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1997 Annual Site Environmental Report Tonopah Test Range, Nevada

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Annual Site Environmental Report

Tonopah Test Range, Nevada

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ABSTRACT

Sandia National Laboratories (SNL) operates the Tonopah Test Range (TTR) for the Department of Energy's (DOE) Weapons Ordnance Program. This annual report (calendar year 1997) summarizes the compliance status to environmental regulations applicable at the site including those statutes that govern air and water quality, waste management, cleanup of contaminated areas, control of toxic substances, and adherence to requirements as related to the National Environmental Policy Act (NEPA). In compliance with DOE orders, SNL also conducts environmental surveillance for radiological and nonradiological contaminants. SNL's responsibility for environmental surveillance extends only to those activities performed by SNL or under its direction. Annual radiological and nonradiological routine releases and unplanned releases (occurrences) are also summarized. This report has been prepared as required by DOE Order 5400.1, *General Environmental Protection Program* (DOE 1990a).

PREFACE

This report presents summary information on the compliance status and monitoring results for Tonopah Test Range (TTR). Appendix B contains all relevant location maps for sampling activities described in chapter 4. The reader may also refer to the Ancillary Information at the end of the report for a listing of acronyms, units, and other abbreviations.

ACKNOWLEDGMENTS

The editorial staff thanks those people who provided information and analytical data necessary for the preparation of this report.

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Tonopah Test Range

A 1986 drop test of a B83 at Tonopah Test Range. Released from the B-1B bomber, the three pilot chutes pull out the bomb's main parachute for a laydown delivery.

EXECUTIVE SUMMARY

As required by U.S. Department of Energy (DOE) Order 5400.1, *General Environmental Protection Program* (DOE1990a), this Annual Site Environmental Report (ASER) has been prepared for Sandia National Laboratories/Nevada (SNL/NV) to characterize current environmental conditions in the vicinity of SNL's operations at the Tonopah Test Range (TTR) and to summarize compliance status with federal, state, and local requirements and permits. This report represents a key component of the DOE's effort to keep the public informed about environmental conditions throughout the DOE complex.

The TTR is located within the boundaries of the Nellis Air Force Range (NAFR) in Nevada and is sited on 336,665 acres at the north end of the range. The TTR is used to support activities related to the missions of the DOE and the United States Air Force (USAF). SNL operates the TTR for research and development (R&D) and component testing activities related to DOE's weapons ordnance programs. These activities include air drops, gun firings, ground-launched rockets, air-launched rockets, and other explosive tests.

The following paragraphs present the major activities, accomplishments, and results of various environmental programs conducted at the TTR under SNL's cognizance during 1997. These environmental program areas and activities include:

- Waste Management
- Environmental Restoration (ER)
- Terrestrial surveillance
- Water quality monitoring
- Air quality compliance and monitoring
- National Environmental Policy Act (NEPA) Activities
- Environmental Occurrences

WASTE MANAGEMENT

TTR is classified as a "small quantity generator" of hazardous waste under the Resource Conservation and Recovery Act (RCRA). In 1997, SNL shipped 3,426 kg of RCRA-hazardous waste and 425,797 kg of regulated non-RCRA waste to permitted treatment, storage, and disposal facilities (TSDFs). Additionally, 466 tons of petroleum-contaminated soils from ER projects were also shipped. Waste management is conducted by SNL's onsite contractor, Kirk-Mayer, Inc. (KMI Services).

An informal waste minimization and recycling program is practiced at TTR. Recycled items include used oil, batteries, solvents, and fluorescent and sodium light bulbs. A total of 7,462 kg of recyclables were shipped offsite for energy recovery or recycling in 1997.

ENVIRONMENTAL RESTORATION (ER)

ER activities at TTR are managed through the DOE Nevada Office (DOE/NV). The DOE currently has 47 Corrective Action Units (CAUs) designated at TTR. These have been categorized into four "Soil Sites CAUs" and 43 "Industrial Sites CAUs." Each CAU comprises one or more specific Corrective Action Sites (CASs). ER sites at TTR include areas contaminated from past rocket firing and target tests, abandoned septic systems, solvent contaminated soils at previous underground storage tank (UST) areas, and disposal areas for ordnance, septic sludge, and depleted uranium (DU).

ER activities in 1997 included Corrective Action Investigations (CAIs) for several septic waste systems, landfills, and underground discharge points (UDPs). Closure activities were

completed for the Cactus Spring waste trenches and the sewage lagoons at the Roller Coaster Sewage Lagoons and North Disposal Trench.

ER sites related to the Project Roller Coaster Tests are referred to as the Clean Slate sites and the Double Tracks Site and are not managed under the CAU system. These sites are contaminated over a large area with transuranics resulting from nuclear weapon destruction tests performed in 1963. Double Tracks is located on NAFR, while all three Clean Slate sites are located on TTR. Remediation was completed for the Double Tracks site in 1996. Clean Slate 1 was remediated in 1997. The remaining two Clean Slate sites (2 and 3) are pending remediation.

TERRESTRIAL SURVEILLANCE

Soil samples were collected from SNL-controlled property areas and vicinity in June 1997. All soil samples were analyzed for total uranium and by gamma spectroscopy. Gamma spectroscopy was used primarily to detect the presence of americium. A total of 40 onsite and perimeter locations were sampled and compared to a total of 14 offsite sampling locations.

Results showed some onsite samples slightly elevated in comparison to offsite samples. Slightly elevated cesium-137 (Cs-137) and total uranium (U_{tot}) concentrations were found at several locations. These are believed to be within the normal range of background concentrations. Americium and plutonium were detected at several locations. Since these radionuclides do not occur naturally, these locations are considered potentially contaminated.

WATER MONITORING

The USAF is required to submit a quarterly Discharge Monitoring Report (DMR) to the State of Nevada. Results of SNL's quarterly sampling and flow monitoring of sewage

discharged from the Area 3 Main Compound must be provided to the USAF for inclusion in the DMR report as required under the conditions of the permit. All results of wastewater sampled from the Area 3 compound in 1997 met regulatory standards.

AIR QUALITY COMPLIANCE AND MONITORING

Air emissions in 1997 were in compliance with the existing permits.

In the past, SNL has performed a dose assessment for TTR based on the diffuse radiological releases from the Clean Slate sites. Continuous air monitoring was conducted from February 1996 to February 1997. Monitoring was conducted at the TTR Airport area. The TTR Airport area was determined to be the location of the maximally exposed individual (MEI) for the purpose of complying with the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulation. The effective dose equivalent (EDE) to the MEI was 0.024 millirem/year (mrem/yr). NESHAP regulations do not require air monitoring for any source contributing less than 0.1 mrem/yr to the MEI. In addition, sources that contribute less than 0.1 mrem/yr do not need to be included in NESHAP dose assessment calculations. For this reason, future NESHAP activities at TTR are expected to be minimal.

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

At TTR, NEPA compliance is a joint effort between SNL, DOE/NV, and the Desert Research Institute (DRI). Activities in 1997 included the completion of the *Final Environmental Impact Statement for the Nevada Test Site and Offsite Locations in the State of Nevada* (DOE 1996). This document included the TTR location.

ENVIRONMENTAL OCCURRENCES

There was only one environmental occurrence in 1997 involving a diesel fuel spill in a rocky area. The ground was cleaned up as much as practical between the bedrock exposures, however a "closure in place" was requested for the remaining contaminated soil that could not be practically removed.

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1 INTRODUCTION

The Tonopah Test Range (TTR) is located on approximately 336,665 acres within the boundaries of the Nellis Air Force Range (NAFR) withdrawal and is used to support activities related to the missions of the U.S. Department of Energy (DOE) and the United States Air Force (USAF). Sandia National Laboratories, Nevada (SNL/NV) operates the TTR with respect to DOE's Weapons Ordnance Program (DRI 1991).

As required in DOE Order 5400.1, *General Environmental Protection Program* (DOE 1990a), this Annual Site Environmental Report (ASER) has been prepared for the TTR to summarize data that characterize site environmental management performance and confirm compliance with federal, state, and local environmental standards and requirements. This report contains summary information about the radiological and nonradiological environmental conditions of the site. The ASER represents a key component of the DOE's effort to keep the public informed about environmental conditions at DOE facilities.

.....

1.1 TTR HISTORY AND OPERATIONS

In 1940, President Roosevelt established the Las Vegas Bombing and Gunnery Range (now referred to as NAFR), which is part of the Nellis Air Force Base (NAFB) Complex. The Complex includes NAFB, located eight miles north of Las Vegas, Nevada, several auxiliary small arm ranges, and the NAFR—divided into a North Range and a South Range (Figure 1-1).

The Nevada Test Site (NTS) is located between these two ranges. The entire NAFB Complex comprises approximately three million acres.

In November 1956, the Air Force withdrew 1,606 sq km (620 sq mi) to the U.S. Atomic Energy Commission (AEC)—now the DOE—for use as a fully-instrumented ballistic test range (DOE 1996). This area, located on the North Range, is now referred to as the TTR. The TTR came into limited use after similar facilities at the Salton Sea Test Base in California and at Yucca Flat on the NTS became inadequate. In the years following World War II, facilities that were built at the TTR were originally designed and equipped to gather data on aircraft-delivered inert test vehicles under AEC cognizance. Over the years, the facilities and capabilities at TTR were expanded to accommodate tests related to the DOE's weapons development program.

By 1957, SNL/NV began operations at TTR for DOE's nuclear ordnance programs providing a capability to operate and test new weapon systems. Principal DOE activities at the TTR include: stockpile reliability testing; research and development testing support of structural development; arming, fusing and firing systems testing; and testing nuclear weapon delivery systems. Currently, the TTR is set up for activities that can vary from simple tests of hardware components and systems—requiring only limited support—to rocket launches and air drops of test vehicles—requiring a full range of technical support.

The Main Compound in Area 3 is the heart the test range activities. The Operations Control

FIGURE 1-1. Location of the Tonopah Test Range (TTR), Within the Boundaries of the Nellis Air Force Range (NAFR), Nevada

Center is located here and controls and coordinates all test functions. The main control room on the second floor affords a 360 degree view of the site.

Another key location at the range is Area 9, which is houses weapons storage facilities and is used to conduct ground to air rocket launching tests.

In recent years, specific test activities at TTR have consisted of the following:

- Air drops for trajectory studies of simulated weapons
- Gun firings
- Ground-launched rockets to study Aeroballistics and material properties
- Air-launched rockets (deployed from aircraft)
- Explosive testing to optimize design of shipping and storage containers
- Static rocket tests related to the Trident Submarine Program
- Ground penetrator tests

These activities require a remote range for both public safety and to maintain national security. The majority of test activities at TTR occur within Cactus Flat, a valley with almost no topographical relief flanked by mountains and hills.

On October 1, 1997 a Memorandum of Agreement (MOA) was signed between DOE Albuquerque Operations Office (DOE/AL) and DOE Nevada Operations Office (DOE/NV) related to operational responsibility at TTR. The MOA specified that DOE/AL and DOE Kirtland Area Office (DOE/KAO) are responsible for the oversight of SNL activities at TTR. DOE/NV, however, will continue to be responsible for Environmental Restoration (ER) activities at the site. SNL/NV is overseen by DOE/NV. SNL/NM works in concert with SNL/NV for all environmental operations at TTR.

.....

1.2 SITE DESCRIPTION AND DEMOGRAPHICS

TTR is sited within the NAFR at the northern boundary. The area north of the TTR boundary is sparsely populated public lands administered by both the Bureau of Land Management (BLM) and the U.S. Forest Service. The land is currently used to graze cattle. To the east of TTR, and also within the NAFR, is the Nevada Wild Horse Range. This land is also administered by the BLM.

The nearest residents are located in the town of Goldfield (population 659), approximately 35.4 km (22 mi) west of the site boundary. The town of Tonopah (population 3,680) is the next largest population center, approximately 48.2 km (30 mi) northwest of the site (DOC 1991). Las Vegas is 225.2 km (140 mi) from TTR. The total population within an 80-kilometer (50-mile) radius around TTR is approximately 6,871 (SNL 1997). This number includes the potential population at TTR if all housing units within the base were used.

.....

1.3 REGIONAL GEOLOGY, HYDROLOGY, CLIMATE, AND FAUNA

Geology

The geology at TTR is characterized by broad, flat, valleys bordered by north/south-trending mountain ranges. The regional area is located in the western part of the Basin-and-Range geophysical province. This area is marked by horst and graben topography, a system of mountains and valleys formed through regional extension. TTR lies northeast of the Walker Lane, a zone of transcurrent faulting and shear, and the Las Vegas Valley shear zone to the southeast (Sinnock 1982). Cactus Flat, the main working area of TTR, is an alluvial-filled basin

bordered by the Cactus Range to the west and the Kawich Range to the east. An area of low hills outcrops in the south. The Cactus Range, situated mostly within the boundaries of TTR, is the remnants of a major volcanic center consisting of relatively young (six million-year-old) folded and faulted tertiary volcanics. These mountains are one of at least five northwest-trending, raised structural blocks that lie along the Las Vegas Valley-Walker Lane lineaments (ERDA 1975). Elevations within TTR range from 1,630 m (5,347 ft) at the valley floor to 2,279 m (7,482 ft) at Cactus Peak.

Surface Water

Drainage patterns within and near TTR are intermittent (ephemeral stream channels) and end in closed basins evaporating within dry lake beds (playas). Ephemeral streams occasionally carry spring runoff to the center of Cactus Flat where there is a string of north-south trending playas; however, due to the high rate of evaporation, little is recharged to the groundwater (DRI 1991).

There are several small springs within the Cactus and Kawich Ranges. Three springs occur within TTR boundaries: Cactus, Antelope, and Silverbow Springs. Water from these springs does not travel more than several tens of meters dissipating rapidly through evaporation and infiltration and the effect on the landscape is purely local.

Groundwater

TTR derives its water from local wells. The U.S. Geological Survey (USGS) has recorded groundwater depths from 21 ft to 454 ft at the site. Groundwater is encountered at the Antelope Mine well in the Cactus Range at 21 ft and at the EH2 well, near the TTR Airport, at 454 ft. The depth to groundwater at the Area 9 well (north end of the site) is approximately 131 ft. South of that well, groundwater is encountered at 361 ft to 394 ft in Area 3. The static water level at Well 6 (the main water supply well) is approximately 350 ft.

Climate

The climate at TTR is mild and usually dry, but, as is typical of high deserts, is subject to large diurnal and seasonal changes in temperature—from a record high of 38.8 degrees Celcius (°C) (102 degrees Fahrenheit [°F]) to a record low of -31 °C (-24 °F) (Schaeffer 1982). The hottest months are July and August with temperatures ranging from the 90s during the day and dropping to the 50s at night. Clear, sunny days with light to moderate winds are usual. Rainfall is dependent on elevation. The annual average at the desert floor is 10 cm (4 in.) and 30.4 cm (12 in.) in the mountains. The primary rainfall season is in the summer with a lesser rainy season in the winter (DOI/BLM 1979). Winds are mostly from the northwest from late fall to spring, being influenced by the Pacific air flow patterns coming over the Sierra Nevada Mountains in California. From summer through early fall, the winds generally shift to a southeasterly direction coming from the Gulf of Mexico. Dust storms are common in the spring and dust devils are common in the summer.

Vegetation

Temperature extremes and arid conditions of the high desert limit vegetational coverage. Sparse vegetation occurring in Cactus Flat is predominantly range grasses and low shrubs typical of the Great Basin Desert flora (ERDA 1975; EG&G 1979a). Vegetation is divided into two basic types at the site by elevation—salt desert shrub in the low lands and northern desert shrub in the higher elevations (DOI/BLM 1979, DRI 1991). Salt desert shrub is characteristic of poorly drained soils and is common along dry lake beds. Specific plants in this group include saltbrush, shadscale, greasewood, Russian thistle, and sagebrush. Northern desert shrub, found in the Cactus Range, includes sagebrush, rabbitbrush, squirrel tail, wheat grass, juniper, and Nevada bluegrass. Joshua trees and juniper grow in the transition zone at the base of the mountains.

Wildlife

The Nevada Wild Horse Range and other wild horse land-use areas composes a significant

portion of the North Range with herds common in Cactus and Gold Flats, the Kawich Valley, Goldfield Hills, and the Stonewall Mountains. Hundreds of wild horses graze freely throughout TTR and the activities onsite have had apparently little effect on the horse population or their grazing habits. When the herd does become too large and overgrazing is a concern, horses are rounded up for dispersal through BLM's Horse Adoption Program.

Other large mammals common to the area include pronghorn antelope, mule deer, kit fox, bobcat, coyote, and gray fox. To a lesser extent, bighorn sheep, mountain lions, and burros are also located in the area (DOI/BLM 1979, DRI 1991).

Birds in the area include the American kestrel, hawks, owls, and quail.

In general, the NAFR land withdrawal has provided a positive effect on local plant and animal life. Since much of the withdrawn area is undisturbed by human activity, large habitat areas are protected from the effects of public use, which can cause significant on and off-road impacts. This is particularly critical in the fragile desert ecosystem where disturbances can take years to recover (DRI 1991).

.....

1.4 CLEAN SLATE AND DOUBLE TRACKS SITES

Project Roller Coaster, performed in May and June of 1963, included a series of four nuclear weapons destruction tests that resulted in plutonium dispersal in the surrounding soils. Three of these tests were conducted within the boundaries of TTR; the fourth was conducted on the NAFR just west of the TTR. The locations of the three Project Roller Coaster tests at TTR are referred to as Clean Slates 1, 2, and 3. The fourth site at NAFR is referred to as Double Tracks. In 1996, the Double Tracks site was

remediated to a soil contamination level of less than or equal to 200 picocuries per gram (pCi/g) of transuranics, and closed out (Figure 1-2).

Table 1-1 summarizes test information related to the four Project Roller Coaster sites. As previously noted, DOE/NV has responsibility for these and all other Environmental Restoration (ER) sites at TTR. SNL will continue to be responsible for environmental compliance at these sites.

The initial cleanup of each Clean Slate site was conducted shortly after each test. Test-related debris was bladed into a hole at test ground-zero and backfilled. An initial fence was built around each test area where the soil contamination was set at approximately 1,000 micrograms per square meter ($\mu\text{g}/\text{m}^2$) of plutonium. The soil survey was conducted on 61-meter grids with a hand-held survey meter or FIDLER (field instrument for the detection of low-energy radiation). In 1973, additional outer fences were set at 40 pCi/g of plutonium in soil also using the hand-held meter method. Soil sampling is conducted periodically at these sites and the areas are visually inspected twice a year to determine whether any fence repairs are required. When discovered, horses that may have wandered inside the fenced areas are promptly removed.

An aerial radiological survey was performed by EG&G, Inc. for the Nevada Applied Ecology Group (NAEG) in 1977. The aerial surveys were undertaken to supplement the FIDLER and previous soil sample measurements of transuranics. The objective was to determine the extent of surficial distribution of plutonium and other transuranic elements dispersed during the Project Roller Coaster tests. Radiation isopleths showing soil activity due to americium-241, plutonium-239, and plutonium-240 were drawn for each area. The cumulative area of the diffuse sources as determined by the aerial survey is 20 million square meters. The results of the survey found transuranic contamination outside the fenced area in the downwind direction (EG&G 1979b).

TABLE 1-1. Project Roller Coaster Test Information

Test	Date of Test	Test Location	Status
Clean Slate 1	May 25, 1963	TTR	Remediation completed in 1997
Clean Slate 2	May 31, 1963	TTR	Remediation scheduled for 1998
Clean Slate 3	June 9, 1963	TTR	Remediation pending
Double Tracks	May 15, 1963	NAFR, North Range (West of TTR)	Remediation completed in 1996

Source: IT 1996 - *Sampling and Analysis Plan for Clean Slate 1*, September 1996.

FIGURE 1-2. Location of Facilities Operated by SNL at the TTR
ER sites shown include the Clean Slate sites from Project Roller Coaster tests.

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2 COMPLIANCE SUMMARY

SNL/NV is responsible for Environment, Safety, Health (ES&H) compliance. This chapter discusses the status of ES&H compliance with federal environmental statutes, regulations, Executive Orders, and DOE orders at TTR in 1997. Environmental audit summaries, occurrence reporting, and environmental permit status for 1997 are also discussed.

It is SNL's goal to operate in full compliance with environmental and other requirements established by federal and state laws. The State of Nevada implements most environmental regulations. Specific state regulations are listed in table A-1 of Appendix A, including regulations governing solid and hazardous waste management, wildlife, sewage systems and radiation control. Radionuclide air emissions regulations are administered directly by the U.S. Environmental Protection Agency (EPA).

Kirk Mayer, Inc. (KMI Services) assists SNL/NV in performing various compliance activities such as air monitoring, water sampling, and waste characterization.

.....

2.1 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA)

CERCLA, commonly known as Superfund, defines certain assessment activities and reporting requirements for inactive waste sites at all federal facilities. The National Priorities List

(NPL) is an ordered ranking of top priority CERCLA sites based on a threshold level of contaminants present, as established by the EPA. There are no NPL designations located at the TTR site.

As required under CERCLA Section 120(d), a Preliminary Assessment (PA) was submitted for all facilities listed on the federal agency hazardous waste compliance docket in 1988. Table 2-1 summarizes SNL's compliance with SARA Title III reporting requirements. TTR was in compliance with all applicable CERCLA requirements in 1997.

Superfund Amendments and Reauthorization Act (SARA), Title III

KMI Services assists SNL/NV in meeting two annual requirements: the SARA Title III, Emergency Planning and Community Right-to-Know Act (EPCRA) reporting requirements for all TTR activities, and the State of Nevada's extremely hazardous materials reporting requirements. In 1997, neither report was required since SNL was below the reporting threshold for EPCRA and no extremely hazardous substances (EHSs) were used at TTR in 1997.

.....

2.2 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

Under the RCRA Hazardous Waste Permit Program (40 CFR 270.61), TTR is permitted as a "small quantity generator." Under this designation, hazardous waste cannot be stored onsite for over 180 days before it must be

shipped offsite for treatment and disposal at an EPA-permitted facility. At TTR hazardous waste shipments are scheduled to occur two to three times per year. In 1997, there were eight hazardous waste shipments; two were made through Romic Environmental Technologies and six were shipped through Safety Kleen.

Sanitary solid waste, which is also regulated under RCRA, is disposed of at landfills onsite. There is one Class II sanitary landfill in operation at TTR operated by the USAF Operations and Maintenance (O&M) contractor. It is used cooperatively by all organizations at TTR.

Underground Storage Tanks (USTs) – RCRA, Subtitle I (implemented under 40 CFR 280) sets forth requirements for USTs that contain hazardous materials or petroleum products. SNL/NV has no current registered USTs in its ownership. The last five USTs were removed in August 1995; two diesel tanks and two gasoline tanks were removed from Area 3 at the site of a former gas station, and one diesel tank was removed from Area 9 that had supplied a generator fuel.

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2.3 FEDERAL FACILITIES COMPLIANCE ACT (FFCACT)

The FFCACT amendments to RCRA specifically address Land Disposal Restriction (LDR) requirements for the treatment for mixed waste (MW) at federal facilities. Since the TTR does not generate MW and currently has no MW stored onsite, this statute is not applicable to SNL/NV operations.

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2.4 CLEAN AIR ACT (CAA) AND CLEAN AIR ACT AMENDMENTS OF 1990 (CAAA)

The requirements of the CAA and CAAA are implemented by State of Nevada air quality regulations. The EPA retains compliance authority for all radionuclide air releases, which are regulated by National Emission Standards for Hazardous Air Pollutants (NESHAP) and implemented under 40 CFR 61, subpart H.

TABLE 2-1. SNL Reporting Activities for TTR in 1997 with Respect to SARA Title III Compliance

SARA, Title III (EPCRA)	Regulation Section Description	SNL Reporting			Explanation
		Yes	No	Not Required	
302 - 303	Planning Notification	✓			This report was submitted to notify state and local emergency response authorities and to carry out other facility notification responsibilities.
304	Emergency Release Notification			✓	There were no reportable quantity releases of EHS or as defined under CERCLA. No EHS is used in routine operations at TTR.
311-312	MSDS/Chemical Inventory	✓			MSDS information is made available to local emergency organizations.
313	Toxic Release Inventory (TRI) Reporting			✓	SNL/NV was below the reporting threshold for any listed chemical.

NOTE: MSDS = Material Safety Data Sheet
EHS = Extremely Hazardous Substance

NESHAP Compliance

In the past, the Clean Slate sites, which are discussed in chapter 1, have been the only source of radionuclide air emissions at TTR. Continuous air monitoring was completed at these sites in 1997. Air monitoring was performed at the location of the maximally exposed individual (MEI) determined to be in the TTR Airport area. Results showed that the dose from these sources was below the reporting threshold of 0.1 mrem/yr (0.024 mrem/yr). A NESHAP report was prepared detailing the monitoring results (SNL 1998).

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2.5 CLEAN WATER ACT (CWA)

Wastewater effluents and potable water supplies are regulated under the CWA and State of Nevada water pollution and sanitary waste systems regulations. Wastewater discharges are administered by the State of Nevada, Bureau of Health Protection Services, and the Nevada Department of Environmental Protection (NDEP). TTR produces wastewater that is discharged to six septic tank systems and the sewer system connected to the USAF facultative sewage lagoon. There were no excursions or other permit violations in 1997 with respect to wastewater discharges. The compliance status of SNL/NV's water supply well is discussed under the Safe Drinking Water Act in the following section.

Storm Water

The issuance of a National Pollutant Discharge Elimination System (NPDES) storm water permit is generally based on whether or not storm water runoff is discharged to "waters of the United States," which include all streams, channels, and arroyos that lead to a river or other significant body of water. The TTR site is primarily a closed basin with runoff evaporating or infiltrating to the ground. However,

following Best Management Practices, SNL/NV may choose to follow the *TTR Storm Water Pollution Prevention Plan* that was developed for the site (CDM 1994). However, since the USAF has permitted its airfield and Area 10 for storm water runoff, SNL/NV is re-evaluating NPDES requirements at TTR.

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2.6 SAFE DRINKING WATER ACT (SDWA)

SNL/NV meets standards for drinking water as defined in the SDWA and State of Nevada public water supply and public water systems regulations. Well 6 provides all drinking water for SNL/NV operations at TTR and is operated under a permit issued by the State of Nevada. SNL remained in compliance with all Well 6 permit requirements. All bacteriological sampling was negative for coliform bacteria. Other chemical monitoring parameters were below regulatory limits.

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2.7 TOXIC SUBSTANCES CONTROL ACT (TSCA)

Compliance with the TSCA at TTR primarily concerns the management of asbestos and polychlorinated biphenyls (PCBs). As defined by TSCA, any material with greater than or equal to 500 parts per million (ppm) is considered "PCB"; materials with greater than or equal to 50 ppm but less than 500 ppm are considered "PCB-contaminated." In 1993, sampling was performed on TTR transformers owned by DOE/KAO to determine if PCBs were present (IT 1993). None of the samples contained over 50 ppm of PCBs.

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2.8 FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

All chemical pesticide and herbicide use at TTR is in accordance with EPA regulations. SNL/NV retains records of the quantities and types of pesticides that are used as well as Material Safety Data Sheets (MSDSs) for each pesticide. There were no violations of FIFRA in 1997.

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2.9 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

NEPA was passed by the U.S. Congress in 1969 to articulate a new national policy with regard to protection of the environment. NEPA regulations require federal agencies to consider environmental impacts of proposed actions including the "no action" alternative. For actions that are deemed likely to result in significant environmental impacts, an Environmental Assessment (EA) or an Environmental Impact Statement (EIS) must be prepared.

SNL/NV's NEPA Program, overseen by SNL/NM, provides technical guidance for comprehensive compliance with NEPA and associated acts including the Cultural Resources Act, the Endangered Species Act (ESA), and other related resource protection laws. In fiscal year 1997 (FY97), the SNL/NV NEPA program was under the direction of DOE Nevada Operations Office (DOE/NV). Since the beginning of FY98 (October 1, 1997) the NEPA program has been under the direction of DOE/KAO.

Activities at SNL/NV were included in the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of*

Nevada (DOE 1996). In CY97, four Environmental Checklist/Action Description Memorandums (ECL/ADMs) were submitted to DOE/NV for NEPA determination, as follows:

- **SNT 97-004: Tri-Lab/DSWA B52 Bomb Bay Fire Test** – The DOE/NV NEPA compliance officer did not return a NEPA determination for the proposal, requesting additional information as the project plan was developed. The description of the proposed action was revised, and the project was resubmitted to DOE/KAO in 1998. A NEPA determination was not received as of May 1998.
- **SNT 97-002: B83 Joint Test Assembly (JTA) Testing** – This proposal was determined by the DOE/NV NEPA compliance officer to be within the scope of activities analyzed in the EIS and associated Record of Decision (ROD).
- **SNT 97-003: B61 Joint Test Assembly (JTA) Testing** – This proposal was determined by the DOE/NV NEPA compliance officer to be within the scope of activities analyzed in the EIS and associated ROD.
- **SNT-97-001 MLRS Elliptical Warhead Tests** – This proposal was determined by the DOE/NV NEPA compliance officer to be within the scope of the EIS and associated ROD.

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2.10 ENDANGERED SPECIES ACT (ESA)

ESA applies to both private individuals and federal agencies. Section 9 of ESA makes it illegal for any person to "take" any endangered species of fish or wildlife. "Take" means to harass, harm, pursue, shoot, hurt, kill, capture, or collect—and includes interfering with habitat.

Section 7 applies only to federal agencies, which must ensure that any action authorized, funded, or carried out by them will not jeopardize the continued existence of a threatened or endangered species, or result in adverse modifications of its habitat. If significant impacts to sensitive species or habitat may result from the proposed action, an EA or an EIS will be prepared.

The final EIS discusses biological resources, (DOE 1996). As of 1996, no federal threatened, endangered, or candidate plant or animal species were known to occur at TTR. Bald eagles and peregrine falcons, however, may be rare migrants at the site. The western burrowing owl, a state-protected species, is known to occur on TTR.

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2.11 CULTURAL RESOURCES ACTS

Federal cultural resources management responsibilities, including those applicable under the National Historic Preservation Act (NHPA), the Archaeological Resources Protection Act (ARPA), and the American Indian Religious Freedom Act (AIRFA), are applicable at TTR. DOE/KAO integrates cultural resources management into its NEPA program.

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2.12 EXECUTIVE ORDERS (EOs)

EO 11988, *Floodplain Management*, and EO 11990, *Protection of Wetlands*, require evaluation of the potential effects of actions taken in these environmentally sensitive areas. However, there are no floodplains or significant wetlands at TTR. There are, however, some

very limited wetlands in the vicinity of several springs, which provide an important source of drinking water for animals in the area. SNL/NV complies with all applicable mandates stated in the EOs.

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2.13 1997 AUDITS

Table 2-2 lists audits and inspections made by agencies external to SNL/NV in 1997. Only minor observations were noted in all cases. There were no State of Nevada audits or inspections conducted in 1997.

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2.14 1997 ISSUES AND ACTIONS FOR TTR

Ongoing self-assessments of SNL's compliance status continue to identify compliance issues. Resolution of these issues is coordinated with regulatory agencies to ensure that they are adequately addressed. The following sections highlight current issues of concern or interest at TTR.

Federal Facility Agreement and Consent Order (FFACO) Compliance for

Environmental Restoration (ER) Activities

An ongoing action started in 1996 is the FFACO with the State of Nevada. This agreement was implemented in May 1996 between the State of Nevada, the DOE, and the Department of Defense (DoD) (DoD/DOE 1996). All DOE cleanup activities in the State of Nevada must be conducted in conformance with the requirements of this agreement. The FFACO is an enforceable agreement with stipulated penalties for violations. The ER sites for which DOE has assumed responsibility, and which are subject to this agreement, include the Nevada Test Site

(NTS), parts of the TTR, sections of the Nellis Air Force Range (NAFR), the Central Nevada Test Area, and the Project School Area.

A summary of DOE's ER sites in Nevada can be found in the FFACO report (DoD/DOE 1996). The list of sites has been modified for consistency with Nevada Department of Environmental Protection (NDEP) requirements and grouped into Corrective Action Units (CAUs) and listed by Corrective Action Site (CAS) numbers. Each CAU is listed in the FFACO under Appendices II (inactive CAUs) and III (active CAUs). Table 3-1 gives a listing of ER sites located at TTR.

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2.15 ENVIRONMENTAL PERMITS

The permit application and registration of SNL/NV activities at TTR are issued directly by the State of Nevada to either DOE/NV or DOE/KAO and administered by KMI Services. SNL/NV and KMI Services ensure all permit conditions are followed. Permits and registrations in effect in 1997 are listed in table 2-3. TTR was in full compliance with all permit requirements for 1997.

TABLE 2-2. Summary of Environmental Audits Performed at TTR in 1997

Audit Title	Duration	Results Summary
RCRA Hazardous Waste Inspection	May 7-8 1997	There were no violations. There were some minor recommendations.
Water Distribution System Vulnerability Assessment (State of Nevada)	May 21, 1996*	There were no violations. A formal report was returned to DOE on Oct 21, 97.
Annual Spill Prevention Control & Countermeasures (SPCC) Inspection	May 21, 1997	There were no violations. There were some minor recommendations.

NOTE: *The 1996 audit is included here because the formal report on the results was not submitted until 1997.

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2.16 OCCURRENCE REPORTING

There was only one environmental occurrence in 1997 as follows:

Diesel fuel Spill – On April 3, 1997, a fuel spill was discovered at the generator station at Antelope Peak. Approximately 20 gal of diesel fuel leaked from the generators built-in fuel

tank. The area near the spill is mostly rock outcrop with very little interstitial soil filling. Initial clean-up efforts removed as much soil and rock as was possible using manual means. Sampling results indicated contamination levels within the excavation were above the regulatory threshold level of 100 mg/kg total petroleum hydrocarbon (TPH). Additional remediation efforts continued with a hoe-ram until further excavation became impractical. An administrative “closure in place” was requested in September 1997 (Blejwas 1997).

TABLE 2-3. Summary of Permit Ownership at TTR

Permit Type and Location	Permit Number	Issue Date	Expiration Date	Comments
Air Quality Permits				
Surface Area Disturbance (General Air Operation Permit)	AP9711-0549	4/4/97	4/4/2002	CS-II ER Project
Site Specific Permit Attachment to AP9411-0549	1574	6/30/97	(see above)*	CS-II ER Project, Permit to operate 15 emission units
2 Emission Units (Air Quality Operation Permit)	AP9611-0680	6/12/96	6/12/2001	1 3x5 Screening Plant 1 7x7 Screening Plant
Open Burn	97-70	1/1/98	12/31/98	B52 burn
RCRA - Hazardous Waste				
SNL/EPA Generator ID No.	NV1890011991			State of NV
Beneficial Use Water Permits				
Well EH-2 (Groundwater appropriation)	50166	7/12/95	Indefinite**	State of NV
Well I EH-7 (Groundwater appropriation)	50168	3/9/95	Indefinite**	State of NV
Well BLM (Groundwater appropriation)	56916	3/9/95	Indefinite**	State of NV
Well 3B (Groundwater appropriation)	58149	2/23/96	Indefinite**	State of NV
Well 3A (Groundwater appropriation)	58150	2/23/96	Indefinite**	State of NV

NOTE: * None stated since this is an attachment to AP9411-0549.

** Once the permit has been issued, the permit is good as long as the permit conditions are met.

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ENVIRONMENTAL PROGRAMS INFORMATION

Environmental programs are in place at TTR to meet compliance with state and federal regulations, Executive Orders, and DOE orders. Programs and activities discussed in this chapter include the Environmental Restoration (ER) Project, the Waste Management Program, National Environmental Policy Act (NEPA) compliance activities, environmental audit results, and environmental occurrences. Chapters 4 and 5 of this report discuss the Environmental Surveillance Program, water quality programs, and air quality programs.

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3.1 ENVIRONMENTAL RESTORATION (ER) ACTIVITIES

ER Project

The ER Project began in the late 1980s to address contamination resulting primarily from nuclear weapons testing and related support activities. In late 1992 and early 1993, an agreement was reached between DOE Headquarters (DOE/HQ), DOE Albuquerque Operations Office (DOE/AL), and DOE Nevada Operations Office (DOE/NV) regarding the management of ER activities at TTR. The outcome of the agreement was that DOE/NV would manage ER Project activities at TTR.

Since 1996, cleanup activities for sites located in the state of Nevada have been regulated by the *Federal Facility Agreement and Consent Order* (FFACO). The FFACO was negotiated among

DOE/NV, the Nevada Division of Environmental Protection (NDEP), and the Department of Defense (DoD). The FFACO took effect on May 10, 1996 and has accomplished the following:

- Established a framework for identifying Corrective Action Sites (CASs)
- Grouped CASs into Corrective Action Units (CAUs)
- Prioritized the CAUs
- Implemented corrective action activities

CAUs located at TTR are addressed by two DOE/NV ER Division subprojects. Sites used to support nuclear testing activities are under the "Industrial Sites Subproject," and those sites where tests resulted in extensive surface and/or shallow subsurface contamination are under the "Soil Sites Subproject." Contamination present includes both radiological and hazardous constituents: radiological contamination includes depleted uranium (DU) and plutonium; Hazardous contamination includes artillery, solvents, septic sludges, and heavy metals.

CAS Identification

The initial identification, description, and listing of CASs at TTR were derived from the Preliminary Assessment (PA) and the *Federal Facility Preliminary Assessment Review* (E&E 1989). In 1993, the potential TTR CASs identified in the PA were subdivided into four "Soil Sites CAUs" and 43 "Industrial Sites CAUs." Twelve additional potential CASs not included in the PA were also identified. These CASs were identified through (1) the ER Sites Inventory process, (2) ordnance removal activities, (3) geophysical surveys, (4) former

worker interviews, (5) archive reviews, (6) site visits, and (7) aerial radiological and multispectral surveys (1993 to 1996).

Table 3-1 summarizes the existing Industrial and Soil Sites CAUs and CASs at the TTR. The ER activities planned for these CASs range from "no activities currently planned" to "NDEP-approved closure." The CAS information presented in table 3-1 is contained in Appendices II, III, and IV of the FFAO (DoD/DOE 1996).

Table 3-2 summarizes the 1997 DOE/NV ER activities related to both the Industrial and Soil Sites CAUs/CASs at TTR.

Air Monitoring at ER sites

Remediation activities were conducted at Clean Slate I in 1997. The Desert Research Institute (DRI) collected air monitoring data from several locations in the vicinity of Clean Slate I before, during, and after remediation activities. While these data have been validated, they have only been presented to DOE/NV in draft reports. A final report has not yet been issued.

Underground Storage Tanks (USTs)

The last USTs at TTR were removed and closed out with the NDEP in 1995.

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3.2 SPILL PREVENTION CONTROL AND COUNTERMEASURES PLAN

The *Oil Spill Prevention Control and Countermeasures (SPCC) Plan* (CDM 1995) was completely implemented in 1995. This plan was prepared in accordance with 40 CFR 112, "Oil Pollution Prevention."

Additionally, there are 11 above-ground storage tanks (ASTs) applicable to the SPCC Plan at TTR. Minor maintenance on some of the facilities was recommended and documented in

the annual SPCC inspection report dated June 3, 1997.

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3.3 WASTE MANAGEMENT PROGRAMS

The Waste Management Program at TTR encompasses the management of active and standby facilities and the treatment, storage, and disposal of radioactive, Resource Conservation and Recovery Act (RCRA)-regulated hazardous waste, other chemical waste, and non-hazardous solid waste. Waste minimization and recycling efforts are a part of the program activities.

Chemical and Hazardous Waste Management

All regulated chemical wastes generated by SNL/NV activities at TTR during 1997 were managed by KMI Services. KMI Services has 14 personnel certified with 40-hour Hazardous Waste Operations and Emergency Response training who also perform hazardous waste sampling, as required. KMI trained staff are used to use local personnel in environmental cleanup and restoration activities. The following categories list amounts of hazardous and chemical waste generated and shipped offsite at TTR in 1997:

Waste Type	Weight
RCRA-regulated	3,426 kg
Non-RCRA regulated	425,797 kg
Recyclables (hazardous/toxic)	7,462 kg
ER Waste	466 tons

All regulated waste was disposed of offsite at permitted treatment storage and disposal facilities (TSDFs). The ER waste consisted of petroleum-contaminated soil. Table 3-3 shows a detailed breakdown of the RCRA waste categories and quantities. Table 3-4 lists regulated non-RCRA waste categories and quantities. Table 3-5 lists waste categories transported offsite for recycling or alternative fuel use. A *Biannual Hazardous Waste Generation Report* is prepared by KMI Services and submitted to the EPA through DOE/NV (DOE 1998).

TABLE 3-1. DOE/NV Environmental Restoration (ER) Project TTR Corrective Action Units (CAUs) and Corrective Action Sites (CASs) (Continues)

Industrial Sites CAUs/CASs		
CAS Number	CAS Description	General Location
CAU-400 - Closed Bomblet Pit and Five Points Landfill, TTR		
TA-19-001-05PT	Ordnance Disposal Pit	Five Points Intersection
TA-55-001-TAB2	Ordnance Disposal Pit	Bunker 2 Road
CAU-401 - Closed Area 3 Gas Station UST Site, TTR		
03-02-003-0357	UST, Gas	First Gas Station, Area 3
CAU-402 - Closed Area 3 Building 0353 UST Site, TTR		
03-02-001-0353	UST, Diesel	Bldg. 0353
CAU-403 - Closed Area 3 Second Gas Station UST, TTR		
03-02-004-0360	USTs	Second Gas Station
CAU-404 - Closed Roller Coaster Lagoons and Trench, TTR		
TA-03-001-TARC	Roller Coaster Lagoons	NW of Antelope Lake
TA-21-001-TARC	Roller Coaster North Disposal Trench	NW of Antelope Lake
CAU-405 Area 3 Septic Systems, TTR		
03-05-002-SW03	Septic Waste System	Area 3
03-05-002-SW04	Septic Waste System	Area 3
03-05-002-SW07	Septic Waste System	Area 3
CAU-406 Areas 3, 9, Bldg. 0374 and UPS UDPs, TTR		
03-51-002-0374	Heavy Duty Shop UDP, Sumps	Bldg. 0374
03-51-003-0358	UPS Building UDP	UPS Building, Area 3
CAU-407 Roller Coaster Rad Safe Area, TTR		
TA-23-001-TARC	Roller Coaster Rad Safe Area	Northwest of Antelope Lake
CAU-408 Bomblet Target Area, TTR		
TA-55-002-TAB2	Bomblet Target Areas	Antelope Lake
CAU-409 Other Waste Sites, TTR		
03-56-001-03BA	Fire Training Area	Area 3
03-58-001-03FN	Sandia Service Yard	Area 3
09-54-001-09L2	Gun Propellant Burn Area	Area 9
RG-24-001-RGCR	Battery Dump Site	Cactus Repeater
TA-53-001-TAB2	Septic Sludge Disposal Pit	Bunker 2
TA-53-002-TAB2	Septic Sludge Disposal Pit	Bunker 2

NOTE: DOE/ERD = Department of Energy/Environmental Restoration Division
 CAU = Corrective Action Unit
 CAS = Corrective Action Site
 UDP = underground discharge point
 UST = underground storage tank

Source: Dod/DOE 1996

TABLE 3-1. DOE/NV Environmental Restoration Project (ER) TTR Corrective Action Units (CAUs) and Corrective Action Sites (CASs) (Continues)

Industrial Sites CAUs/CASs		
CAS Number	CAS Description	General Location
CAU-410		
Area 9 Underground Vault and Disposal Trench, TTR		
09-21-001-09MG	Disposal Trench	East of Area 9 Magazines
09-21-001-TA09	Disposal Trenches	Area 9
CAU-423		
Area 3 UDP, Bldg. 0360, TTR		
03-02-002-0308	UDP	Bldg. 0360
CAU-424		
Area 3 Landfill Complex, TTR		
03-08-001-A301	Landfill Cell A3-1	Area 3 Landfill Complex
03-08-002-A302	Landfill Cell A3-2	Area 3 Landfill Complex
03-08-003-A303	Landfill Cell A3-3	Area 3 Landfill Complex
03-08-004-A304	Landfill Cell A3-4	Area 3 Landfill Complex
03-08-005-A305	Landfill Cell A3-5	Area 3 Landfill Complex
03-08-006-A306	Landfill Cell A3-6	Area 3 Landfill Complex
03-08-007-A307	Landfill Cell A3-7	Area 3 Landfill Complex
03-08-008-A308	Landfill Cell A3-8	Area 3 Landfill Complex
CAU-425		
Area 9 Main Lake Construction Debris Disposal Area, TTR		
09-08-001-TA09	Construction Debris Disposal Area	Area 9/Main Lake
CAU-426		
Cactus Spring Waste Trenches, TTR		
RG-23-001-RGCS	Waste Trenches	Cactus Spring Ranch
CAU-427		
Area 3 Septic Waste Systems 2, 6, TTR		
03-05-003-SW02	Septic Waste System No. 2	Area 3
03-05-007-SW06	Septic Waste System No. 6	Area 3
CAU-428		
Area 3 Septic Waste Systems 1, 5, TTR		
03-05-002-SW01	Septic Waste System No. 1	Area 3
03-05-006-SW05	Septic Waste System No. 5	Area 3
CAU-429		
Area 3, 9 Photo Processing UDPs, TTR		
03-51-001-0355	Photo Shop UDP, Drains	Photo Shop Area 3
09-51-001-0952	Mobile Photographic Lab UDPs	Area 9
CAU-430		
Closed Buried DU Artillery Round #1, TTR		
TA-55-003-0960	DU Artillery Round	South of Area 9

NOTE: DOE/ERD = Department of Energy/Environmental Restoration Division
 CAU = Corrective Action Unit
 CAS = Corrective Action Site
 DU = depleted uranium
 UDP = underground discharge points

Source: DoD/DOE 1996

TABLE 3-1. DOE/NV Environmental Restoration Project (ER) TTR Corrective Action Units (CAUs) and Corrective Action Sites (CASs) (Continues)

Industrial Sites CAUs/CASs		
CAS Number	CAS Description	General Location
CAU-453 Area 9 UXO Landfill, TTR		
09-55-001-0952	Area 9 Landfill	Area 9
CAU-461 Test Area JTA Sites, TTR		
TA-52-002-TAML	DU Impact Site	Main Lake
TA-52-003-0960	DU Artillery Round #2	South of Area 9
TTR-001	1987 W-79 JTA	Unknown – South of Area 9
CAU-484 Antelope and NEDS Lakes Waste Sites, TTR		
TA-52-001-TANL	NEDS Detonation Area	NEDS Lake
TA-52-004-TAAL	Metal Particle Dispersion Test	Antelope Lake
TA-52-005-TAAL	Joint Test Assembly DU Sites	Antelope Lake
CAU-485 Cactus Spring Ranch Pu and DU Site, TTR		
TA-39-001-TAGR	Cactus Spring Ranch, Soil Contamination	West of Target Areas
CAU-486 Double Tracks Rad Safe Area, Nellis Range 71 North		
71-23-001-71DT	Double Tracks Rad Safe Area	Nellis Range 71 North
CAU-487 Thunderwell Site, TTR		
RG-26-001-RGRV	Thunderwell Site	Thunderwell Site
CAU-488 Davis Gun Site, TTR		
RG-52-007-TAML	Davis Gun Penetrator Test	Test Range
CAU-489 WWII UXO Sites, TTR		
RG-55-001-RGMN	WWII Ordnance Site	Mellan Range
RG-55-002-RGHS	WWII Ordnance Site	H-Site Road
RG-55-003-RG36	WWII Ordnance Site	Gate 36E
CAU-490 Station 44 Burn Area, TTR		
RG-56-001-RGBA	Station 44 Burn Area	Station 44
CAU-491 Bunker 2 Debris Mound and NEDS Trench, TTR		
TA-19-002-TAB2	Debris Mound	Bunker 2
TA-21-003-TANL	Disposal Trench	NEDS Lake

NOTE: CAU = Corrective Action Unit
CAS = Corrective Action Site
DOE/ERD = Department of Energy/Environmental Restoration Division
JTA = Joint Test Assembly
NEDS = Non-Explosive Destruction Site
UXO = unexploded ordnance

Source: DoD/DOE 1996

TABLE 3-1. DOE/NV Environmental Restoration Project (ER) TTR Corrective Action Units (CAUs) and Corrective Action Sites (CASs) (Concluded)

Industrial Sites CAUs/CASs		
CAS Number	CAS Description	General Location
CAU-492 South Antelope Lake Disposal Trench, TTR		
TA-21-002-TAAL	Disposal Trench	South Antelope Lake
CAU-493 Colimbo Detonation Site, TTR		
TA-52-006-TAPL	DU Site	Colimbo Detonation Area – NEDS Lake
CAU-494 Rocket Propellant Burn Area, TTR		
TA-54-001-TANL	Rocket Propellant Burn Area	NEDS Lake
CAU-495 Unconfirmed JTA Sites, TTR		
TA-55-006-09SE	Buried Artillery Round	Test Area
TA-55-007-09SE	Buried Artillery Round	Test Area
CAU-496 Buried Rocket Site, TTR		
TA-55-008-TAAL	Buried Rocket	Antelope Lake
Soil Sites CAUs/CASs:		
CAU-412 Double Tracks Plutonium Dispersion, Nellis		
NAFR-23-01	Pu Contaminated Soil	Double Tracks
CAU-412 Clean Slate 1 Plutonium Dispersion, TTR		
TA-23-01CS	Pu Contaminated Soil	Clean Slates I
CAU-413 Clean Slate 2 Plutonium Dispersion, TTR		
TA-23-02CS	Pu Contaminated Soil	Clean Slates II
CAU-414 Clean Slate 3 Plutonium Dispersion, TTR		
TA-23-03CS	Pu Contaminated Soil	Clean Slates III

NOTE: CAU = Corrective Action Unit
CAS = Corrective Action Site
DOE/ERD = Department of Energy/Environmental Restoration Division
DU = depleted uranium

Source: DoD/DOE 1996

TABLE 3-2. Summary of 1997 Industrial and Soil Sites DOE/NV Environmental Restoration (ER) Activities (Continues) *All activities are related to TTR CAUs.*

1997 Activities at Industrial and Soil Sites	Type	CAU Number (if applicable)
Industrial Sites Activities:		
<ul style="list-style-type: none"> Prepared, submitted, and received NDEP approval on final CAIPs for the Area 3 Landfill Complex, Area 9 UXO Landfill, Septic Waste Systems 2 and 6, and Building 0360 UDP. 	Plan	CAU 424 CAU 453 CAU 427 CAU 423
<ul style="list-style-type: none"> Planned, approved, and completed pre-CAI field activities at the Bldg. 0360 UDP involving an interior survey of the pipe feeding the UDP. 	Pre-CAI Field Activities	CAU 423
<ul style="list-style-type: none"> Planned, approved, and completed pre-CAI field activities at the Area 9 UXO Landfill involving surface seismic and subsurface geophysical surveys. 	Pre-CAI Field Activities	CAU 453
<ul style="list-style-type: none"> Planned, approved, and completed CAI field activities at the Area 3 Landfill Complex, Septic Waste Systems 2 and 6, and Area 9 UXO Landfill. 	CAI Field Activities	CAU 424 CAU 453 CAU 427
<ul style="list-style-type: none"> Planned, approved, and completed additional CAI field activities at the Second Gas Station. 	CAI Field Activities	CAU 403
<ul style="list-style-type: none"> Prepared, submitted, and received NDEP approval of final, Rev. 2, CADD for Second Gas Station. 	Decision Document	CAU 403
<ul style="list-style-type: none"> Prepared and submitted draft CADD for the Area 3 Landfill Complex. 	Decision Document	CAU 424
<ul style="list-style-type: none"> Prepared, submitted, and received NDEP approval on draft and final CADDs for the Cactus Spring Waste Trenches and Roller Coaster Sewage Lagoons and North Disposal Trenches CAUs. 	Decision Document	CAU 426 CAU 404
<ul style="list-style-type: none"> Prepared, submitted, and received NDEP approval on draft and final CAPs for the Cactus Spring Waste Trenches and Roller Coaster Sewage Lagoons and North Disposal Trench CAUs. 	Closure Plan	CAU 426 CAU 404
<ul style="list-style-type: none"> Engineered-cap constructed over the trenches at the Cactus Spring Waste Trenches CAU. Completed revegetation of site. 	Closure Activity	CAU 426
<ul style="list-style-type: none"> Regraded disposal trench and placed an engineered cap over sewage lagoons at the Roller Coaster Sewage Lagoons and North Disposal Trench CAU. Completed revegetation of site. 	Closure Activity	CAU 404

NOTE: CADD = Corrective Action Decision Document
 CAI = Corrective Action Investigation
 CAIP = Corrective Action Investigation Plans
 NDEP = Nevada Department of Environmental Protection
 UDP = underground discharge point
 UXO = unexploded ordnance

TABLE 3-2. Summary of 1997 Industrial and Soil Sites DOE/NV Environmental Restoration (ER) Activities (Continued) *All activities are related to TTR CAUs.*

1997 Activities at Industrial and Soil Sites	Type	CAU Number (if applicable)
Industrial Sites Activities continued:		
• Prepared, submitted, and received NDEP approval on Final Closure Report for Buried DU Round # 1.	Closure Report	CAU 430
• Received Notice of Completion from NDEP for the Buried DU Round # 1.	Site Closure	CAU 430
• NDEP approved Clean Closure of Bomblet Pit and Five Points Landfill.	Site Closure	CAU 400
• Conducted and completed Bomblet Pit and Five Points Landfill regrading and revegetation.	Closure Activity	CAU 400
• NDEP approved continuing efforts to locate Buried DU Round No. 1 under a new CAS and an existing CAU. New site identification is 1987 W-79 JTA, CAS TTR-001, under CAU 461.	FFACO Activity	CAU 461
• NDEP approved proposed transfers of CASs from existing CAUs 407 and 410 into newly created CAUs 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, and 496.	FFACO Activity	CAU 407, CAU 410 CAU 484, CAU 485 CAU 486, CAU 487 CAU 488, CAU 489 CAU 490, CAU 491 CAU 492, CAU 494 CAU 493, CAU 495 CAU 496
• Prepared and submitted language for a land-use restriction statement to accompany DOE CAU-closures requiring land-use restrictions.	FFACO Activity, Pre-closure Activity	General
Soil Sites Activities:		
• Submitted Closure Report for Double Tracks.	Closure Report	CAU 411
• Prepared, submitted, and received NDEP approval on draft and final CAIP for Clean Slates 1, 2, and 3.	Plan	CAU 412 CAU 413 CAU 414
• Planned, conducted, and completed CAI field activities at Clean Slates 1.	CAI Field Activities	CAU 412
• Prepared, submitted, and received NDEP approval on draft and final CADD for Clean Slates 1.	Decision Document	CAU 412
• Prepared, submitted, and received NDEP approval on draft and final CAP for Clean Slates 1.	Closure Plan	CAU 412
• Delayed activities at Double Tracks and Clean Slates 1, 2, and 3 due to time needed to develop soil cleanup levels acceptable to all affected organizations. These CAUs were moved from FFACO Appendix III (Active Sites) to FFACO Appendix II (Inactive Sites).	FFACO Activity	CAU 411 CAU 412 CAU 413 CAU 414

NOTE: CADD = Corrective Action Decision Document
CAU = Corrective Action Unit
CAS = Corrective Action Site
DU = depleted uranium
NDEP = Nevada Department of Environmental Protection

TABLE 3-3. RCRA-Regulated Hazardous Waste Shipped Offsite in 1997

RCRA Waste Shipping Name	Waste Codes	Weight (kg)
Waste paint related material	D001, D035, F003, F005, D008	256
Waste paint related material	D001, F003, F005	93
Hazardous waste solid, NOS, (rags with acetone, mek)	D035, F003, F005	20
Hazardous waste solid, NOS, (rags with methylene chloride)	F002	537
Hazardous waste liquid, NOS, (ethylene glycol, with benzene, lead)	D008, D018	38
Waste compressed gasses, flammable, N.O.S., (diethyl ether)	D001, U117	37
Waste aerosols, flammable	D001	313
Waste flammable liquid, NOS (ethanol, turpentine)	D001, U002	98
Waste flammable liquid, NOS, (Methanol, Isopropanol)	D001, D035, U002, U220, U154	116
Waste flammable liquid, NOS, (petroleum distillates)	D001	198
Hazardous waste solid, NOS (soil, methyl ethyl ketone)	F005	61
Waste compressed gases, NOS, (freon, polymeric isocyanate)	D001	196
Waste mercury contained in manufactured articles (mercury vapor lamps)	D009	18
Waste batteries dry (containing potassium hydroxide, nickel-cadmium batteries)	D006	19
Waste gasoline	D001, D018	198
Waste diesel fuel	D001, D018	616
Hazardous waste liquid, NOS, (lead, water)	D008	18
Waste corrosive liquid, basic, organic, NOS, (N-alkyl dimethyl benzyl ammonium chloride)	D002	331
Waste corrosive liquid, basic, inorganic NOS, (sodium hydroxide)	D002	198
Waste corrosive liquid, acidic, inorganic NOS (acetic acid, hydroquinone)	D002	65
TOTAL		3,426 kg

NOTE: NOS = not otherwise specified

TABLE 3-4. Non-RCRA-Regulated Hazardous or Toxic Waste Shipped Offsite in 1997

Non-RCRA Waste	Weight (kg)
Sealed capacitor possible PCB (TSCA)	1
Possible asbestos containing material (TSCA)	73
Batteries non-regulated alkaline	454
Petroleum contaminated soil, rags, filters, etc.	424,969
Toxic liquid, organic, NOS, (diazinon, pyrethrins)	22
Compressed gases, NOS, (halon)	173
Non-RCRA solid (calcium sulfate)	105
TOTAL	425,797

NOTE: NOS = not otherwise specified
PCB = polychlorinated biphenyls
TSCA = Toxic Substance Control Act

TABLE 3-5. Regulated Hazardous or Toxic Waste Shipped Offsite in 1997 for Recycling

Recycled Material	Weight (kg)
Used oil	2,810
Safety Kleen solvent (petroleum naphtha)	789
Safety Kleen immersion cleaner (monoethanolamine)	90
Fluorescent light bulbs	258
Automotive/equipment lead acid batteries	3,515
TOTAL	7,462

Waste Minimization Program

TTR is committed to achieving significant reductions in the amount of both RCRA-regulated and other hazardous wastes generated onsite. To implement this goal, an informal waste minimization program is practiced at TTR. A formal program will be implemented when changes to the existing waste disposal contract are made in 1998. Waste minimization includes recycling and recovery of the following materials:

- Solvents
- Fuels
- Oil
- Antifreeze (onsite recycling unit)
- Lead acid batteries
- Freon (onsite recovery unit)
- Fluorescent and sodium bulbs
- Mercury-containing equipment

Radioactive Waste Management

SNL/NV did not generate any radioactive waste in 1997. Table 3-6 describes waste types and containers currently being stored onsite at SNL's Radioactive Waste Connex located in Area 9. The IT Connex is located adjacent to the SNL Connex and contains the ER radioactive waste. Most radioactive waste in storage is contaminated soils generated from ER remediation. There is also some legacy waste stored at the Connexes. Legacy waste is radioactive waste that is awaiting characterization. At present, there is no known mixed waste (MW) in storage at TTR.

3.4 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) PROGRAM

NEPA Activities at TTR

At TTR, NEPA compliance is a joint effort by SNL/NV, DOE/NV and the Water Resources Center at the Desert Research Institute (DRI), through the University of Nevada System. DRI prepares archaeological and biological surveys and reports. Final reports are submitted to

SNL/NV and DOE/NV for transmittal to the State of Nevada, State Historic Preservation Office (SHPO) for review and decision making.

An Environmental Impact Statement (EIS) that included the TTR site was completed in 1996; the DOE Record of Decision (ROD) was December 9, 1996 (DOE 1996).

3.5 ENVIRONMENTAL MONITORING PROGRAMS AT OR AROUND TTR PERFORMED BY NON-SNL AGENCIES

In addition to SNL, other agencies and contractors perform environmental monitoring activities at TTR as follows:

- *Environmental Protection Agency (EPA)* – The EPA Environmental Monitoring Systems Laboratory in Las Vegas, Nevada, under an interagency agreement with DOE, monitors background radiation in the vicinities of TTR as part of its Offsite Radiation Monitoring Program. Reports are available through the EPA upon request. Two major EPA reports are as follows:

Offsite Monitoring Report: Nevada Test Site and Other Test Areas, Quarterly Report, EPA, Dose Assessment Branch, Nuclear Radiation Assessment Division.

Offsite Environmental Monitoring Report: Radiation Monitoring Around United States Nuclear Test Areas, Calendar Year 1996 (EPA 1997). This report is also published as part of the NTS Annual Site Environmental Report (ASER).

The EPA also prepares reports relative to NAFR activities that may include information on TTR. These reports, described in Volumes 1 through 4 of the *1992 Environmental Monitoring Report, Tonopah Test Range, Tonopah, Nevada* (SNL 1993), are available from the EPA upon request.

TABLE 3-6. Categories of Radioactive Waste Stored Onsite at TTR in 1997 at the Waste Connex in Area 9

Container	Isotope	Contents	Comments
Visquene wrap	Ra-226	Wind radar mount	Contains the Ra-226 system that broke and contaminated two trailers
Visquene wrap	Ra-226	Cut section of contaminated trailer	End section from large original wind radar trailer
Visquene wrap	Ra-226	Cut section of contaminated trailer	Cut section from small wind radar trailer
Steel drum 55 gal	U-238	Drum #291-02	Soil and DU
Steel drum 55 gal	U-238	Drum #889-01	Soil and DU
Steel drum 55 gal	U-238	Drum #691-06	Soil and DU
Steel drum 55 gal	U-238	Drum #591-05	Soil and DU
Steel drum 55 gal	U-238	Drum #4M91-04M	Soil and DU
Steel drum 55 gal	U-238	Drum #391-03	Soil and DU
Steel drum 55 gal	U-238	Drum #791-07	Soil and DU
Steel drum 55 gal	U-238	Drum #191-01	Soil and DU
Steel drum 55 gal	U-238	Drum #992-01	Contaminated coveralls/cleaning materials
Steel drum 10 gal	H3 (suspected)	Drum #2	Contents not positively identified
Steel drum 10 gal	H3		Static guns #1347, #1359
Steel drum 15 gal	Pb-210, Cs-137, Co-60, H-3		Check sources and static guns
Steel drum 15 gal	Ra-226		Radium dials/switches
Steel drum 5 gal	U-238	Contaminated soil	Soil removed from Main Lake near Hard Target to allow for test object recovery
Original case	Ra-226	Radium dial	Excess altimeter equipment
N/A	Thorium		Optic system containing thorium (undamaged)
Cardboard box	(Unknown)		Microwave tubes

NOTE: DU = depleted uranium N/A= not available

- **DRI, University of Nevada System** – The DRI trains and provides monitoring station managers (generally they are local science teachers) to run the EPA monitoring equipment set up at locations within the local community including the towns of Tonopah and Goldfield. The EPA laboratory in Las Vegas, Nevada provides the equipment and performs the analysis and reporting.

DRI also provides external quality assurance (QA) on field measurements taken by the EPA at these community-monitoring stations. DRI monitors selected locations concurrently using a portable monitoring

station (PMS) and thermoluminescent dosimeters (TLDs). DRI prepares an annual report comparing its data with EPA's results and is published as the *Community Radiation Monitoring Program Annual Report* (DRI 1997).

DRI also performs other monitoring—primarily hydrological—for the DOE as requested. This may include evaluating environmental impacts due to range construction projects.

- **Kirk Mayer, Inc. (KMI) Services** – As part of its TTR support activities, KMI Services personnel perform environmental monitoring

activities for DOE and/or SNL when needed as follows:

- Drinking water and wastewater sampling
- National Emission Standards for Hazardous Air Pollutants (NESHAP) 40 CFR 61, Subpart H (radionuclides) air quality monitoring
- Soil sampling and site characterization of spill sites
- Waste sampling and characterization

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3.6 SUMMARY OF RELEASE REPORTING

The following four release reporting documents are required by organizations that are external to SNL/NM.

- *NESHAP Report for Radionuclides Other than Radon from Department of Energy Facilities (Subpart H) Annual Report* – NESHAP, 40 CFR 61, Subpart H, requires that an annual report be submitted from each DOE site where facility sources contribute a

public dose of over 0.1 mrem/yr. The NESHAP report must be submitted to the EPA by June 30th each year, following the reporting year. The report includes the calculated effective dose equivalent (EDE) in mrem/yr for the maximally exposed individual (MEI). Chapter 5 of this report summarizes results of the NESHAP dose assessment results for TTR presented in the annual NESHAP report for TTR (SNL 1998).

- *State of Nevada Reports* – The State of Nevada requires copies of each hazardous waste manifest that accompanies each waste shipment.
- *State of Nevada Extremely Hazardous Material Reporting Requirements* – This is not currently required since SNL/TTR does not use any extremely hazardous materials during its routine operations.
- *Quarterly Discharge Monitoring Reports (DMRs)* – DMRs are prepared and submitted by the USAF to the Nevada Department of Environmental Protection (NDEP). All analytical tested wastewater constituents were within acceptable regulatory limits in 1997.

4 TERRESTRIAL SURVEILLANCE AND WATER MONITORING

This chapter gives an overview of the environmental surveillance and water monitoring activities conducted at TTR by SNL. SNL routinely samples for radiological and/or nonradiological contaminants in the ambient terrestrial environment, in wastewater effluent, and in water supply wells. All sampling is conducted under the direction of SNL/NM's Environmental and Emergency Management Department.

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4.1 TERRESTRIAL SURVEILLANCE OBJECTIVES, SAMPLING SITE SELECTION, AND ANALYSIS METHOD

Environmental surveillance is conducted to detect release residues in the terrestrial environment from air deposition and storm water runoff. Currently, only soil samples and external gamma radiation data are collected. Surface water is not sampled due to the lack of available water (other than three remote springs). Any storm water that does runoff is quickly infiltrated to the ground and much is lost to evaporation (very little recharges to the groundwater) (DRI 1991).

Objectives

The overall objective of the Environmental Surveillance Program is to detect the migration of contaminants related to onsite operations and to determine the potential impact (if any) of SNL site-related activities to the population and the surrounding environment. Data collected is

used to determine the long-term environmental conditions and trends of the site.

Environmental monitoring at TTR by SNL began in 1992. Additional baseline-related sampling was performed in 1994 in areas where SNL has had a long-term or continued presence at TTR.

Sampling Locations

To support the objectives of the Environmental Surveillance Program, soil samples are collected in three distinct areas: offsite, site perimeter, and onsite.

Offsite locations provide a measurement of environmental conditions unaffected by SNL activities at TTR. Data collected at these locations serve as a reference point to compare data collected at perimeter and onsite locations. Offsite locations are shown in figure B-1 of Appendix B. All offsite samples are taken from publicly accessible areas.

Perimeter locations are used to monitor the site boundary for potential contamination migrating either on to or off of TTR. Perimeter locations are shown in figure B-2 of Appendix B.

Onsite locations are located near areas of known contamination, potential sources of contamination, or in areas where contamination, if present, would be expected to accumulate. Onsite locations are shown in figures B-3 to B-11 of Appendix B. All onsite and perimeter locations are in areas of uncontrolled access within TTR.

As part of the 1997 surveillance activities, a total of 54 locations were sampled. The number of samples collected at each area is shown in table 4-1.

Site Selection

Routine environmental surveillance locations remain essentially the same from year to year. Additional locations are added as necessary to monitor new operations or to supplement data from existing locations. The sampling locations, number of samples, and analyses performed are prioritized based on the following criteria:

- Contaminants believed to be present;
- Contamination considered readily dispersible by environmental factors (e.g., wind or rain); and
- Areas with the greatest potential for impact to the public, workers, and the environment.

Sample Collection and Analysis

Terrestrial surveillance was conducted at TTR by staff from the Environmental Surveillance Program in June of 1997.

In 1997, only radiological parameters were determined for terrestrial soil samples. Gamma

spectroscopy, uranium total (U_{tot}), and plutonium isotopic analysis (Pu-238 and Pu-239/240) was performed. Isotopic analysis was done if americium-241 was determined to be greater than the minimum detectable activity (MDA).

Nonradiological analysis of soil samples is not performed every year, and was last done in 1996. The next anticipated nonradiological soil sampling will be in 1998.

All samples were gathered in accordance with SNL's environmental sampling procedure. In cases of replicate sampling, only the first sample collected (sample -01) was used in summary calculations to avoid skewing summary data toward replicate sample data.

Individual sample results from onsite and site perimeter locations were compared to the upper 95 percent confidence limit of the offsite value. The 95 percent limit is based on the mean offsite value plus two standard deviations of all offsite samples collected. Individual onsite or perimeter samples with values greater than the upper 95 percent confidence interval and greater than the range of observed offsite values, were considered potentially contaminated. However, samples that had americium-241 or isotopic plutonium greater than their detection limit were automatically considered potentially contaminated since these radionuclides do not occur naturally in the environment.

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4.2 RADIOLOGICAL TERRESTRIAL SURVEILLANCE RESULTS

4.2.1 Soil Sampling Results

Sample locations for 1997 (Table 4-1) are depicted in figures B-1 through B-11 in Appendix B. Individual radiological sampling results from each sampling area are listed in corresponding tables B-1 through B-7. Results

TABLE 4-1. Sampling Locations at TTR

Number of Samples	Sampling Area
14	Offsite
5	Site perimeter
35	Onsite
5	On-Base Housing Area
6	South Plume Area
3	554th Range Squadron O&M Complex
6	Range Operations Center
2	- Storage Yard
2	- Compound
2	Near the Hard Target/Depleted Uranium Area (various onsite)
3	Mellan Hill Area (various onsite)
6	Various On-site Locations

of replicate sampling are summarized in table B-8.

Table 4-2 summarizes the results of all onsite, perimeter, and offsite sampling. A range of values is presented for all parameters sampled. Additionally, the offsite data is summarized with the mean and standard deviation of all sample values.

Gamma spectral analysis and U_{tot} was determined for all samples. Isotopic plutonium analysis is performed on samples where the concentration of Am-241 was greater than the analytical detection limit.

Offsite Soil Samples

Radiological results from the 14 offsite soil sampling locations were consistent with

previous years' results and are believed to represent the normal, expected range of values for these radionuclides in the soil (Figure B-1 and Table B-1).

The offsite distribution of sample concentrations serves as a reference to compare onsite samples. Due to the limited size of the offsite sampling (14) this comparison should not be considered as exact in the identification of potential contamination. Some onsite locations that appear to be marginally elevated above offsite concentrations may not be contaminated, but rather show the normal, expected, variation in sample concentration. This is believed to be the case for those onsite samples found to be slightly elevated in cesium-137 and U_{tot} .

TABLE 4-2. Radiological Summary Data for Soil Samples Collected at TTR in 1997

Location	Number of Samples	Number of Samples with Measurable Transuranics †			U_{tot} (ug/g)	Cs-137 (pCi/g)	Am-241 (pCi/g)	Pu-238 (pCi/g)	Pu-239/240 (pCi/g)
		Am-241	Pu-238	Pu-239, Pu-240					
Offsite									
- Range	14	0	0	2	2.0 to 3.5	0.08 to 0.95	ND	ND	0.06 to 0.06
- Mean					2.6	0.32			
- Standard Deviation					0.43	0.26			
Site Perimeter	5	0	0	0	2.1 to 2.6	0.13 to 0.70	ND	ND	ND
554th Range O&M	3	0	0	1	2.7 to 2.9	0.34 to 0.73	ND	ND	0.16
On-Base Housing	5	0	0	1	1.2 to 2.9	-0.07 to 0.26	ND	0.06	ND
Range Operations Center (6)	10	0	0	0	2.6 to 3.9	0.0 to 0.46	ND	ND	ND
South Plume Area	6	2	0	4	2.6 to 3.1	0.55 to 0.96	0.12 to 0.26	ND	1.2 to 7.1
Various Onsite Locations (6)	11	1	1	6	2.3 to 5.5	0.03 to 0.74	0.51	0.08	0.18 to 6.5

NOTE: ug/g = micrograms per gram.

pCi/g = picocurie per gram.

ND = Not detected or below the detection limit.

†Samples with measurable americium-241 (greater than detection limit) are considered potentially contaminated.

If americium-241 was detected in any sample, follow-up isotopic plutonium analysis was performed.

Onsite and Perimeter Soil Samples

Radiological results from onsite and perimeter soil sampling are divided among the following six areas:

- **Site Perimeter** – Five samples were collected from the TTR site perimeter (Figure B-2 and Table B-2). All cesium-137 and U_{tot} results were indistinguishable from offsite concentrations. Neither americium-241 nor plutonium-239/240 was detected in concentrations greater than their analytical detection limits.
- **On-Base Housing Area** – Five samples were collected near the TTR On-Base Housing Area (Figure B-3 and Table B-3). All cesium-137 and U_{tot} results were indistinguishable from offsite concentrations. Neither americium-241 nor plutonium-239/240 was detected in concentrations greater than their analytical detection limits. One location (T-37) was found to have plutonium-238 concentrations greater than the analytical detection limit.
- **South Plume Area** – Six samples were collected from the South Plume Area (Figures B-4 and Table B-4). All U_{tot} results were indistinguishable from offsite concentrations. Two locations (T-15 and T-18) contained elevated concentrations of cesium-137. Two sampling locations (T-15 and T-19) were found to contain americium-241 in concentrations greater than their analytical detection limit. Plutonium-238 was not detected in concentrations greater than its analytical detection limit. Four locations (T-15, T-16, T-18, and T-19) were found to have plutonium-239/240 in concentrations greater than the analytical detection limit. All four locations are located at the southern end of Clean Slate 1, an area known or suspected to be contaminated with radioactive material related to the Clean Slate site.
- **554th Range Squadron O&M Complex** – Three samples were collected from the area around the 554th Range Squadron O&M Complex (Figure B-5 and Table B-5). All cesium-137 and U_{tot} results were found to be indistinguishable from offsite concentrations. Neither americium-241 nor plutonium-238 was detected in concentrations greater than their analytical detection limits. One location (OM-03) was found to have an elevated concentration of plutonium-239/240. This location is approximately 1.3 miles west of the O&M Complex.
- **Range Operations Center** – Ten samples were collected from the area around the Range Operations Center (Figure B-6, B-7, B-8 and Table B-7). All cesium-137, americium-142, plutonium-238, and plutonium-239/240 results were found to be indistinguishable from offsite concentrations. One location (OC-20) at the northern end of the Range Operations Compound was found to have an elevated concentration of U_{tot} .
- **Various Onsite Locations** – Eleven samples were collected from various locations onsite (Figures B-9, B-10, and B-11 and Table B-7). All locations were found to be indistinguishable from offsite values for cesium-137. One location (T-20) was found to have an elevated concentration of U_{tot} . One location (D-01) was found to contain both americium-241 and plutonium-238 in concentrations greater than the analytical detection limit. Six samples (D-01, MH-03, MH-04, T-02, T-03, and T-04) were found to contain plutonium-239/240 concentrations greater than the analytical detection limit. Location D-01 is the site of the former Project Roller Coaster Decontamination Area. Locations MH-03, and MH-04 are located in the vicinity of Mellan Hill. Location T-02 is in the down wind of plume footprint of Clean Slate 1,

T-03 is near Clean Slate 2, and T-04 is in the down wind plume of Clean Slate 3.

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4.2.2 Thermoluminescent Dosimeter (TLD) Monitoring Results

In January 1994, SNL began an ambient gamma radiation monitoring program as part of the long-term, routine, Environmental Surveillance Program at TTR. TLDs measure external gamma exposure from both background (e.g., cosmic rays) and man-made sources (e.g., fallout and diffuse sources). Factors such as elevation and local geological deposits can effect TLD measurements. The nationwide average from all sources is 360 millirem per year (mrem/yr).

The TTR TLD network consists of five community (offsite), four perimeter, and 13 onsite locations. Table 4-3 summarizes the TLD measurements of annual radiation exposure. Table B-9 of Appendix B summarizes quarterly results.

Using the same criteria to identify potential locations of concern (offsite 95 percent confidence interval and range of offsite values), onsite TLD location T-13 appears to be elevated. T-13 is located at the northeast corner of the Operations Center perimeter fence. The annual exposure measured at this location was 218 ± 52 mrem/yr compared to an annual average offsite exposure of 135 ± 21 mrem/year. Soil sampling location OC-1 is located near T-13. Soil sampling results at this location do not indicate radionuclide contamination. Gamma surveys have been performed using hand held radiation survey equipment; the surveys found no unusual results. Reviews of the historic TLD data for T-13 shows that the elevated results do not occur every monitoring period but are more cyclic or intermittent in nature (Figure 4-1).

Pressurized ionization chambers (PICs) are used to provide more accurate measurements of gamma exposure than TLDs. A PIC was placed at T-13 in May 1997 and remained there for approximately one year. During this period, the PIC collected hourly exposure measurements. Results will be used in an attempt to better understand the elevated TLD readings at T-13. PIC data do not demonstrate extreme values in exposure at T-13. The explanation for the elevated TLD values is not known but will continue to be investigated. PIC data will be evaluated and summarized in the 1998 Annual Site Environmental Report (ASER) for the TTR.

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4.3 PERSPECTIVE ON PLUTONIUM DISTRIBUTION IN THE ENVIRONMENT

It is generally accepted that once plutonium comes in contact with soil in the environment, it becomes firmly attached to the host particle. Previous studies (Tamura 1974, 1975, 1976) of soil samples from safety-shot areas at the Nevada Test Site (NTS) showed plutonium particle-size association was primarily with coarse silts (50 to 20 microns [μm]) and fine sands (125 to 50 μm). The inhalation of finer sizes ($<7 \mu\text{m}$ diameter at a density of 1 gram per cubic centimeter [g/cm^3]) is considered most hazardous (Tamura 1976). However, the coarser soil particles should not be ignored with regard to environmental transport, as these particle sizes are readily subjected to movement by wind (Leavitt 1980). Leavitt (1976) studied five safety-shot areas in Nevada and reported that the wind had a dominant influence on the surface texture of the desert soil by depositing soil fines around the base of brush or vegetation.

TABLE 4-3. Summary of Thermoluminescent Dosimeter (TLD) Measurements for 1997

Location	Number of Measurements	Annual Exposure (mR/yr)	
		Annual Exposure	Error
Offsite (Community) (C)	5	135	21
Perimeter (P)	4	146	17
Onsite (S)	13	150	21

NOTE: mR/yr = milliroentgen per year

FIGURE 4-1. TLD Location T-13 Results Over Time

A later study by Tamura (1977) discussed the occurrence of sandy mounds formed under desert shrubbery. These mounds are formed by the filtering action of the desert vegetation in intercepting saltating particles (movement of particles by bouncing along the ground surface). This study, and additional studies, found that in plutonium-contaminated areas, the plutonium activity levels were higher in the desert mounds than in the contiguous desert pavement (soil areas with sparse vegetation and underlain by a hardpan surface). This demonstrates the effect of wind erosion in dispersal of contaminated material. The Tamura (1977) study also discussed evidence of plutonium migration downward into the soil profile.

Evidence of water erosion has been observed within the outer control fence at Clean Slate 2. The erosive effects of water may pose another mechanism for transport of the contaminated material. Essington and Fowler (1976) observed the ability of plutonium to migrate to deeper layers of soil with time. Vertical transport of contaminants into the soil column may allow greater exposure of roots and a potential for root uptake of contaminants by the plants. Soil profiles from the safety-shot areas at TTR indicate a decrease in the plutonium-to-amerium ratio with depth (Romney et al. 1975), suggesting greater vertical movement of americium-241 relative to plutonium-239 and plutonium-240. This same report also stated that there is evidence showing that americium is much more readily available to plants through roots than is plutonium. Gilbert et al. (1975) stated that erosive processes and penetration into the soil would eventually flatten out peak contaminant concentrations, and that there was a need for long-term hazard evaluation to determine the change in contaminant concentrations over time at the safety-shot areas.

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4.4 ENVIRONMENTAL MONITORING PERFORMED BY KMI SERVICES

KMI performed or assisted in most environmental monitoring activities in 1997. KMI routine environmental monitoring activities at TTR include:

- Safe Drinking Water Act (SDWA) monitoring
- Wastewater monitoring
- Operating air monitoring equipment (for both SNL and DOE/NV)
- Soil monitoring and site characterization of spill sites
- Management of the long-term environmental TLD network (onsite and offsite)
- Hazardous waste characterization sampling

Environmental compliance permits for TTR include those for the potable water supply, sewage, and air quality. Table 2-3 lists the current permits and expiration dates.

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4.5 WASTEWATER AND SUPPLY WATER MONITORING

In 1997, water monitoring was conducted for both drinking water and wastewater effluent. Analysis results are described below.

4.5.1 Drinking Water Distribution System Sampling Results

KMI Services staff collected water samples quarterly from the Well 6 distribution system that supplies potable water to the Sandia Compound. Samples were transported to a state-certified laboratory in Las Vegas, Nevada for bacteriological analysis.

A state-certified water distribution operator is employed on the support contractor staff to fulfill the state requirement for a certified water distribution operator to operate community water systems. The *Water Conservation Plan for the Tonopah Test Range* complies with State Water Resources Division regulations requiring a water conservation plan for permitted water systems and major water users in Nevada (DOE 1992).

Compliance activities include monthly bacteriological sampling (total coliform). Other samples are analyzed periodically for volatile organic compounds (VOCs), semi-VOCs (SVOC), nitrates and nitrites, lead, copper and unregulated constituents sampling. Complete chemical and radiological analysis of the site's drinking water is required every 3 years and was last performed on March 21, 1996. All sampling is conducted in accordance with the *Tonopah Test Range Site Sampling Plan* (DOE 1990b).

Bacteriologic Sampling Results

Total coliform is an indicator that pathogenic bacteria may be present in the water. All monthly water samples collected from the Well 6 drinking water distribution were negative for coliform bacteria.

VOC Sampling Results

Quarterly sampling of Well 6 for VOCs and SVOCs was started in April of 1996. All samples in 1997 were negative over the three quarters sampled with the exception of two samples. These samples measured Di-(2-ethylhexyl) phthalate at just over the detection limit. However, since this substance is a

common plastisizer, it is believed that the contamination resulted from the sampling containers or from the laboratory environment.

The State of Nevada conducted a vulnerability assessment of Well 6 in March 1996. This survey may result in reduced monitoring requirements for the Well 6 distribution system once published.

Copper and Lead Sampling

Last year, initial sampling of Well 6 for copper and lead was performed (July 18, 1996). Analytical results indicated a 90th percentile lead level of 0.070 mg/l in the drinking water exceeding the Safe Drinking Water Act (SDWA) lead standard of 0.015 mg/l. Copper levels were within acceptable limits.

Mitigation efforts for the high lead levels began with the public education of consumers immediately after receiving the analytical results. Buildings with elevated lead levels in the drinking water were also re-checked for potential sources of lead contamination. The sampling point with the highest level of contamination was found to have a faucet with copper piping and lead solder joints. This faucet was replaced and sampling was rescheduled for October. Light water usage on the day prior to sampling also may have contributed to the elevated lead levels.

On October 16, 1996, sampling for lead and copper was repeated. The required supplemental sampling for pH, alkalinity, conductivity, and calcium was also performed on this date. Approximately 15 hours prior to sampling, faucets from which samples were to be collected, were purged by running the water for at least 15 minutes. The water was then allowed to remain undisturbed in the plumbing system at each sampling site for at least 6 hours prior to sampling.

Resampling results indicated that the 90th percentile lead level dropped to below the detection limit of 0.012 mg/l. The sampling point of the replaced faucet dropped to 0.015

mg/l from a previous result of 0.260 mg/l. A second round of sampling was completed in February 1997. Results showed that lead again met state water quality standards.

EPA Sampling of Well 6

The EPA also performs sampling on Well 6 for nitrate and nitrites every 3 years. In addition, the EPA provides a radiological analysis survey for the Long-Term Hydrologic Monitoring Program. Sampling sites are based on the *Tonopah Test Range Site Sampling Plan* (DOE 1990b) for compliance with the SDWA.

The permit for Well 6 (NY-3014-12NC) is renewed annually by the State of Nevada Bureau of Health Protection Services. Permit updates are obtained annually and copies are forwarded to DOE/KAO and SNL/NV.

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4.5.2 Sewage System and Septic Tank Sampling Results

SNL conducts wastewater monitoring by sampling SNL-operations effluent discharges to the USAF sewage lagoon. Septic system sampling is performed on an as-needed basis.

Sewage System

Sewage from SNL facilities in the Main Compound at Area 3 goes to the USAF facultative sewage lagoon. KMI Services takes quarterly wastewater samples from Area 3 at the point wastewater leaves SNL property and enters the USAF system. The USAF holds the National Pollutant Discharge Elimination System (NPDES) permit and samples the headwater end of the lagoon quarterly. The NPDES permit was modified in 1997 and no longer stipulates that SNL needs to provide quarterly monitoring data to the USAF for inclusion in the Discharge Monitoring Report (DMR). As a result of this change SNL will sample wastewater twice each year instead of quarterly beginning in 1998. KMI collects 48-hour composite wastewater samples on a quarterly basis and has the following parameters analyzed:

- Total cyanide (SNL does not use cyanide containing compounds)
- pH and non-filtered residue
- Phenolics (SNL does not use phenol-containing compounds)
- Chemical Oxygen Demand
- Volatile organic compounds (VOCs)
- Metals (cadmium, chromium, copper, nickel, silver, zinc, lead, selenium, and mercury)
- Semi-VOCs (SVOCs)
- Total recoverable petroleum hydrocarbons (TRPH)
- Oil and grease
- Tritium, gamma spec, and gross alpha and gross beta

All analytical results of wastewater sampled from the Area 3 compound were within regulatory limits in 1997. Results can be obtained from KMI Services.

Septic Tank Systems

There are six active septic tanks at TTR that serve remote locations and are maintained by the TTR facilities group. The sewage from these locations flows into septic tanks and associated drain fields. None of these systems required maintenance, sampling, or pumping in 1997. All other remaining septic systems have been closed or are undergoing closure. Several of the septic tanks that served Area 3 until 1990—when the consolidated sewage system was installed—were investigated under the ER effort by IT Corp. in 1997.

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5 AIR QUALITY SURVEILLANCE AND EMISSIONS MONITORING

Air quality compliance at TTR is met by adherence to specific permit conditions, and compliance with local, state, and federal air regulations. Currently, there are no non-radiological sources that require ambient air quality surveillance or emission monitoring.

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5.1 RADIOLOGICAL AIR MONITORING

SNL/NV does not have any facilities or emission points that generate radionuclide airborne releases. The only sources of airborne radionuclide emissions at TTR are from diffuse sources of plutonium and americium associated with the Clean Slate sites (Figure 5-1). The radionuclide emissions are uncontrolled and are the result of wind re-suspension of contaminated surface soil particulates.

The U.S. Environmental Protection Agency (EPA) has established a 10 mrem/yr effective dose equivalent (EDE) to the maximally exposed individual (MEI) as a result of air emissions from DOE facilities. The EPA requires continuous air monitoring for any radionuclide source that contributes in excess of 0.1 mrem/yr EDE to the MEI. These requirements are stated in 40 CFR 61, Subpart H.

The 1995 NESHAP report for TTR reported a calculated EDE to the MEI of 1.1 mrem/year as a result of diffuse emissions from the Clean Slate sites (SNL 1996). In order to document compliance with the regulation, one year of

continuous air monitoring was performed at the TTR Airport. The TTR Airport area was determined to be the MEI location (SNL 1997) for the purpose of compliance with 40 CFR 61, subpart H. Air monitoring began February 1996. The results from the one year of continuous air monitoring (February 22, 1996 through February 25, 1997) (SNL 1997) indicated an average air concentration, in curies/cubic meter (Ci/m³) as follows:

Americium-241	4.1×10^{-18} Ci/m ³
Plutonium-238	1.6×10^{-18} Ci/m ³
Plutonium-239/240	9.5×10^{-19} Ci/m ³

Based on one year of continuous air monitoring, the EDE to the MEI for 1997 was determined to be 0.024 mrem/yr (Table 5-1). As a comparison, the average nationwide dose a person receives from all radioactive sources (natural and manmade) is approximately 360 mrem/yr—the bulk of which comes from natural sources such as radon.

According to 40 CFR 61, Subpart H, air monitoring is not required for any source with an EDE to the MEI of less than 0.1 mrem/yr. In addition, emissions from sources with less than 0.1 mrem/yr EDE to the MEI are not required for input to calculations performed for the purpose of demonstrating compliance with the regulation. Since SNL/NV currently has no radionuclide air emission sources except for the Clean Slate sites, future NESHAP activities are expected to be minimal. (Other Environmental Restoration [ER] sites with radiological contamination, such as depleted uranium [DU] and plutonium, are not diffuse air emission sources.)

Figure 5-1. TTR Onsite Receptor Locations

TABLE 5-1. Calculated Dose Assessment Results for Onsite Receptor

Dose to Receptor	Location	1997 Measured Dose	NESHAP Standard	Natural Background
Onsite Receptor - EDE to the MEI	Airfield TTR Area	0.024 mrem/yr (0.00024 msievert/yr)	10 mrem/yr 0.1 msievert/yr	360 ¹

NOTE: EDE = effective dose equivalent

MEI = maximally exposed individual

¹ Natural background is estimated at 360 mrem/year nationwide.

6

REFERENCES

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- Blejwas 1997:** Memo from Tom Blejwas, with attached *Hydrocarbon Closure Plan for Antelope Peak Generator Station, Tonopah Test Range*, authored by Dwight Stockham.
- CDM 1995:** Camp Dresser and McKee, *Oil Spill Prevention Control and Countermeasure (SPCC) Plan for Sandia National Laboratories Tonopah Test Range*, Plan 90-12, Rev 2. Prepared for Sandia National Laboratories, Albuquerque, NM (April 1995).
- CDM 1994:** Camp Dresser and McKee, 1994, *TTR Storm Water Pollution Prevention Plan*. Prepared for Sandia National Laboratories by CDM, Albuquerque, New Mexico (March 18, 1994).
- DOC 1991:** U.S. Department of Commerce, Bureau of the Census, *1990 United States Census*. DOC, U.S. Government Printing Office, Washington, DC (1991).
- DoD/DOE 1996:** U.S. Department of Defense and U.S. Department of Energy, *Federal Facilities Agreement and Consent Order 1996* (FFACO). State of Nevada Department of Conservation and Natural Resources Division of Environmental Protection and the U.S. DOE and the U.S. DoD in the Matter of Federal Facility Agreement and Consent Order (March 15, 1996).
- DOE 1998:** U.S. Department of Energy, *Biannual Hazardous Waste Generation Report*. Submitted to the EPA by DOE/NV (1998).
- DOE 1996:** U.S. Department of Energy, *Final Environmental Impact Statement for the Nevada Test Site and Offsite Locations in the State of Nevada*, DOE/EIS 0243. DOE, Nevada Operations Office, Las Vegas, NV (August 1996).
- DOE 1992:** U.S. Department of Energy, *Water Conservation Plan for the Tonopah Test Range*, R4809. DOE/NV, Las Vegas, NV (1992).
- DOE 1990a:** DOE Order 5400.1 (See Orders Section)
- DOE 1990b:** U.S. Department of Energy, *Tonopah Test Range Site Sampling Plan*. DOE/NV, Las Vegas, NV (1990).
- DOI/BLM 1979:** U.S. Department of Interior and the Bureau of Land Management, *Final Environmental Statement Proposed Public Land Withdrawal Nellis Air Force Bombing Range Nys, Clark, and Lincoln Counties, Nevada*, Environmental Impact Analysis Process. Prepared by the Bureau of Land Management, Department of the Interior, and Department of the Air Force, U.S. GPO, Washington, DC (7/27/79).

- DRI 1997:** Desert Research Institute, *Community Radiation Monitoring Program Annual Report 1997*. DRI, Las Vegas, NV (1997).
- DRI 1991:** Desert Research Institute, *Special Nevada Report*. Prepared by Science Applications International Corporation (SAIC) for the Department of the Navy, Department of the Air Force, and Department of the Interior, (September 23, 1991).
- E&E 1989:** Ecology and Environment, Inc., *Federal Facility Preliminary Assessment Review*, EPA Region IX, F9-8903-021, NV3570090016. Ecology and Environment, Inc., San Francisco, CA (1989).
- EG&G 1979a:** Edgerton, Germeshausen & Grier Corporation, *Status of Endangered and Threatened Species on Test Range - A Survey*, EGG-1183-2387. EG&G, Las Vegas, NV (1979).
- EG&G 1979b:** Edgerton, Germeshausen & Grier Corporation, *An Aerial Radiological Survey of Clean Slates 1, 2, and 3, and Double Track, Test Range*, EGG-1183-1737. Energy Measurement Group, EG&G, Las Vegas, NV (1979).
- EPA 1997:** U.S. Environmental Protection Agency, Offsite Environmental Monitoring Report: *Radiation Monitoring Around United States Nuclear Test Areas, Calendar Year 1996*, EPA/402-R-96-007, (author Chaloud, D.J. et al.) (1997).
- ERDA 1975:** U.S. Energy Research and Development Administration, *Environmental Assessment, Tonopah Test Range*, EIA/MA/76-2. ERDA (1975).
- Essington and Fowler 1976:** Essington, E. H., and E. B. Fowler, "Distribution of Transuranic Nuclides in Soils," a review in *Transuranics in Natural Environments*, Report NVO-178. Essington, E. H., and E. B. Fowler (1976).
- Gilbert et al. 1975:** Gilbert, R. O., et al., "Statistical Analysis of ²³⁹⁻²⁴⁰Pu and ²⁴¹Am Contamination of Soil and Vegetation on NAEG Study Sites," in *The Radioecology of Plutonium and Other Transuranics in Desert Environments*, Report NVO-153. Battelle Memorial Institute, Pacific Northwest Laboratory, Richland, WA (1975).
- IT 1996:** IT Corporation, *Sampling and Analysis Plan for Clean Slate 1*. IT Corporation (September 1996).
- IT 1993:** IT Corporation, *Analytical Results for Tonopah Test Range, Transformer Oil Samples, Collected July 16-18, 1993*. IT Corporation, Albuquerque, NM (September 1993).
- Leavitt 1980:** Leavitt, V., *Soil Profiles of Mounds on Plutonium-Contaminated Areas of the Nevada Test Range Complex*. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Las Vegas, NV (1980).
- Leavitt 1976:** Leavitt, V., "Soil Surveys of Five Plutonium-Contaminated Areas on the Test Range Complex in Nevada," in *Nevada Applied Ecology Group Procedures Handbook for Environmental Transuranics*, Report NVO-166. National Environmental Research Center, Las Vegas, NV (1976).
- Romney et al. 1975:** Romney, E. M., et al., "²³⁹⁻²⁴⁰Pu and ²⁴¹Am Contamination of Vegetation in Aged Plutonium Fallout Areas," in *The Radioecology of Plutonium and Other Transuranics in Desert Environments*, Report NVO-153. Laboratory of Nuclear Medicine and Radiation Biology, University of California, Los Angeles, CA (1975).

- Schaeffer 1982:** Schaeffer, J. R., *Climatology of the Tonopah Test Range, 1967*, SC-M-68-522. Sandia National Laboratories, Albuquerque, NM (1982).
- Sinnock 1982:** Sinnock, S., *Geology of the Nevada Test Site and Nearby Areas - Southern Nevada*, SAND82-2207. Sandia National Laboratories, Albuquerque, NM (1982).
- SNL 1998:** Sandia National Laboratories, (1) *NESHAP Annual Report for CY 1997 (EPA Summary)* and (2) *Radiological Dose Calculations and Supplemental Dose Assessment Data for NESHAP Compliance for Sandia National Laboratories, Nevada, CY 1997*. Sandia National Laboratories, Albuquerque, NM (1998).
- SNL 1997:** Sandia National Laboratories, (1) *NESHAP Annual Report for CY 1996 (EPA Summary)* and (2) *Radiological Dose Calculations and Supplemental Dose Assessment Data for NESHAP Compliance for Sandia National Laboratories, Nevada, CY 1996*. Sandia National Laboratories, Albuquerque, NM (1997).
- SNL 1996:** Sandia National Laboratories, (1) *NESHAP Annual Report for CY 1995 (EPA Summary)* and (2) *Radiological Dose Calculations and Supplemental Dose Assessment Data for NESHAP Compliance for Sandia National Laboratories, Nevada, CY 1995*. Sandia National Laboratories, Albuquerque, NM (1996).
- SNL 1993:** Culp, T. And Howard, D, *1992 Environmental Monitoring Report, Tonopah Test Range, Tonopah, Nevada*, SAND 93-1449. Sandia National Laboratories, Albuquerque, NM (1993).
- SNL 1992:** Sandia National Laboratories, *Environmental Monitoring Plan for the Tonopah Test Range, Nevada*. Sandia National Laboratories, Albuquerque, NM (1992).
- Tamura 1977:** Tamura, T., "Plutonium Distribution in a Desert Pavement Desert Mound," in *Environmental Plutonium on the Nevada Test Site and Environs*, Report NVO-171. Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN (1977).
- Tamura 1976:** Tamura, T., "Plutonium Association in Soils," in *Transuranics in Natural Environments*, Report NVO-178. Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN (1976).
- Tamura 1975:** Tamura, T., "Characterization of Plutonium in Surface Soils from Area 13 of the Nevada Test Site," in *The Radioecology of Plutonium and Other Transuranics in Desert Environments*, Report NVO-153. Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN (1975).
- Tamura 1974:** Tamura, T., "The Dynamics of Plutonium in Desert Environments, Nevada Applied Ecology Group Report," in *Distribution and Characterization of Plutonium in Soils from Nevada Test Site*, Report NVO-142. Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN (1974).

ACTS and STATUTES

American Indian Religious Freedom Act (AIRFA) of 1978, as amended. Title 42 U.S.C. 1996.

Archaeological Resources Protection Act (ARPA) of 1979, Public Law 96-95, as amended by Public Law 100-588.

Clean Air Act (CAA) of 1955, as amended. Title 42 U.S.C. 7401. Clean Air Act Amendments (CAAA).

Clean Water Act (CWA) of 1948, (Federal Water Pollution Control Act), as amended. Title 33 U.S.C. 1251.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, as amended. Title 40 U.S.C. 9601.

Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) (Enacted by Public Law 99-499, October 17, 1986; 42 U.S.C. 11001 et seq.).

Endangered Species Act (ESA) of 1973, as amended. Title 16 U.S.C. 1531.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended. Title 7 U.S.C. 136.

National Environmental Policy Act (NEPA) of 1969, as amended. Title 42 U.S.C. 4341.

National Historic Preservation Act (NHPA) of 1966, as amended. Title 16 U.S.C. 470.

Resource Conservation and Recovery Act (RCRA) of 1976. Public Law 94-580, 1976, 90 Statute 2795.

Safe Drinking Water Act (SDWA) of 1974, as amended. Title 42 U.S.C. §300f et seq.

Superfund Amendments and Reauthorization Act (SARA) of 1986. Title III, Section 313, "Toxic Chemical Release Reporting."

Toxic Substances Control Act (TSCA) of 1976. Title 15 U.S.C. 2601.

Federal Facilities Compliance Act (FFCA Act).

CODE OF FEDERAL REGULATIONS

- 10 CFR 1021, 1992** "National Environmental Policy Act Implementing Procedures," as revised April 24, 1992.
- 40 CFR 61, 1973** "National Emission Standards for Hazardous Air Pollutants (NESHAP)," including 1985, Subpart H, "National Emission Standards for Emissions of Radionuclide Other Than Radon From Department of Energy Facilities," as amended.
- 40 CFR 112, 1973** "Oil Pollution Prevention," as amended March 26, 1976.
- 40 CFR 141.26, 1992** "Monitoring Frequency for Radioactivity in Community Water Systems" (Revision 6, September 15, 1992).
- 40 CFR 270.61** "EPA Administered Permit Programs: The Hazardous Waste Permit Program."
- 40 CFR 280** "Technical Standards and Corrective Action Requirements for Owners and Operations of Underground Storage Tanks," (changed many times since 1991).

DOE and EXECUTIVE ORDERS

DOE 1995: U.S. Department of Energy, *National Environmental Policy Act Compliance Program*, DOE Order 451.1. DOE, Washington, DC (September 11, 1995).

DOE 1990a: U.S. Department of Energy, *General Environmental Protection Program*, DOE Order 5400.1. DOE, Washington, DC (1988, change 1, June 21, 1990).

Executive Order 11988: *Floodplain Management* (Signed May 24, 1977; 42 FR 26951, 3 CFR, 1977 Comp., p. 117; Amended by Executive Order 12148, July 20, 1979; 44 FR 43239, 3 CFR, 1979 Comp., p. 412).

Executive Order 11990: *Protection of Wetlands* (Signed May 24, 1977; 42 FR 26961, 3 CFR, 1977 Comp., p. 121).

ANCILLARY INFORMATION

Units of Measure

°C	Celsius degree
cm	centimeter
cm ³	cubic centimeter
°F	Fahrenheit degree
ft	foot
g	gram
gal	gallon
in.	inch
kg	kilogram
km	kilometer
l	liter
m	meter
m ²	square meter
m ³	cubic meter
mg/l	milligrams per liter
mi	mile
mi ²	square mile
m/s	meters per second
ppm	parts per million
μm	micron
yr	year
yd ³	cubic yard

Units of Radiological Measure

Ci	curie (unit of radioactivity)
mrem	millirem (unit of radiation dose)
mrem/yr	millirem per year
mR/yr	milliroentgen per year
pCi	picocurie
pCi/g	picocurie per gram
rem	roentgen equivalent man (unit of dose equivalent)
μg/g	microgram per gram
μg/m ²	microgram per square meter
μg/m ³	microgram per cubic meter

Elements

Al	aluminum	Ar	arsenic
Ba	barium	Be	beryllium
Cu	copper	Hg	mercury
Cd	cadmium	Mn	manganese
Co	cobalt	Ni	nickel
Cr	chromium	V	vanadium
Ti	titanium	Tl	thallium
Fe	iron	Se	selenium
K	potassium	Ag	silver
Pb	lead		
Pu	plutonium		
Si	silica		
Zn	zinc		

Isotopes

Am-241	americium-241
Be-7	beryllium-7
Pu-238	plutonium-238
Pu-239	plutonium-239
Pu-240	plutonium-240
Pu-241	plutonium-241
Pu-242	plutonium-242
Ra-226	radium-226
Th-232	thorium-232
H-3	tritium
Cs-137	cesium-137
U	uranium
U-238	uranium-238
U _{tot}	uranium, total

Abbreviations and Acronyms

AEC	U.S. Atomic Energy Commission
AIRFA	American Indian Religious Freedom Act
ARPA	Archaeological Resources Protection Act
ASER	Annual Site Environmental Report
AST	above-ground storage tank
BLM	Bureau of Land Management
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CADD	Corrective Action Decision Document
CAP	Corrective Action Plan
CAI	Corrective Action Investigation
CAIP	Corrective Action Investigation Plan
CAU	Corrective Action Unit
CAS	Corrective Action Site
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
CY	calendar year
DMR	Discharge Monitoring Report
DOC	U.S. Department of Commerce
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/AL	U.S. Department of Energy/Albuquerque Operations Office
DOE/ERD	U.S. Department of Energy/Environmental Restoration Department
DOE/HQ	U.S. Department of Energy/Headquarters
DOE/KAO	U.S. Department of Energy/Kirtland Area Office
DOE/NV	U.S. Department of Energy/Nevada Operations Office
DOI	U.D. Department of Interior
DRI	Desert Research Institute, Water Resources Center, University of Nevada System
DU	depleted uranium
EA	Environmental Assessment
ECL/ADM	Environmental Checklist/Action Description Memorandum
EDE	effective dose equivalent
EO	Executive Orders
EHS	Extremely Hazardous Substances
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	Environmental Restoration
ERDA	U.S. Energy Research and Development Administration
ES&H	Environment, Safety and Health
ESA	Endangered Species Act
FFCAct	Federal Facilities Compliance Act
FFACO	Federal Facilities Agreement and Consent Order
FIDLER	field instrument for the detection of low-energy radiation
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FY	fiscal year

JTA	Joint Test Assembly
KMI	Kirk-Mayer, Inc. (KMI Services)
LDR	Land Disposal Restriction
MOA	Memorandum of Agreement
MDC	minimum detectable concentrations
MEI	maximally exposed individual
MSDS	Material Safety Data Sheet
MW	mixed waste
NA	not applicable, not available
NAEG	Nevada Applied Ecology Group
NAFB	Nellis Air Force Base (Range Complex)
NAFR	Nellis Air Force Range
NEDS	Non-Explosive Destruction Site
ND	Not Detected (or below the detection limit)
NDEP	Nevada Department of Environmental Protection
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NF	None found
NHPA	National Historic Preservation Act
NOS	not otherwise specified
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	National Response Center
NTS	Nevada Test Site
NV	Nevada
ODIS	Onsite Discharge Information System
O&M	Operations and Maintenance
PA	Preliminary Assessment
PCB	polychlorinated biphenyl
PIC	Pressurized Ionization Chamber
PMS	portable monitoring station
QA	quality assurance
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
ROD	Record of Decision
RQ	Reportable Quantity
RWAP	Radioactive Waste Acceptance Package
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SHPO	State Historic Preservation Office
SNL	Sandia National Laboratories
SNL/NM	Sandia National Laboratories/New Mexico
SNL/NV	Sandia National Laboratories/Nevada
SPCC	Spill Prevention, Control, and Countermeasures
SVOC	semi volatile organic compound
TLD	thermoluminescent dosimeter
TPH	total petroleum hydrocarbon
TRPH	total recoverable petroleum hydrocarbon
TRI	Toxic Release Inventory

TSCA	Toxic Substances Control Act
TSDF	treatment, storage, and disposal facility
TSP	total suspended particulates
TTR	Tonopah Test Range
UDP	underground discharge point
USAF	U.S. Air Force
USGS	U.S. Geological Survey
UST	underground storage tank
UXO	unexploded ordnance
VOC	volatile organic compound

Approximate Conversion Factors for Selected Si (Metric) Units

Multiply Si (metric) unit	by	To obtain U.S. customary unit
cubic meter (m ³)	35	cubic feet (ft ³)
centimeter (cm)	0.39	inch (in.)
meter (m)	3.3	feet (ft)
kilometer (km)	0.62	mile (mi)
square kilometer (km ²)	0.39	square mile (mi ²)
hectare (ha)	2.5	acre
liter (L)	0.26	gallon (gal)
gram (g)	0.035	ounce (oz)
kilogram (kg)	2.2	pound (lb)
microgram per gram (µg/g)	1	part per million (ppm)
milligram per liter (mg/L)	1	part per million (ppm)
Temperature	Equation	Temperature
Celsius (°C)	°F = 9/5 °C + 32	Fahrenheit (°F)

APPENDIX A

**STATE OF NEVADA REGULATIONS AND
PERMIT LISTINGS**

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CONTENTS

TABLE

A-1	State of Nevada Regulations Applicable to the Tonopah Test Range (TTR).....	A-4
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TABLE A-1. State of Nevada Regulations Applicable to the Tonopah Test Range (TTR)

Regulation	Applicable Activity
<u>Nevada Wildlife Regulations</u>	
Nevada Revised Statute, Title 45, Chapter 501. NRS 501.010-501.243	<ul style="list-style-type: none"> - Diversion of surface drainage channels - Clearing, leveling, and grading of site - Road construction - Highway improvement - Installation of water lines - Installation of water reservoirs
Wildlife Regulations NAC 504.510-504.550	<ul style="list-style-type: none"> - Installation of fuel storage tanks - Construction of sanitary landfill - Construction of explosives bunkers
<u>Nevada Air Quality Regulations</u>	
Nevada Revised Statutes, Title 40, Public Health and Safety, Chapter 445. NRS 445.401-445.601	<ul style="list-style-type: none"> - Diversion of surface drainage channels - Clearing, leveling, and grading of site - Road construction - Highway improvement - Installation of water lines - Installation of water reservoirs - Installation of fuel storage tanks - Construction of sanitary landfill - Construction of explosives bunkers - Construction of support buildings - Incinerator - Diesel-powered emergency generator
NAC 445.430-445.995	
<u>Nevada Water Pollution</u>	
Nevada Revised Statutes, Title 40, Public Health and Safety, Chapter 445. NRS 445.131-445.354	<ul style="list-style-type: none"> - Construction of operation of Control Regulations sewage treatment plant - Disposal of drilling fluids - Water treatment plant
NAC 445.070-445.194	

TABLE A-1. State of Nevada Regulations Applicable to the TTR (Continued)

Regulation	Applicable Activity
<u>Nevada Regulations</u> <u>Solid Waste Management</u>	<ul style="list-style-type: none"> - Clearing, leveling, and grading of site - Construction of support buildings - Construction and operation of sanitary landfill - Daily sanitary wastes - Disposal of sewage sludge
Nevada Revised Statutes, Title 40, Public Health and Safety, Chapter 444. NRS 444.510-444.610	
Regulations Governing Solid Waste Management	
<u>Nevada Regulations</u> <u>Governing Individual</u> <u>Sewage Systems</u>	<ul style="list-style-type: none"> - Construction of sewage collection systems
Nevada Revised Statutes, Title 40, Public Health and Safety, Chapter 444. NRS 444.650	
NAC 444.750-444.840	
<u>Nevada Public Water</u> <u>Supply and Public Water</u> <u>Systems Regulations</u>	<ul style="list-style-type: none"> - Installation of water lines - Installation of water reservoirs
Nevada Revised Statutes, Title 40, Public Health and Safety, Chapter 445. NRS 445.030	
NAC 445.370-445.420	

TABLE A-1. State of Nevada Regulations Applicable to the TTR (Concluded)

Regulation	Applicable Activity
<u>Nevada Water Resources</u>	
	- Installation of water lines
	- Installation of water reservoirs
Nevada Revised Statutes, Underground Water and Wells, Chapters 533 and 534. NRS 534.010-534.190	
Regulations for Drilling Wells	
<u>Radiation Control</u>	
	- Use of radioactive sources
Nevada Revised Statutes, Title 40, Public Health and Safety, Chapter 459. NRS 459.010-459.290	
Nevada Regulations for Radiation Control	

APPENDIX B

**SAMPLING LOCATION MAPS
AND RADIOLOGICAL RESULTS**

Tonopah Test Range

Aerial photo of TTR's Range Operations Center and Main Compound.
(See Figure B-8 for comparison.)

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FIGURE B-1. Offsite Soil Sampling Locations

TABLE B-1. Radiological Results of Offsite Soil Sampling, 1997

Location	U _{tot}	Cs-137	Cs-137 Error	Pu-238	Pu-238 Error	Pu- 239/240	Pu-239/240 Error
B-01	2.2	0.28	0.1	0.01	0.03	0.03	0.03
B-02	3.5	0.22	0.11	0	0.02	0	0.01
B-03	3.0	0.12	0.07	-0.01	0.02	0	0.01
B-04	2.7	0.19	0.09	0.04	0.06	0	0.01
B-05	3.0	0.95	0.11	-0.01	0.02	0.06	0.06
B-06	2.4	0.66	0.11	-0.01	0.02	0	0.01
B-07	2.4	0.17	0	-0.05	0.05	-0.03	0.04
B-08	2.7	0.08	0.05	-0.04	0.06	-0.03	0.04
B-09	2.5	0.64	0.12	-0.04	0.06	0	0.05
B-10	3.2	0.08	0	-0.04	0.05	-0.03	0.03
B-11	2.0	0.32	0.11	0.02	0.04	0.06	0.05
B-12	2.6	0.42	0.1	0.02	0.07	-0.01	0.04
B-13	2.5	0.21	0.09	-0.03	0.06	0.01	0.05
B-14	2.1	0.13	0.08	-0.02	0.06	-0.03	0.04

FIGURE B-2. Perimeter Soil Sampling Locations

TABLE B-2. Radiological Results of Perimeter Soil Sampling, 1997

Location	U_{tot} ($\mu\text{g/g}$)	Cs-137 (pCi/g)	Cs-137 Error (pCi/g)
T-06	2.5	0.2	0.08
T-08	2.6	0.29	0
T-11	2.1	0.25	0.09
T-12	2.5	0.7	0.1
T-13	2.4	0.13	0.06

FIGURE B-3. Soil Sampling Locations Near the On-Base Housing Area

TABLE B-3. Radiological Results of On-Base Housing Soil Sampling, 1997

Location	Utot	Cs-137	Cs-137 Error	Pu-238	Pu-238 Error	Pu- 239/240	Pu- 239/240 Error
T-07	2.9	-0.07	0	0.01	0.03	-0.01	0.03
T-34	2.6	0.26	0.1	0.05	0.06	0	0.03
T-35	1.2	0.01	0	0.01	0.03	0	0.03
T-36	2.3	0.25	0.08	0	0.02	-0.02	0.02
T-37	1.2	0.04	0	0.06	0.05	0.05	0.05

FIGURE B-4. Soil Sampling Locations in the South Plume Area

TABLE B-4. Radiological Results of South Plume Area Soil Sampling, 1997

Location	Utot ($\mu\text{g/g}$)	Cs-137 (pCi/g)	Cs-137 Error (pCi/g)	Am-241 (pCi/g)	Am-241 Error (pCi/g)	Pu-238 (pCi/g)	Pu-238 Error (pCi/g)	Pu-239+240 (pCi/g)	Pu-239+240 Error (pCi/g)
T-14	2.6	0.80	0.11	0.08	0.08	-0.02	0.03	0.03	0.04
T-15	2.7	0.87	0.11	0.12	0.09	0.08	0.07	7.1	2.7
T-16	2.8	0.69	0.12	0	0.27	0.01	0.05	1.8	0.7
T-17	2.6	0.72	0.11	-0.04	0.1	0	0.06	0.03	0.06
T-18	3.0	0.96	0.14	0.12	0.17	-0.01	0.06	1.2	0.52
T-19	3.1	0.55	0.12	0.26	0.08	-0.02	0.05	1.3	0.59

FIGURE B-5. Soil Sampling Locations Near the 554th Range Squadron O&M Complex

TABLE B-5. Radiological Results of 554th Range Squadron O&M Complex Soil Sampling, 1997

Location	Utot ($\mu\text{g/g}$)	Cs-137 (pCi/g)	Cs-137 Error (pCi/g)
OM-01	2.7	0.4	0.09
OM-02	2.9	0.34	0.1
OM-03	2.9	0.73	0.1

FIGURE B-6. Soil Sampling Locations Around the Range Operations Center

FIGURE B-7. Soil Sampling Locations Around the Range Operations Center Storage Yard

FIGURE B-8. Soil Sampling Locations in the Range Operations Center and Compound

TABLE B-6. Radiological Results of Range Operations Center Soil Sampling, 1997

Location	Utot ($\mu\text{g/g}$)	Cs-137 (pCi/g)	Cs-137 Error (pCi/g)
OC-01	3.2	0.25	0.12
OC-02	3.1	0.28	0.12
OC-03	2.9	0.11	0.12
OC-04	3.0	0.46	0.08
OC-10	3.4	0.08	0.13
OC-13	3.2	0.24	0.21
OC-19	3.0	0.02	0.12
OC-20	3.9	0	0.14
OC-22	3.1	0.03	0.22
OC-23	2.6	0.07	0.13

FIGURE B-9. Soil Sampling Locations Near the Hard Target/Depleted Uranium Area

FIGURE B-10. Soil Sampling Locations at the Mellan Hill Area

FIGURE B-11. Various Onsite Soil Sampling Locations

TABLE B-7. Radiological Results of Various Onsite Soil Sampling Locations, 1997

Location	Utot ($\mu\text{g/g}$)	Cs-137 (pCi/g)	Cs-137 Error (pCi/g)	Am-241 (pCi/g)	Am-241 Error (pCi/g)	Pu-238 (pCi/g)	Pu-238 Error (pCi/g)	Pu-239+240 (pCi/g)	Pu-239+240 Error (pCi/g)
D-01	2.5	0.03	0.12	0.51	0.09	0.08	0.07	6.5	2.5
MH-03	2.9	0.58	0.1	-0.04	0.04	0.02	0.05	0.22	0.14
MH-04	2.3	0.43	0.08	0.04	0.06	0.05	0.06	1.5	0.64
OP-03	3.3	0.15	0.12	0.02	0.03	0.07	0.07	0.02	0.04
STA-14	2.9	0.47	0.1	-0.05	0.06	-0.06	0.08	0.03	0.04
T-02	3.2	0.31	0.1	0.04	0.06	0.01	0.05	0.18	0.11
T-03	3.2	0.56	0.1	0	0.07	0	0.09	1.1	0.45
T-04	2.8	0.74	0.11	0.01	0.14	-0.08	0.08	0.24	0.14
T-10	2.6	0.20	0.1	0.01	0.04	-0.05	0.08	0.05	0.06
T-20	5.5	0.42	0.1	0.03	0.03	0.04	0.04	0	0.04
T-21	2.9	0.27	0.08	-0.02	0.02	0.01	0.06	-0.02	0.04

TABLE B-8. Results of Radiological Replicate Soil Samples, 1997

Location	Analyte	Number of Samples	Mean (pCi/g)	Standard Deviation (pCi/g)	Coefficient of Variation (%)
D-01	Am-241	3	1.25	1.26	100.47
	Cs-137	3	0.06	0.05	81.51
	Pu-238	3	0.05	0.04	87.18
	Pu-239+240	3	5.77	3.36	58.28
	U _{tot}	3	2.47	0.06	2.34
T-03	Am-241	3	0.09	0.09	92.38
	Cs-137	3	0.61	0.05	7.51
	Pu-238	3	-0.03	0.03	114.56
	Pu-239+240	3	1.80	1.21	67.36
	U _{tot}	3	3.03	0.15	5.04
T-07	Am-241	3	0.01	0.01	86.60
	Cs-137	3	-0.02	0.06	312.25
	Pu-238	3	0.02	0.02	98.97
	Pu-239+240	3	-0.02	0.01	34.64
	U _{tot}	3	2.77	0.15	5.52
T-14	Am-241	3	0.03	0.04	124.90
	Cs-137	3	0.69	0.11	16.04
	Pu-238	3	0.02	0.06	330.45
	Pu-239+240	3	0.17	0.17	97.62
	U _{tot}	3	2.60	0.00	0.00

TABLE B-9. Thermoluminescent Dosimeter Summary Results for the Tonopah Test Range, 1997

Location Class	Period	Units	No. Records	Exposure	Error	Days
Community	Q1	mR	5	26.64	5.80	107
	Q2	mR	4	36.78	4.77	97
	Q3	mR	4	32.90	5.70	99
	Q4	mR	5	38.90	4.70	102
				135.22	20.97	405
Onsite	Q1	mR	13	31.95	6.72	107
	Q2	mR	13	40.40	3.86	97
	Q3	mR	13	38.98	6.95	99
	Q4	mR	13	38.45	3.42	102
				149.78	20.95	405
Perimeter	Q1	mR	4	25.48	4.02	107
	Q2	mR	4	43.77	4.15	97
	Q3	mR	4	39.55	5.48	99
	Q4	mR	4	37.03	3.72	102
				145.83	17.38	405