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1999 Annual Site Environmental Report Tonopah Test Range, Nevada

Dianne Duncan, William Forston, and Rebecca Sanchez

Prepared by
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Albuquerque, New Mexico 87185 and Livermore, California 94550

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1999
Annual Site Environmental Report
Tonopah Test Range, Nevada

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ABSTRACT

The Tonopah Test Range (TTR) in Nevada is a government-owned, contractor-operated facility. Sandia National Laboratories (SNL) is run by Sandia Corporation, a subsidiary of Lockheed Martin Corporation. The U.S. Department of Energy (DOE) oversees the operations of TTR through its Kirtland Area Office (KAO), which reports to the Albuquerque Operations Office (AL). Sandia Corporation conducts operations at TTR in support of DOE's Weapons Ordnance Program and has operated the site since 1957. Westinghouse Government Services subcontracts to SNL in administering most of the environmental programs at the site. This annual report summarizes data and the compliance status of the environmental protection and monitoring program at TTR through December 31, 1999. The compliance status of environmental regulations applicable at the site include state and federal regulations governing air emissions, wastewater effluent, waste management, and Environmental Restoration (ER) cleanup activities. Terrestrial surveillance for radiological and nonradiological contaminants is also conducted, as required by DOE, to determine contaminant levels at offsite, perimeter, and onsite locations. Sandia Corporation is responsible only for those environmental program activities related to SNL's operations. The DOE Nevada Operations office (NVOO) retains responsibility for the cleanup and management of ER sites at TTR. Environmental monitoring and surveillance programs are required by DOE Order 5400.1, *General Environmental Protection Program* (DOE 1990), and DOE Order 231.1, *Environment, Safety and Health Reporting* (DOE 1996a).

Site Environmental Report for 1999
Sandia National Laboratories, Tonopah Test Range, Nevada
Final Approval date: November 2000

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Main Compound at Tonopah Test Range (TTR) Showing the Control Tower that Overlooks the Range Flight Area

NOTE TO THE READER

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Kevin Cabble & Jason Moore	Environmental Restoration (ER) Project
Dianne Duncan	Site Information, Geology, Fauna, and Climate
Charles Fink	Storm Water Program
William Forston	Environmental Monitoring Activities and Waste Management *Bill Forston is the TTR site lead for most environmental programs and the primary contributor to this report.*
Joan Harris	National Environmental Policy Act (NEPA) Activities
Heidi Herrera	Terrestrial Surveillance Program
Adrian Jones	Wastewater Discharge Program
Mike du Mond	Air Quality Compliance (nonradiological air emissions)
Beth Pomatto	National Emission Standards for Hazardous Air Pollutants (NESHAP) (radiological air emissions)

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ABBREVIATIONS

A

AEC	U.S. Atomic Energy Commission
AIRFA	American Indian Religious Freedom Act
AL	U.S. Department of Energy/Albuquerque Operations Office
ARPA	Archaeological Resources Protection Act
ASER	Annual Site Environmental Report
AST	aboveground storage tank

B

BLM	U.S. Bureau of Land Management

C

CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CADD	Corrective Action Decision Document
CAP	Corrective Action Plan
CAI	Corrective Action Investigation
CAIP	Corrective Action Investigation Plan
CAS	Corrective Action Site
CAU	Corrective Action Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
CY	calendar year

D

DMR	Discharge Monitoring Report
DOC	U.S. Department of Commerce
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/HQ	U.S. Department of Energy/Headquarters
DOI	U.S. Department of Interior
DRI	Desert Research Institute, Water Resources Center, University of Nevada System
DU	depleted uranium

ABBREVIATIONS (Continued)

E

EA	Environmental Assessment
EDE	effective dose equivalent
EO	Executive Orders
EHS	Extremely Hazardous Substances
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	Environmental Restoration
ERDA	U.S. Energy Research and Development Administration
ES&H	Environment, Safety, and Health
ESA	Endangered Species Act

F

FFCA	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

I

ICP-AES	Inductively Coupled Plasma - Atomic Emission Spectrum

J

JTA	Joint Test Assembly

K

KAO	U.S. Department of Energy/Kirtland Area Office

L

LDR	Land Disposal Restriction

M

MDA	minimum detectable activity
MOA	Memorandum of Agreement
MDC	minimum detectable concentrations
MEI	maximally exposed individual
MSDS	Material Safety Data Sheet
MW	mixed waste

ABBREVIATIONS (Continued)

N

NA	not applicable or not available
NAEG	Nevada Applied Ecology Group
NAFB	Nellis Air Force Base (Range Complex)
NAFR	Nellis Air Force Range
NEDS	Non Explosive Destruction Site
ND	Not Detected (or below the detection limit)
NDEP	Nevada Department of Environmental Protection
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
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
NVOO	U.S. Department of Energy, Nevada Operations Office

O

O&M	Operations and Maintenance

P

PA	Preliminary Assessment
PCB	polychlorinated biphenyl
PIC	Pressurized Ionization Chamber
PMS	portable monitoring station
PPE	personal protective equipment

Q

QA	quality assurance

R

RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
ROD	Record of Decision
RQ	Reportable Quantity

ABBREVIATIONS (Continued)

S

SAFER	Streamlined Approach for Environmental Restoration
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
SPCC	Spill Prevention, Control, and Countermeasures
SVOC	semi-volatile organic compound

T

TLD	thermoluminescent dosimeter
TPH	total petroleum hydrocarbon
TRPH	total recoverable petroleum hydrocarbon
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal (facility)
TSP	total suspended particulates
TTR	Tonopah Test Range

U

UDP	underground discharge point
USAF	U.S. Air Force
USGS	U.S. Geological Survey
UST	underground storage tank
UXO	unexploded ordnance

V

VOC	volatile organic compound

ABBREVIATIONS (Continued)

Units of Measure

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

Radioactivity Measurements

Ci	curie (unit of radioactivity)
mrem	millirem (unit of radiation dose)
mrem/yr	millirem per year
mR/yr	milliroentgen per year
pCi	picocurie
pCi/g	picocurie per gram
rem	roentgen equivalent man (unit of radiation dose)
µg/g	microgram per gram
$\mu g/m^2$	microgram per square meter
$\mu g/m^3$	microgram per cubic meter
Am-241	americium-241
Pu-238	plutonium-238
Pu-239	plutonium-239
Pu-240	plutonium-240
Pu-241	plutonium-241
Pu-242	plutonium-242
Ra-226	radium-226
Th-232	thorium-232
H-3	tritium
Cs-137	cesium-137
U	uranium
U-238	uranium-238
U_{tot}	uranium, total

Chemical Abbreviations

Al	aluminum
Sb	antimony
Ba	barium
Cu	copper
Co	cobalt
Fe	iron
Mg	magnesium
Mn	manganese
K	potassium
Se	selenium
V	vanadium
Ar	arsenic
Be	beryllium
Cd	cadmium
Cr	chromium
Pb	lead
Hg	mercury
Ni	nickel
Tl	thalium
Ag	silver
Zn	zinc

ABBREVIATIONS (Concluded)

Approximate Conversion Factors for Selected SI (Metric) Units

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


B-2A/B61-11 Certification Drop - TTR (Nov. 20, 1996)

Chapter 1

Introduction

The Tonopah Test Range (TTR) is located on 336,665 acres within the boundaries of the Nellis Air Force Range (NAFR) withdrawal and is used to support activities related to the missions of the U.S. Department of Energy (DOE) and the United States Air Force (USAF). Sandia National Laboratories (SNL), TTR is operated by Sandia Corporation, a subsidiary of Lockheed Martin Corporation, through its contract with the DOE, which is administered by the Kirtland Area Office (KAO). As the operations and maintenance contractor for TTR, Westinghouse Government Service performs most all environmental program functions, including environmental media sampling, wastewater effluent and drinking water monitoring, spill response, and waste management operations. Westinghouse Government Services also operates the range itself during testing and is responsible for data acquisition and optical range oversight.

This Annual Site Environmental Report (ASER) has been prepared in accordance with, and as required by DOE Order 5400.1, *General Environmental Protection Program* (DOE 1990) and DOE Order 231.1, *Environment, Safety, and Health Reporting* (DOE 1996a). The ASER summarizes data from environmental protection and monitoring programs at TTR through December 31, 1999. The status of environmental programs summarized in this report include waste management programs, air, water, and terrestrial monitoring and surveillance programs, the Environmental Restoration (ER) Project, and the National Environmental Policy Act (NEPA) Program. DOE Order 5400.1 specifies the requirements for environmental monitoring conducted at and around the site. The ASER represents a key component of the DOE's effort to keep the public informed about environmental conditions at DOE facilities.

1.1 TTR HISTORY AND OPERATIONS

In 1940, President Roosevelt established the "Las Vegas Bombing and Gunnery Range" (now referred to as NAFR), which is part of the Nellis Air Force Base (NAFB) Complex. The Complex includes NAFB, located eight miles north of Las Vegas, Nevada, several auxiliary small arm ranges, and the NAFR—divided into a North Range and a South Range (Figure 1-1). The Nevada Test Site (NTS) is located between these two ranges. The entire NAFB Complex comprises approximately three million acres. TTR is 32 miles southeast of Tonopah, Nevada.

TTR Site Characteristics

The topography at TTR is characterized by a broad, flat, valley bordered by two north/south trending mountain ranges: the Cactus Range to the west (occurring mostly within the boundaries of TTR) and the Kawich Range to the east. Cactus Flat is the valley floor where the main operational area of TTR is located. An area of low hills outcrops in the south. Elevations within TTR range from 1,630 m (5,347 ft) at the valley floor to 2,279 m (7,482 ft) at Cactus Peak. The elevation within the town of Tonopah is at 1,837 m (6,030 ft).

TTR Site Selection

TTR was eventually selected as a bombing range after similar facilities at the Salton Sea Test Base in California, as well as Yucca Flat on the NTS, became inadequate. By the mid-1950s, the atmosphere at the Salton Sea Test Base became permeated with haze, which limited visibility and hampered photography. Nevada's Yucca Flat site also became inadequate due to the increasing emphasis on low-altitude approaches and deliveries that required flat terrain and a long approach corridor. The TTR site was located in the northwest corner of the then Las Vegas Bombing and Gunnery Range. The site, which was approximately seven times the size of the Salton Sea Test Base, was well suited because it had the immense areas of flat terrain needed for the increasing use of rockets and low-altitude, high-speed aircraft operations. The area was withdrawn in 1956 and TTR became operational in 1957 to operate and test new weapon systems. In the years following World War II, facilities that were built at TTR were originally designed and equipped to gather data on aircraft delivered inert test vehicles under Atomic Energy Commission (AEC) cognizance (now DOE). Over the years, the facilities and capabilities at TTR were expanded to accommodate tests related to the DOE's Weapons Ordnance Program.

Operations Control Center

The Main Compound in Area 3 is the heart of the test range activities. The Operations Control Center, located on the top (4th) floor of the Operations Building, controls and coordinates all test functions and affords a 360 degree view of the site. During test operations, the test director, range safety officer, test project engineer, camera controller, and range communicator, operate the consoles in the Center to control and coordinate all test functions.

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

TTR Activities

Principal DOE activities at the TTR include: stockpile reliability testing; research and development testing support of structural development; arming, fusing and firing systems testing; and testing nuclear weapon delivery systems. (However, no nuclear devices are tested at the range.) TTR is instrumented with a wide array of signal tracking equipment including video, high-speed cameras, and radar tracking devices used to characterize ballistics, aerodynamics, and parachute performance on artillery shells, bomb drops, missiles, and rockets.

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

Air drops (trajectory studies of simulated weapons);

- Gun firings;
- Ground-launched rockets (study of aeroballistics and material properties);
- Air-launched rockets (deployed from aircraft);
- Explosive testing (for example, shipping and storage containers);
- Static rocket tests (related to the Trident Submarine Program); and
- Ground penetrator tests.

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

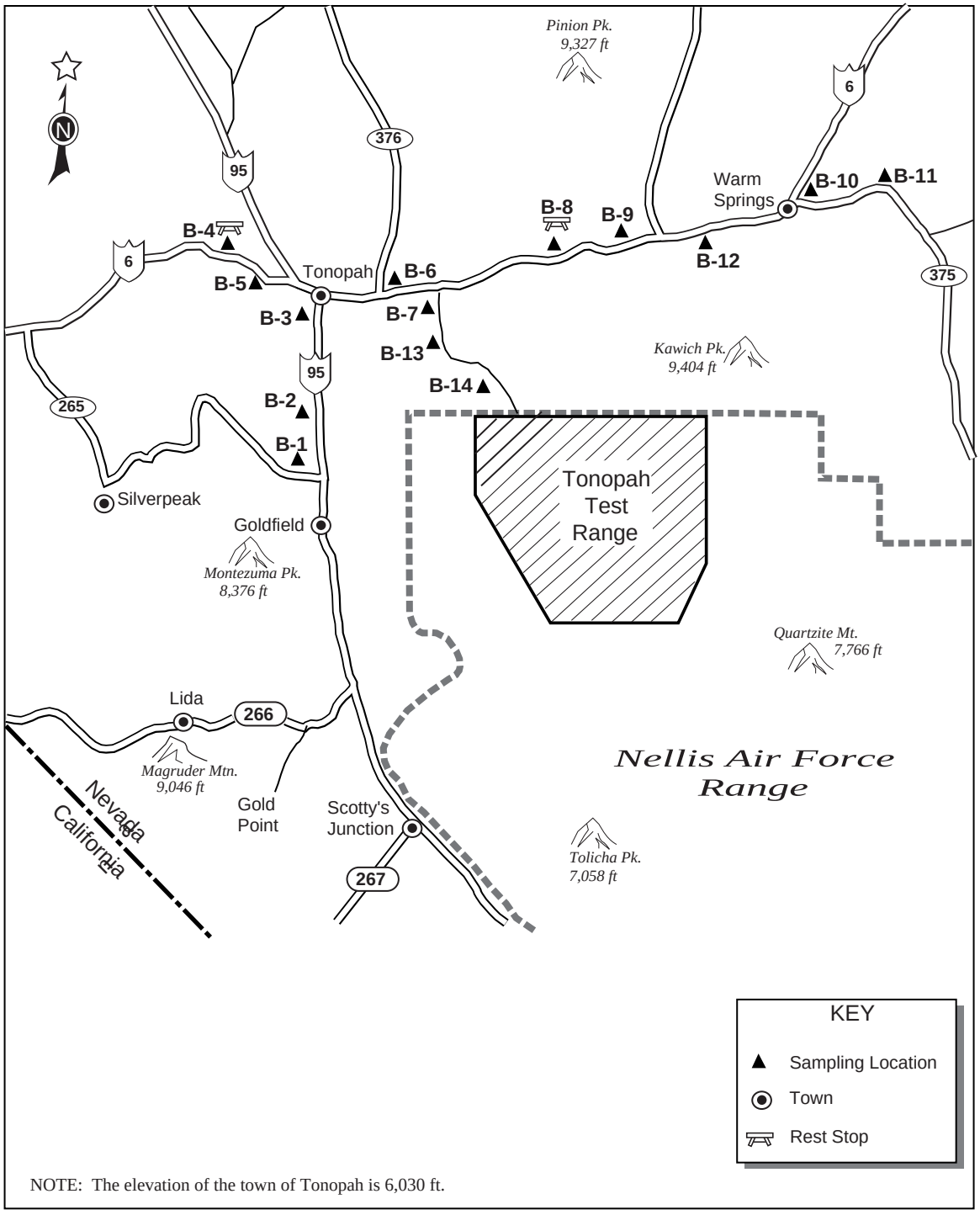

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FIGURE B-1. Offsite Soil Sampling Locations
(14 Locations)

Site Responsibility
On October 1, 1997 a Memorandum of Agreement (MOA) was signed between DOE Albuquerque Operations Office (AL) and DOE Nevada Operations Office (NVOO) with regards to operational test activities at TTR. It was determined that KAO would be responsible for the oversight of TTR. NVOO, however, will continue with the oversight of Environmental Restoration (ER) activities at the site. Environmental program management, as discussed in this report is a joint effort between Sandia Corporation employees and contractors at TTR and personnel from Sandia National Laboratories, New Mexico (SNL/NM) with oversight from KAO.

1.2 SITE DESCRIPTION AND DEMOGRAPHICS

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

The nearest residents are located in the town of Goldfield (population 659), approximately 35.4 km (22 mi) west of the site boundary. The town of Tonopah (population 4,400) is the next largest population center, approximately 48.2 km (30 mi) northwest of the site (DOC 1991). Las Vegas is 225 km (140 mi) from TTR. The total population within an 80-kilometer (50-mile) radius around TTR is approximately 7,000. This number includes the potential population at TTR if all housing units at the site were occupied.

1.3 REGIONAL GEOLOGY, HYDROLOGY, CLIMATE, AND FAUNA

Geology
The regional area around TTR is located in the western part of the Basin and Range geophysical province. This area is marked by horst and graben topography, a system of mountains and down-dropped fault valleys formed through regional extension. TTR lies northeast of the Walker Lane, a zone of transcurrent faulting and shear, and the Las Vegas Valley shear zone to the southeast (Sinnock 1982).

The Cactus Range to the west of TTR is the remnants of a major volcanic center consisting of relatively young (six million-year-old) folded and faulted tertiary volcanics. This range is one of at least five northwest trending, raised structural blocks that lie along the Las Vegas Valley-Walker Lane lineaments (ERDA 1975).

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

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

Groundwater
TTR derives its water from local wells. The U.S. Geological Survey (USGS) has recorded groundwater depths from 21 to 454 ft at the site. Groundwater is encountered at the Antelope

Mine well in the Cactus Range at 21 ft and at the EH2 well, near the TTR Airport, at 454 ft. The depth to groundwater at the Area 9 well (north end of the site) is approximately 131 ft. South of that well, groundwater is encountered at 361 to 394 ft in Area 3. The static water level at Well 6 (the main water supply well) is approximately 350 ft.

Climate

The climate at TTR is mild and usually dry, but, as is typical of high deserts, is subject to large diurnal and seasonal changes in temperature—from a record high of 38.8 ºC (102 ºF) to a record low of -4 ºC (24 ºF) (Schaeffer 1982). July and August are hottest with temperatures ranging from the 90s during the day and dropping to the 50s at night. Clear, sunny days with light to moderate winds are usual.

Rainfall is dependent on elevation. The annual average at the desert floor is 10 cm (4 in.) and 30.4 cm (12 in.) in the mountains. The primary rainfall season is in the summer with a lesser rainy season in the winter (DOI/BLM 1979).

Winds are mostly from the northwest from late fall to spring, and are influenced by the Pacific air flow patterns coming over the Sierra Nevada Mountains in California. From summer through early fall, the winds generally shift to a southeasterly direction blowing in from the Gulf of Mexico. Dust storms are common in the spring and dust devils occur in the summer.

Vegetation

Temperature extremes and arid conditions of the high desert limit vegetation coverage. Sparse vegetation occurring in Cactus Flat is predominantly range grasses and low shrubs typical of the Great Basin Desert flora (ERDA 1975; EG&G 1979a).

Vegetation is divided into two basic types at the site by elevation—salt desert shrub in the low areas and northern desert shrub in the higher elevations (DOI/BLM 1979, DRI 1991). Salt desert shrub is characteristic of poorly drained soils and is common along dry lakebeds. Specific plants in this group include shadscale (a type of salt bush) (*Atriplex confertilfolia*), Russian thistle (*Salsola kali*), and sagebrush (*Artemesia tridentata*). Northern desert shrub, found in the Cactus Range, includes a variety of sagebrush, rabbitbrush (*Chrysothamnus nauseosus*), squirrel tail (*Elymus longifolius*), juniper (*Juniperus* varieties), and Nevada bluegrass (*Poa nevadensis*). Joshua trees (*Yucca brevifolia*) and juniper grow in the transition zone at the base of the mountains.

Wildlife

The Nevada Wild Horse Range and other wild horse land-use areas compose a significant portion of the North Range with herds common in Cactus and Gold Flats, the Kawich Valley, Goldfield Hills, and the Stonewall Mountains. Hundreds of wild horses (*Equus caballus*) graze freely throughout TTR and activities onsite have had apparently little affect on the horse population or their grazing habits. The Bureau of Land Management (BLM) routinely rounds up a portion of the herds for dispersal through the Horse Adoption Program.

Other mammals common to the area include pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), kit fox (*Vulpes macrotis*), bobcat (*Zynx rufus*), coyote (*Canis latrans*), and gray fox (*Urocyon cinereoargenteus*). To a lesser extent, bighorn sheep (*Ovis canadensis*), mountain lion (*Felis concolor*), and burros (*Equus asinus*) are also present (DOI/BLM 1979, DRI 1991). Common birds include various raptor species.

In general, the NAFR land withdrawal has provided a positive effect on local plant and animal life. Since much of the withdrawn area is undisturbed by human activity, large habitat areas are protected from the affects of public use. For example, recreational off-road vehicles can cause significant impacts to desert flora and fauna and it can take years for fragile desert ecosystems to recover from disturbances.

1.4 CLEAN SLATE AND DOUBLE TRACKS SITES

Project Roller Coaster, performed in May and June of 1963, included a series of four nuclear weapons destruction tests that resulted in plutonium dispersal in the surrounding soils. Three of these tests were conducted within the boundaries of TTR; the fourth was conducted on the NAFR just west of the TTR. The locations of the three Project Roller Coaster tests at TTR are referred to as Clean Slates 1, 2, and 3 (Figure 1-2). The fourth site at NAFR is referred to as Double Tracks. In 1996, the Double Tracks was closed after being remediated to a soil contamination level of less than or equal to 200 picocuries per gram (pCi/g) of transuranics.

Table 1 summarizes test information related to the four Project Roller Coaster sites. As previously noted, NVOO has responsibility for the remediation of these and all other Environmental Restoration (ER) sites at TTR. Sandia Corporation will continue to be responsible for environmental compliance at these sites (e.g., air monitoring).

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

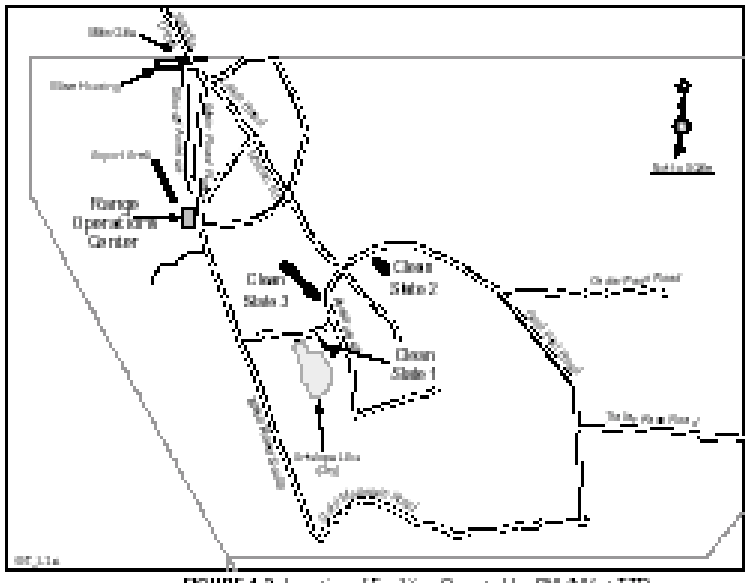


FIGURE 1-2. Location of Facilities Operated by SNL/NV at TTR

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

Air Monitoring at ER sites

Remediation activities were conducted at Clean Slate 1 in 1997. The Desert Research Institute (DRI) collected air monitoring data from several locations in the vicinity of Clean Slate 1 before, during, and after remediation activities. While these data have been validated, they have as yet only been presented to NVOO in draft reports. A final report is pending. Bechtel Nevada operates two air monitoring stations at TTR for NVOO. The samplers are located at Bunker 2 (near Clean Slate 3) and at Clean Slate 2. The samplers are operated on a continuous basis and filters are changed weekly by Westinghouse personnel. This air monitoring was halted by NVOO in April 2000 and will not resume until remediation efforts at the Clean Slate sites begin again in approximately two years.

TABLE 1-1. Project Roller Coaster Test Information

Test Name	Date of Test	Location	Status
Clean Slate 1	May 25, 1963	TTR	Remediation completed in 1997.
Clean Slate 2	May 31, 1963	TTR	Remediation on hold.
Clean Slate 3	June 9, 1963	TTR	Remediation pending.
Double Tracks	May 15, 1963	NAFR, North Range (west of TTR)	Remediation completed in 1996.

SOURCE: IT 1996 – Sampling and Analysis Plan for Clean Slate 1, September 1996.

Chapter 2

Compliance Summary

Sandia Corporation is responsible for Environment, Safety, and Health (ES&H) compliance for activities at TTR performed under its direction. This chapter discusses the status of ES&H compliance with federal environmental statutes, regulations, Executive Orders (EOs), and DOE Orders. Environmental audit summaries, occurrence reporting, and environmental permit status for 1999 are presented at the end of the chapter.

Sandia Corporation strives to meet 100 percent compliance with environmental laws, regulations, and other requirements established by federal and state agencies. The State of Nevada implements most environmental regulations applicable to TTR. Specific state regulations listed in Appendix A include regulations governing solid and hazardous waste management, wildlife, wastewater effluent, and radiation control. Radionuclide air emissions regulations are administered directly by the U.S. Environmental Protection Agency (EPA).

Sandia Corporation works in close cooperation with Sandia National Laboratories, New Mexico (SNL/NM) to carry out environmental program activities at TTR. Both Sandia Corporation in Nevada and New Mexico (SNL/NM) are responsible for environmental compliance at the site. Westinghouse contracts to Sandia Corporation and performs or assists with most environmental program activities such as air monitoring, water sampling, and waste characterization. The shaded box on the following page describes the major federal laws applicable to environmental compliance at TTR.

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

CERCLA defines assessment activities and reporting requirements for inactive waste sites at federal facilities. As required by CERCLA, a Preliminary Assessment (PA) was submitted in 1988 for all facilities listed on the federal agency hazardous waste compliance docket. Sites with significant contamination were put on the National Priorities List (NPL), an ordered ranking of cleanup priority. There are no NPL or "Superfund" sites located at TTR.

Additional CERCLA requirements are given in the Superfund Amendments and Reauthorization Act (SARA) Title III for reportable quantity (RQ) releases and chemical inventory reporting. Sandia Corporation was in full compliance with CERCLA and SARA in 1999.

Emergency Planning and Community Right-to-Know Act (EPCRA)

SARA Title III is also known as EPCRA. EPCRA requires the submittal of a Toxic Release Inventory (TRI) report for chemical releases over a given threshold quantity. In 1999, Sandia Corporation was not required to submit a TRI report since its chemical use onsite was below the reporting threshold. The State of Nevada also requires reporting for the use of extremely hazardous substances (EHSs). However, no EHSs were used at TTR in 1999. Table 2-1 summarizes Sandia Corporation's compliance with SARA Title III reporting requirements.

Major Environmental Regulations & Statutes Applicable to Sandia at TTR	
✓ **CERCLA**, Comprehensive Environmental Response, Compensation, and Liability Act	*Provides federal funding for cleanup of inactive waste sites on the National Priority List (NPL) and mandates requirements for reportable releases of hazardous substances*
✓ **SARA**, Superfund Amendments and Reauthorization Act	*SARA,Title III, known as the Emergency Planning and Community-Right-to-Know Act (EPCRA), mandates communication standards for hazardous materials over a threshold amount that are stored or used in a community*
✓ **RCRA**, Resource, Conservation, and Recovery Act	*Mandates the management of listed hazardous waste and hazardous materials*
✓ **FFCA**, Federal Facilities Compliance Act	*Directs federal agencies in the management of mixed waste*
✓ **CAA and CAAA,** Clean Air Act and CAA Amendments ✓	*Provides standards to protect the nation's air quality*
✓ **NESHAP**, National Emission Standards for Hazardous Air Pollutants	*Specifies standards for radionuclide air emissions and other hazardous air releases*
✓ **CWA**, Clean Water Act	*Provides general water quality standards to protect the nation's water sources and byways*
✓ **SDWA,** Safe Drinking Water Act	*Provides specific standards for sources used for drinking water*
✓ **TSCA**, Toxic Substance Control Act	*Specifies rules for the manufacture, distribution, and disposal of specific toxic materials such as asbestos and polychlorinated biphenyls (PCBs)*
✓ **FIFRA**, Federal Insecticide, Fungicide, and Rodenticide Act	*Controls the distribution and use of various pesticides*
✓ **NEPA**, National Environmental Policy Act	*Ensures that federal agencies review all of their proposed activities that have the potential to affect the environment and provide an opportunity for public involvement for projects potential significant impacts*
✓ **ESA**, Endangered Species Act	*Provides special protection status for federally-listed endangered and threatened species*
✓ **Cultural resources acts**	*Includes various acts that protect archeological, historical, and religious sites and resources*
✓ **Executive Orders (EOs)**	*Two EOs provide specific protection for wetlands and floodplains*

TABLE 2-1. Reporting Activities for TTR in 1999 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 a EHS as defined under CERCLA. No EHS is used in routine operations at TTR.
311-312	MSDS/Chemical Inventory	✓			MSDS information is made available to local emergency organizations.
313	Toxic Release Inventory (TRI) Reporting			✓	Sandia Corporation was below the reporting threshold for any listed chemical.

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

2.2 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

Under the RCRA Hazardous Waste Permit Program (40 CFR 270.61), TTR is permitted as a "small quantity generator." Under this designation, hazardous waste cannot be stored onsite for over 180 days before it must be shipped offsite for treatment and disposal at an EPA-permitted facility. At TTR, hazardous waste shipments are scheduled to occur at least two to three times per year. In 1999, a total of 609 kg of RCRA waste was generated by Sandia Corporation's activities. An additional 5,781 kg of chemical and toxic waste, including used oil, was recycled. (ER Project waste is not included in these totals.)

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

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

2.3 FEDERAL FACILITIES COMPLIANCE ACT (FFCA)

The FFCA amendments to RCRA specifically address Land Disposal Restriction (LDR) requirements for the treatment of mixed waste (MW) at federal facilities. Since the TTR does

not generate MW and currently has no MW stored onsite, this statute is not applicable to Sandia Corporation's operations at TTR.

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

The requirements of the CAA and CAAA of 1990 are implemented by the State of Nevada air quality regulations. Air Emissions from nonradionuclide sources, such as generators and other combustion sources, are permitted under a Class II Air Quality Permit. Sandia Corporation tracks emissions and pays a fee to the State based on the total standard tons emitted. Sandia Corporation met all air quality permit conditions in 1999.

NESHAP Compliance

The EPA retains compliance authority for all radionuclide air releases, which are regulated by National Emission Standards for Hazardous Air Pollutants (NESHAP) and implemented under 40 CFR 61, Subpart H.

The Clean Slate sites, discussed in Chapter 1, have been the only source of radionuclide air emissions at TTR. Continuous air monitoring was conducted from February 22, 1996 to February 25, 1997 (SNL 1997). Air monitoring was performed at the location of the maximally exposed individual (MEI)—determined to be in the TTR Airport area. The result of 0.024 mrem/yr was below the threshold of 0.1 mrem/yr for which continuous air monitoring would be required, and approximately 500 times less than the EPA standard of 10 mrem/yr. The 1999 Annual NESHAP Report and Chapter 5 of this report discusses these monitoring results (SNL 2000). Bechtel Nevada continues to operate two air monitoring stations at TTR.

2.5 CLEAN WATER ACT (CWA)

Wastewater effluents and potable water supplies are regulated under CWA and State of Nevada water pollution and sanitary waste systems regulations. The State of Nevada, Bureau of Health Protection Services, and the Nevada Department of Environmental Protection (NDEP) administer regulations relevant to wastewater discharges. At TTR, wastewater is discharged to the sewer system connected to the USAF sewage lagoon and to six septic tank systems.

There were no excursions or other permit violations in 1999 with respect to wastewater discharges.

Storm Water

The issuance of a National Pollutant Discharge Elimination System (NPDES) storm water permit is generally based on whether or not storm water runoff is discharged to "Waters of the U.S." This definition includes rivers, lakes, streams, and swamps, as well as channels and arroyos that lead to waters that are currently used, have been used in the past, or may be susceptible for use in interstate or foreign commerce. The TTR site is primarily a closed basin with runoff evaporating or infiltrating to the ground. The USAF has permitted its airfield and Area 10 for storm water runoff and have cognizance over all storm water issues at the site. Currently, Sandia Corporation does not conduct any activities at TTR that require storm water monitoring.

2.6 SAFE DRINKING WATER ACT (SDWA)

Sandia Corporation meets standards for drinking water as defined in the SDWA and State of Nevada public water supply and public water

systems regulations. Well 6 provides all drinking water for Sandia Corporation's operations at TTR and is operated under a permit issued by the State of Nevada. Sandia Corporation remained in compliance with all Well 6 permit requirements in 1999.

2.7 TOXIC SUBSTANCES CONTROL ACT (TSCA)

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

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

Chemical pesticide use at TTR may include the use of herbicides, rodenticides, and insecticides, as required. All chemicals used are EPA-approved and applied in accordance with applicable label guidelines and regulations. Sandia Corporation retains records of the quantities and types of pesticides that are used as well as Material Safety Data Sheets (MSDSs) for each pesticide. There were no violations of FIFRA in 1999.

2.9 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

NEPA law applies to federal government agencies; and any private entities that are performing federally-sponsored projects. NEPA requires federal agencies, such as DOE, to analyze the potential impacts to the environment from their proposed actions. If the proposed action is potentially "significant," the agency would be required to prepare an Environmental Assessment (EA) or an Environmental Impact Statement (EIS) before the project could be started. Although, a major intention of NEPA is to preserve the environment for future generations, the law does not mandate environmental protection per se—it only ensures that federal agencies make an informed decision and are aware of the environmental impacts of their actions before proceeding. NEPA does mandate that the decision process be open for public review.

Activities at the TTR conducted by Sandia Corporation are included in the *Final Environmental Impact Statement for the Nevada Test Site and Offsite Locations in the State of Nevada* (DOE 1996). SNL/NM provides technical guidance for all NEPA issues at TTR. SNL/NM's NEPA Program is under the direction of the Kirtland Area Office (KAO).

1999 NEPA Documentation

During 1999, SNL/NM submitted two NEPA Checklists to KAO for proposed projects at TTR.

2.10 ENDANGERED SPECIES ACT (ESA)

ESA applies to both private individuals and federal agencies. Federal agencies must ensure that any action authorized, funded, or carried out by them will not jeopardize the continued

existence of a threatened or endangered species, or result in adverse modifications of its habitat. ESA is addressed under the NEPA Program. If potentially significant impacts to sensitive species or habitats are found as a result of the proposed action, an EA or an EIS must be prepared.
The EIS for NTS, which includes activities at TTR, discusses biological resources present at the site (DOE 1996). As of 1996, no federal threatened, endangered, or candidate plant or animal species were known to occur at TTR. Bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus*), however, may be rare migrants at the site. The western burrowing owl (*Athene cunicularia hypugaea*), a state-protected species, is known to occur on TTR. Table 2-2 lists all endangered, threatened, and sensitive species occurring within Nye county, therefore having the potential to occur at TTR.

2.11 CULTURAL RESOURCES ACTS

Federal cultural resources management responsibilities are applicable to activities at TTR. These include but are not limited to compliance with the following laws and their associated regulations:

- National Historic Preservation Act (NHPA)
- Archaeological Resources Protection Act (ARPA)
- American Indian Religious Freedom Act (AIRFA)

Cultural resources requirements are generally addressed through the NEPA program. KAO has responsibility for determining the level of applicability.

2.12 EXECUTIVE ORDERS (EOs)

EO 11988, *Floodplain Management*, and EO 11990, *Protection of Wetlands*, require evaluation of the potential effects of actions taken in these environmentally sensitive areas. However, there are no floodplains or significant wetlands at TTR. There are, however, some very limited wetlands in the vicinity of several springs. These provide an important source of drinking water for wildlife in the area. Sandia Corporation complies with all applicable mandates stated in the EOs.

2.13 1999 AUDITS

Table 2-3 lists audits and inspections conducted by various agencies in 1999 including assessments made by SNL/NM. Only minor observations were noted in all cases. There was one audit conducted by the State of Nevada in 1999.

2.14 1999 ISSUES AND ACTIONS FOR TTR

Ongoing self-assessments of Sandia Corporation'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.

TABLE 2-2. Threatened, Endangered, and Sensitive Species Potentially Occurring in Nye County, Nevada

Common Name	Scientific Name	Federal Status	State of Nevada
PLANTS			
Beatley milkvetch	*Astragalus beatleyae*	Species of Concern	State Protected
Sodaville milkvetch	*Astragalus lentiginosus var. sesquimetralis*	Species of Concern	State Protected
Milkvetch	*Astragalus phoenix*	Threatened	State Protected
Spring-loving centaury	*Centaurium namophilum*	Threatened	State Protected
Ash Meadows sunray	*Enceliopsis nudicaulis var. corrugata*	Threatened	State Protected
Sunnyside green gentian	*Frasera gypsicola*	Species of Concern	State Protected
Ash Meadows gumplant	*Grindelia fraxinopratensis*	Threatened	State Protected
Ash Meadows ivesia	*Ivesia kingii var. eremica*	Threatened	State Protected
Ash Meadows blazingstar	*Mentzelia leucophylla*	Threatened	State Protected
Amargosa niterwort	*Nitrophila mohavensis*	Endangered	State Protected
Sand cholla	*Opuntia pulchella*		State Protected
Williams combleaf	*Polyctenium williamsiae*	Species of Concern	State Protected
Tonopah fishhook cactus	*Sclerocactus nyensis*		State Protected
Hermit cactus	*Sclerocactus polyancistrus*		State Protected
FISH			
White River desert sucker	*Catostomus clarki intermedius*	Species of Concern	State Protected
Moorman White River springfish	*Crenichthys baileyi thermophilus*	Species of Concern	State Protected
Devils Hole pupfish	*Cyprinodon diabolis*	Endangered	State Protected
Ash Meadows Amargosa pupfish	*Cyprinodon nevadensis mionectes*	Endangered	State Protected
Warm Springs Amargosa pupfish	*Cyprinodon nevadensis pectoralis*	Endangered	State Protected
Pahrump poolfish	*Empetrichthys latos latos*	Endangered	State Protected
Big Smoky Valley tui chub	*Gila bicolor ssp.*	Species of Concern	State Protected
Hot Creek Valley tui chub	*Gila bicolor ssp.*	Species of Concern	State Protected
Railroad Valley tui chub	*Gila bicolor ssp.*	Species of Concern	State Protected
White River spinedace	*Lepidomeda albivallis*	Endangered	State Protected
Moapa dace	*Moapa coriacea*	Endangered	State Protected
Lahontan cutthroat trout	*Oncorhynchus clarki henshawi*	Threatened	State Protected
Big Smoky Valley speckled dace	*Rhinichthys osculus lariversi*		State Protected
Nevada speckled dace	*Rhinichthys osculus nevadensis*	Endangered	State Protected
REPTILES & AMPHIBIANS			
Banded gila monster	*Heloderma suspectum cinctum*	Species of Concern	State Protected
Columbia spotted frog	*Rana luteiventris*		
Amargosa toad	*Bufo nelsoni*	Species of Concern	State Protected
BIRDS			
Northern goshawk	*Accipiter gentilis*	Species of Concern	State Protected
Western burrowing owl	*Athene cunicularia hypugaea*	Species of Concern	State Protected
Ferruginous hawk	*Buteo regalis*	Species of Concern	State Protected
Swainson's hawk	*Buteo swainsoni*		State Protected
Sage grouse	*Centrocercus urophasianus*		State Protected
Western snowy plover	*Charadrius alexandrinus nivosus*		State Protected
Black tern	*Chlidonias niger*	Species of Concern	State Protected
Western least bittern	*Ixobrychus exilis hesperis*	Species of Concern	State Protected
Flammulated owl	*Otus flammeolus*		State Protected
Phainopepla	*Phainopepla nitens*		State Protected
White-faced Ibis	*Plegadis chihi*	Species of Concern	State Protected
Yuma clapper rail	*Rallus longirostris yumanensis*	Endangered	State Protected

Federal Facility Agreement and Consent Order (FFACO) Compliance for Environmental Restoration (ER) Activities

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

- Nevada Test Site (NTS),
- Areas within TTR,
- Areas within Nellis Air Force Range (NAFR),
- Central Nevada Test Area, and
- Project Shoal Area (east of Carson City in Churchill County).

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), which are 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.

2.15 ENVIRONMENTAL PERMITS

Environmental compliance permits for TTR include those for the potable water supply, sewage, and specific air emission units such as generators. The permit application and registration of Sandia Corporation activities at TTR are issued directly by the State of Nevada to either NVOO or KAO and administered by Westinghouse. Sandia Corporation and Westinghouse ensure all permit conditions are followed. Permits and registrations in effect in 1999 are listed in Table 2-4. TTR was in full compliance with all permitting requirements for 1999.

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 KAO and Sandia Corporation.

2.16 OCCURRENCE REPORTING

There were no reportable spills or other environmental occurrences during 1999.

TABLE 2-3. Summary of Environmental Audits Performed at TTR in 1999

Audit Title	Date	Results Summary
ES&H Self-Assessment of Department 15324, Tonopah Test Range (TTR)	June 10, 1999	Several noteworthy comments and numerous minor recommendations were made.
Lockheed Martin ES&H Compliance Audit	February 1999	Several recommendations were made.
Electrical Safety Assistance Visit (SNL/NM)	March 9-11, 1999	Several noteworthy comments.
Annual Spill Prevention Control and Countermeasures (SPCC) Inspection (SNL/NM)	August 31, 1999	There were no violations. Several minor recommendations were made.
Tonopah Test Range (TTR) Fire Protection Assessment (SNL/NM)	May 28, 1999	Several recommendations.
Asbestos Inspection (SNL/NM)	March 9-11, 1999	Several recommendations.
State of Nevada Sanitary Survey of Water Distribution System and Sampling	April 7, 1999	Several recommendations.

TABLE 2-4. Summary of Permit Ownership at TTR

Permit Type and Location	Permit Number	Issue Date	Expiration Date	Comments
Air Quality Permits				
Surface Area Disturbance (General Air Operation Permit)	AP9711-0549	Apr 4 1997	Apr 4, 2002	CS-II ER Project
• Site Specific Permit Attachment to above	1574	Jun 30, 1997		Attachment to CS-II ER Project, Permit to operate 15 emission units *
Class II Air Quality Operation Permit	AP9611-0680	Mar 1, 1999	Jun 12, 2001	1 3 x 5 Screening Plant 1 7 x 7 Screening Plant Generators (53 emission units) Boilers (7 emission units) Maintenance Activities (5 emission units) Propane Storage Tanks (23 emission units) Surface Area Disturbance (> 5 acres)
RCRA - Hazardous Waste				
Hazardous Waste Generator	NV1890011991	Jan 7, 1993	Indefinite	State of Nevada
Production Well (Drinking Water)				
Well 6 Production Well	NY-3014-12NC	Sep 1999	Sep 2000	State of Nevada

NOTE: * "Emission units" are sources such as generators and boilers.

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"

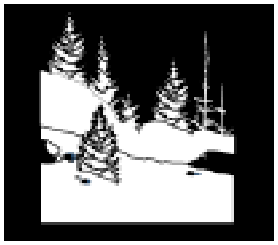
DOE 1990: Tonopah *Test Range Site Sampling Plan*

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.

State of Nevada Division of Environmental Protection; Revision, Air Quality Permit AP 9611-0680, 15 May 1998



Chapter 3

Environmental Programs Information

Environmental programs are in place to meet compliance with state and federal regulations, Executive Orders (EOs), and U.S. Department of Energy (DOE) Orders. Programs and activities discussed in this chapter include the Environmental Restoration (ER) Project, the Waste Management Program, National Environmental Policy Act (NEPA) compliance activities, and environmental monitoring by outside agencies. Terrestrial surveillance, water quality programs, and air quality programs are discussed in the remaining chapters of this report.

Surveillance and Effluent Monitoring Programs

In general, surveillance monitoring is the sampling of ambient environmental media, such as soil, sediment, vegetation, groundwater, and air. Effluent monitoring is the direct sampling of waste streams such as wastewater and air emissions. Effluent and surveillance monitoring activities are discussed in Chapters 4, 5, 6, and 7. The specific programs covered in these chapters include: the Terrestrial Surveillance Program, the Ambient Air Quality Program, the Air Quality Compliance Program, the National Emission Standards for Hazardous Air Pollutants (NESHAP) Program, and groundwater monitoring and protection programs for both the ER Project and general base-wide groundwater surveillance monitoring.

3.1 ENVIRONMENTAL RESTORATION (ER) ACTIVITIES

The ER Project at TTR began in 1980 to address contamination resulting primarily from nuclear weapons testing and related support activities. In late 1992 and early 1993, an agreement was reached between DOE Headquarters (DOE/HQ), DOE's Albuquerque Operations Office (AL), and DOE's Nevada Operations Office (NVOO) regarding the management of ER activities at TTR. The decision was made to designate the responsibility of all ER sites to NVOO.

Since 1996, cleanup activities for sites located in the State of Nevada have been regulated by the Federal Facility Agreement and Consent Order (FFACO). The FFACO was negotiated between NVOO, the Nevada Division of Environmental Protection (NDEP), and the Department of Defense (DoD). The Compliance Order took effect on May 10, 1996 and accomplished the following:

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

The FFACO is also discussed in Section 2.14. CAUs located at TTR are addressed by two ER Division Projects:

- ***Industrial Sites Project*** – Past sites used to support nuclear testing activities, and
- ***Soil Sites Project*** – Areas where tests resulted in extensive surface and/or shallow subsurface contamination.

ER site contamination includes radiological (e.g., depleted uranium [DU] and plutonium) and nonradiological constituents (artillery, solvents, septic sludges, and heavy metals).

CAS Identification
The initial identification, description, and listing of CASs at TTR were derived from the Preliminary Assessment (PA) and the *Federal Facility Preliminary Assessment Review* (E&E 1989). In 1993, the potential TTR CASs identified in the PA were subdivided into four "Soil Sites CAUs" and 43 "Industrial Sites CAUs." Twelve additional potential CASs not included in the PA were also identified. These CASs were identified through:

- ER sites inventory process;
- Ordnance removal activities;
- Geophysical surveys;
- Former worker interviews;
- Archive reviews;
- Site visits; and
- Aerial radiological and multispectral surveys (1993 to 1996).

The remediation activities at the Clean Slate and Double Tracks sites (Project Roller Coaster) are discussed in Chapter 1. These sites are listed in Table 3-1 as CAU-411, -412, -413, and -414 under Soil Sites.

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

1999 ER Activities
Cleanup at ER sites in 1999 generated a total of 16,312 kg of primarily hydrocarbon-impacted soils (non-RCRA waste) and 7,642 kg or RCRA waste. RCRA waste included rinsate, personal protective equipment (PPE), sampling debris, and field-testing kits. All RCRA-hazardous waste is shipped offsite to permitted treatment, storage, and disposal (TSD) facilities. Construction debris is disposed of at the Air Force's sanitary landfill. A total of 834,668 kg of low-level radioactive waste (LLW) was generated by ER activities in 1999 (Table 3-2). Westinghouse participates in environmental cleanup and restoration activities.

3.2 WASTE MANAGEMENT PROGRAMS

All waste generated by Sandia Corporation activities at TTR is managed by Westinghouse under the Waste Management Program. (Sandia does not handle waste generated by ER activities.) Waste categories include radioactive waste, RCRA-hazardous waste, other chemical waste, and non-hazardous solid waste. Waste minimization and recycling efforts are integrated into Waste Management Program activities. Westinghouse has 14 certified personnel who also perform hazardous waste sampling, as required.

Waste generated and handled by Sandia Corporation at TTR in 1999 was as follows:

Waste Type	Weight
RCRA waste	609 kg
Non-hazardous chemical waste	18,651 kg
Recyclable (hazardous or toxic)	5,781 kg
Radioactive waste	none

Sandia Corporation shipped all regulated waste to offsite permitted TSD facilities.

TABLE 3-1. NVOO Environmental Restoration (ER) Project TTR Corrective Action Units (CAUs) and Corrective Action Sites (CASs)

Industrial Sites CAUs/CASs		
CAS Number	**CAS Description**	**General Location**
CAU-400 - *Closed* Bomblet Pit and Five Points Landfill, TTR		
TA-19-001-05PT	Ordnance Disposal Pit	Five Points Intersection
TA-55-001-TAB2	Ordnance Disposal Pit	Bunker 2 Road
CAU-401 - *Closed* Area 3 Gas Station UST Site, TTR		
03-02-003-0357	UST, Gas	First Gas Station, Area 3
CAU-402 - *Closed* Area 3 Bldg. 0353 UST Site, TTR		
03-02-001-0353	UST, Diesel	Bldg. 0353
CAU-403 - *Closed* Area 3 Second Gas Station UST, TTR		
03-02-004-0360	USTs	Second Gas Station
CAU-404 - *Closed* Roller Coaster Lagoons and Trench, TTR		
TA-03-001-TARC	Roller Coaster Lagoons	NW of Antelope Lake
TA-21-001-TARC	Roller Coaster North Disposal Trench	NW of Antelope Lake
CAU-405 Area 3 Septic Systems, TTR		
03-05-002-SW03	Septic Waste System	Area 3
03-05-002-SW04	Septic Waste System	Area 3
03-05-002-SW07	Septic Waste System	Area 3
CAU-406 Area 3 Bldg. 03-74 and Bldg. 03-58 UDPs, TTR		
03-51-002-0374	Heavy Duty Shop UDP, Sumps	Bldg. 0374
03-51-003-0358	UPS Building UDP	UPS Building, Area 3
CAU-407 Roller Coaster Rad Safe Area, TTR		
TA-23-001-TARC	Roller Coaster Rad Safe Area	Northwest of Antelope Lake
CAU-408 Bomblet Target Area, TTR		
TA-55-002-TAB2	Bomblet Target Areas	Antelope Lake
CAU-409 Other Waste Sites, TTR		
RG-24-001-RGCR	Battery Dump Site	Cactus Repeater
TA-53-001-TAB2	Septic Sludge Disposal Pit	Bunker 2
TA-53-002-TAB2	Septic Sludge Disposal Pit	Bunker 2

SOURCE: DoD/DOE 1996 and ongoing updates
NOTE: CAU = Corrective Action Unit
CAS = Corrective Action Site
UDP = underground discharge point
UST = underground storage tank

TABLE 3-1. NVOO Environmental Restoration (ER) Project TTR Corrective Action Units (CAUs) and Corrective Action Sites (CASs) (Continued)

Industrial Sites CAUs/CASs		
CAS Number	**CAS Description**	**General Location**
CAU-410 Area 9 Underground Vault and Disposal Trench, TTR		
09-21-001-09MG	Former Bunker or Underground Vault	East of Area 9 Magazines
09-21-001-TA09	Disposal Trenches	Area 9
CAU-423 Area 3 UDP, Bldg. 0360, TTR		
03-02-002-0308	UDP	Bldg. 0360
CAU-424 Area 3 Landfill Complex, TTR		
03-08-001-A301	Landfill Cell A3-1	Area 3 Landfill Complex
03-08-002-A302	Landfill Cell A3-2	Area 3 Landfill Complex
03-08-002-A303	Landfill Cell A3-3	Area 3 Landfill Complex
03-08-002-A304	Landfill Cell A3-4	Area 3 Landfill Complex
03-08-002-A305	Landfill Cell A3-5	Area 3 Landfill Complex
03-08-002-A306	Landfill Cell A3-6	Area 3 Landfill Complex
03-08-002-A307	Landfill Cell A3-7	Area 3 Landfill Complex
03-08-002-A308	Landfill Cell A3-8	Area 3 Landfill Complex
CAU-425 Area 9 Main Lake Construction Debris Disposal Area, TTR		
09-08-001-TA09	Construction Debris Disposal Area	Area 9/Main Lake
CAU-426 Cactus Spring Waste Trenches, TTR		
RG-08-001-RGCS	Waste Trenches	Cactus Spring Ranch
CAU-427 Area 3 Septic Waste Systems 2 and 6, TTR		
03-05-002-SW02	Septic Waste System No. 2	Area 3
03-05-002-SW06	Septic Waste System No. 6	Area 3
CAU-428 Area 3 Septic Waste Systems 1 and 5, TTR		
03-05-002-SW01	Septic Waste System No. 1	Area 3
03-05-002-SW05	Septic Waste System No. 5	Area 3
CAU-429 Area 3 Bldg. 03-55 and Area 9 Bldg. 09-52 UDPs, TTR		
03-51-001-0355	Photo Shop UDPs, Drains	Photo Shop Area 3
09-51-001-0952	Mobile Photographic Lab UDPs	Area 9
CAU-430 - *Closed* DU Artillery Round #1, TTR		
TA-55-003-0960	DU Artillery Round	South of Area 9

SOURCE: DoD/DOE 1996 and ongoing updates
NOTE: CAU = Corrective Action Unit
CAS = Corrective Action Site
DU = depleted uranium
UDP = underground discharge points

TABLE 3-1. NVOO Environmental Restoration (ER) Project TTR Corrective Action Units (CAUs) and Corrective Action Sites (CASs) (Continued)

Industrial Sites CAUs/CASs		
CAS Number	**CAS Description**	**General Location**
CAU-453 Area 9 UXO Landfill, TTR		
09-55-001-0952	Area 9 Landfill	Area 9
CAU-461 Test Area JTA Sites, TTR		
TA-52-002-TAML	DU Impact Site	Main Lake
TA-52-003-0960	DU Artillery Round #2	South of Area 9
TTR-001	1987 W-79 JTA	Unknown – South of Area 9
CAU-484 Antelope and NEDS Lakes Waste Sites, TTR		
TA-52-001-TANL	NEDS Detonation Area	NEDS Lake
TA-52-004-TAAL	Metal Particle Dispersion Test	Antelope Lake
TA-52-005-TAAL	JTA DU Sites	Antelope Lake
CAU-485 - *Closed* Cactus Spring Ranch Pu and DU Site, TTR		
TA-39-001-TAGR	Cactus Spring Ranch, Soil Contamination	West of Target Areas
CAU-486 Double Tracks Rad Safe Area, Nellis Range 71 North		
71-23-001-71DT	Double Tracks Rad Safe Area	Nellis Range 71 North
CAU-487 Thunderwell Site, TTR		
RG-26-001-RGRV	Thunderwell Site	Thunderwell Site
CAU-488 Davis Gun Site, TTR		
RG-52-007-TAML	Davis Gun Site - Mellan	Test Range
CAU-489 WWII UXO Sites, TTR		
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 36E
CAU-490 Station 44 Burn Area, TTR		
RG-56-001-RGBA	Fire Training Area	Station 44
03-56-001-03BA	Fire Training Area	Area 3
03-58-001-03FN	Sandia Service Yard	Area 3
09-54-001-09L2	Solid Propellant Burn Site	Area 9
CAU-491 Bunker 2 Debris Mound and NEDS Trench, TTR		
TA-19-002-TAB2	Debris Mound	Bunker 2
TA-21-003-TANL	Disposal Trench	NEDS Lake

SOURCE: DoD/DOE 1996 and ongoing updates
NOTE: CAU = Corrective Action Unit
CAS = Corrective Action Site
JTA = Joint Test Assembly
NEDS = Non-Explosive Destruction Site
UXO = unexploded ordnance

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

Industrial Sites CAUs/CASs		
CAS Number	**CAS Description**	**General Location**
CAU-492 South Antelope Lake Disposal Trench, TTR		
TA-21-002-TAAL	Disposal Trench	South Antelope Lake
CAU-493 Colimbo Detonation Site, TTR		
TA-52-006-TAPL	DU Surface Debris	Colimbo Detonation Area, NEDS Lake
CAU-494 Rocket Propellant Burn Area – NEDS Lake, TTR		
TA-54-001-TANL	Rocket Propellant Burn Area	NEDS Lake
CAU-495 Unconfirmed JTA Sites, TTR		
TA-55-006-09SE	Buried Artillery Round	Test Area
TA-55-007-09SE	Buried Artillery Round	Test Area
CAU-496 Buried Rocket Site – Antelope Lake, TTR		
TA-55-008-TAAL	Buried Rocket	Antelope Lake
CAU-499 Hydrocarbon Spill Site, TTR		
RG-25-001-RD24	Hydrocarbon Spill Site	Radar 24 Site
Soil Sites CAUs/CASs:		
CAU-411 Double Tracks Plutonium Dispersion, Nellis		
NAFR-23-01	Pu-contaminated Soil	Double Tracks
CAU-412 Clean Slate I Plutonium Dispersion, TTR		
TA-23-01CS	Pu-Contaminated Soil	Clean Slates I
CAU-413 Clean Slate II Plutonium Dispersion, TTR		
TA-23-02CS	Pu-Contaminated Soil	Clean Slates II
CAU-414 Clean Slate III Plutonium Dispersion, TTR		
TA-23-03CS	Pu-Contaminated Soil	Clean Slates III

SOURCE: DoD/DOE 1996 and ongoing updates
NOTE: CAU = Corrective Action Unit
CAS = Corrective Action Site
DU = depleted uranium

Table 3-3 shows a detailed breakdown of the RCRA waste categories and quantities. Table 3-4 lists regulated non-RCRA waste categories and quantities. Table 3-5 lists waste categories transported offsite for recycling or alternative fuel use. A *Biannual Hazardous Waste Generation Report* is prepared by Westinghouse and submitted to the EPA through NVOO (DOE 1999).

Waste Minimization Program

TTR is committed to achieving significant reductions in the amount of chemical and hazardous wastes generated onsite. 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, and
- Mercury-containing equipment.

Radioactive Waste Management

Sandia Corporation did not generate any radioactive waste in 1999. However, radioactive waste was generated by remediation of ER sites under the cognizance of NVOO.

3.3 SPILL PREVENTION CONTROL AND COUNTER-MEASURES (SPCC) PLAN

The *Oil Spill Prevention Control and Countermeasures (SPCC) Plan* (SNL 1999a), which was revised in 1999, pertains to oil storage equipment and secondary containments subject to 40 CFR 112, "Oil Pollution Prevention" and 40 CFR 110, "Discharge of Oil."

There are 11 above-ground storage tanks (ASTs) applicable to the SPCC Plan at TTR. Minor maintenance on some of the facilities was recommended and documented in the annual SPCC inspection report dated August 31, 1999.

TABLE 3-2. Low-Level Waste (LLW) Generated by the ER Project in 1999

Container	Isotope	Contents	Weight (kg)	Comments
5 - Steel drum 55 gal	Pu-239/240	PPE, plastic, debris	1,246	ER work at CAU 407
1 - Steel drum 55 gal	Pu-239/240	Concrete	498	ER work at CAU 407
13 - Steel drum 55 gal	Pu-239/240	Contaminated soil	4,124	ER work at CAU 407
9 - B25 boxes	U-238	Contaminated soil	43,400	ER work at CAU 461 (DU round 32)
35 - trucks	U-238	Contaminated soil	785,400	ER work at CAU 461 (TAML Site)
		Total	**834,668 kg**	

NOTE: PPE = personal protective equipment

TABLE 3-3. RCRA-Regulated Hazardous Waste Shipped Offsite in 1999

Waste Description	Waste Codes	Generated (kg)
ER RCRA WASTE		
NOS, toxic liquid, (rinsate from ER work)	F002, F004, D008, D009, D027	617
NOS, toxic liquid, (rinsate from ER work)	F002, F004, D008	1,270
NOS, toxic liquid, (rinsate and spent solvent from field testing kit)	F001, F002, F004, D008, D009, D019, D027	73
NOS, toxic liquid, (field testing kit waste)	F001, D019, U211	73
NOS, hazardous solid, (soil, PPE, sampling debris from ER work)	F002, F004, D008, D009, D027	2,132
NOS, (soil, PPE, sampling debris from ER work)	F002, F004, D008	3,402
NOS, (soil, PPE, sampling debris from field test kit)	F001, F002, F004, D008, D009, D019, D027	34
NOS, (soil, PPE sampling debris from field test kit)	F001, D019	34
Isopropanol	D001	7
	Total ER-RCRA Waste	**7,642**
OTHER RCRA WASTE		
Drugs liquid N.O.S.	P042, D002	8
Waste photographics fixer	D011	113
NOS, Toxic liquid, organic, (ethylene glycol, lead)	D008	9
NOS, (rags with methylene chloride)	F002, F003, F005, D035	254
Aerosols flammable (petroleum distillates)	D001	83
Paint-related material	D001	83
Starting fluid (thin walled)	D001	6
Calcium Hypochlorite	D001	53
	Total Other RCRA Waste	**609**
	Total RCRA Waste	**8,251**

NOTE: NOS = not otherwise specified
PPE = personal protective equipment

TABLE 3-4. Non-RCRA-Regulated Hazardous or Toxic Waste Shipped Offsite in 1999

Non-RCRA Waste	Generated (kg)
ER Waste - hydrocarbon impacted soil and debris	16,312
Used alkaline batteries	380
Toxic liquids, organic, NOS	13
Incandescent light bulbs	40
Sulfamic acid	33
Empty containers	104
Oil contaminated rags	299
Separator pit clean-out	560
Contaminated absorbant	2
Tar and asphalt	27
Oil filters	265
Scrap metal steel	144
Dririte	171
Oil filled capacitor (non-PCB)	4
TOTAL	**18,651**

NOTE: NOS = not otherwise specified
PCB = polychlorinated biphenyls

TABLE 3-5. Recycled Regulated Hazardous or Toxic Waste Shipped Offsite in 1999

Recycled Material	Generated (kg)
ER waste	0
Used oil	2,936
Used oil and water mixture	622
Fluorescent light bulbs	144
Nickel-cadmium batteries	11
Waste batteries with acid	95
Waste diesel fuel/gasoline	438
Sodium vapor bulbs, barium	25
Solid hazardous waste, NOS, lead	77
Waste combustible liquid, NOS, petroleum naptha	126
Automotive/equipment lead acid batteries	1,307
TOTAL	**5,781**

NOTE: NOS = not otherwise specified

3.4 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) PROGRAM

NEPA Activities at TTR

At TTR, NEPA compliance is a joint effort by Sandia Corporation in Nevada and New Mexico (SNL/NM) and KAO. Additionally, under the direction of Sandia Corporation, compliance is supported by 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/NM for transmittal to KAO for review and decision making and consultation with state and federal agencies.

The final Environmental Impact Statement (EIS), which includes the TTR site, was completed in 1996; the DOE Record of Decision (ROD) was filed on December 9, 1996 (DOE 1996).

3.5 ENVIRONMENTAL MONITORING PERFORMED BY OUTSIDE AGENCIES

In addition to Sandia Corporation, other agencies perform environmental monitoring activities at TTR as described below.

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 Reports Program. Reports are available through the EPA upon request. Two major EPA reports are as follows:

- *Offsite Monitoring Report: Nevada Test Site and Other Test Areas, Quarterly Report* – EPA, Dose Assessment Branch, Nuclear Radiation Assessment Division.
- *Offsite Environmental Monitoring Report: Radiation Monitoring Around United States Nuclear Test Areas, Calendar Year 1999* – This report is also published as part of the Nevada Test Site (NTS) Annual Site Environmental Report (ASER).

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

Desert Research Institute (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 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). An annual report is prepared comparing DRI results with EPA results:

- *Community Radiation Monitoring Program Annual Report* (DRI 1999)

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

Westinghouse

As part of its TTR support activities, Westinghouse personnel perform environmental monitoring activities for DOE and/or Sandia Corporation when needed as follows:

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

3.6 SUMMARY OF RELEASE REPORTING

The following three release reporting documents are required to be submitted to external organizations agencies if releases exceed applicable threshold quantities:

- *NESHAP Report for Radionuclides Other than Radon from Department of Energy Facilities (Subpart H) Annual Report* – NESHAP, 40 CFR 61, Subpart H, requires that an annual report be submitted from each DOE site where facility sources contribute a public dose of over 0.1 mrem/yr. The NESHAP report must be submitted to the EPA by June 30th each year, following the reporting year. The report includes the calculated effective dose equivalent (EDE) in mrem/yr for the maximally exposed individual (MEI). Chapter 5 of this report summarizes results of the NESHAP dose assessment results for TTR.
- *State of Nevada Reports* – The State of Nevada requires copies of each hazardous waste manifest that accompanies each waste shipment.
- *State of Nevada Extremely Hazardous Material Reporting Requirements* – This is not currently required since Sandia Corporation does not use any extremely hazardous materials during its routine operations.

Chapter 4

Terrestrial Surveillance and Water Monitoring

Surveillance and water monitoring activities are conducted routinely for all Sandia Corporation work areas at the site. Samples are taken to determine the level of radiological and nonradiological contaminants in the ambient terrestrial environment, in wastewater effluent, and in water supply wells. Most environmental monitoring and surveillance is conducted under the direction of the Environmental Management and Integrated Training Department at Sandia National Laboratories, New Mexico (SNL/NM). The Terrestrial Surveillance Team from SNL/NM conducts soil sampling once a year. The onsite contractor, Westinghouse Government Services, conducts various environmental sampling, such as taking wastewater samples, throughout the year.

4.1 TERRESTRIAL SURVELLANCE

Program Objectives

The overall objective of the Terrestrial Surveillance Program is to detect the presence and migration of contaminants related to onsite operations at TTR and to determine the potential impact (if any) of Sandia Corporation's site activities to the population and the surrounding environment. Data is used to determine long-term environmental conditions and trends at the site.

DOE Order 5400.1, *General Environmental Protection Program* (DOE 1990) mandates environmental surveillance monitoring to detect potential contaminants that may have accumulated in the environment through the action of wind and water, such as air deposition and storm water runoff.

Routine Sampling Locations

Sample Media

Terrestrial materials commonly sampled include soils, water-deposited sediments, surface waters, and vegetation. Because TTR is located in a desert environment where there are no naturally-occurring bodies of water (lakes, rivers, and creeks) and vegetation is scarce, only soil samples are taken to assess the presence of potential contaminants. Any storm water that does runoff, quickly infiltrates to the sandy soils or is lost to evaporation. Very little surface runoff recharges to the groundwater (DRI 1991). There are, however, three remote springs in the surrounding hills west of TTR operations, however, since these springs are upgradient and far removed from operational areas, they are not used for terrestrial sampling.

In addition to soil sampling, external gamma radiation measurements are made using thermoluminescent dosimeters (TLDs). These instruments measure the ambient level of gamma radiation (from both man-made and natural background sources). Natural sources include cosmic radiation and emissions from naturally-occurring isotopes found in rocks and minerals. Man-made sources contributing to gamma levels at TTR come from the radioactive residues in soils at previous test sites, such as the Clean Slate sites, where plutonium and americium isotopes are still present.

Sandia Corporation began environmental monitoring at TTR in 1992. In addition to routine sampling, a large-scale baseline sampling was performed in 1994 in areas where SNL has had a long-term or continued presence.

Routine environmental surveillance locations remain essentially the same from year to year. Additional locations may be 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.

Soil samples are collected from various locations within three general areas: offsite, onsite, and the site perimeter.

- **Offsite locations** are used to provide a measurement of environmental conditions unaffected by SNL's activities at TTR. Data collected from offsite locations serve as a reference point to compare data collected at perimeter and onsite locations. Multiple years of sampling data are compiled to determine statistical averages for offsite concentrations. Offsite locations are chosen both in remote, natural settings as well as in areas near local population centers and along highways. Figure B-1 of Appendix B shows the 14 offsite locations sampled.

- **Perimeter locations** are used to provide a measurement of the site boundary to ascertain if potential contamination is migrating either onto or off of TTR property. Figure B-2 shows the eight perimeter locations sampled. All perimeter locations are in areas of uncontrolled access within TTR.

- **Onsite locations** are near areas of known contamination, potential sources of contamination, or in areas where contamination, if present, would be expected to accumulate, such as downgradient or downwind from Environmental Restoration (ER) areas. Onsite sampling locations are shown in Figures B-3, B-4a and b, and Tables B-5a, B-5b, and B-5c of Appendix B. A total of 22 locations were sampled onsite.

Colimbo Site Sampling Task, 1999

In 1999, a special one-time sampling project was performed at the Colimbo site, a proposed site for an outdoor fire test facility just west of Antelope Dry Lake Bed. The purpose of this one-time sampling was to establish a baseline of existing concentrations of metals and radionuclides for a proposed fire test facility, which has since been withdrawn.

1999 Sample Collection and Analysis

SNL/NM's Environmental Surveillance Team collected routine terrestrial samples at TTR in May 1999 for both radiological and nonradiological (stable metal) analysis at onsite, perimeter, and offsite locations as listed in Table 4-1, 4-2, and 4-3. Sampling for the Colimbo site was conducted in February 1999.

4.2 PRIORITIZATION ANALYSIS METHODOLOGY

In order to bring clarity and simplification to terrestrial surveillance results, SNL/NM developed a statistical methodology to aid in prioritizing sites found with various levels of contamination (Shyr, Herrera, and Haaker 1998). The Prioritization Statistical Analysis Prioritization Method is based on two questions:

1. Are the results higher than offsite (baseline) measurements?

2. Is there an increasing trend over the last nine years?

TABLE 4-1. Onsite Terrestrial Surveillance Locations

Location Number	Sample Location	Replicate Location
South Plume		
T-14	N/S Mellan Airstrip – Antelope Tuff	Yes
T-16	N/S Mellan Airstrip – SW of T-14	
T-17	N/S Mellan Airstrip – sign post	
T-18	N/S Mellan Airstrip – NE of T-17	
T-19	NE of NW/SE Mellan Airstrip	
Range Operations Center		
OC-02	Waste Water Monitoring Station	
OC-03	"Danger Powerline Crossing" Sign	
OC-04	Main Road/Edward's Freeway	
OC-10	SW Corner of SNL Ops Center	
OC-13	NE Corner of SNL Ops Center	
OC-19	Storage Shelters, 03-38/03-39	
OC-22	Sand Building	
OC-23	Generator Storage Area	
Various Onsite Locations		
D-01	Roller Coaster Decon	Yes
MH-03	Mellan Hill – Metal Scrap Pile	
MH-04	Mellan Hill – North	
T-02	N/S mellan Airstrip (TLD at south fence post)	
T-03	TLD at Clean Slate 2	Yes
T-04	TLD at Clean Slate 3	
T-10	Brownes Road/Denton Freeway	
T-20	Main Road/Lake Road (SE)	
T-21	Near Hard Target/Depleted Uranium (DU) Area	

TABLE 4-2. Perimeter Terrestrial Surveillance Locations

Location Number	Sample Location	Replicate Location
OM-03	O&M Complex (Owan Drive post)	
T-06	Cedar Pass Road Guard Station	
T-08	On-Base Housing (Main guard gate/power pole CP17)	
T-11	Cactus Springs (north fence post)	
T-12	TLD at "US Gov't Property" Sign	
T-13	Cactus Springs (TLD south of T-11)	
T-36	On-Base Housing (NE fence line)	
T-37	On-Base Housing (guard station)	

TABLE 4-3. Offsite Terrestrial Surveillance Locations

Location Number	Sample Location	Replicate Location
B-01	Alkali/Silver Peak Turnoff	
B-02	Cattle Guard	
B-03	Tonopah Ranger Station	
B-04	State Road 6/95 Rest Area	
B-05	Gabbs Pole Line Road	
B-06	State Roads 6/376 Junction	
B-07	Rocket	
B-08	State Road 6 Rest Area	
B-09	Stone Cabin/Willow Creek	
B-10	State Roads 6 and 375 Junction	
B-11	State Road 375 Ranch Cattle Gate	
B-12	Golden Arrow/Silver Bow	
B-13	Five miles south of Rocket	
B-14	Nine miles south of Rocket	

Based on the results of these questions, sampling locations are classified into four priority levels as shown in Table 4-4. Category 1 represents the level of most significant concern, while Category 4 is the level of no concern at all. To date, there has been no Category 1 sites identified at TTR. Therefore, this report discusses only Category 2 and 3 results. As shown in the table, specific actions will be taken depending on the designated category.

Comparison of Results

Data from onsite and perimeter locations over the last six years (August 1994 to August 1999) were compared to data from offsite locations gathered during the same period. This set of data provides a record from which to perform a trend analysis. Onsite and perimeter data were also compared to:

- U.S. surface soil averages (CRC 1992);
- RCRA Subpart S proposed action levels (where available); and
- Laboratory detection limits.

4.3 RADIOLOGICAL PARAMETERS

Radiological analysis is performed on all soil samples collected from and around the TTR. The complete report detailing 1999 terrestrial surveillance results is published in *Tonopah Test Range Data Analysis in Support of the Annual Site Environmental Report 1999* (SNL 1999b). Radiological analyses include the following analytical procedures:

- ***Gamma spectroscopy*** – Gamma emissions are high-energy electromagnetic energy emitted by certain radioactive atoms. The gamma spectrometry test identifies and quantifies the presence of gamma-emitting isotopes, such as americium-241, cesium-137, and potassium-40.

- ***Isotopic Plutonium*** – Isotopic plutonium analysis was performed on any sample for which gamma spectroscopy identified americium-241 in concentrations greater than its minimum detectable activity (MDA).

TABLE 4-4. Decision Matrix for Determining Priority Action Levels Based on Categories Assigned at Each Sampling Location

Category	Are results higher than offsite?*	Is there an increasing trend over the last 9 years?	Priority for Further Investigation
1	**Yes**	**Yes**	**1st Priority** - Immediate attention needed. Specific investigation planned and/or notifications made to responsible parties.
2	**Yes**	No	**2nd Priority** - Some concern based on the level of contaminant present. This may be from a known site of contamination already being addressed under the ER Project. Investigation planned and/or notifications made to responsible parties.
3	No	**Yes**	**3rd Priority** - A minor concern since contaminants present are not higher than offsite averages. An investigation may or may not be needed.
4	No	No	**4th Priority** - No concern. No investigation required.

NOTE: Based on Prioritization Statistical Analysis Methodology (Shyr, Herrera, and Haaker 1998).
*While some sites may appear higher than offsite, there may not be a statistically significant difference.

- ***Uranium, total (U_{tot})*** – All uranium isotopes are radioactive and are differentiated by the number of neutrons present (92 protons and 142 or more neutrons), uranium-234, -235, -236, -238, and -239/240. A test to measure total uranium (U_{tot}) is a general trend indicator for detecting all isotopes of uranium. Elevated levels may trigger an isotope-specific analysis.

4.4 ONSITE AND PERIMETER RADIOLOGICAL RESULTS

Radiological parameter results are discussed for each sample media analyzed for all onsite and perimeter locations. Analyte results found to be statistically higher than offsite results (Category 2), or results that show increasing trends but remain below offsite results (Category 3), are discussed. As mentioned earlier, there have been no Category 1 results for which both criteria are met.

4.4.1 Soil Results

Radiological results for all onsite, perimeter, and offsite locations are presented in Appendix B:

- Offsite – Table B-1a;
- Perimeter – Table B-2a;
- Onsite –
  South Plume, TableB-3a;
  Range Operations, Table B-4a; and
  Various Onsite Location, Table B-5a.

All radiological results are reported as gross results (natural background plus any man-made contributions.)

CATEGORY 2 (Higher than Offsite)

There were no Category 2 (higher than offsite) results for radiological parameters. All analyses performed on samples collected from onsite or perimeter locations were statistically indistinguishable from offsite concentrations.

CATEGORY 3 (Increasing Trend)

There were no Category 3 (increasing trends) results for radiological parameters. All analyses performed on samples collected from onsite or

perimeter locations showed no increasing trends, although several locations (including offsite locations) showed decreasing trends. These locations are summarized in the box below.

Decreasing Trends	
Analyte	**Location**
Cesium-137	OC-03, B-13
Total Uranium	OC-13, T-10, T-21 B-01, B-06, B-14

4.4.2 Thermoluminescent Dosimeter (TLD) Monitoring Results

In January 1994, Sandia Corporation began an ambient gamma radiation monitoring program as part of the long-term, routine, Environmental Surveillance Program at TTR. TLDs measure external gamma exposure from both background (e.g., cosmic rays) and man-made sources (e.g., fall-out and diffuse sources). Factors such as elevation and local geological deposits can effect TLD measurements. The nationwide average from all sources is 250 millirem per year (mrem/yr) (Brookins 1992).

The TTR TLD network consists of five community (offsite), four perimeter, and 13 onsite locations. Table 4-5 summarizes the TLD measurements for annual radiation exposure.

Results showed no statistical difference between locations types (community, perimeter, or onsite). As shown in Figure 4-1, the data points for 1999 are nearly identical for the three location categories.

During 1997, the results identified high values at onsite TLD location T-13, located at the northeast corner of the Operations Center perimeter fence. The 1997 annual value was 218 ±52 mrem/yr compared to an annual average offsite exposure of 135 ±21 mrem/yr. However, in 1998 and 1999, the anomalous high was not observed. The 1998 result was 157 ±6.6 mrem/yr compared to the offsite average of 144 ±4 mrem/yr. The 1999 result was 150.8 ±12.66 mrem/yr compared to the offsite average of 154.5 ±6.96 mrem/yr. Therefore T-13 is no longer a site of concern. However, reviews of the historic TLD data for T-13 does show that the elevated results tend to occur on a cyclic or intermittent basis.

4.5 NONRADIOLOGICAL PARAMETERS

Nonradiological sampling has occurred every year since 1994 with the exception of 1997. In 1999, all samples were analyzed for 20 stable metals plus mercury. The list of 21 metals has been modified over time to best represent a broad range of toxic pollutant indicators based on RCRA and CERCLA target list metals. With the exception of mercury, the presence and quantity of all analytes are determined by EPA's Inductively Coupled Plasma-Atomic Emission Spectrum (ICP-AES) method. This method super heats the sample to a plasma state and identifies elements by the atomic emission spectrum produced.

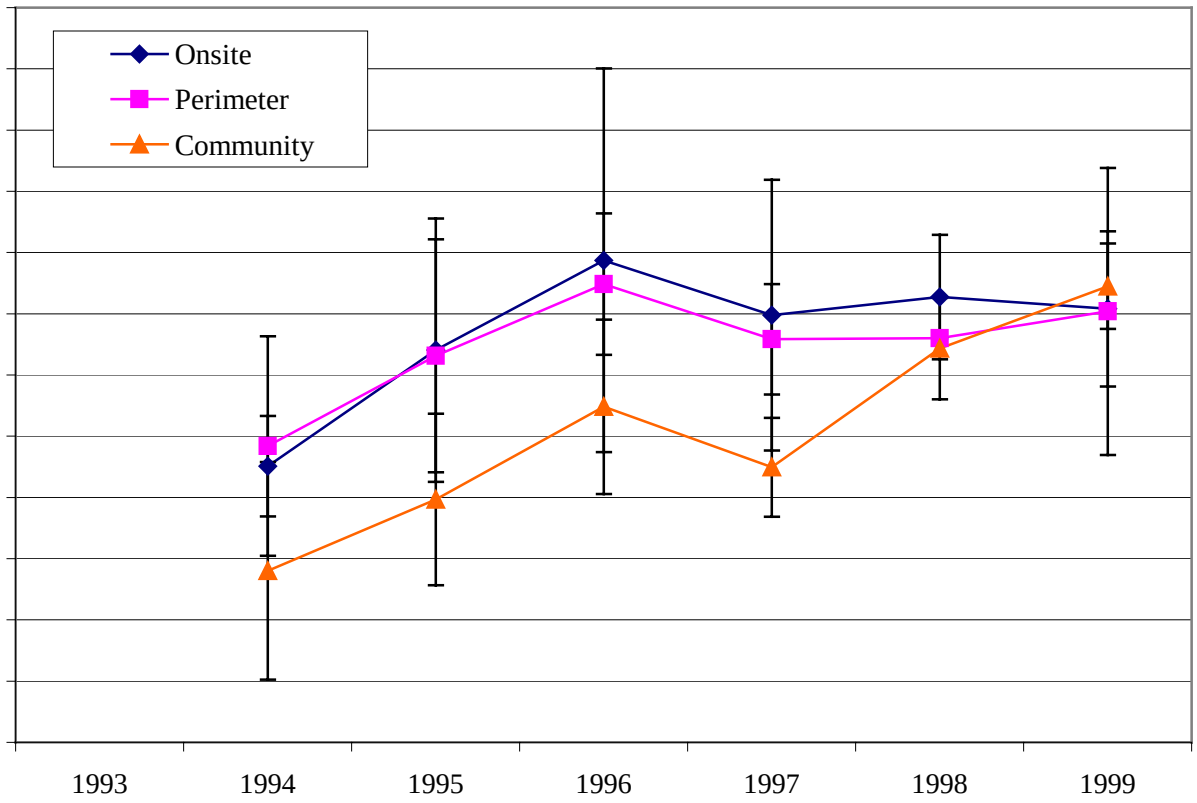
ICP-20 Metals

The Terrestrial Surveillance Team has modified the analyte list over time by selecting the most useful metals. For example, calcium, silicon, strontium, and titanium were removed from the list since they are naturally abundant in the soil and are not useful indicators of pollution. These

TABLE 4-5. Summary of Thermoluminescent Dosimeter (TLD) Measurements for 1999

Location Class	Sample Size	Units	Mean	Error	Minimum	Maximum
TTR (Onsite)	13	mrem/yr	150.80	12.66	133.90	185.30
Perimeter	4	mrem/yr	150.38	23.44	118.80	175.40
Offsite	5	mrem/yr	154.50	6.96	144.80	164.30

NOTE: mrem/yr = millirem per year



GURE 4-1. Thermoluminescent Dosimeter (TLD) Average Annual Results for TTR From 1994 to 2000

metals were replaced with thallium, selenium, arsenic, and antimony. The current list of metals analyzed is as follows:

Aluminum	Antimony	Arsenic
Barium	Beryllium	Cadmium
Chromium	Cobalt	Copper
Iron	Lead	Magnesium
Manganese	Mercury	Nickel
Potassium	Selenium	Silver
Thallium	Vanadium	Zinc

As was done for radiological results, locations were categorized from 1 to 4 based on the contamination present and the results of the trend analysis.

4.6 ONSITE AND PERIMETER NONRADIOLOGICAL RESULTS

4.6.1 Soil Results

Nonradiological results are for stable metals.

CATEGORY 2 Higher than Offsite

- **South Plume Area –** Five samples were collected from the South Plume Area of Clean Slate 1 (Figures B-3 and Table B-3b). All analyses performed on samples collected from the South Plume Area showed no increasing trends for any nonradiological parameter.

- **Range Operations Center** – Eight samples were collected from around the Range Operations Center (Figures B-4a and B-4b, and Table B-4b). Location OC-19, located within the main set of trailers at the Range Operations Center, showed values of nickel that were higher than community values. All other analyses performed on samples collected from the Range Operations Center showed values similar to community levels.

- **Various Onsite Locations** – Nine samples were collected from various locations onsite (Figures B-5a, B-5b, and B-5c, and Table B-5b). Four locations showed elevated results higher than community for at least one nonradiological parameter.

Location D-01 showed significantly elevated results for iron again this year. D-01, the former Project Roller Coaster decontamination site, had an average iron result of 16,360 mg/kg. The average iron result for offsite locations was 8,359 mg/kg. The RCRA Subpart S action level for iron is 21,000 mg/kg. This location will continue to be monitored.

Location MH-04 showed significantly elevated results for manganese. MH-04, located at Mellan Hill, had an average of 514 mg/kg. The average manganese results for offsite locations was 316 mg/kg. The RCRA Subpart S action level for manganese is 400 mg/kg. Since this is the first year that high manganese results were noted at this location, further monitoring results will be needed to determine if there is a statistical trend present. Monitoring will continue at this site.

Location T-20 showed significantly elevated results for magnesium. T-20, located adjacent to the fenced depleted uranium (DU) area near the Hard Target, had average magnesium levels of 6,146 mg/kg. The average manganese results for offsite locations was 3,515 mg/kg. The RCRA Subpart S action level for manganese is 460,000 mg/kg. This location will continue to be monitored.

Location T-21 showed significantly elevated results for aluminum and magnesium. T-21, located adjacent to the fenced DU area near the Hard Target, had an average aluminum result of 17,860 mg/kg (compared to 7,300 mg/kg offsite) and an average magnesium result of 6,146 mg/kg (compared to 3,515 mg/kg offsite). The RCRA Subpart S action levels for aluminum is 80,000 mg/kg and manganese is 460,000 mg/kg. This location will continue to be monitored.

- **Perimeter Locations** – Nine samples were collected from various locations onsite (Figures B-5a, B-5b, and B-5c, and Table B-5b). Location T-11, located in the foothills at the west perimeter gate between Nellis Air Force Range (NAFR) and TTR, showed elevated results for manganese. The average manganese result was 712 mg/kg as compared to the average offsite value of 316 mg/kg. The RCRA Subpart S action level for manganese is 400 mg/kg. This location will continue to be monitored.

  All other analyses performed on perimeter sample locations were statistically indistinguishable from offsite concentrations.

CATEGORY 3 Increasing Trend

- **South Plume Area –** Five samples were collected from the South Plume Area of Clean Slate 1 (Figures B-3 and Table B-3b). Location T-16, located NE of NW/SE Mellan Airstrip, showed an increasing trend for magnesium with values ranging from 3,200 to 4,000 mg/kg. All other analyses performed on samples collected from the South Plume Area showed no increasing trends for any nonradiological parameter.

- **Range Operations Center** – Eight samples were collected from around the Range Operations Center (Figures B-4a and B-4b, and Table B-4b). Location OC-13, located outside the perimeter fence of the Range Operations Center, showed an increasing trend for zinc. Zinc values ranged from 43 to 135 mg/kg. The average offsite zinc concentrations was 33 mg/kg. The RCRA Subpart S action level for zinc is 23,000 mg/kg. This location will continue to be monitored.

  All other analyses performed on samples collected from the Range Operations Center showed no increasing trends for any nonradiological parameter.

- **Various Onsite Locations** – Nine samples were collected from various locations onsite (Figures B-5a, B-5b, and B-5c, and Table B-5b). All analyses performed on samples collected from the various onsite locations showed no increasing trends for any nonradiological parameter.

- **Perimeter Locations** – Eight locations were collected from perimeter locations (Figures B-2 and Tables B-2a and B-2b). Location T-13, located in the foothills at the west perimeter gate that separates NAFR from TTR, showed an increasing trend for manganese, as measured over the past five years. Manganese concentrations have ranged from 326 to 508 mg/kg with an average of 402 mg/kg; the average offsite value of 316 mg/kg. The average manganese values for U.S. soils range form 20 to 3,000 mg/kg with an average of 495 mg/kg. The RCRA Subpart S action level for manganese is 400 mg/kg. However, since manganese is a common constituent of volcanic rocks, such as the volcanic rocks of the Cactus Range on the west side of TTR, it has yet to be determined whether manganese results at T-13 are attributable to man-made pollution or to natural geologic conditions. Since the manganese result at T-13 is just at the RCRA Subpart S action level, SNL/NM's Terrestrial Surveillance Team will determine what action, if any, to take after next year's results have been analyzed. At present, this location will continue to be monitored.

4.6.2 Results of Colimbo Site Sampling Event

In 1999, a limited one-time sampling of stable metals and radionuclide was made at the Colimbo site. This area was being considered in the site selection process for a proposed fire

experiment, which has since been withdrawn. Sample locations are shown in Figure B-6. A total of 18 samples were taken at a radius up to 1,000 m. Samples were analyzed for 20 stable metals plus mercury, and radionuclides (U_{tot} and gamma emitting isotopes). Radionuclide results are given in Table B-7a. Stable metal results are given in Table B-7b.

Replicate Samples

Replicate (triplicate) sampling was performed the Colimbo site to assess the reproducibility of the sampling technique and the variation of results of a given location. Triplicate results are shown in Tables B-8a (radionuclides) and Table B-8b (stable metals). The results demonstrate the high reproducibility in individual sampling.

All data were provided to SNL/NM's National Environmental Policy Act (NEPA) point of contact for the fire experiment and TTR project personnel. Nothing further was done with this data.

4.7 PERSPECTIVE ON PLUTONIUM DISTRIBUTION IN THE ENVIRONMENT

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

A later study by Tamura (1977) demonstrates the effect of wind erosion in dispersal of contaminated material. Sandy mounds, formed under desert shrubbery, collect by the filtering action of the desert vegetation in intercepting saltating particles (movement of particles along the ground surface). This and additional studies found that in plutonium-contaminated areas, the plutonium activity levels were higher in the desert mounds than in the contiguous desert pavement (soil areas with sparse vegetation and underlain by a hard-pan surface).

The Tamura (1977) study also discussed evidence of plutonium migration downward into the soil profile. Evidence of water erosion has been observed within the outer control fence at Clean Slate 2. The erosive effects of water may pose another mechanism for transport of the contaminated material. Essington and Fowler (1976) observed the ability of plutonium to migrate to deeper layers of soil with time. Vertical transport of contaminants into the soil column may allow greater exposure of roots and a potential for root uptake of contaminants by the plants. Soil profiles from the safety-shot areas at TTR indicate a decrease in the plutonium-to-americium ratio with depth (Romney et al. 1975), suggesting greater vertical movement of americium-241 relative to plutonium-239 and plutonium-240. This same report also stated that there is evidence showing that americium is much more readily available to plants through roots than is plutonium. Gilbert et al. (1975) stated that erosive processes and penetration into the soil would eventually flatten out peak contaminant concentrations, and that there was a need for long-term hazard

evaluation to determine the change in contaminant concentrations over time at the safety-shot areas.

4.8 ENVIRONMENTAL MONITORING PERFORMED BY WESTINGHOUSE

Westinghouse Government Services, the onsite contractor at TTR, performed or assisted in most environmental monitoring activities at the site in 1999. These included the following routine environmental monitoring duties:

- Production Well 6 sampling;
- Wastewater sampling
- Ambient air monitoring;
- Soil sampling at spill sites etc.
- Managing the TLD network; and
- Hazardous waste characterization.

4.9 WATER MONITORING

Results for potable water and wastewater effluent sampling are presented below. The issue of storm water monitoring is also discussed.

The *Water Conservation Plan for the Tonopah Test Range* complies with State Water Resources Division regulations requiring a water conservation plan for permitted water systems and major water users in Nevada (DOE 1992).

4.9.1 Production Well Monitoring

Production Well 6, which supplies drinking water to the Sandia Compound in Area 3, is routinely sampled for contaminants. All sampling is conducted in accordance with requirements set by the state (State of Nevada 1997). Analytes are sampled at different intervals as follows:

- **Total Colliform** – monthly
- **Nitrates and nitrites** – annually
- **Dioxins** – quarterly
- **VOCs and semi-VOCs** – annually
- **Copper and lead** – annually (but going to three year interval)

A complete chemical and radiological analysis of the site's drinking water is required by the state every three years; this was last performed on April 8, 1999. Sampled parameters included, but were not limited to, nitrates, nitrites, VOCs, lead, copper, and arsenic.

Parallel Sampling by the EPA
The EPA also performs sampling on Well 6 for nitrate and nitrites every three years. In addition, the EPA provides a radiological analysis survey for the Long-Term Hydrologic Monitoring Program. Sampling sites are based on state specified locations (State of Nevada 1997) and are in accordance with the Safe Drinking Water Act (SDWA).

4.9.2 Sewage System and Septic Tank Monitoring

Wastewater samples were taken in August 1999. Sandia Corporation conducts wastewater monitoring at the United States Air Force (USAF) sewage lagoon and septic tanks. There were no surface discharges made at TTR in 1999.

Sewage System
Sewage from SNL's facilities in the Main Compound at Area 3 goes to the USAF facultative sewage lagoon. Westinghouse takes annual 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 for its wastewater discharges. The Air Force takes quarterly samples from the headwater end of the lagoon. In the past, Sandia Corporation provided quarterly sampling results to the Air Force for inclusion into their USAF Discharge Monitoring Report (DMR); however, the NPDES permit was modified in 1997 and no longer stipulates the requirement of quarterly data from Sandia Corporation. Therefore, Sandia Corporation now only provides annual sample results to the Air Force.

Westinghouse collects 48-hour composite wastewater samples on an annual basis and has the following parameters analyzed:

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

All analytical results of Sandia Corporation's wastewater sampled from the Area 3 compound were within regulatory limits in 1999. Results can be obtained from Westinghouse Government Services.

Septic Tank Systems

Septic tank systems are sampled on a as-needed basis. There are six septic systems onsite owned by Sandia Corporation at TTR. TTR's six active septic tanks, used in remote locations, are maintained by the TTR facilities group. The sewage from these locations flows into septic tanks and associated drain fields. None of these systems required maintenance, sampling, or pumping in 1999. All other remaining septic systems have been closed or are undergoing closure and are being addressed by the Environmental Restoration (ER) Project.

4.9.3 Storm Water Monitoring

Currently, Sandia Corporation has no requirement to perform storm water monitoring at TTR. All storm water issues and monitoring is managed by the Air Force.

Chapter 5

Air Quality Surveillance and Emissions Monitoring

Air quality compliance at TTR is met by adherence to specific permit conditions and compliance with local, state, and federal air regulations. Ambient air quality monitoring is not currently required at TTR. The last ambient air monitoring was conducted in 1996 to ascertain the level of radiological constituents in the air as discussed below.

5.1 RADIOLOGICAL AIR MONITORING

Operations by Sandia Corporation at TTR do not involve activities that release radioactive emissions from either point sources (stacks and vents) or diffuse sources such as outdoor testing. However, diffuse radiological emissions are produced from the re-suspension of americium and plutonium present at the Clean Slate Environmental Restoration (ER) sites. Other ER sites with minor radiological contamination, such as depleted uranium (DU), do not produce air emission sources from re-suspension.

National Emission Standard for Hazardous Air Pollutants (NESHAP)

NESHAP, 40 CFR 61, Subpart H, "National Emission Standards for Emission of Radionuclides Other than Radon from Department of Energy Facilities," has set a maximum of 10 mrem/yr for all combined air emission pathway sources from any U.S. Department of Energy (DOE) facility. Although the dose calculated from the Clean Slate sites is many times less than this standard, there was a question of whether the site would require continuous radiological air monitoring or not.

The 1995 NESHAP report for TTR reported a calculated effective dose equivalent (EDE) to the maximally exposed individual (MEI) of 1.1 mrem/yr as a result of diffuse emissions from the Clean Slate sites (SNL 1996). Because the U.S. Environmental Protection Agency (EPA) requires continuous air monitoring for any radionuclide source that contributes a dose in excess of 0.1 mrem/yr to the MEI, Sandia Corporation instituted continuous air monitoring at the site. This monitoring was conducted for one year, from February 22, 1996 to February 25, 1997. The monitoring site was chosen at the TTR Airport where the highest calculated dose for the onsite MEI was determined. This site selection is discussed in the 1996 NESHAP report (SNL 1997). The dose assessment result from the continuous monitoring was 0.024 mrem/yr. This was about five times less than the 0.1 mrem/yr threshold cutoff for which continuous monitoring would be required by the EPA. The average air concentration, in curies per cubic meter (Ci/m^3) were measured as follows:

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

Although an annual calculated dose assessment is not required for the site, Sandia Corporation continues to produce an annual NESHAP report for TTR (SNL 2000). The results from the 1996-1997 monitoring will continue to be used for as long as there is no change in the status of the Clean Slate sites. Table 5-1 summarizes the dose assessment results for 1998. As a comparison, the average nationwide dose a person receives from all radioactive sources

(natural and man-made) is approximately 250 mrem/yr—the bulk of which comes from natural sources such as radon (Brookins 1992). Future NESHAP activities at TTR are expected to be minimal.

5.2 NONRADIOLOGICAL AIR EMISSIONS

TTR's Class II Air Quality Permit requires emission monitoring from nonradionuclide sources. At TTR these sources include generators, paint booths, and various combustion sources. In 1999, the total emissions reported to the State of Nevada were 23.26 standard tons (Table 5-2).

TABLE 5-1. Calculated Dose Assessment Results for Onsite Receptor (1998 data)

Dose to Receptor	Location	1997 Measured Dose*	NESHAP Standard	Natural Background
Onsite Receptor (EDE to the MEI)	Airport TTR Area	0.024 mrem/yr *(0.00024 msievert/yr)*	10 mrem/yr 0.1 msievert/yr	250[1]

NOTE: * Dose calculated from continuous monitoring Feb 1996 – Feb 1997.
EDE = effective dose equivalent
MEI = maximally exposed individual
[1] Natural background is estimated at 250 mrem/year nationwide.

TABLE 5-2. Emissions From TTR Sources in 1999

Pollutant	Standard Tons
Hazardous air pollutants (HAPs)	1.01
Nitrous oxides (NO_X)	17.90
Particulate matter (PM)	2.9
Sulfur dioxide (SO_2)	1.17
Volatile Organic Compounds (VOCs)	0.28
Total	23.26

Chapter 6

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Clean Air Act (CAA) and **CAA Amendments of 1990** (U.S.C. Title 42, Chapter 85, §7401)

Clean Water Act (CWA) of 1977 and the **Federal Water Pollution Control Act**
(U.S.C. Title 33, Chapter 26, §1251)

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980
(U.S.C. Title 42, Chapter 103, §9601)

Emergency Planning and Community Right to Know Act (EPCRA) of 1986 (U.S.C., Title 42, Chapter 116, §11001 et seq.)

Endangered Species Act (ESA) (U.S.C., Title 16, Chapter 35, §1531 et sec.)

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(RCRA Section 3004j Land Disposal Restrictions)
(RCRA Section 6002 Federal Procurement)
(RCRA Subpart S Action Levels)

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NOTE: U.S.C = United States Code

CODE OF FEDERAL REGULATIONS

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APPENDIX A

STATE OF NEVADA
ENVIRONMENTAL REGULATIONS

Nevada regulatory information can be found at the Nevada State Legislature website:

http://www.leg.state.nv.us/

A listing of the Nevada Administrative Code (NAC) can be found at:
http://www.leg.state.nv.us/NAC/Index.htm

TABLE A-1. State of Nevada Administrative Code (NAC) Applicable to the Tonopah Test Range (TTR)

Chapter 445A, *Water Controls*	**Applicable Sources or Activities**
NAC 445A.070 to 445A.348, "Water Pollution Controls"	• Septic tanks • Surface water runoff
NAC 445A.450 to 445 A. 6731, "Public Water Systems"	• Production well sampling

Chapter 445B, *Air Controls*	**Applicable Sources or Activities**
NAC 445B.001 to 445B.395, "Air Pollution"	• Open burning • Hazardous air pollutants from stacks and vents • Disturbance of soils during construction (particulate matter)
NAC 445B.400 to 445B.774, "Emissions From Engines"	• Generators • Mobile sources

Chapter 534, Underground Water and Wells	**Applicable Sources or Activities**
NAC 534.010 to 534.450, "Underground Water and Wells"	• Drilling, operation, and abandonment of wells

Chapter 444, Sanitation	**Applicable Sources or Activities**
NAC 444.570 to 444., "Solid Waste Disposal"	• Disposal of construction debris • Disposal of routine non-hazardous solid wastes • Disposal of septic sludge
NAC 444A.005 to 444A470, "Programs for Recycling"	• Recyclable materials including waste tires

Chapter 504, *Wildlife Mangement and Propagation*	**Applicable Sources or Activities**
NAC 504.001 to 504.340, "Wildlife Management Areas" NAC 504.510 to 504.550, "Alteration of Stream or Watershed"	• Road construction • Construction activities
NAC 504.800 to 504.865, "Preservation of Wild Horses" *	• General activities on the range in wild horse areas

NOTE: This law provides protection to endangered, threatened, and sensitive species.

***** Two wild horse units encompass areas within the Nellis Air Force Range:

- **"Unit 252:** That portion of Nye County ….. and those portions of the Nellis Air Force Range as authorized by the United States Department of Defense."
- **"Unit 253:** That portion of Nye County … including those portions of the Nellis Air Force Range as authorized by the United States Department of Defense and the Nevada Test Site as authorized by the United States Department of Energy."

APPENDIX B

SAMPLING LOCATION MAPS
AND
TERRESTRIAL SURVEILLANCE RESULTS

Target Lake at Tonopah Test Range (1960s)

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FIGURES

TABLES

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TABLE B-1a. Radiological Results for Offsite Soil Sampling Locations, 1999

Analyte	B-01	B-02	B-03	B-04	B-05	B-06	B-07	B-08	B-09	B-10	B-11	B-12	B-13	B-14	Average Offsite Value
Utot (μg/g)	0.302	0.855	0.582	0.409	0.727	0.314	0.301	0.355	0.377	0.852	0.479	0.542	0.349	0.312	3
Am-241 (pCi/g)	0.00814	0.0246	0.103	-0.0356	0.00528	0.0197	-0.0703	-0.0567	-0.0143	-0.0611	-0.0895	0.0146	-0.152	0.0114	0.003
Am-241 *Error*	*0.115*	*0.0407*	*0.218*	*0.0356*	*0.115*	*0.229*	*0.157*	*0.101*	*0.123*	*0.113*	*0.141*	*0.144*	*0.236*	*0.263*	--
Cs-137 (pCi/g)	0.0531	0.288	0.136	0.0194	0.0293	0.136	0.0898	0.171	0.138	0.0529	0.435	0.345	0.0588	0.183	0.31
Cs-137 *Error*	*0.0379*	*0.0663*	*0.0557*	*0.0271*	*0.0269*	*0.0761*	*0.0441*	*0.0456*	*0.0425*	*0.0329*	*0.0667*	*0.0569*	*0.0485*	*0.0995*	--
K-40 (pCi/g)	29.8	31.4	31.6	31.9	35.9	27.4	36.8	33.1	32.5	16.2	35.2	35.1	29.8	30.8	34
K-40 *Error*	*3.49*	*3.17*	*3.96*	*3.42*	*3.83*	*3.03*	*4.32*	*3.61*	*3.53*	*1.96*	*4.25*	*4.03*	*3.28*	*3.52*	--

NOTE: Am-241 was below detection limits (MDA).

TABLE B-1b. Stable Metal Results for Offsite Soil Sampling Locations, 1999

	(All Units are mg/kg)															
Analyte	**B-01**	**B-02**	**B-03**	**B-04**	**B-05**	**B-06**	**B-07**	**B-08**	**B-09**	**B-10**	**B-11**	**B-12**	**B-13**	**B-14**	**Average Offsite Value (94-99)***	**Highest Offsite Value (94-99)***
Aluminum	6,610	7,360	6,690	4,750	8,330	3,910	7,250	5,000	8,150	7,350	5,840	6,050	5,290	4,200	7,269	12,700
Antimony	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.381	0.191	0.191	0.191	0.191	3	6
Arsenic	2.04	7.56	3.93	2.37	5.28	3.13	1.92	1.3	1.62	4.59	3.84	2.16	0.884	1.07	9	43
Barium	101	146	89.7	84.4	107	70.7	117	106	131	253	152	134	76.1	76	151	810
Beryllium	0.302	0.427	0.567	0.213	0.436	0.222	0.359	0.284	0.418	0.542	0.227	0.336	0.229	0.234	0.50	1
Cadmium	0.187	0.173	0.0857	0.0895	0.181	0.118	0.518	0.103	0.0829	0.966	0.114	0.164	0.0389	0.019	0.47	1.4
Chromium	2.6	3.31	2.9	2.61	3.37	2.28	2.8	1.95	14.4	4.25	1.73	2.5	1.61	2.03	12	48
Cobalt	2.84	3.52	2.44	1.36	2.88	1.61	3	2	2.34	3	3.05	2.36	1.03	1.18	3.0	5.4
Copper	4.46	6.75	4.58	2.8	10.6	4.65	4.69	2.94	3.6	7.97	2.84	3.72	1.64	2.12	7	18
Iron	7,900	7,880	7,430	6,220	8,070	5,370	8,880	6,600	8,600	9,830	6,180	6,560	4,980	4,490	8,322	16,800
Lead	10.9	40.8	14.3	6.85	6.2	9.02	34.4	9.04	57.3	16.6	8.89	8.86	4.51	5.34	14.5	57.3
Magnesium	2,770	3,350	3,090	1,260	3,620	2,420	2,650	1,490	2,890	10,400	3,230	2,240	1,330	1,330	3,500	18,000
Manganese	361	510	381	134	189	209	388	303	187	278	367	433	114	115	309	551
Nickel	3.82	4.87	2.92	2.17	4.39	2.42	3.83	2.11	3.44	10.1	2.58	2.97	1.66	1.8	5	22
Potassium	1,810	2,060	1,530	1,160	2,550	1,530	2,890	1,930	2,270	2,700	2,870	2,740	2,590	1,900	2,876	5,300
Selenium	0.135	0.135	0.135	0.135	0.135	0.135	0.135	0.135	0.135	0.284	0.135	0.135	0.135	0.135	3	7
Silver	0.031	0.465	0.0943	0.031	0.031	0.539	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.68	3
Thallium	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.882	0.482	0.221	0.221	0.221	9	27
Vanadium	6.64	10.7	10.6	5.58	8.49	5.67	6.95	6.27	7.76	15.1	8.09	5.56	4.03	4.31	14	47
Zinc	26.4	24.8	27.1	16.2	19.8	24.4	32.7	22.8	17.8	50	12.9	16.8	10.2	10.7	33	87

***NOTE**: Metals were not sampled during 1997.

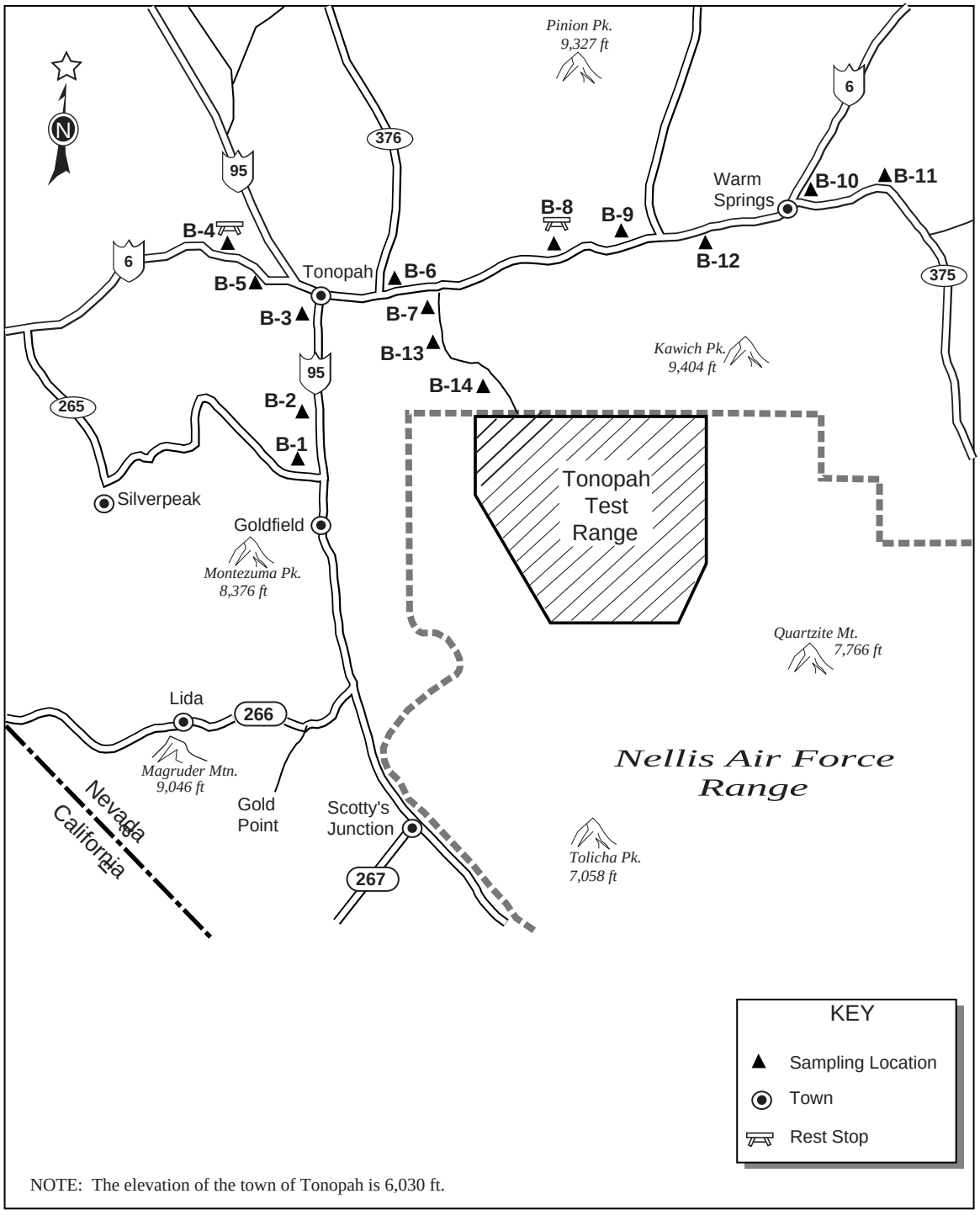

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FIGURE B-1. Offsite Soil Sampling Locations
(14 Locations)

TABLE B-2a. Radiological Results for Perimeter Soil Sampling Locations, 1999

Analyte	OM-03	T-06	T-08	T-11	T-12	T-13	T-36	T-37	Average Offsite Value
Utot (µg/g)	0.321	0.301	0.336	0.352	0.618	0.327	0.504	0.405	3
Am-241 (pCi/g)	0.175	-0.122	-0.0791	-0.0224	0.0284	0.0565	0.00425	0.000411	0.003
Am-241 *Error*	*0.193*	*0.143*	*0.153*	*0.0564*	*0.0347*	*0.115*	*0.04*	*0.0315*	--
Cs-137 (pCi/g)	0.642	0.243	0.0879	0.134	0.406	0.137	0.0573	0.00379	0.31
Cs-137 *Error*	*0.0774*	*0.0667*	*0.0378*	*0.0413*	*0.0714*	*0.0446*	*0.0581*	*0.0365*	--
K-40 (pCi/g)	37.2	35.3	34.2	32	35.9	35.4	32.4	31.6	34
K-40 *Error*	*4.16*	*3.91*	*4.14*	*3.88*	*3.54*	*3.9*	*3.26*	*3.11*	--

NOTE: Am-241 was below detection limits (MDA).

TABLE B-2b. Stable Metal Results for Perimeter Soil Sampling Locations, 1999

Analyte	(All Units are mg/kg)									
	OM-03	T-06	T-08	T-11	T-12	T-13	T-36	T-37	Average Offsite Value (94-99)*	Highest Offsite Value (94-99)*
Aluminum	5,640	5,010	2,890	4,020	6,170	3,190	4,120	3,790	7,269	12,700
Antimony	0.191	0.191	0.394	0.191	0.191	0.191	0.191	0.191	3	6
Arsenic	1.64	1.58	1.25	6	8.62	7.22	1.28	1.37	9	43
Barium	73.9	77.9	56.3	112	125	144	61.6	61.2	151	810
Beryllium	0.3	0.32	0.183	0.448	0.514	0.492	0.27	0.235	0.50	1
Cadmium	0.125	0.131	0.046	0.0595	0.152	0.0904	0.0673	0.019	0.47	1.4
Chromium	2.1	2.5	1.43	2.55	3.65	2.36	2.4	1.78	12	48
Cobalt	1.75	2.42	0.918	3.49	2.97	3.26	1.28	1.26	3.0	5.40
Copper	2.9	3.46	1.71	3.62	5.09	5.41	3.86	2.31	7	18
Iron	5,570	5,040	3,750	9,080	7,050	8,930	4,490	4,300	8,322	16,800
Lead	6.81	8.92	3.42	13.2	10.5	12.4	4.56	3.52	14.5	57.3
Magnesium	2,040	1,950	1,060	1,630	3,050	1,230	1,500	1,390	3,500	18,000
Manganese	227	309	115	422	457	508	141	133	309	800
Nickel	2.48	3.19	1.29	2.54	4.05	2.47	2.13	1.89	5	22
Potassium	2,060	1,880	1,250	1,650	2,040	1,550	1,770	1,440	2,876	5,300
Selenium	0.135	0.135	0.135	0.364	0.135	0.292	0.135	0.135	3	7
Silver	0.031	0.031	0.031	0.031	0.031	0.031	0.115	0.031	0.68	3
Thallium	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	9	27
Vanadium	4.73	4.86	4.05	8.35	10.1	7.87	4.9	4.92	14	47
Zinc	13.8	27.1	15.4	36.8	30	32.7	18.9	37.6	33	87

*__NOTE__: Metals were not sampled during 1997.

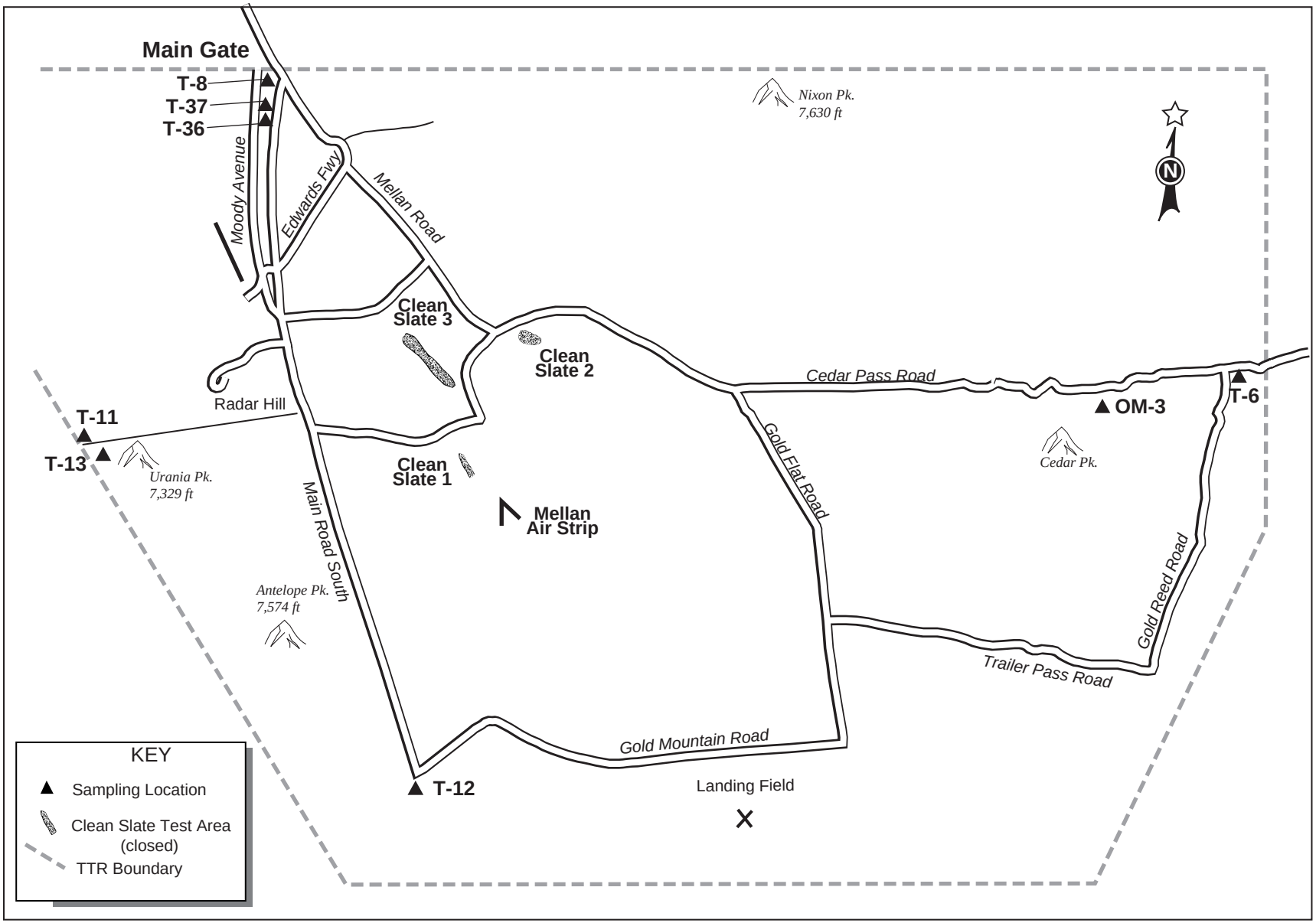

FIGURE B-2. Perimeter Soil Sampling Locations
(Eight Locations)

TABLE B-3a. Radiological Results for South Plume Area Soil Sampling Locations, 1999

Analyte	T-14	T-16	T-17	T-18	T-19	Average Offsite Value
Utot (µg/kg)	0.448	0.541	0.386	0.445	0.553	3
Am-241 (pCi/g)	0.0658	-0.0661	0.0482	0.0351	-0.0439	0.003
Am-241 *Error*	0.092	0.116	0.145	0.147	0.169	--
Cs-137 (pCi/g)	0.298	0.311	0.538	0.391	0.331	0.31
Cs-137 *Error*	0.0567	0.059	0.0826	0.0642	0.0768	--
K-40 (pCi/g)	31.9	34.2	33.9	36.2	37.3	34
K-40 *Error*	3.59	3.71	3.72	4.1	4.49	--

NOTE: Am-241 was below detection limits (MDA).

TABLE B-3b. Stable Metal Results for South Plume Area Soil Sampling Locations, 1999

Analyte	(All Units are mg/kg)						
	T-14	T-16	T-17	T-18	T-19	Average Offsite Value (94-99)*	Highest Offsite Value (94-99)*
Aluminum	9,460	8,610	6,130	7,690	4,110	7,269	12,700
Antimony	0.191	0.191	0.191	0.191	0.191	3	6
Arsenic	3.41	3.82	3.09	3.04	3.14	9	43
Barium	214	195	164	168	84.2	151	810
Beryllium	0.54	0.509	0.368	0.456	0.299	0.50	1
Cadmium	0.176	0.163	0.13	0.0898	0.0794	0.47	1.4
Chromium	5.42	4.69	3.43	4.63	2.16	12	48
Cobalt	3.8	3.44	2.43	3.43	1.82	3.0	5.40
Copper	6.57	6.45	5.13	5.61	3.08	7	18
Iron	8,880	7,890	6,110	7,280	4,290	8,322	16,800
Lead	10.5	11.2	11.1	9.13	6.57	14.5	57.3
Magnesium	3,820	3,890	2,910	3,200	1,570	3,500	18,000
Manganese	392	483	378	403	280	309	800
Nickel	6.27	5.32	3.76	5.04	2.3	5	22
Potassium	4420	4,170	4,010	3,910	1,710	2,876	5,300
Selenium	0.289	0.135	0.135	0.135	0.268	3	7
Silver	0.031	0.031	0.031	0.031	0.031	0.68	3
Thallium	0.221	0.221	0.221	0.221	0.221	9	27
Vanadium	13.9	11.5	9.32	11.5	5.77	14	47
Zinc	29	29.4	28.8	25.1	15.2	33	87

*__NOTE__: Metals were not sampled during 1997.

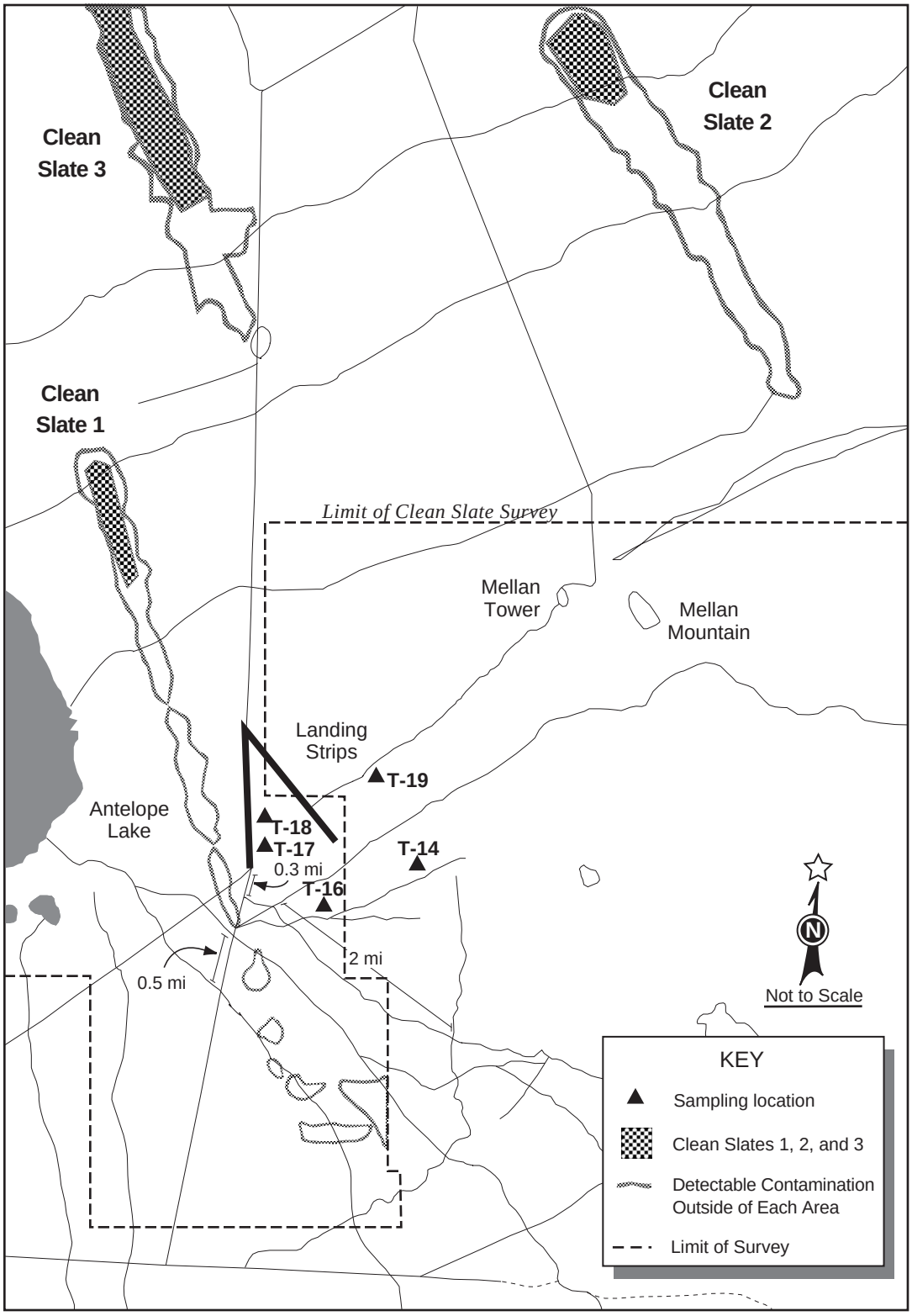

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FIGURE B-3. Soil Sampling Locations in the South Plume Area (Five Locations)

TABLE B-4a. Radiological Results for Range Operations Center Soil Sampling Locations, 1999

Analyte	OC-02	OC-03	OC-04	OC-10	OC-13	OC-19	OC-22	OC-23	Average Offsite Value
Utot (µg/kg)	0.359	0.364	0.367	0.565	0.368	0.329	0.399	0.326	3
Am-241 (pCi/g)	-0.0572	-0.00247	0.0913	0.00819	-0.0295	0.00201	-0.0404	0.0784	0.003
Am-241 *Error*	0.183	0.093	0.145	0.131	0.116	0.039	0.137	0.161	--
Cs-137 (pCi/g)	0.0751	0.0239	0.417	0.112	0.136	-0.0138	0.0201	0.208	0.31
Cs-137 *Error*	0.0529	0.0415	0.063	0.053	0.0428	0.03	0.0229	0.0493	--
K-40 (pCi/g)	39.3	36.1	32.8	34.9	35.4	33.6	35.5	35.5	34
K-40 *Error*	4.27	4.16	3.63	4	3.82	3.56	4.01	4.32	--

NOTE: Am-241 was below detection limits (MDA).

TABLE B-4b. Stable Metal Results for Range Operations Center Soil Sampling Locations, 1999

	(All Units are mg/kg)									
Analyte	**OC-02**	**OC-03**	**OC-04**	**OC-10**	**OC-13**	**OC-19**	**OC-22**	**OC-23**	**Average Offsite Value (94-99)***	**Highest Offsite Value (94-99)***
Aluminum	6,790	5,220	7,040	7,110	5,960	5,360	3,880	6,640	7,269	12,700
Antimony	0.191	0.191	0.371	0.191	0.395	4.59	0.191	0.191	3	6
Arsenic	2.87	2	2.64	4.81	6.4	2.14	2.43	1.7	9	43
Barium	87.1	89.2	123	101	99.1	104	112	118	151	810
Beryllium	0.412	0.32	0.381	0.386	0.345	0.378	0.311	0.315	0.50	1
Cadmium	0.143	0.191	0.114	0.374	0.181	1.8	0.0743	0.157	0.47	1.4
Chromium	2.58	2.65	2.5	2.97	2.1	30.2	2.92	2.38	12	48
Cobalt	2.77	2.45	2.83	2.36	2.52	4.26	3.08	2.44	3.0	5.40
Copper	4.74	4.19	4.28	4.78	6.66	5.91	3.27	4.05	7	18
Iron	7,750	6,570	8,670	7,920	8,550	7920	12,200	8,220	8,322	16,800
Lead	9.59	8.53	8.24	17.2	12	14.6	8.95	9.68	14.5	57.3
Magnesium	2,620	2,090	2,960	2,490	1,850	4,630	2,580	2,380	3,500	18,000
Manganese	268	230	271	233	257	227	269	332	309	800
Nickel	3.87	3.22	4.02	3.47	3.18	10.4	3.44	3.32	5	22
Potassium	2,260	1,990	2,120	1,910	1,730	2,430	1,700	2,420	2,876	5,300
Selenium	0.135	0.135	0.135	0.135	0.135	0.291	0.135	0.135	3	7
Silver	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.415	0.68	3
Thallium	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	9	27
Vanadium	7.64	7.39	8.21	9.59	11	9.85	9.95	5.87	14	47
Zinc	28.1	20.7	19.4	48.1	135	196	42.5	29.2	33	87

*__NOTE__: Metals were not sampled during 1997.

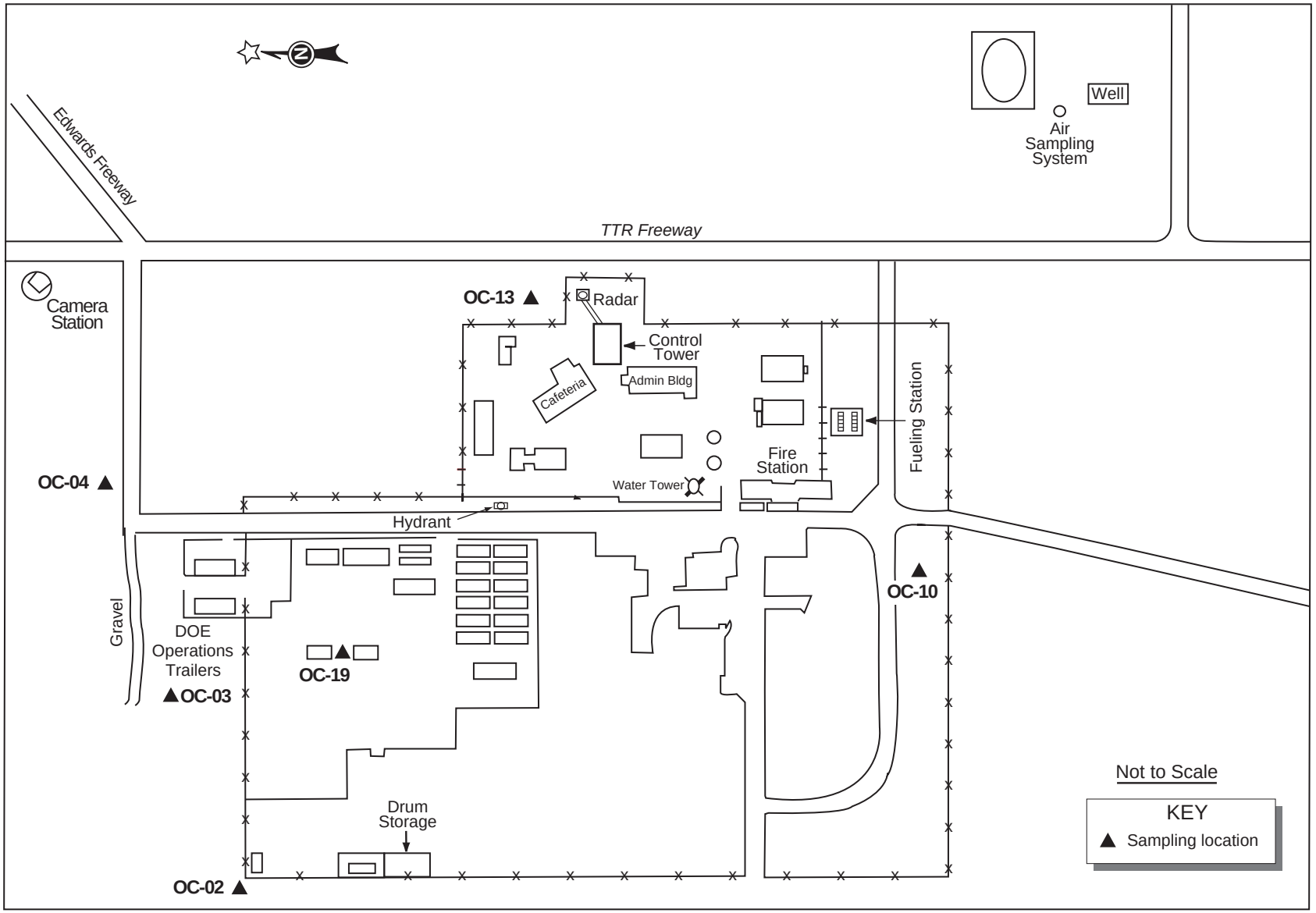

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FIGURE B-4a. Soil Sampling Locations in the Range Operations Center and Compound (Six Locations)

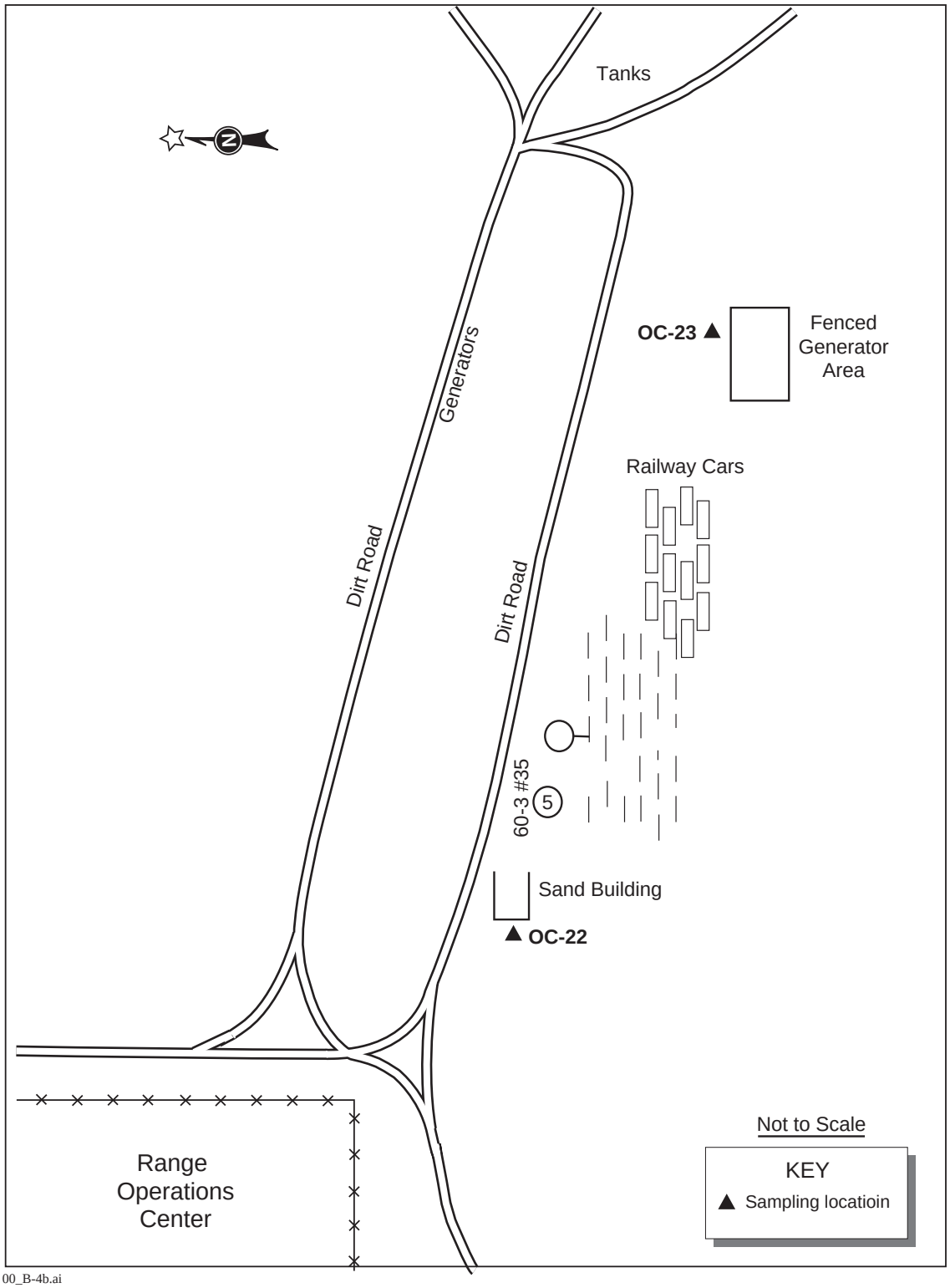

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FIGURE B-4b. Soil Sampling Locations Around the Range Operations Center Storage Yard (Two Locations)

TABLE B-5a. Stable Metal Results for Various Onsite Soil Sampling, 1999

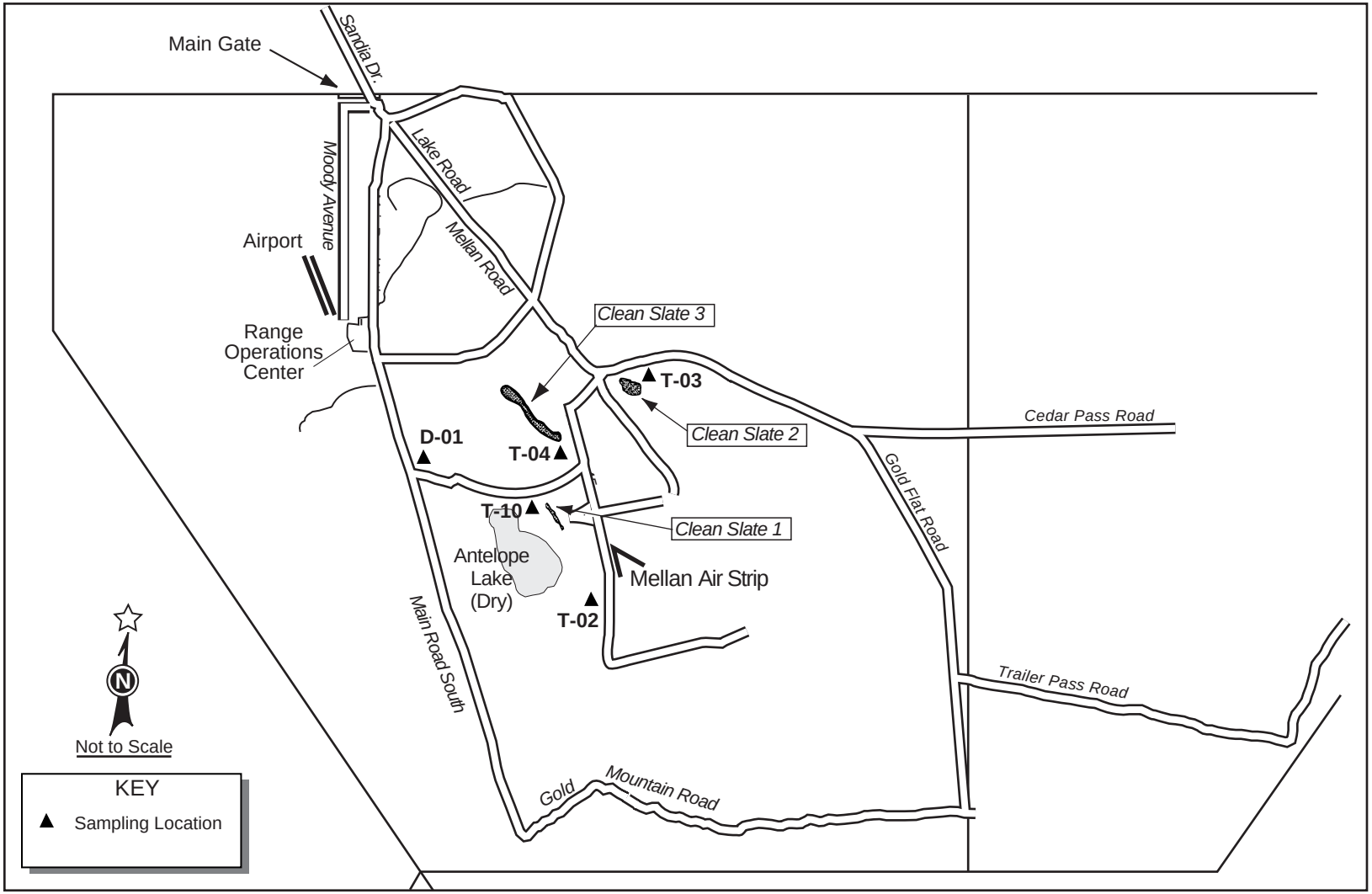
Analyte	(All Units are mg/kg)										
	D-01	MH-03	MH-04	T-02	T-03	T-04	T-10	T-20	T-21	Average Offsite Value (94-99)*	Highest Offsite Value (94-99)*
Aluminum	15,600	6,980	5,420	6,680	4,890	4,450	5,230	19,300	12,700	7269	12,700
Antimony	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	3	6
Arsenic	2.41	2.07	3.08	2.33	1.78	2.65	2.19	3.99	3.11	9	43
Barium	88.8	84.3	115	76.9	77.8	85.9	91.5	143	104	151	810
Beryllium	0.455	0.381	0.353	0.421	0.273	0.351	0.358	1	0.644	0.50	1
Cadmium	0.169	0.276	0.225	0.164	0.124	0.161	0.256	0.471	0.243	0.47	1.4
Chromium	3.48	3.06	2.31	2.59	1.86	1.69	2.37	7.36	5	12	48
Cobalt	4.44	2.16	2.7	2.19	1.87	1.98	2.18	5.72	3.46	3.0	5.40
Copper	4.4	4.31	3.76	3.42	2.81	2.89	3.69	11.8	7.68	7	18
Iron	22,100	7,400	5,850	6,780	5,540	5,160	5,900	17,800	12,300	8322	16,800
Lead	9.68	11.1	8.52	7.18	7.09	5.5	6.17	12.1	7.41	14.5	57.3
Magnesium	3,530	2,510	2,260	2,160	1,560	1,900	2,490	7,670	4,760	3,500	18,000
Manganese	304	256	483	228	288	343	328	507	322	309	800
Nickel	4.33	3.54	3.28	3.58	2.13	2.22	2.93	9.41	5.87	5	22
Potassium	2,410	2,080	2,180	2,070	1,440	1,710	2,230	5,470	3,760	2,876	5,300
Selenium	0.135	0.135	0.135	0.135	0.135	0.135	0.135	0.513	0.328	3	7
Silver	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.0871	0.031	0.68	3
Thallium	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221	9	27
Vanadium	8.2	6.18	5.99	6.68	4.78	5.57	5.94	15.2	10.9	14	47
Zinc	22.6	21.9	17	18.3	13.5	14.9	17.2	41.7	28	33	87

*__NOTE__: Metals were not sampled during 1997.

TABLE B-5b. Radiological Results of Various Onsite Soil Sampling Locations, 1999

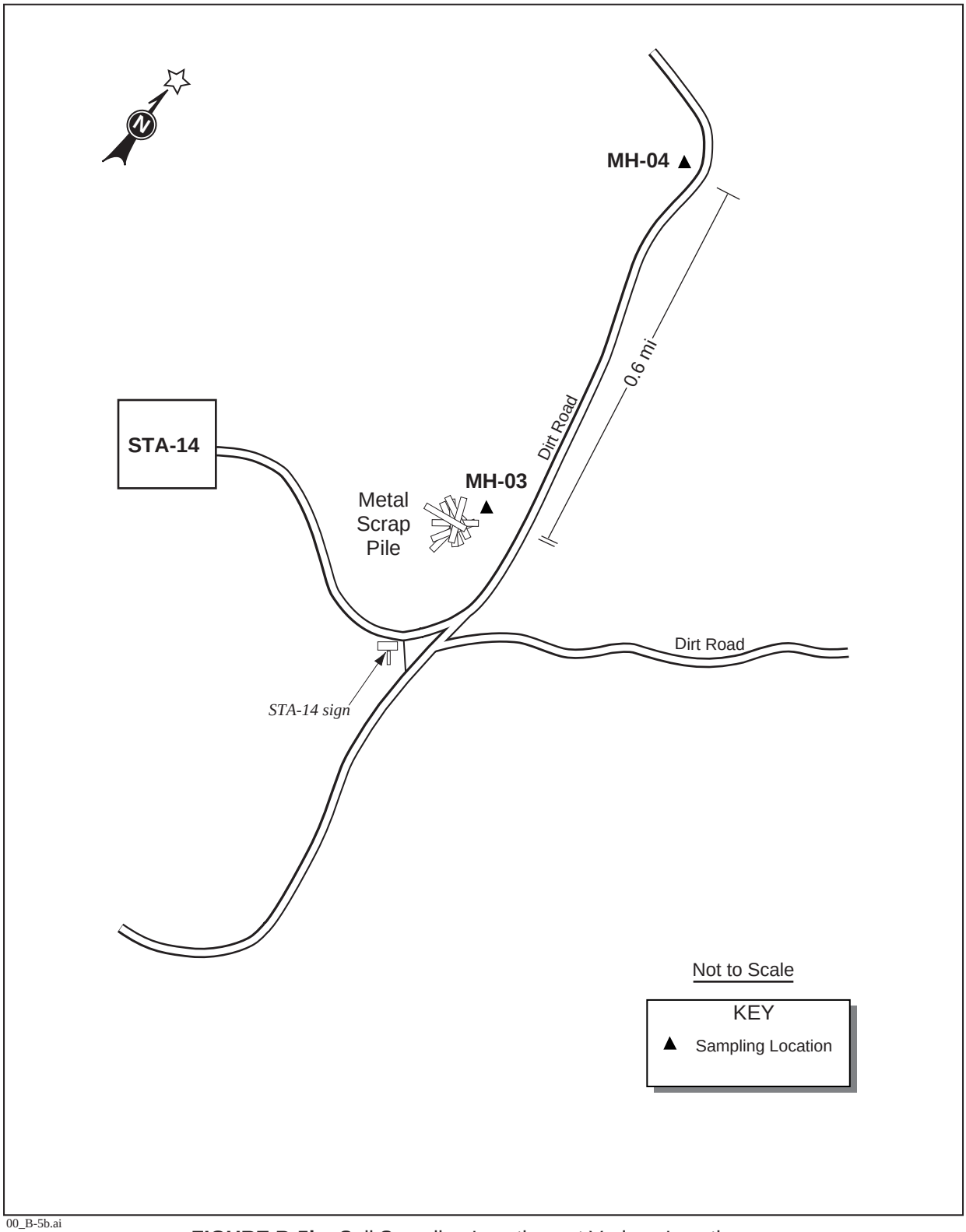
Analyte	D-01	MH-03	MH-04	T-02	T-03	T-04	T-10	T-20	T-21	Average Offsite Value
Utot (μmg/kg)	0.287	0.312	0.361	0.479	0.372	0.363	0.403	1.82	0.927	3
Am-241 (pCi/g)	0.714	0.0684	0.0521	0.0143	0.156	0.00714	-0.00188	-0.00374	-0.0561	0.003
Am-241 *Error*	0.151	0.116	0.0994	0.0387	0.232	0.0461	0.202	0.0742	0.16	--
Cs-137 (pCi/g)	0.178	0.742	0.342	0.453	0.514	0.351	0.305	0.391	0.282	0.31
Cs-137 *Error*	0.0367	0.0952	0.0601	0.0839	0.0757	0.0843	0.125	0.0642	0.0676	--
K-40 (pCi/g)	31	35.7	34.3	35.3	33.6	36.6	34.1	32.3	35.5	34
K-40 *Error*	3.77	3.82	3.78	3.7	3.9	3.62	3.69	3.98	4.21	--
Pu-238 (pCi/g)	0.0601	ND	ND	ND	ND	ND	ND	ND	ND	0.0122
Pu-238 *Error*	0.0372	--	--	--	--	--	--	--	--	--
Pu-239/240 (pCi/g)	3.7	ND	ND	ND	ND	ND	ND	ND	ND	0.0089
Pu-239/240 *Error*	0.595	--	--	--	--	--	--	--	--	--

NOTE: Am-241 was below detection limits (MDA).



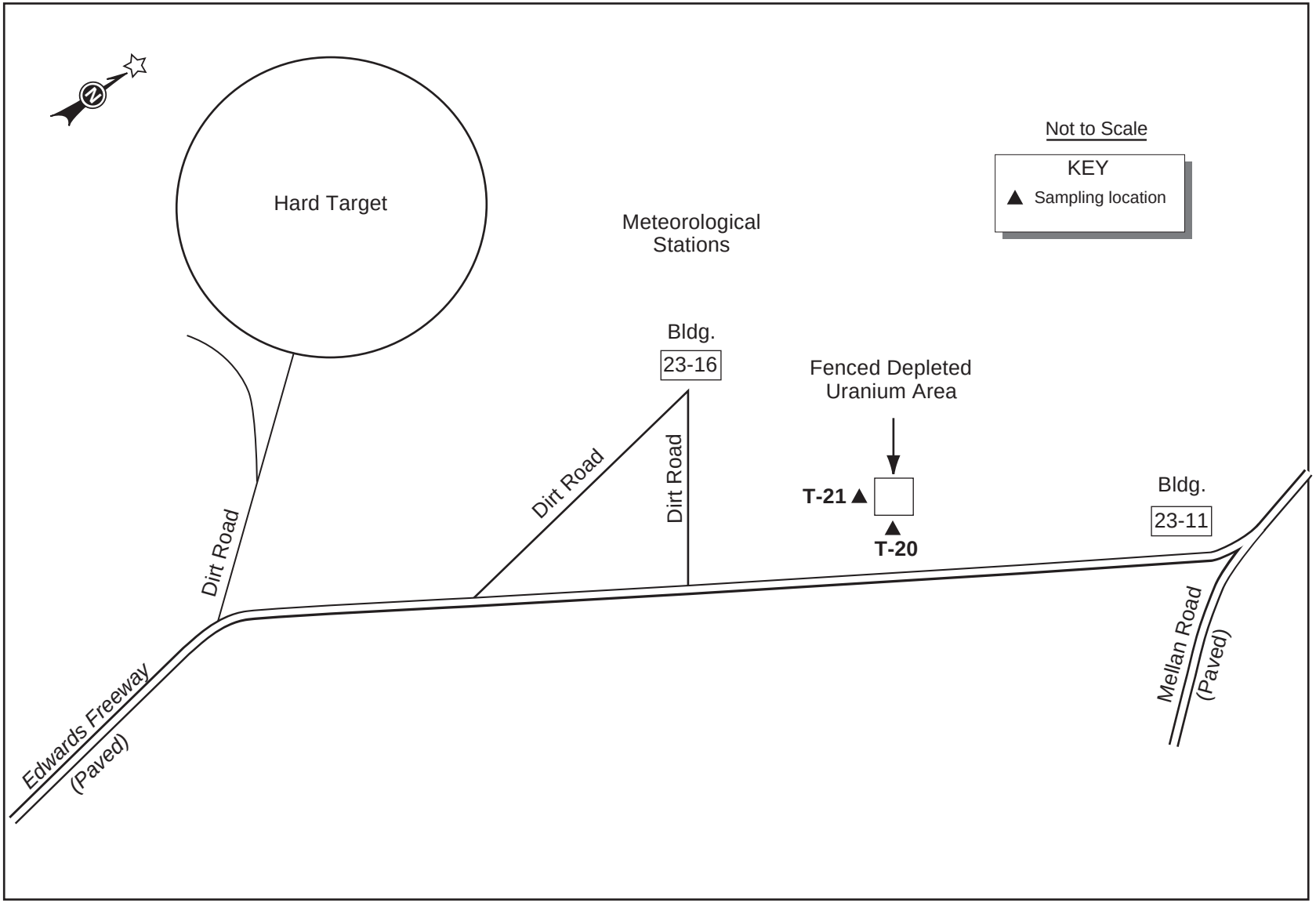
00_B-5a.ai

FIGURE B-5a. Various Onsite Soil Sampling Locations
(Five Locations)



00_B-5b.ai

FIGURE B-5b. Soil Sampling Locations at Various Locations - Mellan Hill Area (Two Locations)



00_B-5c.ai

FIGURE B-5c. Soil Sampling at Various Locations - Near the Hard Target/Depleted Uranium Area (Two Locations)

TABLE B-6a. Summary of Radiological Results for Triplicate Soil Sampling Locations, 1999

Location	Radionuclide	Units	Count	Average	Std Dev	Minimum	Maximum	CV (%)
D-01	Uranium	mg/kg	3	0.271	0.041	0.224	0.302	15.27
	Am-241	pCi/g	3	0.542	0.152	0.427	0.714	28.00
	CS-137	pCi/g	3	0.15	0.03	0.12	0.178	19.39
	K-40	pCi/g	3	31.17	1.36	29.9	32.6	4.36
	Pu-238	pCi/g	3	0.078	0.050	0.0397	0.134	63.66
	Pu-239+240	pCi/g	3	7.7	4.9	3.7	13.1	63.60
T-03	Uranium	mg/kg	3	0.421	0.043	0.372	0.454	10.24
	Am-241	pCi/g	3	0.074	0.087	-0.0178	0.156	118.36
	CS-137	pCi/g	3	0.467	0.110	0.341	0.546	23.62
	K-40	pCi/g	3	35.3	1.9	33.6	37.4	5.47
T-14	Uranium	mg/kg	3	0.421	0.023	0.404	0.448	5.56
	Am-241	pCi/g	3	0.015	0.045	-0.02	0.0658	289.79
	CS-137	pCi/g	3	0.332	0.029	0.298	0.35	8.87
	K-40	pCi/g	3	34.1	2.0	31.9	35.7	5.82

NOTE: CV = Coefficient of variation.
This is a measure of variability in the data. Values with CV greater than 100% have very high variability.

TABLE B-6b. Summary of Stable Metal Results for Triplicate Sampling, 1999

Analyte	Units	D-01 (Onsite)						T-03 (Onsite)					
		Count	Mean	Std Dev	Minimum	Maximum	CV (%)	Count	Mean	Std Dev	Minimum	Maximum	CV (%)
Aluminum	mg/kg	3	10,680	4,421	7,040	15,600	41.40	3	4813	75	4740	4890	1.56
Antimony	mg/kg	3	0.191	0.00	0.191	0.191	0.00	3	0.191	0.00	0.191	0.191	0.00
Arsenic	mg/kg	3	1.97	0.41	1.6	2.41	20.87	3	1.98	0.34	1.78	2.38	17.32
Barium	mg/kg	3	88.7	14.3	74.4	103	16.12	3	75.6	2.01	73.9	77.8	2.66
Beryllium	mg/kg	3	0.485	0.14	0.367	0.634	28.03	3	0.268	0.006	0.261	0.273	2.40
Cadmium	mg/kg	3	0.119	0.04	0.089	0.169	36.93	3	0.118	0.007	0.111	0.124	5.63
Chromium	mg/kg	3	3.65	0.71	3.04	4.43	19.46	3	1.78	0.14	1.62	1.87	7.94
Cobalt	mg/kg	3	4.65	0.60	4.18	5.33	12.97	3	1.85	0.09	1.75	1.92	4.73
Copper	mg/kg	3	4.66	0.92	3.9	5.68	19.70	3	2.71	0.12	2.58	2.81	4.31
Iron	mg/kg	3	14,400	6,710	9,800	22,100	46.60	3	5,350	165	5,240	5,540	3.09
Lead	mg/kg	3	8.75	0.95	7.78	9.68	10.86	3	7.09	0.71	6.38	7.8	10.01
Magnesium	mg/kg	3	3850	589	3,490	4,530	15.30	3	1,553	90.18	1,460	1,640	5.81
Manganese	mg/kg	3	303	37	266	340	12.20	3	280	16.5	261	291	5.90
Nickel	mg/kg	3	4.60	1.09	3.68	5.8	23.59	3	2.05	0.08	1.97	2.13	3.91
Potassium	mg/kg	3	2,546	616.47	2,010	3,220	24.21	3	1,413	64	1340	1,460	4.55
Selenium	mg/kg	3	0.213	0.14	0.135	0.369	63.43	3	0.135	0.00	0.135	0.135	0.00
Silver	mg/kg	3	0.031	0.00	0.031	0.031	0.00	3	0.031	0.00	0.031	0.031	0.00
Thallium	mg/kg	3	0.221	0.00	0.221	0.221	0.00	3	0.221	0.00	0.221	0.221	0.00
Vanadium	mg/kg	3	8.4	0.35	8.2	8.8	4.12	3	4.58	0.33	4.2	4.78	7.14
Zinc	mg/kg	3	24.0	1.35	22.6	25.3	5.64	3	13.17	0.49	12.6	13.5	3.75

NOTE: CV = Coefficient of variation.
This is a measure of variability in the data. Values with CV greater than 100% have very high variability.

TABLE B-6b. Summary of Stable Metal Results for Triplicate Soil Sampling Locations, 1999 (concluded)

		T-14 (South Plume)					
Analyte	**Units**	**Count**	**Mean**	**Std Dev**	**Minimum**	**Maximum**	**CV (%)**
Aluminum	mg/kg	3	8,707	654.32	8,280	9,460	7.52
Antimony	mg/kg	3	0.191	0.00	0.191	0.191	0.00
Arsenic	mg/kg	3	3.28	0.21	3.04	3.41	6.42
Barium	mg/kg	3	235	33.81	214	274	14.39
Beryllium	mg/kg	3	0.483	0.05	0.443	0.54	10.49
Cadmium	mg/kg	3	0.224	0.04	0.176	0.259	19.20
Chromium	mg/kg	3	4.66	0.66	4.28	5.42	14.05
Cobalt	mg/kg	3	3.48	0.32	3.17	3.8	9.04
Copper	mg/kg	3	5.70	0.78	5.09	6.57	13.61
Iron	mg/kg	3	7,863	882.86	7,290	8,880	11.23
Lead	mg/kg	3	10.24	0.92	9.22	11	8.97
Magnesium	mg/kg	3	3,270	479.48	2,940	3,820	14.66
Manganese	mg/kg	3	439	98.90	373	553	22.51
Nickel	mg/kg	3	5.51	0.72	4.83	6.27	13.11
Potassium	mg/kg	3	4,157	234.59	3,970	4,420	5.64
Selenium	mg/kg	3	0.233	0.09	0.135	0.289	36.55
Silver	mg/kg	3	0.031	0.00	0.031	0.031	0.00
Thallium	mg/kg	3	0.221	0.00	0.221	0.221	0.00
Vanadium	mg/kg	3	12.5	1.22	11.7	13.9	9.73
Zinc	mg/kg	3	26.37	2.29	24.9	29	8.67

NOTE: CV = Coefficient of variation.
This is a measure of variability in the data. Values with CV greater than 100% have very high variability.

TABLE B-7a. Radiological Results for Colimbo Soil Sampling Locations, 1999

Analyte	COL-01	COL-02	COL-03	COL-04	COL-05	COL-06	COL-07	COL-08	COL-09	COL-10	Average Offsite Value
Utot (mg/kg)	0.468	0.45	0.472	0.434	0.479	0.547	0.445	0.441	0.449	0.386	3
Am-241 (pCi/g)	0.00258	0	0.0136	0.00424	0.0238	0.124	0.082	0.021	0.129	0.0205	0.003
Am-241 *Error*	*0.115*	*0.0448*	*0.113*	*0.0332*	*0.173*	*0.167*	*0.0998*	*0.0799*	*0.102*	*0.0514*	--
Cs-137 (pCi/g)	0.383	0.488	0.753	0.663	0.517	0.505	0.67	0.434	0.568	0.499	0.31
Cs-137 *Error*	*0.0624*	*0.0836*	*0.0934*	*0.0997*	*0.0692*	*0.101*	*0.0969*	*0.0712*	*0.0742*	*0.0725*	--
K-40 (pCi/g)	31	29.4	31.3	32	31.7	26.3	31.4	31.7	29.8	33.1	34
K-40 *Error*	*3.43*	*2.95*	*3.63*	*3.15*	*3.84*	*2.95*	*3.35*	*3.54*	*3.27*	*4.01*	--

NOTE: Am-241 was below detection limits (MDA).

TABLE B-7a. Radiological Results for Colimbo Soil Sampling Locations, 1999 (concluded)

Analyte	COL-11	COL-12	COL-13	COL-14	COL-15	COL-16	COL-17	COL-18	Average Offsite Value
Utot (mg/kg)	0.624	0.618	0.451	0.425	0.521	0.43	0.383	1.48	3
Am-241 (pCi/g)	0.0309	0.0241	0.127	0.0213	-0.0702	0.0394	-0.121	0.0244	0.003
Am-241 *Error*	0.0482	0.0441	0.0946	0.0406	0.197	0.0998	0.109	0.102	--
Cs-137 (pCi/g)	0.735	0.547	0.571	0.483	0.416	0.186	0.414	0.379	0.31
Cs-137 *Error*	0.111	0.0982	0.0796	0.103	0.0721	0.0531	0.0659	0.0663	--
K-40 (pCi/g)	31	29.7	31	30.6	31.2	29.1	33	29.6	34
K-40 *Error*	3.11	3.01	3.65	3.08	3.84	3.47	3.81	3.24	--

NOTE: Am-241 was below detection limits (MDA).

TABLE B-7b. Stable Metal Results from Colimbo, 1999

	(All Units are mg/kg)											
Analyte	**COL-01**	**COL-02**	**COL-03**	**COL-04**	**COL-05**	**COL-06**	**COL-07**	**COL-08**	**COL-09**	**COL-10**	**Average Offsite Value (94-99)***	**Highest Offsite Value (94-99)***
Aluminum	8,090	9,200	7,950	7,970	10,500	8,680	9,640	8,700	8,700	9,190	7,269	12,700
Antimony	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	3	6
Arsenic	5.12	5.95	5.99	5.18	5.74	5.4	5.87	7.16	6.15	5.82	9	43
Barium	142	146	159	150	156	143	148	150	140	143	151	810
Beryllium	0.517	0.583	0.491	0.504	0.659	0.559	0.618	0.582	0.55	0.615	0.50	1
Cadmium	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.47	1.4
Calcium	7,710	7,930	7,550	5,130	8,380	6,600	9,340	5,470	9,210	5,350		
Chromium	5.18	6.34	4.95	4.83	6.6	5.57	6.2	5.37	5.48	5.51	12	48
Cobalt	3.91	4.52	4.3	4.05	5.23	4.27	4.8	4.84	4.2	4.45	3.0	5.40
Copper	6.68	7.63	6.22	5.93	8.02	6.83	7.42	6.68	6.7	6.52	7	18
Iron	9,790	11,500	10,000	10,100	12,900	10,900	11,700	11,900	10,700	11,500	8,322	16,800
Lead	10.6	12.3	12	11.5	13.3	12.5	13.2	12.2	12.4	13.1	14.5	57.3
Magnesium	3,950	4,670	4,180	3,840	4,990	4,250	4,530	4,070	4,000	3,960	3,500	18,000
Manganese	410	463	502	482	498	462	473	512	447	464	309	800
Mercury	0.0122	0.0163	0.00247	0.0136	0.019	0.00468	0.0133	0.0139	0.00708	0.00434		
Nickel	5.26	6.63	5.87	5.25	7.01	5.99	6.72	5.98	6.03	6.02	5	22
Potassium	2,730	2,960	2,700	2,980	3,390	2,930	3,290	3,050	2,850	3,280	2876	5,300
Selenium	0.653	0.135	0.408	0.135	0.286	0.269	0.388	0.388	0.36	0.135	3	7
Silver	0.188	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.68	3
Sodium	315	567	610	251	345	309	363	347	468	257		
Thallium	0.221	0.44	0.221	0.47	0.507	0.221	0.221	0.527	0.221	0.221	9	27
Vanadium	13.6	16.8	13.5	13.5	18	15	16.1	16	14.4	15.3	14	47
Zinc	29.1	34.1	29.5	29.2	38	32.9	35	34	32.5	34.6	33	87

***NOTE**: Metals were not sampled during 1997.

TABLE B-7b. Stable Metal Results from Colimbo, 1999 (Continued)

Analyte	(All Units are mg/kg)									
	COL-11	COL-12	COL-13	COL-14	COL-15	COL-16	COL-17	COL-18	Average Offsite Value (94-99)*	Highest Offsite Value (94-99)*
Aluminum	8,740	7,860	7,520	7,120	10,900	6,670	5,970	8,780	7,269	12,700
Antimony	0.191	0.191	0.191	0.191	0.191	0.191	0.191	0.191	3	6
Arsenic	5.59	5.02	4.92	5.27	6.55	8.46	4.27	7.06	9	43
Barium	152	138	142	134	146	193	135	197	151	810
Beryllium	0.579	0.518	0.522	0.481	0.674	0.484	0.404	0.621	0.50	1
Cadmium	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.47	1.4
Calcium	7,310	6,900	6,900	6,700	11,000	4,960	2,330	10,800		
Chromium	5.58	4.87	4.62	4.46	7.6	3.83	3.57	5.93	12	48
Cobalt	4.39	3.71	4.12	3.71	4.87	3.85	2.95	6.09	3.0	5.40
Copper	6.93	5.61	5.61	5.33	8.32	4.84	3.73	7.52	7	18
Iron	10,900	10,100	9,460	8,890	13,700	12,700	9330	16,900	8,322	16,800
Lead	12.9	11.2	11.9	10.3	12.9	11.5	7.95	13.3	14.5	57.3
Magnesium	4,040	3,580	3,280	3,570	5,310	2,780	2,110	4,450	3,500	18,000
Manganese	467	424	470	428	488	358	340	491	309	800
Mercury	0.0185	0.0129	0.00473	0.00694	0.00395	0.00314	0.00225	0.0102		
Nickel	6.02	5.17	5.2	4.96	7.8	3.9	3.47	6.62	5	22
Potassium	3,100	2,740	2,520	2,620	3,520	2,420	1,940	3,060	2,876	5,300
Selenium	0.273	0.54	0.28	0.135	0.635	0.417	0.445	0.618	3	7
Silver	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.031	0.68	3
Sodium	433	261	199	421	812	346	184	495		
Thallium	0.221	0.221	0.473	0.221	0.566	0.221	0.623	0.221	9	27
Vanadium	14.6	13.9	12.7	11.8	19.9	13.2	11.8	17.6	14	47
Zinc	33	30.3	29.3	27	39.9	27.8	24.9	40.6	33	87

***NOTE**: Metals were not sampled during 1997.

TABLE B-8a. Summary of Radiological Results for Triplicate Soil Sampling at Colimbo Site, 1999

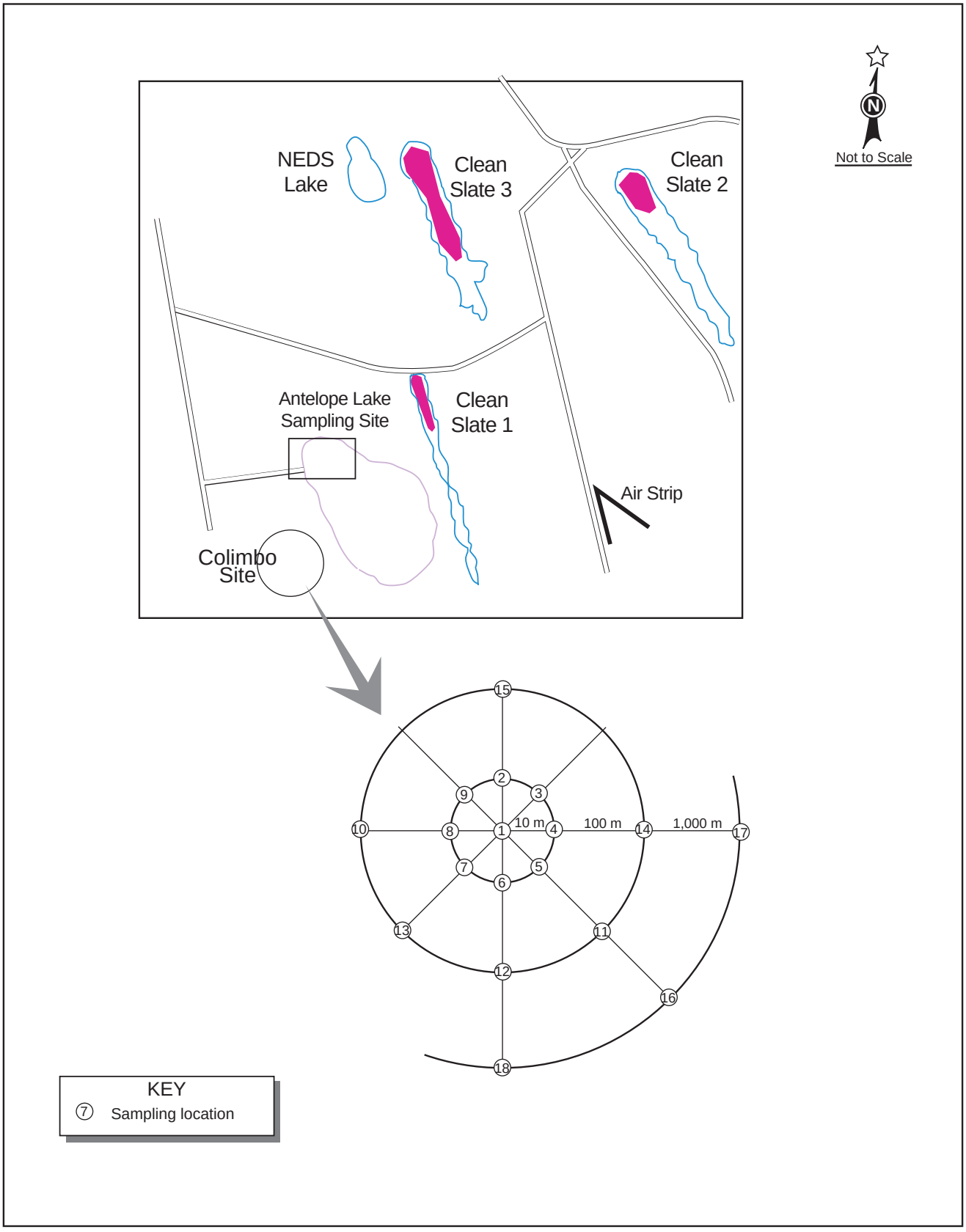
Location	Radionuclide	Units	Count	Average	Std Dev	Minimum	Maximum	CV (%)
COL-01	Uranium	mg/kg	3	0.460	0.012	0.446	0.468	2.70
	Americium-241	pCi/g	3	0.077	0.123	0.00258	0.219	158.85
	Cesium-137	pCi/g	3	0.456	0.102	0.383	0.572	22.34
	Potassium-40	pCi/g	3	30.7	0.3	30.4	31	0.98
COL-18	Uranium	mg/kg	3	0.804	0.586	0.442	1.48	72.81
	Americium-241	pCi/g	3	0.0207	0.008664	0.0108	0.0269	41.86
	Cesium-137	pCi/g	3	0.351	0.039	0.306	0.379	11.21
	Potassium-40	pCi/g	3	29.6	1.1	28.6	30.7	3.54

NOTE: CV = Coefficient of variation.
This is a measure of variability in the data. Values with CV greater than 100% have very high variability.

TABLE B-8b. Summary of Triplicate Sampling for Stable Metal Results at Colimbo Site, 1999

Analyte	Units	COL-01						COL-18					
		Count	Average	Std Dev	Minimum	Maximum	CV (%)	Count	Average	Std Dev	Minimum	Maximum	CV (%)
Aluminum	mg/kg	3	8,960	837	8,090	9,760	9.34	3	8,293	701	7,490	8,780	8.45
Antimony	mg/kg	3	0.191	0.000	0.191	0.191	0.00	3	0.261	0.121	0.191	0.4	46.29
Arsenic	mg/kg	3	6.52	1.64	5.12	8.32	25.08	3	6.30	0.91	5.29	7.06	14.48
Barium	mg/kg	3	153	13	142	168	8.79	3	181	14	169	197	7.88
Beryllium	mg/kg	3	0.583	0.070	0.517	0.657	12.05	3	0.561	0.069	0.485	0.621	12.36
Cadmium	mg/kg	3	0.019	0.000	0.019	0.019	0.00	3	0.019	0.000	0.019	0.019	0.00
Calcium	mg/kg	3	8,543	1,522	7,620	10,300	17.81	3	8,900	2,380	6,230	10,800	26.75
Chromium	mg/kg	3	5.93	0.85	5.18	6.86	14.41	3	5.36	0.94	4.28	5.93	17.50
Cobalt	mg/kg	3	4.32	0.42	3.91	4.74	9.61	3	5.23	0.87	4.36	6.09	16.54
Copper	mg/kg	3	7.40	0.85	6.68	8.34	11.51	3	7.18	1.18	5.86	8.15	16.48
Iron	mg/kg	3	11,463	1,819	9,790	13,400	15.87	3	16,367	839	15,400	16,900	5.12
Lead	mg/kg	3	11.6	0.9	10.6	12.2	7.35	3	13.1	2.4	10.6	15.3	18.05
Magnesium	mg/kg	3	4,387	413	3,950	4,770	9.41	3	3,997	546	3,390	4,450	13.67
Manganese	mg/kg	3	457	45	410	500	9.87	3	419	65	363	491	15.63
Mercury	mg/kg	3	0.01005	0.00426	0.00514	0.0128	42.40	3	0.00865	0.00143	0.00739	0.0102	16.52
Nickel	mg/kg	3	6.14	0.84	5.26	6.93	13.66	3	5.65	1.02	4.59	6.62	18.02
Potassium	mg/kg	3	2,977	245	2,730	3,220	8.23	3	2,967	90	2880	3,060	3.04
Selenium	mg/kg	3	0.382	0.260	0.135	0.653	68.09	3	0.913	0.286	0.618	1.19	31.38
Silver	mg/kg	3	0.083	0.091	0.031	0.188	108.77	3	0.112	0.071	0.031	0.165	63.61
Sodium	mg/kg	3	411	89	315	490	21.58	3	565	88	495	664	15.64
Thallium	mg/kg	3	0.438	0.376	0.221	0.872	85.81	3	0.221	0	0.221	0.221	0.00
Vanadium	mg/kg	3	16.00	2.82	13.6	19.1	17.60	3	16.5	2.0	14.2	17.7	12.08
Zinc	mg/kg	3	33.07	4.00	29.1	37.1	12.10	3	36.4	4.3	32.1	40.6	11.68
Cyanide, Total	mg/kg	3	0.239	0.093	0.139	0.322	38.76	3	0.185	0.078	0.138	0.275	42.37

NOTE: CV = Coefficient of variation.
This is a measure of variability in the data. Values with CV greater than 100% have very high variability.



00_B-6.ai

FIGURE B-6. Soil Sampling Locations at Colimbo Site (18 Locations)

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