SANDIA REPORT

SAND97-2049 • UC-630
Unlimited Release
Printed August 1997

1996 Site Environmental Report Tonopah Test Range Tonopah, Nevada

Todd Culp, William Forston, Dianne Duncan, Rebecca Sanchez

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under Contract DE-AC04-94AL85000.

Issued by Sandia National Laboratories, operated for the United States Department of Energy by Sandia Corporation.

Available to DOE and DOE contractors from
Office of Scientific and Technical Information
PO Box 62
Oak Ridge, TN 37831

Prices available from (615) 576-8401, FTS 626-8401

Available to the public from
National Technical Information Service
US Department of Commerce
5285 Port Royal Rd
Springfield, VA 22161

NTIS price codes
Printed copy: A08
Microfiche copy: A01

SAND97-2049
Unlimited Release
Printed August 1997

Distribution
Category UC-630

1996
SITE ENVIRONMENTAL REPORT
TONOPAH TEST RANGE
TONOPAH, NEVADA

Todd Culp, Author
Environmental Monitoring and Reporting Department
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185-0854

William Forston, Author
Kirk-Mayer, Inc.
Tonopah, NV 89049

Dianne Duncan, Editor
GRAM, Inc.
8500 Menaul, Suite B-335
Albuquerque, NM 87112

Rebecca Sanchez, Technical Word Processing
Jobs Plus
1512-D Wyoming Blvd., NE
Albuquerque, NM 87112

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 1996) summarizes the compliance status to environmental regulations applicable at the site including those statutes that govern air and water quality, waste management, clean-up 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 herein. This report is prepared for the DOE as required by DOE Order 5400.1 (DOE 1988).

PREFACE

This report presents summary information on the compliance status and monitoring results for TTR. Appendix B contains all relevant location maps for sampling activities described in Chapter 4. The reader may also refer to the Ancillary Data at the end of the report (Chapter 7) for a listing of acronyms, units, and other abbreviations.

ACKNOWLEDGMENTS

The authors thank those people who provided information and analytical data necessary for the preparation of this report.

NOTE TO THE READER

If you have comments or questions about this report, or need further information, contact:

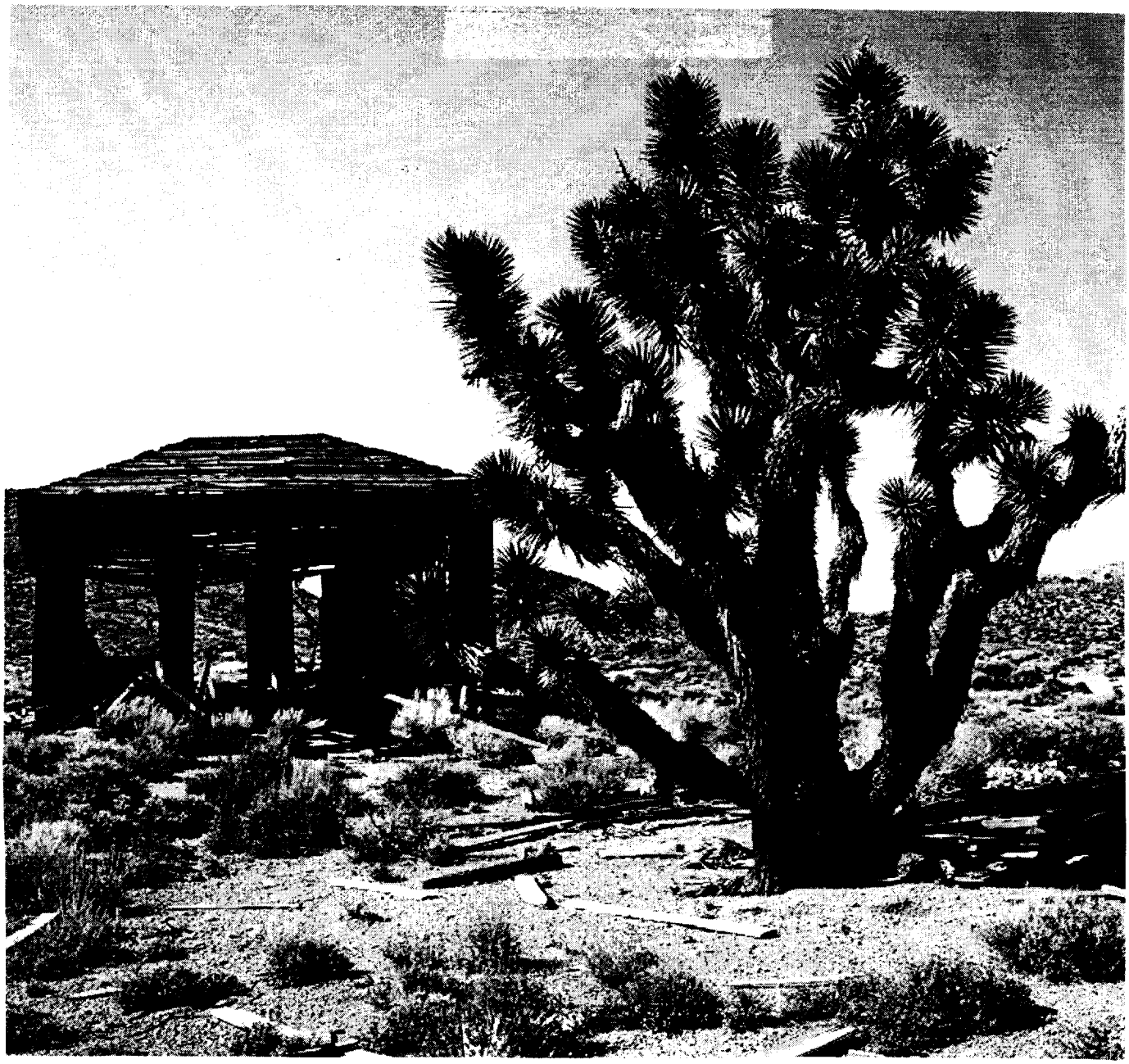
Sandia National Laboratories
ES&H Center
Environmental Monitoring and Reporting Department
MS 0854
P.O. Box 5800
Albuquerque, NM 87185
(505) 845-7886 (Todd Culp)
(505) 845-7154 (FAX)

CONTENTS

CONTENTS (Concluded)

TABLES

FIGURES



The remains of an old homestead on TTR

EXECUTIVE SUMMARY

As required by U.S. Department of Energy (DOE) Order 5400.1, 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. For this 1996 calendar year (CY1996) report, significant 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 cognizance during 1996. These environmental program areas include:

- Waste Management
- Environmental Restoration (ER)
- Terrestrial Surveillance
- Water Monitoring
- Air Quality Compliance and Monitoring
- National Environmental Policy Act (NEPA) Activities
- Occurrence Reporting

WASTE MANAGEMENT

TTR is classified as a small quantity generator of hazardous waste under the Resource Conservation and Recovery Act (RCRA). In CY1996, 930 kg of RCRA-hazardous waste and 2,135 kg of regulated non-RCRA waste were shipped offsite for disposal to permitted treatment, storage, and disposal facilities (TSDF). All waste management is conducted by SNL's onsite contractor, Kirk-Mayer, Inc. (KMI Services).

environmental program achievements are highlighted, as well as noting any areas of non-compliance, corrective actions, or other areas of ongoing improvements.

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.

Radioactive waste produced onsite is primarily comprised of ER-contaminated soils. In 1996, a total of 312 tons of soil were excavated from ER sites.

An informal waste minimization program is practiced at TTR. Recycled items include antifreeze, Freon, oil, lead batteries, solvents, and fluorescent and sodium light bulbs. A total of 8,988 kg of material was shipped offsite for energy recovery or recycling in 1996.

ENVIRONMENTAL RESTORATION (ER)

ER activities at TTR are conducted through the DOE Nevada Office (DOE/NV). The DOE currently has 20 Corrective Action Units (CAUs) designated at TTR. 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 sites related to the Project Roller Coaster Tests are referred to as the Clean Slate sites and the Double Tracks Site. 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, all three Clean Slate sites are located on TTR.

ER activities in 1996 included cleanup of the Five Points Landfill site and the Bomblet Pit. Site investigations were performed for the Second Gas Station, Roller Coaster Sewage Lagoons, and Cactus Springs Waste Trenches. Additionally, several plans were completed including a TTR CAU work plan. An Interim Corrective Action Plan for Double Tracks was also completed.

TERRESTRIAL SURVEILLANCE

Soil samples were collected from SNL controlled property areas and vicinity in June 1996. All samples were analyzed for 19 standard metals, total uranium (U_{tot}), and by gamma spectroscopy primarily to detect the presence of americium. Onsite and perimeter radiological sample results were only slightly elevated for Cs-137 and uranium as compared to offsite samples. However, due to the limited sample size (14 offsite) and the insignificant difference of values, the elevated values are considered within the normal range of sample variation. Nonradiological results showed elevated metals in soils—cadmium, titanium, and zinc—collected from the Range Operations Center. Samples collected in the vicinity of the Hard Target Area were elevated for aluminum, beryllium, cobalt, titanium, copper, iron, magnesium, manganese, and potassium. Elevated metals were also present in the vicinity of the Clean Slate sites.

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 1996 were within regulatory limits.

The SNL Main Compound drinking water is supplied from Well 6. Elevated results for copper and lead were found in the July 1996 samples. The highest level of contamination was determined to be caused from a faucet with copper piping and lead solder joints. The faucet was replaced and the water was resampled in October 1996. Results from this sampling showed results within the limits set by the Safe Drinking Water Act.

AIR QUALITY COMPLIANCE AND MONITORING

Air emissions in 1996 were in compliance with applicable permits. Ambient air monitoring was last performed in 1995 at three locations. Results did not indicate significantly elevated results for nonradiological or radiological parameters. However, in the vicinity of the Clean Slate sites diffuse radionuclide emissions are released from broad areas of contamination. Results from the 1995 NESHAP dose assessment indicated an Effective Dose Equivalent (EDE) to the Maximally Exposed Individual (MEI) of 1.1 mrem/yr. Continuous air monitoring is required for doses over 0.1 mrem/year as required by the Environmental Protection Agency (EPA). In February 1996, a continuous monitoring program commenced. Because monitoring of the large area covered by the Clean Slate sites is impractical, the EPA approved a continuous air monitor station to be set up at the MEI location determined to be located at the TTR Airport area. The EDE to the MEI in 1996 was again calculated to be 1.1 mrem/year, or 11 percent of the maximum allowable dose of 10 mrem/year.

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 1996

included the completion of an Environmental Impact Statement (EIS) for the TTR.

ENVIRONMENTAL OCCURRENCES

There were two reportable quantity (RQ) releases in 1996 from two separate incidences involving fuel spills. On February 27, 1996, approximately 70 gal. of diesel fuel was released from a generator after a bleed screw vibrated loose. A total of 30 cubic yards of contaminated soil was removed and a Clean Closure Plan was submitted to the State of Nevada. A second spill occurred on August 31, 1996, involving a leak from a gasoline truck nozzle. This resulted in contamination of approximately 6 cubic yards of soil. The soil was removed and a Clean Closure Plan was also submitted.

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 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 (DOE 1988), this site environmental report 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 represents a key component of the DOE's effort to keep the public informed about environmental conditions at DOE facilities. This annual report contains summary information about the radiological and nonradiological environmental conditions of the site and identifies trends with regard to effluent releases.

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 8 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 were built at the TTR which 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 weapons systems. The principal DOE activities at the TTR are: stockpile reliability testing; Research and Development (R&D) testing support of structural development; arming, fusing and firing systems testing; and testing weapons delivery systems related to nuclear weapons. Currently, the TTR is setup for activities which 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.

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

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

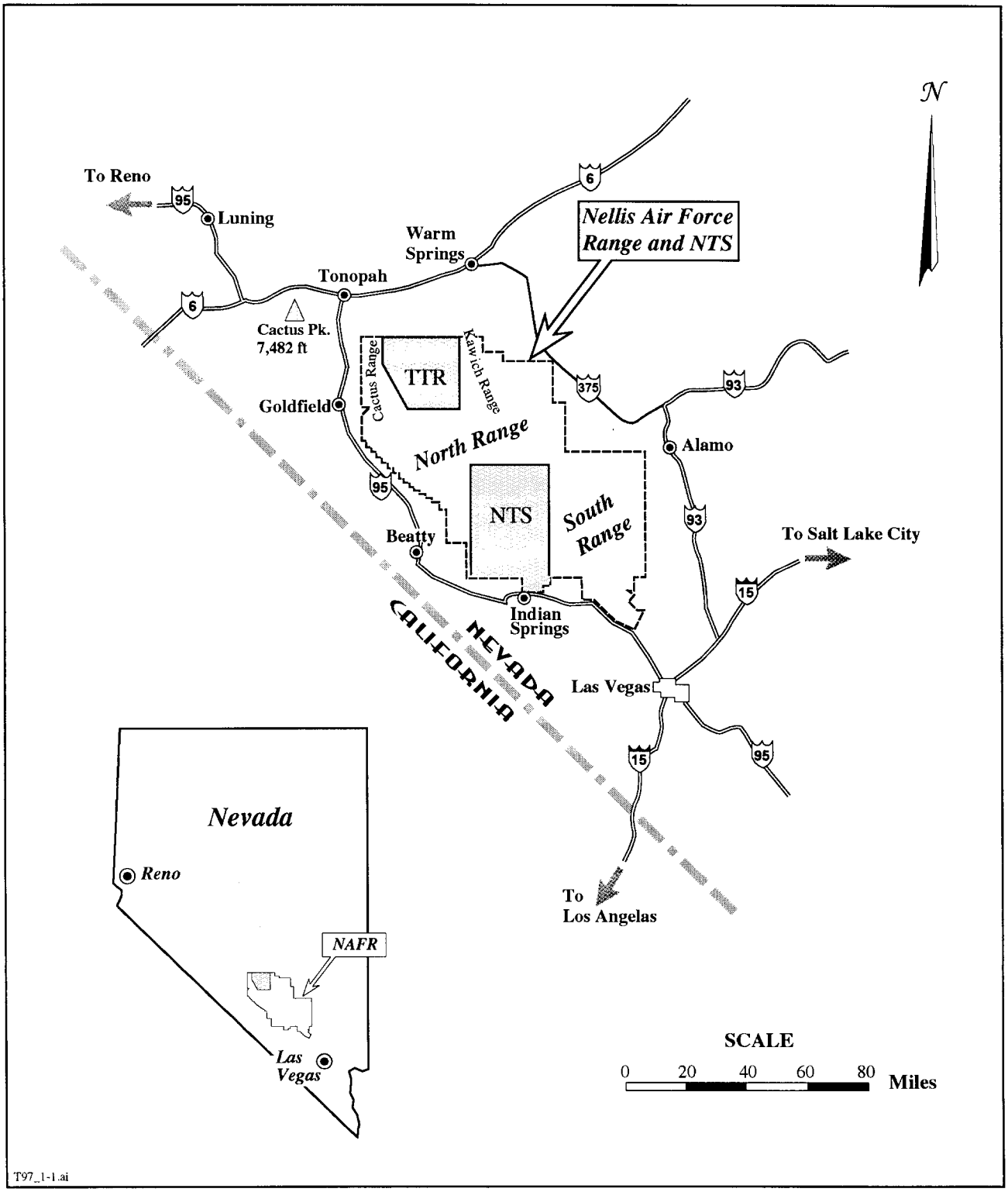


Figure 1-1. Location of the Tonopah Test Range, within the boundaries of the Nellis Air Force Range, Nevada.

These activities require a remote range for both the public's 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. In 1996, SNL/NV, DOE, and USAF activities included flying sorties, rocket/missile flights, and air drops. There are no planned or scheduled changes through the year 2000 in ownership, mission, boundaries, or use of DOE-related activities at the TTR.

1.2 SITE DESCRIPTION and DEMOGRAPHICS

The TTR is sited completely within NAFR boundaries with its northern perimeter contiguous with the northern boundary of the North Range. The area north of the boundary consists of sparsely populated public lands used to graze cattle, and is administered by both the Bureau of Land Management (BLM) and the U.S. Forest Service. The east side of TTR is bordered by the Nevada Wild Horse Range—also within the North Range—which is administered by the BLM.

The nearest inhabitant is located in the town of Goldfield approximately 22 miles west of the site boundary. The nearest population centers relative to TTR include the town of Goldfield, population 659, and the town of Tonopah, 30 miles northwest, population 3,680 (DOC 1991). The total population within a 50-mile radius around the TTR is approximately 8,790. 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

TTR is situated in a high-desert environment that consists of broad flat valleys bordered by north/south-trending mountain ranges located in the western part of the Basin-and-Range geophysical province. TTR lies northeast of a zone of transcurrent faulting and shear, termed the Walker Lane, 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 two mountain ranges: the Cactus Range to the west and the Kawich Range to the east (with an area of low hills to the south). The Cactus Range, situated mostly within the boundaries of TTR, is the remnants of a major volcanic center consisting of relatively young folded and faulted six million-year-old 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 1630 m (5347 ft) at the valley floor to 2279 m (7482 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). Neither the Cactus Range nor the Kawich Range have perennial streams which flow into the TTR. 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 are within TTR boundaries: Cactus, Antelope and Silverbow Springs. Water from these springs does not travel more than several tens of meters and it disappears rapidly through evaporation and infiltration with its effect on the landscape purely local.

Groundwater

Water used for TTR facilities operations comes from wells tapping underlying groundwater in alluvium derived from the surrounding mountains. Well depth to groundwater varies from 21 ft (Antelope Mine)

to 454 ft (EH2). The depth to groundwater at Area 9 is approximately 131 ft; the depth to groundwater at Area 3 is 361–394 ft (provided by the U.S. Geological Survey [USGS]). Static water level at Well 6 (SNL/NV's water supply well) is approximately 350 ft.

Climate

The climate at TTR is mild and usually dry, but, as is typical of high deserts, it is subject to large diurnal and seasonal changes in temperature—from a record high of 102 degrees Fahrenheit (ºF) to a record low of -24 ºF (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 with an average of 4 in. at the desert floor to up to 12 in. in the mountains. Seasonal rainfall occurs in a double maximum—the largest occurring in the summer and the second maximum occurring 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, southeasterly winds from the Gulf of Mexico predominate. Dust storms are common in the spring, and dust devils are common in the summer.

Vegetation

Because of the temperature extremes and arid conditions at TTR, Cactus Flat is sparsely covered with vegetation—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 highlands (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 higher elevations of the Cactus Range, includes sagebrush, rabbitbrush, squirrel tail, wheat grass, and Nevada bluegrass. Joshua trees grow in the foothills and juniper trees are found in the foothills and 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 Mountain areas. Hundreds of wild horses graze freely throughout TTR and the activities onsite have apparently had little effect on the horse population or their grazing habits. In the past, the herd has had to be reduced to prevent overgrazing—horses are adopted through a BLM program.

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

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

One positive effect of the NAFR land withdrawal on local plant and animal populations, in general, is that large areas are protected from the effects of public use, such as on and off-road travel into remote areas, which can greatly impact habitats. Withdrawn areas where activities do not disturb the natural environment provide areas of natural refuge for wildlife resources (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 North Range 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, referred to as Double Tracks, was remediated to a soil contamination level of less than or equal to 200 picocuries per gram (pCi/g) of transuranics and closed out in 1996 (Figure 1-2). Table 1-1 summarizes test information related to the four Project Roller Coaster sites. Through agreement with DOE's Albuquerque Operations Office (DOE/AL), DOE's Nevada Operations Office (DOE/NV) has the Environmental Restoration (ER) responsibilities for the remaining Project Roller Coaster sites; SNL maintains the environmental compliance responsibilities. Clean Slate sites are not included in Corrective Action Units (CAUs) designated by Corrective Action Site (CAS) numbers under Resource Conservation and Recovery Act (RCRA) regulation, as is the case with other ER sites.

The initial cleanup of each Clean Slate site was conducted shortly after each test and consisted of blading the test-related debris into a hole at test ground-zero. The holes were then backfilled with dirt and a fence was erected around each test area. The fenced boundaries were set at approximately 1000 micrograms plutonium per square meter ($\mu g/m^2$) as determined using hand-held survey meters (Rarrick 1993). In 1973, additional outer fences were built, set at 40 pCi/g of plutonium in soil as determined also using hand-held survey meters (Rarrick 1993). This survey was conducted with a field instrument for the detection of low-energy radiation (FIDLER) using 61-meter grids.

Surface soil has been sampled periodically at the Clean Slate sites. An aerial radiologic survey was performed by Edgerton, Germeshausen & Grier Corporation (EG&G) for the Nevada Applied Ecology Group (NAEG) in 1977 using the 1973 grid. The objective of the aerial survey was to determine the surficial distribution of plutonium and other transuranic elements dispersed during the Project Roller Coaster tests. The aerial surveys were undertaken to supplement the FIDLER and previous soil sample measurements of Americium-241 (Am-241). Radiation isopleths showing soil activity due to Am-241, Plutonium-239 (Pu-239), and Plutonium-240 (Pu-240) were drawn for each area (EG&G 1979b). This survey showed the extent of the transuranic contamination, both inside and outside the two control fences of the Clean Slate sites. The Clean Slate areas are examined visually 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.

Table 1-1. Project Roller Coaster Test information.

Test	Date	Location	Status
Clean Slate 1	May 25, 1963	TTR	Final remediation completed in FY1997
Clean Slate 2	May 31, 1963	TTR	Final remediation completed in FY1997
Clean Slate 3	June 9, 1963	TTR	Remediation pending
Double Tracks	May 15, 1963	NAFR, North Range (West of TTR)	Site was remediated and closed in 1996

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

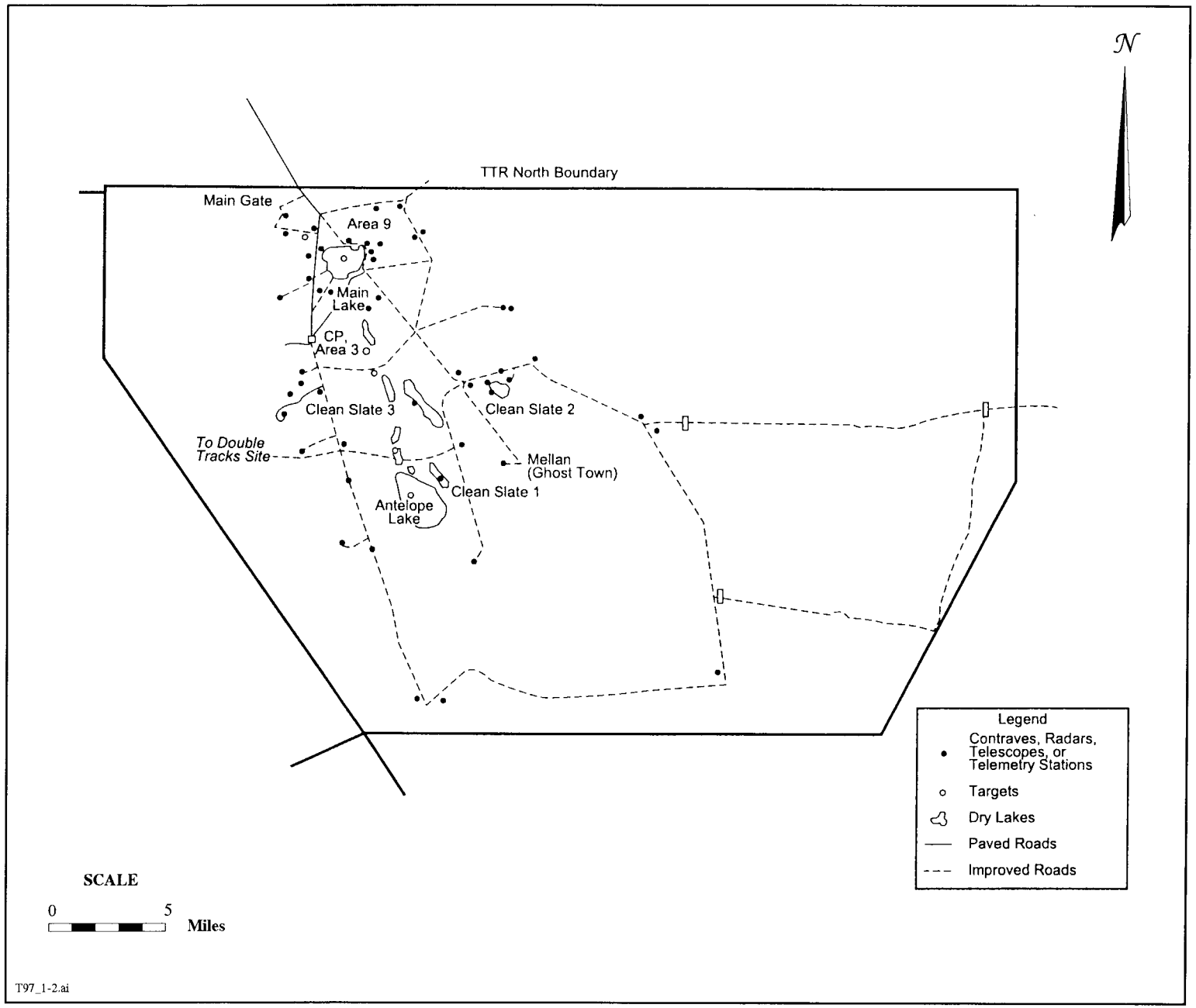


Figure 1-2 Location of facilities operated by SNL at the TTR. ER sites shown include the Clean Slate sites from the Project Roller Coaster Tests.

References

- DOE 1988: DOE Order 5400.1
- Sinnock 1982
- ERDA 1975
- EG&G 1979a
- EG&G 1979b
- DOC 1995 NTS EIS
- DOI/BLM, Final EIS, 1981
- Rarrick 1993

NEW References

- **Final DOE/EIS 1996**: Aug 1996 Final Environmental Impact Statement for the Nevada Test Site and Off Site Location in Nevada"
- **DOC 1995 NTS EIS:**
- **DRI 1991**: *Special Nevada Report*. Prepared by SAIC, Desert Research Institute and submitted by the USAF, Dept. of Navy, and Department of Interior. SAIC, DRI September 23, 1991.
- **IT 1995x**: IT Corp. - Estimated total area for individual TTR Environmental Restoration Investigation Sites, October 16, 1995.
- **Final DOE/EIS 1996**:
- **DOE/BLM, Final EIS, 1981**:
- **Schaeffer 1992**:

2 COMPLIANCE SUMMARY

Sandia National Laboratories (SNL) strives to operate in full compliance with environmental and other requirements established by Federal and State laws, Executive Orders (EOs), and DOE Orders. The following sections summarize the status of the TTR in complying with major environmental statutes, regulations, and DOE Orders. Kirk-Mayer, Inc. (KMI), the facilities support contractor, assists SNL/NV in performing various compliance activities such as air monitoring and water sampling.

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 U.S. Environmental Protection Agency (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 (DOE 1988b). TTR was in compliance with all applicable CERCLA requirements in 1996.

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.

Table 2-1. SNL reporting activities for TTR in 1996 with respect to SARA Title III compliance.

		SNL Reporting			
SARA, Title III (EPCRA)	**Regulation Section Description**	**Yes**	**No**	**Not Required**	**Explanation**
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
311-312	MSDS/Chemical Inventory	✓			MSDS information is made available to local emergency organizations.
313	Toxic Release Inventory (TRI) Reporting			✓	SNL was below the reporting threshold of >10,000 lb/yr of any listed chemical

NOTE: MSDS = Material Data Safety Sheet

2.2 RESOURCE CONSERVATION and RECOVERY ACT (RCRA)

Under RCRA (40 CFR 270.61), TTR is permitted as a "less than 180-day storage area" small quantity generator. Hazardous waste shipments are scheduled to occur two to three times per year. During 1996, there was one hazardous waste shipment through Romic Environmental Technologies and five Safety Kleen waste shipments. Hazardous chemical wastes are collected, packaged, and shipped offsite to an EPA-permitted treatment, storage, and disposal facility (TSDF). Standard Operating Procedures (SOPs) have been written to ensure continued compliance with RCRA regulations. Currently, one Class II sanitary landfill is in operation at TTR. This unit is operated by the USAF Operations and Maintenance (O&M) contractor and is cooperatively used 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 having removed the last five known USTs in August 1994 (certificates of destruction are retained in SNL/NV files). These tanks included two diesel and two gasoline tanks excavated from Area 3 at the site of a former gas station; and one diesel tank in Area 9 that had supplied generator fuel.

In 1996, the Environmental Restoration (ER) Group Contractor, International Technology Corp. (IT Corp.) investigated and sampled the soil in two suspected UST sites within Area 3, based on undocumented historical information. The first suspected tank, when exposed, turned out to be a culvert pipe for a french drain that was fed from an old vehicle maintenance shop. The second site, suspected to be the old Second TTR Gas Station, was investigated using characterization drill holes to obtain soil samples. Soil contamination (diesel fuel and gasoline) was found to a depth of 22 ft but not more than 72 ft (there was no analytical data between 22 and 72 ft). This site will require additional investigative cleanup work. It is believed that an administrative closure will be requested from the State of Nevada.

2.3 FEDERAL FACILITIES COMPLIANCE ACT (FFCAct)

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

2.4 CLEAN AIR ACT (CAA) and CLEAN AIR ACT AMENDMENTS of 1990 (CAAA)

TTR is regulated by the Clean Air Act (CAA) and Clean Air Act Amendments of 1990 (CAAA), and State of Nevada air quality regulations, published in the Nevada Revised Statutes, Title 40, *Public Health and Safety*, Chapter 445. Applicable air quality regulations are listed in Table A-1 of Appendix A. Table 2-3 lists all currently held air permits and registrations in place at TTR. In 1996, the air permits were issued by the State of Nevada for the following activities:

Permits	**Owner**
Aboveground storage tanks	USAF
Concrete batch plants	USAF
Crushers	USAF
Screen	USAF
Vapor extraction unit (emissions >2 tons/yr)	USAF
Surface Disturbance (>5 acres)	DOE/KAO
Portable screen and screening plant	DOE/NV

NESHAP Compliance

A NESHAP annual report was prepared for CY96 (SNL 1997a) detailing radiological dose assessment results for TTR (see Section 5.3). In 1996, there were no instances of noncompliance, however, continuous air monitoring for TTR's diffuse sources, which was required in 1996 is discussed under Section 2.14.

Nonradiological Air Emissions

Nonradiological air emissions in 1996 were in compliance with all applicable permits.

A permit was obtained for a screening plant and portable screen in June 1996. However, due to recently increased testing activities and commitments in other areas, this equipment has yet to be used. The Nevada Department of Environmental Protection (NDEP) may require, at its discretion, opacity checks or particulate matter (PM) air monitoring of the screening process.

2.5 CLEAN WATER ACT (CWA)

TTR is regulated by the Clean Water Act (CWA) and State of Nevada water pollution and sanitary waste systems regulations (Table A-1). Wastewater and well water permits are listed in Table 2-3. TTR wastewater includes septic tank systems and wastewater discharged to the USAF facultative sewage lagoon. There were no excursions or other permit violations in 1996 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.

There are six active septic tanks at TTR that serve remote locations and are maintained by the TTR facilities group. None of these systems required maintenance, sampling, or pumping in 1996. The remaining septic systems have been closed or are undergoing closure. The 13 septic tanks that served Area 3 until 1990—when the consolidated sewage system was installed—will require further testing to ensure that no hazardous constituents are present before disposing of the sewage and closing the tanks in conformance with State of Nevada regulations.

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 accessible 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 activities on TTR may be permitted by SNL itself. A storm water permit was issued to the USAF for Area 10 and the airfield (Table 2-3).

2.6 SAFE DRINKING WATER ACT (SDWA)

TTR is regulated by the Safe Drinking Water Act (SDWA) and State of Nevada public water supply and public water systems regulations. Drinking water for SNL/NV operations at TTR is provided by Well 6 permitted by the State of Nevada in compliance with the public water supply standards. Compliance activities include monthly bacteriological sampling (total coliform). Samples are analyzed quarterly for volatile organic compounds/semi-volatile organic compounds (VOC/SVOC) and unregulated constituents sampling. Annual samples are analyzed for nitrates and nitrites, lead and copper. Complete chemical and radiological analysis of the site's drinking water (required every 3 years) was collected March 21, 1996. All sampling is conducted in accordance with the *Tonopah Test Range Site Sampling Plan* (DOE 1990).

In 1996, all bacteriological sampling was negative for coliform bacteria. VOC/SVOC samples were positive in one 1996 quarterly sampling but were later determined to be caused by contamination within the sampling container.

Elevated lead in the Well 6 water system at Area 3 discovered at 0.070 mg/L, exceeded the SDWA standard of 0.015 mg/L. Sampling with the highest levels were traced to a faucet with lead solder joints. The faucet was replaced and the entire system was purged and resampled after 6 hours, after which time, levels dropped to satisfactory levels. Section 4.6 describes the sampling efforts. SNL remained in compliance with all Well 6 permit requirements.

2.7 TOXIC SUBSTANCES CONTROL ACT (TSCA)

Compliance with the Toxic Substances Control Act (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 50 ppm is considered PCB-contaminated while materials with greater than or equal to 500 ppm are PCBs. TTR transformers owned by DOE/KAO were sampled and analyzed in 1993 for PCB contamination (IT 1993). None of the samples contained over 50 ppm of PCBs and therefore, are non-PCB by EPA definition.

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

All chemical pesticide and herbicide use at TTR is in accordance with EPA regulations. SNL 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 the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) in 1996.

2.9 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

DOE requires National Environmental Policy Act (NEPA) review for all DOE actions potentially affecting the environment; thus, even actions that may be categorically excluded are reviewed for impacts on the environment including endangered species, cultural resources as discussed in the following sections.

In 1996, two Environmental Checklist/Action Description Memorandums (ECL/ADM) were submitted for NEPA determination as follows:

- **SNT 96-001:** Radio Frequency and Electromagnetic Testing. The DOE determination was made on May 6, 1996 for a Categorical Exclusion**.**
- **SNT 96-002:** Air Drop Tests. The DOE determination was made on May 17, 1996 stating that this activity was already covered under an existing EA (ERDA 1975).

2.10 ENDANGERED SPECIES ACT (ESA)

The DOE must review Endangered Species Act (ESA) requirements when planning Federal actions or major construction activities. The key provision of the ESA for Federal activities is Section 7, “Consultation,” which states that Federal agencies must consult with the U.S. Fish and Wildlife Service to ensure that any agency actions are "not likely to jeopardize the continued existence of any threatened or endangered (T/E) species or threatened species or result in the destruction or adverse modification of habitat of such species."

The term “sensitive species” has a much broader connotation for NEPA compliance purposes than “threatened or endangered.” It includes Federally-listed and State-listed T/E species, candidate species for listing, species listed by other Federal agencies, and species perceived by the public as “sensitive.”

The Environmental Impact Statement (EIS) completed for the Nevada Test Site (NTS) and vicinities (e.g., TTR) discusses impacts to sensitive and T/E species that may be either inhabiting within or migrating through the area (DOE 1996).

2.11 CULTURAL RESOURCES ACTS

TTR holds responsibilities for cultural resources management including those responsibilities applicable under the National Historic Preservation Act (NHPA), the Archaeological Resources Protection Act (ARPA), and the American Indian Religious Freedom Act (AIRFA). SNL/NV integrates cultural resources management into its NEPA program.

2.12 EXECUTIVE ORDERS (EOs)

Executive Orders (EOs) 11988, *Floodplain Management*, and 11990, *Protection of Wetlands*, require evaluation of the potential effects of actions taken in floodplains and wetlands. 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.

2.13 1996 AUDITS

Table 2-2 lists audits and inspections made by agencies external to SNL/NV in 1996. Only minor observations were noted in all cases.

2.14 1996 ISSUES & 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.

FFACO Compliance for Environmental Restoration (ER) Activities

The Federal Facility Agreement and Consent Order (FFACO) with the State of Nevada was implemented between the State of Nevada, the DOE, and the Department of Defense (DoD) in May of 1996 (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.

Table 2-2. Summary of environmental audits performed in 1996.

Audit Title	Duration	Results Summary (Document Reference)
Water Distribution System Vulnerability Assessment (State of Nevada)	3/21/96	Formal report not yet provided, accomplished by Larry L. Roundtree, State of Nevada
RCRA Walkthrough (KMI Local)	4/29/96	Minor recommendations (4/3/96 Memo, William Forston, KMI)
Above Ground Storage Tank/Bulk Storage Inspection (KMI Local)	1/17/96	Minor recommendations (1/23/96 Memo, William Forston, KMI)
RCRA Peer Review Audit (DOE/NV & Bechtel Nevada)	5/6/96	Minor Discrepancies (6/25/96 Memo, Runore Wycoff, DOE/NV Response and Comments, 10/2/96 Roger Smith, SNL/TTR)

NESHAP Issue

Based on the dose assessment results, the Estimated Dose Equivalent (EDE) to the Maximally Exposed Individual (MEI), located at the TTR Airfield area, was determined to be in excess of 0.1 mrem/yr but less than 10 mrem/yr. The EDE to the MEI was calculated to be 1.1 mrem/year. As a result, the fugitive source at the TTR requires continuous air monitoring according to the criteria specified in 40 CFR 61, Subpart H.

Due to the areal extent of the fugitive source (approximately 20 million square meters), monitoring at the source is not considered practical. An alternate method was approved by the EPA Region IX in 1995 to monitor the closest receptor location (the TTR Airfield). Monitoring was conducted for a period of one year beginning in 1996 and was used to demonstrate compliance with NESHAP. The *NESHAP Monitoring Plan for the TTR* (SNL 1995a) describes the methods used. A summary of 1996 dose assessment is documented in the *NESHAP Annual Report* (SNL 1997a). The results of the one-year continuous air monitoring will be provided in a Summary Report to the EPA, DOE/KAO, and DOE/NV. Results will also be summarized in the 1997 NESHAP Report for SNL/NV.

Septic Tanks

The facility group performed sampling of the inactive septic tanks in fiscal year 1990 (FY1990) using procedures that met Federal and State requirements. Since FY90, Federal and State regulations imposed more stringent testing parameters, including the requirement for analytical testing using the toxicity characteristic leaching procedure (TCLP). Septic tank sampling was also performed in 1993. Inactive septic tanks will be sampled again during future ER activities.

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. Table 2-3 lists the current permits, permit owners, expiration dates, issuing agencies, and responsible parties. TTR was in full compliance with all permit requirements for 1996.

2.16 OCCURRENCE REPORTING

There were two occurrences as a result of spills related to SNL/NV activities in 1996. Both spills were reportable quantity (RQ) releases and were reported to the State of Nevada.

Diesel fuel Spill

On February 27, 1996, approximately 70 gal. of fuel oil spilled from a portable generator at building 89-01, Flat Top Bunker. The generator had been filled with 73 gal. of fuel, started, and left running unattended. A bleed screw vibrated loose allowing all remaining fuel to be pumped to the ground. The spill was discovered 50 minutes after the generator was started. Mitigation efforts were initially made the same day to excavate all contaminated soil (approximately 20 cubic yards). After a subsequent site evaluation with a photo ionization detector (PID) indicated residual contamination present, an additional 10 cubic yards of soil were removed. Final soil analysis for total petroleum hydrocarbons (TPH) (modified 8015) indicated that adequate cleanup of the spill site had been accomplished based on Nevada Department of Environmental Protection standards (NDEP). A clean closure plan was developed and submitted to the State of Nevada by DOE/NV on January 6, 1997. Comments from the State of Nevada remain pending. The following corrective actions were taken to prevent this type of spill in the future:

- A checklist was developed for the start-up of generators at TTR identifying the systems to monitor during generator operation. Appropriate personnel were trained. (Completed March 6, 1996.)

- The existing generator service log process was modified to identify the fuel filter system check to be performed at each scheduled maintenance interval. (Completed March 6, 1996.)

- All generators onsite with similar fuel filter systems were evaluated for loose bleeder valves. (Completed March 20, 1996.)

Gasoline Spill

On August 31, 1996, a slow leak from the fuel nozzle of a gasoline truck parked at the Heavy Equipment Parking Area (Area 3) resulted in soil contamination to the immediate area. (The vehicle was borrowed from Bechtel Nevada but was under SNL authority.) Approximately 6 cubic yards of soil were excavated during the cleanup process. Soil samples for TPH (modified 8015) and volatile organics were collected from the spill site and excavated soil pile. Sample results indicated that adequate cleanup had been accomplished. A clean closure plan was developed and submitted to the State of Nevada by DOE/NV on January 6, 1997. Comments from the State of Nevada remain pending.

Table 2-3. Summary of permit ownership at the TTR.

Permit Type and Location	Permit Number	Issue Date	Expiration Date	Agency	Ownership
Air Quality Permits					
Petro Storage JP-8	AP9711-0557	11/21/95	11/21/2000	State of NV	USAF
Petro Storage JP-8	AP9711-0557	11/21/95	11/21/2000	State of NV	USAF
Petro Storage JP-8	AP9711-0557	11/21/95	11/21/2000	State of NV	USAF
Petro Storage JP-8	AP9711-0557	11/21/95	11/21/2000	State of NV	USAF
Petro Storage Diesel #1	AP9711-0557	11/21/95	11/21/2000	State of NV	USAF
Petro Storage Diesel #1	AP9711-0557	11/21/95	11/21/2000	State of NV	USAF
Large Batch Plant (Ross)	AP9711-0557	11/21/95	11/21/2000	State of NV	USAF
Small Batch Plant (Johnson)	AP9711-0557	11/21/95	11/21/2000	State of NV	USAF
Crushers (2416 & 1524)	AP9711-0557	11/21/95	11/21/2000	State of NV	USAF
Screens (2416)	AP9711-0557	11/21/95	11/21/2000	State of NV	USAF
Incinerator	AP9711-0557	11/21/95	11/21/2000	State of NV	USAF
Vapor Extraction†	AP9999-0457	11/21/95	03/28/2005	State of NV	USAF
Surface Disturbance	2844		9/15/98	State of NV	DOE/NV
Screen Plant	AP9611-0680	06/12/96	06/12/2001	State of NV	DOE/NV
Portable Screen	AP9611-0680	06/12/96	06/12/2001	State of NV	DOE/NV
Public Water System					
Mancamp - Well 1A (BLM)	NY-4068-12C	09/1997	09/1997	State of NV	USAF
Industrial Area	NY-5001-12NC	09/1997	09/1997	State of NV	USAF
Sandia Compound - Well 6	NY-3014-12NC	09/1997	09/1997	State of NV	DOE/NV
Tonopah Electronic Combat Range (TECR) Operations & Maintenance Well	NY-5002-12NC	09/1997	09/1997	State of NV	USAF
NPDES (Sewage System)					
Tonopah Integrated Air Defense System (TIADS) Mancamp Industrial Area	NEV20001	11/8/95	11/8/2000	State of NV	USAF
RCRA - Hazardous Waste					
SNL/EPA Generator ID No.	NV1890011991		N/A	State of NV	DOE/NV
Beneficial Use Water Permits					
Well EH-1	50166	Canceled	12/9/96	State of NV	DOE/NV‡
Well EH-2	50169	09/19/86	Indefinite	State of NV	DOE/NV‡
Well 1-A	50168	Canceled	12/9/96	State of NV	DOE/NV‡
Well EH-7	53885	09/25/89	Indefinite	State of NV	DOE/NV‡
Well BLM	56916	02/14/83	Indefinite	State of NV	DOE/NV‡
Well 3 B	58149	09/19/86	Indefinite	State of NV	DOE/NV‡
Well 3 A	58150	09/19/86	Indefinite	State of NV	DOE/NV‡

NOTE: †Permit to Construct
‡for USAF well

Table 2-3. Summary of permit ownership at the TTR (Concluded).

Permit Type and Location	Permit Number	Issue Date	Expiration Date	Agency	Ownership
Pending Applications for Beneficial Use Permits (Submitted 12/20/96)					
Area 9 Well Sandia 7	62682	Pending		State of NV	DOE/NV
Area 3 Well 6	62683	Pending		State of NV	DOE/NV
Roller Coaster Well	62684	Pending		State of NV	DOE/NV
General Discharge Permit for Storm water					
General Storm water Area 10 and airfield	GNV0022233-20493	1/1997	5/14/98	State of NV	USAF

NOTE: † Permit to Construct
‡ for USAF well

New References

SNL 19__2a: "Chemical Waste Management at TTR" SOP SP473341

SNL 19__2b: "RCRA Contingency Plan for Building 03-17 Hazardous Waste Accumulation Facility"

DOE 1990: *Tonopah Test Range Site Sampling Plan*

Stockham 1996: A clean closure plan developed by Dwight Stockham, SNL/NM was submitted to the State of Nevada by DOE/NV on 1/6/97.

Stockham 1996b: A clean closure plan developed by Dwight Stockham , SNL/NM was submitted to the State of Nevada by DOE/NV on 1/6/97.

DoD/DOE 1996: 1996 Federal Facility Agreement and Consent Order (FFACO). Implemented by DOE, DoD, and the State of Nevada, signed May 1996. Rev. 1.

3 ENVIRONMENTAL PROGRAMS INFORMATION

SNL maintains a variety of environmental programs to protect the environment and ensure compliance with environmental regulations. This chapter describes SNL/NV's program activities at TTR to remediate sites of past contamination; to manage hazardous, radioactive, and other regulated wastes; to conduct National Environmental Policy Act (NEPA)-related environmental activities; and to respond to releases and environmental occurrences.

There are also specific programs at TTR to perform environmental surveillance; this includes monitoring of terrestrial media, air quality, and wastewater. All Terrestrial Surveillance activities are discussed in Chapter 4.

3.1 ENVIRONMENTAL RESTORATION (ER) ACTIVITIES

ER Site Management

The Environmental Restoration (ER) Project is a phased DOE program to identify, assess, and correct past spill, release, or disposal sites at all DOE-owned and operated sites including the SNL-operated areas of TTR. The method parallels the EPA's CERCLA program to identify, characterize, and clean up inactive waste sites and past release sites. In late 1992 and early 1993, an agreement was reached between DOE Headquarters (DOE/HQ), DOE/KAO, and DOE/NV regarding the management of the ER activities at TTR. The decision was made for the DOE/NV ER Project to manage all ER sites in Nevada including the TTR sites. IT Corp. currently serves as the site ER Group contractor.

ER Site Identification

The initial identification, description, and listing of ER sites at TTR was derived from the Preliminary Assessment (PA) and the Federal Facility Preliminary Assessment Review (E&E 1989). In 1993, IT Corp. subdivided the potential ER sites identified from the PA located throughout the TTR into 43 ER sites. Twelve additional unverified/potential ER sites not included in the PA were also identified by IT Corp. In general, new ER sites are identified through the ER site inventory process, geophysical surveys, and aerial radiological and multispectral surveys. These newly identified sites were included and listed based upon joint efforts of the DOE/NV and SNL in the form of interviews with former site workers, archive reviews, and site visits.

Table 3-1 summarizes the ER Project sites at TTR planned for investigation by SNL/NV. The ER site information presented here is contained in Appendix III of the October 1996 Federal
Facilities Agreement and Consent Order (FFACO) (DoD/DOE 1996).

ER Activities at TTR in 1996

Table 3-2 summarizes the major ER activity accomplishments at TTR during 1996. This included completion on four plans, three closure activities and several new site investigations. In 1996, ER activities were conducted by DOE/NV through an interim agreement with DOE/AL and DOE/KAO.

On February 3, 1995, DOE/NV received a permit exclusion for performing corrective action at TTR from the Nevada Division of Environmental Protection (NDEP). The implementation of the corrective action work plan involved the removal and processing of unexploded ordnance (UXO) and other debris at five Corrective Action Sites (CAS). Three of these sites were active during 1996.

Table 3-1. DOE Environmental Restoration Division TTR Corrective Action Units (CAUs) and sites (Continues).

CAU-400 DOE/ERD Closed Ordnance Disposal Pits, Bomblet Pit & Five Point Landfill, Tonopah Test Range, FFACO.		
Corrective Action Site (CAS) Number	**Corrective Action Site Description**	**General Location**
TA-19-001-05PT	Ordnance Disposal Pit	Five Points Intersection
TA-55-001-TAB2	Ordnance Disposal Pit	Bunker 2 Road
CAU-401 DOE/ERD Closed Underground Storage Tank Site, Gas Station, Area 3 Tonopah Test Range, FFACO.		
Corrective Action Site (CAS) Number	**Corrective Action Site Description**	**General Location**
03-02-003-0357	Underground Storage Tank, Gas	First Gas Station, Area 3
CAU-402 DOE/Industrial - DOE/ERD Closed Underground Storage Tank Site, Building 0353, Area 3 Tonopah Test, FFACO.		
Corrective Action Site (CAS) Number	**Corrective Action Site Description**	**General Location**
03-02-001-0353	Underground Storage Tank, Diesel	Building 0353
CAU-403 DOE/Industrial - DOE/ERD Underground Storage Tank Sites, Area 3 Tonopah Test, FFACO.		
Corrective Action Site (CAS) Number	**Corrective Action Site Description**	**General Location**
03-02-004-0360	Underground Storage Tanks	Second Gas Station
CAU-404 DOE/Industrial - DOE/ERD Roller Coaster Lagoons and Trench, Tonopah Test, FFACO.		
Corrective Action Site (CAS) Number	**Corrective Action Site Description**	**General Location**
TA-03-001-TARC	Roller Coaster Lagoons	NW of Antelope Lake
TA-03-001-TARC	Roller Coaster N. Disposal Trench	NW of Antelope Lake

Table 3-1. DOE Environmental Restoration Division TTR Corrective Action Units (CAUs) and sites (Continued).

CAU-405 DOE/Industrial - DOE/ERD Septic Waste Systems, Area 3, Tonopah Test, FFACO.		
Corrective Action Site (CAS) Number	**Corrective Action Site Description**	**General Location**
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 DOE/Industrial - DOE/ERD Underground Discharge Points, Areas 3, 9, Tonopah Test, FFACO.		
Corrective Action Site (CAS) Number	**Corrective Action Site Description**	**General Location**
03-02-002-0308	Underground Discharge Point	Building 0360
03-52-002-0374	Heavy Duty Shop UDP, Sumps	Building 0374
03-52-003-0358	UPS Building UDP	UPS Building, Area 3
CAU-407 DOE/Industrial - DOE/ERD Radioactive Contamination Sites, Surface/Near Surface, Tonopah Test, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
71-23-00171DT	Double Tracks Rad Safe Area	Nellis Range 71
TA-23-001-TARC	Roller Coaster Rad Safe Area	NW of Antelope Lake
TA-39-001-TAGR	Cactus Spring Ranch, Soil Contam.	West of Target Areas
TA-52-001-TANL	Rocket Propellant Burn Area	NEDS Lake
TA-52-002-TAML	Depleted Uranium Impact Site	Main Lake
TA-52-003-0960	Depleted Uranium Artillery Round	South of Area 9
TA-52-004-TAAL	Metal Particle Dispersion Test	Antelope Lake
TA-52-005-TAAL	Joint Test Assembly DU Sites	Antelope Lake
CAU-408 DOE/Industrial - DOE/ERD Ordnance Sites, Tonopah Test, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
TA-55-002-TAB2	Bomblet Target Areas	Antelope Lake

Table 3-1. DOE Environmental Restoration Division TTR Corrective Action Units (CAUs) and sites (Continued).

CAU-409 DOE/Industrial - DOE/ERD Other Waste Sites, Tonopah Test, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
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-RCCR	Battery Dump Site	Cactus Repeater
TA-53-001-TAB2	Septic Sludge Disposal Pit	Area 3
TA-53-002-TAB2	Septic Sludge Disposal Pit	Area 3
CAU-410 DOE/Industrial - DOE/ERD Miscellaneous Sites, Tonopah Test, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
09-21-001-09MG	Disposal Trench	East of Area 9 Magazines
09-21-001-TA09	Disposal Trenches	Area 9
RG-26-001-RGRV	Lead Contamination, Soil Contamination	Thunderwell Site
RG-52-007-TAML	Davis Gun Penetrator Test	Test Range
RG-55-001-RGMN	WWII Ordnance Site	Mellan Airstrip
RG-55-002-RGHS	WWII Ordnance Site	H-Site Road
RG-55-003-RG36	WWII Ordnance Site	Gate 36B
RG-56-001-RGBA	Station 44 Burn Area	Station 44
TA-19-002-TAB2	Debris Mound	Bunker 2
TA-21-003-TAAL	Disposal Trench	South Antelope Lake
TA-21-003-TANL	Disposal Trench	NEDS Lake
TA-52-006-TAPL	Depleted Uranium Site	Colinabo Detonation Area
TA-54-001-TANL	Rocket Propellant Burn Area	NEDS Lake
TA-55-006-09SE	Buried Artillery Round	Test Area
TA-55-007-09SE	Buried Artillery Round	Test Area
TA-55-008-TAAL	Buried Rocket	Antelope Lake
CAU-423 DOE/Industrial - DOE/ERD Underground Discharge Points, Areas 3, Tonopah Test, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
03-02-002-0308	Underground Discharge Point	Area 3

Table 3-1. DOE Environmental Restoration Division TTR Corrective Action Units (CAUs) and sites (Continued).

CAU-424 DOE/Industrial - DOE/ERD Underground Discharge Points, Areas 9 Landfill, Tonopah Test, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
03-08-001-A301	Landfill Cell A3-1	Area 9
03-08-001-A302	Landfill Cell A3-2	Area 9
03-08-001-A303	Landfill Cell A3-3	Area 9
03-08-001-A304	Landfill Cell A3-4	Area 9
03-08-001-A305	Landfill Cell A3-5	Area 9
03-08-001-A306	Landfill Cell A3-6	Area 9
03-08-001-A307	Landfill Cell A3-7	Area 9
03-08-001-A308	Landfill Cell A3-8	Area 9
CAU-425 DOE/Industrial - DOE/ERD Construction Debris Disposal Area, Area 9 Tonopah Test, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
09-08-001-TA09	Construction Debris Disposal Area	Area 9/Main Lake
CAU-426 DOE/Industrial - DOE/ERD Cactus Spring Waste Trenches, Tonopah, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
RG-23-001-RCCS	Waste Trenches	Cactus Spring Ranch
CAU-427 DOE/Industrial - DOE/ERD Septic Waste Systems 2 & 6, Area 3 Tonopah Test, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
03-05-002-SW02	Septic Waste System	Area 3
03-05-002-SW06	Septic Waste System	Area 3
CAU-428 DOE/Industrial - DOE/ERD Septic Waste Systems 1 & 5, Area 3 Tonopah Test, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
03-05-002-SW01	Septic Waste System	Area 3
03-05-002-SW05	Septic Waste System	Area 3

Table 3-1. DOE Environmental Restoration Division TTR Corrective Action Units (CAUs) and sites (Concluded).

CAU-429 DOE/Industrial - DOE/ERD Photoprocessing Underground Storage Points, Area 3 Tonopah Test, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
03-51-001-0355	Photo Shop UDP, Drains	Photo Shop
09-51-001-0952	Mobile Photographic Lab UDPs	Area 9
CAU-430 DOE/Industrial - DOE/ERD Buried DU Artillery Round #1, Test Area, Tonopah, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
TA-55-003-0960	Depleted Uranium Artillery Round[1]	South of Area 9
CAU-453 DOE/Industrial - DOE/ERD Underground Discharge Points, Areas 9 Landfill, Tonopah Test, FFACO.		
Corrective Action Site Number	**Corrective Action Site Description**	**General Location**
09-55-001-0952	Area 9 Landfill	Area 9

Source: DoD/DOE 1996

NOTE: [1]This site has been approved for closure by NDEP.

Table 3-2. Major ER accomplishments at TTR in 1996.

1996 ER Accomplishments	Type	CAU number (if applicable)
• Prepared and delivered TTR CAU Work Plan	Plan	(none)
• Submitted and received approval for the SAFER Plan for depleted uranium (DU) Round	Plan	CAU 430
• Completed approved closure confirmation for Bomblet Pit and Five Points Landfill	Closure Confirmation	CAU -400
• Prepared Draft and Final Reports for Bomblet Pit and 5 Points Landfill	Report	CAU-400
• KMI Radworker personnel accomplished final radiological contamination cleanup of the Five Points Landfill site during 1996.	Cleanup	CAU-400
• Prepared and obtained DOE Radioactive Waste Acceptance Package (RWAP) approval and implemented NVO-325 Waste Characterization Sampling Analysis Plans (SAPs) at 3 TTR Sites.	Plan	(none)
• Planned, approved, and completed site investigations at Second Gas Station, Roller Coaster Sewage Lagoons, and Cactus Springs Waste Trenches.	Site Investigation	CAU-426 CAU-404 CAU-403
• Performed Geophysical Surveys at Area 3 Landfill	Survey	CAU 424
• Prepared Draft Closure Report for Buried DU Round	Closure Report	CAU 430
• Completed Interim Action for Double Tracks	Interim Action	
• Completed Double Tracks Site Revegetation	Closure activity	not applicable
• Prepared NEPA Documentation for Double Tracks*	NEPA documentation	not applicable
• Prepared Interim Corrective Action Plan for Double Tracks	Plan	not applicable

NOTE: * Under USAF supervision

Site	CAS No.	1996 Active
Bomblet Pit	TA-55-001-TA-B2	✓
Five Points Landfill	TA-19-001-05-PT	✓
Roller Coaster Sewage Lagoons	TA-03-001-TA-RC	✓
Area 9 Landfill,	09-10-001-09-52	
Area 9 Construction Debris Area	09-08-001-TA-09	

These five sites contained construction debris, UXO, practice ordnance, scrap metal, and some various items containing hydrocarbons, hazardous, or radioactive constituents. There was no ordinance processing at any of these sites during 1996, although, some sampling debris and radioactive material cleanup occurred. Hazardous waste collected from the Roller Coaster Sewage Lagoons was shipped to a TSDF in 1995. Additionally, 220 tons of nonhazardous and nonradioactive debris from the Roller Coaster Sewage Lagoons was disposed of at the TTR landfill in 1996.

Air Monitoring at ER sites

The Clean Slate sites are a diffuse source of plutonium and americium contamination. As discussed under Section 2.14, continuous air monitoring commenced in 1996 due to a calculated dose to the MEI result greater than 0.1 mrem/year.

All samples collected at the TTR Airfield area were analyzed for plutoium-238, (Pu-238), Pu-239, Pu-240, and Americium-241 (Am-241) by alpha spectroscopy. The Pu isotopic analysis includes: Pu-238, Pu-239, and Pu-240. For NESHAP compliance, the analysis of Pu-238 is not required due to its low contribution (<10%) to the total EDE. However, since the isotopic Pu analysis includes Pu-238, the Pu-238 results has been included in all calculations and summaries.

Underground Storage Tanks (USTs)

Past UST sites designated as ER Corrective Action Sites are managed under RCRA as discussed in Section 2.2. Two underground storage tank sites were approved for closure by the NDEP in CY95 and have been removed from the ER list.

- CAU 401 CAS-03-02-003-0357
- CAU 402 CAS-03-02-001-0353

These sites will remain in Appendix IV (closed sites) of the FFACO.

The first tank within CAU 401 had been earlier suspected to be the site of a UST, but upon further investigation it was found that only an aboveground storage tank (AST) had been previously located at the site. The site was approved for closure even though a UST never existed there. The second tank within CAU 402 had a favorable site characterization and required no further remediation according to the State of Nevada rules.

The Environmental Restoration Group investigated and sampled two suspected undocumented/historical UST sites at Area 3 in 1996. One of these sites will require additional cleanup.

3.2 SPILL PREVENTION CONTROL & COUNTERMEASURES PLAN

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

There are 172 electrical transformers in use or in temporary storage at TTR: 73 have been installed at ground level and require secondary spill containments; 60 are installed on utility poles and are not applicable to the plan; the remaining 39 transformers are in storage—those that are filled with transformer oil are within secondary containments.

Additionally, there were 12 ASTs applicable to the plan in 1996. At the close of CY1996, this number dropped to 11 after ownership of

one tank was transferred to the USAF. Minor maintenance of all facilities applicable to the plan was recommended in 1996 and documented in an inspection memo completed on January 18.

3.3 WASTE MANAGEMENT PROGRAMS

Waste management is the safe and effective management of active and standby facilities and the treatment, storage, and disposal of radioactive, regulated hazardous and chemical waste and non-hazardous solid waste. Waste management also includes general waste minimization efforts and recycling activities. The following sections summarize the waste management programs and activities at TTR in 1996.

Chemical and Hazardous Waste Management

Regulated chemical wastes generated by SNL/NV activities at TTR during 1996 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. This ability has enabled DOE/NV to use local personnel in environmental cleanup and restoration activities.

The following categories list amounts of waste generated and shipped offsite at TTR in 1996:

Waste Type	Weight
RCRA regulated	930 kg
Non-RCRA regulated	2135 kg
Recyclables	8988 kg
ER Waste (contaminated soils)	312 tons

All regulated waste was disposed of offsite at a permitted Treatment Storage and Disposal Facility (TSDF). 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 transported offsite for recycling or alternative fuel use. A *Biennial Hazardous Waste Generation Report* is prepared by KMI Services and submitted to the EPA through DOE/NV (DOE 1997).

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. 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

TTR generates radioactive waste—the bulk of which comes from contaminated ER soils. At present, there is no mixed waste (MW) generated at TTR nor is there any MW in storage. 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 activity.

Table 3-3. RCRA-regulated chemical and hazardous waste shipped offsite in 1996 for disposal.

RCRA Waste Shipping Name	Waste Codes	Weight (kg)
Waste Paint Related Material	D001, D035, F003, F005	186
Hazardous Waste Solid, NOS, (rags with acetone, mek)	D035, F002, F003, F005	268
Hazardous Waste Liquid, NOS, (Ethylene Glycol, with Benzene, Lead)	D008, D018	55
Waste Diethyl Ether	D001	20
Waste Aerosols, Flammable	D001	238
Waste Flammable Liquid, NOS (Paint, Naphtha)	D001	56
Hazardous Waste Solid, NOS (Toluene, Acetone)	D035, F003, F005	21
Waste Batteries dry (containing potassium Hydroxide, Nickel cadmium Batteries)	D006	30
Waste Flammable Liquid, NOS (Acetone, Epoxy Resin)	D001, U002	14
Waste Flammable Solid, NOS (Sodium Metal)	D001, D003	26
Waste Toxic Solid inorganic, NOS (Lead Flux)	D008	4
Waste Corrosive Liquid, Acidic, inorganic NOS (Acid pH $\leq$ 1)	D002	12
	TOTAL	930 kg

NOTE: NOS = not otherwise specified

Table 3-4. Regulated hazardous or toxic waste (other than RCRA Waste) shipped offsite for treatment and disposal.

Non-RCRA Waste Material	Weight (kg)
Sealed Capacitor possible PCB (TSCA)	31
Possible asbestos containing material (TSCA)	4
Batteries non-regulated Alkaline	247
Petroleum Contaminated soil, rags, filters, etc.	285,463
Spend Drager Tubes (corrosive, solid, NOS)	13
Non-RCRA Solid (Adhesives)	5
Non-RCRA Solid (calcium sulfate)	43
TOTAL	285,806 kg

Table 3-5. Regulated hazardous or toxic waste shipped offsite in 1996 for recycling.

Waste Material	Weight (kg)
Used oil	5547
Safety Kleen solvent (petroleum naphtha)	676
Safety Kleen immersion cleaner (monoethanolamine)	129
Sodium light bulbs	124
Automotive/Equipment lead acid batteries	2512
TOTAL	8,988 kg

Table 3-6. Categories of radioactive waste stored onsite at TTR in 1996 at the Waste Connex in Area 9.

Container	Isotope	Contents	Comments
Visquene wrap	Radium-226	Wind Radar Mount	Contains the Radium-226 system that broke and contaminated 2 trailers
Visquene wrap	Radium-226	Cut Section of Contaminated Trailer	End section from large original wind radar trailer
Visquene wrap	Radium-226	Cut Section of Contaminated Trailer	Cut section from small wind radar trailer
Steel drum 55 gal	U-238	Drum #291-02	Soil & Depleted Uranium
Steel drum 55 gal	U-238	Drum #889-01	Soil & Depleted Uranium
Steel drum 55 gal	U-238	Drum #691-06	Soil & Depleted Uranium
Steel drum 55 gal	U-238	Drum #591-05	Soil & Depleted Uranium
Steel drum 55 gal	U-238	Drum #4M91-04M	Soil & Depleted Uranium
Steel drum 55 gal	U-238	Drum #391-03	Soil & Depleted Uranium
Steel drum 55 gal	U-238	Drum #791-07	Soil & Depleted Uranium
Steel drum 55 gal	U-238	Drum #191-01	Soil & Depleted Uranium
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 & Static Guns
Steel drum 15 gal	Radium-226		Radium Dials/Switches
Steel drum 5 gal	U-238	Waste Contaminated Soil	Soil removed from Main Lake near Hard Target to allow for test object recovery
Original case	Radium-226	Radium Dial	Excess Altimeter Equipment
N/A	Thorium		Optic System containing Thorium undamaged
Cardboard box	(Unknown)		Microwave Tubes

3.4 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) PROGRAM

The National Environmental Policy Act (NEPA) requires that Federal agencies prepare environmental impact statements (EISs) on proposals for "major Federal action significantly affecting the quality of the human environment." Other NEPA compliance documentation includes Environmental Assessments (EA).

The DOE extensively revised NEPA implementing procedures and published the final form on April 24, 1992 (57 FR 15122). The regulations rewrote the old 10 CFR 1021. The DOE amended these regulations on July 9, 1996 (61 FR 36222). The 1996 amendments incorporate changes that improve DOE's efficiency in implementing NEPA requirements by reducing costs and preparation time while maintaining quality consistent with the DOE Secretarial Policy Statement on NEPA issued in June 1994. Additionally, DOE Order 451.1 (DOE 1995), issued on September 11, 1995, establishes responsibilities and procedures to implement NEPA in conformance with the new DOE NEPA regulations.

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. In 1996, DRI accomplished one cultural resource survey for SNL operations.

An EIS including 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:

- **U.S. 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.

- **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 1996).

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

- **Water Resources Center, DRI, University of Nevada System**. DRI is under contract with DOE to provide services that include public information activities and air and terrestrial radiation monitoring support. During 1996, DRI set up an air monitoring and meteorologic station at Bunker 2 near the Clean Slate 3 site.

- **EG&G.** In 1996, EG&G conducted a DU survey of the Hard Target area and surrounding vicinities using six Kiwi Sodium Iodine Detectors. The purpose of the surveys was to locate areas containing projectile fragments of DU. Areas identified as containing DU were verified using hand held survey meters; results have been documented. The contaminated areas are scheduled for eventual remediation.

- **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

  - Air quality monitoring for particulate matter (PM_{10}) and total suspended particulates (TSP)

  - Soil sampling and site characterization of spill sites

- **EPA and Others.** Other agencies also prepare reports relative to NAFR activities that may include information on TTR. These reports, described in Volumes 1 through 4 of the *SNL/NV Environmental Compliance Summary Report* (SNL 1993), are available from the respective agencies. Reports that are prepared on a regular basis include:

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

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

3.6 SUMMARY OF RELEASE REPORTING

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

- **Reportable Quantity (RQ) Accidental Release Reporting:** RQ release reporting is required by the CERCLA and SARA Title III. CERCLA requires that release to the environment, of a hazardous substance in a quantity greater than or equal to the RQ, must be reported immediately to the National Response Center (NRC) at telephone number (800) 424-8802. However, if the release is "Federally permitted" under CERCLA Section 101(10)H, it is exempted from CERCLA reporting. This reporting exemption also applies to any "Federally permitted" release under SARA, Title III.

- **Radioactive Effluent Information System/Onsite Discharge Information System (EIS/ODIS) Annual Report:** DOE Order 5400.1 requires that data relevant to radioactive effluent and onsite discharges from the previous year for all planned and unplanned releases must be reported to the Waste Information System Branch of Edgerton, Germeshausen, and Greer Corporation (EG&G), Idaho, Inc., by April 1st each year (DOE 1988). The EIS/ODIS report for 1996, submitted in 1997, covered all routine and non-routine releases from SNL/NM operations. TTR had no radioactive onsite discharges during 1996.

- **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 from each DOE site 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 millirem per year for the Maximally Exposed Individual (MEI) and in person-rem for the local population. Chapter 5 of this report summarizes results of the NESHAP dose assessment results for TTR presented in the *Annual NESHAP Report for TTR* (SNL 1997a).

- **State of Nevada Reports:** The State of Nevada requires copies of each hazardous waste manifest accompanying 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 Division of Environmental Protection. All analytical tested wastewater constituents were within acceptable regulatory limits in 1996.

References

- **DOE 1988a:** *Federal Facility Preliminary Assessment Review* (Ecology and Environment, Inc., 1989).

- **DoD/DOE 1996:** 1996 Federal Facility Agreement and Consent Order (FFACO). Implemented by DOE, DoD, and the State of Nevada, signed May 1996. Rev. 1.

- **EPA 1997:** U.S. Environmental Protection Agency 1995 Hazardous Waste Report, U.S. DOE SNL Tonopah Test Range, 03/26/97

4 TERRESTRIAL SURVEILLANCE and WATER MONITORING

This chapter gives an overview of the monitoring activities conducted at TTR by SNL. SNL samples for radiological and nonradiological constituents in the soil to detect release residues in the terrestrial environment from air deposition, and storm water runoff. Monitoring is also conducted for the ambient environment by measuring external gamma radiation.

Other than three remote springs located within TTR's boundary, there are no standing areas of natural water collection or perennial streams. Any storm water that does runoff is quickly evaporated and very little recharges to the ground **(DRI 1991**). Therefore, sampling of surface water is not performed. Groundwater samples are collected and analyzed from one well which supplies potable water to Area 3.

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

4.1 TERRESTRIAL SURVELLANCE OBJECTIVES, SAMPLING SITE SELECTION, and ANALYSIS METHOD

Objectives

The overall objectives of the Environmental Surveillance Program are 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. The specific objectives include the annual sampling of the long-term, routine environmental surveillance locations and supplementing the environmental baseline data collected in 1992 (SNL 1992a). Additional baseline-related sampling was performed in 1994 in areas where SNL has had a long-term or continued presence at TTR. The annual sampling of the routine surveillance locations provides information related to the long-term environmental conditions and trends of the site.

Site Selection

Environmental monitoring at TTR by SNL began in 1992. To support the objectives of the Environmental Surveillance Program, soil samples are collected in three distinct areas: offsite, site perimeter, and onsite. The 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. The perimeter locations are used to monitor the site boundary for potential contamination migrating either onto or off of TTR. 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. All samples collected in 1996 were collected from areas of uncontrolled access within TTR and publicly accessible areas at offsite locations.

Most 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.

Environmental thermoluminescent dosimeters (TLDs) have been placed at various locations offsite, at the site perimeter, and onsite to measure external gamma radiation.

Sample Collection and Analysis

In June 1996, staff from the Sandia National Laboratories/New Mexico's (SNL/NM) Environmental Monitoring and Reporting Department, under the direction of the Environmental Surveillance Program, collected soil samples at TTR. Soil samples were gathered in accordance with *Environmental Sampling Procedure* (SNL 1992b). In cases of replicate sampling, only the first sample collected (sample A) was used in summary calculations to avoid skewing summary data toward replicate sample data.

As part of the 1996 surveillance activities, a total of 54 locations were sampled. The number of samples collected at each area is shown in Table 4-1. Detailed sampling site maps are presented in Appendix B.

All soil samples were analyzed for nonradiological and radiological parameters. Radiological analyses include total uranium (U_{tot}), gamma spectroscopy and, when required, isotopic plutonium. Nonradiological analyses was performed using the Inductively Coupled Plasma Atomic Emission Spectrum (ICP-AEC) method. A total of 19 stable metals were analyzed as follows.

Aluminum (Al)	Chromium (Cr)
Cadmium (Cd)	Cobalt (Co)
Copper (Cu)	Calcium (Ca)
Barium (Ba)	Beryllium (Be)
Lead (Pb)	Iron (Fe)
Magnesium (Mg)	Manganese (Mn)
Titanium (Ti)	Nickel (Ni)
Potassium (K)	Silver (Ag)
Vanadium (V)	Strontium (Sr)
Zinc (Zn)	

Samples collected in 1996 were analyzed by a different analytical laboratory than the analysis in recent years. Although, the new laboratory has performed the analysis in previous years. Some minor variation in analytical results is expected when changing analytical laboratories.

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

For individual samples collected from onsite and site perimeter locations, radiological and nonradiological results were compared to the upper 95 percent confidence limit. The 95 percent limit is based on the mean offsite value plus two standard deviations of all offsite samples collected. Individual samples with values greater than the upper 95 percent confidence interval and greater than the range of observed values were considered potentially contaminated. (The exception is Am-241 and isotopic Pu. Samples with any detectable quantity of these isotopes were considered potentially contaminated.)

4.2 RADIOLOGICAL TERRESTRIAL SURVEILLANCE RESULTS

4.2.1 Soil Sampling Results

Figures B-1 through B-11 of Appendix B shows the 1996 environmental surveillance soil sampling locations as listed in Table 4-1. Individual radiological sampling results from each sampling area are listed in corresponding Tables B-1 through B-7. Results of replicate sampling are summarized in Table B-9. Table 4-2 summarizes the radiological soil sampling data from all sampling locations. The offsite data is summarized with the mean, standard deviation, and range of values presented. Onsite areas are summarized by presenting the range of values for each of the sampling areas.

The sample analysis methodology employed for soil samples required U_{tot} and gamma spectral analysis for all samples. If the gamma spectral analysis detected Am-241 in concentrations greater than its analytical detection limit, then isotopic Pu analysis was performed. Only those samples with Am-241 concentrations greater than the analytical detection limit are reported.

Offsite Soil Sampling - 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 (see 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 locations which 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 samples found to be slightly elevated in Cs-137 and $U_{tot.}$

Table 4-2. Radiological summary data for soil samples collected at TTR in 1996.

Location	Number of Samples	Number of Samples with Measurable† Am-241	U_{tot} (ug/g)	Cs-137 (pCi/g)	Am-241 (pCi/g)	Pu-238 (pCi/g)	Pu-239/240 (pCi/g)
Offsite							
Range	14	0	1.8 to 4.0	0.06 to 0.70	ND	ND	ND
Mean			2.67	0.34	ND	ND	ND
Standard Deviation			0.68	0.20	ND	ND	ND
Site Perimeter	5	0	2.1 to 2.5	0.09 to 0.50	ND	ND	ND
554th Range O&M	3	0	1.3 to 2.1	0.32 to 0.72	ND	ND	ND
On-Base Housing	5	0	2.3 to 2.8	0.0 to 0.30	ND	ND	ND
Range Operations Center (6)	10	0	2.7 to 4.0	0.01 to 0.51	ND	ND	ND
South Plume Area	6	1	1.3 to 2.4	0.37 to 0.69	0.18	–0.01	1.6
Various Onsite Locations (6)	11	5	1.8 to 4.3	0.08 to 0.85	0.03 to 0.71	-0.01 to 0.03	0.11 to 5.4

NOTE: ug/g = micrograms per gram; pCi/g = picocurie per gram; if Americium-241 was detected in any sample, follow-up isotopic plutonium analysis was performed.
ND = Below detection limit
†Samples with measurable Am-241 (greater than detection limit) are considered potentially contaminated.

Onsite Soil Sampling - Radiological results from onsite soil sampling are divided among the following six areas:

- Site Perimeter - Five samples were collected from the TTR site perimeter (see Figure B-2 and Table B-2). All Cs-137 and U_{tot} results were indistinguishable from offsite concentrations.

- On-Base Housing Area - Five samples were collected from near the On-Base Housing Area (see Figure B-3 and Table B-3). All Cs-137 and U_{tot} results were indistinguishable from offsite concentrations.

- South Plume Area - Six samples were collected from the South Plume Area (see Figure B-4 and Table B-4). All Cs-137 and U_{tot} results were indistinguishable from offsite concentrations. The sample collected from location **T-19** contained elevated concentration of Am-241; additional analysis showed elevated concentrations of Pu. **T-19** is located at the southern end of Clean Slate 1, in areas known or suspected to be contaminated with radioactive material related to the Clean Slate 1 dispersal test.

- 554th Range Squadron O&M Complex - Three samples were collected from the area around the 554th Range Squadron O&M Complex (see Figure B-5 and Table B-5). All Cs-137 and U_{tot} results were indistinguishable from offsite concentrations. The sample collected from location **OM-3** showed elevated concentration of Cs-137. However, Cs-137 concentrations from all other locations were indistinguishable from offsite. **OM-3** is located approximately 1.3 miles west of the 554^{th} O&M Complex.

- Range Operations Center - Eleven samples were collected from the area around the Range Operations Center (see Figure B-6, B-7, and B-8 and Table B-6). All Cs-137 and U_{tot} results were indistinguishable from offsite concentrations.

- Various Onsite Locations - Ten samples were collected from various locations onsite (see Figure B-9, B-10 & B-11 and Table B-7). Samples collected at locations **MH-3**, **MH-4**, and **STA-14** showed elevated concentrations of Cs-137. Cs-137 concentrations from all other locations were indistinguishable from offsite. **MH-3** showed elevated concentrations of U_{tot}. U_{tot} concentrations from all other locations were indistinguishable from offsite. **D-1**, **MH-4**, **STA-14**, **T-3**, and **T-4** were found to have elevated concentrations of Am-241; additional analysis showed elevated concentrations of Pu. **STA-14** and **T-3** are both located in the vicinity of Clean Slate 2. Location **D-1** is the site of the former Project Roller Coaster Decontamination Area and **T-4** is located in the vicinity of Clean Slate 3.

4.2.2 Thermoluminescent Dosimeter (TLD) Monitoring Results

As part of the long-term, routine, Environmental Surveillance Program at TTR, SNL began an ambient gamma radiation monitoring program in January 1994. TLDs measure external gamma exposure from both background (e.g., cosmic rays) and man-made sources (e.g., fall-out and diffuse sources). Factors such as elevation and local geological deposits can effect TLD measurements.

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-8 of Appendix B lists the TLD locations and individual 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 260 ± 42 mR/yr compared to an annual average offsite exposure of 135 ± 19 mR/yr. Soil sampling location **OC-1** located very near to **T-13**, does not indicate elevated levels. A survey of the area around **T-13** using a hand held radiation survey meter was performed in 1996; no unusual results were found. A review of the historic TLD data for **T-13** shows that elevated results do not occur every monitoring period but are more cyclic or intermittent in nature (Figure 4-1). The source of the elevated results is not known but will continue to be investigated.

4.3 NONRADIOLOGICAL TERRESTRIAL SURVEILLANCE RESULTS

Soil Sampling Results

Tables C-1 through C-7 of Appendix C list the individual nonradiological sample results for the soil sampling. Figures B-1 through B-11 show soil sampling locations. Results of replicate sampling are summarized in Table C-8. Table 4-4 summarizes the nonradiological soil sampling data from all sampling locations.

Offsite Soil Sampling - Nonradiological 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 the 19 analyzed metals (see Figure B-1 and Table C-1).

Onsite Soil Sampling - Results from onsite sampling of nonradiological parameters are divided into the following six areas:

- Site Perimeter - Five samples were collected from the TTR site perimeter (see Figure B-2 and Table C-2). Sample **T-11** contained elevated concentrations of Fe and Mn. **T-11** is located at the west perimeter gate that separates NAFB from TTR. All other analyses performed on samples collected from the site perimeter were indistinguishable from offsite concentrations.

- On-Base Housing Area - Five samples were collected from near the On-Base Housing Area (see Figure B-3 and Table C-3). All five samples collected were indistinguishable from offsite concentrations.

- South Plume Area - Six samples were collected from the South Plume Area (see Figure B-4 and Table C-4). Sample **T-14** contained elevated concentrations of Al, Fe, Ti, and V; **T-16** and **T-15** both contained elevated concentrations of Al and Ti; **T-18** contained elevated Ti. These locations are

Table 4-3. Summary of thermoluminescent dosimeter measurements for 1996.

Location	Number of Measurements	Annual Exposure (mR/yr)		
		Mean	Standard Deviation	Range
Offsite (Community) (C)	5	135	19	116 ± 14 to 150 ± 24
Perimeter (P)	4	155	18	140 ± 13 to 167 ± 29
Onsite (S)	13	159	17	139 ± 11 to 260 ± 42

NOTE: mR/yr = milliroentgen per year

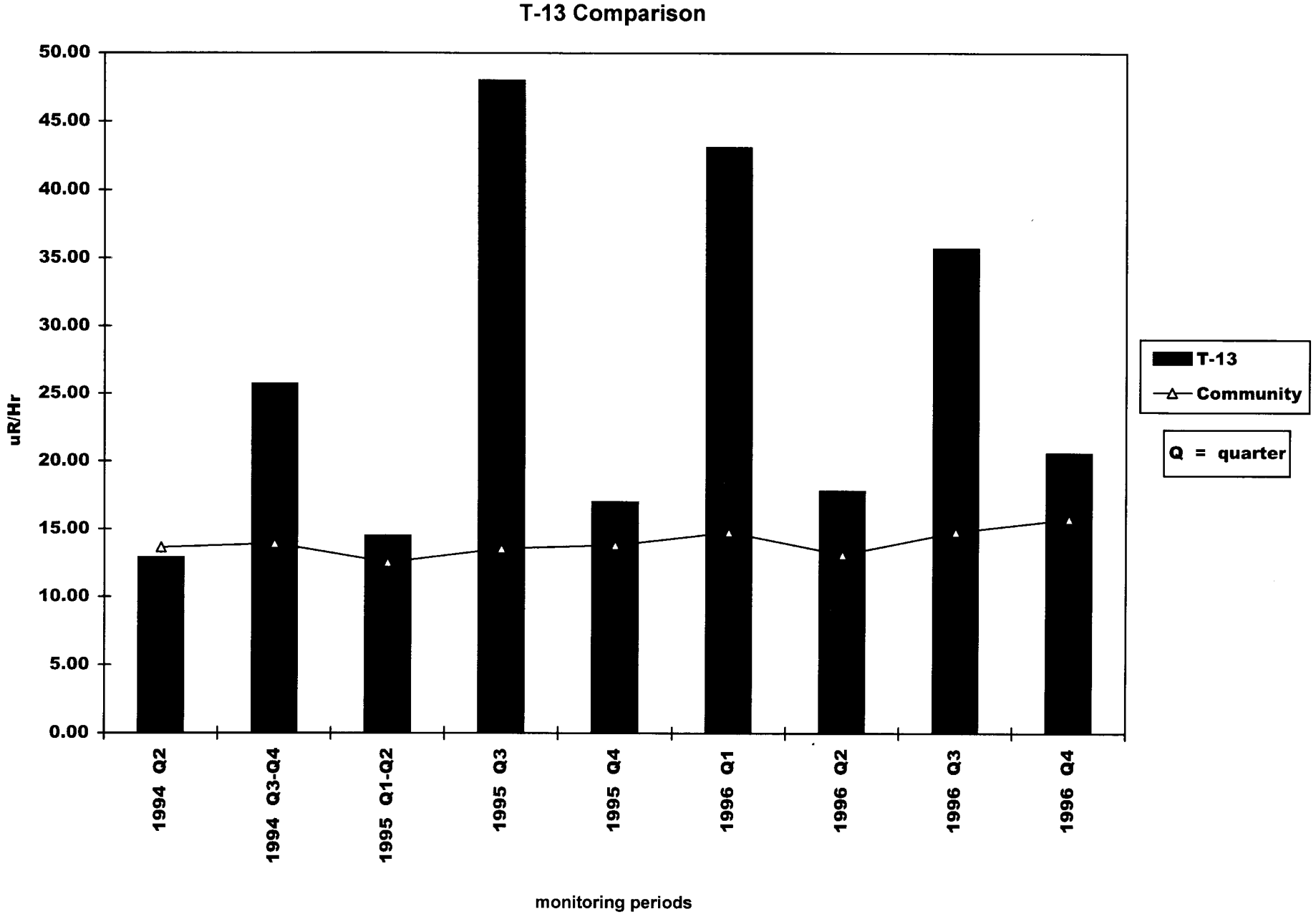


Figure 4-1. TLD location T-13 compared to average community values.

Table 4-4. Nonradiological summary table for soil samples collected at TTR in 1996.

Location	Metals	Number of Samples	Average	Standard Deviation	Range
554th Range Squadron	Aluminum	3	6100.00	754.98	5400 to 6900
	Barium	3	77.00	20.95	59 to 100
	Beryllium	3	0.50	0.00	0.5 to 0.5
	Cadmium	3	0.50	0.00	0.5 to 0.5
	Calcium	3	2100.00	435.89	1800 to 2600
	Chromium	3	12.83	5.25	7.5 to 18
	Cobalt	3	1.97	0.55	1.4 to 2.5
	Copper	3	4.47	0.75	3.6 to 4.9
	Iron	3	5666.67	1078.58	4900 to 6900
	Lead	3	8.67	1.53	7 to 10
	Magnesium	3	1900.00	600.00	1300 to 2500
	Manganese	3	250.00	75.50	180 to 330
	Nickel	3	3.33	0.58	3 to 4
	Potassium	3	2700.00	100.00	2600 to 2800
	Silver	3	0.50	0.00	0.5 to 0.5
	Strontium	3	21.67	4.73	18 to 27
	Titanium	3	146.67	46.19	120 to 200
	Vanadium	3	7.80	1.65	6.7 to 9.7
	Zinc	3	20.33	4.16	17 to 25
Offsite	Aluminum	14	6192.86	1589.61	3600 to 9300
	Barium	14	138.50	58.30	82 to 320
	Beryllium	14	0.55	0.09	0.5 to 0.8
	Cadmium	14	0.50	0.00	0.5 to 0.5
	Calcium	14	11585.71	9354.30	1900 to 29000
	Chromium	14	10.36	3.71	6.9 to 18
	Cobalt	14	2.90	0.82	1.5 to 4.3
	Copper	14	7.07	2.52	4.2 to 12
	Iron	14	7200.00	1470.74	4400 to 9000
	Lead	14	13.57	4.42	7 to 25
	Magnesium	14	3335.71	1690.52	1600 to 8000
	Manganese	14	301.43	83.93	140 to 430
	Nickel	14	5.00	2.42	3 to 12
	Potassium	14	2971.43	753.89	1800 to 4400
	Silver	14	0.54	0.11	0.5 to 0.9
	Strontium	14	68.07	45.02	24 to 180
	Titanium	14	163.71	59.38	92 to 240
	Vanadium	14	12.26	4.07	6.3 to 21
	Zinc	14	32.71	12.84	16 to 65
On-Base Housing	Aluminum	5	4260.00	545.89	3600 to 4900
	Barium	5	86.60	16.24	72 to 110
	Beryllium	5	0.50	0.00	0.5 to 0.5
	Cadmium	5	0.50	0.00	0.5 to 0.5
	Calcium	5	3760.00	2669.83	1500 to 8100
	Chromium	5	10.84	2.71	8.2 to 15
	Cobalt	5	1.48	0.41	1 to 2.1
	Copper	5	2.84	0.29	2.6 to 3.3

Table 4-4. Nonradiological summary table for soil samples collected at TTR in 1996 (Continued).

Location	Metals	Number of Samples	Average	Standard Deviation	Range
On-Base Housing (Continued)	Iron	5	5040.00	606.63	4300 to 5700
	Lead	5	5.20	0.45	5 to 6
	Magnesium	5	1540.00	304.96	1200 to 1900
	Manganese	5	146.00	23.02	120 to 170
	Nickel	5	2.60	0.55	2 to 3
	Potassium	5	2080.00	319.37	1600 to 2300
	Silver	5	0.50	0.00	0.5 to 0.5
	Strontium	5	28.00	11.90	16 to 44
	Titanium	5	142.00	14.83	120 to 160
	Vanadium	5	7.94	1.12	6.6 to 9.1
	Zinc	5	18.20	2.49	16 to 22
Range Operations Center & Compound	Aluminum	10	6450.00	1409.69	4700 to 9300
	Barium	10	103.30	23.04	74 to 130
	Beryllium	10	0.55	0.07	0.5 to 0.7
	Cadmium	10	0.61	0.23	0.5 to 1.1
	Calcium	10	10610.00	3917.61	5600 to 17000
	Chromium	10	10.76	2.21	6.7 to 14
	Cobalt	10	3.04	0.63	2.3 to 4.2
	Copper	10	7.38	2.34	4.1 to 11
	Iron	10	7470.00	1277.19	5800 to 10000
	Lead	10	12.50	5.68	7 to 27
	Magnesium	10	2880.00	801.11	2000 to 4500
	Manganese	10	262.00	33.27	220 to 330
	Nickel	10	4.10	1.10	3 to 7
	Potassium	10	2750.00	579.75	2200 to 4300
	Silver	10	0.50	0.00	0.5 to 0.5
	Strontium	10	58.70	19.50	33 to 85
	Titanium	10	217.00	63.95	120 to 330
	Vanadium	10	13.97	2.80	9.7 to 18
	Zinc	10	43.90	30.23	24 to 120
Site Perimeter	Aluminum	5	6000.00	2016.18	3600 to 8400
	Barium	5	103.80	25.66	78 to 140
	Beryllium	5	0.54	0.09	0.5 to 0.7
	Cadmium	5	0.50	0.00	0.5 to 0.5
	Calcium	5	2860.00	1760.11	1600 to 5900
	Chromium	5	13.16	3.09	9.8 to 18
	Cobalt	5	3.10	1.21	1.2 to 4.5
	Copper	5	7.26	3.03	4.8 to 12
	Iron	5	8280.00	2937.18	4400 to 12000
	Lead	5	12.20	5.50	5 to 20
	Magnesium	5	2060.00	838.45	1200 to 3100
	Manganese	5	362.00	147.21	130 to 510
	Nickel	5	4.40	1.14	3 to 6
	Potassium	5	2420.00	356.37	1900 to 2800
	Silver	5	0.52	0.04	0.5 to 0.6
	Strontium	5	27.20	7.60	18 to 37

Table 4-4. Nonradiological summary table for soil samples collected at TTR in 1996 (Concluded).

Location	Metals	Number of Samples	Average	Standard Deviation	Range
Site Perimeter (Continued)	Titanium	5	111.60	81.47	16 to 200
	Vanadium	5	11.30	4.65	6.4 to 18
	Zinc	5	34.60	13.16	18 to 53
South Plume Area	Aluminum	6	8800.00	2286.48	5700 to 12000
	Barium	6	179.50	49.29	87 to 230
	Beryllium	6	0.52	0.04	0.5 to 0.6
	Cadmium	6	0.50	0.00	0.5 to 0.5
	Calcium	6	5900.00	2751.00	2000 to 10000
	Chromium	6	10.93	2.08	8.6 to 14
	Cobalt	6	3.47	0.61	2.5 to 4.3
	Copper	6	6.03	1.10	4.2 to 7.5
	Iron	6	9266.67	1961.29	6300 to 12000
	Lead	6	10.67	1.03	9 to 12
	Magnesium	6	3283.33	773.09	1900 to 4100
	Manganese	6	355.00	44.16	300 to 400
	Nickel	6	4.83	1.17	3 to 6
	Potassium	6	4033.33	1040.51	2200 to 5400
	Silver	6	0.50	0.00	0.5 to 0.5
	Strontium	6	61.17	24.99	21 to 84
	Titanium	6	373.50	204.27	21 to 570
	Vanadium	6	16.37	4.70	9.2 to 22
	Zinc	6	30.67	4.68	22 to 36
Various on-site	Aluminum	11	8827.27	4014.50	5700 to 18000
	Barium	11	120.91	25.22	84 to 160
	Beryllium	11	0.63	0.24	0.5 to 1.1
	Cadmium	11	0.51	0.03	0.5 to 0.6
	Calcium	11	8100.00	6373.38	2200 to 20000
	Chromium	11	12.02	2.27	8.5 to 16
	Cobalt	11	4.03	1.56	2.3 to 6.2
	Copper	11	7.64	3.55	4.9 to 15
	Iron	11	9663.64	2862.61	6900 to 15000
	Lead	11	12.64	5.71	8 to 28
	Magnesium	11	3909.09	2019.63	2200 to 8100
	Manganese	11	381.82	110.80	240 to 610
	Nickel	11	5.36	2.54	2 to 10
	Potassium	11	3700.00	1681.67	2200 to 7500
	Silver	11	0.50	0.00	0.5 to 0.5
	Strontium	11	62.18	44.34	31 to 150
	Titanium	11	207.27	61.17	120 to 300
	Vanadium	11	14.16	3.21	9.8 to 20
	Zinc	11	37.27	16.04	24 to 74

located in areas known or suspected to be contaminated with radioactive material related to the Clean Slate 1 dispersal test. All other analyses performed on samples collected from the South Plume Area were indistinguishable from offsite concentrations.

- 554th Range Squadron O&M Complex - Three samples were collected from the area around the 554th Range Squadron O&M Complex (see Figure B-5 and Table C-5). All three samples collected were indistinguishable from offsite concentrations.

- Range Operations Center - Ten samples were collected from the area around the Range Operations Center (see Figures B-6, B-7, & B-8, and Table C-6). Sample **OC-10** contained elevated concentrations of Cd and Pb. **OC-3** contained elevated concentrations of Cd; **OC-2** and **OC-4** contained elevated concentrations of Ti; **O-13** and **OC-19** contained elevated concentrations of Zn. **OC-2, -3, -4, -10**, and **-13** are located around the perimeter of the Range Operations Compound in areas where, if contamination was present, it would be expected to accumulate. **OC-19** is located between two storage shelters inside the compound. All other analyses performed on samples collected from the area around the Range Operations Center were indistinguishable from offsite concentrations.

- Various On-Site Locations - Eleven samples were collected from various locations onsite (see Figures B-9, B-10, B-11 and Table C-7). Sample **T-20** contained elevated concentrations of Al, Be, Co, Cu, Fe, Mg, Mn, and K. **T-21** contained elevated concentrations of Al, Be, Co, Cu, Fe, K, and Ti. **T-20** and **T-21** are located in the vicinity of the Hard Target near a fenced area suspected of being contaminated with DU. **OP-3** contained elevated concentrations of Cd, Pb, and Zn. **D-1** contained elevated concentrations of Co and Fe and is in the area of the former Project Roller Coaster Decontamination site. This site is also located south of the Range Operations Center (near Well 6) and the former PM_{10} air monitoring station.

  All other analyses performed on samples collected from the various locations onsite were indistinguishable from offsite concentrations.

  At locations where individual sample concentrations are considerably greater than the offsite upper 95 present confidence level and greater than the range of offsite values, the location was assumed to be potentially contaminated. Where multiple constituents appear to be greater than the criteria—even marginally—the location was assumed to be potentially contaminated.

4.4 PERSPECTIVE on PLUTONIUM DISTRIBUTION in the ENVIRONMENT

It is generally accepted that once Pu 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 Pu particle-size association was primarily with coarse silts (50 to 20 μm) and fine sands (125 to 50 μm). Whereas the inhalation of finer sizes (<7 μm diameter at a density of 1 gram per cubic centimeter [g/cm^3]) is considered most hazardous (Tamura 1976), 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.

A later study by Tamura (1977) discussed the occurrence of sandy mounds formed under

desert shrubbery. These mounds were formed by the filtering action of the desert vegetation in intercepting saltation and creeping particles. The vegetation intercepts the material being moved through the environment by wind. This study and additional studies found that in Pu-contaminated areas, the Pu activity levels were higher in the desert mounds than in the contiguous desert pavement (areas without vegetation). This demonstrates the effect of wind erosion in dispersal of contaminated material. The Tamura (1977) study also discussed evidence of Pu 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 Pu 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 Pu-to-Am ratio with depth (Romney et al. 1975), suggesting greater vertical movement of Am-241 relative to Pu-239 and Pu-240. This same report also stated that there is evidence showing that Am is much more readily available to plants through roots than is Pu. 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.

4.5 ENVIRONMENTAL MONITORING PERFORMED by KMI SERVICES

KMI performed or assisted in most environmental monitoring activities in 1996. KMI routine environmental monitoring activities at TTR include:

- Safe Drinking Water Act 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 list the current permits and expiration dates.

4.6 WATER MONITORING

4.6.1 Drinking Water Distribution System Sampling Results

In 1996, water monitoring was conducted for both drinking water and wastewater effluent. Analysis results are described below.

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 an 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 TTR* complies with State Water Resources Division regulations requiring a water conservation plan for permitted water systems and major water users in Nevada (DOE 1992).

Bacteriologic Sampling

Monthly water samples are collected from the Well 6 drinking water distribution system for bacteriologic analysis. Samples are analyzed for total coliform (an indicator that pathogenic bacteria may be present in the water). All monthly samples in 1996 were negative for coliform bacteria.

Sampling Results for the Regional Synthetic Organic Constituents

Quarterly sampling of Well 6 for volatile and semivolatile organic compounds (VOCs and SVOCs) was started in April of 1996. All samples were negative over the three quarters sampled with the exception of two samples which measured Di (2-ethylhexyl) phthalate at just over the detection limit. However, this substance is a common plastisizer and it is believed that contamination of the sampling containers or from the laboratory environment occurred. 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

Initial sampling of Well 6 for Cu and Pb was accomplished on July 18, 1996. Analytical results indicated a 90th percentile Pb level of 0.070 mg/L in the drinking water exceeding the Safe Drinking Water Act Pb standard of 0.015 mg/L. Cu levels were within acceptable limits.

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

Sampling for lead and copper was repeated on October 16, 1996. The required supplemental sampling for pH, alkalinity, conductivity, and Ca 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 Pb 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.

EPA Sampling of Well 6

Well 6 is also sampled by the EPA for other nonradiological parameters such as nitrate and nitrites. Additionally, 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 1990) for compliance with the Safe Drinking Water Act.

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.

4.6.2 Sewage System and Septic Tank Sampling Results

Sewage System

Sewage from SNL facilities at Area 3 of TTR 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 does not stipulate the monitoring requirements of SNL, but does require SNL's monitoring results to be included in the Discharge Monitoring Report (DMR) submitted to the

State of Nevada at the end of each quarter. 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 (Cd, Cr, Cu, Ni, Ag, Zn, Ar, Pb, Se, and Hg)
- Semivolatile organics
- 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 1996. Results can be obtained from KMI Services.

Septic Tank Systems

There are currently six active septic systems under SNL control at TTR serving remote areas. The sewage from these locations flows into septic tanks and associated drain fields. These septic system discharges fall primarily under the statutory authority of the Clean Water Act (CWA) and the Safe Drinking Water Act (SDWA) as amended. Septic discharges are regulated under Nevada Administrative Code, Chapters 444-445 (Appendix A, Table A-1), and are administered by the State of Nevada, Bureau of Health Protection Services, and the NDEP. Sampling of septic systems was not required in 1996.

5 AIR QUALITY SURVEILLANCE and EMISSIONS MONITORING

Air quality compliance at TTR is met by adherence to specific permit conditions, ambient air monitoring, and periodic direct emission sampling, as required. SNL/NM complies with local, State, and Federal regulations in accordance with the objectives of the Clean Air Act (CAA) and the Clean Air Act Amendments of 1990 (CAAA).

5.1 METEOROLOGICAL DATA

meteorological observations of wind direction, wind speed, and stability class (inferred from wind and solar insolence).

5.2 RADIOLOGICAL AIR MONITORING

At present, the only ambient air monitoring at TTR required by the EPA (or the State of Nevada) is radiological air monitoring related to the Clean Slate sites. Routine radionuclide air emissions are regulated by the EPA in accordance with NESHAP—40 CFR 61, Subpart H.

The EPA has set a maximum individual public dose limit of 10 mrem/year resulting from the radiological air emissions from any DOE facility. As a comparison, the average nation-wide dose a person receives from all radioactive sources (natural and manmade) is 360 mrem/year—the bulk of which comes from natural sources such as radon and natural radioactivity given off by elements within the body.

The 1996 annual *NESHAP Report for SNL/NV* was submitted to the EPA as required

Meteorological data is gathered to support the requirements of National Emission Standard Hazardous Air Pollutants (NESHAP)—40 CFR 61, Subpart H to provide input to dose assessment calculations.

A composite meteorological data set for the TTR area was developed based on information from two sources: Tonopah Municipal Airport and onsite at TTR. The Tonopah Municipal Airport is located approximately 65 km north of TTR (DOC 1994) and an onsite meteorological station located in the northern portion of TTR (DOC 1993). The composite data set includes hourly

by June 30, 1997 (SNL 1997a). The report contains listed radionuclide emissions from each source and a summary of the dose assessment results. A more comprehensive supplemental document detailing facility emission factors, demographic data, and dose assessment calculations is available to the EPA and the DOE upon request (SNL 1997b).

Release Sources

NESHAP regulation requires continuous air monitoring for any source (or combined sources from a DOE facility) that contribute in excess of 0.10 mremyr to the MEI. The dose assessment for 1995 was 1.1 mrem/yr. Continuous air monitoring commenced in February 1996 and will continue for one year. Routine air monitoring was discontinued in support of the one-year continuous monitoring of the MEI location. This location has been determined to be located at the TTR Airfield. Based on the results of the continuous monitoring, a graded approach to air monitoring at TTR will be implemented as referenced in the TTR NESHAP Permit application. The results from the one-year continuous monitoring will be

included in the 1997 Annual Site Environmental Report (ASER) for TTR.

During 1996, no radiological point-source releases occurred as a result of TTR operations. The potential releases associated with the diffuse Clean Slate ER sites occur as a result of the wind resuspension of soil particulates (fugitive dust) contaminated with transuranic radionuclides. The 1977 EG&G aerial radiological survey of Clean Slates 1, 2, and 3 documented the level of residual surface-soil activity in the form of radiation isopleths showing the soil activity of Am-241, Pu-239, and Pu-240 (EG&G 1979b). The study concluded that the contaminated area associated with the Clean Slate sites is approximately 20 million square meters.

The annual diffuse source term associated with the Clean Slate sites was calculated using a wind resuspension model which calculates the rate at which soil particulates become airborne. This model uses site-specific information (e.g., wind speed, wind direction, and contaminant source term) whenever appropriate.

A release of 0.39 curies per year (Ci/yr) of total transuranic activity (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, and Am-241) was calculated as the resuspended source term associated with the Clean Slate sites. This resuspended source term is assumed to be entirely respirable.

5.4 ASSESSMENT OF POTENTIAL DOSE TO THE PUBLIC

A radiation dose was calculated based on the resuspension of contamination originating from the Clean Slate sites. The dose assessment was performed for onsite and offsite receptors. The concept of "onsite receptors" is conservatively assumed to include members of the military, military contractors, and other non-SNL/NV personnel who work at TTR but over whom SNL/NV has little or no operational control. This definition is believed to be consistent with current EPA and DOE guidance.

The dose calculation results summarized in this section were performed to document NESHAP (40 CFR 61, Subpart H) compliance. (see Todd) More detailed information pertaining to this calculation may be found in the *NESHAP Compliance Summary* (SNL 1997a) and the *Radiological Dose Calculations and Supplemental Dose Assessment Data for NESHAP Compliance for Sandia National Laboratories, Nevada, 1996* (SNL 1997b).

Receptor Locations

For determination of potential dose to the public, receptor locations were divided into on-site and offsite members of the public. The TTR onsite receptor locations consist of the On-Base Housing Area, the TTR Airport Area, the South Perimeter, and the 554th Range Squadron O&M Complex (Figure 5-1). The TTR offsite region includes distinct populations of permanent residents. (Figure 5-2).

Dose Assessment Results

The regional population dose was calculated to be 0.86 person-rem per year (person-rem/yr). The effective dose equivalent (EDE) to the MEI was calculated to be 1.1 mrem/yr. The MEI is located at the onsite TTR Airfield Area. The MEI dose is a factor of approximately eight below the NESHAP dose standard of 10 mrem/yr. The offsite MEI was calculated to be 0.18 mrem/yr and was located at the Tonopah Municipal Airport. Results are given in Table 5-1.

Table 5-1. Calculated dose assessment results for onsite and offsite receptors and for collective populations.

Dose to Receptor	Location	1996 Calculated Dose	NESHAP Standard	Natural Background
Onsite Receptor EDE to the MEI	Airfield TTR Area	1.1 mrem/yr *(_____msievert/yr)*	10 mrem/yr 0.1 msievert/yr	_____[1]
Offsite Receptor EDE to the MEI	Tonopah Municipal Airport	0.18 mrem/yr *(_____msievert/yr)*	10 mrem/yr 0.1 msievert/yr	
Collective Regional Population[2]	All within an 80-km radius	0.86 person rem/yr *(_____person sievert/yr)*	(No standard available)	> _____

NOTE: EDE = effective dose equivalent MEI = maximally exposed individual

1 = Based on average community values obtained from the thermoluminescent dosimeter (TLD) network _____. (Natural background is estimated at 360 mrem/year nationwide)

2 = Based on a population of _____ people in the Tonopah area.

3= Based on a population of _____ people estimated living within an 80-km radius

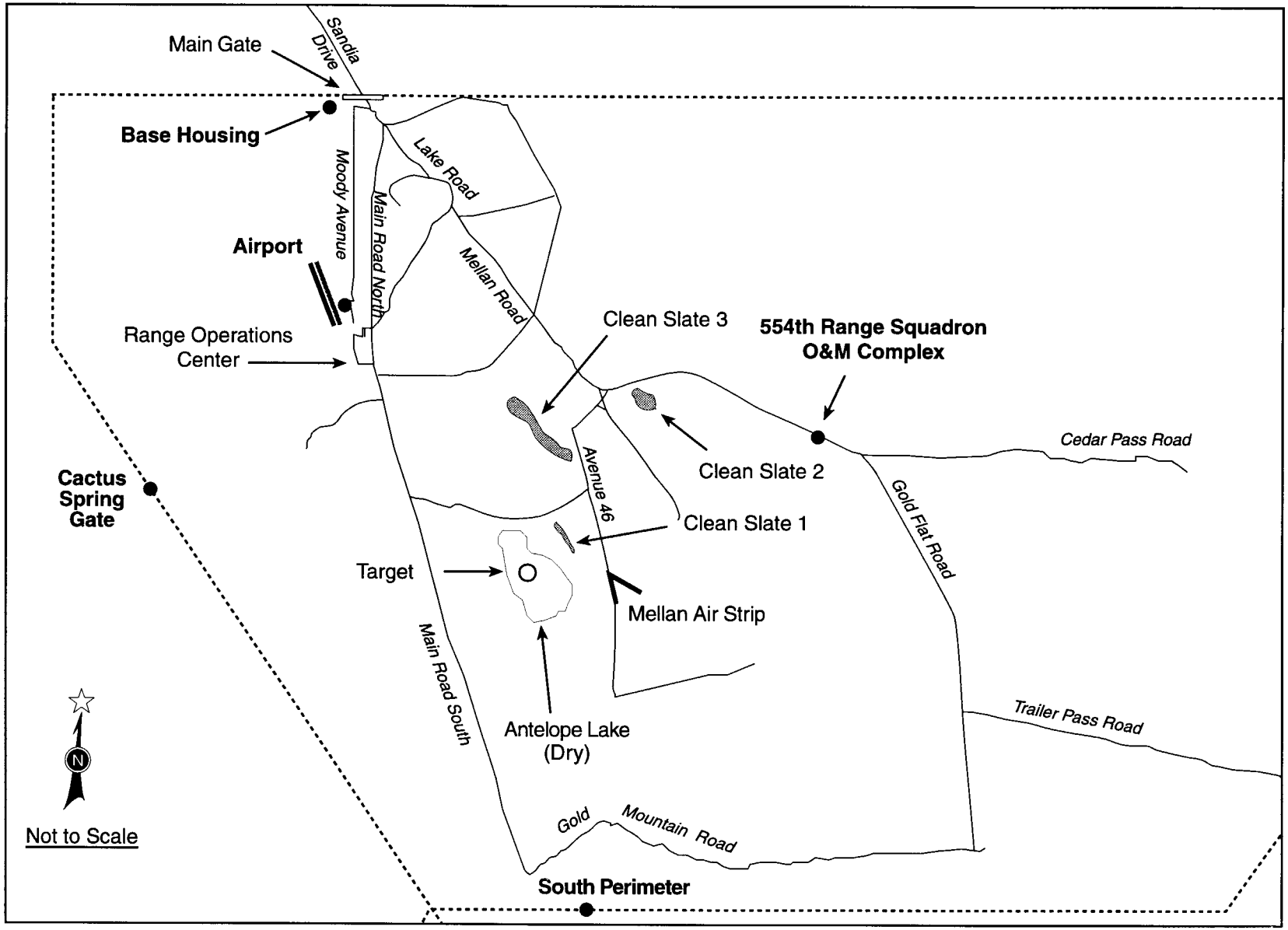


Figure 5-1 Tonopah Test Range onsite receptor locations.

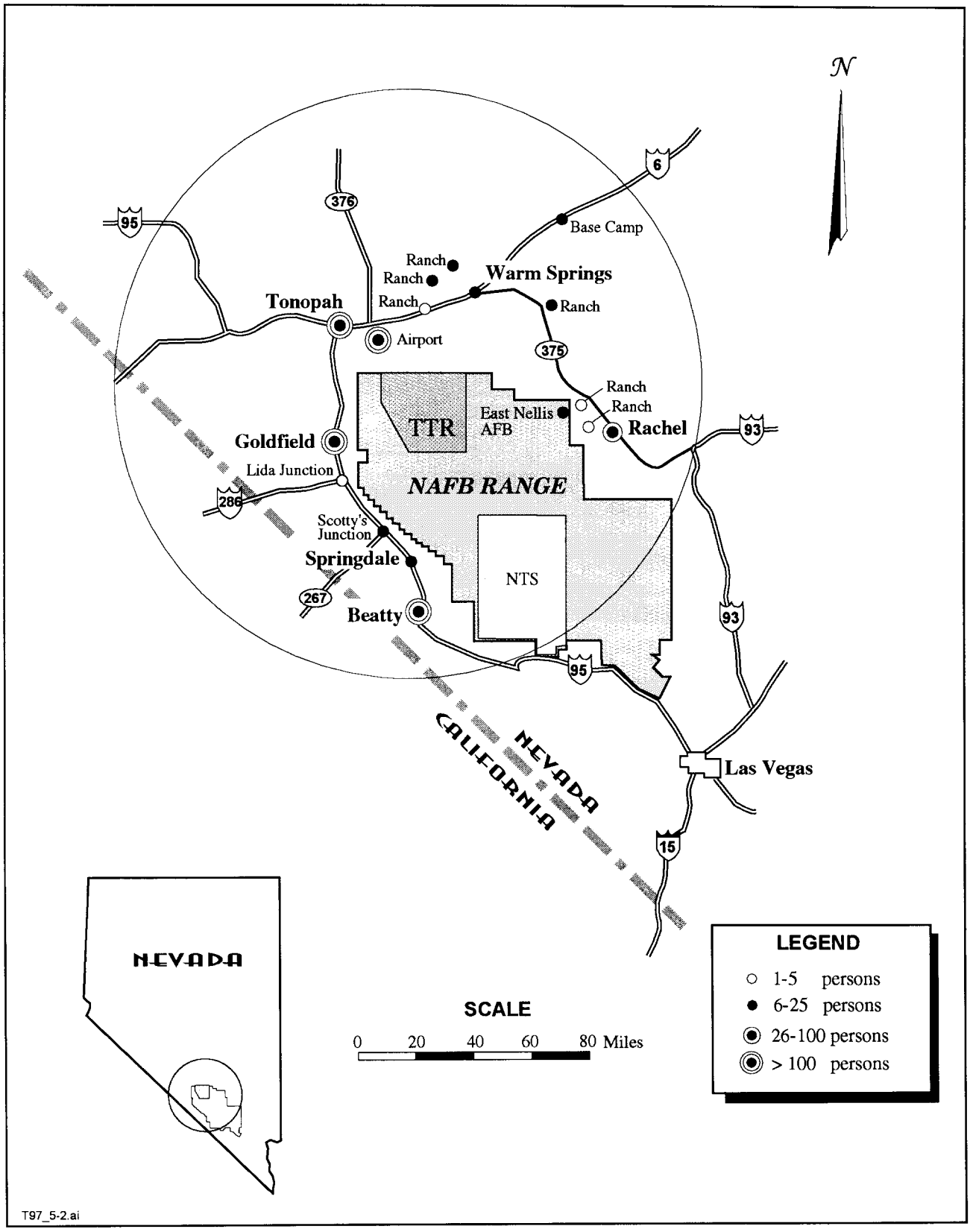


Figure 5-2. Public receptor zone around TTR.

6

REFERENCES

DOC 1993: U.S. Department of Commerce, *Weather Service Nuclear Support Office Meteorological Data for the Tonopah Test Range, 1989-1992*. National Weather Service, Western Region, Las Vegas, NV (1993).

DOC 1994: U.S. Department of Commerce, *NOAA (National Oceanic and Atmospheric Administration) Environmental Data Service, monthly and annual distribution by Pasquill Stability Classes, STAR Program, Tonopah, NV.* National Climatic Center (NCC) Federal Building, Ashville, NC (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 1997: U.S. Department of Energy, *Biannual Hazardous Waste Generation Report*. Submitted to the EPA by DOE/NV (1997).

DOE 1996: U.S. Department of Energy, *Final Environmental Impact Statement for 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 TestRange*, R4809, DOE/NV, Las Vegas, NV (1992).

DOE 1990: U.S. Department of Energy, *Tonopah Test Range Site Sampling Plan*, DOE/NV, Las Vegas, NV (1990).

DOE 1988: (See Orders section).

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 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).

DRI 1996: Desert Research Institute, *Community Radiation Monitoring Program Annual Report 1996.* DRI, Las Vegas, NV (1996).

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 1996: U.S. Environmental Protection Agency, Offsite Environmental Monitoring Report: *Radiation Monitoring Around U.S. Nuclear Test Areas, CY 1993*, EPA/402-R-96-007, (author Chaloud, D.J. et al.) (1996).

EPA 1991: U.S. Environmental Protection Agency, *CAP-88, Clean Air Act Assessment Package*. Radiation Shielding Information Center, CCC-542, Oak Ridge, TN (1991).

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. (1976).

Gilbert et al. 1975: Gilbert, R. O., et al., "Statistical Analysis of $^{239\text{-}240}$Pu and ^{241}Am 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: International Technology Corporation, *Sampling and Analysis Plan for Clean Slate 1*. International Technology Corporation (September 1996).

IT 1993: International Technology Corporation, *Analytical Results for Tonopah Test Range, Transformer Oil Samples, Collected July 16-18, 1993*. IT, 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).

Rarrick 1993: Rarrick, H., Personal communication with Todd Culp (February 2, 1993).

Romney et al. 1975: Romney, E. M., et al., *$^{239-240}$Pu and ^{241}Am 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 1997a: Sandia National Laboratories, *NESHAP Annual Report for CY 1996.* Sandia National Laboratories, Albuquerque, NM (1997).

SNL 1997b: Sandia National Laboratories, *Radiological Dose Calculations and Supplemental Dose Assessment Data for NESHAP Compliance for Sandia National Laboratories, Nevada, 1995.* Sandia National Laboratories, Albuquerque, NM (1997).

SNL1995a: Sandia National Laboratories, *NESHAP Monitoring Plan for TTR.* Transimission letter (dated October 13,1995) from SNL/NM Dept. 7575, Su Hwang, to DOE/KAO, Susan Lacy; DOE submitted to EPA with permit application.

SNL 1995b: Sandia National Laboratories, *Oil Spill Prevention Control and Countermeasure (SPCC) Plan for Sandia National Laboratories Tonopah Test Range*, Plan 90-11, Rev 2. Sandia National Laboratories, Albuquerque, NM (April 1995).

SNL1995c: Sandia National Laboratories, *NEPA Compliance Guide for Sandia National Laboratories*, SAND 1648. Sandia National Laboratories, Albuquerque, NM (1995).

SNL 1992a: Sandia National Laboratories, *Environmental Monitoring Plan for the Tonopah Test Range, Nevada*, Sandia National Laboratories, Albuquerque, NM (1992).

SNL 1992b: Sandia National Laboratories, *Environmental Sampling Procedure*,SP471991. Sandia National Laboratories, Albuquerque, NM (November 19, 1992).

SNL 1991: Sandia National Laboratories, *National Environmental Policy Act (NEPA) Program*, PG470110. Sandia National Laboratories, Albuquerque, NM (1991).

SNL 1993: Culp, T. And Howard, D, Tonopah Test Range, "1992 Environmental Monitoring Report, Tonopah Test Range, Tonopah, Nevada," SAND 93-1449. Sandia National Laboratories, Albuquerque, NM (1993).

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) (Enactedby 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 (FFCAct).

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 1988: 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).

7 Ancillary Information

Units of Measure

ºC	Celsius degree
cm	centimeter
cm^2	square centimeter
cm^3	cubic centimeter
ºF	Fahrenheit degree
ft	foot
g	gram
gal	gallon
hr	hour
in.	inch
kg	kilogram
km	kilometer
km^2	square kilometer
lb	pounds
L	liter
m	meter
m^2	square meter
m^3	cubic meter
mg/m^3	milligrams per cubic meter
mg/L	milligrams per liter
mi	mile
mi^2	square mile
m/s	meters per second
ppm	parts per million
sec	second
sec/yr	seconds per year
tons/yr	tons per year
:m	micron
yr	year
yd^3	cubic yard

Units of Radiological Measure

Ci	curie (unit of radioactivity)
Ci/yr	curies per year
dpm	disintegration per minute
mrem	millirem (unit of radiation dose)
mrem/yr	millirem per year
mR/yr	milliroentgen per year
person-mrem/yr	person-millirem per year
person-rem/yr	person-rem per year
pCi	picocurie
R	roentgen (unit of radiation exposure)
rem	roentgen equivalent man (unit of dose equivalent)
:g/g	microgram per gram
:g/m^2	microgram per square meter
:g/m^3	microgram per cubic meter

Elements

				Isotopes	
Al	aluminum	Ar	arsenic	Am-241	Americium-241
Ba	barium	Be	beryllium	Be-7	Beryllium-7
Cu	copper	Hg	mercury	Pu-238	Plutonium-238
Cd	cadmium	Mn	manganese	Pu-239	Plutonium-239
Co	cobalt	Ni	nickel	Pu-240	Plutonium-240
Cr	chromium	V	vanadium	Pu-241	Plutonium-241
Ti	titanium	Tl	thalium	Pu-242	Plutonium-242
Fe	iron	Se	selenium	Ra-226	Radium-226
K	potassium	Ag	silver	Th-232	Thorium-232
Pb	lead			H-3	tritium
Pu	plutonium			Cs-137	Cesium-137
Si	silica			U	uranium
Zn	zinc			U-238	Uranium-238
				U_{tot}	Uranium, total

Abbreviations and Acronyms

ADM	Action Description Memorandum
AEC	U.S. Atomic Energy Commission
AES	Atomic Emission Spectrum
AIRFA	American Indian Religious Freedom Act
ARPA	Archaeological Resources Protection Act
ASER	Annual Site Environmental Report
AST	aboveground storage tank
BLM	Bureau of Land Management
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAU	Corrective Action Unit
CAS	Corrective Action Site
CEM	Certified Environmental Manager
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
CY	calendar year
DAC	Derived Air Concentration
DCG	Derived Concentration Guides
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.S. Department of the Interior
DRI	Desert Research Institute, Water Resources Center, University of Nevada System
DU	depleted uranium
EA	Environmental Assessment
ECL	Environmental Checklist
EDE	effective dose equivalent
EG&G	Edgerton, Germeshausen & Grier Corporation
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPD	Environmental Programs Departments
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

ICP	inductively coupled plasma (method)
ICRP	International Commission on Radiological Protection
IT	International Technology Corporation
KMI	Kirk-Mayer, Inc. (KMI Services)
LDR	Land Disposal Restriction
MDC	minimum detectable concentrations
MEI	maximum 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
ND	Not detected
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
PID	photo ionization detector
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
SAP	Sample Analysis Plan
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
SOP	Standard Operating Procedure
SPCC	Spill Prevention, Control, and Countermeasures
STAR	Stability Array
SVOC	semi volatile organic compound

T/E	threatened or endangered
TA	Technical Area
TCLP	toxicity characteristic leaching procedure
TECR	Tonopah Electronic Combat Range
TFW	Tactical Fighter Wing
TIADS	Tonopah Integrated Air Defense System
TLD	thermoluminescent dosimeter
TPH	total petroleum hydrocarbon
TRPH	total recoverable petroleum hydrocarbon
TRI	Toxic Release Inventory
TRU	transuranic
TSCA	Toxic Substances Control Act
TSDF	treatment, storage, and disposal facility
TSP	total suspended particulates
TTR	Tonopah Test Range
USAF	U.S. Air Force
USGS	U.S. Geological Survey
UXO	unexploded ordnance
UST	underground storage tank
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 (Φg/g)	1	part per million (ppm)
milligram per liter (mg/L)	1	part per million (ppm)
Temperature	**Equation**	**Temperature**
Celsius (ºC)	°F = 9/5 °C + 32	Fahrenheit (ºF)

APPENDIX A

STATE OF NEVADA REGULATIONS AND PERMIT LISTINGS

This page intentionally blank

CONTENTS

TABLES

Table A-1. State of Nevada regulations applicable to the Tonopah Test Range (TTR).

Regulation	Applicable Activity
Nevada Wildlife Regulations **Nevada Revised Statute, Title 45, Chapter 501. NRS 501.010-501.243** **Wildlife Regulations NAC 504.510-504.550**	**- 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**
Nevada Air Quality Regulations **Nevada Revised Statutes, Title 40, Public Health and Safety, Chapter 445. NRS 445.401-445.601** **NAC 445.430-445.995**	**- 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**
Nevada Water Pollution **Nevada Revised Statutes, Title 40, Public Health and Safety, Chapter 445. NRS 445.131-445.354** **NAC 445.070-445.194**	**- Construction of operation of Control Regulations sewage treatment plant** **- Disposal of drilling fluids** **- Water treatment plant**

Table A-1. State of Nevada regulations applicable to the TTR (Continued).

Regulation	Applicable Activity
Nevada Regulations Solid Waste Management **Nevada Revised Statutes, Title 40, Public Health and Safety, Chapter 444. NRS 444.510-444.610** **Regulations Governing Solid Waste Management**	**- Clearing, leveling, and grading of site** **- Construction of support buildings** **- Construction and operation of sanitary landfill** **- Daily sanitary wastes** **- Disposal of sewage sludge**
Nevada Regulations Governing Individual Sewage Systems **Nevada Revised Statutes, Title 40, Public Health and Safety, Chapter 444. NRS 444.650** **NAC 444.750-444.840**	**- Construction of sewage collection systems**
Nevada Public Water Supply and Public Water Systems Regulations **Nevada Revised Statutes, Title 40, Public Health and Safety, Chapter 445. NRS 445.030** **NAC 445.370-445.420**	**- Installation of water lines** **- Installation of water reservoirs**

Table A-1. State of Nevada regulations applicable to the TTR (Concluded).

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

APPENDIX B

SAMPLING LOCATION MAPS AND RADIOLOGICAL RESULTS

This page intentionally blank

CONTENTS

FIGURES

TABLES

This page intentionally blank

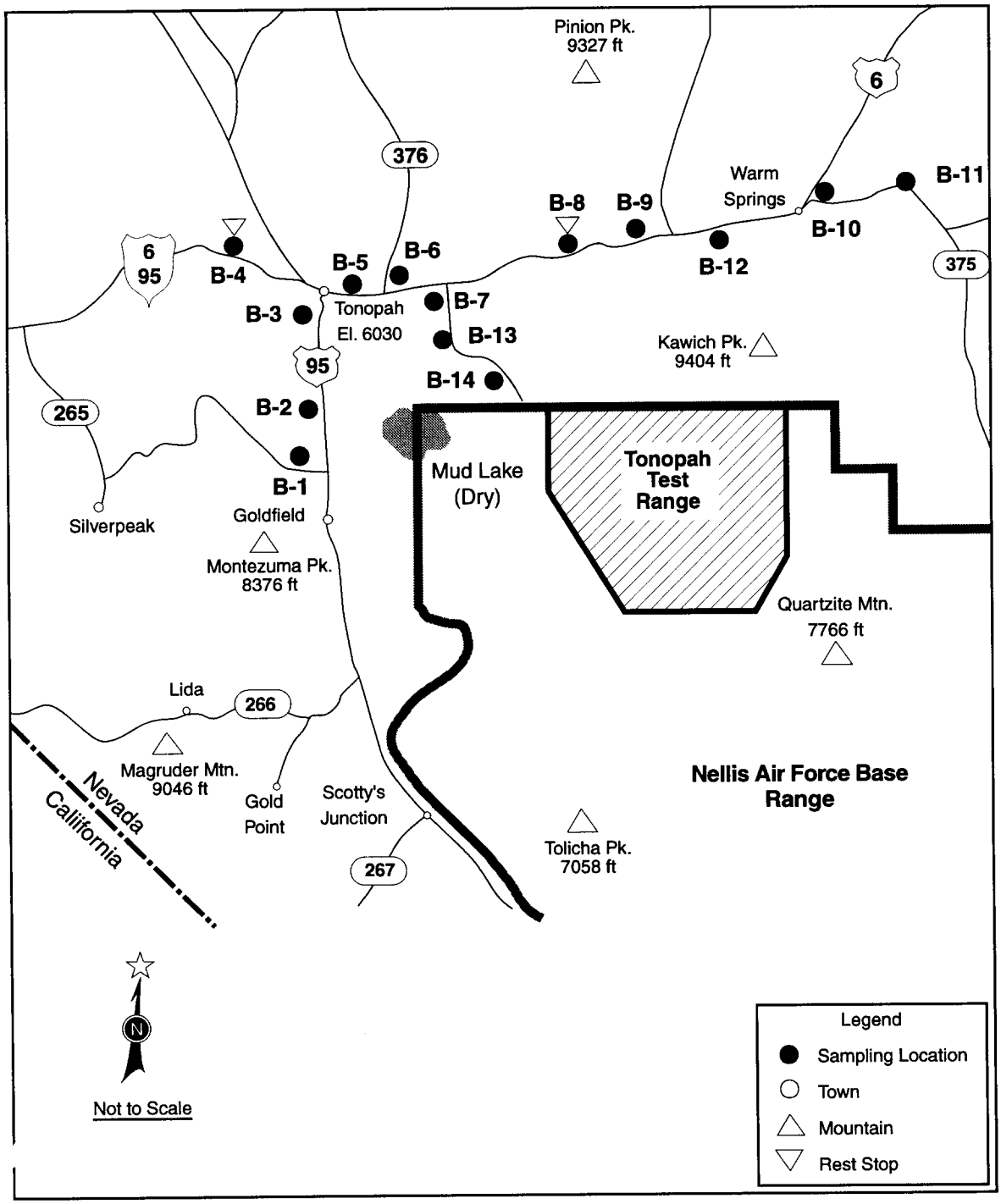


Figure B-1. Offsite soil sampling locations.

Table B-1. Radiological results of offsite soil sampling, 1996.

Location	Utot (ug/g)	Cs-137 (pCi/g)	Cs-137 Error (pCi/g)
B-1	2.7	0.10	0.04
B-2	3.7	0.09	0.03
B-3	4.0	0.42	0.05
B-4	2.5	0.37	0.06
B-5	3.6	0.70	0.08
B-6	2.7	0.52	0.07
B-7	1.8	0.49	0.06
B-8	2.5	0.50	0.06
B-9	2.2	0.43	0.06
B-10	3.1	0.14	0.04
B-11	2.0	0.41	0.05
B-12	2.3	0.45	0.05
B-13	2.1	0.14	0.04
B-14	2.2	0.06	0.03

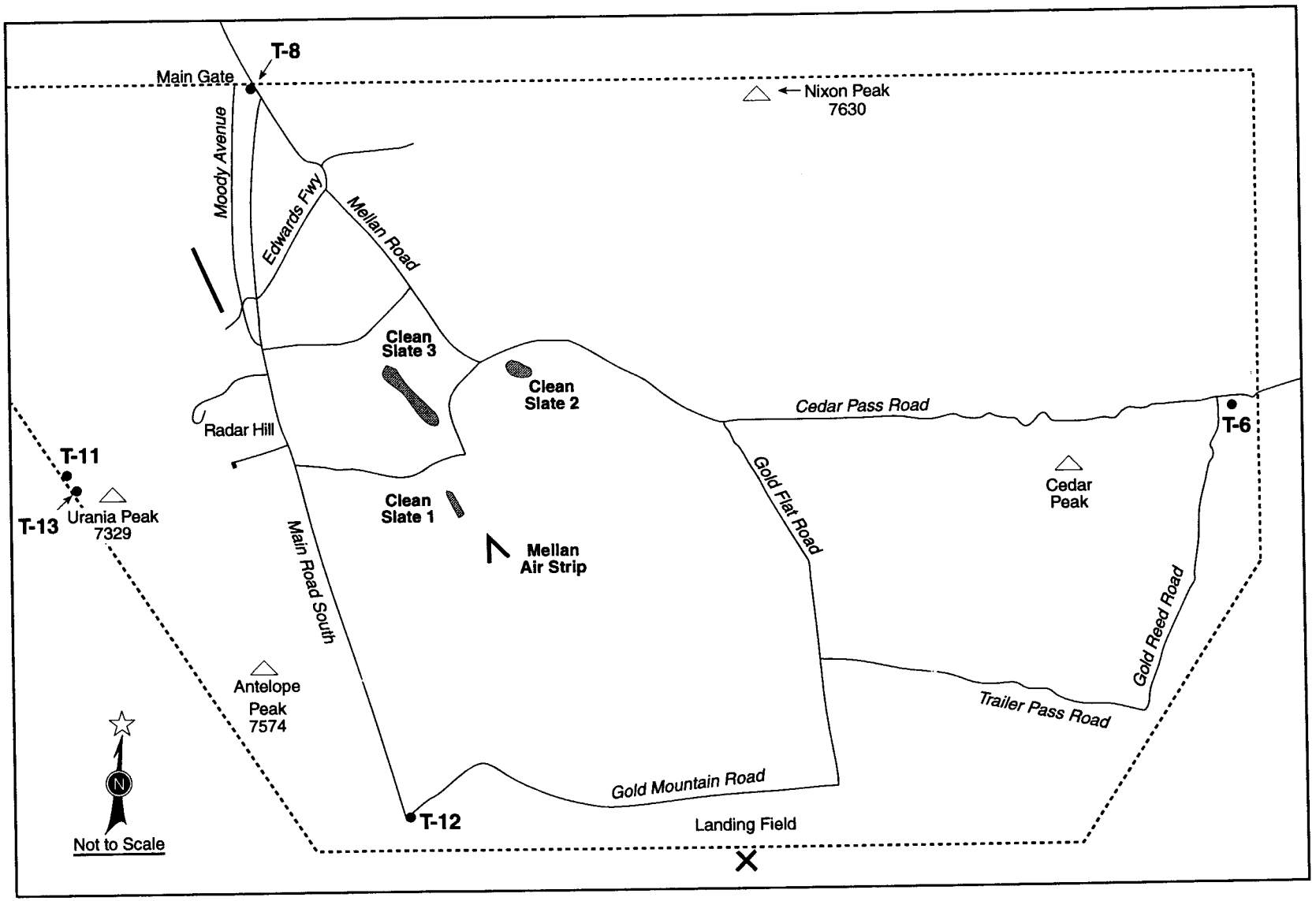


Figure B-2. Perimeter soil sampling locations.

Table B-2. Radiological results of perimeter soil sampling, 1996.

Location	U_{tot} (μg/g)	Cs-137 (pCi/g)	Cs-137 Error (pCi/g)
T-6	2.5	0.27	0.04
T-8	2.5	0.09	0.04
T-11	2.5	0.38	0.05
T-12	2.1	0.35	0.05
T-13	2.1	0.5	0.08

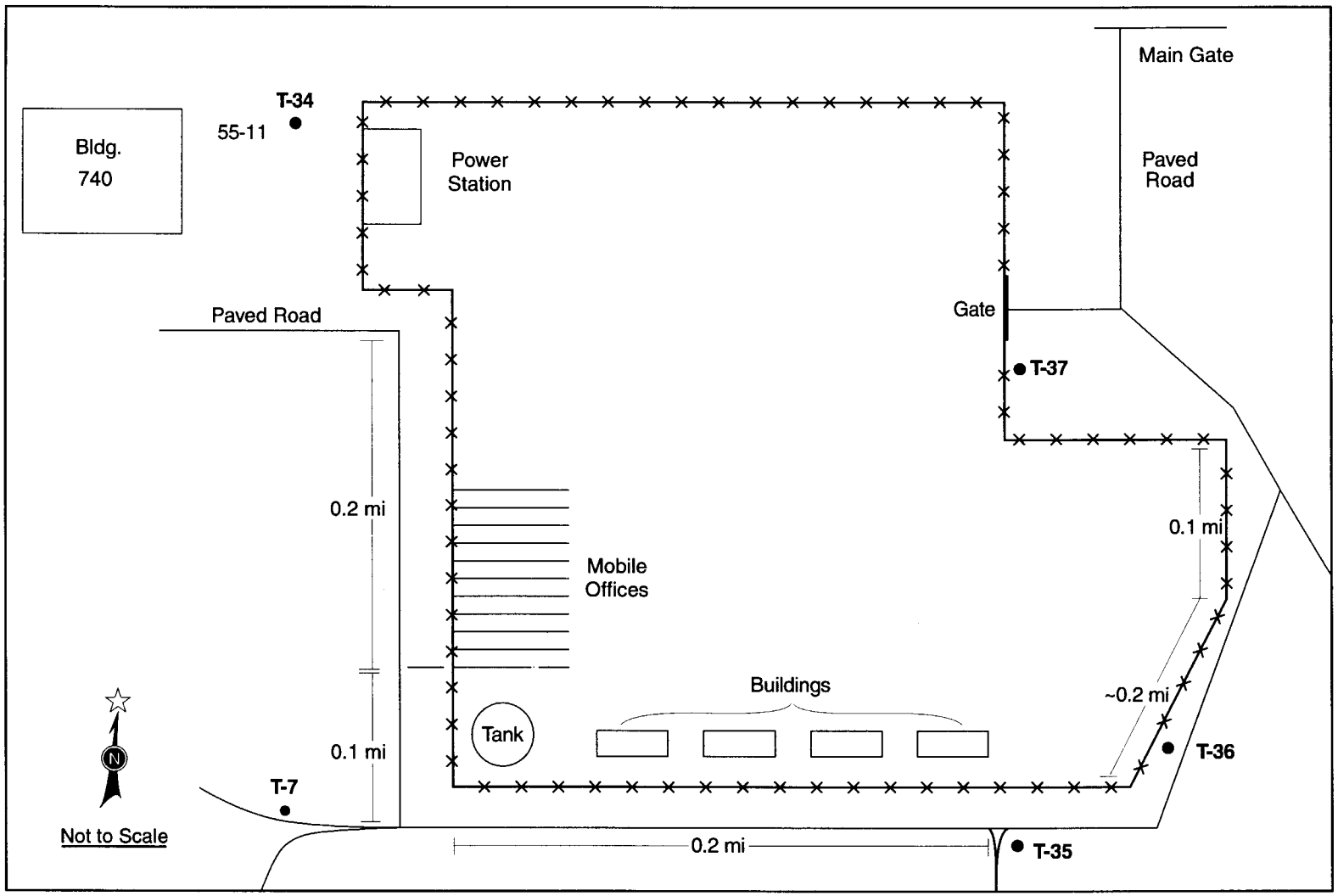


Figure B-3. Soil sampling locations near the On-Base Housing Area.

Table B-3. Radiological results of on-base housing soil sampling, 1996.

Location	Utot (μg/g)	Cs-137 (pCi/g)	Cs-137 Error (pCi/g)
T-07	2.6	0.19	0.11
T-34	2.4	0.3	0.05
T-35	2.5	0.15	0.04
T-36	2.3	0.23	0.04
T-37	2.8	0	0.12

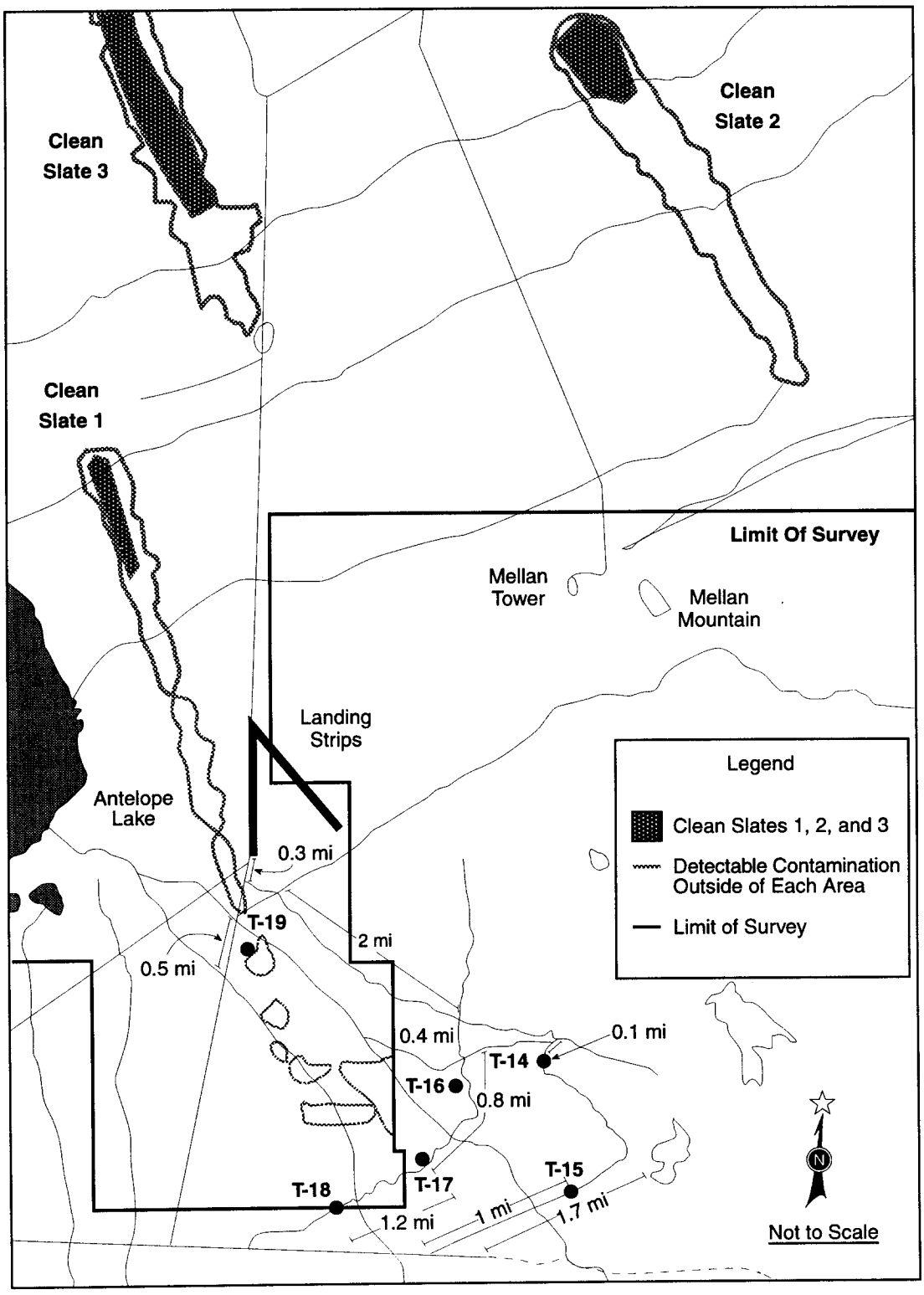


Figure B-4. Soil sampling locations in the South Plume Area.

Table B-4. Radiological results of South Plume Area soil sampling, 1996.

Location	Utot (µg/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	2.40	0.66	0.07	--	--	--	--	--	--
T-15	1.50	0.63	0.07	--	--	--	--	--	--
T-16	2.20	0.37	0.05	--	--	--	--	--	--
T-17	1.60	0.67	0.08	--	--	--	--	--	--
T-18	1.60	0.55	0.06						
T-19	1.30	0.69	0.07	0.18	0.14	-0.01	0.01	1.6	0.17

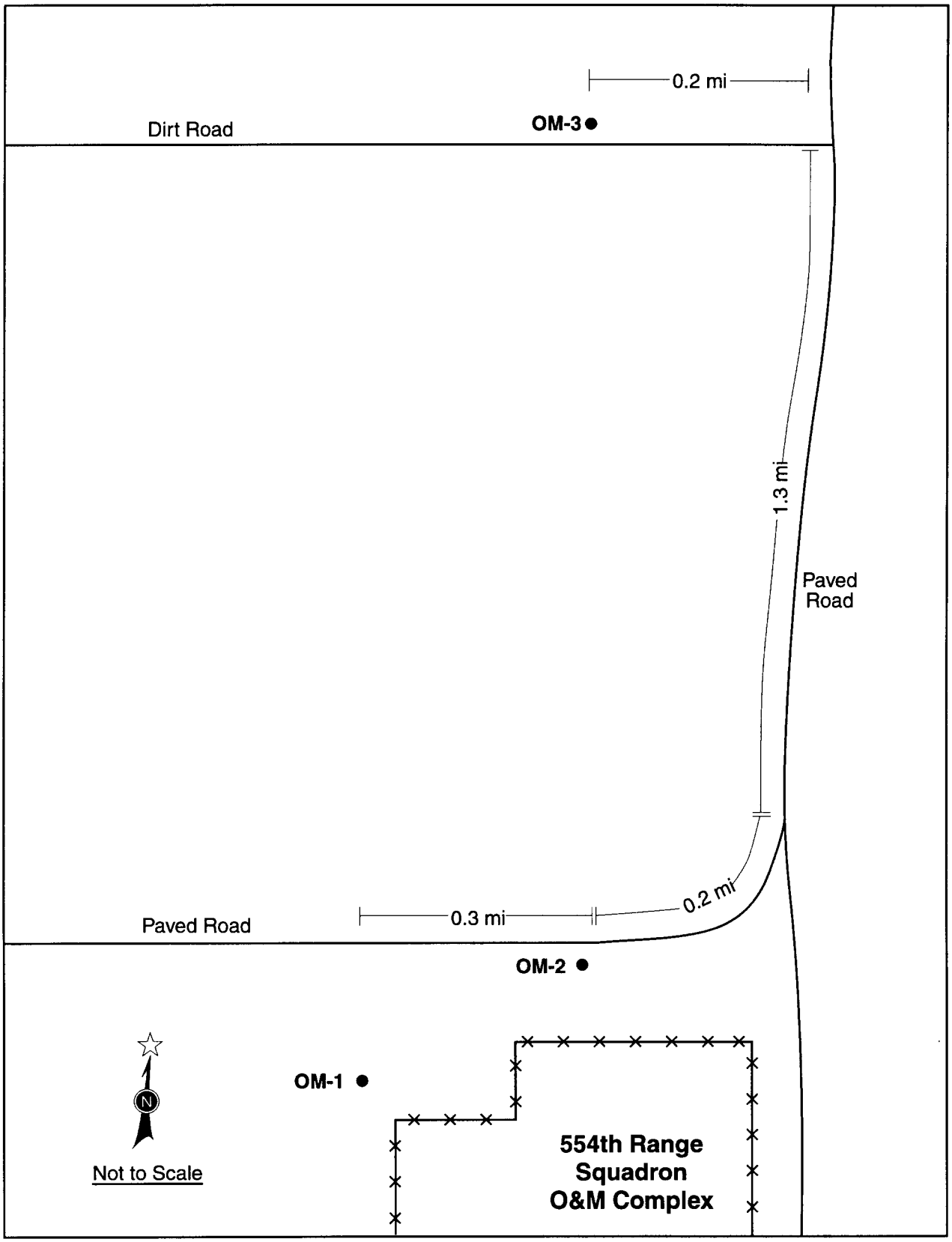


Figure B-5. Soil sampling locations near the 554th Range Squadron O&M Complex.

Table B-5. Radiological results of 554th Range Squadron O&M Complex soil sampling, 1996.

Location	Utot (μg/g)	Cs-137 (pCi/g)	Cs-137 Error (pCi/g)
OM-1	2.1	0.38	0.05
OM-2	1.3	0.32	0.05
OM-3	1.5	0.72	0.08

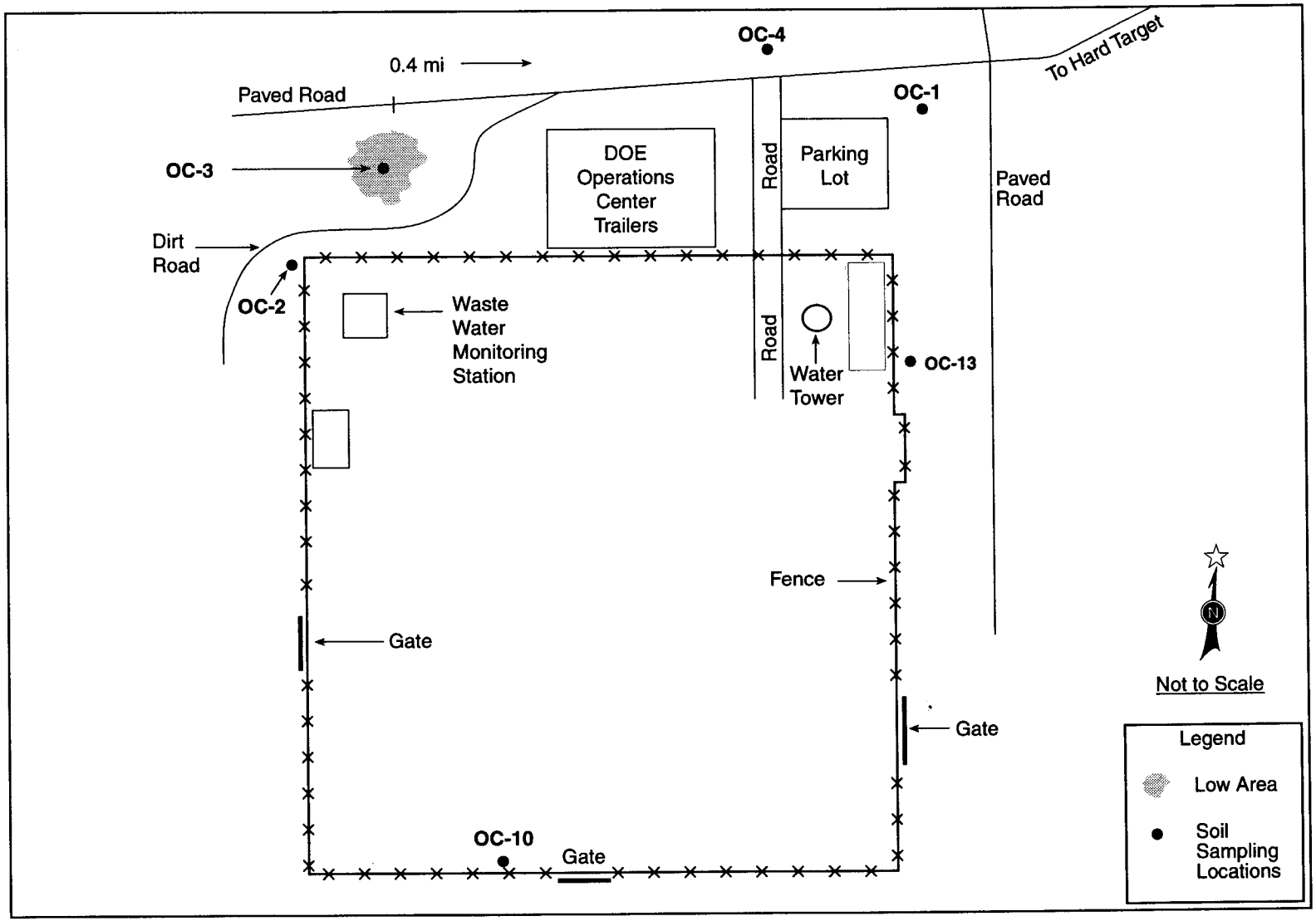


Figure B-6. Soil sampling locations around the Range Operations Center.

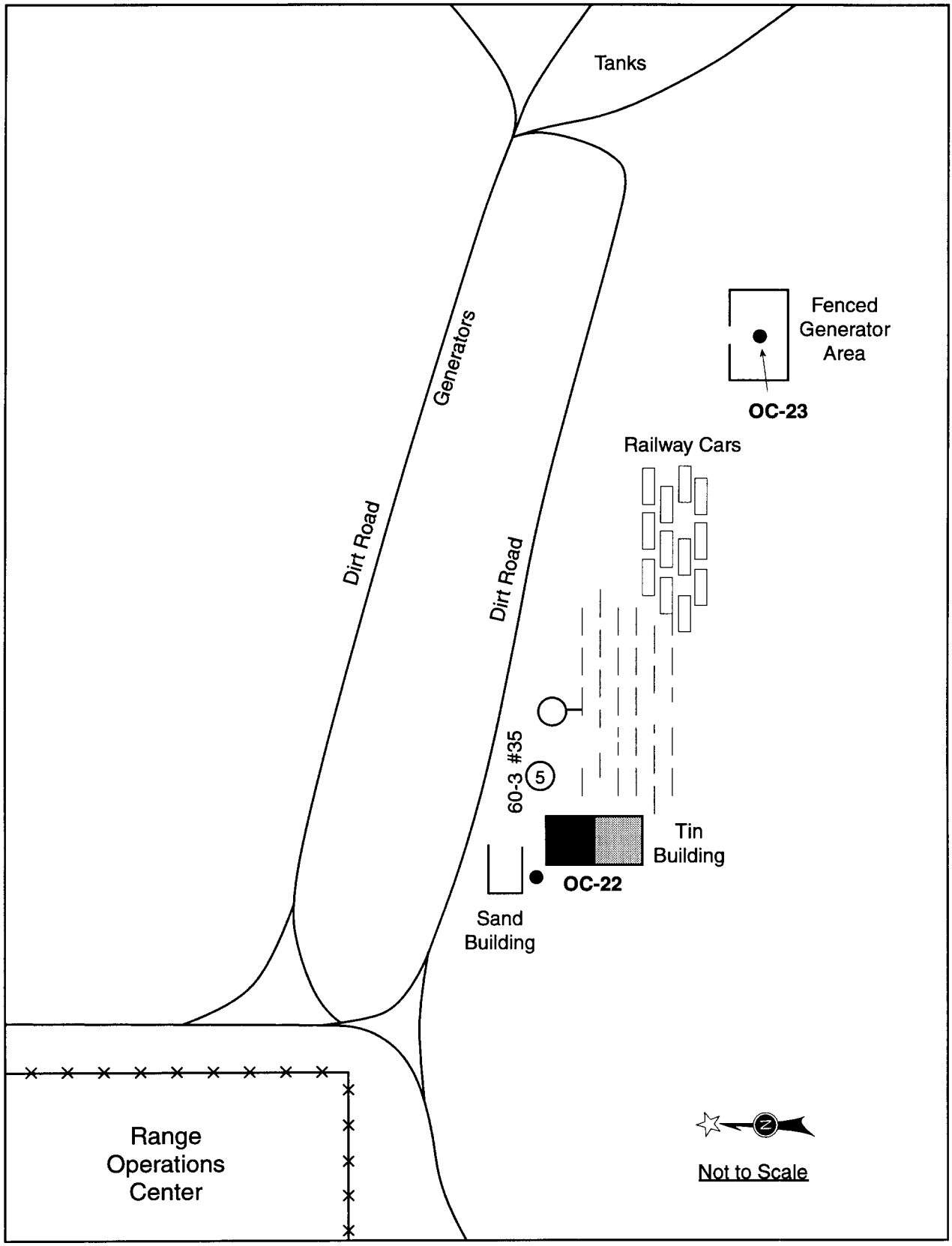


Figure B-7. Soil sampling locations around the Range Operations Center Storage Yard.

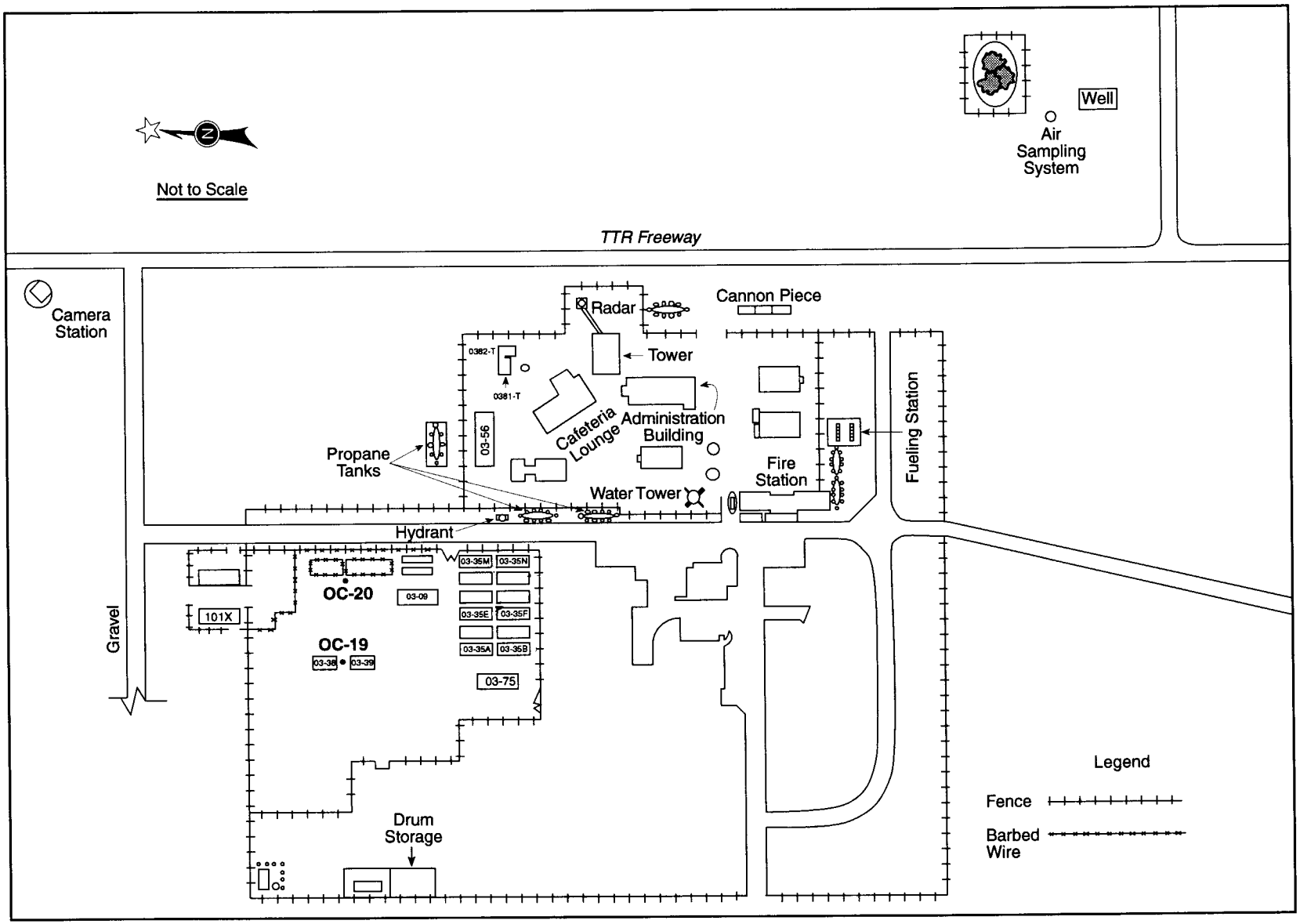


Figure B-8. Soil sampling locations in the Range Operations Center and Compound.

Table B-6. Radiological results of Range Operations Center soil sampling, 1996.

Location	Utot (μg/g)	Cs-137 (pCi/g)	Cs-137 Error (pCi/g)
OC-01	3.2	0.11	0.04
OC-02	2.8	0.24	0.04
OC-03	3.1	0.1	0.04
OC-04	3	0.51	0.06
OC-10	3.4	0.11	0.04
OC-13	3.2	0.39	0.05
OC-19	3	0.01	0.1
OC-20	4	0.08	0.09
OC-22	2.7	0.05	0.03
OC-23	2.7	0.09	0.04

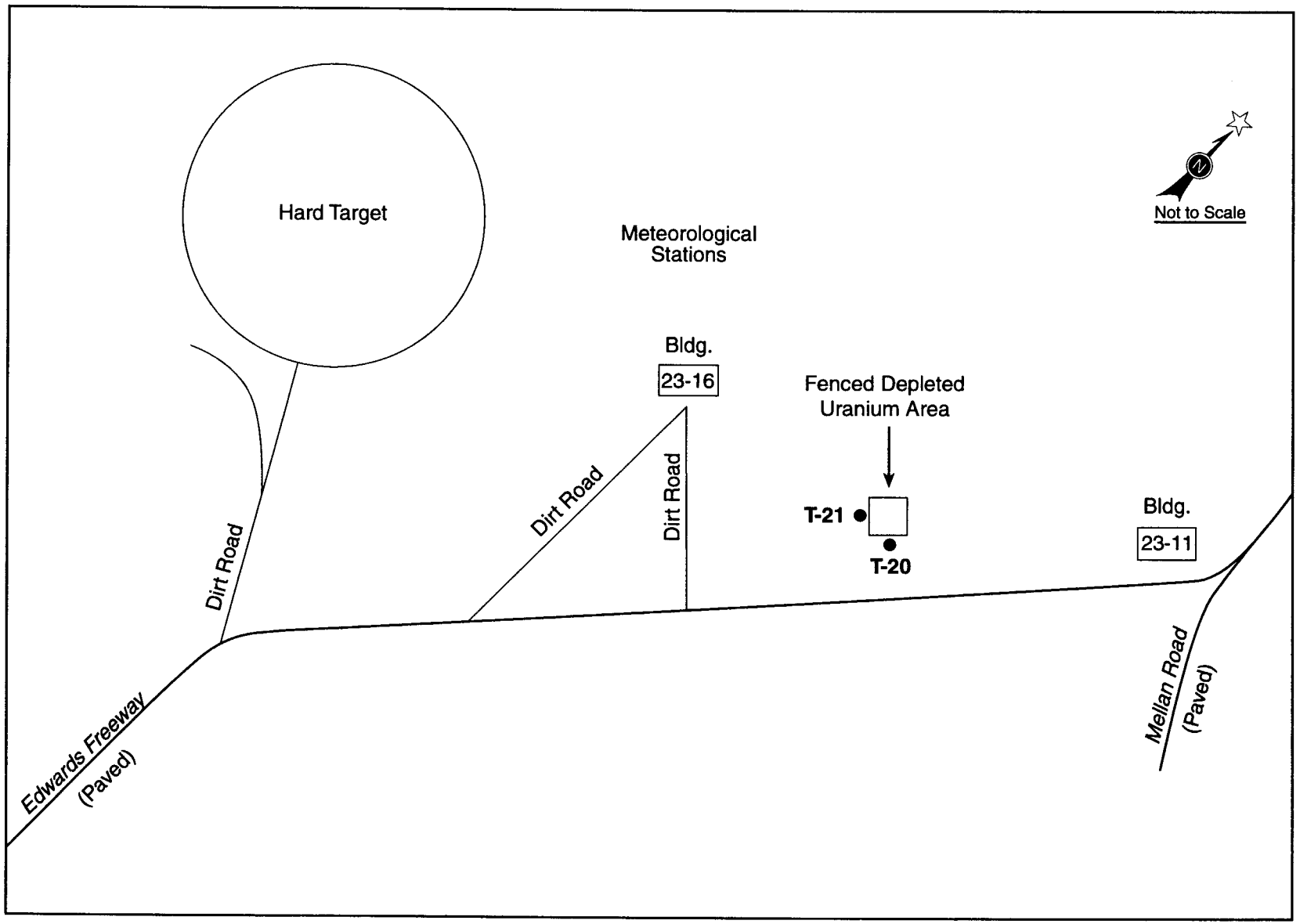


Figure B-9. Soil sampling locations near the Hard Target/Depleted Uranium Area.

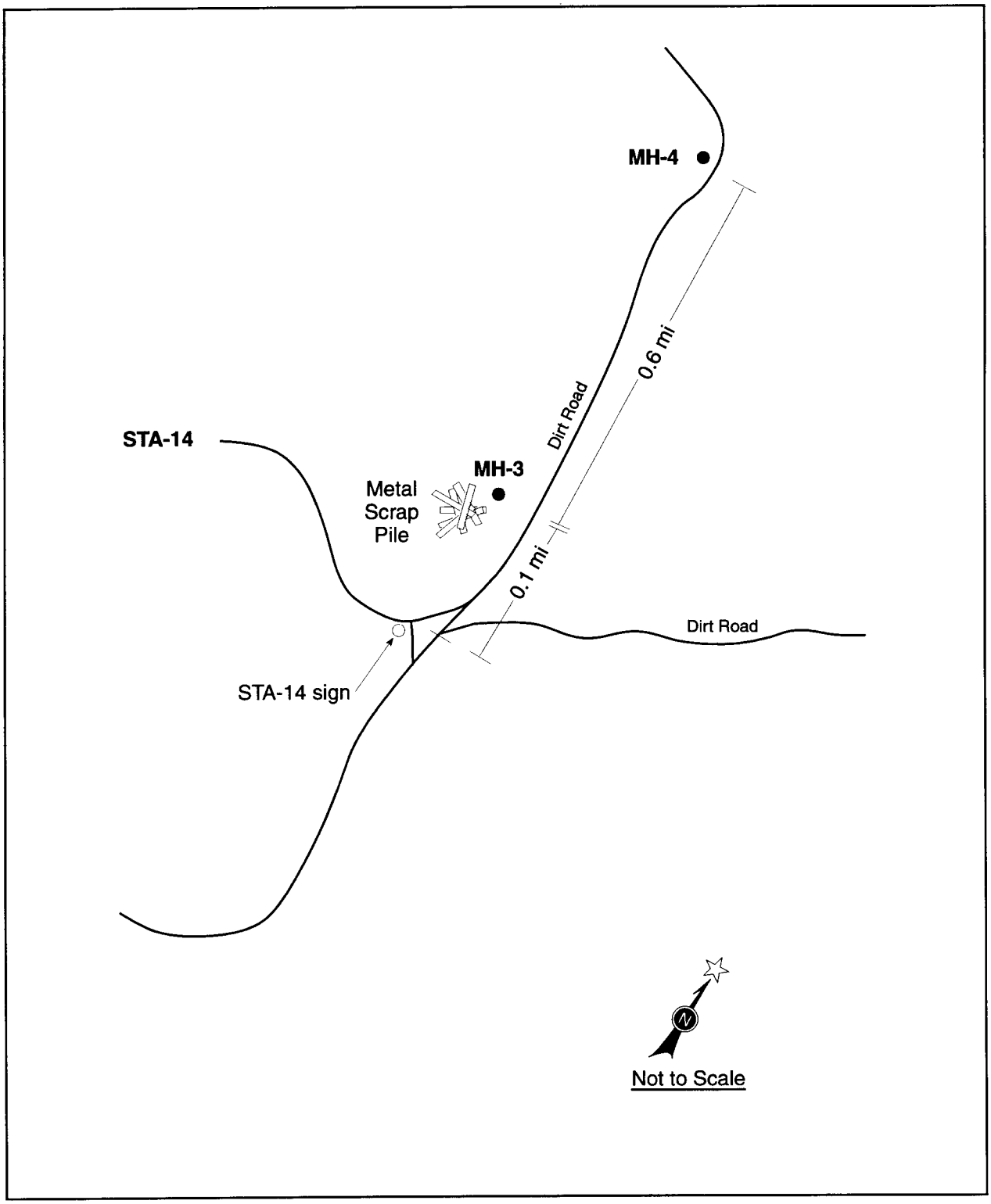


Figure B-10. Soil sampling locations at the Mellan Hill Area.

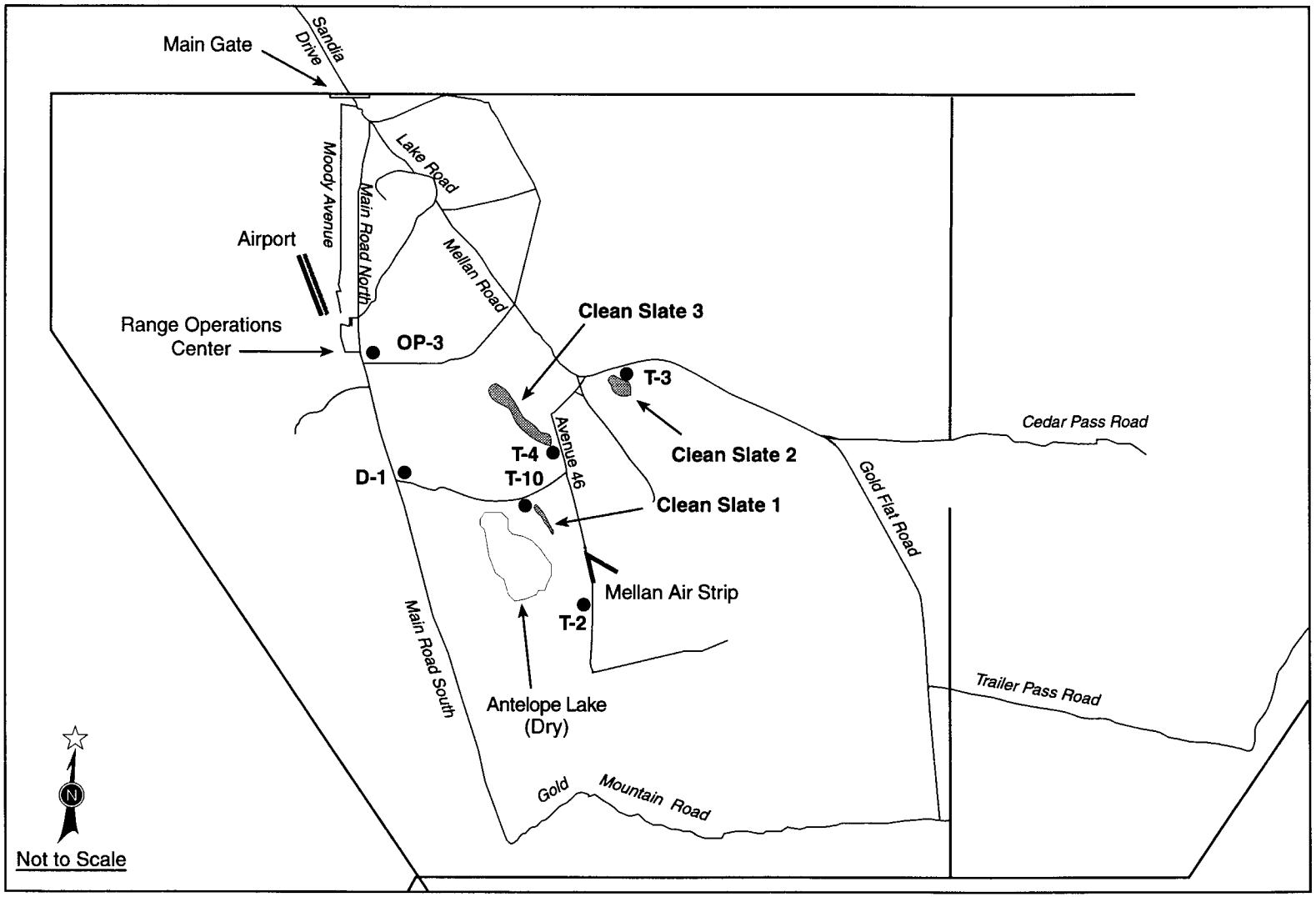


Figure B-11. Various onsite soil sampling locations.

Table B-7. Radiological results of various onsite soil sampling locations, 1996.

Location	Utot (µg/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-1 (Fig. B-11)	2.4	0.08	0.03	0.42	0.10	0.02	0.02	5.40	0.26
MH-3 (Fig. B-10)	4.3	0.80	0.08						
MH-4 (Fig. B-10)	3.0	0.85	0.08	0.04	0.02	0.02	0.03	1.30	0.01
OP-3 (Fig. B-11)	3.1	0.13	0.04						
STA-14 (Fig. B-10)	1.8	0.71	0.07	0.03	0.02	-0.01	0.02	0.11	0.04
T-2 (Fig. B-11)	2.2	0.30	0.05						
T-3 (Fig. B-11)	2.2	0.40	0.05	0.05	0.02	0.00	0.01	0.77	0.22
T-4 (Fig. B-11)	2.1	0.11	0.03	0.71	0.07	0.03	0.07	4.90	0.13
T-10 (Fig. B-11)	3.0	0.12	0.04	--	--	--	--	--	--
T-20 (Fig. B-9)	3.7	0.40	0.06	--	--	--	--	--	--
T-21 (Fig. B-9)	3.0	0.26	0.04	--	--	--	--	--	--

Table B-8. Thermoluminescent dosimeter results for the Tonopah Test Range.

Location	Description	First Period		Second Period		Third Period		Fourth Period		Annual Exposure
		Days	(mR)	Days	(mR)	Days	(mR)	Days	(mR)	(mR/yr)
Onsite										
T-1	Antelope Lake/Target Area	91	34.40 ± 2.40	103	35.80 ± 7.30	78	32.40 ± 3.20	112	44.70 ± 3.10	147.30 ± 16.00
T-2	Mellan Airstrip	91	36.80 ± 3.20	103	40.40 ± 2.80	78	35.30 ± 3.10	112	49.00 ± 3.20	161.50 ± 12.30
T-3	Clean Site 2	91	35.60 ± 3.60	103	40.50 ± 3.60	78	30.30 ± 8.10	112	37.20 ± 2.40	143.60 ± 17.70
T-4	Clean Slate 3 (Ave. 46)	91	33.30 ± 2.00	103	39.60 ± 2.50	78	34.40 ± 3.50	112	43.50 ± 2.80	150.80 ± 10.80
T-5	Gate 1	91	35.60 ± 4.20	103	40.30 ± 2.80	78	34.30 ± 3.00	112	47.70 ± 6.30	157.90 ± 16.30
T-7	Onsite Housing	91	31.30 ± 1.60	103	37.90 ± 2.50	78	26.30 ± 2.80	112	43.90 ± 3.90	139.40 ± 10.80
T-9	Project Roller Coaster Decontamination Area	91	30.40 ± 4.70	103	35.50 ± 6.10	78	27.60 ± 4.70	112	50.70 ± 6.10	144.20 ± 21.60
T-10	Near Clean Slate 1	91	34.90 ± 5.70	103	40.00 ± 2.50	78	34.40 ± 3.10	112	46.10 ± 3.00	155.40 ± 14.30
T-13	Operations Center, NE corner	91	94.10 ± 11.00	103	43.90 ± 2.70	78	66.90 ± 25.20	112	55.40 ± 3.60	260.30 ± 42.50
T-14	Operations Center, NW corner	91	30.40 ± 4.80	103	35.00 ± 6.90	78	26.00 ± 4.10	112	48.40 ± 3.10	139.80 ± 18.90
T-15	Airport	91	33.30 ± 1.30	103	41.00 ± 5.50	78	30.70 ± 2.90	112	53.00 ± 3.40	158.00 ± 13.10
T-16	Area 9	91	34.00 ± 1.30	103	43.50 ± 1.90	78	28.10 ± 4.20	112	49.40 ± 3.90	155.00 ± 11.30
T-17	Hard Target	91	33.10 ± 1.70	103	41.20 ± 2.90	78	27.10 ± 4.70	112	48.90 ± 9.50	150.30 ± 18.80
Perimeter										
T-6	Cedar Gate	91	37.10 ± 2.20	103	41.70 ± 2.90	78	30.20 ± 5.00	112	49.70 ± 6.60	158.70 ± 16.70
T-8	Main Gate	91	29.40 ± 2.80	103	39.20 ± 2.70	78	25.70 ± 3.80	112	45.30 ± 3.30	139.60 ± 12.60
T-11	Cactus Spring Gate	91	40.70 ± 2.90	103	37.40 ± 13.60	78	35.50 ± 8.50	112	53.60 ± 4.40	167.20 ± 29.40
T-12	S Perimeter	91	32.90 ± 4.10	103	40.30 ± 3.90	78	28.70 ± 3.10	112	52.00 ± 2.80	153.90 ± 13.90
Community										
T-18	Town of Tonopah	91	31.90 ± 7.20	103	30.70 ± 7.10	78	26.70 ± 4.10	112	43.70 ± 4.60	133.00 ± 23.00
T-19	Town of Goldfield	91	28.70 ± 3.60	103	28.60 ± 1.80	78	23.80 ± 2.90	112	35.30 ± 6.20	116.40 ± 14.50
T-20	Roadside rest on Hwy 95	91	31.90 ± 2.10	103	27.70 ± 6.60	78	25.60 ± 2.80	112	41.50 ± 2.80	126.70 ± 14.30
T-21	Roadside rest on Hwy 6	91	33.60 ± 5.00	103	39.40 ± 1.70	78	30.00 ± 6.00	112	46.50 ± 11.40	149.50 ± 24.10
T-22	TTR entrance and Hwy 6, Junction	91	35.40 ± 4.70	103	35.70 ± 4.60	78	32.40 ± 2.70	112	44.90 ± 4.80	148.40 ± 16.80

NOTE: mR = milliroentgen; mR/yr = milliroentgen per year; NA = not applicable to less than three periods of data.

Table B-9. Results of radiological replicate soil samples, 1996.

Sample Location	Analyte	Number of Samples	Mean (pCi/g)	Standard Deviation (pCi/g)	Coefficient of Variation (%)
D-01	Am-241	3	0.84	± 1.1	130
	Cs-137	3	0.23	± 0.23	100
	Pu-238	2	0.01	± 0.01	100
	Pu-239+240	2	6.6	± 1.6	24
	Utot	3	2.4	± 0.20	8.3
T-03	Am-241	3	0.05	± 0.06	120
	Cs-137	3	0.58	± 0.18	31
	Pu-238	2	0.0	--	--
	Pu-239+240	2	0.84	± 0.10	12
	Utot	3	2.3	± 0.1	4.4
T-07	Cs-137	3	0.07	± 0.11	160
	Utot	3	2.7	± 0.10	3.7
T-14	Cs-137	3	0.58	± 0.12	21
	Utot	3	2.0	± 0.46	23

APPENDIX C

NONRADIOLOGICAL ANALYTICAL DATA

This page intentionally blank

CONTENTS

TABLES

Table C-1. Nonradiological results of offsite soil samples. Concentrations are in (ug/g).

Location	Aluminum	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
B-1	5600	110	0.5	0.5	15000	7.1	3.4	7	7200	15
B-2	9300	120	0.8	0.5	25000	7.8	4.3	11	9000	12
B-3	6400	110	0.7	0.5	19000	8.1	2.9	6.3	8000	18
B-4	3600	82	0.5	0.5	4200	17	1.9	6.5	4900	12
B-5	7600	130	0.5	0.5	21000	9.6	4.1	12	9000	13
B-6	8800	190	0.6	0.5	9600	11	3.8	9.8	8400	14
B-7	6000	130	0.5	0.5	5600	11	2.9	7.4	8100	25
B-8	5900	140	0.5	0.5	2600	15	2.2	4.3	7200	13
B-9	5000	140	0.5	0.5	1900	9.2	2.4	4.7	6200	15
B-10	4900	320	0.6	0.5	29000	18	3.2	9.1	8800	16
B-11	7100	130	0.5	0.5	18000	7.2	2.7	4.6	7100	11
B-12	6400	140	0.5	0.5	5600	7.8	3	5.5	6600	11
B-13	4500	100	0.5	0.5	2300	9.4	1.5	4.2	4400	7
B-14	5600	97	0.5	0.5	3400	6.9	2.3	6.6	5900	8

Location	Magnesium	Manganese	Nickel	Potassium	Silver	Strontium	Titanium	Vanadium	Zinc
B-1	2800	350	5	2500	0.5	59	110	10	32
B-2	4800	310	7	3700	0.6	120	130	15	38
B-3	3500	410	5	3100	0.5	77	170	15	37
B-4	2500	210	4	1800	0.9	29	110	7.8	30
B-5	4500	320	7	2600	0.5	88	240	17	34
B-6	4000	350	5	3700	0.5	110	240	15	32
B-7	2800	370	4	3200	0.5	38	100	9.6	52
B-8	1600	300	3	2500	0.5	32	240	12	29
B-9	1700	260	3	2100	0.5	24	220	11	25
B-10	8000	300	12	2100	0.5	84	130	21	65
B-11	3800	300	5	4400	0.5	180	240	14	22
B-12	2600	430	4	3800	0.5	40	150	9.3	26
B-13	1600	140	3	2900	0.5	40	92	6.3	16
B-14	2500	170	3	3200	0.5	32	120	8.6	20

Table C-2. Nonradiological results of perimeter soil samples. Concentrations are in (ug/g).

Location	Aluminum	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
T-6	6400	86	0.5	0.5	2200	9.8	2.9	4.8	6400	10
T-8	3600	78	0.5	0.5	1600	18	1.2	8.5	4400	5
T-11	8400	95	0.7	0.5	2800	12	4.5	12	12000	20
T-12	7300	120	0.5	0.5	5900	12	3.6	6	9300	12
T-13	4300	140	0.5	0.5	1800	14	3.3	5	9300	14

Location	Magnesium	Manganese	Nickel	Potassium	Silver	Strontium	Titanium	Vanadium	Zinc
T-6	2000	330	4	2700	0.5	27	180	9.3	27
T-8	1200	130	3	1900	0.5	18	120	6.4	18
T-11	2700	510	6	2400	0.5	32	16	18	53
T-12	3100	460	5	2800	0.5	37	200	14	39
T-13	1300	380	4	2300	0.6	22	42	8.8	36

Table C-3. Nonradiological results of On-base Housing area soil samples. Concentrations are in (ug/g).

Location	Aluminum	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
T-7	4600	110	0.5	0.5	8100	9.3	1.6	3.3	5300	5
T-34	3600	72	0.5	0.5	1500	9.7	1	2.9	4300	5
T-35	3800	73	0.5	0.5	2500	12	1.3	2.6	4500	5
T-36	4400	82	0.5	0.5	2200	15	1.4	2.8	5400	5
T-37	4900	96	0.5	0.5	4500	8.2	2.1	2.6	5700	6

Location	Magnesium	Manganese	Nickel	Potassium	Silver	Strontium	Titanium	Vanadium	Zinc
T-7	1800	140	3	2300	0.5	44	150	8.7	19
T-34	1200	130	2	1600	0.5	16	120	6.6	16
T-35	1300	120	2	1900	0.5	21	140	6.9	16
T-36	1500	170	3	2300	0.5	22	140	8.4	18
T-37	1900	170	3	2300	0.5	37	160	9.1	22

Table C-4. Nonradiological results of South Plume area soil samples. Concentrations are in (ug/g).

Location	Aluminum	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
T-14	12000	230	0.6	0.5	6900	12	4.3	7.5	12000	11
T-15	10000	210	0.5	0.5	7100	12	3.8	5.8	10000	12
T-16	9700	190	0.5	0.5	10000	8.6	3.6	5.9	10000	10
T-17	6800	180	0.5	0.5	5200	9	3.2	6.1	7900	11
T-18	8600	180	0.5	0.5	4200	10	3.4	6.7	9400	11
T-19	5700	87	0.5	0.5	2000	14	2.5	4.2	6300	9

Location	Magnesium	Manganese	Nickel	Potassium	Silver	Strontium	Titanium	Vanadium	Zinc
T-14	4100	400	6	5400	0.5	83	550	22	36
T-15	3600	390	5	4400	0.5	84	570	20	32
T-16	3800	310	5	4100	0.5	78	450	18	32
T-17	3100	390	4	3900	0.5	50	280	13	32
T-18	3200	340	6	4200	0.5	51	370	16	30
T-19	1900	300	3	2200	0.5	21	21	9.2	22

Table C-5. Nonradiological results of 554th Range Squadron O&M soil samples. Concentrations are in (ug/g).

Location	Aluminum	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
OM-1	6000	59	0.5	0.5	1800	18	1.4	3.6	4900	9
OM-2	5400	72	0.5	0.5	1900	7.5	2	4.9	5200	7
OM-3	6900	100	0.5	0.5	2600	13	2.5	4.9	6900	10

Location	Magnesium	Manganese	Nickel	Potassium	Silver	Strontium	Titanium	Vanadium	Zinc
OM-1	1300	180	3	2600	0.5	18	120	6.7	17
OM-2	1900	240	3	2800	0.5	20	120	7	19
OM-3	2500	330	4	2700	0.5	27	200	9.7	25

Table C-6. Nonradiological results of Range Operations Center and Compound soil samples. Concentrations are in (ug/g).

Location	Aluminum	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
OC-1	7800	110	0.6	0.5	9700	13	3	7.9	8100	9
OC-2	9300	130	0.7	0.5	14000	12	4.2	11	10000	13
OC-3	5400	74	0.5	1.1	5600	9.7	2.7	6.7	7100	11
OC-4	7200	130	0.5	0.5	9200	9.4	3.9	7.5	8600	9
OC-10	6000	130	0.5	1	17000	14	2.8	7.7	7300	27
OC-13	7100	120	0.6	0.5	11000	6.7	3.5	7.4	8200	14
OC-19	5800	78	0.5	0.5	6400	12	3	6.3	7100	11
OC-20	6200	90	0.6	0.5	16000	8.8	2.5	4.2	6200	7
OC-22	4700	87	0.5	0.5	9800	12	2.3	4.1	6300	15
OC-23	5000	84	0.5	0.5	7400	10	2.5	11	5800	9

Location	Magnesium	Manganese	Nickel	Potassium	Silver	Strontium	Titanium	Vanadium	Zinc
OC-1	3000	260	4	3000	0.5	67	210	15	26
OC-2	4500	330	7	4300	0.5	85	310	18	45
OC-3	2000	240	4	2600	0.5	35	230	13	31
OC-4	3200	280	4	2600	0.5	63	330	16	26
OC-10	2700	260	4	2600	0.5	71	200	14	41
OC-13	2700	300	4	2600	0.5	70	240	18	120
OC-19	2200	250	4	2400	0.5	44	180	12	70
OC-20	2400	220	3	2200	0.5	81	120	13	24
OC-22	2200	230	4	2600	0.5	38	170	11	32
OC-23	3900	250	3	2600	0.5	33	180	9.7	24

Table C-7. Nonradiological results of various onsite soil samples. Concentrations are in (ug/g).

Location	Aluminum	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead
D-1	8200	130	0.6	0.5	5500	11	6	7.1	12000	13
MH-3	6500	84	0.5	0.5	7000	12	2.3	5.3	7200	9
MH-4	8900	150	0.5	0.5	4100	15	3.5	6	8200	12
OP-3	6000	120	0.5	0.6	15000	16	2.7	8.7	8200	28
STA-14	7000	120	0.5	0.5	3200	13	3.3	5.9	8100	10
T-2	9000	96	0.5	0.5	3700	10	2.8	4.9	8300	9
T-3	6100	90	0.5	0.5	2200	11	2.9	5.5	7400	8
T-4	6700	120	0.6	0.5	5200	9.7	5.7	5.9	11000	12
T-10	5700	110	0.5	0.5	5200	8.5	3	5.7	6900	8
T-20	18000	150	1.1	0.5	20000	13	6.2	15	15000	16
T-21	15000	160	1.1	0.5	18000	13	5.9	14	14000	14

Location	Magnesium	Manganese	Nickel	Potassium	Silver	Strontium	Titanium	Vanadium	Zinc
D-1	4600	360	7	3400	0.5	52	140	17	36
MH-3	2600	240	3	2800	0.5	35	180	12	24
MH-4	3100	610	6	3100	0.5	32	250	13	30
OP-3	2500	250	4	3300	0.5	90	150	13	74
STA-14	2800	390	2	2700	0.5	39	230	13	26
T-2	2800	280	5	3300	0.5	31	220	12	28
T-3	2200	320	3	2200	0.5	31	220	12	25
T-4	3900	400	6	2800	0.5	48	120	15	35
T-10	3000	400	4	3100	0.5	36	170	9.8	26
T-20	8100	490	10	7500	0.5	150	300	20	54
T-21	7400	460	9	6500	0.5	140	300	19	52

Table C-8. Concentrations (in μg/g) of metal replicate samples.

Sample Location	Analyte	Number of Samples	Mean (pCi/g)	Standard Deviation (pCi/g)	Coefficient of Variation (%)
D-1	Aluminum	3	6800	±1400	21
	Barium	3	120	± 12	60
	Beryllium	3	0.50	± 0.06	12
	Cadmium	3	0.50	--	--
	Calcium	3	4500	± 1800	40
	Chromium	3	11.0	--	--
	Cobalt	3	4.6	± 2.0	43
	Copper	3	5.5	± 1.6	29
	Iron	3	9800	± 3000	31
	Lead	3	10	± 3	30
	Magnesium	3	3500	± 1300	37
	Manganese	3	400	± 58	15
	Nickel	3	5.00	± 2.00	40
	Potassium	3	2800	± 600	2
	Silver	3	0.5	--	--
	Strontium	3	45	± 14	31
	Titanium	3	150	± 46	31
	Vanadium	3	14	± 3.9	28
	Zinc	3	30	± 6.7	22
T-3	Aluminum	3	6600	± 680	10
	Barium	3	96	± 5.5	5.7
	Beryllium	3	0.5	--	--
	Cadmium	3	0.5	--	--
	Calcium	3	2500	± 250	10
	Chromium	3	12	± 1.0	8.3
	Cobalt	3	2.8	± 0.06	2.1
	Copper	3	5.2	± 0.26	5.0
	Iron	3	7600	± 200	2.6
	Lead	3	9	± 0.6	6.7
	Magnesium	3	2200	--	--
	Manganese	3	330	± 26	7.9
	Nickel	3	3	± 0.6	20
	Potassium	3	2300	± 58	2.5
	Silver	3	0.50	--	--
	Strontium	3	32	± 1.2	3.8
	Titanium	3	250	± 30	12
	Vanadium	3	12	--	--
	Zinc	3	25	±0.58	2.3

Table C-8. Concentrations (in μg/g) of metal replicate samples (Concluded).

Sample Location	Analyte	Number of Samples	Mean	Standard Deviation	Coefficient of Variation
T-7	Aluminum	3	5000	± 400	8.0
	Barium	3	120	± 5.8	4.8
	Beryllium	3	0.50	--	--
	Cadmium	3	0.50	--	--
	Calcium	3	9400	± 1500	16
	Chromium	3	9.6	± 1.3	14
	Cobalt	3	1.9	± 0.30	16
	Copper	3	3.2	± 0.15	4.7
	Iron	3	5700	± 400	7.0
	Lead	3	6	± 0.6	10
	Magnesium	3	1900	± 120	6.3
	Manganese	3	150	± 5.8	3.9
	Nickel	3	3	± 1	3.0
	Potassium	3	2400	± 100	4.2
	Silver	3	0.5	--	--
	Strontium	3	48	± 4.5	9.4
	Titanium	3	160	± 15	9.4
	Vanadium	3	9.9	± 1.2	12
	Zinc	3	20	± 1.2	6.0
T-14	Aluminum	3	11000	± 1200	11
	Barium	3	220	± 10	4.6
	Beryllium	3	0.6	± 0.06	10
	Cadmium	3	0.50	--	--
	Calcium	3	6900	± 1100	16
	Chromium	3	11	± 1.4	13
	Cobalt	3	4.1	± 0.35	8.5
	Copper	3	7.3	± 0.76	10
	Iron	3	11000	± 1300	12
	Lead	3	12	± 1	8.3
	Magnesium	3	4000	± 320	8.0
	Manganese	3	390	± 5.8	1.5
	Nickel	3	6	± 0.6	10
	Potassium	3	5400	±200	3.7
	Silver	3	0.5	--	--
	Strontium	3	77	± 6.5	8.4
	Titanium	3	470	± 91	19
	Vanadium	3	20	± 2.6	13
	Zinc	3	34	± 2.9	8.5

UNLIMITED RELEASE DISTRIBUTION:

U.S. Department of Energy (50)
Kirtland Area Office (KAO)
Environment, Safety, Health, and
Compliance Branch
P.O. Box 5400
Albuquerque, NM 87185

U.S. Department of Energy (1)
Nevada Operations Office
P.O. Box 98518
Las Vegas, NV 89193-8518

New Mexico Environment Department (1)
c/o DOE-KAO-ESHCB
P.O. Box 5400
Albuquerque, NM 87185-5400

Albuquerque City Environmental
Services (1)
400 Marquette Ave. NW
Albuquerque, NM 87117

Captain Robert C. Viramontes (1)
2000 Wyoming Blvd.
377 ABW/EMP
KAFB, NM 87117-5606

Director (1)
Inhalation Toxicology Research Institute
P.O. Box 5800
Albuquerque, NM 87185

Environmental Protection Agency (EPA) (1)
Headquarters Office
401 M Street, SW
Washington, DC 20460

Environmental Protection Agency (EPA) (1)
Region IX Office
215 Fremont Street
San Francisco, CA 94105

U.S. Department of Energy/HQ, (3)
Office of Environmental Policy
and Assistance (EH-41)
1000 Independence Ave. SW
Washington, DC 20585

U.S. Department of Energy/HQ, (2)
Office of Research, Development and
Testing Facilities (DP-13)
1000 Independence Ave. SW
Washington, DC 20585

U.S. Department of Energy/HQ, (1)
Office of Environmental
Oversight (EM-22)
1000 Independence Ave. SW
Washington, DC 20585

U.S. Department of Energy/HQ, (2)
Office of Southwestern Area
Programs (EM-45)
1000 Independence Ave. SW
Washington, DC 20585

U.S. Department of Energy (3)
Albuquerque Operations Office, EPD
P.O. Box 5400
Albuquerque, NM 87185-5400

SANDIA NATIONAL LABORATORIES,
INTERNAL DISTRIBUTION

1	(MS 0102)	R. A. David, 00002
1	(MS 0104)	Print Media, 12630
1	(MS 0141)	Robert J. Park, 11300
1	(MS 0315)	R. G. Hay, 2419
1	(MS 0361)	Lynn Jones, 7000
1	(MS 0369)	A. O. Bendure, 7523
1	(MS 0748)	L. J. Shyr, 6413
1	(MS 0841)	J. A. Fernandez, 9104
5	(MS 0854)	T. A. Culp, 7575
2	(MS 0854)	D. K. Duncan, 7575
1	(MS 0854)	H. Herrera, 7575
1	(MS 0854)	H. A. Hwang, 7575
1	(MS 0854)	Hans Oldewage, 7575
1	(MS 0854)	Stephannie Pope, 7575
10	(MS 0854)	R. V. Sanchez, 7575
1	(MS 1007)	K. Kuhlmann, 9672
1	(MS 1035)	J. G. Yeager, 7526
1	(MS 1041)	J. R. Guth, 7522
10	(MS 1043)	Records Center and 7500 Library, 7512
1	(MS 1044)	G. E. Chavez, 7577
1	(MS 1044)	S. J. Ward, 7511
5	(MS 1054)	T. E. Blejwas, 7500
1	(MS 1147)	W. B. Cox, 6681
1	(MS 1392)	Bill Forston, 9719
5	(MS 1392)	R. A. Smith, 9719
1	(MS 9018)	Central Technical Files, 8940-2
5	(MS 0899)	Technical Library, 4916
2	(MS 0619)	Review & Approval Desk, 12690 For DOE/OSTI

US GOVERNMENT PRINTING PRINTING OFFICE: 1997-573-127.42149