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NEVADA TEST SITE ANNUAL SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1997

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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's (EPA's) Laboratory (various names) in 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 ninth 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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MEASUREMENT UNITS AND NOMENCLATURE

Radioactivity data in this report are expressed in both traditional units (e.g., pCi/L) and International System (abbreviated SI) units. These units are explained below.

background Ambient background radiation to which people are exposed. Naturally occurring radioactive elements contained in the body, in the ground, and in construction materials, cosmic radiation, and radioactivity in the air all contribute to an average radiation dose equivalent to humans of about 350 mrem per year. In laboratory measurements of radioactivity in samples, background is the activity determined when a sample of distilled water is processed through the system (also called a blank).

becquerel Abbreviation Bq. The Bq is the SI unit for disintegration rate.
1 Bq = 1 disintegration per second.

concentration Usually expressed as µCi/mL, or pCi/m^3.

curie Abbreviation Ci. The historic unit for disintegration rate. 1 Ci = 3.7 x 10^{10} disintegrations per second = 3.7 x 10^{10} Bq. The usual submultiples of Ci are mCi (10^{-3} Ci or one thousandth Ci), µCi (10^{-6} Ci or one millionth Ci), and pCi (10^{-12} or one trillionth Ci).

EDE Effective dose equivalent - radiation dose corrected by various weighting factors that relate dose to the risk of serious effects.

rem Rem (for roentgen equivalent man) is the unit for expressing dose equivalent, or the energy imparted to a person when exposed to radiation. The commonly used subunit is the millirem (10^{-3} rem or one thousandth rem), abbreviated mrem.

roentgen Abbreviation R. A unit expressing the intensity of X or (radiation at a point in air. The usual unit is mR for 10^{-3} R (one thousandth R).

volume The SI unit for volume is m^3 (cubic meter). Other units used are liter (L) and mL (10^{-3} L or one thousandth liter). One cubic meter = 1,000 L, 1 L = 1.06 quarts.

The elements and corresponding symbols used in this report are:

Element	Symbol	Element	Symbol
Aluminum	Al	Iron	Fe
Americium	Am	Krypton	Kr
Argon	Ar	Lithium	Li
Arsenic	As	Mercury	Hg
Barium	Ba	Nitrogen	N
Beryllium	Be	Oxygen	O
Boron	B	Plutonium	Pu
Cadmium	Cd	Radium	Ra
Calcium	Ca	Radon	Rn
Carbon	C	Selenium	Se
Cesium	Cs	Sulfur	S
Chlorine	Cl	Strontium	Sr
Chromium	Cr	Technetium	Tc
Copper	C	Thorium	Th
Fluorine	F	Thulium	Tm
Germanium	Ge	Tritium	^3H
Hydrogen	H	Uranium	U
Iodine	I	Xenon	Xe

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LIST OF ACRONYMS AND ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
AIRFA	American Indian Religious Freedom Act
ARL/SORD	Air Resource Laboratory, Special Operations and Research Division
ASER	Annual Site Environmental Report
ASL	Analytical Services Laboratory
ASN	Air Surveillance Network
AVO	Amador Valley Operations
BN	Bechtel Nevada
BOD	Biochemical Oxygen Demand
BoFF	Bureau of Federal Facilities, State of Nevada
CA	Composite Analysis
CAA	Clean Air Act
CADD	Corrective Action Decision Document
CAP	Corrective Action Plan
CAP88-PC	Clean Air Package 1988 (EPA software program for estimating doses)
CEDE	Committed Effective Dose Equivalent
CEI	Compliance Evaluation Inspection
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CP	Control Point
CRMP	Community Radiation Monitoring Program
CTLP	Community Technical Liaison Program
CWA	Clean Water Act
CX	Categorical Exclusion
CY	Calendar Year
DAF	Device Assembly Facility
DCG	Derived Concentration Guide
DDR	Data Discrepancy Report
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
DQO	Data Quality Objectives
DRI	Desert Research Institute, University and Community College System, Nevada
DTRA	Defense Threat Reduction Agency
EA	Environmental Assessment
EDE	Effective Dose Equivalent
EGIS	Ecological Geographic Informational System
EHS	Extremely Hazardous Substances
EIS	Environmental Impact Statement
ELU	Ecological Landform Unit
EMAC	Ecological Monitoring and Compliance
E-MAD	Engine Maintenance, Assembly and Disassembly (on the NTS)
EML	Environmental Measurements Laboratory (DOE)
EMP	Environmental Monitoring Plan
EOD	Explosive Ordnance Disposal (NTS)
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Reporting and Community Right-to-Know Act
EPD	DOE Environmental Protection Division
ERP	Environmental Restoration Project
ESA	Endangered Species Act

ESHD	Environment, Safety and Health Division (DOE/NV)
ESS&H	Environment, Safety, Security, and Health
FFACO	Federal Facilities Agreement and Consent Order
FFCA	Federal Facilities Compliance Act
FY	Fiscal Year
gal	Gallon
GBq	Gigabequerel (10^9 bequerels)
GIS	Geographical Information System
GZ	Ground Zero
HRMP	Hydrologic Resources Management Program
HSC	Hazardous Materials Spill Center
HTO	Tritiated Water
HWSU	Hazardous Waste Storage Unit
ICRP	International Commission on Radiological Protection
ID	Identification
IT	International Technology Corporation
IUC	International Uranium Corporation
JIT	Just-in-Time
keV	Kilo-electronvolt
LANL	Los Alamos National Laboratory
LAO	Los Alamos Operations (BN)
LDR	Land Disposal Restrictions
LLNL	Lawrence Livermore National Laboratory
LLW	Low-Level (Radioactive) Waste
LTHMP	Long-Term Hydrological Monitoring Program
LVAO	Las Vegas Area Operation (BN)
M&O	Management and Operation
MAPEP	Mixed Analyte Performance Evaluation Program
MCL	Maximum Contaminant Level
MDC	Minimum Detectable Concentration
MEI	Maximally Exposed Individual
MQO	Measurement Quality Objectives
MSDS	Material Safety Data Sheet
MSL	Mean Sea Level
MSN	Milk Surveillance Network (R&IE-LV)
NAC	Nevada Administrative Code
NAFB	Nellis Air Force Base
NAFRC	Nellis Air Force Range Complex
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NEPD	Nevada Environmental Protection Division
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NLVF	North Las Vegas Facility (BN)
NPDES	National Pollution Discharge Elimination System
NR	National Register of Historic Places
NRS	Nevada Revised Statutes
NSHPO	Nevada State Historical Preservation Office
NTS	Nevada Test Site
ORNL	Oak Ridge National Laboratory
ORSP	Offsite Radiological Safety Program
PA	Performance Assessment

List of Acronyms and Expressions, cont.

PCB	Polychlorinated Biphenyl
PE	Performance Evaluation
PEIS	Programmatic Environmental Impact Statement
PESP	Performance Evaluation Studies Program
pH	Hydrogen ion concentration
PHS	U.S. Public Health Service
PIC	Pressurized Ion Chamber
PPOA	Pollution Prevention Opportunity Assessments
ppm	Parts per Million
QA	Quality Assurance
QAP	Quality Assessment Program
RCRA	Resource Conservation and Recovery Act
R&IE-LV	Radiation & Indoor Environment National Laboratory - Las Vegas (EPA)
REECo	Reynolds Electrical & Engineering Company, Inc.
RMP	Resource Management Plan
ROD	Record of Decision
ROI	Return on Investment
RSD	Relative Standard Deviation
RSL	Remote Sensing Laboratory (BN)
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
SAFER	Streamlined Approach for Environmental Restoration
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SGZ	Surface Ground Zero
SMSY	Strategic Materials Storage Yard
SOP	Standard Operating Procedure
STL	Special Technologies Laboratory (BN)
TCE	Trichloroethane
TDS	Total Dissolved Solids
TLD	Thermoluminescent Dosimeter
TRU	Transuranic
TSCA	Toxic Substances Control Act
TTR	Tonopah Test Range
UGTA	Underground Test Area
UNLV	University of Nevada, Las Vegas
U.S.	United States of America
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WAC	Waste Acceptance Criteria
WAMO	Washington Aerial Measurements Operations (BN)
WEF	Waste Examination Facility
WIPP	Waste Isolation Pilot Plant
WI	Work Instructions

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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 1997, indicated that operations on the NTS were conducted in compliance with applicable DOE, state, and federal 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 liquid effluents, or resuspension of soil was not detectable offsite, and exposure above existing background to members of the offsite population was not measured by the offsite monitoring program. Using the U.S. Environmental Protection Agency's (EPA's) Clean Air Package 1988 (CAP88)-PC model and NTS radionuclide emissions and environmental monitoring data, the calculated effective dose equivalent (EDE) to the maximally exposed individual offsite would have been 0.089 mrem. This value is less than 1 percent of the federal dose limit prescribed for 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 have complied with the requirements of air quality permits and state or local wastewater discharge and hazardous waste permits as mandated for each location.

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 under the purview of Assistant Manager of Technical Services and upgrading the Environmental Management activities to the Assistant Manager level to address those environmental issues that have arisen in the course of performing the original primary mission of the DOE/NV, underground testing of nuclear explosive devices. DOE/NV management has vigorously promoted the practice of pollution prevention, including waste minimization and material recycling.

Operational releases and seepage of radioactivity are reported soon after their occurrence. In compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), as set forth in Title 40 Code of Federal Regulations Part 61, the accumulated annual emissions are used as part of the input to the EPA's CAP88-PC software program to calculate potential EDEs 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 normally 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 1997 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 HTO from tunnel and characterization well containment ponds.
- 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.
- Release of ^{85}Kr from tests under Pahute Mesa when atmospheric pressure changes occur. Such releases were statistically undetectable in 1997.

Diffuse emissions included HTO, only slightly above detection limits, from the Radioactive Waste Management Site in Area 5 (RWMS-5) and the SEDAN crater in Area 10 and resuspended $^{239+240}$Pu from areas on the NTS where it was deposited by atmospheric nuclear tests or device safety tests in earlier years. 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 in the offsite area above ambient levels.

Onsite liquid discharges to containment ponds included approximately 20 Ci (740 GBq) of tritium. This was much less than last year's tritium releases. Evaporation of this material could have contributed HTO to the atmosphere, but the amounts were too small to be detected by the tritium monitors onsite. No liquid effluents were discharged to offsite areas.

ONSITE ENVIRONMENTAL SURVEILLANCE

Environmental surveillance on the 3,500-km^2 (1,350-mi^2) NTS is designed to cover the entire area with some emphasis on areas of past nuclear testing and present operational activities. In 1997, samplers were operated at 48 locations to collect air particulate samples, at 13 locations to collect HTO in atmospheric moisture, and at 3 locations to collect air for analysis of noble gas content. Grab samples were collected frequently from water supply wells, water taps, springs, open reservoirs, containment ponds, and sewage lagoons. Thermoluminescent dosimeters (TLDs) were placed at 166 locations on the NTS to measure ambient gamma exposures.

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 radioactive waste [LLW] site).

Approximately 2,400 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. Gross beta analysis of the air samples yielded an annual average for the network of 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 1997, 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 Concentration Guide (DCG) 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 dispersed plutonium over a small portion of the surface of the NTS.

The annual average concentration of ^{85}Kr from the three noble gas monitoring stations was 27 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 13 locations on the NTS and analyzed for HTO content. The annual arithmetic average of (4.7 ± 9.7) x 10^{-6} pCi/mL (0.17 ± 0.36 Bq/m^3) was similar to last year's average. The highest annual average concentrations were at the E Tunnel pond, the SEDAN crater, and RWMS-5 locations, in that order. The primary radioactive liquid discharge to the onsite environment in 1997 was 16 Ci (0.6 TBq) of tritium (as HTO) in seepage from E Tunnel. Also, effluent produced during pumping from wells in Area 3 contained about 4.2 Ci (0.16 GBq) of HTO. For dose calculations, all of the HTO was assumed to have evaporated.

Surface water sampling was conducted quarterly at eight open reservoirs, seven springs, two containment ponds and an effluent, and nine 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 tunnel containment pond and characterization well effluent ponds contained detectable levels of radioactivity, as would be expected.

Water samples from onsite supply wells and drinking water distribution systems were analyzed for radionuclides. The supply well average gross beta activity of 7.0 x 10^{-9} µCi/mL (0.26 Bq/L) was 3 percent of the DCG for ^{40}K (used for comparison purposes); gross alpha was 6.2 x 10^{-9} µCi/mL (0.23 Bq/L), which was about 40 percent of the drinking water standard; the maximum ^{90}Sr measured was 1.7 x 10^{-10} µCi/mL (6.3 mBq/L), about 2 percent of the DCG; ^{3}H averaged about 3.4 x 10^{-9} µCi/mL (0.12 Bq/L), less than 0.002 percent of the DCG; $^{239+240}$Pu and ^{238}Pu were both below their minimum detectable levels of about 2 x 10^{-11} µCi/mL (0.074 mBq/L).

Analysis of the TLD network showed that the 16 boundary station locations had an annual average exposure of 127 mR, and the 9 historic stations annual average was 95 mR, both within the range of values previously reported.

OFFSITE ENVIRONMENTAL SURVEILLANCE

The offsite radiological monitoring program is conducted around the NTS by the EPA's Radiation & Indoor Environments National Laboratory-Las Vegas (R&IE-LV), under an Interagency Agreement with DOE. This program consists of several environmental sampling, radiation detection, and dosimetry networks as described below. These networks operated continuously during 1997.

The Air Surveillance Network (ASN) was made up of 20 continuously operating sampling locations surrounding the NTS, 6 of which also had high-volume air samplers. The ASN stations included 16 sampling locations, at Community Technical Liaison Program (CTLP) stations, described below. During 1997, 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 detected by this network was ^{238}Pu or $^{239+240}$Pu on high-volume air-filter samples.

The Milk Surveillance Network consisted of 11 sampling locations within 300 km (186 mi) of the NTS. Samples were analyzed for ^{90}Sr, which averaged 0.7 pCi/L. The data from this network are consistent with previous data and indicate little or no change.

In 1997, external exposure was monitored by a network of 38 TLDs and 27 pressurized ion chambers (PICs) located in towns and communities around the NTS. There was also a PIC located at the SALMON site near Baxterville, Mississippi. The PIC network in the communities surrounding the NTS indicated background exposures, ranging from 71 to 156 mR/yr, that were consistent with previous data and well within the range of background data in other areas of the United States. The exposures measured by the TLDs were slightly less, as has been true in the past.

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 Alaska, Colorado, Mississippi, New Mexico, and Nevada where underground nuclear 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 ^{3}H and ^{137}Cs has been detected the last few years. No concentrations of radioactivity that were detected in air, water, or milk samples posed any significant health risk to nearby residents.

A network of 17 CTLP stations was operated by local residents, one without an air sampler. 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. Samples and data from these CTLP stations were analyzed and reported by R&IE-LV and also interpreted and reported by the Desert Research Institute, University of Nevada System. All measurements for 1997 were consistent with previous years and were within the normal background range for the United States.

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 EDE to any offsite individual would have been 0.089 mrem (8.9×10^{-4} mSv), and the dose to the population within 80 km of the several emission sites on the NTS would have been 0.26 person-rem (2.6×10^{-3} person-Sv), both of which were less than last year. The hypothetical person receiving this dose would also have been exposed to 144 mrem from natural background radiation. A summary of the potential EDEs due to operations at the NTS is presented in Table 1.2.

ECOLOGICAL STUDIES

The Ecological Monitoring and Compliance Program monitoring tasks, which were selected for 1997, included habitat mapping on the northern portion of the NTS, characterizing the natural springs on the NTS, conducting a census of the horse population, and periodically monitoring man-made water sources to assess their effects on wildlife. Ecological monitoring of certain spill tests at the Hazardous Materials Spill Center (HSC) (formerly Liquefied Gaseous Fuels Spill Test Facility) was also conducted.

Field surveys were conducted from June 1996 through February 1997 to identify those natural NTS springs, seeps, tanks, and playas, which could be designated by the U.S. Army Corps of Engineers as jurisdictional wetlands. A summary report of the survey findings entitled “NTS Wetlands Assessment” has been published.

LOW-LEVEL WASTE DISPOSAL

Environmental monitoring at the RWMS, Area 3 (RWMS-3) has detected plutonium in air samples. However, the upwind/downwind sampler results were equivalent, and 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 (Figure 2.3, Chapter 2 displays these locations).

Environmental monitoring at and around RWMS-5 indicated that HTO in air was detectable at, but not beyond, the waste site boundaries. This monitoring included air sampling, water sampling, 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. Also, three monitoring wells, installed to satisfy Resource Conservation and Recovery Act (RCRA) requirements for a mixed-waste disposal operation, have not yet detected migration of hazardous materials.

RADIOLOGICAL MONITORING AT OFFSITE SUPPORT FACILITIES

Fence line monitoring, using Panasonic UD-814 TLDs, was conducted at offsite DOE/NV support facilities in North Las Vegas, Nevada; Santa Barbara, California; and at the Washington Aerial Measurements Operation. The 1997 results indicated that only background radiation was detected at the fence line of these facilities. In 1995, a small amount of tritium was accidently released from a calibration range building in North Las Vegas that was still detectable this year in the room where the release occurred. 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 0.00025 mrem, which is 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 discharges offsite that involved nonradiological hazardous materials. The primary environmental permit areas for the NTS were monitored to verify compliance with ambient air quality and the RCRA requirements. Air emissions sources common to the NTS included particulates from construction, aggregate production, surface disturbances, fugitive dust from unpaved roads, fuel burning equipment, open burning, and fuel storage facilities. NTS environmental permits active during 1997, which were issued by the state of Nevada or by federal agencies, included one comprehensive air quality permit covering emissions from construction of facilities, boilers, storage tanks, and open burning; four permits for surface disturbance (environmental restoration activities); seven permits for onsite drinking water distribution systems; one permit for sewage discharges to lagoon collection systems; six permits for septage hauling; one incidental take permit for the threatened desert tortoise; and one permit for the scientific collection and study of various species on the NTS. Further, a RCRA permit has been obtained for general NTS operations and for two specific facilities on the NTS.

Permits at non-NTS operations included 12 air pollution control permits, 2 sewage discharge permits, and 2 hazardous material storage permits. Three EPA Generator Identification numbers were issued to NTS operations, and three local RCRA-related permits were required at two of those operations.

The only nonradiological air emission of regulatory concern under the Clean Air Act (CAA) has been due to asbestos removal during building renovation projects and from insulated piping at various locations on the NTS. During 1997, there were no projects that required state of Nevada notifications. The annual estimate for non-scheduled asbestos demolition/renovation for fiscal year 1997 was sent to EPA Region 9 in December 1997.

RCRA requirements were met through an operating permit for hazardous waste storage, mixed waste storage, and explosive ordnance disposal operations. A Federal Facilities Agreement and Consent Order (FFACO) has been signed with the state that exempts the NTS from potential enforcement action related to mixed waste storage prohibition under RCRA.

The state's annual Compliance Evaluation Inspection during September 1997 found only minor deficiencies.

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 the state of Nevada operating permits, liquid discharges to 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 January and June of 1997, the state inspected all NTS equipment regulated by the state air quality permit. There were no findings as a result of these inspections.

In compliance with the Safe Drinking Water Act (SDWA) and seven state of Nevada drinking water supply system permits, the onsite distribution systems supplied by onsite wells are sampled monthly for residual chlorine, pH, bacteria, and, less frequently, for other water quality indicators. No exceedances have been found.

Monitoring for polychlorinated biphenyls as required by the Toxic Substances Control Act (TSCA) was done and was reported to the EPA and the state in June 1997.

At the HSC, 2 series of spill tests using 38 different chemicals were conducted during 1997. 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 R&IE-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 activities include compliance with the USFWS Biological Opinion on NTS Activities and the Biological Opinion on Fortymile Canyon Activities. NEPA activities included action on 3 Environmental Impact Statements (EISs), 5 Environmental Assessments (EAs), and 44 Categorical Exclusions. The Record of Decision on the sitewide EIS for the NTS and other test locations within the state of Nevada was published in December 1996.

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 were within the regulated levels established by city or county publicly owned treatment works.

Underground storage tank activities were limited to continued remediation of sites from previous tank removals.

In 1997, 13 surveys were conducted for historical and archaeological sites that identified 25 prehistoric and historic archeological sites. Four of these are considered candidates for listing on the National Register of Historic Places.

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 1997, work continued on a summary report, site records, and an artefact inventory of materials in the DOE/NV Curatorial Facility in preparation for an AIRFA consultation.

Waste minimization and pollution prevention activities conducted at the NTS and its offsite facilities involve an intensive recycling program and active product substitution projects.

1.5 GROUNDWATER PROTECTION

A LTHMP was instituted in 1972 to be operated by the EPA under an Interagency Agreement. In 1997 surface waters and groundwaters were monitored on and around the NTS, at five sites in other states, and at two off-NTS locations in Nevada 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.

HTO was detected in samples from wells at formerly utilized sites, such as the SALMON (Mississippi), GNOME (New Mexico), and GASBUGGY (New Mexico), at levels consistent with previous experience. The HTO in water from Well EPNG 10-36 at GASBUGGY that began to be detected in 1984, was detected for the sixth 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 is underway. The design of the program is for installation or recompletion of groundwater characterization wells at strategic locations on and near the NTS. Through 1997, 15 of these wells have been drilled on the NTS and 10 existing wells recompleted, while 16 wells have been drilled or completed in the near offsite area, downgradient of the NTS.

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 RWMSs are operated on the NTS, one each in Areas 3 and 5. During 1997, the RWMSs received LLW generated at the NTS and other DOE facilities. Waste is disposed of in shallow pits and trenches in RWMS-5 and in selected craters in RWMS-3. Transuranic (TRU) and TRU mixed wastes are stored on a curbed asphalt pad on pallets in overpacked 55-gal drums and assorted steel boxes pending characterization and shipment to the Waste Isolation Pilot Plant 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 RWMS-5.

Environmental monitoring at both sites included air sampling for radioactive particulates and HTO in air and external exposure measurements using TLDs. Water sampling and vadose zone monitoring for moisture and hazardous constituents are conducted at the RWMS-5. Environmental monitoring results for 1997 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 so there is no disposal of hazardous waste on the NTS.

Pit 3 in RWMS-5 has interim status for mixed waste generated on the NTS.

LLW will only be accepted for disposal from generators (onsite and offsite) that have submitted a waste application that meets the requirements of the Waste Acceptance Criteria document (NTS 1996) and that have 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 EPA's R&IE-LV.

ONSITE NONRADIOLOGICAL QUALITY ASSURANCE

The onsite nonradiological QA program was not operative during 1997, because stable chemical analyses are done by offsite contract laboratories. These contract laboratories are monitored for their participation and performance in various performance evaluation programs.

ONSITE RADIOLOGICAL QUALITY ASSURANCE

The onsite radiological QA program includes conformance to best laboratory practice and implementation of the provisions of DOE Order 5700.6C. The external QA intercomparison program for radiological data QA consists of participation in the DOE Quality Assessment Program administered by the DOE Environmental Measurements Laboratory and the Performance Evaluation Studies Program conducted by the EPA's National Exposure Research Laboratory.

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 R&IE-LV for the Offsite Radiological Safety Program meets all requirements of EPA policy and also includes applicable elements of the DOE QA requirements and regulations. The 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 1997

- 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 claimed that the DOE failed to comply with NEPA requirements at the NTS and must initiate a single, sitewide EIS for all major federal actions at the NTS. The state was seeking to halt shipments of LLW from Fernald and all other transportation, receipt, storage, and disposal of all kinds of waste and was 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 sitewide EIS. As of the end of 1997, the remaining claim, regarding disposal of LLW from offsite facilities is still unsettled.

- A notification letter was received regarding alleged potentially responsible party status connected with a commercial disposal site in California. The state notified DOE/NV that Omega Chemical Co., a hazardous waste treatment and storage facility, possessed documents indicating that DOE/NV had shipped hazardous waste to the site between 1988 and 1992. The company has declared bankruptcy and is unable to clean up the site. Jurisdiction of this site has been transferred to the EPA, which so far, has made no contact.

ACCOMPLISHMENTS FOR 1997

- One EIS and three EAs were initiated during 1997.

- Throughout 1997, 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.

- The Nevada Operations 1997 Site Pollution Prevention Program Plan, was completed and submitted to DOE Headquarters.

- Continued use of a Just-in-Time supply system allowed NTS contractors to reduce product stock and control potentially hazardous products.

- Progress continued on the NTS groundwater characterization program. Fifteen special wells have been completed and ten existing wells have been recompleted to meet program requirements.

- Environmental Restoration Program activities were conducted at some 29 sites during 1997.

- DOE/NV has entered into several consent orders and agreements. These are (1) a Memorandum of Understanding 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, (5) a FFACO for providing storage of low-level mixed waste generated at the NTS and for environmental restoration of contaminated areas, and (6) a Programmatic Agreement with the state covering archaeological and historic preservation activities.

- The Cotter concentrate, consisting of 1,148 barrels of material stored in Area 5 for many years, was shipped to an offsite contractor for recycling of the contained material.

- The last deficiency from a 1993 Environmental Compliance Audit was closed this year. This audit, by the Reynolds Electrical & Engineering Co. (the previous M&O contractor), was conducted at all facilities and work sites on the NTS.

- The following offsite remedial actions were completed in 1997:

1) Plutonium-contaminated soil was removed from the site of the 1963 CLEAN SLATE I nuclear device storage-transportation test on the NAFRC, and the site was revegetated. The soil was disposed of in the LLW site in Area 3, NTS.

2) At the SHOAL site in Nevada, four monitoring wells were installed to a depth of 396 m (1,300 ft), Desert Research Institute DRI conducted aquifer tests, and SAFER closure of one mud pit was completed.

3) At the RULISON site in Colorado, quarterly sampling for hazardous waste at four wells, a two year program required by the state, was completed. No migration of hazardous wastes has been detected.

4) At the FAULTLESS site in Nevada, surface characterization of mudpits at wells UC-1, UC-3, and UC-4 was performed.

5) At the SALMON site in Mississippi, 14 new shallow groundwater monitoring wells were installed, pumps were refurbished and installed in four existing wells, and one seismic check hole was plugged.

1.9 CONCLUSION

The environmental monitoring results presented in this report document that operational activities on the NTS in 1997 were conducted so that no measurable 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 0.09 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 instrument at Beatty, Nevada.

There were no major incidents of nonradiological contaminant releases to the environment in 1997. Many contaminated sites are on schedule for remediation, and intensive efforts to characterize and protect the NTS environment, implemented in 1990, were continued in 1997.

Table 1.1 Radionuclide Emissions on the NTS - 1997[a]

Radionuclide	Half-life (years)	Quantity Released (Ci) [b]
Airborne Releases:		
^{3}H	12.35	[c]140
$^{239+240}Pu$	24065.	[c]0.28
Containment Ponds:		
^{3}H	12.35	[d]20
^{238}Pu	87.743	1.5×10^{-6}
$^{239+240}Pu$	24065.	3.4×10^{-5}
^{90}Sr	29.	1.5×10^{-5}
^{137}Cs	30.17	1.7×10^{-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 1997

	Maximum EDE at NTS Boundary[a]	Maximum EDE to an Individual[b]	Collective EDE to Population within 80 km of the NTS Sources
Dose	0.12 mrem (1.2×10^{-3} mSv)	0.089 mrem (8.9×10^{-4} mSv)	0.26 person-rem (2.6×10^{-3} person Sv)
Location	Site boundary 40 km WNW of NTS CP-1	Springdale, NV 58 km WNW of NTS CP-1	31,000 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	1.2	0.89	-----
Background	144 mrem (1.44 mSv)	144 mrem (1.44 mSv)	3064 person-rem (30.6 person Sv)
Percentage of Background	8.0×10^{-2}	6.0×10^{-2}	8×10^{-3}

(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) west northwest 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 HTO 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; (4) open-air nuclear reactor and engine testing; and (5) eleven underground tests for various purposes at other locations in the U.S. No nuclear tests were conducted in 1997. Nonnuclear testing included controlled spills of hazardous material at the Hazardous Materials Spill Center (HSC). Low-level radioactive and mixed waste disposal and transuranic (TRU) and hazardous waste 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 groundwater 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/km^2 versus approximately 29 persons/km^2 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, the U.S. Department of Energy, Nevada Operations Office (DOE/NV) is accountable for six non-NTS Bechtel Nevada (BN) facilities in five different cities. These BN operations support DOE/NV programs with activities ranging from aerial measurements and aircraft maintenance to electronics and heavy industrial fabrication. All of these latter operations are in metropolitan areas.

2.1 NTS OPERATIONS

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 3,500 km^2 (1,350 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, called the Nellis Air Force Range Complex (NAFRC) and the Tonopah Test Range(TTR) (see Figure 2.1). These two areas provide a buffer zone varying from 24 to 104 km (15 to 65 mi) between the NTS and public lands. The combination of the NAFRC and the NTS is one of the larger unpopulated land areas in the United States, comprising some 14,200 km^2 (5,470 mi^2). Figure 2.2 shows the general layout of the NTS, including the

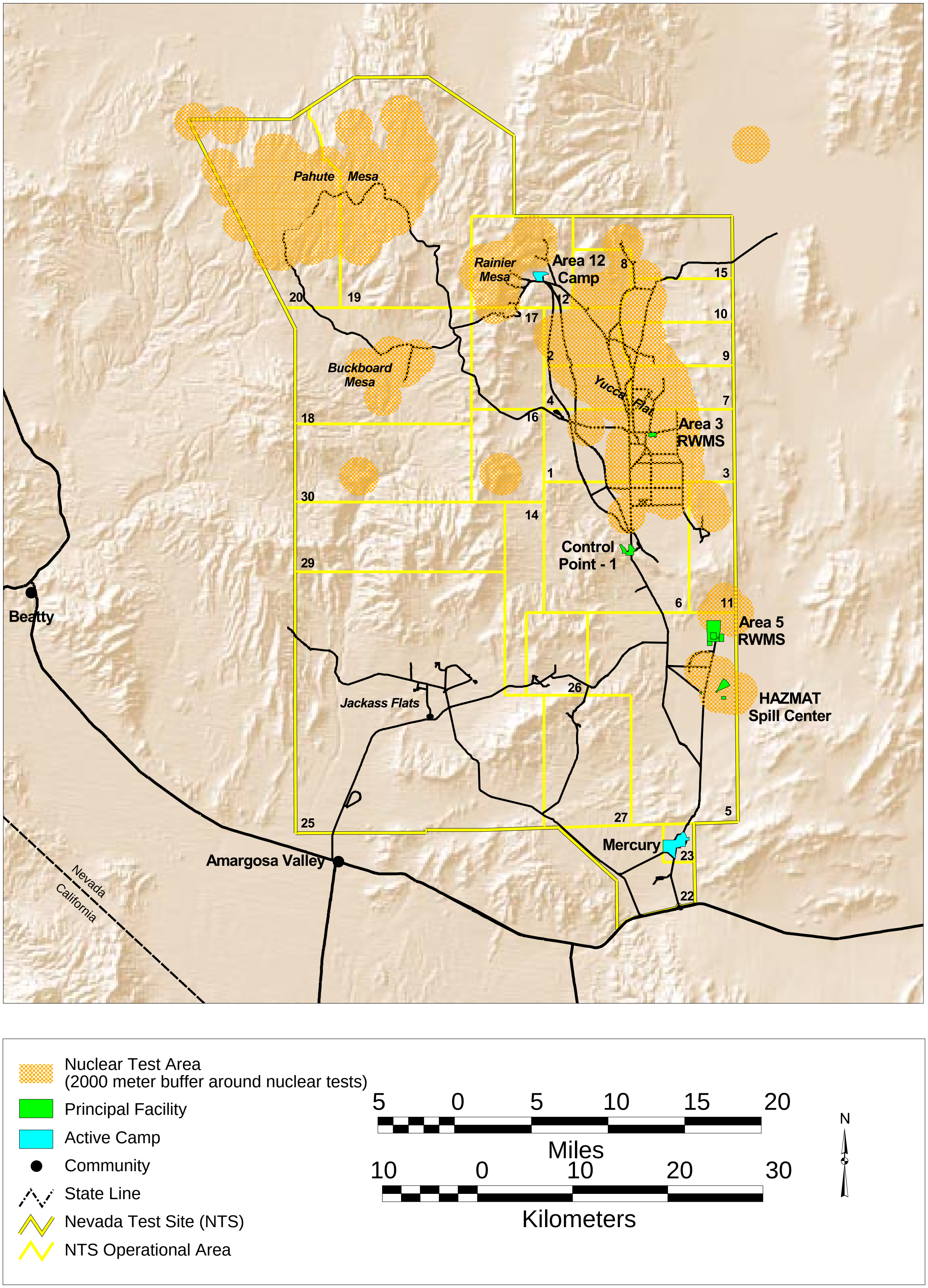


Figure 2.2 NTS Area Numbers, Principal Facilities, and Testing Areas

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 he NTS, is the main base camp for worker housing and administrative operations for the NTS.

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 tethered balloons or dropped from an aircraft. Several tests were categorized as "safety" experiments, involving the destruction of a nuclear device with nonnuclear explosives. Some surface safety tests resulted in dispersion of plutonium in the test vicinity. One of these test areas lies just north of the NTS boundary, and four others, involving transport/storage safety, lie at the north end of the NAFRC (see Figure 2.3). All nuclear tests are listed in DOE/NV Report NVO-209 (DOE 1994a).

Underground nuclear tests were first conducted in 1957. Testing was discontinued during a moratorium that began in November 1958, but was resumed in September 1961 after tests by the Union of Soviet Socialist Republics began. 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, that explored peaceful uses of nuclear explosives. The first and largest test, SEDAN (PHS 1963) was detonated at the northern end of Yucca Flat. There have been no U.S. nuclear explosive tests since September 1992.

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 (1,530-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 was conducted in Area 25, and a series of tests with a nuclear ramjet engine was conducted in Area 26.

Limited nonnuclear testing has also occurred at the NTS, including spills of hazardous materials at the HSC in Area 5. The tests conducted at the HSC, from the latter half of the 1980s to date, involved 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, and the DOE. At the Explosive Ordnance Disposal in Area 11, explosive materials are destroyed, generally by detonation, with the amounts destroyed being limited in order to maintain downwind air concentrations within state limits.

Waste storage and disposal facilities for defense low-level radioactive waste (LLW) and mixed waste are located in Areas 3 and 5. At the Area 5 Radioactive Waste Management Site (RWMS-5), LLW from DOE-affiliated onsite and offsite generators is disposed of using standard shallow land disposal techniques. A greater confinement disposal technique was once used for disposal of wastes that had high specific activity, high mobility, or were not acceptable for normal disposal. This method of disposal is no longer used.

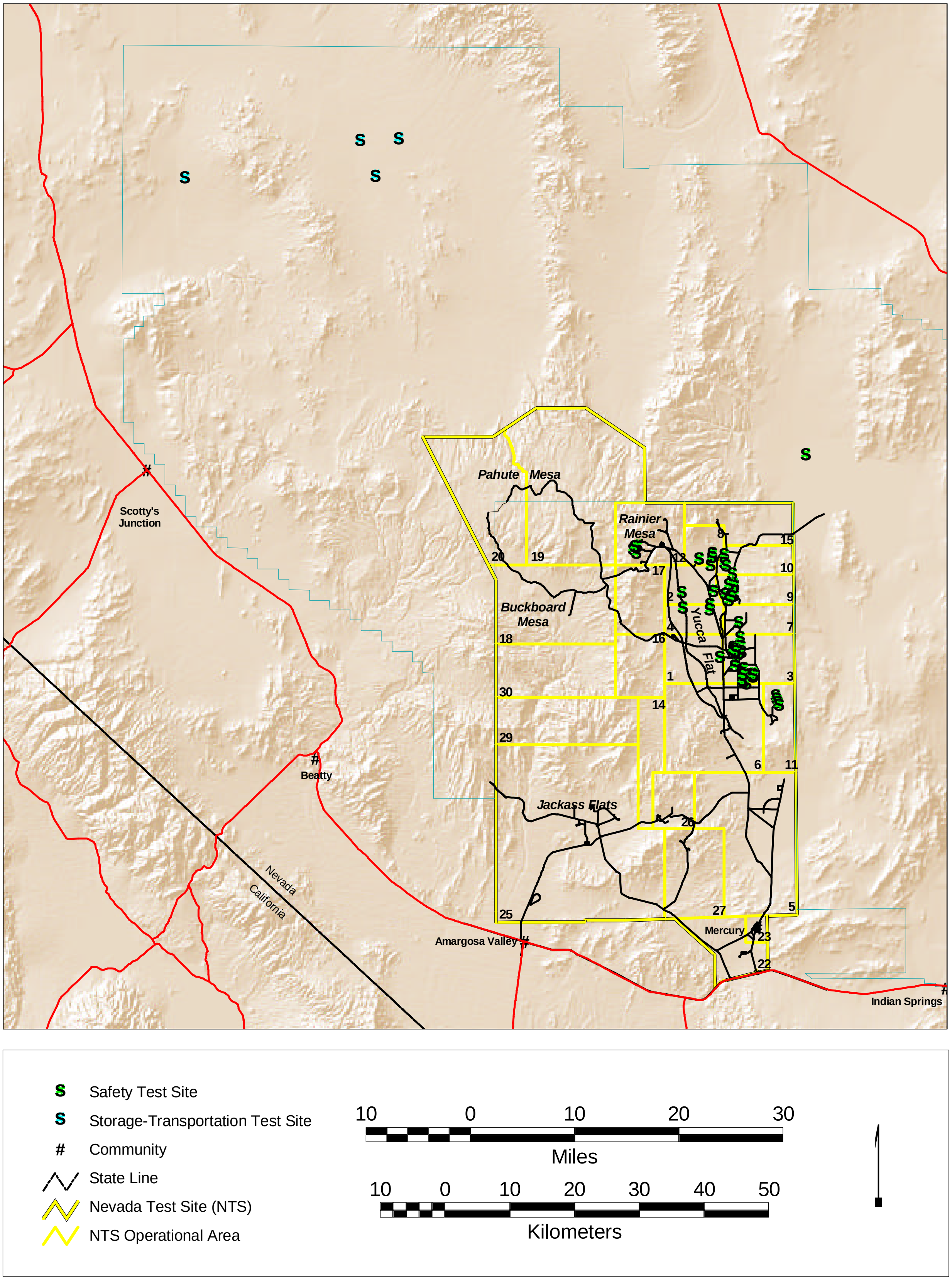


Figure 2.3 Location of Safety Tests on the NTS and the Nellis Air Force Range Complex

TRU wastes are retrievably stored in surface containers at the RWMS-5 pending shipment to the Waste Isolation Pilot Plant (WIPP) facility in New Mexico. Nonradioactive hazardous wastes are accumulated at a special accumulation site before shipment to a licensed offsite disposal facility.

At the Area 3 RWMS (RWMS-3), bulk LLW (such as debris from atmospheric nuclear test locations) and LLW in large non-standard packages are emplaced and buried in selected surface subsidence craters (formed as a result of prior underground nuclear tests).

1997 ACTIVITIES

NUCLEAR TESTS

No nuclear explosives tests were conducted during 1997, 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 as a result of the prior nuclear tests. The surveillance program and results are described in Chapters 4, 5, and 6.

NTS-RELATED ACTIVITIES

LLW and mixed waste handling and disposal, TRU waste storage and monitoring prior to shipment to the WIPP in New Mexico, and remedial actions related to sites contaminated by tests of nuclear devices are some of the activities that occurred in 1997.

Compliance with state and federal environmental laws and regulations was another principal activity during 1997. Specifically included were actions related to (1) National Environmental Policy Act documentation preparation, such as Environmental Impact Statements, Environmental Assessments, etc.; (2) Clean Air Act compliance for asbestos renovation projects, radionuclide emissions, and state air quality permits; (3) Clean Water Act compliance involving state wastewater permits; (4) Safe Drinking Water Act compliance involving monitoring of drinking water distribution systems; (5) Resource Conservation and Recovery Act management of hazardous wastes; (6) Comprehensive Environmental Response, Compensation, and Liability Act reporting; and (7) Toxic Substances Control Act 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.

HAZARDOUS MATERIALS SPILL CENTER (HSC)

DOE/NV's HSC 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 BN. The HSC is the basic research tool for studying the dynamics of accidental releases of various hazardous materials. This is described more completely in Chapter 6.

TOPOGRAPHY AND TERRAIN

The topography of the NTS is typical of the Great Basin Section 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 (3,000 ft) above mean sea level (MSL) in the south and east, rising to 2,230 m (7,300 ft) in the mesa areas toward the northern and western boundaries. The slopes on the upland surfaces are steep and

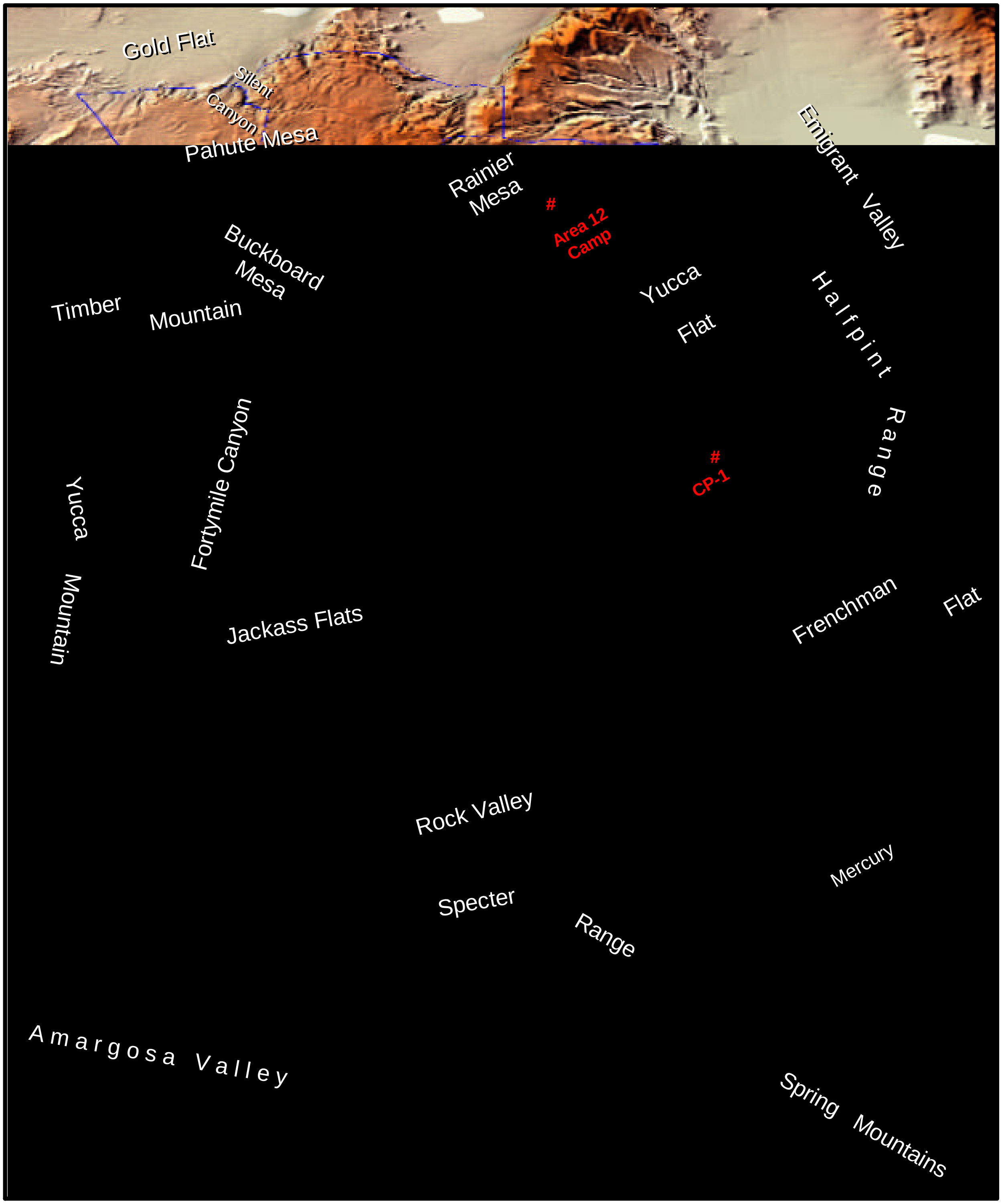


Figure 2.4 Topgraphy of the NTS

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.

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 (USGS) 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 United States.

In general, the geology consists of three major rock units. These rock units 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) with clastic rocks (shale and quartzite) near the top and at the bottom of the section. 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 the Tertiary age are predominantly rhyolitic tuffs and lavas, which erupted from various volcanic centers. The aggregate thickness of the volcanic rocks is many thousands of feet, but in most places the actual 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 (2,000 to 3,000 ft) in the central portions of the valleys. The alluvium in Yucca Flat is vertically offset along the prominent north-south-trending Yucca fault.

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 nuclear tests were conducted below the groundwater table; others were at varying depths above the groundwater table. Nuclear tests below the groundwater 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.

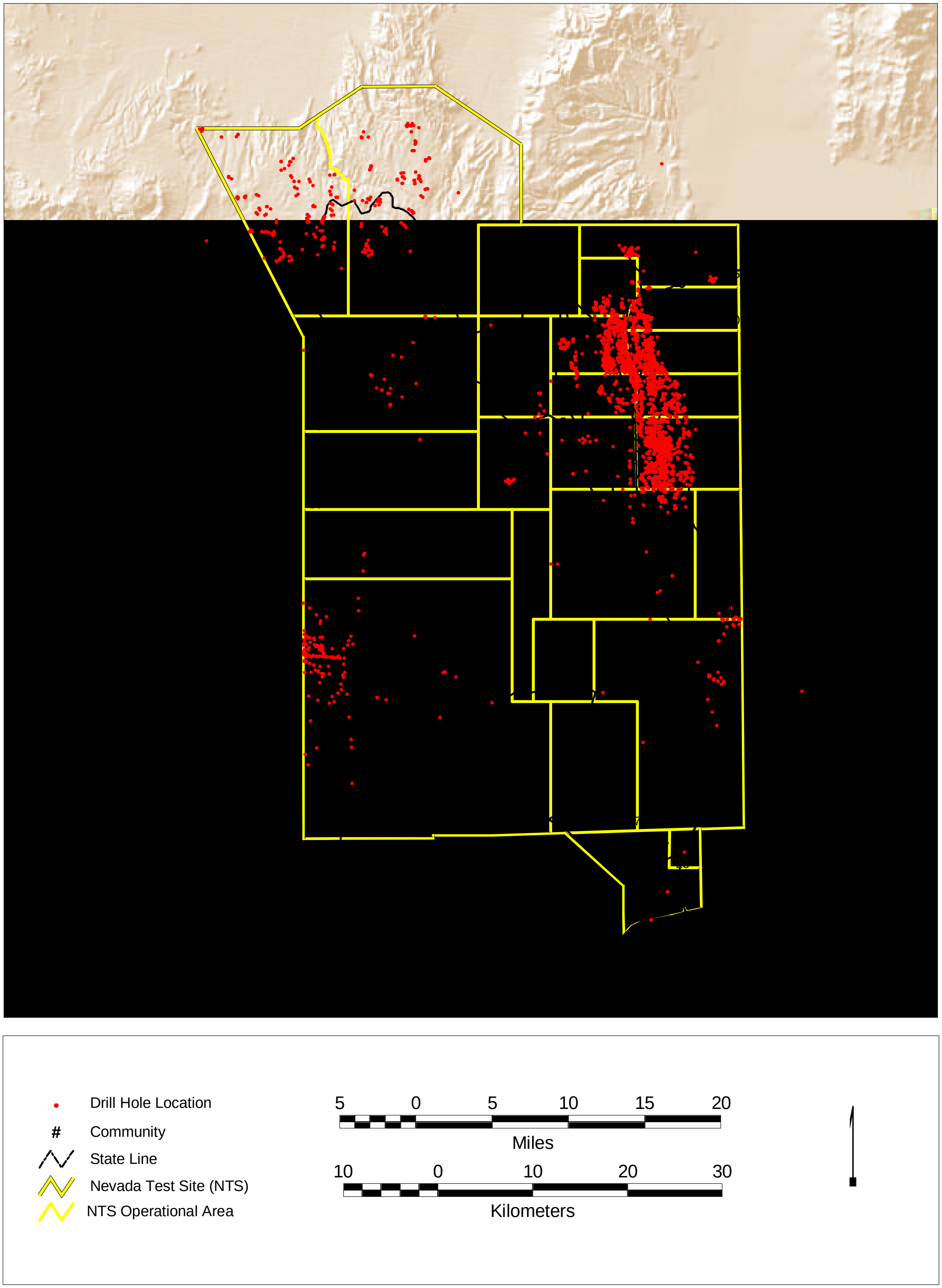


Figure 2.6 Drill Hole Locations on the NTS

Depths to groundwater under the NTS vary from about 210 m (690 ft) beneath the Frenchman Flat playa (Winograd and Thordarson 1975) in the southern part of the NTS to more than 700 m (2,300 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 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 and the USGS (Russell 1990, and Laczniak et al., 1996). 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 210 m (690 ft) to about 580 m (1,900 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 ephemeral 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 aquifers and 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 210 to 350 m (690 to 1,150 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 western part and older Tertiary sedimentary rocks in the southwestern part of the valley. In general, the depth to water is at least 210 m (690 ft) beneath Frenchman playa and increases to nearly 360 m (1,180 ft) near the margins of the valley (Winograd and Thordarson 1975). The water table beneath Frenchman Flat is considerably shallower 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 tuff confining unit. 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.

The only hydrostratigraphic units encountered at Pahute Mesa are the volcanic aquifers and aquitards. Pahute

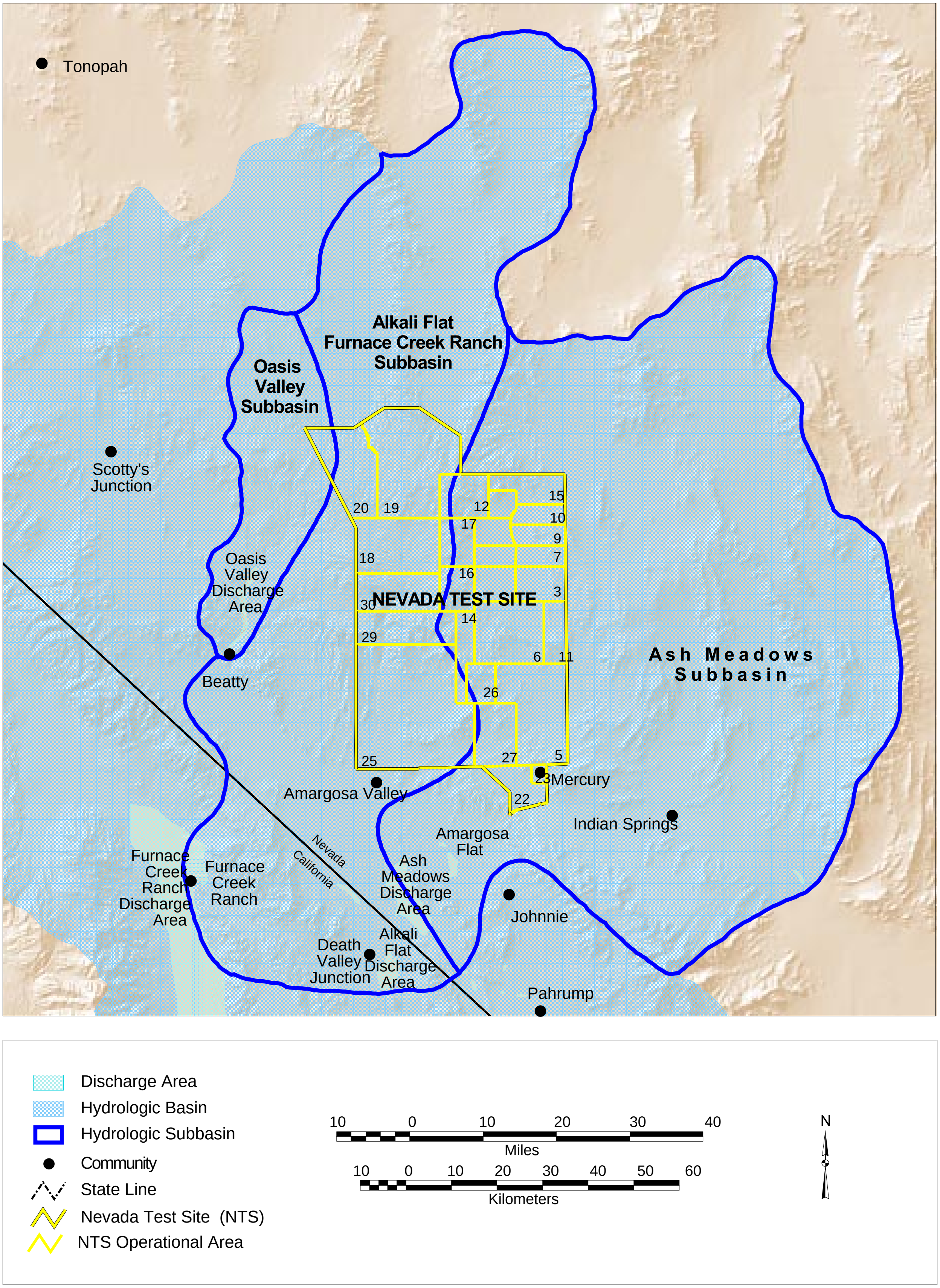


Figure 2.7 Groundwater Hydrologic Units of the NTS and Vicinity

Mesa is thought to be a part of both the Oasis Valley and Alkali Flat/Furnace Creek Ranch subbasins (Fig. 2.7). 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. 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 (Blankennagel and Weir 1973).

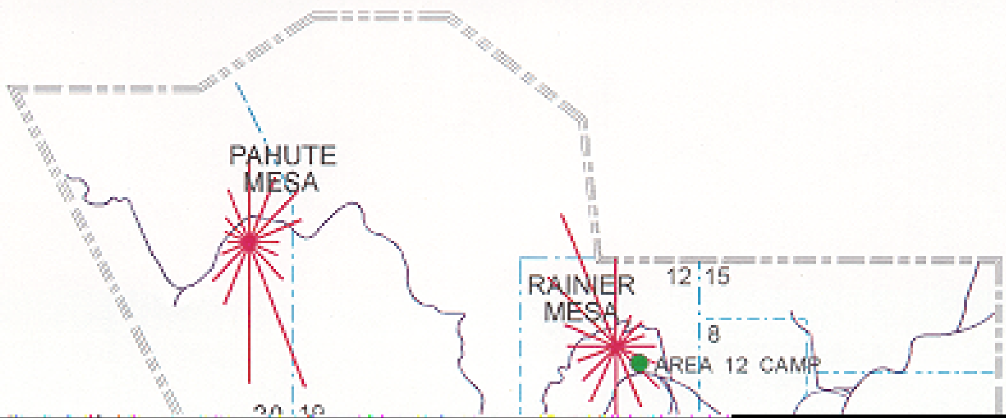
The hydrostratigraphic units beneath Rainier Mesa consist of the welded and bedded tuff aquifer, tuff confining unit, the lower carbonate aquifer, and the lower clastic aquitard. The volcanic aquifer and aquitards support a semiperched groundwater lens. Nuclear testing at Rainier Mesa was conducted within 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.

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 2,000 m (6,560 ft) above MSL in Area 20 on Pahute Mesa, the average daily maximum temperatures range from 40 to 80 ^{o} F, and minimum temperatures from 21 to 57^{o} F (4 to 27^{o} C and -6 to 14^{o} C, respectively). In Area 6 (Yucca Flat, 1,200 m [3,940 ft MSL]), the average daily maximum temperatures range from 51 to 96^{o} F and the minimum temperatures from 28 to 62^{o} F (11 to 36^{o} C and -2 to 17^{o} 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 from the south 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 10-m wind roses for the NTS are shown in Figure 2.8.


PAHUTE MESA
RAINIER MESA
12
15
8
AREA 12 CAMP

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 zone of transition between these two. 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 1,220 and 1,520 m (4,000 and 5,000 ft) in elevation in Yucca Flat, transitional associations are dominated by *Grayia spinosa-Lycium andersonii* (hopsage/desert thorn) associations, while the upper alluvial fans support *Coleogyne* types. Above 1,520 m (5,000 ft), the vegetation mosaic is dominated by sagebrush associations of *Artemisia tridentata* and *Artemisia arbuscula* subspecies *nova*. Above 1,830 m (6,000 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 the most important group of mammals on the NTS, based on distribution and relative abundance. Larger mammals include feral horses, mule deer, mountain lions, bobcats, coyote, kit foxes, and rabbits, among others. Among other taxa, the reptiles include the desert tortoise, over 12 lizards, and 17 snakes; 4 of which are venomous. Bird species are mostly migrants or seasonal residents. Most nonrodent mammals have been placed in the "protected" classification by the state of Nevada. The Mojave population of the desert tortoise, *Gopherus agassizii*, is listed as threatened by the U.S. Fish and Wildlife Service. The habitat of the desert tortoises on the NTS is found in the southern third of the NTS outside the recent areas of nuclear explosive test activities.

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 this 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 coexisted 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.

DEMOGRAPHY

The population of the area surrounding the NTS has been estimated based on the 1990 Bureau of Census estimates (Department of Commerce 1990). Excluding Clark County, the major population center (over 1,000,000 in 1996), the population density within a 150-km (90-mi) radius of the NTS is about 0.5 persons/km^2. In comparison, the 48 adjoining states (1990 census) had a population density near 29 persons/km^2. 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 nearly 20,000, is about 50 mi (80 km) south of CP-1. The Amargosa Farm area, which has a population of about 1,200, 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 1,500 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 5,000 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 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 population of 24,000. The Owens Valley, where many small towns are located, lies west of Death Valley. The largest town in Owens Valley is Bishop, 225 km (140 mi) west-northwest of the NTS, with a population of 3,500.

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 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 population estimate of 22,000, and Kingman, located 280 km (174 mi) southeast of the NTS, with a population of about 13,000.

SURROUNDING LAND USE

Figure 2.9 is a map of the offsite area showing a wide variety of land uses such as farming, 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 4,400 m (14,500 ft) above MSL in the Sierras, including parts of the Owens and San Joaquin agricultural 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 agricultural activity is the 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

Under a contract with DOE/NV, BN has several offsite operations that support activities at the NTS. Each of these facilities is located in a metropolitan area.

City, county, and state regulations govern emissions, waste disposal, and sewage. No independent BN 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 above a small fraction of federal guidelines are expected during normal facility operations.

AMADOR VALLEY OPERATIONS (AVO)

The AVO facility in Pleasanton, California, occupies a 5,520-m^2 (59,445-ft^2) two-story combination office/laboratory building. AVO is located near the Lawrence Livermore National Laboratory (LLNL) in Livermore, California, to simplify logistics and communications associated with BN support of LLNL programs. Although most of the work has been in support of NTS underground weapons testing, 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.

SPECIAL TECHNOLOGIES LABORATORY (STL)

STL is located in Santa Barbara, California. The current facilities occupy approximately 4,608 m^2 (49,600 ft^2) 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, neutron activation, and pulsed X-ray system experiments.

LAS VEGAS AREA OPERATIONS (LVAO)

The LVAO includes the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory (RSL) on the NAFB in North Las Vegas, Nevada. These facilities provide technical support for the DOE/NV activities.

The NLVF 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 RSL 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, warehousing, and emergency operations. Areas of environmental interest are photo processing, aircraft maintenance, and operations.

LOS ALAMOS OPERATIONS (LAO)

The LAO resides in an engineering and laboratory office complex of approximately 4,645 m^2 (50,000 ft^2). It is located near the Los Alamos National Laboratory (LANL) facility to provide local support for LANL's programs. The work performed includes direct support to the LANL Science-Based Stockpile Stewardship program, the DOE Research and Development 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 and above ground testing diagnostics; and the analysis of data from prior experiments. Areas of environmental interest include small solvent cleaning, metal machining operations, and a small photo laboratory.

WASHINGTON AERIAL MEASUREMENTS OPERATIONS (WAMO)

The WAMO, located at Andrews Air Force Base, consists of five buildings: a 186-m^2 (2,000-ft^2) Butler Building used as office space; a 1,110-m^2 (12,000-ft^2) hangar, combination electronics laboratory, aircraft maintenance, and office complex; a 37-m^2 (400-ft^2) equipment service and storage building; and 186 m^2 (2,000 ft^2) in each of two other joint tenant buildings. WAMO provide an effective east coast emergency response capability and an eastern aerial survey capacity to the DOE/NV. Areas of environmental interest include minor solvent cleaning operations, used fuels, and oils.

2.3 NON-NTS UNDERGROUND TEST SITES

Nuclear explosive tests have been conducted underground for a variety of purposes at eight different non-NTS sites in the U.S. The tests and their locations appear in Table 2.1 (AEC 1964, 1965, 1966, 1970, 1972, 1973a, 1973b; DOE 1978, 1984, 1986; PHS 1966). 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 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 Island, Alaska, occurs only periodically. Sampling results for these sites appear in Chapter 5 of this report.

Table 2.1 Non-NTS Underground Nuclear Test Sites

Test 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 Island, 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, Nevada	Seismic calibration	01/19/68
RULISON	Grand Valley, Colorado	Gas stimulation experiment	09/10/69
MILROW	Amchitka Island, Alaska	Seismic calibration	10/02/69
CANNIKIN	Amchitka Island, 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 (CY) 1997 involved the permitting and monitoring requirements of numerous state of Nevada and federal regulations. Primary activities included the following: (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; (7) Toxic Substances Control Act (TSCA) management of polychlorinated biphenyls; (8) Endangered Species Act (ESA) compliance involving the conduct of pre-construction surveys and site-wide surveys to document the status of state and federally listed endangered or threatened plant and animal species; and (9) National Historic Preservation Act (NHPA) compliance for the protection of Cultural and Native American Resources. There were no activities requiring compliance with Executive Orders on Flood Plain Management or Protection of Wetlands.

Throughout 1997, the NTS was subject to several formal compliance agreements with regulatory agencies, including a Memorandum of Understanding with Nevada covering releases of radioactivity; a Federal Facilities Agreement and Consent Order (FFACO) with Nevada; Agreements in Principle with Nevada and Mississippi covering environment, safety, and health activities; and a Settlement Agreement to manage mixed transuranic (TRU) waste. Emphasis on waste control and minimization at the NTS continued in 1997.

In June 1994, the state of Nevada filed a Complaint for Declaratory Judgement and Injunction against the U.S. Department of Energy (DOE). 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, the remainder are yet unresolved.

Compliance activities at the DOE Nevada Operations Office (DOE/NV) non-NTS facilities involved the permitting and monitoring requirements of (1) the CAA for airborne emissions, (2) the CWA for wastewater discharges, (3) SDWA regulations, (4) RCRA disposal of hazardous wastes, and (5) hazardous substance reporting. Pollution prevention and waste minimization efforts continued at all locations.

3.1 COMPLIANCE STATUS

NATIONAL ENVIRONMENTAL POLICY ACT

Section 102 of the 1969 NEPA requires all federal agencies to consider environmental effects, values, and reasonable alternatives before making a decision to implement any major federal action that 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 related to DOE/NV proposed actions.

DOE uses three levels of documentation to demonstrate compliance 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 have been found to have no adverse environmental impacts, based on similar, previous activities. During 1997, DOE/NV activities involved all three of these categories.

During fiscal year (FY) 1996 and FY97, a draft NEPA Environmental Evaluation Checklist was circulated by DOE/NV Environmental Protection Division (EPD). In October 1997, the Checklist was formally issued by EPD. Completion of the Checklist is required under the DOE/NV Work Acceptance Process Procedural Instructions (DOE 1997d) for all proposed projects or activities. The Checklist is reviewed by the DOE/NV NEPA Compliance Officer to determine whether the project or activity is included in the NTS/EIS and record of decision (ROD) or other previously completed NEPA analysis. During FY97 Checklists were completed for 44 proposed projects or activities. Nineteen of these 44 were exempted from further NEPA analysis by being a CX; twenty were exempted due to previous analysis in the NTS/EIS and ROD; one is still pending; three resulted in further analysis required in EAs (one of which was later withdrawn); and one required further analysis in an EIS.

One EIS was initiated during 1997 for the withdrawal of public lands for range safety and training purposes at the Naval Air Station in Fallon, Nevada. Still pending are the following documents:

- Nellis Air Force Range Complex EIS.
- Los Alamos National Laboratory Sitewide EIS.
- Land Surface Research and Development EA.
- Kistler Aerospace Corp. in Areas 18 and 19 EA.

Work was conducted on two EAs, including:

- Defense Special Weapons Agency, Johnston Atoll Pilot-Scale Technology Demonstrations and the Transport and Disposal of Contaminated Rubble and Soil.
- Southern California/Southern Nevada Intermodal Transportation of Low Level Radioactive Waste to the NTS.

Throughout CY97, the staff of the EPD continued to maintain and update the NEPA Compliance Guide (Volume III), a quick reference handbook containing procedures, formats, and guidelines for those personnel responsible for NEPA compliance activities. The staff of the EPD 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/HQ.

CLEAN AIR ACT

The CAA and the 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.

NTS NESHAP ASBESTOS COMPLIANCE

The state of Nevada Division of Occupational Safety and Health regulations (Nevada Administrative Code [NAC] 618.760-805) require that all asbestos abatement projects in Nevada, involving friable asbestos in quantities greater than or equal to three linear feet or three square feet, 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 Title 40 Code of Federal Regulations (CFR) 61.145-146 (CFR 1989).

During 1997, there were no projects that required state of Nevada notifications be made. The annual estimate for non-scheduled asbestos demolition/renovation for FY98 was sent to EPA Region 9 in December 1997.

RADIOACTIVE EMISSIONS ON THE NTS

NTS operations were conducted in compliance with the NESHAP radioactive air emission standards of Subpart H, of Title 40 CFR 61. In compliance with those requirements, a report on airborne radioactive effluents is provided to DOE/HQ 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 community of Mercury. Based on the amount of radioactivity handled, the exhaust from the analytical laboratories is considered negligible compared to other sources on the NTS and the tunnels have been sealed (although water still seeps from one). Present sources are gases from the ground caused by barometric pressure variations, evaporation of tritiated water (HTO) from containment ponds, diffusion of HTO vapor from the Area 5 Radioactive Waste Management Site (RWMS-5), and resuspension of plutonium contaminated soil from nuclear safety test and atmospheric test locations.

In the 1997 NTS NESHAP report for airborne radioactive effluents (Black 1998), airborne emission of HTO vapor from the containment ponds was conservatively reported as if all the liquid discharge into the ponds had evaporated and become airborne. For HTO vapor diffusing from the RWMS-5, plutonium particulate resuspension from Areas 3 and 9, and various other areas on and near the NTS, 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 Clean Air Package 1988 (CAP88-PC) software program was used to determine what total activity would have to have been emitted from the geometric center of the region in question in order to produce that EDE. Resuspended radioactivity was estimated by employing a published formula and confirming with offsite data.

Using these conservative estimates of air emissions in 1997 as input to the CAP88-PC computer model, the EDE would have been only 0.09 mrem, much less than the 10-mrem limit that is specified in Title 40 CFR 61.

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. A summary of NTS permits is in Table 3.1. (See Chapter 4 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 1996 Air Quality Permit Data Report was sent to the state of Nevada on February 21, 1997. This report includes aggregate production, operating hours of permitted equipment, and a report of all surface disturbances of five acres or greater. In order to provide consistency in responses, the state provided forms, which required calculation of actual emissions. During 1996, approximately six tons of pollutants were emitted from operations at the NTS.

NTS air quality permits limit particulate emissions to 20 percent opacity. Certification of personnel to perform valid visible emission opacity evaluations is required by the state, with recertification required every six months. During 1997, one Bechtel Nevada (BN) Environmental Compliance Department employee was recertified. In 1997, several visible emission evaluations of permitted air quality point sources were conducted. When visual evaluations determine that an emission exceeds the opacity requirement, corrective action is initiated. No exceedances of the opacity limit were noted in 1997.

During 1997, state of Nevada personnel conducted two inspections of NTS equipment regulated by air quality operating permits. In January 1997, the state conducted an inspection to verify process flow diagrams for all permitted facilities prior to issuance of the NTS Class II Air Quality Operating Permit. In June 1997, a state inspector returned to conduct an annual inspection of permitted facilities. There were no findings as a result of that inspection.

NON-NTS OPERATIONS

Under normal conditions, the six non-NTS facilities operated by the DOE/NV do not produce radioactive effluents. The six are (1) the North Las Vegas Facility (NLVF); (2) the Remote Sensing Laboratory (RSL) in North Las Vegas; (3) the Special Technologies Laboratory (STL) in Santa Barbara, California; (4) the Amador Valley Operation (AVO) in Livermore, California; (5) the Los Alamos Operation (LAO) in Los Alamos, New Mexico; and (6) the Washington Aerial Measurements Operation (WAMO) in Washington, DC.

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 summary of NTS permits is displayed in Table 3.1, and a complete listing of applicable permits appears in Chapter 5. There are no National Pollutant Discharge Elimination System permits for the NTS, as there are no wastewater discharges to onsite or offsite surface waters.

NTS OPERATIONS

Discharges of wastewater are regulated by the state of Nevada under the Nevada Water Pollution Control Act (NRS 445A .131-354). 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.

RESOURCE CONSERVATION AND RECOVERY ACT

The RCRA of 1976 and Hazardous and Solid Waste Amendments of 1984 (Title 40 CFR 260-281) constitute the statutory basis for the regulation of hazardous waste and underground storage tanks (USTs).

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.

NTS RCRA COMPLIANCE

In 1995, DOE/NV received a RCRA Hazardous Waste Operating Permit for the Area 5 Hazardous Waste Storage Unit (HWSU) and the Area 11 Explosive Ordnance Disposal (EOD) Unit. In addition, the Part B Permit application was revised to include the Mixed Waste Storage Pad (now under interim status) and updated information concerning general facility conditions. During 1996, the permit was modified to include the change in contractor and operational changes concerning the EOD and HWSU. The permit application modification for the Pit 3 Mixed Waste Disposal Unit was completed and submitted to the state in 1997. Several other minor modifications were made to the permit during 1997, mostly relating to updated personnel and training records.

No biennial report for hazardous waste generation was required to be submitted in 1997.

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 RWMS-5 TRU pad. This was amended in June 1994 to include environmental restoration mixed waste generated in Nevada. 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 (LDR) until October 6, 1995. The NEPD specified that this exemption would be extended through February 1996, pending negotiations towards a signed FFCA Consent Order. A Consent Order was signed, effective March 27, 1996, requiring compliance with a Site Treatment Plan (DOE 1996a), which was also finalized in March 1996. Compliance with the Consent Order exempts the NTS from potential enforcement action resulting from the mixed waste storage prohibition under RCRA.

The NEPD conducted its annual Compliance Evaluation Inspection (CEI) in September 1997. A few minor areas of concern were identified. At the end of 1997 NEPD, DOE, and BN were still resolving the issues and coming to common agreement on the corrective actions. It is unlikely that NEPD will pursue any formal enforcement actions as a result of the CEI.

HAZARDOUS WASTE REPORTING FOR NON-NTS OPERATIONS

In 1996, at contract transition, the existing EPA ID numbers for the AVO, STL, and LAO locations were terminated. BN obtained new numbers for AVO and STL and will operate the LAO facility as a conditionally exempt small quantity generator. In 1997, it was not required to submit the state of Nevada Hazardous Waste Generator biennial report for hazardous wastes generated at the NLVF under EPA Identification Number NVD097868731.

UNDERGROUND STORAGE TANKS

NTS OPERATIONS

The NTS 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 the NEPD to satisfy state regulatory reporting requirements.

During 1997, there were no USTs that were required to be removed in accordance with state and federal regulations. Remedial activities continued at previous tank removal sites during 1997 as funding became available.

NON-NTS OPERATIONS

There were no issues involving USTs at non-NTS locations during 1997.

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

In April 1996, the DOE/NV, Department of Defense, and the NEPD entered into an FFACO pursuant to Section 120(a)(4) of CERCLA and Sections 6001 and 3004(u) of RCRA to address the environmental restoration of historic contaminated sites at the NTS, parts of Tonopah Test Range (TTR), parts of the Nellis Air Force Range Complex (NAFRC), the Central Nevada Test Area, and the Project SHOAL Area. Appendix VI of the FFACO describes the strategy that will be employed to plan, implement, and complete environmental corrective action at facilities where nuclear-related operations were conducted.

EMERGENCY REPORTING AND COMMUNITY RIGHT-TO-KNOW ACT (EPCRA)

Compliance with this Act is discussed in the paragraphs below and summarized in the following checklist:

SARA Title III Reports

EPCRA Section	NTS Compliance Yes	No	Not Required
302-302: Planning Notification	x		
304: EHS Release Notification			x
311-312: MSDS/Chemical Inventory	x		
313: TRI Reporting		x	

Additional compliance activities under CERCLA/SARA for 1997 included the Nevada Combined Agency Report, which combines reporting under SARA Section 312, Tier II and Nevada Chemical Catastrophe Prevention Program requirements. The latter program covers extremely hazardous substances (EHSs).

The 1997 Nevada Combined Agency Hazardous Substances Reports for the NTS and other Nevada operations (NLVF and RSL) were submitted to the state as required. Due to the low reporting thresholds established by the Fire Marshall (many at one pound) the reports included many chemicals, both mixtures and single constituents. There were no reportable EHSs for 1996 so a report was not required in 1997.

The Nevada Combined Agency Reports for the Area 5 Hazardous Materials Spill Center and Areas 5 and 6 were also submitted as required.

In compliance with Executive Order 12856, a Toxic Release Inventory Report required by Section 313 of the SARA Title III must be provided if the facility, any time in the prior calendar year, exceeds any section 313 threshold for manufacture, process, or other use. In CY96 no thresholds were exceeded, so no report was required in 1997.

NON-NTS TIER II REPORTING UNDER SARA TITLE III

The reports for the off-NTS Nevada facilities, RSL and NLVF, are described under EPCRA above.

Other non-Nevada operations either had no chemicals above reporting thresholds or submitted their chemical inventories to the cities/counties as part of their business plans.

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 registration of facilities storing highly hazardous substances above listed thresholds. Reporting for this program is also covered by the Nevada Combined Agency Report discussed under EPCRA above. There were no reportable chemicals for 1996, and therefore no reports were submitted to the state in 1997.

TOXIC SUBSTANCES CONTROL ACT

State of Nevada regulations implementing the TSCA require submittal of an annual report describing polychlorinated biphenyl (PCB) control activities. The 1996 NTS PCB annual report was transmitted to EPA and the state of Nevada in June 1997. 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-two large and four small low volume PCB capacitors remain under the management of the LANL in Area 27 of the NTS. One PCB-containing transformer was repaired and put in service at the NTS in 1996, but was later found to still contain PCBs so it was removed from service again. In 1997, this transformer was successfully retrofitted so now there are no known PCB or PCB-containing transformers in-service at the NTS.

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 lagoon berms. All other pesticide applications were on an as-requested basis. General-use pesticides were preferred, although restricted-use herbicides and rodenticides were used. Contract companies applied pesticides at all non-NTS facilities in 1997.

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 1997 at the NTS relating to the Federal Insecticide, Fungicide, and Rodenticide Act.

HISTORIC PRESERVATION

The NHPA (36 CFR 79, 1966) 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 (NR) of Historic Places. Accordingly, cultural resource surveys and other studies are conducted 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 the projects on these sites. Technical reports contain the results of these data recovery programs. A data recovery plan was developed for one archaeological site and a field data recovery program was completed last October. Great Basin Indian tribal representatives visited this site before and after the fieldwork. The data recovery plan included three monitors from the major tribes. For those historic properties, which can be avoided by NTS activities, a monitoring program has been developed to field verify the condition of these sites through time.

The NHPA also requires that federal agencies inventory the cultural resources under their jurisdiction. In 1994, a survey of archaeological sites near four springs on the NTS was conducted. The results of this inventory were presented in a 1997 technical report. Also, a survey report on the second phase of the Fortymile Canyon rock art inventory was completed. Last spring, DOE/NV conducted interviews with Great Basin Indian tribal cultural experts at the Fortymile rock art locale.

The American Indian Religious Freedom Act directs federal agencies to consult with Native Americans to protect their right to exercise their traditional 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, human remains, sacred objects, or objects of cultural patrimony. A collection of DOE/NV archaeological materials, which had been housed at the Harry Reid Center at University of Nevada, Las Vegas (UNLV), was transferred to the DOE/NV Curatorial Facility along with the data for the archaeological sites. A summary report, site records, and an artifact inventory were completed for this collection. NAGPRA consultation on these artifacts will be conducted in the near future.

THREATENED AND ENDANGERED SPECIES PROTECTION

The ESA (Title 50 CFR 17.11) 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 and the desert tortoise and bald eagle are the only threatened species, which occur on the NTS. No threatened or endangered plants are known to occur on the site. A non-jeopardy Programmatic Biological Opinion was issued by the U.S. Fish and Wildlife Services (USFWS) to DOE/NV in August 1996 for planned activities at the NTS for a ten-year period.

The Desert Tortoise Compliance Program implemented the terms and conditions of the Programmatic Biological Opinion and documented compliance actions taken by DOE/NV. The terms and conditions, which were implemented in 1997, included the following: (1) tortoise clearance surveys for two projects (conducted within 24 hours from the start of project construction); (2) onsite monitoring of construction for two projects when heavy equipment was being used; (3) quarterly monitoring of tortoise-proof fencing around the ER-5-2 Well and at sewage treatment ponds in Areas 6, 22, 23, and 25; (4) zone-of-Influence transect surveys around two proposed underground testing area well sites near Beatty, Nevada believed to be outside suitable tortoise habitat; and (5) preparation of an annual compliance report to the USFWS for NTS activities that were conducted in CY97.

A total of 339 transects totaling 902 km (559 mi) were surveyed on the NTS over the last half of CY97 and the first quarter of CY98 for the presence of desert tortoises or their sign in areas of unknown tortoise abundance.

Areas of "none to very low" tortoise abundance were identified by the sample transect data. According to the 1996 Biological Opinion, tortoise clearance surveys are optional for new projects located in these areas. A GIS-generated map of the "none to very low" tortoise abundance areas was submitted to the USFWS for their concurrence, and a draft document of the survey results was prepared and will be finalized in CY98.

There is one bird (mountain plover [*Charadrius montanus*]) and two plant species (Clokey's eggvetch [*Astragalus oophorus* var. *clokeyanus*] and Blue Diamond cholla [*Opuntia whipplei* var. *multigeniculata*]), which are known, or are expected to exist on the NTS, that are candidates for listing by the USFWS under the ESA. There are ten plant, one reptile, one bird, and six bat species that occur on the NTS, which the USFWS has removed from the list of candidate species for listing. These species are now considered by the USFWS to be "species of concern" belonging to a group of species from which new candidates will be selected, if warranted. In 1997, preconstruction biological surveys were conducted at four proposed construction sites to determine the presence of these species. Survey results and mitigation recommendations were documented in survey reports. Field surveys to determine the presence and distribution of the reptile, bird, and bat species, which are "species of concern" on the NTS, were started in 1996 and were completed in 1997. Field survey results were summarized in a report titled "Distribution of the Chuckwalla, Western Burrowing Owl, and Six Bat Species on the Nevada Test Site" (Steen et al., 1997), which was prepared and published as a DOE topical report in May. Field surveys for Clokey's eggvetch were conducted in 1997 and will be completed in 1998.

EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT

There were no projects in 1997, 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.

EXECUTIVE ORDER 11990, PROTECTION OF WETLANDS

There were no projects in 1997, 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.

Field surveys were conducted under the Ecological Monitoring and Compliance program from June 1996 through February 1997 to identify those natural NTS springs, seeps, tanks, and playas, which could be designated by the U.S. Army Corps of Engineers as jurisdictional wetlands. A summary report of survey findings titled "Nevada Test Site Wetlands Assessment" (Hansen et al., 1997) was completed and distributed as a DOE topical report in May.

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

Actions taken to comply with the requirements of this Order are discussed in Section 3.2.

3.2 CURRENT ENVIRONMENTAL COMPLIANCE ISSUES AND ACTIONS

There were numerous activities and actions relating to environmental compliance issues in 1997. These activities and actions are discussed below, grouped by general area of applicability.

CLEAN AIR ACT

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. The Nevada Administrative Code (NAC) determines annual fees based on tons of actual emissions. Annual fees for facilities generating less than 25 tons of emissions are $0. The fee is $3.75 per ton for facilities that produce more than 25 tons of emissions in a calendar year. From the 1996 annual report, which was submitted in February 1997, it was determined that approximately six tons of emissions were produced, so that no annual fee was required.

An application to obtain a Class II air quality operating permit for the NTS was submitted in April 1996 and then revised and resubmitted in November 1996. In February 1997, the state issued a Class II Air Quality Operating Permit AP9711-0549 for the NTS. The permit replaced all existing air quality permits on the NTS except for the Hazardous Material Spill Center (HSC) and the open burn permits. The new permit omitted the Area 5 and Area 23 portable slant screens, which are no longer required to be permitted. In April 1997, the permit was modified to include a Cambilt conveyor, which was relocated to the TTR to be used in conjunction with the CLEAN SLATES environmental restoration projects (See Non-NTS Air Quality Permits).

The five-year operating permit for the HSC was renewed in October 1997. The new permit, AP9711-0556, contains several new requirements, including weekly monitoring and recording of throughput amounts and hours of operation of emission units, and a 20 percent opacity restriction. DOE/NV EPD is currently working with the state to modify these restrictions.

Two open burn permits were renewed by the state in 1997. These include Permit 97-34, for the Area 27 burn box, and Permit 97- 20, for fire and radiological emergency response training exercises. Notification and reporting requirements previously listed in the Area 27 burn permit were deleted from the 1997 renewal. These requirements were also deleted from the other burn permit during the preceding year. In January 1997, the state determined that it was not necessary to permit activities that didn't meet the definition of open burning as it appears in the NAC. Therefore, because activities such as high explosives tests are not included in the NAC definition, the Big Explosives Experiment Facility open burn permit was not renewed.

The NTS also has a Nevada Hazardous Materials Storage Permit Number 13-97-0034-X, issued by the state Fire Marshall, and is renewed annually when a facility makes a report required by the state's Chemical Catastrophe Prevention Act. Table 3.1 contains a permit summary.

NON-NTS AIR QUALITY PERMITS

In April 1997, a permit was issued for the CLEAN SLATES environmental restoration project, located on the TTR. The permit consisted of a General Air Quality Operating Permit (AP9711-0549), which included surface disturbance restrictions and an Approval of Location, which granted approval to operate 16 pieces of permitted equipment that had been relocated from the DOUBLE TRACKS project at the NAFRC to the TTR. A report documenting production amounts and operating hours was submitted to the state upon completion of the CLEAN SLATE I project in June 1997.

The state issued a permit for the CLEAN SLATE II environmental restoration project, also located on the TTR, in June 1997. The permit included a Surface Area Disturbance Permit 9711-0549 and a Site Specific Permit Attachment 1574 to reflect the change of location of 15 pieces of permitted equipment from the CLEAN SLATE I project location. The CLEAN SLATE II project has not yet been initiated.

Twelve air pollution control permits were active for emission units at the Las Vegas Area Operations. 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 had one air pollution control permit for a degreasing operation, but the permit was terminated in December 1997 when a nontoxic degreaser was substituted. For the other non-NTS operations, no permits have been required, or the facilities have been exempted.

CLEAN WATER ACT

Dewatering of septage and wintertime 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 during 1997 and will be used again in 1998 for this application.

A total of 12 active septic tank systems are in service on the NTS. Two active holding tanks, which require replacement with an approved system, are still in service on the NTS. Nine additional septic tank systems serve unoccupied buildings, but will remain on active status until permanently closed. Facility Managers have been informed of deficiencies noted during inspections.

Construction of the Area 23 Infiltration Basin Groundwater Monitoring Well was completed on February 27, 1996. Installation of a pump with cable and discharge piping and development of a completion report were completed during 1997 to finish the project. The monitoring well is now functional and in compliance with groundwater protection requirements contained in state general permit GNEV93001.

The Area 25 Test Cell C was taken out of service during the first quarter of 1997 to comply with SDWA regulations. No system action will be required at the sewage lagoons to comply with the permit requirements at this time. Improvements will be implemented if use of the facility is needed in the future.

A bypass sewer line for the Area 25 Central Support primary sewage lagoon was constructed from November 12 through November 18 as a result of joint efforts between the BN Waste Management Project/Technical Support and DOE/Yucca Mountain Site Characterization Office staffs. This line will provide for operational flexibility and in situ primary lagoon infiltration rate measurements. The effectiveness of biological clogging on the existing soils was determined in 1997 to be inadequate for compliance with the groundwater protection program, so conceptual designs on options have been initiated.

Funding for design of engineered liner installation within the Area 25 Reactor Control Point sewage lagoons was received from DOE/Asset Management Division in October of 1996. Engineering drawings for this installation have been drafted, and a cost estimate for the installation of a geosynthetic liner was completed during the first quarter 1997. A second project cost estimate depicting the installation of a liner mix developed from soils readily available at the Area 1 Batch Plant has also been prepared. Both of these options are being considered, as well as suspending the intermittent use of the facility.

Funding for design of an engineered liner in the Area 6 DAF primary sewage lagoon was obtained in FY97. The most feasible and cost effective method to comply with groundwater protection requirements at this site is to line the primary lagoon to attain full containment with existing flow rates. Funding has been requested for FY98 to install the liners by the permit deadline date.

SAFE DRINKING WATER ACT

Engineering design has been completed on approximately 50 buildings or facilities at the NTS requiring retrofit through installation of backflow prevention devices on water service lines. These facilities required over 110 separate installations; the last one was completed this year.

During 1997, a ten-inch water line was installed leading to the Area 5 HSC. Plans were also finalized to replace the Army Well tank and to recoat four other existing tanks. This tank work will begin in 1998.

The Operations and Maintenance Manual for the NTS water distribution systems was updated to incorporate some recently passed state of Nevada regulations.

There was no sanitary survey of the water distribution systems by the Nevada Bureau of Health Protection Services during 1997.

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

Other than the reporting covered in Section 3.1, there is no formal CERCLA program at the NTS. The FFACO, with the state, may preclude the NTS from being placed on the National Priority List. More of a RCRA approach in remediating environmental problems will be taken by the FFACO.

HISTORIC PRESERVATION

Historic preservation studies and surveys are conducted by the Desert Research Institute (DRI), University and Community College System of Nevada. In 1997, 13 surveys were conducted for historic properties on the NTS, and unpublished reports on the findings were prepared. These surveys identified 25 prehistoric and historic archaeological sites. Through consultation with the Nevada State Historical Preservation Office, four of these sites were considered eligible for the NR. Work continued on historic structures associated with early NTS activities. Impacts planned to the Engineering Maintenance Assembly and Disassembly Facility in Area 25 required the preparation of Historic American Engineering Records documentation for the facility. This documentation will reside in the Library of Congress. Historic American Building Survey documentation is in preparation for the EPA Farm.

Other efforts in 1997, 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 Title 36 CFR 79, a multi-phase program is in progress to upgrade the NTS archaeological collection and archives. In 1997, DRI continued and completed the piece-by-piece inventory of the lithic artifacts in the collection. Approximately 500,000 artifacts in the collection have been inventoried and repackaged according to federal requirements.

POLLUTION PREVENTION AND WASTE MINIMIZATION

IMPLEMENTATION

BN published the Nevada Operations Site Pollution Prevention Program Plan in 1997 for the Nevada Operations Office in accordance with DOE/NV and DOE/HQ requirements. This plan is a guidance document, utilized to reduce waste generation and any potential pollutant releases to the environment. BN reviews the plan annually and revises it every three years, or as needed, to incorporate the most current pollution prevention and waste minimization requirements and Executive Orders. This provides a means of establishing ongoing goals for further improvements and increased protection to public health and the environment by:

- Reducing employee exposure.
- Reducing resource usage.

- Reducing inventories of chemicals that require reporting under the SARA and the EPA 33/50 Pollution Program.

- Reducing exposure to civil and criminal liabilities under environmental laws.

- Reducing waste management and compliance costs.

- Reducing overhead costs and increasing productivity through improved work processes and greater awareness.

GOALS AND DESCRIPTIONS

The site-specific quantitative goals and deliverables for 1997 were satisfied. These goals include reducing of hazardous and sanitary waste generation, increasing sanitary waste recycling and increasing Affirmative Procurement of EPA-Designated Recycled Products. The goals are based on the 1993 baseline quantities for routine waste.

The BN Just-in-Time (JIT) supply system continues to account for nearly 90 percent of all procurement actions, providing the most commonly used 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.

PROCUREMENT CONTROLS

The purchase of any item that requires a Material Safety Data Sheet (MSDS), including JIT purchase requisitions, is screened by Environmental, Safety, and Health personnel and Waste Management Projects/Nonradioactive Waste Operations personnel. They determine the need for the hazardous material requested and review MSDSs for products purchased outside the BN JIT system. These products may be approved or disapproved. The approval process relies on the health, safety, and environmental issues related to the product. If the waste generated by these materials has the potential to be regulated under the 1980 CERCLA/RCRA, or has a potential of causing harm to individuals or the environment, the reviewers will approve that purchase only if there is no approved substitute for the product, and the use of the product cannot be prevented by process modification.

AFFIRMATIVE PROCUREMENT

The DOE/NV and BN established an Affirmative Procurement Program to comply with the requirements of Executive Order 12873 to procure products containing recovered materials. This program focuses on seven major categories, including construction materials, landscape, non-paper office, paper office, park and recreation, transportation and vehicular products. Under each category are a number of specific products. In FY97, 100 percent of construction materials, 96 percent of paper office products, 80 percent of non-paper office products, and 64 percent of vehicle re-refined lubricating oil, procured by BN, contained recovered materials. Additionally, BN increased procurement of retread tires by 12 percent. There were no new purchases in FY97 for the remaining major categories.

COTTER CONCENTRATE

In 1987, the material known as "Cotter Concentrate," which had been designated by DOE/HQ as strategic material, was shipped to the DOE NTS from the DOE Mound Facility. It was to eventually undergo additional uranium extraction for use in the DOE nuclear weapons program. In January 1995, due to the decline in demand for raw materials for the production of nuclear weapons, DOE/HQ determined that there was no longer a use for the Cotter Concentrate as strategic material and declared the material mixed waste. Responsibility for performing treatment of the waste to meet the LDR requirements and disposal of the material was assigned to the DOE/NV. In 1997, this waste was redesignated as a feedstock material and shipped to a uranium processing facility known as International Uranium Corporation (IUC), formerly Energy Fuels Nuclear, located in southeastern Utah. IUC performed additional uranium extraction, followed by disposal of the residue generated by their reprocessing.

The benefits to DOE/NV were cost savings of approximately three million dollars, due to reprocessing as feedstock material rather than having to perform treatment and disposal. In addition, the material, approximately 197 m^3, was recycled and used as a resource, instead of being discarded as a waste. The extracted uranium will be used in the production of energy by commercial nuclear power plants.

TRAINING

BN is committed to implementing effective pollution prevention, waste minimization, and recycling awareness. Every practical effort is implemented to educate all employees in pollution prevention. Employee education is accomplished through formal training, articles published in BN newsletters, and other awareness program strategies. A Pollution Prevention home page will be developed and placed on the BN Intranet during FY98.

Management and employees working in the environmental arena are instructed in BN pollution prevention and waste minimization policies and procedures. The level of instruction qualifies personnel to perform pollution prevention tasks. Environmental awareness training is presented to managers and employees on an as needed basis.

CHEMICAL AND MATERIAL EXCHANGE

BN continues to coordinate chemical and material exchanges whenever possible. Virgin chemicals and materials that are destined for disposal as waste as a result of process modification, discontinued use, or shelf life expiration are returned to the vendor or transferred to another government contractor or agency to be utilized. This is a substantial cost savings for both BN and DOE/NV. Examples of chemical and material exchanges made during 1997 are listed below:

- Returned an estimated 91 gallons of unused chemicals, destined for disposal, to the vendor.
- Coordinated redistribution of 32 different chemicals that were destined to be disposed of. The estimated cost saving was $30,000.
- Assisted in transferring 73 pounds of virgin mercury, destined for disposal, from the BN Material Testing Laboratory to U.S. Geological Survey in Area 25.
- Coordinated with BN Redistribution and Sales Group on the Energy-Related Laboratory Equipment Program to donate miscellaneous laboratory equipment, estimated at $9,000, to the UNLV Physics Laboratory.
- A BN Procurement representative took a pro-active pollution prevention approach to return 4,700 expired and 11,850 soon-to-expire Celtite resin cartridges to the vendor for reuse. These cartridges were previously disposed of as hazardous waste, so the estimated cost savings was $8,751.

POLLUTION PREVENTION OPPORTUNITY ASSESSMENTS (PPOAs)

BN implements pollution prevention and waste minimization options involving source reduction and elimination via product substitution, reuse, and recycle. These efforts reduce the total volume of hazardous, radioactive, mixed, and nonhazardous solid waste streams generated and disposed of. Waste streams are carefully reviewed to identify opportunities for reducing or eliminating the volume and toxicity of wastes generated through the use of PPOAs.

BN implements pollution prevention options in accordance with the Pollution Prevention Act hierarchy that states the following criteria should be implemented to prevent or reduce pollution at the source wherever feasible:

- Recycle wastes in an environmentally acceptable manner.
- Reuse if applicable.
- Treat wastes that cannot feasibly be prevented or recycled.
- Dispose of wastes only as a last resort.

Pollution prevention is the DOE's preferred approach to environmental management. BN's activities have reduced or eliminated hazardous chemicals and generated cost savings/avoidance in disposal, product, energy, and labor costs. Progress toward meeting mission objectives poses continuing challenges and opportunities for pollution prevention to reduce future risks and costs associated with managing wastes and pollutants.

The sitewide (NTS and NLVFs) waste reduction results have come from formal processes such as PPOAs, a Return on Investment (ROI) Project, solid and liquid waste recycling, affirmative procurement, and from employees knowledgeable with processes which generate waste or use hazardous chemicals.

A PPOA is a systematic, planned, and documented procedure with the objective of identifying methods that reduce energy consumption or eliminate waste streams. The technical and economical feasibility of options are evaluated, and the most promising options are selected for implementation. Options include product substitution, cross contamination control, process change (i.e., the use of alternate equipment or procedure), and onsite recycling. During 1997, one PPOA was conducted at the RSL Photography Laboratory located on the NAFB. This pollution prevention opportunity was selected as having the greatest potential for waste stream reduction.

This PPOA analyzed the feasibility of combining two processors; the Hope roller transport E-6 processor and Kodak RT-1811 roller transport film processor, in order to eliminate the E-6 film process. The PPOA investigated the opportunity to eliminate the prehardener and neutralizer stages of the RT-1811 process. The goal of the PPOA was to reduce the chemical usage, thereby minimizing associated waste and worker exposure to the hazardous components of the chemicals. The most viable recommendation was to upgrade the equipment to Kodak Aerial Color Processor, Model RT-1611, a durable, high speed, self-threading roller transport processor designed for the latest Kodak color aerial films. This option eliminated the need for the prehardener and neutralizer chemicals and associated safety and health hazards and waste products. Additionally, the RT-1611 will most likely accommodate E-6 film products, eliminating the need for that process. The feasibility is good, with an estimated annual cost saving of $38,405 and an anticipated annual reduction in the quantity of chemicals of 2,150 gallons.

RETURN ON INVESTMENT (ROI)

The ROI program was initiated to demonstrate the economic benefit of implementing pollution prevention projects and focus on those with the potential for reducing operational costs. The ROI program is based upon total cost savings achieved across all DOE organizations compared to the dollars spent to implement the project. The ROI project listed below was identified and implemented in FY97 with an estimated payback period of 1.01 years.

The ROI project consists of replacing of expired tritium powered EXIT signs with nonhazardous photoluminescent EXIT signs.

Implementation of this ROI successfully eliminates future use of EXIT signs containing tritium and also diverts expired signs from a low level waste landfill. Seventy-six tritium powered EXIT signs have been shipped offsite to one of the original manufacturers for disposal. The manufacturer will recover the remaining tritium in the EXIT signs for reuse in other products. Replacement, nonhazardous photoluminescent EXIT signs have been procured and installed to replace the signs containing tritium. The photoluminescent EXIT signs can be disposed of in a sanitary landfill, effectively eliminating the costs of disposal offsite. Through product substitution, future use of a hazardous radioactive material and generation of a hazardous radioactive waste will be avoided. This ROI for replacing tritium powered EXIT signs is high, with a short payback period of just over one year.

PUBLIC AND COMMUNITY OUTREACH PROGRAM

The BN Pollution Prevention Project Office, along with DOE/NV and Wackenhut Services Incorporated, continue to participate in public and community outreach programs. These activities include the Earth Fair, JASON Foundation for Education, Nevada Regional Science Bowl, open house for employees at the NLVF and NTS, and presentations related to pollution prevention and waste minimization at local schools.

SOLID WASTE RECYCLING

The solid waste recycling project (high-grade paper, mixed paper, cardboard, and aluminum cans) continues at all BN locations. During 1997, the solid waste recycling project at the NTS improved with the installation of recycling stations (collection containers) in all occupied buildings.

BN improved the following recycling projects during 1997:

- Onsite recycling of antifreeze from heavy equipment and light duty vehicles. This project was initiated by an employee of Fleet Operations.
- The lead weights were removed from vehicle tires during scheduled routine maintenance and collected for recycling offsite.
- The retread tire project began in late 1996. The project consists of sending old tires from heavy equipment and light duty vehicles offsite to be recapped; if the tires are beyond use, they are sent offsite to be salvaged or recycled. Recapped tires are purchased for limited types of vehicles.
- The NTS Reproduction Shop was closed during 1997. An estimated 25,000 sheets of various forms were made into scratch pads, an alternative use suggested by an employee from the Reproduction Shop.

Table 3.2 contains the amount of various items recycled during 1997.

REPORTS

The BN CY96 pollution prevention accomplishments, to be published in the Annual Report of Waste Generation and Pollution Prevention Progress Report, were completed and transmitted to DOE/HQ on February 25, 1997.

The SARA Section 313 chemical usage report and the 33-50 TRI Program Priority chemical usage report for CY96 were submitted to DOE/NV on March 27, 1997.

The Nevada Operations Site Pollution Prevention Program Plan, 1997, was submitted and approved by DOE/NV and transmitted to DOE/HQ on July 8, 1997.

The Affirmative Procurement Report was submitted and approved by DOE/NV on December 18, 1997, and forwarded to DOE/HQ, in accordance with RCRA, Section 6002(d) and Executive Order 12873.

Quarterly pollution prevention reports were submitted to DOE/HQ during 1997.

SOLID/SANITARY WASTE

During 1997, landfills were operated in Areas 6, 9, and 23. The amount of material disposed of in each is provided in Chapter 6.0.

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 5, 1995 (later delayed by two years). As the result of an agreement with the NEPD Bureau of Federal Facilities (NEPD/BoFF), the Class II landfill at U-10c Crater in Area 9 was closed on October 5, 1995, for retrofit as a Class III Site. The retrofit consisted of the installment of a barrier layer of at least four feet of native soil to segregate the different waste types and to inhibit leachate transport to the lower waste zone. In addition, five neutron monitoring tubes were installed in the barrier layer to monitor possible leachate production and water activity. Upon the NEPD approval of the installed barrier and operating plan, U-10c Crater was reopened in January 1996 as a Class III Site for the disposal of industrial solid waste and other inert waste. An application for a permit to operate the U-10c Crater as a Class III industrial solid waste disposal site was submitted to the NEPD/BoFF in May 1996. The Class III permit application was revised and resubmitted in August 1996 in response to informal comments provided by the NEPD/BoFF. Operating Permit SW 13 097 03 was issued by NEPD with an effective date of July 17, 1997.

An application for a permit to operate the Area 23 landfill as a Class II Municipal and Industrial Solid Waste Disposal Site was submitted to the NEPD/BoFF in October 1996. This was approved by NEPD issuing Operating Permit SW 13 097 04, with an effective date of December 12, 1997.

Chapter 6 also gives the amount of hydrocarbon contaminated soil disposed of in the Area 6 landfill in 1997. An application for a permit to operate the Area 6 hydrocarbon landfill as a Class III solid waste disposal site was submitted to the NEPD/BoFF in March 1996. Upon receipt of verbal comments from the NEPD/BoFF, a revised application was submitted in April 1996, followed by the receipt of a Notification of Completeness from the NEPD/BoFF in May 1996. An evaluation of the merits of the application was conducted and, as a result, minor changes were incorporated in the application document. A copy of the revised permit application was submitted to the NEPD/BoFF in August 1996. Operating Permit SW 13 097 02 was then issued by NEPD with an effective date of May 23, 1997.

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 identify hazardous debris and material. In 1997, cleanup activities were completed in Area 2, as confirmed in a September 15, 1997, letter to DOE/NV from NEPD. During this cleanup approximately 131,260 pounds of solid waste were removed from Area 2 and properly disposed of in U10c Landfill. Also, 9,048 pounds of lead materials and 17,000 pounds of electrical cable were delivered to the NTS Salvage Yard for recycling and reclamation.

FEDERAL FACILITIES AGREEMENT AND CONSENT ORDER

REMEDIAL ACTIVITIES - SURFACE AREAS

Environmental restoration activities continued at the NTS and TTR in 1997. Activities followed the agreements specified in the FFACO signed between the DOE/NV and the NEPD.

These activities follow a formal work process beginning with a Data Quality Objectives (DQO) meeting between DOE, NEPD, and contractors. The purpose of the DQO meeting is to define the scope of work, how the site characterization is to be done (sampling strategy), and to develop the conceptual model for the site. The conceptual model defines the nature and extent of waste in the subsurface and guides the investigation. A Corrective Action Investigation Plan is prepared providing the information on how the site is to be characterized.

Site characterization is carried out and documented in the Corrective Action Decision Document (CADD). This report provides the information that either confirms the conceptual model or modifies it. If suitable information is available to make a decision, a remedial alternative is selected from several identified for analysis that best provides site closure. (In some instances, additional site characterization may be required before the CADD can be prepared). The CADD may also include a risk assessment to better define the risk to humans and the environment.

If a site requires remediation, a Corrective Action Plan (CAP) is prepared that provides the necessary design and other information on how the remediation is to be performed. A CAP includes the proposed methods to be used to close a site, quality control measures, waste management strategy, design drawings (when appropriate), verification sampling strategies (for clean closures) and other information necessary to perform the closure. Some sites also require a Post Closure Plan as the site or parts of the site are closed in place. Information on inspections and monitoring are provided in an Annual Post Closure Monitoring Report.

Once the closure has been completed, a Closure Report is prepared. This document provides information on the work performed, results of verification sampling, as-built drawings (if appropriate), waste management, etc.

The NEPD is a participant throughout the remediation process. The Community Advisory Board is also kept informed by DOE/NV of the progress made.

Some small sites are closed under the Streamlined Approach for Environmental Restoration (SAFER) process. These sites typically have small amounts of contamination and can be remediated by simple excavation and sampling to verify that the Remediation Level has been reached. A SAFER plan is prepared providing the methods to be used to close the site. After closure a SAFER closure report is prepared documenting the work performed.

Work performed in 1997 is summarized below:

- The Area 6 Decontamination Pond RCRA Closure Unit characterization was completed. Additional geotechnical sampling and testing was completed for the Corrective Measures Study. Design and field testing for the engineered cover was started and will be completed in 1998. Closure activities are anticipated to be completed in 1998.

- An annual report was submitted to comply with the conditions of the RCRA Part B Permit for the Area 2 Bitcutter Shop and LLNL Post Shot Containment Building Injection Wells RCRA Closure Unit that was closed in 1996.

- The closure of the Area 25 Jr. Hot Cell was completed by the disposal of the radiological waste in the Area 3 Radiological Waste Management Facility.

- The expedited closure of the Area 15 EPA Farm was completed in October 1997. The facility was decontaminated and dismantled. Waste disposal and closure documentation will be completed in 1998.

- Characterization of portions of the Area 25 Engine Maintenance Assembly and Disassembly (E-MAD) Building was completed in 1997. Two characterization reports were issued. No decontamination activities were conducted because the facility end-use requirements would be determined in the future.

- Closure of the Area 12 Fleet Operations Steam Cleaning Discharge Area was completed by excavation and removal of approximately 61 m^3 (80 yd^3) of petroleum hydrocarbon soil. Biennial monitoring (every two years) for the next six years of undisturbed impacted areas will be required to evaluate whether or not sufficient degradation of the petroleum hydrocarbons has been demonstrated.

- Clean closure of the Area 6 Steam Cleaning Effluent Ponds RCRA Closure Unit was completed by excavation and disposal of approximately 412 m^3 (540 yd^3) of soil as a RCRA hazardous waste and 534 m^3 (700 yd^3) of nonhazardous petroleum hydrocarbon impacted soil. The Closure Report will be prepared and transmitted to the NEPD for concurrence during 1998.

- The Area 23 Building 650 Leachfield RCRA Closure Unit characterization was completed. The Closure Plan and field work will be completed in 1998.

- The contents of the aboveground tanks located at the Area 23 Fire Training Pit were characterized and disposed of as a RCRA hazardous waste (approximately 3,000 gal [11.4 m^3]). Site debris and materials were sampled for disposal/reuse. Some materials were removed from the site and disposed of as nonhazardous construction debris. The site characterization activities and additional site debris/material disposal/reuse are anticipated to be completed in 1998.

- The SAFER Closure Plan for the Area 5 and 6 Aboveground Tanks was prepared, completed, and approved by the NEPD. Closure activities are anticipated to be completed in 1998.

- The Area 2 Photo Skid site characterization was completed and the results indicated that no remediation activities were required. The site was restored by backfilling and grading. No Closure Report was required for site closure.

- Characterization activities were completed for the TTR Area 3 Landfill Complex and Area 9 UXO Landfill. The Corrective Action Decision Document and Corrective Action Plan will be prepared and transmitted to the NEPD for concurrence during 1998. Remedial activities are planned for 1998.

- Fencing of the TTR Five Points Landfill and Bomblet Pit was completed to support the revegetation activities. Both sites were seeded with native plant species, and site inspections will be completed in the following years to evaluate the progress of the revegetation activities.

- Characterization of the TTR Second Gas Station was completed. Based upon the results, the NEPD has concurred with the recommended closure in-place of the petroleum impacted soils. The Closure Report will be prepared and transmitted to the NEPD for concurrence during 1998.

- Characterization activities were started at the TTR Building 360 Underground Discharge Point and Areas 2 and 6 Septic Systems. The Corrective Action Decision Document and Corrective Action Plan will be prepared and transmitted to the NEPD for concurrence during 1998.

- An expedited closure in-place of the TTR Roller Coaster Sewage Lagoons and North Disposal Trench was completed by constructing an engineered vegetative cover over the sites. The construction activities were designed and successfully implemented to eliminate the generation of any waste during the closure activities since the site was impacted with pesticides above the EPA Preliminary Remediation Goals. The site is located approximately 56 km (35 mi) northwest of the NTS. The Closure Report will be prepared and transmitted to the NEPD for concurrence during 1998.

- An expedited closure in-place of the TTR Cactus Spring Waste Trenches was completed by constructing an engineered vegetative cover over the site. The site is also located approximately 56 km (35 mi) northwest of the NTS. The Closure Report will be prepared and transmitted to the NEPD for concurrence during 1998.

- An expedited closure of the Project SHOAL area mud pit was completed by the SAFER, which resulted in the excavation and disposal of approximately 184 m^3 (240 yd^3) of petroleum hydrocarbon impacted drilling muds. The mud pit area was regraded to the approximate original topography. The Project SHOAL Area is located about 274 km (170 mi) northwest of the NTS.

Remediation of the CLEAN SLATE I site was completed. Approximately 12,382 m^3 (16,220 yd^3) of plutonium contaminated soil was shipped to the NTS for disposal. A Closure Report was prepared and transmitted to DOE.

An aerial radioactivity survey of the Project 57 site was completed. Completion of site characterization activities is planned for 1999.

Reclamation success at the DOUBLE TRACKS site was monitored, and the data were included as part of the annual Reclamation Progress report.

The Building A-1 (Atlas) tritium decontamination was completed. All decontaminated areas have been free-released with the condition that a weekly long-term monitoring program be conducted for a least one year.

There were also two Housekeeping Sites (CAU 344 & 349) in the FFACO, at the NTS, that were cleaned up during 1997.

RADIATION PROTECTION

NTS OPERATIONS

Redesign of the environmental surveillance networks on the NTS during 1997 will result in a reduction of monitoring costs while maintaining necessary and sufficient coverage. Results of monitoring, during 1997, indicated full compliance with the radiation exposure guidelines of DOE Order 5400.5, "Radiation Protection of the Public and the Environment", and the Title 40 CFR 141 National Primary Drinking Water Regulations. Onsite air monitoring results showed average annual concentrations ranging from 0.008 percent of the DOE Order 5400.5 guidelines for ^{85}Kr in air to 2.6 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.

NON-NTS BN OPERATIONS

Results of environmental monitoring at the off-NTS operations performing radiological work during 1997 indicate full compliance with the radiation exposure guidelines of DOE Order 5400.5 and Title 10 CFR 835. No radioactive or nonradioactive surface water/liquid discharges, subsurface discharges through leaching, leaking, or seepage into the soil column, well disposal, or burial occurred at any of the BN operations. Use of radioactive materials is primarily limited to sealed sources; however, unsealed tritium is used in some operations.

A small seepage of tritium into the air at the NLVF Atlas Building (reported in 1995) continued during 1997. 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 WAMO in Washington, DC, the Atlas, NLVF A-1 Source Range, and the STL during the operation of the sealed tube neutron generator or during operation of the Febetron. Sealed sources are tested every six months to assure there is no leakage of radioactive material. Operation of any radiation generating devices is controlled by BN procedures. At least two thermoluminescent dosimeters (TLDs) are at the fence line on each side of these facilities that are exchanged quarterly with additional control TLDs kept in a shielded safe. The TLD results were consistent with previous data indicating no exposures to the public from any of the monitored facilities.

ENVIRONMENTAL COMPLIANCE AUDITS

In March 1993, an environmental compliance assessment was conducted by Reynolds Electrical & Engineering Co., Inc. (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 by BN, the successor to REECo. The assessment identified approximately 55 of these system deficiencies. During 1997, the last of the identified deficiencies was closed.

OCCURRENCE REPORTING

Occurrences are environmental, health, and/or safety-related tests, which are reported in several categories in accordance with the requirements of DOE Order 5000.3B, "Occurrence Reporting and Processing of Operations Information." The two reportable environmental occurrences for 1997 on NTS facilities appear in Table 3.2. An analysis of occurrences for 1997 as required by the Order showed that there were four main reasons for them: (1) management problems - 25 percent, (2) personnel error - 21 percent, (3) procedural problems - 12 percent, and (4) external phenomena - 38 percent.

LEGAL ACTIONS

DOE/NV was not involved with any legal actions during 1997.

3.3 PERMIT SUMMARY

For facilities used in the operation and maintenance of the NTS and non-NTS facilities, the 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 1997 (Table 3.1), 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 the NEPD review for permission to construct or operate.

Table 3.1 Environmental Permit Summary - 1997

	Air Pollution	Wastewater	Drinking Water	Waste Disposal	Number of EPA Generator User IDs	Hazardous Materials Storage Permit	Endangered Species Act
NTS	5	7	7	4	1[(a)]	3	2
Las Vegas Area Operations Office	12[(b)]	1			1[(a)]	2	
Amador Valley Operations					1	1	
Los Alamos Operations							
Special Technologies Laboratory (Santa Barbara)	1	2			2	1	
TOTAL	18	10	7	4	5	7	2

(a) Biennial Report Required.
(b) Routine Monitoring of Emissions is Not Required.

Table 3.2 NTS Recycling Activities - 1997

Material	Quantity
Office Paper	278.63 mt[a]
Aluminum (bulk)	35.9 mt
Aluminum cans	7.39 mt
Used Motor Oil	29.9 mt
Cable and copper	22.68 mt
Iron and steel	183.19 mt
Batteries	38.66 mt
Lead	2.56 mt
Toner Cartridges	2.80 mt
Silver Recovery	.01 mt
Tritium	874 curies
Tires	48.1 mt
Chemical and material exchanges	212.12 mt

(a) mt - metric ton (1,000 kg)

Table 3.3 Off-Normal Occurrences at NTS Facilities

Date	Report Number	Description	Status
01/22/97	NVOO-BNLV-NTS-1997-0002	A small fuel leak under a piece of heavy equipment was discovered in August 1996. After the equipment was removed and remediation started in January 1997, the extent of the cleanup was sufficient for required notification.	Complete
04/28/97	NVOO-BNLV-NTS-1997-0006	A drum of compressor oil leaked about 35 gallons on the ground	Complete

4.0 AIR SURVEILLANCE ACTIVITIES

The air surveillance activities consist of monitoring and compliance programs for the Nevada Test Site (NTS), near offsite areas, and support facilities. These activities include radiological and nonradiological monitoring and environmental permit and operations compliance. There are two radiological monitoring programs associated with the NTS, one onsite and the other offsite. The onsite program is conducted by Bechtel Nevada (BN), the operations & maintenance contractor for the NTS. BN is responsible for NTS air surveillance, effluent monitoring, and ambient gamma radiation monitoring. The offsite program is conducted by the U. S. Environmental Protection Agency's (EPA's) Center for Environmental Restoration, Monitoring and Emergency Response of the Radiation & Indoor Environments National Laboratory in Las Vegas, Nevada (R&IE-LV). Non-radiological air monitoring is primarily for permit compliance.

4.1 ONSITE RADIOLOGICAL MONITORING

At the NTS, radiological effluents may originate from tunnels, underground test sites (at or near surface ground zeros), resuspension of surface deposits, and 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 air surveillance program, as of the end of 1997. Air sampling was conducted for radioactive particulates, noble gases, and tritiated water (HTO) vapor. The air sampling locations are shown in Figure 4.1, and Figure 4.2 shows the locations where ambient gamma radiation monitoring is conducted on the NTS using thermoluminescent dosimeters (TLDs).

CRITERIA

Title 40, Code of Federal Regulations (CFR) 50, "National Primary and Secondary Ambient Air Quality Standards" (CFR 1971) and Title 40 CFR 61,"National Emission Standards for Hazardous Air Pollutants," Subpart H, "Emission of Radionuclides Other Than Radon from Department of Energy Facilities" (CFR 1989) issued by the EPA are the primary drivers for air monitoring programs. In turn, the U.S. Department of Energy (DOE) published DOE Order 5400.1, "General Environmental Protection Program," (DOE 1990b) which establishes environmental protection program requirements, authorities, and responsibilities for 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 1990e), DOE Order 5480.1B, "Environment, Safety, and Health Program for DOE Operations" (DOE 1990d); DOE Order 5484.1, "Environmental Protection, Safety, and Health Protection Information Reporting Requirements" (DOE 1990f); DOE Order 5400.5, "Radiation Protection of the Pishe, radioronmentujı˝0 -1.155d HSI" state

(DOE 1991d).


3 TLDs
12
15
8

AIRBORNE EFFLUENT MONITORING

Airborne radioactive effluents are the emissions on the NTS with the greatest potential for reaching members of the public. For all activities on the NTS, the estimated effective dose equivalent to any member of the public offsite from all airborne radionuclide emissions continues to be much less than one mrem/yr (<10% of the guideline). Compliance with the regulations listed above requires periodic measurements of effluents to confirm the low emission levels. The estimated effluents for 1997 are shown in Table 4.5 and include measured and calculated effluents, evaporated liquids, and resuspension of contaminated soils.

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. 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" published in November 1991 (DOE 1991c). This plan was updated in 1992 and 1993, but will be superseded by a "Routine Radiological Environmental Monitoring Plan" that is in review and will be completed in 1998.

ENVIRONMENTAL SURVEILLANCE

Air surveillance was conducted onsite throughout the NTS. Equipment at fixed locations continuously sampled the ambient air to monitor for radioactive material content. Ambient gamma exposures were measured with TLDs placed at fixed locations.

AIR MONITORING

The air surveillance program operated samplers that were designed to detect airborne radioactive particles, radioactive noble gases, and ^{3}H, as water vapor in the form of $^{3}H^{3}HO$ or ^{3}HHO (HTO).

The air sampling units used to measure radioactive particulates were operated at 48 stations on the NTS (Figure 4.1) and Nellis Air Force Range Complex (NAFRC) during 1997. These stations included 13 at radioactive waste management facilities. Access, worker population, geographical coverage, presence of radioactivity, and availability of electrical power were considerations in site selection for air samplers. During 1996, air samplers powered by solar photovoltaic/battery systems were acquired for operation in contaminated areas where commercial power was not available and were in use during 1997.

An air sampling unit consisted of a constant volume pump drawing approximately 85 L/min (3 cfm) of air through a 9-cm (3.5-in) diameter Whatman GF/A glass-fiber filter that trapped air particulates. Due to the moratorium on nuclear explosives testing, charcoal cartridges are no longer used in the air sampler. The particulate filter was mounted in a plastic, cone-shaped sample holder that faced downward at a height of 1.5 m (5 ft) above ground. A run-time clock measured the operating time. The clock time multiplied by 85 L/min yields the volume of air sampled, which was about 860 m^3 (30,000 ft^3) during the typical 7-day sampling period.

The filters were analyzed for gross alpha, gross beta, and for gamma-emitting radionuclides. The filters from the Area 5 Radioactive Waste Management Site (RWMS-5) samplers were not analyzed for gross alpha. The filters from 13 weeks of sampling were composited and analyzed for plutonium isotopes. Noble gases were continuously sampled at three locations and analyzed for ^{85}Kr. These sampling units were housed in a metal tool box and consisted of three metal air bottles attached to the sampling unit 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 (14 ft^3) each at standard conditions.

Airborne HTO vapor was monitored at 13 locations throughout the NTS. For this monitoring, a small pump continuously drew air into the sampler at approximately 0.4 L/min, the total volume being measured with a dry-gas meter. The HTO vapor was removed from the air stream by a silica-gel drying column followed by a drierite column, for detection of breakthrough. These columns were exchanged biweekly.

The analytical procedures used on all these air samples are summarized in Table 4.2.

AMBIENT GAMMA MONITORING

Ambient gamma monitoring was conducted at 166 stations within the NTS (Figure 4.2) by use of TLDs. 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 1,000 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 were exchanged quarterly. Locations were chosen at the site boundary, at locations where historical monitoring has occurred, or where operations or ground contamination have occurred.

The TLD network at the NTS in 1997 began with 160 TLDs at fixed locations. During the year, two new stations were established near the U-3co crater in Area 3, four new stations were established outside the fenced area of the RWMS-3 and 18 stations around the Mounds Strategic Materials storage compounds in Area 5 were terminated after the radioactive materials were shipped out to a uranium reprocessing facility to recover uranium. Throughout the year, TLDs were used at a total of 166 locations. At the end of the year, 63 stations were terminated and 15 new stations were added reducing the total to 100 stations.

WASTE MANAGEMENT SITE MONITORING

Environmental surveillance on the NTS included monitoring of RWMSs. These sites are used for the disposal of low-level radioactive waste from the NTS and other DOE facilities. Shallow-land disposal in trenches and pits was done at the RWMS-5 and in subsidence craters at the RWMS-3.

There were 17 air particulate sampling stations, 9 HTO vapor sampling stations, and 48 TLD stations placed inside and around RWMS-5 at the beginning of 1997. The site was assessed using site specific monitoring data, and it was determined that the facility could be adequately monitored with 7 air particulate and 4 HTO samplers, with no change in TLDs. The RWMS-3 was monitored by four air particulate stations, one HTO sampling station, and by nine TLD stations.

4.2 OFFSITE RADIOLOGICAL MONITORING

Under the terms of an Interagency Agreement between DOE and EPA's Office of Radiation and Indoor Air, the R&IE-LV conducts an Offsite Radiation Safety Program (ORSP) around the NTS. The primary activity of the ORSP is routine monitoring of potential human exposure pathways. Secondary activities include maintaining readiness to monitor during nuclear testing, emergency response, public information, and community assistance.

Maintaining readiness was exercised during two subcritical experiments conducted in 1997, REBOUND and HOLOG. For each of the two experiments, R&IE-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 compliance with National Emission Standards for Hazardous Air Pollutants (NESHAPs) and with DOE orders 5400.1 and 5400.5 continued throughout 1997.

Environmental monitoring networks, described in following Chapters, measure radioactivity in air (this chapter), groundwater (Chapter 5), and milk (Chapter 6). These networks monitor the major potential pathways for transfer of

air samplers were operational at six of the

[redacted]

The primary purpose of EPA's offsite environmental dosimetry program is to establish dose estimates to populations living in the areas surrounding the NTS. 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 a filter of approximately 1,000 mg/cm^2. An average of the corrected values for the latter three elements gives the total exposure for each TLD. For quality assurance purposes, two UD-814 TLDs are deployed at each fixed environmental station location. The TLDs are exchanged quarterly.

In addition to a fixed environmental TLD, EPA deploys personnel TLDs to individual volunteers, predominantly CTLP station managers and their alternates, living in areas surrounding the NTS.

Panasonic Model UD-802 TLDs are used for personnel monitoring. The UD-802 consists of two elements, each of $Li_2B_4O_7$:Cu and $CaSO_4$:Tm phosphors. The phosphors are behind filters of approximately 17,300,300 and 1,000 mg/cm^2 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 to the participating individuals. These TLDs are also exchanged quarterly.

An average daily exposure rate was calculated for each quarterly exposure period and the average of the four values was multiplied by 365.25 to obtain the total annual exposure for a station. New computers and software were installed to increase report options, and further hardware upgrades were completed in 1997.

In 1997, the TLD program consisted of 39 fixed environmental monitoring stations and 18 offsite personnel. Figure 4.4 shows the fixed environmental TLD monitoring stations and the location of personnel monitoring participants.

PRESSURIZED ION CHAMBER (PIC) 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 shell is a spherical electrode with an electrical charge opposite to the shell. When gamma radiation penetrates the sphere, ionization of the gas occurs and the negative ions are collected by the center electrode. The 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 may change with altitudes (cosmic radiation), with radioactivity in the soil (terrestrial radiation), and may vary slightly within a location due to weather patterns.

Data are currently recorded on magnetized recorder tapes, memory data cartridges, and strip chart recorders. Previously, data collection was performed by satellite telemetry for immediate access to the PIC data. In October 1997, the funding for support and maintenance of the Los Alamos National Laboratory (LANL) satellite telemetry system, which allowed EPA access to near real-time data, was discontinued. Currently, the PICs are visited weekly at the stations immediately adjacent to the NTS and monthly at the other stations to retrieve data. EPA stations in Boulder City, Henderson, Las Vegas, and Mississippi, display gamma and

meteorological data near real-time on the LANL NEWNET web page which is updated every 24 hours.

There are 26 PICs located in communities around the NTS and 1 in Mississippi. The Boulder City station was relocated and returned to operation on August 19, 1997, at St. Judes Ranch, approximately a quarter mile northeast of the previous site. The locations of the PIC stations around the NTS are shown in Figure 4.3.

COMMUNITY TECHNICAL LIAISON PROGRAM (CTLP)

Because of the successful experience with the Citizen's Monitoring Program during the purging of the Three Mile Island containment in 1980, the CRMP was begun. Because of reductions in the scope of monitoring, the CRMP was changed to the CTLP. It now consists of stations located in the states of Nevada and Utah. In 1997, there were 17 stations located in these two states. The CTLP 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 quality assurance checks of the data. Shown in Figure 4.3 are the locations of the CTLP stations.

Each station is operated by a local resident. In most cases, this resident is a high-school science teacher. Samples are analyzed at the R&IE-LV. Data interpretation is provided by DRI to the communities involved. All of the 17 CTLP stations had one of the samplers for the ASN and Noble Gas and Tritium Surveillance Network, on either routine or standby status, and a TLD. In addition, a PIC and recorder for immediate readout of external gamma exposure and a recording barograph are located at all stations. All of the equipment is mounted on a stand at a prominent location in each community so the residents can become 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.

4.3 NONRADIOLOGICAL MONITORING

The 1997 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 as discussed in Chapters 5 and 6. Air quality monitoring is not required for the NTS. The air permits issued by the state of Nevada do require opacity and material throughput measurements. In 1997, nonradiological monitoring was conducted for two series of tests conducted at the Hazardous Material Spill Center (HSC) on the NTS.

MONITORING OF NTS OPERATIONS

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 operational activities. This included motor pool facilities; large equipment and drill 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 (CP) Complex in Area 6.

The HSC in Area 5 is a source of potential release of nonradiological contaminants to the environment, depending on the individual tests conducted. In 1997, there were two series of tests, involving 38 different chemicals, conducted at this facility.

Routine nonradiological environmental monitoring on the NTS in 1997 was limited to Nevada operating permit requirements, and asbestos sampling in conjunction with asbestos removal and renovation projects and in accordance with occupational safety and NESHAPs compliance.

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. 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 1996 Air Quality Permit Data Report was sent to the state of Nevada on February 21, 1997. During 1996, approximately six tons of pollutants were emitted from operations at the NTS. This report includes aggregate production, operating hours of permitted equipment, and a report of all surface disturbances of five acres or greater. In order to provide consistency in responses, the state provided forms to be completed, which also required calculation of actual emissions.

NTS air quality permits limit particulate emissions to 20 percent opacity. Certification of personnel to perform valid visible emission opacity evaluations is required by the state, with recertification required every six months. During 1997, one BN Environmental Compliance Department employee was recertified. In 1997, several visible emission evaluations were conducted of permitted air quality point sources. When visual evaluations determine that an emission exceeds the opacity requirement, corrective action is initiated. No exceedances of the opacity limit were noted in 1997.

During 1997, state of Nevada personnel conducted two inspections of NTS equipment regulated by air quality operating permits. In January 1997, the state conducted an inspection to verify process flow diagrams for all permitted facilities prior to issuance of the NTS Class II Air Quality Operating Permit. In June 1997, a state inspector returned to conduct an annual inspection of permitted facilities. There were no findings reported as a result of these inspections.

OFFSITE MONITORING

The HSC 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. At the beginning of each HSC test series and at other tests in the series depending on projected need, a field monitoring technician from the EPA with appropriate air sampling equipment is deployed downwind of the test at the NTS boundary to measure chemical concentrations that may have reached the offsite area. No such monitoring occurred in 1997.

NON-NTS FACILITY MONITORING

Under normal conditions, the operations at the six non-NTS facilities operated by BN for DOE/NV do not produce radioactive effluents. The six are, (1) the North Las Vegas Facility (NLVF), (2) the Remote Sensing Laboratory (RSL), (3) the Special Technologies Laboratory (STL), (4) the Amador Valley Operation (AVO), (5) the Los Alamos Operation (LAO), and (6) the Washington Aerial Measurements Operation (WAMO).

Air quality operating permits were required for three of the six non-NTS operations.

There were no effluent monitoring requirements associated with these permits. Nineteen emission units at the Las Vegas Area Operation (LVAO), which includes the NLVF and the RSL, were regulated during 1997 under conditions of 13 permits issued by the Clark County Health District in Las Vegas, Nevada.

The STL of Santa Barbara, California, holds a permit, issued by the county of Santa Barbara, to operate a vapor degreaser. The Air Pollution Control District Permit conditions include throughput limitations and record keeping requirements.

No air permits were held or required for the AVO, LAO, or WAMO facilities in 1997.

AIR QUALITY PERMITS

Air quality permits were required for numerous locations at the NTS and at two non-NTS facilities in Las Vegas. The permits required for 1997 are listed in Table 4.3. The permits required in 1997 for other non-NTS facilities that support the work of DOE/NV are listed in Table 4.4.

4.4 AIR SURVEILLANCE PROGRAM RESULTS

ONSITE RADIOLOGICAL MONITORING

AIRBORNE EFFLUENTS

During 1997, effluent monitoring at the NTS involved several operational facilities and some inactive locations. Due to the continuation of the moratorium on nuclear testing throughout 1997, effluent monitoring for nuclear tests was not required. The results of effluent monitoring, calculated or measured, are set forth in Table 4.5. The total curies of radioactivity included in Table 4.5 are less than were reported in the "1996 Annual Site Environmental Report" because of smaller tritium emissions.

AIR SAMPLING RESULTS

GROSS ALPHA

The annual average gross alpha results for each air sampling station are shown in Table 4.6. The NTS average gross alpha result was 1.7 x 10^{-15} µCi/mL (63 µBq/m^3), only 7 percent higher than the median minimum detectable concentration (MDC). This average was slightly lower than the 1996 value. The samples from the NAFRC were all higher than the NTS average at 2.2 x 10^{-15} µCi/mL (81 µBq/m^3).

The samples collected from the air samplers at the low-level radioactive waste disposal facility in RWMS-3 had gross alpha levels slightly above the NTS average. Previous investigations have not discovered the source for gross alpha radioactivity in air. The air samples from RWMS-5 were not analyzed for gross alpha radioactivity.

GROSS BETA

The annual average gross beta results for each air sampling station are shown in Figure 4.5 and Figure 4.6 indicates the distribution of this radioactivity. The NTS average this year is the same as for 1996 at 2.0 x 10^{-14} µCi/mL (0.74 mBq/m^3). The air samples from the NAFRC had the same average value. This is consistent with the results for the past few years. Figure 4.7 depicts the trend in concentration for the past few years, but expressed as percent Derived Concentration Guide (DCG) (set by the EPA as 10 mrem per year for inhaled radioactivity). Note that the levels are only about 2 percent of the DCG. This guide is for public exposure and is based on ^{90}Sr, once a common beta emitting isotope in the environment. The basic data are in Table 4.6.

Air samples from RWMS-3 had gross beta levels that were consistent with the NTS average value, while those from RWMS-5 were slightly higher than the average.

PLUTONIUM

The annual average ^{238}Pu result of 6.7 x 10^{-19} µCi/mL (2.5 µBq/m^3) is less than the median MDC for this isotope and less than

the 1996 average. The results from the NAFRC were similar. Only 5 of the 45 stations had results slightly greater than the MDC. The annual averages for ^{238}Pu and for $^{239+240}$Pu are included in Table 4.6.

The $^{239+240}$Pu network average of 1.9 x 10^{-17} µCi/mL (0.7 µBq/m^3) was about eight times the MDC but was less than the 1996 average value. To indicate the distribution of this nuclide over the NTS, the annual average concentration for each station is plotted in Figure 4.8 (see Figure 4.6 for RWMS-5). The elevated values in Area 3 are evident therein. The maximum offsite concentration, at Rachel, Nevada, (see Table 4.15) was 1.8 x 10^{-17} µCi/mL (0.7 µBq/m^3), about equal to the onsite average and much less than the onsite maximum concentrations. Of the NAFRC samples, the set from CLEAN SLATE I had the highest concentration of any station on- or offsite, perhaps because of cleanup activities at that location in the summer of 1997. The trend of the NTS site-wide $^{239+240}$Pu concentration with time for the past few years is shown on Figure 4.9. There the data are plotted as a percent of the DCG for the general population as was done for the gross beta data above. The peak in the curve in 1992 was due to increased concentrations during the summer of 1992 in Area 3, which was probably due to increased vehicular traffic and construction activities.

Air samples from RWMS-3 have concentrations of plutonium generally above the NTS average, while those from RWMS-5 are generally lower than the NTS average, as they are this year.

GAMMA

Gamma spectral analyses of the glass-fiber filters indicated only naturally occurring radioactive materials. The predominant one was ^{7}Be formed by cosmic ray interaction with nitrogen in the atmosphere. The annual average values for this isotope are shown in Table 4.6 and the NTS average of 2.1 x 10^{-13} µCi/mL (7.8 mBq/m^3) is similar to the value for 1996. The concentrations in samples from the NAFRC were all much lower at 1.2 x 10^{-13} µCi/mL (4.4 mBq/m^3).

Concentrations of ^{7}Be in air samples from both RWMS-3 and RWMS-5 were about 10 percent higher than the NTS average value.

NOBLE GASSES

There were only three locations on the NTS where samples were collected for analysis of radioactive noble gasses. There is a sampler at the BJY location, one in Area 19, and one in Area 20. Only ^{85}Kr is detected in these samples at present. The annual average of these three stations was 27 x 10^{-12} µCi/mL (1 Bq/m^3), consistent with previous results for this isotope. The analytical data are summarized in Table 4.7.

TRITIATED WATER VAPOR (HTO)

The annual average value for the 13 stations in this network was 4.2 x 10^{-6} pCi/mL (0.2 Bq/m^3). This concentration is slightly higher than it was in 1996 as each station had a slightly higher concentration. All of the data are displayed in Table 4.8 and are plotted as a trend over the last several years in Figure 4.10. The data plotted in Figure 4.10 are the network average concentration of HTO in each year expressed as a percent of the DCG for the general offsite population. Although there has been a slight downward trend over the period plotted, all values are less than 0.2 percent of the DCG.

The HTO concentrations for the two stations near RWMS-3 were less than the network average. However, two of the four stations around the RWMS-5 had concentrations exceeding the network average, as has generally occurred. This is related to the tritium disposed of at this site.

TREND AT THE WASTE MANAGEMENT SITES

The trends in air concentrations of HTO in atmospheric moisture and plutonium at RWMS-3 and RWMS-5 are set forth in

[redacted]

Tables 4.9 and 4.10, respectively. There appears to be a trend of decreasing $^{239+240}Pu$ and HTO concentration at RWMS-5 but not at RWMS-3.

ONSITE TLD RESULTS

The 1997 average exposure for the 16 boundary monitoring stations was 127 mR/year, essentially the same as the average value of 124 mR/yr for these stations in 1996 (see Table 4.11). Also, the 1997 average exposure for the nine historically monitored stations was 0.26 mR/day (95 mR/yr), as shown in Table 4.12. The results for these stations for the last four years have been almost identical.

Both sets of results indicate that external radiation measured by TLDs has not changed to any measurable extent, at least for the last few years.

OFFSITE RADIOLOGICAL RESULTS

AIR SAMPLING RESULTS

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

Gamma spectrometry was performed on all samples from the ASN high and low volume air samplers. The majority of the samples were gamma-spectrum negligible (i.e., no gamma-emitting radionuclides detected). Naturally occurring ^{7}Be was detected occasionally by the low-volume network of samplers. It was detected consistently by the high-volume sample method with an average annual activity of 1.5×10^{-13} µCi/mL, slightly less then the onsite average.

GROSS ALPHA

Gross alpha analysis was performed on all low-volume network samples. The average annual gross alpha activity was 2.0×10^{-15} µCi/mL (73 µBq/m^3), slightly higher than the onsite results. Summary results for the ASN are shown in Table 4.13.

GROSS BETA

As in previous years, the gross beta results from the low-volume sampling network consistently exceeded the analytical MDC. The annual average gross beta activity was $1.5 \pm 0.60 \times 10^{-14}$ µCi/mL ($5.5 \pm 2.2 \times 10^{-4}$ Bq/m^3), somewhat lower than the results for the onsite network. Summary gross beta results for the ASN are in Table 4.14.

PLUTONIUM

High-volume samples were collected monthly and analyzed for plutonium isotopes. Due to a low limit of detection for high-volume sampling and analysis methods, environmental levels of $^{239+240}Pu$ were consistently detected at all six of the sampling sites. A total of 66 samples were analyzed during the CY, of which 52 were above the MDC for $^{239+240}Pu$, and 13 were above the MDC for ^{238}Pu. The average annual activity was 0.18×10^{-18} µCi/mL (7 nBq/m^3) for ^{238}Pu and 4.2×10^{-18} µCi/mL (0.16 µBq/m^3) for $^{239+240}Pu$, about one-fourth the activity detected in the onsite air network. Summary results of the high-volume data are shown in Table 4.15.

TLD RESULTS FOR STATIONS

There were 39 offsite environmental stations monitored with TLDs in 1997. Figure 4.4 shows current fixed environmental monitoring locations. Total annual exposure for 1997 ranged from 61 mR (0.61mSv) per year at Pahrump, Nevada, to 161 mR (1.6 mSv) per year at Blue Jay, Nevada, with a mean annual exposure of 99 mR (0.99 mSv) per year for all operating locations. The next highest annual exposure was 130 mR (1.3 mSv) per year at Queen City Summit, Nevada. All results are shown in Table 4.16. These results are consistent with those for 1996.

TLD RESULTS FOR PERSONNEL

Eighteen offsite residents were issued TLDs to monitor their annual dose equivalent. Locations of personnel monitoring participants are also shown in Figure 4.4. Annual whole body dose equivalents ranged from a low of 74 mrem (0.74 mSv) to a high of 147 mrem (1.5 mSv) with a mean of 98 mrem (0.98 mSv) for all monitored personnel during 1997. A summary of the results is shown in Table 4.17. These results are also similar to those for 1996.

PRESSURIZED ION CHAMBER NETWORK

The PIC data presented in this section are based on daily averages of gamma exposure rates from each station. Table 4.18 contains the number of daily averages available from each station and the maximum, minimum, mean, standard deviation, and median of the averages. The mean ranged from 8.1 µR/hr at Pahrump, Nevada, to 17.7 µR/hr at Milford, Utah, or annual exposures from 71 to 155 mR (18 to 40 µC/kg). The table shows the total mR/yr and the average gamma exposure rate for each station. Background levels of environmental gamma exposure rates in the United States (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 United States background levels. The data from the Milford, Stone Cabin Ranch, and Tonopah stations show the greatest range and the most variability. All of these data are within a few tenths µR/hr from those of last year.

NON-NTS BN FACILITY MONITORING

BN facilities that 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 and operation of the Febetron; the Washington Aerial Measurements Operation (WAMO) during storage of sealed sources; 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 BN Radiation Protection Records. Operation of radiation generating devices is controlled by BN procedures.

Fence line radiation monitoring at STL, WAMO, and NLV was conducted during 1997 using Panasonic Type UD-814 TLDs. At least two TLDs were at the fence line on each side of any facility. TLDs were exchanged on a quarterly basis with additional control TLDs kept in a shielded safe. These TLD results are given in Table 4.19. The range of results, 52 to 115 mR/yr, is within the background range in the continental U.S.

Table 4.1 Summary of the NTS Air and Direct Radiation Surveillance Program - 1997

Sample Type	Description	Collection Frequency	Number of Locations[(a)]	Type of Analysis
Onsite Monitoring				
Air	Sampling through Whatman GF/A glass fiber filter, 85 L/min.	Weekly Monthly	45 1[(a)]	Gamma spectroscopy, gross α & ß,($^{238,239+240}$Pu, quarterly composite).
	Low-volume sampling through silica gel	Biweekly	13	HTO (tritiated water)
	Low-volume sampling	Weekly	3	^{85}Kr
External Gamma Radiation Levels	UD-814AS thermoluminescent dosimeters	Quarterly	166	Total quarterly exposure
Offsite Monitoring				
Air	Sampling through 5-cm glass-fiber filter and a charcoal cartridge, 56 L/min	Weekly	20	Gamma spectroscopy, gross α & ß
	Sampling through 500-cm^2 glass-fiber filter at 1100 L/min	Monthly	6	Gamma spectroscopy $^{238,239+240}$Pu
External Gamma Radiation Levels	UD-814AS thermoluminescent dosimeters	Quarterly	39	Quarterly exposure at deployed location
	UD-802 thermoluminescent dosimeters	Quarterly	18	Quarterly exposure of offsite personnel
External Gamma Radiation Rate	Reuter-Stokes Pressurized Ion Chambers	Continuous	26	Continuous rate recording summarized hourly

(a) This sampler was operated on a monthly schedule until September 1997 then changed to weekly.

Table 4.2 Analytical Procedures, Air and TLD - 1997

Analysis	Sample Type Nominal Size	Analytical Procedure	Equipment	Count Time (min)	Estimated MDC
BN Analytical Procedures					
Gross α	Air, 860 m^3	After 5 - 7 days, place in planchet	Gas-flow proportional counter	20	74 µBq/m^3 (2 x 10^{-3} pCi/m^3)
Gross β	Air, 860 m^3	Continue count.	Gas-flow proportional counter	20	150 µBq/m^3 (4 x 10^{-3} pCi/m^3)
Gamma spectrometry	Air, 860 m^3	Move planchet to Gamma Spec	HpGe, calibrated 1 keV per channel, 20 to 2000 keV	20	370 µBq/m^3 (1 x 10^{-2} pCi/m^3) for ^{137}Cs
$^{238,239+240}$Pu Quarterly composite	Air, 11,000 m^3	Acid dissolution, ion-exchange, ppt with ^{242}Pu tracer, collect on filter	Alpha spectrometer with solid-state PIP detector	333	0.1 µBq/m^3 (3 x 10^{-6} pCi/m^3)
Tritium	Air, 8 m^3	Moisture trapped on silica gel, removed with heat	5 mL in cocktail counted in liquid scintillation counter	70	0.07 Bq/m^3 (2 pCi/m^3)
^{85}Kr	Air, 0.4 m^3	Cryogenic separation, collect in cocktail	Liquid scintillation counter	20	0.37 Bq/m (10 pCi/m^3)
Ambient gamma	TLD, UD-814AS	Expose in field, 3 months	Automatic TL reader		10 mR per quarter
EPA Analytical Procedures					
Gross α	Air, 560 m^3	After 7-14 days place in planchet	Gas-flow proportional counter	30	30 µBq/m^3 (8 x 10^{-4} pCi/m^3)
Gross β	Air, 560 m^3	After 7-14 days place in planchet	Gas-flow proportional counter	30	90 µBq/m^3 (2.5 x 10^{-3} pCi/m^3)
Gamma spectrometry	Air, 560 m^3 Low-vol 10,000 m3 High-vol	Place on detector, has online analytical program	HpGe detector, calibrated 0.5 keV/channel from 40 to 2000 keV	30	2 mBq (0.05pCi)/m^3 20 µBq (5 x 10^{-4} pCi) per m3 (Hi-vol), ^{137}Cs

Table 4.2 (Analytical Procedures, Air and TLD - 1997, cont.)

EPA Analytical Procedures

Analysis	Sample Type Nominal Size	Analytical Procedure	Equipment	Count Time (min)	Estimated MDC
$^{238,239+240}Pu$	Air, 10,000 m^3	Acid dissolution, separate by ion exchange, electroplate	Alpha spectrometer, silicon surface barrier detector	1000	2 µBq/m^3 (5 x 10^{-5} pCi/m^3)
Ambient gamma	TLD, UD-814	Expose in field, 3 months	Automatic TL reader		5 mR per quarter
Ambient gamma	TLD, UD-802	Personnel wear 3 months	Automatic TL reader		5 mR per quarter
Gamma rate	Pressurized ion chamber	Expose in field	Online display and data storage systems		5 µR/hr

Table 4.3 NTS Active Air Quality Permits - 1997

Permit No.	Facility or Operation	Expiration Date
AP9711-0549		02/07/02
Area 1 Facilities	Shaker Plant Circuit	
	Rotary Dryer Circuit	
	Wet Aggregate Plant	
	Concrete Batch Plant	
	Sandbag Facility	
	Cedar Rapids Screen	
	Cambilt Conveyer	
Area 3 Facilities	Mud Plant	
Area 5 Facilities	Naval Thermal Treatment Unit	
Area 6 Facilities	Cementing Equip. (silos)	
	Decontamination Facility Boiler	
	Diesel Fuel Tank	
	Gasoline Fuel Tank	
	Portable Field Bins	

Table 4.3 (NTS Active Air Quality Permits - 1997, cont.)

Permit No.	Facility or Operation	Expiration Date
AP9711-0549, cont.		
Area 23 Facilities	Building 753 Boiler	
	Cafeteria Boilers (2)	
	Diesel Fuel Tank	
	Gasoline Fuel Tank	
	NTS Surfaces Disturbances	
	WSI Incinerator	
AP9711-0556	Area 5 HSC	10/20/02
AP9611-0683	DOUBLE TRACKS Surface Disturbance (TTR)	06/12/01
AP9711-0549	CLEAN SLATE I Environmental Restoration Project	04/04/02
AP9711-0549	CLEAN SLATE II Environmental Restoration Project	06/30/02
OP 97-20	NTS Open Burn - Training	02/06/98
OP97-34	Area 27 Burn Box	02/06/98

Table 4.4 Active Air Quality Permits for Non-NTS Facilities - 1997

Permit No.	Facility or Operation	Expiration Date
Las Vegas Area Operation[(a)]		
A38702	Hamada Offset Press, NLVF	Indef.
A06505	Time Saver Aluminum Sander, NLVF	Indef.
A06507	Trinco Dry Blast with Dry Bag Dust Filters, NLVF	Indef.
A38701	Spray Paint Booth, NLVF	Indef.
A06503	Three Emergency Generators, and Emergency Fire Control Equipment, NLVF	Indef.
A38703	Emergency Generator, NLVF	Indef.
A34801	Columbia Boiler Model WL-180, Penthouse #1, RSL	Indef.
A34802	Columbia Boiler Model WL-90, Penthouse #1, RSL	Indef.
A34803	4.0 MM BTU Water Heater #2, RSL	Indef.
A34804	Cummins Emergency Generator and Emergency Fire Control Pump, RSL	Indef.
A34805	Spray Paint Booth, RSL	Indef.
A0034811	Excimer Laser, RSL	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 4.5 NTS Radionuclide Emissions - 1997

Onsite Liquid Discharges

Containment Ponds	Curies[a]				
	^{3}H	^{90}Sr	^{137}Cs	^{238}Pu	$^{239+240}Pu$
Area 12, E Tunnel	1.6×10^{1}	1.5×10^{-5}	1.7×10^{-3}	1.5×10^{-6}	3.4×10^{-5}
Area 3, Well U-3cn PS#2	3.7×10^{0}				
Area 3, Well U-3cn#5	5.5×10^{-1}				
TOTAL	2.0×10^{1}	1.5×10^{-5}	1.7×10^{-3}	1.5×10^{-6}	3.4×10^{-5}

Airborne Effluent Releases

Facility Name	Curies[a]	
	^{3}H[b]	$^{239+240}Pu$
Areas 3 and 9[c]		0.036
Area 5, RWMS[d]	2.4×10^{-1}	
Atlas Facility[d]	1.1×10^{-1}	
SEDAN Crater [d]	1.4×10^{2}	
Other Areas[c]		0.24
TOTAL	1.4×10^{2}	0.28

(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) Resuspension from known surface deposits.
(d) Calculated from air sampler data.

Table 4.6 Summary Data (µCi/mL) for Gross Alpha, Gross Beta, ^{7}Be and Plutonium in Air - 1997

Location	Gross α	Gross β	Beryllium-7	^{238}Pu	$^{239+240}$Pu
Area 1, BJY	1.5×10^{-15}	1.9×10^{-14}	2.0×10^{-13}	7.9×10^{-19}	2.1×10^{-17}
Area 2, Complex	1.7×10^{-15}	2.0×10^{-14}	2.4×10^{-13}	2.8×10^{-19}	4.9×10^{-18}
Area 2, 2-1 Substation	1.5×10^{-15}	1.9×10^{-14}	2.2×10^{-13}	5.2×10^{-19}	2.1×10^{-17}
Area 3, Mud Plant	1.7×10^{-15}	1.9×10^{-14}	2.1×10^{-13}	5.8×10^{-19}	4.1×10^{-17}
Area 3, U-3ah/at E		1.8×10^{-14}	2.3×10^{-13}	1.0×10^{-18}	1.9×10^{-17}
Area 3, U-3ah/at N	1.9×10^{-15}	2.0×10^{-14}	2.3×10^{-13}	6.5×10^{-19}	4.9×10^{-17}
Area 3, U-3ah/at S	2.0×10^{-15}	1.9×10^{-14}	2.3×10^{-13}	7.3×10^{-19}	7.3×10^{-17}
Area 3, U-3ah/at W		1.7×10^{-14}	2.3×10^{-13}	-4.6×10^{-20}	1.2×10^{-17}
Area 3, U-3bh S	1.9×10^{-15}	1.8×10^{-14}	2.0×10^{-13}	-2.0×10^{-19}	2.0×10^{-17}
Area 3, U-3bg N	2.2×10^{-15}	2.1×10^{-14}	1.5×10^{-13}	-1.9×10^{-19}	6.4×10^{-17}
Area 3, Well ER-3-1	1.5×10^{-15}	1.9×10^{-14}	1.8×10^{-13}	4.4×10^{-19}	1.1×10^{-17}
Area 4, Bunker T-4	1.6×10^{-15}	1.9×10^{-14}	2.6×10^{-13}	6.9×10^{-18}	3.7×10^{-17}
Area 5, RWMS No. 1		2.1×10^{-14}	2.3×10^{-13}	4.1×10^{-19}	3.2×10^{-18}
Area 5, RWMS No. 4		2.2×10^{-14}	2.3×10^{-13}	2.6×10^{-20}	3.0×10^{-18}
Area 5, RWMS No. 6		2.2×10^{-14}	2.5×10^{-13}	6.1×10^{-20}	2.2×10^{-18}
Area 5, RWMS No. 8		2.2×10^{-14}	2.5×10^{-13}	4.3×10^{-20}	2.5×10^{-18}
Area 5, RWMS Pit 5		2.1×10^{-14}	2.2×10^{-13}	9.9×10^{-20}	1.8×10^{-18}
Area 5, TP Building N		2.4×10^{-14}	2.3×10^{-13}	1.9×10^{-19}	1.4×10^{-18}
Area 5, TP Building S		2.3×10^{-14}	1.8×10^{-13}	-7.4×10^{-20}	1.6×10^{-18}
Area 5, WEF S	2.0×10^{-15}	2.0×10^{-14}	2.0×10^{-13}	-1.1×10^{-19}	2.7×10^{-18}
Area 5, WEF N	1.9×10^{-15}	2.0×10^{-14}	1.4×10^{-13}	3.9×10^{-19}	2.0×10^{-18}
Area 5, DOD	1.6×10^{-15}	1.9×10^{-14}	1.9×10^{-13}	5.0×10^{-20}	4.4×10^{-18}
Area 5, Well 5B	1.8×10^{-15}	2.2×10^{-14}	2.3×10^{-13}	5.3×10^{-20}	2.7×10^{-18}
Area 6, YUCCA	1.8×10^{-15}	2.1×10^{-14}	1.5×10^{-13}	2.3×10^{-19}	1.4×10^{-17}
Area 6, CP-6	1.7×10^{-15}	2.0×10^{-14}	2.5×10^{-13}	8.0×10^{-19}	6.6×10^{-18}
Area 6, Well 3	1.6×10^{-15}	1.9×10^{-14}	1.5×10^{-13}	3.1×10^{-19}	7.1×10^{-18}
Area 7, UE-7ns	1.5×10^{-15}	1.8×10^{-14}	1.7×10^{-13}	7.6×10^{-20}	1.0×10^{-17}
Area 9, 9-300	2.2×10^{-15}	1.9×10^{-14}	1.6×10^{-13}	4.2×10^{-18}	2.6×10^{-16}
Area 10, Gate 700 S	1.6×10^{-15}	1.9×10^{-14}	2.1×10^{-13}	1.9×10^{-19}	6.6×10^{-18}
Area 10, SEDAN Crater	1.6×10^{-15}	2.0×10^{-14}	2.1×10^{-13}	2.1×10^{-18}	4.6×10^{-17}
Area 11, Gate 293	1.4×10^{-15}	1.8×10^{-14}	1.3×10^{-13}	3.9×10^{-20}	1.1×10^{-17}
Area 12, Complex	1.1×10^{-15}	1.6×10^{-14}	2.3×10^{-13}	6.0×10^{-19}	1.5×10^{-18}
Area 15, EPA Farm	1.5×10^{-15}	1.8×10^{-14}	1.8×10^{-13}	3.0×10^{-19}	2.9×10^{-17}
Area 16, 3545 Substation	1.4×10^{-15}	1.8×10^{-14}	2.0×10^{-13}	1.5×10^{-20}	1.9×10^{-19}
Area 18, Well UE-18t	1.5×10^{-15}	1.8×10^{-14}	1.6×10^{-13}	1.5×10^{-19}	2.0×10^{-17}
Area 20, SCHOONER	1.5×10^{-15}	1.9×10^{-14}	2.6×10^{-13}	2.0×10^{-18}	2.0×10^{-18}
Area 20, CABRIOLET	1.7×10^{-15}	1.8×10^{-14}	2.0×10^{-13}	2.8×10^{-18}	4.3×10^{-19}
Area 20, Complex	1.4×10^{-15}	1.6×10^{-14}	1.9×10^{-13}	1.0×10^{-19}	5.4×10^{-19}
Area 23, Bldg 790 No. 2	1.6×10^{-15}	2.1×10^{-14}	2.7×10^{-13}	-7.2×10^{-20}	3.4×10^{-19}
Area 23, H&S Building	1.5×10^{-15}	1.9×10^{-14}	2.2×10^{-13}	1.1×10^{-19}	8.6×10^{-19}
Area 25, E-MAD N	1.5×10^{-15}	1.8×10^{-14}	2.2×10^{-13}	6.6×10^{-20}	1.3×10^{-18}
Area 25, NRDS	1.8×10^{-15}	1.9×10^{-14}	2.3×10^{-13}	7.0×10^{-20}	7.1×10^{-19}
Area 27, Complex	1.3×10^{-15}	1.7×10^{-14}	1.2×10^{-13}	1.1×10^{-19}	1.6×10^{-18}
Average	1.6×10^{-15}	2.0×10^{-14}	2.1×10^{-13}	6.5×10^{-19}	1.9×10^{-17}
Area 13, Project 57	2.0×10^{-15}	1.9×10^{-14}	1.2×10^{-13}	7.7×10^{-19}	5.1×10^{-17}
Area 52, CLEAN SLATE I	2.5×10^{-15}	2.1×10^{-14}	1.2×10^{-13}	2.2×10^{-18}	4.0×10^{-16}
Area 52, CLEAN SLATE III	2.3×10^{-15}	2.0×10^{-14}	1.2×10^{-13}	-6.8×10^{-20}	3.3×10^{-18}
Area 52, DOUBLE TRACKS	2.0×10^{-15}	2.0×10^{-14}	1.2×10^{-13}	-8.0×10^{-20}	4.5×10^{-18}
Average	2.2×10^{-15}	2.0×10^{-14}	1.2×10^{-13}	7.0×10^{-19}	1.6×10^{-16}
Median MDC	1.5×10^{-15}	4.1×10^{-15}	1.1×10^{-13}	8.3×10^{-19}	2.5×10^{-18}

Table 4.7 Summary of NTS ^{85}Kr Concentrations - 1997

		^{85}Kr Concentration (10^{-12} µCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as % DCG
Area 1, BJY	48	38	6.2	28	7.5	<0.01
Area 19, Pahute Substation	43	40	-9.2	24	9.1	<0.01
Area 20, Dispensary	46	49	4.4	29	9.2	<0.01
All Stations	137	49	-9.2	27	8.8	<0.01

Median MDC was 8.7 x 10^{-12} µCi/mL

Table 4.8 Airborne Tritium Concentrations on the NTS - 1997

		^{3}H Concentration (10^{-6} pCi/mL)				
Location	Number	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG
Area 1, BJY	26	2.2	-0.4	0.84	0.74	<0.01
Area 3, Mud Plant	25	4.2	-0.64	1.2	1.3	0.013
Area 3, U-3ah/at N	25	3.4	-1.4	1.2	1.2	0.012
Area 5, RWMS No. 1	26	3.6	-0.2	1.3	0.86	0.013
Area 5, RWMS No. 4	26	15	0.30	3.7	3.5	0.037
Area 5, RWMS No. 6	25	3.9	-0.33	1.5	1.1	0.015
Area 5, RWMS No. 8	21	7.4	-0.18	1.5	1.1	0.085
Area 6, Decon Pad	14	56	4.1	21	12	0.21
Area 10, SEDAN Crater	25	29	0.001	9.6	8.6	0.095
Area 12, Complex	25	7.6	-2.3	0.40	1.7	<0.01
Area 12, E Tunnel Pond No.2	26	39	-0.14	13	11	0.13
Area 15, EPA Farm	25	20.	1.9	6.4	3.9	0.064
Area 23, H&S Building	26	1.3	-1.1	-0.03	0.60	<0.01
All Stations	315	56	-2.3	4.2	7.2	0.047

Median MDC was 2.7 x 10^{-6} pCi/mL

Table 4.9 Mean Air Monitoring Results for Various Radionuclides at the RWMS-3, 1994 to 1997

Year	$^{239+240}$Pu (x 10^{-17} µCi/mL)	^{238}Pu (x 10^{-17} µCi/mL)	Tritium (x 10^{-12} µCi/mL)
Arithmetic Mean 1997	3.8	0.06	1.2
Arithmetic Mean 1996	16	0.25	0.5
Arithmetic Mean 1995	8.8	0.16	NA
Arithmetic Mean 1994	13	0.25	NA
Mean MDC	0.25	0.083	2.8
Derived Concentration Guide	2,000	3,000	100,000

Table 4.10 Mean Air Monitoring Results for Various Radionuclides at the RWMS-5, 1994 - 1997

Year	$^{239+240}Pu$ (x 10^{-17} µCi/mL)	^{238}Pu (x 10^{-17} µCi/mL)	Tritium (x 10^{-12} µCi/mL)
Arithmetic Mean 1997	0.23	0.03	3.7
Arithmetic Mean 1996	0.51	0.02	3.2
Arithmetic Mean 1995	0.6	0.01	5.7
Arithmetic Mean 1994	1.1	0.04	4.9
Mean MDC	0.25	0.083	2.8
Derived Concentration Guide	2,000	3,000	100,000

Table 4.11 NTS Boundary Gamma Monitoring Results Summary - 1997

Location	First Quarter (mR/day)	Second Quarter (mR/day)	Third Quarter (mR/day)	Fourth Quarter (mR/day)	Annual Average (mR/d)	Annual Average (mR/yr)
310 U-15E Substation	0.27	0.27	0.27	0.25	0.27	97
342 Stake C-31	0.40	0.45	0.44	0.38	0.42	150
355 Gold Meadows	0.29	0.30	0.30	(a)	0.29	107
365 Stake R-29	0.38	0.44	0.43	0.37	0.40	150
382 Stake J-41	0.35	0.40	0.40	0.34	0.37	140
383 Stake LC-4	0.44	0.49	0.48	0.43	0.46	170
384 Stake A-118	0.39	0.43	0.43	0.40	0.41	150
386 Papoose Lake Road	0.22	0.23	0.22	0.21	0.22	81
387 Gate 19-3P	0.39	0.43	0.45	(a)	0.41	150
388 Hill Top	0.35	0.36	0.37	0.41	0.38	140
389 East of U11B	0.32	0.33	0.35	0.32	0.33	120
400 Army Well No. 1	0.24	(a)	0.23	0.22	0.23	83
402 3.3 Miles SE of Aggregate Pit	0.17	0.18	0.18	0.17	0.17	63
403 Guard Station 510	0.34	0.39	0.34	0.33	0.35	130
404 Yucca Mountain	0.42	0.41	0.38	0.35	0.39	140
405 Cat Canyon/Buggy Rd	0.44	0.50	0.50	0.45	0.47	170

(a) Missing TLD.

Table 4.12 NTS TLD Historical Station Comparisons, 1991-1997

Area	Station	Exposure Rate (mR/day) 1991	1992	1993	1994	1995	1996	1997
5	Well 5B	0.36	0.31	0.39	0.34	0.30	0.30	0.30
6	CP-6	0.24	0.23	0.30	0.19	0.19	0.21	0.20
6	Yucca Oil Storage	0.33	0.31	0.37	0.27	0.26	0.28	0.28
23	Building 650 Dosimetry	0.19	0.18	0.26	0.15	0.15	0.14	0.16
23	Building 650 Roof	0.19	0.18	0.25	0.14	0.15	0.14	0.16
23	Post Office	0.24	0.23	0.30	0.21	0.20	0.18	0.20
25	HENRE Site	0.40	0.36	0.45	0.32	0.33	0.34	0.32
25	NRDS Warehouse	0.39	0.37	0.46	0.33	0.36	0.32	0.33
27	Cafeteria	0.42	0.39	0.46	0.33	0.33	0.34	0.37
Network Average		0.31	0.28	0.36	0.25	0.25	0.25	0.26

Table 4.13 Gross Alpha Results for the Offsite Air Surveillance Network - 1997

Sampling Location	Concentration (10^{-15} µCi/mL [37 µBq/m^3]) Number	Maximum	Minimum	Mean	Standard Deviation
Alamo, NV	52	5.3	0.0	2.2	1.2
Amargosa Center, NV	50	5.9	-0.1	1.8	1.3
Beatty, NV	52	5.4	0.3	2.4	1.3
Boulder City, NV	23	6.6	0.3	2.7	1.5
Goldfield, NV	52	6.8	0.3	2.2	1.4
Henderson, NV	51	6.3	-0.6	2.0	1.4
Indian Springs, NV	51	3.4	0.2	1.3	0.73
Las Vegas, NV	51	4.4	0.1	2.0	0.95
Overton, NV	51	6.0	0.2	1.8	1.3
Pahrump, NV	50	3.6	-0.4	1.6	0.93
Pioche, NV	50	3.3	0.2	1.4	0.72
Rachel, NV	51	7.3	0.2	2.9	1.6
Sunnyside, NV	35	4.3	-0.2	1.3	0.91
Stone Cabin, NV	52	4.3	0.9	2.4	0.88
Tonopah, NV	51	4.1	0.0	1.8	1.0
Twin Springs, NV	52	12	-0.4	2.5	1.8
Cedar City, UT	52	4.8	0.7	2.4	0.98
Delta, UT	52	5.5	0.3	1.2	0.93
Milford, UT	47	3.8	0.3	1.5	0.78
St. George, UT	21	6.6	0.7	2.5	1.5

Mean MDC = 7.5 x 10^{-16} µCi/mL Standard Deviation of Mean MDC = 2.3 x 10^{-16} µCi/mL

Table 4.14 Gross Beta Results for the Offsite Air Surveillance Network - 1997

Sampling Location	Concentration (10^{-14} µCi/mL [0.37 mBq/m^3]) Number	Maximum	Minimum	Mean	Standard Deviation
Alamo, NV	52	6.9	0.46	1.5	0.85
Amargosa Center, NV	50	2.7	0.20	1.5	0.52
Beatty, NV	52	3.1	0.51	1.5	0.50
Boulder City, NV	23	3.0	0.13	1.8	0.71
Goldfield, NV	52	2.4	0.20	1.4	0.51
Henderson, NV	51	3.0	0.39	1.5	0.52
Indian Springs, NV	51	3.1	0.27	1.4	0.54
Las Vegas, NV	51	3.0	0.00	1.4	0.60
Overton, NV	51	3.5	0.65	1.7	0.57
Pahrump, NV	50	2.4	0.47	1.4	0.40
Pioche, NV	50	2.4	0.08	1.4	0.51
Rachel, NV	51	4.2	0.36	1.5	0.60
Stone Cabin, NV	52	2.6	0.10	1.3	0.47
Sunnyside, NV	35	2.6	0.63	1.3	0.42
Tonopah, NV	51	3.1	0.28	1.3	0.48
Twin Springs, NV	52	5.3	0.41	1.6	0.78
Cedar City, UT	52	2.3	0.48	1.4	0.45
Delta, UT	52	3.8	0.69	1.6	0.72
Milford, UT	47	3.0	0.21	1.6	0.56
St. George, UT	21	3.7	0.91	2.2	0.71

Mean MDC = 2.43 x 10^{-15} µCi/mL Standard Deviation of Mean MDC = 3.89 x 10^{-16} µCi/mL

Table 4.15 Plutonium Results for the Offsite Hi-Volume Air Surveillance Network - 1997

^{238}Pu Concentration (10^{-18} µCi/mL)

Sampling Location	Number	Maximum	Minimum	Mean	Standard Deviation	%DCG[(a)]
Alamo, NV	12	0.34	-0.10	0.04	0.09	[(b)]
Amargosa Center, NV	11	0.74	0.00	0.14	0.21	[(b)]
Goldfield, NV	9	0.28	-0.17	0.12	0.08	[(b)]
Las Vegas, NV	12	0.24	-0.24	-0.01	0.07	[(b)]
Rachel, NV	12	1.8	-0.16	0.64	0.67	0.03
Tonopah, NV	10	0.49	0.00	0.13	0.14	[(b)]

Mean MDC = 0.51 x 10^{-18} µCi/mL   Standard Deviation of Mean MDC = 0.39 x 10^{-18} µCi/mL

(a) Derived Concentration Guide; Established by DOE Order as 2 x 10^{-15} µCi/mL
(b) Not applicable, result less than MDC

Note: To convert µCi/mL to Bq/m^3 multiply by 3.7 x 10^{10} (e.g., [0.64 x 10^{-18}] x [37 x 10^9] = 24 nBq/m^3).

$^{239+240}$Pu Concentration (10^{-18} µCi/mL)

Sampling Location	Number	Maximum	Minimum	Mean	Standard Deviation	%DCG[(a)]
Alamo, NV	12	4.3	0.00	1.1	1.1	0.06
Amargosa Center, NV	11	8.0	0.21	1.5	2.2	0.08
Goldfield, NV	9	5.0	0.17	1.3	1.4	0.06
Las Vegas, NV	12	1.5	-0.19	0.56	0.36	0.03
Rachel, NV	12	77	0.49	18	25	0.90
Tonopah, NV	10	2.3	0.25	0.91	0.60	0.05

Mean MDC = 0.35 x 10^{-18} µCi/mL   Standard Deviation of Mean MDC = 0.24 x 10^{-18} µCi/mL

(a) Derived Concentration Guide; Established by DOE Order as 3 x 10^{-15} µCi/mL
(b) Not applicable, result less than MDC

Note: To convert µCi/mL to Bq/m^3 multiply by 3.7 x 10^{10} (e.g., [1.1 x 10^{-18}] x [37 x 10^9] = 41 nBq/m^3).

Table 4.16 Gamma Monitoring Results for Offsite Stations - 1997

Station	Daily Exposure (mR)			Total (mR)	Percent
Name	Min	Max	Mean	Exposure	Complete
Alamo, NV	0.23	0.25	0.24	113	100
Amargosa Center, NV	0.20	0.23	0.21	76	75
Beatty, NV	0.30	0.32	0.31	112	100
Blue Jay, NV	0.32	0.46	0.36	131	100

Table 4.16 (Gamma Monitoring Results for Offsite Stations - 1997, cont.)

Station	Daily Exposure (mR)			Total (mR)	Percent
Name	Min	Max	Mean	Exposure	Complete
Boulder City, NV	0.23	0.26	0.24	86	100
Caliente, NV	0.26	0.28	0.27	97	100
Cedar City, UT	0.19	0.21	0.20	72	100
Complex I, NV	0.29	0.30	0.29	107	100
Coyote Summit, NV	0.33	0.35	0.34	122	100
Delta, UT	0.22	0.33	0.25	87	100
Ely, NV	0.20	0.20	0.20	72	100
Furnace Creek, CA	0.20	0.21	0.21	75	100
Goldfield, NV	0.26	0.28	0.27	99	100
Groom Lake, NV	0.24	0.26	0.25	91	100
Henderson (CCSN), NV	0.23	0.28	0.25	90	100
Hiko, NV	0.19	0.22	0.20	72	100
Indian Springs, NV	0.20	0.21	0.21	74	50
Las Vegas UNLV, NV	0.13	0.20	0.17	61	100
Lund, NV	0.27	0.29	0.28	100	100
Lund, UT	0.29	0.32	0.30	111	100
Medlins Ranch, NV	0.29	0.31	0.30	111	100
Mesquite, NV	0.19	0.21	0.20	72	100
Milford, UT	0.23	0.33	0.30	112	100
Moapa, NV	0.22	0.24	0.24	86	100
Nyala, NV	0.23	0.25	0.24	89	100
Overton, NV	0.19	0.20	0.20	71	100
Pahrump, NV	0.16	0.18	0.17	61	100
Pioche, NV	0.23	0.25	0.24	85	100
Queen City Summit, NV	0.33	0.38	0.36	130	100
Rachel, NV	0.30	0.32	0.31	113	100
Sacorbatus Flats, NV	0.20	0.35	0.30	111	100
St. George, UT	0.17	0.19	0.18	64	100
Stone Cabin, NV	0.29	0.33	0.31	114	100
Sunnyside, NV	0.17	0.24	0.19	69	100
Tonopah Test Range, NV	0.33	0.37	0.34	125	100
Tonopah, NV	0.32	0.35	0.33	120	100
Twin Springs, NV	0.31	0.33	0.32	116	100
Uhaldes Ranch, NV	0.30	0.31	0.31	111	100
Warm Springs #1, NV	0.27	0.29	0.28	103	100

Table 4.17 Gamma Monitoring Results for Offsite Personnel - 1997

Personnel ID#	Associated Station Name	Number of Days	Daily Deep Dose Exposure (mrem) Min	Max	Mean	Total Annual Exposure	Percent Complete
022	Alamo, NV	358	0.21	0.25	0.22	83	100
038	Beatty, NV	300	0.37	0.46	0.41	147	100
042	Tonopah, NV	357	0.25	0.36	0.32	116	100
293	Pioche, NV	357	0.22	0.27	0.24	86	100
344	Delta, UT	301	0.21	0.23	0.22	80	100
345	Delta, UT	301	0.27	0.31	0.28	103	100
346	Milford, UT	317	0.24	0.31	0.27	100	100
347	Milford, UT	317	0.28	0.30	0.30	108	100
348	Overton, NV	300	0.20	0.27	0.22	82	100
427	Alamo, NV	336	0.20	0.30	0.25	95	100
592	Rachel, NV	298	0.21	0.35	0.28	103	100
593	Cedar City, UT	358	0.26	0.35	0.31	113	100
595	Las Vegas, NV	328	0.20	0.27	0.23	84	100
596	Las Vegas, NV	328	0.17	0.25	0.23	84	100
607	Tonopah, NV	335	0.26	0.41	0.33	120	100
608	Logandale, NV	300	0.17	0.26	0.21	79	100
610	Caliente, NV	357	0.27	0.40	0.31	112	100
621	Indian Springs, NV	358	0.20	0.21	0.20	74	100

Table 4.18 Summary of Gamma Exposure Rates as Measured by PIC - 1997

Station	Number of Daily Averages	Gamma Exposure Rate (μR/hr) Maximum	Minimum	Standard Deviation	Median	mR/yr	1997 Mean (μR/hr)
Alamo, NV	364	15.0	11.9	0.25	12.8	111	12.7
Amargosa Center, NV	365	14.0	10.0	0.76	11.0	97	11.1
Beatty, NV	334	19.0	15.3	0.24	12.8	143	16.3
Boulder City, NV	70	12.3	10.6	0.27	11.4	99	11.3
Caliente, NV	304	16.0	13.0	0.28	14.2	125	14.3
Cedar City, UT	335	12.6	9.0	0.47	10.5	91	10.4
Complex I, NV	365	18.9	14.0	0.43	15.3	134	15.3
Delta, UT	303	12.9	10.5	0.35	11.9	103	11.8
Furnace Creek, CA	297	11.0	8.6	0.28	9.7	86	9.8
Goldfield, NV	359	17.1	14.0	0.34	15.3	135	15.4
Henderson, NV	286	19.0	12.0	0.42	13.7	119	13.6
Indian Springs, NV	356	14.0	10.7	0.32	11.5	101	11.5
Las Vegas, NV	294	12.7	8.3	0.27	10.2	89	10.2
Medlin's Ranch, NV	365	18.7	15.0	0.38	16.4	143	16.4
Milford, UT	304	19.0	16.3	0.50	17.6	155	17.7

Note: Multiply μR/hr by 2.6×10^{-4} to obtain $\mu C \cdot kg^{-1} \cdot hr^{-1}$.

Table 4.18 (Summary of Gamma Exposure Rates as Measured by PIC - 1997, cont.)

Station	Number of Daily Averages	Gamma Exposure Rate (µR/hr) Maximum	Minimum	Standard Deviation	Median	mR/yr	1997 Mean (µR/hr)
Nyala, NV	304	17.0	11.0	0.38	12.3	108	12.3
Overton, NV	334	12.0	9.0	0.27	10.1	88	10.0
Pahrump, NV	358	10.6	7.0	0.18	8.0	71	8.1
Pioche, NV	364	13.9	10.9	0.27	11.9	105	12.0
Rachel, NV	350	19.0	15.2	0.33	16.4	145	16.5
St. George, UT	360	10.0	7.8	0.16	8.3	73	8.3
Stone Cabin Ranch, NV	328	20.0	15.4	0.43	17.0	150	17.1
Terrell's Ranch, NV	365	19.0	15.0	0.29	16.0	141	16.1
Tonopah, NV	358	19.3	16.5	0.45	17.6	154	17.6
Twin Springs, NV	364	20.0	15.0	0.47	16.4	146	16.6
Uhalde's Ranch, NV	304	19.0	12.8	0.84	17.4	149	17.0

Note: Multiply µR/hr by 2.6 x 10^{-4} to obtain µC · kg^{-1} · hr^{-1}.

Table 4.19 BN Offsite Boundary Monitoring Data - 1997

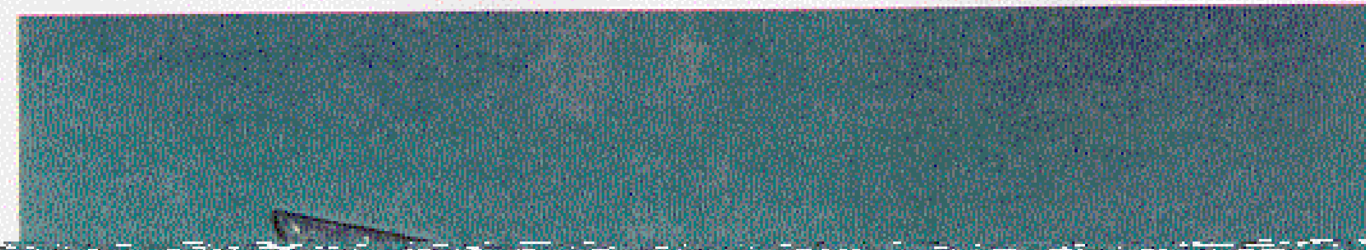
Station I.D.#	Description	1st Qtr (mR)	2nd Qtr (mR)	3rd Qtr (mR)	4th Qtr (mR)	1997 (mR)
	Washington Aerial Measurements Operation					
WA-006	Calibra Lab Door, Bldg 1794	34.8	14.5	22.6	17.4	89.3
WA-007	Work Area Wall, Bldg 1794	35.1	16.4	23.4	16.2	91.1
WA-020	Background Station	33.7	13.9	22.9	14.1	84.6
WA-021	Background Station	34.5	16.8	23.8	18	93.1
WA-022	Background Station	39	17.4	26.7	17.7	100.8
WA-023	Background Station	39.8	20.4	26.7	18.9	105.8
WA-012	Control - 1	32.5	29.2	19	12.3	93
WA-012	Control - 2	32.2	29.2	(a)	13.2	99.5
	North Las Vegas Facility					
LV-055	NW Corner Fence/Gate C6	21.8	19.4	19.8	19.8	80.8
LV-056	NW Corner Fence/Gate C6	21.2	19.5	19.35	19.35	79.4
LV-057	N Fence--West End A-12	16.7	15.1	14.95	14.95	61.7
LV-058	N Fence--West End A-12	16.4	14.8	15.1	15.1	61.4
LV-059	N Fence--West End A-4	16.4	15.4	14.35	14.35	60.5
LV-060	N Fence--West End A-4	16.1	14.8	15.2	15.2	61.3
LV-061	NE Corner Fence/A-12	15.8	13.6	13.9	13.9	57.2
LV-062	NE Corner Fence/A-12	15.5	13.4	14.2	14.2	57.3
LV-063	E Fence/Center A-Complex	15.2	12.8	14.05	14.05	56.1

(a) Missing data.

Table 4.19 (BN Offsite Boundary Monitoring Data - 1997, cont.)

Station I.D.#	Description	1st Qtr (mR)	2nd Qtr (mR)	3rd Qtr (mR)	4th Qtr (mR)	1997 (mR)
	North Las Vegas Facility, cont.					
LV-064	E Fence/Center A-Complex	14.3	14.2	13.45	13.45	55.4
LV-065	NLV Badge Off (A-7)/A-2	14	13.1	13	13	53.1
LV-066	NLV Badge Off (A-7)/A-2	14	13.1	13.05	13.05	53.2
LV-067	E Fence/North End B-Complex	16	13.9	14.35	14.35	58.6
LV-068	E Fence/North End B-Complex	16.7	14.2	14.5	14.5	59.9
LV-069	E Fence/South End B-Complex	17	14.5	14.9	14.9	61.3
LV-070	E Fence/South End B-Complex	16.1	15.1	14.9	14.9	61
LV-071	S Fence/Center	17.3	15.1	19.05	19.05	70.5
LV-072	S Fence/Center	17.3	14.8	15.25	15.25	62.6
LV-075	C-1 W End Guard Gate	20	17.1	18.45	18.45	74
LV-076	C-1 W End Guard Gate	20.9	17.7	17.85	17.85	74.3
LV-077	W Fence/Gate C-3	17	(a)	(a)	(a)	
LV-078	W Fence/Gate C-3	17.3	(a)	(a)	(a)	
LV-079	NW End A-13/Double G	17	16	16.1	16.1	65.2
LV-080	NW End A-13/Double G	17.3	14.8	15.2	15.2	62.5
LV-098	Control - 1	(a)	9.9	9.5	9.5	38
LV-099	Control - 2	(a)	10.1	9.4	9.4	38
	Special Technologies Laboratory					
ST197	Bldg. 226, West Fence	20	16.2	21	(a)	76.3
ST198	Bldg. 226, West Fence	21.2	16.5	19.9	(a)	76.8
ST199	Bldg. 229-C, Left Side	20.9	18.8	21.9	18	79.6
ST200	Bldg. 229-C, Left Side	21.2	18.2	21.3	18.3	79
ST201	Bldg. 227, E Fence	21.2	17.6	21	(a)	79.7
ST202	Bldg. 227, E Fence	20.3	16.8	21	(a)	77.5
ST205	Bldg. 227, NE Corner Step	20.4	16.2	21	(a)	76.8
ST206	Bldg. 227, NE Corner Step	20.6	17.1	20.7	(a)	77.9
ST207	Bldg. 227, NE Fence	23.6	17.4	21.5	(a)	83.3
ST208	Bldg. 227, NE Fence	20.9	17.9	21.6	(a)	80.5
ST209	Bldg. 227, Behind CF Shed	21.8	17.6	22.2	18.9	80.5
ST210	Bldg. 227, Behind CF Shed	20.9	16.7	22.8	18.3	78.7
ST211	Bldg. 227, E Fence Center	(a)	(a)	(a)	18.7	
ST212	Bldg. 227, E Fence Center	(a)	(a)	(a)	18.4	
ST213	Bldg. 227, SE Fence Corner	23	17.9	22.5	17.8	81.2
ST214	Bldg. 227, SE Fence Corner	21.6	17.9	23.6	17.5	80.6
ST141	Bldg. 227, Rear on Fence	25.1	19.9	23.4	19.4	87.8
ST-C1	Control 1	(a)	13	(a)	14.2	54.4
ST-C2	Control 2	(a)	13.6	(a)	14.2	54

(a) Missing data.



5.0 WATER SURVEILLANCE ACTIVITIES

The primary mission of the U.S. 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 generated by such tests 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 (ERP) goals are to safeguard the public's health and safety and to protect the environment. This involves the assessment and cleanup of contaminated sites and facilities to meet standards required by federal and state environmental laws. In 1996, DOE formalized an agreement with the state for implementing corrective actions based on public health and environmental considerations in a cost-effective and cooperative manner. Investigation and cleanup activities continued on the NTS and Nellis Air Force Range Complex and at offsite locations in the state of Nevada and other states.

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 1997, groundwater was monitored on and around the NTS, at five 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 sites have been decreasing and were well below the National Primary Drinking Water Regulation levels. NTS supply wells were monitored for specific radioactive constituents and for permit compliance.

5.1 WATER MONITORING PROGRAM INFORMATION

Water monitoring activities conducted on the NTS and related facilities involve surveillance of surface and groundwaters, drinking water systems, sewage treatment ponds, and actions protective of groundwater resources.

ONSITE ENVIRONMENTAL MONITORING

CRITERIA

DOE Order 5400.1, "General Environmental Protection Program," establishes environmental protection program requirements, authorities, and responsibilities for 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, "Environment, Safety, and Health Program for DOE 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."

WATER EFFLUENT MONITORING

Radiologically contaminated water continued to be discharged from E Tunnel in Rainier Mesa (Area 12) despite efforts to seal that tunnel. 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. Flow data obtained from the Defense Special Weapons Agency (formerly the Defense Nuclear Agency) were used to calculate the total volume discharged. Annual average radioactivity concentrations were calculated from the quarterly measurements. From these, the total amount of radioactivity in the effluent was obtained.

Water pumped from wells drilled, or recompleted, to obtain data for characterization of the NTS groundwater was discharged into containment ponds. In 1997, two wells were recompleted at emplacement hole U-3cn. These wells were purged and the purge water placed in lined containment ponds. The total volume and the tritium concentration of water in each pond were available.

Analytical procedures are summarized in Table 5.1 for both Bechtel Nevada (BN) and Radiation and Indoor Environment National Laboratory - Las Vagas (R&IE-LV).

WATER ENVIRONMENTAL MONITORING

Environmental monitoring was conducted onsite throughout the NTS and the near offsite area. Surface water and groundwater samples were routinely collected at preestablished locations and analyzed for radioactivity.

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 done for these types of samples is shown in Table 5.2. Sampling locations are shown on Figures 5.1 and 5.2.

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 done on samples from the water supply wells by concentrating the volume and tritium content of a 250-mL sample aliquot to 10 mL by electrolysis of a 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 a sample, precipitating the barium and radium as a sulfate, separating the precipitate, and analyzing it by counting for 500 minutes in a low-level gamma spectroscopy facility.

The radiochemical procedure for plutonium was similar to that described in Section 4.1. Alpha spectroscopy was used to measure any ^{238}Pu, $^{239+240}$Pu, and the ^{242}Pu tracer present in the samples.

The present R&IE-LV sampling locations on the NTS, or immediately outside its borders on federally owned land are shown in Figure 5.3. All sampling locations are selected by DOE and primarily represent potable water supplies. R&IE-LV samples onsite wells without pumps and, for quality assurance purposes, collects samples from some potable wells sampled by BN. A total of 22 wells was sampled. All samples were analyzed by gamma spectrometry and for tritium.

5.2 LONG-TERM HYDROLOGICAL MONITORING PROGRAM (LTHMP)

The EPA's R&IE-LV is responsible for operation of the LTHMP, including sample collection, analysis, and data reporting. Until implementation of the LTHMP in 1972, monitoring of ground and surface waters was done by the U.S. Public Health Service (PHS), the U.S. Geological Survey (USGS), and the U.S. Atomic Energy Commission (AEC) contractor organizations. The LTHMP consists of routine radiological monitoring, analysis, and reporting of samples collected from specific wells on the NTS and of wells, springs, and surface waters in the offsite area around the NTS. Samples are also 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 shallow groundwater, and during cleanup and disposal operations, shallow groundwater at the Tatum Dome Test Site in Mississippi was contaminated with tritium.

Summaries of the 1997 sampling results for each of the offsite LTHMP locations are provided in Section 5.5.

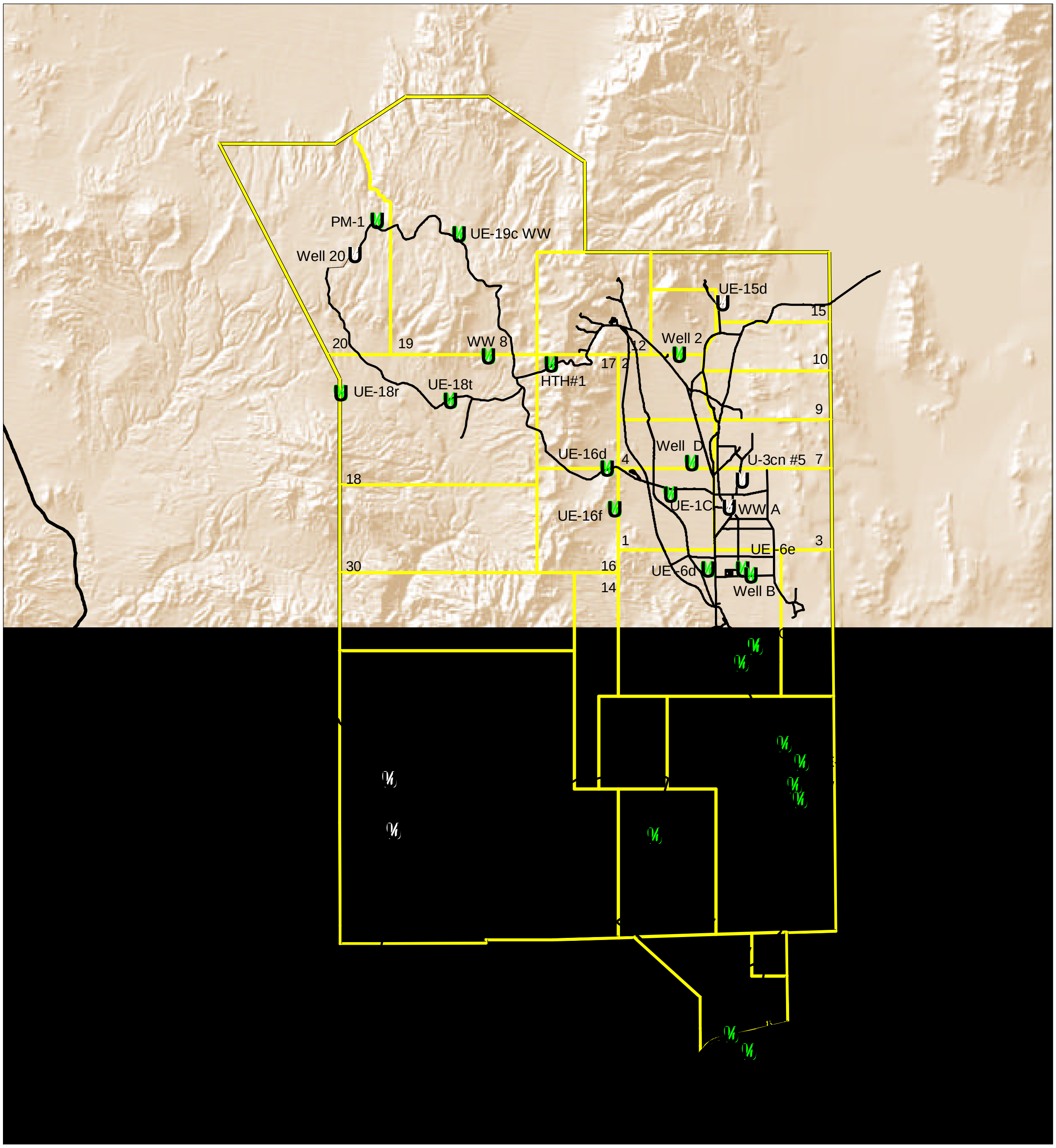
SAMPLING AND ANALYSIS PROCEDURES

The procedures for the analysis of samples collected for this report are described by Johns et al., 1979 and are summarized in Table 5.1. These include gamma spectral analysis and radiochemical analysis for tritium. The procedures are based on a standard methodology for the stated analytical procedures. Two methods for tritium analysis were performed: conventional and electrolytic enrichment. The samples were initially analyzed for tritium by the conventional method followed by enrichment analysis if the results were less than 800 pCi/L (30 Bq/L). In late 1995, it was decided that only 25 percent of the samples would be analyzed by the electrolytic enrichment method. The samples selected have a tritium result of less than 800 pCi/L by the conventional method and are from locations that are in position to show possible migration. Two 250-mL glass bottles and a 1-gal plastic container are filled at each sampling location. At the sample collection sites, the pH, conductivity, water temperature, and sampling depth are measured and recorded when the sample is collected. For wells with operating pumps, the samples were 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 1,800 m (5,900 ft).

The first time samples are collected from a well, ^{89,90}Sr, ^{238}Pu, $^{239+240}$Pu, and uranium isotopes are determined by radiochemical analysis, in addition to analysis mentioned above. The 250-mL samples are analyzed for tritium and the 1-gal sample from each site is analyzed by gamma spectrometry.

GROUNDWATER NEAR THE NEVADA TEST SITE

Water sampling around the NTS is conducted by R&IE-LV under an interagency agreement with DOE to ensure the



U Not Sampled This Year

U Water Sampling Location

Community

State Line

Nevada Test Site (NTS)

NTS Operational Area

5 0 5 10 15 20

Miles

10 0 10 20 30

Kilometers

Figure 5.3 Wells on the NTS Sampled by R&IE-LV - 1997 radiological safety of public drinking water supplies, and representative water sources of rural residents and, where suitable, to monitor any migration of radionuclides from the NTS. This water monitoring is conducted within the LTHMP. R&IE-LV personnel routinely collect and analyze water samples from locations in the offsite areas surrounding the NTS. 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 drinking water supplies used by the offsite population are represented in the LTHMP samples. Figure 5.4 is a map of the locations sampled.

GROUNDWATER AT OTHER TEST AREAS

Sampling for the LTHMP is also conducted at sites of past nuclear device testing in other parts of the United States to ensure the radiological 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 groundwaters 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 (SALMON) site in Mississippi. Sampling is normally conducted in odd numbered years on Amchitka Island, Alaska, at the site of Projects CANNIKIN, LONG SHOT, and MILROW.

5.3 GROUNDWATER PROTECTION PROGRAM

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 variably 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 210 m (approximately 690 ft) below the land surface and is often more than 300 m (approximately 1,000 ft). The hydrogeologic units, at the NTS, occur in three groundwater subbasins in the Death Valley Groundwater Basin (see Chapter 2, Figure 2.7, 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.

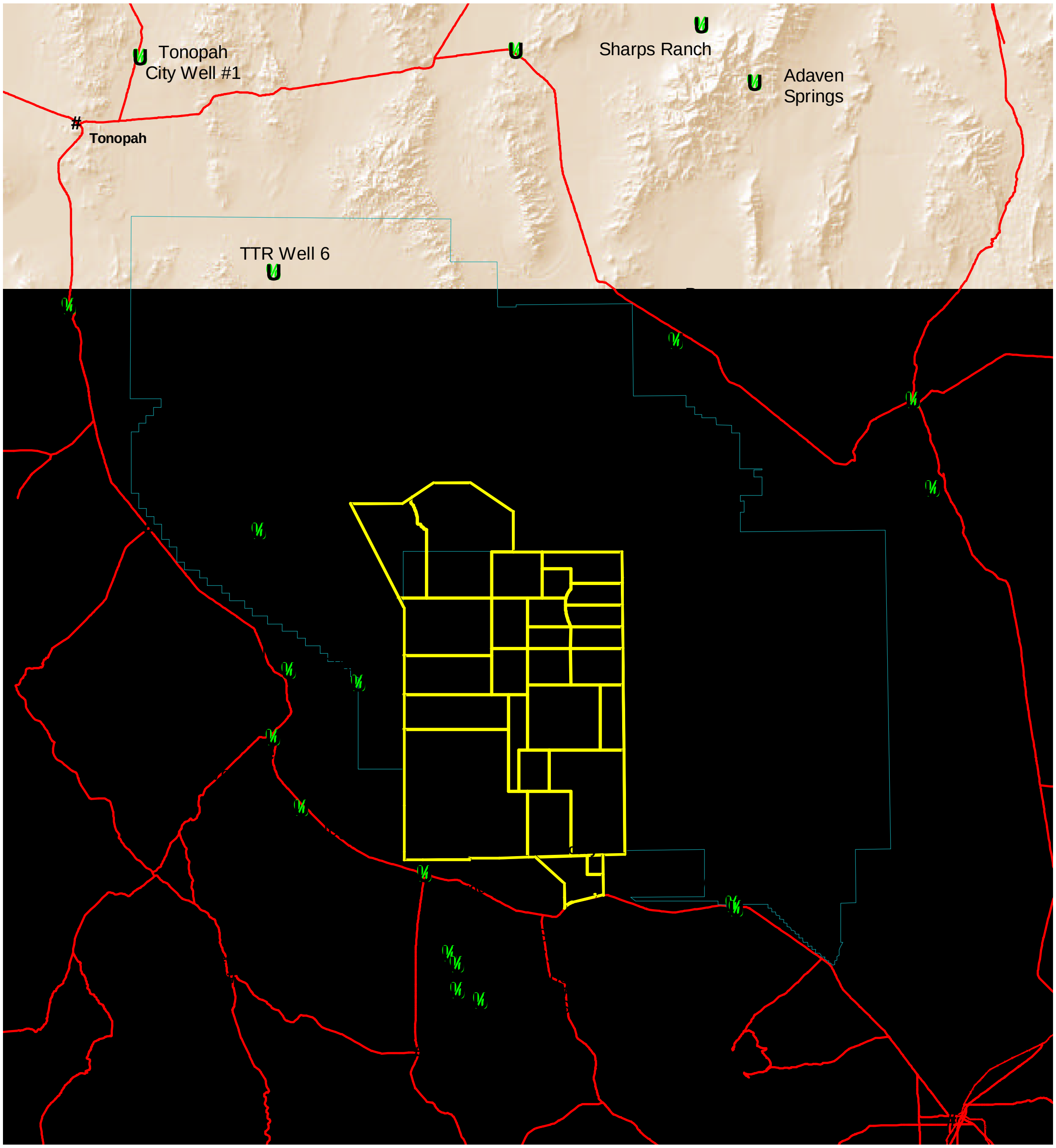
Groundwater beneath the far northwestern corner of the NTS may be in the Oasis Valley Subbasin, which discharges by evapotranspiration in Oasis Valley. Some underflow from the subbasin discharge areas probably travels to springs in Death Valley. Regional groundwater flow is from the upland recharge areas 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 (Laczniak et al., 1996).

HYDROGEOLOGY OF NON-NTS UNDERGROUND TEST SITES

The following descriptions of the hydrogeology of non-NTS underground test sites are summarized from Chapman and Hokett, 1991.

FALLON, NEVADA

The Project SHOAL site is located in the granitic uplift of the Sand Spring Range.



Tonopah
City Well #1
Sharps Ranch
Adaven
Springs
Tonopah
TTR Well 6

The highland area around the site is a regional groundwater recharge area, with regional discharge occurring to the west in Fourmile Flat and Eightmile Flat and to the northeast in Dixie Valley. Evidence suggests that a groundwater divide exist 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 separated by clay aquitards. Ground-water flow velocities through the granite to the alluvial aquifers of Fairview Valley are calculated to be very low (Chapman and Hokett 1991).

CENTRAL, 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.

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 flow 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.

RIFLE, COLORADO

Project RIO BLANCO is located in the Fort Union and Mesa Verde sandstones in the Piceance Creek Basin. Three aquifers comprise most 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.

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.

HATTIESBURG, MISSISSIPPI

Project DRIBBLE and the Miracle Play Program were conducted in the Tatum Salt Dome (also known as the SALMON Site). 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 results in uncertainties in groundwater flow directions.

FARMINGTON, 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 m/yr.

CARLSBAD, 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.

NTS AREAS OF POSSIBLE GROUNDWATER CONTAMINATION

In 1996, DOE/NV analyzed and confirmed the location of 908 underground tests in 878 holes at the NTS that are included in areas of possible groundwater contamination as indicated on Figure 5.5. Approximately one third (259) of these tests were at or below the water table (DOE 1996a). 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 have contaminated the local groundwater with over 60 radionuclides being present in significant quantities. Tritium is the most abundant radionuclide, with an estimated 300 million curies present in or near the water table (DOE 1996c).

Surface activities associated with underground testing and other NTS activities such as disposal of low-level radioactive waste (LLW) and mixed wastes, spill testing of hazardous liquefied 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 known sites are categorized by type and listed in Appendices II, III, and IV of the Federal Facility Agreement and Consent Order (FFACO), jointly agreed to by the DOE, U. S. Department of Defense (DOD), and Nevada Environmental Protection Division (NEPD). 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 of into subsidence craters have the potential to reach groundwater.

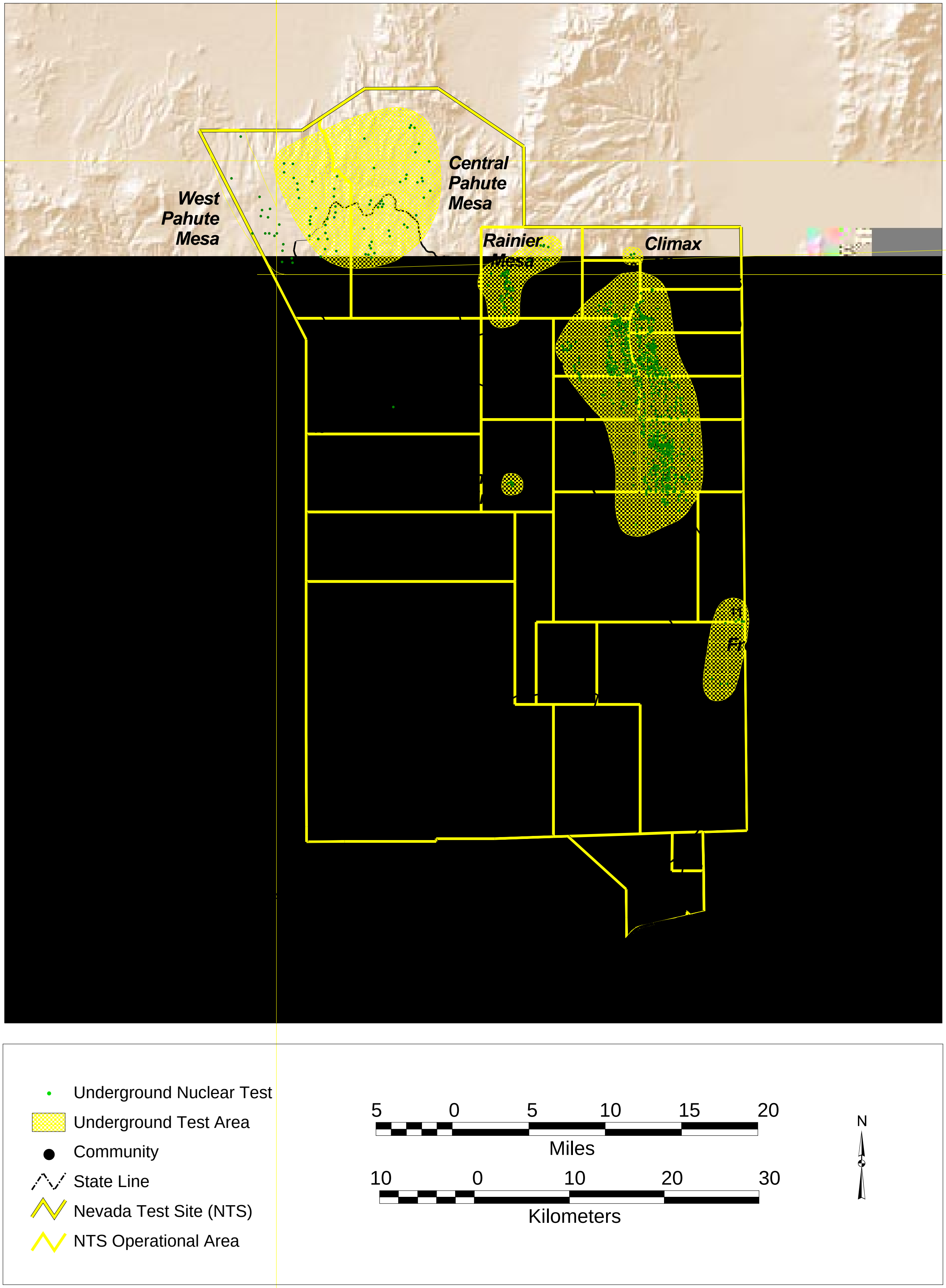


Figure 5.5 Areas of Potential Groundwater Contamination on the NTS

ACTIVITIES PROTECTIVE OF GROUNDWATER

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.

WASTE TREATMENT, STORAGE, AND DISPOSAL

DOE/NV currently operates disposal facilities in Areas 3 and 5 at the NTS for LLW generated by DOE and the DOD facilities. All hazardous wastes generated at the NTS are stored at a Hazardous Waste

VADOSE ZONE MONITORING

SEWAGE LAGOON COMPLIANCE

State Water Pollution Control Permit GNEV93001 requires that one of four methods of groundwater protection be established at active sewage lagoons on the NTS by January 31, 1999. The four acceptable groundwater protection methods identified in the permit include groundwater monitoring, vadose zone monitoring, engineered liner installation, and hydrogeological site characterization.

Over the past four years, groundwater protection permit compliance has been attained at nine of the NTS facilities. Groundwater protection permit compliance has not been attained at two remaining facilities: (1) the Area 6 Device Assembly Facility, and (2) the Area 25 Reactor Control Point. Full compliance will be attained at all sites by the expiration date of the permit.

Initial groundwater sampling at the Area 23 Infiltration Basin Groundwater Monitoring Well SM-23-1 was performed in August 1997, and compliance monitoring will begin in 1998. Results indicate that the groundwater adjacent to and beneath the infiltration basin meets drinking water standards. Information on improvements to the monitoring well is contained in Chapter 3.

5.4 ENVIRONMENTAL RESTORATION

The Nevada ERP was begun in the late 1980s to address contamination resulting primarily from nuclear weapons testing and related support operations. The goals of the project are to safeguard the public's health and safety and to protect the environment. This involves the assessment and cleanup of contaminated sites and facilities to meet standards required by federal and state environmental laws. Approximately 878 sites used for historic underground nuclear tests will be investigated, along with areas where more than 100 aboveground tests were conducted. Additionally, 1,500 other sites that were used for support operations will potentially require environmental remediation.

The DOE/NV is working closely with representatives of the state of Nevada to ensure compliance with applicable environmental regulations. A FFACO was signed by the DOE, DOD, and NEPD in May 1996. The FFACO provides a mechanism for implementing corrective actions based on public health and environmental considerations in a cost-effective and cooperative manner. It also establishes a framework for identifying, prioritizing, investigating, remediating, and monitoring contaminated DOE sites in Nevada. The FFACO's corrective action requirements supersede some portions of the NTS RCRA Permit issued in May 1995.

Investigations and remediations follow a strategy for investigation and remediation outlined in Appendix VI, Corrective Action Strategy, of the FFACO. The strategy is based on four steps: (1) identifying corrective action sites, (2) grouping the sites into corrective action units, (3) prioritizing the units for funding and work, and (4) implementing investigations or actions as applicable. The sites are broadly organized into underground test area sites, industrial sites, soil sites, and off sites. Information related to investigation and cleanup activities as it relates to groundwater protection follows.

UNDERGROUND TEST AREA (UGTA) SITES

The UGTA subproject focused on well development, testing, and sampling wells near underground nuclear tests. Some of this work was also supported by the HRMP. These activities were conducted in order to determine radiochemical and hydrogeologic conditions near tests in support of modeling at the scale of Corrective Action Units.

Contaminated fluid produced during drilling and sampling was managed in accordance with the UGTA Waste Management Plan (DOE 1996d) to prevent degradation of groundwater. Evaporation of tritiated water from the drilling operations is included in the calculations for compliance with the National Emissions Standard for Hazardous Air Pollutants.

Accomplishments of the UGTA project in 1997 include the sampling of two wells at the TYBO underground nuclear test and a "Forced Gradient Experiment" at the BULLION test on Pahute Mesa. Other activities included the development and sampling of three zones in Well UE-10j located in northern Yucca Flat and two wells near the BILBY site in south central Yucca Flat. Three post-shot wells "hot wells" were also sampled, including U-3cn PS#2 (BILBY), U-4u PS2A (DALHART), and U-20n PSPS1 ddh (CHESHIRE). In general, results show no evidence of man-made radionuclides in the regional carbonate aquifer beneath Yucca Flat, and expected levels of contamination in the post shot and near-event wells at Yucca Flat and on Pahute Mesa. These activities are summarized below. Results are scheduled for publication in 1998.

BULLION FORCED-GRADIENT EXPERIMENT

The BULLION Forced-Gradient Experiment was conducted from June 2 to August 28, 1997, at Well Cluster ER-20-6 on Pahute Mesa in the northwestern corner of the NTS. This well cluster consists of three wells: a production well (ER-20-6 #3) and two injection/sampling wells located 88.7 m (ER-20-6 #2) and 130.1 m (ER-20-6 #1) from the production well. The wells are approximately aligned with the local groundwater gradient and the major fracture system, a short distance downgradient from the BULLION test. Well #3 was pumped at 116 gal/ min to induce a groundwater gradient towards this well. A selection of tracers was injected into the other two wells, and breakthrough curves for the tracers were determined by analyzing samples from Wells #2 and #3.

The experiment was designed to characterize transport parameters in fractured volcanic rocks, specifically effective porosity, matrix diffusion, and dispersivity. The tracers used are conservative, but have significantly different diffusion coefficients. The wells were also sampled for water chemistry and radiochemistry parameters. During the experiment, onsite monitoring of tritium concentration at all three wells found that concentration declined to the low thousands of picocuries per liter, rather than the substantial increases expected from transport of radionuclides from the BULLION test cavity. Radionuclides were variously analyzed by IT, Lawrence Livermore National Laboratory (LLNL), Desert Research Institute (DRI), and Los Alamos National Laboratory (LANL 1998). Additional information and analytical results will be reported by the respective organizations during 1998.

POST-SHOT WELLS ("HOT WELLS")

Two post-shot cavity holes were sampled in 1997 by a joint LANL-LLNL-USGS team. Drill-back hole U-4u PS#2A (for the DALHART test) was sampled this year, because it is one of the "hot holes" monitored periodically, and because it is a candidate for a test of a new pumping methodology. The DALHART test was fired on October 13, 1988, in central Yucca Flat. U-4u PS#2A was drilled into the cavity region in 1990. Analyses of water samples collected in July 1997, indicated a tritium activity of 26 µCi/L (9.7×10^5 Bq/L) (LANL 1998).

Post-shot Well U-20n PS#1 DDH was drilled to support studies of radionuclide migration from the cavity/chimney region of the CHESHIRE underground test that was conducted on Pahute Mesa in February of 1976. Radionuclide migration studies at this site have been intermittent since 1976. Water samples collected from this well in July 1997 had a tritium activity of about 150 µCi/L (5.7×10^6 Bq/L) (LANL 1998).

WELL UE-10J

Well UE-10j is located in northern Yucca Flat and is completed in the lower carbonate aquifer (regional aquifer) (DOE 1995). Well development, groundwater sampling, and data compilation for Well UE-10j were performed in 1997 (IT 1997).

Well development of the three completion zones, which are equipped with sliding sleeves, was conducted in March 1997. Groundwater characterization samples were collected from each completion zone and analyzed by Lockheed Analytical Services for general chemistry, principal cations and anions, metals, and radionuclides. Gamma scan analytical results include actinium-228, bismuth-214, cobalt-57/60, cesium-134/137, potassium-40, lead-212/214, thorium-234, thallium-208, uranium-235, and tritium. Bismuth-214 was the only radionuclide detected in the middle interval, at 25 pCi/L, compared to a laboratory minimum detectable concentration (MDC) of 19 pCi/L. LLNL analyzed groundwater samples from each of the completion zones for radiochemistry and isotopic analyses. The analytical results revealed the groundwater samples contain natural levels of all the isotopes measured. The DRI collected groundwater samples from each completion zone for stable isotopic analyses. Static water-level measurements for Well UE-10j were taken quarterly by the USGS. The above data was reported in IT 1997.

BILBY

Two wells, located at the NTS BILBY site in south-central Yucca Flat, were refurbished and sampled by the UGTA Subproject in 1997. The purpose of this work was to restore and/or replace the existing submersible pumps that were installed approximately 20 years ago in Hydrologic Test Hole U-3cn#5 and Post-Shot Hole U-3cn PS#2. U-3cn#5 was completed below the BILBY cavity in the lower carbonate aquifer, and U-3cn PS#2 accesses the BILBY cavity and rubble chimney. Analysis of groundwater samples collected on January 22, 1997, at U-3cn PS#2 showed tritium (1.33×10^7 pCi/L), cesium-137 (1.1 pCi/L), and barium-133 (0.26 pCi/L). Cesium-137 is an expected component of groundwater close to a nuclear test, while barium-133 is unexpected. Tritium activity for groundwater samples from U-3cn#5, collected on January 29, 1997, remained low, ranging between 1,600 and 3,080 pCi/L. No gamma emitters, other than those naturally present in groundwater, were detected (LANL 1998). The low tritium activity observed at U-3cn#5 is believed to be the result of poor hydraulic conductivity of the zeolitized-bedded tuffs (tuff confining unit) between the test cavity and the underlying lower carbonate aquifer (LLNL 1997).

TYBO/BENHAM

From 1995 to early 1996, the UGTA subproject drilled two holes, ER-20-5 #1 and #3, adjacent to the site of the underground nuclear test, code named TYBO (DOE 1997c). Water samples from these wells were analyzed at LANL and LLNL and were found to contain radionuclides not often measured in similar sites (LANL 1998).

The purpose of drilling at Well Cluster ER-20-5 was to characterize the nature and extent of radionuclide migration adjacent to a relatively large yield test conducted below the water table. The TYBO test was conducted on Pahute Mesa on May 14, 1975, at a depth of 765 m (2,509 ft), well below the static water level of 630 m (2,066 ft). Well ER-20-5 #1 was completed and screened in a transmissive aquifer at a depth comparable to the working point of the TYBO test. Well ER-20-5 #3 was completed and screened in a deeper transmissive aquifer at a depth comparable to the working point of the 1968 BENHAM test, located 1,300 m (4,265 ft) to the north (DOE 1997c). The BENHAM test was fired on December 19, 1968, at a depth of 1,402 m (4,599 ft) well below the static water table of 641 m (2,102 ft). Both ER-20-5 #1 and #3 were believed to be sited hydrologically downgradient of the TYBO test.

Radionuclides detected include ^{137}Cs, ^{60}Co, $^{152,154,155}Eu$, and $^{239+240}Pu$. Except for tritium, the activity levels measured in the ER-20-5 groundwater are well below the drinking water limits calculated by EPA standards. Groundwater samples collected in April 1997 at ER-20-5 #1 had a tritium activity of 6.89 x 10^7 pCi/L (2.55 MBq/L) and 1.42 x 10^5 pCi/L (5.3 kBq/L) at ER-20-5 #3. Prefiltering of the water samples indicates that, except for tritium, the radionuclides are associated with particulates and colloids. Furthermore, isotopic ratios for $^{239+240}Pu$ are relative to the BENHAM test 1,300 m (4,265 ft) to the north, and not to the closer TYBO test, as expected (Thompson et al., 1997).

INDUSTRIAL SITES AND DECONTAMINATION AND DECOMMISSIONING

The Area 6 Decontamination Pond RCRA Closure Unit characterization was completed. Additional geotechnical sampling and testing was completed for the Corrective Measures Study. Design and field testing for the engineered cover was started and will be completed in 1998. Closure activities are anticipated to be completed in 1998.

An annual report was submitted to comply with the conditions of the RCRA Part B Permit for the Area 2 Bitcutter Shop and LLNL Post Shot Containment Building Injection Wells RCRA Closure Unit that was closed in 1996. These facilities and other NTS facilities with RCRA closure plans are listed in Table 5.4.

ABANDONED UNDERGROUND STORAGE TANKS

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 the NEPD to satisfy state regulatory reporting requirements.

During 1997, there were no USTs that were required to be removed in accordance with state and federal regulations. Remedial activities continued at previous tank removal sites during 1997 as funding became available.

SOIL SITES

In 1997, radiologically contaminated soils from the CLEAN SLATE I site, on the NAFRC, northwest of the NTS were removed and disposed of in Area 3 on the NTS. However, these contaminated soils were at the ground surface and did not contaminate the subsurface or groundwater. Therefore, they are not discussed further here.

OFFSITE LOCATIONS

The offsite areas are described in Section 5.2 of this chapter. Activities related to groundwater protection at these sites are conducted as part of the ERP. Investigation and cleanup at these sites are being conducted in accordance with the FFACO, with the state of Nevada, for the two sites in Nevada, SHOAL and FAULTLESS. In the remainder of the states, agreements will be developed as the restoration activities proceed. Following is a summary of activities at sites where activities were conducted during 1997.

At the Project SHOAL site, an investigation plan was completed and approved; four monitoring wells were installed to a total depth of 396 m (1,300 ft); DRI conducted aquifer testing, and SAFER closure of one mudpit was completed.

At the Project RULISON site, following mudpit cleanup in 1995, quarterly sampling was done at four groundwater wells for hazardous waste during the second and final year, as required by the state of Colorado. No migration of hazardous wastes has been detected so far. IT Corporation is writing a closure report on this project.

Surface characterization of mudpits at wells UC-1, UC-3, and UC-4 was conducted at the FAULTLESS site.

At the SALMON site, 14 new shallow groundwater monitoring wells were installed, pumps were rehabilitated and installed in 4 existing wells, and 1 seismic check hole was plugged.

5.5 WATER SURVEILLANCE PROGRAM RESULTS

The analytical results obtained for water samples collected onsite and offsite are described in this Section. Only a few samples contained detectable concentrations of radionuclides. Table 5.5 lists the routine sampling locations, onsite and offsite, where well water samples contained concentrations greater than 0.2 percent of the National Primary Drinking Water Standards.

ONSITE WATER MONITORING RESULTS

RADIOACTIVITY IN SURFACE WATER

Surface water sampling at the NTS was conducted at eight open reservoirs, seven natural springs, a containment pond and an effluent, and nine sewage lagoons. The locations of these sources are shown in Figure 5.2. When water was available and the weather permitted, a grab sample was taken using the schedule in Table 5.2. 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 5.2. Sources of surface water were, for the most part, man-made; i.e., created for or by NTS operations.

The annual average for each radionuclide analyzed in surface waters is presented in Table 5.6, along with the results from analysis of tunnel effluents. The annual averages for open reservoirs and natural springs are compared to the Derived Concentration Guide (DCGs) for ingested water. The results from gamma spectrometry were non-detectable for all sample locations. Most radionuclide levels were below the detection limit, except for samples from the E Tunnel effluent and ponds, which had tritium concentrations ranging up to 1.1 x 10^{-3} µCi/mL.

With the exception of containment ponds, no annual average concentration in surface waters was found to be statistically different from any other at the 5 percent significance level. The analytical results from the Area 12 containment ponds showed measurable quantities of radioactivity as has been noted previously.

OPEN RESERVOIRS

Open reservoirs have been established at various locations on the NTS for industrial uses. The annual average concentrations of gross beta 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 5.7.

NATURAL SPRINGS

Of the nine natural springs found onsite, (i.e., spring-supplied pools located within the NTS), only seven had enough water to be sampled. These springs are a source of drinking water for wild animals on the NTS. The annual average gross beta results for all spring are shown in Table 5.6 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 at the close of 1993, liquid effluents ceased at all except E Tunnel. The E Tunnel containment ponds were 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 gamma activity in accordance with the schedule in Table 5.2. The annual average of gross beta analyses from the two sampling locations is listed in Table 5.6.

The effluent from characterization wells in Area 3 was discharged into containment ponds. The total liquid discharged was measured. By multiplying that volume by the average concentration of ^{3}H in collected samples, shown in Table 5.6, the total amount of tritium discharged (4.2 Ci or 0.16 TBq) was calculated.

SEWAGE LAGOONS

Samples were collected quarterly during this year from nine sewage lagoons on the network at the end of 1997. Each of the lagoons is part of a closed system used for evaporative treatment of sanitary waste. The lagoons are located in Areas 5, 6, 12, 22, 23, and 25. The annual gross beta concentration averages for all lagoons ranged between 7.7 and 33 x 10^{-9} µCi/mL (0.28 to 1.2 Bq/L). No radioactivity was detected above the MDCs for ^{3}H or ^{90}Sr. No test-related radioactivity was detected by gamma spectrometric analyses.

RADIOACTIVITY IN SUPPLY WELLS AND DRINKING 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. The NTS water system consisted of 11 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 taps on the end-points of the distribution systems 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 11 supply wells. Each well was sampled and analyzed as noted in the schedule in Table 5.2.

The locations of the supply wells are shown in Figure 5.1. Water from these wells (ten potable and one nonpotable) was used for a variety of purposes during 1997. 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 are maintained in a database so that long-term trends and changes can be studied. Table 5.8 lists the drinking water sources, and Table 5.9 lists the potable and nonpotable supply wells and their respective radioactivity averages. No test-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 sampling period.

As a check on any effect the water distribution system might have on water quality, samples were taken from seven water distribution system end-points (tap water samples). 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 consists of five drinking water systems. The components of the five are shown in Table 5.8. These systems, fed by ten potable supply wells, are the source of the water for the seven end-points. Table 5.10 lists the annual concentration averages for all the analyses performed on tap water samples. No test-related radionuclides were detected by gamma spectrometry.

GROSS BETA

As shown in Table 5.9, 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 5B and was 1.1×10^{-8} µCi/mL (0.41 Bq/L), which was 3.7 percent of the DCG for ^{40}K and 28 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. All concentration averages were comparable to those reported last year.

As in previous years, the gross beta concentration averages for all tap water samples were above the median MDC of the measurements. The highest annual average occurred in the Area 23 Cafeteria, 10×10^{-9} µCi/mL (0.37 Bq/L), similar to the supply well water. The annual EDE is also equivalent to that from the supply well water.

TRITIUM

As shown in Table 5.9, the average tritium concentrations at all locations was below the average MDC of the measurement (note that the MDC was 13×10^{-9} µCi/mL, based on tritium enrichment analysis).

The annual average tritium concentrations in tap water samples, as shown in Table 5.10, were all less than the median MDC of 7.2×10^{-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 1.4×10^{-8} µCi/mL (0.52 Bq/L). These MDC values are 0.9 percent and 0.018 percent, respectively, of the drinking water DCG adjusted to a 4 mrem (0.04 mSv) EDE.

PLUTONIUM

All supply water samples analyzed for ^{238}Pu and $^{239+240}Pu$ had concentrations below their MDC's of about 2.0×10^{-11} µCi/mL, which are about 2.0 percent of their respective DCGs adjusted to a 4 mrem EDE per year. Table 5.9 lists the concentration averages for these nuclides for each location.

The annual averages of $^{239+240}Pu$ and ^{238}Pu for each tap water sample were below the median MDC of the measurements, which were both less than 2 percent 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 (Title 40 CFR 141), gross alpha measurements were made on quarterly samples from the drinking water systems, namely the potable supply wells. As shown in Table 5.9, the average gross alpha concentration for all of the supply wells, except Well J-12 and Well 8, was above the median MDC of 1.4×10^{-9} µCi/mL. The highest concentration occurred in samples from Well C-1 in Area 6 and was 17×10^{-9} µCi/mL (0.63 Bq/L). This is acceptable according to the EPA drinking water standard (Title 40 CFR 141) as long as the combined concentration of ^{226}Ra and ^{228}Ra is less than 5×10^{-9} µCi/mL (0.18 Bq/L). The combined Ra concentration, for these two wells, was less than the combined MDC of 4.5×10^{-9} µCi/mL (0.17 Bq/L), as shown in Table 5.11.

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 tap water samples. As shown in Table 5.10, the annual concentration averages for gross alpha radioactivity in tap water samples collected at five locations, 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 5.11, the sum 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

Beginning in 1994, ^{90}Sr analyses were changed from annually to quarterly on samples collected from the potable supply wells, but analyses on non-potable supply wells remained on an annual basis. The concentration averages of ^{90}Sr for each location, as shown in Table 5.9, were below the median MDC.

As indicated by Table 5.10, the ^{90}Sr results for samples collected from all the selected tap water samples had concentrations that were less than the median MDC of the measurements.

LTHMP MONITORING ON AND AROUND THE NEVADA TEST SITE

NEVADA TEST SITE MONITORING

The present R&IE-LV sampling locations on the NTS, or immediately outside its borders on federally owned land are shown in Figure 5.3. All sampling locations are selected by DOE and primarily represent potable water supplies. Since 1995, R&IE-LV has only sampled wells without pumps and, for quality assurance purposes, collected samples from some of the potable wells sampled by BN. A total of 22 wells was sampled.

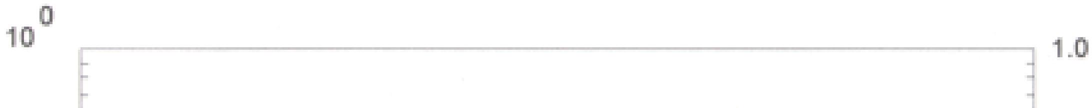
All samples were analyzed by gamma spectrometry and for tritium. No gamma-emitting radionuclides were detected in any of the NTS samples collected in 1997. Summary results of tritium analyses are given in Table 5.12. The highest average tritium activity was 6.0×10^4 pCi/L (2.2 kBq/L) in a sample from Well UE-5n. This activity is less than 70 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. Six of the wells sampled yielded tritium results greater than the MDC. The trend in tritium concentration in samples from Test Well B is shown in Figure 5.6 and is typical of a well with decreasing tritium concentrations. Well UE-7ns was routinely sampled between 1978 and 1987 and sampling began again in 1992. An increasing trend in tritium activity was evident at the time sampling ceased in 1987.

OFFSITE MONITORING IN THE VICINITY OF THE NEVADA TEST SITE

Water sampling around the NTS is conducted by the EPA's R&IE-LV, under an interagency agreement with DOE, to ensure the radiological safety of public drinking water supplies and representative water sources or rural residents and, where suitable, to monitor any migration of radionuclides from the NTS. The sampling locations are shown on Figure 5.4 and the analytical results are in Table 5.13. No man-made gamma-emitting radionuclides were detected in any sample. Adaven Spring showed detectable tritium activity, while the sample from the low-level waste site south of Beatty had barely detectable activity.

LTHMP MONITORING AT OTHER TEST SITES

Annual sampling of surface and groundwaters 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 (SALMON) site in Mississippi. Sampling is normally conducted in odd numbered years on Amchitka Island, Alaska, at the site of Projects CANNIKIN, LONG SHOT, and MILROW.



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PROJECT SHOAL

Project SHOAL, a 12-kt test emplaced at 365 m (1,198 ft), was conducted on October 26, 1963, in Fallon Nevada, 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.

Samples were collected on February 24 and 25, 1997. The sampling locations are shown in Figure 5.8. Only nine of the ten routine wells were sampled. Spring Windmill, and Smith and James Spring have been deleted. In 1997, four new wells were added to the LTHMP at this site, which are positioned near ground zero (GZ). Well HC-3 was dry and will have to be reworked. It will be sampled in 1998. At least one location, Well HS-1, should intercept radioactivity migrating from the test cavity, should it occur (Chapman and Hokett 1991).

Gamma-ray spectral analysis results indicated that no man-made gamma-emitting radionuclides were present in any samples above the MDC. One of the new wells, HC-4 drilled in 1996, had a tritium concentration of 860 ± 160 pCi/L (320 ± 6 Bq/L). Tritium concentrations at all the other locations were below the MDC (see Table 5.15).

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 2,568 m (8,425 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 May 6, 1997, with collection of samples from all sampling locations in the area of Grand Valley and Rulison, Colorado. Routine sampling locations are shown in Figure 5.9 and include five local ranches, five sites in the vicinity of surface GZ (SGZ), including one test well, a surface-discharge spring, and a surface sampling location on Battlement Creek. Seven new monitoring wells were completed at the RULISON site in 1995. Wells RU-1 and RU-2 were added to the LTHMP in 1997, as part of the Remedial Investigation and Feasibility Study.

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 1997 was from 42 ± 5 pCi/L (2 ± 0.2 Bq/L) at Well RU-1, to 100 ± 5.9 pCi/L (4 ± 0.2 Bq/L) at Lee Hayward Ranch. All values were less than 1 percent of the DCG (see Table 5.16). The detectable tritium activities were probably a result of the high natural background in the area. This was supported by the DRI analysis, which indicated that most of the sampling locations were shallow, drawing water from the surficial aquifer, which was unlikely to become contaminated by any radionuclides arising from the Project RULISON cavity (Chapman and Hokett 1991). Gamma-ray spectral analysis results indicated that man-made gamma-emitting radionuclides were not detectable.

PROJECT RIO BLANCO

Project RIO BLANCO, a joint government-industry test designed to stimulate natural gas flow, was conducted under the Plowshare Program. The test was conducted on May 17, 1973, at a location between Rifle and Meeker Colorado. Three nuclear explosives, with a total yield of 99 kt, were 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


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cleanup and restoration activities were completed. Tritiated water produced during testing was injected to 1,710 m (5,610 ft) in a nearby gas well.

Samples were collected May 7 and 8, 1997, from the sampling sites shown in Figure 5.10. Only 13 of the 14 routine wells were sampled. No sample was collected from CER #4, which was not accessible due to heavy rainfall. The routine sampling locations included three springs and six wells. Three of the wells are located near the cavity and at least two of the wells (Wells RB-D-01 and RB-D-03) were suitable for monitoring possible migration of radioactivity from the cavity.

No radioactive materials attributable to the RIO BLANCO test were detected in samples collected in May 1997. The range of tritium activity, using the enrichment method, was from 36 ± 5.2 (1.3 ± 0.2 Bq/L) at the B-1 Equity Camp to 25 ± 3.7 (1 ±0.1 Bq/L) at Fawn Creek, 8,400 ft downstream (see Table 5.17). The tritium concentrations are well below 20,000 pCi/L level defined in the EPA National Primary Drinking Water Regulations (Title 40 CFR 141). All samples were analyzed for presence of gamma-ray emitting radionuclides, and none were detected.

PROJECT GNOME

Project GNOME, conducted on December 10, 1961, near Carlsbad, New Mexico, was a multipurpose test performed in a salt formation. A 3-kt nuclear explosive was emplaced at 371 m (1,217 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 (740, 370, 370, and 150 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 25 through 27, 1997. The routine sampling sites, depicted in Figure 5.11, include nine monitoring wells in the vicinity of GZ and the municipal water supplies at Loving and Carlsbad, New Mexico.

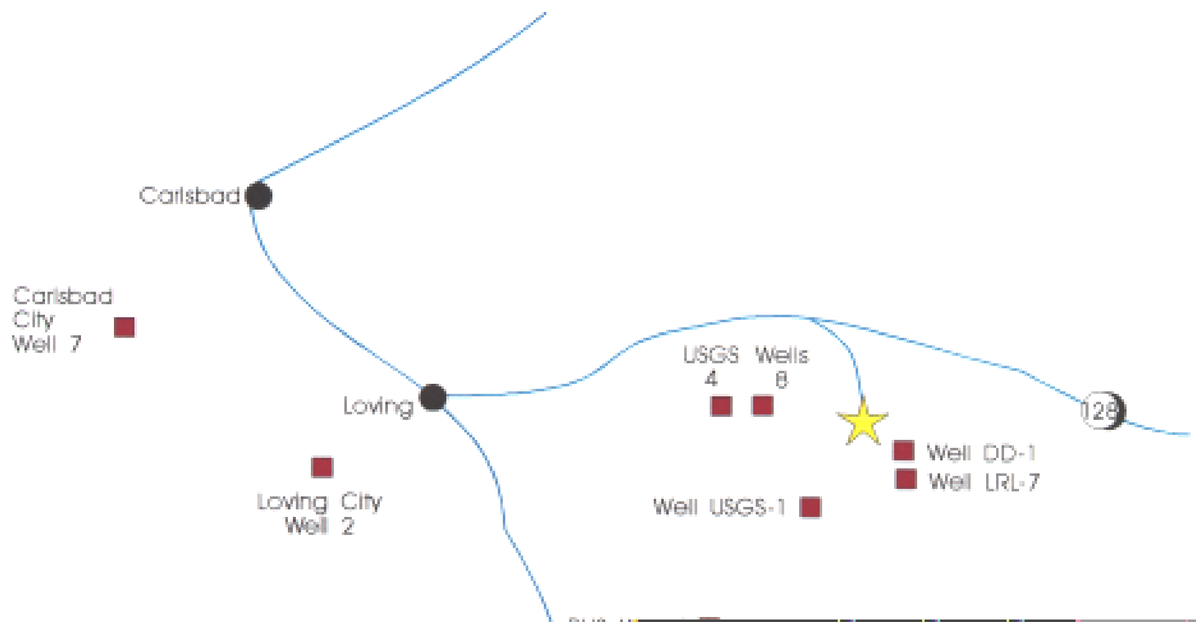
Tritium results greater than the MDC were detected in water samples from 6 of the 12 sampling locations in the immediate vicinity of GZ. Tritium activities in Wells DD-1, LRL-7, USGS-4, and USGS-8 ranged from 6.16 x 10^{7} to 2.46 x 10^{3} pCi/L (2.29 x 10^{6} to 91 Bq/L), as shown in Table 5.18. Well DD-1 collects water from the test cavity; Well LRL-7 collects water from a side drift; and Wells USGS-4 and -8 were used in the radionuclide tracer study conducted by the USGS. None of these wells are sources of potable water.

In addition to tritium, ^{137}Cs and ^{90}Sr concentrations were observed in samples from Wells DD-1, LRL-7, and USGS-8 and ^{90}Sr activity was detected in Well USGS-4 as in previous years (see Table 5.18). 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. All other tritium results were below the MDC.

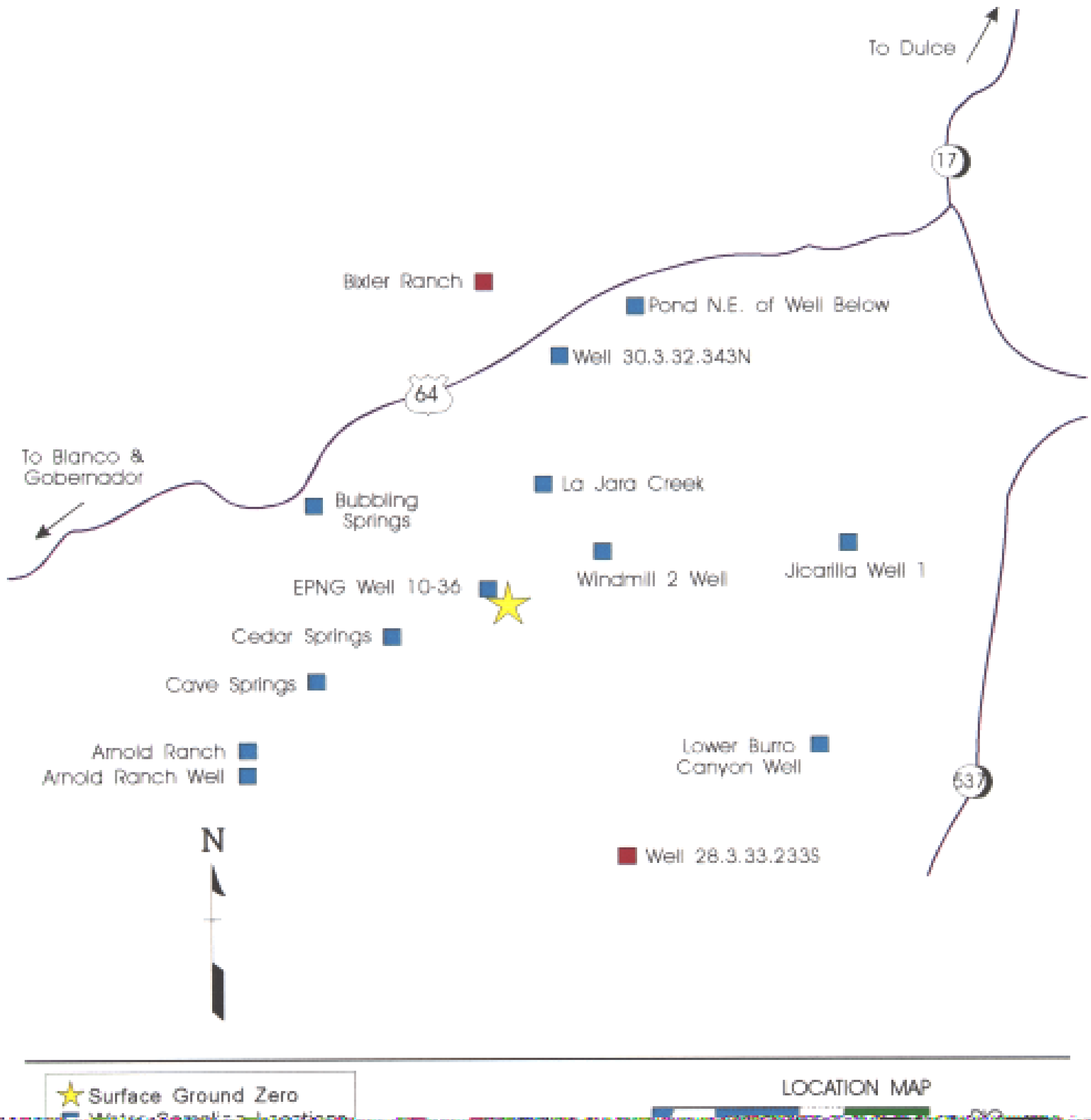
PROJECT GASBUGGY

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 1,290 m (4,240 ft). Production testing was completed in 1976, and restoration activities were completed in July 1978.

Sampling at GASBUGGY was conducted during May 10 through 12, 1997. Only 12 samples were collected at the designated sampling locations shown in Figure 5.12.



Carlsbad
Carlsbad City Well 7
Loving
Loving City Well 2
USGS Wells
4
8
Well DD-1
Well LRL-7
Well USGS-1
128


To Dulce
17
Bixler Ranch
Pond N.E. of Well Below
Well 30.3.32.343N
64
To Blanco & Gobernador
La Jara Creek
Bubbling Springs
Jicarilla Well 1
Windmill 2 Well
EPNG Well 10-36
Cedar Springs
Cave Springs
Arnold Ranch
Arnold Ranch Well
Lower Burro Canyon Well
537
Well 28.3.33.233S
N
Surface Ground Zero
LOCATION MAP

The Bixler Ranch Well has been sealed up and the Well 28.3.33.233 south had the pumps removed and no samples could be obtained.

The Cedar Springs sampling site yielded a tritium activity of 46 ± 5.8 pCi/L (1.7 ± 0.2 Bq/L). For Lower Burro Canyon, the tritium activity was 93 ± 5.5 pCi/L (3.4 ± 0.2 Bq/L), which was less than 0.2 percent of the DCG and similar to the range seen in previous years (see Table 5.19). Tritium samples from the other locations were all below the average MDC. Well EPNG 10-36, a gas well located 132 m (435 ft) northwest of the test cavity, with a sampling depth of approximately 1,100 m (3,600 ft), has yielded detectable tritium activities since 1984. The sample collected in May 1997 contained tritium at a concentration of 122 ± 5.9 pCi/L (4.5 ± 0.2 Bq/L), as shown in Table 5.19. The migration mechanism and route is not currently known, although an analysis by DRI indicated two feasible routes: one through the Printed Cliffs sandstones and the other one through the Ojo Alamo sandstone, one of the principal aquifers in the region (Chapman et al., 1996b). In either case, fractures extending from the cavity may be the primary or a contributing mechanism.

All gamma-ray spectral analysis results indicated that no man-made gamma-emitting radionuclides were present in any offsite samples. Tritium concentrations of water samples collected onsite and offsite are consistent with those of past studies at the GASBUGGY site.

PROJECT DRIBBLE

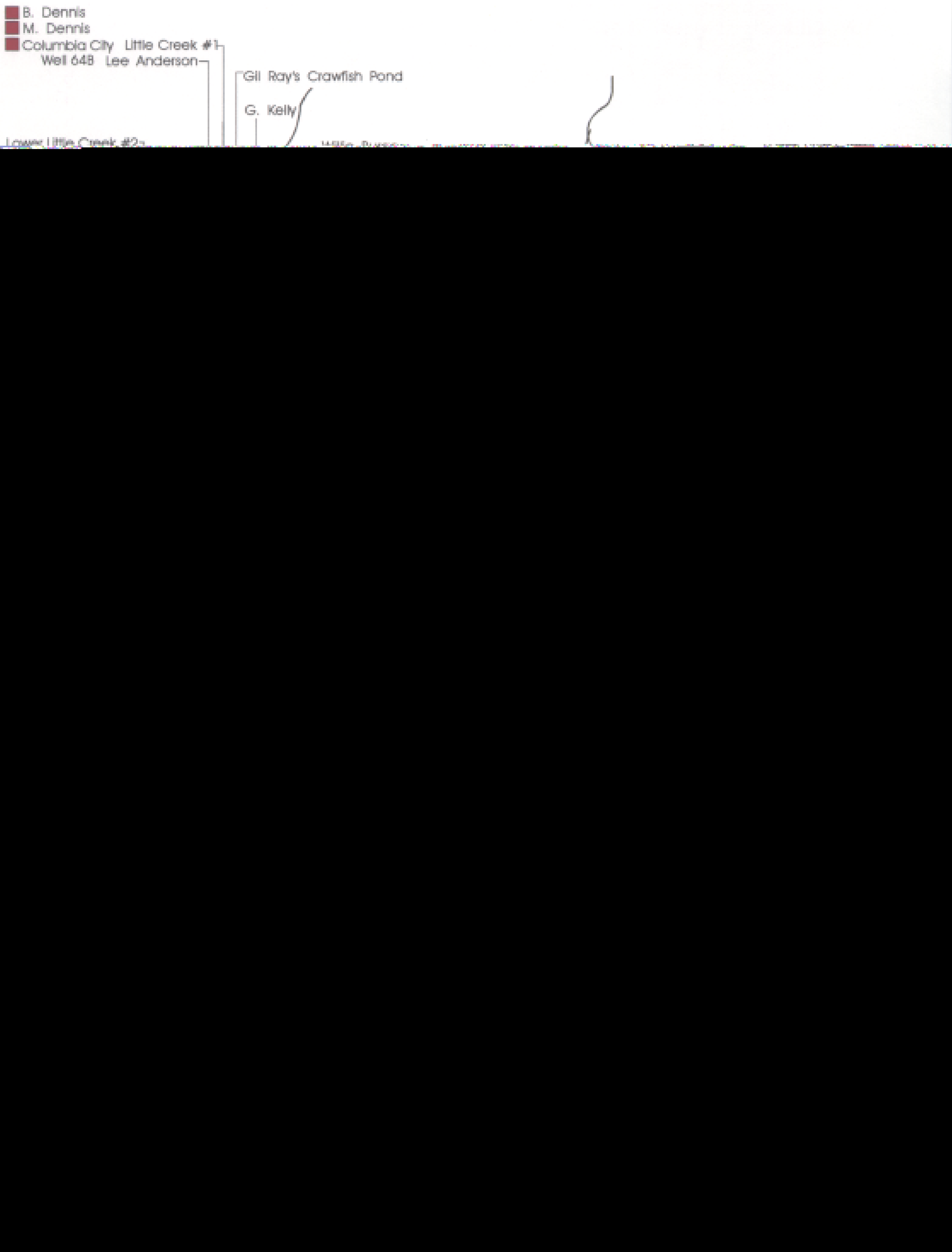
Project DRIBBLE was comprised of two nuclear and two gas explosive tests, conducted in the SALMON test site area near Hattiesburg, Mississippi, under the Vela Uniform Program. The purpose of Project DRIBBLE was to study the effects of decoupling on seismic signals produced by nuclear explosives tests. The first test, SALMON, was a nuclear device with a yield of about 5.3 kt, detonated on October 22, 1964, at a depth of 826 m (2,710 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 near SGZ. Shallow wells, labeled HMH wells on Figure 5.13, have been added to the area near SGZ to monitor this contamination. Fifteen new wells were completed in 1996 and first sampled by the EPA LTHMP Program in 1997. These wells are shallow, between 9 m to 12 m (30 ft to 40 ft) in depth. In addition to the monitoring of wells near GZ, extensive sampling of water wells is conducted in the nearby offsite area as shown in Figure 5.14.

Because of the variability noted in past years in samples from the shallow monitoring wells near the SALMON 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 to recharge. These second samples may be representative of formation water, whereas the first samples may be more indicative of recent rainfall.

Sampling on and in the vicinity of the SALMON site was conducted between April 20 through 24, 1997.

Long-term decreasing trends in tritium concentrations are evident for those locations that had detectable tritium activity at the beginning of the LTHMP, such as in the samples from the Baxterville City Well depicted in Figure 5.15 and Well HM-S shown in Figure 5.16. Due to the high rainfall in the area, the normal sampling

[redacted]


B. Dennis
M. Dennis
Columbia City
Little Creek #1
Well 648
Lee Anderson
Gil Ray's Crawfish Pond
G. Kelly

[redacted]

procedure is modified for the shallow onsite wells as described above. Of the 45 locations sampled onsite, 20 sites were sampled twice (pre-and post-pumping), and 8 yielded tritium activities greater than the MDC in either the first or second sample. Of these, eight yielded results higher than normal background (approximately 60 pCi/L [2.2 Bq/L]), as shown in Table 5.20. The locations where the highest tritium activities were measured generally correspond to areas of known contamination. 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.

Six of the previously sampled locations regularly have tritium values above those expected in surface water samples. Of the 15 new wells, tritium values ranged from 3.4 x 10^4 to 14 ± 3.2 pCi/L (1.3 x 10^{3} to 0.5 ± 0.2 Bq/L) as shown in Table 5.20. Only one well was above the MDC in the 36 samples collected from the offsite sampling locations. Tritium activity ranged from less than the MDC to 26 pCi/L (1 Bq/L), 0.01 percent of the DCG. These results do not exceed the natural tritium activity expected in rain water in this area.

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 1997 (Davis 1997, available from R&IE-LV).

AMCHITKA ISLAND, ALASKA

Sampling was conducted June 3 through 17, 1997. The sampling locations on Amchitka Island are shallow wells and surface sampling sites. Therefore, the monitoring network for Amchitka Island is restricted to monitoring of surface contamination and drinking water supplies.

All gamma-ray spectral analysis results indicated that no man-made gamma-emitting radionuclides were present in any samples collected onsite. Tritium concentrations of water samples collected onsite are consistent with those of past studies at the three sites, MILROW, CANNIKIN, and LONG SHOT. Results are discussed in greater detail in the “Amchitka Alaska Special Sampling Report” (Faller 1997 available from R&IE-LV).

GROUNDWATER MONITORING

GROUNDWATER QUANTITY

Water levels are monitored annually by the USGS on and around the NTS at approximately 156 measurement locations. Data for the 1995 water year are reported in Bauer et al., 1996, the most recent publication. Results are used in regional and local groundwater models, but are not routinely analyzed for water level trends. However, no significant water level impacts associated with groundwater usage were detected in 1996.

The USGS has begun to compile historic water-level and water-withdrawal data to evaluate trends of water withdrawal and water levels in the southern NTS area. The purpose of the study is to determine whether correlations exist that may indicate short- or long-term effects of water use in Frenchman Flat and Mercury Valley. Ten wells have been used as production wells and 11 wells have been used for observation. Water-level data were evaluated for all the observation wells and production wells having sufficient water-level data.

Water usage on the NTS is monitored by the both the USGS and BN. The data are reported in Bauer et al., 1996. Water use at the NTS continues to decline, due to the cessation of underground nuclear testing in 1992 and was about 1.33 x 10^6 m^3 (351 x 10^6 gal) in 1997.

GROUNDWATER QUALITY

LLNL collaborated with LANL and USGS to collect fluid samples from post-shot wells at the NTS. In addition to radionuclides more commonly found in cavity fluids, the presence of low-levels of plutonium (0.22 pCi/L at collection time) were confirmed in one of the wells. Results from this sampling event will be included in the LLNL Hot Well Database, which compiles new and historical radiochemical data from cavity and near cavity wells on the NTS. Isotopic and chemical data from 107 samples of southern Nevada waters were compiled and published (Rose et al., 1997). LLNL continues to investigate the occurrence, distribution, and potential mobility of radionuclides in the sub-surface through investigation of archival post-shot debris. Static leaching experiments of glass and crystalline samples commenced to elucidate controls on the solubility of radionuclides.

Regional-scale groundwater investigations concentrated on determining recharge locations and flow paths for the groundwater flow systems in southern Nevada. This included two separate sampling trips, during which approximately 50 samples were collected. Geochemical and isotopic measurements included cation and anion chemistry, oxygen, hydrogen and carbon stable isotopes, and radiocarbon.

Groundwater quality was determined by monitoring wells and springs, both onsite and offsite, for radioactive constituents as discussed above. The remainder of this chapter summarizes analyses of water for chemical constituents, radioisotopes, and stable isotopes in order to comply with environmental permits, better characterize NTS groundwater quality, and support regional groundwater flow and transport models.

DOE continued efforts to create a long-term monitoring program for wells in or near underground nuclear test cavities. The program objectives are to characterize the hydrologic source term and evaluate the decay and potential migration of radionuclides through monitoring at or near the source. LANL and LLNL monitored water at the TYBO, BULLION, and CHESHIRE tests on Pahute Mesa and the DALHART and DILBY tests in Yucca Flat (LANL 1998). A LLNL summary report will be released in 1998.

5.6 NONRADIOLOGICAL MONITORING

The 1997 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. The Ecological Monitoring and Compliance Program performed habitat mapping in the southern third of the NTS, characterized NTS springs, monitored man-made water sources, conducted wild horse and chukar surveys, prepared a biological monitoring plan for the Hazardous Materials Spill Center (HSC), and surveyed for several former candidate species for federal listing under the Endangered Species Act. In 1997, nonradiological monitoring was conducted for two series of tests conducted at the HSC on the NTS.

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

Routine nonradiological environmental monitoring on the NTS in 1997 was limited to:

- Sampling of drinking water distribution systems and water haulage trucks for Safe Drinking Water Act (SDWA) and state of Nevada compliance.

- Sewage lagoon influent and E Tunnel discharge sampling for compliance with state of Nevada operating permit requirements.

CLEAN WATER ACT RESULTS

NTS OPERATIONS

The NTS General Permit requires quarterly reporting for biochemical oxygen demand (BOD) and specific conductance, 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 5.21, 5.22, 5.23, and 5.24, 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 1997, the Yucca Lake system exceeded the 30 cm in the first quarter, and these sampling results are given in Table 5.25. All values in this table are in compliance with the permit requirements.

NON-NTS OPERATIONS

Only the North Las Vegas Facility (NLVF) and the Remote Sensing Laboratory (RSL) are required by permit to sample and analyze wastewater effluent and submit self-monitoring reports. The NLVF self-monitoring report consists of two outfalls and the burn pit batch discharge being monitored. The Clark County Sanitation District wastewater permit for the RSL requires biannual monitoring of two outfalls, quarterly pH, and monthly septage reports. All sampling results for 1997 were within permit limits.

SAFE DRINKING WATER ACT RESULTS

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. Common sampling points were restroom and cafeteria sinks. 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 445A and Title 40 CFR 141.

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 results during 1997.

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

Samples from trucks, which hauled potable water from NTS wells to work areas, were also analyzed for coliform bacteria. During 1996, the state relaxed the requirement to test every truck load of water, to testing each of the three trucks weekly. There were no positive coliform sample results in 1997 that required superchlorination and resampling.

CHEMICAL ANALYSIS

Chemical analysis in 1997 consisted of VOCs, metals, and inorganics.

ORGANIC COMPOUND ANALYSIS

Samples for VOCs were collected during the first quarter of 1997 from potable water wells 4A and 5B and during the third quarter from well 5B. The samples were analyzed by a state-approved laboratory. None of the results were above quantitation limits.

METAL ANALYSIS

In compliance with a state agreement, samples were collected in the first and third quarters and analyzed for lead and copper. These samples were taken from faucets and a fill stand at 37 separate locations at the NTS, covering all the potable water distribution systems. All results were below the method detection limits of 0.5 mg/L for copper and 0.01 mg/L for lead.

INORGANIC COMPOUND ANALYSIS AND WATER QUALITY

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 four parts per million. Samples taken from Area 25 wells J-12 and J-13 in the first quarter of 1997 confirmed that the fluoride concentration was acceptable.

During the first quarter of 1997, all systems (ten water wells) were sampled and analyzed for nitrates. The results of these analyses are shown in Table 5.26. Since the samples from wells J-12 and J-13 had nitrate concentrations at one half the maximum contaminant level of 10 mg/L, repeat analyses were required for the next four consecutive quarters. Samples from these two wells in the second, third, and fourth quarters of 1997 have all been satisfactory, at less than half of the maximum contaminant level.

CHARACTERIZATION AND MONITORING OF NTS SPRINGS

From June 1996 through February 1997, biologists visited 25 natural water sources at the NTS to determine if these mesic habitats qualify for jurisdictional wetlands protection. A summary report of all findings titled "Nevada Test Site Wetlands Assessment" (Hansen et al., 1997) was completed and distributed as a DOE/NV topical report in May. The report identifies 16 NTS natural water sources that may be classified as jurisdictional wetlands and 8 water sources that may be classified as waters of the United States. The report also identifies and summarizes previous studies on NTS natural water sources; describes their known physical, chemical, and biological features; identifies the current DOE management practices related to the protection of NTS wetlands; and identifies the information needed to develop and implement resource management objectives for NTS wetlands.

Periodic monitoring of selected NTS natural water sources was continued in 1997. Nine water sources were visited between June and August. They included Cane, Captain Jack, Gold Meadows, Tippipah, Topopah, Tub, and Whiterock Springs; Reitmann Seep; and Yucca Playa Pond. Selected hydrology, water quality, and wildlife usage data were collected. These data were summarized and presented in an annual report titled "Ecological Monitoring and Compliance Program Fiscal Year 1997 Report," submitted to DOE/NV in September.

5.7 WATER QUALITY PERMITS

Water quality permits were required by the state for onsite drinking water systems. Other types of water permits were required for onsite and offsite sewage-related activities.

ONSITE WATER PERMITS

DRINKING WATER SYSTEM PERMITS

Four NTS drinking water system permits issued by the state of Nevada, as shown in Table 5.27 were renewed with new expiration dates. 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. These permits were also renewed. No drinking water systems were maintained by non-NTS facilities.

SEWAGE DISCHARGE PERMITS

Sewage discharge permits from the state of Nevada, Division of Environmental Protection are listed in Table 5.28 and require submission of quarterly discharge monitoring reports.

NTS SEWAGE HAULING PERMITS

Permits issued by the state of Nevada Division of Health for six sewage hauling trucks for the NTS were renewed in November 1995 and are listed in Table 5.29.

NON-NTS SEWAGE PERMITS

Sewage permits were required for four locations at non-NTS operations. These included two permits at the LVAO facilities and two at the Special Technologies Laboratory (STL) as shown in Table 5.28. Each was issued by the county or local municipality in which the facility was located as follows:

- NLVF - The NLVF self-monitoring report was submitted in October 1997. Two outfalls and the burn pit batch discharge are monitored.

- RSL - The Clark County Sanitation District wastewater permit for the RSL required biannual monitoring of two outfalls, quarterly pH, and monthly septage reports. RSL monitoring reports were submitted in May and December 1997.

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

Table 5.1 Summary of Analytical Procedures for Water Samples - 1997

Type of Analysis	Analytical Equipment	Count Time-min	Analytical Procedure	Sample Size-mL	Approximate MDC
		BN	Procedures		
Gross α	Gas-flow Proportional Counter	100	Boil down. Place on planchet and heat to dryness	900	2 pCi/L
Gross β	Gas-flow Proportional Counter	100	Boil down. Place on planchet and heat to dryness	900	2 pCi/L
Gamma	HpGe detector calibrated at 1 keV/channel	100	Online computer analysis	500	10 pCi/L for ^{137}Cs
Tritium Convent.	Liquid scintil- lation counter	70	Distillation of 100 mL	2.5	300-700 pCi/L
Tritium Enrichment	Liquid scintil- lation counter	300	Electrolysis of 250 mL basic solution	5	20 pCi/L
Plutonium	Alpha Spectrometer	1000	Tracer, ion exchange, collect ppt on filter	900	0.02 pCi/L
Radium	Gamma Spectrometer	500	Tracer, ppt as sulfate, collect on filter	90	1 pCi/L for ^{228}Ra 3 pCi/L for ^{226}Ra
Strontium	Gas-flow Proportional Counter	100	ppt as carbonate, count yttrium in growth	900	0.3 pCi/L
		R&IE-LV	Procedures		
Gamma	HpGe detector calibrate at 0.5 keV/channel	100	Online computer analysis	3500	Varies with nuclide/detector ^{137}Cs: 7 pCi/L
Tritium Convent.	Liquid scintil- lation counter	300	Distillation of sample	5-10	300-700 pCi/L
Tritium Enrichment	Liquid scintil- lation counter	300	250 mL concentrate by electrolysis, distill	5	5 pCi/L

Table 5.2 Summary of the Water Surveillance Program - 1997

Sample Type	Description	Collection Frequency	Number of Sampling Locations(a)	Type of Analysis
		Onsite Monitoring		
Tap Water	Grab sample	Monthly	7	Gamma spectroscopy, gross ß, ^{3}H, ($^{238,239+240}Pu$, gross α quarterly), (^{90}Sr annually).
Potable Supply Wells	Grab sample	Quarterly	10	Gamma spectroscopy, gross α & ß, $^{226 \& 228}Ra$, $^{238,239+240}Pu$, ^{3}H enrich, ^{90}Sr.
Nonpotable Supply Wells	Grab sample	Quarterly	2	Gamma spectroscopy, gross α & ß, ^{3}H, (^{90}Sr annually) $^{238,239+240}Pu$.
Open Reservoirs	Grab sample	Annually	15	Gamma spectroscopy, gross ß, ^{3}H, ^{90}Sr $^{238,239+240}Pu$.
Natural Springs	Grab sample	Annually	8	Gamma spectroscopy, gross ß, ^{3}H, ^{90}Sr $^{238,239+240}Pu$.
Containment Ponds	Grab sample	Quarterly	1	Gamma spectroscopy, gross ß, ^{3}H, $^{238,239+240}Pu$ (^{90}Sr annually).
Sewage Lagoons	Grab sample	Quarterly	9	Gamma spectroscopy, gross ß, ^{3}H, $^{238,239+240}Pu$ (^{90}Sr annually).

(a) All locations were not sampled for various reasons.

Table 5.3 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

Table 5.3 (Groundwater Monitoring Parameters at the RWMS-5, cont.)

Parameters Establishing Water Quality, cont.

Phenols
Sulfate

Indicators of Contamination

pH
Conductivity
Total Organic Carbon
Total Organic Halogen

Additional Selected Parameters

Volatile Organics
Tritium

Table 5.4 NTS Facilities with RCRA Closure Plans

Location	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 5.5 Locations with Detectable Man-Made Radioactivity - 1997[(a)]

Location	Radionuclide	Concentration $\times 10^{-9}$ µCi/mL
NTS Onsite Network		
Well UE-5n	^{3}H	60,000
Well UE-6d	^{3}H	540
Well UE-7ns	^{3}H	530
Project DRIBBLE, Mississippi		
Well HMH-2	^{3}H	290
Well HMH-5	^{3}H	880
Well HMH-10	^{3}H	160
Well HM-L	^{3}H	960

(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.

Table 5.5 (Locations with Detectable Man-Made Radioactivity - 1997[a], cont.)

Location	Radionuclide	Concentration x 10^{-9} µCi/mL
(Project DRIBBLE, Mississippi, cont.)		
Well HM-S	^{3}H	3300
Half Moon Creek Overflow	^{3}H	200
REECo Pit B	^{3}H	590
REECo Pit C	^{3}H	320
SAI-1-H	^{3}H	34,000
SAI-2-H	^{3}H	3200
SAI-4-H	^{3}H	340
SAI-5-H	^{3}H	1300
SAI-6-H	^{3}H	160
GNOME, New Mexico		
Well DD-1	^{3}H	6.2×10^{7}
	^{90}Sr	13,000
	^{137}Cs	6.9×10^{5}
Well LRL-7	^{3}H	2500
	^{90}Sr	2.5
	^{137}Cs	160
Well USGS-4	^{3}H	74,000
	^{90}Sr	4800
	^{137}Cs	<5.0
Well USGS-8	^{3}H	68,000
	^{90}Sr	4000
	^{137}Cs	100

(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.

Table 5.6 Radioactivity in NTS Surface Waters - 1997

Source of Water	Number of Locations	Annual Average Concentrations (10^{-9} µCi/mL) Gross ß	Tritium	^{238}Pu	$^{239+240}Pu$	^{90}Sr	% DCG Range[a]
Open Reservoirs	8	10	-159	-0.0016	-0.008	-0.060	<0.01-0.1
Natural Springs	7	9.8	-32	-0.0010	0.012	-0.084	<0.01-0.1
Containment Ponds							
E Tunnel	2[b]	76	10×10^{5}	0.38	3.1	1.1	[c]
U-3cn Wells	2	--	13×10^{6}	--	--	--	[c]
Sewage Lagoons	8	20	31	-0.001	0.016	-0.080	[c]
Mean MDC		1.2	740	0.015	0.018	0.34	

(a) DCG based on value for drinking water (4 mrem EDE).
(b) A pond and an effluent.
(c) Not a potable water source.

Table 5.7 NTS Open Reservoir Gross Beta Analysis Results - 1997

Location	Gross Beta Concentration (10^{-9} µCi/mL): Concentration	Concentration as %DCG[(a)]
Area 2, Mud Plant Reservoir	9.7	24
Area 2, Well 2 Reservoir [(b)]	-	-
Area 3, Mud Plant Reservoir[(b)]	-	-
Area 3, Well A Reservoir	14	35
Area 5, UE-5c Reservoir	18	45
Area 5, Well 5B Reservoir	12	30
Area 6, Well 3 Reservoir	13	32
Area 6, Well C1 Reservoir	8.0	20
Area 18, Camp 17 Reservoir	3.2	8.0
Area 18, Well 8 Reservoir[(b)]	-	-
Area 19, UE-19c Reservoir[(b)]	-	-
Area 20, Well 20A Reservoir[(b)]	-	-
Area 23, Swimming Pool[(b)]	-	-
Area 25, Well J-11 Reservoir	4.4	11
Area 25, Well J-12 Reservoir[(b)]	-	-

(a) DCG based on ^{90}Sr value for drinking water (4 mrem EDE - 40 pCi/L)
(b) Reservoir was dry.

Table 5.8 NTS Drinking Water Sources - 1997

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 5.9 NTS Supply Well Radioactivity Averages - 1997

Description	Gross Beta	^{3}H	$^{239+240}$Pu	^{238}Pu	Gross Alpha	^{90}Sr[(a)]
	Annual Average Concentrations - 10^{-9} µCi/mL					
	Potable Water Supply Wells					
Area 5, Well 5C	6.7	3.5	0.00005	-0.0006	9.5	-0.036
Area 6, Well 4	6.6	0.6	-0.0008	-0.0016	9.8	-0.0001
Area 6, Well 4A	7.2	4.2	-0.0003	-0.0021	11	-0.097

Table 5.9 (NTS Supply Well Radioactivity Averages - 1997, cont.)

	Annual Average Concentrations - 10^{-9} µCi/mL					
Description	Gross Beta	^{3}H	$^{239+240}Pu$	^{238}Pu	Gross Alpha	^{90}Sr[(a)]
Potable Water Supply Wells						
Area 5, Well 5B	11.	4.7	0.0008	-0.0019	5.3	-0.004
Area 6, Well C1	9.8	2.6	-0.0018	-0.0033	11	0.049
Area 16, Well UE-16d	7.6	4.1	-0.0017	-0.0014	7.4	0.17
Area 18, Well 8	3.2	0.4	-0.0012	0.012	0.8	0.015
Area 22, Army Well No.1	5.8	0.2	-0.0005	0.0033	4.3	0.082
Area 25, Well J-12	4.7	5.3	-0.0004	0.017	1.4	0.051
Area 25, Well J-13	4.7	3.9	-0.0009	-0.0021	2.0	0.17
Non-Potable Water Supply Wells						
Area 5, Well UE-5c	8.6	1.4	-0.0007	-0.0001	9.0	0.08
Median MDC	1.2	13	0.017	0.021	1.4	0.34

Table 5.10 Radioactivity Averages for NTS Tap Water Samples - 1997

	Annual Average Concentrations -10^{-9} µCi/mL					
Description	Gross Beta	^{3}H	$^{239+240}Pu$	^{238}Pu	Gross Alpha	^{90}Sr[(a)]
Area 1, Bldg. 101[(b)]	6.8	-39	-0.0027	-0.0004	7.7	-0.12
Area 2, Restroom	3.4	250	-0.0020	-0.0007	0.7	-0.16
Area 6, Cafeteria	6.2	-59	-0.0018	0.0002	9.2	-0.083
Area 6, Bldg. 6-900	6.8	-50	-0.0014	-0.0005	9.7	-0.055
Area 12, Bldg. 12-23	3.8	80	-0.0054	-0.0012	0.7	-0.036
Area 23, Cafeteria	7.3	17	-0.0033	-0.0011	5.8	-0.051
Area 25, Bldg. 4221	5.6	128	-0.0033	-0.0014	2.4	0.009
Median MDC	1.2	740	0.020	0.016	1.4	0.31

(a) ^{90}Sr values are for one sample.
(b) One sample collected from Area 1 Ice House when Building 101 inaccessible.

Table 5.11 Radium Analysis Results for NTS Potable Water Supply Wells - 1997

Location	Number of Samples	^{226}Ra Arithmetic Mean	Standard Deviation	^{228}Ra Arithmetic Mean	Standard Deviation
		Concentrations (10^{-9} µCi/mL)			
Area 5, Well 5B	4	0.27	1.1	0.45	0.31
Area 5, Well 5C	4	1.6	1.4	0.38	0.46
Area 6, Well 4	4	0.086	2.0	0.40	0.31
Area 6, Well 4A	3	0.83	0.62	0.29	0.17
Area 6, Well C-1	4	1.9	2.2	0.76	0.34
Area 16, Well UE-16d	4	1.1	1.7	0.09	0.43
Area 18, Well 8	4	1.4	1.6	0.10	0.70
Area 23, Army Well No. 1	4	0.85	0.88	0.18	0.82
Area 25, Well J-12	4	0.28	0.67	0.42	0.40
Area 25, Well J-13	4	0.49	1.5	-0.01	0.54
Median MDC		3.5		0.97	

Table 5.12 Summary of Tritium Results for NTS Wells Sampled by R&IE-LV - 1997

Location	Number of Samples	Maximum	Minimum	Arithmetic Mean	1 Sigma	Mean as %DCG[(a)]	Mean MDC
	Tritium Concentration (pCi/L)						
Test Well B	*1*	---	---	*46*	*2.2*	*0.05*	*5.6*
Test Well D	*1*	---	---	*3.0*	*1.6*	*(b)*	*5.3*
Test Well F	*2*	*31*	*26*	*29*	*2.4*	*0.03*	*4.9*
Well C-1	1	---	---	0.46	1.7	(b)	*5.6*
Well HTH-1	1	---	---	180	70	(b)	230
Well PM-1	1	---	---	180	70	(b)	230
Well UE-1c	2	140	-77	32	70	(b)	220
Well UE-5n	2	66000	54000	60000	400	67	230
Well UE-6d	*2*	*540*	*510*	*520*	*6.6*	*0.58*	*5.5*
Well UE-6e	2	77	-51	13	68	(b)	230
Well UE-7ns	2	530	310	420	100	0.47	230
Well UE-16d	1	---	---	66	70	(b)	230
Well UE-16f	1	---	---	58	69	(b)	230
Well UE-18r	*2*	*3.7*	*-2.9*	*0.4*	*2.2*	(b)	*5.2*
Well UE-18t	1	---	---	210	70	(b)	230
Well 1 Army	2	19	-26	-4	95	(b)	220
Well 2	1	---	---	19	69	(b)	230
Well 4	*1*	---	---	*-3.1*	*1.8*	(b)	*6.0*
Well 5B	1	---	---	-3.0	1.6	(b)	*5.8*
Well 5C	1	---	---	-100	65	(b)	220
Well 6A Army	*1*	---	---	*6.8*	*1.8*	*<0.01*	*4.2*
Well 8	1	---	---	-12	69	(b)	230

(a) DCG - Derived Concentration Guide; established by DOE Order as 90,000 pCi/L for water.
(b) Not applicable because the result is less than the MDC or water is known to be nonpotable.
Note: *Italic indicates enrichment analysis,* regular font indicates conventional analysis.

Table 5.13 LTHMP Summary of Tritium Results for Wells Near the NTS - 1997

Location	Number of Samples	Tritium Concentration (pCi/L) Max	Min	Mean	1 Standard Deviation	% of DCG[a]	Mean MDC
Adaven							
Adaven Spring	*3*	*24*	*17*	*21*	*2.9*	*0.02*	*6.6*
	4	2 7	-29	9	140	(b)	220
Alamo							
Well 4 City	2	27	-140	-55	95	(b)	220
Amargosa Valley							
Bar-B-Q Ranch	*1*	--	--	*1.1*	*1.4*	*(b)*	*4.8*
	1	--	--	-26	66	(b)	220
Ponderosa Dairy Well 2	1	--	--	11	65	(b)	220
Ash Meadows							
Big Spring	*1*	*4.9*	*-2.3*	*1.3*	*2.6*	(b)	*5.8*
Crystal Pool	*3*	*4.5*	*-3.7*	*0.3*	*3.5*	*(b)*	*6.9*
	4	88	-170	-120	140	(b)	230
Fairbanks Spring	*1*	--	--	*0.7*	*2.0*	*(b)*	*6.5*
Longstreet Spring	*1*	--	--	*1.7*	*1.6*	(b)	*5.3*
	2	66	-26	20	95	(b)	220
17S-50E-14cac	2	-51	-64	-57	94	(b)	220
Well 18S-51E-7db	2	-12	-26	-19	65	(b)	220
Beatty							
Low Level Waste Site	*3*	*7.5*	*2.5*	*4.6*	*2.9*	(b)	*4.8*
	4	180	-29	28	140	(b)	230
Tolicha Peak	4	27	-150	-59	140	(b)	230
11S-48E-1dd Coffer's	4	66	-68	9	140	(b)	230
12S-47E-7dbd City	2	66	-100	-17	95	(b)	220
Clark Station							
TTR Well 6	2	-26	-51	-38	95	(b)	220
Goldfield							
Klondike #2 Well	2	49	-12	18	95	(b)	220
Hiko							
Crystal Springs	2	-12	-26	-19	95	(b)	220
Indian Springs							
Sewer Co. Well 1	2	49	-12	18	95	(b)	220
Air Force Well 2	2	66	-26	20	95	(b)	220
Lathrop Wells							
15S-50E-18cdc City	2	11	-12	-0.5	95	(b)	220

(a) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.
(b) Not applicable because the result is less than the MDC or water is known to be nonpotable.
Note: *Italic indicates enrichment analysis,* regular font indicates conventional analysis.

Table 5.13 (LTHMP Summary of Tritium Results for Wells Near the NTS - 1997, cont.)

Location	Number of Samples	Max	Min	Mean	1 Standard Deviation	% of DCG[a]	Mean MDC
		Tritium Concentration (pCi/L)					
Nyala							
Sharp's Ranch	2	27	11	19	95	[b]	220
Oasis Valley							
Goss Springs	1	--	--	-13-	68	[b]	230
Pahrump							
Calvada City Well	4	66	-68	9	140	[b]	230
Rachel							
Penoyer Culinary	4	-49	-64	0	140	[b]	230
Tonopah							
City Well	2	100	-26	37	95	[b]	220
Warm Springs							
Twin Springs Ranch	*3*	*2.5*	*-2.5*	*0.4*	*3.1*	*[b]*	*5.9*
	4	-26	-130	-69	140	[b]	230

(b) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.
(c) Not applicable because the result is less than the MDC or water is known to be nonpotable.
Note: *Italics indicate enrichment analysis*, normal font conventional analysis.

Table 5.14 LTHMP Summary of Tritium Results for Project FAULTLESS - 1997

Location	Number of Samples	Result	1 Standard Deviation	% of DCG[a]	Mean MDC
		Tritium Concentration (pCi/L)			
Hot Creek Ranch	1	-51	70	[b]	230
Blue Jay Maintenance	1	22	70	[b]	230
Base Camp Well	1	-51	70	[b]	230
Well HTH-1	*1*	*4.0*	*3.6*	[b]	*5.9*
Well HTH-2	*1*	*2.1*	*4.0*	[b]	*6.5*
Well Six Mile	1	-12	70	[b]	230

(a) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.
(b) Not applicable because result is less than the MDC or water is known to be nonpotable.
Note: *Italic indicates enrichment analysis,* regular font indicates conventional analysis.

Table 5.15 LTHMP Summary of Tritium Results for Project SHOAL - 1997

Location	Number of Samples	Tritium Concentration (pCi/L) Result	1 Standard Deviation	% of DCG [(a)]	Mean MDC
Hunts' Station	1	-51	70	[(b)]	230
Well Flowing	1	-51	70	[(b)]	230
Well H-2	1	-118	70	[(b)]	240
Well H-3	*1*	*3.6*	*4.0*	[(b)]	*6.5*
Well HS-1	*1*	*1.4*	*3.4*	[(b)]	*6.4*
Well HC-1	1	-78	70	[(b)]	240
Well HC-2	*1*	*0.44*	*2.9*	[(b)]	*4.7*
Well HC-3	Well Dry				
Well HC-4	1	860	80	0.96	240

(a) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.
(b) Not applicable because the result is less than the MDC or water is known to be nonpotable.
Note: *Italic indicates enrichment analysis,* regular font indicates conventional analysis.

Table 5.16 LTHMP Summary of Tritium Results for Project RULISON - 1997

Location	Number of Samples	Tritium Concentration (pCi/L) Result	1 Sigma	% of DCG [(a)]	Mean MDC
Battlement Creek	*1*	*36*	*3.7*	*0.04*	*5.0*
City Springs	1	80	70	[(b)]	230
Gardner Ranch	1	40	70	[(b)]	230
Well CER Test	*1*	*55*	*4.5*	*0.06*	*5.7*
Hayward Ranch	*1*	*100*	*5.9*	*0.11*	*6.8*
Potter Ranch	1	200	70	[(b)]	230
Jacobs Ranch	1	280	70	0.31	230
Rothgery Ranch	1	200	70	[(b)]	230
Spring 300 Yards N	*1*	*30*	*3.8*	*0.03*	*5.3*
Well RU-1	*1*	*42*	*5.0*	*0.05*	*6.9*
Well RU-2	*1*	*33*	*3.8*	*0.03*	*5.3*

(a) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.
(b) Not applicable because the result is less than the MDC or water is known to be nonpotable.
Note: *Italic indicates enrichment analysis,* regular font indicates conventional analysis.

Table 5.17 LTHMP Summary of Tritium Results for Project RIO BLANCO - 1997

Location	Number of Samples	Tritium Concentration (pCi/L) Result	1 Sigma	% of DCG[a]	Mean MDC
B-1 Equity Camp	*1*	*36*	*5.2*	*0.04*	*7.4*
Brennan Windmill	*1*	*3.2*	*3.2*	*(b)*	*5.7*
CER 1 Black Sulpher	1	80	70	*(b)*	230
CER 4 Black Sulpher		No Access			
Fawn Creek 1	1	120	70	*(b)*	230
Fawn Creek 500' Up	1	80	70	*(b)*	230
Fawn Creek 500' Down	1	40	70	*(b)*	230
Fawn Creek 6800' Up	1	-40	70	*(b)*	230
Fawn Creek 8400' Down	*1*	*25*	*3.7*	*0.03*	*5.3*
Fawn Creek 3	1	40	70	*(b)*	230
Johnson Artesian	1	80	70	*(b)*	230
Well RB-D-01	*1*	*1.4*	*4.0*	*(b)*	*6.6*
Well RB-D-03	1	80	70	*(b)*	230
Well RB-S-03	1	40	70	*(b)*	230

(a) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.
(b) Not applicable because the result is less than the MDC or water is known to be nonpotable.
Note: *Italic indicates enrichment analysis,* regular font indicates conventional analysis.

Table 5.18 LTHMP Summary of Tritium Results for Project GNOME - 1997

Location	Number of Samples	Tritium Concentration (pCi/L) Result	1 Sigma	% of DCG[a]	Mean MDC
Carlsbad City Well	1	10	70	(b)	230
Loving City Well 2	*1*	*5.7*	*3.1*	*<0.01*	*6.4*
Well DD-1[c]	1	6.2×10^7	5.8×10^5	6.9×10^5	220
Well LRL-7[d]	1	2.5×10^3	220	2.8	220
Well PHS 6	1	-29	70	(b)	230
Well PHS 8	1	-29	70	(b)	230
Well PHS 9	1	-29	70	(b)	230
Well PHS 10	1	10	70	(b)	230
Well USGS 1	*1*	*-12*	*3.8*	(b)	*6.3*
Well USGS 4[e]	1	7.4×10^4	320	82	230
Well USGS 8[f]	1	6.8×10^4	300	76	230
J. Mobley Ranch	*1*	*7.9*	*3.6*	(b)	*5.7*

(a) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.
(b) Not applicable because the result is less than the MDC or water is known to be nonpotable.
Note: *Italic indicates enrichment analysis,* regular font indicates conventional analysis.

Table 5.18 (LTHMP Summary of Tritium Results for Project GNOME - 1997, cont.)

Additional Results Greater than the MDC

Nuclide	Result	1 Standard Deviation	MDC	Units
(c) ^{90}Sr	1.3×10^4		1.3×10^3	pCi/L
^{137}Cs	6.9×10^5	4.8×10^4	6.5	pCi/L
(d) ^{90}Sr	2.5		1.2	pCi/L
^{137}Cs	160	10	6.5	pCi/L
(e) ^{90}Sr	4800		1.2	pCi/L
(f) ^{90}Sr	4000		1.2	pCi/L
^{137}C	99	10	4.6	pCi/L

Table 5.19 LTHMP Summary of Tritium Results for Project GASBUGGY - 1997

Location	Number of Samples	Tritium Concentration (pCi/L) Result	1 Sigma	% of DCG [(a)]	Mean MDC
La Jara Creek	1	120	70	[(b)]	230
Lower Burro Canyon	*1*	*93*	*5.5*	*0.10*	*6.4*
Pond N of 30.3.32.3	1	80	70	[(b)]	230
Arnold Ranch Spring	1	40	70	[(b)]	230
Arnold Ranch Well	*1*	*-0.45*	*3.6*	[(b)]	
Bixler Ranch	Ranch Abandoned				
Bubbling Springs	1	120	70	[(b)]	230
Cave Springs	1	190	70	[(b)]	230
Cedar Springs	*1*	*43*	*4.5*	*0.05*	*6.1*
Well Jicarilla	1	40	70	[(b)]	230
Well 28.3.33.233	Pump Out				
Well 30.3.32.343	*1*	*-2.1*	*3.3*	[(b)]	*5.5*
Windmill 2	1	80	70	[(b)]	230
Well EPNG 10-36	*1*	*120*	*5.9*	*0.13*	*6.3*

(a) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.
(b) Not applicable because the result is less than the MDC or water is known to be nonpotable.
Note: *Italic indicates enrichment analysis,* regular font indicates conventional analysis.

Table 5.20 LTHMP Summary of Tritium Results for Project SALMON - April 1997

Location		Date Collected	Tritium Concentration (pCi/L) Result	1 Sigma	% of DCG[a]	Mean MDC
Baxterville, MS						
Anderson, Billy Ray		4/22/97	55	71	(b)	230
Anderson Pond		4/22/97(c)	11	3.4	0.01	5.2
Anderson, Robert Harvey		4/23/97	Sample lost in lab			
Anderson, Robert Lowell, Jr.		4/21/97(c)	1.1	3.4	0.01	5.2
Anderson, Robert Lee		4/21/97(c)	1.1	3.8	0.01	5.9
Anderson, Tony		4/22/97	-63	70	(b)	230
Burge, Joe		4/21/97	-23	70	(b)	230
Cockerham, Steve		4/24/97	-23	70	(b)	230
Daniels, Webster, Jr.		4/23/97(c)	-9.6	4.4	(b)	7.5
Daniels - Well No. 2 Fish Pond		4/23/97	16	70	(b)	230
Hilbey, Billy		4/22/97	-23	70	(b)	230
Salt Dome Hunting Club		4/23/97(c)	17	3.4	0.02	5.1
Salt Dome Timber Co.		4/22/97	16	70	(b)	230
Saucier, Dennis		4/22/97	16	70	(b)	230
Well Ascot 2		4/23/97(c)	26	4.1	0.03	6.0
Baxterville Well City		4/22/97(c)	17	4.0	0.02	6.1
Well E-7		4/21/97(c)	3.5	3.7	(b)	6.0
Well HM-1	Pre pump	4/22/97(c)	16	3.8	0.02	5.7
	½ hr pump	4/21/97	-23	70	(b)	230
	1 hr pump	4/21/97	-23	70	(b)	230
	Post	4/21/97(c)	-1.1	3.1	(b)	5.1
Well HM-2A	Pre pump	4/21/97(c)	-1.1	2.8	(b)	4.7
	½ hr pump	4/21/97	-23	70	(b)	230
	1 hr pump	4/21/97	16	70	(b)	230
	Post pump	4/21/97(c)	-1.4	3.0	(b)	4.9
Well HM-2B	Pre pump	4/21/97(c)	-0.96	3.0	(b)	5.0
	½ hr pump	4/21/97	-63	70	(b)	230
	1 hr pump	4/21/97	-23	70	(b)	230
	Post pump	4/21/97(c)	2.2	3.2	(b)	5.2
Well HM-3	Pre pump	4/21/97(c)	2.0	3.3	(b)	5.3
	½ hr pump	4/21/97	-23	70	(b)	230
	1 hr pump	4/21/97	-23	70	(b)	230
	1½ hr pump	4/21/97	-100	70	(b)	230
	Post pump	4/21/97(c)	2.4	3.0	(b)	4.9

(a) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.
(b) Not applicable because the result is less than the MDC or water is known to be nonpotable.
(c) Enrichment analysis.
(d) Pre indicates sampling prior to pumping the well, Dup indicates a duplicate sample, Post indicates sampling after pumping the well, and Post Dup is a duplicate sample after pumping the well.

Table 5.20 (LTHMP Summary of Tritium Results for Project SALMON - April 1997, cont.)

			Tritium Concentration (pCi/L)			
Location		Date Collected	Result	1 Sigma	% of DCG[(a)]	Mean MDC
(Baxterville, MS, cont.)						
Half Moon Creek	Pre	4/20/97[(c)]	0.17	2.7	[(b)]	4.4
	Post	4/22/97[(c)]	21	4.4	0.02	6.5
Half Moon Creek	Pre[(d)]	4/20/97[(c)]	-1.4	2.7	[(b)]	4.5
Overflow	Post	4/20/97[(c)]	200	6.4	0.22	5.7
	Post Dup	4/20/97[(c)]	190	6.9	0.21	6.5
Lee, P. T.		4/21/97	130	72	[(b)]	230
Little Creek No. 1		4/21/97	-23	70	[(b)]	230
Lower Little Creek No. 2		4/21/97	94	72	[(b)]	230
Mills, Roy		4/21/97	94	72	[(b)]	230
Napier, Denice		4/22/97[(c)]	12	3.8	0.01	5.8
Noble's Pond		4/21/97	-13	70	[(b)]	230
Noble, W. H., Jr.		4/25/97	-23	70	[(b)]	230
Pond West of GZ	Pre	4/20/97[(c)]	0.12	3.7	[(b)]	6.0
	Post	4/21/97[(c)]	13	3.3	0.01	5.0
REECo Pit Drainage-A		4/21/97	No Sample			
REECo Pit Drainage-B		4/21/97[(c)]	590	9.6	[(b)]	6.4
REECo Pit Drainage-C		4/21/97[(c)]	320	6.6	[(b)]	5.1
	Dup	4/21/97[(c)]	340	7.7	[(b)]	6.2
Well HM-L	Pre pump[(d)]	4/21/97	920	76	1.0	230
	½ hr pump	4/21/97	960	79	1.1	230
	1 hr pump	4/21/97	720	76	0.8	230
	1½ hr pump	4/21/97	960	79	1.1	230
	Post pump	4/21/97	880	78	1.0	230
Well HM-L2	Pre[(d)]	4/22/97	-100	70	[(b)]	230
	Post	4/22/97	-23	70	[(b)]	230
Well HM-S	Pre	4/20/97	3400	97	3.8	230
	Post	4/21/97	3300	96	3.7	230
Well HMH-1	Pre	4/20/97	1600	84	1.8	230
	Post	4/21/97	2100	88	2.3	230
Well HMH-2	Pre	4/20/97[(c)]	220	5.7	0.24	4.5
	Post	4/22/97[(c)]	290	6.3	0.32	5.1
Well HMH-3	Pre	4/20/97[(c)]	14	3.3	0.02	5.0
	Post	4/21/97[(c)]	12	3.3	0.01	5.1
	Dup	4/21/97[(c)]	14	3.3	0.02	5.1
Well HMH-4	Pre	4/20/97	130	72	[(b)]	230
	Post	4/21/97	-63	70	[(b)]	230

(a) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.
(b) Not applicable because the result is less than the MDC or water is known to be nonpotable.
(c) Enrichment analysis.
(d) Pre indicates sampling prior to pumping the well, Dup indicates a duplicate sample, Post indicates sampling after pumping the well, and Post Dup is a duplicate sample after pumping the well.

Table 5.20 (LTHMP Summary of Tritium Results for Project SALMON - April 1997, cont.)

Location		Date Collected	Tritium Concentration (pCi/L) Result	1 Sigma	% of DCG[a]	Mean MDC
(Baxterville, MS, cont.)						
Well HMH-5	Pre	4/20/97	410	74	0.46	230
	Post	4/21/97	880	76	0.98	230
	Dup	4/21/97	250	73	0.28	230
Well HMH-6	Pre	4/20/97	55	71	[b]	230
	Post	4/20/97	-63	70	[b]	230
Well HMH-7		4/20/97	No Sample, well under water			
Well HMH-8		4/20/97	No Sample, well under water			
Well HMH-9	Pre	4/20/97	130	72	[b]	230
	Post	4/21/97	-63	70	[b]	230
Well HMH-10	Pre	4/20/97[c]	110	4.6	0.12	4.6
	Post	4/21/97[c]	160	5.0	0.18	5.0
Well HMH-11	Pre	4/20/97[c]	55	3.7	0.06	4.5
	Post	4/21/97[c]	110	4.5	0.12	5.0
Well HMH-12	Pre	4/20/97	55	71	[b]	230
	Post	4/21/97	-63	70	[b]	230
Well HMH-13	Pre	4/20/97	-23	70	[b]	230
	Post	4/21/97	-23	70	[b]	230
Well HMH-14	Pre	4/20/97	-23	70	[b]	230
	Post	4/21/97	-63	70	[b]	230
Well HMH-15	Pre	4/20/97	16	70	[b]	230
	Post	4/21/97	-63	70	[b]	230
Well HMH-16	Pre	4/20/97	55	71	[b]	230
	Post	4/21/97	55	71	[b]	230
Well HT-2C		4/23/97[c]	0.3	2.9	[b]	4.7
Well HT-4		4/24/97[c]	1.6	3.2	[b]	5.2
Well HT-5		4/24/97[c]	0.59	3.4	[b]	5.6
		New Monitoring Wells				
SA1-1-H		4/23/97	34.500	450	38	230
SA1-2-H		4/23/97	No Sample, lost in lab			
SA1-4-H		4/23/97[c]	340	7.0	0.38	5.5
SA1-5-H		4/23/97	1300	160	1.4	230
SA1-6-H		4/23/97[c]	160	5.0	0.18	4.4
SA1-7-H		4/23/97[c]	33	3.7	0.04	5.2

(a) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.
(b) Not applicable because the result is less than the MDC or water is known to be nonpotable.
(c) Enrichment analysis.
(d) Pre indicates sampling prior to pumping the well, Dup indicates a duplicate sample, Post indicates sampling after pumping the well, and Post Dup is a duplicate sample after pumping the well.

Table 5.20 (LTHMP Summary of Tritium Results for Project SALMON - April 1997, cont.)

Location	Date Collected	Tritium Concentration (pCi/L) Result	1 Sigma	% of DCG[(a)]	Mean MDC
(Baxterville, MS, New Monitoring Wells, cont.)					
SA3-4-H	4/23/97[(c)]	25	5.8	0.03	8.8
SA3-5-H	4/23/97[(c)]	22	4.9	0.02	7.5
SA3-1-M	4/23/97[(c)]	9	3.3	0.01	5.2
SA3-3-M	4/23/97[(c)]	15	3.5	0.02	5.4
SA4-1-M	4/23/97[(c)]	4.8	3.4	[(b)]	5.4
SA5-1-M	4/23/97[(c)]	15	4.0	0.02	6.2
SA5-2-M	4/23/97[(c)]	20	3.8	0.02	5.7
SA5-3-M	4/23/97[(c)]	14	3.2	0.02	4.8
Columbia, MS					
Dennis, Buddy	4/22/97	-23	70	[(b)]	230
Dennis, Marvin	4/22/97	-63	70	[(b)]	230
Well 64B City	4/22/97[(c)]	12	4.0	0.01	6.3
Lumberton, MS					
Anderson, Arleene	4/22/97	16	70	[(b)]	230
Anderson, Lee L	4/22/97	94	72	[(b)]	230
Boren Crawfish Pond	4/21/97	55	71	[(b)]	230
Hartfield, Ray	4/21/97	-23	70	[(b)]	230
Ladner, Rushing, Debra	4/21/97	55	71	[(b)]	230
Powell, Sliannon	4/23/97	16	70	[(b)]	230
Rogers, Robert	4/24/97	170	72	[(b)]	230
Saul, Ola	4/21/97	16	70	[(b)]	230
Smith, Howard - Pond	4/22/97	16	70	[(b)]	230
Thompson, Roswell	4/21/97	-23	70	[(b)]	230
Well 2 City	4/22/97[(c)]	1.7	3.4	[(b)]	5.5
Purvis, MS					
Burge, Willie Ray & Grace	4/21/97	-63	70	[(b)]	230
Boren, Ron	4/22/97	-63	70	[(b)]	230
City Supply	4/22/97[(c)]	0.8	3.7	[(b)]	6.1
Rain Sample					
IT Compound (Baxterville)	4/22/97	-23	70	[(b)]	230

(a) DCG - Derived Concentration Guide. Established by DOE Order as 90,000 pCi/L.
(b) Not applicable because the result is less than the MDC or water is known to be nonpotable.
(c) Enrichment analysis.
(d) Pre indicates sampling prior to pumping the well, Dup indicates a duplicate sample, Post indicates sampling after pumping the well, and Post Dup is a duplicate sample after pumping the well.

Table 5.21 Influent Quality - 1997

	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	257	2.7	472	1.38	<60	0.64	454	1.65
Mercury	360	3.8	514	0.97	99	1.15	242	0.88
Yucca Lake	148	1.81	50	0.63	109	0.76	296	0.88
Tweezer	375	4.1	135	1.15	188	0.84	266	1.16
CP-6	0	0	-	-	-	-	-	-
CP-72	0	0	-	-	-	-	-	-
DAF	135	1.58	106	1.31	20	0.95	30	1.03
Reactor Control	0	0	0	0	0	0	0	0
Test Stand 1	0	0	0	0	0	0	0	0
Base Camp 25	192	1.65	124	0.85	41	0.98	161	1.61
Base Camp 12	<6	0.28	8	0.36	<6	0.23	<6	0.21
Test Cell C	0	0	0	0	0	0	0	0
RWMS Site 5	66	1.35	40	0.65	86	0.75	309	1.63

(a) Biochemical Oxygen Demand - 5-day Incubation.
(b) Specific Conductance.
Note: CP-6 and CP-72 not in use after first quarter.

Table 5.22 Organic Loading Rates - 1997

Facility	Limit (Kg/day)	(Jan-Mar) Mean Daily Load	(Apr-June) Mean Daily Load	(Jul-Sept) Mean Daily Load	(Oct-Dec) Mean Daily Load
			Metered Rates		
Mercury	172	77.05	120.91	27.387	41.36
LANL on Tweezer	5.0	3.52	1.01	0.770	0.84
Yucca Lake	8.6	3.32	2.30	3.367	12.45[(a)]
Base Camp 12	54	0.04	0.08	0.125	0.04
RWMS Site 5	0.995	0.32	0.36	0.117	0.45
			Calculated Rates		
CP-6	8.7	0	-	-	-
CP-72	1.1	0	-	-	-
DAF	7.6	0.67	3.21	0.345	0.21
Reactor Control	4.2	0	0	0	0
Eng Test Stand	2.3	0	0	0	0
Test Cell C	1.3	0	0	0	0
Base Camp 25	7.4	1.29	1.43	0.594	1.08
Gate 100	2.4	0.54	1.72	0.386	0.84

(a) Erroneous result due to problem with automatic sampler, will resample in January.
Note: CP-6 and CP-72 not in service after the first quarter.

Table 5.23 Pond Water Depths in Infiltration Basins - 1997

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	40	0.7	53	59
Mercury, Basin	180	0	0	0	0
Yucca Lake					
North Basin	140	126	127	110	0
South Basin	140	0	0	0	115
Tweezer					
East Basin	244	0	0	0	0
West Basin	244	0	0	0	0
CP-6					
East Basin	90	0	-	-	0
West Basin	90	0	-	-	0
CP-72	90	0	-	-	0
DAF					
Basin 1	150	0	0	0	0
Basin 2	150	0	0	0	0
Reactor Control, Basin	130	0	0	0	0
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	0	0	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

Note: CP-6 and CP-72 were not in service after the first quarter.

Table 5.24 Influent Toxics for Facilities that Received Industrial Wastewater - 1997

Parameter	Compliance Limit (mg/L)	Mercury Measurement (mg/L)	Area 25 Base Camp Measurement (mg/L)	Area 6 DAF Measurement (mg/L)	Area 5 RWMS Measurement (mg/L)	Area 6 LANL Measurement (mg/L)	Area 6 Yucca Lake Measurement (mg/L)
Arsenic	5.0	0.015	(a)	0.0167	(a)	0.0127	(a)
Barium	100	0.59	0.665	0.499	0.735	0.618	0.508
Cadmium	1.0	(a)	(a)	(a)	(a)	(a)	(a)
Chromium	5.0	(a)	(a)	(a)	(a)	(a)	(a)
Lead	5.0	(a)	(a)	(a)	(a)	(a)	(a)
Mercury	0.2	(a)	(a)	(a)	(a)	(a)	(a)
Selenium	1.0	(a)	(a)	(a)	(a)	(a)	(a)
Silver	5.0	(a)	(a)	(a)	(a)	(a)	(a)
Benzene	0.5	(a)	(a)	(a)	(a)	(a)	(a)
Carbon Tertachloride	0.5	(a)	(a)	(a)	(a)	(a)	(a)
Chlorobenzene	100	(a)	(a)	(a)	(a)	(a)	(a)
Chloroform	6.0	(a)	(a)	(a)	(a)	(a)	(a)
1,4-dichlorobenzene	7.5	(a)	(a)	(a)	(a)	(a)	(a)
1,2-dichlorobenzene	0.5	(a)	(a)	(a)	(a)	(a)	(a)
1,1-dichloroethylene	0.7	(a)	(a)	(a)	(a)	(a)	(a)
Methylethyl Ketone	200	(a)	(a)	(a)	(a)	(a)	(a)

(a) Not Detected.

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

Table 5.24 (Influent Toxics for Facilities that Received Industrial Wastewater - 1997, cont.)

Parameter	Compliance Limit (mg/L)	Mercury Measurement (mg/L)	Area 25 Base Camp Measurement (mg/L)	Area 6 DAF Measurement (mg/L)	Area 5 RWMS Measurement (mg/L)	Area 6 LANL Measurement (mg/L)	Area 6 Yucca Lake Measurement (mg/L)
Pyridine	5.0	(a)	(a)	(a)	(a)	(a)	(a)
Tetrachloroethylene	0.7	(a)	(a)	(a)	(a)	(a)	(a)
Trichloroethylene	0.5	(a)	(a)	(a)	(a)	(a)	(a)
Vinyl Chloride	0.2	(a)	(a)	(a)	(a)	(a)	(a)
Cresol, total	200	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
2,4-dinitrotoluene	0.13	(a)	(a)	(a)	(a)	(a)	(a)
Hexachlorobenzene	0.13	(a)	(a)	(a)	(a)	(a)	(a)
Hexachlorobutadiene	0.5	(a)	(a)	(a)	(a)	(a)	(a)
Nitrobenzene	2.0	(a)	(a)	(a)	(a)	(a)	(a)
Pentachlorophenol	100	(a)	(a)	(a)	(a)	(a)	(a)
2,4,5-trichlorophenol	400	(a)	(a)	(a)	(a)	(a)	(a)
2,4,6-trichlorophenol	2.0	(a)	(a)	(a)	(a)	(a)	(a)
Chlorodane	0.03	(a)	(a)	(a)	(a)	(a)	(a)
Endrin	0.02	(a)	(a)	(a)	(a)	(a)	(a)
Heptachlor	0.008	(a)	(a)	(a)	(a)	(a)	(a)
Lindane	0.4	(a)	(a)	(a)	(a)	(a)	(a)
Methoxychlor	10.0	(a)	(a)	(a)	(a)	(a)	(a)
Toxaphene	0.5	(a)	(a)	(a)	(a)	(a)	(a)
2,4-D	10.0	(a)	(a)	(a)	(a)	(a)	(a)
2,4,5-TP (Silvex)	1.0	(a)	(a)	(a)	(a)	(a)	(a)

(a) Not Detected.

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

Table 5.25 Sampling Data for Infiltration Ponds Containing 30 cm or More - 1997

Parameter	Action Level mg/L	A-6 Yucca Lake Q1 Result mg/L
Arsenic	0.5	[(b)]
Cadmium	0.1	[(b)]
Chromium	0.5	[(b)]
Lead	0.5	[(b)]
Selenium	0.1	[(b)]
Silver	0.5	[(b)]
Nitrate Nitrogen	100	[(b)]
Sulfate	5000	87.2
Chloride	1000	74.1
Fluoride	40	1.6
Tritium[(a)]	Monitor Only	[(b)]

(a) Unit for tritium is 10^{-7} µCi/cc.
(b) Not Detected.

Table 5.26 Nitrate Analyses of Well Water Samples (mg/L), First Quarter - 1997

Well Name	Limit	Result	Well Name	Limit	Result
Well 5C	10	<1	Well J-12	10	5
Well 5B	10	3	Well J-13	10	5
Well 4	10	2	Well 8	10	<1
Well C-1	10	4	Well UE-16d	10	<1
Well 4-A	10	4	Well Army 1	10	<1

Table 5.27 NTS Drinking Water System Permits - 1997

Permit No.	Area(s)	Expiration Date
NY-5024-12NC	Area 1	09/30/98
NY-4099-12C	Area 2 & 12	09/30/98
NY-360-12C	Area 23	09/30/98
NY-4098-12NCNT	Area 25	09/30/98
NY-835-12NCNT	Sitewide Truck	09/30/98
NY-836-12NCNT	Sitewide Truck	09/30/98
NY-841-12NCNT	Sitewide Truck	09/30/98

Table 5.28 Sewage Discharge Permits - 1997

Permit No./Location	Areas	Expiration Date
NTS Permits		
GNEV93001[(a)]	NTS General Permit	01/31/99
Off-NTS Permits		
Las Vegas Area Operations		
VEH-112	NLVF (Sewage Contribution)[(a)]	12/31/99
Special Technologies Laboratory		
AII-204/ Santa Barbara, California		12/31/98
III-331/ Santa Barbara, California		12/31/98

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

Table 5.29 Permits for NTS Septic Waste Hauling Trucks - 1997

Permit Number	Vehicle Identification Number	Expiration Date
NY-17-03311	Septic Tank Pumper E-104573	11/30/98
NY-17-03313	Septic Tank Pumper E-105293	11/30/98
NY-17-03314	Septic Tank Pumper E-105299	11/30/98
NY-17-03315	Septic Tank Pumper E-105919	11/30/98
NY-17-03317	Septic Tank Pumper E-105918	11/30/98
NY-17-03318	Septic Tank Pumping Subcontractor Vehicle	11/30/98

[redacted]

6.0 OTHER REPORTABLE ACTIVITIES

Reported in this section are environmental surveillance activities other than those in air and water. Activities reported are those related to the Nevada Test Site (NTS) missions and special studies under the purview of the Environmental Protection Division of the U.S Department of Energy Nevada Operations Office (DOE/NV).

6.1 TEST-RELATED ACTIVITIES

Under the terms of an Interagency Agreement between the DOE and the U.S. Environmental Protection Agency (EPA), the EPA's Office of Radiation and Indoor Environment National Laboratory-Las Vegas (R&IE-LV) conducts the Offsite Radiation Safety Program (ORSP). The primary activity of the ORSP is routine monitoring of potential human exposure pathways. Maintaining readiness to conduct nuclear testing, public information, and community assistance constitutes secondary activities.

Two subcritical experiments were conducted in 1997, REBOUND and HOLOG. For each of the two tests, R&IE-LV senior personnel served on the Test Controller's Scientific Advisory Panel and on the EPA's offsite radiological safety staff.

No radioactive materials were released to the ambient environment as a result of these two experiments.

6.2 RADIOLOGICAL SURVEILLANCE

OFFSITE 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 nutrients, and certain radionuclides are readily traceable through the food 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 miles) of the NTS. This network was designed to monitor areas adjacent to the NTS, which could be affected by a release of activity, as well as from areas unlikely to be affected. There were 11 locations comprising the MSN at the beginning of 1997. Samples were collected from only ten of these locations, as shown in Figure 6.1, because the Hafen Ranch in Ivins, Utah, was not milking during the collection period.

Raw milk was collected in 3.8-L (1-gal) Cubitainers from each MSN location in July and preserved with formaldehyde. The samples were analyzed by high-resolution gamma spectrometry for gamma emitters and for ^{90}Sr by radiochemical separation and beta counting.

The average total potassium concentration derived from naturally occurring ^{40}K activity was 1.5 g/L for samples analyzed by gamma spectrometry. No other gamma-ray emitters were detected. Selected MSN milk samples were analyzed for ^{90}Sr, and the results are similar to those obtained in previous years.

[redacted]

Only Rockview Dairies, Inc., located in Moapa, Nevada, had a ^{90}Sr result above the MDC (1.9 ± 0.44 pCi/L). The MSN network average ^{90}Sr values are shown in Table 6.1.

6.3 NONRADIOLOGICAL MONITORING

The 1997 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. The Ecological Monitoring and Compliance (EMAC) program performed habitat mapping in northern NTS areas, characterized springs, monitored man-made water sources, conducted wild horse surveys, and prepared a biological monitoring plan for the Hazardous Material Spill Center (HSC). In 1997, nonradiological monitoring was performed for two series of tests involving 38 chemicals that were conducted at the HSC.

ENVIRONMENTAL SURVEILLANCE

Routine nonradiological environmental monitoring on the NTS in 1997 was limited to:

- Nevada operating permit requirements.
- Sampling of electrical equipment oil, soil, water, surfaces, and waste oil for the presence of polychlorinated biphenyls as part of Toxic Substance Control Act compliance.
- Sampling of soil, water, sediment, waste oil, and other media for Resource Conservation and Recovery Act (RCRA) constituents.

Two facilities at the NTS that are listed in the NTS Hazardous Waste Management Permit have undergone RCRA Closure and require post-closure monitoring.

- Post-closure monitoring of the Mercury Landfill Hazardous Waste Trenches RCRA Closure Unit was conducted on a monthly and quarterly basis for soil moisture. Monthly monitoring during the last quarter of calendar year (CY) 1997 was required because the 30-day cumulative rainfall exceeded the permit requirements of one inch. The covers are performing as designed, with no releases occurring. Sealing the neutron tubes outside of the covers to prevent infiltration of water was completed.
- Post Closure monitoring of the U-3fi Injection Well RCRA Closure Unit was conducted on a quarterly basis. Downward movement of moisture was not detected during the CY; therefore, the conditions of the permit have not been exceeded.

In support of facility operations at the NTS, samples are collected and analyzed from various waste streams in order to show compliance with operational requirements, or to properly dispose of the wastes generated. Most of the nonradiological analyses are performed at approved offsite laboratories. During 1997, 138 bulk or air samples were collected for asbestos determination, 85 oil samples collected for polychlorinated biphenyl (PCBs) determination, and 1,412 samples of various kinds collected for chemical characterization.

ECOLOGICAL MONITORING

The ecological monitoring tasks conducted under the EMAC program in 1997 included habitat mapping within the northern part of the NTS, characterizing and monitoring hydrologic and biotic parameters of the natural springs on the NTS, conducting a census of the NTS horse population, monitoring man-made water sources to assess their affects on wildlife, necessary monitoring of spill tests at the HSC in Area 5, and surveying control plots at the HSC annually.

HABITAT MAPPING

From April through September 1997, the northeastern third of the NTS was partitioned into 500 Ecological Landform Units (ELUs) using regular and multispectral aerial photographs of the NTS and Satellite Pour l'Observation de la Terre (SPOT) satellite imagery. ELUs were then visited to confirm unit boundaries, describe vegetation and other physical and biological characteristics of the unit, and photograph the site vegetation. The majority of the ELUs sampled were within the Yucca Flat drainage basin. Much of the area sampled had been previously disturbed by ground clearing and historic nuclear testing activities, creating great diversity in habitats. No Geographical Information System (GIS) spatial coverages were developed for ELUs sampled in 1997, because emphasis was placed on conducting field work. Habitats in the remaining one-third of the NTS (mountains and mesas in the northwest portion of the NTS) will be sampled, and GIS spatial coverages and Resource Management Plan (RMP) map products will be completed in 1998. Habitat and species range maps will also be prepared for inclusion in Bechtel Nevada's (BN's) Ecological GIS (EGIS).

The GIS-based map products and database produced by this activity will facilitate ecosystem management of the NTS, the analysis of NTS species distribution and abundance, the preparation of future environmental assessments and impact statements, and siting of new NTS projects and facilities. The map products to be completed in 1998 will be the base vegetation and species habitat maps used in the NTS RMP.

CHARACTERIZING AND MONITORING NTS SPRINGS

From June 1996 through February 1997, biologists visited 25 natural water sources at the NTS to determine if these mesic habitats qualify for jurisdictional wetlands protection. A summary report of all findings titled "Nevada Test Site Wetlands Assessment" (Hansen et al., 1997) was completed and distributed as a DOE/NV topical report in May. The report identifies 16 NTS natural water sources that may be classified as jurisdictional wetlands and 8 water sources that may be classified as waters of the United States. The report also identifies and summarizes previous studies on NTS natural water sources; describes their known physical, chemical, and biological features; identifies the current DOE management practices related to the protection of NTS wetlands; and identifies the information needed to develop and implement resource management objectives for NTS wetlands.

Periodic monitoring of selected NTS natural water sources was continued in 1997. Nine water sources were visited between June and August. They included Cane, Captain Jack, Gold Meadows, Tippipah, Topopah, Tub, and Whiterock Springs; Reitmann Seep; and Yucca Playa Pond. Selected hydrology, water quality, and wildlife usage data were collected. These data were summarized and presented in an annual report titled "Ecological Monitoring and Compliance Program Fiscal Year 1997" submitted to DOE/NV in September. Cane, Gold Meadows, and Reitmann Seep had no visible surface flow, while the other springs exhibited some surface flow. Three locations had some limited physical disturbance (Cane, Captain Jack, and Gold Meadows Springs), notably from horse activity (grazing and trampling of vegetation) at the latter two. Most water quality parameters varied moderately between sites, particularly water temperature (range of 1.7° to 26°C [35° to 79°F]) and dissolved oxygen, which was low (< 3.0 parts per million [ppm]) at six springs and higher (> 6 ppm) at eight other natural water sources. Total dissolved solids (TDS) were moderately low at most springs (within a range of 33 to 435 ppm), compared to TDS, at the Yucca Playa Pond (> 1,000 ppm), probably due to evaporation and concentration of salts at Yucca Playa Pond. The surface area of water at this ephemeral pond was greatly reduced during early June (3,000 m^2 [32,292 ft^2]) from the surface area measured in January (23,000 m^2 [247,000 ft^2]) when TDS was much lower (162 ppm).

Three species of mammals and 18 species of birds were detected at 10 water sources. The most abundant and widely distributed species was the mourning dove, observed at eight sites. The highest number of individual birds was observed at Topopah Spring and included chukar and mourning doves, predominantly. The most abundant passerine species were ravens, observed at Gold Meadows Spring and house finches, which were found at four water sources. Hydrobiid springsnails were present at Cane Spring inside the cave pool.

HORSE SURVEYS

Horse abundance surveys were conducted from July through September. A standard road course on the NTS was driven to locate and identify horses. Horses were not marked, but were identified by their unique physical features. Individual horses observed more than one time during the sampling period were considered recaptures. The population estimate based on sampling was 40 animals. The 95 percent confidence interval for this population estimate, based on the Capture Program (White et al., 1982), was 40 to 47 animals. Three foals were observed during the summer. Six horses observed in 1996 were missing in 1997, representing a 13 percent decline in the population. One horse, which was not observed in 1996, drowned in Camp 17 pond in October 1996. This is the first known occurrence of horse drowning on the NTS. Over the past three years, the feral horse population at the NTS has declined about 29 percent, from 56 to 40 horses. Natural processes (e.g., predation, emigration) may be the cause of this population decline, but data to verify this have not been collected.

The annual population census of horses has routinely been conducted in the summer when horses are nearer to water sources and thus easier to find. These census surveys provide an adequate estimate of the summer range, but are not useful for estimating their annual range. Efforts were made in 1997 to collect data on horse and horse sign sightings to better estimate their annual range. Horse sign sightings were recorded in each ELU sampled as part of the habitat mapping task and during surveys for sensitive plant species. Selected roads were also driven within the suspected annual horse range and all fresh signs (estimated to be < 1 year old) observed adjacent to the roads were recorded. Data collected indicated that the 1997 NTS horse range includes Kawich Canyon, Gold Meadows, Rainier Mesa, Big Burn Valley, Buckboard Mesa, Redrock Valley, the Eleana Range, the southwestern foothills of the Eleana Range, and northwest Yucca Flat. Most roads on Pahute Mesa were not driven, so horse use in most of Areas 19 and 20 could not be determined. In 1998, horse sign data will be entered into BN's EGIS and analyzed to characterize those vegetation communities used by horses and to map their annual range.

Selected water sources on the NTS were surveyed to evaluate their effect on the distribution of horses. Only two natural water sources (Captain Jack Spring in Area 12 and Gold Meadows Spring in Area 19) and one man-made pond (Camp 17 Pond in Area 18) were used by horses in the summer of 1997. Two man-made ponds, Well 2 Pond and the Mud Plant Pond, both in Area 2, were used by horses in the past. Well 2 Pond was heavily used by horses in 1995, but has been dry since then. The Mud Plant Pond was used in 1996, but its water surface area dropped by half to 400 m^2

(4,305 ft^2) in August 1997, making it unusable by horses. As a result, 11 to 13 horses relied completely on Captain Jack Spring for summer water. An estimated 25 to 29 horses appeared to be dependent on Camp 17 pond during the summer and fall and Gold Meadows Spring during the summer until it dried up in late August 1997. Field surveys indicate that the 1997 summer distribution of horses has not changed significantly from that observed in previous years because of their dependence on water sources in Areas 12 and 18.

MONITORING MAN-MADE WATER SOURCES

In 1997, only one animal mortality (ground squirrel) was observed and attributed to entrapment in a plastic lined sump. No animal mortalities at unlined or cement-lined ponds were observed. Soil placed in mounds over plastic lining in the corners of sumps was determined to be the most practical and effective way to limit animal mortalities.

HSC MONITORING

Biologists reviewed chemical spill test plans for two experiments at the HSC. It was determined that all experiments would represent minimal risk and no field biological monitoring of treatment transects for these experiments would be required. Letters documenting these reviews were submitted to DOE/NV's Environment Safety and Health Division in April and September 1997.

Control and treatment transects surrounding the HSC were established in 1997. Treatment transects are each 1,000 m (3,280 ft) long and at three distances (1, 3, and 5 km [0.6, 1.9, and 3.1 mi]) downwind from the spill site. Control transects are similar lengths and are at similar distances upwind. The control transects were selected to contain similar plant species as the treatment transects. Seasonal baseline sampling of the transects was conducted in March and September. Data collected included the presence of any dead animals, observations of wildlife or their sign (i.e., scat, burrows, nests, tracks), and any damage to vegetation. No evidence of damage to wildlife or vegetation was observed. The sampling periods for this baseline monitoring of the transects will correspond with periods of maximum plant growth such as spring, periods of declining growth and increasing plant stress such as summer, and periods of dormancy such as winter. Sampling of these transects throughout each year will document any long-term or cumulative impacts of testing that would not be detected otherwise.

HISTORIC PRESERVATION

Historic preservation studies and surveys are conducted by the Desert Research Institute (DRI), University and Community College System of Nevada. In 1997, 13 surveys were conducted for historic properties on the NTS, and reports on the findings were prepared (Beck; Dubarton and Drollinger; Holz and Beck; Jones and Drolllinger; McCarty and Drollinger [1997]). These surveys identified 25 prehistoric and historic archaeological sites. Through consultation with the Nevada State Historical Preservation Office, four of these sites were considered eligible for the National Register of Historic Places. Work continued on historic structures associated with early NTS activities. Impacts planned to the Engine Maintenance Assembly and Disassembly Facility in Area 25 required the preparation of Historic American Engineering Records documentation for the facility. This documentation will reside in the Library of Congress. Historic American Building Survey documentation is in preparation for the EPA Farm.

Other efforts in 1997, 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 36 CFR 79, "Protection of Historic and Cultural Properties" (CFR 1966), a multi-phase program is in progress to upgrade the NTS archaeological collection and archives. In 1997, DRI completed the piece-by-piece inventory of lithic artifacts in the collection. About 500,000 artifacts have been inventoried and repackaged according to federal requirements.

6.4 HAZARDOUS MATERIAL [redacted]

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. The plans for each test series were examined by an Advisory Panel that consisted of DOE/NV and EPA's R&IE-LV professional personnel [redacted] disposed of at the Area 5 Radioactive Waste Management Site (RWMS-5), in shallow pits and trenches. LLW in large containers and unpackaged bulk waste from NTS environmental restoration projects are buried in selected subsidence craters at the Area 3 RWMS (RWMS-3). Hazardous, transuranic (TRU), and mixed TRU wastes are stored aboveground pending shipment to offsite permitted disposal facilities.

RWMS-5 WASTE MANAGEMENT OPERATIONS

The RWMS-5 is used for the disposal of radioactive waste generated at the NTS and at offsite DOE and U.S. Department of Defense facilities. LLW is accepted for disposal from generators that have received approval from DOE Headquarters and DOE/NV. Disposal of mixed waste is still restricted to waste generated on the NTS.

LLW, mixed waste, and small quantities of TRU waste have been disposed of in 22 shallow pits and trenches since disposal operations began in 1961. The shallow pits and trenches range in depth from 4.6 to 14.6 m (15 to 48 ft). Filled pits and trenches are covered by a 2.4 m (8 ft) alluvium cap pending final closure of the site.

LLW disposed of prior to DOE's implementation of RCRA (Title 40 CFR 260-281) in 1986 may contain low levels of hazardous constituents. A single disposal unit, Pit 3, has interim status as a mixed waste disposal unit for NTS generated wastes that meet the RCRA Land Disposal Restrictions (LDR) requirements. Low-level mixed waste generated on the NTS is stored on the TRU waste storage pad until characterization is complete. If the waste meets or has been treated to meet LDR requirements, it may be disposed of in Pit 3.

Transuranic mixed waste is stored in a covered building on a specially constructed RCRA-designed pad. The Waste Examination Facility (WEF) was designed and constructed to characterize and certify TRU mixed waste for disposal at the Waste Isolation Pilot Plant in New Mexico. In 1997, the WEF began pilot testing and is expected to begin operations in 1998. Low-level radioactive mixed waste is also currently stored on the TRU waste storage pad.

In 1997, uranium ore residues from the Mound Plant in Miamisburg, Ohio, which were stored north of the RWMS-5 in the Strategic Material Storage Yard (SMSY), were transferred to an out-of-state facility. Waste is no longer stored in the SMSY.

In 1997, the RWMS-5 received 9.76×10^3 m^3 (3.45×10^5 ft^3) of waste containing a total of 2.6×10^5 Ci (9.6×10^3 TBq) of reportable radionuclides. This is a small increase in volume but a large increase in activity from the previous year (see Table 6.2). Tritium accounted for approximately 99.9 percent of total radioactivity disposed of in 1997 and accounted for the increase in activity over 1996 (see Table 6.3). Natural uranium and thorium contributed the majority of the remaining activity.

Radioactivity in air, groundwater, vegetation, gamma and neutron radiation fields, and soil moisture content were monitored at the RWMS-5 in 1997. Radioactivity in air, gamma radiation fields, and soil moisture content were monitored at the RWMS-3. Air samples were analyzed for gross alpha radiation, gross beta radiation, photon-emitting radionuclides, plutonium, and tritium. All airborne radionuclide concentrations were a small fraction of DOE allowable limits. Tritium was the only man-made airborne radionuclide detected at the RWMS-5 and probably originates from LLW disposed of there. Plutonium was the only man-made airborne radionuclide detected at the RWMS-3. The airborne plutonium likely originates from the resuspension of soils contaminated by atmospheric nuclear weapons tests. Groundwater samples were analyzed for RCRA parameters, gross alpha, gross beta, tritium, and photon emitting radionuclides. No man-made radionuclides or hazardous chemicals were detected. Gamma radiation fields were monitored by thermoluminescent dosimeters. Neutron radiation fields at the perimeter of the TRU waste storage pad were monitored by proton recoil dosimeters. Dose equivalents greater than background were measured at the RWMS-3 and RWMS-5, at locations where radioactive waste is stored or remained exposed in active disposal units. Contamination from atmospheric nuclear weapons tests contributed to the dose equivalent measured at the RWMS-3. Soil moisture monitoring did not detect the infiltration of wetting fronts below the depth of waste disposal units at either site. The results of air monitoring are described in Chapter 4 and of water monitoring in Chapter 5.

RWMS-5 PERFORMANCE ASSESSMENT (PA)

The DOE assesses the long-term performance of LLW disposal sites by conducting a PA. This is a systematic analysis of the potential risks posed by a waste disposal site to the public and to the environment and a comparison of those risks to established performance objectives. A PA identifies the processes that could cause detectable releases of radioactive materials to the accessible environment during operation of the site. The only release pathway expected in the near term is diffusion of volatile radionuclides through the operational cap to the atmosphere. Tritium is the most abundant volatile radionuclide disposed of at the RWMS-5. PA models indicate that nonvolatile radionuclides may eventually be detected in soil excavated by burrowing animals and in deep-rooted vegetation growing on disposal unit covers. Site characterization data and modeling studies indicate that transport of nonvolatile radionuclides from the waste to the uppermost aquifer is extremely unlikely because of the thick dry vadose zone, low precipitation, and high potential evapotranspiration at the site.

RWMS-5 monitoring results are generally consistent with PA results. Tritium is the volatile radionuclide with the largest inventory and is routinely detected in air samples at the RWMS-5 at levels that are a small fraction of DOE allowable limits. Since maintenance operations keep operational covers vegetation free, deep-rooted vegetation samples are not routinely available for analysis. Tritium is the only radionuclide that has been detected in previous analyses of cap vegetation. Groundwater monitoring results confirm that after 37 years of operations, groundwater beneath the RWMS-5 remains uncontaminated. Monitoring of soil moisture content confirms that infiltrating precipitation does not percolate through the disposal unit operational caps before it evaporates and returns to the atmosphere.

RWMS-3 WASTE MANAGEMENT OPERATIONS

The RWMS-3 is used for the disposal of bulk waste. Packaged bulk LLW is accepted from approved onsite and offsite generators. Unpackaged bulk LLW from NTS environmental restoration projects also has been accepted and disposed of. Disposal is in subsidence craters formed by underground nuclear tests. 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 1 m (3 ft) of clean alluvium. Waste disposed of at the RWMS-3 tends to have a lower activity concentration than waste disposed of at the RWMS-5 because bulk waste tends to be generated by environmental restoration projects.

Waste disposal operations at the RWMS-3 began in the U-3ax crater in 1968. The U-3ax crater was eventually joined with U-3bl to form the U-3ax/bl disposal unit. This unit received mostly unpackaged LLW from NTS nuclear testing operations. The U-3ax/bl disposal unit was filled in 1987 and covered with a 2.4-m (8-ft) thick temporary closure cap. This disposal unit is a mixed waste management unit as mixed waste is known to have been disposed of. Waste disposal operations moved to the U-3at crater in 1988 and was joined with the U-3ah crater to form the U-3ah/at disposal unit. This disposal unit remained open in 1997 and contains LLW only. During 1997, disposal of unpackaged plutonium contaminated soil from the CLEAN SLATE I site on the Nellis Air Force Range Complex about 14 mi (22 km) east of Goldfield, Nevada began in the U-3bh crater.

During 1997, the RWMS-3 received 1.49×10^4 m^3 (5.26×10^5 ft^3) of waste containing 6.5 Ci (0.24 GBq) of activity (see Table 6.4). This was an increase in volume and a slight increase in the activity disposed of, compared to the previous year. Isotopes of plutonium and ^{241}Am from the cleanup of the CLEAN SLATE I site accounted for approximately 95 percent of the total radioactivity disposed of during 1997 (see Table 6.5).

RWMS-3 PERFORMANCE ASSESSMENT

A PA has been conducted for the RWMS-3 (Shott et al., 1997b). Release pathways at the RWMS-3 are expected to be the same as at the RWMS-5 because of the similar site conditions and disposal operations. However, the inventory of radioactive materials disposed of at the RMWS-3 is much less than that disposed of at the RWMS-5. The RWMS-3 inventory of ^{3}H, the most likely radionuclide to be released, is significantly less than at the RWMS-5, so the potential for detecting releases of radioactivity is also significantly less. Moreover, the interpretation of environmental monitoring results at the RWMS-3 is confounded by the presence of significant soil contamination from aboveground testing. The small RWMS-3 inventory combined with the existing soil contamination from aboveground testing makes interpretation of environmental monitoring data from the RWMS-3 difficult.

HAZARDOUS WASTES

NTS OPERATIONS

Hazardous wastes generated on the NTS are accumulated at a location east of the RWMS in Area 5, the Hazardous Waste Accumulation Site, before shipment to an offsite Treatment, Storage, and Disposal facility. Hazardous waste generation activities at the NTS are performed under EPA Identification (ID) Number NV3890090001. The NTS continues to be regulated by the 1995 NTS RCRA Hazardous Waste Operating Permit (No. NEV HW009) for the general operation of the facility and the specific operation of the Hazardous Waste Storage Unit (HWSU) and the Explosive Ordnance Disposal Unit. Three permit modifications have occurred since October 1, 1996. These modification include changes in the NTS training program and personnel changes in the Area 5 and Area 11 Emergency Management Plans. The Pit 3 Mixed Waste Disposal Unit located in the Area 5 RWMS continues to operate under RCRA 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 report required by the state's Chemical Catastrophe Prevention Act is submitted.

CHEMICAL ANALYSES

In support of facility operations at the NTS, samples are collected and analyzed from various waste streams in order to show compliance with operational requirements or to properly dispose of the wastes generated. Most of the nonradiological analyses are performed at offsite approved laboratories. During 1997, there were 138 bulk or air samples collected for asbestos determination, 85 oil samples collected for PCBs determination, and 1,412 samples collected for chemical characterization.

NON-NTS OPERATIONS

Four EPA Generator ID numbers have been issued to five non-NTS operations. In addition, three local ID numbers were required at one operation. Hazardous waste is managed at all locations, by using satellite accumulation areas. Three operations have centralized accumulation areas. All hazardous and industrial wastes are transported offsite to RCRA-permitted facilities for approved treatment and/or disposal.

SANITARY WASTE

At the NTS there are three nonhazardous waste landfills that have state of Nevada Operating Permits, i.e., the Area 6 Hydrocarbon Disposal Site, the Area 9 U-10c Solid Waste Disposal Site, and the Area 23 Solid Waste Disposal Site. There are no monitoring requirements for non-hazardous solid waste disposed of at the NTS in the three landfills; however, before the waste is disposed of, it is weighed. During 1997, there were approximately 12,500 tons of waste disposed of at the NTS, as shown in Table 6.6.

The permitting process considers groundwater protection at these locations. At the Area 23 Class II Municipal and Industrial Solid Waste Disposal Site, a groundwater monitoring well has been installed. This well also serves to satisfy monitoring requirements for the Mercury sewage lagoon system. An initial baseline water sample was collected in August 1997, and compliance monitoring will begin in 1998.

The RCRA-permitted Area 5 HWSU also had groundwater protection considered in the permitting process. The facility has impervious cement floor compartments with adequate spill containment capacity to store containers of hazardous waste. In the event there was a release to the soil during container handling, there is spill containment present to control the release.

6.6 PERMITS FOR NTS OPERATIONS

Federal and state permits have been issued to DOE/NV and to BN (Table 6.7). These permits are required for the conduct of such DOE/NV activities as hazardous and sanitary waste storage and disposal for certain ecological studies and for operations involving endangered species. All BN 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.

The only RCRA permit in use at the NTS is the Hazardous Waste Management Permit NEV HW009. With this permit, hazardous waste generated at the NTS can be stored at the Area 5 HWSU for up to one year. It is then shipped offsite for treatment and/or disposal. During 1997, the total amount of hazardous waste shipped offsite was 1,022,360 pounds, 2,900 gallons, and 60 cubic yards (464 T, 766 L, and 46 m^3).

The North Las Vegas Facility (NLVF) has a Waste Generator number of NVD09786831 that covers generation and a 90-day accumulation of hazardous waste. The waste is shipped offsite for final treatment and/or disposal. During 1997, there were 2,910 kg (6,415 lb) of hazardous waste shipped offsite from the NLVF.

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 Number 1-5-96-F-33) from the United States Fish and Wildlife Service (USFWS).

The Nevada Division of Wildlife issued a scientific collection permit, S15842, to BN that allows collection of wildlife samples.

Table 6.1 Summary of Radionuclides Detected in Milk Samples - 1997

Number of samples with results > MDC
(Network average concentration in pCi/L)

	1997	1996	1995
^{3}H	Not Analyzed	Not Analyzed	0(37)
^{89}Sr	Not Analyzed	0(0.01)	0(0.03)
^{90}Sr	1(0.70)	0(0.63)	0(0.61)

Table 6.2 Low-Level Waste Disposed of at the RWMS-5, 1993 - 1997

Calendar Year	Volume of LLW Disposed of (m^3)	Activity of LLW Disposed of (Ci)
1993	8,327	3.0×10^{4}
1994	12,300	5.2×10^{4}
1995	9,171	5.6×10^{2}
1996	7,293	7.7×10^{3}
1997	9,762	2.6×10^{5}

Table 6.3 Inventory of Radionuclides (>0.1 Ci) Disposed of at the RWMS-5 in 1997

Radionuclide	Activity (Ci)	Percent of Total Activity
^{3}H	2.8×10^{5}	1.0×10^{2}
^{238}U	7.0×10^{1}	2.5×10^{-2}
^{232}Th	2.5×10^{1}	9.1×10^{-3}
^{228}Th	2.4×10^{1}	8.6×10^{-3}
^{228}Ra	2.2×10^{1}	8.0×10^{-3}
^{234}U	2.1×10^{1}	7.5×10^{-3}
^{241}Pu	6.9×10^{0}	2.5×10^{-3}
^{230}Th	5.7×10^{0}	2.1×10^{-3}
^{239}Pu	3.9×10^{0}	1.4×10^{-3}
^{99}Tc	3.1×10^{0}	1.1×10^{-3}
^{235}U	1.4×10^{0}	5.0×10^{-4}
^{240}Pu	8.3×10^{-1}	3.0×10^{-4}
^{241}Am	6.2×10^{-1}	2.2×10^{-4}
^{236}U	4.2×10^{-1}	1.5×10^{-4}
^{210}Pb	2.7×10^{-1}	9.9×10^{-5}
^{137}Cs	2.3×10^{-1}	8.1×10^{-5}
^{90}Sr	1.8×10^{-1}	6.5×10^{-5}
^{226}Ra	1.7×10^{-1}	6.1×10^{-5}
^{133}Ba	1.7×10^{-1}	6.0×10^{-5}
^{238}Pu	1.0×10^{-1}	3.6×10^{-5}
Total	2.8×10^{5}	1.0×10^{2}

Table 6.4 Low-Level Waste Disposed of at the RWMS-3, 1993 - 1997

Calendar Year	Volume of LLW Disposed (m^3)	Activity of LLW Disposed (Ci)
1993	9,848	0.24
1994	10,550	0.21
1995	11,073	3.1
1996	7,033	5.7
1997	14,910	6.5

Table 6.5 Inventory of Radionuclides (>1 mCi) Disposed of at the RWMS-3 in 1997

Radionuclide	Activity (Ci)	Percent of Total Activity
^{239}Pu	3.7×10^{0}	5.7×10^{1}
^{241}Pu	1.8×10^{0}	2.8×10^{1}
^{240}Pu	3.5×10^{-1}	5.4×10^{0}
^{241}Am	2.5×10^{-1}	3.8×10^{0}
^{238}U	9.4×10^{-2}	1.5×10^{0}
^{234}U	7.6×10^{-2}	1.2×10^{0}
^{228}Ra	5.9×10^{-2}	9.1×10^{-1}
^{228}Th	4.4×10^{-2}	6.8×10^{-1}
^{137}Cs	1.6×10^{-2}	2.5×10^{-1}
^{232}Th	1.4×10^{-2}	2.2×10^{-1}
^{230}Th	8.4×10^{-3}	1.3×10^{-1}
^{226}Ra	6.7×10^{-3}	1.0×10^{-1}
^{99}Tc	5.5×10^{-3}	8.4×10^{-2}
^{235}U	5.4×10^{-3}	8.3×10^{-2}
^{236}U	5.3×10^{-3}	8.2×10^{-2}
Total	6.5×10^{0}	1.0×10^{2}

Table 6.6 Quantity of Wastes Disposed of in Landfills - 1997

	Quantity (in pounds)		
Month	Area 9	Area 23	Area 6
January	1,870,110	427,600	260,990
February	367,340	130,300	94,480
March	217,520	190,000	12,400
April	1,157,870	124,400	340
May	1,029,180	300,350	4,170
June	1,451,190	155,980	300

Table 6.6 (Quantity of Wastes Disposed of in Landfills - 1997, cont.)

	Quantity (in pounds)		
Month	Area 9	Area 23	Area 6
July	183,070	216,460	1,001,220
August	878,160	513,640	10,360,360
September	1,432,890	381,240	33,640
October	1,157,890	239,520	8,140
November	117,420	240,820	17,440
December	162,560	240,820	50
Total	10,025,200	3,161,130	11,793,530

Table 6.7 Permits Required for NTS Operations - 1997

EPA Generator ID

NV3890090001	NTS Activities
NVD097868731	NLV Activities

NTS Permits

Permit No.	Areas	Expiration Date
NEV HW009	NTS Hazardous Waste Management (RCRA)	05/01/00
SW 13 097 02	Area 6 Hydrocarbon Disposal Site	On Closure
SW 13 097 03	Area 9 U-10c Solid Waste Disposal Site	On Closure
SW 13 097 04	Area 23 Solid Waste Disposal Site	On Closure
13-97-0034-X	NTS Hazardous Materials	12/31/97
13-97-0037-X	HSC Hazardous Materials	12/31/97
S15482	Scientific Collection of Wildlife Samples	12/31/98
File 1-5-96-F-33	USFWS -- Desert Tortoise Incidental Take Authorization	08/00/06
Interim Status	RCRA Part B -- Pit 3 Mixed Waste Disposal Operation	On Permit Approval
13-94-0034-X	State Chemical Catastrophe Prevention Act Compliance	Renewal on report submission

Off-NTS Permits

Las Vegas Area Operations

03-97-0265-X	NLV Hazardous Materials	12/31/97
03-97-0266-X	RSL Hazardous Materials	12/31/97

7.0 DOSE ASSESSMENT

The offsite environmental surveillance system, operated around the Nevada Test Site (NTS) by the U.S. Environmental Protection Agency's (EPA's) Radiation and Indoor Environments National Laboratory in Las Vegas (R&IE-LV), measured no radiation exposures attributable to recent NTS operations. However, using onsite emission measurements and calculated resuspension data as input to the EPA's Clean Air Package 1988 (CAP88-PC) model, a potential effective dose equivalent (EDE) to the maximally exposed individual (MEI) was calculated to be 0.089 mrem (8.9 x 10^{-4} mSv) to a hypothetical resident of Springdale, Nevada, located 58 km (36 mi) west-northwest of Control Point 1 (CP-1) on the NTS. The calculated population dose (collective EDE) to the approximately 31,000 residents living within 80 km (50 mi) from each of the NTS airborne emission sources was 0.26 person-rem (2.6 x 10^{-3} person-Sv). Monitoring network data indicated an 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 0.015 mrem (1.5 x 10^{-4} mSv). These maximum dose estimates, excluding background, are less than 1 percent of the most restrictive standard.

7.1 ESTIMATED DOSE FROM NTS 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, based on monitoring data or calculated resuspension of deposited radioactivity, 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) monitoring networks with documented assumptions and conversion factors to calculate the committed EDE (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, some of which were monitored by EPA's offsite monitoring networks during 1997. These were:

- Background radiation due to natural sources such as cosmic radiation, radioactivity in soil, and ^{7}Be in air.
- Worldwide distributions of man-made radioactivity, such as ^{90}Sr in milk and plutonium 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 discussed below.

ESTIMATED DOSE USING REPORTED NTS EMISSIONS

Onsite source emission measurements, as provided by Department of Energy (DOE), are listed in Chapter 4, Table 4.5, and include tritium 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 in Area 5. A calculation of estimated dose from NTS effluents was performed using EPA's CAP88-PC model (EPA 1992a). The results of the model indicated that the hypothetical individual with the maximum calculated dose from airborne NTS radioactivity would reside at Springdale, Nevada, 58 km (36 mi) west-northwest of CP-1. The maximum dose to that individual could have been 0.089 mrem (8.9×10^{-4} mSv). For comparison, data from the PIC monitoring network indicated an exposure 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 31,000 individuals, based on estimated population data. The collective population dose within 80 km (50 mi) from each of these sources was calculated to be 0.26 person-rem (2.6×10^{-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, 0.088 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 3.4×10^{-17} µCi/mL. This is about 20 times the annual average plutonium in air measured in Goldfield, Nevada, (nearest community) of 0.14×10^{-17} µCi/mL (Chapter 4, Table 4.15). Table 7.1 summarizes the annual contributions to the EDEs due to 1997 NTS operations as calculated by use of CAP88-PC and the radionuclides listed in Chapter 4, Table 4.5.

Input data for the CAP88-PC model included meteorological data from ARL/SORD and effluent release data calculated from monitoring results and from resuspension estimates. These 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. The model results are considered over-estimates of the dose to offsite residents. This has been confirmed by comparison with the offsite monitoring results.

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 1997. 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 an average value for previous year’s offsite tritium were used. No vegetable or animal samples were collected in 1997 so calculations for these intakes are not done.

Data quality objectives (DQOs) 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 7.2.

The concentrations given in Table 7.2 are expressed in terms of activity per unit volume. 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 storage or handling of ingested materials.

- Adult respiration rate = 8,400 m^3/yr from International Commission on Radiological Protection Publication 21 (ICRP 1975)

- Milk intake (average for 20 and 40 yr old) = 110 L/yr (ICRP 1975)

- Water consumption = 2 L/day (ICRP 1975)

The EDE conversion factors are derived from Federal Guidance Report No. 11 (EPA 1988). 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 a concentration of tritium in air of 0.2 pCi/m^3:

- (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} x 1.5 = 1.6 x 10^{-4} mrem/yr. Dose calculations from ORSP data are summarized in Table 7.2.

The individual CEDEs, from the various pathways, added together give a total of 0.015 mrem/yr. 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.

In 1997, because of budget cuts and the standby status of nuclear device testing, samples of game animals and garden vegetables were not collected. Also, the noble gas and tritium sampling network was discontinued in the offsite locations, and the air sampling network was reduced. In order to calculate an EDE for a resident of Springdale, Nevada, using the MEI from the CAP88-PC operation, it is necessary to make some assumptions as shown in the next section.

7.2 DOSE (EDE) FROM OFFSITE EXPOSURES

The NTS average ^{85}Kr concentration is representative of statewide levels, so it can be used in this calculation. Also, tritium in air does not change much from year to year, so previous data for that can be used. Finally, Goldfield, Nevada, has the nearest air sampler to Springdale, Nevada, so its plutonium concentration is used to calculate the EDE. In addition, 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 NTS surveillance network was 0.12 pCi/m^3. With a dose conversion factor for inhalation of 2.6 x 10^{-7} mrem/pCi, and a breathing volume of 8,400 m^3/yr, this equates to a dose of 2.6 x 10^{-4} mrem. Also, assume the network average of ^{90}Sr in milk and the average of tritium in water for sources near Springdale apply. All of the calculations that use these assumptions are shown in Table 7.2 and lead to an EDE at that location of 0.015 mrem, which is about 16 percent of the EDE calculated by use of CAP88-PC. Both of these calculated EDEs are negligible, compared to the PIC measurement of 144 mR at Beatty in 1997.

The maximum offsite EDE would have been at Rachel, Nevada, because the network's highest annual average $^{239+240}$Pu concentration of 1.8 x 10^{-17} µCi/mL (0.7 µBq/m^3) occurred there. A resident of Rachel would thus receive an inhalation exposure leading to 0.047 mrem (4.7 x 10^{-4} mSv) EDE for 1997. When exposure to the other radionuclides listed in Table 7.2 is added, the total becomes 0.059 mrem.

Therefore, based on offsite monitoring data, the MEI would live in Rachel, Nevada, and the EDE would be 0.059 mrem as contrasted with the CAP88-PC result that the MEI would live in Springdale, Nevada, and the EDE would be 0.089 mrem.

7.3 SUMMARY

The offsite environmental surveillance system operated around the NTS by EPA's R&IE-LV detected no radiological exposures that could be attributed to recent NTS operations, but a calculated EDE of 0.015 mrem can be obtained, if certain assumptions are made, as shown in Table 7.2. Calculation with the CAP88-PC model, using estimated or calculated effluents from the NTS during 1997, resulted in a maximum dose of 0.089 mrem (8.9 x 10^{-3} mSv) to a hypothetical resident of Springdale, Nevada, 14 km (9 mi) west of the NTS boundary. Based on monitoring network data, this dose is calculated to be 0.015 mrem. This latter EDE is about 17 percent of the dose obtained from CAP88-PC calculation. This maximum dose estimate is less than 1 percent of the International Commission of Radiological Protection (ICRP) recommendation that an annual EDE for the general public not exceed 100 mrem/yr (ICRP 1985). The calculated population dose (collective EDE) to the approximately 31,000 residents living within 80 km (50 mi) of each of the NTS airborne emission sources was 0.26 person-rem (2.6 x 10^{-3} person-SV). Background radiation yielded an EDE of 3,064 person-rem (30.6 person-Sv).

Data from the PIC gamma monitoring indicated a 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 DQOs are defined, as given in Chapter 8), no conclusions can be made regarding the achieved data quality as compared to the DQOs for this insignificant dose.

Table 7.1 Summary of Effective Dose Equivalents from NTS Operations - 1997

	Maximum EDE at NTS Boundary[a]	Maximum EDE to an Individual[b]	Collective EDE to Population within 80 km of the NTS Sources
Dose	0.12 mrem (1.2×10^{-3} mSv)	0.089 mrem (8.9×10^{-4} mSv)	0.26 person-rem (2.6×10^{-3} person-Sv)
Location	Site boundary 40 km WNW of NTS CP-1	Springdale, NV 58 km WNW of NTS CP-1	31,000 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	1.2	0.89	-----
Background	144 mrem (1.44 mSv)	144 mrem (1.44 mSv)	3064 person-rem (30.6 person-Sv)
Percentage of Background	0.08	0.06	0.008

(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) west-northwest 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 4.5 and assuming all tritiated water input to the Area 12 containment ponds was evaporated.
(c) National Emission Standards for Hazardous Air Pollutants.

Table 7.2 Monitoring Networks Data Used in Dose Calculations - 1997

Medium	Radionuclide	Concentration	Mrem\Year	Comment
Meat				Not collected this year
Milk	^{90}Sr	0.7 [a] (0.023)	1.1×10^{-2}	Concentration is the average of all network results
	^{3}H	0	0	Not Analyzed
Drinking Water	^{3}H	1.8 [a] (0.07)	8.4×10^{-5}	Concentration is average from 4 wells in the area
Vegetables				Not collected this year
Air	^{3}H	0.2 [b] (0.007)	1.6×10^{-4}	Concentration is average network result (1994 data)
	^{7}Be	0.12 [b] (0.0044)	2.6×10^{-4}	Annual average for NTS area
	^{85}Kr	27.[b] (0.93)	4.1×10^{-4}	NTS network average
	$^{239+240}$Pu	1.3×10^{-6} [b] (4.8×10^{-8})	3.4×10^{-3}	Annual average for Goldfield, Nevada

TOTAL (Air = 4.2×10^{-3}, Liquids = 1.1×10^{-2}) = 1.5×10^{-2} mrem/yr

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

8.0 LABORATORY QUALITY ASSURANCE

It is the policy of U.S. Department of Energy 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 (PE) programs. The external QA program for radiological data consists of participation in the 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. The radiological external QA program also consists of participation in the Oak Ridge National Laboratories (ORNL) radiobioassay study conducted by ORNL in Oak Ridge, Tennessee. External radiation measurement QA for the onsite program and EPA's Radiation & Indoor Environments National Laboratory-Las Vegas (R&IE-LV) offsite Thermoluminescent Dosimeter (TLD) programs consists of participation in EML's DOE Laboratory Accreditation Program (DOELAP). The nonradiological data QA program 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 performed by R&IE-LV. The QA program developed by R&IE-LV for the Offsite Radiological Safety Program (ORSP) meets all requirements of EPA policy, and also includes applicable elements of the requirements and regulations of DOE/NV QA. 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.

8.1 POLICY

Environmental surveillance, conducted onsite by Bechtel Nevada (BN) and offsite by EPA's R&IE-LV, is governed by the DOE QA policy as set forth in DOE Order 5700.6C, "Quality Assurance". The Order outlines ten specific elements that must be considered for compliance with the QA policy. These elements are:

1. Program
2. Personnel Training & Qualification
3. Quality Improvement
4. Documents and Records
5. Work Processes
6. Design
7. Procurement
8. Data Acceptance and Review
9. Management Assessment
10. Independent Assessment

In addition, R&IE-LV meets the EPA policy which states that all decisions which are dependent on environmental data must be supported by data of known quality. The EPA's 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, the EPA's policy requires participation in a QA Program by all EPA organizational units involved in environmental data collection. The QA policies and requirements of R&IE-LV are summarized in the "Quality Management Plan" (EPA/ORIA 1996). The QA 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," (unpublished). 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 of the R&IE-LV.

8.2 OVERVIEW OF THE LABORATORY QA PROGRAM

The BN Analytical Services Laboratory (ASL) implements the requirements of the DOE Order 5700.6C through integrated quality procedures. The quality of data and results is ensured through both process-based and procedure-specific QA.

Procedure-specific QA begins with the development and implementation of work instructions (WIs) 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 QA 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 QA 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 QA 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 R&IE-LV to ensure the quality of environmental radiological data collected off the NTS.

8.3 DATA AND MEASUREMENT QUALITY OBJECTIVES

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 (MQO), which define acceptable variability in the measured data, are established to ensure the quality of the measurements.

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).

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. Workplace and personnel monitoring to determine possible worker exposures is conducted by Industrial Hygienists and Health Physicists from the Environment, Safety, Security, and Health Division of BN.

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 BN. 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 ES&H 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.

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 BN's Environmental Management Procedures, and offsite methodologies by similar R&IE-LV procedures. The locations of nonradiological environmental sampling and monitoring are determined through site remediation and characterization activities and by permit requirements.

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.

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.

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.

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 put into the model. An environmental monitoring plan for the NTS, "Environmental Monitoring Plan, Nevada Test Site and Support Facilities" (DOE, 1991c) 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.

COMPARABILITY

Comparability refers to the degree of confidence and consistency we have in our analytical results, or defined as "the confidence with which one data set can be compared to another" (Stanley and Verner 1985). To achieve comparability in measurement data, sample collection and handling, laboratory analyses, and data analysis and validation are performed in accordance with established WIs. 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 EPA PESP.

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 BN 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. R&IE-LV's completeness objective for the Long-Term Hydrological Monitoring Program 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.

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 TLDs, precision is assessed from variations in the three $CaSO_4$ elements of each environmental 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 8.1. 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.

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 ASL 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 the staff of the ASL until several months after the measurements are made and the results sent back to the QA laboratory. 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 8.2 shows the accuracy objectives of the ASL and of the R&IE-LV.

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 R&IE-LV and ASL participate in several interlaboratory PE programs such as EPA's PESP and EML's QAP and the DOELAP for TLDs. The ASL also participates in two bioassay programs, DOELAP and ORNL.

The accuracy of the TLDs is tested every two or three years by DOELAP. This involves a three-part, single blind, performance testing program followed by an independent onsite assessment of the overall program. Both BN and R&IE-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.

8.4 RESULTS FOR COMPLETENESS, PRECISION, AND ACCURACY

Summary data for completeness, precision, and accuracy are provided in Tables 8.3 to 8.6, respectively. Complete data used in these MQO’s for 1997 may be found in the associated document, "Environmental Data Report for the Nevada Test Site - 1997" (DOE/NV/11718-232).

COMPLETENESS

The analysis completeness data for calendar year 1997 are shown in Table 8.3. 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 of MQOs for the onsite networks were met or exceeded in all cases. For the offsite networks, the MQOs were met or exceeded except for the high volume and pressurized ion chamber networks, where field equipment malfunction prevented complete collections.

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 8.4 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 R&IE-LV, the analysis for gross alpha in air and a few low-activity air samples, in which ^{7}Be was detected, did not meet the precision MQO. Activity barely exceeds the minimum detectable concentration (MDC) for most of these samples resulting in a decrease in precision for the analysis group. The precision data for all other analyses were well within their respective MQOs. The R&IE-LV data presented in Table 8.4 include only duplicate pairs that exceeded the MDC.

For the ASL, the reason for the low precision in some of the analyses was the low activity in these environmental samples as noted by R&IE-LV above, e.g., for tritium in air, the few that were useful for calculation of precision barely exceeded the MDC.

ACCURACY

The ASL and R&IE-LV accuracy objectives were measured through participation in the interlaboratory comparison and QAPs discussed below.

RADIOLOGICAL PERFORMANCE EVALUATION RESULTS

The external radiological PESP 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 1997 results of the interlaboratory PE and QAPs conducted by the EPA and DOE/EML are provided in Tables 8.5 and 8.6. The column or section in each table labeled percent Bias is the accuracy of analysis and may be compared to the objectives listed in Table 8.2. The individual radionuclide recoveries are listed in tables which may be found in the associated document, "Environmental Data Report for the Nevada Test Site - 1997" (DOE/NV/11718-232).

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 R&IE-LV failed the accuracy MQO in only 1 of the 20 analyses attempted in the EPA PE Study. In the EML QAP, 8 of the 29 analyses performed exceeded the DQO of ± 20 percent. In 1997, R&IE-LV maintained accreditation by DOELAP for the personnel TLD program. QA checks are routinely performed to ensure compliance with applicable performance standards.

BN's ASL results exceeded the 3 normalized deviation limits in 2 of the 56 analyses attempted. The MQOs for accuracy in analysis of DOE/EML samples were not met in only 3 of the 85 analyses attempted.

CORRECTIVE ACTIONS IMPLEMENTED IN RESPONSE TO PERFORMANCE EVALUATION PROGRAMS

BN 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, and an improved tracking system for PE samples.

In the R&IE-LV, the 1997 results that did not meet analysis criteria were investigated to determine the cause of the reported error. Corrective actions were implemented.

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 1997 intercomparison studies for all variables measured were compared with the grand average to calculate a normalized deviation for the R&IE-LV results. With the exception of one gamma spectroscopy sample, 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 R&IE-LV results with the 188 laboratories participating in the EPA PESP.

One of the two EML studies for 1997 was reported outside of acceptable limits for gamma spectroscopy in both air and water matrices. The problem with the air filters was traced to incorrect spiking (i.e., preparation) of the air filters. The samples were successfully re-analyzed to demonstrate that the analyst could meet the objectives of the study.

R&IE-LV continued to participate in the DOE Mixed Analyte Performance Evaluation Program (MAPEP) during 1997. Analysis of water and soil matrix samples was performed with all analytical results within the acceptable bias limit of ±20 percent.

The onsite ASL’s results in the EML QAP were acceptable. There were only three instances in which the ASL results were greater than the MQO. Corrective actions were made and the results from the next semi-annual PE sample were acceptable. 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 the ASL results as compared to the grand average was calculated for each analysis. The outcome for this calculation did not differ from the accuracy results reported above. Thus comparability of the ASL results is the same as its accuracy on PE samples as reported above.

SPIKE AND REAGENT BLANK DATA

Reagent blanks prepared by ASL were analyzed for the same radionuclides as the samples. Only 4 of 212 reagent blank results exceeded the MDC of the analysis for which the blanks were prepared.

A similar number of spike samples were prepared by ASL. The accuracy (as percent recovery) varied from 70 to 122 percent for the eight different analyses. The standard deviations of these percent recoveries is a measure of precision. These ranged from 3.5 to 15.1 percent for eight of the analyses.

Table 8.1 Precision Objectives Expressed as Percents

Analysis	Conc. > 10 MDC	4 MDC ≤ Conc. ≤ 10 MDC
ASL		
Gross Alpha	±30	±60
Gross Beta	±30	±60
Gamma Spectrometry	±30	±60
Scintillation Counting	±30	±60
Alpha Spectrometry	±20	±50
Noble Gas Analysis	±30	±40

Note: The precision objective for TLDs at environmental levels is 10 percent.

Analysis	Conc. > 10 MDC	4 MDC ≤ Conc. ≤ 10 MDC
R&IE-LV		
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
Plutonium	±20	±30

Table 8.2 Accuracy Objectives Expressed as Percent Bias

Analysis	Conc. > 10 MDC	4 MDC ≤ Conc. ≤ 10 MDC
ASL		
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 objective for TLDs is 20 percent for exposures <10 mR and 10 percent for ≥10 mR.

Analysis	Conc. > 10 MDC	4 MDC ≤ Conc. ≤ 10 MDC
R&IE-LV		
Tritium, Conventional	±10	±30%
Strontium (Milk)	±10	±30%
Thorium	±10	±30%
Uranium	±10	±30%
Tritium, Enriched	±20	±30%
Strontium (other media)	±20	±30%
Plutonium	±20	±30%
TLDs	Meet DOELAP Criteria	

Table 8.3 Analysis Completeness Data for Calendar Year - 1997

Analysis	Medium	Completeness Percent BN	Completeness Percent R&IE-LV
Gross Alpha/Beta	Low Volume Particulate Air Filter	93.6	95.5
Plutonium	High Volume Particulate Air Filter	(a)	85.3
Plutonium	Low Volume Particulate Air Filter	97.0	--
Gamma Spectrometry	Low Volume Particulate Air Filter	98.0	95.5
Gamma Spectrometry	Low Volume Charcoal Air Filter	(a)	95.5
Gamma Spectrometry	High Volume Particulate Air Filter	(a)	85.3
Tritiated Water	Air	90.6	(a)
Krypton-85	Air	87.6	(a)
Gross Alpha	Potable Water Taps	96.6	
Gross Beta	Potable Water Taps	96.6	(a)
Gamma Spectrometry	Potable Water Taps	96.6	(a)
Tritiated Water	Potable Water Taps	96.6	(a)
Plutonium	Potable Water Taps	96.6	(a)
Gross Beta	Wells, Reservoirs, Springs, Ponds	100	(a)
Plutonium	Wells, Reservoirs, Springs, Ponds	100	(a)
Gamma Spectrometry	Wells, Reservoirs, Springs, Ponds	100	98.0
Tritiated Water	Wells, Reservoirs, Springs, Ponds	100	97.8
Strontium-90	Wells, Reservoirs, Springs, Ponds	98.5	(a)
Gross Alpha	Potable Wells and Taps	97.5	(a)
Tritium	Milk	(a)	93.5
Strontium	Milk	(a)	93.5
Pressurized Ion Chamber	Ambient Radiation	(a)	91.7
TLDs, Environmental	Ambient Radiation	90.2	98.7
TLDs, Personnel	Ambient Radiation	(a)	100

(a) Analyses not performed.

Table 8.4 Precision Estimates from Replicate Sampling - 1997

Analysis	Number of Replicate Analyses	Precision Estimate %RSD
ASL		
Gross Beta in Air	47	15.9
Gamma in Air	35	23.1
Gross Alpha in Air	41	46.5
Tritium in Air	21	27.2
Gross Alpha in Potable Water	28	5.1
Gross Beta in Potable Water	35	15.1
HTO in Tunnel Effluent	8	3.6
Pu in Tunnel Effluent	16	8.5
R&IE-LV		
Gross Alpha in Air	84	28.5
Gross Beta in Air	145	18.0
Gamma Spectrometry (Low-Vol ^{7}Be)	14	36.2
Gamma Spectrometry (Hi-Vol ^{7}Be)	11	46.8
Tritium in Water (enriched)	12	7.9
Tritium in Water (unenriched)	2	26.2

Table 8.5 Accuracy of R&IE-LV Radioanalyses (EML QAP and PESP) - 1997

Water Samples Range of Results - pCi/L

Analysis	No.	PESP	R&IE-LV	% Bias
Gross Alpha	5	10 - 75	12 - 71	-4.2 - 20
Gross Beta	5	7 - 167	13 - 162	-3.2 - 13
Gamma Spec.[a]	5	10 - 745	12 - 6300	-9 - 790
Strontium	2	10 - 25	12 - 24	-4 - 23
Alpha Spec.	5	5 - 58	5 - 55	-6 - 3
Tritium	2	10880 - 22000	10800 - 21300	3.1 - -0.4

(a) One group of samples submitted for gamma spectrometric evaluation included an incorrect dilution factor, thus a reporting error. Positive % Bias for the remaining samples was a maximum of 12 for the 1997 reporting period.

% Bias Range for Analysis of EML QAP Samples

Analysis	No.	Air	Soil	Vegetation	Water
Plutonium	13	-3.1 - 6.5	-30 - 1.9	-11 - 13	0.5 - 1.3
Uranium	4	(a)	(a)	(a)	0.8 - 20
Strontium	5	(a)	-100	-100 - -91	-11 - 15
Tritium	2	(a)	(a)	(a)	-16 - -11
Gamma Spec.	19	-5.2 - 18	(a)	(a)	25 - 28

(a) No sample.

% Bias Range for Analysis of MAPEP QAP Samples

Plutonium	4	(a)	1.4 - 3.9	(a)	-4.0 - -4.8
Strontium	1	(a)	(a)	(a)	-15
Gamma Spec.	3	(a)	(a)	(a)	-5.6 - 4.6

(a) No sample.

Table 8.6 Accuracy of ASL Radioanalyses (EPA PESP and EML QAP) - 1997

Analysis Water Samples	No.	BN/ASL Average pCi/L	EPA QA Known	Normalized Deviation[a] Grand Avg.
^{60}Co	5	15.7 - 109	0.23 - 3.46[b]	0.15 - 3.77[b]
^{65}Zn	2	48.7 - 342	2.41 - 4.73[b]	1.86 - 4.36[b]
^{134}Cs	5	414 - 80.3	-1.50 - 1.02	-0.50 - 2.57
^{60}Co	4	10.0 - 28.3	0.00 - 0.92	-0.16 - 0.62

(a) No sample.
(b) Results exceed three Normalized Deviations.

Table 8.6 (Accuracy of ASL Radioanalyses [EPA PESP and EML QAP] - 1997, cont.)

Analysis Water Samples	No.	BN/ASL Average pCi/L	EPA QA Known	Normalized Deviation[a] Grand Avg.
^{65}Zn	2	85.3 - 107	1.21 - 2.24	0.64 - 1.56
^{134}Cs	4	9.0 - 136	-1.73 - 0.00	-0.63 - 0.63
^{137}Cs	4	23.0 - 78.0	0.85 - 1.39	0.09 - 0.64
^{133}Ba	2	25 - 97.7	-0.23 - 0.00	0.44 - 0.54
^{89}Sr	4	8.7 - 40.3	-1.73 - -0.12	-1.78 - 0.13
^{90}Sr	4	13.0 - 22.3	-0.92 - 0.00	-0.41 - 0.17
^{131}I	2	13.7 - 110	1.06 - 4.55[b]	0.79 - 4.22[b]
Tritium	2	7950 - 10900	-0.17 - 0.12	0.05 - 0.49
^{226}Ra	6	3.9 - 25.5	0.37 - 4.33[b]	0.35 - 4.21[b]
^{228}Ra	6	4.1 - 10.9	0.49 - 2.71	0.47 - 2.64
U (nat.)	6	4.8 - 39.0	-0.79 - 0.04	-0.48 - 0.68
Gross Alpha	5	2.7 - 45.1	-1.20 - 0.38	-0.77 - 0.10
Gross Beta	5	14.6 - 122	-1.70 - 1.11	-1.48 - 0.78

(a) ± 3 Normalized Deviation is acceptable.
(b) Results exceed three Normalized Deviations, only two results exceeded.

% Bias Range for Analysis of EML QAP Samples

Analysis	No.	Air	Soil	Vegetation	Water
Americium	2	3.9 - 7.0	-5.0 - 18.3	-2.0 - 15	-5.0 - 7.9
Plutonium	4	-11.6 - -1.0	-22.9 - -1.0	-28.4 - 10	-25.8 - 8
Uranium	4	-0.5 - 18	-12 - -1	(a)	-2 - 10
Strontium	2	-8 - -5.5	-14 - 9.9	-15 - -11	-11 - -1.3
Tritium	2	(a)	(a)	(a)	6.0 - 9.9
Gamma Spec.[b]	6	-18 - 7.5	-24[c] - 11.3	-41[c] - 9.6	-2 - 15.6
Gross Alpha	2	0.0 - 4.0	(a)	(a)	-5.0 - 4.0
Gross Beta	2	4 - 202	(a)	(a)	-17 - 13

(a) No sample.
(b) Number of Isotopes was 12 (air), 6 (soil & vegetation), and 7 (water).
(c) Two high bias analyses in soil and one in vegetation.

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