Agency
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/HQ	DOE Headquarters
DOELAP	DOE Laboratory Accreditation Program
DOE/NV	DOE Nevada Operations Office
DOT	U.S. Department of Transportation
DQO	Data Quality Objectives
DRI	Desert Research Institute
EA	Environmental Assessment
EDE	Effective dose equivalent
EG&G	Edgerton, Germeshausen, & Grier
EG&G/EM	EG&G/Energy Measurements, Inc.

List of Acronyms and Expressions, cont.

EHS	Extremely Hazardous Substances
Eh	Oxidation potential
EIS	Environmental Impact Statement
EIS/ODIS	Environmental Information System/Onsite Discharge Information System
EMAD	Engine Maintenance, Assembly and Disassembly
EML	Environmental Measurements Laboratory
EMSL/LV	Environmental Monitoring Systems Laboratory, Las Vegas
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
EPD	DOE Environmental Protection Division
EPTox	extraction procedure toxicity
ERP	Environmental Restoration Project
ERPESP	Environmental Radioactivity Performance Evaluation Studies Program
ESA	Endangered Species Act
ES&H	Environment, Safety, and Health
ESS&H	Environment, Safety, Security, & Health
FFA	Federal Facilities Agreement
FFCA	Federal Facilities Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FOAV	Finding of Alleged Violation
Gbq	Giga Bequerel (x 10^9)
GCD	Greater Confinement Disposal
GIS	geographical information system
GMX	Gadgets, Mechanics and Explosives
GOES	Geostationary Operational Environmental Satellite
GSD	Goleta Sanitation District
GZ	ground zero
HEPA	high-efficiency particulate filter
HPD	REECo Health Protection Department
HRMP	Hydrologic Resources Management Program
HSWA	Hazardous and Solid Waste Amendments
HTO	tritiated water
HWAS	Hazardous Waste Accumulation Storage
ICRP	International Commission on Radiological Protection
ID	identification
IH	REECo Industrial Hygiene
IT	International Technology Corp.
JIT	Just-in-Time
KAFB	Kirtland Air Force Base
KO	Kirtland Operations, EG&G/EM
LANL	Los Alamos National Laboratory
LAO	Los Alamos Operations, EG&G/EM
LCS	laboratory control standard
LDR	Land Disposal Restrictions
LGFSTF	Liquified Gaseous Fuels Spill Test Facility
LINAC	linear accelerator
LLD	lower limit of detection
LLNL	Lawrence Livermore National Laboratory
LLW	low-level (radioactive) waste
LTHMP	Long-Term Hydrological Monitoring Program (RSL-LV)
LVAO	Las Vegas Area Operations, EG&G/EM

List of Acronyms and Expressions, cont.

MCL	Maximum Contaminant Levels
MDA	minimum detectable activity
MDC	minimum detectable concentration
MEI	maximally exposed individual
MGD	million gallons per day
MOU	memorandum of understanding
MQO	Measurement Quality Objectives
MSL	mean sea level
MSN	Milk Surveillance Network (RSL-LV)
MWMU	Mixed Waste Management Unit
NAC	Nevada Administrative Code
NAEG	Nevada Applied Ecology Group
NAFB	Nellis Air Force Base
NAGPRA	Native American Graves Protection and Repatriation Act
NDEP	Nevada Division of Environmental Protection
NEPA	National Environmental Policy Act
NERL-LV	National Exposure Research Laboratory - Las Vegas
NESHAP	National Emission Standards for Hazardous Air Pollutants
NEST	Nuclear Emergency Search Team
NGTSN	Noble Gas and Tritium Surveillance Network (RSL-LV)
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
NLV	North Las Vegas, Nevada
NLVF	North Las Vegas Facility
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPL	National Priority List
NPS	National Park Service
NR	National Register of Historic Places
NRC	National Response Center
NRS	Nevada Revised Statutes
NTS	Nevada Test Site
NTSO	DOE Nevada Test Site Operations
NV-ERP	Nevada Environmental Restoration Project
NVLAP	National Voluntary Laboratory Accreditation Program
offsite	in the immediate area off the NTS
onsite	on the NTS
O&M	Operations and Maintenance
OP	Operating Permit
OR	Occurrence Report
ORNL	Oak Ridge National Laboratory
ORSP	Offsite Radiological Safety Program
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PESP	Performance Evaluation Studies Program
pH	Hydrogen ion concentration
PHS	U.S. Public Health Service
PIC	pressurized ion chamber
POTW	Publicly Owned Treatment Works
PPOA	Pollution Prevention Opportunity Assessments
ppb	parts per billion

List of Acronyms and Expressions, cont.

ppm	parts per million
QA	quality assurance
QAP	Quality Assessment Program
QC	quality control
QSG	Quality Support Group
RC	residual chlorine
RCRA	Resource Conservation and Recovery Act
R&D	Research and Development
REECo	Reynolds Electrical & Engineering Company, Inc.
RIDP	Radionuclide Inventory and Distribution Program
RI/FS	remedial investigation and feasibility study
RNMS	Radionuclide Migration Study
RPD	relative percent difference
RSD	EPA Radiation Science Division
RSD	relative standard deviation
RSL	Remote Sensing Laboratory
RSL-LV	EPA Radiation Sciences Laboratory - Las Vegas
RSN	Raytheon Services Nevada
RWMS	Radioactive Waste Management Site
RWMS-3	Radioactive Waste Management Site, Area 3
RWMS-5	Radioactive Waste Management Site, Area 5
s	sample standard deviation
SARA	Superfund Amendments and Reauthorization Act
SASN	Standby Air Surveillance Network (RSL-LV)
SBO	Santa Barbara Operations, EG&G/EM
SC	Specific Conductance
SDWA	Safe Drinking Water Act
SGZ	surface ground zero
SIC	Standard Industrial Classification
SMSY	Strategic Materials Storage Yard
SMSN	Standby Milk Surveillance Network (RSL-LV)
SNL	Sandia National Laboratories
SOP	Standard Operating Procedure
STL	Special Technologies Laboratory, EG&G/EM
TCA	thermal curve adapter
TDS	total dissolved solids
TLD	thermoluminescent dosimeter
TMI	Three Mile Island
TP	TRU Pad
TRU	transuranic
TSCA	Toxic Substances Control Act
TSD	Treatment, Storage and Disposal
TSS	total suspended solids
TTR	Tonopah Test Range
UCB	University California, Berkeley
UCLA	University of California, Los Angeles
UGTA	Underground Test Area
UNLV	University of Nevada, Las Vegas
URDS	upper respiratory disease syndrome
USDI	United States Department of Interior

List of Acronyms and Expressions, cont.

USAF	United State Air Force
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
UTM	Universal Transverse Mercator
VCA	Voluntary Compliance Agreement
VOC	volatile organic compound
WAMO	Washington Aerial Measurements Operations, EG&G/EM
WCO	Woburn Cathode Ray Tube Operations, EG&G/EM
WHO	World Health Organization
WOD	REECo Waste Operations Department
WIPP	Waste Isolation Pilot Plant
WM & PPAP	Waste Minimization & Pollution Prevention Awareness Plan

1.0 SUMMARY

Monitoring and surveillance on and around the Nevada Test Site (NTS) by U.S. Department of Energy (DOE) contractors and NTS user organizations during 1995 indicated that operations on the NTS were conducted in compliance with applicable federal and DOE regulations and guidelines. All discharges of radioactive liquids remained onsite in containment ponds, and there was no indication of potential migration of radioactivity to the offsite area through groundwater. Surveillance around the NTS indicated that airborne radioactivity from diffusion, evaporation of effluents, or resuspension was not detectable offsite, and no measurable net exposure to members of the offsite population was detected through the offsite dosimetry program. Using the U.S. Environmental Protection Agency's (EPA) CAP88-PC model and NTS radionuclide emissions and environmental monitoring data, the calculated effective dose equivalent to the maximally exposed individual offsite would have been 0.18 mrem. This value is less than two percent of the federal dose limit due to radionuclide air emissions. Any person receiving this dose would also have received 144 mrem from natural background radiation. There were no nonradiological releases to the offsite area. Hazardous wastes were shipped offsite to approved disposal facilities. Compliance with the various regulations stemming from the National Environmental Policy Act (NEPA) is being achieved and, where mandated, permits for air and water effluents and waste management have been obtained from the appropriate agencies. Cooperation with other agencies has resulted in seven different consent orders and agreements.

Support facilities at off-NTS locations complied with the requirements of air quality permits and state or local wastewater discharge and hazardous waste permits.

1.1 ENVIRONMENTAL MANAGEMENT

The DOE Nevada Operations Office (DOE/NV) is committed to increasing the quality of its management of NTS environmental resources. This has been promoted by the establishment of an Environmental Protection Division and a Health Protection Division within the Office of Environment, Safety, Security, and Health (ESS&H) and upgrading the Environmental Management activities to the Assistant Manager level to address those environmental issues that arise in the course of performing the primary mission of the DOE/NV, underground testing of nuclear explosive devices. An environmental survey in 1987 and a Tiger Team assessment in 1989 identified numerous issues that had to be resolved before DOE/NV could be considered to be in full compliance with environmental laws and regulations. At the end of 1995, all of the 149 Tiger Team findings had been satisfied. Progress on corrective actions to bring operations into compliance have been reported to DOE Headquarters (DOE/HQ) Office of ESS&H in a Quarterly Compliance Action Report.

Operational releases of radioactivity were reported soon after their occurrence to the Idaho National Engineering Laboratory through Environmental Information System/Onsite Discharge Information System (EIS/ODIS) reports. In compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), the accumulated annual data from these reports are used each year as input to the EPA's CAP88-PC software program to calculate potential effective dose equivalents to people living beyond the boundaries of the NTS and the surrounding exclusion areas.

1.2 RADIOLOGICAL ENVIRONMENT

Radiological effluents in the form of air emissions and liquid discharges are released into the environment as a routine part of operations on the NTS. Radioactivity in liquid discharges released to onsite waste treatment or disposal systems (containment ponds) is monitored to assess the efficacy of treatment and control and to provide a quantitative and qualitative annual summary of released radioactivity. Air emissions are monitored for source characterization and operational safety as well as for environmental surveillance purposes.

Air emissions in 1995 consisted primarily of small amounts of tritium, radioactive noble gases, and plutonium released to the atmosphere that were attributed to:

- Diffusion of tritiated water (HTO) vapor in atmospheric moisture from evaporation of tritiated water from tunnel and characterization well containment ponds.
- Continuing seepage of radioactive noble gases from higher yield (>20 kt) tests previously conducted on Pahute Mesa.
- Diffuse emissions calculated from the results of environmental surveillance activities.
- Resuspension of plutonium as measured with air sampling equipment or calculated by use of resuspension equations.

Diffuse emissions included HTO, only slightly above detection limits, from the Radioactive Waste Management Site in Area 5 (RWMS-5), resuspended $^{239+240}$Pu from areas on the NTS where it was deposited by atmospheric nuclear or device safety tests, and ^{85}Kr from Pahute Mesa. Table 1.1 shows the quantities of radionuclides released from all sources, including postulated loss of laboratory standards. None of the radioactive materials listed in this table were detected above ambient levels in the offsite area.

Onsite liquid discharges to containment ponds included approximately 283 Ci (10.5 TBq) of tritium. This was about six times last year's tritium releases because of effluent from characterization wells drilled in Area 20 this year. Evaporation of this material could have contributed HTO to the atmosphere, but the amounts were too small to be detected by the tritium monitors offsite. No liquid effluents were discharged to offsite areas.

1.2.1 ONSITE ENVIRONMENTAL SURVEILLANCE

Environmental surveillance on the 3500 km^2 (1350 mi^2) NTS is designed to cover the entire area with some emphasis on areas of past nuclear testing and present operational activities. In 1995, there were 57 samplers for air particulates and reactive gases; 17 samplers collecting HTO in atmospheric moisture, and 6 samplers collecting air for analysis of noble gas content. Grab samples were collected frequently from water supply wells, springs, open reservoirs, containment ponds, and sewage lagoons. Thermoluminescent dosimeters (TLDs) were placed at 168 locations on the NTS.

Data from these networks are summarized as annual averages for each monitored location. Those locations with concentrations above the NTS average are assumed to reflect onsite emissions. These emissions arise from diffuse (areal) sources and from particular operational activities; e.g., radioactivity buried in the Low-Level Waste (LLW) site.

Approximately 2500 air samples were analyzed by gamma spectroscopy. All isotopes detected by gamma spectroscopy were naturally occurring in the environment (^{40}K, ^{7}Be, and members of the uranium and thorium series), except for a few instances where very low levels of ^{137}Cs were detected. The gross beta annual average for the air sampling network was 2.0 x 10^{-14} µCi/mL (0.74 mBq/m^3). Plutonium analyses of monthly or quarterly composited air filters indicated an annual arithmetic average below 10^{-16} µCi/mL (4 µBq/m^3) of $^{239+240}$Pu and below 10^{-18} µCi/mL (0.04 µBq/m^3) of ^{238}Pu for all locations during 1995, with the majority of results for both isotopes being on the order of 10^{-18} µCi/mL (0.04 µBq/m^3). A slightly higher average was found in samples in certain areas, but that level was calculated to be only 0.01 percent of the Derived Air Concentration (DAC) for exposure to the public. Higher than background levels of plutonium are to be expected in some air samples because atmospheric testing in the 1950s and nuclear safety tests (where chemical explosives were used to blow apart nuclear devices) deposited plutonium on a small portion of the surface of the NTS..

The annual average concentration of ^{85}Kr from the six noble gas monitoring stations was 28 x 10^{-12} µCi/mL (1 Bq/m^3). This concentration is similar to that reported in previous years and is attributed to worldwide distribution of ^{85}Kr from the use of nuclear technology.

Throughout the year, atmospheric moisture was collected for two-week periods at 17 locations on the NTS and analyzed for HTO content. The annual arithmetic average of (3.7 ± 7.0) x 10^{-6} pCi/mL (0.13 ± 0.26 Bq/m^3) was similar to last year's average. The locations on the border of the RWMS-5 and at the Area 10, SEDAN Crater had the highest concentrations. The primary radioactive liquid discharge to the onsite environment in 1995 was 261 Ci of tritium in effluent generated during drilling of characterization wells in Area 20. Seepage from test Tunnel E in Rainier Mesa (Area 12)contributed 20 million liters of water containing about 21 Ci (1.8 Tbq) of tritium to containment ponds near the tunnels. For dose calculations, all of the HTO was assumed to have evaporated.

Surface water sampling was conducted quarterly at 15 open reservoirs, 8 springs, 1 containment pond, and 11 sewage lagoons. A grab sample was taken from each of these surface water sites for analysis of gross beta, tritium, gamma-emitters, and plutonium isotopes. Strontium-90 was analyzed once per year for each location. Water samples from the springs, reservoirs, and lagoons contained background levels of gross beta, tritium, plutonium, and strontium. Samples collected from the containment pond contained detectable levels of radioactivity as would be expected.

Water from onsite supply wells and distribution systems was sampled and analyzed for radionuclides. The supply well average gross beta activity of 8.1 x 10^{-9} µCi/mL (0.3 Bq/L) was 3 percent of the Derived Concentration Guide (DCG) for ^{40}K (used for comparison purposes); gross alpha was 6.4 x 10^{-9} µCi/mL (0.24 Bq/L), which was 40 percent of the drinking water standard; ^{90}Sr was measured at 0.23 x 10^{-10} µCi/mL (0.9 Bq/L), about 1 percent of the DCG; ^{3}H concentrations averaged about 0.26 x 10^{-9} µCi/mL (9.6 mBq/L), less than 0.006 percent of the DCG; $^{239+240}$Pu was -0.9 x 10^{-12} µCi/mL (-0.3 x 10^{-4} Bq/L), and ^{238}Pu was 0.18 x 10^{-12} µCi/mL (6.7 µBq/L), both below detectable levels.

Analysis of the TLD network showed that the 15 boundary station locations had an annual average exposure of 114 mR, and the 9 control stations annual average was 92 mR, both within the range of values previously reported.

1.2.2 OFFSITE ENVIRONMENTAL SURVEILLANCE

The offsite radiological monitoring program is conducted around the NTS by the EPA's Radiation Sciences Laboratory-Las Vegas (RSL-LV), under an Interagency Agreement with DOE. This program consists of several environmental sampling, radiation detection, and dosimetry networks that are described below. These networks operated continuously during 1995.

The Air Surveillance Network (ASN) was made up of 20 continuously operating sampling locations surrounding the NTS.

The ASN stations included 18 located at Community Radiation Monitoring Program (CRMP) stations, described below. During 1995, no airborne radioactivity related to current activities at the NTS was detected on any sample from the ASN. Other than naturally occurring ^{7}Be, the only specific radionuclide possibly detected by this network was ^{238}Pu or $^{239+240}$Pu on a few air filter samples.

The Milk Surveillance Network (MSN) consisted of 10 sampling locations within 300 km (186 mi) of the NTS. Tritium and ^{90}Sr are rarely detected in milk samples at present and ^{89}Sr is practically never detected. The levels in the milk network have decreased over time since reaching a maximum in 1964. The results from this network are consistent with previous data and indicate little or no change.

Other foods have been analyzed regularly, most of which were meat from domestic or game animals collected on and around the NTS. This year, only one deer from the NTS was sampled and analyzed. The ^{90}Sr levels in samples of animal bone remained very low, as did $^{239+240}$Pu in both bone and liver samples.

In 1995, external exposure was monitored by a network of 47 TLDs and 27 pressurized ion chambers (PICs). The PIC network in the communities surrounding the NTS indicated background exposures, ranging from 72 to 164 mR/yr, that were consistent with previous data and well within the range of background data in other areas of the U.S. Internal exposure was assessed by whole-body counting through use of a single germanium detector, lung counting with six semi-planar detectors, and bioassay through radiochemical procedures. In 1995, counts were made on 60 individuals. In the participants, the spectra obtained were representative of natural background with only normal ^{40}K being detected. No transuranics were detected in any lung counting data.

Sampling of Long-Term Hydrological Monitoring Program (LTHMP) wells and surface waters around the NTS showed only background radionuclide concentrations. The LTHMP also included groundwater and surface water monitoring at locations in Colorado, Mississippi, New Mexico, and Nevada where underground tests were conducted. The results obtained from analysis of samples collected at those locations were consistent with previous data except for a sample from a deep well at Project GASBUGGY where the tritium concentration continues to increase and ^{137}Cs has been detected. No concentrations of radioactivity that were detected in air, water, milk, or animal samples posed any significant health risk.

A network of 18 CRMP stations was operated by local residents. Each station was an integral part of the ASN and TLD networks. In addition, they were equipped with a PIC connected to a gamma-rate recorder. Each station also had satellite telemetry transmitting equipment so that gamma exposure measurements acquired by the PICs are transmitted via the Geostationary Operational Environmental Satellite (GOES) to the NTS and from there to the RSL-LV by dedicated telephone line. Samples and data from these CRMP stations were analyzed and reported by RSL-LV and interpreted and reported by the Desert Research Institute (DRI), University of Nevada system. All measurements for 1995 were consistent with previous years and were within the normal background range for the U.S.

Although no radioactivity attributable to current NTS operations was detected by any of the offsite monitoring networks, based on the NTS releases reported in Table 1.1, an atmospheric dispersion model calculation CAP88-PC indicated that the maximum potential effective dose equivalent to any offsite individual would have been 0.18 mrem (1.8×10^{-3} mSv), and the dose to the population within 80 km of the emission sites would have been 0.53 person-rem (5.3×10^{-3} person-Sv). The hypothetical person receiving this dose would also have been exposed to 144 mrem from natural background radiation. A summary of the potential effective dose equivalents due to operations at the NTS is presented in Table 1.2.

1.2.3 ECOLOGICAL STUDIES

In 1995, DOE/NV reviewed the ecological monitoring studies conducted under Basic Environmental Compliance and Monitoring Program (BECAMP) over the past eight years. These studies monitored the flora and fauna on the NTS to assess changes in ecological conditions over time. Data were summarized from previous years' studies of vegetation, small mammals, and lizards conducted on disturbed and undisturbed areas of the NTS. Data for these studies were not collected in 1995 during the study review and data summarization efforts. Work began on redesigning an ecological monitoring plan for DOE/NV activities on NTS to address changes in DOE/NV missions and policies.

Monitoring of feral horses continued for the sixth consecutive year. All horses, including foals, were individually identified. Selected water sources on the NTS were surveyed to evaluate their effect on the distribution of horses. In addition, field surveys of chukar were initiated in 1995 to assess their reproductive success and relative abundance on the NTS. The Nevada Department of Wildlife received permission from DOE/NV to trap and relocate NTS chukar. Eighty-six chukar were removed from three areas on the NTS.

1.2.4 LOW-LEVEL WASTE DISPOSAL

Environmental monitoring at the RWMS, Area 3 (RWMS-3) has detected plutonium in air samples. However, plutonium was detected in other air samples from Area 3 indicating that the source is resuspended plutonium. Elevated levels of plutonium have been detected in air samples from several areas on the NTS where operational activities and vehicular traffic resuspend plutonium for detection by air sampling. The presence of plutonium on the NTS is primarily due to atmospheric and safety tests conducted in the 1950s and 1960s. These tests spread plutonium in the eastern and northeastern areas of the NTS (see Chapter 2, Figure 2.3, for these locations). Environmental monitoring at and around RWMS-5 indicated that radioactivity was just detectable at, but not beyond, the waste site boundaries. This monitoring included air sampling, water sampling, tritium migration studies, and external gamma exposure measurement. Vadose zone monitoring for hazardous constituents has been installed in the mixed waste disposal pit (Pit 3) in RWMS-5 as a method of detecting any downward migration of mixed waste.

1.2.5 RADIOLOGICAL MONITORING AT OFFSITE SUPPORT FACILITIES

Fence line monitoring, using Panasonic UD-814 TLDs, was conducted at EG&G Energy Measurements, Inc., (EG&G/EM) facilities in North Las Vegas, at Nellis Air Force Base, and in Santa Barbara, California. The 1995 results indicated that only background radiation was detected at the fence line. A small amount of tritium was accidently released from a calibration range building in North Las Vegas. Fence line monitoring of the release provided data for input into the CAP88-PC program for calculating offsite exposures. The maximum offsite exposure was calculated to be only 0.0006 mrem, far below the EPA permissible limit of 10 mrem.

1.3 NONRADIOLOGICAL MONITORING

Nonradiological environmental monitoring of NTS operations involved only onsite monitoring because there were no nonradiological hazardous material discharges offsite. The primary environmental permit areas for the NTS were monitored to verify compliance with ambient air quality and the Resource Conservation and Recovery Act (RCRA) requirements. Air emissions sources common to the NTS included particulates from construction, aggregate production, and surface disturbances, fugitive dust from unpaved roads; fuel burning equipment, open burning, and fuel storage facilities. NTS environmental permits active during 1995, which were issued by the state of Nevada or federal agencies included 16 air quality permits involving emissions from construction operation facilities, boilers, storage tanks, and open burning; 8 permits for onsite drinking water distribution systems; 1 permit for sewage discharges to lagoon collection systems; 8 permits for septage hauling; 1 incidental take permit for the threatened desert tortoise; and 3 permits for wildlife handling, collection; and salvage. RCRA Part A and Part B permit applications, based on comments made by the state of Nevada, continued during 1995.

Non-NTS EG&G/EM permits included 17 air pollution control permits and 4 sewage discharge permits. Five EPA Generator Identification (ID) numbers were issued to six EG&G/EM operations, and three local RCRA-related permits were required at two EG&G/EM operations.

The only nonradiological air emissions of regulatory concern under the Clean Air Act (CAA) were due to asbestos removal during building renovation projects and from insulated piping at various locations onsite. During 1995, three state of Nevada notifications were made, and one of these projects required notification to EPA Region 9. Reynolds Electrical Engineering Co., Inc., (REECo) collected and analyzed bulk, occupational, environmental, and clearance samples for these projects. The annual estimate for non-scheduled asbestos demolition/renovation for 1996 was sent to EPA Region 9 in November 1995.

RCRA required monitoring included waste management and environmental compliance activities that necessitated the analysis of soil, water, sediment, and oil samples. Low levels of targeted chemicals were found in several samples.

As there are no liquid discharges to navigable waters, offsite surface water drainage systems, or publicly owned treatment works, no Clean Water Act (CWA), National Pollution Discharge Elimination System (NPDES) permits were required for NTS operations. Under the conditions of state of Nevada operating permits, liquid discharges to 13 onsite sewage lagoons are regularly tested for biochemical oxygen demand, pH, and total suspended solids. In addition to the state-required monitoring, these influents were also tested for RCRA-related constituents as an internal initiative to further protect the NTS environment.

In compliance with the Safe Drinking Water Act (SDWA) and eight state of Nevada drinking water supply system permits for onsite distribution systems supplied by onsite wells, drinking water systems are sampled monthly for residual chlorine, pH, bacteria, and, less frequently, for other water quality parameters. Federal and state standards for fluorides and pH were slightly exceeded in the water system. In the case of fluorides, the state granted a variance to exceed secondary fluoride standards as long as primary standards were met. For exceedance of the pH standard, the state has been contacted to assist in developing a mitigation plan.

Monitoring for polychlorinated biphenyls (PCBs) as required by the Toxic Substances Control Act (TSCA) involved analysis of 106 various samples. Eleven sample results with concentrations greater than five parts per million PCBs were reported.

At the Liquified Gaseous Fuels Spill Test Facility (LGFSTF), 5 series of spill tests using 24 different chemicals were conducted during 1995. None of the tests generated enough airborne contaminants to be detected at the NTS boundary during or after the tests. Boundary monitoring was performed by RSL-LV personnel.

1.4 COMPLIANCE ACTIVITIES

DOE/NV is required to comply with various environmental laws and regulations in the conduct of its operations. Monitoring activities required for compliance with the CAA, CWA, SDWA, TSCA, and RCRA are summarized above. Endangered Species Act (ESA) activities include compliance with the U.S. Fish and Wildlife Service (USFWS) Biological Opinion on the NTS Activities, USFWS Biological Opinion on Forty-mile Canyon Activities, and preparation of Biological Assessments. Also, NEPA activities included action on 11 Environmental Impact Statements (EIS), 10 Environmental Assessments (EA) and 47 Categorical Exclusions (CX). Of these, only the categorical exclusions were initiated in 1995.

Wastewater discharges at the NTS are not regulated under NPDES permits because all such discharges are to onsite sewage lagoons. Discharges to these lagoons are permitted under the Nevada Water Pollution Control Act. Wastewater discharges from the non-NTS support facilities of EG&G/EM were within the regulated levels established by city or county publicly owned treatment works.

During 1995, nine underground storage tanks were removed in accordance with state and federal regulations (see Chapter 3, Table 3.2). Reportable releases were discovered with the removal of three tanks in Area 25 at the Control Building, the Power House, and the Radiation Safety Building. Remedial activities are planned for 1996 at these release sites providing funding becomes available.

In 1995, a cultural resource survey was conducted for historical and archaeological sites on Rainier Mesa and a report on the findings prepared. One data-recovery project that began in 1994 was completed. A paper entitled "Cultural Chronology of Pahute and Rainier Mesas" was completed.

The American Indian Religious Freedom Act (AIRFA) directs federal agencies to consult with Native Americans to protect their right to exercise their traditional religions. In 1995, 5 elders from 17 tribal groups examined almost 300 items from DOE/NV's collection and recommended that nearly all be placed in perpetuity beneath the ground.

1.5 GROUNDWATER PROTECTION

The DOE/NV instituted a LTHMP in 1972 to be operated by the EPA under an Interagency Agreement. Groundwater was monitored on and around the NTS, at five sites in other states, and at two off-NTS locations in Nevada in 1995 to detect the presence of any radioactivity that may be related to nuclear testing activities. No radioactivity was detected above background levels in the groundwater sampling network surrounding the NTS. Low levels of tritium, in the form of HTO, were detected in onsite wells as has occurred previously. None exceeded 33 percent of the National Primary Drinking Water Regulation level.

Tritiated water was detected in samples from wells at formerly utilized sites, such as DRIBBLE (Mississippi), GNOME (New Mexico), and GASBUGGY (New Mexico) at levels consistent with previous experience. The tritium concentration in Well EPNG10-36 at GASBUGGY continued the increase that began about 1984, and ^{137}Cs was detected for the fourth year in a row.

Because wells that were drilled for water supply or exploratory purposes are used in the NTS monitoring program rather than wells drilled specifically for groundwater monitoring, a program of well drilling for groundwater characterization has been started. The design of the program is for installation or recompletion of groundwater characterization wells at strategic locations on and near the NTS. Through 1995, 13 of these wells have been drilled and 11 existing wells recompleted for a total of 24. Of these, two wells were drilled in 1995, and water quality parameters are being collected for future use in the characterization project.

Other activities in this program included studies of groundwater transport of contaminants (radionuclide migration studies) and nonradiological monitoring for water quality assessment and RCRA requirements.

1.6 RADIOACTIVE AND MIXED WASTE STORAGE AND DISPOSAL

Two radioactive waste disposal facilities are operated on the NTS: the RWMS-5 and the RWMS-3. During 1995, the RWMSs received LLW generated at the NTS and other DOE facilities. Waste is disposed of in shallow pits, trenches in the RWMS-5, and in selected craters in the RWMS-3. Transuranic and TRU mixed wastes are stored on a curbed asphalt pad on pallets in overpacked 55 gallon drums and assorted steel boxes pending shipment to the Waste Isolation Pilot Plant (WIPP) in New Mexico. The RWMS-3 is used for disposal of bulk LLW waste and LLW that is contained in packages that are larger than the specified standard size used at the RWMS-5. Environmental monitoring at both sites included air sampling for radioactive particulates and reactive gases and external exposure measurements using TLDs. Sampling for HTO in air, water sampling, tritium migration studies, and vadose zone monitoring for moisture and hazardous constituents are conducted at the RWMS-5. Environmental monitoring results for 1995 indicated that measurable radioactivity from waste disposal operations was detectable only in the immediate vicinity of the facilities.

Because the NTS is not a RCRA permitted disposal facility, RCRA regulations require the shipment of nonradioactive hazardous waste to licensed disposal facilities offsite. No disposal of hazardous waste was performed at the NTS in 1995.

A Mixed Waste Management Unit (MWMU) is planned to be located immediately north of the existing pits within RWMS-5 and will be part of routine disposal operations. This area, designed to encompass 10 hectares (25 acres), will contain 8 landfill cells to be used for mixed waste disposal. Construction of the MWMU will commence upon completion of necessary NEPA documentation and issuance of a state of Nevada Part B Hazardous Waste Permit.

Mixed waste and LLW will only be accepted for disposal from generators (onsite and offsite) that have: submitted a waste application as required by NVO-325, NTS Defense Waste Acceptance Criteria, Certification, and Transfer Requirements; verified compliance to NVO-325; and received DOE/NV approval of the waste stream(s) for disposal at the NTS.

1.7 QUALITY ASSURANCE

The quality assurance (QA) program covering NTS activities has three components. There are QA programs for nonradiological analyses, for onsite radiological analyses, and for offsite radiological analyses conducted by RSL-LV.

1.7.1 ONSITE NONRADIOLOGICAL QUALITY ASSURANCE

The onsite nonradiological QA program was not operative during 1995 because of budgetary restrictions. The current QA program includes sample management activities such as sample collection, chain-of-custody, shipment, and data review. The offsite subcontract laboratories are monitored for their participation and performance in various performance evaluation programs.

1.7.2 ONSITE RADIOLOGICAL QUALITY ASSURANCE

The onsite radiological QA program includes conformance to best laboratory practices and implementation of the provisions of DOE Order 5700.6C. The external QA intercomparison program for radiological data quality assurance consists of participation in the DOE Quality Assessment Program (QAP) administered by the DOE

Environmental Measurements Laboratory (EML) and the Performance Evaluation Studies Program conducted by the EPA's National Exposure Research Laboratory.

1.7.3 OFFSITE RADIOLOGICAL QUALITY ASSURANCE

The policy of the EPA requires participation in a centrally managed QA program by all EPA organizational units involved in environmental data collection. The QA program developed by the RSL-LV for the Offsite Radiological Safety Program (ORSP) meets all requirements of EPA policy and also includes applicable elements of the DOE QA requirements and regulations. The ORSP QA program defines data quality objectives (DQOs), which are statements of the quality of data a decision maker needs to ensure that a decision based on those data is defensible. Achieved data quality may then be evaluated against these DQOs.

1.8 ISSUES AND ACCOMPLISHMENTS

PRINCIPAL COMPLIANCE PROBLEMS FOR 1995

- On June 28, 1994, the state of Nevada filed a Complaint for Declaratory Judgement and Injunction in the U.S. District Court against DOE. Nevada claims that DOE has failed to comply with NEPA requirements at the NTS and must initiate a single, site-wide EIS for all major federal actions at the NTS. The state seeks to halt shipments of LLW from Fernald and all other transportation, receipt, storage, and disposal of mixedwaste, hazardous waste, and defense waste. The state is also seeking to enjoin DOE from pursuing any "Weapons Complex" activities until publication of the EIS. In January 1995 the U.S. District Court dismissed the claims regarding Fernald waste and the site-wide EIS but the other claims remain to be answered.
- In March 1995, the state filed a Finding of Alledged Violation (FOAV) alleging RCRA violations for failure to adequately characterize, to appropriately label, and to properly containerize hazardous waste and failure to place an EPA code on the waste. This involved lead bricks and pipes at a lead storage area. After discussion, Nevada reduced the proposed fine from $135,000 to $52,000.
- DOE/NV received two notification letters in 1995 alleging potential responsible party status for waste disposal sites in California and Colorado. A California hazardous waste facility declared bankruptcy and is unable to clean up the site: documents indicate some NTS waste was shipped there between 1988 and 1992. The Colorado incident involves the salvage sale of drums that occurred from 1974 to 1977 at the Hansen Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Container Site. Because of the minimal contribution to the Colorado site, EPA settled with REECo for $5,684.
- In 1993, the state of Nevada indicated a desire to begin negotiating a three-party Federal Facilities Agreement (FFA). The DOE/NV, Defense Nuclear Agency (DNA), and state negotiations for this agreement continued in 1994 and 1995. A Memorandum of Understanding (MOU) is being formulated with the DNA to address joint concerns. The DNA is expected to be a signatory to the FFA.

ACCOMPLISHMENTS FOR 1995

- The initial Annual NEPA Planning Summary covering accomplishments during 1994 was prepared in January 1995.
- A draft Implementation Plan for a new NTS EIS was approved in June 1995, and the draft site-wide EIS for the NTS and offsite locations in the state of Nevada is expected to be published and released for public comment in January 1996.
- Work was performed on 10 EAs during 1995, of which 4 were approved. Two of the

EAs were discontinued due to a change in programmatic needs.

- Throughout 1995, the DOE/NV continued to maintain and update the DOE/NV Compliance Guide (Volume III), a handbook containing procedures, formats, and guidelines for personnel responsible for NEPA compliance activities.
- Continued use of a Just-in-Time (JIT) supply system allowed NTS contractors to reduce product stock and control potentially hazardous products.
- All of the 149 Tiger Team findings from the 1989 assessment have now been resolved.
- Progress continued on the NTS groundwater characterization program. Thirteen special wells have been completed and eleven existing wells have been recompleted to meet program requirements.
- At the state of Nevada's request, the Waste Management Program installed three pilot wells at RWMS-5. Underground conditions were carefully monitored, and the data have been used for site characterization. The uppermost groundwater table was found at approximately 244 m (800 ft). Only naturally occurring radioactivity was detected in the groundwater.
- The DOE/NV has entered into several consent orders and agreements. These are: (1) a MOU with the state covering radiological releases; (2) an Agreement in Principle with Nevada and Mississippi covering oversight of environment safety and health activities; (3) a Cooperative Agreement with Alaska's Fish and Wildlife Service; (4) a Settlement Agreement with the state to manage mixed TRU waste and a Mutual Consent Agreement for providing storage of low-level mixed waste generatedat the NTS; (5) a Programmatic Agreement with the state covering archaeological and historic preservation activities; (6)a MOU with Nye County as a cooperating agency on the NTS EIS; and (7) a MOU with the Bureau of Land Management as a cooperating agency on the NTS EIS.

The environmental monitoring results presented in this report document that operational activities on the NTS in 1995 were conducted so that no radiological exposure occurred to the offsite public. Calculation of the highest individual dose that could have been received by an offsite resident (based on estimation of onsite worst-case radioactive releases obtained by measurement or engineering calculation and assuming the person remained outside all year) equated to 0.18 mrem to a person living in Springdale, Nevada. This may be compared to that individual's exposure to 144 mrem from natural background radiation as measured by the PIC at Beatty, Nevada.

There were no major incidents of nonradiological contaminant releases to the environment, and intensive efforts to characterize and protect the NTS environment, implemented in 1990, were continued in 1995.

Table 1.1 Radionuclide Emissions on the NTS - 1995(a)

Radionuclide	Half-life (years)	Quantity Released (Ci) (b)
Airborne Releases:		
^{3}H	12.35	(c)1.2
^{85}Kr	10.72	300.
$^{239+240}Pu$	24065.	(c)0.40
Containment Ponds:		
^{3}H	12.35	(d)283
^{238}Pu	87.743	6.8×10^{-5}
$^{239+240}Pu$	24065.	1.0×10^{-4}
^{90}Sr	29.	6.2×10^{-5}
^{137}Cs	30.17	5.5×10^{-3}
Gross Beta	---	3.3×10^{-3}

(a) Assumes worst-case point and diffuse source releases.
(b) Multiply by 37 to obtain GBq.
(c) Includes calculated data from air sampling results, postulated loss of laboratory standards, and calculated resuspension of surface deposits.
(d) This amount is assumed to evaporate to become an airborne release.

Table 1.2 Summary of Effective Dose Equivalents from NTS Operations During 1995

	Maximum EDE at NTS Boundary(a)	Maximum EDE to an Individual(b)	Collective EDE to Population within 80 km of the NTS Sources
Dose	0.22 mrem (2.2×10^{-3} mSv)	0.18 mrem (1.8×10^{-3} mSv)	0.53 person-rem (5.3×10^{-3} person-Sv)
Location	Site boundary 40 km WNW of NTS CP-1	Springdale, NV 58 km WNW of NTS CP-1	32,210 people within 80 km of NTS Sources
NESHAP Standard	10 mrem per yr (0.1 mSv per yr)	10 mrem per yr (0.1 mSv per yr)	-----
Percentage of NESHAP	2.2	1.8	-----
Background	144 mrem (1.44 mSv)	144 mrem (1.44 mSv)	3064 person-rem (30.6 person Sv)
Percentage of Background	1.5×10^{-1}	1.2×10^{-1}	1.7×10^{-2}

(a) The maximum boundary dose is to a hypothetical individual who remains in the open continuously during the year at the NTS boundary located 40 km (25 mi) WNW from the NTS Control Point 1.
(b) The maximum individual dose is to an individual outside the NTS boundary at a residence where the highest dose-rate occurs as calculated by CAP88-PC (Version 1.0) using NTS effluents listed in Table 5.1, assuming all tritiated water input to containment ponds was evaporated, assuming resuspended plutonium was carried offsite, and summing the contributions from each NTS source.

2.0 INTRODUCTION

The Nevada Test Site (NTS), located in southern Nevada, was the primary location for testing of nuclear explosives in the continental U.S. from 1951 to 1992. Historically, nuclear testing has included: (1) atmospheric testing in the 1950s and early 1960s; (2) underground testing in drilled, vertical holes and horizontal tunnels; (3) earth-cratering experiments; and (4) open-air nuclear reactor and engine testing. No nuclear tests were conducted in 1995. Non-nuclear testing included controlled spills of hazardous material at the Liquefied Gaseous Fuels Spill Test Facility (LGFSTF). Low-level radioactive and mixed waste disposal and storage facilities for defense waste are also operated on the NTS.

The NTS environment is characterized by desert valley and Great Basin mountain terrain and topography, with a climate, flora, and fauna typical of the southern Great Basin deserts. Restricted access and extended wind transport times are notable features of the remote location of the NTS and adjacent U.S. Air Force lands. Also characteristic of this area are the great depths to slow-moving groundwaters and little or no surface water. These features afford protection to the inhabitants of the adjacent areas from potential exposure to radioactivity or other contaminants resulting from operations on the NTS. Population density within 150 km of the NTS is only 0.5 persons per square kilometer versus approximately 29 persons per square kilometer in the 48 contiguous states. The predominant use of land surrounding the NTS is open range for livestock grazing with scattered mining and recreational areas.

In addition to the NTS operations, DOE/NV is accountable for six non-NTS EG&G Energy Measurements, Inc. (EG&G/EM) facilities in five different cities. The EG&G/EM operations support the DOE/NV programs with activities ranging from aerial measurements and aircraft maintenance to electronics and heavy industrial fabrication. All of these operations are in metropolitan areas.

The EPA's Radiation Sciences Laboratory in Las Vegas, Nevada (RSL-LV), conducts hydrological studies at eight formerly used U.S. nuclear testing locations off the NTS. The last test conducted at any of these sites was in 1973 (Project RIO BLANCO in Colorado).

2.1 NTS OPERATIONS

2.1.1 NTS DESCRIPTION

The NTS has been operated by the DOE as the on-continent test site for nuclear weapons testing. It is located in Nye County, Nevada, with the southeast corner lying about 105 km (65 mi) northwest of the city of Las Vegas, Nevada, as shown in Figure 2.1. The NTS encompasses about 3500 km^2 (1350 mi^2), an area larger than the state of Rhode Island. The dimensions of the NTS vary from 46 to 56 km (28 to 35 mi) in width (eastern to western border) and from 64 to 88 km (40 to 55 mi) in length (northern to southern border). The NTS is surrounded on the east, north, and west sides by public exclusion areas, previously designated the Nellis Air Force Base (NAFB) Bombing and

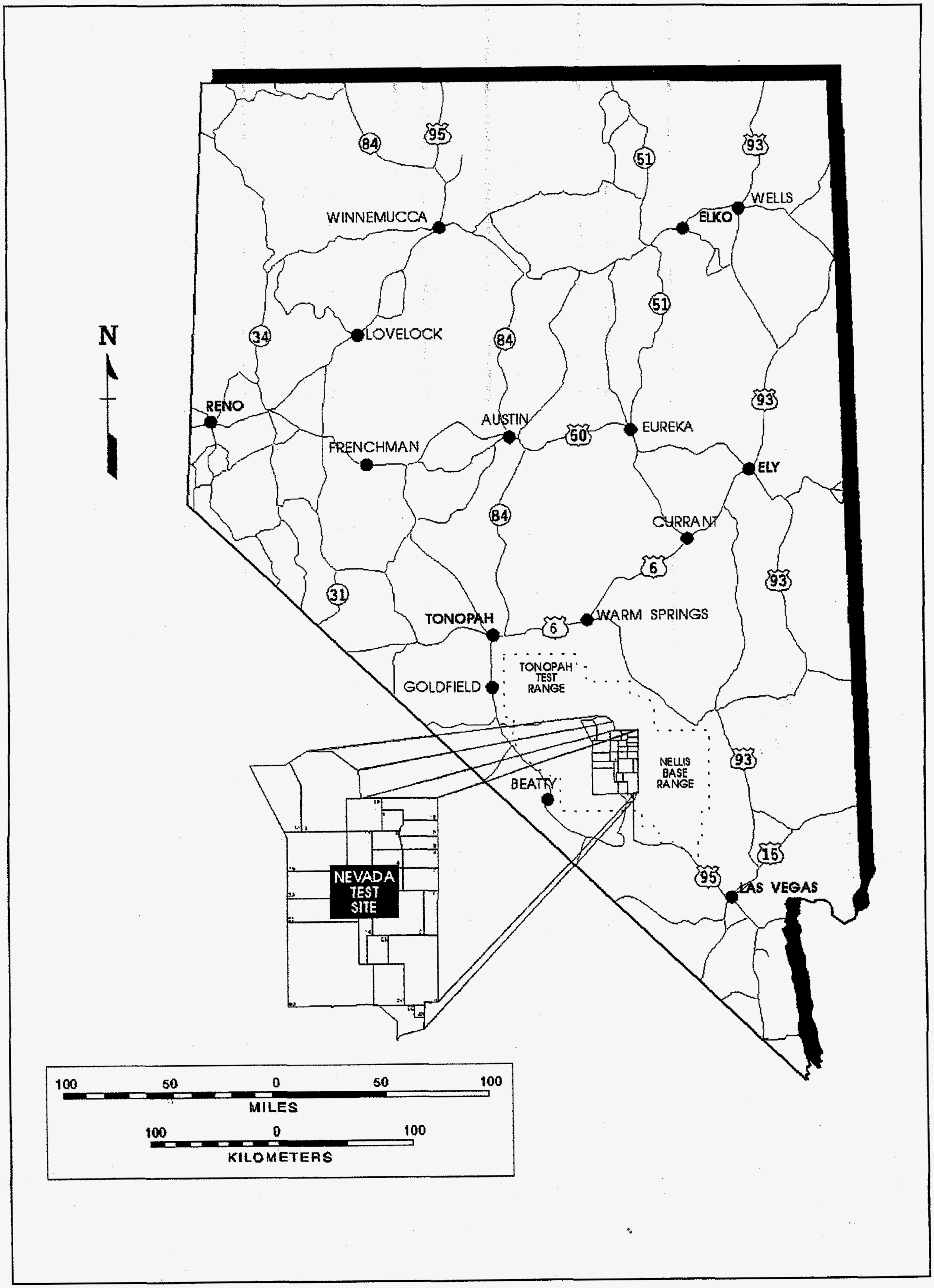


Figure 2.1 NTS Location

Gunnery Range and the Tonopah Test Range (Figure 2.1). These two areas comprise the Nellis Base Range, which provides a buffer zone varying from 24 to 104 km (15 to 65 mi) between the NTS and public lands. The combination of the Nellis Base Range and the NTS is one of the larger unpopulated land areas in the U.S., comprising some 14,200 km^2 (5470 mi^2). Figure 2.2 shows the general layout of the NTS, including the location of major facilities and area numbers referred to in this report. The areas outlined in green in Figure 2.2 indicate the principal geographical areas used recently for underground nuclear testing. Mercury, Nevada, at the southern end of the NTS, is the main base camp for worker housing and administrative operations for the NTS. Area 12 Base Camp, at the northern end of the NTS, was another major worker housing and operations support facility.

2.1.2 MISSION AND NATURE OF OPERATIONS

The NTS has been the primary location for testing the nation's nuclear explosive devices since January 1951. Tests conducted through the 1950s were predominantly atmospheric tests. These tests involved a nuclear explosive device detonated while on the ground surface, on a steel tower, suspended from a tethered balloon, or dropped from an aircraft. Several of the tests were non-nuclear, i.e., "safety" tests involving destruction of a nuclear device with non-nuclear explosives. Safety tests resulted in dispersion of plutonium in the test vicinity. One of these test areas lies just north of the NTS boundary on the Nellis Base Range (see Figure 2.3). All nuclear tests are listed in DOE/NV Report NVO-209 (DOE 1994).

Underground nuclear tests were first conducted in 1957. Testing was discontinued during a moratorium from November 1958 through September 1961. Four small atmospheric (surface) tests were conducted in 1961 and 1962 following the resumption of underground and atmospheric testing. Two additional safety test series were conducted in the mid-1960s, one on the previously designated NAFB Bombing and Gunnery Range and one on the Tonopah Test Range. Since late 1962 nearly all tests were conducted in sealed vertical shafts drilled into Yucca Flat and Pahute Mesa or in horizontal tunnels mined into Rainier Mesa. Five earth-cratering (shallow-burial) tests were conducted over the period of 1962 through 1968 as part of the Plowshare Program, which explored peaceful uses of nuclear explosives. The first and largest (SEDAN) was detonated at the northern end of Yucca Flat.

Other nuclear testing over the history of the NTS has included the Bare Reactor Experiment - Nevada series in the 1960s. These tests were performed with a 14-MeV neutron generator mounted on a 465 m (1530 ft) steel tower used to conduct neutron and gamma-ray interaction studies on various materials. From 1959 through 1973 a series of open-air nuclear reactor, nuclear engine, and nuclear furnace tests were conducted in Area 25. Another series of tests with a nuclear ramjet engine was conducted in Area 26 by the Lawrence Livermore National Laboratory (LLNL), Livermore, California.

Limited non-nuclear testing has also occurred at the NTS, including spills of hazardous materials at the LGFSTF in Area 5. The tests at the LGFSTF, conducted from the latter half of the 1980s to date, involve controlled spilling of liquid materials to study both spill control and mitigation measures and the resultant dispersion and transport of airborne clouds. These tests are cooperative studies involving private industry, the U.S. Department of Transportation (DOT), and the DOE. At the Explosive Ordnance Disposal (EOD) Facility, explosive materials are destroyed, generally by detonation, with the amounts destroyed being limited to maintain downwind air concentrations within state limits. Waste storage and disposal facilities for defense radioactive and mixed waste are located in Areas 3 and 5. At the Area 5 Radioactive Waste Management Site (RWMS-5), low-level radioactive wastes (LLW) from DOE-affiliated onsite and offsite generators are disposed of using standard shallow land

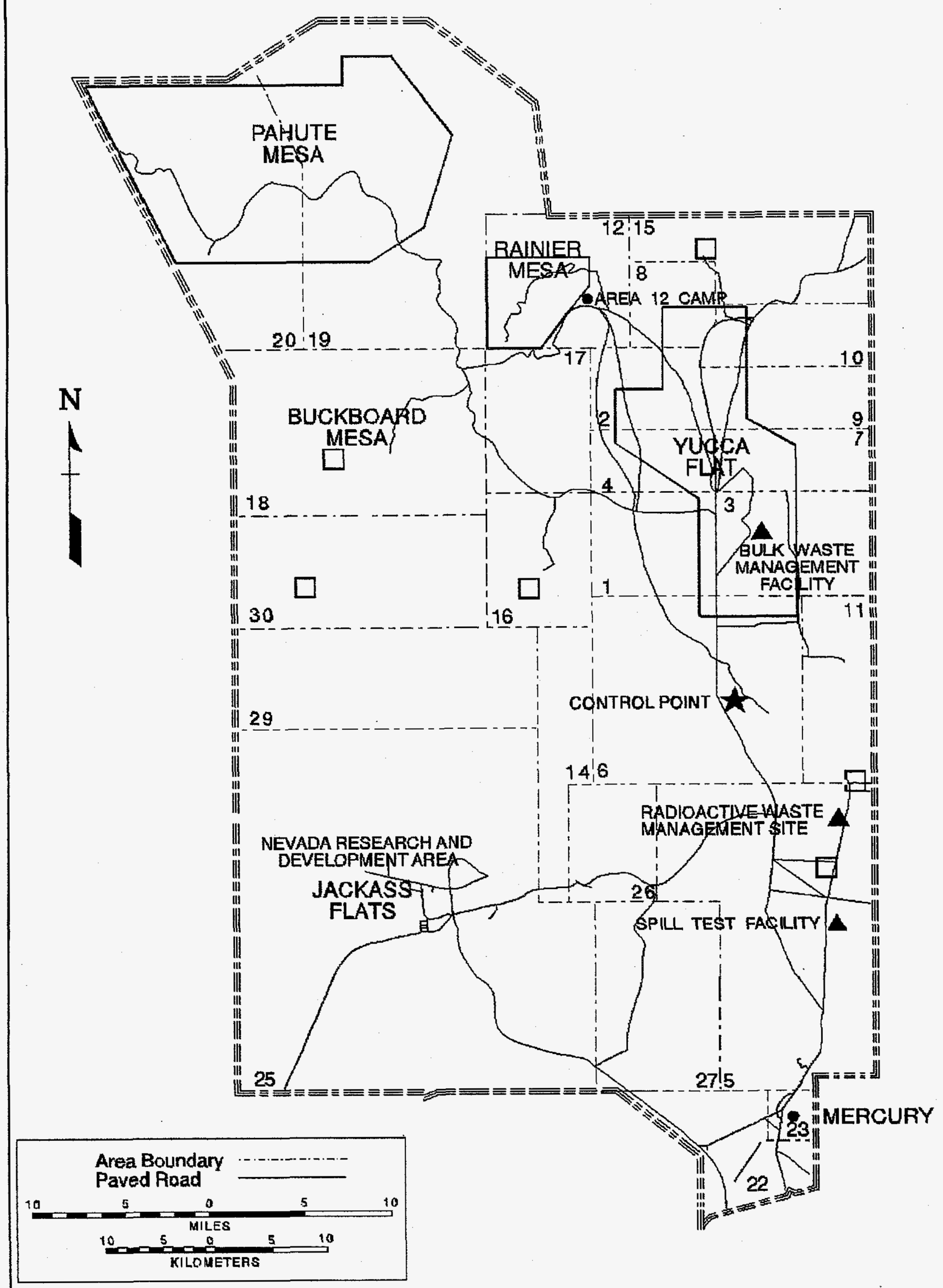


Figure 2.2 NTS Area Designations, (▲) Principal Facilities, and (□) Testing Areas

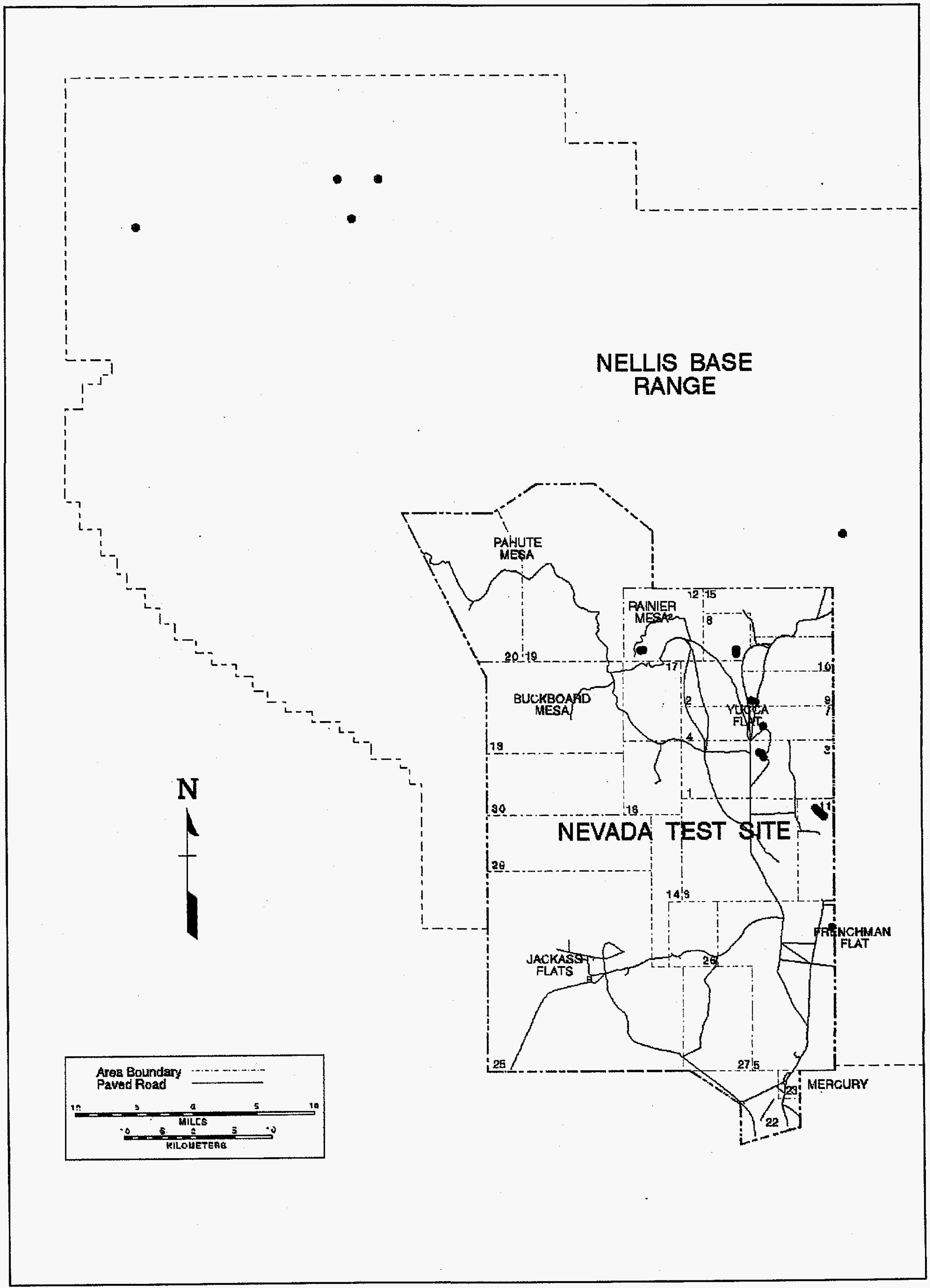


Figure 2.3 Location of Safety Tests on NTS and the Nellis Base Range

disposal techniques. A greater confinement disposal technique was used for disposal of wastes that had high specific activity, high mobility, or were not acceptable for normal disposal. This method is no longer used.

Transuranic wastes are retrievably stored in surface containers at the RWMS-5 pending shipment to the Waste Isolation Pilot Plant (WIMP) facility in New Mexico. Nonradioactive hazardous wastes are accumulated at a special accumulation site before shipment to a licensed offsite disposal facility. At the RWMS-3, bulk LLW (such as debris from atmospheric nuclear test locations) and LLW in large non-standard packages is emplaced and buried in selected surface subsidence craters (formed as a result of prior underground nuclear tests).

2.1.3 1995 ACTIVITIES

2.1.3.1 NUCLEAR TESTS

No nuclear explosives tests were conducted during 1995 due to the moratorium announced in late 1992. However, continuous environmental surveillance for radioactivity and radiation was conducted both onsite and offsite because of the large number of potential effluent sources that exist on the NTS resulting from prior nuclear tests. The surveillance program and results are described in Chapters 4 and 5.

2.1.3.2 LIQUEFIED GASEOUS FUELS SPILL TEST FACILITY

The U.S. DOE's LGFSTF is a research and demonstration facility available on a user-fee basis to private and public sector test and training sponsors concerned with the safety aspects of hazardous chemicals. The site is located in Area 5 of the NTS and is maintained by EG&G/EM. The LGFSTF is the basic research tool for studying the dynamics of accidental releases of various hazardous materials. Discharges from the LGFSTF tanks occur at a controlled rate and consist of a measured volume of hazardous test fluid released on a surface especially prepared to meet the test requirements. The Facility has the capability for releasing large volumes of cryogenic and non-cryogenic liquids. Spill rates for the cryogenic system range from 1,000 to 26,000 gpm with the capability to release the entire contents of two tanks in two minutes. The non-cryogenic system can release materials at rates of 500 to 5,000 gpm with the entire 24,000 gallons capable of being released in five minutes. Test sponsors can vary intake air temperature, humidity, release rate, and release volume in an 8 ft x 16 ft x 96 ft wind tunnel. There are two spill pads available for use in contained open air releases of volumes of 50 to 1,000 gallons. An area has been added to provide the capability for determining the efficacy of encapsulated chemical protective suiting materials when exposed to high concentrations of toxic and hazardous gaseous materials.

An array of diagnostic sensors may be placed up to 16 km downwind of the spill point to obtain cloud-dispersion data. Deployment of the array is test dependent and is not used for all experiments. The array can consist of up to 20 meteorological and 41 sensor stations to gather wind data and gaseous concentration data from a variety of sensors at various levels above ground. The array and associated data-acquisition system are linked to the LGFSTF control point by means of telemetry. The operation and performance of the LGFSTF are controlled and monitored from the Command Control and Data Acquisition System building located one mile from the test fluid spill area.

LGFSTF personnel monitor and record operating data, close-in and downwind meteorological data, and downwind gaseous concentrations. Calculation of the potential path of the test effluent is used to help control the test and monitor the data, which is done from a remote location. Five series of spill tests were conducted in 1995.

2.1.4 TOPOGRAPHY AND TERRAIN

The topography of the NTS is typical of much of the Basin and Range physiographic province of Nevada, Arizona, and Utah.

North-south-trending mountain ranges are separated by broad, flat-floored, and gently-sloped valleys. The topography is depicted in Figure 2.4. Elevations range from about 910 m (3000 ft) above mean sea level (MSL) in the south and east, rising to 2230 m (7300 ft) in the mesa areas toward the northern and western boundaries. The slopes on the upland surfaces are steep and dissected, whereas the slopes on the lower surfaces are gentle and alluviated with rock debris from the adjacent highlands.

The principal effect upon the terrain from nuclear testing has been the creation of numerous dish-shaped surface subsidence craters, particularly in Yucca Flat. Most underground nuclear tests conducted in vertical shafts produced surface subsidence craters that occurred when the overburden above a nuclear cavity collapsed and formed a rubble "chimney" to the surface. A few craters have been formed as a result of tests conducted on or near the surface, by shallow depth-of-burial cratering experiments, or following some tunnel events.

There are no continuously flowing streams on the NTS. Surface drainages for Yucca and Frenchman Flats, closed-basin systems, are onto the dry lake beds (playas) in each valley. The remaining areas of the NTS drain via arroyos and dry stream beds that carry water only during unusually intense or persistent storms. Rainfall or snow melt typically infiltrates quickly into the moisture-deficient soil or runs off in normally dry channels, where it evaporates and seeps into permeable sands and gravels. During extreme conditions, flash floods may occur.

2.1.5 GEOLOGY

The basic lithologic structure of the NTS is depicted in Figure 2.5. Investigations of the geology of the NTS, including detailed studies of numerous drill holes and tunnels, have been in progress by the U.S. Geological Survey and other organizations since 1951. Because of the large number of drilled holes,see Figure 2.6, the NTS is probably one of the better geologically characterized large areas within the U.S.

In general the geology consists of three major rock units. These are: (1) complexly folded and faulted sedimentary rocks of Paleozoic age overlain at many places by; (2) volcanic tuffs and lavas of Tertiary age, which (in the valleys) are covered by; (3) alluvium of late Tertiary and Quaternary age. The sedimentary rocks of Paleozoic age are many thousands of feet thick and are comprised mainly of carbonate rocks (dolomite and limestone) in the upper and lower parts, separated by a middle section of clastic rocks (shale and quartzite). The volcanic rocks in the valleys are down-dropped and tilted along steeply dipping normal faults of late Tertiary age. The alluvium is rarely faulted and is derived from erosion of Tertiary and Paleozoic rocks. Compared to the Paleozoic rocks, the Tertiary rocks are relatively undeformed, and dips are generally gentle. The volcanic rocks of Tertiary age are predominantly tuffs, which erupted from various volcanic centers and lavas, mostly of rhyolitic composition. The aggregate thickness of the volcanic rocks is many thousands of feet, but in most places the total thickness of the section is far less because of erosion or nondeposition. These materials erupted before the collapse of large volcanic centers known as *calderas*. Alluvial materials fill the intermountain valleys and cover the adjacent slopes. These sediments attain thicknesses of 600 to 900 m (2000 to 3000 ft) in the central portions of the valleys. The alluvium in Yucca Flat is vertically offset along the prominent north-south-trending Yucca fault.

2.1.6 HYDROGEOLOGY

The deep aquifers, slow groundwater movement, and exceedingly slow downward movement of water in the overlying unsaturated zone serve as significant barriers to transport of radioactivity from unsaturated zone sources via groundwater; greatly limiting the potential for transport of radioactivity to offsite areas. Some historic

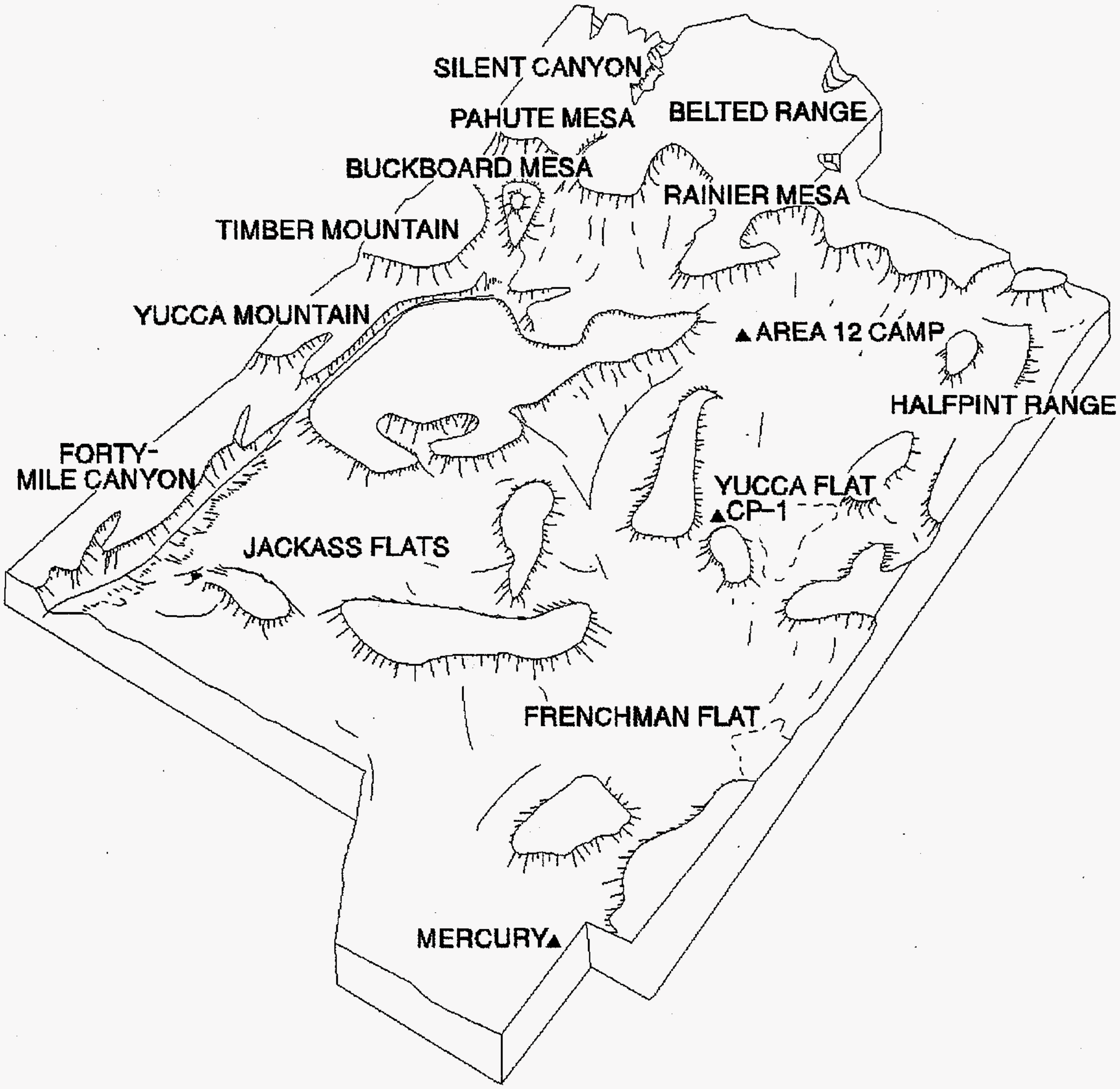
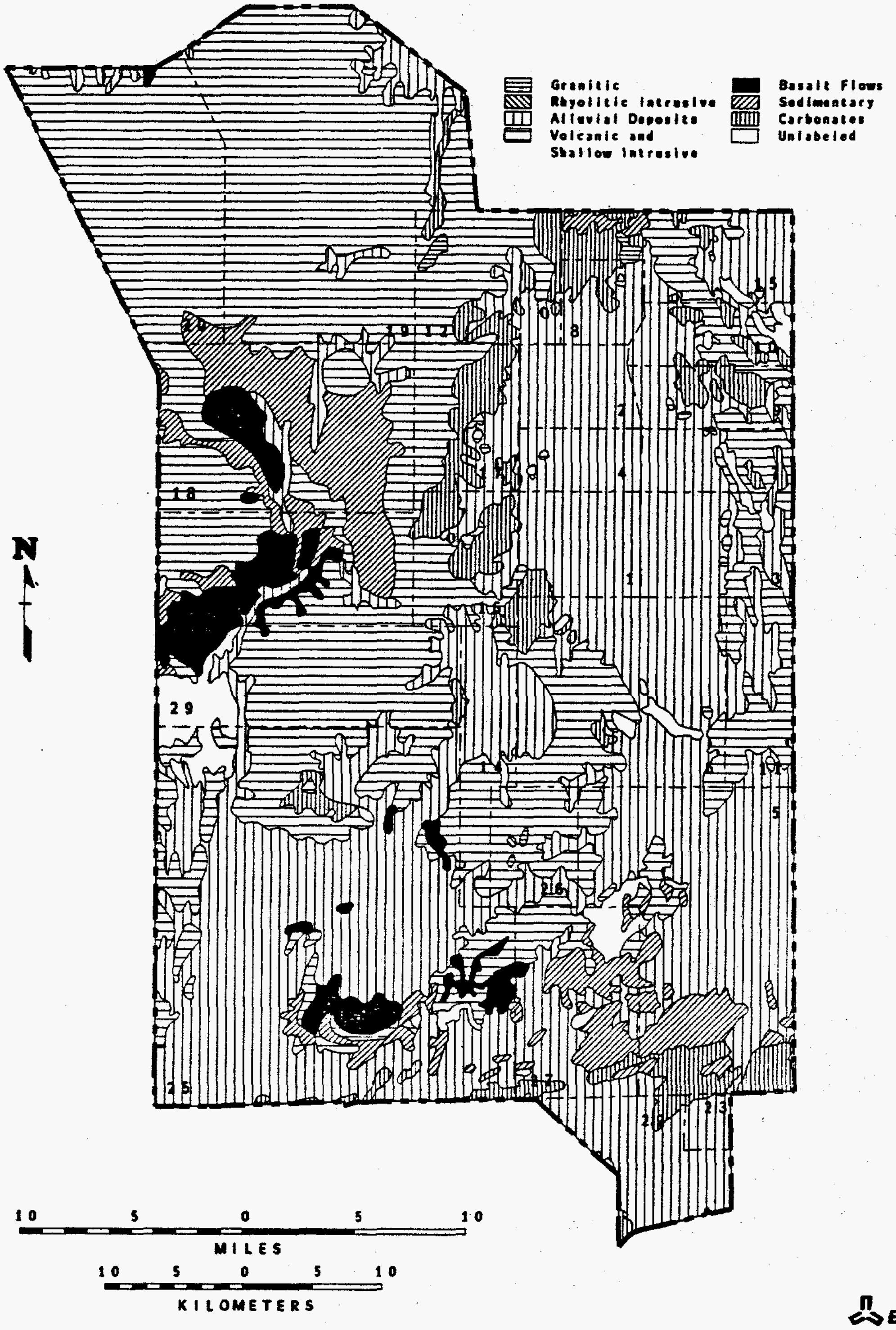


Figure 2.4 Topography of the NTS



EG&G

Figure 2.5 Basic Lithologic Structure of the NTS

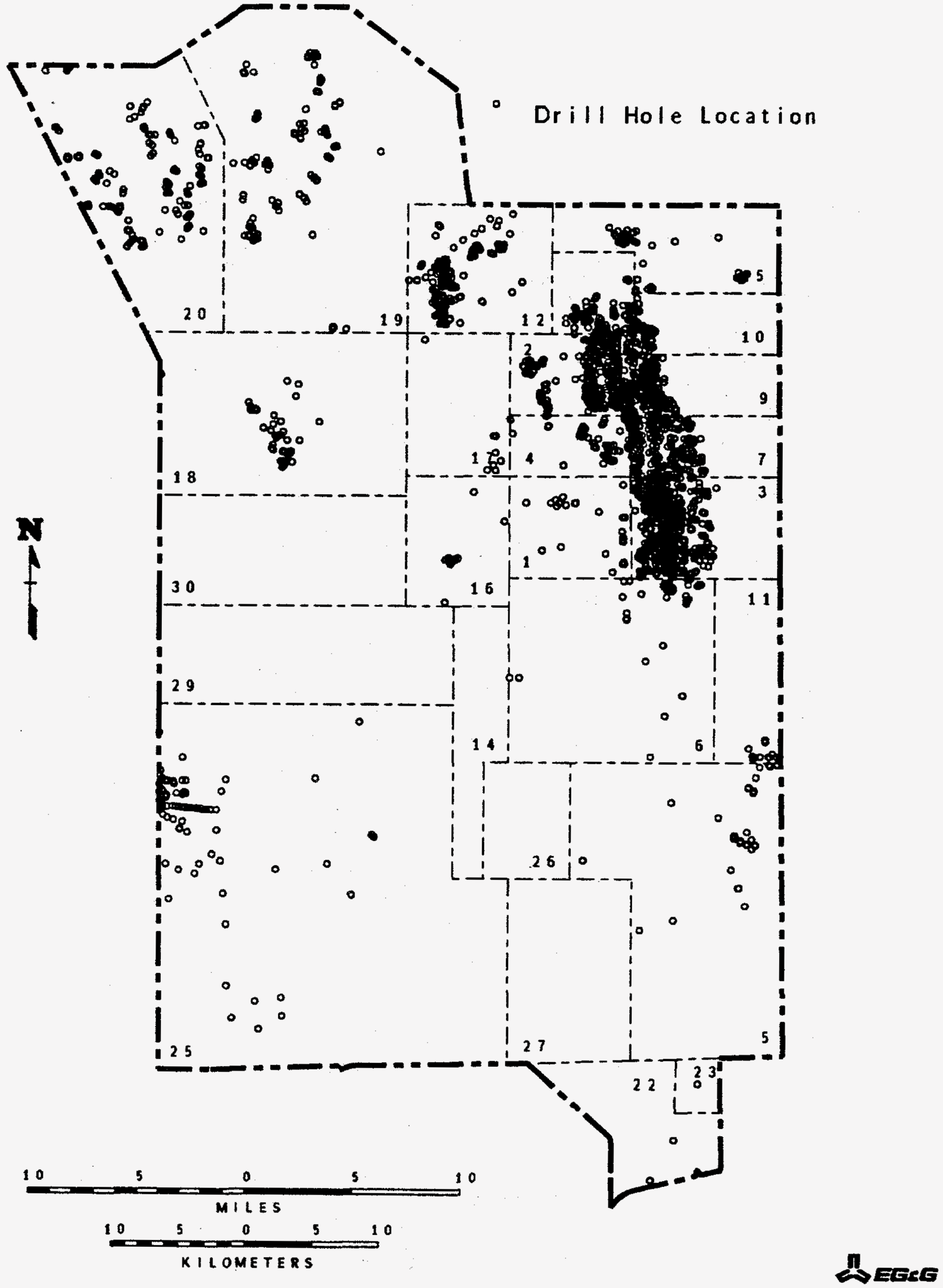


Figure 2.6 Drill Hole Locations on the NTS

nuclear tests were conducted below the groundwater table, others were at varying depths above the groundwater table. Nuclear tests below the water table have a greater potential for offsite migration. However, the great distance to offsite water supply wells or springs makes it unlikely that contaminants will be transported in significant quantities.

Depths to groundwater beneath the NTS vary from about 157 m (515 ft) beneath the Frenchman Flat playa (Winograd and Thordarson 1975) in the southern part of the NTS to more than 700 m (2300 ft) beneath part of Pahute Mesa. In the eastern portions, the water table occurs generally in the alluvium and volcanic rocks above the regional carbonate aquifer, and in the western portions it occurs predominantly in volcanic rocks. The flow in the shallower parts of the groundwater body is generally toward the major valleys (Yucca and Frenchman) where it may deflect downward to join the regional drainage to the southwest in the carbonate aquifer.

The hydrogeology of the underground nuclear testing areas on the NTS (Figure 2.7) has been summarized by the Desert Research Institute, University of Nevada System (Russell 1990). Yucca Flat is situated within the Ash Meadows groundwater subbasin. Groundwater occurs within the valley-fill, volcanic, and carbonate aquifers and in the volcanic and clastic aquitards. The depth to water generally ranges from 160 m (525 ft) to about 580 m (1900 ft) below the ground surface. The tuff aquitard forms the principal Cenozoic hydrostratigraphic unit beneath the water table in the eastern two thirds of the valley and is unconfined over most of its extent. The valley-fill aquifer is saturated in the central part of the valley and is unconfined (Winograd and Thordarson 1975).

Some underflow, past all of the subbasin discharge areas, probably reaches springs in Death Valley. Recharge for all of the subbasins most likely occurs by precipitation at higher elevations and infiltration along stream courses and in playas. Regional groundwater flow is from the upland recharge areas in the north and east towards discharge areas at Ash Meadows and Death Valley, southwest of the NTS. Due to the large topographic changes across the area and the importance of fractures to groundwater flow, local flow directions can be radically different from the regional trend. Groundwater is the only local source of drinking water in the NTS area. Drinking and industrial water supply wells for the NTS produce from the lower and upper carbonate, the volcanic, and the valley-fill aquifers. Although a few springs emerge from perched groundwater lenses at the NTS, discharge rates are low, and spring water is not currently used for DOE activities. South of the NTS, private and public supply wells are completed in a valley-fill aquifer. Frenchman Flat is also within the Ash Meadows subbasin. Regional groundwater flow in this valley occurs within the major Cenozoic and Paleozoic hydrostratigraphic units at depths ranging from 157 to 360 m (515 to 1180 ft) below the ground surface. Perched water is found as shallow as 20 m (66 ft) within the tuff and lava flow aquitards in the southwestern part of the valley. In general, the depth to water is at least 157 m (515 ft) beneath Frenchman playa and increases to nearly 360 m (1180 ft) near the margins of the valley (Winograd and Thordarson 1975). The water table beneath Frenchman Flat is considerably shallower (and stratigraphically higher) than beneath Yucca Flat. Consequently, the areal extent of saturation in the valley-fill and volcanic aquifers is correspondingly greater.

Winograd and Thordarson (1975) hypothesized that groundwater within the Cenozoic units of Yucca and Frenchman Flats probably cannot leave these basins without passing through the underlying and surrounding lower carbonate aquifer. In addition, lateral gradients within the saturated volcanic units exist and may indicate groundwater flow toward the central areas of Yucca and Frenchman Flats prior to vertical drainage.

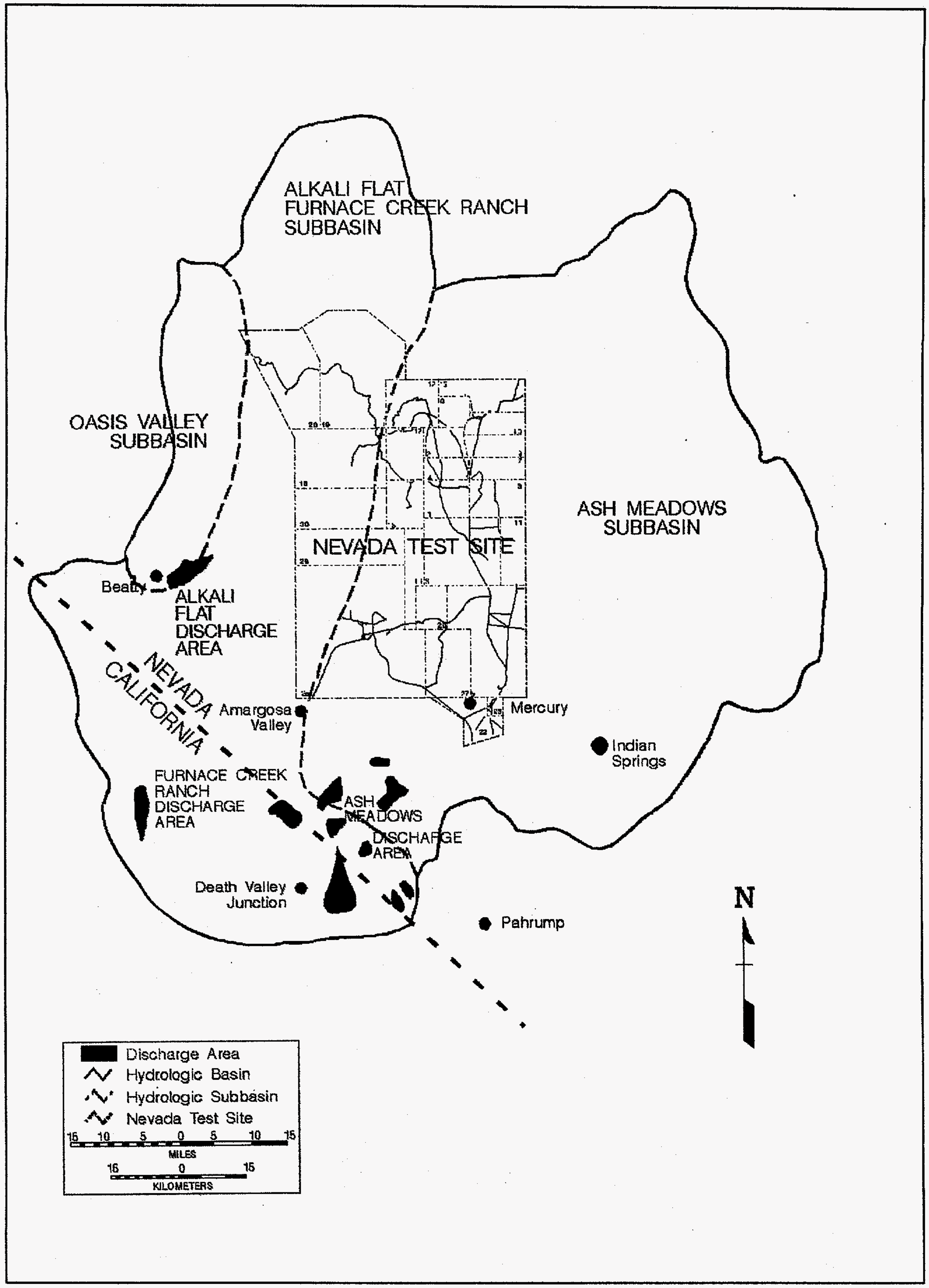


Figure 2.7 Groundwater Hydrologic Units of the NTS and Vicinity

The only hydrostratigraphic units encountered at Pahute Mesa are the volcanic aquifers and aquitards. Pahute Mesa is thought to be a part of both the Oasis Valley and Alkali Flat/Furnace Creek Ranch subbasins. The location of the inter-basin boundary is uncertain. Groundwater is thought to move towards the south and southwest, through Oasis Valley, Crater Flat and western Jackass Flats (Blankennagel and Weir 1973). Points of discharge are thought to include the springs in Oasis Valley, Alkali Flat, and Furnace Creek. The amount of recharge to Pahute Mesa and the amount of underflow which moves to the various points of discharge are not accurately known. Vertical gradients within Pahute Mesa suggest that flow may be downward in the eastern portion of the mesa but upward in the western part.

The hydrostratigraphic units beneath Rainier Mesa consist of the welded and bedded tuff aquifer, zeolitized tuff aquitard, the lower carbonate aquifer, and the tuffaceous and lower clastic aquitards. The volcanic aquifer and aquitards support a semiperched groundwater lens. Nuclear testing at Rainier Mesa was conducted within the tuff aquitard. Work by Thordarson (1965) indicates that the perched groundwater is moving downward into the underlying regional aquifer. Depending on the location of the subbasin boundary, Rainier Mesa groundwater may be part of either the Ash Meadows or the Alkali Flat/Furnace Creek Ranch subbasin. The regional flow from the mesa may be directed either towards Yucca Flat or, because of the intervening upper clastic aquitard, towards the Alkali Flat discharge area in the south. The nature of the regional flow system beneath Rainier Mesa requires further investigation.

2.1.7 CLIMATE AND METEOROLOGY

Precipitation levels on the NTS are low, runoff is intermittent, and the majority of the active testing areas onsite drain into closed basins on the NTS. Topography contributes to temporal and spatial variability of precipitation. For example, on the NTS the mesas receive an average annual precipitation of 23 cm (9 in), which includes wintertime snow accumulations. The lower elevations receive approximately 15 cm (6 in) of precipitation annually, with occasional snow accumulations lasting only a matter of days (Quiring 1968).

Elevation also influences temperatures on the NTS. At an elevation of 2000 m (6560 ft) above MSL in Area 20 on Pahute Mesa, the average daily maximum temperatures range from 40 to 80°F, minimums from 21 to 57°F (4 to 27°C and -6 to 14°C, respectively). In Area 6 [Yucca Flat, 1200 m (3940 ft MSL)], the average daily maximums range from 51 to 96°F and the minimums from 28 to 62°F (11 to 36°C and -2 to 17°C, respectively).

Wind direction and speed are important aspects of the environment at the NTS. The movements of large-scale pressure systems control the seasonal changes in the wind direction frequencies. Predominating winds are southerly during summer and northerly during winter. The general downward slope in the terrain from north to south results in an intermediate scenario that is reflected in the characteristic diurnal wind reversal from southerly winds during the day to northerly winds at night. This north to south reversal is strongest in the summer and, on occasion, becomes intense enough to override the wind regime associated with large-scale pressure systems. This scenario is very sensitive to the orientation of the mountain slopes and valleys. At higher elevations such as Area 20, the average annual wind speed is 17 km/h (10 mi/h) but is only 11 km/h (7 mi/h) in the valleys, such as Yucca Flat. The prevailing wind direction during winter months is from the north-northeast and north-northwest but it reverses in the summer months. The 1992 ten-meter wind rose patterns for the NTS are shown in Figure 2.8.

2.1.8 FLORA AND FAUNA

The vegetation on most of the NTS includes various associations of desert shrubs typical of the Mojave or Great Basin Deserts or the

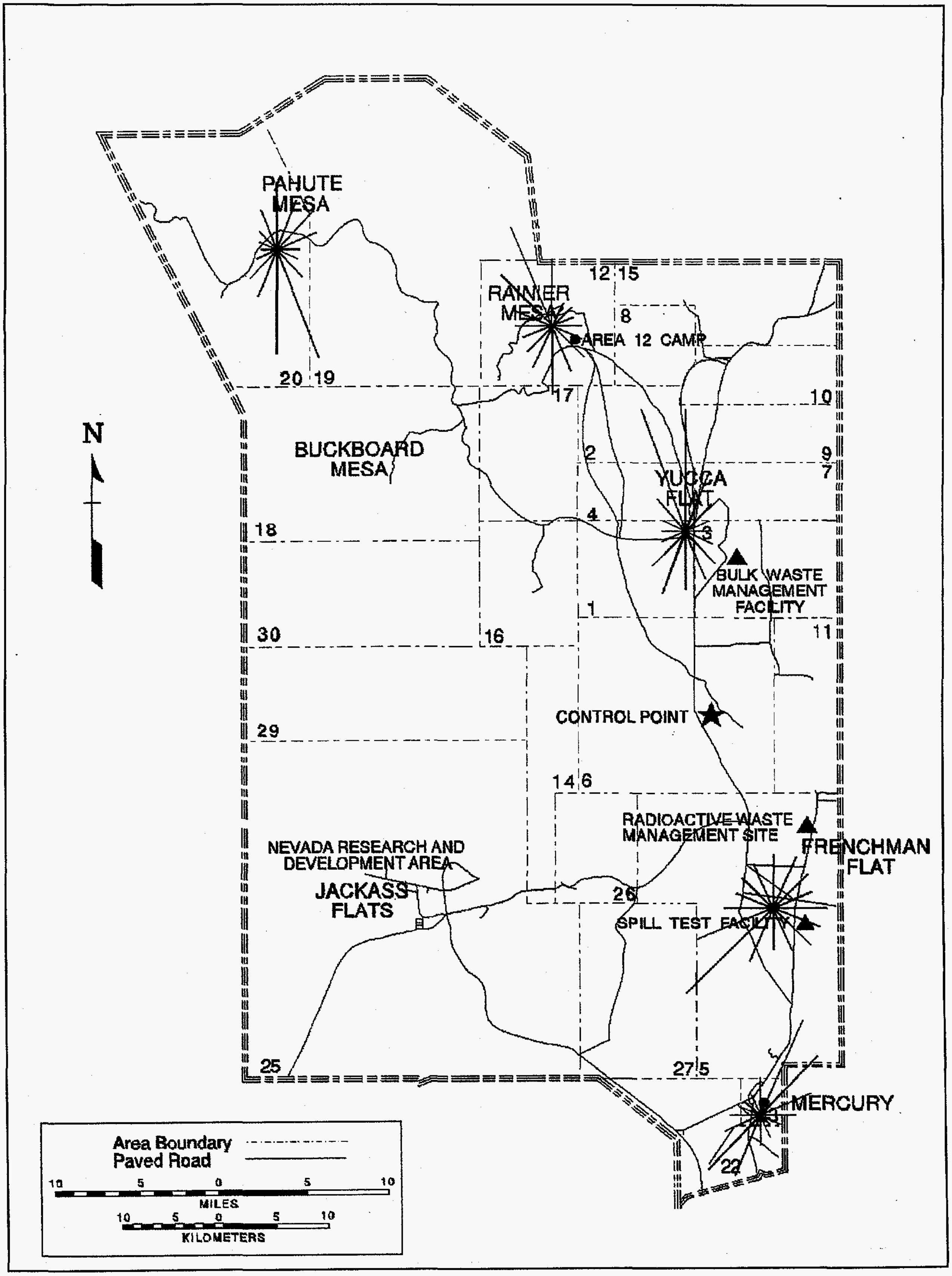


Figure 2.8 1992 Wind Rose Patterns for the NTS (Courtesy of Air Resource Laboratory Special Operations & Research Division)

zone of transition between these two. There are areas of desert woodland (piñon, juniper) at higher elevations. Even there, typical Great Basin shrubs, principally sagebrushes, are conspicuous. Although shrubs (or shrubs and small trees) are the dominant forms, herbaceous plants are well represented in the flora and play an important role in supporting animal life.

Extensive floral collection has yielded 711 taxa of vascular plants within or near the boundaries of the NTS (O'Farrell and Emery 1976). Associations of creosote bush, *Larrea tridentata*, which are characteristic of the Mojave Desert, dominate the vegetation mosaic on the bajadas of the southern NTS. Between 1220 and 1520 m (4000 and 5000 ft) in elevation in Yucca Flat, transitional associations are dominated by *Grayia spinosa-Lycium andersonii* (hopsage/desert thorn) associations, while the upper bajadas support *Coleogyne* types. Above 1520 m (5000 ft) the vegetation mosaic is dominated by sagebrush associations of *Artemisia tridentata* and *Artemisia arbuscula* subspecies *nova*. Above 1830 m (6000 ft) piñon pine and juniper mix with the sagebrush associations where there is suitable moisture for these trees. No plant species located on the NTS is currently on the federal endangered species list; however, the state of Nevada has placed *Astragalus beatleyae* on its critically endangered species list.

Most mammals on the NTS are small and secretive (often nocturnal in habitat), hence not often seen by casual observers. Rodents are, based on distribution and relative abundance, the most important group of mammals on the NTS. Larger mammals include feral horses, burros, deer, mountain lions, bobcats, coyote, kit foxes, and rabbits. Reptiles include four species of venomous snakes. Bird species are mostly migrants or seasonal residents. Most nonrodent mammals have been placed in the "protected" classification by the state of Nevada. On August 4, 1989, the Mojave population of the desert tortoise, *Gopherus agassizii*, was placed on the endangered species list by the U.S. Fish and Wildlife Service. This population was relisted as threatened on April 2, 1990. The reasons for listing this population included deterioration and loss of habitat, collection for pets and other purposes, elevated levels of predation, loss from disease, and the inadequacy of existing regulatory mechanisms to protect tortoises and their habitat. Tortoise habitat on the NTS is found in the southern third of the NTS outside the recent areas of nuclear explosive test activities.

2.1.9 CULTURAL RESOURCES

Human habitation of the NTS area began at least as early as 10,000 years ago. Various indigenous cultures occupied the region in prehistoric times. The survey of less than 5 percent of the NTS area has located more than 2,000 archaeological sites which contain the only information available concerning the prehistoric inhabitants. The site types identified include rock quarries, tool-manufacturing areas, plant-processing locations, hunting locales, rock art, temporary camps, and permanent villages. The prehistoric people's lifestyle was sustained by a hunting and gathering economy which utilized all parts of the NTS. While major springs provided perennial water, the prehistoric people developed strategies to take advantage of intermittent fresh water sources in the arid region. In the nineteenth century, at the time of initial contact, the area was occupied by Paiute and Shoshone Indians.

Prior to 1940, the historic occupation consisted of ranchers, miners and Native Americans. Several natural springs were able to sustain livestock, ranchers and miners. Stone cabins, corrals, and fencing stand today as testaments to these early settlers. The mining activities included two large mines, one at Wahmonie, the other at Climax Mine. Prospector claim markers are found in these and other parts of the NTS. Native Americans co-existed with the settlers and miners, utilizing the natural resources of the region and, in some cases, working for the new arrivals. They also maintained a connection with the land, especially areas important to them for religious and historical reasons. These locations, referred to as traditional cultural properties, continue to be significant to the Paiute and Shoshone Indians.

Between 1940 and 1950, the area now known as the NTS was under the jurisdiction of NAFB and was part of the Nellis Bombing and Gunnery Range. Very few locations associated with this time period have been identified. In 1950, the NTS was selected as the continental nuclear testing ground. Surveys have located and recorded many structures associated with nuclear testing. These structures are significant because of the importance of the nuclear testing program in the history of the United States as well as its effects on the rest of the world.

2.1.10 DEMOGRAPHY

The population of the area surrounding the NTS has been estimated based on 1990 Bureau of Census estimates (Department of Commerce 1990). Excluding Clark County, the major population center (over 1,000,000 in 1995), the population density within a 150-km (90-mi) radius of the NTS is about 0.5 persons per square kilometer. In comparison, the 48 adjoining states (1990 census) had a population density near 29 persons per square kilometer. The offsite area within 80 km (50 mi) of the NTS Control Point (CP) is predominantly rural. CP-1 (a building at the Control Point) historically has been the point from which distances from the NTS were determined. Several small communities are located in the area, the largest being in the Pahrump Valley. This growing rural community, with an estimated population of 20,000, is about 80 km (50 mi) south of CP-1. The Amargosa Farm area, which has a population of about 1200, is approximately 50 km (30 mi) southwest of CP-1. The largest town in the near offsite area is Beatty, which has a population of about 1500 and is approximately 65 km (40 mi) to the west of CP-1.

The Mojave Desert of California, which includes Death Valley National Monument, lies along the southwestern border of Nevada. The National Park Service estimated that the population within the boundaries ranges from 200 permanent residents during the summer months to as many as 5000 tourists and campers on any particular day during holiday periods in the winter months. As many as 30,000 are in the area during "Death Valley Days" in the month of November. The largest nearby population in this desert is in the Ridgecrest-China Lake area about 190 km (118 mi) southwest of the NTS containing about 28,000 people. The next largest is in the Barstow area located 265 km (165 mi) south-southwest of the NTS with a 1992 population of 24,000. The Owens Valley, where numerous small towns are located, lies 50 km (31 mi) west of Death Valley. The largest town in the Owens Valley is Bishop, located 225 km (140 mi) west-northwest of the NTS, with a population of 3500.

The extreme southwestern region of Utah is more developed than the adjacent portion of Nevada. The largest community is St. George, located 220 km (137 mi) east of the NTS, with a 1991 population of 29,000. The next largest town, Cedar City, with a population of 14,000, is located 280 km (174 mi) east-northeast of the NTS.

The extreme northwestern region of Arizona is mostly rangeland except for that portion in the Lake Mead Recreation Area. In addition, several small communities lie along the Colorado River. The largest towns in the area are Bullhead City, 165 km (103 mi) south-southeast of the NTS, with a 1991 population estimate of 22,000, and Kingman, located 280 km (174 mi) southeast of the NTS, with a population of about 13,000.

2.1.11 SURROUNDING LAND USE

Figure 2.9 is a map of the offsite area showing a wide variety of land uses such as mining, grazing, camping, fishing, and hunting within a 300-km (180-mi) radius of the CP-1. West of the NTS elevations range from 85 m (280 ft) below MSL in Death Valley to 4400 m (14,500 ft) above MSL in the Sierra Nevadas, including parts of the Owens and San Joaquin agricultural

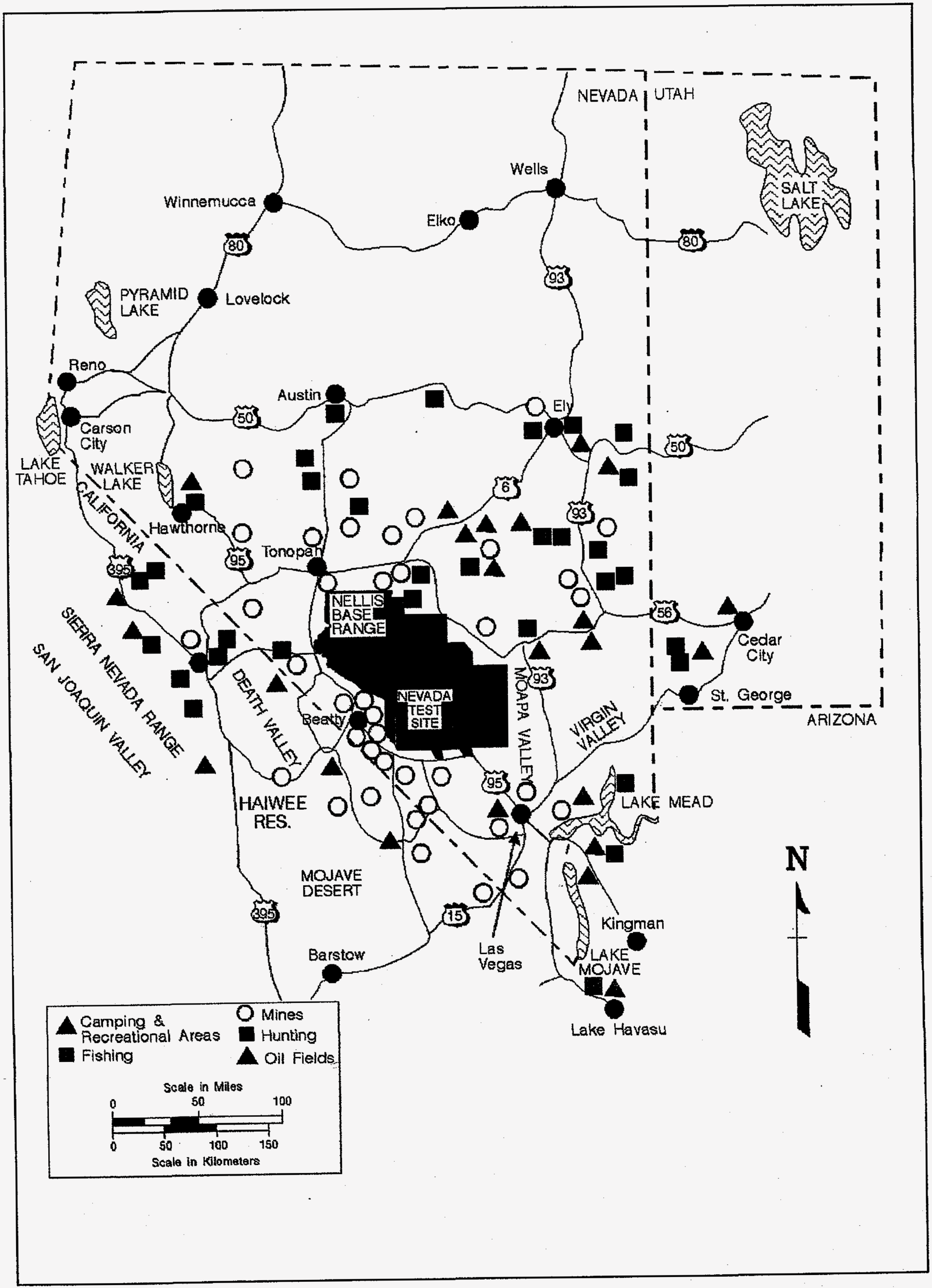


Figure 2.9 Land Use Around the NTS

valleys. 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 and Moapa Valleys, supporting irrigation for small-scale but intensive farming of a variety of crops. Grazing is also common in this area, particularly towards the northeast. The area north of the NTS is also mid-latitude steppe where the major agricultural activity is grazing of cattle and sheep, and a minor is growing of alfalfa hay. Many of the residents cultivate home gardens.

Recreational areas lie in all directions around the NTS and are used for such activities as hunting, fishing, and camping. In general the camping and fishing sites to the north of the NTS are not utilized in the winter months. Camping and fishing locations to the south are utilized throughout the year. The peak hunting season is from September through January.

2.2 NON-NTS FACILITIES

EG&G/EM had several offsite operations in support of activities at the NTS under a contract with the DOE/NV. Those that were operational in support of NTS activities are described in the following sections. Each of these facilities is located in a metropolitan area.

City, county, and state regulations govern emissions, waste disposal, and sewage. No independent EG&G/EM systems exist for sewage disposal or for supplying drinking water, and hazardous waste is moved off the facility sites for disposal. Radiation sources are sealed, and no radiological emissions are expected during normal facility operations.

2.2.1 AMADOR VALLEY OPERATIONS (AVO)

AVO facility in Pleasanton, California, occupies a 5520 m^2 (59,445 ft^2) two story combination office/laboratory building. AVO is located near the LLNL in Livermore, California, to simplify logistics and communications associated with EG&G/EM support of LLNL programs. Most of the work is in support of NTS underground weapons testing, but AVO also supports LLNL with optical alignment systems, and a variety of mechanical and electrical engineering activities associated with energy research and development programs. Areas of environmental interest include two small chemical cleaning operations.

2.2.2 SPECIAL TECHNOLOGIES LABORATORY (STL)

STL is located in Santa Barbara, California. In February, 1995, the STL picked up additional personnel and a facility in Goleta, California from the Santa Barbara Operations that were closed down. The current facilities occupy approximately 4125 m^2 (44,400 square feet) and consist of combination office/lab areas used primarily for engineering and electronic research. The research is conducted to develop a suite of sensor systems for testing and field deployment in support of DOE Headquarters and DOE/NV. Areas of environmental interest include a small printed circuit board operation, minor solvent cleaning operations and neutron activation experiments.

2.2.3 LAS VEGAS AREA OPERATIONS (LVAO)

LVAO includes two facilities, the North Las Vegas facility and the Remote Sensing Laboratory on the NAFB in North Las Vegas, Nevada. Both provide technical support for the DOE/NV test program.

The North Las Vegas facility includes multiple structures totaling about 53,820 m^2 (585,000 ft^2). At the facility, there are numerous areas of environmental interest, including metal finishing operations, a radiation source range, an X-ray laboratory, solvent and chemical cleaning operations, small amounts of pesticide and herbicide application, photo laboratories, and hazardous waste generation and accumulation.

The Remote Sensing Laboratory is an 11,000 m^2 (118,000 ft^2) facility located on a 14 ha (35 acre) site within the confines of the NAFB. The facility includes space for aircraft maintenance and operations, mechanical and electronics assembly, computer operations, photo processing, a light laboratory, and warehousing. Areas of environmental interest are photo processing and aircraft maintenance and operations.

2.2.4 LOS ALAMOS OPERATIONS (LAO)

LAO resides in a facility of approximately 6040 m^2 (65,000 ft^2). It is a two-story combination engineering/laboratory/office complex located near the Los Alamos National Laboratory (LANL) facility to provide local support for LANL's programs. The work performed includes direct support of the LANL testing program, the DOE Research and Development (R&D) Program, and miscellaneous DOE cash-order work. LAO's primary activities are twofold: the design, fabrication, and fielding of data acquisition systems used in underground nuclear testing diagnostics and the analysis of data from underground and high-altitude experiments. Two LAOs also have the responsibility of building and fielding Continuous Reflectrometry for Radius versus Time Experiment (CORRTEX) III recorders. Areas of environmental interest include small solvent cleaning, alodining, metal machining operations, and a small photo laboratory.

2.2.5 WASHINGTON AERIAL MEASUREMENTS OPERATIONS(WAMO)

The WAMO, located at Andrews Air Force Base, consists of a 186 m^2 (2000 ft^2) Butler building used as office space; a 1110 m^2 (12,000 ft^2) combination electronics laboratory, aircraft maintenance, and office complex; and a portion of a large aircraft hangar. WAMO operations provide an effective East Coast Nuclear Emergency Search Team (NEST) response capability and an eastern aerial survey capacity to the DOE/NV. Areas of environmental interest include minor solvent cleaning operations and used fuels and oils.

2.3 NON-NTS UNDERGROUND EVENT SITES

In past years, nuclear tests were conducted for a variety of purposes at eight different non-NTS sites in the U.S. The events and their locations that were sampled in 1995 appear in Table 2.1. Activities at these locations generally are limited to annual sampling of surface and groundwater at over 200 wells, springs, etc., at locations near the sites where nuclear explosive tests were conducted. However, a Remedial Investigation/Feasibility Study has begun at the Mississippi test location which will include significant new characterization activities. Sampling near three test sites on Amchitka, Alaska, occurs only in odd numbered years. Sampling results for these sites appear in Chapter 9 of this report.

Table 2.1 Non-NTS Nuclear Underground Test Sites

Event Name	Location	Purpose	Date of Test
GNOME	Carlsbad, New Mexico	Multi-purpose in salt	12/10/61
SHOAL	Fallon, Nevada	Test detection research	10/26/63
SALMON (Dribble)	Hattiesburg, Mississippi	Test detection research	10/22/64
LONG SHOT	Amchitka, Alaska	Test detection research	10/29/65
STERLING (Dribble)	Hattiesburg, Mississippi	Test detection research	12/03/66
GASBUGGY	Farmington, New Mexico	Gas stimulation experiment	12/10/67
FAULTLESS	Central Nevada	Seismic calibration	01/19/68
RULISON	Grand Valley, Colorado	Gas stimulation experiment	09/10/69
MILROW	Amchitka, Alaska	Seismic calibration	10/02/69
CANNIKIN	Amchitka, Alaska	Spartan missile warhead test	11/06/71
RIO BLANCO	Rifle, Colorado	Gas stimulation experiment	05/17/73

3.0 COMPLIANCE SUMMARY

Environmental compliance activities at the Nevada Test Site (NTS) during calendar year 1995 involved the permitting and monitoring requirements of numerous state of Nevada and federal regulations. Primary activities included: (1) National Environmental Policy Act (NEPA) documentation preparation; (2) Clean Air Act (CAA) compliance for asbestos renovation projects, radionuclide emissions, and state air quality permits; (3) Clean Water Act (CWA) compliance involving state wastewater permits; (4) Safe Drinking Water Act (SDWA) compliance involving monitoring of drinking water distribution systems; (5) Resource Conservation and Recovery Act (RCRA) management of hazardous wastes; (6) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) reporting; and (7) Toxic Substances Control Act (TSCA) management of polychlorinated biphenyls. Also included were preactivity surveys to detect and document archaeological and historic sites on the NTS. Compliance with the Endangered Species Act involved conducting pre-operation surveys to document the status of state of Nevada and federally listed endangered or threatened plant and animal species. There were no activities requiring compliance with Executive Orders on Flood Plain Management or Protection of Wetlands.

Throughout 1995, the NTS was subjected to several formal compliance agreements with regulatory agencies, including: a Programmatic Agreement with the Nevada Division of Historic Preservation and Archaeology and the Advisory Council on Historic Preservation; a Biological Opinion with the United States Fish and Wildlife Service (USFWS) for protection of the desert tortoise; a Memorandum of Understanding with Nevada covering releases of radioactivity; Agreements in Principle with Nevada and Mississippi covering Environment, Safety, and Health (ES&H) activities; and a Settlement Agreement to manage mixed transuranic (TRU) waste. Emphasis on waste control and minimization at the NTS continued in 1995.

In June 1994, the state of Nevada filed a Complaint for Declaratory Judgement and Injunction against the Department of Energy Nevada Operations Office (DOE/NV). This action seeks a judgement that DOE has failed to comply with NEPA requirements at the NTS. In January 1995, three of the claims in this case were dismissed by the U.S. District Court.

Compliance activities at DOE/NV non-NTS facilities operated by EG&G Energy Measurements, Inc. (EG&G/EM), involved the permitting and monitoring requirements of: (1) the CAA for airborne emissions, (2) the CWA for wastewater discharges, (3) state SDWA regulations, (4) RCRA disposal of hazardous wastes, and (5) hazardous substance reporting. Waste minimization efforts continued at all EG&G/EM operations.

3.1 COMPLIANCE STATUS

3.1.1 NATIONAL ENVIRONMENTAL POLICY ACT

Section 102 of the NEPA of 1969 requires all federal agencies to consider environmental effects and values and reasonable alternatives before making a decision to implement any major federal action which may have a significant impact on the human environment.

Since November 1994, DOE/NV has had full delegation of authority from DOE Headquarters (DOE/HQ) for Environmental Assessments (EAs), issuing Findings of No Significant Impact, and associated floodplain and wetland action documentation relating to DOE/NV proposed actions.

Within DOE, there are three levels of documentation used to comply with NEPA: (1) An Environmental Impact Statement (EIS) is a full disclosure of the potential environmental effects of proposed actions and the reasonable alternatives to those actions; (2) An EA is a concise discussion of a proposed action and alternatives and the potential environmental effects to determine if an EIS is necessary; and (3) A Categorical Exclusion (CX) is used for classes of activities which, based on similar past activities, has been found to have no adverse environmental impacts. During 1995, DOE/NV was involved in activities under all three of these categories.

A Notice of Intent to prepare a sitewide EIS for the NTS and other test locations within the state of Nevada, including the Tonopah Test Range, portions of Nellis Air Force Range, the Project SHOAL site, and the Central Nevada Test Area, was published in the Federal Register on August 10, 1994. The Preliminary Draft EIS was sent out for internal comments in December 1995. Comments will be incorporated and the Draft EIS is expected to be sent out for review in January 1996. After a series of Public Hearings, the final EIS is scheduled for publication in June 1996.

Work was conducted on 10 EAs during 1995. They include:

(1) Nevada Support Facility, at the North Las Vegas Facility, North Las Vegas, NV (DOE/EA-0955)--approved and distributed as a final on February 22, 1995.
(2) Device Assembly Facility(DAF) NTS, Area 6 (DOE/EA-0971)--approved and distributed as a final on June 8, 1995.
(3) Interim Storage of Nuclear Weapons at the NTS, Area 27 (DOE/EA-1031)--withdrawn.
(4) Liquid Waste Treatment System, NTS, Area 6, preapproval draft distributed for review in August.
(5) Sewage Lagoon System, at the NTS Radioactive Waste Management Site Area 5 (RWMS-5)--approved and distributed as a final on March 3, 1995.
(6) Fire Training Facility, NTS, Area 23.
(7) Solid Waste Disposal, NTS, Areas 5, 9, and 23--approved and distributed as a final on September 8, 1996.
(8) Double Tracks Site Remediation, Tonopah Test Range (TTR).
(9) RWMS-5 Site Access Improvement Project.
(10) Navy Thermal Treatment Unit Test at the Liquified Gaseous Fuels Spill Test Facility (LGFSTF).

Forty-seven CX documents were processed by DOE/NV during 1995.

As of January 31, 1996, there are no additional EISs expected to be required of DOE/NV within the next 24 months. However, DOE/NV anticipates involvement as a cooperating agency in supporting the preparation of a new Department of Air Force EIS on the renewal of the Nellis Air Force Range withdrawal.

Throughout calendar year 1995, the DOE/NV Environmental Protection Division (EPD) staff continued to maintain and update the DOE/NV NEPA Compliance Guide (Volume III), a quick reference handbook containing procedures, formats, and guidelines for those personnel responsible for DOE/NV's NEPA compliance activities. As noted in last year's annual summary, over 70 controlled copies of the DOE/NV NEPA Compliance Guide have been distributed for use within the DOE/NV organization. The EPD staff prepared Volume III to supplement the NEPA Compliance Guides, Volumes I and II, prepared and distributed by the Office of NEPA Policy and Assistance, DOE Headquarters.

3.1.2 CLEAN AIR ACT

Clean Air Act and state of Nevada air quality control compliance activities were limited to asbestos abatement, radionuclide monitoring and reporting under the National Emission Standards for Hazardous Air Pollutants (NESHAP), and air quality permit compliance requirements. There were no criteria pollutant or prevention of significant deterioration monitoring requirements for NTS operations.

3.1.2.1 NTS NESHAP ASBESTOS COMPLIANCE

The state of Nevada, Division of Occupational Safety and Health, regulations (Nevada Revised Statutes [NRS] 618.760-805) requires that all asbestos abatement projects in Nevada, involving friable asbestos in quantities greater than or equal to 3 linear ft or 3 ft^2, submit a Notification Form. Notifications are also required to be made to the U.S. Environmental Protection Agency (EPA) Region 9 for projects which disturb greater than 260 linear ft or 160 ft^2 of asbestos-containing material in accordance with 40 C.F.R. 61.145-146.

During 1995, three state of Nevada notifications were made, and one of these projects required notification to EPA Region 9. A list of these notifications appears in Table 3.1. Reynolds Electrical & Engineering Company, Inc., (REECo) collected and analyzed bulk, occupational, environmental, and clearance samples for these projects. The annual estimate for non-scheduled asbestos demolition/renovation for FY 1996 was sent to EPA Region 9 in November 1995.

3.1.2.2 RADIOACTIVE EMISSIONS ON THE NTS

NTS operations were conducted in compliance with the NESHAP radioactive air emission standards of Subpart H, of 40 C.F.R. 61. In compliance with those requirements, DOE/NV provides reports to DOE/HQ on airborne radioactive effluents for submission to EPA.

There are two locations on the NTS where airborne radioactive effluents may be emitted from permanent stacks: (1) the tunnels in Rainier Mesa, and (2) the analytical laboratory hoods in the town of Mercury. The tunnels are closed and based on the amount of radioactivity handled, the exhaust from the analytical laboratories is considered negligible compared to other sources on the NTS. Diffuse sources which are difficult to monitor, include seepage of noble gases from the ground caused by barometric pressure variations, evaporation of tritiated water from containment ponds, diffusion of tritiated water vapor from the RWMS-5, and resuspension of plutonium contaminated soil from safety and atmospheric test locations.

In the 1995 NTS NESHAP report for airborne radioactive effluents (Black 1996), effluents from the tunnel ventilation systems were not reported because the tunnels were inactive. The airborne emission of tritiated water vapor from the containment ponds was conservatively reported as if all the liquid discharge into the ponds had evaporated and become airborne. For tritiated water vapor diffusing from the RWMS-5, plutonium particulate resuspension from Areas 3, 9 and various other areas on and near the NTS, and seepage of ^{85}Kr from Pahute Mesa, the airborne effluents were conservatively estimated as follows. The monitoring station with the maximum annual average concentration for the radionuclide in question was selected from among the surrounding sampling stations. An effective dose equivalent (EDE) was then calculated for that concentration. EPA's CAP88-PC software program was used to determine what total activity would have to have been be emitted from the geometric center of the region in question in order to produce that EDE.

Using these best estimates of air emissions in 1995 as input to the CAP88-PC computer software model, EDEs and collective EDEs were calculated. The maximum potential individual EDE would have been only 0.18 mrem, much less than the 10 mrem limit specified in 40 C.F.R. 61.

3.1.2.3 NTS AIR QUALITY PERMIT COMPLIANCE

Compliance with air quality permits is accomplished through permit reporting and renewals and ongoing verification of operational compliance with permit specified limitations. (See Chapter 4, Table 4.3, for a listing of active permits.) Common air pollution sources at the NTS include aggregate production, stemming activities, surface disturbances, fugitive dust from unpaved roads, fuel burning equipment, open burning, and fuel storage facilities. The 1994 Air Quality Permit Data Report was sent to the state of Nevada on February 13, 1995. This report includes aggregate production, operating hours of permitted equipment, and a report of all surface disturbances of five acres or greater. Hourly production rates were within permit specifications for 11 facilities.

NTS air quality permits limit particulate emissions to 20 percent opacity, with the exception of one permit which limits opacity to 10 percent. Certification to perform visible emissions opacity evaluations is required by the state, with recertification required every six months. During 1995, three REECo Environmental Compliance Office personnel and five operational personnel were certified and/or recertified. In 1995 these personnel performed, at a minimum, semiannual visible emission evaluations of permitted air quality point sources. When visual evaluations determine that an emission exceeds the opacity requirement, corrective action is initiated. Only the Area 1 Rotary Dryer exceeds opacity limit. Modifications that were initiated in 1993 to improve the situation are under way to bring the dryer into full compliance (see Section 3.2.1).

During 1995, the state of Nevada personnel conducted one inspection of NTS equipment permitted under air quality operating permits or permits to construct. No findings of violations were issued.

3.1.2.4 NON-NTS EG&G/EM OPERATIONS

Normally, no activities that are part of ongoing operations at the six EG&G/EM facilities with DOE/NV projects produce radioactive effluents. In 1995, however, an unplanned release of radioactive tritium occurred at the Atlas Facility in North Las Vegas. This release was only a fraction of the level requiring action under the NESHAP radioactive air emission standards.

Air quality operating permits were required for three of the six EG&G/EM operations. There were no effluent monitoring requirements associated with these permits. Compliance for each of these specific permits is discussed below. Twenty emission units at the EG&G/EM, Las Vegas Area Operation (LVAO), which includes the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory (RSL), were regulated during 1995 under conditions of 15 permits issued by the Clark County Health District (CCHD), Las Vegas, Nevada.

Amador Valley Operations (AVO) discontinued operation of its' two solvent cleaning processes.

Special Technologies Laboratory (STL) holds a permit to operate a vapor degreaser issued by the County of Santa Barbara, Air Pollution Control District (APCD). Permit conditions include throughput limitations and record-keeping requirements.

Woburn Cathode Ray Tube Operations (WCO) ceased operation and was closed during the last quarter of 1994.

No air permits were held or required for Los Alamos Operations, nor Washington Aerial Measurements Operations in 1995.

3.1.3 CLEAN WATER ACT

The Federal Water Pollution Control Act, as amended by the CWA, establishes ambient water quality standards and effluent discharge limitations which are generally applicable to facilities which discharge any materials into the waters of the United States. Discharges from DOE/NV facilities are primarily regulated under the laws and regulations of the facility host states. Monitoring and reporting requirements are typically included under state or local permit requirements. A complete listing of applicable permits appears in Section 4.3. There are no National Pollutant Discharge Elimination System (NPDES) permits for DOE/NV facilities as there are no wastewater discharges to onsite or offsite surface waters.

3.1.3.1 NTS OPERATIONS

Discharges of wastewater are regulated by the state of Nevada under the Nevada Water Pollution Control Act. The state of Nevada also regulates the design, construction, and operation of wastewater collection systems and treatment works. Wastewater monitoring at the NTS was limited to sampling wastewater influents to sewage lagoons and containment ponds.

State general permit GNEV93001, which regulates all ten active sewage treatment facilities on the NTS, was issued by the Nevada Division of Environmental Protection (NDEP), and became effective on February 1, 1994. Hydrogeological modeling utilizing site specific soil characteristics, vadose zone monitoring, groundwater monitoring, or lining an adequate portion of the impoundments at a specific facility were all accepted by NDEP as methods to comply with the permit requirements for protection of the groundwater.

Compliance with sewage lagoon discharge permit requirements was achieved with the following four exceptions:

- Organic loading limits listed in the permit were exceeded four times at three different facilities throughout the calendar year. Abnormally high influent flow rates were recorded at the Area 22, Gate 100 facility during the first and second quarters; the Area 6, Los Alamos National Laboratory (LANL) Camp facility during the third quarter; and at the Area 6, Yucca Lake facility during the fourth quarter. An innovative continuous flow measuring and sampling device installed at the Area 22, Gate 100 facility was taken out of service since solids accumulation created an artificial head. The flow rates recorded at the Area 6, LANL Camp and Yucca Lake facilities were also abnormally high due to solids accumulation. No operational problems were encountered at these facilities verifying that organic loadings on the primary lagoons was not excessive.

- A design flaw was also noted at the Yucca Lake continuous flow measuring device. The flow through the 3 inch influent Parshall flume is submerged resulting in an increased head at the measuring point. An insert for the flume has been ordered to correct this defect.

- An unauthorized discharge of approximately 10,000 gal of raw sewage from the Area 25, Reactor Control Point collection system occurred on May 1, 1995. The main influent line was crushed by a backhoe performing environmental investigative work for a septic tank/leach field closure. The break occurred at a point where inadequate cover depth of 15 inches and improper cover material were installed on the line.

- Staff gages reliable to 8 cm are required in each infiltration basin according to Part I.D.2 of the general permit for sewage lagoons. These gages were only installed in the new RWMS-5 sewage lagoons, but no other active sites.

Arsenic at a concentration of 0.91 mg/L was found within the Area 6, Yucca Lake infiltration basins in June of 1995. The general permit requires that an investigation be performed to determine the cause of any exceedance which is ten times the Nevada drinking water standard for specific inorganic constituents of infiltration basin liquids. Action to address this anomalous concentration and satisfy permit requirements will be completed in early 1996.

A May 17, 1995, letter from NDEP indicated that the state's interest regarding completion of all groundwater protection activities is deferred until the general permit expires on January 31, 1999. Action outlines will still be submitted to NDEP at the start of each fiscal year to demonstrate progress in the implementation of acceptable methods of groundwater protection as improvements at all active facilities cannot be completed during the final year for which the permit is in effect. Evaluation of the acceptable methods for groundwater protection are reviewed on a regular basis due to the constant changes in material, equipment, construction, and indirect costs as well as changes in the usage of facilities. The chosen alternative for a facility which still requires an improvement may change from conclusions made in prior Action Outlines.

Defense Nuclear Agency (DNA) staff is still investigating a means to terminate the surface discharge from the U-12e Tunnel portal in Area 12. The flow rate has not stabilized during these investigations, but has averaged less than 10 gal per minute. An application for a discharge permit was sent to NDEP in June of 1993. NDEP has yet to initiate the permit process for this flow by issuing a draft permit for review.

State of Nevada compliance personnel routinely inspected the NTS sewage lagoons and tunnel discharge ponds in 1995. No findings or notices of violation were issued for these permitted units.

3.1.3.2 NON-NTS EG&G/EM OPERATIONS

Permits for wastewater discharges were held for four non-NTS facilities. Monitoring and reporting were performed according to specific local requirements.

The LVAO wastewater permit was revised from a Class I permit to a Class II permit by the City of North Las Vegas Department of Public Works. Monitoring was reduced from two times a year to once per year in October. The monitoring requirements were retained for the MG burn pit (a device for cutting metal) water prior to discharging; however, monitoring at ten additional outfalls prior to discharge was eliminated. The NLVF self-monitoring reports were submitted in October and November 1995.

The Clark County Sanitation District wastewater permit for the RSL required biannual monitoring of two outfalls and quarterly pH and monthly septage reports. RSL monitoring reports were submitted in May and November 1995.

The STL holds wastewater permits for the Botello Road and Elkhill Road locations. There is no required self monitoring.

The WCO ceased operation and was closed during the last quarter of 1994.

No wastewater permits were held for the Los Alamos Operations, or the Washington Aerial Measurements Operations in 1995.

3.1.4 SAFE DRINKING WATER ACT

3.1.4.1 NTS OPERATIONS

The SDWA primarily addresses quality of potable water supplies through sampling and monitoring requirements for drinking water systems. The state of Nevada has enacted and enforces SDWA regulations including system operations such as operation and maintenance, water haulage, operator certification, permitting, and sampling requirements.

As required under state health regulations, potable water distribution systems at the NTS are monitored for residual chlorine content and coliform bacteria. Monitoring results for 1995 are discussed in Section 7.1.1.1. There were no incidents of positive coliform in 1995.

NTS potable water distribution systems are also monitored for volatile organic compounds, inorganic compounds, and other water quality parameters. These monitoring results are discussed in Section 7.1.1.2. Volatile organic compounds, PCBs, and pesticides were not detected in any NTS potable water distribution system. Nitrate samples were also collected during 1995, with all of the results being below the maximum contaminant level (MCL).

3.1.4.2 NTS WATER HAULAGE

To accommodate the diverse and often transient field work locations at the NTS, a substantial water haulage program is used. To ensure potability of hauled water, the water is obtained from potable water fill stands, chlorinated in the truck and then sampled for coliform bacteria. The state of Nevada decided in 1994 that water hauling trucks should be permitted as water distribution systems. Permits were obtained again in 1995 for the three trucks and are listed in Chapter 4, Table 4.4. There were no positive coliform sample results in 1995.

3.1.4.3 NON-NTS EG&G/EM OPERATIONS

The WCO ceased operation and was closed during the last quarter of 1994. EG&G/EM has no other operations requiring compliance with SDWA.

3.1.5 RESOURCE CONSERVATION AND RECOVERY ACT

The Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984 constitute the statutory basis for the regulation of hazardous waste and underground storage tanks.

Under Section 3006 of RCRA, the EPA may authorize states to administer and enforce hazardous waste regulations. Nevada has received such authorization and acts as the primary regulator for many DOE/NV facilities. The Federal Facilities Compliance Act (FFCA) of 1992 extends the full range of enforcement authorities in federal, state, and local laws for management of hazardous wastes to federal facilities, including the NTS. A discussion of actions regarding the FFCA at the NTS is given in Section 3.1.6.

3.1.5.1 NTS RCRA COMPLIANCE

Compliance activities under state of Nevada hazardous waste management regulations during 1995 included receipt of a RCRA Hazardous Waste Operating Permit, participation in several NDEP inspections, and a response to a state finding of alleged violation (FOAV). The NDEP's Bureau of Federal Facilities (BoFF) staff routinely inspects NTS facilities and work sites.

During 1995, DOE/NV received a RCRA Hazardous Waste Operating Permit for operating the Area 5 Hazardous Waste Storage Unit and the Area 11 Explosive Ordnance Disposal (EOD) Unit. In addition, the DOE/NV revised the Part B Permit application to include the Mixed Waste Storage Pad and updated information concerning general facility conditions.

On January 5, 1994, the state of Nevada and DOE/NV entered into a Mutual Consent Agreement, which allowed low-level radioactive mixed wastes generated on the NTS to be moved into storage at the Area 5 RWMS TRU pad. This was amended in June to include Environmental Restoration mixed waste generated in Nevada. A quantity of waste was already in storage at this facility and will continue to be held in storage until a final determination of the proper treatment and disposal technology is established by the EPA. Under the FFCA, these mixed wastes were exempt from storage prohibitions in the Land Disposal Restrictions until October 6, 1995. NDEP has specified that this exemption has been extended through February 1996 pending negotiations towards a signed FFCA Compliance Order.

A Compliance Evaluation Inspection (CEI) was conducted in August 1995 by NDEP personnel. Four potential violations were identified in the 1995 CEI report. In a letter dated October 16, 1995, the NDEP stated that it would not pursue formal enforcement proceedings against DOE or REECo with regard to these potential violations.

From March 9, 1995 through April 20, 1995, the state conducted a formal RCRA inspection of the facilities at the NTS that perform photographic processing. On June 6, 1995, the state issued an inspection report which listed 36 potential violations of state and federal law governing the treatment, storage, and disposal of hazardous waste. EG&G/EM was cited for 17 potential violations, REECo for 16 potential violations, and LANL for 1 potential violation.

On June 21, 1995, REECo, EG&G/EM, and the state entered into a Voluntary Compliance Agreement (VCA) in the interest of amicably resolving any differences of opinion regarding environmental requirements under the NTS wastewater permit and other legal standards. The state agreed that in lieu of pursuing enforcement actions, REECo and EG&G/EM would complete a variety of activities designed to promote community service, education, and the clean-up of blighted sites located on the NTS. REECo and EG&G/EM also agreed to certain changes in the management of photographic wastes containing silver, including establishing a centralized management system for spent silver recovery canisters. On December 5, 1995, the state issued a letter confirming that all actions required by the VCA had been completed satisfactorily.

Following an informal inspection of the Area 25 paint shop in July 1995, the state issued an inspection report/advisory letter to DOE/NV and REECo alleging noncompliance with NAC 444.8632 "Compliance with Federal Regulations Adopted By Reference," and NAC 444.8671 “EPA Waste Code.” The state declined to issue any FOAVs. REECo did change its paint disposal practices to correct the problems noted by the state.

On February 21, 1995, the state conducted a formal RCRA inspection of the T2B site at the NTS. Lead shielding material with radiological contamination at the T2B site had been characterized as mixed waste, but had not been moved to the designated mixed waste storage area. On March 10, 1995, the state issued a FOAV to DOE/NV and REECo for the improper storage of waste lead at the T2B site, in violation of NAC 444.8632 “Compliance with Federal Standards.” On May 22, 1995, the state determined that “DOE, as the facility owner, is responsible for overseeing and insuring its contractor's actions comply with regulatory requirements . . . ” Therefore, the penalty assessment was directed to DOE.

3.1.5.2 HAZARDOUS WASTE REPORTING FOR NON-NTS, EG&G/EM OPERATIONS

LVAO submitted to DOE/NV, in February 1994, for submission to the state of Nevada, the Hazardous Waste Generator biennial report for hazardous wastes generated at the North Las Vegas Facility under EPA ID Number NVD097868731. No additional actions were required in 1995.

3.1.5.3 UNDERGROUND STORAGE TANKS

NTS OPERATIONS

The NTS underground storage tank (UST) program continues to meet regulatory compliance schedules for the reporting, upgrading or removal of documented USTs. Efforts are continuing to identify undocumented USTs at the NTS. Once identified, undocumented USTs are reported to NDEP to satisfy state regulatory reporting requirements.

During 1995, nine USTs were removed in accordance with state and federal regulations (see Table 3.2). Reportable releases were discovered with the removal of three tanks in Area 25 at the Control Building, the Power House, and the Radiation Safety Building. Remedial activities have commenced at each site. Twelve reportable UST release sites were remediated in 1995, including the Area 12 Boiler House and Gas Station, the Area 23, By-Pass Yard and Gas Station, three sites at the Area 25, Power House, the Area 25, Technical Services Building, the Area 26, Power House, the Area 27, Boiler House, and the Area 11, Tweezer Facility.

NON-NTS EG&G/EM OPERATIONS

There were no issues involving UST at non-NTS locations during 1995.

3.1.6 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA)

Compliance activities under CERCLA/SARA for 1995 included SARA Section 312, Tier II reporting, and SARA Section 313 reporting to the state of Nevada.

The possibility of listing the NTS on the National Priority List (NPL) of hazardous waste sites carries potential for extensive budgetary and organizational impacts. Although the NTS has not been listed on the NPL, planning for environmental mitigation and restoration are ongoing (see Section 3.2.8). The state of Nevada has taken action to negotiate a formal agreement with DOE/NV rather than waiting for the EPA to list the NTS on the NPL. This agreement will clearly establish the state's role and authority over sites requiring evaluation and corrective actions, and establish agreed-upon tasks, time schedules, and funding commitments. Negotiations continued in 1995 between the DOE, the DNA and the NDEP to develop a Federal Facilities Agreement (FFA). The final approval of the FFA is expected by April 1996. A preliminary three year schedule of activities for the Environmental Restoration Program and Defense Programs projects was provided to NDEP.

3.1.6.1 NTS TIER II REPORTING UNDER SARA TITLE III

In 1992, the state of Nevada combined reporting requirements for the SARA Title III, Sections 301-312 Tier II report to include information for the Nevada Fire Marshall Division, Uniform Fire Code Materials Report. The State renamed the document the "Nevada Combined Agency Hazardous Substances Report." The 1994 Nevada Combined Agency Hazardous Substances Report for the NTS was submitted to the state on April 5, 1995, and contained information on 34 different chemicals in 36 areas which were above the reporting threshold.

3.1.6.2 NON-NTS TIER II REPORTING UNDER SARA TITLE III

The combined SARA Section 312, Tier II Report for the Area 5, Spill Test Facility and the EG&G/EM facilities in Areas 5 and 6 was submitted to DOE/NV in April 1995. Ammonia and sulfur dioxide exceeded the SARA Extremely Hazardous Substances (EHS) threshold planning quantity. The Nevada Combined Agency Reports for EG&G/EM's LVAO were submitted to DOE/NV in April 1995. There were no reportable EHSs at the NLVF.

3.1.6.3 SARA TITLE III SECTION 313 REPORTING

In compliance with Executive Order 12856, DOE/NV must provide a Toxic Release Inventory Report required by Section 313 of the SARA Title III. In calender year 1994, no chemicals over the reporting threshold were handled so no report was required in 1995.

3.1.7 STATE OF NEVADA CHEMICAL CATASTROPHE PREVENTION ACT

The state of Nevada Chemical Catastrophe Prevention Act of 1992 contains regulations for facilities defined as Highly Hazardous Substance Regulated Facilities. This law requires the registration of highly hazardous substances above predetermined thresholds. There were no reportable chemicals for 1994, but a negative report to the state in 1995 was not required.

3.1.8 TOXIC SUBSTANCES CONTROL ACT

State of Nevada regulations implementing the TSCA require submittal of an annual report describing polychlorinated biphenyl (PCB) control activities. The 1994 NTS

PCB annual report was transmitted to EPA and the state of Nevada on June 7, 1995. The report included the quantity and status of PCB and PCB-contaminated transformers and electrical equipment at the NTS. Also reported were the number of shipments of PCBs and PCB-contaminated items from the NTS to an EPA approved disposal facility. Fifty-four (54) large and five small, low volume PCB capacitors remain under the management of the LANL in Area 27 of the NTS.

3.1.9 FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT

Pesticide usage included insecticides, herbicides, and rodenticides. Insecticides were applied twice a month at the food service and storage areas. Herbicides were applied once or twice a year at NTS sewage lagoons berms. All other pesticide applications were on an as-requested basis. General-use pesticides were preferred, although restricted-use herbicides and rodenticides were sometimes used. Contract companies applied pesticides at all non-NTS facilities in 1995.

Records were maintained on all pesticides used, both general and restricted. These records will be held for at least three years. State-sponsored training materials are available for all applicators. No unusual environmental activities occurred in 1995 at the NTS relating to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

3.1.10 HISTORIC PRESERVATION

The National Historic Preservation Act requires federal agencies to consider any impact of their actions on cultural resources (archaeological sites, historic sites, historic structures, and traditional cultural properties) eligible for listing in the National Register of Historic Places (NR). Accordingly, DOE/NV conducts cultural resource surveys and other studies to assess any impacts NTS operations may have on such resources. When cultural resources eligible for the NR are found in a project area, and they cannot be avoided, plans are written for programs to recover data to mitigate the effects of operations on these sites. Technical reports contain the results of these data recovery programs. A data recovery program for a prehistoric site which began in 1994 was completed. More than 27,000 artifacts were analyzed and a draft technical report was prepared on the various archaeological studies conducted at the NTS. The final technical report for another archaeological data recovery program was completed and distributed.

The American Indian Religious Freedom Act (AIRFA) directs federal agencies to consult with Native Americans to protect their right to exercise their traditional religions. In 1989 the NTS AIRFA Compliance Program was established to assist DOE/NV in the development and implementation of a consultation plan, designed to solicit Native American comments regarding the effects of DOE/NV activities on Native American historic properties and the expression of traditional Native American religions. The Native American Graves Protection and Repatriation Act (NAGPRA) requires federal agencies to consult with Native Americans regarding items in their artifact collections which may be associated funerary items and human remains. In 1995, 5 elders from the 17 Native American tribal groups examined almost 300 items in the NTS collections. A workbook summarizing their information was completed and distributed to the tribes. The tribes representatives met at the NTS and recommended that nearly all the artifacts be considered NAGPRA items to be placed in perpetuity beneath the ground on the NTS.

As part of the Programmatic Agreement with the State Historic Preservation Office and the Advisory Council on Historic Preservation, work continued on the Long Range Study Plan for Pahute and Rainier Mesas. The objective of the plan is to study a geographically representative sample of all cultural resources on Pahute and Rainier Mesas. A modification of this plan, known as Attachment A, requires a summary and synthesis of existing archaeological data from the Mesas and the preparation of three professional papers over a 2- to 3-year period. In 1995, the first paper, Cultural Chronology of Pahute and Rainier Mesas, was reviewed, revised, and completed. Work was initiated on the Adaptive Strategies paper. In 1995, one cultural resources survey was conducted on Rainer Mesa and located one historic archaeological site which was determined ineligible for the NR. During the tenure of this agreement, no data recovery will be undertaken on the Mesas.

3.1.11 THREATENED AND ENDANGERED SPECIES PROTECTION

The Endangered Species Act (ESA) requires federal agencies to insure that their actions do not jeopardize the continued existence of federally listed endangered or threatened species or their critical habitat. The American peregrine falcon is the only endangered species that has been documented on the NTS. The desert tortoise and the bald eagle are threatened species which occur on the NTS. DOE/NV consulted with the U.S. Fish and Wildlife Service (USFWS) and received a non-jeopardy Biological Opinion in April 1991 for planned activities at Forty-mile Canyon on the NTS for a 9-year period and a non-jeopardy Biological Opinion in May 1992 for planned activities at the NTS for a 5-year period.

There are 22 species known or expected to occur on the NTS that are candidates for listing by the USFWS under the ESA. In 1995, DOE/NV conducted 17 preconstruction biological surveys at proposed construction sites to determine the presence of these species. Survey results and mitigation recommendations were documented in survey reports.

Locations were mapped and updated for one Category 2 candidate plant species for federal listing (*Parish's phacelia*). New locations of two other candidate plant species were found as a result of the *Parish's phacelia* surveys. After summarizing the results of data collected on all candidate plant species from 1991 through 1995, a final report was prepared that summarized the distributions, habitat, and status of Category 2 candidate plant species on and near the NTS.

3.1.12 EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT

There were no projects in 1995 which required consultation for floodplain management. NTS design criteria do not specifically address floodplain management; however, all projects are reviewed for areas which would be affected by a 100-year flood pursuant to DOE Order 6430.1A.

3.1.13 EXECUTIVE ORDER 11990, PROTECTION OF WETLANDS

There were no projects in 1995 which required consultation for protection of wetlands. NTS design criteria do not specifically address protection of wetlands; however, all projects are reviewed pursuant to the requirements of DOE Order 5400.1.

3.1.14 EXECUTIVE ORDER 12856, FEDERAL COMPLIANCE WITH RIGHT-TO-KNOW LAWS AND POLLUTION PREVENTION REQUIREMENTS

Actions taken to comply with the requirements of this Executive Order are discussed in Section 3.2.6.

3.2 CURRENT ENVIRONMENTAL COMPLIANCE ISSUES AND ACTIONS

There were numerous activities and actions relating to environmental compliance issues in 1995. These activities and actions are discussed below grouped by general area of applicability.

3.2.1 CLEAN AIR ACT

Modifications to the Area 1 Rotary Dryer, including the installation of new heat tiles and modifications to the storage silo, are still in progress to bring the operation into full compliance with state opacity limits. The Area 3, Portec Hopper, which had been scheduled for relocation to the Area 1 Batch Plant, has not been in operation and will be dismantled and sold.

Under Title V, Part 70 of the CAA Amendments, all owners or operators of Part 70 sources must pay annual fees that are sufficient to cover costs of state operating permit programs. Accordingly, annual source maintenance and emission fees of $17,500 were assessed by the state in August 1995, for all NTS facilities operating under Air Quality Operating Permits. Of the $17,500, only $10 was attributable to emissions. At a workshop held by the state in October 1995, Bureau of Air Quality personnel stated that the existing fee schedule was being revised to possibly place more emphasis on emissions fees rather than maintenance fees.

On October 5, 1995, the EPA Region 9 issued identical warning letters to DOE/NV and REECo, alleging violations of Section 608 of the CAA, which deals with emissions of ozone-depleting compounds (mainly refrigerants). The EPA had received a written complaint stating that REECo knowingly vented regulated refrigerants to the atmosphere and assigned uncertified technicians to perform refrigeration work. REECo reviewed the allegations and determined they were unsubstantiated. The EPA has not corresponded further or attempted any enforcement action.

3.2.2 CLEAN WATER ACT

A NPDES permit may be issued for the NTS and the NLVF as part of the state implementation of the federal storm water discharge regulations. The federal storm water regulations identify regulated facilities by a Standard Industrial Classification (SIC) code. A survey conducted in accordance with guidance received from the EPA Region 9 and the Office of Management and Budget revealed that the primary SIC code for the NLVF suggested that it was not an activity subject to those regulations. A survey report was prepared and submitted to the state of Nevada requesting a formal determination on the regulatory status of the NLVF. This determination is still pending.

Dewatering of septage and winter time portable toilet waste was conducted in the Area 25 Engine Test Stand No. 1 sewage lagoon and two Area 12 sewage lagoon secondary infiltration basins. The Area 2 secondary basin was permanently abandoned after a flash flood destroyed the facility in March of 1995. The Area 12 and Area 25 locations will be used again in 1996 for this application.

Improvements to the Area 6 Decontamination Facility were completed in May of 1995. A fourth Baker tank, individual outlets from all the holding tanks, and a common discharge line which directs flow of acceptable quality to the domestic sewage collection system were installed. Previous comprehensive sampling and analyses have verified that this flow is acceptable. An updated Operation and Maintenance Manual which includes these improvements and operational changes still must be submitted to NDEP for approval.

A total of 14 active septic tank/leachfield systems and two holding tanks are still in service on the NTS. Facility Managers of each will be informed of deficiencies noted during recent inspections. The two active holding tanks must be taken out of service or replaced with acceptable septic tank/leachfield systems.

Approval of the Closure Plan for Active or Recently Abandoned Septic Tank/Holding Tank Systems was granted by NDEP in August 1995. Final NDEP comments contained in the approval have been included in the plan. The Plan contains guidance for content sampling, analysis, and disposal; tank abandonment; and, requirements for future leachfield sampling.

Funding was secured in 1995 for the installation of geo-synthetic clay liners within the existing primary lagoons and secondary infiltration basin at the Area 22 system. Construction should be started by the early summer of 1996.

Funding for hydrogeological modeling proposed for the Area 6 DAF and the LANL Camp infiltration basins was not secured in 1995. An acceptable method of groundwater protection will again be proposed at both of these sites in the future. The installation of an engineered liner in one of the secondary infiltration basins at the LANL Camp facility to a 2 foot depth is now the most cost effective method of complying with the permit due to recent reduction in flows.

A February 27, 1995, letter from the Yucca Mountain Site Characterization Office indicated that the sewage lagoon operations serving the Area 25 Central Support facilities will be assessed and that costs for appropriate monitoring, modeling, or engineered solutions would be funded in fiscal years 1996 and 1997. That letter also indicated that plans were finalized to relocate users of the Area 25 Test Cell C sewage lagoons by 1998. It can then be taken out of service.

No improvements are planned to the Area 25 Reactor Control Point sewage lagoons. Expansion of the lagoons is required to prevent a surface discharge due to increased usage along with implementation of a groundwater protection method. Treated sewage flowed into the secondary basin for the first time in September 19, 1995. Pumping is required to ensure containment of treated sewage within the existing impoundments. It is planned to take this facility out of service by the expiration date of the permit since no source of funding is available for expansion and evaluation of groundwater protection methods.

The Area 6 CP Gravity Sewer Main Project was completed on September 12, 1995. Sewage flows previously directed into the CP-6 and CP-72 sewage lagoons are now discharged into the Area 6 Yucca Lake facility. A savings of approximately $ 20,000 per year for monitoring, operation, and maintenance costs will be realized by taking the two lagoon sites out of service.

The Area 23, Infiltration Basin Groundwater Monitoring Well Project Management Plan was approved by NDEP on August 24, 1995. Drilling activity for the monitoring well was initiated on October 30, 1995, with completion anticipated in February of 1996. Compliance with the groundwater protection requirements in the permit will be attained for the Area 23 sewage lagoons with the completed installation.

Construction of the RWMS-5 sewage collection system and lagoons was completed in September 1995. Engineered liners have been installed within both primary lagoons and both secondary basins to comply with the groundwater protection requirements in the state general permit. As-built certification and sewage lagoon specifications still must be forwarded to NDEP for approval and addendum to the general permit.

Construction of the Area 3 RWMS septic tank/leachfield system was completed in October 1995. This installation eliminated the use of a sewage holding tank which did not comply with state regulations.

The Area 6, Service Station septic tank/leachfield system was placed in service in September 1995. This installation also eliminated the use of a sewage holding tank which did not comply with state regulations. Approval for closure of the sewage holding tank is still required from NDEP.

3.2.3 SAFE DRINKING WATER ACT

Engineering design was completed in 1995 on approximately 50 buildings or facilities at the NTS requiring retrofit through installation of backflow prevention devices on water service lines. These facilities included over 110 separate installations. Engineering plans for four of these facilities were sent to the state for approval prior to start of construction. As of the end of 1995, work in eight facilities has been completed, and materials for all remaining installations have been received. REECo has completed installation of anti-siphon devices in approximately 132 facilities that did not require state approval or engineering. It is projected that all backflow prevention work will be completed by May 1996.

During 1995, quarterly samples continued to be collected from Well 4 to monitor the nitrate level. The state-collected sample in 1993 was over half the allowable level, which requires four quarterly samples to be taken. All sample results were within the allowable level, and the required sampling was completed in 1995.

The well casings were raised to extend at least six inches above the surface at Well 4 and at the Army Well to meet state requirements. Other system improvements were the replacement of the water line between Army Well and Mercury, replacement of pump equipment in six wells and the replacement of two booster pumps at the 5a Booster Station.

There was no inspection of the water distribution systems by the Nevada Bureau of Health Service during 1995.

3.2.4 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

Other than the reporting covered in Section 3.1.6, there is no formal CERCLA program at the NTS. The FFA with the state may preclude the NTS from being placed on the National Priority List. The FFA will take more of a RCRA approach in remediating environmental problems.

3.2.5 HISTORIC PRESERVATION

Historic preservation studies and surveys are conducted by the Desert Research Institute (DRI), University and Community College System of Nevada. In 1995, 25 surveys were conducted for historic properties on the NTS, and reports on the findings were prepared. These surveys identified four prehistoric archaeological sites, four historic archaeological sites, and three historic structures associated with the nuclear testing program. Only one of these locales was considered eligible for the NR. One other structure and one other location associated with the nuclear testing program were evaluated for their historic significance and were deemed eligible for the NR. To negate potential adverse effects on the Japanese Village and Jr. Hot Cell, the structures were recorded in accordance with the Historic American Building Survey requirements. The documents for the Japanese Village are in review at the National Park Service. The Jr. Hot Cell documentation has been completed and approved.

Other efforts in 1995 included administration of the cultural resources program on the NTS, preparing management objectives and plans, and promoting public relations and communications concerning the NTS archaeology and cultural resources program.

To comply with federal regulations in 36 C.F.R. 79, a multi-phase program is in progress to upgrade the NTS archaeological collection and archives. In 1995, DRI continued the piece-by-piece inventory of the lithic artifacts in the collection. Over 60 percent of the nearly 500,000 artifacts in the collection have been inventoried and repackaged according to federal requirements.

3.2.6 WASTE MINIMIZATION

3.2.6.1 NTS OPERATIONS

The majority of NTS contractors and users have published Waste Minimization/Pollution Prevention Plans and Task Plans in accordance with DOE/NV requirements. These plans are designed to reduce waste generation and possible pollutant releases to the environment.

Some contractors have revised their plans, incorporating the most current waste minimization requirements and Executive Orders, and are establishing ongoing goals for further improvements. These ongoing efforts provide increased protection of public health and the environment, as well as:

- Reduced employee exposure.
- Reduced waste management and compliance costs.
- Reduced resource usage.
- Reduced inventories of chemicals that require reporting under the SARA, and the EPA 33/50 Pollution Prevention Program.
- Reduced exposure to civil and criminal liabilities under environmental laws.
- Reduced overhead costs and increased productivity through improved work processes and greater awareness.

All DOE/NV quantitative goals and schedules for 1995 were met or exceeded. Total NTS hazardous waste generation was reduced in 1995 compared to waste generated in 1994. The NTS program recycles and returns to productive use significant quantities of materials. (see Table 3.3).

The REECo Just-in-Time (JIT) supply system now accounts for nearly 90 percent of all procurement actions, providing most common use items; e.g., cleansers and lubricants, to all NTS agencies. This program has significantly reduced on-hand stores, thereby reducing administrative and handling costs, and significantly reducing waste generation due to expiration of shelf life or overstock conditions. All parties benefit in reduced waste disposal and increased productivity.

Chlorofluorocarbon (freon) recycling equipment is in place at all NTS service and maintenance centers. All freon is recovered and reused, eliminating ozone-depleting substance emissions into the atmosphere almost completely. New service personnel are trained and certified in the operation of this equipment. Previously certified workers were recertified under a Federal EPA clause recognizing primary training efforts. Approximately 80 service personnel are currently certified to operate freon recycling equipment.

The DOE/NV, its contractors, and other agencies and users serve as members of the DOE/NV Waste Minimization Task Force which conducts pollution prevention campaigns, reaching all employees as well as the surrounding community. The Task Force has developed a Pollution Prevention and Waste Minimization training course which has been concurred with by DOE/NV and is available to all DOE/NV contractors and users.

3.2.6.2 NON-NTS EG&G/EM OPERATIONS

POLICIES AND PROCEDURES

During 1995, processes were evaluated for product substitution, cross-contamination control, or site treatment. Organizational Operating Procedure No. 31-C300-004.A, "JIT Purchase Requisition Review" establishes the review requirements for the procurement of hazardous materials to ensure proper tracking and appropriate substitutes are identified.

TRAINING

EG&G/EM employees and managers are trained on company policies, procedures, and rules and review waste minimization training videos. Some employees have completed the performance-based training module entitled "Introduction to Waste Minimization Techniques." Many employees received refresher training during 1995.

PRODUCT SUBSTITUTION

EG&G/EM has made progress towards substituting chemicals that have a high stratospheric ozone depletion potential with chemicals that have a lower depletion potential. Most air conditioner refrigerants at EG&G/EM facilities have been substituted with HCFC-22, which has an ozone depletion potential of five percent as compared to CFC-11 and CFC-12. Substitutions for 1,1,1-trichloroethane have either been implemented or are in the trial phase. Less hazardous janitorial chemicals have replaced existing stock to minimize variety and quantity of chemicals used and stored onsite.

POLLUTION PREVENTION OPPORTUNITY ASSESSMENTS (PPOA)

Fifteen PPOAs were completed in fiscal year 1995 (FY95). Eight of the 15 have been implemented, which has reduced the amount of waste streams or decreased the use of precious resources.

REPORTS

The 1994 annual report on Waste Generation and Waste Minimization Progress was submitted to DOE in September 1995, in accordance with the requirements of DOE Order 5400.1, "General Environmental Protection Program."

RECYCLING

Freon recycling systems capable of capturing, cleaning, and drying the freon for reuse are used for air conditioning systems EG&G/EM operates and maintains. EG&G/EM has also implemented a recycling program for HP Laser Jet II/III and Canon FAX toner cartridges. EG&G/EM recycled over 2064 lb of automotive batteries, 2,628 lb of toner cartridges, and 265,160 lb of OPSEC and high-grade paper.

TREATMENT/VOLUME REDUCTION

The RSL Photo/Video Section implemented in FY95 the following process modifications to the aerial film processors (Kodak RT-1811 and Houston VNF) to minimize potassium ferricyanide bleach consumption and associated discharges to the Clark County Sanitation District (CCSD).

The aerial film processes bleach tank's spillover and drainage are transported via a plumbing network to a Kobelcell ferricyanide bleach regeneration system. During the aerial film's bleaching process, potassium ferricyanide, the bleaching agent, is depleted, converting all metallic silver formed by development into insoluble silver salts. Potassium ferrocyanide is the by-product of this chemical reaction.

The bleach regeneration process incorporates a Nash Cell to electrolytically convert potassium ferrocyanide to potassium ferricyanide. Depleted bleach is circulated through an electrically charged cell, converting the ferrocyanide to ferricyanide with the by-products of hydroxide and hydrogen gas. The hydrogen gas discharged from the regeneration process is 5 percent of the threshold for flammability. The hydroxide is separated from the ferricyanide solution and mixed with a solution of hydrobromic acid. The bromide and water replenishment make up the requirements for an active regenerated ferricyanide bleach. The ferricyanide bleach is then pumped to a 150-gal holding tank and routed back to the aerial film processors completing the closed loop regeneration process.

The Kobelcell bleach regeneration system reduces aerial bleach consumption by 1,850 gal annually. Additionally, total cyanide discharges to the CCSD have been virtually eliminated. Since the aerial bleach regeneration system is a closed-loop process, all remaining cyanide discharges to the CCSD are associated with ferricyanide carry-over transported by the aerial film into the fixer and wash processor tanks following the bleach tanks. The following process modifications were implemented in FY95 to eliminate total cyanide discharges associated with aerial film carry-over.

The aerial processor's fixer chemical tank spillover and drainage are pumped to a holding tank containing silver bearing chemicals, pH adjusted, electrolytically desilvered, pumped through a metallic replacement column, transported to a holding tank, pH adjusted and then processed through evaporators to reduce the spent chemical's volume by up to 97 percent. The evaporators produce two products, water distillate and a dried sludge. The water distillate from the evaporators is pumped to a 4000-gal holding tank. After the water has accumulated to a set threshold in the holding tank, it is routed through a neutralization system to achieve a pH between 5.0 and 11.0. The dried sludge is accumulated in 55-gal drums for disposal. The final stage of treatment consists of routing the water distillate through a network of ion exchange columns. The columns reduce the silver concentration to a level below the permitted 6.3 ppm.

Annual non-regenerated EA-5 bleach and associated labor mixing costs equal $19,500. The annual cost for operating the Kobelcell bleach regeneration system is $9,000. Annual savings of $10,500 are realized by regenerating EA-5 bleach. Additionally, 1,800 gal of ferricyanide bleach annually discharged to the CCSD are eliminated.

MATERIAL & WASTE STREAM SUMMARY

		Total Releases				
Input Material	Annual Usage	% Recycle	% Air	% Liquid	% Solid	% Total
Hydrobromic Acid	6 gal	99	< 1.0	< 1.0	0	< 1.0
Potassium Ferricyanide	15,000 gal	99	< 1.0	< 1.0	0	< 1.0
EA-5 Bleach	1,850 gal	99	< 1.0	< 1.0	0	< 1.0
Water	150 gal	90	10	< 1.0	0	10

3.2.7 SOLID/SANITARY WASTE

During 1995, sanitary landfills were operated in Areas 9 and 23. The amount of material disposed of in each is provided in Chapter 7.0, Table 7.9.

EPA regulations promulgated in 1991 required that Class II municipal solid waste landfills; i.e., those receiving less than 20 tons per day of waste be closed by October 9, 1995. (This requirement was delayed by EPA for two years on October 5, 1995.) An agreement was made with the NDEP/BoFF which allowed the existing Class II landfill at U-10c Crater to be partially closed for accepting municipal solid waste and reopened as a less regulated Class III landfill for the acceptance of construction debris only. The partial closure plan accepted by NDEP/BoFF required the placement of a barrier layer consisting of at least four feet of native soil compacted to 90 percent. Five neutron monitoring tubes were to be placed three feet into the barrier layer and one tube outside of the landfill to detect the percolation of moisture into the soil.

Construction of the barrier began on October 16, 1995, and by December 14, 1995, the neutron monitoring tubes were in place. A Construction Summary Report was prepared for NDEP/BoFF's acceptance, and the landfill will reopen in mid-January. Total cost for the project was approximately $700,000.

Table 7.9 in Chapter 7.0 gives the amount of hydrocarbon contaminated soil disposed of in the Area 6 landfill in 1995. The O&M Plan for this facility was approved in 1995 to allow for the disposal of gasoline-contaminated soil. The revision indicates the sampling and analysis to be done to ensure lead and benzene concentrations meet the state criteria for disposal in the hydrocarbon landfill.

Eleven inactive landfills had been identified by the NDEP/BoFF which required closure according to solid waste regulations promulgated prior to 1991. Discussions with NDEP/BoFF personnel allowed one of these sites (a crater used as landfill) to be considered closed for purposes of this corrective action program. Work plans were prepared and accepted by NDEP/BoFF prior to commencing closure work. Each work plan requires post-closure inspection and maintenance for a minimum of five years. Closure work started in mid-October. Eight of the remaining ten sites were completed by the end of 1995.

The NTS Cleanup Project, initiated in 1994, is an activity devised to remove and dispose of or recycle, where applicable, nonhazardous debris and material and readily identifiable hazardous debris and material. Approximately 681,000 lbs of solid waste were removed from Area 2 and properly disposed of. Also, approximately 62,000 lbs of salvageable materials, consisting primarily of lead-acid batteries, were salvaged and subsequently recycled.

3.2.8 ENVIRONMENTAL RESTORATION/REMEDIATION ACTIVITIES

The NTS has an ongoing Environmental Restoration Program (ERP) for the characterization and restoration of contaminated facilities or areas. In 1995, characterization and restoration activities associated with the ERP included:

- Post closure monitoring of the Mercury Landfill Hazardous Waste Trenches RCRA Closure Unit was conducted on a quarterly basis for soil moisture. Due to excessive precipitation in the winter months, monthly monitoring was conducted during the first six months of the year. Monthly inspections of the two covers also occurred. The covers are performing as designed with no releases occurring. Monthly inspections of the unit indicated that the surface drainage needs to be modified to prevent standing water. A preliminary drainage design was completed in August. This work as well as maintenance to neutron access tubes is planned for 1996.
- Characterization of the U3fi Injection Well RCRA Closure Unit was completed in August. Unit closure was initiated on September 5 and it was closed on September 28, 1995.
- Eight underground storage tanks were removed under the Environmental Restoration Program and one was removed under Defense Programs. All tank contents were removed and properly disposed of, and the soil around the tanks was sampled for proper site closure.
- Remediation was completed at the Area 2 Vertical Pull Test Facility with the excavation and disposal of the lead and petroleum hydrocarbon impacted soils. Impact to the soils was the result of the use of lead containing pipe lubricants during pipe thread testing and cleaning activities.
- Preliminary characterization of the Area 23, Building 650 Leachfield RCRA Closure Unit was conducted through a hole in the bottom of the distribution box. Results indicate that fission products are present below the distribution box. Additional characterization will be conducted in 1996 to determine site conditions and remedial options.

- The Area 2, Bitcutter Shop and Lawrence Livermore National Laboratory (LLNL) Post Shot Containment Building were removed. In March, approximately 90 gal of lead impacted sludge was removed from one injection well. The Bitcutter Shop and LLNL Post Shot Containment Building characterization was completed in May. All investigation derived waste was properly managed and disposed of in November 1995 (seventy-two 55-gal drums).

- Decommissioning and decontamination activities of the Area 25 Jr. Hot Cell began in August and were completed in September to meet a DOE/HQ and NV milestone.

- Fourteen abandoned leachfields were sampled for a wide range of parameters for preliminary characterization. A report summarizing the activities and findings was submitted to DOE/NV. Additional characterization will be required to determine site conditions and disposal options.

- The Area 12 Fleet Operations Steam Cleaning Discharge Area was sampled for a wide range of parameters to evaluate site conditions. Additional sampling is anticipated during 1996 to determine remedial options and waste volumes for disposal.

- A total estimated cost was prepared for the environmental restoration/remediation of the former Areas 2 and 3 Camps under Defense Programs.

- Preliminary characterization of the Area 6 Steam Cleaning Effluent Ponds RCRA Closure Unit was conducted.

- Twelve UST sites, where the tanks had been removed in prior years, were remediated in 1995.

3.2.9 RADIATION PROTECTION

3.2.9.1 NTS OPERATIONS

Redesign of the environmental surveillance networks on the NTS during 1995 resulted in a reduction of monitoring costs while maintaining necessary and sufficient coverage. Results of this monitoring during 1995 indicated full compliance with the radiation exposure guidelines of DOE Order 5400.5, "Radiation Protection of the Public and the Environment" and the 40 C.F.R. 141 National Primary Drinking Water Regulations. Onsite air monitoring results showed average annual concentrations ranging from 0.009 percent of the DOE Order 5400.5 guidelines for ^{85}Kr in air to 1.6 percent of the guidelines for $^{239+240}$Pu in air. Drinking water supplies on the NTS contained less than 0.001 percent of the DOE Order 5400.5 guideline and less than 0.004 percent of the National Primary Drinking Water Regulation for tritium. Supply wells contained 0.0 percent of the DOE Order 5400.5 guideline for $^{239+240}$Pu.

3.2.9.2 NON-NTS EG&G/EM OPERATIONS

Results of environmental monitoring at the off-NTS EG&G/EM operations doing radiological work during 1995 indicate full compliance with the radiation exposure guidelines of DOE Order 5400.5. An unplanned radioactive emission at the Atlas facility in North Las Vegas caused by inspection of stored tritium foils released about 123 mCi. Onsite air monitoring results at this facility showed a maximum average annual concentration of 28.5 pCi/m^3 (1.1 Bq/m^3) for tritium in air. Using CAP88-PC, this release caused a maximum EDE to an offsite person of 0.59 µrem, far below the 10 mrem EPA limit. No radioactive or nonradioactive surface water/liquid discharges, subsurface discharges through leaching, leaking, seepage into the soil column, well disposal, or burial occurred at any of the EG&G/EM operations. Use of radioactive materials is primarily limited to sealed sources; however, unsealed tritium sources are used in some operations. Facilities which use radioactive sources or radiation producing equipment, with the potential to expose the general population outside the property line to direct radiation, are: STL during the operation of the sealed tube neutron generator; STL during operation of the Febetron; the RSL at NAFB; and the Atlas, NLVF A-1 *Source*

Range. Sealed sources are tested every six months to ensure there is no leakage of radioactive material. Fence line radiation monitoring was conducted at these facilities. At least two TLDs are at the fence line on each side of the facility. The TLDs are exchanged quarterly with additional control TLDs kept in a shielded safe. The monitoring data were consistent with previous data indicating no exposures to the public from any of the monitored facilities.

3.2.10 ENVIRONMENTAL COMPLIANCE AUDITS

3.2.10.1 TIGER TEAM COMPLIANCE ASSESSMENT

The DOE Tiger Team Compliance Assessment of the NTS conducted from October 30 to December 1, 1989, was part of a 10-point initiative by the Secretary of Energy to conduct independent oversight compliance and management assessments of environmental, safety, and health programs at DOE facilities. The Team identified 149 deficiencies including 45 environmental "findings" in its assessment, none of which reflected situations which presented an immediate risk to public health or the environment. In 1995, the last of these deficiencies was closed.

3.2.10.2 NTS ENVIRONMENTAL SURVEYS

In March 1993, an environmental compliance assessment was conducted by REECo of all active REECo facilities and work sites at the NTS. Numerous deficiencies were corrected at the time of the assessment. Those deficiencies which were not correctable were assigned a system deficiency number and are being formally tracked. The assessment identified approximately 55 of these system deficiencies. As of the end of 1995, two of the identified deficiencies remain open. As part of the Environmental Corrective Action Plan developed to prevent these problems from reoccurring, line management is now required to perform monthly compliance inspections of their facilities, and to enter any deficiencies into an Automated Deficiency Tracking System (ADTS) for corrective action tracking. During 1995 line management inspections found 88 (42 percent) of the 209 environmental deficiencies that were entered into the ADTS.

3.2.11 OCCURRENCE REPORTING

Occurrences are environmental, health, and/or safety-related events which are reported in several categories in accordance with the requirements of DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information." The reportable occurrences for both on- and off-NTS facilities appears in Tables 3.4 and 3.5, respectively. An analysis of occurrences for 1995 as required by the Order showed that there were four main reasons for them: (1) management problems - 50 percent, (2) personnel error -18 percent, (3) procedural problems - 11 percent, and (4) external phenomena - 9 percent.

3.2.12 LEGAL ACTIONS

On June 28, 1994, the state of Nevada filed a Complaint for Declaratory Judgement and Injunction against DOE in the U.S. District Court in Nevada. Nevada is seeking declaratory judgements that DOE has failed to comply with NEPA requirements at the NTS by not issuing a sitewide EIS for all major federal actions at the NTS and seeking orders to halt shipments of low-level radioactive waste from Fernald, as well as all other transportation, receipt, storage, and disposal of mixed waste, hazardous waste, and defense waste. The state is also seeking to enjoin DOE from pursuing any "Weapons Complex" activities, including nuclear testing, research, and development that will significantly impact the environment until publication of the sitewide EIS. In January 1995, the Court dismissed claims regarding an EIS due to mootness since DOE/NV had already begun the scoping process for a sitewide EIS, dismissed Nevada's claims regarding shipment of Fernald low-level waste, and dismissed claims regarding contents of the EIS as not yet ripe for adjudication. The remaining claim is regarding disposal of low-level radioactive waste from other offsite disposal facilities. Discovery is proceeding in this case.

DOE/NV and REECo received a notification letter regarding alleged potentially responsible party status connected with a commercial disposal site in California. The California Department of Toxic Substances Control notified DOE/NV that Omega Chemical Co., a hazardous waste treatment and storage facility which recently declared bankruptcy and is unable to clean up the site, possessed records indicating that DOE/NV had shipped hazardous waste to the site between January 1988 and January 1992. Jurisdiction of this site has been transferred to the U.S. EPA.

3.3 PERMIT SUMMARY

For facilities used in the operation and maintenance of the NTS and non-NTS facilities, the DOE/NV contractors providing such operation and support activities for the DOE/NV have been granted numerous permits by the appropriate regulatory authorities. In addition to the existing number of permits in 1995 (Table 3.6) the EOD Facility and the Area 5 Storage Facility of the RCRA Part B permit application were permitted, while the other units in the application are in various stages of NDEP review for permission to construct or operate.

Table 3.1 NESHAP Notifications to the State of Nevada for NTS Asbestos Activities - 1995

Area	Building	Friable Asbestos	Date
23	1000	32 Square Feet of Ceiling Tiles	March 1995
23	Manholes Beside Bldgs. 116 & 156	25 Square Feet of Asbestos Cloth Wrapped Around Cable	April 1995
23	152[a]	435 Square Feet of Silver Felt-Like Roof Coating	June 1995

(a) Project also Reported to EPA Region 9.

Table 3.2 Underground Storage Tank Activities - 1995

Area/Facility	Tank Number	Action Taken
02/Vert. Pull Test	02-VPTF-1	Removal
12/B-Tunnel	12-B-1	Removal
12/Comm Bldg.	12-COMM-1	Removal
23/Warehouse 7	23-W7-1	Removal
23/Fire Station	23-425-1	Removal
23/JTO Bldg.	23-600-1	Removal
25/R-MAD	25-3110-2	Removal
25/E-MAD	25-3900-1	Removal
26/Disassembly Bldg.	26-2201-1	Removal

Table 3.3 NTS Recycling Activities - 1995

Material	Quantity
Office Paper	165 tons
Aluminum (bulk)	125 tons
Aluminum cans	0 tons
Used Motor Oil	82 tons
Cable	280 tons
Light Iron	2500 tons
Heavy Iron	1160 tons
Brass & Copper	0 tons
Batteries	359 tons
Tires	191 tons
Cardboard	1 ton
Lead	142 tons

Table 3.3 (NTS Recycling Activities - 1995, cont.)

Material	Quantity
Off-NTS Recycling Activities, NLV Facility	
Automotive Batteries	2,064 lbs
Toner Cartridges (3#Cart)	2,628 lbs
SEC/High-Grade Paper	265,160 lbs
Silver Recovery	5,666 g
Mixed Paper	75,700 lbs
Cardboard	26,150 lbs
Aluminum Cans	5,640 lbs
Used Oil	250 gal

Table 3.4 Off-Normal Occurrences at NTS Facilities

Date	Report Number	Description	Status
02/02/95	NVOO-REED-OMDO-1995-0001	Draining Diesel from Forklift, 15 - 20 gal Spilled, Area 25	Complete
02/09/95	NVOO-REEC-OMDO-1995-0002	Diesel Fuel Spill from 2000-gal Fuel Tank Blown Over by Wind, Area 2	Complete
02/15/95	NVOO-REEC-EHDO-1995-0002	Ethylene Glycol Spill Due to Motor Vehicle Accident	Complete
03/15/95	NVOO-REEC-EMD0-1995-0001	FOAV for Improper Storage of Lead, T-2 Site, Area 2	Complete
04/12/95	NVOO-REEC-OMDO-1995-0007	While Filling 5-gal cans, 75 gal Spilled, Area 1	Complete
05/25/95	NVOO-REEC-EMDO-1995-0002	Petroleum Leakage from Abandoned Underground Storage Tank, B-tunnel Area 12	Complete
09/19/95	NVOO-REEC-OMDO-1995-0004	Petroleum Leakage from Abandoned UST, Area 12 Camp	Complete

Table 3.5 Off-Normal Environmental Occurrences at Off-NTS Support Facilities

Date	Report Number	Description	Status
10/02/95	NVOO-EGGO-NLVF-1995-0001	Curtailment of Operations of A-1 Source Range at North Las Vegas Facilities	Pending
10/02/95	NVOO-EGGO-NLVF-1995-0002	Tritium Contamination of Workplace and Equipment	Pending
10/02/95	NVOO-EGGO-NLVF-1995-0003	Notification of Significant Non-Compliance Violation, Clark County Sanitation Pretreatment Standard	Complete

Table 3.6 Environmental Permit Summary - 1995

	Air Pollution	Wastewater	Drinking Water	Number of EPA Generator User IDs	Nevada Hazardous Materials Storage Permit	Endangered Species Act
NTS	16	9	8	1[a]	1[b]	4
EG&G, NTS, LGFSTF					1	
Las Vegas Area Operations Office	15[c]	2		2	2	
Amador Valley Operations	1			1	1	
Los Alamos Operations				1		
Special Technologies Laboratory (Santa Barbara)	1	2		1	1	
Washington Aerial Measurements Dept.						
TOTAL	33	13	8	6	6	4

(a) Biennial Report Required.
(b) Area 5, Liquefied Gaseous Fuels Spill Test Facility.
(c) Routine Monitoring of Emissions is Not Required.

4.0 ENVIRONMENTAL PROGRAM INFORMATION

The environmental monitoring and compliance programs for the Nevada Test Site (NTS) and offsite EG&G Energy Measurements, Inc. (EG&G/EM) facilities consist of radiological monitoring, nonradiological monitoring, and environmental permits and operations compliance.

4.1 RADIOLOGICAL MONITORING

There are two radiological monitoring programs associated with the NTS, one onsite and the other offsite. The onsite program is conducted by several organizations. Reynolds Electrical & Engineering Co., Inc. (REECo), the operations & maintenance contractor for the NTS, was responsible for environmental surveillance and effluent monitoring. Several other organizations, such as the Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), Desert Research Institute (DRI), and the U. S. Environmental Protection Agency (EPA) also make radiological measurements onsite. The offsite program is conducted by the EPA's Radiation Sciences Laboratory in Las Vegas, Nevada (RSL-LV).

4.1.1 ONSITE MONITORING

At the NTS radiological effluents may originate from tunnels, from underground test event sites (at or near surface ground zeros [SGZs]), and from facilities where radioactive materials are either used, processed, stored, or discharged. All of these sources have the potential to, or are known to discharge radioactive effluents into the environment. Two types of monitoring operations are used for these sources: (1) effluent monitoring, which measures radioactive material collected at the point of discharge; and (2) environmental surveillance, which measures radioactivity in the general environment.

Table 4.1 is a summary of the routine environmental surveillance program. Air sampling is conducted for radioactive particulates, halogens, noble gases, and tritiated water vapor (see Figure 4.1 for sampling locations). Ambient gamma radiation monitoring is conducted throughout the NTS using thermoluminescent dosimeters (TLDs) (see Figure 4.2). Water from groundwater wells, springs, well reservoirs, water taps, and waste disposal ponds is analyzed for radioactivity (see Figures 4.3 and 4.4).

4.1.1.1 CRITERIA

DOE Order 5400.1, "General Environmental Protection Program," establishes environmental protection program requirements, authorities, and responsibilities for Department of Energy (DOE) operations. These mandates require compliance with applicable federal, state and local environmental protection regulations. Other DOE directives applicable to environmental monitoring include DOE Order 5480.11, "Radiation Protection for Occupational Workers"; DOE Order 5480.1B, "Environmental, Protection, Safety, and Health Protection Program for Department of Energy Operations"; DOE Order 5484.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements"; DOE Order 5400.5, "Radiation Protection of the Public and the Environment"; and DOE/EH-0173T, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance."

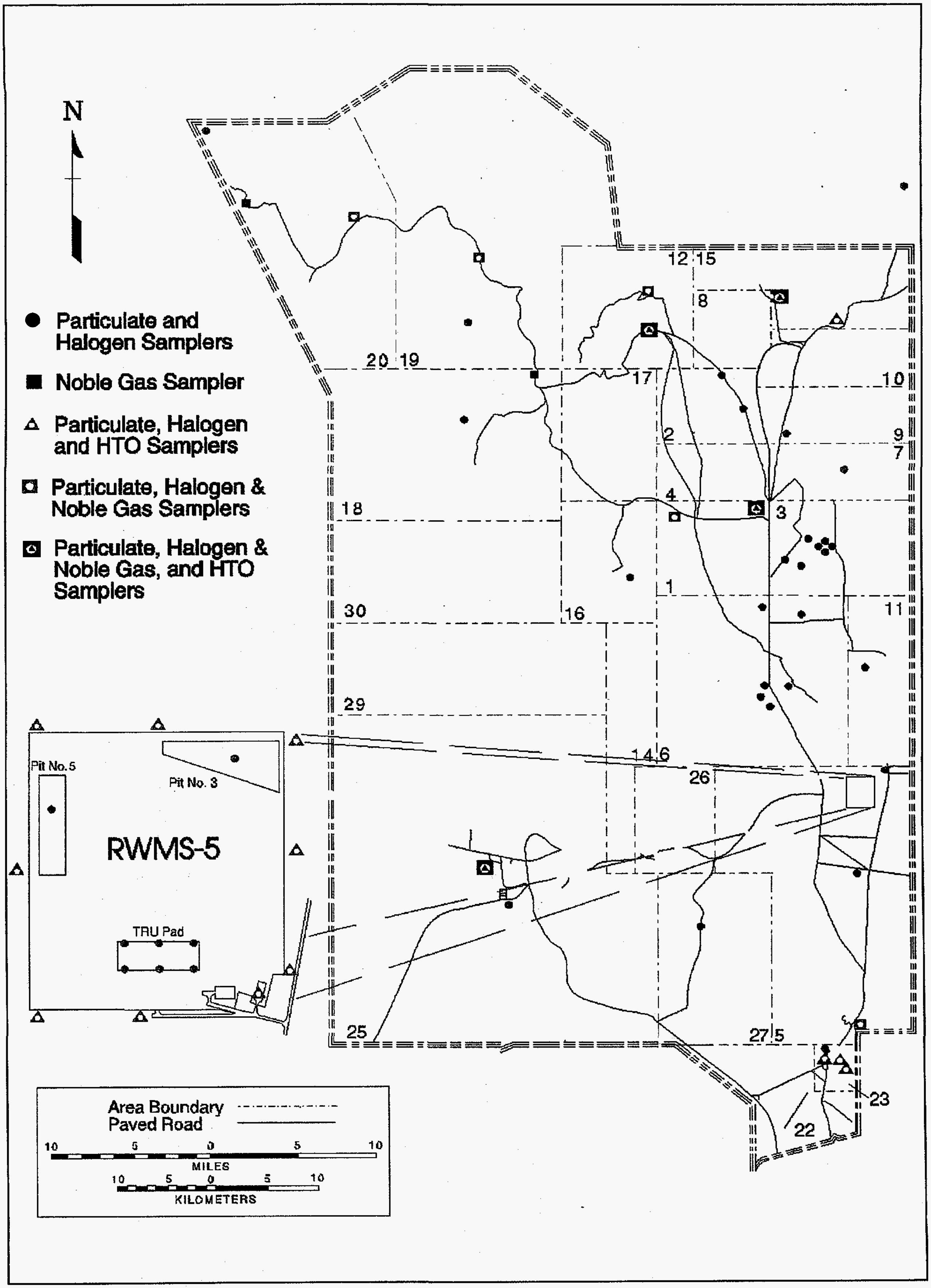


Figure 4.1 Air Sampling Stations on the NTS - 1995

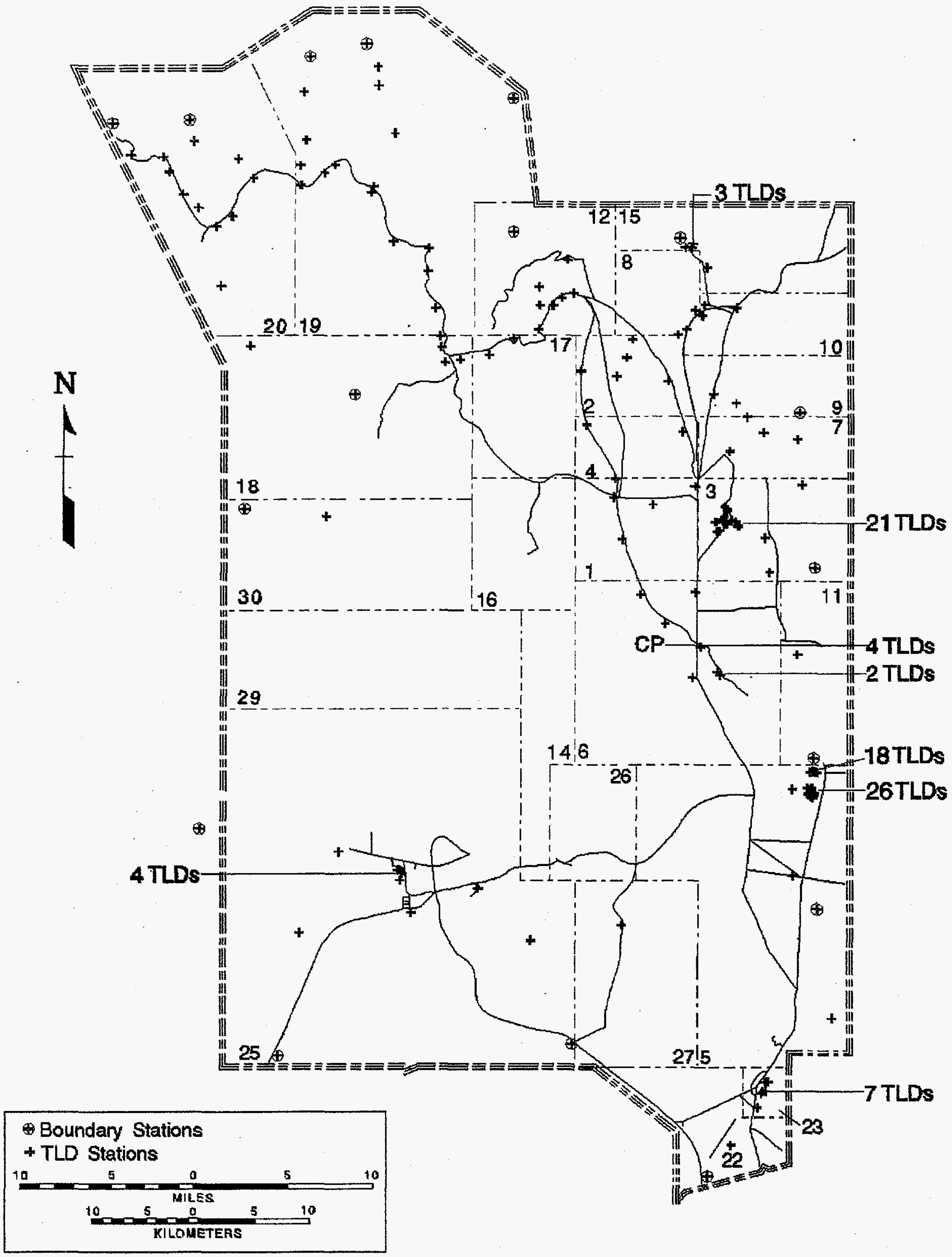


Figure 4.2 Thermoluminescent Dosimeter Stations on the NTS (+) - 1995

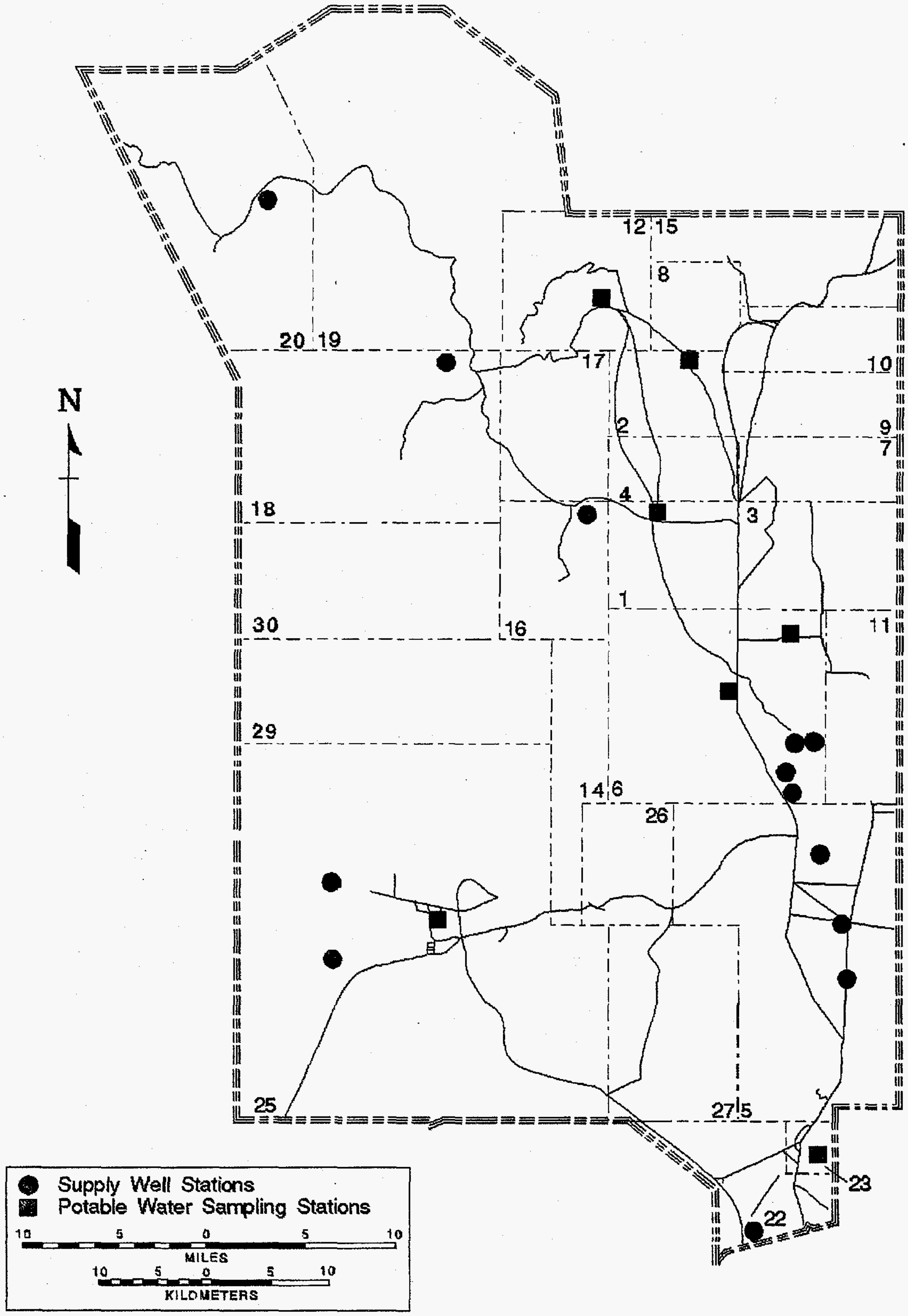


Figure 4.3 Supply Well and Potable Water Sampling Stations on the NTS - 1995

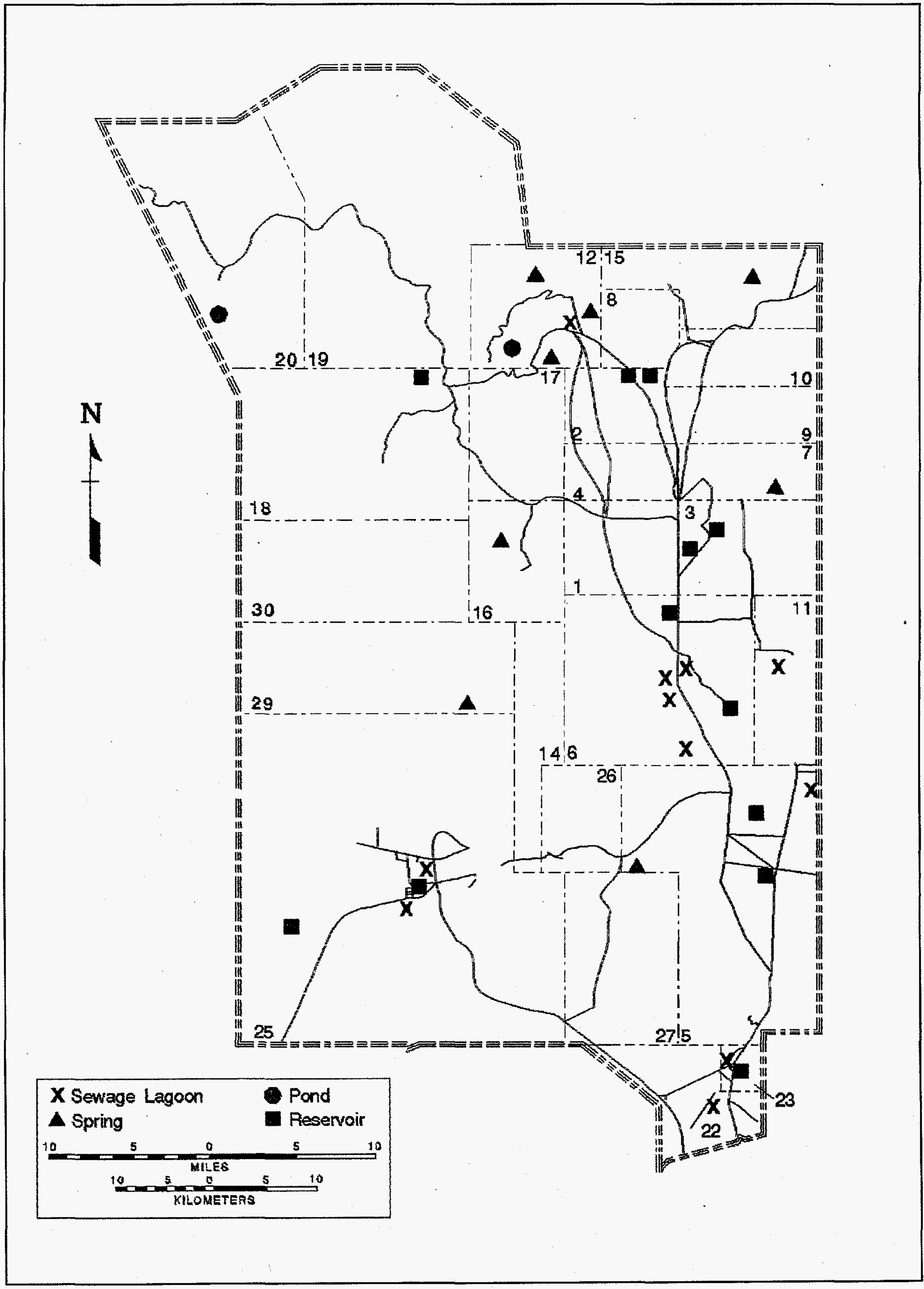


Figure 4.4 Surface Water Sampling Locations on the NTS - 1995

4.1.1.2 EFFLUENT MONITORING

During 1995, effluent monitoring at the NTS involved tunnel and groundwater characterization well discharge waters. Due to the continuation of the moratorium on nuclear testing throughout the year, no effluent monitoring for nuclear tests was required.

LIQUID EFFLUENT MONITORING

Radiologically contaminated water was discharged only from E Tunnel in Rainier Mesa (Area 12). N and T Tunnels were sealed to prevent liquid effluent discharges. A grab sample was collected quarterly from the tunnel's effluent discharge point and from the tunnel's containment pond. These samples were analyzed for tritium (^{3}H), gross beta, ^{238}Pu, $^{239+240}$Pu and gamma emitters. In addition, an annual sample was analyzed for ^{90}Sr. Tritium was the radionuclide most consistently detected at the tunnel sites. Other radionuclides were detected infrequently.

In previous years the flow rate of liquid effluents from the tunnel was measured by equipment installed by the DRI, University of Nevada. These previous measurements were used to quantify the total radiological effluent release for 1995. The quarterly average concentration of the radionuclide of interest in the effluent was multiplied by the total quantity of liquid discharged based on the average flow rate for the quarter and the quarterly values summed to obtain the annual value.

This year, groundwater characterization wells drilled near a nuclear test cavity produced water containing high levels of tritium. This water was analyzed as it was discharged to containment ponds and the volume calculated from the pond area and liquid depth.

Typical lower limits of detection for water analyses were:

- Gross α: 1×10^{-9} µCi/mL (0.037 Bq/L)
- Gross ß: 1×10^{-9} µCi/mL (0.037 Bq/L)
- Gamma Spectroscopy: 0.1 to 20×10^{-7} µCi/mL (0.3 - 74 Bq/L) (Using a ^{137}Cs standard)
- Tritium (conventional): 5×10^{-7} µCi/mL (18.5 Bq/L)
- Tritium (enrichment): 2×10^{-8} µCi/mL (0.74 Bq/L)
- ^{90}Sr: 2×10^{-10} µCi/mL (7.4×10^{-3} Bq/L)
- ^{226}Ra: 1×10^{-9} µCi/mL (0.074 Bq/L)
- ^{238}Pu: 2×10^{-11} µCi/mL (7.4×10^{-4} Bq/L)
- $^{239+240}$Pu: 2×10^{-11} µCi/mL (7.4×10^{-4} Bq/L)

AIRBORNE EFFLUENT MONITORING

As the moratorium on nuclear testing was continued throughout the year, airborne effluent monitoring was not required on Pahute Mesa.

4.1.1.3 ENVIRONMENTAL SURVEILLANCE

Environmental surveillance was conducted onsite throughout the NTS. Equipment at fixed, continuously sampling stations was used to monitor for radioactive materials in the air. Surface water and groundwater samples were routinely collected at pre-established locations and analyzed for radioactivity. Ambient gamma exposures were measured with TLDs placed at fixed locations.

AIR MONITORING

The environmental surveillance program maintained samplers designed to detect airborne radioactive particles, radioactive gases (including radioiodines and noble gases), and radioactive hydrogen (^{3}H) as water vapor in the form ^{3}H^{3}HO or ^{3}HHO.

Air sampling units were located at 57 stations on the NTS (Figure 4.1) to measure radioactive particulates and halogens. These stations included 15 inside radioactive waste management facilities. By year's end, the number of stations was reduced to 45. Access, worker population, geographical coverage, and availability of electrical power were considered in site selection. During this year, air samplers powered by solar photovoltaic-battery systems were placed in nine contaminated areas where commercial power was unavailable.

An air sampling unit consisted of a positive displacement pump drawing approximately 140 L/min (5 cfm) of air through a nine-centimeter diameter Whatman GF/A glass fiber filter for trapping particulates. This was followed by a charcoal cartridge for collecting radioiodines. The filter and cartridge were mounted in a plastic, cone-shaped sample holder. A dry-gas meter measured the volume of air sampled during the sampling period (typically seven days). The unit collected approximately 1400 cubic meters of air during the sampling period.

The filters were held for no less than five nor more than seven days prior to analysis to allow naturally occurring radon and its daughter products to decay. Gross beta counting was performed with a gas-flow proportional counter for 20 minutes. The lower limit of detection for gross beta, assuming typical counting parameters, was 2×10^{-15} µCi/mL (7.4×10^{-5} Bq/m^3) using a ^{90}Sr calibration source. Gamma spectroscopy of the filter and cartridge was accomplished using germanium detectors with an input to a 2000-channel spectrometer. This spectrometer was calibrated at 1 kiloelectronvolt (keV) per channel from 0.02 to 2 megaelectronvolts (MeV) using a National Institute of Standards and Technology (NIST) traceable mixed radionuclide source. The lower limit of detection for gamma spectroscopy is 5×10^{-15} µCi/mL (1.8×10^{-4} Bq/m^3) for ^{137}Cs.

Weekly air samples collected for radioactive waste operations in Area 3 and 5 were composited on a monthly basis and radiochemically analyzed for ^{238}Pu and $^{239+240}$Pu. The weekly air filters collected from all other locations were composited quarterly and analyzed for plutonium. The filters were subjected to an acid dissolution and an ion-exchange recovery on a resin bed. Plutonium was deposited by plating on a stainless steel disk. The chemical yield of the plutonium was determined with an internal ^{242}Pu tracer. Alpha spectroscopy was performed utilizing a solid-state silicon surface barrier detector. The lower limit of detection for ^{238}Pu and $^{239+240}$Pu was approximately 1×10^{-17} µCi/mL (3.7×10^{-7} Bq/m^3).

Initially, radioactive noble gases ^{85}Kr and ^{133}Xe were continuously sampled at ten locations. This network was reduced to three locations by year's end, and ^{133}Xe analysis was discontinued. The noble gas samplers maintained a steady sampling flow rate of approximately 0.08 L/min. These sampling units were housed in a metal tool box with three metal air bottles attached to the sampling units with short hoses. A vacuum was maintained on the first bottle by pumping the sample into the other two bottles. The two collection bottles were exchanged weekly and contained a sample volume of about 400 L each at standard conditions.

The noble gases were separated from the atmospheric sample by cryogenic gas fractionation. Water and carbon dioxide were removed at room temperature, and the Kr and Xe were collected on charcoal at liquid nitrogen temperatures. These gases were transferred to a molecular sieve where they were separated from any remaining gases and from each other. The krypton was transferred to a scintillation vial and counted on a liquid scintillation counter. The lower limit of detection for ^{85}Kr was 3×10^{-12} µCi/mL (0.1 Bq/m^3).

Airborne tritiated water vapor was initially monitored at 17 permanent locations throughout the NTS and at two temporary locations for preoperational monitoring at the Liquid Waste Treatment Facility. For this monitoring, a small pump drew air continuously into the sampler at approximately 0.4 L/min, the total volume being measured with a dry gas meter. The tritiated water vapor was removed from the air stream by a silica-gel drying column followed by a drierite column. These columns were exchanged every two weeks. Appropriate aliquots of condensed moisture were obtained by heating the silica gel. The tritium activity was then obtained by liquid scintillation counting. The median Minimum Detectable Concentration(MDC) for tritiated water vapor analysis was 2×10^{-12} µCi/mL (0.074 Bq/m^3) of air.

AMBIENT GAMMA MONITORING

Ambient gamma monitoring was conducted at 194 stations within the NTS (Figure 4.2) through use of TLDs, later reduced to 168 stations. The dosimeter used was the Panasonic UD-814AS environmental dosimeter, consisting of four elements housed in an air-tight, water-tight, ultraviolet-light-protected case. One element, made of lithium borate, was only slightly shielded in order to measure low-energy radiation. The other three elements, made of calcium sulfate, were shielded by 1000 mg/cm^2 of plastic and lead to monitor penetrating gamma radiation only. TLDs were deployed in a holder placed about one meter above the ground and exchanged quarterly. Locations were chosen at the site boundary, or where operations or ground contamination occurred.

WATER MONITORING

Water samples were collected from selected potable tap-water points, water supply wells, natural springs, open reservoirs, sewage lagoons, and containment ponds. The frequency of collection and types of analyses performed for these types of samples are shown in Table 4.1. Sampling locations are shown on Figures 4.3 and 4.4.

A 500-mL aliquot was taken from the water sample, placed in a plastic bottle, and counted for gamma activity with a germanium detector. A 2.5-mL aliquot was used for ^{3}H analysis by liquid scintillation counting. The remainder of the original sample was evaporated to 15 mL, transferred to a stainless steel counting planchet, and evaporated to dryness after the addition of a wetting agent. Alpha and/or beta analyses were accomplished by counting the planchet samples for 100 minutes in a gas-flow proportional counter.

Tritium enrichment analyses were performed by concentrating the volume and tritium content of a 250 mL sample aliquot to 10 mL by electrolysis of the basic solution and analyzing a 5 mL portion of the concentrate by liquid scintillation counting.

The ^{226,228}Ra concentrations were determined from low-background gamma spectrometric analyses of radium sulfate. The samples were prepared by adding a barium carrier and ^{225}Ra tracer to 800 mL of sample, precipitating the barium and radium as a sulfate, separating the precipitate, and counting for 500 minutes.

The radiochemical procedure for plutonium was similar to that previously described in this chapter under "Air Monitoring." Alpha spectroscopy was used to measure any ^{238}Pu, $^{239+240}$Pu, and the ^{242}Pu tracer present in the samples.

WASTE MANAGEMENT SITE MONITORING

Environmental surveillance on the NTS included Radioactive Waste Management Sites (RWMS). These sites are used for the disposal of low-level radioactive waste (LLW) from the NTS and other DOE facilities. Shallow disposal in trenches, pits, and augured shafts, was accomplished at the Area 5 RWMS (RWMS-5) and in subsidence craters at the Area 3 RWMS (RWMS-3).

RWMS-5 monitoring included 17 permanent air particulate/halogen sampling stations, nine permanent tritiated water vapor sampling stations, and 26 TLD stations placed inside and around the site. The RWMS-3 is monitored by four air particulate/halogen sampling stations with several TLD stations located nearby.

4.1.1.4 SPECIAL ENVIRONMENTAL STUDIES

The Basic Environmental Compliance and Monitoring Program (BECAMP) was involved in special studies at the NTS that focused on the movement of radionuclides through the environment and the resultant dose to man. BECAMP uses the past accomplishments of two former DOE/NV-sponsored programs at the NTS, the Nevada Applied Ecology Group (NAEG) and the Radionuclide Inventory and Distribution Program (RIDP) in ongoing efforts to design effective programs to assess changes over time in the radiological conditions on the NTS, update human dose-assessment models, and provide information to DOE/NV for site restoration projects and compliance with environmental regulations.

In 1995, DOE/NV reviewed the ecological monitoring studies conducted under BECAMP over the past eight years. These studies monitored the flora and fauna on the NTS to assess changes in ecological conditions over time. Data were summarized from previous years' studies of vegetation, small mammals, and lizards conducted on disturbed and undisturbed areas of the NTS. Data for these studies were not collected in 1995.

4.1.2 OFFSITE MONITORING

Under the terms of an Interagency Agreement between DOE and EPA, the Environmental Monitoring Systems Laboratory, Las Vegas, (EMSL-LV) conducts the Offsite Radiation Safety Program (ORSP) in areas surrounding the NTS. In October 1995 these activities were assumed by the RSL-LV which is assigned to EPA's Office of Radiation and Indoor Air. The largest component of the RSL-LV program is routine monitoring of potential human exposure pathways. Public information and community assistance activities constitute a second component.

Due to the continuing moratorium on nuclear weapons testing, only readiness exercises were conducted in 1995. For each of the three tests, RSL-LV senior personnel served on the Test Controller's Scientific Advisory Panel and on the EPA offsite radiological safety staff. Routine offsite environmental monitoring for National Emission Standards for Hazardous Air Pollutants (NESHAP), DOE orders 5400.1, 5400.5, and 10 C.F.R. 834 continued throughout 1995.

Environmental monitoring networks, described in the following subsections, measure radioactivity in air, milk, and groundwater. These networks monitor the major potential pathways of radionuclide transfer to man. Ambient gamma radiation levels are monitored using Reuter-Stokes pressurized ion chambers (PICs) and Panasonic TLDs. Groundwater on and in the vicinity of the NTS is monitored in the Long-Term Hydrological Monitoring Program (LTHMP). Data from these monitoring networks are used to calculate an annual exposure dose to the offsite residents.

A decreased number of Community Radiation Monitoring Program (CRMP) stations that were established at prominent locations in a number of offsite communities continued to operate. The CRMP stations contain samplers for several of the monitoring networks and are managed by local residents. The DRI is a cooperator with RSL-LV in the CRMP.

4.1.2.1 AIR MONITORING

The inhalation of radioactive airborne particles can be a major pathway for human exposure to radiation. The atmospheric monitoring networks are designed to detect environmental radioactivity from both NTS and non-NTS activities. Data from atmospheric monitoring can be used to determine the concentration and source of airborne radioactivity and to project the fallout patterns and durations of exposure to man. Atmospheric monitoring networks have included the Air Surveillance, Noble Gas, and Atmospheric Moisture (Tritium-in-Air) Networks. The noble gas and tritium-in-air networks were inactivated in 1994.

The Air Surveillance Network (ASN) was originally designed to monitor the areas within 350 km (220 mi) of the NTS. Due to the current moratorium on nuclear weapons testing, DOE began reducing the area of the offsite monitoring networks to within approximately 130 km (80 mi) of the NTS. Station location depends in part on the availability of electrical power and a resident willing to operate the equipment. This continuously operating network is supplemented by a Standby Air Surveillance Network (SASN) encompassing the contiguous states west of the Mississippi River. Standby samplers are identical to those used at the active stations and are operated by state and municipal health department personnel or by other local residents.

During 1995 the ASN consisted of 20 continuously operating sampling stations as shown in Figure 4.5 and 73 standby stations.

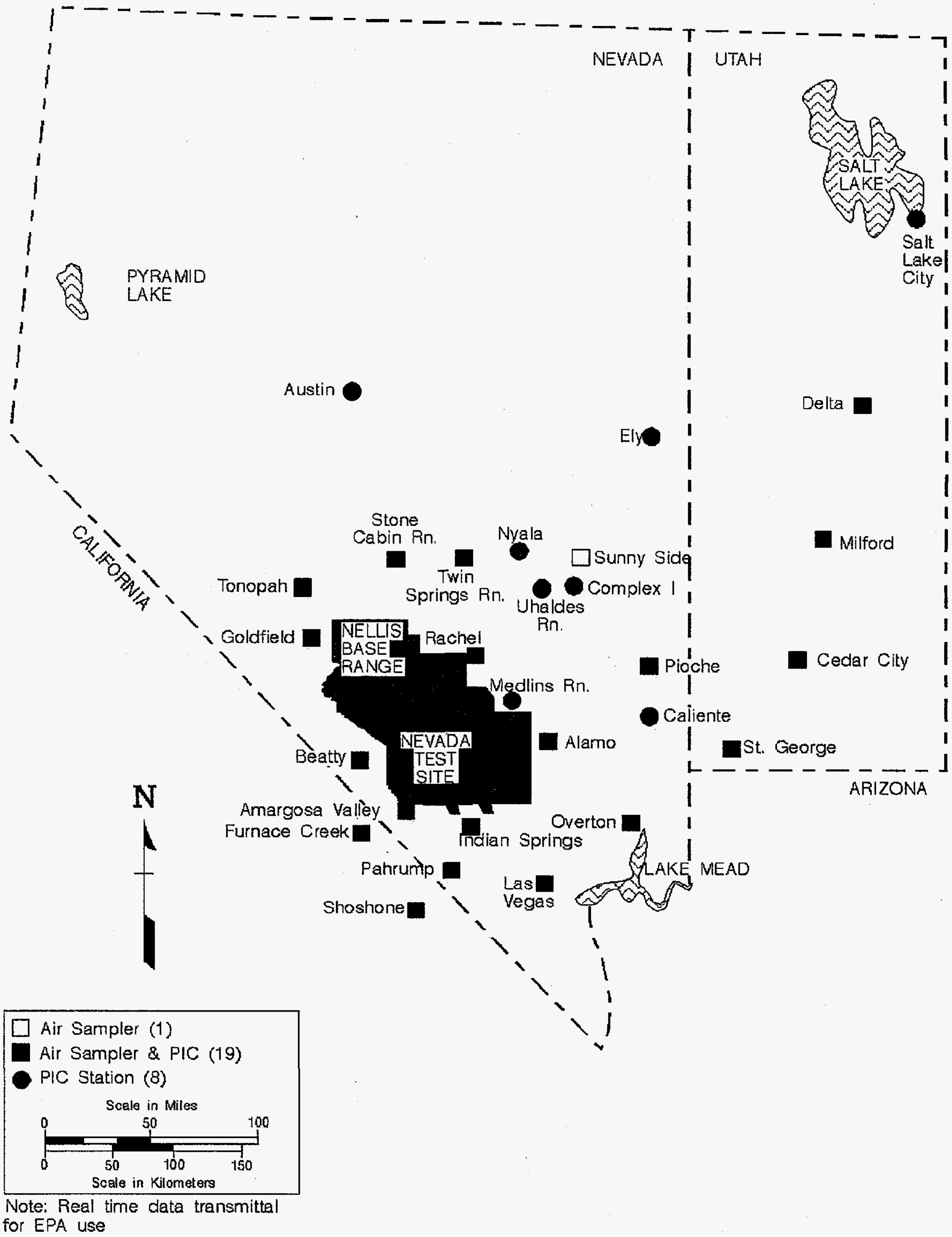


Figure 4.5 ASN and PIC Station Locations - 1995

High volume air samplers were installed at five of the stations at the beginning of the year. The SASN was not activated during 1995. Dismantling of the SASN began during the fall of 1995 and is expected to be completed by the end of March, 1996.

Low-volume air samplers at each station are equipped to collect particulate radionuclides on 5-cm (2.0-in) diameter glass-fiber filters at a flow rate of about 80 m^3 (2800 ft^3) per day. Filters are changed weekly (approximately 560 m^3 or 20,000 ft^3 of air sampled). Activated charcoal cartridges placed directly behind the filters to collect gaseous radioiodine are changed at the same time as the fiber filters. High-volume air samplers at selected stations collect particulate on 8 x 10 inch glass fiber filters at a flow rate of approximately 1,600 m^3 (58,000 ft^3) per day. Duplicate air samples are collected from two routine ASN stations each week. The duplicate samplers operate at randomly selected stations for three months and are then moved to new locations. One duplicate high-volume sampler is operated in the same manner as the low-volume sampler. High-volume samples are collected every two weeks (approximately 22,000 m^3 or 800,000 ft^3 of air is sampled).

At RSL-LV, both the glass-fiber filters and the charcoal cartridges were promptly analyzed by high-resolution gamma spectrometry. Each of the glass-fiber filters was then analyzed for gross alpha and gross beta activity 7 to 14 days after sample collection to allow time for the decay of naturally occurring radon-thoron progeny. Glass-fiber filters from selected stations were composited and analyzed for plutonium isotopes.

4.1.2.2 WATER MONITORING

As part of the LTHMP, RSL-LV personnel routinely collect and analyze water samples from locations on the NTS and from sites in the surrounding offsite areas. Due to the scarcity of surface waters in the region, most of the samples are groundwater, collected from existing wells. Samples from specific locations are collected monthly, biannually, annually, or biennially in accordance with a preset schedule. Many of the drinking water supplies used by the offsite population are represented in the LTHMP samples. Results for the LTHMP samples are discussed in Chapter 9.

4.1.2.3 MILK SURVEILLANCE NETWORK (MSN)

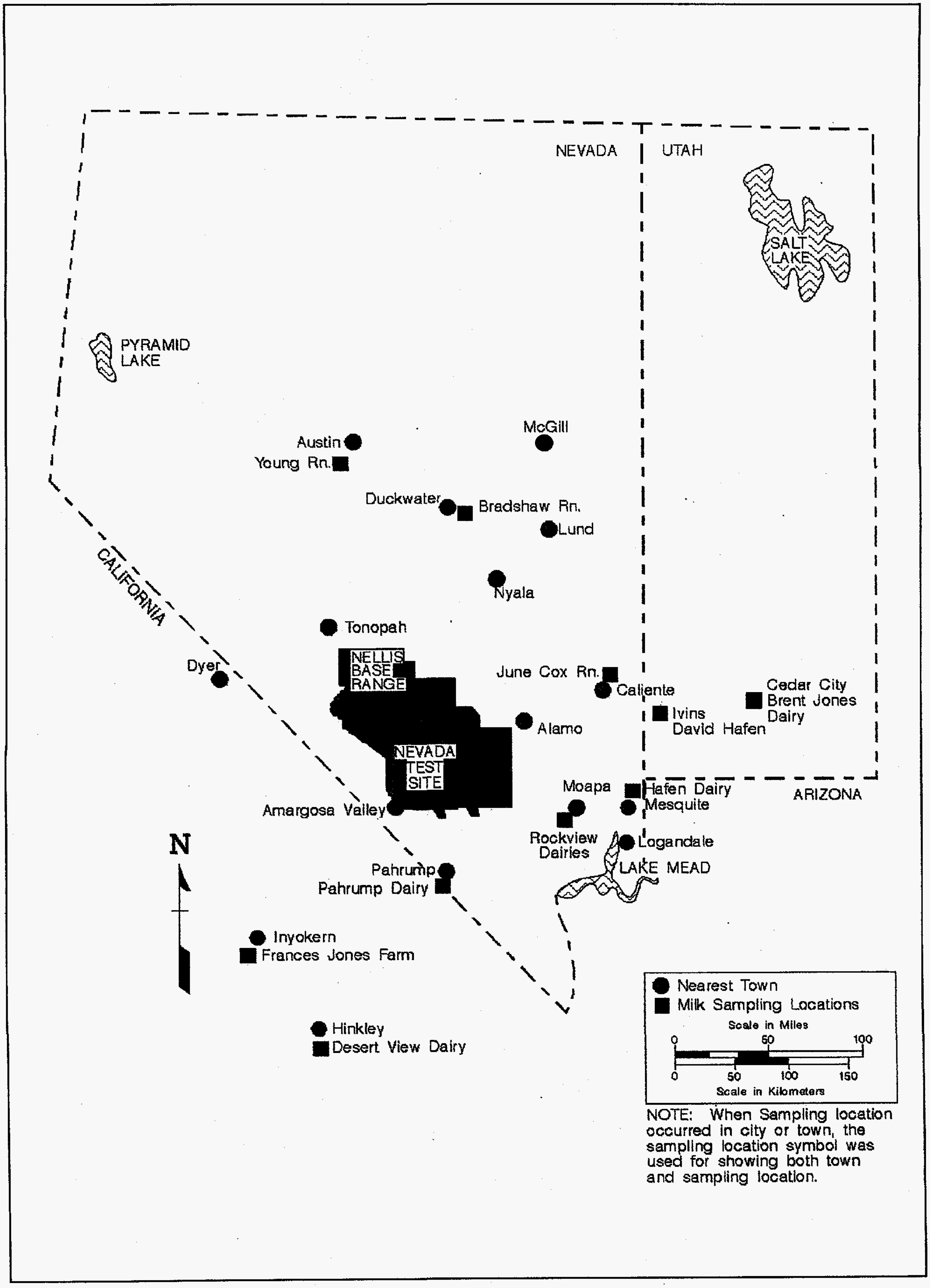
Milk is an important source for evaluating potential human exposures to radioactive material. It is one of the most universally consumed foodstuffs and certain radionuclides are readily traceable through the chain from feed or forage to the consumer. This is particularly true of radioiodine isotopes which, when consumed in sufficient quantities, can cause impairment of thyroid function. Because dairy animals consume vegetation representing a large area and because many radionuclides are transferred to milk, analysis of milk samples yields information on the deposition of small amounts of radionuclides over a relatively large area.

The MSN includes commercial dairies and family-owned milk cows and goats representing the major milksheds within 300 km (186 mi) of the NTS. The 10 locations comprising the MSN at the beginning of 1995 are shown in Figure 4.6. Samples were collected from nine of these locations in 1995 because the Mesquite, NV, dairy closed. The Standby Milk Surveillance Network (SMSN) was discontinued October 1, 1994.

Raw milk was collected in 3.8-L (1-gal) Cubitainers from each MSN location in July and preserved with formaldehyde. The samples are analyzed for ^3H by liquid scintillation counting and for ^{89}Sr and ^{90}Sr by radiochemical separation and beta counting. This network was designed to monitor areas adjacent to the NTS, which could be affected by a release of radioactivity, as well as areas unlikely to be so affected.

4.1.2.4 BIOMONITORING

The biomonitoring program for radionuclides has been discontinued. No samples of beef cattle or vegetation were collected offsite and only one mule deer was collected on the NTS. The deer was hunted by personnel



NOTE: When Sampling location occurred in city or town, the sampling location symbol was used for showing both town and sampling location.

Figure 4.6 Milk Surveillance Network Stations - 1995 with a special permit to carry weapons on the NTS. The location of the mule deer is shown in Figure 4.7. The deer was dressed in the field with precautions taken to minimize risk of contamination. The location of the deer, weight, sex, condition, and other information were recorded on a field data form. Organs were removed, sealed in sample bags, and labeled. Later, at the NTS farm facility, samples are placed in 350 mL sealed aluminum cans for gamma counting. Samples of blood were analyzed for gamma-emitting radionuclides and tritium. Bone samples were shipped to a contract laboratory for ashing.

All analyses for plutonium isotopes and strontium, gamma, and tritium are done at the RSL-LV Radioanalysis Laboratory.

4.1.2.5 THERMOLUMINESCENT DOSIMETRY NETWORK

The primary purpose of an offsite environmental dosimetry program is to identify potential increases in ambient radiation levels in areas surrounding the NTS. Continuing to monitor "natural background" is essential for offsite characterization. Panasonic Model UD-814 TLDs are used for environmental monitoring. The UD-814 consists of one element of $Li_2B_4O_7$:Cu and three elements of $CaSO_4$:Tm phosphors. The $CaSO_4$:Tm elements are behind an approximately 1000 mg/cm^2 filter. An average of the corrected values for the three elements gives the total exposure for each TLD. Two UD-814 TLDs are deployed at each environmental station location so six values are available for Quality Assurance (QA) purposes.

In addition to a fixed environmental TLD program, EPA deploys personnel TLDs to a limited number of individual volunteers living in areas surrounding the NTS. Panasonic Model UD-802 TLDs are used for personnel monitoring. The UD-802 consists of two elements of $Li_2B_4O_7$:Cu and two elements of $CaSO_4$:Tm phosphors. The phosphors are behind approximately 17, 300, 300, and 1000 mg/cm^2 of filtration, respectively. With the use of different phosphors and filtrations, a dose algorithm can be applied to ratios of the different element responses. This process defines the radiation type and energy and provides data for assessing an absorbed dose equivalent.

Figure 4.8 shows fixed environmental TLD monitoring stations and the location of personnel monitoring participants.

During 1995 a soft cycle was installed on one of the Panasonic TLD readers which improves the heating cycle of the reader and lowers the percent coefficient of variation. Subsequent heating adjustments were made to the reader. Once validation is completed on the reader, installation of a soft cycle will be performed on the other reader. In addition, the reader's heating conditions will be replicated -- one to another -- using a thermal curve adapter (TCA) for improved backup capability. New computers and software will also be installed in 1996 to improve report options.

4.1.2.6 PRESSURIZED ION CHAMBER NETWORK

The PIC network uses Reuter-Stokes models 1011, 1012, and 1013 PICs. The PIC is a spherical shell filled with argon gas at 25 times atmospheric pressure. In the center of the chamber is a spherical electrode with a charge opposite to the outer shell. When gamma radiation penetrates the sphere, ionization of the gas occurs and the negative ions are collected by the center electrode. The electrical current generated is proportional to the radiation exposure.

The PIC measures gamma radiation exposure rates and because of its sensitivity, may detect low-level exposures not detected by other monitoring methods. The primary function of the PIC network is to detect changes in ambient gamma radiation due to human activities. In the absence of such activities, ambient gamma radiation rates naturally differ among locations as they vary with altitude (cosmic radiation), with radioactivity in the soil (terrestrial radiation), and vary slightly within a location due to weather patterns.

There are 27 PICs located in communities around the NTS and one in Mississippi, which provide near real-time estimates of

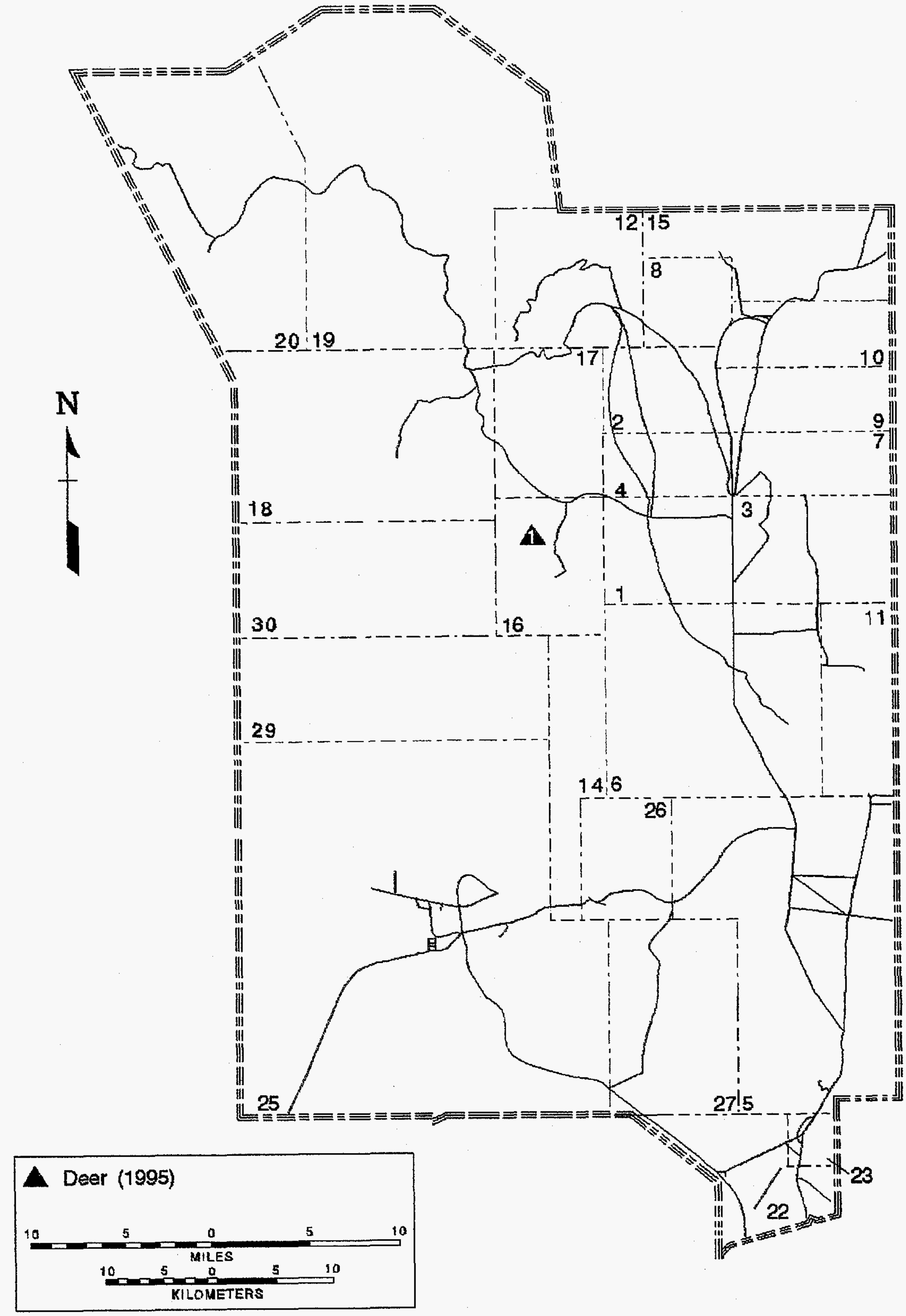


Figure 4.7 Onsite Collection Sites for Animals Sampled - 1995

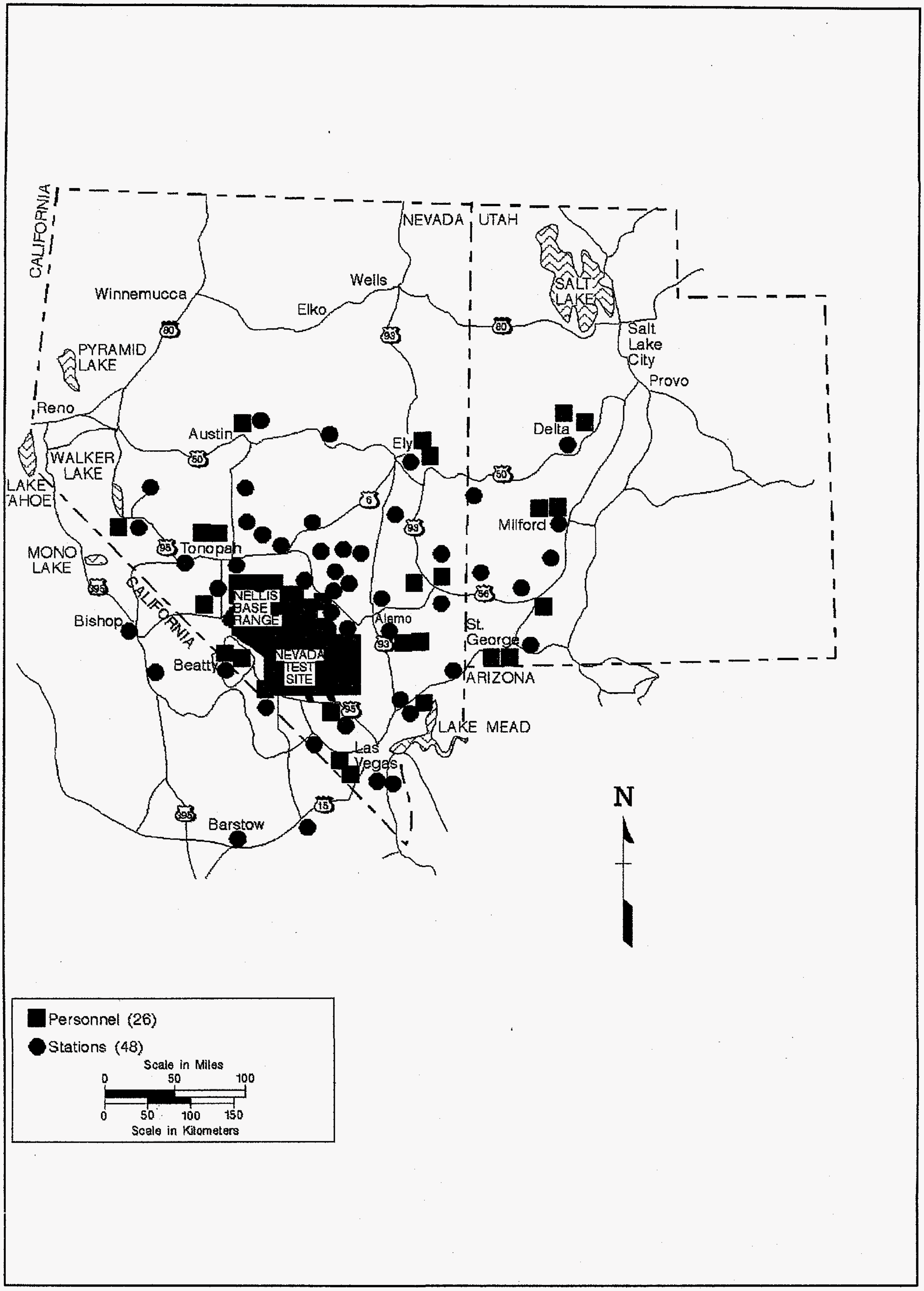


Figure 4.8 TLD Fixed Environmental Stations and Personnel Monitoring Participants - 1995

gamma exposure rates. The locations of the PICs are shown in Figure 4.5 for stations around the NTS. Near real-time telemetry-based data retrieval is achieved by the connection of each PIC to a device which collects and transmits the data through the Geostationary Operational Environmental Satellite directly to an NTS/Los Alamos receiver and then to RSL-LV by dedicated telephone line. In addition to telemetry retrieval, PIC data are also recorded on either magnetic tapes and hard copy strip charts or on magnetic cards. The magnetic tapes and cards provide a backup for the telemetry data.

4.1.2.7 INTERNAL DOSIMETRY NETWORK

Internal radiation exposure is caused by radionuclides that are ingested, absorbed, or inhaled and retained within the body. The RSL-LV Internal Dosimetry Program employs two methods to detect body burdens: whole body counting (including lung counting) and urinalysis. A detailed discussion of this network may be found in Section 5.2.2.7 of this report.

4.1.2.8 COMMUNITY RADIATION MONITORING PROGRAM

Because of the successful experience with the Citizen's Monitoring Program during the purging of the Three Mile Island (TMI) containment in 1980, the CRMP consisting of stations located in the states of California, Nevada, and Utah was begun. In 1995, there were 18 stations located in these three states. The CRMP is a cooperative project of the DOE, EPA, and DRI.

DOE/NV sponsors the program. The EPA provides technical and scientific direction, maintains the instrumentation and sampling equipment, analyzes the collected samples, and interprets and reports the data. The DRI administers the program by hiring the local station managers and alternates, securing rights-of-way, providing utilities, and performing additional QA checks of the data.

Each station is operated by a local resident, in most cases a high-school science teacher. Samples are analyzed at the RSL-LV. Data interpretation is provided by DRI to the communities involved. All of the 18 CRMP stations had one of the samplers for the ASN In addition, a PIC and recorder for immediate readout of external gamma exposure and a recording barograph are located at the station. and a TLD. All of the equipment is mounted on a stand at a prominent location in each community so the residents are aware of the surveillance and, if interested, can check the data. Also, computer-generated reports of the PIC data are issued monthly for each station.

4.2 NONRADIOLOGICAL MONITORING

The 1995 nonradiological monitoring program for the NTS included onsite sampling of various environmental media and substances for compliance with federal and state regulations or permits and for ecological studies. BECAMP conducted wild horse and chukar surveys on the NTS in 1995. Nonradiological monitoring was conducted in 1995 for five series of tests conducted at the Liquefied Gaseous Fuels Spill Test Facility (LGFSTF) on the NTS.

Nonradiological monitoring of non-NTS DOE/NV facilities was conducted by EG&G/EM at three facilities. This monitoring was limited to wastewater discharges to publicly owned treatment works.

4.2.1 NTS OPERATIONS MONITORING

4.2.1.1 ROUTINE MONITORING

As there were no industrial-type production facility operations on the NTS, there was no significant production of nonradiological air emissions or liquid discharges to the environment. Sources of potential contaminants were limited to construction support and NTS operation activities. This included motor pool facilities; large equipment and drilling rig maintenance areas; cleaning, warehousing, and supply facilities; and general worker support facilities (including lodging and administrative offices) in the Mercury Base Camp, Area 12 Camp, and to a lesser extent in Area 20 and the NTS Control Point Complex in Area 6. The LGFSTF in Area 5 is a source of potential release of nonradiological contaminants to the environment, depending on the individual tests conducted. In 1995 there were five series of tests involving 24 different chemicals conducted at this facility. Monitoring was performed to assure these contaminants did not move to offsite areas. Since these monitoring functions are performed by the RSL-LV at the NTS boundary, monitoring functions for the LGFSTF are described below in Section 4.2.2, "Offsite Monitoring." Routine nonradiological environmental monitoring on the NTS in 1995 was limited to:

- Sampling of drinking water distribution systems and water haulage trucks for Safe Drinking Water Act and state of Nevada compliance;
- Sewage lagoon influent and N-tunnel discharge sampling for compliance with state of Nevada operating permit requirements;
- Sampling of electrical equipment oil, soil, water, surfaces, and waste oil for the presence of polychlorinated biphenyls (PCB) as part of Toxic Substance Control Act compliance;
- Asbestos sampling in conjunction with asbestos removal and renovation projects and in accordance with occupational safety and NESHAP compliance; and
- Sampling of soil, water, sediment, waste oil, and other media for the Resource Conservation and Recovery Act (RCRA) constituents.

4.2.1.2 ECOLOGICAL MONITORING

In 1995 DOE/NV reviewed the ecological monitoring studies conducted under BECAMP over the past eight years. These studies monitored the flora and fauna on the NTS to assess changes in ecological conditions over time. Data were summarized from previous years' studies of vegetation, small mammals, and lizards conducted on disturbed and undisturbed areas of NTS. Data for these studies were not collected in 1995 during the study review and data summarization efforts. Work began on redesigning an ecological monitoring plan for DOE/NV activities on the NTS to address changes in DOE/NV missions and policies.

Monitoring of feral horses, however, continued for the sixth consecutive year. All horses, including foals, were individually identified. Selected water sources on the NTS were surveyed to evaluate their effect on the distribution of horses. In addition, field surveys of chukar were initiated in 1995 to assess their reproductive success and relative abundance on the NTS. The Nevada Department of Wildlife received permission from DOE/NV to trap and relocate NTS chukar. Eighty-six chukar were removed from three areas on the NTS.

4.2.2 OFFSITE MONITORING

The LGFSTF was established in the Frenchman Basin in Area 5 as a basic research tool for studying the dynamics of accidental releases of various hazardous materials and the effectiveness of mitigation procedures. The LGFSTF was designed and equipped to: (1) discharge a measured volume of a hazardous fluid at a controlled rate on a specially prepared surface; (2) monitor and record down-wind gaseous concentrations, operating data, and close-in/down-wind meteorological data; and (3) provide a means to control and monitor these functions from a remote location.

The Facility has the capability for releasing large volumes of cryogenic and non-cryogenic liquids at rapid rates through a 500-ft spill line to the experimental area supporting the tank farm. Spill rates for the cryogenic system range from 1,000 to 26,000 gpm with the capability to release the entire contents of both tanks in two minutes. The non-cryogenic system can be released at rates of 500 to 5,000 gpm with the entire 24,000 gal capable of being released in five minutes.

Test sponsors can vary intake air temperature, humidity, release rate and release volume in an 8 ft x 16 ft x 96 ft wind tunnel. There are two spill pads available for use in contained open-air releases of volumes of 50 to 1,000 gal. Test Area 4 has been added primarily to provide the testing capability for determining the efficacy of totally encapsulated chemical protective suiting materials when exposed to high concentrations of toxic and hazardous gaseous materials. DOE/NV provides the facilities, security, and technical support, but all costs are borne by the organization conducting the tests. In 1995 five series of tests were conducted involving 24 different chemicals. The plans for each test series were examined by an Advisory Panel that consisted of DOE/NV and RSL-LV professional personnel augmented by personnel from the organization performing the tests.

For each test, the RSL-LV provided an advisor on offsite public health and safety for the Operations Controller's Test Safety Review Panel. At the beginning of each test series and at other tests depending on projected need, a field monitoring technician from the EPA with appropriate air sampling equipment was deployed downwind of the test at the NTS boundary to measure chemical concentrations that may have reached the offsite area. Samples were collected with a hand-operated Dräger pump and sampling tube appropriate for the chemical being tested. Not all tests were monitored by EPA if professional judgement indicated that, based on previous experience with the chemical and the proposed test parameters, NTS boundary monitoring was unnecessary.

The EPA monitors at the NTS boundary, in contact by two-way radio, were always placed at the projected cloud center line at the time when the cloud was expected to arrive at the boundary, so the air samples would be collected at the time and place of maximum concentration. The exact location of the boundary monitor was adjusted during the test to ensure that monitoring was performed at the projected cloud center line.

4.2.3 NON-NTS FACILITY MONITORING

Although permits for the six EG&G/EM non-NTS facilities, included 17 air pollution, 4 wastewater, and 3 local hazardous waste generator permits, effluent monitoring was limited to wastewater discharges at two sites (see below). A description involving any unexpected emission was required for some permits, but again, monitoring was not required. All results from routine monitoring were within the permit limits, and monitoring activities were limited to the following:

- The Las Vegas Area Operations (LVAO) wastewater permit was revised from a Class I permit to a Class II permit by the city of North Las Vegas Department of Public Works. Monitoring was reduced from two times a year to once per year in October. The monitoring requirements were retained for analyzing the MG burn pit (metal-cutting device) water prior to discharging; however, monitoring of the ten metal finishing outfalls was eliminated. NLVF self monitoring reports were submitted in October and November 1995.

- The Clark County Sanitation District wastewater permit for the RSL required biannual monitoring of two outfalls and quarterly pH and monthly septage reports. RSL monitoring reports were submitted in May and November 1995. EG&G/EM has installed a silver recovery electrolytic unit, evaporators, ion exchange system, an improved pH neutralization system, pH monitoring, and associated plumbing and electrical systems. Installation was completed April 30, 1995.

4.3 ENVIRONMENTAL PERMITS

NTS environmental permits active during 1995 which were issued by the state of Nevada or Federal agencies included 16 air quality permits involving emissions from construction operation facilities, boilers, storage tanks, and open burning; 8 permits for onsite drinking water distribution systems; 1 permit for sewage discharges to lagoon collection systems; 8 permits for septage hauling; 1 incidental take permit for the threatened desert tortoise, and 3 permits for wildlife handling, collection, and salvage. RCRA Part A and Part B permit applications based on comments made by the state of Nevada, continued during 1995.

Non-NTS EG&G/EM permits included 16 air pollution control permits and 4 sewage discharge permits. Nine EPA Generator Identification (ID) numbers were issued to seven EG&G/EM operations, and three local RCRA-related permits were required at two EG&G/EM operations.

4.3.1 AIR QUALITY PERMITS

Air quality permits were required for numerous locations at the NTS and at two non-NTS facilities.

4.3.1.1 NTS AIR QUALITY PERMITS

Table 4.2 is a listing of state of Nevada air quality operating or construction permits active in 1995. The expiration date indicated in the table for air quality permits to construct, identified with the prefix PC, is identified as "varies" because a permit to construct is generally valid until the time the state performs an inspection and an operating permit is issued.

During 1995, the Bureau of Air Quality began revising all air quality operating permits to meet the new Clean Air Act requirements under Title V. At the NTS, permits have been consolidated according to area. For example, Permit AP9711-0554, issued for Area 6, includes the Well 3 Yard cementing equipment, the bulk fuel storage tanks, and the Decontamination Facility boiler. During 1995, four consolidated permits were issued for Areas 1, 5, 6, and 23. It is anticipated that the remaining single-source permits will be replaced by consolidated permits in 1996. The annual reporting date of operating hours and production amounts was revised from April 15 to February 1. As before, the new permits are valid for five years.

For OP 95-21, the Nevada Air Quality Officer must be notified of each burn no later than five days following the burn, either by telephone or written communication. During 1995 no open burns of explosives-contaminated debris were conducted in Area 27. As the Part A and B RCRA permit applications did not include burning of explosives in Area 27, these burning activities were transferred to the Area 11 Explosive Ordnance Disposal (EOD) Area that received RCRA permit approval by the state during 1995.

For OP 96-20, the Air Quality Officer no longer must be notified by telephone at least two working days in advance of each training exercise for Class A flammables with a written summary of each exercise submitted within 15 days following the exercise. This summary, which includes the date, time, duration, exact location, and amount of flammables burned, is now included in an annual report. During 1995, five burn events, which included seven fires, were conducted for radiological emergency response training. No training burns were conducted by onsite fire protection services, and no controlled burns for Class A flammables were held in 1995. Burn permits which had been issued for the demolition of old buildings and for a single burn which involved destruction of a Bradley vehicle expired in 1995 and were not renewed.

4.3.1.2 NON-NTS AIR QUALITY PERMITS

Fifteen air pollution control permits were active for emission units at EG&G/EM LVAO. These permits were issued through the Clark County Health District. Annual renewal is contingent upon payment of permit fees. Permits are amended and revised only if the situation under which the permit has been issued changes. STL has one air pollution control permit. For the other non-NTS, EG&G/EM operations, no permits have been required or the facilities have been exempted. Table 4.3 lists each of the required permits.

4.3.2 DRINKING WATER SYSTEM PERMITS

Five NTS drinking water system permits issued by the state of Nevada as shown in Table 4.4 were renewed with new expiration dates as shown. During 1994, the state of Nevada determined that the trucks used for hauling potable water should also have permits, so three additional permits were obtained and renewed in 1995. No drinking water systems were maintained by non-NTS facilities.

4.3.3 SEWAGE DISCHARGE PERMITS

Sewage discharge permits from the state of Nevada, Division of Environmental Protection (NDEP), are listed in Table 4.5 and require submission of quarterly discharge monitoring reports. One NTS General Permit replaced all four individual system permits on January 31, 1994.

4.3.3.1 NTS SEWAGE HAULING PERMITS

Permits issued by the state of Nevada Division of Health for eight sewage hauling trucks for the NTS were renewed in November 1995 and are listed in Table 4.6.

4.3.3.2 NON-NTS SEWAGE PERMITS

Sewage permits were required for four of the six non-NTS EG&G/EM operated facilities. These included two permits at the LVAO facilities and two at the STL as shown in Table 4.5. Each was issued by the county or community in which the facility was located.

4.3.4 RCRA PERMITS

4.3.4.1 NTS OPERATIONS

Hazardous waste generation activities at the NTS continue to be performed under EPA ID Number NV3890090001. RCRA permit application Part A and Part B has been submitted to the state of Nevada for the following NTS operations: Pit 3 Mixed Waste Disposal Units (existing), the Mixed Waste Disposal Units (proposed), the Area 5 Hazardous Waste Storage Unit (existing), the Area 11 EOD Area (existing), and the Mixed Waste Storage Pad (existing)(see Section 3.1.5.1). During 1995, the Area 11 EOD Unit and the Area 5 Hazardous Waste Storage Unit received Permit Approval. The Pit 3 Mixed Waste Disposal Units still has interim status.

The NTS also has a "Nevada Hazardous Materials Storage Permit," Number 13-94-0034-X, issued by the state Fire Marshall. This permit is renewed annually when a facility makes a report required by the Chemical Catastrophe Prevention Act (see Section 3.1.7).

4.3.4.2 NON-NTS FACILITIES

Five EPA Generator ID numbers have been issued to five EG&G/EM operated facilities. In addition, three local ID numbers were required at two of those facilities. Hazardous waste is managed at all locations using satellite accumulation areas. Three facilities have centralized accumulation areas. All hazardous and industrial wastes are transported offsite to RCRA-permitted facilities for approved treatment and/or disposal.

4.3.5 ENDANGERED SPECIES ACT/WILDLIFE PERMITS

Federal and state permits have been issued to DOE/NV and to NTS entities. These permits are required for the conduct of

DOE/NV activities in habitat of the threatened desert tortoise and for the study and collection of this threatened species and other wildlife. (All EG&G/EM non-NTS facilities are located in existing metropolitan areas and are not subject to the Endangered Species Act.) Annual reports associated with these permits are filed as stipulated in each permit.

DOE/NV activities on the NTS comply with all terms and conditions of a desert tortoise incidental take authorization issued in a Biological Opinion (File No. 1-5-91-F-225) from the U.S. Fish and Wildlife Service (USFWS). Desert tortoise studies are performed under a USFWS threatened species permit (No. PRT-781234) issued to EG&G/EM in 1994 (expiration date: May 30, 1998).

The Nevada Division of Wildlife issued a scientific collection permit to EG&G/EM (No. S-11009) on January 1, 1995, for the collection and study of various species at the NTS. This permit expired on December 31, 1995. Also, the USFWS issued REECo a Special Purpose Salvage permit (No. PRT-762816) on November 8, 1993, which allowed the salvaging of dead migratory birds. It also expired on December 31, 1995.

Table 4.1 Summary of Onsite Environmental Surveillance Program - 1995

Sample Type	Description	Collection Frequency	Number of Sampling Locations(a)	Type of Analysis
Air	Sampling through Whatman GF/A glass fiber filter and a charcoal cartridge	Weekly	45	Gamma spectroscopy, gross β,($^{238,239+240}$Pu, monthly composite)(b)
	Low-volume sampling through silica gel	Biweekly	15	HTO (tritium oxide)
	Low-volume sampling	Weekly	3	^{85}Kr and ^{133}Xe
Potable Water	Grab sample	Monthly/ Quarterly	7	Gamma spectroscopy, gross β, ^{3}H, ($^{238,239+240}$Pu, gross α quarterly), (^{90}Sr annually)
Potable Supply Wells	Grab sample	Quarterly	11	Gamma spectroscopy, gross β, ^{3}H, ^{226}Ra, $^{238,239+240}$Pu, ^{3}H enrichment, gross α, ^{90}Sr quarterly
Non-Potable Supply Wells	Grab sample	Quarterly	2	Gamma spectroscopy, gross β, ^{3}H, $^{238,239+240}$Pu, gross α, quarterly, (^{90}Sr annually)
Open Reservoirs	Grab sample	Quarterly	15	Gamma spectroscopy, gross β, ^{3}H, $^{238,239+240}$Pu quarterly, (^{90}Sr annually)
Natural Springs	Grab sample	Quarterly	8	Gamma spectroscopy, gross β, ^{3}H, $^{238,239+240}$Pu quarterly, (^{90}Sr annually)
Containment Ponds	Grab sample	Monthly	2	Gamma spectroscopy, gross β, ^{3}H, $^{238,239+240}$Pu quarterly, (^{90}Sr annually)
Sewage Lagoons	Grab sample	Quarterly	11	Gamma spectroscopy, gross β, ^{3}H, $^{238,239+240}$Pu quarterly, (^{90}Sr annually)
External Gamma Radiation Levels	UD-814AS thermoluminescent dosimeters	Quarterly	169	Total quarterly exposure

(a) Not all of these locations were sampled because of inaccessibility or lack of water.

(b) Beginning with the fourth quarter of 1994, the air filters from stations, other than the 12 stations inside RWMS Areas 3 and 5, were composited quarterly for plutonium analyses. Monthly compositing of filters was continued for the stations inside the RWMS.

Table 4.2 NTS Active Air Quality Permits - 1995

Permit No.	Facility or Operation	Expiration Date
AP9711-0549	Area 1 Facilities Shaker Plant Rotary Dryer Aggregate Plant Concrete Batch Plant Sandbag Facility	03/21/00
AP9711-0554	Area 6 Facilities Cementing Equip. (silos) Decontamination Facility Boiler Diesel Fuel Tank Gasoline Fuel Tank Slant Screen	11/21/99
AP9711-0555	Area 23 Facilities Building 753 Boiler Cafeteria Boilers (2) Diesel Fuel Tank Gasoline Fuel Tank Slant Screen NTS Surfaces Disturbances WSI Incinerator	14/04/96
AP9711-0578	Area 5 Facilities Slant Screen	05/05/00
OP 1975[(a)]	Area 2 Portable Stemming System	12/04/94
OP 1976[(a)]	Area 2 Portable Stemming System	12/04/94
OP 2744	Area 12 Cafeteria Boiler	03/23/98
OP 2849	Area 12 Concrete Batch Plant	12/02/98
OP 2850	Area 6 Portable Field Bins	12/02/98
PC 2988	Area 3 Two-Part Epoxy Batch Plant	Varies
PC 3246	Area 3 Mud Plant	Varies
PC 3774	Area 6 Portable Stemming System	Varies
OP 2625	Area 5 Spill Test Facility	11/02/97
OP 96-20	NTS Open Burn - Training	10/24/96
OP 95-21	Area 27 Open Burning	01/23/96
OP 95-24	Area 4 BEEF Facility	02/29/96

(a) Permits renewal submitted.

Table 4.3 Active Air Quality Permits, Non-NTS Facilities - 1995

Permit No.	Facility or Operation	Expiration Date
Las Vegas Area Operation[a]		
A38702	Hamada Offset Press, Bldg. C-1, NLVF	02/28/98
A06501	Spray Paint Booth, Bldg. A-16 NLVF	02/28/98
A06505	Time Saver Aluminum Sander, NLVF	02/28/98
A06506	Abrasive Blasting, NLVF	02/28/98
A06507	Trinco Dry Blast with Dry Bag Dust Filters, NLVF	02/28/98
A38701	Spray Paint Booth, NLVF	02/28/98
A06502	Vapor Degreasers #1	02/28/98
A06503	3 Emergency Generators, and Emergency Fire Control Equipment, NLVF	02/28/98
A38703	Emergency Generator, NLVF	02/28/98
A34801	Columbia Boiler Model WL-180, Penthouse #1, RSL	02/28/98
A34802	Columbia Boiler Model WL-90, Penthouse #1, RSL	02/28/98
A34803	4.0 MM BTU Water Heater #2, RSL	02/28/98
A34804	2 Cummins Emergency Generators and Emergency Fire Control Equipment, RSL	02/28/98
A34805	Spray Paint Booth, Room 1328, RSL	02/28/98
A34811	Excimer Laser	Indef.
Special Technologies Laboratory[a]		
8477	Permit to Operate a 12 Gallon Capacity Vapor Degreaser	Indef.

(a) An annual fee is paid on these permits.

Table 4.4 NTS Drinking Water Supply System Permits - 1995

Permit No.	Area(s)	Expiration Date
NY-5024-12NC	Area 1	09/30/96
NY-4099-12C	Area 2 & 12	09/30/96
NY-360-12C	Area 23	09/30/96
NY-4098-12NCNT	Area 25	09/30/96
NY-5000-12NCNT	Area 6	09/30/96
NY-835-12NCNT	Site Wide Truck	09/30/96
NY-836-12NCNT	Site Wide Truck	09/30/96
NY-841-12NCNT	Site Wide Truck	09/30/96

Table 4.5 Sewage Discharge Permits - 1995

Permit Number/Location	Areas	Expiration Date
	NTS Permits	
GNEV93001(a)	NTS General Permit	01/31/99
	Off-NTS Permits	
Las Vegas Area Operations		
CCSD-032/Remote Sensing Laboratory(a)		06/30/96
VEH-112/North Las Vegas Facility(a)		03/13/97
Special Technologies Laboratory		
AII-204/ Santa Barbara, California		
III-331/ Santa Barbara, California		12/31/95

(a) Owner/Operator effluent monitoring required by permit.

Table 4.6 NTS Sewage Waste Hauling Trucks

Permit Number	Vehicle Identification Number	Expiration Date
NY-17-03310(a)	Septic Tank Pumper E-104866	11/30/95
NY-17-03311	Septic Tank Pumper E-104573	11/30/96
NY-17-03312	Septic Tank Pumper E-104296	11/30/96
NY-17-03313	Septic Tank Pumper E-105293	11/30/96
NY-17-03314	Septic Tank Pumper E-105299	11/30/96
NY-17-03315	Septic Tank Pumper E-105919	11/30/96
NY-17-03317	Septic Tank Pumper E-105918	11/30/96
NY-17-03318	Septic Tank Pumping Subcontractor Vehicle	11/30/96

(a) Truck no longer used, permit allowed to expire.

5.0 RADIOLOGICAL MONITORING RESULTS

Radiological monitoring results from onsite environmental programs included effluent sampling results for airborne emissions and liquid discharges to containment ponds and environmental sampling results for onsite surveillance conducted by Reynolds Electrical & Engineering Co., Inc., (REECo). Offsite environmental surveillance was conducted by the U.S. Environmental Protection Agency's (EPA's) Radiation Sciences Laboratory - Las Vegas (RSL-LV). Onsite monitoring results indicated that environmental concentrations of radioactivity resulting from Nevada Test Site (NTS) air emissions were statistically no different than background except in the immediate vicinity of the emissions. These airborne emissions, and radioactive liquid discharges to onsite containment ponds, produced concentrations that were only a fractional percentage above background in terms of potential exposure of onsite workers. Offsite monitoring indicated that environmental radionuclide concentrations and exposure rates were statistically no different than background, with no measurable exposure of offsite residents from current NTS test operations. Small amounts of radioactivity were detected in animal samples collected onsite.

5.1 RADIOLOGICAL EFFLUENT MONITORING

Since no nuclear tests were performed at the NTS during 1995, monitoring efforts for radioactive effluents consisted primarily of routine air sampling and of periodic sampling of liquid discharges to the Area 12 tunnel containment ponds. Air samples collected in and around the Area 5 Radioactive Waste Management Site (RWMS-5) indicated that no measurable radioactivity was detectable away from the area, although trace amounts of tritium were detected at its boundary. Samples in Area 3, at the Area 9 Bunker, and a few other areas showed above-background levels of $^{239+240}$Pu. Measured ^{85}Kr levels on Pahute Mesa were about 6 pCi/m^3 (0.22 Bq/m^3) higher than the NTS average, due to atmospheric pumping of the krypton from past nuclear tests. In each case, by using data from the station with the highest annual average, replacing the diffuse source with an equivalent point source, and using CAP88-PC, upper limits of 0.023 Ci (850 MBq) of $^{239+240}$Pu, 0.97 Ci (36 GBq) of ^{3}H, and 300 Ci (11 TBq) of ^{85}Kr were estimated for airborne emissions from Area 3, from the RWMS-5, and from Pahute Mesa, respectively. Using a different model, an upper limit of 0.048 Ci (1.8 GBq) was estimated for airborne emissions of $^{239+240}$Pu from the Area 9 Bunker. The primary liquid effluent was water from Area 20 characterization wells collected in a containment pond. Influent to this pond contained 261 Ci (9.7 TBq) of tritium (^{3}H).

5.1.1 EFFLUENT MONITORING PLAN

An important part of the NTS Environmental Monitoring Plan (DOE 1991c), as required by DOEOrder 5400.1 (DOE 1990b), is the onsite Effluent Monitoring Plan, in which the Area 12 tunnels, the Area 6 Decontamination Facility, nuclear test sites, Radioactive Waste Management Sites, and all other potential effluent sites throughout the NTS have been assessed for their potential to contribute to the public dose.

Airborne radioactive effluents are the emissions on the NTS with the greatest potential for reaching members of the public. All radioactive liquid effluents from activities on the NTS are contained within its boundaries. For all activities on the NTS, the estimated effective dose equivalent to any member of the public from all airborne radionuclide emissions is much less than one mrem/year. Requirements of the National Emission Standards for Hazardous Air Pollutants (NESHAP) are set forth in 40 C.F.R. 61.93(b)(4)(ii), and in Regulatory Guide DOE/EH-0173T (DOE 1991d). Compliance with these requirements is achieved by periodic measurements of effluents to confirm the low emission levels. For consistency with past practices, the monitoring methods and procedures developed over the years are being used with changes being introduced as conditions warrant.

5.1.2 AIRBORNE EFFLUENTS

No nuclear tests were performed during 1995, so there were no test-related effluents. The majority of radioactive air effluents at the NTS in 1995 originated from tritiated water seeping from E Tunnel and pumped from characterization wells, resuspension of contaminated surface soil, and seepage of ^{85}Kr from underground tests with various amounts of other radionuclides calculated from monitoring data (see Table 5.1 for a listing of onsite releases).

An increase in efforts to monitor radioactive air emissions at the NTS began in November 1988 as a result of requirements in DOE Order 5400.1, DOE Order 5400.5, and regulatory guide DOE/EH-0173T, as well as from EPA requirements in the NESHAP, 40 C.F.R. 61. Known and potential effluent sources throughout the NTS were assessed for their potential to contribute to public dose and were considered in designing the Site Effluent Monitoring Plan, which forms part of the Environmental Monitoring Plan, Nevada Test Site and Support Facilities, DOE/NV/10630-28, published in November 1991. This plan was updated in 1992 and 1993.

5.1.2.1 CHARACTERIZATION WELL EFFLUENT

As part of environmental restoration activities, the groundwater under the NTS is being characterized by drilling special wells for measuring the characteristics of NTS aquifers. In 1995, three such wells were drilled near the cavity created by a nuclear explosive test. The water pumped from these wells into containment ponds was contaminated with tritium. Measurement of the tritium concentration and volume of water discharged gives a source term for this activity.

5.1.2.2 TUNNEL COMPLEX EFFLUENT

As noted above, there was fluid drainage from the E Tunnel complex during 1995. The HTO content is shown in Table 5.1.

5.1.2.3 RADIOACTIVE WASTE MANAGEMENT SITES

Two permanent particulate/halogen samplers were located within the disposal pits at the RWMS-5. The 1995 annual average concentration of gross beta activity in samples taken within Pit 3 in Area 5 was 1.7 x 10^{-14} µCi/mL (0.63 mBq/m^3). Pit 5, a new pit, was opened this year and an air sampler installed. The annual average gross beta for this pit was 2.5 x 10^{-14} µCi/mL (0.93 mBq/m^3), within the range of NTS results. The NTS 1995 annual average gross beta concentration was 2.0 x 10^{-14} µCi/mL (0.74 mBq/m^3). These results indicate that, except for trace amounts of tritium as noted below, the operations in the RWMS-5 are not contributing radiological effluents to the NTS environment. Average annual gross beta and plutonium results for 1995 from all the samples collected at the RWMS-5 facility are shown in Figure 5.1.

Nine HTO samplers were located on the perimeter of RWMS-5 as shown in Figure 5.2. The 1995 annual average HTO concentration for the nine stations was 5.6 x 10^{-6} pCi/mL (0.21 Bq/m^3); the individual values are displayed in Figure 5.2. This value is less than 0.06 percent of the Derived Concentration Guide for tritiated water vapor in air.

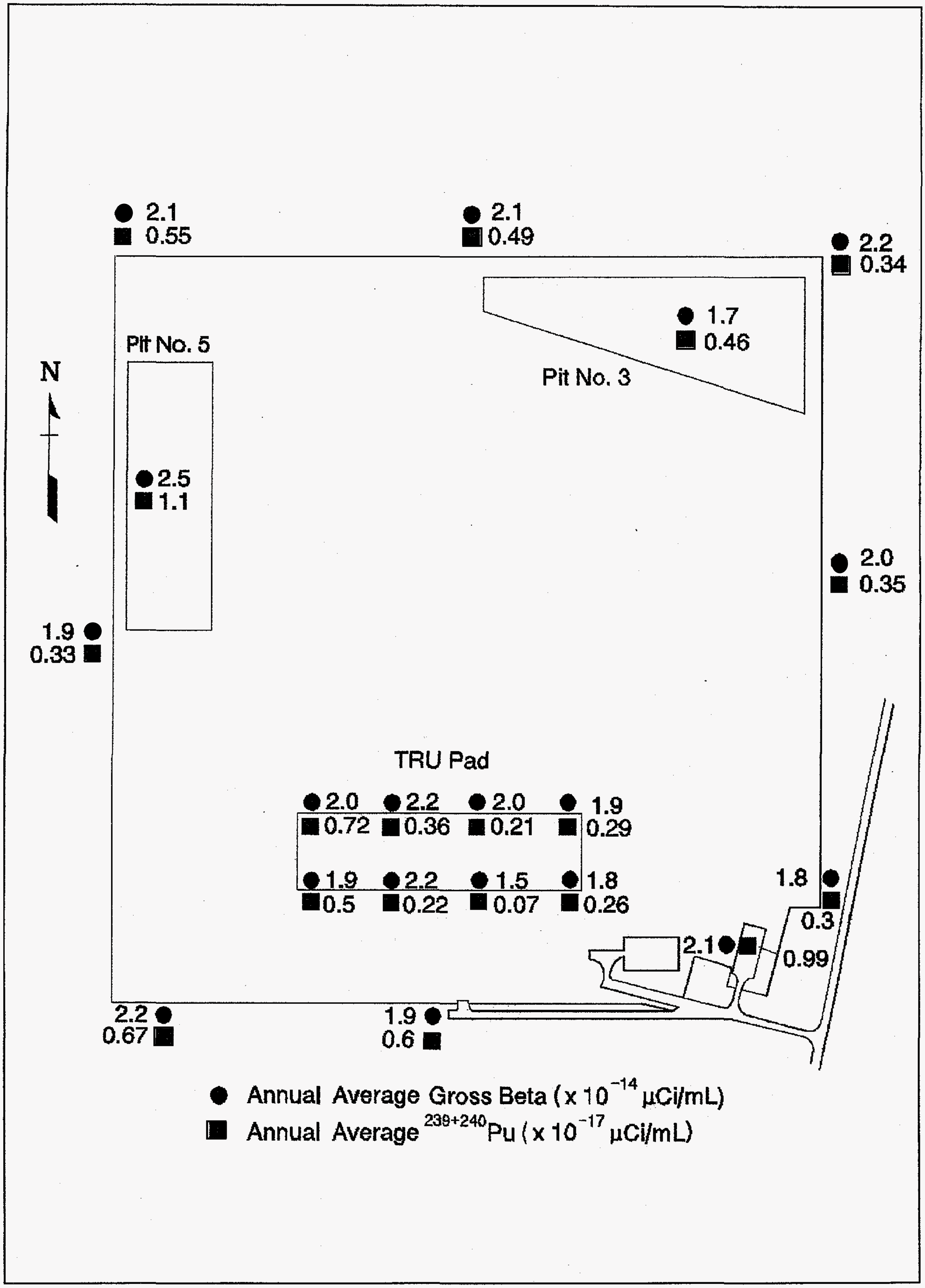


Figure 5.1 RWMS-5 Air Sampling Annual Average Results - 1995

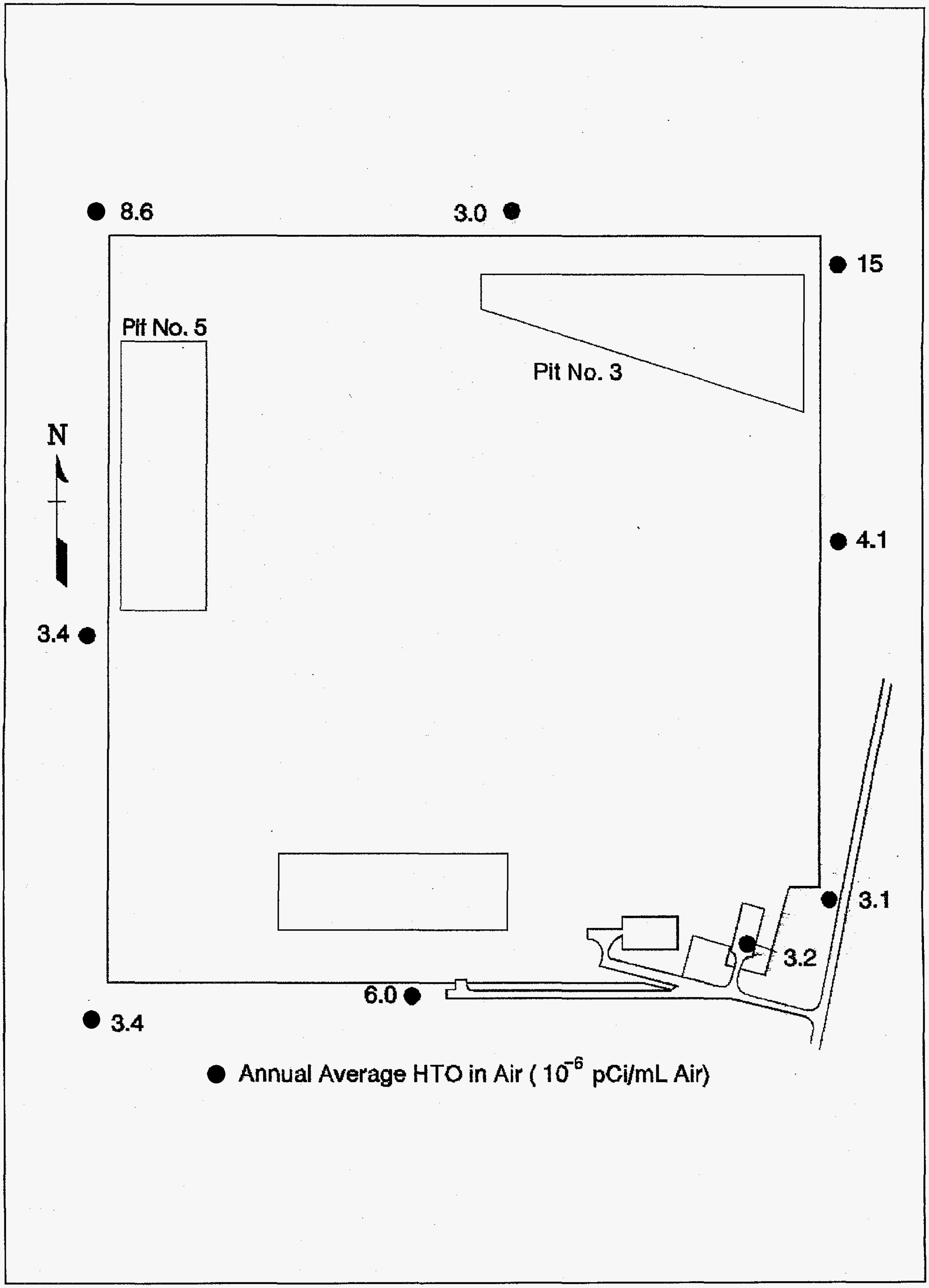


Figure 5.2 RWMS-5 HTO Annual Average Results - 1995

The Area 3 RWMS (RWMS-3) is used for disposal of radiologically contaminated waste in packages that are unsuitable for disposal in the Area 5 facility. This waste is buried in subsidence craters much like waste is buried at the RWMS-5. The RWMS-3 is surrounded by four permanent particulate/halogen samplers located approximately north, south, east, and west of the burial pit. Several TLDs were distributed at the RWMS-3 and surrounding areas.

Although a statistical analysis shows that there are differences between NTS areas in levels of environmental exposure, there were not enough data to determine the pattern of the differences. Nevertheless, an examination of annual average exposure rates shows that the gamma exposure rates detected at the perimeter fences of RWMS-3 and RWMS-5 are similar to gamma measurements taken at other locations on the NTS.

The gross beta 1995 annual average at the RWMS-3 of 1.7×10^{-14} µCi/mL was slightly lower than the 1994 average, and was not statistically different at the five percent significance level from the sitewide average of 2.0×10^{-14} µCi/mL (0.74 mBq/m^3). However, $^{239+240}$Pu results indicated that levels of these radionuclides in the vicinity of the RWMS-3 were consistently above the NTS average. Vehicular traffic and opera tional activities in Area 3 apparently resuspend plutonium that was deposited on the soil surface during earlier nuclear explosives testing. These elevated $^{239+240}$Pu levels indicated that Area 3 is a diffuse source of effluents. Air sampling results are displayed in Tables 5.2, 5.3, and 5.4.

5.1.3 LIQUID DISCHARGES

The radioactive liquid discharges at the NTS in 1995 originated from tunnel drainage and from water pumped from characterization wells in Area 20. Typically, all liquid discharges within the NTS have been held in containment ponds. Monthly grab samples were taken from each pond and where possible, from the influent.

Radioactivity in liquid discharges released to the containment ponds was monitored to assess the efficacy of tunnel sealing and provide a quantitative and qualitative annual summary of the radioactivity released onsite for use in calculating doses for NESHAP compliance.

5.1.3.1 TUNNELS

Rainier Mesa in Area 12 is the location where nuclear tests were conducted within tunnels by the Department of Defense (DOD). Seepage water discharged from these tunnels was collected in containment ponds as described above. This water was usually contaminated with radionuclides, mainly ^{3}H, generated during nuclear tests in previous years.

Liquid effluents were discharged during 1995 only from E Tunnel. The liquid discharge from this tunnel decreased during 1995 compared to previous years because of success in sealing the tunnels. The flow from T Tunnel was eliminated with the installation of plugs in 1993. Only at E Tunnel was the 1995 flow comparable to that for previous years.

Monitoring results indicated that the water discharged from E tunnel contained measurable quantities of ^{3}H and small amounts of other radionuclides. Total quantities of ^{3}H, ^{238}Pu, $^{239+240}$Pu, ^{90}Sr, ^{137}Cs, and beta activity were determined for this liquid effluent source and are listed in Table 5.1. No liquid effluents were discharged offsite.

5.1.3.2 CHARACTERIZATION WELL EFFLUENT

The total volume of liquid discharged to containment ponds from the three characterization wells in Area 20 during 1995 was 891,700 gal (3375 m^3) that contained 260.8 Ci of tritium. This was a new source for this year.

5.1.3.3 DECONTAMINATION FACILITY

The Decontamination Facility, located in Area 6, was not used during 1995 since no nuclear tests were conducted. Until a new lined containment pond is constructed, any effluent from that Facility will be captured in holding tanks and held for disposal.

5.2 RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE

Onsite surveillance of airborne particulates, noble gases, and tritiated water vapor indicated concentrations that were generally not statistically different from background concentrations. Surface water samples collected from open reservoirs or natural springs and industrial-purpose water, exclusive of tunnel ponds, gave no indication of statistically significant contamination levels. External gamma exposure monitoring results indicated a decrease from 1994. Special environmental studies included soil radionuclide transport studies and development of a NTS-specific dose assessment model. Results of offsite environmental surveillance by the U.S. EPA RSL-LV showed no NTS-related radioactivity was detected by the offsite monitoring networks and there were no apparent net exposures detectable by the offsite internal dosimetry network. Radionuclides were detectable at levels near the minimum detectable concentration (MDC) in tissues from a deer collected onsite.

5.2.1 ONSITE ENVIRONMENTAL SURVEILLANCE

At the end of 1995 the onsite radiological surveillance networks consisted of 45 air sampling stations; 3 radioactive noble gas sampling stations; 15 tritiated water vapor sampling stations; surface water samples from 15 open water supply reservoirs, 8 springs, 1 containment pond, and 11 sewage lagoons; groundwater samples from 11 potable and 2 non-potable supply wells and 7 drinking water consumption points; and 168 locations where thermoluminescent dosimeters (TLDs) measure gamma exposures. Summary tables for each of the analytes for this program are placed at the end of this chapter. Individual results for each collected sample are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1995" (DOE/NV/11718-038, in prep.).

5.2.1.1 RADIOACTIVITY IN AIR

A total of 63 air sampling stations were operated at various times during the year. Eight of the stations had solar photovoltaic battery powered samplers and were placed in contaminated areas where commercial power was unavailable. At each of the stations, samples were collected weekly on glass fiber filters (for particulate) and charcoal cartridges (for halogens). The filters were counted for gamma and gross beta activity, composited monthly for RWMS samplers or quarterly for the remainder, and then analyzed for ^{238}Pu and $^{239+240}$Pu. The charcoal cartridges were counted for gamma activity only if test-related radionuclides were detected on the particulate filters.

Air monitoring for the noble gases began at six fixed locations and ended with only three. These air samples were collected weekly. A distillation process separated the radioactive krypton and xenon from the sample for measurement.

Tritiated water vapor was monitored continuously at 15 locations and monitored for only a portion of the year at five locations which were either terminated or added during the year. Samples were collected every two weeks and analyzed for ^{3}H. Liquid scintillation counting was used for these measurements.

For the purpose of comparing measured quantities of airborne radioactivity to the Derived Air Concentrations (DAC), the guides for occupational exposures found in DOE

Order 5480.11, and to the Derived Concentration Guides (DCG), the guides for exposures to members of the general public found in DOE Order 5400.5, the following assumptions were made:

- The chemical species of the radionuclides detected was unknown so the most restrictive DAC or DCG was used (almost always Class Y compounds which take on the order of years to clear from the respiratory system). The DCG and DAC values used are listed in Table 5.5.
- For air sampling results, all of the gross beta activity detected was assumed to be ^{90}Sr.

5.2.1.2 AIR (PARTICULATE AND HALOGEN GAS) SAMPLING RESULTS

GROSS BETA

Figure 5.3 displays the average NTS gross beta results for 1995. Air particulate samples were held for five to seven days prior to gross beta counting and gamma spectrum analysis to allow for the decay of radon and radon daughters. Table 5.2 presents the network arithmetic averages, minimums, and maximums for gross beta in air during 1995. All results exceeded the MDC, except for instances where the sample volume was unusually low. The network 1995 annual average gross beta concentration was 2.0 x 10^{-14} µCi/mL (0.74 mBq/m^3), similar to 1994. This concentration is 0.001 percent of the ^{90}Sr DAC listed in DOE Order 5480.11 and less than 3 percent of the 10 mrem DCG in DOE Order 5400.5. A statistical evaluation of the gross beta concentrations indicated that a lognormal distribution provides an adequate approximation to the true distribution.

Although the gross beta concentration average for all stations was the same as last year's, it was apparent that there was a slight increasing trend in concentrations throughout the year which changed abruptly to a decrease between October and December. This trend was observed at all stations and was similar to what was observed last year. No deficiency or discrepancy was found to which this trend could be attributed.

PLUTONIUM

The composite filter samples from each particulate sampling location were analyzed for ^{238}Pu and $^{239+240}$Pu. Figure 5.4 shows the airborne $^{239+240}$Pu annual average results for each of the sampling locations. Tables 5.3 and 5.4 list the maximum, minimum, annual arithmetic mean, standard deviation, and the mean expressed as a percentage of the DCG for each sampling location, for $^{239+240}$Pu and ^{238}Pu, respectively. The ranges in the annual mean concentrations for ^{238}Pu and $^{239+240}$Pu for all stations were -0.095 to 1.0 x 10^{-17} µCi/mL and -0.16 to 72 x 10^{-17} µCi/mL (-3.5 to 37 x 10^{-8} and -0.06 to 27 x 10^{-6} Bq/m^3), respectively. The arithmetic mean and standard deviation of ^{238}Pu in air for all stations were (6.3 ± 15) x 10^{-19} µCi/mL (2.3 ± 5.6 x 10^{-8} Bq/m^3). Most observed values of ^{238}Pu were well below the limit of detection. The arithmetic mean and standard deviation of $^{239+240}$Pu in air for all stations were (3.2 ± 7.8) x 10^{-17} µCi/mL (1.2 ± 2.9) x 10^{-6} Bq/m^3. The network arithmetic mean for $^{239+240}$Pu was 33 percent lower than the 1994 mean concentration, a decrease that is within the statistical variation of the network results.

During 1995, the maximum annual average (mean) $^{239+240}$Pu concentration was found at the Area 9, 9-300 Bunker and the next highest at the Area 3 sampling locations. Results from samples taken at Area 9, 9-300 Bunker averaged 16 x 10^{-17} µCi/mL (5.9 µBq/m^3) during 1995. This quantity was less than 0.01 percent of the DAC and 1 percent of the 10 mrem DCG. Historically, the highest concentrations of $^{239+240}$Pu have occurred in Areas 3 and 9. A statistical analysis of the $^{239+240}$Pu results indicated that due to the heterogeneity of the variances, the differences reported among the areas are not statistically significant.

The presence of plutonium on the NTS is primarily due to atmospheric tests and tests in which nuclear devices were detonated with

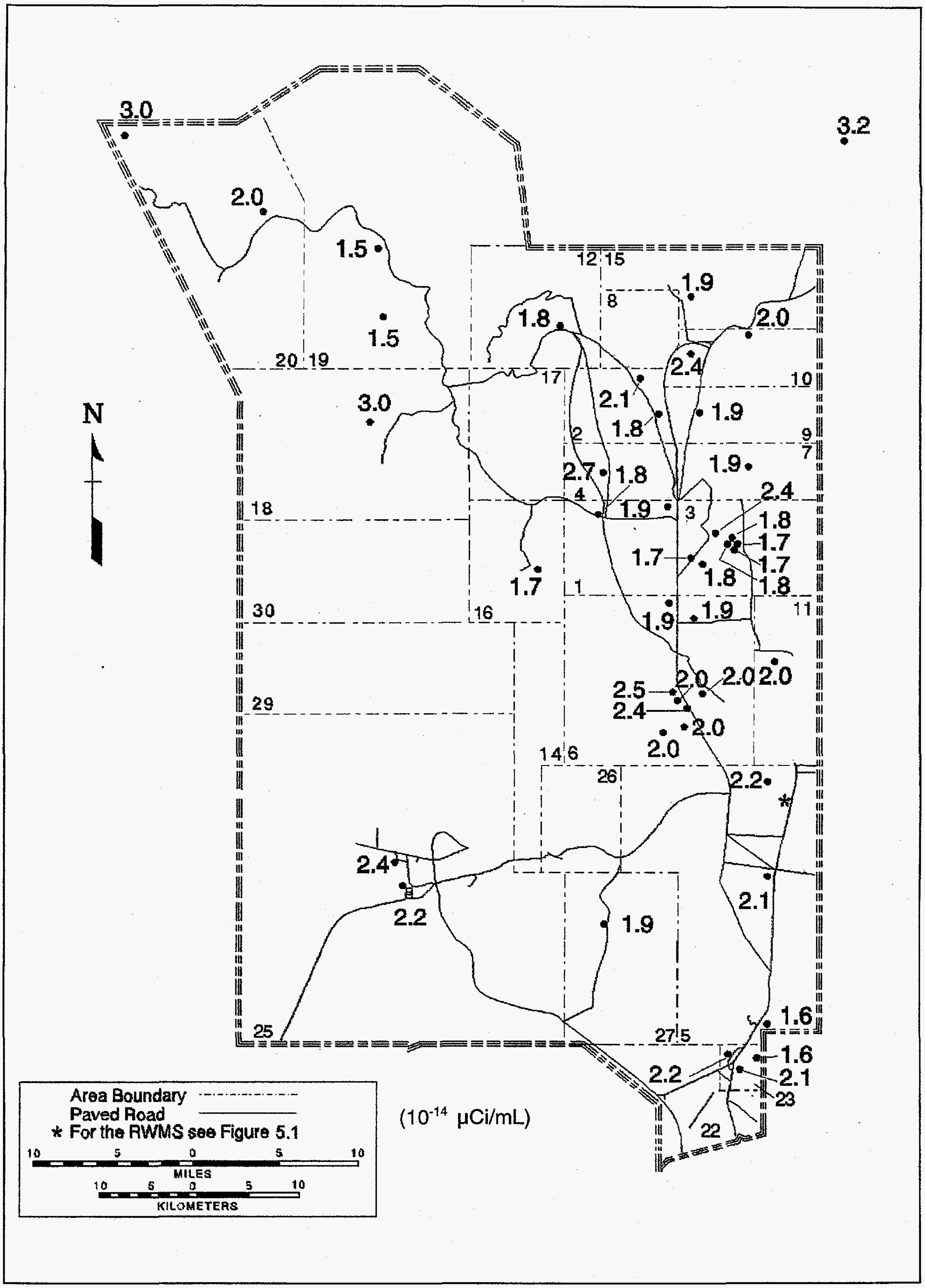


Figure 5.3 NTS Airborne Gross Beta Annual Average Concentrations - 1995

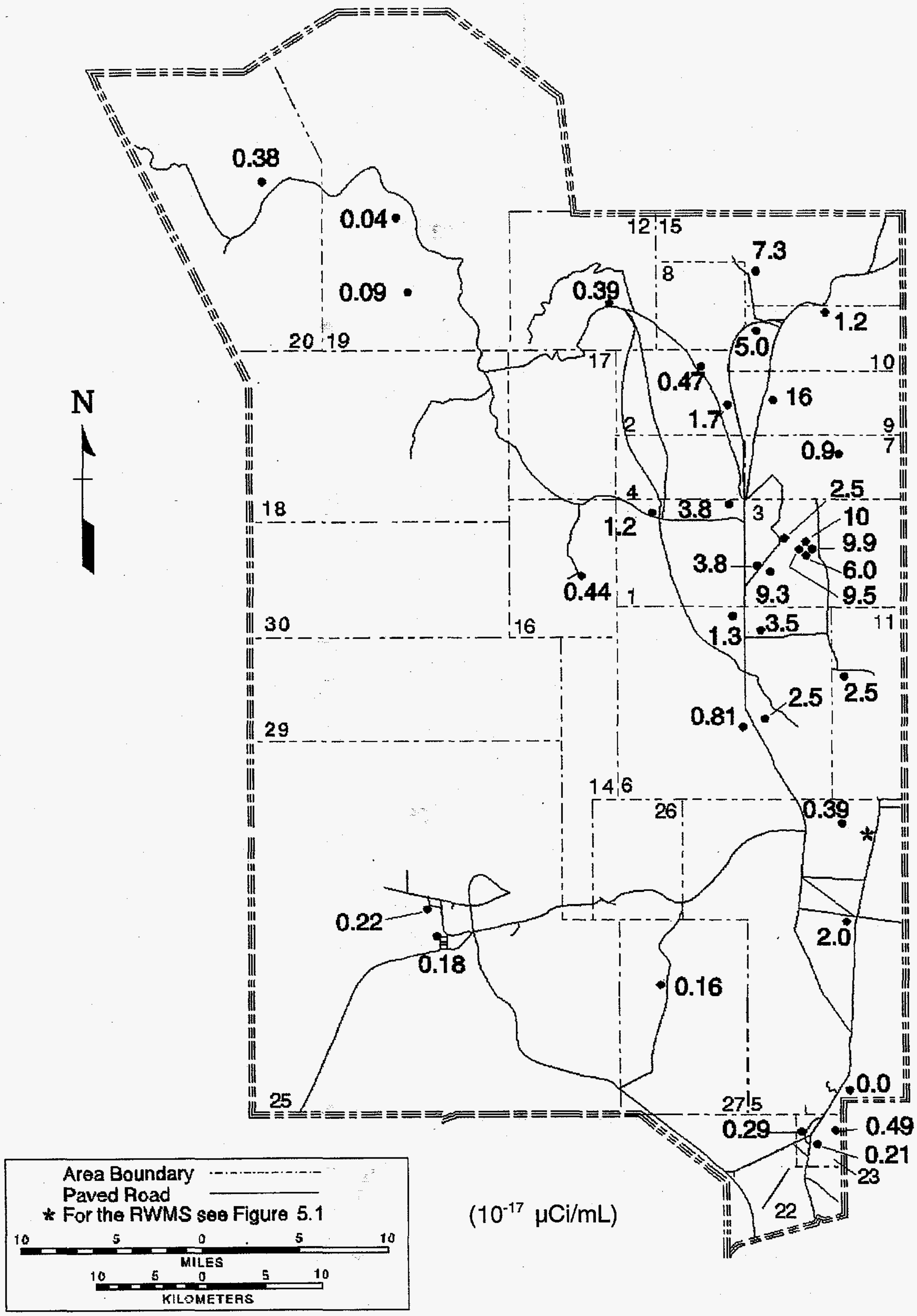


Figure 5.4 NTS Airborne $^{239+240}$Pu Annual Average Results - 1995

high explosives ("safety shots"). These latter tests spread low-fired plutonium in the eastern and northeastern areas of the NTS (see Chapter 2, Figure 2.3 for these locations). Almost three decades later, measurable levels of plutonium in air are still present because operational activities and vehicular traffic in these areas resuspended some of the ^{238}Pu and $^{239+240}$Pu in the soil.

GAMMA

The glass fiber filters used to collect particulates were analyzed by gamma spectroscopy. The only radionuclides detected by gamma spectroscopy were naturally occurring in the environment (^{40}K, ^{7}Be, and members of the uranium and thorium series), except for traces of an event related radionuclide, ^{137}Cs, which was detected in seven samples. All of these samples had ^{137}Cs concentrations <0.1 percent of the 10 mrem DCG.

5.2.1.3 NOBLE GAS SAMPLING RESULTS

The locations at which compressed air samples were routinely collected throughout the year are shown in Figure 5.5 with the annual averages of the ^{85}Kr analyses. All average concentrations were well below the DCG values of 3×10^{-7} µCi/mL (1.1×10^{4} Bq/m^{3}) for ^{85}Kr. The samplers at three locations will constitute the new network; the remainder were terminated during the year because of budget limitations and the cessation of nuclear explosives tests. Due to the closing of Areas 19 and 20 during the winter months, these stations did not begin sampling until April and May 1994. Summaries of the results are listed in Table 5.6. Individual results for each collected sample are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1995" (DOE/NV/11718-038, in prep.).

As in the past, the levels of ^{85}Kr (half-life of 10.76 years) observed in the samples were from worldwide nuclear power and fuel processing operations, with a small contribution of ^{85}Kr from underground nuclear tests at the NTS. Xenon-133 analyses were not done this year because its short half-life of 5.27 days and the moratorium on tests make it unlikely that any would be detected on the NTS.

KRYPTON-85

Again this year the highest annual average concentration occurred in Area 20, at the Area 20 Camp, 34×10^{-12} µCi/mL (1.3 Bq/m^{3}), which is 0.01 percent of the 10 mrem DCG. The higher average for the samples collected in Area 20 was expected as it is in the northern portion of the NTS in the proximity of the sites where seepage of noble gases from the ground has been observed in the past. Stations in this area have consistently had the highest concentration of noble gases.

Nevertheless, statistical evaluation of these data showed that the average concentration for Area 20 was not significantly higher than the other averages at the five percent significance level. Each location had environmental levels of ^{85}Kr with occasional spikes attributed to seepage of noble gases from the Pahute Mesa area. All data since 1982 were evaluated for any trend in concentrations. The ^{85}Kr concentrations were found to have remained relatively constant over this period.

5.2.1.4 TRITIATED WATER VAPOR SAMPLING RESULTS

The concentrations of tritiated water vapor determined from sampling conducted at 15 permanent sampling stations are summarized in Table 5.7. Individual results for each collected sample are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1995," (DOE/NV/11718-038, in prep.), which also includes a statistical evaluation of the data.

As shown in Table 5.7, the location having the highest annual average tritium concentration was the Area 5 RWMS No. 4 station with an

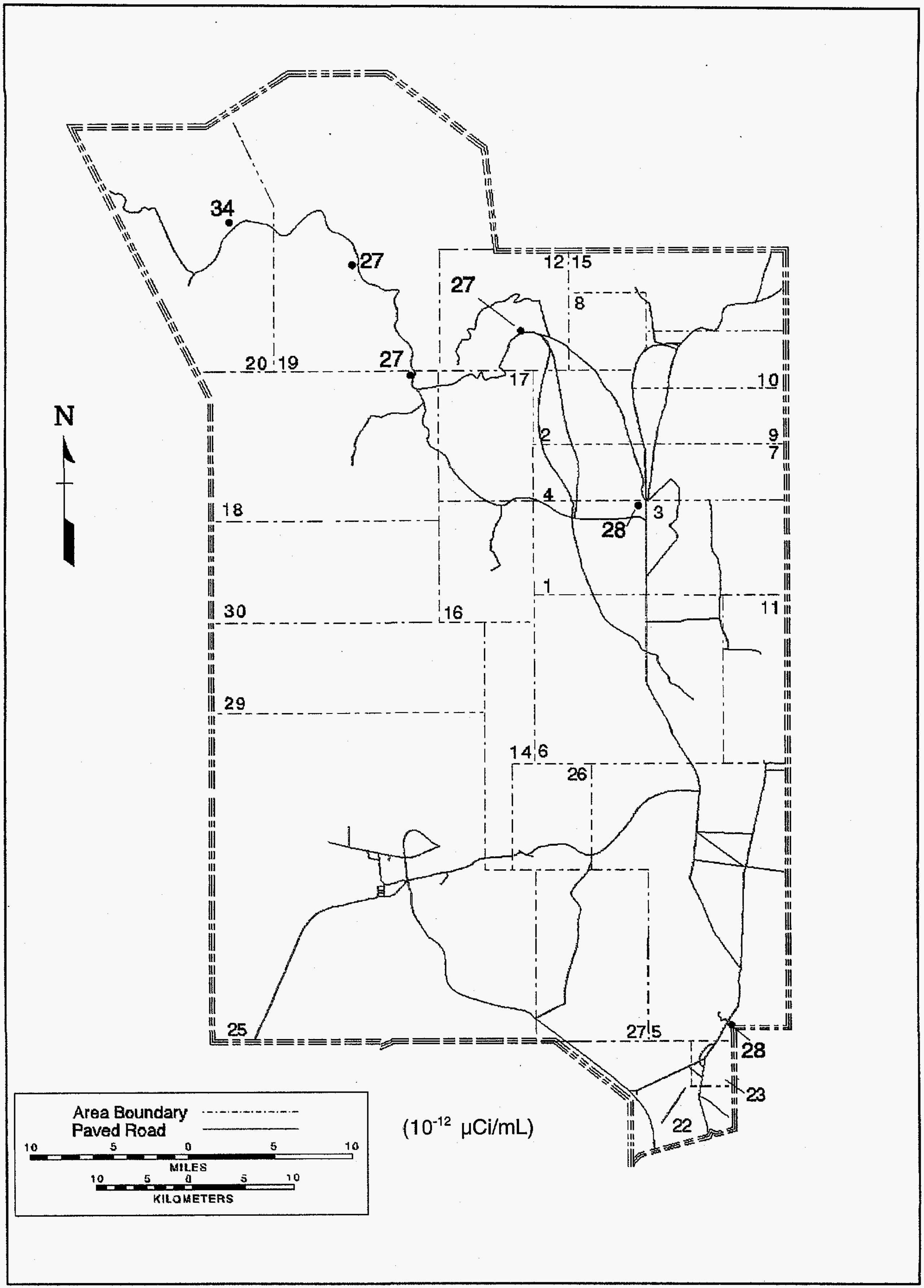


Figure 5.5 NTS ^{85}Kr Annual Average Concentrations - 1995

average of 15 x 10^{-6} pCi/mL (0.56 Bq/m^3). This average was only 0.15 percent of the 10 mrem DCG for tritium. The annual average concentration at each station is shown in Figure 5.6 and Figure 5.2 for RWMS-5.

The data were found to be lognormally distributed, therefore the natural logarithms of the individual concentrations were used in a one-way analysis of variance to test for differences between station means. This statistical testing also identified three separate groups of stations, similar to those found in the data for 1994. The annual concentration averages at the locations in the higher grouping were 0.15 percent or less of the 10 mrem DCG.

A review of the historical trend in concentrations at the NTS over the years 1982 through 1995 was made. The review found that the average tritium concentration for all environmental stations showed an exponential decrease from about 1.4 x 10^{-4} pCi/mL in 1982 to about 4.0 x 10^{-5} pCi/mL in 1987, followed by a steady decrease to the current value, 1.7 x 10^{-6} pCi/mL. The same trend was observed at all environmental stations, including the RWMS stations, which implies that the RWMS, although emitting measurable tritium, may not be the only source of tritium at the NTS.

5.2.1.5 RADIOACTIVITY IN SURFACE WATER

Surface water sampling at the NTS was conducted at 12 open reservoirs, 8 natural springs, 3 containment ponds or effluents, and 11 sewage lagoons. The locations of these sources are shown in Figure 4.4. When water was available and the weather permitted, a grab sample was taken quarterly. The sample was analyzed for ^{3}H, gross beta, gamma activity, ^{238}Pu, $^{239+240}$Pu, and ^{90}Sr according to the schedule shown in Table 4.1. Sources of surface water were, for the most part, man-made, i.e., created for or by NTS operations. There is no known human consumption of any surface water on the NTS.

The annual average for each radionuclide analyzed in surface waters is presented in Table 5.8, along with the results from analysis of tunnel effluents. The annual averages for open reservoirs and natural springs (see Figure 5.7) are compared to the DCGs for ingested water. Gamma results for all sample locations indicated that radionuclide levels were consistently below the detection limit except for samples from the containment ponds.

With the exception of containment ponds, no annual average concentration in surface waters was found to be statistically different from any other at the five percent significance level. The analytical results from the Area 12 containment ponds showed measurable quantities of radioactivity and displayed identifiable trends.

OPEN RESERVOIRS

Open reservoirs have been established at various locations on the NTS for industrial uses. The annual average concentrations of radioactivity were compared to the DCGs for ingested water listed in DOE Order 5400.5, even though there was no known consumption of these waters. The appropriate data are shown in Table 5.9.

NATURAL SPRINGS

Of the nine natural springs found onsite (i.e., spring-supplied pools located within the NTS), eight were consistently sampled. These springs were a source of drinking water for wild animals on the NTS. The annual average gross beta results for each spring are shown in Table 5.10 and compared to the ^{90}Sr DCG for drinking water, although the water is not used for drinking. The highest result was for Area 7, Reitman Seep, but it was still below the DCG.

CONTAINMENT PONDS

Due to the sealing of the tunnels by the end of the year 1993, liquid effluents ceased at all except E Tunnel. The E Tunnel containment pond was fenced and posted with radiological warning signs. During each sampling, a grab sample was taken from the E Tunnel containment pond and at the effluent discharge point. The samples were analyzed for ^{3}H, ^{90}Sr, ^{238}Pu, $^{239+240}$Pu, gross beta, and

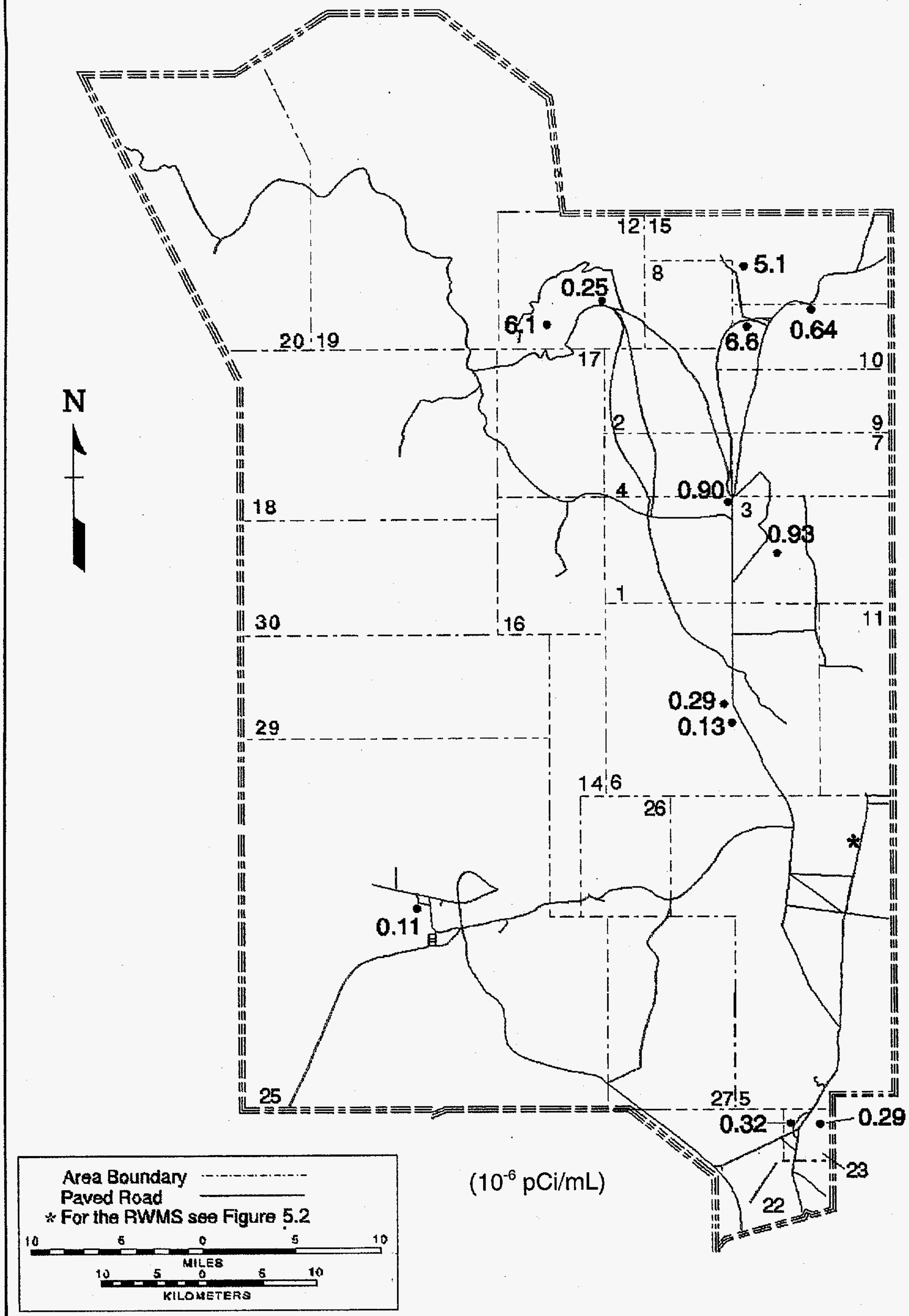


Figure 5.6 NTS Tritiated Water Vapor Annual Average Concentrations - 1995

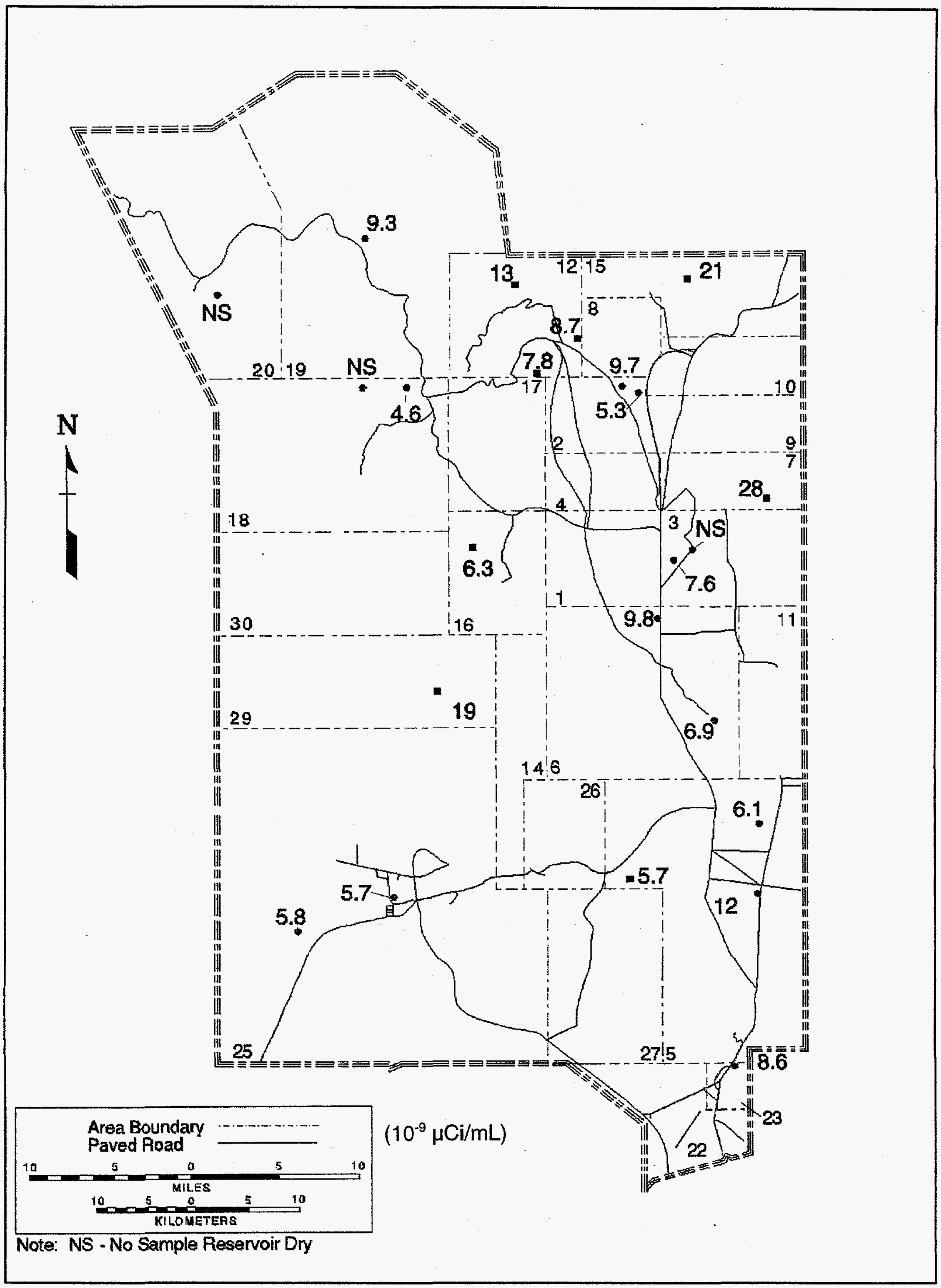


Figure 5.7 Annual Average Gross Beta in Open Reservoirs(●) and Natural Springs(■) - 1995

gamma activity in accordance with the schedule in Table 4.1. The annual average of gross beta analyses from each sampling location is listed in Table 5.11 and compared to the DCG for ingested water. This water is not used for drinking.

The effluent from characterization wells drilled in Area 20 was discharged into containment ponds. The total liquid discharged was calculated from the measured area and water depth. The averaged ^{3}H concentration of collected samples can then be used to calculate the total discharged (261 Ci or 9.6 TBq).

SEWAGE LAGOONS

Samples were collected quarterly during this year from the 11 sewage lagoons on the network at the end of 1995. Each of the lagoons is part of a closed system used for evaporative treatment of sanitary waste. The lagoons are located in Areas 6, 12, 22, 23, and 25. There was no known contact by the working population during the year. The annual gross beta concentration averages for all lagoons ranged between 0.88 and 26 x 10^{-8} µCi/mL (0.33 to 9.6 Bq/L). No radioactivity was detected above the MDCs for tritium, ^{238}Pu, $^{239+240}Pu$, or ^{90}Sr. No event-related radioactivity was detected by gamma spectrometric analyses.

5.2.1.6 RADIOACTIVITY IN SUPPLY WELL WATER

The principal water distribution system on the NTS is potentially the critical pathway for ingestion of waterborne radionuclides. Consequently, the water distribution system is sampled and evaluated frequently. At the start of 1995 the NTS water system consisted of 13 supply wells, 10 of which supplied potable water to onsite distribution systems. The drinking water is pumped from the wells to the points of consumption. The supply wells were sampled on a quarterly basis. Drinking water is sampled at end-points to provide a constant check of the radioactivity and to allow end-use activity comparisons to the radioactivity of the water in the supply wells. In this section analytical results are presented from samples taken at the 13 supply wells. Each well was sampled and analyzed as noted in the schedule in Table 4.1.

The locations of the supply wells are shown in Figure 5.8. Water from these wells (10 potable and 3 non-potable) was used for a variety of purposes during 1995. Samples were collected from those wells which could potentially provide water for human consumption. These data were used to help document the radiological characteristics of the NTS groundwater system. The sample results were maintained in a database so that long-term trends and changes could be studied. Table 5.12 lists the drinking water sources, and Table 5.13 lists the potable and non-potable supply wells and their respective radioactivity averages. No event-related radionuclides were detected by gamma spectrometry. Included in the table are the median MDCs for each of the measurements for comparison to the concentration averages for each location. For various operational reasons, samples could not be collected from all locations every month.

GROSS BETA

As shown in Table 5.13, the gross beta concentration averages for all the supply wells were above the median MDC of the measurement. The highest average gross beta activity occurred at Well C and was 2.1 x 10^{-8} µCi/mL (0.78 Bq/L), which was 7.0 percent of the DCG for ^{40}K and 53 percent of the DCG for ^{90}Sr based upon 4 mrem effective dose equivalent (EDE) per year. In earlier reports (Scoggins 1983 and Scoggins 1984), it was noted that the majority of gross beta activity was attributable to naturally occurring ^{40}K. The gross beta annual averages are shown at their supply well sampling locations in Figure 5.8. All concentration averages were comparable to those reported last year, except for Well C which was a factor of 3 higher than last year. This is an anomaly probably due to the high dissolved and suspended solids in the samples.

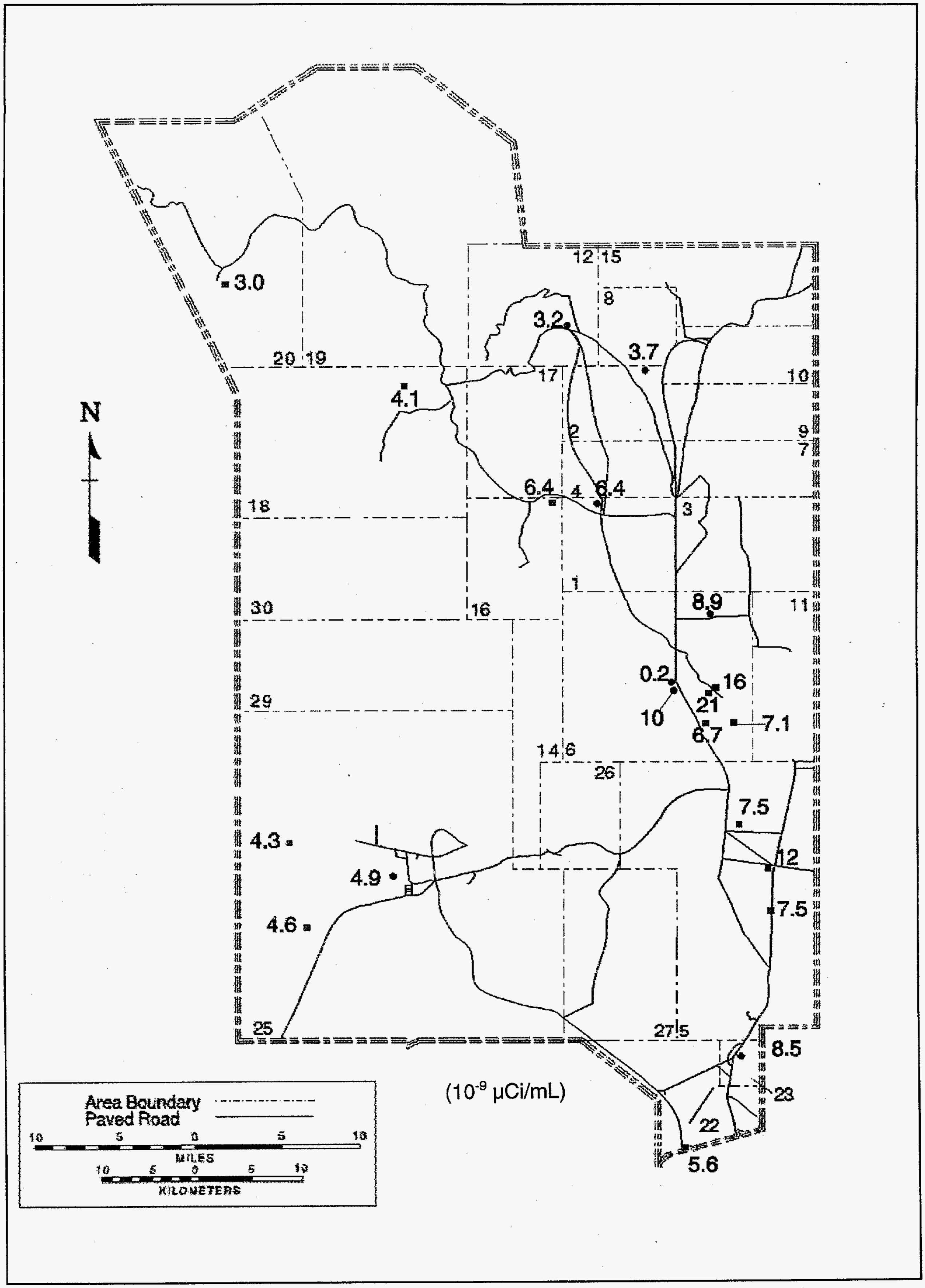


Figure 5.8 Annual Average Gross Beta in Supply Wells (■) and Potable Water (●) - 1995

TRITIUM

As shown in Table 5.13 the average tritium concentrations at all locations were at or below the average MDC of the measurement (note that the MDC was 16 x 10^{-9} µCi/mL for the tritium enrichment analysis).

PLUTONIUM

All supply water samples analyzed for ^{238}Pu and $^{239+240}$Pu had concentrations below their MDCs of about 2.4 x 10^{-11} µCi/mL, which are 1.2 and 2.2 percent of their respective DCGs adjusted to a 4 mrem EDE per year. Table 5.13 lists the concentration averages for these nuclides for each location.

GROSS ALPHA

As shown in Table 5.13, the average gross alpha concentration for all of the supply wells, except for Well 8 and Well J-12 were above the median MDC of 1.5 x 10^{-9} µCi/mL. The highest concentration from the potable wells occurred in samples from the Area 6, Well C-1, and was 13 x 10^{-9} µCi/mL (0.48 Bq/L). This is acceptable according to the EPA drinking water standard as long as the combined concentration of ^{226}Ra and ^{228}Ra is less than 5 x 10^{-9} µCi/mL (0.18 Bq/L). The combined Ra concentration for this well was less than this at 1.6 x 10^{-9} µCi/mL (0.06 Bq/L).

STRONTIUM

Beginning in 1994, ^{90}Sr analyses were changed from annually to quarterly on samples collected from the potable supply wells. Note that the ^{90}Sr results for two of the non-potable supply wells are for single samples and not an average. Concentrations of ^{90}Sr slightly above the MDC of the measurement were reported for 12 percent of the samples from the supply wells. However, in Table 5.13 all of the ^{90}Sr concentration averages were below the median MDC.

5.2.1.7 RADIOACTIVITY IN DRINKING WATER

As a check on any effect the water distribution system might have on water quality, seven end-points (labeled potable water in Figure 5.8) were sampled. In order to ensure that all of the water available for consumption was being considered, each drinking water system was identified. The drinking water network at the NTS was found to consist of five drinking water systems. The components of the five are shown in Table 5.12. These systems, fed by 10 potable supply wells, are the source of the water for 7 end-points. Table 5.14 lists the annual concentration averages for all the analyses performed on the end point samples. No event-related radionuclides were detected by gamma spectrometry.

GROSS BETA

As in previous years, the gross beta concentration averages for all end-points were above the median MDC of the measurements. The highest annual average occurred in Area 6 Cafeteria, 10 x 10^{-9} µCi/mL (0.37 Bq/L). This annual average was 3.3 and 25 percent of the DCG for ^{40}K and ^{90}Sr, respectively, adjusted to an annual 4 mrem EDE.

TRITIUM

The annual average tritium concentrations, as shown in Table 5.14, were all less than the median MDC of 7.8 x 10^{-7} µCi/mL. The *tritium* concentrations for all end-point water samples, which were determined by a conventional liquid scintillation counting method, are expected to be lower than the MDC because the levels of tritium in the potable supply wells were near the median tritium enrichment MDC of 1.6 x 10^{-8} µCi/mL (0.59 Bq/L). These MDC values of 7.8 x 10^{-7} and 1.6 x 10^{-8} µCi/mL are 1.0 percent and 0.02 percent, respectively, of the drinking water DCG adjusted to a 4 mrem (0.04 mSv) EDE per year.

PLUTONIUM

The annual averages of $^{239+240}$Pu and ^{238}Pu for each end-point were below the median MDC of the measurements, which were 1 and 2 percent, respectively, of the 4 mrem DCG. These isotopes are not normally detected in drinking water.

GROSS ALPHA

In accordance with the National Primary Drinking Water Regulations (40 C.F.R. 141), gross alpha measurements were made on quarterly samples from the drinking water systems, namely, the potable supply wells reported in the previous section of this report. As added assurance that no radioactivity gets into the systems between the supply wells and end-point users, measurements of gross alpha are also made on quarterly samples from the end-points. As shown in Table 5.14, the annual concentration averages for gross alpha radioactivity in samples collected at four of the end-points exceeded the screening level at which ^{226}Ra analysis is required, 5 pCi/L (0.19 Bq/L). Samples from the supply wells were collected and analyzed for both ^{226}Ra and ^{228}Ra. As shown by the radium results in Table 5.15, the sums of the average concentrations for ^{226}Ra and ^{228} Ra were all less than 5 pCi/L so the onsite systems were in compliance with drinking water regulations.

STRONTIUM

As indicated by Table 5.14, the ^{90}Sr results for samples collected from all the selected end-points had concentrations that were less than the median MDC of the measurements.

5.2.1.8 EXTERNAL GAMMA EXPOSURES - ONSITE AREA

The TLD network at the NTS in 1995 consisted of 194 TLDs at fixed locations. Each TLD is fixed on a stake about one meter above the ground to measure ambient beta and gamma radiation. Three TLDs posted at the Liquid Waste Treatment System and four at the Device Assembly Facility (DAF) were deployed only for the fourth quarter of 1995. There were another 17 TLD locations that were discontinued during the fourth quarter of 1995 due to the budget cut for FY96. Fifteen of the stations were established as the boundary locations and were reachable by truck as stated in the previous year's report.

Environmental monitoring is done with the UD-814 Dosimeters of special design. The UD-814 is a modification of UD-804 environmental dosimeter with the addition of a $Li_2B_4O_7$:Cu element in position 1 encapsulated in 14 mg/cm^2 to monitor beta particles in the environment. The remaining three elements are replicates of $CaSO_4$:Tm encapsulated in 1000 mg/cm^2 of plastic and lead. Since $CaSO_4$ is about 30 times more sensitive than $Li_2B_4O_7$:Cu, it makes an excellent phosphor to measure the low doses (10 mR/month) generally encountered in low level radiation environments.

The results for boundary locations are given in the Table 5.16. The annual rates were between 58 mR/year and 161 mR/year for all the boundary locations.

A group of locations which were not, to the best available knowledge, influenced by radiological contamination, and had been monitored for many years served as controls for the NTS. The data from these locations are presented in Table 5.17. The annual rates were between 54 mR/year and 130 mR/year and overall network extrapolated average exposure rate was 0.23 mR/day or 83 mR/year.

An investigation of historical trends in onsite environmental gamma levels as measured by the TLD network showed no significant differences between years until 1993, except for data from 1987 (dosimetry system changed) and 1988 (due to a calibration problem). A change in procedure has introduced an additional significant change in historical trend data in 1994. A description of this analysis is published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1995," (DOE/NV/11718-038, in prep.).

5.2.2 OFFSITE ENVIRONMENTAL SURVEILLANCE

The RSL-LV offsite environmental surveillance program was operated to detect any releases of radioactivity related to current NTS activities which could potentially result in human exposure. Monitoring was concentrated on possible human exposure pathways so monitoring locations were generally selected to represent inhabited areas around the NTS. Monitoring was not designed to provide full spatial characterization of the offsite area, nor was the monitoring designed to detect all types of radioactivity arising from all natural and manmade sources. Possible pathways monitored included inhalation, ingestion, and external exposure. In brief (a full description is in Chapter 4) the following was done. Alpha, beta, and gamma radiation in air were monitored by the Air Surveillance Network (ASN), which included 20 continuously operating stations around the NTS. Noble gas and atmospheric moisture samplers were discontinued in 1994. Groundwater and some surface water supplies were sampled regularly in the Long-Term Hydrological Monitoring Program (LTHMP). Water sampling locations included 37 wells on the NTS or immediately outside its borders and 32 locations in the offsite area. The Milk Surveillance Network (MSN) consisted of annual collections from 10 locations in the immediate offsite area, of which 9 were sampled this year. The network included family-owned cows and goats and commercial dairies. The Biomonitoring Network was reduced to collection and analysis of one mule deer from the NTS.

External gamma radiation was monitored by the Pressurized Ion Chamber (PIC) Network and the TLD Network. The PIC network included 27 stations that were connected by satellite telemetry to the NTS for real-time data collection. Approximately 25 local residents voluntarily participated in the TLD network and another 47 TLDs were located at fixed environmental stations. In late 1995, the offsite Internal Dosimetry Program, which had included an annual whole-body and lung count and urinalysis, was discontinued.

The results of monitoring conducted in 1995 are discussed in the following subsections for each of the environmental surveillance networks mentioned above. No major accidental releases of radionuclides from the NTS were reported in 1995. All individual sample data are published separately, but summary data are included herein.

5.2.2.1 AIR MONITORING NETWORKS

The following sections describe results for the ASN. The atmospheric monitoring network measures the major radionuclides which could potentially be emitted from activities on the NTS, as well as naturally occurring radionuclides. This network represents the possible inhalation exposure pathway for the general public.

AIR SURVEILLANCE NETWORK

Gamma spectrometry was performed promptly on all ASN samples. The majority of the samples were gamma-spectrum negligible (i.e., no gamma-emitting radionuclides detected). Naturally occurring ^{7}Be, annual average 3.7×10^{-13} µCi/mL, was detected occasionally.

As in previous years, the gross beta results consistently exceeded the analytical MDC. The annual average gross beta activity was $1.61 \pm 0.38 \times 10^{-14}$ µCi/mL ($6.0 \pm 1.4 \times 10^{-4}$ Bq/m^{3}) for the ASN. Summary results for the ASN gross beta are in Table 5.18. Individual results are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1995," (DOE/NV/11718-038, in prep.).

Gross alpha analysis was performed on all samples. The average annual gross alpha activity was 1.4×10^{-15} µCi/mL (52 µBq/m^{3}). Summary results for the ASN gross alpha are shown in Table 5.19.

Selected air prefilters were also analyzed for plutonium isotopes. This report contains results for samples collected during the fourth quarter of 1994 and the first and second quarters of 1995, presented in Table 5.20. Due to the length of time required for analysis, the data for the third and fourth quarter are not available but will be included in the combined report for 1996. Although annual average values were essentially nondetectable, one sample exceeded the MDC. This was a composite sample from Rachel, NV for $^{239+240}$Pu analysis.

5.2.2.2 WATER MONITORING

Environmental surveillance of water in the offsite areas is conducted as part of the LTHMP. Results are discussed in Chapter 9 of this report.

5.2.2.3 MILK SURVEILLANCE NETWORK

The average total potassium concentration derived from naturally occurring ^{40}K activity was 1.5 g/L for samples analyzed by gamma spectrometry. Selected MSN milk samples were analyzed for ^{3}H, ^{89}Sr, and ^{90}Sr, and the results are similar to those obtained in previous years; neither increasing nor decreasing trends are evident. The MSN network average values are shown in Table 5.21 for ^{3}H, ^{89}Sr, and ^{90}Sr.

5.2.2.4 BIOMONITORING

The site where one mule deer was collected in 1995 is shown in Chapter 4, Figure 4.7. The results of the collected samples are discussed below.

MULE DEER

Blood samples are analyzed for gamma-emitting radionuclides and tritium. Soft tissue samples (lung, muscle, liver, rumen contents, and fetus) are analyzed for gamma-emitting radionuclides. Additionally, samples of soft tissue and bone were ashed and then analyzed for plutonium isotopes; ashed bone samples were also analyzed for ^{90}Sr. The results are shown in Figure 5.9.

The mule deer collected on the NTS during the first quarter of 1995 was a female 4 - 5 years old. The deer was collected at the north end of Mid Valley Road in Area 16. The doe was estimated to be in about the 90th day of gestation. No histopathology was noted except for sarcocyts in the skeletal muscle.

No gamma-emitting radionuclides were found above MDC. Amniotic fluid found with the fetus contained tritium at 456 pCi/L (MDC = 443 pCi/L). The analysis for ^{238}Pu was below MDC for all samples. Detectable concentrations of ^{239}Pu were found in samples of the fetus at .0036 pCi/g of ash (MDC = 0.0027 pCi/g ash), and concentrations were found in muscle samples at 0.0052 pCi/g of ash (MDC = 0.0037 pCi/g ash). ^{90}Sr found in bone samples was 2.9 pCi/g of ash (MDC = 0.25 pCi/g ash).

5.2.2.5 THERMOLUMINESCENT DOSIMETRY NETWORK

OFFSITE STATION NETWORK

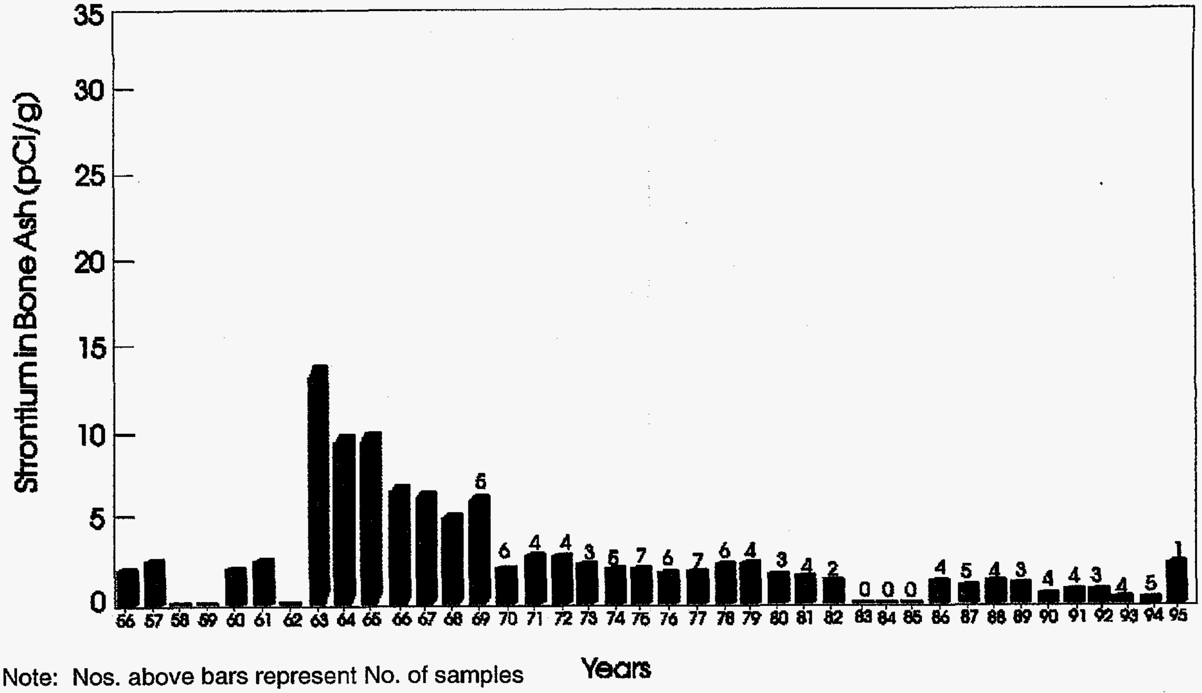
There were 47 offsite environmental stations monitored using TLDs. Figure 4.8 shows current fixed environmental monitoring locations. Total annual exposure for 1995 ranged from 55 mR (0.55 mSv) per year at the McCarran International Airport station to 140 mR (1.4 mSv) per year at Queen City Summit, Nevada, with a mean annual exposure of 97 mR (0.97 mSv) per year for all operating locations. The next highest annual exposure was 130 mR (1.3 mSv) per year at Austin, Nevada. These results are consistent with those for 1994.

OFFSITE PERSONNEL NETWORK

A limited number of offsite personnel were issued TLDs to monitor their annual absorbed dose equivalent. Locations of personnel monitoring participants are also shown in Figure 4.8. Annual whole body absorbed dose equivalents ranged from a low of 70 mrem (0.70 mSv) to a high of 130 mrem (1.3 mSv) with a mean of 98 mrem (0.93 mSv) for all monitored personnel during 1995. These results are similar to those for 1994.

5.2.2.6 PRESSURIZED ION CHAMBER NETWORK

The PIC data presented in this section are based on weekly averages of gamma exposure rates from each station. Table 5.22 contains the number of weekly averages available from each station and the maximum, minimum, mean, standard deviation, and median of the weekly averages. The mean ranged from 8.2 µR/hr at Pahrump, NV to 18.7 µR/hr at Stone Cabin Ranch, NV or annual exposures from 73 to 164 mR (19 to 43 µC/Kg). For each station, this table also



Note: Nos. above bars represent No. of samples

Figure 5.9 Average Strontium Levels in Mule Deer, 1956 - 1995

shows the total mR/yr (calculated based on the mean of the weekly averages) and the average gamma exposure rate from 1994. Background levels of environmental gamma exposure rates in the U.S. (from the combined effects of terrestrial and cosmic sources) vary between 49 and 247 mR/yr (13 to 64 µC/kg-yr) (BEIR III, 1980). The annual exposure levels observed at each PIC station are well within these U.S. background levels. Figure 5.10 shows the distribution of the weekly averages from each PIC station arranged by ascending means (represented by filled circles). The horizontal lines extend from the box to the minimum and maximum values. The data from the Austin, Overton, Rachel and Uhalde's Ranch stations show the greatest range and the most variability. Data from the Austin station have historically shown a natural fluctuation during the winter months (EPA 1993). These data are within a few tenths µR/hr from those of last year.

5.2.2.7 INTERNAL DOSIMETRY PROGRAM

The RSL-LV Internal Dosimetry Program was developed to identify the presence of radionuclides that have been ingested, absorbed, or inhaled by offsite residents, and to determine the total quantities of these contaminants and their possible health effects. To accomplish this task, a Whole Body Counting facility is operated at the laboratory in which semiconductor detectors are used to scan participants for gamma- or X-rays that could indicate that a radioactive burden has accumulated. A routine scan involves a 1000 to 2000-second data collection time with a large volume detector placed near a reclining individual inside a heavily shielded vault. Scans of the lungs are conducted in a similar manner with an array of detectors that are highly sensitive to low energy gamma emitting radionuclides such as plutonium or uranium.

The Internal Dosimetry Program for the year included the Radiological Safety Program consisting of: selected government and contractor employees; members of other federal, state, or local institutions; and the general public. In 1995, a total of 60 whole body scans was conducted. No radioactivity above background levels was detected in any of the scans (spectra). The Offsite Internal Dosimetry Program (which monitored individuals living in the area surrounding the

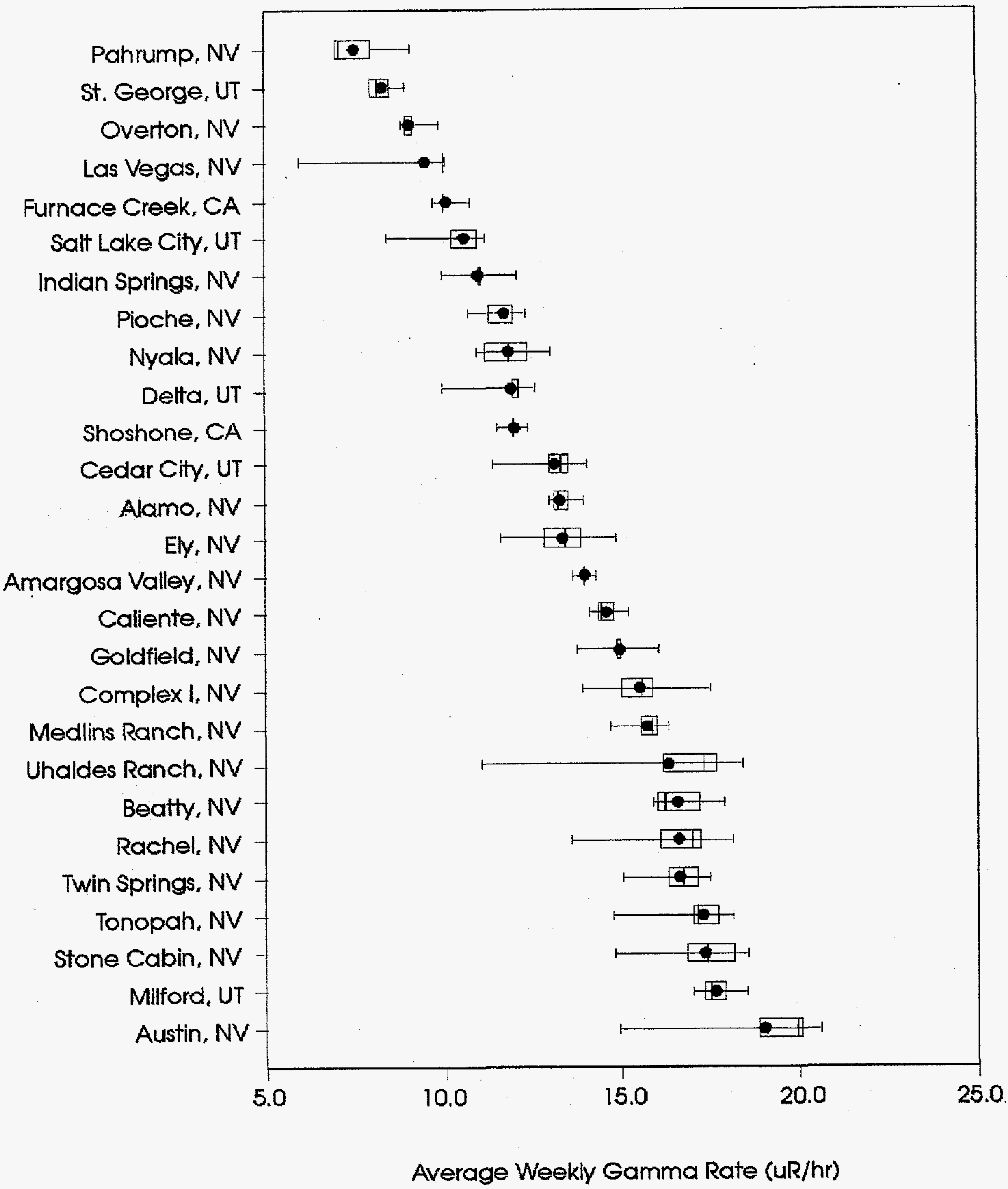


Figure 5.10 Distribution of Weekly Averages from Each PIC Network Station - 1995

NTS) was discontinued. The tritium analyses for bioassay were also discontinued. The last whole body scan was done on September 28, 1995.

5.2.3 NON-NTS EG&G/EM FACILITY MONITORING

EG&G/EM facilities which use radioactive sources or radiation producing equipment with the potential to expose the general population outside the property line to direct radiation are: the Special Technologies Laboratory (STL), during operation of the Sealed Tube Neutron Generator; STL during operation of the Febetron; the Remote Sensing Laboratory (RSL) at Nellis Air Force Base; and the Atlas North Las Vegas Facility (NLVF) A-1 Source Range. Sealed sources are tested every six months to assure there is no leakage of radioactive material. The data from sealed source testing are kept in the EG&G/EM Radiation Protection Records.

Fence line radiation monitoring at STL, RSL, and NLV was conducted during 1995 using Panasonic Type UD-814 TLDs. At least two TLDs were at the fence line on each side of the facility. TLDs were exchanged on a quarterly basis with additional control TLDs kept in a shielded safe. These TLD results are given in Table 5.23. The range of results, 52 to 96 mR/yr, is within the background range in the continental U.S.

Table 5.1 NTS Radionuclide Emissions - 1995

Onsite Liquid Discharges

Containment Ponds	Curies[(a)] ^{3}H	^{90}Sr	^{137}Cs	^{238}Pu	$^{239+240}$Pu
Area 12, E Tunnel	2.1×10^{1}	6.2×10^{-5}	5.5×10^{-3}	1.3×10^{-5}	1.0×10^{-4}
Area 20, Well ER-20	2.6×10^{2}				
TOTAL	2.8×10^{2}	6.2×10^{-5}	5.5×10^{-3}	1.3×10^{-5}	1.0×10^{-4}

Airborne Effluent Releases

Facility Name (Airborne Releases)	Curies[(a)] ^{3}H[(b)]	^{85}Kr	$^{239+240}$Pu
Area 3[(c)]			0.023
Area 5, RWMS[(c)]	9.7×10^{-1}		
Atlas Facility	2.5×10^{-1}		
Area 9 Bunker[(c)]			0.048
Pahute Mesa		300	
Other Areas[(d)]			0.33
TOTAL	1.2×10^{0}	300	4.0×10^{-1}

(a) Multiply by 3.7×10^{10} to obtain Bq. Calculated releases from laboratory spills and losses are included in Table 1.1.
(b) In the form of tritiated water vapor, primarily HTO.
(c) Calculated from air sampler data.
(d) Resuspension from known surface deposits.

Table 5.2 Airborne Gross Beta Concentrations on the NTS - 1995

		Gross Beta Concentration (10^{-14} µCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, Gravel Pit	39	3.1	0.55	1.8	0.65	2.0
Area 1, BJY	48	4.8	0.42	1.9	0.81	2.1
Area 2, Complex	32	4.5	0.82	2.1	0.82	2.3
Area 2, 2-1 Substation	49	4.1	0.05	1.8	0.72	2.1
Area 3, U3AH/AT S	46	3.1	0.48	1.7	0.54	1.9
Area 3, U3AH/AT E	49	3.2	0.29	1.7	0.65	1.9
Area 3, U3AH/AT N	46	3.2	0.62	1.8	0.57	2.0
Area 3, U3AH/AT W	48	6.2	0.56	1.8	0.85	2.0
Area 3, Complex	29	2.8	0.69	1.7	0.45	1.8
Area 3, Mud Plant	51	3.7	0.56	1.8	0.64	2.0
Area 3, Well ER-3-1	19	3.9	1.17	2.4	0.70	2.6
Area 4, Bunker T-4	2	3.9	1.51	2.7	1.71	3.0
Area 5, RWMS Pit 5	28	5.1	1.31	2.5	0.82	2.8
Area 5, RWMS No. 4	51	4.9	0.87	2.2	0.80	2.4
Area 5, RWMS No. 5	52	4.8	1.03	2.1	0.76	2.3
Area 5, RWMS No. 6	50	4.8	1.04	2.1	0.73	2.3
Area 5, RWMS No. 7	51	4.1	0.77	1.9	0.65	2.1
Area 5, RWMS No. 8	52	5.6	0.85	2.2	0.90	2.5
Area 5, RWMS Pit-3	39	2.8	0.77	1.7	0.48	1.9
Area 5, RWMS No. 9	52	4.1	0.73	1.9	0.64	2.2
Area 5, Gate 200 S	40	2.8	0.62	1.6	0.54	1.8
Area 5, DOD Yard	50	5.0	0.71	2.2	0.84	2.5
Area 5, RWMS No. 2	40	3.0	0.76	1.8	0.54	2.0
Area 5, RWMS No. 3	50	4.6	1.00	2.0	0.74	2.2
Area 5, RWMS No. 1	52	5.0	0.78	2.1	0.89	2.3
Area 5, RWMS TP SE	16	3.4	0.94	1.8	0.60	2.0
Area 5, RWMS TP S	16	3.0	0.65	1.5	0.57	1.7
Area 5, RWMS TP SW	40	3.3	1.00	1.9	0.53	2.1
Area 5, RWMS TP NW	38	3.9	0.77	2.0	0.69	2.2
Area 5, RWMS TP N	39	3.5	0.80	2.0	0.62	2.2
Area 5, RWMS TP NE	40	3.2	0.84	1.9	0.57	2.1
Area 5, RWMS Pit-4	19	2.8	0.77	1.7	0.55	1.9
Area 5, RWMS TP Bldg.	36	4.1	1.06	2.2	0.78	2.5
Area 5, RWMS TP Bldg.	34	3.9	1.22	2.2	0.74	2.5
Area 5, Well 5B	47	4.2	0.88	2.1	0.72	2.3
Area 6, Yucca	49	4.0	0.49	2.0	0.70	2.2
Area 6, Bldg. 6-900	39	3.4	0.91	1.9	0.51	2.1
Area 6, CP 6	40	4.7	0.68	2.0	0.76	2.2
Area 6, Well 3	50	3.8	0.72	1.9	0.64	2.2
Area 6, Gas Station	18	3.3	0.97	2.5	0.70	2.8
Area 6, Substation 6-9	12	3.5	1.24	2.4	0.70	2.6
Area 7, UE-7ns	50	4.5	0.48	1.9	0.75	2.1
Area 9, Area 9-300	50	5.1	0.76	1.9	0.74	2.1

Median MDC = 1.5 x 10^{-15} µCi/mL.

Table 5.2 (Airborne Gross Beta Concentrations on the NTS - 1995, cont.)

	Gross Beta Concentration (10^{-14} µCi/mL)					
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 10, Gate 700 S	51	5.1	0.30	2.0	0.77	2.2
Area 10, Sedan Crater	17	4.0	1.1	2.4	0.67	2.6
Area 12, 12 Complex	44	3.7	0.49	1.8	0.75	2.0
Area 13, Area 13	2	4.8	1.7	3.2	2.2	3.6
Area 15, EPA Farm	52	4.2	0.67	1.9	0.66	2.1
Area 16, 3545 Substation	46	3.7	0.53	1.7	0.69	1.9
Area 18, Well UE-18t	2	4.5	1.4	3.0	2.1	3.3
Area 19, Echo Peak	33	2.8	1.0	1.9	0.42	2.1
Area 19, Pahute Substation	38	2.8	1.0	1.8	0.42	2.0
Area 20, Schooner	2	4.2	1.8	3.0	1.7	3.3
Area 20, Complex	32	3.4	0.64	2.0	0.67	2.2
Area 23, Building 790 No. 2	49	4.6	0.59	2.2	0.82	2.5
Area 23, East Boundary	39	2.7	0.76	1.6	0.46	1.8
Area 23, H&S Building	50	4.7	0.71	2.1	0.92	2.4
Area 25, E-MAD N	48	5.5	0.56	2.4	1.03	2.7
Area 25, NRDS	48	4.1	0.80	2.2	0.75	2.5
Area 27, Cafeteria	44	3.7	0.79	1.9	0.68	2.1
TTR, Double Tracks	1	1.7	1.69	1.7	0.00	1.9
TTR, Clean Slate	1	1.8	1.75	1.8	0.00	1.9

Median MDC = 1.5×10^{-15} µCi/mL.

Table 5.3 Airborne $^{239+240}$Pu Concentrations on the NTS - 1995

	$^{239+240}$Pu Concentration (10^{-17} µCi/mL)					
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, Gravel Pit	3	2.0	0.12	1.2	0.98	0.61
Area 1, BJY	4	6.1	0.49	3.8	2.4	1.9
Area 2, Area 2	4	0.87	-0.03	0.47	0.38	0.24
Area 2, 2-1 Substation	4	3.8	0.33	1.7	1.5	0.83
Area 3, U3AH/AT S	12	12	-0.07	6.0	4.6	3.0
Area 3, U3AH/AT E	12	40	-0.07	9.9	13	4.9
Area 3, U3AH/AT N	12	31	0.08	10	9.4	5.0
Area 3, U3AH/AT W	12	42	0.08	9.5	12	4.8
Area 3, Area 3	3	7.2	1.2	3.8	3.1	1.9
Area 3, Mud Plant	4	18	0.43	9.3	7.8	4.7

Median MDC = 7.1×10^{-18} µCi/mL.

Table 5.3 (Airborne $^{239+240}$Pu Concentrations on the NTS - 1995, cont.)

		$^{239+240}$Pu Concentration (10^{-17} µCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 3, Well ER3-1	1	2.5	2.5	2.5	0.0	1.2
Area 5, RWMS Pit 5	7	3.9	0.17	1.1	1.3	0.54
Area 5, RWMS No. 4	6	0.57	0.09	0.34	0.2	0.17
Area 5, RWMS No. 5	6	1.2	0.07	0.49	0.45	0.24
Area 5, RWMS No. 6	6	1.4	0.15	0.55	0.50	0.27
Area 5, RWMS No. 7	6	1.3	0.06	0.33	0.49	0.17
Area 5, RWMS No. 8	6	1.9	-0.02	0.67	0.64	0.34
Area 5, RWMS Pit 3	9	1.8	-0.16	0.46	0.58	0.23
Area 5, RWMS No. 9	6	1.8	0.08	0.60	0.61	0.30
Area 5, Gate 200 S	2	0.019	-0.02	-0.00	0.03	-0.00
Area 5, DOD	4	0.66	0.02	0.39	0.29	0.19
Area 5, RWMS No. 2	3	0.51	0.17	0.30	0.19	0.15
Area 5, RWMS No. 3	6	0.85	0.06	0.35	0.28	0.18
Area 5, RWMS No. 1	5	2.0	0.18	0.99	0.78	0.49
Area 5, RWMS TP SE	3	0.88	-0.05	0.26	0.54	0.13
Area 5, RWMS TP S	3	0.18	-0.04	0.07	0.11	0.04
Area 5, RWMS TP SW	9	1.9	-0.05	0.50	0.57	0.25
Area 5, RWMS TP NW	9	2.9	-0.05	0.72	0.93	0.36
Area 5, RWMS TP N	9	0.59	-0.06	0.21	0.25	0.10
Area 5, RWMS TP NE	9	0.63	-0.05	0.29	0.25	0.14
Area 5, RWMS Pit 4	4	0.85	-0.04	0.27	0.40	0.13
Area 5, RWMS TP Bldg. N	9	2.2	-0.04	0.36	0.72	0.18
Area 5, RWMS TP Bldg. S	9	0.53	-0.08	0.22	0.19	0.11
Area 5, Well 5B	4	5.7	0.10	2.0	3.2	1.0
Area 6, Yucca	4	6.5	0.12	2.5	2.8	1.3
Area 6, Bldg. 6-900	3	9.6	0.22	3.5	5.3	1.7
Area 6, CP-6	4	1.2	0.07	0.81	0.51	0.41
Area 6, Well 3	4	2.8	0.20	1.3	1.4	0.65
Area 7, UE-7ns	4	1.2	0.42	0.9	0.44	0.45
Area 9, Area 9-300	4	39	2.9	16	17	8.2
Area 10, Gate 700 S	4	2.5	0.18	1.2	0.99	0.61
Area 10, Sedan Crater	1	5.0	5.0	5.0	0.0	2.5
Area 11, Gate 293	4	4.0	0.18	2.5	1.8	1.2
Area 12, Complex	4	1.1	0.08	0.39	0.49	0.19
Area 15, EPA Farm	4	16	0.39	7.3	6.7	3.7
Area 16, 3545 Substation	4	1.4	0.10	0.44	0.63	0.22
Area 19, Echo Peak	2	0.14	0.04	0.09	0.07	0.05
Area 19, Pahute Substation	2	0.10	-0.02	0.04	0.09	0.02
Area 20, Area 20	3	0.6	0.14	0.38	0.33	0.19
Area 23, Bldg. 790 No. 2	4	1.1	-0.06	0.29	0.54	0.15
Area 23, East Boundary	3	0.83	0.13	0.49	0.35	0.25
Area 23, H&S Bldg.	4	0.30	0.11	0.21	0.08	0.11
Area 25, E-MAD N	3	0.38	0.07	0.22	0.15	0.11
Area 25, NRDS	4	0.52	-0.03	0.18	0.26	0.09
Area 27, Area 27	4	0.31	0.08	0.16	0.11	0.08

Median MDC = 7.1×10^{-18} µCi/mL.

Table 5.4 Airborne ^{238}Pu Concentrations on the NTS - 1995

		^{238}Pu Concentration (10^{-17} µCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, Gravel Pit	3	0.079	-0.011	0.020	0.051	<0.01
Area 1, BJY	4	0.30	0.025	0.11	0.12	0.038
Area 2, Complex	4	0.15	-0.015	0.028	0.080	<0.01
Area 2, 2-1 Substation	4	0.23	-0.009	0.10	0.097	0.034
Area 3, U3AH/AT S	12	0.56	-0.037	0.19	0.22	0.064
Area 3, U3AH/AT E	12	0.55	-0.070	0.12	0.17	0.039
Area 3, U3AH/AT N	12	0.42	-0.057	0.16	0.17	0.053
Area 3, U3AH/AT W	12	0.75	-0.069	0.16	0.23	0.054
Area 3, Complex	3	0.26	0.022	0.11	0.13	0.037
Area 3, Mud Plant	4	0.29	-0.005	0.14	0.13	0.048
Area 3, Well ER-3-1	1	0.029	0.029	0.029	0.0	0.010
Area 5, RWMS Pit 5	7	0.11	-0.035	-0.009	0.051	<0.01
Area 5, RWMS No. 4	6	-0.008	-0.032	-0.019	0.010	<0.01
Area 5, RWMS No. 5	6	0.32	-0.030	0.065	0.13	0.022
Area 5, RWMS No. 6	6	0.11	-0.028	0.027	0.060	<0.01
Area 5, RWMS No. 7	6	-0.007	-0.029	-0.018	0.010	<0.01
Area 5, RWMS No. 8	6	0.072	-0.033	-0.0062	0.040	<0.01
Area 5, RWMS Pit-3	9	0.21	-0.070	0.039	0.090	0.013
Area 5, RWMS No. 9	6	-0.005	-0.038	-0.019	0.013	<0.01
Area 5, Gate 200 S	2	-0.006	-0.009	-0.0078	0.002	<0.01
Area 5, DOD Yard	4	0.028	-0.009	0.0013	0.018	<0.01
Area 5, RWMS No. 2	3	0.026	-0.060	-0.015	0.044	<0.01
Area 5, RWMS No. 3	6	-0.005	-0.035	-0.018	0.012	<0.01
Area 5, RWMS No. 1	5	0.059	-0.032	0.0034	0.040	<0.01
Area 5, RWMS TP SE	3	0.093	-0.023	0.018	0.065	<0.01
Area 5, RWMS TP S	3	-0.012	-0.020	-0.016	0.004	<0.01
Area 5, RWMS TP SW	9	0.12	-0.038	-0.008	0.050	<0.01
Area 5, RWMS TP NW	9	0.25	-0.029	0.025	0.095	<0.01
Area 5, RWMS TP N	9	0.11	-0.034	0.017	0.056	<0.01
Area 5, RWMS TP NE	9	0.086	-0.022	-0.007	0.035	<0.01
Area 5, RWMS Pit-4	4	0.34	-0.015	0.11	0.17	0.036
Area 5, RWMS TP Bldg. N	9	0.097	-0.095	0.001	0.062	<0.01
Area 5, RWMS TP Bldg. S	9	0.49	-0.041	0.084	0.20	0.028
Area 5, Well 5B	4	1.0	-0.009	0.27	0.50	0.089
Area 6, Yucca Waste Pond	4	0.066	-0.014	0.009	0.038	<0.01
Area 6, Bldg. 6-900	3	0.33	-0.008	0.11	0.20	0.036
Area 6, CP-6	4	0.22	-0.015	0.057	0.11	0.019
Area 6, Well 3	4	0.73	-0.011	0.20	0.36	0.066
Area 7, UE-7ns	4	0.81	-0.005	0.22	0.39	0.073
Area 9, 9-300 Bunker	4	0.46	0.10	0.22	0.17	0.073
Area 10, Gate 700 S	4	0.13	-0.012	0.059	0.062	0.020
Area 10, Sedan Crater	1	0.61	0.61	0.61	0.0	0.20
Area 11, Gate 293	4	0.053	-0.012	0.015	0.030	<0.01
Area 12, Complex	4	0.095	-0.017	0.037	0.046	0.012
Area 15, EPA Farm	4	0.54	0.027	0.21	0.23	0.069

Median MDC = 3.8×10^{-18} µCi/mL.

Table 5.4 (Airborne ^{238}Pu Concentrations on the NTS - 1995, cont.)

		^{238}Pu Concentration (10^{-17} µCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 16, 3545 Substation	4	-0.005	-0.016	-0.010	0.005	<0.01
Area 19, Echo Peak	2	0.024	-0.016	0.0040	0.028	<0.01
Area 19, Pahute Substation	2	0.031	-0.011	0.010	0.030	<0.01
Area 20, Complex	3	0.35	-0.010	0.13	0.19	0.042
Area 23, Building 790 No. 2	4	-0.009	-0.029	-0.015	0.010	<0.01
Area 23, East Boundary	3	0.035	-0.010	0.0062	0.025	<0.01
Area 23, H&S Building	4	0.080	-0.009	0.034	0.037	0.011
Area 25, E-MAD N	3	-0.008	-0.010	-0.009	0.001	<0.01
Area 25, NRDS	4	0.11	-0.011	0.030	0.056	0.010
Area 27, Cafeteria	4	-0.007	-0.017	-0.010	0.005	<0.01

Median MDC = 5.6×10^{-18} µCi/mL.

Table 5.5 Derived Limits for Radionuclides in Air and Water

	µCi/mL		
Radionuclide	DAC (Air)(a)	DCG (Air)(b)	DCG (Water)(c)
^{3}H	2×10^{-5}	1×10^{-8}	8×10^{-5}
^{40}K	2×10^{-7}	9×10^{-11}	3×10^{-7}
^{85}Kr (d)	1×10^{-4}	3×10^{-7}	-
^{89}Sr	6×10^{-8}	3×10^{-11}	8×10^{-7}
^{90}Sr	2×10^{-9}	9×10^{-13}	4×10^{-8}
^{133}Xe	1×10^{-4}	5×10^{-8}	-
^{137}Cs	5×10^{-5}	4×10^{-11}	1×10^{-7}
^{226}Ra	3×10^{-10}	1×10^{-13}	4×10^{-9}
^{238}Pu(a)	7×10^{-12}	3×10^{-15}	2×10^{-9}
$^{239+240}$Pu(a)	6×10^{-12}	2×10^{-15}	1×10^{-9}

(a) DAC - The Derived Air Concentration used for limiting radiation exposures of workers. The values are based on either a stochastic effective dose equivalent of 5 rem or a nonstochastic organ dose of 50 rem, which ever is more limiting (DOE Order 5480.11). Class Y is used for plutonium.

(b) DCG - Derived Concentration Guides are reference values for conducting radiological protection programs at operational DOE facilities and sites. The DCG values are for an effective dose equivalent of 10 mrem (0.1 mSv) (inhalation) for a year as required by 40 C.F.R. 61.92 and DOE Order 5400.5.

(c) The values listed for beta and photon emitters in the table are based on 4 mrem committed effective dose equivalent for the radionuclide taken into the body by ingestion of water during one year (730 L).

(d) Nonstochastic value.

Table 5.6 Summary of NTS ^{85}Kr Concentrations - 1995

		^{85}Kr Concentration (10^{-12} µCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, BJY	40	48	10	28	7.5	<0.01
Area 5, Gate 200 S.	29	79	9.1	28	13	<0.01
Area 12, Camp	20	35	11	27	4.9	<0.01
Area 18, Gate 400	25	42	11	27	6.2	<0.01
Area 19, Pahute Substation	16	42	11	27	7.6	<0.01
Area 20, Dispensary	15	66	12	34	12	<0.01
All Stations	145	79	9.1	28	9.1	<0.01

Table 5.7 Airborne Tritium Concentrations on the NTS - 1995

		^{3}H Concentration (10^{-6} pCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, BJY	25	3.7	-1.3	0.86	1.2	< 0.01
Area 3, Mud Plant	6	1.4	0.43	0.93	0.47	<0.01
Area 5, RWMS No. 1	24	12.	-0.28	3.2	3.1	0.032
Area 5, RWMS No. 2	21	10.	-0.70	3.1	3.1	0.031
Area 5, RWMS No. 3	24	14.	-0.47	4.1	3.7	0.041
Area 5, RWMS No. 4	26	53.	0.32	15.	16.	0.15
Area 5, RWMS No. 5	20	11.	-0.15	3.0	3.1	0.030
Area 5, RWMS No. 6	26	58.	-0.42	8.6	13.	0.086
Area 5, RWMS No. 7	26	10.	-0.41	3.4	3.0	0.034
Area 5, RWMS No. 8	26	10.	-0.57	3.4	3.3	0.034
Area 5, RWMS No. 9	25	14.	0.83	6.0	4.2	0.060
Area 6, Gas Station	8	1.3	-0.35	0.29	0.64	< 0.0
Area 6, Substation 6-9	9	0.60	-0.34	0.13	0.32	< 0.01
Area 10, Gate 700 S	17	1.9	-1.3	0.64	0.90	< 0.01
Area 10, Sedan Crater	9	12.	2.0	6.6	3.5	0.066
Area 12, Complex	26	2.0	-1.7	0.25	0.65	< 0.01
Area 12, E-Tunnel Pond No. 1	2	6.6	5.6	6.1	0.69	0.061
Area 15, EPA Farm	25	10.	0.79	5.1	2.6	0.051
Area 23, Bldg. 790 No. 2	24	3.4	-0.67	0.29	0.85	< 0.01
Area 23, H&S Bldg.	15	2.6	-0.90	0.32	0.88	< 0.01
Area 25, E-MAD N	18	1.4	-1.9	0.11	0.81	< 0.01
All Stations	402	58	-1.9	3.8	7.0	0.038

Average MDC ± 1 Standard Deviation was $(2.6 \pm 1.2) \times 10^{-6}$ pCi/mL.

Table 5.8 Radioactivity in NTS Surface Waters - 1995

		Annual Average Concentrations (10^{-9} μCi/mL)					
Source of Water	No. of Locations	Gross ß	Tritium	^{238}Pu	$^{239+240}$Pu	^{90}Sr	% of DCG Range(a)
Open Reservoirs	12	7.6	-15	4.1×10^{-4}	-0.0014	-0.064	<0.01-0.02
Natural Springs	8	14	-65	-3.3×10^{-4}	0.0028	0.011	<0.01-0.28
Containment Ponds							
E Tunnel	2	81	7.5×10^{5}	0.67	5.5	2.6	(c)
Well ER-20-5	4	-	9.7×10^{7}	-	-	-	(c)
Decon Facility(b)	-	-	-	-	-	-	
Sewage Lagoons	11	18	1.5	0.0013	0.0014	-0.079	(c)

(a) DCG based on value for drinking water (4 mrem EDE).
(b) No samples collected due to no effluent and dry pond.
(c) Not a potable water source.

Table 5.9 NTS Open Reservoir Gross Beta Analysis Results - 1995

	Gross Beta Concentration (10^{-9} μCi/mL)	
Location	Concentration	Concentration as %DCG(a)
Area 2, Mud Plant Reservoir	5.3	13
Area 2, Well 2 Reservoir	9.7	24
Area 3, Mud Plant Reservoir(b)	-	-
Area 3, Well A Reservoir	7.6	19
Area 5, UE-5c Reservoir	6.1	15
Area 5, Well 5B Reservoir	12	30
Area 6, Well 3 Reservoir	9.8	25
Area 6, Well C1 Reservoir	6.9	17
Area 18, Camp 17 Reservoir	4.6	12
Area 18, Well 8 Reservoir(b)	-	-
Area 19, UE-19c Reservoir	9.3	23
Area 20, Well 20A Reservoir(b)	-	-
Area 23, Swimming Pool	8.6	22
Area 25, Well J-11 Reservoir	5.7	14
Area 25, Well J-12 Reservoir	5.8	15

(a) DCG based on ^{90}Sr value for drinking water (4 mrem EDE).
(b) Reservoir was dry.
Note: Annual samples only.

Table 5.10 NTS Natural Spring Gross Beta Analysis Results - 1995

	Gross Beta Concentration (10^{-9} μCi/mL)	
Location	Concentration	Concentration as %DCG[a]
Area 5, Cane Spring	5.7	14
Area 7, Reitmann Seep	28	70
Area 12, Captain Jack	7.8	20
Area 12, Gold Meadows	13	33
Area 12, White Rock Spring	8.7	22
Area 15, Tub Spring	21	53
Area 16, Tippipah Spring	6.3	16
Area 29, Topopah Spring	19	48

(a) DCG based on ^{90}Sr value for drinking water (4 mrem EDE).
Note: Annual samples only.

Table 5.11 NTS Containment Pond Gross Beta Analysis Results - 1995

		Gross Beta Concentration (10^{-9} μCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG[a]
Area 12, E Tunnel Effluent	4	87	7.7	51	40	130
Area 12, E Tunnel Pond No. 1	4	145	27	85	49	210
Area 20, Well ER-20-5 Ponds	--	--	--	--	--	--[b]

(a) DCG based on ^{90}Sr value for drinking water (4 mrem EDE).
(b) Analyzed only for tritium.

Table 5.12 NTS Drinking Water Sources - 1995

System	Supply Wells	End-Point
No. 1	Wells C1, 4, 4A	Area 6, Cafeteria Area 6, Building 6-900
No. 2	Well 8	Area 2, Restroom Area 12, Building 12-23
No. 3	Well UE-16d	Area 1, Building 101
No. 4	Wells 5B, 5C, and Army No. 1	Area 23, Cafeteria
No. 5	Wells J-12, J-13	Area 25, Building 4221

Table 5.13 NTS Supply Well Radioactivity Averages - 1995

Description	Gross Beta	^{3}H	$^{239+240}$Pu	^{238}Pu	Gross Alpha	^{90}Sr
	µCi/mL					
			Potable Water Supply Wells			
Area 5, Well 5C	7.5×10^{-9}	-1.7×10^{-9}	-1.1×10^{-12}	-8.7×10^{-13}	9.2×10^{-9}	9.3×10^{-11}
Area 6, Well 4	6.7×10^{-9}	-2.3×10^{-9}	8.7×10^{-13}	2.0×10^{-12}	7.6×10^{-9}	8.2×10^{-11}
Area 6, Well 4A	7.1×10^{-9}	-2.0×10^{-9}	-9.5×10^{-13}	3.8×10^{-13}	8.8×10^{-9}	-4.5×10^{-11}
Area 5, Well 5B	1.2×10^{-8}	-1.6×10^{-9}	-2.0×10^{-12}	-8.4×10^{-14}	4.8×10^{-9}	4.5×10^{-10}
Area 6, Well C1	1.6×10^{-8}	1.7×10^{-8}	-1.4×10^{-12}	-6.6×10^{-13}	1.3×10^{-8}	1.4×10^{-10}
Area 16, Well UE-16d	6.4×10^{-9}	5.0×10^{-11}	-3.1×10^{-12}	7.7×10^{-13}	5.3×10^{-9}	-3.8×10^{-11}
Area 18, Well 8(a)	4.1×10^{-9}	1.4×10^{-9}	-1.1×10^{-12}	1.7×10^{-12}	7.6×10^{-10}	1.9×10^{-10}
Area 22, Army Well No. 1(a)	5.6×10^{-9}	7.3×10^{-10}	-1.3×10^{-12}	1.4×10^{-12}	2.5×10^{-9}	1.3×10^{-11}
Area 25, Well J-12	4.6×10^{-9}	-1.7×10^{-9}	-5.6×10^{-13}	-2.5×10^{-12}	1.2×10^{-9}	5.3×10^{-11}
Area 25, Well J-13	4.3×10^{-9}	6.1×10^{-10}	1.6×10^{-12}	-3.8×10^{-13}	1.7×10^{-9}	6.0×10^{-11}
			Non-Potable Water Supply Wells			
Area 5, Well UE-5c(c)	7.5×10^{-9}	-3.7×10^{-9}	7.2×10^{-13}	-3.8×10^{-13}	5.9×10^{-9}	5.6×10^{-11}
Area 6, Well C(b) 2.1×10^{-8}	-4.6×10^{-9}	3.3×10^{-12}	-8.3×10^{-13}	1.6×10^{-8}	1.7×10^{-10}	
Area 20, Well U-20(c)	3.0×10^{-9}	1.3×10^{-9}	-4.8×10^{-12}	2.5×10^{-12}	5.9×10^{-9}	-1.4×10^{-10}
Median MDC 1.4×10^{-9}	1.6×10^{-8}	2.4×10^{-11}	2.4×10^{-11}	1.5×10^{-9}	3.2×10^{-10}	

(a) Three samples collected.
(b) Two samples collected.
(c) Only one sample collected.

Table 5.14 Radioactivity Averages for NTS End-Use Consumption Points - 1995

Description	Gross Beta	^{3}H	$^{239+240}$Pu	^{238}Pu	Gross Alpha	^{90}Sr(a)
	µCi/mL					
Area 1, Bldg. 101	6.4×10^{-9}	1.6×10^{-7}	-2.3×10^{-12}	5.5×10^{-13}	7.2×10^{-9}	1.7×10^{-11}
Area 2, Restroom	3.7×10^{-9}	8.7×10^{-8}	-4.0×10^{-14}	4.6×10^{-12}	6.1×10^{-10}	-9.2×11^{-12}
Area 6, Cafeteria	1.0×10^{-8}	1.5×10^{-7}	9.2×10^{-13}	2.6×10^{-12}	1.3×10^{-8}	-1.0×10^{-10}
Area 6, Bldg. 6-900	8.9×10^{-9}	-7.7×10^{-8}	-2.4×10^{-12}	1.2×10^{-12}	8.0×10^{-9}	-1.2×10^{-10}
Area 12, Bldg. 12-23	3.2×10^{-9}	6.0×10^{-8}	-1.9×10^{-12}	-3.0×10^{-14}	5.5×10^{-10}	-3.5×10^{-11}
Area 23, Cafeteria	8.5×10^{-9}	2.3×10^{-8}	-7.0×10^{-14}	1.5×10^{-12}	5.2×10^{-9}	-3.9×10^{-11}
Area 25, Bldg. 4221	4.9×10^{-9}	1.6×10^{-7}	7.9×10^{-13}	-1.5×10^{-12}	1.3×10^{-9}	1.9×10^{-11}
Median MDC	1.4×10^{-9}	7.8×10^{-7}	2.3×10^{-11}	2.2×10^{-11}	1.5×10^{-9}	3.1×10^{-10}

(a) ^{90}Sr values are for one sample.

Table 5.15 Radium Analysis Results for NTS Drinking Water - 1995

		Concentrations (10^{-9} µCi/mL)			
Location	Number	^{226}Ra Arithmetic Mean	Standard Deviation	^{228}Ra Arithmetic Mean	Standard Deviation
Area 5, Well 5B	4	0.24	0.10	-0.071	0.22
Area 5, Well 5C	4	0.16	0.81	-0.12	0.25
Area 6, Well 4	4	0.43	0.35	0.038	0.13
Area 6, Well 4A	4	0.58	0.38	-0.087	0.15
Area 6, Well C	2	0.66	0.15	0.057	0.080
Area 6, Well C-1	4	1.4	0.31	0.24	0.21
Area 16, Well UE-16d	4	0.85	0.44	-0.17	0.36
Area 18, Well 8	3	0.51	0.52	-0.094	0.20
Area 23, Army Well No. 1	3	0.92	0.35	-0.13	0.16
Area 25, Well J-12	4	0.29	0.26	0.041	0.26
Area 25, Well J-13	4	0.26	0.64	0.42	0.48

Table 5.16 NTS Boundary Gamma Monitoring Results Summary - 1995

Location	First Quarter (mR/day)	Second Quarter (mR/day)	Third Quarter (mR/day)	Fourth Quarter (mR/day)	Annual Average (mR/d)	(mR/yr)
310 15E Substation	0.33	0.25	0.29	0.26	0.28	103
342 Stake C-31	0.34	(a)	0.41	0.30	0.35	128
Gold Meadows	(b)	(b)	0.26	(a)	0.26	95
Stake R-29	0.32	0.42	0.42	0.37	0.38	140
Stake J-41	0.38	0.39	(a)	0.38	0.38	140
Stake LC-4	(b)	(a)	0.44	(a)	0.44	161
Papoose Lake Road	0.22	(b)	(a)	0.20	0.21	77
387 Gate 19-3P	(b)	(b)	0.37	(b)	0.37	135
Hill Top	(b)	(b)	0.36	0.36	0.36	131
East of U11B	0.31	0.31	0.31	0.32	0.31	114
Army Well No. 1	0.22	(a)	(a)	(a)	0.22	80
Jct Jackass Flats	0.19	(b)	0.19	0.20	0.19	71
3.3 Miles SE OF	0.16	(a)	0.16	0.16	0.16	58
Guard Station 510	0.35	(b)	0.34	0.31	0.33	122
Yucca Mountain	0.56	0.41	0.36	0.37	0.43	155
Gate 30-3P IN	(b)	(b)	(b)	(b)		

(a) Missing TLD.
(b) Location could not be found.

Table 5.17 NTS TLD Control Station Comparison, 1989 - 1995

		Exposure Rate (mR/day)						
Area	Station	1989	1990	1991	1992	1993	1994	1995
5	Well 5B	0.36	0.34	0.37	0.31	0.40	0.34	0.30
6	CP-6	0.27	0.25	0.25	0.23	0.30	0.19	0.19
6	Yucca Oil Storage	0.32	0.32	0.33	0.31	0.37	0.27	0.26
23	Building 650 Dosimetry	0.19	0.20	0.19	0.18	0.26	0.15	0.15
23	Building 650 Roof	0.18	0.19	0.19	0.18	0.25	0.14	0.15
23	Post Office	0.23	0.23	0.24	0.23	0.30	0.21	0.20
25	HENRE Site	0.38	0.39	0.40	0.36	0.45	0.31	0.36
25	NRDS Warehouse	0.38	0.39	0.39	0.37	0.46	0.33	0.33
27	Cafeteria	0.32	0.40	0.42	0.39	0.46	0.33	0.33
Network Average		0.29	0.30	0.31	0.28	0.36	0.25	0.25

Table 5.18 Gross Beta Results for the Offsite Air Surveillance Network - 1995

	Gross Beta Concentration (10^{-14} µCi/mL [0.37 mBq/m^3])				
Sampling Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation
Alamo, NV	52	2.6	0.17	1.4	0.54
Amargosa Valley, NV	34	2.5	0.46	1.3	0.46
Amargosa Center, NV	12	4.6	0.84	2.3	0.88
Beatty, NV	10	3.5	0.69	2.2	0.80
Clark Station, NV Stone Cabin Ranch	52	20	0.53	1.6	2.6
Currant, NV Blue Eagle Ranch	17	1.9	0.24	0.96	0.49
Goldfield, NV	49	3.4	0.45	1.5	0.64
Indian Springs, NV	12	3.9	0.47	2.2	1.0
Las Vegas, NV	11	3.2	0.25	1.6	0.89
Overton, NV	47	3.9	0.59	1.9	0.74
Pahrump, NV	12	3.2	0.70	2.0	0.63
Pioche, NV	49	3.6	0.13	1.3	0.55
Rachel, NV	51	3.4	0.52	1.4	0.61
Sunnyside, NV	23	2.3	0.58	1.3	0.53
Tonopah, NV	50	2.9	0.12	1.3	0.54
Twin Springs, NV Fallini's Ranch	49	3.9	0.63	1.6	0.65
Cedar City, UT	47	3.4	0.39	1.2	0.50
Delta, UT	31	8.3	0.10	1.4	1.5
Milford, UT	49	5.6	0.54	1.7	0.77
St. George, UT	14	15	-0.05	2.1	3.8

Mean MDC: 2.39 x 10^{-15} µCi/mL Standard Deviation of Mean MDC: 1.23 x 10^{-15} µCi/mL

Table 5.19 Gross Alpha Results for the Offsite Air Surveillance Network - 1995

Sampling Location	Concentration (10^{-15} µCi/mL [37 µBq/m^3]) Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation
Alamo, NV	52	4.9	0.00	1.4	0.99
Amargosa Valley, NV	34	4.3	-0.20	1.2	0.82
Amargosa Center, NV	12	5.0	0.50	1.7	1.2
Beatty, NV	10	4.3	0.70	1.8	1.0
Clark Station, NV Stone Cabin Ranch	52	5.4	0.30	2.0	1.1
Currant, NV Blue Eagle Ranch	17	2.1	-0.50	0.75	0.64
Goldfield, NV	49	3.2	0.00	1.1	0.65
Indian Springs, NV	12	4.2	0.60	2.0	1.2
Las Vegas, NV	11	2.9	-0.50	1.7	1.0
Overton, NV	47	3.6	-0.30	1.3	0.90
Pahrump, NV	12	2.6	0.40	1.4	0.78
Pioche, NV	49	2.5	0.10	0.90	0.51
Rachel, NV	51	4.2	0.10	1.2	0.93
Sunnyside, NV	23	2.5	0.20	0.8	0.53
Tonopah, NV	50	3.1	-0.20	0.98	0.63
Twin Springs, NV Fallini's Ranch	49	4.2	0.00	1.1	0.81
Cedar City, UT	47	4.5	-0.20	1.9	1.0
Delta, UT	31	6.1	0.00	1.4	1.5
Milford, UT	49	3.1	-0.20	1.3	0.70
St. George, UT	14	14.0	0.10	1.7	3.6

Mean MDC: 7.59 x 10^{-16} µCi/mL Standard Deviation of Mean MDC: 5.57 x 10^{-16} µCi/mL

Table 5.20 Offsite Low Volume Airborne Plutonium Concentrations - 1995

Composite Sampling Location	^{238}Pu Concentration (10^{-18} µCi/mL) Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Alamo, NV	14	8.1	-2.8	1.8	3.4	NA
Amargosa Valley, NV	15	6.1	-5.1	0.86	3.3	NA
Las Vegas, NV	4	3.9	0.0	1.5	1.9	NA
Rachel, NV	15	6.0	-2.8	1.4	2.6	NA

Mean MDC: 8.1 x 10^{-18} µCi/mL Std. Dev. of Mean MDC: 4.8 x 10^{-18} µCi/mL

Composite Sampling Location	$^{239+240}$Pu Concentration (10^{-18} µCi/mL) Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG[(a)]
Alamo, NV	14	14.0	0.0	3.38	3.71	NA[(b)]
Amargosa Valley, NV	15	4.6	-2.5	0.98	2.18	NA[(b)]
Las Vegas, NV	4	4.1	-2.6	-0.42	3.05	NA[(b)]
Rachel, NV	15	25.0	-1.3	3.46	6.47	NA[(b)]

Mean MDC: 9.5 x 10^{-18} µCi/mL Std. Dev. of Mean MDC: 4.9 x 10^{-18} µCi/mL

(a) DCG; Established by DOE Order as 3 x 10^{-15} µCi/mL.
(b) Not applicable, result less than MDC.
Note: To convert from µCi/mL to Bq/m^3 multiply by 3.7 x 10^{10} (e.g., [7.1 x 10^{-18}] x [37 x 10^9] = 26 µBq/m^3).

Table 5.21 Summary of Radionuclides Detected in Milk Samples

	Milk Surveillance Network No. of samples with results > MDC (Network average concentration in pCi/L)		
	1995	1994	1993
^{3}H	0(37)	0(85)	0(120)
^{89}Sr	0(0.03)	0(0.22)	0(-0.18)
^{90}Sr	0(0.61)	2(0.44)	5(0.55)

Table 5.22 Summary of Weekly Gamma Exposure Rates as Measured by Pressurized Ion Chambers - 1995

		Gamma Exposure Rate (μR/hr)						
Station	Number of Weekly Averages	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Median	mR/yr	1994 Mean (μR/hr)
Furnace Creek, CA	15	10.7	10.2	10.3	0.13	10.3	91	10.4
Shoshone, CA	49	12.0	11.1	11.4	0.21	11.4	100	11.4
Alamo, NV	48	13.5	12.4	12.8	0.24	12.8	112	12.9
Amargosa Valley, NV	43	14.4	13.7	14.0	0.14	14.0	123	14.1
Austin, NV	50	19.8	16.4	18.7	0.74	18.9	164	18.3
Beatty, NV	49	17.0	15.9	16.4	0.25	16.3	144	17.5
Caliente, NV	44	15.3	14.0	14.4	0.30	14.3	126	14.5
Complex I, NV	51	16.9	14.1	15.5	0.55	15.4	136	15.6
Ely, NV	48	14.1	13.1	13.5	0.25	13.6	118	13.3
Goldfield, NV	46	16.6	14.7	15.5	0.44	15.4	136	15.2
Indian Springs, NV	47	11.9	11.2	11.4	0.17	11.4	100	11.6
Las Vegas, NV	2	9.9	9.5	9.7	0.30	9.7	85	9.2
Medlin's Ranch, NV	49	17.0	15.7	16.3	0.31	16.2	143	16.0
Nyala, NV	48	12.6	11.6	12.0	0.25	11.9	105	12.0
Overton, NV	49	10.5	9.3	9.6	0.31	9.5	84	9.4
Pahrump, NV	51	8.6	8.0	8.2	0.16	8.2	72	8.8
Pioche, NV	46	11.9	10.5	11.5	0.23	11.5	101	11.3
Rachel, NV	49	17.6	16.1	16.8	0.50	16.7	147	17.1
Stone Cabin Ranch, NV	49	19.4	16.6	18.0	0.57	17.9	157	18.7
Tonopah, NV	50	19.0	15.4	17.7	0.54	17.8	155	17.9
Twin Springs, NV	44	19.0	15.9	17.6	0.70	17.6	154	16.8
Uhalde's Ranch, NV	49	18.1	11.7	16.7	1.56	17.1	146	16.7
Cedar City, UT	44	15.3	14.0	14.4	0.30	14.3	126	11.2
Delta, UT	34	12.8	11.7	12.1	0.26	12.1	106	12.0
Milford, UT	50	19.1	17.2	17.7	0.48	17.5	155	17.6
Salt Lake City, UT	32	10.8	9.2	10.2	0.46	10.1	89	10.3
St. George, UT	50	9.0	8.1	8.4	0.22	8.3	73	8.3

Note: Multiply μR/hr by 2.6×10^{-10} to obtain $C \cdot kg^{-1} \cdot hr^{-1}$.

Table 5.23 EG&G/EM Boundary Line Monitoring Data - 1995

Facility: EG&G - Remote Sensing Laboratory/Nellis

Station ID No.	Description	1st Qtr. (mR)	2nd Qtr. (mR)	3rd Qtr. (mR)	4th Qtr. (mR)	CY-95 (mR)
RS-022	SE Fence--Near Gate	20.2	21.0	18.6	26.6	96
RS-023	SE Fence--Near Gate	19.9	20.6	19.5	27.0	87
RS-024	S Fence--Center	17.6	19.3	17.1	23.3	77
RS-025	S Fence--Center	16.8	21.6	16.8	25.7	81
RS-026	SW Fence--Near Gate	14.7	17.2	28.6	20.6	81
RS-027	SW Fence--Near Gate	14.2	16.2	14.8	20.9	66
RS-028	NW Fence--Near Gate	15.9	17.6	15.1	20.9	70
RS-029	NW Fence--Near Gate	14.5	16.2	15.4	21.9	68
RS-030	N Fence--Center	16.8	21.3	17.7	23.9	80
RS-031	N Fence--Center	17.1	20.3	18.0	24.3	80
RS-032	NE Fence--Near Corner	14.2	15.5	14.2	19.6	64
RS-033	NE Fence--Near Corner	15.0	16.6	15.7	20.6	68
RS-098	Control - 1	11.0	13.9	11.8	36.7	52
RS-099	Control - 2		14.5	12.4	34.1	54

Facility: EG&G - Atlas/Las Vegas

Station ID No.	Description	1st Qtr. (mR)	2nd Qtr. (mR)	3rd Qtr. (mR)	4th Qtr. (mR)	CY-95 (mR)
LV-055	NW Corner Fence/Gate C6	19.0	18.7	17.7	28.5	84
LV-056	NW Corner Fence/Gate C6	17.8	18.1	17.4	28.5	82
LV-057	N Fence-West End A-12	15.4	16.6	18.7	25.5	76
LV-058	N Fence--West End A-12	16.9	17.2	22.3	24.4	81
LV-059	N Fence--West End A-4	16.9	17.2	17.4	25.1	77
LV-060	N Fence--West End A-4	17.2	16.0	16.0	26.8	76
LV-061	NE Corner Fence/A-12	14.8	15.1	15.4	23.8	69
LV-062	NE Corner Fence/A-12	15.7	15.4	15.7	24.1	71
LV-063	E Fence/Center A-Complex	15.4	15.1	15.4	23.4	69
LV-064	E Fence/Center A-Complex	15.7	15.7	15.4	24.4	71
LV-065	NLV Badge Off (A-7)/A-2	14.2	14.8	15.7	23.7	68
LV-066	NLV Badge Off (A-7)/A-2	14.5	14.8	16.4	24.4	70
LV-067	E Fence/North End B-Complex	16.3	17.7	16.4	24.1	74
LV-068	E Fence/North End B-Complex	15.4	15.7	16.7	25.4	73
LV-069	E Fence/South End B-Complex	16.9	16.6	16.7	27.5	78
LV-070	E Fence/South End B-Complex	15.4	15.7	16.0	26.8	74
LV-071	S Fence/Center/Next to Substation	16.0	16.6	15.7	26.8	75
LV-072	S Fence/Center/Next to Substation	16.6	16.6	17.1	23.7	74
LV-073	SW Corner/Gate C-1	16.0	15.4	16.7	24.7	73
LV-074	SW Corner/Gate C-1	15.7	16.6	17.0	24.1	73
LV-075	C-1 W End Guard Gate	19.9	19.9	19.0	28.2	87
LV-076	C-1 W End Guard Gate	19.9	20.5	19.7	27.5	88
LV-077	W Fence/Gate C-3	16.9	17.7	24.4	26.1	85
LV-078	W Fence/Gate C-3	16.0	16.6	16.7	26.8	76
LV-079	NW End A-13/Double G	17.2	18.4	17.7	25.8	79
LV-080	NW End A-13/Double G	16.3	17.8	16.4	24.1	75
LV-098	Control - 1		11.6	14.0	13.6	49
LV-099	Control - 2		11.3	13.7	13.9	55

Table 5.23 (EG&G/EM Boundary Line Monitoring Data - 1995, cont.)

Facility: EG&G - Special Technologies Laboratory

Station ID No.	Description	1st Qtr. (mR)	2nd Qtr. (mR)	3rd Qtr. (mR)	4th Qtr. (mR)	CY-95 (mR)
ST197	Bldg. 226, West Fence	20.7	22.7	25.0	17.0	85
ST198	Bldg. 226, West Fence	21.3	23.0	26.7	17.5	88
ST199	Bldg. 229-C, Left Side of Sliding Gate	28.8	30.0	(a)	17.2	101
ST200	Bldg. 229-C, Left Side of Sliding Gate	28.1	29.0	(a)	17.0	99
ST201	Bldg. 227, E Fence	27.3	22.7	24.0	16.1	90
ST202	Bldg. 227, E Fence	20.7	23.0	24.4	15.8	84
ST203	Bldg. 227, E Fence NE Corner	21.6	24.0	(a)	16.7	83
ST204	Bldg. 227, E Fence NE Corner	20.6	24.0	(a)	17.0	82
ST205	Bldg. 227, NE Corner Step	20.4	24.0	25.4	16.7	86
ST206	Bldg. 227, NE Corner Step	20.0	23.0	27.7	16.1	87
ST207	Bldg. 227, NE Fence	24.7	43.7	28.4	18.1	115
ST208	Bldg. 227, NE Fence	23.8	45.4	29.0	17.2	115
ST209	Bldg. 227, Behind CF Shed	23.2	23.7	26.0	18.1	91
ST210	Bldg. 227, Behind CF Shed	23.2	26.7	26.4	17.5	94
ST211	Bldg. 227, E Fence Center	21.3	25.0	25.7	18.7	91
ST212	Bldg. 227, E Fence Center	21.6	25.4	25.4	18.4	91
ST213	Bldg. 227, SE Fence Corner	22.8	25.4	25.4	17.8	91
ST214	Bldg. 227, SE Fence Corner	22.2	26.1	25.7	17.5	92
ST141	Bldg. 227, Rear on Fence	24.4	24.0	27.7	18.7	95
ST147	Bldg. 231, Rear on Fence	24.2	23.0	27.7	19.3	94
Control		19.1	17.3	(a)	14.4	68
Control		19.1	17.6	(a)	14.4	68

(a) Not available, missing data.

6.0 DOSE ASSESSMENT

The offsite environmental surveillance system operated around the Nevada Test Site (NTS) by the U.S. Environmental Protection Agency (EPA), Radiation Sciences Laboratory-Las Vegas (RSL-LV) measured no radiation exposures that could be attributed to recent NTS operations. The potential effective dose equivalent (EDE) to the maximally exposed individual (MEI) was calculated to be 0.18 mrem (1.8 x 10^{-3} mSv) to a hypothetical resident of Springdale, Nevada located 40 km (25 mi) WNW of Control Point 1 (CP-1), on the NTS. This value was based on onsite emission measurements, estimates provided by U.S. Department of Energy (DOE) and calculated resuspension data input to EPA's CAP88-PC model. The calculated population dose (collective effective dose equivalent) to the approximately 32,210 residents living within 80 km (50 mi) from each of the NTS airborne emission sources was 0.53 person-rem (5.3 x 10^{-3} person-Sv). Monitoring network data indicated a 1995 exposure to the MEI of 144 mrem (1.44 mSv) from normal background radiation. The calculated dose to this individual from worldwide distributions of radioactivity as measured from surveillance networks was 0.023 mrem (2.3 x 10^{-4} mSv). An EDE of 8.5 x 10^{-4} mrem (8.5 x 10^{-6} mSv) was included that would be received if edible tissues from a contaminated deer collected on the NTS were to be consumed. All of these maximum dose estimates, excluding background, are <2 percent of the most restrictive standard.

6.1 ESTIMATED DOSE FROM NEVADA TEST SITE ACTIVITIES

The potential EDE to the offsite population due to NTS activities is estimated annually. Two methods are used to estimate the EDE to residents in the offsite area in order to determine the community potentially most impacted by airborne releases of radioactivity from the NTS. In the first method, effluent release estimates and meteorological data are used as inputs to EPA's CAP88-PC model which then produces estimated EDEs. The second method entails using data from the Offsite Radiological Safety Program (ORSP) with documented assumptions and conversion factors to calculate the committed effective dose equivalent (CEDE). The latter method provides an estimate of the EDE to a hypothetical individual continuously present outdoors at the location of interest that includes both NTS emissions and worldwide fallout. In addition, a collective EDE is calculated by the first method for the total offsite population residing within 80 km (50 mi) of each of the NTS emission sources. Background radiation measurements are used to provide a comparison with the calculated EDEs. In the absence of detectable releases of radiation from the NTS, the Pressurized Ion Chamber (PIC) network provides a measurement of background gamma radiation in the offsite area.

There are four sources of possible radiation exposure to the population of Nevada that were monitored by EPA's offsite monitoring networks during 1995. These four sources were:

- Background radiation due to natural sources such as cosmic radiation, radioactivity in soil, and ^{7}Be in air.
- Worldwide distributions of manmade radioactivity, such as ^{90}Sr in milk, ^{85}Kr in air, and Pu in soil.
- Operational releases of radioactivity from the NTS, including those from drill back and purging activities when they occur.
- Radioactivity that was accumulated in migratory game animals during their residence on the NTS.

Operational releases and calculated sources of radioactive emissions from the NTS are used as input data for CAP88-PC to provide estimates of exposures to offsite populations. The other three sources of exposure listed above are treated in Section 6.1.2 below.

6.1.1 ESTIMATED DOSE USING REPORTED NTS EMISSIONS

Onsite source emission measurements, as provided by the DOE, are listed in Chapter 5, Table 5.1, and include tritium, radioactive noble gases, and plutonium. These are estimates of releases made at the point of origin. Meteorological data collected by the Air Resources Laboratory Special Operations and Research Division, (ARL/SORD) were used to construct wind roses and stability arrays for the following areas: Mercury, Area 12, Area 20, Yucca Flat, and the Radioactive Waste Management Site (RWMS) in Area 5. A calculation of estimated dose from NTS effluents was performed using EPA's CAP88-PC model (EPA 1992). The results of the model indicated that the hypothetical individual with the maximum calculated dose from airborne NTS radioactivity would reside at Springdale, Nevada, 40 km (25 mi) WNW of CP-1. The maximum dose to that individual would be 0.18 mrem (1.8×10^{-3} mSv). For comparison, data from the PIC monitoring network indicated a 1995 dose of 144 mrem (1.44 mSv) from background gamma radiation occurring in that area. The population living within a radius of 80 km (50 mi) from the airborne sources on the NTS was estimated to be 32,210 individuals, based on 1995 data. The collective population dose within 80 km (50 mi) from each of these sources was calculated to be 0.53 person-rem (5.3×10^{-3} person-Sv). Activity concentrations in air that would cause these calculated doses are much higher than actually detected by the offsite monitoring network. For example, 0.15 mrem of the calculated EDE to the MEI is due to plutonium. The annual average plutonium concentration in air that would cause this EDE is 59 times the annual average measured plutonium in air in Amargosa Valley. Table 6.1 summarizes the annual contributions to the EDEs due to 1995 NTS operations as calculated by use of CAP88-PC and the radionuclides listed in Chapter 5, Table 5.1.

Input data for the CAP88-PC model include meteorological data from ARL/SORD and effluent release data reported by DOE. The effluent release data are known to be estimates and the meteorological data are mesoscale; e.g., representative of an area approximately 40 km (25 mi) or less around the point of collection. However, these data are considered sufficient for model input, primarily because the model itself is not designed for complex terrain such as that on and around the NTS. Errors introduced by the use of the effluent and meteorological data are small compared to the errors inherent in the model so the model results are considered over-estimates of the dose to offsite residents. This was confirmed by comparison with the offsite monitoring results.

6.1.2 ESTIMATED DOSE USING MONITORING NETWORK DATA

Potential CEDEs to individuals may be estimated from the concentrations of radioactivity as measured by the EPA monitoring networks during 1995. Actual results obtained in analysis are used; the majority of which are less than the reported minimum detectable concentration (MDC). No krypton or tritium in air data were collected offsite so the onsite krypton for this year and last year's offsite tritium were used. Similarly, last year's data for deer and beef liver were used. No vegetables were collected in 1995 so no calculations for vegetables were done.

Data quality objectives for precision and accuracy are, by necessity, less stringent for values near the MDC so confidence intervals around the input data are broad. The concentrations of radioactivity detected by the monitoring networks and used in the calculation of potential CEDEs are shown in Table 6.2.

The concentrations given in Table 6.2 are expressed in terms of activity per unit volume or weight. These concentrations are converted to a dose by using the assumptions and dose conversion factors described below. The dose conversion factors assume continuous presence at a fixed location and no loss of radioactivity in meat and vegetables through storage and cooking.

- Adult respiration rate = 8400 m^3/yr [International Commission on Radiological Protection (ICRP) 1975]
- Milk intake (average for 20 and 40 yr old) = 110 L/yr (ICRP 1975)
- Consumption of beef liver = 0.5 lb/wk (11.5 kg/yr)
- An average deer has 100 lb (45 kg) of meat
- Water consumption = 2 L/day (ICRP 1975)
- Fresh vegetable consumption = 516 g/day (1.1 lb/day) for a four-month growing season (ICRP 1975).

The EDE conversion factors are derived from EPA-520/1-88-020 (Federal Guidance Report No. 11). Those used here are:

- ^{3}H: 6.4 x 10^{-8} mrem/pCi (ingestion or inhalation)
- ^{7}Be: 2.6 x 10^{-7} mrem/pCi (inhalation)
- ^{90}Sr: 1.4 x 10^{-4} mrem/pCi (ingestion)
- ^{85}Kr: 1.5 x 10^{-5} mrem/yr per pCi/m^3 (submersion)
- $^{238,239+240}Pu$: 3.7 x 10^{-4} mrem/pCi (ingestion, f_1=10^{-4}) 3.1 x 10^{-1} mrem/pCi (inhalation, Class Y)

The algorithm for the internal dose calculation is:

- (concentration) x (intake in volume (mass)/unit time) x (CEDE conversion factors) = CEDE

As an example calculation, the following is the result of breathing tritium in air:

- (2 x 10^{-1} pCi/m^3) x (8400 m^3/yr) x (6.4 x 10^{-8} mrem/pCi) = 1.1 x 10^{-4} mrem/yr

However, in calculating the inhalation CEDE from ^{3}H, the value must be increased by 50 percent to account for skin absorption (ICRP 1979). The total dose in one year, therefore, is 1.1 x 10^{-4} mrem/yr x 1.5 = 1.6 x 10^{4} mrem/yr. Dose calculations from ORSP data are summarized in Table 6.2.

The dose from consumption of a mule deer collected on the NTS is included in Table 6.2. The individual CEDEs from the various pathways added together give a total of 0.023 mrem/yr. The additional dose from ingestion of deer meat and liver containing the $^{239+240}Pu$ activities given in Table 6.2 would be:

{[(5.2 x 10^{-1} pCi/kg) x (45 kg meat)] + [(4.3 x 10^{-2} pCi/kg) x (0.28 kg liver)]} x (3.7 x 10^{-4} mrem/pCi) = 8.7 x 10^{-3} mrem.

Total EDEs can be calculated based on different combinations of data. If the interest was in just one area, for example, the concentrations from those stations closest to that area could be substituted into the equations used herein.

6.2 DOSE (EDE) FROM BACKGROUND RADIATION

In addition to external radiation exposure due to cosmic rays and gamma radiation from naturally occurring radionuclides in soil (e.g., ^{40}K, uranium and thorium daughters), there is a contribution from ^{7}Be that is formed in the atmosphere by cosmic ray interactions with oxygen and nitrogen. The annual average ^{7}Be concentration measured by the offsite surveillance network was 0.37 pCi/m^3. With a dose conversion factor for inhalation of 2.6 x 10^{-7} mrem/pCi, and an annual breathing volume of 8400 m^3/yr, this equates to a dose of 8.1 x 10^{-4} mrem as calculated in Table 6.2.

This is a negligible quantity when compared with the PIC network measurements that vary from 73 to 164 mR/year, depending on location.

6.3 SUMMARY

The extensive offsite environmental surveillance system operated around the NTS by EPA's RSL-LV detected no radiological exposures that could be attributed to recent NTS operations, but a calculated EDE of 0.023 mrem can be obtained if certain assumptions are made. Calculation with the CAP88-PC model, using estimated or calculated effluents from the NTS during 1995, resulted in a maximum dose of 0.18 mrem (1.8×10^{-3} mSv) to a hypothetical resident of Springdale, Nevada, 14 km (9 mi) W of the NTS boundary. Based on monitoring network data, this dose is calculated to be 0.023 mrem. This latter EDE is about 12 percent of the dose obtained from CAP88-PC calculation. This maximum dose estimate is less than 1 percent of the ICRP recommendation that an annual effective dose equivalent for the general public not exceed 100 mrem/yr (ICRP 1985). The calculated population dose (collective EDE equivalent) to the approximately 32,210 residents living within 80 km (50 mi) of each of the NTS airborne emission sources was 0.53 person-rem 5.3×10^{-3} person-Sv). Background radiation would yield a CEDE of 3064 person-rem (30.6 person-Sv).

Data from the PIC gamma monitoring indicated a 1995 dose of 144 mrem from background gamma radiation measured in the Springdale area. The CEDE calculated from the monitoring networks or the model as discussed above is a negligible amount by comparison. The uncertainty (2σ) for the PIC measurement at the 144 mrem exposure level is approximately 5 percent. Extrapolating to the calculated annual exposure at Springdale, Nevada, yields a total uncertainty of approximately 7 mrem which is greater than either of the calculated EDEs. Because the estimated dose from NTS activities is less than 1 mrem (the lowest level for which Data Quality Objectives [DQOs] are defined, as given in Chapter 10) no conclusions can be made regarding the achieved data quality as compared to the DQOs for this insignificant dose.

Table 6.1 Summary of Effective Dose Equivalents from NTS Operations during 1995

	Maximum EDE at NTS Boundary(a)	Maximum EDE to an Individual(b)	Collective EDE to Population within 80 km of the NTS Sources
Dose	0.22 mrem (2.2 x 10^{-3} mSv)	0.18 mrem (1.8 x 10^{-3} mSv)	0.53 person-rem (5.3 x 10^{-3} person-Sv)
Location	Site boundary 40 km WNW of NTS CP-1	Springdale, NV 58 km WNW of NTS CP-1	32,210 people within 80 km of NTS Sources
NESHAP(c) Standard	10 mrem per yr (0.1 mSv per yr)	10 mrem per yr (0.1 mSv per yr)	-----
Percentage of NESHAP	2.2	1.8	-----
Background	144 mrem (1.44 mSv)	144 mrem (1.44 mSv)	3064 person-rem (30.6 person Sv)
Percentage of Background	0.15	0.12	0.017

(a) The maximum boundary dose is to a hypothetical individual who remains in the open continuously during the year at the NTS boundary located 40 km (25 mi) WNW from CP-1.

(b) The maximum individual dose is to a person outside the NTS boundary at a residence where the highest dose-rate occurs as calculated by CAP88-PC (Version 1.0) using NTS effluents listed in Table 5.1 and assuming all tritiated water input to the Area 12 containment ponds was evaporated.

(c) National Emission Standards for Hazardous Air Pollutants.

Table 6.2 Monitoring Networks Data used in Dose Calculations

Medium	Radionuclide	Concentration	Mrem\Year	Comment
Animals				
Beef Liver (1994 data)	$^{239+240}$Pu	1.56 x 10^{-1} (1.9 x 10^{-2})(a)	6.6 x 10^{-4}	Concentrations are the median for each tissue type
Deer Muscle	$^{239+240}$Pu	5.2 x 10^{-1} (1.0 x 10^{-3})(a)	8.5 x 10^{-4}	
Deer Liver (1994 data)	$^{239+240}$Pu	4.3 x 10^{-2} (1.6 x 10^{-3})(a)	4.4 x 10^{-6}	

(a) Units are pCi/kg and Bq/kg.
(b) Units are pCi/L and Bq/L.
(c) Units are pCi/m^3 and Bq/m^3.

Table 6.2 (Monitoring Networks Data used in Dose Calculations, cont.)

Medium	Radionuclide	Concentration	Mrem\Year	Comment
Milk	^{90}Sr	0.61 (0.023)(b)	9.4×10^{-3}	Concentration is the average of all network results
	^{3}H	37 (1.4)(b)	2.6×10^{-4}	Concentration is the average of all network results
Drinking Water	^{3}H	1.2 (0.05)(b)	6.5×10^{-5}	Concentration is the average from wells in the area
Vegetables				Not collected this year
Air (1994 data)	^{3}H	0.2 (0.007)(c)	1.6×10^{-4}	Concentrations are average or median network results
	^{7}Be	0.37 (0.014)(c)	8.1×10^{-4}	
(NTS data)	^{85}Kr	28 (1.1)(c)	4.4×10^{-4}	
	$^{239+240}$Pu	9.8×10^{-7} (3.6×10^{-8})(c)	2.6×10^{-3}	

TOTAL (Air = 4.0×10^{-3}, Liquids = 9.7×10^{-3}, Meat = 9.1×10^{-3}) = 2.3×10^{-2} mrem/yr

(a) Units are pCi/kg and Bq/kg.
(b) Units are pCi/L and Bq/L.
(c) Units are pCi/m^{3} and Bq/m^{3}.

7.0 NONRADIOLOGICAL MONITORING RESULTS

Nonradiological monitoring of the Nevada Test Site (NTS) operations was confined to onsite monitoring as there were no nonradiological discharges to the offsite environment. Types of monitoring conducted included: (1) drinking water distribution systems for Safe Drinking Water Act (SDWA) compliance, (2) sewage influents to lagoons for state of Nevada permit requirements, (3) polychlorinated biphenyls (PCBs) as part of Toxic Substance Control Act (TSCA) compliance, (4) asbestos monitoring for asbestos removal and renovation projects, and (5) environmental media for hazardous characteristics and constituents. Wild horses and chukar were also monitored as components of an NTS ecological monitoring program being reviewed and redesigned.

7.1 ENVIRONMENTAL SAMPLES

7.1.1 SAFE DRINKING WATER ACT

Water sampling was conducted for analysis of bacteria, volatile organic compounds (VOCs), inorganic constituents, and water quality as required by the SDWA and state of Nevada regulations. Samples were taken at various locations throughout all drinking water distribution systems on the NTS by Reynolds Electrical & Engineering Co., Inc. (REECo). Common sampling points were restroom and cafeteria sinks (see Chapter 4, Figure 4.3). All samples were collected according to accepted practices, and the analyses were performed by state approved laboratories. Analyses were performed in accordance with Nevada Administrative Code (NAC) 445 and 40 C.F.R. Part 141.

7.1.1.1 BACTERIOLOGICAL SAMPLING

Samples were submitted to the state-approved Associated Pathologists Laboratories in Las Vegas, Nevada for coliform analyses. All water distribution systems were tested once a month, with the number of people being served determining the number of samples collected. If coliform bacteria are present, the system must be shut down and chlorinated. In order to reopen the system, three or four consecutive samples must meet state requirements, depending again on the number of people served. There were no incidents of positive coliform bacteria results during 1995.

Residual chlorine (RC) and pH levels were determined at the collection point by using colorimetric methods approved by the state. The results were recorded in REECo's drinking water sample logbook, and the chlorine residual level was recorded on an analysis form.

Sample results for 1995 for coliform and RC are given in Table 7.1, along with applicable state of Nevada permit numbers. The RC results are paired with the coliform results from each specific sample. The RC results were all within state permit limits.

Samples from each truck which hauled potable water from NTS wells to work areas were also analyzed for coliform bacteria. There were no positive coliform sample results in 1995.

7.1.1.2 Chemical Analysis

Chemical analysis in 1995 consisted of: (1) VOCs, (2) pesticides, and (3) nitrate levels from Well 4.

VOLATILE ORGANIC COMPOUND ANALYSIS

Samples for VOCs were collected during the second quarter of 1995 from all NTS potable water wells. The samples were analyzed by a state approved laboratory. None of the results for VOCs were above quantitation limits.

Samples were also collected from each well all four quarters and analyzed for pesticides. Because all the results were negative, pesticide analyses will probably not be required by the state for a few years.

INORGANIC COMPOUND ANALYSIS AND WATER QUALITY

The nitrate sample collected for Well 4 during 1993 by the state inspector did not exceed the Maximum Concentration Level (MCL); however, because it was over 50 percent of the MCL the well must be sampled for four quarters. This resampling was completed in the third quarter of 1995, and all sample results were under the MCL, so no further sampling is required.

To comply with a 1991 variance to the Area 25 water system permit, fluoride samples need to be taken annually before July 31 to confirm that the fluoride concentration is less than 4 ppm. Samples taken from Area 25 wells J-12 and J-13 in January 1995 confirmed that the fluoride concentration was <4 ppm.

7.1.2 CLEAN WATER ACT

7.1.2.1 NTS OPERATIONS

The NTS General Permit requires quarterly reporting for biochemical oxygen demand (BOD), specific conductance (SC), organic loading rates, and water depths in infiltration basins. It also requires reporting of second quarter influent toxics sampling. The results of this sampling are shown in Tables 7.2 to 7.5 respectively. All values in these tables are in compliance with the permit requirements.

The permit also requires monitoring of the infiltration basins which attain a depth of 30 cm or more in January and June for parameters listed in Appendix II of the permit. Sampling is required as soon as any other system exceeds the 30 cm. Three secondary ponds at the Area 23 facility usually contain the required depth, but are excluded as needing the sampling in Part III.C.4 of the permit. During 1995 the Yucca Lake system exceeded the 30 cm in the first two quarters, the Device Assembly Facility (DAF) system exceeded in the second quarter, the Gate 100 system exceeded in the first quarter, and the Reactor Control Point system exceeded in the third quarter. These sampling results are given in Table 7.6.

7.1.2.2 NON-NTS SAMPLING RESULTS

Only the EG&G/EM, North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory (RSL), were required by permit to sample and analyze wastewater effluent and submit self monitoring reports. The EG&G/EM, NLVF wastewater permit was downgraded from a Class I permit to a Class II permit by the City of North Las Vegas Department of Public Works. This reduced monitoring from twice a year to once per year in October. The monitoring requirements were retained for analyzing the MG burn pit (metal-cutting device) water prior to discharging; however, monitoring of the ten metal finishing outfalls was eliminated.

The Clark County Sanitation District wastewater permit for the RSL required biannual monitoring of two outfalls and quarterly pH and monthly septage reports. RSL monitoring reports were submitted in January and July 1995. EG&G/EM has installed a silver recovery electrolytic unit; evaporators, ion exchange system, an improved pH neutralization system, pH monitoring, and associated plumbing and electrical systems. Installation was completed April 30, 1995.

7.1.3 NON-HAZARDOUS SOLID WASTE DISPOSAL

Monitoring of the three sanitary landfills was limited to recording daily refuse amounts by weight. The state has no permit system for landfills, but these do have approved Operation & Maintenance manuals. All waste disposed of in the Area 23 landfill was weighed at the Gate 100 weighing station. All waste disposed of in 10c Crater (Area 9) was weighed at the landfill on a new weighing station. About 18,000 tons of waste were disposed of in the Areas 6, 9, and 23 sanitary landfills as shown in Table 7.7.

7.1.4 TOXIC SUBSTANCES CONTROL ACT

During 1995, a total of 106 samples were analyzed for PCBs. Eleven sample results were reported with concentrations greater than five parts per million.

7.1.5 NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS

During 1995, 702 bulk or general area air samples were collected and analyzed in conjunction with asbestos removal and renovation projects at the NTS. The sample volume was divided equally between general area and bulk air samples.

7.1.6 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

A total of 2281 chemical analyses were performed in 1995 in support of waste management and environmental compliance activities at the NTS. Table 7.8 gives a breakdown of these analyses by matrix and analysis type.

7.1.7 SPECIAL STUDIES

Five series of tests were conducted involving 24 different chemicals at the Liquified Gaseous Fuels Spill Test Facility (LGFSTF) in 1995. Pursuant to the agreement between LGFSTF and the state of Nevada, the EPA is invited to participate in both the spill test advisory panels and the field monitoring.

7.2 ECOLOGICAL CONDITIONS

All components of the DOE/NV-sponsored Basic Environmental Compliance and Monitoring Program (BECAMP) were evaluated in 1995 for their ability to meet current DOE/NV objectives given changes in NTS missions and DOE policy. Work began on developing a comprehensive NTS ecological monitoring program focused on site-specific compliance with the National Environmental Policy Act and the new Federal Land and Facility Use Management Policy. During data evaluations and program development efforts, field data on annual and perennial plants, reptiles, small mammals, and deer were not collected. Data collection may be resumed in part or in total as necessary under the revised monitoring program to be initiated in 1996. BECAMP field efforts which were maintained in 1995, however, included the monitoring of wild horses and chukar on the NTS. Data on annual plant populations and precipitation from two established sampling plots on NTS were collected in 1995 as independent research and are reported below.

7.2.1 FLORA

Winter annual plant densities in Rock Valley totaled 1822 ± 335 (mean ± 2 standard errors) per square meter, and produced 52 ± 20 g/m^2 dry weight. This was 50 times the biomass produced at the same location in 1994. *Bromus rubens* made up 64 percent of density and 73 percent of the biomass. Rainfall in Rock Valley for September 1994 through April 1995 totaled 238 mm, compared to 64 mm for 1993-1994.

In Southwestern Yucca Flat, at the YUF001 baseline site, winter annual densities were 1354 ± 397 /m^2, and biomass 50 ± g/m^2, compared to 192 ± 38 /m^2 and 3 ± 2 g/m^2 in 1994. *B. rubens* contributed 55 percent of density and 74 percent of biomass. Rainfall from September 1994 through April 1995 totaled 220 mm, compared to 87 mm in 1993-1994.

No data on perennial plants were collected in 1995. However, regression lines of rainfall versus perennial live volume produced from 8 years of the BECAMP program (Hunter 1995) indicate that in Yucca Flat, total live volume should have increased slightly, from 18.0 to 19.9 $m^3/100m^2$.

7.2.2 FAUNA

Fifty-four horses were identified during field surveys conducted between August and December. Three foals first observed in 1994 survived to yearling age. Five adults observed in 1994 were missing, representing a possible 8 percent decline in the population. One new foal was observed in August but was absent by year-end. Selected water sources on NTS also were surveyed to evaluate their effect on the distribution of horses on NTS. Camp 17 pond in Area 18 and Well 2 pond in Area 2 were heavily used by horses. An estimated 35 horses appear dependent on water at Camp 17 pond and 17 horses appear dependent on the Well 2 pond during summer and fall. The distribution of horses in 1995 relative to NTS water sources has not changed from previous years.

Summer brood surveys for chukar were conducted for five days between June 19 and August 17, 1995. Four NTS springs were visited: Tippipah, Topopah, Tub, and Cane springs. These springs were those at which the Nevada Division of Wildlife (NDOW) requested permission to trap birds in 1995 for relocation elsewhere in the state. At Topopah Spring, an estimated 20 young and 8 adults were observed. At Tub Spring, an estimated 75 young and 5 adults were observed. No chukar were observed at Tippipah or at Cane springs. Nevada Division of Wildlife biologists trapped and removed 71 chukar from Tub Spring on August 31 and September 1, eight chukar from Topopah Spring on September 13, and seven chukar from Cane Spring on September 14. At the time of trapping, the NDOW biologists estimated that there were 80 chukar at Topopah Spring and approximately 30 chukar at Cane Spring.

Table 7.1 Monthly Monitoring Results for NTS Potable Water Systems - 1995[(a)]

Area	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PERMIT NY-360-12C												
Area 22												
RC	0.6	0.6	0.4	0.6	0.8	1.5	0.2	0.8	0.6	0.6	0.1	0.0
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
Area 23												
RC	0.6	0.8	0.6	0.8	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.5
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	0.6	0.6	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	0.1	1.0	0.6	0.8	0.6	1.5	0.5	1.0	0.8	0.8	1.0	0.5
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	--	--	--	--	--	--	1.0	1.0	0.8	0.8	--	--
Coliform	--	--	--	--	--	--	0	0	0	0	--	--
RC	--	--	--	--	--	--	1.0	1.0	0.8	--	--	--
Coliform	--	--	--	--	--	--	0	0	0	--	--	--
RC	--	--	--	--	--	--	1.0	--	--	--	--	--
Coliform	--	--	--	--	--	--	0	--	--	--	--	--
PERMIT NY-4098-12NC												
Area 25												
RC	0.4	0.6	1.0	1.5	0.6	1.0	0.0	1.0	0.8	0.8	1.0	1.5
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	--	--	--	1.0	--	--	1.0	0.8	0.8	0.8	0.8	1.0
Coliform	--	--	--	0	--	--	0	0	0	0	0	0
RC	--	--	--	--	--	--	1.0	0.8	1.0	1.2	--	--
Coliform	--	--	--	--	--	--	0	0	0	0	--	--
PERMIT NY-4099-12NC												
Area 12												
RC	0.8	0.2	0.5	0.6	0.05	1.0	0.3	0.4	0.3	0.1	0.8	0.6
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	0.1	0.6	0.4	0.6	0.05	0.05	0.3	0.8	0.1	0.1	0.4	0.8
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
PERMIT NY-5000-12NC												
Area 6												
RC	1.0	0.8	1.0	1.0	1.0	0.6	0.5	0.0	0.1	0.8	1.5	2.0
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	1.0	0.6	0.6	0.6	1.0	0.6	0.2	0.5	0.8	0.1	1.2	0.8
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	0.8	0.6	0.6	0.6	1.0	0.6	0.4	0.8	1.0	1.0	0.8	2.0
Coliform	0	0	0	0	0	0	0	0	0	0	0	0
RC	0.8	--	--	--	--	1.0	--	0.8	--	--	--	--
Coliform	0	--	--	--	--	0	--	0	--	--	--	--
Area 6 (Sample of Water at Area 5)												
RC	--	1.0	1.0	1.0	0.8	0.06	1.0	1.0	1.0	0.4	1.2	0.06
Coliform	--	0	0	0	0	0	0	0	0	0	0	0
Area 6 (Sample of Water at Area 27)												
RC	0.2	0.1	0.1	1.0	0.3	--	0.25	0.1	0.1	0.0	1.2	1.5
Coliform	0	0	0	0	0	--	0	0	0	0	0	0
PERMIT NY-5024-12NC												
Area 1												
RC	0.8	1.0	0.1	0.3	1.0	0.05	0.4	0.8	0.5	0.1	0.8	0.5
Coliform	0	0	0	0	0	0	0	0	0	0	0	0

(a) RC - residual chlorine in parts per million (ppm); coliform colony count is in number/100 mL.

Table 7.2 Influent Quality

	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter	
Facility	BOD5[a] (mg/L)	S.C.[b] (μmhos/cm)	BOD5 (mg/L)	S.C. (μmhos/cm)	BOD5 (mg/L)	S.C. (μmhos)	BOD5 (mg/L)	S.C. (μmhos/cm)
Gate 100	238	1.12	240	1.40	144	1.24	340	0.88
Mercury	355	0.93	412	.93	178	0.77	71	0.80
Yucca Lake	338	1.19	196	1.15	157	1.14	524	0.75
Tweezer	393	1.54	126	1.02	376	1.71	280	1.32
CP-6	608	1.26	190	1.00	406	1.35	0	0
CP-72	193	1.05	81	1.07	37	0.82	0	0
DAF	201	1.04	162	1.39	<20	1.50	77	1.08
Reactor Control	0	0	0	0	0	0	129	0.82
Test Stand 1	0	0	0	0	0	0	0	0
Base Camp 25	203	1.00	199	.99	144	0.97	125	0.78
Base Camp 12	69	0.34	64	.30	57	0.41	16	0.29
Base Camp 2	0	0	0	0	-	-	-	-
Test Cell C	0	0	0	0	0	0	0	0
RWMS Site 5	-	-	-	-	-	-	203	1.05

(a) Biochemical Oxygen Demand.
(b) Specific Conductance.

Table 7.3 Organic Loading Rates for 1995

		Metered Rates			
Facility	Limit (Kg/day)	(Jan-Mar) Mean Daily Load	(Apr-June) Mean Daily Load	(Jul-Sept) Mean Daily Load	(Oct-Dec) Mean Daily Load
Mercury	172	65.0	97.3	72.5	16.7
DAF	7.6	-	1.22	-	-
Gate 100	2.4	-	2.97	-	-
LANL on Tweezer	5.0	-	1.67	10.9	1.24
Base Camp 25	7.4	-	4.16	-	-
Yucca Lake	8.6	6.74	7.01	4.0	23.9[a]
Base Camp 12	54	-	1.75	0.9	0.24
RWMS Site 5	0.995	-	-	-	0.77
		Calculated Rates			
CP-6	8.7	3.45	1.08	5.0	0
CP-72	1.1	0.29	0.12	0.05	0
DAF	7.6	1.74	-	0.17	0.29
Reactor Control	4.2	0	0	0	1.00
Eng Test Stand	2.3	0	0	0	0
Test Cell C	1.3	0	0	0	0
Base Camp 25	7.4	4.37	-	1.4	1.18
Base Camp 2	1.2	0	0	-	-
Gate 100	2.4	4.33	-	1.6	0.90
LANL on Tweezer	5.0	2.42	-	-	-
Base Camp 12	54	0.57	-	-	-

(a) Considered to be an anomalous value.

Table 7.4 Pond Water Depths in Infiltration Basins

Impound	Maximum Operating Depth, cm	Average Depth, cm (1st Quarter)	Average Depth, cm (2nd Quarter)	Average Depth, cm (3rd Quarter)	Average Depth, cm (4th Quarter)
Gate 100, Basin	90	35	16	0	0
Mercury, Basin	180	0	0	0	0
Yucca Lake					
North Basin	140	40	35	5	15
South Basin	140	39	41	4	20
Tweezer					
East Basin	244	0	0	0	0
West Basin	244	0	0	0	0
CP-6					
East Basin	90	1	2	0	0
West Basin	90	1	0	0	0
CP-72	90	0	0	0	0
DAF					
Basin 1	150	0	0	0	0
Basin 2	150	0	15	0	0
Reactor Control, Basin	130	0	0	7	12
Test Stand 1, Basin	90	0	0	0	0
Test Cell C, Basin	90	0	0	0	0
Base Camp 25, Basin	100	0	0	0	0
Base Camp 12, Basin 1	120	3	1	0	0
Base Camp 12, Basin 2	120	0	0	0	0
Base Camp 12, Basin 3	120	0	0	0	0
Base Camp 12, Basin 4	120	0	0	0	0
Base Camp 12, Basin 5	120	0	0	0	0
Base Camp 2, Basin	90	38(a)	0	0	0

(a) Infiltration basin was partially filled with rain water during a flash flood.

Table 7.5 Influent Toxics for Facilities that Receive Industrial Wastewater

Parameter	Compliance Limit (mg/L)	Mercury Measurement (mg/L)	Area 25 Central Support Measurement (mg/L)	Area 6 DAF Measurement (mg/L)	Area 6 CP Measurement (mg/L)	Area 6 LANL Measurement (mg/L)	Area 6 Yucca Lake Measurement (mg/L)
Arsenic	5.0	ND	ND	<0.01	ND	ND	ND
Barium	100	0.025	0.036	ND	0.021	0.120	0.025
Cadmium	1.0	ND	ND	<0.005	ND	ND	ND
Chromium	5.0	ND	ND	<0.05	ND	ND	ND
Lead	5.0	ND	ND	<0.05	ND	ND	ND
Mercury	0.2	ND	<0.0015	ND	ND	ND	ND
Selenium	1.0	ND	ND	<0.01	ND	ND	ND
Silver	5.0	ND	ND	<0.05	ND	ND	ND
Benzene	0.5	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	0.5	ND	ND	ND	ND	ND	ND
Chlorobenzene	100	ND	ND	ND	ND	ND	ND
Chloroform	6.0	ND	ND	ND	ND	ND	ND
1,4-dichlorobenzene	7.5	ND	ND	ND	ND	ND	ND
1,2-dichlorobenzene	0.5	ND	ND	ND	ND	ND	ND
1,1-dichloroethylene	0.7	ND	ND	ND	ND	ND	ND
Methylethyl Ketone	200	ND	ND	12	ND	ND	0.035
Pyridine	5.0	ND	ND	ND	ND	ND	ND
Tetrachloroethylene	0.7	ND	ND	ND	ND	ND	ND
Trichloroethylene	0.5	ND	ND	ND	ND	ND	ND
Vinyl Chloride	0.2	ND	ND	ND	ND	ND	ND

(a) Units for tritium are 10^{-7} uCi/cc.

ND Not Detected.

Note: Volatile samples were taken from each primary lagoon as they can not be composited. No volatiles were detected during this reporting period. Future measurements for volatile samples from facilities with multiple primary lagoons will be average values.

Table 7.5 (Influent Toxics for Facilities that Receive Industrial Wastewater, cont.)

Parameter	Compliance Limit (mg/L)	Mercury Measurement (mg/L)	Area 25 Central Support Measurement (mg/L)	Area 6 DAF Measurement (mg/L)	Area 6 CP Measurement (mg/L)	Area 6 LANL Measurement (mg/L)	Area 6 Yucca Lake Measurement (mg/L)
Cresol, total	200	ND	ND	ND	ND	ND	ND
2,4-dinitrotoluene	0.13	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	0.13	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	0.5	ND	ND	ND	ND	ND	ND
Nitrobenzene	2.0	ND	ND	ND	ND	ND	ND
Pentachlorophenol	100	ND	ND	ND	ND	ND	ND
2,4,5-trichlorophenol	400	ND	ND	ND	ND	ND	ND
2,4,6-trichlorophenol	2.0	ND	ND	ND	ND	ND	ND
Chlorodane	0.03	ND	ND	ND	ND	ND	ND
Endrin	0.02	ND	ND	ND	ND	ND	ND
Heptachlor	0.008	ND	ND	ND	ND	ND	ND
Lindane	0.4	ND	ND	ND	ND	ND	ND
Methoxychlor	10.0	ND	ND	ND	ND	ND	ND
Toxaphene	0.5	ND	ND	ND	ND	ND	ND
2,4-D	10.0	ND	ND	ND	ND	ND	ND
2,4,5-TP (Silvex)	1.0	ND	ND	ND	ND	ND	ND
Nitrate Nitrogen	100	ND	ND	<1.0	ND	ND	ND
Sulfate	5000	ND	ND	<5.0	ND	ND	ND
Chloride	1000	ND	ND	81.0	ND	ND	ND
Fluoride	40	ND	ND	2.0	ND	ND	ND
Tritium	Monitor Only	ND	ND	2.09(a)	ND	ND	ND

(a) Units for tritium are 10^{-7} uCi/cc.

ND Not Detected.

Note: Volatile samples were taken from each primary lagoon as they can not be composited. No volatiles were detected during this reporting period. Future measurements for volatile samples from facilities with multiple primary lagoons will be average values.

Table 7.6 Sampling Data for Infiltration Ponds Containing 30 cm or More

Parameter	Action Level mg/L	A-6 Yucca Lake/Q1 Result mg/L	A-22 Gate 100/Q1 Result mg/L	A-6 Yucca Lake/Q2 Result mg/L	A-6 DAF Q2 Result mg/L	A-25 Reactor Control Pt/Q3 Result mg/L
Arsenic	0.5	<0.010	<0.010	0.91	<0.01	0.022
Cadmium	0.1	0.030	0.040	0.03	<0.005	0.005
Chromium	0.5	<0.250	<0.250	0.08	<0.05	0.004
Lead	0.5	0.003	0.002	0.34	<0.05	0.0042
Selenium	0.1	<0.020	<0.020	0.03	<0.01	0.004
Silver	0.5	<0.200	<0.200	0.03	<0.05	0.003
Nitrate Nitrogen	100	<0.500	<0.500	0.04	<1.0	0.05
Sulfate	5000	63	82	160	<5.0	41
Chloride	1000	117	80	370	81	47
Fluoride	40	2	2	2.1	2.0	3.0
Tritium(a)	Monitor Only	1.62(a)	1.68(a)	ND	2.09(a)	ND

(a) Units for tritium is 10^{-7} μCi/cc.

ND - Not Detected.

Table 7.7 Quantity of Waste Disposed of in Landfills - 1995

Month	Quantity (in pounds) Area 9	 Area 23	 Area 6
January	1,237,600	211,360	480
February	1,823,909	351,040	272,184
March	4,528,510	440,004	960,620
April	2,384,015	255,260	3,375,520
May	4,934,964	261,910	477,940
June	2,728,750	164,525	645,470
July	2,975,968	145,470	23,422
August	2,955,889	275,820	40,800
September	857,150	360,290	40,120
October	1,174,870	1,187,390	4,720
November	0	501,740	59,520
December	0	332,990	0
Total	25,601,625	4,487,799	5,900,796

Table 7.8 Number of RCRA Samples Analyzed - 1995

Sample Type Analysis	Soil	Water	Oil	Other	Total
Volatile Organic	244	98	98	48	488
Semi-volatile Organic	152	61	61	30	304
ICP Metals[a]	91	36	36	18	181
TCLP Metals[b]	230	92	92	46	460
pH	51	20	20	11	102
Flashpoint	37	15	15	7	74
TPH[c]	219	88	88	43	438
Chlor-D-tect	46	18	18	9	91
PCB/Pest	71	29	29	14	143
Total	1141	457	457	226	2281

(a) "ICP Metals" refers to samples analyzed on an inductively coupled plasma spectrometer for the presence of certain metals.

(b) "TCLP Metals" refers to samples that have been subjected to the EPA approved "toxicity characteristic leaching procedure.

(c) "TPH" (Total Petroleum Hydrocarbons) refers to samples usually associated with underground storage tanks and fuel spills.

8.0 RADIOACTIVE AND MIXED WASTE STORAGE AND DISPOSAL

Disposal of low-level radioactive waste (LLW) from Department of Energy (DOE) approved generators occurs at two areas on the Nevada Test Site (NTS). Disposal of packaged LLW at the Radioactive Waste Management Site, Area 5 (RWMS-5) is in shallow pits and trenches. LLW packaged in large bulk waste containers, and unpackaged bulk waste (only from the NTS) are buried in selected subsidence craters at the Radioactive Waste Management Site, Area 3 (RWMS-3).

Hazardous waste and specific categories of radioactive waste are stored above ground in Area 5. Transuranic (TRU) waste categorized as mixed waste; i.e., radioactive material mixed with hazardous waste, is stored in a covered building on a specially constructed Resource Conservation and Recovery Act (RCRA) designed pad. The TRU waste will be characterized for proposed disposal at the Waste Isolation Pilot Plant (WIPP) in New Mexico. Low-level radioactive mixed waste is currently being stored on the TRU waste storage pad before permanent disposal. Uranium ore residues that are considered mixed waste are stored north of the RWMS-5. Hazardous wastes generated on the NTS are accumulated at the Hazardous Waste Accumulation Site east of the RWMS-5 before shipment to an offsite treatment, storage and disposal facility.

During 1995, environmental monitoring involved air sampling, radiation dose rate surveys, ground water analysis, and environmental sampling. Air samples were collected at RWMS-3 and RWMS-5 for analysis of gross beta radiation, photon-emitting radionuclides, plutonium, and tritium. Tritium was the only airborne radionuclide detected at the RWMS-5 from the disposal of radioactive waste. All radionuclide concentrations were well below derived concentration guides (DCG). Gamma radiation fields were monitored by thermoluminescent dosimeters (TLD). Gamma doses greater than background were detected at the RWMS-5 in areas where waste is stored or disposed. Neutron radiation fields at the perimeter of the TRU waste storage pad were monitored by proton recoil dosimeters. Radiation exposure rates were consistent with historical ranges.

8.1 WASTE DISPOSAL OPERATIONS

Radioactive waste disposal was initiated at Area 5 on the NTS in 1961. By July 1976, six trenches out of nine developed trenches had been filled with LLW. In 1978, waste disposal operations were expanded when the DOE established the Radioactive Waste Management Project for the disposal of defense related LLW from the NTS and from offsite DOE generators and U.S. Department of Defense (DOD) facilities. The state of Nevada granted the NTS interim status in 1987 for the disposal of low-level mixed waste in Pit 3 of the RWMS-5. LLW disposed of prior to 1986 may contain low levels of constituents that would be regulated as hazardous waste under RCRA. Mixed waste disposal was curtailed in 1990 by the DOE because of the possible presence of Land Disposal Restrictions (LDR) constituents. The state of Nevada later directed that the DOE provide National Environmental Policy Act (NEPA) documentation and implement a state approved Waste Analysis Plan. No offsite mixed waste has been received for disposal since 1990. Mixed waste generated on the

NTS may be disposed of in Pit 3 of the RWMS-5 if LDR requirements are met. The RWMS-3 has been used for the disposal of bulk atmospheric test debris, bulk LLW in large containers, and packaged LLW.

Hazardous waste generated on the NTS is accumulated at the Hazardous Waste Accumulation Site (HWAS) which is adjacent to and east of the RWMS-5. At this site, the hazardous waste is prepared for shipment to an offsite treatment, storage, and disposal facility. Hazardous waste is not accepted from offsite generators.

8.1.1 AREA 5 RADIOACTIVE WASTE MANAGEMENT SITE

The RWMS-5 occupies approximately 296 hectares (732 acres) and is located in the northern area of Frenchman Flat, approximately 26 km (16 mi) north of the NTS main gate. Currently, 37 hectares (92 acres) are posted as radiological areas used for waste storage and disposal. Before 1968, Area 5 had been used for the testing of conventional weapons and both above and below ground testing of nuclear weapons.

The general surface geology of the area is alluvial sediment derived from tuffaceous material. The basin is filled with up to 305 m (1000 ft) of alluvium from the surrounding mountain ranges. The disposal site is located on a gently sloping alluvial fan extending southward from the Massachusetts Mountains, which lie approximately 3.3 km (2 mi) to the north. The slope of the terrain is two percent near the disposal site, but increases to 3 percent to the west. Two shallow dry washes cross the site, from the northwest and from the northeast. An earthen dike has been constructed along the western, northern, and eastern borders of the RWMS-5 to prevent water flow into the disposal area.

In the past, disposal of LLW and mixed wastes occurred in shallow land burial trenches and pits at depths ranging from 4.6 m to 9.1 m (15 to 30 ft). Pits and trenches that reach full capacity are temporarily covered by 2.4 m (8 ft) of soil until a permanent closure cap is constructed. In addition, disposal of high specific activity waste has occurred in augured shafts that are 36 m (120 ft) in depth, termed Greater Confinement Disposal (GCD). When disposal capacity is reached, GCD shafts are filled with soil from 21 m (70 ft) to the surface.

LLW is accepted for disposal from generators that have received approval from DOE Headquarters (DOE/HQ) and DOE Nevada Operations Office (DOE/NV). Prior to receiving approval, generators must submit an application detailing the characterization of the waste for disposal and their waste certification program. The waste program must meet NVO-325 (Revision 1), "Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements." Approval may be granted if an audit shows that the waste characterization meets the requirements and the waste certification plan has been satisfactorily implemented. Approved generator programs are reviewed and audited annually.

The majority of the waste disposed of in 1995 was placed in Pits 4 and 5. Construction of Pit 5 was completed during the first quarter of 1995. Pit 4 was filled during 1995 and its operations moved to Pit 5.

During 1995, LLW was received from 15 generators. A volume of 9,171 m^3 (3.24×10^5 ft^3) containing a total of 556 Ci (20.6 TBq) of radioactivity was disposed of at the RWMS-5. This was a decrease both in volume and radioactivity from the previous year (see Table 8.1). Tritium and uranium accounted for over 94.4 percent of total radioactivity disposed of (see Table 8.2). The majority of the remaining radioactivity was attributed to isotopes of thorium and plutonium.

8.1.1.1 RWMS-5 MIXED WASTE MANAGEMENT UNIT

A Mixed Waste Management Unit (MWMU) is planned for construction in the northeastern area of the RWMS-5. The proposed MWMU will cover approximately 10 hectares (25 acres) and contain 8 landfill cells. Mixed waste disposal operations at the NTS will recommence under interim status in Pit 3 upon completion of NEPA documentation and a state approved Waste Analysis Plan. Disposal operations at the MWMU will be initiated upon issuance of a state RCRA Part B Permit. In the interim, an agreement between DOE/NV and the Nevada Division of Environmental Protection (NDEP) has been negotiated that allows low-level mixed waste generated on the NTS to be stored on the TRU waste storage pad until treatment or permanent disposal.

8.1.1.2 RWMS-5 GROUNDWATER MONITORING

Data collection was initiated in 1993 and was continued during 1995 to monitor the groundwater chemistry under the waste disposal cells at RWMS-5. The purpose of this study is to determine the water quality and the flow gradients. Sampling is being performed using three pilot wells drilled in 1992 into the uppermost aquifer under the disposal cells. Further information on this study can be found in Section 9.2.2.3 of this document and in the "1995 Groundwater Monitoring Report" (Bechtel 1995).

8.1.2 AREA 3 RADIOACTIVE WASTE MANAGEMENT SITE

The RWMS-3 lies at an elevation of 1230 m (4050 ft) and covers approximately 20 hectares (50 acres). It is located in the center of Yucca Flat approximately 5 miles north of the Yucca Dry Lake Bed. The site is located on alluvial sediments that are approximately 1500 ft deep. Atmospheric and underground nuclear tests have been conducted in several areas in Yucca Flat including Area 3. Safety tests have resulted in the dispersion of plutonium in surface soils in Area 3.

The RWMS-3 is used for the management of bulk debris from above ground nuclear tests and packaged bulk LLW generated offsite. Subsidence craters formed by underground nuclear tests are used for disposal. The subsidence craters range in depth from 15 to 24 m (49 to 78 ft) and are filled by alternating layers of stacked waste packages and 3 ft of clean fill dirt. Two craters, U-3ax and U-3bl, have been filled to date. A 2.5-m (8 ft) thick operational cap of clean soil extending 1.2 m (4 ft) above grade has been used for temporary closure of U3ax/bl craters. In 1995, the RWMS-3 received 11,073 m^3 (3.9×10^5 ft^3) of waste containing 3.1 Ci (115 GBq) of radioactivity (see Table 8.3). There was a slight increase in volume of waste and radioactivity disposed of during 1995 as compared to 1994. Tritium accounted for approximately 92.0 percent of the total radioactivity disposed of during 1995 (see Table 8.4). The adjacent craters U-3ah/at are being used at present for LLW disposal.

8.1.3 STRATEGIC MATERIALS STORAGE YARD

The strategic materials storage yard is used for storage of mixed waste consisting of residues from the processing of uranium ores from the Mound Plant in Miamisburg, Ohio. On a mass basis, this material is primarily ^{238}U and iron. The residues contain approximately 290 Ci (11 TBq) of total radioactivity. Storage of this waste north of the RWMS-5 will continue until treatment for disposal is performed. In 1995, cement stabilization was assessed as a possible treatment option. Dates for completion of treatment activities and further information on the waste can be found in the "NTS Site Treatment Plan" (DOE-1995b).

The residue material is packaged in steel drums inside wooden boxes that are stored inside steel cargo containers. A total of 28 cargo containers is stored on concrete pads that are surrounded by a control fence. Required inspections are performed routinely to ensure the integrity of the waste containers. Opening of the cargo containers for inspection is controlled following established as low as reasonably achievable (ALARA) practices to reduce radiation exposure to personnel.

8.1.4 TRANSURANIC WASTE STORAGE

The TRU waste storage pad is located in the southeast corner of the RWMS-5. The pad is used for interim storage of TRU waste previously received from Lawrence Livermore National Laboratory (LLNL). During 1992, all of the mixed TRU waste packaged in 55-gal drums was overpacked into steel drums with carbon filter vents. This waste is stored in a cover building that sits on a curbed asphalt pad surrounded by a security fence. The pad and waste storage configuration comply with RCRA, 40 C.F.R. 265, Subpart I.

Inspections of all mixed TRU waste containers are performed weekly while inspections of the TRU waste storage pad are performed monthly. The current inventory is awaiting permanent disposal at the WIPP. This waste will be characterized and packaged for certification according to WIPP criteria.

8.2 ENVIRONMENTAL MONITORING AT WASTE STORAGE AND DISPOSAL SITES

The Analytical Services Department (ASD), Environmental Section was responsible for collection of samples and verifying sample results. The ASD Radioanalytical Section was responsible for analysis of the samples. Collection and analysis of samples were performed in accordance with approved operating procedures. The Waste Management Program reviews the sampling results for any unexpected trends.

8.2.1 AIR MONITORING

Air sampling is conducted at nine stations along the perimeter of the RWMS-5 fence, at two stations inside the TRU waste storage cover and at one station in Pit 5. Two samplers inside the TRU cover building along with the perimeter samplers were determined to provide adequate monitoring for the TRU waste storage facility. Originally, there were six stations that surrounded the TRU waste storage pad. The Pit 3 sampling station was discontinued in September 1995 due to suspension of operations in Pit 3. Air sampling is also conducted at four stations along the perimeter of the U-3ah/at craters at RWMS-3.

Air samplers operate at an air flow rate of approximately 140 L/min (5 cf/min). Sampling media is a 9 cm (approximately 4 in) glass-fiber filter. Filters are exchanged on a weekly basis. Each filter is analyzed for gross beta/gamma radiation. The filters are composited monthly for samplers located at the perimeter of RWMS-5 and quarterly for all other sample locations and analyzed for ^{238}Pu and $^{239+240}$Pu. Samplers for tritiated water (HTO) are located with eight of the particulate samplers along the perimeter of the RWMS-5. Tritiated water is not measured at the RWMS-3. Sampling for radioiodine was discontinued in 1995 because radioiodine is not expected to be produced from disposal operations. Radioiodine was measured in the past because it was produced during nuclear testing.

8.2.1.1 RWMS-5 AIR MONITORING

Tritium, ^{238}Pu,$^{239+240}$Pu, (see Table 8.5) and gross beta activity were measured in air at the RWMS-5 during 1995. The 1995 airborne plutonium levels were generally lower than those in 1994. The average concentration of $^{239+240}$Pu during 1995 was 0.6 x 10^{-17} µCi/mL (0.22 µBq/m^3), while the maximum concentration was 3.4 x 10^{-17} µCi/mL (1.3 µBq/m^3). The average concentration is approximately 0.3 percent of the 10 mrem per year modified DCG for $^{239+240}$Pu (2 x 10^{-15} µCi/mL [74 µBq/m^3]) (DOE Order 5400.5). The average air concentration of ^{238}Pu was approximately a factor of 46 lower than the air concentration of $^{239+240}$Pu. Airborne plutonium in Area 5 is most likely due to resuspension of contaminated soils and not attributable to the waste disposed of in this LLW site.

The average HTO concentration was 5.7 x 10^{-12} µCi/mL (0.21 Bq/m^3) where the highest concentration was 5.8 x 10^{-11} µCi/mL (2.1 Bq/m^3). The high value is approximately 0.6 percent of the 10 mrem per year modified DCG for HTO (1 x 10^{-8} µCi/mL [370 Bq/m^3]). Tritium is associated with waste disposal operations. The levels of tritium have remained consistent with historical averages. The average HTO air concentration in 1995 was in the range of the 1993 average concentration of 7.9 x 10^{-12} µCi/mL (0.29 Bq/m^3) and the 1994 average concentration of 4.9 x 10^{-12} µCi/mL (0.18 Bq/m^3).

Gross beta air concentration results are used as a screening tool to check if a significant release occurred and if other radionuclides warrant analysis. The results were in the range of 10^{-14} and 10^{-15} µCi/mL. These levels are consistent with levels for previous years.

8.2.1.2 RWMS-3 AIR MONITORING

Traces of plutonium (^{238}Pu and $^{239+240}$Pu) were detected in air at all of the RWMS-3 samplers in 1995. The average air concentration of $^{239+240}$Pu in 1995 was 8.9×10^{-17} µCi/mL (3.3 µBq/m^3) which was slightly less than the 1994 average of 13.1×10^{-17} µCi/mL (4.9 µBq/m^3). The average air concentration of ^{238}Pu was approximately a factor of 56 lower than the average concentration of $^{239+240}$Pu. The highest concentration of $^{239+240}$Pu detected in 1995 was 42×10^{-17} µCi/mL (15.5 µBq/m^3) which is far below the Derived Air Concentration (DAC) for $^{239+240}$Pu. Airborne plutonium is most likely due to resuspension of soils contaminated by atmospheric weapons testing, and is not attributable to the waste being disposed of at this site. Gross beta air concentrations were consistent with the RWMS-5 results.

8.2.2 RADIATION EXPOSURE RATES

Areas where disposal operations take place are radiologically controlled through engineering and administrative controls to ensure radiation exposures are ALARA. Workers are trained thoroughly in exposure reduction techniques and ALARA practices. Worker radiation doses have remained below ALARA administration goals that are considerably less than the DOE occupational limit.

8.2.2.1 GAMMA EXPOSURE

Thermoluminescent dosimeters (TLDs) were deployed at 44 locations at RWMS-5 and at 5 locations of the U3ah/at craters at RWMS-3 disposal site to measure the gamma radiation exposure (see Table 8.6). Ten TLDs were placed within the perimeter of RWMS-5 including six TLDs around the TRU waste storage pad, two TLDs in Pit 3, and two TLDs in the operational disposal pit (Pits 4 and 5). The TLDs in the pits were approximately 30 m (100 ft) from the waste stacks. Fifteen TLDs were located at the perimeter of the RWMS-5 site and one was placed at the facility office. Another 18 TLDs were located around the Strategic Materials Storage Yard (SMSY). All TLDs were exchanged and analyzed quarterly.

The TLDs located at the perimeter of RWMS-3 and RWMS-5 had exposures that were slightly above or at background levels (see Table 8.6). Exposure rates at the TRU pad, in the operational disposal pits of RWMS-5 and at the SMSY were above background due to their proximity to the radioactive waste containers. No significant increases were identified when comparing the 1995 exposure rates with historical levels.

8.2.2.2 NEUTRON DOSE EQUIVALENTS

Neutron dose equivalents were measured at six locations at the perimeter of the TRU waste storage pad. The dose equivalents for 1995 ranged from the detection limit of 84 mrem to 221 mrem per year. Neutron doses for 1995 were consistent with the 1994 results.

8.2.3 VADOSE ZONE MONITORING FOR MIXED WASTE DISPOSAL

A vadose zone monitoring program has been implemented to allow earlier detection of potential contaminant migration from the mixed waste disposal pit (Pit 3) at the RWMS-5. Monitoring is conducted in 24 access tubes. Tubes are installed through the operational cover (approximately 8 ft deep), the waste zone (20 - 30 ft), and ten feet of soil below the pit floor. Tubes are monitored quarterly with neutron moisture meters to detect wetting fronts from precipitation. Wetting fronts that progressed through the operational cap and into the waste zone could indicate that contaminant migration might have occurred. In 1995 and in the past, no wetting fronts have been detected below the operational cap.

8.2.4 TRITIUM MIGRATION STUDIES AT THE RWMS-5

The results of the tritium migration study at the Greater Confinement Disposal (GCD) site showed that the waste buried between depths of 70 and 120 ft has remained isolated from the accessible environment (i.e., the surface). In addition, plants and near surface soil were sampled above shallow land disposal cells in RWMS-5 to confirm seasonal variations. Results indicated that the worker and public radiation exposure are negligible.

Table 8.1 Low-Level Waste Disposed of at RWMS-5 for 1993 - 1995

Calendar Year	Volume of LLW Disposed (m^3)	Activity of LLW Disposed (Ci)
1995	9171	5.56×10^{2}
1994	12300	5.17×10^{4}
1993	8327	3.00×10^{4}

Table 8.2 Radionuclides Disposed of at the RWMS-5 During 1995

Radionuclide	Activity (Ci)	Percent of Total Activity
^{3}H	244.34	43.97
^{238}U	184.24	33.16
^{234}U	92.56	16.66
^{235}U	3.53	0.64
^{228}Th	6.80	1.22
^{230}Th	0.68	0.12
^{232}Th	6.77	1.22
^{238}Pu	0.66	0.12
^{239,240}Pu	1.60	0.29
^{241}Pu	7.56	1.36
^{137}Cs	3.62	0.65
^{90}Sr	1.48	0.27
^{99}Tc	1.11	0.20
^{60}Co	0.38	0.07
Other	0.31	0.06
Total	555.64	100

Table 8.3 Low-Level Waste Disposed of at RWMS-3 for 1993 -1995

Calendar Year	Volume of LLW Disposed(m^3)	Activity of LLW Disposed (Ci)
1995	11073	3.1
1994	10550	0.21
1993	9848	0.24

Table 8.4 Radionuclides Disposed of at RWMS-3 During 1995

Radionuclide	Activity(Ci)	Percent of Total Activity
^{3}H	2.8545	92.00
^{238}U	0.1382	4.45
^{234}U	0.1017	3.28
^{235}U	0.0083	0.27
Total	3.1027	100.00

Table 8.5 Air Monitoring Results for Various Radionuclides at RWMS-5 for 1994 - 1995

Year	$^{239+240}$Pu (x 10^{-17} µCi/mL)	^{238}Pu (x 10^{-17} µCi/mL)	Tritium (x 10^{-12} µCi/mL)
Average 1995	0.6	0.013	5.7
High 1995	3.4	0.11	5.8
Average 1994	1.1	0.038	4.9
High 1994	52	0.15	4.7
Derived Concentration Guide (10 mrem for nonworkers)	200	300	10^{4}

Table 8.6 External Gamma Exposure Measured by TLDs at the RWMS

Calendar Year	Number of Dosimeters	Average (mR/y)	Standard Deviation (mR/y)
RWMS-5, perimeter	16	127	10.7
RWMS-5, TRU pad, Pit 3 and 5	10	304	224
RWMS-3, ah/at perimeter	5	137	21.6
Strategic Material Storage Yard	18	1804	1051

9.0 GROUNDWATER PROTECTION

The primary mission of the Department of Energy Nevada Operations Office (DOE/NV) at the Nevada Test Site (NTS) has been the testing of nuclear devices and their components. The DOE/NV's Environmental Protection Policy Statement outlines a general policy of preventing pollutants from reaching groundwater, but it also recognizes that some options for groundwater protection are precluded by an increased risk of atmospheric releases and potential violation of international agreements. Therefore, the DOE/NV groundwater protection policy represents a balance between strict compliance with atmospheric release agreements and minimization of groundwater impacts. Groundwater protection is implemented by various programs that address compliance with regulatory requirements, minimization of waste streams, closure and monitoring of waste facilities, remedial investigations, groundwater monitoring, and environmental research.

The Nevada Environmental Restoration Project (NV-ERP) was established to assess past hazardous and radioactive waste contamination that may have occurred as a result of operations at DOE/NV facilities. For those sites that could pose a threat to human health, welfare, and/or the environment, remedial actions consistent with the National Oil and Hazardous Substances Pollution Contingency Plan were developed. The NV-ERP has been designed to ensure DOE/NV compliance with federal laws such as the Resource Conservation and Recovery Act (RCRA); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and the Superfund Amendments and Reauthorization Act (SARA).

A program of well drilling at the NTS for groundwater characterization continued in 1995. This program will continue until the location, quantity, and movement of groundwater and contaminants are sufficiently understood to support a Remedial Investigation and Feasibility Study (RI/FS). The RI/FS will evaluate potential groundwater contaminant transport pathways, risks associated with these pathways, and possible remedial actions.

DOE/NV instituted a Long-Term Hydrological Monitoring Program (LTHMP) in 1972 to be operated by the U. S. Environmental Protection Agency (EPA) under an Interagency Agreement. In 1995, groundwater was monitored on and around the NTS, at six sites in other states, and at two off-NTS locations in Nevada to detect any radioactivity that may be related to previous nuclear testing activities. Although tritium initially seeped from two of the offsite tests, the tritium levels in wells at both of these sites are decreasing and were well below the National Primary Drinking Water Regulation levels. NTS supply wells were monitored for gross alpha and beta activity as well as tritium levels.

9.1 EXISTING GROUNDWATER CONDITIONS

9.1.1 HYDROGEOLOGY OF THE NTS

The NTS has three general water-bearing units: the lower carbonate aquifer, volcanic aquifers, and valley-fill aquifers. The water table occurs variously in the latter two units while groundwater in the lower carbonate aquifer occurs under confined conditions. The depth to the saturated zone is highly variable but is generally at least 150 m (approximately 500 ft) below the land surface and is often more than 300 m (approximately 1000 ft). The hydrogeologic units at the NTS occur in three groundwater subbasins in the Death Valley Groundwater Basin (see Chapter 2, Figure 2.9, for a diagram of these systems). The actual subbasin boundaries are poorly defined, but what is known about the basin hydrology is summarized below.

Groundwater beneath the eastern part of the NTS is in the Ash Meadows Subbasin and discharges along a spring line in Ash Meadows, south of the NTS. Most of the western NTS is in the Alkali Flat-Furnace Creek Subbasin with discharges occurring by evapotranspiration at Alkali Flat and by spring flow near Furnace Creek Ranch. Groundwater beneath the far northwestern corner of the NTS may be in the Oasis Valley Subbasin which discharges by evapotranspiration in Oasis Valley. Some underflow from the subbasin discharge areas probably travels to springs in Death Valley. Regional groundwater flow is from the upland recharge areas in the north and east toward discharge areas in Ash Meadows and Death Valley, southwest of the NTS. Because of large topographic changes across the area and the importance of fractures to groundwater flow, local flow directions may be radically different from the regional trend (Waddell 1982).

9.1.2 HYDROGEOLOGY OF NON-NTS UNDERGROUND EVENT SITES

The following descriptions of the hydrology of non-NTS underground event sites are summarized from Chapman and Hokett 1991.

9.1.2.1 FALLON, NEVADA

The Project SHOAL site is located in the granitic uplift of the Sand Springs Range. The highland area around the site is a regional groundwater recharge area, with regional discharge occurring to the west in Four-mile Flat and Eight-mile Flat, and to the northeast in Dixie Valley. Evidence suggests that a groundwater divide exists northwest of the site and that the main component of lateral movement of groundwater near the site is southeast toward Fairview Valley. Groundwater in Fairview Valley moves north to the discharge areas in Dixie Valley. Groundwater in Fairview Valley occurs in three separate alluvial aquifers that are separated by clay aquitards. Groundwater flow velocities through the granite to the alluvial aquifers of Fairview Valley are calculated to be very slow.

9.1.2.2 BLUE JAY, NEVADA

The Project FAULTLESS site is located in a thick sequence of alluvial material underlain by volcanic rocks in the northern portion of Hot Creek Valley. Recharge to the alluvial aquifer and volcanic aquifer occurs in the higher mountain ranges to the west with groundwater flowing toward the east-central portion of the valley and discharging by evapotranspiration and underflow to Railroad Valley.

9.1.2.3 AMCHITKA ISLAND, ALASKA

The groundwater system of Amchitka Island is typical of an island-arc chain with a freshwater lens floating on seawater in fractured volcanic rocks. Active freshwater circulation occurs by precipitation recharging the water table with a curving flow path downward in the interior of the island and upward near the coast. Generally, the hydraulic gradient is from the axis of the island toward the coast. Groundwater travel times have been estimated to be between 23 and 103 years from the test cavities to the Bering Sea.

9.1.2.4 RIO BLANCO, COLORADO

Project RIO BLANCO is located in the Fort Union and Mesa Verde Sandstones in the Piceance Creek Basin. Three aquifers comprise the majority of the groundwater resources; a shallow alluvial aquifer, the upper "A" potable aquifer, and the lower "B" saline aquifer. The "A" and "B" aquifers are separated by the Mahogany Oil Shale aquitard. These aquifers lie well above the test depth. The alluvial aquifer is the primary source of groundwater in the area with flow to the northeast toward the Piceance Creek. Recharge to the alluvial aquifer occurs by downward infiltration of precipitation and surface water, and by upward leakage from underlying aquifers. The "A" aquifer is larger in areal extent than the overlying alluvial aquifer with the permeability in the "A" aquifer controlled by a vertical fracture system. The "B" aquifer exhibits minimal communication with the "A" aquifer.

9.1.2.5 GRAND VALLEY, COLORADO

Project RULISON is located in the Mesa Verde Sandstone which is overlain by alluvium, the Green River Formation (shale and marlstone), the Wasatch Formation (clay and shale), and the Ohio Creek Formation (conglomerate). The direction of groundwater flow is thought to be northward. The principal groundwater resources of the area are in the alluvial aquifer which is separated from the test horizon by great thicknesses of low-permeability formations. Pressure tests of deep water-bearing zones indicated very little mobile water.

9.1.2.6 BAXTERVILLE, MISSISSIPPI

Project DRIBBLE and the Miracle Play Program were conducted in the Tatum Salt Dome. The Tatum Salt Dome interrupts and deforms the lower units of coastal marine deposits in the area, has low permeability, and allows little water movement. Seven hydrologic units are recognized in the area, exclusive of the salt dome and its anhydrite caprock. These are, from the surface downward, the Surficial Aquifer, the Local Aquifer, and Aquifers 1, 2, 3, 4, and 5. These aquifers consist of sands and gravels, sandstones, shales, and limestones with low-permeability clay beds acting as aquitards. The natural flow has been disrupted by pumping from the upper aquifers and by injection of oil-field brines into Aquifer 5. The transient conditions and lack of data result in uncertainties in groundwater flow directions.

9.1.2.7 GOBERNADOR, NEW MEXICO

Project GASBUGGY is located on the eastern side of the San Juan Basin. The direction of groundwater movement is not well known, but is thought to be to the northwest in the Ojo Alamo Sandstone toward the San Juan River. The test was conducted in the underlying Pictured Cliffs Sandstone and Lewis Shale which are not known to yield substantial amounts of water. The rate of groundwater movement in the Ojo Alamo Sandstone is estimated to be approximately 0.01 meters per year.

9.1.2.8 MALAGA, NEW MEXICO

The Project GNOME site is located in the northern part of the Delaware Basin which contains sedimentary rocks and a thick sequence of evaporites. The test was conducted in the halites of the Salado Formation which is overlain by the Rustler Formation, the Dewey Lake Redbeds, and alluvial deposits. The Rustler Formation contains three water-bearing zones: a dissolution residue at its base, the Culebra Dolomite, and the Magenta Dolomite. The Culebra Dolomite is the most regionally extensive aquifer in the area. The groundwater in the Culebra is saline but is suitable for domestic and stock uses. Groundwater in the Culebra flows to the west and southwest toward the Pecos River.

9.1.3 AREAS OF POSSIBLEGROUNDWATER CONTAMINATION AT THE NTS

A preliminary assessment of underground and surface contamination at the NTS was conducted by the DOE in 1987 and submitted to the EPA Region 9. The survey delineated known and potential sources of groundwater contamination at the NTS including underground nuclear testing areas and surface facilities (Figure 9.1). Information from this document and from DOE/NV's "Site Specific Plan for Environmental Restoration and Waste Management, Five Year Plan," was used to describe the possible areas of groundwater contamination at the NTS. Table 9.1 is a listing of routine sampling locations at NTS and off-NTS sites where 1995 groundwater samples contained levels of man-made radioactivity greater than 0.2 percent of the National Primary Drinking Water Regulations.

To date, over 1050 announced nuclear tests have been conducted at the NTS with the majority of them occurring in Yucca Flat, Frenchmen Flat, Pahute Mesa, Rainier Mesa, and Shoshone Mountain. The principal by-products from these tests were heavy metals and a wide variety of radionuclides with differing half-lives and decay products. Detonations within, or near, the regional water table may have contaminated the local groundwater with radionuclides, principally tritium.

Surface activities associated with underground testing and other NTS activities such as disposal of low-level radioactive and mixed wastes, spill testing of hazardous liquified gaseous fuels, and transport of radioactive materials, also pose potential soil and groundwater contamination risks. The types of possible contaminants found on the surface of the NTS include radionuclides, organic compounds, metals, and residues from plastics, epoxy, and drilling muds. A wide variety of surface facilities, such as former injection wells, leach fields, sumps, waste storage facilities, tunnel containment ponds and muck piles, and storage tanks, may have contaminated the soil and shallow unsaturated zone of the NTS. The great depths to groundwater and the arid climate mitigate the potential for mobilization of surface and shallow subsurface contamination. However, contaminants entering the carbonate bedrock from Rainier Mesa tunnel ponds, contaminated wastes injected into deep wells, underground tests near the water table, and wastes disposed into subsidence craters have the potential to reach groundwater.

9.2 GROUNDWATER PROTECTION

DOE/NV has instituted a policy regarding protection of the environment. This policy states: "A principal objective of the DOE/NV policy is to assure the minimization of potential impacts on the environment, including groundwater, from underground testing. An ongoing program to monitor and assess the effectiveness of groundwater protection efforts will be enhanced so that resources are allocated based on current understanding of the effectiveness of groundwater protection programs." Groundwater protection activities contained within DOE/NV programs are described below.

9.2.1 GROUNDWATER PROTECTION FOR UNDERGROUND NUCLEAR TESTS

The DOE/NV standard operating procedure "Protection of Groundwater at Nuclear Test Locations" (NTS-SOP 5417), defines five criteria for siting underground nuclear tests based upon the current understanding of the effects of testing on the groundwater environment. Before an emplacement hole or emplacement drift can be used for a test, documentation must be submitted by the sponsoring user to the DOE/NV Assistant Manager for Environmental Restoration and Waste Management Division (AMEM) to show compliance with these criteria, which are:

- Future testing should utilize previously used areas of testing.
- Tests with working points at or below the water table should be minimized. Testing within perched water conditions is excluded from this criterion.

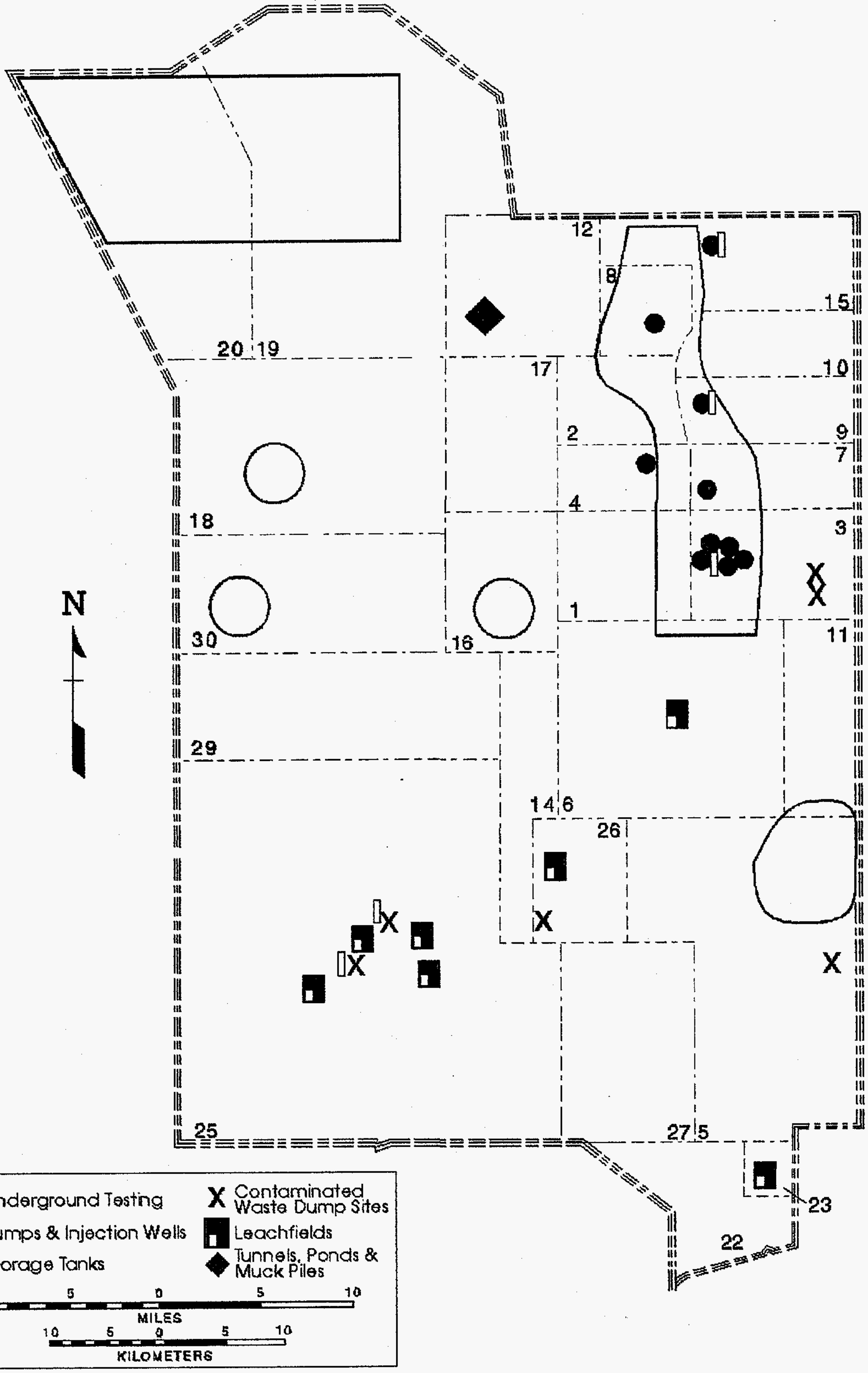


Figure 9.1 Areas of Potential Groundwater Contamination on the NTS

- Working points should be placed no closer than two cavity radii from any regional carbonate aquifer.
- Emplacement holes should not be sited within 1,500 m of the NTS boundary where groundwater leaves the NTS.
- Emplacement holes which extend more than two cavity radii or 30 m, whichever is greater, beneath the working point should be plugged to prevent the open borehole from becoming a preferential pathway for groundwater contamination.

The Hydrologic Resources Management Program (HRMP) reviews the emplacement hole documentation for technical content and the DOE/NV Environmental Protection Division (EPD) reviews the documentation for environmental compliance. Based on recommendations by AMEM, HRMP, and EPD, the proposed location will either be approved or modifications recommended. If groundwater levels encountered during drilling of the emplacement holes are substantially different than predicted, the acceptability of the emplacement hole will be re-evaluated.

9.2.2 GROUNDWATER PROTECTION FOR SURFACE FACILITIES

Because of the large distance from the surface to groundwater, there is a minimal risk of groundwater contamination from surface activities at the NTS. Nonetheless, provisions for groundwater protection from surface activities have been established in several programs: (1) Waste Minimization and Pollution Prevention Awareness; (2) Decontamination and Decommissioning; and (3) Waste Treatment, Storage, and Disposal.

9.2.2.1 WASTE MINIMIZATION AND POLLUTION PREVENTION AWARENESS PROGRAM

The Waste Minimization and Pollution Prevention Awareness Program is designed to reduce waste generation and possible pollutant releases to the environment, increasing the protection of employees and the public. All DOE/NV contractors and NTS users who exceed the EPA criteria for small-quantity generators have established implementation plans in accordance with DOE/NV requirements. Contractor programs ensure that waste minimization activities are in accordance with federal, state, and local environmental laws and regulations, and DOE Orders. A discussion of 1995 activities is given in Section 3.2.6.

9.2.2.2 DECONTAMINATION AND DECOMMISSIONING PROGRAM

The Decontamination and Decommissioning Program identifies inactive radiologically contaminated facilities, assesses the extent of contamination, minimizes its spread, ensures that facilities are maintained in a safe manner pending determination of final disposition, and secures or disposes of facilities. Seven facilities at the NTS have been identified for decontamination and decommissioning.

9.2.2.3 WASTE TREATMENT, STORAGE, AND DISPOSAL

DOE/NV currently operates two disposal facilities in Areas 3 and 5 at the NTS for low-level radioactive waste (LLW) generated by DOE and the Department of Defense (DOD) facilities. The Area 5 Radioactive Waste Management Site (RWMS-5) also serves as a temporary storage area for Lawrence Livermore National Laboratory (LLNL) transuranic wastes, which will be shipped upon final certification to the Waste Isolation Pilot Plant in New Mexico for disposal. All hazardous wastes generated at the NTS are stored at a Hazardous Waste Accumulation Site in Area 5 until shipped offsite to EPA-approved commercial disposal facilities. Uranium-ore residues designated as strategic materials are stored north of the RWMS-5. The Area 3 RWMS (RWMS-3) is used for the disposal of non-standard packaged LLW from offsite and unpackaged bulk wastes from the NTS.

Mixed waste disposal facilities are presently operating under the RCRA interim status pending completion of the RCRA permitting process. Site characterization activities are being performed in support of the RCRA Part B permit application to evaluate the potential for the release and migration of waste from the waste disposal activities. Because of it's great depth, groundwater is not monitored directly. However, monitoring and vadose zone studies are being conducted beneath RWMS-5 to detect the migration of contaminants from the waste facilities.

During 1992, three pilot wells (UE5PW-1, UE5PW-2, UE5PW-3) were drilled through the vadose zone into the uppermost aquifer under the RWMS-5. The principal purpose of these wells was to characterize the hydrogeology of the vadose zone under the waste disposal cells at RWMS-5. This characterization is consistent with the leakage detection requirements for interim treatment, storage, and disposal (TSD) facilities required by EPA and the state of Nevada.

In accordance with 40 C.F.R. 265 - Subpart F, operators of interim status TSD facilities are required to collect quarterly samples for one year from one upgradient and three downgradient wells for characterization of background water quality. The first collections of these characterization data were performed in 1993. In 1994 and 1995, the frequency was reduced to semi-annual and results were statistically compared with the initial characterization data.

Sampling protocols for characterization and detection data collection were based on the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (EPA 1986). Groundwater elevation was measured prior to each sampling event. Water was withdrawn from each well with dedicated submersible double piston pumps for the purpose of purging and sample collection. Temperature, pH, specific conductance, and Eh (oxidation potential) were monitored during purging and at the conclusion of sampling. Samples were collected and analyzed in accordance with written procedures that specified sample collection methodology, sample preservation, sample shipment, analytical procedures, and chain-of-custody control. Preservative measures were applied in the field to all samples at the time of removal from each well.

Based on characterization results during 1993 and detection monitoring results for 1994 and 1995, the uppermost aquifer beneath the RWMS-5 disposal cells is suitable for use as drinking water or for agricultural purposes. The analyses performed for these samples can be found in Table 9.2. No chemical or radiological contaminants attributable to either DOE weapons testing or waste management activities have been detected in the three wells.

9.3 ENVIRONMENTAL RESTORATION

The NV-ERP was established to assess past hazardous and radioactive waste contamination that may have occurred as a result of operations at DOE facilities. For those sites that could pose a threat to human health, welfare, and/or the environment, remedial actions consistent with the National Oil and Hazardous Substances Pollution Contingency Plan are developed. The NV-ERP has been designed to ensure DOE/NV compliance with federal laws such as RCRA, CERCLA, and the SARA. CERCLA and SARA are the primary legislative acts governing remedial action at former hazardous waste disposal sites. These acts require the development of a RI/FS to assess the potential risks present at a site and to develop and evaluate remedial actions. The ERP has been modified to include a RI/FS for all former DOE/NV hazardous waste disposal and expended nuclear test sites. As an initial action, a site characterization is conducted to determine the type of contamination present, the extent and concentration of contaminants, and to identify and delineate potential contaminant transport pathways.

9.3.1 UNDERGROUND NUCLEAR TESTING SITES

The Underground Test Area (UGTA) RI/FS, conducted by the NV-ERP, has entered into preliminary negotiations with the state of Nevada Department of Environmental Protection (NDEP). Early negotiations have culminated in the Federal Facilities Agreement (FFA). The strategy outlined in the FFA is based upon the acknowledgment that there is a high degree of uncertainty in the groundwater transport of radionuclides from UGTAs on the NTS. This uncertainty is to be quantified, via modeling, and presented to the NDEP. It is the strategy of DOE that current levels of uncertainty are acceptable and once concurrence is reached with NDEP, the aforementioned models can be used to develop compliance boundaries and to design monitoring networks to assess whether the compliance boundaries remain unaffected by transport.

Field studies conducted in 1995 continued data collection in support of the UGTA. These activities, conducted by International Technology Corp. (IT) and Reynolds Electrical & Engineering Company, Inc., (REECo), included deepening and coring Well 6-1 (Well ER-6-1) and Wells ER-20-1, 5, & 6). In total, 13 characterization wells have been drilled and 11 others have been recompleted for the UGTA. Two of these were drilled in 1995.

9.3.2 SURFACE FACILITIES

Because of the arid climate and the great depths to groundwater, any contaminants found in the near-surface environment are unlikely to migrate to or contaminate groundwater. However, liquid wastes distributed to leachfields, unlined ponds, and subsidence craters could introduce contaminants into the unsaturated zone and supply the mechanisms necessary to transport contaminants to the local groundwater table. Injection of liquid wastes into wells also greatly increases the potential for contamination of groundwater by shortening the pathway to the water table and supplying a medium of transport. Corrective actions and RCRA closures are planned for various NTS leachfields, ponds, and subsidence craters. All injection wells have been closed and remediated.

9.3.2.1 RAINIER MESA TUNNEL PONDS

Nuclear devices have been tested in horizontal tunnels mined into Rainier Mesa at the NTS. The tests were conducted in zeolitized volcanic tuffs which act as a perching layer for water infiltrating from the mesa surface. During normal mining operations, fractures containing water are intercepted, creating artificial springs in the tunnels. Periodically, these waters contained radionuclides from underground nuclear tests, and were drained out of the tunnels into unlined evaporation ponds. Mining and related operations also released organic compounds and heavy metals to the tunnel effluent. In 1994, N Tunnel and T Tunnel were plugged; at year's end, E Tunnel was in the process of being plugged. During 1995, efforts to plug E Tunnel continued.

9.3.2.2 SURFACE OPERATIONAL SUPPORT FACILITIES

NTS operational support facilities such as ponds, sumps, lagoons, leachfields, and injection wells have been identified for assessment of contamination. Corrective actions and RCRA closures are being conducted to bring facilities into compliance with current regulations, characterize and remediate contaminated facilities, and close disposal sites.

Corrective actions are being taken at NTS sewage lagoons, steam-cleaning pads, and decontamination facilities. Closed-loop steam-cleaning systems have been installed at steam-cleaning pads. A general wastewater discharge permit has been issued for the sewage lagoons. Liners will be placed in some of the sewage lagoons and a monitoring well is being installed at the Area 23 sewage lagoons. In 1993, preparation of RI/FS work plans for some facilities was initiated. As part of the RCRA site closure process, discharges of liquid wastes to injection wells, ponds, leachfields, and subsidence craters were discontinued. NTS facilities which were planned to be closed per RCRA, by DOE/ERD, are shown in Table 9.3. Of the facilities listed, the Area 27 Explosive Ordnance Disposal Facility was cleaned and closed in November 1994, and the Area 3 U3fi injection well and Area 23 Hazardous Waste Trench were closed in 1995. A monitoring well was drilled at an angle below the waste zone at the Area 3 U3fi and will be monitored for at least the next 10 years.

9.4 HYDROLOGIC RESOURCES MANAGEMENT PROGRAM

The Hydrology/Radionuclide Migration Program has previously provided information and support on radionuclide and hazardous substance source terms, near-field hydrology, site hydrology, and contamination transport. Many of this program's historic work elements, in particular, source characterization and subsurface transport of contaminants, have been assumed by AMEM and the UGTA Operable Unit. Accordingly, the name, mission, and objectives of this program have been redefined. The HRMP is now responsible for groundwater stewardship, hydrology and radionuclide characterization for operations support, and integrated monitoring. Previously established milestones have been extended due to the 1995 budget cuts.

HRMP activities are conducted by agencies such as LLNL, Los Alamos National Laboratory (LANL), U.S. Geological Survey (USGS), and Desert Research Institute (DRI) with expertise in the sciences required to study the subsurface effects of the weapons testing program. Program organization is divided into four broad categories: (1) Program Coordination and Technical Support, (2) Operational Support, (3) Groundwater Protection, and (4) Groundwater Monitoring.

9.4.1 PROGRAM COORDINATION AND TECHNICAL SUPPORT

The primary purpose of the HRMP coordination and technical support task was to carry out the many different activities of the HRMP that are not directly related to the individual research projects in the program. Such activities included attending program planning, review, and coordination meetings; writing, editing, and reviewing project reports, work plans, proposals, and other documents; providing radiation safety training; and processing security badge requests, conducting security briefings, and preparing security plans and regulations. These and other general administrative, programmatic, field, and laboratory support activities were performed as needed throughout 1995. The main objectives of the task are the planning, developing, managing, budgeting, and coordination of the HRMP.

9.4.1.1 HYDROSTRATIGRAPHIC UNIT DELINEATION AT THE NEVADA TEST SITE

Efforts were made at compiling a geologic, hydrogeologic, and hydrologic column for the NTS. Work on the hydrostratigraphic and lithostratigraphic units in Yucca Flat was completed and a first draft of the report was prepared for review. A thesis entitled "Hydrostratigraphic Units within the Alluvium and Tertiary Volcanics of East Central Yucca Flat, Nevada Test Site," by Craig Shirley, was successfully defended. The thesis will become a DRI publication, scheduled for completion in 1996. Lithologic and geophysical log data from 46 boreholes in East Central Yucca Flat on the NTS were used to develop lithostratigraphic and hydrostratigraphic columns. Non-zeolitized volcanic lithostratigraphic units geologically correlate to hydrostratigraphic units. Zeolitized volcanic lithostratigraphic units are combined into a single hydrostratigraphic unit. No systematic trend of porosity or permeability was found in the alluvium which comprises the uppermost hydrostratigraphic unit. (Profiles of mean porosity vs. lithostratigraphic elevation for 11 lithostratigraphic units were presented.) Nuclear test cavities, rubble chimneys, and collapsed craters collectively comprise a fourth hydrostratigraphic unit.

Another thesis, "Comparison and Correlation of Lithostratigraphic and Hydrostratigraphic Units of Southwest Area 20, Pahute Mesa, Nevada Test Site," by Deborah Dale, will be completed as a DRI publication in FY 1996. Recognizing hydrogeologic units based strictly upon the lithostratigraphic boundaries of the host rock(s) assumes the groundwater flow potential of the rock will remain constant throughout the entire unit. This method of delineation overlooks potential variation in the hydrogeologic characteristics of the rock, which can cause fluctuations in the hydrogeologic unit's ability to transmit water. Hydrostratigraphic units classify rock based upon its porosity and permeability, ignoring boundaries based upon age, lithology, and/or mode of deposition. In this study, a comparison of hydrostratigraphic and lithostratigraphic units within two exploratory wells on Pahute Mesa revealed sufficient variation in the unit-boundary locations to justify separation of these two types of stratigraphic units in future hydrogeologic investigations.

9.4.1.2 RISK ASSESSMENT OF NEVADA TEST SITE GROUNDWATERS

A paper entitled "Radionuclide Migration Using Travel Time Transport Approach and its Application in Risk Analysis," by Andricevic et al., (DRI) was published in the *Journal of Hydrology*. Evaluation of the potential impacts on public health from contaminants in groundwater is related to the estimation of the travel time of the contaminants migrating in the groundwater from the input zone to the accessible environment. Direct application to risk analysis for migrating radionuclides at the NTS revealed the importance and necessity of considering parameter uncertainty and its correlation in the application of the transport travel time approach. Migration of tritium, because of the lack of sorption, is found to provide the largest potential health risk to the accessible environment. The results from the risk-based screening analysis suggest that tritium has a short effective half-life (both physical and biological) and is responsible for about 90 percent of the total risk.

9.4.2 OPERATIONAL SUPPORT

Operational Support activities are designed to respond to environmental requirements of DOE Order 5400.1 and to provide hydrologic and radionuclide information to NTS testing and other operations. The activities emphasize hydrologic, environmental monitoring, and environmental restoration issues that are tied to weapons testing and its impacts. In addition, Operational Support activities complement NV-ERP studies and provide technical support for the management and operation of NTS groundwater monitoring programs.

9.4.2.1 WATER-LEVEL ALTITUDES

The USGS collects water-level elevation measurements in wells, emplacement holes, and test holes to support operations at the NTS. These data along with other hydrogeologic data are maintained in a computerized database. Both historical and current data are used to produce water-table altitude maps to estimate the depth to water at proposed weapons testing sites and to determine aquifer properties.

9.4.2.2 YUCCA FLAT HYDROLOGY STUDY

Unusually high hydraulic pressures observed in Yucca Flat present problems with respect to nuclear testing by increasing engineering and material costs and causing concern for radionuclide migration. Hydraulic information necessary to understand and to mitigate problems caused by the high pressure zone in Yucca Flat is being collected.

The movement of groundwater within Yucca Flat is complex and not well understood. Generally, groundwater is thought to flow from the overlying Cenozoic hydrologic units downward into the underlying Paleozoic hydrologic units and then flows laterally in the Paleozoic units. This study uses historical as well as recently acquired NV-ERP groundwater-quality and isotopic data to model possible chemical reactions in the various hydrologic units and along several flowpaths. Preliminary modeling results from two flowpaths in Yucca Flat indicate that historical carbon-13 and carbon-14 groundwater values collected from the same wells at different times and analyzed at different laboratories are highly variable. Preliminary modeling also indicates the need for detailed mineralogical characterization of solid-phase aquifer materials. Ongoing geochemical modeling efforts will attempt to constrain the effects of these issues.

During 1995, the USGS collected and analyzed continuous water-level data in wells UE-2ce, UE-4t#1, UE-4t#2, UE-3e#4-1, UE-3e#4-2, UE-3e#4-3, and U-3cn#5. A reduction in funding and loss of staff in 1995 necessitated discontinuing this investigation; however, data collected during this study will benefit future studies of the high pressure area and can be used to analyze aquifer properties at a later date.

9.4.2.3 EVALUATION OF AQUIFER PROPERTIES

A study by the USGS has involved the analysis of water-level fluctuations in wells to determine aquifer properties and the related investigation of evaluating the suitability of transducer systems in measuring water-level fluctuations in deep wells and test holes under nonstressed conditions. The analysis of the frequency response of water levels in wells and test holes to earth tides, atmospheric loading, and to seismic events was discontinued due to reduction in funding and loss of project staff. Data collected at wells equipped with transducers were analyzed to determine if hydrologic properties of the hydrogeologic units at the NTS and vicinity could be determined by means other than conventional aquifer tests. Preliminary results show that at certain wells, such as WW-4a and U-3cn#5, hydrologic properties could be determined. An abstract of the techniques used at the NTS by the USGS-Hydrology Program was presented at a USGS conference.

9.4.2.4 DRILLBACK ACTIVITIES AT NUCLEAR TEST SITES

Stainless steel pressure tubes (bailers) have been used for many years to collect water samples down hole. During 1995, LANL designed and tested a modified bailer to remedy the problem of clogged inlet ports when sampling fluid high in particulates. In July 1995, the modified bailer was successfully field tested in the access tube at the BASEBALL site. LANL is working on the modification of several more bailers and expects to use them at sites where the fluid contains significant amounts of solids.

9.4.2.5 PAHUTE MESA GROUNDWATER LEVELS

During drilling at Pahute Mesa, water is often encountered in emplacement holes well above the predicted elevation of the local groundwater table. This water may originate as fluids introduced during drilling, from naturally perched groundwater draining into the borehole, or from penetration of the shallower-than-expected local groundwater table. In 1991, during drilling of the final 100 m of borehole U-19bh, a lithium-bromide (LiBr) tracer was added to drilling fluids. Analysis of tracer concentration in water in the emplacement hole after drilling suggests that this water originates from perched groundwater that lies above the bottom of the borehole. Br mass in U-19bh has changed little since fluid levels stabilized in the borehole in late summer 1991, indicating little or no movement of water out of the borehole.

Although Pahute Mesa is widely considered to be a recharge area for the Oasis Valley and Alkalai Flat-Furnace Creek hydrologic subbasins, these investigations so far have been unable to find evidence of significant groundwater fluxes in certain emplacement holes. Preliminary results suggest that the shallow hydrologic system of Pahute Mesa consists of isolated, relatively stagnant bodies of water; therefore, any contamination found in this shallow system may not be mobile. Continued monitoring of tracer concentrations at the two sites will be important in confirming the surprising lack of mobility of elevated water bodies at Pahute Mesa. A DRI report (Hershey and Brikowski 1995) was published on this work.

9.4.2.6 GROUNDWATER RECHARGE

It is assumed that, because of the great depth to groundwater and the arid climate at the NTS, surface contamination and radionuclides from water table tests will not migrate through the unsaturated zone to the groundwater. However, few investigations have been conducted to verify this assumption that will most likely be questioned by environmental regulators in the future. The recharge of precipitation infiltrating to the water table is not believed to occur uniformly throughout the NTS region under the present climate. The present arid conditions limit groundwater recharge to higher-elevation mesas and to flash-flood events in major drainages. This ongoing study uses chemical and isotopic analyses of precipitation and groundwater to predict the composition of recharging waters and to reevaluate the apparent groundwater ages. The computer program NETPATH is being used to calculate carbon-isotope mass balance and transfer to mineral, gas, andaqueous phases under assumed equilibrium conditions. Preliminary data searches and modeling simulations indicate that two important model input parameters, soil-gas carbon-13 and solid-phase soil-carbonate carbon-14 values are not sufficiently characterized at the NTS. Assuming possible carbon-isotope ranges for these parameters in the upper reaches of Forty-mile Wash for a surface-to-groundwater recharge distance of 30 m, preliminary modeling results suggest a recharge time ranging from approximately 300 to 2,500 years. Modeling of recharge at Pahute Mesa is continuing.

9.4.3 GROUNDWATER PROTECTION

HRMP groundwater protection activities at the NTS range from evaluation of proposed emplacement holes to establishment of a wellhead protection program. A well development and maintenance program has been initiated to ensure reliability of the potable water supply, optimal location of new potable water wells, proper design and construction of new potable water wells, proper plugging of unusable wells, and the long-term reliability of monitoring wells to supply representative water samples. The HRMP also addresses compliance issues from time to time, such as provisions of the Safe Drinking Water Act (SDWA) mandating extensive protective activities around any public groundwater-supply system.

9.4.3.1 RADIONUCLIDE TRANSPORT STUDIES

Nuclear weapons testing at the NTS has caused radionuclide contamination of the groundwater in close proximity to these tests. Colloid transport, groundwater transport, and radionuclide distribution studies have been undertaken to gain a better understanding of this process. A graduate student at LANL is currently involved in a laboratory study to validate a mathematical model of colloid transport and then apply this model to colloid transport at the NTS. In another study, a professor and students at University California, Berkeley are attempting to use the computer program TRACR3D to model the elution of krypton from a pumped well (RNM-2S) at the CAMBRIC site. The elution pattern of krypton is different from that of tritium, of which many studies have previously been conducted at that site.

The USGS proposed a study during 1995 to investigate the potential for surface-water transport of radionuclides at the NTS, but the activity was discontinued due to funding reductions.

In 1989, the INGOT event was fired in hole U-2gg at a depth of 500 m beneath Yucca Flat at the NTS. In 1994, a satellite hole was drilled to within 10 m of the edge of the cavity at the depth of the working point. This hole was drilled intentionally outside of the cavity in the vadose zone to ensure that any observed radionuclide signatures would be the result of transport associated with the explosion and not transport by groundwater during or after the event. Results of studies conducted by LLNL suggest that some nuclear cavities may contain a surrounding region composed largely of volatile radionuclides that were transported in late time along fractures created by the nuclear explosion. If these radionuclides have been deposited on free surfaces, they may be available to groundwater through processes such as ion exchange, desorption, and surface-layer alteration associated with dissolution.

9.4.4 GROUNDWATER MONITORING

Groundwater monitoring at the NTS is an ongoing activity conducted by several different DOE/NV contractors and is conducted to satisfy environmental, health, and safety regulations of the state of Nevada,the EPA, and the DOE. Groundwater monitoring is also conducted to determine the presence and movement of radionuclides produced from underground nuclear testing.

9.4.4.1 MONITORING OF GROUNDWATER LEVELS

The USGS monitors groundwater levels in a network of 50 selected wells, test holes, and emplacement holes at the NTS and at 40 other wells and test holes in areas adjacent to the NTS. These networks of selected wells allow for intermittent or continuous measurement of depth to water for the purpose of monitoring fluctuations in groundwater levels.

During 1995, the USGS-Hydrology Program compiled water-use data using REECo water production reports from 14 wells. To more accurately monitor groundwater withdrawal at the NTS, seven water-supply wells were instrumented with flowmeters and dataloggers. The seven water-supply wells instrumented with this equipment included Water Wells 4, 4A, J-12, UE-16d, C, C-1 and Army #1.

9.4.4.2 GROUNDWATER SAMPLING

Groundwater samples from the NTS, when collected, are analyzed for radionuclides by LLNL, LANL, and the USGS [tritium analysis of USGS samples is done by the EPA's Radiation Sciences Laboratory in Las Vegas, Nevada (RSL-LV)].

During 1995, LANL and LLNL personnel participated in efforts to obtain water from the cavity or chimney at two drill sites, U-4u ps2a and U-7ba ps1as (the BASEBALL site). Efforts to collect water samples at U-4u ps2a were unsuccessful, but several samples were obtained from U-7ba ps1as using the modified bailer LANL had developed. The collected water samples were split between LLNL and LANL laboratories, and the tritium content and gamma activity were measured. LANL's results (shown in Table 9.4) indicated that despite the small-volume water samples, all of the radionuclides found when the drill-back holes were made in 1994 were found in this analysis.

Results of LLNL's 1992/1993 groundwater sampling and analysis campaign of over 30 wells on the NTS helped identify offsite recharge and discharge centers as a focus for the 1995 sampling effort. Areas include Pahranagat Valley, Emigrant Valley, Ash Meadows, Oasis Valley and the U.S. Air Force (USAF) lands north of the NTS. Because of security, safety, and logistical concerns, USAF lands were inaccessible. However, samples were collected from 19 other spring and well sites outside the NTS boundaries. Analysis for environmental isotopes is scheduled for 1996.

9.5 LONG-TERM HYDROLOGICAL MONITORING PROGRAM

The EPA's RSL-LV is responsible for operation of the LTHMP, including sample collection, analysis, and data reporting. From the early 1950s until implementation of the LTHMP in 1972, monitoring of ground and surface waters was done by the U.S. Public Health Service (PHS), the USGS, and the U.S. Atomic Energy Commission (AEC) contractor organizations. The LTHMP conducts routine radiological monitoring of specific wells on the NTS and of wells, springs, and surface waters in the offsite area around the NTS. In addition, samples are collected from sites in Nevada, Colorado, New Mexico, Mississippi, and Alaska where nuclear tests have been conducted. In 1965, tritium escaped from the LONG SHOT test on Amchitka Island and contaminated the groundwater. During cleanup and disposal operations, shallow groundwater at the Tatum Dome Test Site in Mississippi was contaminated by tritium. The tritium concentration in water at both of these sites has steadily decreased and is well below the drinking water standard.

A discussion of LTHMP sampling and analysis procedures and locations is provided below. Summaries of the 1995 sampling results for each of the offsite LTHMP locations is provided in Section 9.6. More detailed sampling results for the LTHMP will be published separately in the "Environmental Data Report for the Nevada Test Site - 1995," (DOE/NV/11718-038, in prep.).

9.5.1 SAMPLING AND ANALYSIS PROCEDURES

Under standard operating procedures, three samples are collected from each source. Two samples are collected in 500-mL glass bottles to be analyzed for tritium. The results from one of these samples are reported while the other sample serves as a backup in case of loss or as a duplicate sample. The third sample is collected in a 3.8-L plastic container (Cubitainer). At LTHMP sites other than the NTS and vicinity, two Cubitainer samples are collected. One of these is analyzed by gamma spectrometry and the other is stored as a backup or for duplicate analysis. At a few locations, because of limited water supply, only 500-mL samples for tritium analysis are collected.

For wells with operating pumps, the samples are collected at the nearest convenient outlet. If the well has no pump, a truck-mounted sampling unit is used. With this unit it is possible to collect 3-L samples from wells as deep as 1800 meters (5,900 ft). At the normal sample collection sites, the pH, conductivity, water temperature, and sampling depth are measured and recorded when the sample is collected.

The first time samples are collected from a well, ^{89,90}Sr, $^{238,239+240}$Pu, and uranium isotopes are determined by radiochemistry. At least one of the Cubitainer samples from each site is analyzed by gamma spectrometry. If conventional tritium analysis results are close to or less than the minimum detectable concentration (MDC) of approximately 400 to 700 pCi/L (15 to 26 Bq/L), the sample is concentrated by electrolysis (i.e., enrichment) and reanalyzed. This enrichment reduces the MDC to approximately 5 to 7 pCi/L (0.2 to 0.26 Bq/L).

9.5.2 ACTIVITIES ON AND AROUND THE NEVADA TEST SITE

9.5.2.1 NEVADA TEST SITE MONITORING

The present sample locations on the NTS, or immediately outside its borders on federally owned land, are shown in Figure 9.2. All sampling locations are selected by DOE and primarily represent potable water supplies. In 1995, sampling on the NTS was reduced for EPA to only sample downhole wells and to collect ten percent of the potable wells sampled by REECo for quality assurance purposes. A total of 19 down holes was scheduled to be sampled semiannually and annually. Only 16 were sampled for various reasons.

All samples were analyzed by gamma spectrometry and for tritium by the enrichment method. No gamma-emitting radionuclides were detected in any of the NTS samples collected in 1995. Summary results of tritium analyses are given in Table 9.5. The highest tritium activity was 3.27×10^4 pCi/L (1210 Bq/L) in a sample from Well UE-5n. This activity is less than 33 percent of the DCG for tritium established in DOE Order 5400.5 for comparison with the dose limit (4 mrem) in the National Primary Drinking Water Regulations. Five of the wells sampled semiannually yielded tritium results greater than the MDC. The trend in tritium concentration in samples from Test Well B is shown in Figure 9.3 and is typical of a well with decreasing concentrations.

Well UE-7ns was routinely sampled between 1976 and 1987 and sampling began again in 1992. An increasing trend in tritium activity was evident at the time sampling ceased in 1987. Recent results have shown a decrease from those previous results.

9.5.2.2 OFFSITE MONITORING IN THE VICINITY OF THE NEVADA TEST SITE

The monitoring sites in the area around the NTS are shown in Figure 9.4. Most of the sampling locations represent drinking water sources for rural residents or public drinking water supplies for the communities in the area. The sampling locations include 12 wells, 9 springs, and a surface water site. All of the locations are sampled quarterly or semiannually.

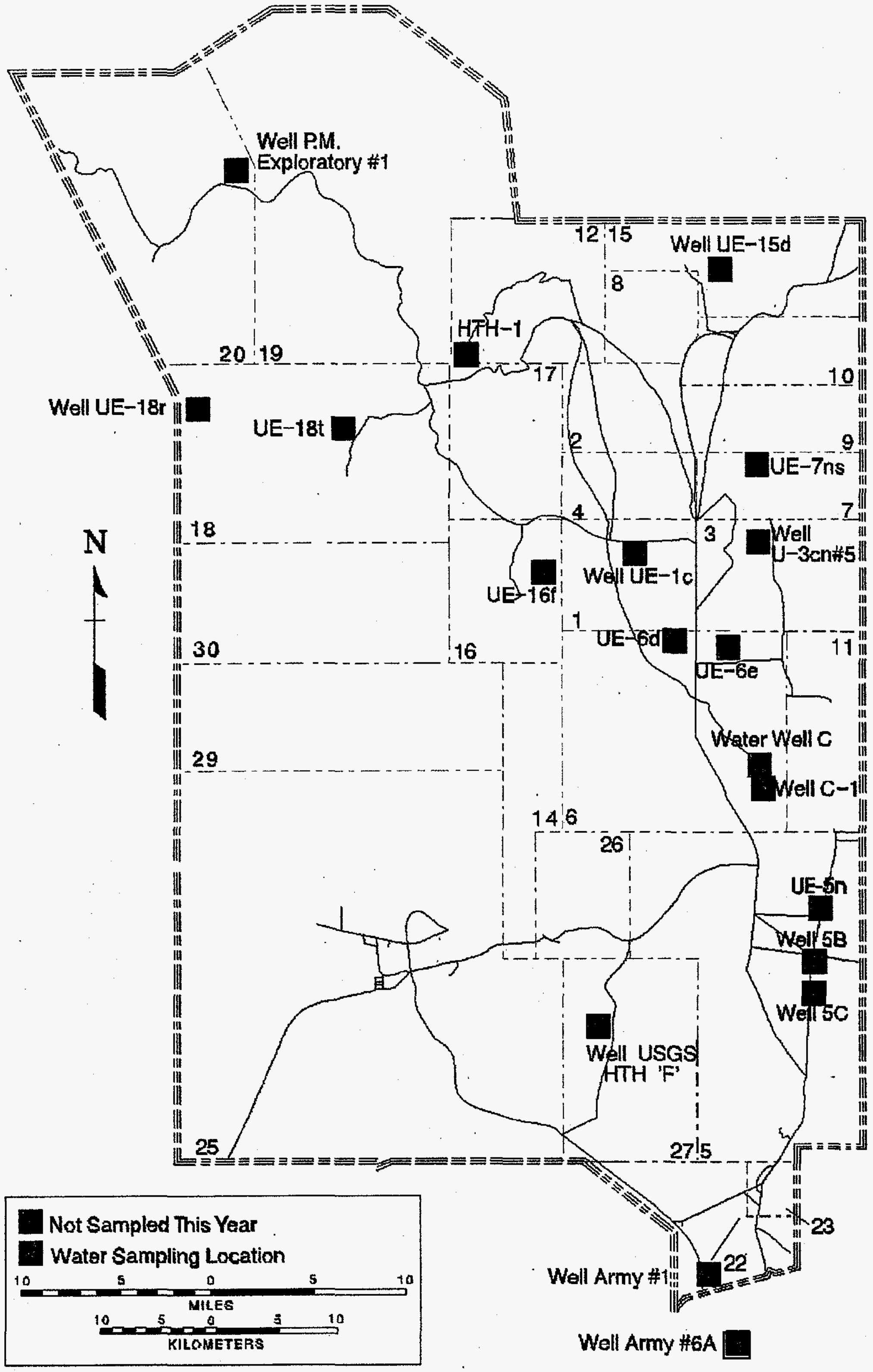


Figure 9.2 Wells on the NTS Included in the LTHMP

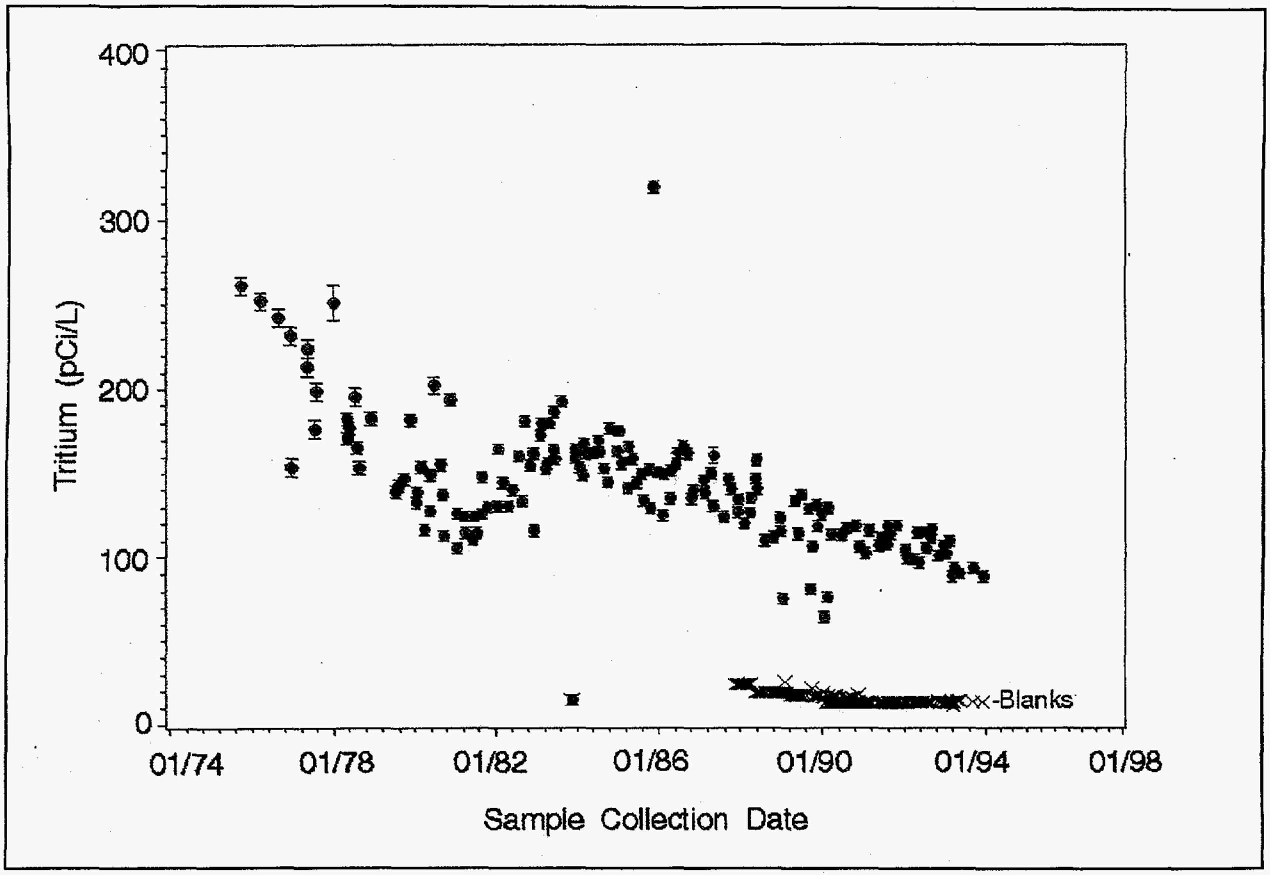


Figure 9.3 Tritium Concentration Trends in Test Well B on the NTS

Gamma spectrometric analyses are performed on the samples when collected. No gamma-emitting radionuclides were detected in any sample. Tritium analyses are performed on a semiannual basis using the enrichment method. Adaven Spring was the only site consistently showing detectable tritium activity. The tritium activity in this spring represents environmental levels that have been decreasing over time.

9.6 LTHMP AT OFF-NTS NUCLEAR DEVICE TEST LOCATIONS

The LTHMP conducts sampling at sites of past nuclear device testing in other parts of the United States to ensure the safety of public drinking water supplies and, where suitable sampling points are available, to monitor any migration of radionuclides from the test cavity. Annual sampling of surface and ground waters is conducted at the Projects SHOAL and FAULTLESS sites in Nevada, the Projects GASBUGGY and GNOME sites in New Mexico, the Projects RULISON and RIO BLANCO sites in Colorado, and the Project DRIBBLE site in Mississippi. Sampling was conducted in both the spring and fall to determine rainfall dilution of ^{3}H concentration at the Mississippi site. Sampling is conducted in odd numbered years on the island of Amchitka, Alaska, site of Projects CANNIKIN, LONG SHOT, and MILROW.

The sampling procedure is the same as that used for sites on the NTS and offsite areas (described in Section 9.5.1), with the exception that two 3.8-L samples are collected in Cubitainers. The second sample serves as a backup or as a duplicate sample.

Because of the variability noted in past years in samples from the shallow monitoring wells near Project DRIBBLE ground zero (GZ), the sampling procedure was modified several years ago. A second sample is taken after pumping for a specified period of time or after the well has been pumped dry and permitted

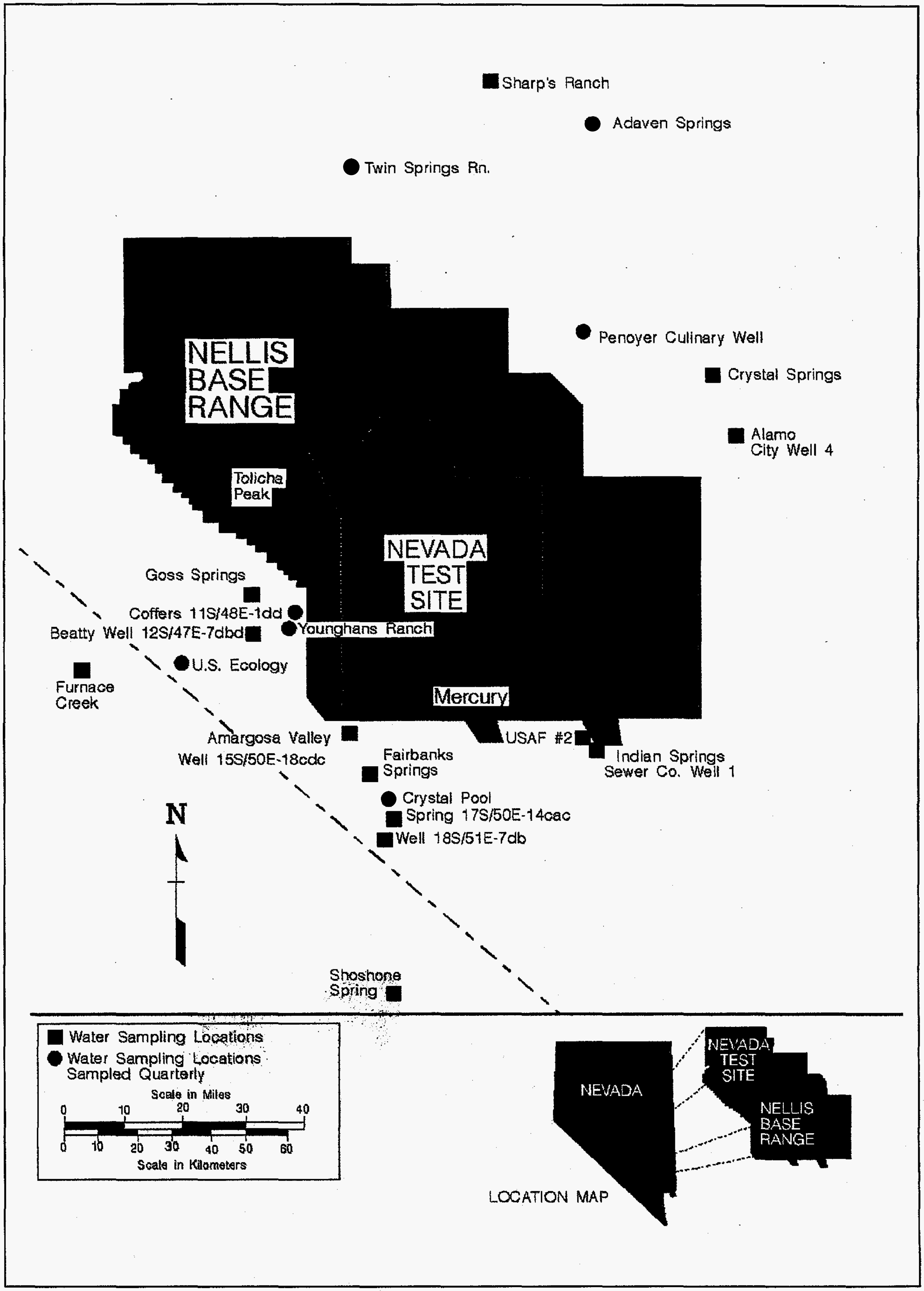


Figure 9.4 Wells Outside the NTS Included in the LTHMP

to recharge with water. These second samples may be representative of formation water, whereas the first samples may be more indicative of recent rainfall.

9.6.1 PROJECT FAULTLESS

Project FAULTLESS was a "calibration test" conducted on January 19, 1968, in a sparsely populated area near Blue Jay Maintenance Station, Nevada. The test had a yield of less than 1 megaton (Mt) and was designed to test the behavior of seismic waves and to determine the usefulness of the site for high-yield tests. The emplacement depth was 975 m (3199 ft). A surface crater was created, but as an irregular block along local faults rather than as a saucer-shaped depression.

Sampling was conducted on March 1 - 3, 1995, at locations shown in Figure 9.5 which include one spring and five wells of varying depths. All of these locations are being used as, or are suitable for, drinking water supplies. At least two wells (HTH-1 and HTH-2) are positioned to intercept potential migration from the test cavity (Chapman and Hokett, 1991). All samples yielded negligible gamma activity. There was no tritium activity above the MDC. Six-mile well was not sampled due to an inoperative pump.

9.6.2 PROJECT SHOAL

Project SHOAL, a 12-kiloton (kt) test emplaced at 365 m (1198 ft), was conducted on October 26, 1963, in a sparsely populated area near Frenchman Station, Nevada. The test, part of the Vela Uniform Program, was designed to investigate detection of a nuclear detonation in an active earthquake zone. The working point was in granite, and no surface crater was created. Sampling was conducted February 27 - 28, 1995. The routine sampling locations (see Figure 9.6) include one spring, one windmill, and five wells of varying depths. Six of these seven sampling locations were sampled. At least one location, Well HS-1, should intercept radioactivity migrating from the test cavity (Chapman and Hokett, 1991).

No gamma activity was detected in any of the samples. A tritium result of 39 ± 3.8 pCi/L (1.4 ± 0.14 Bq/L), 0.02 percent of the DCG, was detected in the water sample from Smith/James Spring, but all remaining samples yielded tritium results less than the MDC. The result for Smith/James Springs is consistent with values obtained in previous years, as shown in Figure 9.7. The most probable source of this tritium is assumed to be rainwater infiltration, not the Project SHOAL cavity.

9.6.3 PROJECT RULISON

Cosponsored by the AEC and Austral Oil Company under the Plowshare Program, Project RULISON was designed to stimulate natural gas recovery in the Mesa Verde formation. The test, conducted near Grand Valley, Colorado on September 10, 1969, consisted of a 40-kt nuclear explosive emplaced at a depth of 2568 m (8425 ft). Production testing began in 1970 and was completed in April 1971. Cleanup was initiated in 1972 and the wells were plugged in 1976. Some surface contamination resulted from decontamination of drilling equipment and fallout from gas flaring. Contaminated soil was removed during the cleanup operations.

Sampling was conducted June 13, 1995, with collection of nine samples in the area of Grand Valley and Rulison, Colorado. Routine sampling locations, shown in Figure 9.8, include the Grand Valley municipal drinking water supply springs, water supply wells for five local ranches, and three sites in the vicinity of GZ, including one test well, a surface-discharge spring, and a surface sampling location on Battlement Creek. An analysis of the sampling locations indicated that none are likely to detect migration of radionuclides from the test cavity (Chapman and Hokett, 1991).

Tritium has never been observed in measurable concentrations in the Grand Valley City Springs. All of the remaining sampling sites show detectable levels of tritium, which have generally exhibited a stable or decreasing trend over the last two decades. The range of tritium activity in 1995 was from 54 ± 3.9 pCi/L (2.0 Bq/L) at Battlement Creek, to 85 ± 4.5 pCi/L (3.1 Bq/L) at Lee Hayward Ranch. All values were

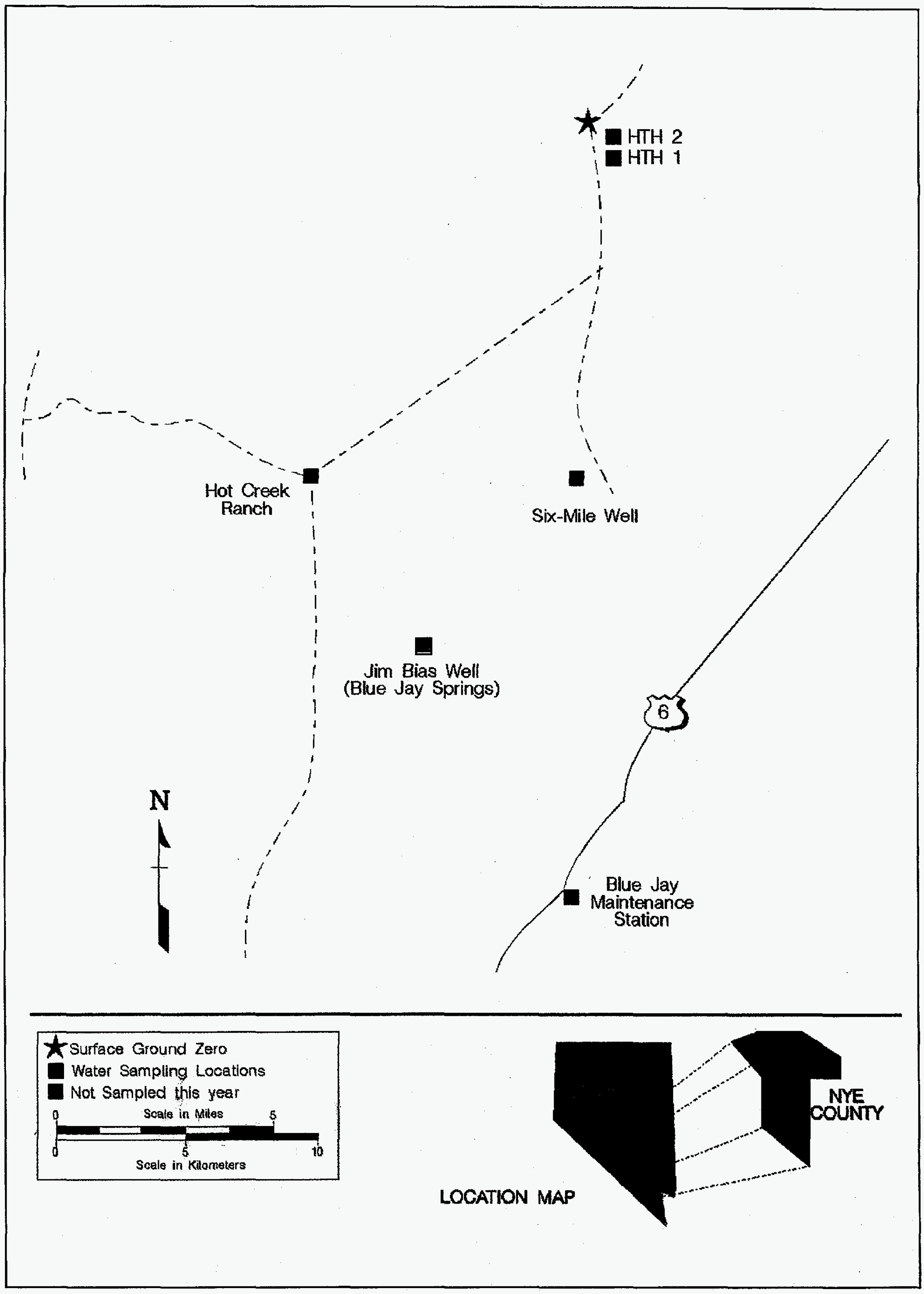


Figure 9.5 LTHMP Sampling Locations for Project FAULTLESS - 1995

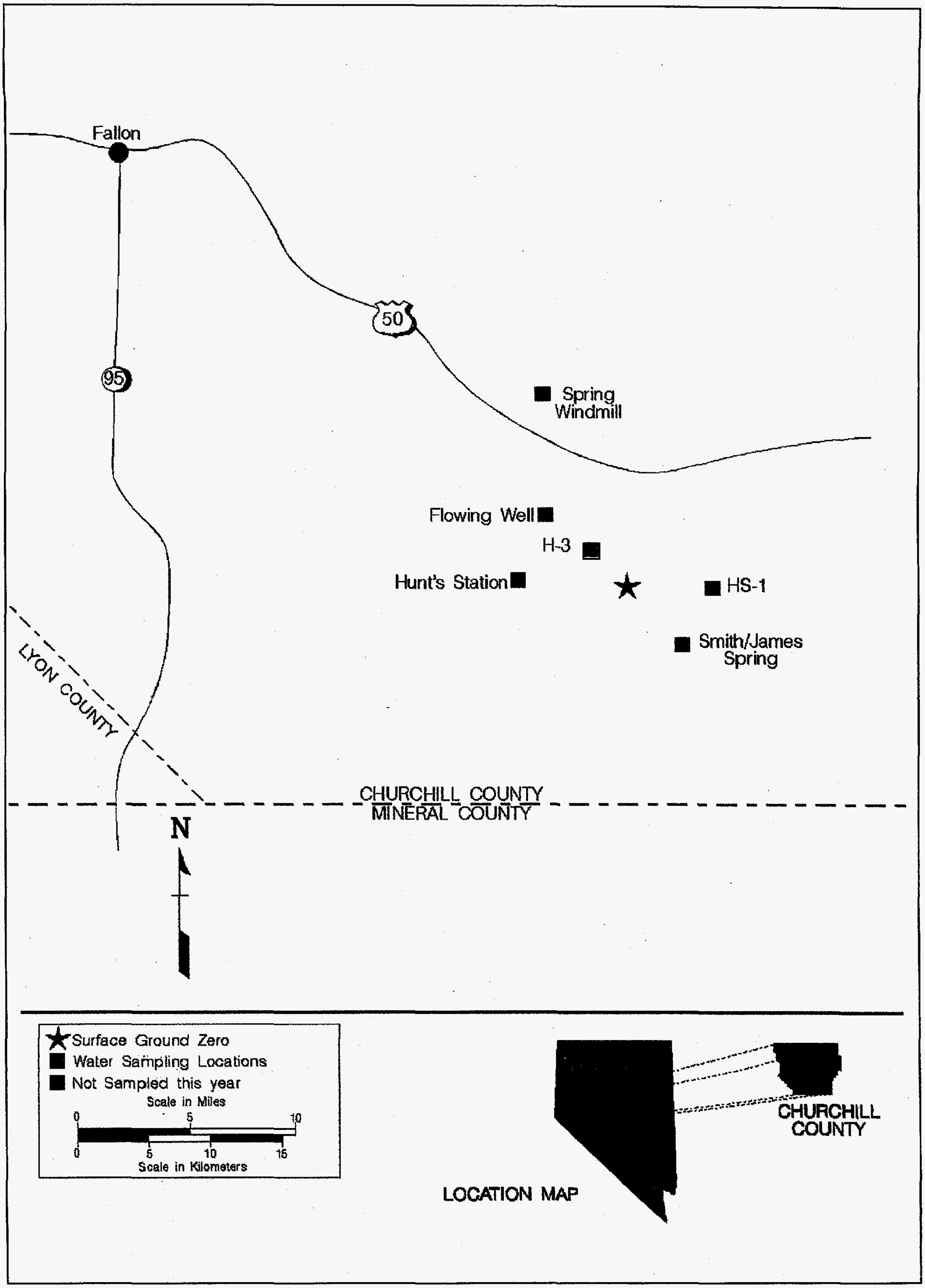


Figure 9.6 LTHMP Sampling Locations for Project SHOAL - 1995

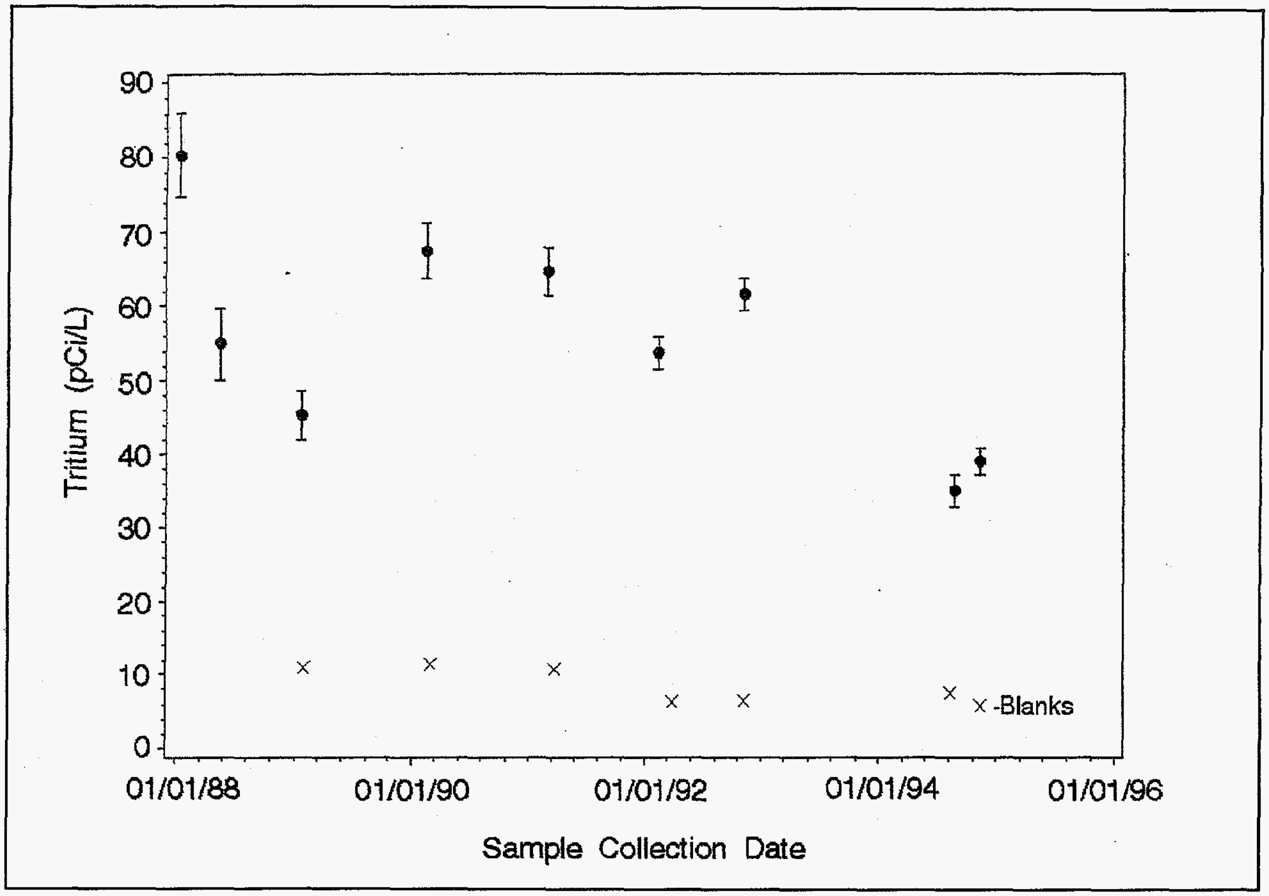


Figure 9.7 Tritium Results in Water from Smith/James Spring, Nevada

less than one percent of the DCG. The detectable tritium activities are probably a result of the high natural background in the area. This is supported by the DRI analysis, which indicated that most of the sampling locations are shallow, drawing water from the surficial aquifer which is unlikely to become contaminated by any radionuclides arising from the Project RULISON cavity (Chapman and Hokett, 1991).

9.6.4 PROJECT RIO BLANCO

Project RIO BLANCO was a joint government-industry test designed to stimulate natural gas flow and was conducted under the Plowshare Program. The test was conducted on May 17, 1973, at a location between Rifle and Meeker, Colorado, using three explosives with a total yield of 99 kt emplaced at 1780-, 1920-, and 2040-m (5840-, 6299-, and 6693-ft) depths in the Fort Union and Mesa Verde formations. Production testing continued to 1976 when cleanup and restoration activities were completed. Tritiated water produced during testing was injected to 1710 m (5610 ft) in a nearby gas well.

Samples were collected June 14 - 15, 1995 from the sampling sites, shown in Figure 9.9, which include two shallow supply wells, six surface water sites along Fawn Creek, three springs, and three wells located near the cavity. At least two of the wells (Wells RB-D-01 and RB-D-03) are suitable for monitoring possible migration of radioactivity from the test cavity. There is no statistically significant difference between sites located upstream and downstream of the cavity area. There was no detectable tritium in the three monitoring wells, indicating migration from the test cavity has not been detected. No gamma activity was detected in any sample.

9.6.5 PROJECT GNOME

Project GNOME, conducted on December 10, 1961, near Carlsbad, New Mexico, was a multipurpose test performed in a salt

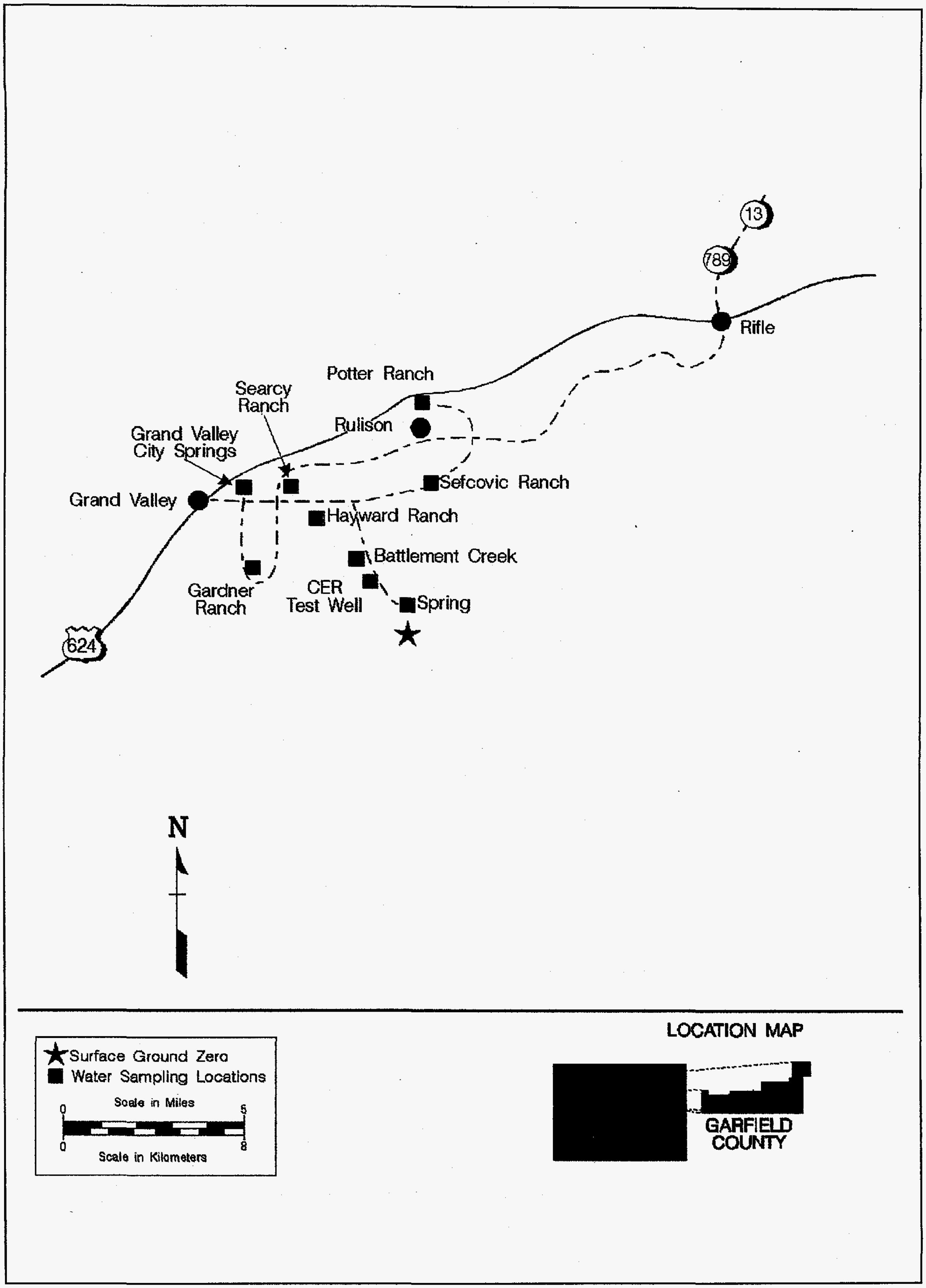


Figure 9.8 LTHMP Sampling Locations for Project RULISON - 1995

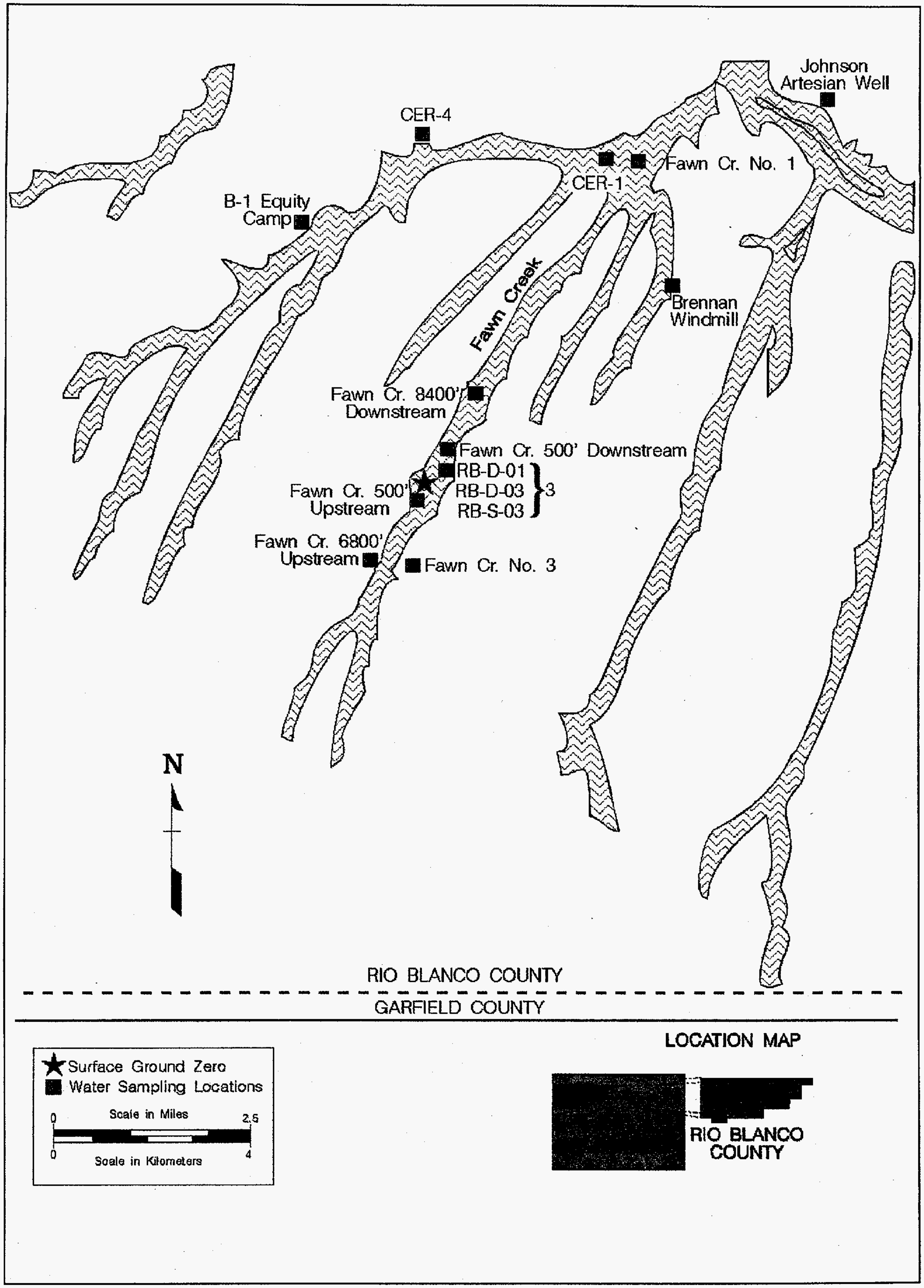


Figure 9.9 LTHMP Sampling Locations for Project RIO BLANCO, Colorado

formation. A slightly more than 3-kt nuclear explosive was emplaced at 371 m (1217 ft) depth in the Salado salt formation. Radioactive gases were unexpectedly vented during the test. The USGS conducted a tracer study in 1963, involving injection of 20 Ci ^{3}H, 10 Ci ^{137}Cs, 10 Ci ^{90}Sr, and 4 Ci ^{131}I (27, 14, 14, and 5.5 GBq respectively) into Well USGS-8 and pumping water from Well USGS-4. During cleanup activities in 1968-69, contaminated material was placed in the test cavity access well. More material was slurried into the cavity and drifts in 1979.

Sampling at Project GNOME was conducted June 22 - 25, 1995. The routine sampling sites, depicted in Figure 9.10, include nine monitoring wells in the vicinity of GZ, and the municipal supplies at Loving and Carlsbad, New Mexico. Stock tanks at PHS 8, PHS 9, and PHS 10, were sampled at the request of DOE. Tritium results from stock tank PHS 8 were greater than the MDC. The remaining two were below the MDC.

Tritium results greater than the MDC were detected in water samples from seven of the nine sampling locations in the immediate vicinity of GZ. Tritium activities in Wells DD-1, LRL-7, USGS-4, and USGS-8 ranged from 1.04 ± 10^4 pCi/L (385 Bq/L) in Well LRL-7 to 8.58 x 10^7 pCi/L (3.2 MBq/L) in Well DD-1. Well DD-1 collects water from the test cavity, Well LRL-7 collects water from a sidedrift, and Wells USGS-4 and -8 were used in the radionuclide tracer study conducted by the USGS. None of these wells supply potable water. In addition to tritium, ^{137}Cs concentrations were observed in samples from Wells DD-1, LRL-7, and USGS-8, while ^{90}Sr activity was detected in Wells DD-1, USGS-4 and USGS-8. The remaining two wells with detectable tritium concentrations were PHS wells 6 and 8, with results less than 0.02 percent of the DCG. No tritium was detected in the remaining sampling locations, including Well USGS-1, which the DRI analysis (Chapman and Hokett, 1991) indicated is positioned to detect any migration of radioactivity from the cavity.

9.6.6 PROJECT GASBUGGY

Project GASBUGGY was a Plowshare Program test co-sponsored by the U.S. Government and El Paso Natural Gas. Conducted near Farmington, New Mexico on December 10, 1967, the test was designed to stimulate a low productivity natural gas reservoir. A nuclear explosive with a 29-kt yield was emplaced at a depth of 1290 m (4240 ft). Production testing was completed in 1976 and restoration activities were completed in July 1978.

Sampling at GASBUGGY was conducted June 17 - 19, 1995. The 12 routine sampling locations included 6 wells, 1 windmill, 3 springs, and 2 surface water sites, as depicted in Figure 9.11. The two surface water sampling sites and three springs yielded tritium activities that were less than 0.02 percent of the DCG, similar to the activity seen in previous years. Tritium activities in two shallow wells which were sampled this year varied from 1.3 to 7.0 ± 2.8 pCi/L (0.05 to 0.26 Bq/L). Bixler Ranch was closed and was not sampled. The pump at Windmill 233 South was removed and Windmill 343 North was inoperative.

Well EPNG 10-36, a well located 132 m (435 ft) northwest of the test cavity with a sampling depth of approximately 1100 m (3600 ft), had yielded tritium activities between 100 and 560 pCi/L (3.7 and 21 Bq/L) in the years since 1984. The tritium activity is roughly the same as observed in 1994. Samples from various depths were collected in 1995. These samples yielded tritium activities from 9.4 ± 3.9 to 127 ± 5.5 pCi/L at 1900′ (0.35 to 4.7 Bq/L).

The presence of fission products in samples collected in 1995 from EPNG 10-36 confirms that migration from the Project GASBUGGY cavity has occurred. The migration mechanism and route are not currently known, although an analysis by DRI indicated two feasible routes, one through the Painted Cliffs sandstone and the other through the Ojo Alamo sandstone, one of the principal aquifers

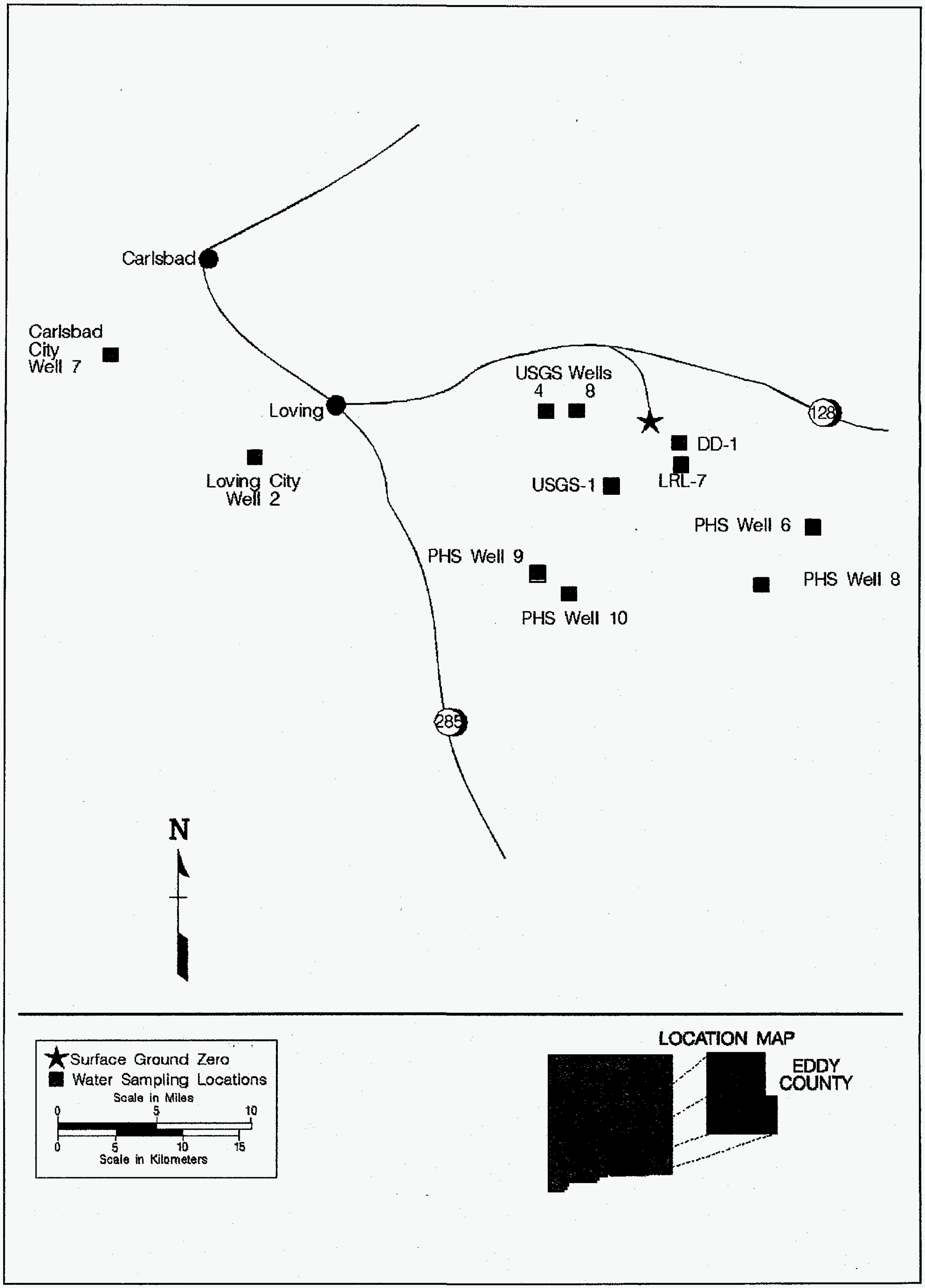


Figure 9.10 LTHMP Sampling Locations for Project GNOME - 1995

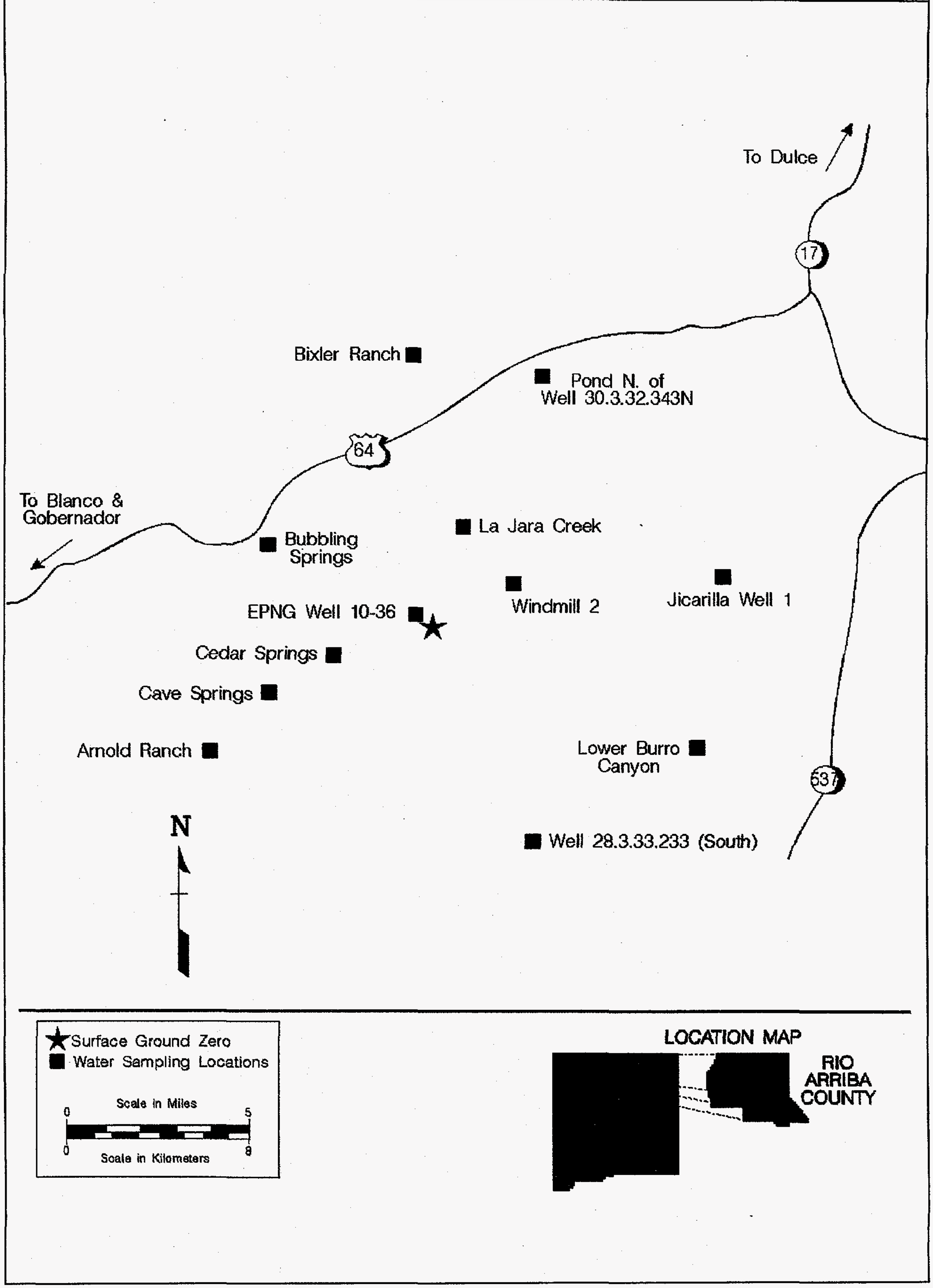


Figure 9.11 LTHMP Sampling Locations for Project GASBUGGY - 1995

in the region (Chapman and Hokett, 1991). In either case, fractures extending from the cavity may be the primary or a contributing mechanism.

9.6.7 PROJECT DRIBBLE

Project DRIBBLE was comprised of two nuclear and two gas explosive tests, conducted in the SALMON Test Site area of Mississippi under the Vela Uniform Program. The purpose of Project DRIBBLE was to study the effects of decoupling on seismic signals produced by nuclear explosives tests. The first test, SALMON, was a nuclear device with a yield of about 5 kt, detonated on October 22, 1964, at a depth of 826 m (2710 ft). This test created the cavity used for the subsequent tests, including STERLING, a nuclear test conducted on December 3, 1966, with a yield of 380 tons, and the two gas explosions, DIODE TUBE (on February 2, 1969) and HUMID WATER (on April 19, 1970). The ground surface and shallow groundwater aquifers were contaminated by disposal of drilling muds and fluids in surface pits. The radioactive contamination was primarily limited to the unsaturated zone and upper, nonpotable aquifers. Shallow wells, labeled HMH wells on Figure 9.12, have been added to the area near surface GZ to monitor this contamination. In addition to the monitoring wells near GZ, extensive sampling of water wells is conducted in the nearby offsite area as shown in Figure 9.13.

A total of 164 samples was collected on and in the vicinity of the SALMON Test Site in April 1995. In the 52 samples collected from offsite sampling locations, tritium activities ranged from less than the MDC to 33 pCi/L (1.2 Bq/L), 0.02 percent of the DCG. These results do not exceed the natural tritium activity expected in rainwater in the area. In general, results for each location were similar to results obtained in previous years. Long-term decreasing trends in tritium concentrations are evident only for a few locations, such as the Baxterville City Well, depicted in Figure 9.14.

Due to the high rainfall in the area, the normal sampling procedure is modified for the shallow onsite wells as described in Section 9.6. Of the 32 locations sampled onsite (20 sites sampled twice), all yielded tritium activities greater than the MDC in either the first or second sample. Of these, nine yielded results higher than normal background [approximately 60 pCi/L (2.2 Bq/L)] as shown in Table 9.1. The locations where the highest tritium activities were measured generally correspond to areas of known contamination. Decreasing trends are evident for the wells where high tritium activities have been found, such as Well HM-S depicted in Figure 9.15. No tritium concentrations above normal background values were detected in any offsite samples. Man-made gamma-ray emitting radionuclides were not detected in any sample collected in this study.

Results of sampling related to Project DRIBBLE are discussed in greater detail in the Onsite and Offsite Environmental Monitoring Report, "Radiation Monitoring around SALMON Test Site," Lamar County, Mississippi, April 1995 (available from RSL-LV).

9.6.8 AMCHITKA ISLAND, ALASKA

Sampling is normally conducted every two years but a low budget prevented collection during 1995. The next sampling is scheduled for 1997.

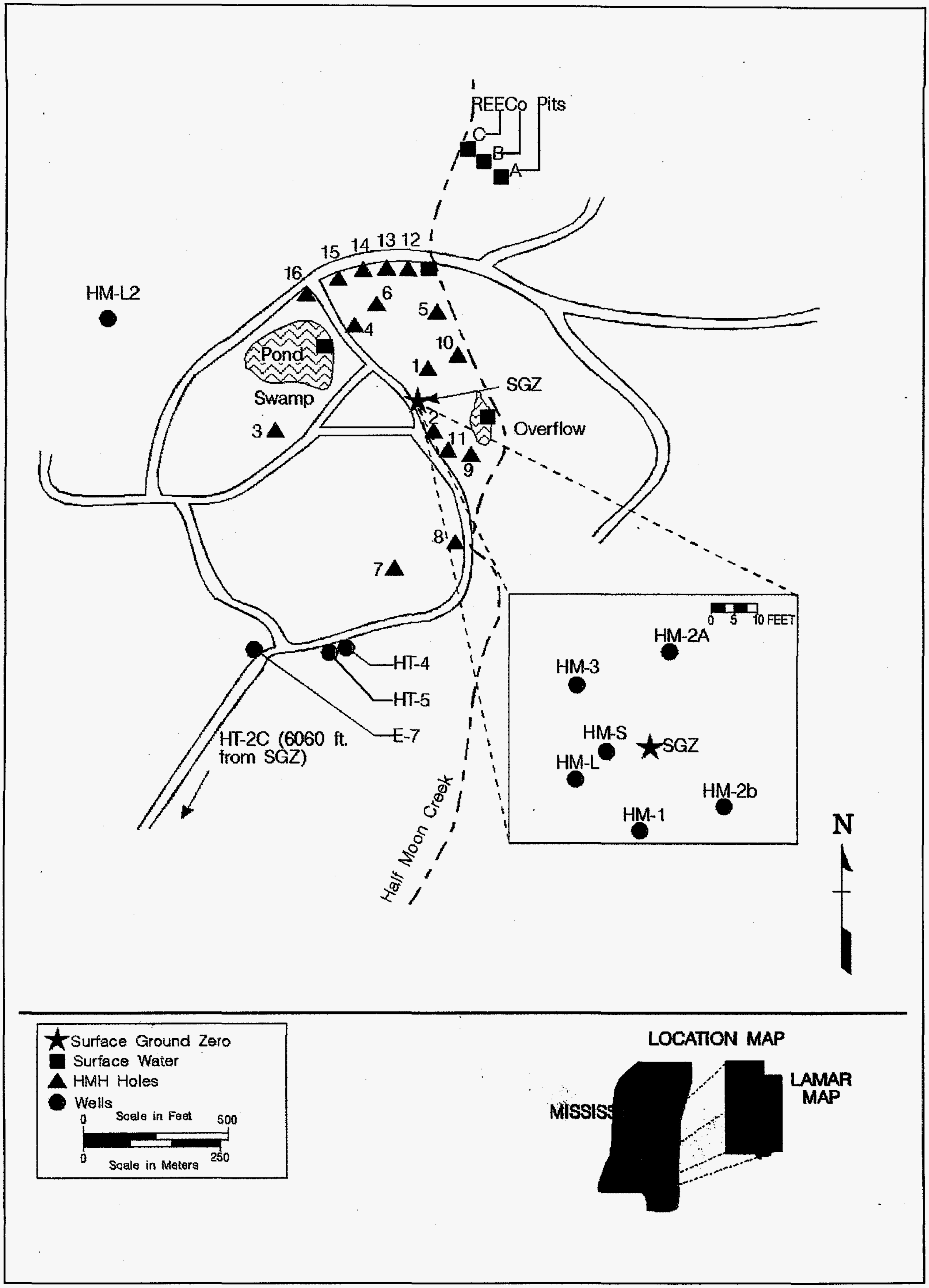


Figure 9.12 LTHMP Sampling Locations for Project DRIBBLE, Near Ground Zero - 1995

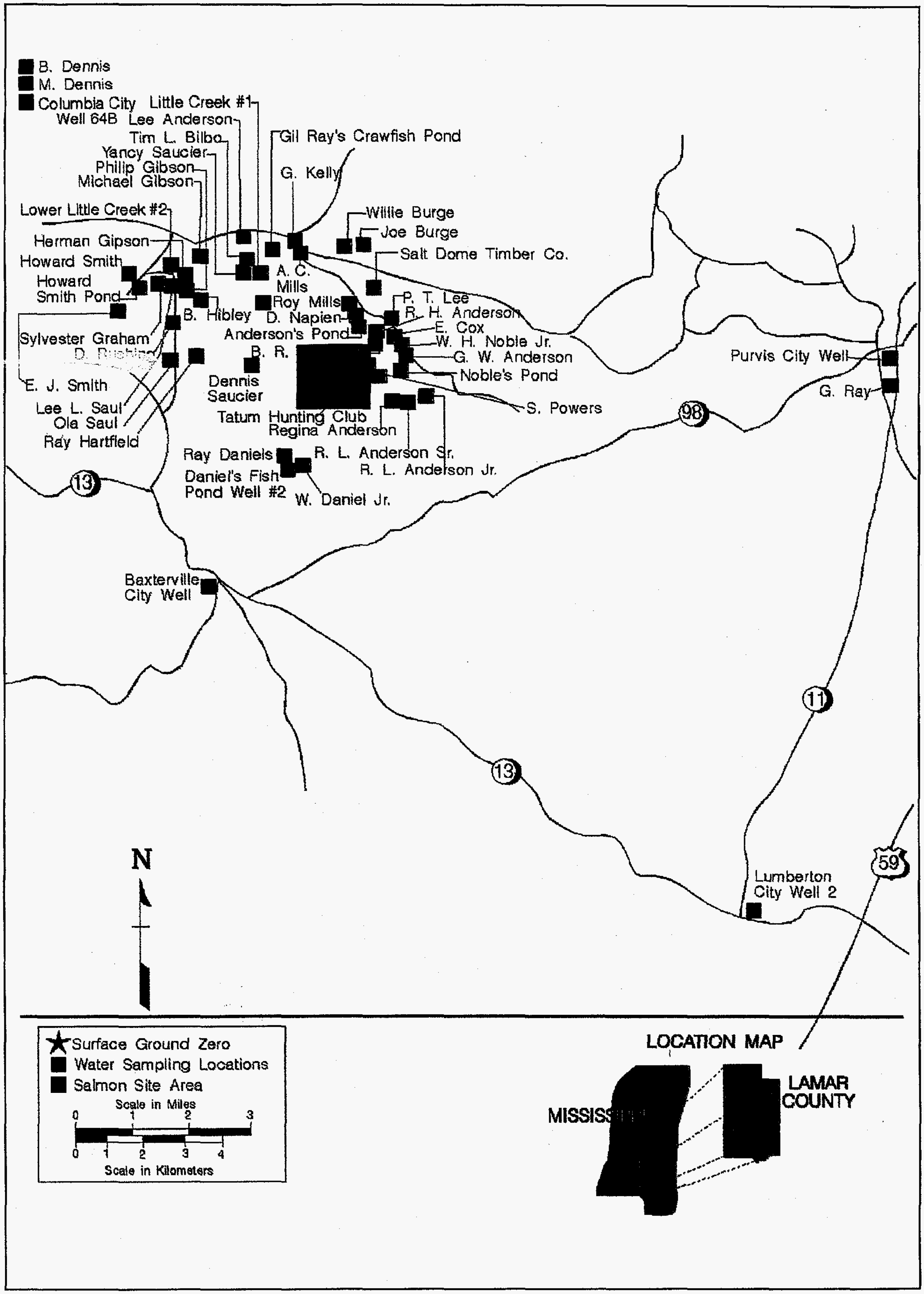


Figure 9.13 LTHMP Sampling Locations for Project DRIBBLE, Towns and Residences - 1995

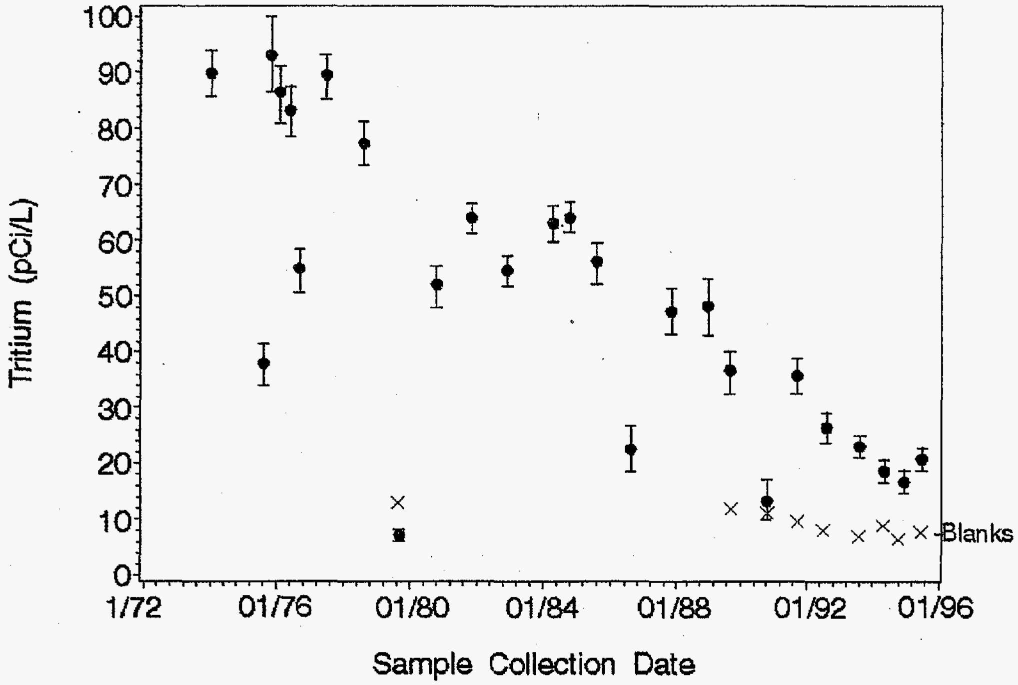


Figure 9.14 Tritium Results Trends in Baxterville, MS Public Drinking Water Supply - 1995

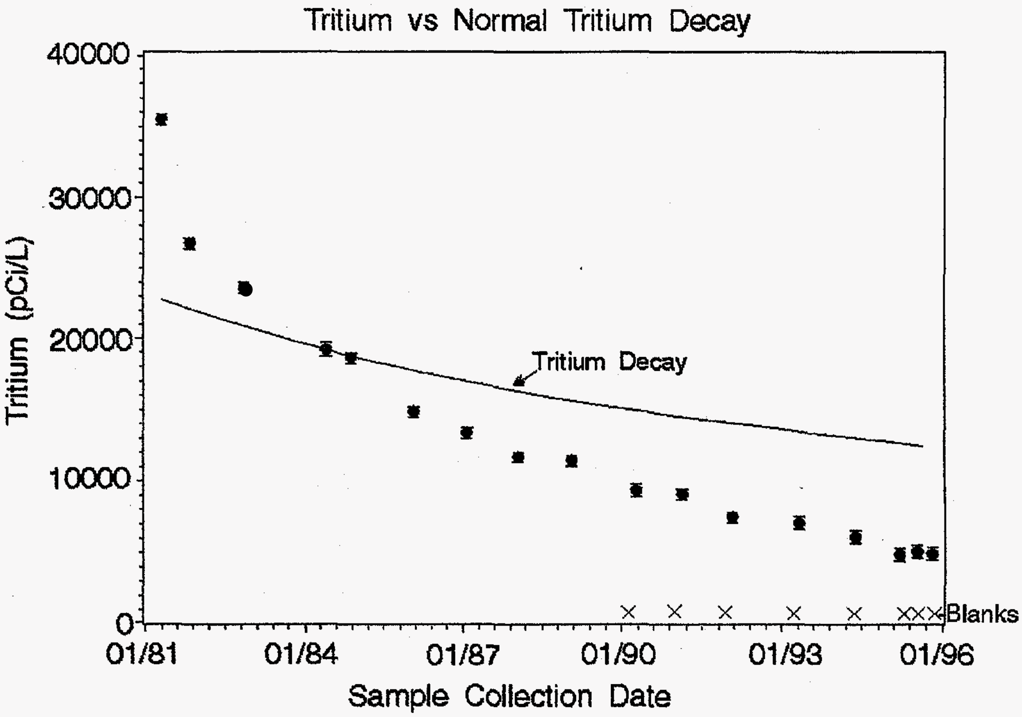


Figure 9.15 Tritium Results in Well HM-S, SALMON Site, Project DRIBBLE - 1995

Table 9.1 Locations With Detectable Man-Made Radioactivity in 1995 (a)

Sampling Location	Radionuclide	Concentration x 10^{-9}µCi/mL
NTS Onsite Network		
Well PM-1	^{3}H	220
Well UE-5n	^{3}H	3.3×10^{4}
Well UE-6d	^{3}H	900
Well UE-7ns	^{3}H	1300
Well UE-18t	^{3}H	190
Project DRIBBLE, Mississippi (b)		
Well HMH-1	^{3}H	470
Well HMH-2	^{3}H	3600
Well HMH-5	^{3}H	2400
Well HM-L	^{3}H	1700
Well HM-S	^{3}H	5100
Half Moon Creek Overflow	^{3}H	200
Project GASBUGGY, New Mexico		
Well EPNG 10-36	^{3}H	130
Project GNOME, New Mexico		
Well DD-1	^{3}H	8.6×10^{7}
	^{90}Sr	1.1×10^{4}
	^{137}Cs	7.5×10^{5}
Well LRL-7	^{3}H	1.0×10^{4}
	^{137}Cs	1.6×10^{2}
	^{90}Sr	<22
Well USGS-4	^{3}H	8.3×10^{4}
	^{90}Sr	5.9×10^{3}
	^{137}Cs	<5.2
Well USGS-8	^{3}H	8.1×10^{4}
	^{90}Sr	4.2×10^{3}
	^{137}Cs	<0.12

(a) Only ^{3}H concentrations greater than 0.2 percent of the 4 mrem DCG are shown {i.e., greater than 1.6×10^{-7} µCi/mL [160 pCi/L (6 Bq/L)]}. Detectable levels of other man-made radioisotopes are also shown.

(b) Project DRIBBLE wells were sampled in April 1995.

Table 9.2 Groundwater Monitoring Parameters at the RWMS-5

Parameters Determining Suitability of Groundwater

Total and Dissolved Metals - As, Ba, Cd, Cr, Hg, Ag, Pb, Se
Total and Dissolved Gross Alpha/Beta

Parameters Establishing Water Quality

Chloride
Total and Dissolved Fe, Mn, Na
Phenols
Sulfate

Indicators of Contamination

pH
Conductivity
Total Organic Carbon
Total Organic Halogen

Additional Selected Parameters

Volatile Organics (8270)
Tritium

Table 9.3 NTS Facilities with RCRA Closure Plans

Area	Designation
Area 2	Bitcutter Shop & LLNL Post Shot Shop
Area 2	U-2bu Subsidence Crater
Area 3	U-3fi Injection Well [closed]
Area 6	Decontamination Facility Evaporation Pond
Area 6	Steam Cleaning Effluent Pond
Area 23	Building 650 Leachfield
Area 23	Hazardous Waste Trenches [closed]
Area 27	Explosive Ordnance Disposal Facility [closed]

Table 9.4 Sample Activities from U-7ba ps1as

Measured Depth (m)	H-3 (Bq/mL)	Cs-137 (Bq/g)	Co-60 (Bq/g)	Sb-125 (Bq/g)	Eu-155 (Bq/g)
366	4.6×10^2	1.6×10^0			
427	6.4×10^2	2.6×10^1	4.2×10^1	3.9×10^1	2.4×10^1
488	8.2×10^2	3.8×10^1	6.6×10^1	5.9×10^1	3.8×10^1
549	1.9×10^3	3.3×10^1	4.2×10^1	4.5×10^1	2.4×10^1
584	3.6×10^3	6.2×10^1	1.2×10^2	1.1×10^2	7.2×10^2

Table 9.5 Long-Term Hydrological Monitoring Program Summary of Tritium Results for Nevada Test Site Network, 1995

		Tritium Concentration (pCi/L)					
Location	Number	Maximum	Minimum	Arithmetic Mean	1 Sigma	Mean as %DCG	Mean MDC
Well UE-6d	1	670	670	670	11	0.76	6.1
Well UE-6e	3	21	13	16	2.1	0.02	6.4
Well UE-7ns	1	550	550	550	4.6	0.61	5.2
Well UE-16f	1	16	16	16	1.6	0.02	4.9
Well UE-18r	1	0.92	0.92	0.92	1.3	NA	4.2
Well UE-18t	1	190	190	190	3.0	0.21	5.4
Well 6A Army	2	18	4.8	12	3.9	0.01	6.1
Well HTH-1	1	27	27	27	1.6	0.03	4.5
Well PM-1	1	220	220	220	3.1	0.25	5.0
Well U3cn-5	0			Inaccessible			
Well UE-1c	2	4.3	0.53	2.4	1.7	NA	5.7
Well UE-15d	0			Pump inoperative			
Well HTH-F	0			Pump inoperative			
Well C	1	11	11	11	1.6	0.01	4.8
Well C1	1	3.3	3.3	3.3	1.6	0.01	5.1
Well 1 Army	1	0.63	0.63	0.63	1.4	NA	4.4
Well 5B	2	5.1	2.7	3.9	1.8	NA	5.7
Well 5C	3	2.3	1.7	2.1	1.6	NA	5.6
Well UE 5n	2	33000	23000	28000	220	31	430

Conventional and/or enrichment tritium analysis techniques were used for the samples summarized in this table.

DCG	Derived Concentration Guide; established by DOE Order 5400.5 as 90,000 pCi/L for water.
NA	Not applicable; percent of concentration guide is not applicable as the tritium result is less than the MDC or the water is known to be nonpotable.

10.0 LABORATORY QUALITY ASSURANCE

It is the policy of DOE Nevada Operations Office (DOE/NV) that all data produced for its environmental surveillance and effluent monitoring programs be of known quality. Therefore, a quality assurance (QA) program is used for collection and analysis of samples for radiological and nonradiological parameters to ensure that data produced by the laboratory meets customer and regulatory defined requirements. Data quality is assured through process-based QA, procedure-specific QA, data quality objectives (DQOs), and performance evaluation programs. The external QA program for radiological data consists of participation in the U.S. Department of Energy (DOE) Quality Assessment Program (QAP) administered by the DOE Environmental Measurements Laboratory (EML), and the Performance Evaluation Studies Program (PESP) conducted by the U.S. Environmental Protection Agency (EPA) National Exposure Research Laboratory in Las Vegas (NERL-LV). The radiological external QA program also consists of participation in the DOE Laboratory Accreditation Program (DOELAP) Radiobioassay In-Vitro study administered by DOE; the Oak Ridge National Laboratories (ORNL) radiobioassay study conducted by ORNL in Oak Ridge, Tennessee; and the Tritium Enrichment program sponsored by the DOE/NV Environmental Protection Division (EPD). The QA program for nonradiological data was accomplished by using commercial laboratories with appropriate certification or accreditation by state or government agencies.

The environmental surveillance program off the Nevada Test Site (NTS) was conducted by Radiation Sciences Laboratory-Las Vegas (RSL-LV). The QA program developed by RSL-LV for the Offsite Radiological Safety Program (ORSP) meets all requirements of EPA policy, and also includes applicable elements of the DOE/NV QA requirements and regulations. The ORSP QA program defines DQOs, which are statements of the quality of data a decision maker needs to ensure that a decision based on that data is defensible.

10.1 POLICY

Environmental surveillance, conducted onsite by Reynolds Electrical & Engineering Company, Inc., (REECo) and offsite by EPA's RSL-LV, is governed by DOE QA policy as set forth in DOE Order 5700.6C. The Order outlines 10 specific elements that must be considered for compliance with the QA policy. These elements are:

- Program
- Personnel Training & Qualification
- Quality Improvement
- Documents and Records
- Work Processes
- Design
- Procurement
- Data Acceptance and Review
- Management Assessment
- Independent Assessment

In addition, RSL-LV meets the EPA policy which states that all decisions which are dependent on environmental data must be supported by data of known quality. EPA policy requires participation in a centrally managed QA program by all EPA elements as well as those monitoring and measurement efforts supported or mandated through contracts, regulations, or other formalized agreements. Further, EPA policy requires participation in a QA program by all EPA organizational units involved in environmental data collection. The QA policies and requirements of RSL-LV are summarized in the "Quality Management Plan" (EPA 1994a). Policies and requirements specific to the ORSP are documented in the "Quality Assurance Program Plan for the Nuclear Radiation Assessment Division Offsite Radiation Safety Program" (EPA 1992b). The requirements of these documents establish a framework for consistency in the continuing application of QA standards and implementing procedures in support of the ORSP. Administrative and technical implementing procedures based on these QA requirements are maintained in appropriate manuals or are described in standard operating procedures (SOP) of the RSL-LV, Radiation Science Division (RSD).

10.2 OVERVIEW OF THE LABORATORY QA PROGRAM

The REECo Analytical Services Department (ASD) implements the requirements of DOE Order 5700.6C, "Quality Assurance," through integrated quality procedures. The quality of data and results is assured through both process-based and procedure-specific QA.

Procedure-specific QA begins with the development and implementation of SOPs which contain the analytical methodologies and required quality control samples for a given analysis. Personnel performing a given analysis are trained and qualified for that analysis, including the successful analysis of a quality control sample. Analysis-specific operational checks and calibration standards traceable to either the National Institute of Standards and Technology (NIST) or the EPA are required. Quality control samples, e.g., spikes, blanks, and replicates, are included for each analytical procedure. Compliance to analytical procedures is measured through procedure specific assessments or surveillances.

An essential component of process-based quality assurance is data review and verification to assess data usability. Data review requires a systematic, independent review against pre-established criteria to verify that the data are valid for their intended use. Initial data processing is performed by the analyst or health physicist generating the data. An independent review is then performed by another analyst or health physicist to ensure that data processing has been correctly performed and that the reported analytical results correspond to the data acquired and processed. Data checks are made for internal consistency, proper identification, transmittal errors, calculation errors, and transcription errors. Supervisory review of data is required prior to release of the data to sample management personnel for data verification. Data verification ensures that the reported results correctly represent the sampling and/or analyses performed, and includes assessment of quality control sample results. Data processing by sample management personnel ensures that analytical results meet project requirements. Data discrepancies identified during the data review and verification process are documented on data discrepancy reports (DDRs). DDRs are reviewed and compiled quarterly to discern systematic problems.

Process-based quality assurance programs also include periodic operational checks of analytical parameters such as reagent water quality and storage temperatures. Periodic calibration is required for all measuring equipment such as analytical balances, analytical weights, and thermometers. The overall effectiveness of the quality assurance program is determined through systematic assessments of analytical activities. Systematic problems are documented and corrective actions tracked through System Deficiency Reports.

Similar procedures and methodologies are used by RSL-LV to ensure the quality of environmental radiological data collected off the NTS.

10.3 DATA AND MEASUREMENT QUALITY OBJECTIVES

10.3.1 DATA QUALITY OBJECTIVES

DQOs delineate the circumstances under which measurements are made, and define the acceptable variability in the measured data. DQOs are based on the decision(s) to be made, the range of sampling possibilities, what measurements will be made, where the samples will be taken, how the measurements will be used, and what calculations will be performed on the measurement data to arrive at the final desired result(s). Associated measurement quality objectives (MQOs), which define acceptable variability in the measured data, are established to ensure the quality of the measurements.

10.3.1.1 DECISIONS TO BE MADE

The primary decisions to be made, based on radiological environmental surveillance measurements, are whether, due to NTS activities: (1) any member of the general public, outside the site boundaries, receives an effective dose equivalent (EDE) that exceeds regulatory limits; (2) there is detectable contamination of the environment; or (3) there is a biological effect. A potential EDE to a member of the public from NTS activities is much more likely to be due to inhalation or ingestion of radionuclides which have reached the person through one or more pathways, such as transport through the air (inhalation exposure), or through water and/or foodstuffs (ingestion exposure), than to be due to external exposure. A pathway may be quite complex; e.g., the food pathway could include airborne radioactivity falling on soil and plants, also being absorbed by plants, which are eaten by an animal, which is then eaten by a member of the public. At the NTS, because of the depth of aquifers, negligible horizontal or vertical transport, lack of surface water flows and little rain, very sparse vegetation and animal populations, lack of food grown for human consumption, and large distances to the nearest member of the public, the airborne pathway is by far the most important for a possible EDE to a member of the public.

Decisions made based on nonradiological data are related to waste characterization, extent and characterization of spills, compliance with regulatory limits for environmental contaminants, and possible worker exposure(s).

10.3.1.2 RANGE OF SAMPLING POSSIBILITIES

Determination of the numbers, types, and locations of radiological sampling stations is based on factors such as the location of possible sources, isotopes of concern, wind and weather patterns, the geographical distribution of human populations, the levels of risk involved, the desired sensitivity of the measurements, physical accessibility to sampling locations, and financial constraints. The numbers, types, and location of nonradiological samples are typically defined by regulatory actions on the NTS and are determined by environmental compliance or waste operations activities. Work place and personnel monitoring to determine possible worker exposures is conducted by Health Protection Department (HPD) Industrial Hygienists and Health Physicists.

10.3.1.3 MEASUREMENTS TO BE MADE

Radioanalyses are made of air, water, or other media samples to determine the types and amounts of radioactivity in them. These measurements are then converted to radioactivity concentrations by dividing by the sample volume or weight, which is measured separately. Nonradiological inorganic or organic constituents in air, water, soil, and sludge samples are analyzed and reported by commercial laboratories under contract to REECo. Methods and procedures used to measure possible worker exposures to nonradiological hazards are defined by Occupational Safety and Health Administration or National Institute of Occupational Safety and Health protocols. Typical contaminants for which HPD personnel collect samples and request analyses are asbestos, solvents, and welding metals. Sample media which are analyzed include urine, blood, air filters, charcoal tubes, and bulk asbestos.

10.3.1.4 SAMPLING LOCATIONS

The locations of routine radiological environmental surveillance sampling both on and off the NTS are described in Chapters 4 and 5 of this Report. Onsite sampling methodologies are described in REECo's Environmental Section SOPs, and offsite methodologies by similar RSL-LV procedures. The locations of nonradiological environmental sampling and monitoring are determined through site remediation and characterization activities and by permit requirements.

10.3.1.5 USE OF THE MEASUREMENTS

There are several techniques to estimate the EDE to a member of the public. One technique is to measure the radionuclide concentrations at the location(s) of interest and use established methodologies to estimate the EDE a person at that location could receive. Another technique is to measure radionuclide concentrations at specific points within the site and to use established models to calculate concentrations at other offsite locations of interest. The potential EDE to a person at such a location could then be estimated. This second technique is the one used for most of the environmental surveillance data measured at the NTS.

10.3.1.6 CALCULATIONS TO BE PERFORMED

The EDE of greatest interest is the EDE to the maximally exposed individual (MEI). The MEI is located where, based on measured radioactivity concentrations and distances from all contributing NTS sources, the calculational model gives the greatest potential EDE for any member of the public. The assumptions used in the calculational model are conservative; i.e., the calculated EDE to the MEI most certainly exceeds the EDE any member of the public would actually receive. The model used at the NTS is EPA's CAP88-PC, a wind dispersion model approved for this purpose.

10.3.2 MEASUREMENT QUALITY OBJECTIVES

MQOs are commonly described in terms of representativeness, comparability, completeness, precision, and accuracy. Although the assessment of the first two characteristics must be essentially qualitative, definite numerical goals may be set and quantitative assessments performed for the latter three.

10.3.2.1 REPRESENTATIVENESS

Representativeness is the degree to which a sample is truly representative of the sampled medium, i.e., the degree to which measured analytical concentrations represent the concentrations in the medium being sampled (Stanley and Verner, 1985). Representativeness also refers to whether the locations and frequency of sampling are such that calculational models will lead to a correct estimate of potential EDE to a member of the public when measured radioactivity concentrations are input into the model. An environmental monitoring plan for the NTS, DOE/NV/10630-28, "Environmental Monitoring Plan, Nevada Test Site and Support Facilities," has been established to achieve representativeness for environmental data. Factors which were considered in designing this monitoring plan include locations of known and potential sources, historical and operational knowledge of isotopes and pathways of concern, hydrological, and topographical data, and locations of human populations.

10.3.2.2 COMPARABILITY

Comparability refers to the degree of confidence and consistency we have in our analytical results, or is defined as "the confidence with which one data set can be compared to another" (Stanley and Verner, 1985). Sample collection and handling, laboratory analyses, data analysis and validation are performed in accordance with established SOPs to achieve comparability in measurement data. Standard reporting units and a consistent number of significant digits are used. Instruments are calibrated using NIST-traceable sources. Each batch of field samples is accompanied by a spiked sample with a known quantity of the compound(s) of interest. Extensive QA measures are used for all analytical processes. In addition, comparability is attained through comparison of external performance audit results to those achieved by other laboratories participating in the PESP.

10.3.2.3 COMPLETENESS

Completeness is defined as the percentage of samples collected versus those which had been scheduled to be collected, or the percentage of valid analysis results versus the results which would have been obtained if all samples had been obtained and correctly analyzed. Realistically, samples can be lost during shipping, handling, preparation, and analysis, or not collected as scheduled. Also data entry or transcription errors can be made. The REECo completeness objectives for all radiological samples and analyses have been set at 90 percent for sample collection and 85 percent for analyses, or 75 percent overall. RSL-LV's completeness objective for the Long-Term Hydrological Monitoring Program (LTHMP) is 80 percent and for the other networks is 90 percent.

Completeness for inorganic and organic analyses is based on the number of valid results received versus the number requested.

10.3.2.4 PRECISION

Precision refers to "the degree of mutual agreement characteristic of independent measurements as the result of repeated application of the process under specified conditions" (Taylor 1987). Practically, precision is determined by comparing the results obtained from performing the same analysis on split samples, or on duplicate samples taken at the same time from the same location, maintaining sampling and analytical conditions as nearly identical as possible. Precision for samples is determined by comparing results for duplicate samples of particulates in air, tritiated water vapor, noble gases, and some types of water samples. For thermoluminescent dosimeters (TLD), precision is assessed from variations in the three $CaSO_4$ elements of each TLD. Precision is expressed quantitatively as the percent relative standard deviation (%RSD), i.e., the ratio of the standard deviation of the measurements being compared to their mean converted to percent. The smaller the value of the %RSD, the greater is the precision of the measurement. The precision objectives are shown in Table 10.1. They are a function of the concentration of radioactivity in the samples, i.e., the analysis of samples with concentrations near zero will have low precision while samples with higher concentrations will have proportionately higher precision.

10.3.2.5 ACCURACY

Accuracy refers to how well we can measure the true value of a given quantity and can be defined as "the degree of agreement of a measured value with the true or expected value of the quantity of concern" (Taylor 1987). For practical purposes, assessments of accuracy for ASD are done by performing measurements on special QA samples prepared, using stringent quality control, by laboratories which specialize in preparing such samples. The values of the activities of these samples are not known by ASD staff until several months after the measurements are made and the results sent back to the QA laboratory. Additionally, quality control samples with known values are submitted to the Laboratories by the ASD Quality Support Group. These sample values are unknown to the analysts and serve to measure the accuracy of the analytical procedures. The accuracy of these measurements, which is assumed to extend to other similar measurements performed by the laboratory, may be defined as the ratio of the measured value divided by the true value, expressed as a percent. Percent bias is the complement of percent accuracy, i.e., %Bias = 100 - % accuracy. The smaller the percent bias, the more accurate are the measurements. Table 10.2 shows the ASD and RSL-LV accuracy objectives.

Measurements of sample volumes should be accurate to ±5 percent for aqueous samples (water and milk) and to ±10 percent for air and soil samples. The sensitivity of radiochemical and gamma spectrometric analyses must allow no more than a 5 percent risk of either a false negative or false positive value. Control limits for accuracy, monitored with matrix spike samples, are required to be no greater than ±20 percent for all gross alpha and gross beta analyses and for gamma spectrometric analyses.

Both the RSL-LV and ASD laboratories participate in several interlaboratory performance evaluation (PE) programs such as EPA's PESP and EML's QAP and the DOELAP for TLDs. The ASD Laboratory also participates in two bioassay programs which are conducted by the DOELAP and ORNL.

The accuracy of the TLDs is tested every two or three years by the DOELAP. This involves a three-part, single-blind, performance testing program followed by an independent onsite assessment of the overall program. Both REECo and RSL-LV participate in this program.

Once the data have been finalized, they are compared to the MQOs. Completeness, accuracy, and precision statistics are calculated. If data fail to meet one or more of the established MQOs, they may still be used in data analysis; however, the data and any interpretive results must be qualified. Current and historical data are maintained in an access-controlled database.

All sample results exceeding the traditional natural background activity range are investigated. If data are found to be associated with a non-environmental condition, e.g., a check of the instrument using a calibration source, the data are flagged and are not included in calculations of averages, etc. Only data verified to be associated with a non-environmental condition are flagged; all other data are used in calculation of averages and other statistics, even if the condition is traced to a source other than the NTS.

10.4 RESULTS FOR COMPLETENESS, PRECISION, AND ACCURACY

Summary data for completeness, precision, and accuracy are provided in Tables 10.3 to 10.6. Complete data used in these MQOs for 1995 may be found in the "Environmental Data Report for the Nevada Test Site - 1995" (DOE/NV/11718-038, in prep.).

10.4.1 COMPLETENESS

Analysis completeness data for calendar year 1995 are shown in Table 10.3. These percentages represent all analyses which were carried to completion, and include some analyses for which the results were found to be invalid for other reasons. Had objectives not been met for some analyses, other factors would be used to assess acceptability, e.g., fit of the data to a trend or consistency with results from samples collected before and after.

The completeness MQOs for the onsite networks were met or exceeded in all cases except for ^{85}K collection and analyses. For the offsite networks, the MQOs were met or exceeded. The completeness was >89%, just short of the 90 percent objective.

10.4.2 PRECISION

From replicate samples collected and analyzed throughout the year, the %RSD was calculated for various types of analyses and sampling media. The results of these calculations are shown in Table 10.4 for both the onsite and offsite networks. In addition to examination of %RSDs for individual duplicate pairs, an overall precision estimate was determined by calculating the pooled standard deviation, based on the algorithm given in Taylor (1987). To convert to a unitless value, the pooled standard deviation was divided by the grand mean and multiplied by 100 to yield a %RSD. The table presents the pooled data and estimates of overall precision. The pooled standard deviations and %RSD indicate the estimated achieved precision for samples.

For the RSL-LV Laboratory, the samples not meeting the precision MQO were low-activity air-particulate samples analyzed for gross alpha in air. The data would still be useful, as many of the individual samples met the MQO and the others would serve as an alerting mechanism, suggesting an event that requires some investigation. The precision data for all other analyses were well within their respective MQOs.

For the ASD Laboratory, there was one analysis that failed to meet the MQO, namely, ^{85}Kr in air. Subsequent investigation of the analytical procedure revealed equipment and procedure problems for part of the year that have since been corrected. One reason for the low precision in some of the analyses was the low activity in these environmental samples, e.g., for tritium in air, the few that were useful for calculation of precision barely exceeded the minimum detectable concentration (MDC).

10.4.3 ACCURACY

The ASD and RSL-LV accuracy objectives were measured through participation in the interlaboratory comparison and quality assessment programs discussed below.

10.4.3.1 RADIOLOGICAL PERFORMANCE EVALUATION RESULTS

The external radiological PE program consisted of participation in the QAP conducted by DOE/EML and the PESP conducted by EPA. These programs serve to evaluate the performance of the radiological laboratory and to identify problems requiring corrective actions.

Summaries of the 1995 results of the interlaboratory performance evaluation and quality assessment programs conducted by the EPA and DOE/EML are provided in Tables 10.5 and 10.6. The last column in each table (percent Bias) is the accuracy of analysis and may be compared to the objectives listed in Table 10.2. The individual radionuclide recoveries are listed in tables which are being published separately in the "Environmental Data Report for the Nevada Test Site - 1995" (DOE/NV/11718-038, in prep.).

Accuracy, as percent difference or percent bias is calculated by:

$$\%BIAS = \left(\frac{C_m - C_a}{C_a}\right) 100$$

where

$\%BIAS$ = *percent bias*

C_m = *measured sample activity*

C_a = *known sample activity*

The RSL-LV Laboratory failed the accuracy MQO in only 1 of the 25 analyses attempted in the EPA PE Study. In the EML QAP, 4 of the 41 analyses performed exceeded the DQO of ±20 percent. In 1994 RSL-LV obtained renewed accreditation by the DOELAP for the environmental TLD program and also participated in the U.S. Army TMDE Activity which had the objectives of both a QA check on the DOELAP categories and a data gathering activity on performance characteristics of personnel TLDs. The results of this blind testing confirmed that the RSL-LV TLD program was accurate and reproducible within the established performance standards.

REECo's ASD Laboratory accuracy in the EPA PESP was acceptable having only 1 unacceptable result. The MQOs for accuracy in analysis of DOE/EML samples were not met in only 2 of the 21 samples supplied.

10.4.3.2 CORRECTIVE ACTIONS IMPLEMENTED IN RESPONSE TO PERFORMANCE EVALUATION PROGRAMS

REECo results were generally within the control limits determined by the program sponsors. Results which were not within acceptable performance limits were investigated, and corrective actions taken to prevent reoccurrence. Corrective actions included a new process for preparing and including quality control samples, training of analysts, the use of an internal standard for solvents, and an improved tracking system for PE samples.

10.4.4 COMPARABILITY

The EPA PESP and the EML QAP provide results to each laboratory participating in each study that include a grand average for all values, excluding outliers. A normalized deviation statistic compares each laboratory's result (mean of three replicates) to the known value and to the grand average. If the value of this statistic (in multiples of standard normal deviate, unitless) lies between control limits of -3 and +3, the accuracy (deviation from known value) or comparability (deviation from grand average) is within normal statistical variation.

Data from the 1995 intercomparison studies for all variables measured were compared with the grand average to calculate a normalized deviation for the RSL-LV results. All analyses were within three standard normal deviate units of the grand mean, and most were within two normalized deviate units. This indicates acceptable comparability of the RSL-LV Laboratory results with the 73 to 262 laboratories participating in the EPA PESP.

The onsite ASD Laboratory's results in the EML QAP were acceptable. In only two instances were the ASD results greater than the MQO. The EPA PESP includes a grand average (average result from all participating laboratories, less outliers) in its report to participants. Using the formula for percent bias described above, the percent bias of ASD results as compared to the grand average was calculated for each analysis. The average deviation from the EPA known value was 0.71 while the average deviation from the grand average was 0.90 so the ASD had both acceptable accuracy and acceptable comparability except for plutonium in water samples.

Table 10.1 Precision Objectives Expressed as Percents

ASD Laboratory

Analysis	Conc. > 10 MDC	4 MDC ≤ Conc. ≤ 10 MDC
Gross Alpha	±30	±60
Gross Beta	±30	±60
Gamma Spectrometry	±30	±60
Scintillation Counting	±30	±60
Alpha Spectrometry	±20	±50

Note: The precision objective for TLDs at environmental levels is 10 percent.

RSL-LV Laboratory

Conventional Tritium	±10	±30
Strontium (in milk)	±10	±30
Thorium	±10	±30
Uranium	±10	±30
Enriched Tritium	±20	±30
Strontium (in other media)	±20	±30
Noble Gases	±20	±30
Plutonium	±20	±30

Table 10.2 Accuracy Objectives Expressed as Percent Bias

ASD Laboratory

Analysis	Conc. > 10 MDC	4 MDC ≤ Conc. ≤ 10 MDC
Gross Alpha	±20	±50
Gross Beta	±20	±50
Gamma Spectrometry	±20	±50
Scintillation Counting	±20	±50
Alpha-Spectrometry	±20	±50
Noble Gas Analysis	±30	±60

Note: The accuracy objective for TLDs is 20 percent for exposures < 10 mR and 10 percent for exposures ≥ 10 mR.

RSL-LV Laboratory

Tritium, Conventional	±10	±30% of MDC
Strontium (Milk)	±10	±30% of MDC
Thorium	±10	±30% of MDC
Uranium	±10	±30% of MDC
Tritium, Enriched	±20	±30% of MDC
Strontium (other media)	±20	±30% of MDC
Plutonium	±20	±30% of MDC
TLDs	Meet DOELAP Criteria	

Table 10.3 Analysis Completeness Data for Calendar Year 1995

Analysis	Medium	Completeness Percent REECo	Completeness Percent RSL-LV
Gross Beta	Particulate Air Filter	93.0	92.2
Plutonium	Particulate Air Filter	98.2	92.2
Gamma Spectrometry	Particulate Air Filter	98.0	92.2
Gamma Spectrometry	Charcoal Air Filter	(a)	92.2
Tritiated Water	Air	97.1	(a)
Krypton-85	Air	74.0	(a)
Gross Beta	Potable Water Endpoints	93.6	(a)
Gamma Spectrometry	Potable Water Endpoints	93.6	(a)
Tritiated Water	Potable Water Endpoints	93.6	(a)
Plutonium	Potable Water Endpoints	96.6	(a)
Gross Beta	Wells, Reservoirs, Springs, Ponds	91.6	(a)
Plutonium	Wells, Reservoirs, Springs, Ponds	95.5	(a)
Gamma Spectrometry	Wells, Reservoirs, Springs, Ponds	91.6	90.5
Tritiated Water	Wells, Reservoirs, Springs, Ponds	91.6	89.7
Strontium-90	Wells, Reservoirs, Springs, Ponds	95.5	(a)
Gross Alpha	Potable Wells and Endpoints	98.7	(a)
Tritium	Milk	(a)	100
Strontium	Milk	(a)	100
Animal Investigation	Tissues	(a)	100
Pressurized Ion Chamber	Ambient Radiation	(a)	99.1
TLDs	Ambient Radiation	(a)	71.2

(a) Analyses not performed.

Table 10.4 Precision Estimates from Replicate Sampling - 1995

Analysis	Number of Replicate Analyses	Precision Estimate % RSD
	ASD Laboratory	
Gross Beta in Air	42	11.5
Gamma in Air	32	16.1
Gross Alpha in Potable Water	17	15.5
Gross Beta in Potable Water	19	16.0
HTO in Tunnel Effluent	4	1.4
Pu in Tunnel Effluent	12	32.8
	RSL-LV Laboratory	
Gross Alpha in Air	168	62.5
Gross Beta in Air	169	16.2
Gamma Spectrometry (^{7}Be)	12	31.3
^{85}Kr in Air	---	---
Tritium in Water (enriched)	51	45.6
Tritium in Water (unenriched)	9	5.9

Table 10.5 Accuracy of RSL-LV Radioanalyses (EML QAP and PESP) - 1995

Water Samples Range of Results - pCi/L

Analysis	No.	PESP	RSL-LV	% Bias
Gross Alpha	4	5 - 99	6 - 102	-30 - 14
Gross Beta	4	5 - 124	8 - 123	-0.4 - 54
Gamma Spec	7	35 - 148	35 - 154	-11 - 4
Strontium	4	8 - 20	8 - 15	-30 - 0
Alpha Spec	4	11 - 30	10 - 29	-14 - -0.7
Tritium	2	4900 - 7400	4700 - 7100	-4.2 - -3.9

Air Filter Samples Range of Results - pCi/L

Gross Alpha	1	25	24	-3.2
Gross Beta	1	87	81	-6.5
^{137}Cs	1	25	24	-5.2
^{90}Sr	1	30	27	-9.0

Milk Samples Range of Results - pCi/L

^{89}Sr	1	20	22	8.5
^{90}Sr	1	15	15	2.0
^{131}I	1	99	63	-36
^{137}Cs	1	50	54	8.6
Potassium	1	1700	1500	-11

% Bias Range for Analysis of EML QAP Samples

		Air	Soil	Vegetation	Water
Gross Alpha	1	(a)	(a)	(a)	2.3
Gross Beta	1	(a)	(a)	(a)	68
Plutonium	13	-6.3 - 9.7	-0.6 - 4.3	-13 - 5.4	-1.8 - 10
Uranium	3	(a)	(a)	(a)	9.6 - 157
Strontium	3	(a)	(a)	6.3	-9.6 - 8.5
Tritium	1	(a)	(a)	(a)	-4.8
Gamma Spec	19	-5.2 - 18	(a)	(a)	25 - 28

(a) No sample.

Table 10.6 Accuracy of ASD Radioanalyses (PESP and EML QAP) - 1995

Analysis Water Samples	No.	REECo/ASD Average pCi/L	PESP Known	Normalized Deviation(a) Grand Avg.
^{60}Co	3	65.3	1.85	1.97
^{65}Zn	3	132	0.89	0.37
^{134}Cs	3	43	0.92	2.01
^{137}Cs	3	54	1.66	0.92
^{133}Ba	3	99	-0.06	0.52
Strontium	3	14	-0.46	-0.21
^{131}I	6	135	1.53	1.37
Tritium	3	4920	0.16	0.46
^{226}Ra	3	27	0.98	1.5
U (nat.)	3	30	-0.35	0.06
^{239}Pu	3	38.8	-3.62	-2.85

(a) ± 3 Normalized Deviation is acceptable.

% Bias Range for Analysis of EML QAP Samples

		Air	Soil	Vegetation	Water
Americium	2	-41 - -35	-40 - 10	-15 - 22	128 - -1.5
Plutonium	4	-50 - 8	-15 - -4	-34	-8 - 9
Uranium	3	-13 - 111	-51 - -13	(a)	-4.1 - 6
Strontium	2	6 - 16	17 - 26	-23 - 5.6	-1.2 - 8
Tritium	2	(a)	(a)	(a)	-17 - 1.2
Gamma Spec	6	-42 - 4.6	-23 - -12	-37 - 27	-9 - 16
Gross Alpha	1	39	(a)	(a)	31
Gross Beta	1	(a)	(a)	(a)	-9

(a) No sample.

REFERENCES

Bechtel Nevada Corp., 1995, "Area 5 Radioactive Waste Management Site, 1995 Groundwater Monitoring Program," Waste Management Operations, Environmental Management Division, Unnumbered Report.

BEIR III, 1980, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation: 1980," Committee on the Biological Effects of Ionizing Radiation III, National Academy Press, 2101 Constitution Ave, N.W., Washington, D.C. 20418.

Black, S. C., 1995, "National Emission Standards for Hazardous Air Pollutants Submittal 1994," Report DOE/NV/11432-194, Reynolds Electrical & Engineering Co., Inc., Las Vegas, NV.

Blankennagel, R. K. and J. E. Weir, 1973, "Geohydrology of the Eastern Part of Pahute Mesa, Nevada Test Site, Nye County, Nevada," U.S. Geological Survey Prof. Paper 712-B.

Chapman, J. B. and S. L. Hokett, 1991, "Evaluation of Groundwater Monitoring at Offsite Nuclear Test Areas," DOE Nevada Field Office Report DOE/NV/10845-07, Las Vegas, Nevada.

Code of Federal Regulations, 1966, "Protection of Historic and Cultural Properties," Title 36, Part 800.

Code of Federal Regulations, 1973, "Threatened and Endangered Species Regulations," U.S. Fish and Wildlife Service, Title 50, Parts 17.11 and 17.12.

Code of Federal Regulations, 1976, "National Primary Drinking Water Regulations," Title 40, Part 141, U.S. Environmental Protection Agency.

Code of Federal Regulations, 1977, "Clean Water Act Regulations," U.S. Environmental Protection Agency, Title 40, Parts 110 to 136.

Code of Federal Regulations, 1984, "Resource Conservation and Recovery Act Regulations," U.S. Environmental Protection Agency, Title 40, Parts 260 to 281.

Code of Federal Regulations, 1986, "Superfund, Emergency Planning and Community Right-to-Know Act Regulations," U.S. Environmental Protection Agency, Title 40, Parts 300 to 373.

Code of Federal Regulations, 1989, "National Emission Standards for Hazardous Air Pollutants," Title 40, Part 61, U.S. Environmental Protection Agency.

Daniels, J. I., R. Andricevic, L. R. Anspaugh and R. L. Jacobson, 1993, "Risk-Based Screening Analysis of Groundwater Contaminated by Radionuclides Introduced at the Nevada Test Site," in: Pilot Study Risk Assessment for Selected Problems at the Nevada Test Site (NTS), J. I. Daniels, Editor, Lawrence Livermore National Laboratory Report UCRL-LR-113891, Livermore, CA, June 1993.

EG&G/EM (EG&G Energy Measurements), 1994, "The Northern Boundary of the Desert Tortoise Range on the Nevada Test Site," U.S. Department of Energy Topical Report EGG 111265-1103, 20pp.

References, cont.

Friesen, H. N., 1992, "Summary of the Nevada Applied Ecology Group and Correlative Programs," Nevada Field Office, U.S. Department of Energy Report DOE/NV-357, Las Vegas, Nevada.

Hershey, R. and T. Brikowski, 1995, "Continued Investigation of the Occurrence of Water in Pahute Mesa Emplacement Holes," Report DOE/NV/10845-52, Desert Research Institute, Las Vegas, Nevada.

Hunter, R. B., 1994, "Status of the Flora and Fauna on the Nevada Test Site, 1994," Report DOE/NV/11432-195, pp 245-348, EG&G Energy Measurements, Las Vegas, Nevada.

International Commission on Radiological Protection, 1975, "Report of the Task Group on Standard Man," ICRP Publication 23, Pergamon Press, New York.

International Commission on Radiological Protection, 1979, "Limits for Intake by Workers," ICRP Publication 30, Supplement to Part 1, Pergamon Press, New York.

International Commission on Radiological Protection, 1985, Insert to "Quantitative Bases for Developing an Index of Harm," ICRP Publication 45, Pergamon Press, New York.

Kercher, J. R., and L. R. Anspaugh, 1991, "Analysis of the Nevada-Applied-Ecology-Group Model of Transuranic Radionuclide Transport and Dose," Journal of Environmental Radioactivity 13: 191-216.

National Council on Radiation Protection and Measurement, 1975, "Krypton-85 in the Atmosphere," NCRP Report No. 44, Washington D.C.

Nevada Revised Statutes, "Public Health and Safety/Water Pollution Control," Title 40, Chapter 445, and Nevada Administrative Code 445.247.

Nevada Revised Statutes, "Public Health and Safety/Disposal of Hazardous Waste," Title 40, Chapter 459, and Nevada Administrative Code 444.8632.

Nuclear Energy Agency, 1981, "The Environmental and Biological Behavior of Plutonium and Some Other Transuranium Elements," Organization for Economic Cooperation and Development, Paris, France.

O'Farrell, T. P., and L. A. Emery, 1976, "Ecology of the Nevada Test Site: A Narrative Summary and Annotated Bibliography," Desert Research Institute, U.S. Department of Energy, NVO-167.

Patton, S. E. 1992, "Beryllium in Soils of the Nevada Test Site: A Preliminary Assessment," Lawrence Livermore National Laboratory, Livermore, California UCRL-ID-104740.

Quiring, R. E., 1968, "Climatological Data, Nevada Test Site, Nuclear Rocket Development Station," ESSA Research Laboratory Report ERLTM-ARL-7, Las Vegas, Nevada.

Reno, R. L. and L. C. Pippin, 1985, "An Archaeological Reconnaissance of Yucca Flat, Nye County, Nevada," Social Sciences Center, Desert Research Institute, University of Nevada, Technical Report No. 35.

References, cont.

Russell, C. E., 1990, "Assessment of the Nevada Test Site Monitoring Well System," Report DOE/NV/10384-31, Water Resources Center, Desert Research Institute, University of Nevada, Las Vegas, Nevada.

Sanderson, C. G., and S. C. Scarpitta, 1991, "Environmental Measurements Laboratory, Semi-Annual Department of Energy Quality Assessment Program Report," Report # EML-535, U.S. Department of Energy, New York, New York.

Scoggins, W. A., 1983, "Environmental Surveillance Report for the Nevada Test Site, January 1982 through December 1982," DOE/NVO-410-76, Reynolds Electrical & Engineering Co., Inc., Las Vegas, Nevada.

Scoggins, W. A., 1984, "Environmental Surveillance Report for the Nevada Test Site, January 1983 through December 1983," DOE/NVO-10327-4, Reynolds Electrical & Engineering Co., Inc., Las Vegas, Nevada.

Shinn, J. H., E. H. Essington, R. O. Gilbert and F. J. Gouveia, 1993, "Precision of In Situ Gamma Spectrometry for Estimation of Plutonium Concentrations in Soil: Effects of Soil Variability," Lawrence Livermore National Laboratory, Livermore, California. PREPRINT.

Stanley, T. W. and S. S. Verner, 1985, "The U.S. Environmental Protection Agency's Quality Assurance Program," in J. K. Taylor and T. W. Stanley (eds.), *Quality Assurance for Environmental Measurements,* ASTM STP-867, Philadelphia, Pennsylvania.

Taylor, J. K., 1987, "Quality Assurance of Chemical Measurements," Chapter 4, Lewis Publications.

Thordarson, W., 1965, "Perched Ground Water in Zeolitized Bedded Tuff, Rainier Mesa and Vicinity, Nevada Test Site," U.S. Geological Survey Open-File Report TEI-862.

U.S. Department of Commerce, 1990, "Population Count Pursuant to Public Law 94-171," Bureau of Census, Washington, D.C.

U.S. Department of Energy, 1988b, "Radioactive Waste Management," DOE Order 5820.2A.

U.S. Department of Energy, 1988c, "Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements," Report NVO-325, Nevada Operations Office, Las Vegas, Nevada.

U.S. Department of Energy, 1990a, "Occurrence Reporting and Processing of Operations Information," DOE Order 5000.3B.

U.S. Department of Energy, 1990b, "General Environmental Protection Program," DOE Order 5400.1.

U.S. Department of Energy, 1990c, "Radiation Protection of the Public and the Environment," DOE Order 5400.5.

References, cont.

U.S. Department of Energy, 1990d, "Environmental Protection, Safety, and Health Protection Program for DOE Operations," DOE Order 5480.1B.

U.S. Department of Energy, 1990e, "Radiation Protection for Occupational Workers," DOE Order 5480.11.

U.S. Department of Energy, 1990f, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements," DOE Order 5484.1.

U.S. Department of Energy, 1990g, "Site Specific Plan for Environmental Restoration and Waste Management," Report DOE/NV-336, Nevada Operations Office, Las Vegas, Nevada.

U.S. Department of Energy, 1991a, "Quality Assurance," DOE Order 5700.6C.

U.S. Department of Energy, 1991b, "General Design Criteria Manual," DOE Order 6430.1A.

U.S. Department of Energy, 1991c, "Environmental Monitoring Plan, Nevada Test Site and Support Facilities," Report DOE/NV/10630-28, Nevada Field Office, Las Vegas, Nevada.

U.S. Department of Energy, 1991d, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance," Report DOE/EH-0173T, Washington, D.C.

U.S. Department of Energy, 1994a, "United States Nuclear Tests: July 1945 through September 1992," Report DOE/NV-209 (Revision 14), Nevada Operations Office, Las Vegas, Nevada.

U.S. Department of Energy, 1994b, "Site Characterization and Monitoring Data from Area 5 Pilot Wells, Nye County, Nevada," DOE/NV/11432-74, Reynolds Electrical & Engineering Co., Inc., Las Vegas, Nevada.

U.S. Department of Energy, 1994c, "Nevada Operations Office Annual Site Environmental Report - 1993," DOE/NV/11432-123, Reynolds Electrical & Engineering Co., Inc., Las Vegas, Nevada.

U.S. Department of Energy, 1995a, "Environmental Data Report for the Nevada Test Site - 1995," DOE/NV/11718-038, in prep., Reynolds Electrical & Engineering Co., Inc., Las Vegas, Nevada.

U.S. Department of Energy, 1995b, "Nevada Test Site Site Treatment Plan," Report DOE/NV-397, Nevada Operations Office, Las Vegas, Nevada.

U.S. Energy Research and Development Administration, 1977, "Final Environmental Impact Statement, Nye County, Nevada," Nevada Operations Office, Las Vegas, Report ERDA-1551, available from the U.S. Department of Commerce, NTIS, Springfield, Virginia.

U.S. Environmental Protection Agency, 1976, "Quality Assurance Handbook for Air Pollution Measurement Systems," Report EPA/600/9-76/005, Office of Research and Development, Research Triangle Park, North Carolina.

References, cont.

U.S. Environmental Protection Agency, 1980, "Upgrading Environmental Radiation Data," Health Physics Society Committee Report HPSR-1, EPA 520/1-80-012, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency, 1983, "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans - QAMS-005/80," Office of Research and Development, Report EPA/600/4-83/004, Washington, D.C.

U.S. Environmental Protection Agency, 1986, "RCRA Groundwater Monitoring Technical Enforcement Guidance Document," Office of Solid Waste and Emergency Response Report No. OSWER-9950.1, 208 pp.

U.S. Environmental Protection Agency, 1987, "Quality Assurance Program Plan," EPA/600/X-87/241, Environmental Monitoring Systems Laboratory, P.O. Box 93478, Las Vegas, Nevada 89193-3478.

U.S. Environmental Protection Agency, 1988, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Ingestion, and Submersion," Federal Guidance Report No. 11, EPA/520/1-88/020, Washington, D.C.

U.S. Environmental Protection Agency, 1992a, "User's Guide for CAP88-PC, Version 1.0," Office of Radiation Programs, Las Vegas Facility, Report 402-B-92-001.

U.S. Environmental Protection Agency, 1992b, "Quality Assurance Program Plan - Offsite Radiological Safety Program," Report EPA/600/X-92/xxx, Nuclear Radiation Assessment Division, Environmental Monitoring Systems Laboratory, Las Vegas, NV.

U.S. Environmental Protection Agency, 1993, "Offsite Environmental Monitoring Report, Radiation Monitoring Around United States Nuclear Test Areas, Calendar Year 1991," Report EPA/600/R-93/141, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

U.S. Environmental Protection Agency, 1994a, "Quality Management Plan ," Report EPA/600/X-93-024, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

U.S. Environmental Protection Agency,. 1994b, "Environmental Radioactivity Performance Evaluation Studies Program and Radioactive Standards Distribution Program," Report EPA/600/R-94/xxx, Environmental Monitoring Systems Laboratory, Las Vegas, NV.

U.S. Nuclear Regulatory Commission, 1991, "NRC TLD Direct Radiation Monitoring Network Progress Report, October to December, 1991," NUREG-0873, 11: No. 4, U.S. Nuclear Regulatory Commission, Region 1, U.S. Government Printing Office, Washington, D.C.

Waddell, R. K., 1982, "Two-Dimensional Steady-State Model of Groundwater Flow, Nevada Test Site and Vicinity, Nevada-California," U.S. Geological Survey, Water-Resources Investigations Report 82-4085.

Winograd, I. J., and W. Thordarson, 1975, "Hydrogeologic and Hydrochemical Framework, South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site," U.S. Geological Survey Professional Paper 712-c, U.S. Government Printing Office, Washington, D.C., 1975.

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