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Calendar Year 2006

Annual Site Environmental Report for Tonopah Test Range, Nevada and Kauai Test Facility, Hawaii

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Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94Al85000.

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Annual Site Environmental Report
Tonopah Test Range, Nevada & Kauai Test Facility, Hawaii

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ABSTRACT

Tonopah Test Range (TTR) in Nevada and Kauai Test Facility (KTF) in Hawaii are government-owned, contractor-operated facilities operated by Sandia Corporation (Sandia), a wholly owned subsidiary of Lockheed Martin Corporation. The U.S. Department of Energy (DOE)/National Nuclear Security Administration (NNSA), through the Sandia Site Office (SSO), in Albuquerque, NM, administers the contract and oversees contractor operations at TTR and KTF. Sandia manages and conducts operations at TTR in support of the DOE/NNSA's Weapons Ordnance Program and has operated the site since 1957. Washington Group International subcontracts to Sandia in administering most of the environmental programs at TTR. Sandia operates KTF as a rocket preparation launching and tracking facility. This Annual Site Environmental Report (ASER) summarizes data and the compliance status of the environmental protection and monitoring program at TTR and KTF through Calendar Year (CY) 2006. The compliance status of environmental regulations applicable at these sites include state and federal regulations governing air emissions, wastewater effluent, waste management, terrestrial surveillance, and Environmental Restoration (ER) cleanup activities. Sandia is responsible only for those environmental program activities related to its operations. The DOE/NNSA/Nevada Site Office (NSO) retains responsibility for the cleanup and management of ER TTR sites. Currently, there are no ER Sites at KTF. Environmental monitoring and surveillance programs are required by DOE Order 450.1, *Environmental Protection Program* (DOE 2005) and DOE Manual 231.1-1A, *Environment, Safety, and Health Reporting* Manual (DOE 2004).

Calendar Year 2006 Annual Site Environmental Report
Sandia National Laboratories, Tonopah Test Range, Nevada &
Kauai Test Facility, Hawaii
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NOTE TO THE READER

The goals for the TTR and KTF Annual Site Environmental Reports are to present summary environmental performance, compliance with environmental standards and requirements, and to highlight significant facility programs. In addition, DOE views this document as a valuable tool for maintaining a dialogue with our community about the environmental health of these sites.

We are striving to improve the quality of the contents as well as include information that is important to you. Please provide feedback, comments, or questions to:

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NOTE: Appendices are either located after Chapter 6 or on the CD that is affixed to the back cover of this document.

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

A	AEA	Atomic Energy Act
	ACM	Asbestos Containing Material
	AEC	U.S. Atomic Energy Commission
	AIRFA	American Indian Religious Freedom Act
	ARPA	Archaeological Resources Protection Act
	ASER	Annual Site Environmental Report
	AST	aboveground storage tank
B	BLM	U.S. Bureau of Land Management
	BMP	Best Management Practice
	BSA	Bulk Storage Areas
C	CAA	Clean Air Act
	CAAA	Clean Air Act Amendments
	CAS	Corrective Action Site
	CAU	Corrective Action Unit
	CEMP	Community Environmental Monitoring Program
	CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
	CFR	Code of Federal Regulations
	COD	chemical oxygen demand
	CWA	Clean Water Act
	CY	Calendar Year
D	D&D	decontamination and demolition
	DMR	Discharge Monitoring Report
	DoD	U.S. Department of Defense
	DOE	U.S. Department of Energy
	DOE/AL	U.S. Department of Energy, Albuquerque Operations Office
	DRI	Desert Research Institute, Water Resource Center, University of Nevada System
	DU	depleted uranium
E	EA	environmental assessment
	EDE	effective dose equivalent
	EG&G	Edgerton, Gemeshausen and Grier, Inc.
	EHS	extremely hazardous substance
	EIS	environmental impact statement
	EM	Environmental Management (Department)
	EMS	Environmental Management System
	EO	Executive Order
	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
	FONSI	Finding of No Significant Impact
H	HAR	Hawaii Administrative Rules
	HQ	headquarters

I	IDW	Investigation-Derived Waste
	IHIR	Industrial Hygiene Investigative Report
	IOC	inorganic compounds
	ISMS	Integrated Safety Management System
J	JTA	Joint Test Assembly
K	KTF	Kauai Test Facility
L	LDR	Land Disposal Restriction
	LLW	low-level waste
	LOB	Launch Operations Building
M	MAB	Missile Assembly Building
	MBTA	Migratory Bird Treaty Act
	MDA	minimum detectable activity
	MOA	Memorandum of Agreement
	MEI	maximally exposed individual
	MSDS	Material Safety Data Sheet
	MST	Missile Service Tower
	MW	mixed waste
N	NAC	Nevada Administrative Code
	NAEG	Nevada Applied Ecology Group
	NAFB	Nellis Air Force Base (Range Complex)
	NDEM	Nevada Division of Emergency Management
	NDEP	Nevada Department of Environmental Protection
	NEPA	National Environmental Policy Act
	NESHAP	National Emission Standards for Hazardous Air Pollutants
	NFA	No Further Action
	NHPA	National Historic Preservation Act
	NNSA	National Nuclear Security Administration
	NOT	Notice of Termination
	NPDES	National Pollutant Discharge Elimination System
	NPL	National Priorities List
	NSP	Non-covered Source Permit
	NSPS	New Source Performance Standard
	NSO	Nevada Site Office
	NTS	Nevada Test Site
	NTTR	Nevada Test and Training Range
	NV	Nevada
O	OEIS	Overseas Environmental Impact Statement
	O&M	Operations and Maintenance
P	PA	Preliminary Assessment
	PCB	polychlorinated biphenyl
	PMRF	Pacific Missile Range Facility
	PMS	portable monitoring station
	PPE	personal protective equipment
	PSD	Prevention of Significant Deterioration
	PVC	polyvinylchloride
	PWS	Public Water System
Q	QA	quality assurance

R	R&D	research and development
	RCRA	Resource Conservation and Recovery Act
	ROD	Record of Decision
	RQ	Reportable Quantity
	RY	reporting year
S	SAIC	Science Applications International Corporation
	SARA	Superfund Amendments and Reauthorization Act
	SDWA	Safe Drinking Water Act
	SHPO	State Historic Preservation Office
	SME	Subject Matter Expert
	SNL	Sandia National Laboratories
	SNL/KTF	Kauai Test Facility
	SNL/NM	Sandia National Laboratories, New Mexico
	SOC	Synthetic Organic Compounds
	SOP	Standard Operating Procedure
	SPCC	Spill Prevention, Control, and Countermeasures
	SSO	Sandia Site Office
	STARS	Strategic Targeting System
	SVOC	semi-volatile organic compound
	SWPPP	Storm Water Pollution Prevention Plan
T	TLD	thermoluminescent dosimeter
	TQ	threshold quantity
	TRPH	total recoverable petroleum hydrocarbon
	TRI	Toxic Release Inventory
	TSCA	Toxic Substances Control Act
	TSD	treatment, storage, and disposal (facility)
	TTR	Tonopah Test Range
U	UDP	underground discharge points
	USAF	U.S. Air Force
	USFS	U.S. Forest Service
	USGS	U.S. Geological Survey
	USN	United States Navy
	UST	underground storage tank
	UXO	unexploded ordnance
V	VOC	volatile organic compound
W	WGI	Washington Group International
	WSMR	White Sands Missile Range
	WWII	World War II

Units of Measure

ºC	Celsius degree	m	meter
cm	centimeter	m^2	square meter
ºF	Fahrenheit degree	m^3	cubic meter
ft	feet	mg	milligram
g	gram	mi	mile
in	inch	ppm	parts per million
km	kilometer	yd	yard
kg	kilogram	yd^3	cubic yard
yr	year	lb	pound
Std Dev	standard deviation		

Radioactivity Measurements

Ci	curie (unit of radioactivity)	pCi/g	picocurie per gram
mrem	millirem (unit of radiation dose)	rem	roentgen equivalent man (unit of radiation dose)
mrem/yr	millirem per year		
mR/yr	milliroentgen per year	mSv	millisievert (unit of radiation dose)
pCi	picocurie	µg/m^2	microgram per square meter
µR/hr	microroentgen per hour	µg/g	microgram per gram

Chemical Abbreviations

Am-241	americium-241	Cs-137	cesium-137
Pu-238	plutonium-238	Pu-239	plutonium-239
Pu-240	plutonium-240	U_{tot}	uranium, total

Approximate Conversion Factors for Selected SI (Metric) Units

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

TTR & KTF
EXECUTIVE SUMMARY

Photo by: Jennifer Payne

Tonopah Test Range (TTR) Environmental Programs:

- Waste Management
- Environmental Restoration (ER) Project
- Terrestrial Surveillance
- Water Quality
- Air Quality
- National Environmental Policy Act (NEPA) Activities

Kauai Test Facility (KTF) Environmental Programs:

- NEPA Activities
- Water Quality
- Air Quality
- Terrestrial Surveillance

Sandia National Laboratories (SNL) (a wholly owned subsidiary of Lockheed Martin Corporation) at Tonopah Test Range (TTR) and Kauai Test Facility (KTF) are government owned, contractor-operated facilities owned by the U.S. Department of Energy (DOE)/National Nuclear Security Administration (NNSA). The DOE/NNSA/Sandia Site Office (SSO) in Albuquerque, New Mexico executes the DOE/NNSA direction. This report was prepared in accordance with, and as required by, DOE Order 450.1, *Environmental Protection Program* (DOE 2005) and DOE Manual 231.1-1A, *Environment, Safety, and Health Reporting* Manual (DOE 2004). This report summarizes data from environmental protection and monitoring programs at TTR and KTF for Calendar Year (CY) 2006. It also discusses Sandia Corporation's (Sandia) compliance with environmental statutes, regulations, and permit provisions and highlights other significant environmental programs and efforts at TTR and KTF. This report is a key component of Sandia's and DOE's efforts to keep the public informed about environmental conditions throughout the DOE/NNSA complex.

TTR

Sandia conducts operations at TTR in support of the DOE/NNSA's Weapons Ordnance Program. Sandia's activities involve research and development and the testing of weapon components and delivery systems. Many of these activities require a remote test range with a long flight corridor for air drops and rocket launches. Other activities include explosive tests and gun firings.

Environmental Programs

The following environmental programs are in place at TTR:

- Waste management,
- Environmental Restoration (ER) Project,
- Terrestrial surveillance,
- Water quality monitoring,
- Air quality compliance (AQC), and
- National Environmental Policy Act (NEPA).

Waste Management

Waste generated at TTR in 2006 included hazardous waste regulated by the Resource Conservation and Recovery Act (RCRA) and non-hazardous industrial and sanitary waste. All hazardous waste was shipped to permitted treatment, storage, and disposal facilities. (Sandia does not handle waste generated by ER activities.)

ER Project

ER activities at TTR are conducted through the DOE/NNSA/Nevada Site Office (NSO). ER sites that are scheduled for remediation or closed at TTR include areas impacted from target tests and detonations, including non-impacted surface debris and areas impacted by ordnance, depleted uranium, and heavy metals.

Terrestrial Surveillance

Soil samples were collected from sixteen off-site, ten perimeter, and twenty-seven on-site locations in 2006. Soil is the only terrestrial medium sampled at TTR. Samples are collected to detect air deposited pollutants or contaminants transported and deposited as a result of surface water runoff.

A summary report for non-radiological constituents collected between 1994 and 2005 was prepared, analyzed, and published in a summary report (SNL 2006). The results showed no anomalies that required further investigation.

In 2006, soils were analyzed for radiological constituents. The results showed no anomalies that required further investigation. Non-radiological monitoring is historically monitored every other year and was not conducted this year. In the future, routine sampling for non-radiological parameters at fixed locations will be reduced and more emphasis placed on sampling specific areas of interest with potential environmental impact. However, the total number of samples collected annually should remain approximately the same.

Water Quality

Waste monitoring results confirmed that all permit conditions set by the State of Nevada were met in 2006.

Water quality samples are routinely taken from Production Well 6, which supplies potable water for SNL/TTR's Main Compound. Production well monitoring continues to be monitored quarterly for Di (2-Ethylhexyl) Phthalate until it is undetected in two consecutive quarterly samples. In 2006, all secondary contaminant sample results were within the State of Nevada defined maximum

contaminant levels (MCL) with the exception of iron and potential of hydrogen (pH) (see 4.2.1). Testing of the arsenic removal system indicated adequate removal of arsenic from drinking water. Backflow prevention devices were installed at all required locations in the distribution system. The State of Nevada approved all upgrades and modifications of the water distribution system in 2006.

Air Quality

Radiological air emissions are regulated by National Emission Standards for Hazardous Air Pollutants (NESHAP). The only radionuclide sources at TTR are the three Clean Slate Sites, which are sources of diffuse radionuclide emissions as a result of the re-suspension of contaminated soils. These sites are currently being addressed by DOE/NNSA/NSO under the ER Project. The calculated dose for the maximally exposed individual was 0.024 millirem per year (mrem/yr), which is approximately 400 times less than the 10 mrem/yr standard set by the U.S. Environmental Protection Agency (EPA). Based on this value, an annual dose assessment is not required to be calculated for the TTR site.

TTR's Class II Air Quality Permit requires emission reports from significant non-radionuclide sources. At TTR, these sources include the screening plant and portable screen. In 2006, there were no measurable emissions as the screens were not used.

NEPA

At TTR, NEPA compliance is coordinated between Sandia and DOE/NNSA/SSO. A total of four TTR NEPA reviews were processed during 2006. Two NEPA reviews were completed by SNL/NM. Two NEPA checklists were submitted to SSO for review; of these two, one was found to be categorically excluded. The proposal to move current Joint Test Assembly flight testing capabilities from TTR to White Sands Missile Range resulted in a determination to prepare an environmental assessment (EA).

TTR is under evaluation in the DOE *2030 Programmatic Environmental Impact Statement* that will outline a plan to establish a smaller, more efficient nuclear weapons complex able to respond to future challenges.

KTF

KTF is operated by Sandia as a rocket preparation, launching, and tracking facility for DOE/NNSA, as well as in support of other U.S. military agencies. SNL/KTF exists as a facility within the boundaries of the U.S. Department of Defense (DoD) Pacific Missile Range Facility (PMRF). SNL/KTF, located on the island of Kauai at the north end of the PMRF near Nohili Point, has been an active rocket launching facility since 1962. Three rockets were launched from SNL/KTF in 2006.

The following environmental programs are in place at KTF:

- AQC,
- NEPA,
- Water quality monitoring, and
- Terrestrial surveillance (every five years).

Air Quality

As required by the State of Hawaii, the 2005 Annual Fee and Monitoring Report (air emissions) was submitted to the State of Hawaii on January 31, 2006 (SNL 2007). In 2006, the total fuel usage reported to the State of Hawaii was 15,867 gallons (gal) of diesel fuel. Sandia was in compliance with all air quality regulations in 2006.

NEPA

In 2005, DOE/NNSA/SSO determined to review and update the Site-Wide EA for KTF. During 2006, the U.S. Navy initiated preparation of the Draft Environmental Impact Statement (EIS)/ Overseas Environmental Impact Statement (OEIS) for the Hawaii Range Complex.The environmental impact analysis for KTF is to be included in this EIS.

Water Quality

Septic tanks do not require permitting or sampling, but as a best management practice (BMP), Sandia periodically performs sampling. No contaminants were identified above the reporting limits.

Terrestrial Surveillance

Terrestrial surveillance is conducted every five years. No sampling occurred this year.

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chapter one

TTR INTRODUCTION

Photo by: Jennifer Payne

In This Chapter...

TTR History and Operations
Site Description and Demographics
Regional Geology, Hydrology, Climate, and Fauna
Clean Slate and Double Track Sites

Environmental Snapshot

The climate at TTR is typical of high desert, mid-latitude locations with large diurnal and seasonal changes in temperature and little total rainfall. Temperature extremes on the test range vary from a high near 40 °C (104 °F) in summer to approaching -30 °C (-22 °F) in winter.

Sandia Corporation (Sandia), a wholly owned subsidiary of Lockheed Martin Corporation, manages and operates the Tonopah Test Range (TTR) in Nevada through its contract with the U.S. Department of Energy (DOE)/National Nuclear Security Administration (NNSA)/Sandia Site Office (SSO). TTR is owned by DOE/NNSA and overseen by the DOE/NNSA/SSO in Albuquerque, New Mexico.

Sandia National Laboratories (SNL)/TTR is located on approximately 280 square miles (179,200 acres) within the boundaries of the Nevada Test and Training Range (NTTR) withdrawal and is used to support DOE/NNSA and U.S. Air Force (USAF) activities and missions. Washington Group International (WGI) performs most environmental program functions on behalf of Sandia, including environmental media sampling, wastewater effluent and drinking water monitoring, water treatment, spill response, and waste management operations. WGI also supports TTR during tests by operating optics equipment, recovering test objects, and performing radiography.

This Annual Site Environmental Report (ASER) is prepared in accordance with the following DOE orders that pertain to environmental protection and management:

- DOE Order 450.1, *Environmental Protection Program* (DOE 2005)
- DOE Manual 231.1-1A, *Environment, Safety, and Health Reporting* (DOE 2004)
- DOE Manual 231.1-2, *Occurrence Reporting and Processing of Operations Information* (DOE 2003)
- DOE Order 435.1, Chg 1, *Radioactive Waste Management* (DOE 2001a)
- DOE Order 5400.5, Chg 2, *Radiation Protection of the Public and the Environment* (DOE 1993)
- SEN-22-90, *DOE Policy on Signatures of RCRA Permit Applications* (DOE 1990)

This ASER summarizes data from environmental protection and monitoring programs at TTR for 2006. It also discusses Sandia's compliance with environmental statutes, regulations, permit provisions and other significant environmental activities. The environmental programs summarized here include waste management; air, water, and terrestrial monitoring and surveillance; the Environmental Restoration (ER) Project; and the National Environmental Policy Act (NEPA). DOE Order 450.1 specifies the requirements for environmental monitoring conducted at and around the TTR site. This ASER is an important component of the DOE's and Sandia's efforts to keep the public informed about environmental conditions at DOE/NNSA facilities.

Sandia's strategy for managing and implementing its Environment, Safety, and Health (ES&H) Program is described in the Integrated Safety Management System (ISMS). The ISMS is structured around five safety management functions and provides processes to guide line management in identifying and controlling hazards. Sandia is utilizing an Environmental Management System (EMS) as an enhancement of the ISMS. The EMS is that part of the ISMS that addresses the environmental consequences of SNL/NM's activities, products, and services. In 2006, SNL/NM continued working to improve environmental management (EM) based on best management practices (BMPs), bench marking, and process improvements. On December 2, 2005, Sandia informed the DOE/NNSA/SSO that it had fully implemented an EMS in accordance with the requirements outlined in DOE Order 450.1.

1.1 TTR HISTORY AND OPERATIONS

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

TTR Site Characteristics

The topography at TTR is characterized by a broad, flat valley bordered by two north and 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 5,347 feet at the valley floor to 7,482 feet at Cactus Peak. The elevation of the town of Tonopah is 6,030 feet.

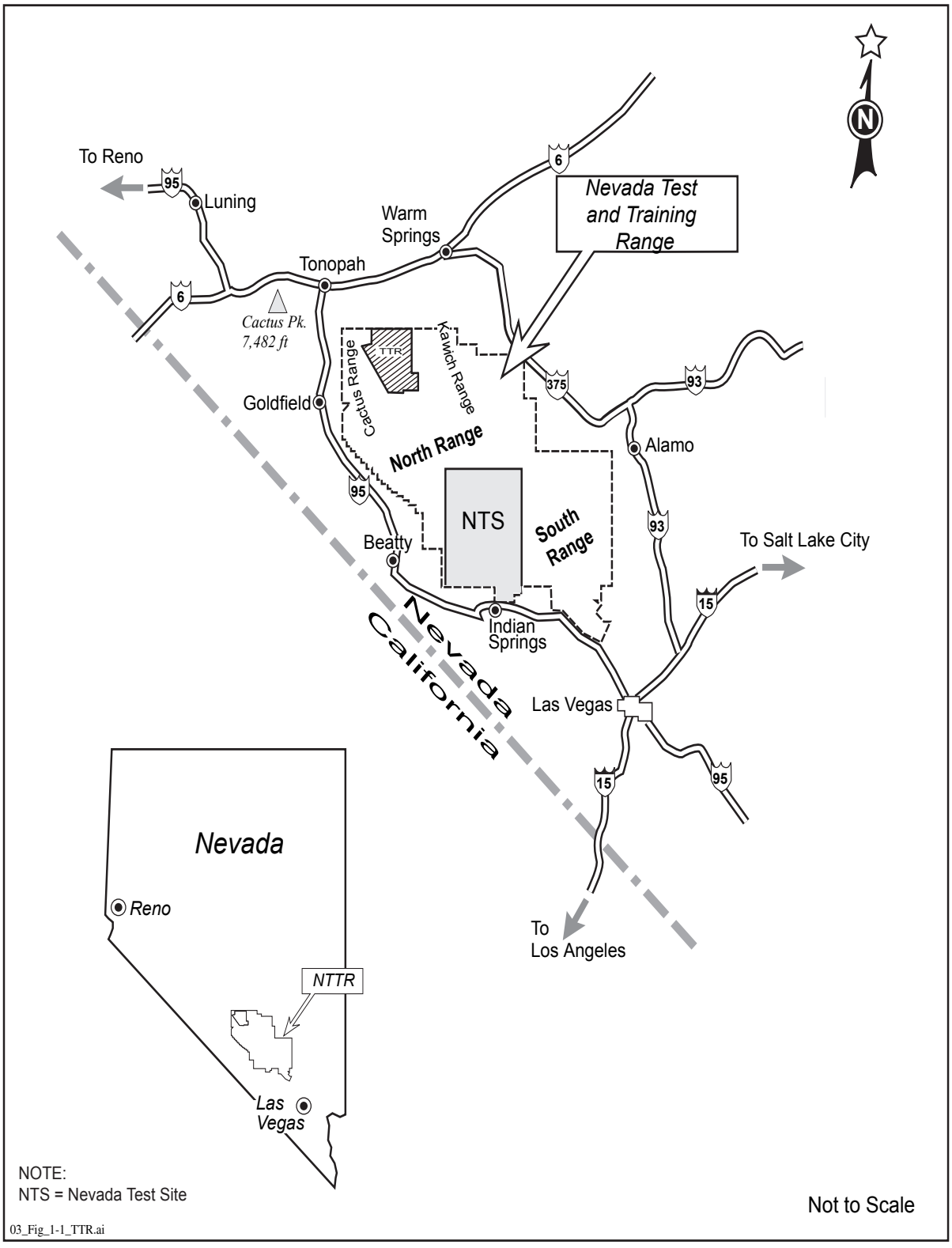

FIGURE 1-1. Location of the Tonopah Test Range (TTR), Within the Boundaries of the Nevada Test and Training Range (NTTR), Nevada.

TTR Site Selection

TTR was selected as a test range after similar facilities at Salton Sea Test Base in California, as well as Yucca Flat on the NTS, became inadequate. By the mid-1950s, the atmosphere at 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 Salton Sea Test Base, was well suited because it had immense areas of flat terrain needed for the increasing use of rockets and low-altitude, high-speed aircraft operations. A permit from the U.S.A.F. was obtained in 1956, and TTR became operational to test new weapon systems in 1957. Following World War II, facilities built at TTR were designed and equipped to gather data on aircraft delivered inert test vehicles under U.S. Atomic Energy Commission (AEC) cognizance (now DOE). As technologies changed, the facilities and capabilities at TTR were expanded to accommodate tests related to DOE/NNSA's Weapons Ordnance Program.

Operations Control Center

The Main Compound in Area 3 is the heart of test range activities. The Operations Control Center 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 Operations Control Center to control and coordinate all test functions.

TTR Activities

Principal DOE activities at TTR include stockpile reliability testing; research and development (R&D) testing support for structural development; arming, fusing, and firing systems testing; and testing nuclear weapon delivery systems. No nuclear devices are tested at TTR.

TTR is instrumented with a wide array of signal tracking equipment that includes video; high-speed cameras; 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 (e.g., shipping and storage containers)
- Static rocket tests (related to the Trident Submarine Program)
- Ground penetrator tests

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

Site Responsibility

On October 1, 1997, a Memorandum of Agreement (MOA) was signed between DOE/NNSA/SSO and the DOE/NNSA, Nevada Site Office (NSO) regarding operational test activities at TTR (DOE 1994). It was determined that DOE/NNSA/SSO is responsible for the oversight of TTR; however, DOE/NNSA/NSO will continue oversight of ER activities at TTR. Environmental program management, as discussed in this ASER, is a joint effort between SNL/TTR and SNL/NM employees and contractors, with oversight from DOE/NNSA/SSO. In April 2002, a Land Use Permit was signed between the USAF and NNSA entitled, "Department of the Air Force Permit to the National Nuclear Security Administration To Use Property Located On The Nevada Test and Training Range, Nevada" (USAF/DOE/NNSA 2002). The current size of TTR is now approximately 280 square miles (179,200 acres). Prior to the April 2002 lease agreement, the footprint was 335,655 acres.

1.2 SITE DESCRIPTION AND DEMOGRAPHICS

TTR is located within the NTTR at its northern boundary. The area north of the TTR boundary is comprised of sparsely populated public lands jointly administered by the U.S. Bureau of Land Management (BLM) and the U.S. Forest Service (USFS). The land is currently used to graze cattle.

There also is a substantial irrigated farming operation north of the range. To the east of TTR, and within the NTTR, is the Nevada Wild Horse Range, which is administered by BLM.

The nearest residents are located in the town of Goldfield (population 659), approximately 22 miles west of the site boundary. The town of Tonopah (population 4,400) is approximately 30 miles northwest of the site (DOC 2007). Las Vegas is 140 miles southeast of TTR. The total population within the 50 mile radius around TTR is approximately 7,000, which 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 lakebeds; 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 occur within TTR's boundaries: Cactus Springs, Antelope Springs, and Silverbow Springs. Water from these springs does not travel more than several tens of meters before it dissipates through evaporation and infiltration. The effect on the landscape is purely local.

Groundwater

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

Climate

The climate at TTR is typical of high desert, mid-latitude locations, with large diurnal and seasonal changes in temperature and little total rainfall. Temperature extremes at the test range vary from highs near 40º C (104º F) in summer to approaching -30º C (-22º F) in winter. July and August are the hottest months with highs generally between 32º to 37º C (90sº F) during the day and dropping to between 10º and 15º C (50sº F) at night. January conditions vary from highs of 5º to 10º C (40sº F) to lows -7º to -11º C (teensº F). An eight year climatology developed from data taken in the 1960s identified the record high of 38.8º C (102º F) with a record low of -31º C (-24º F) (Schaeffer 1970).

Rainfall, though sparse, is dependent on elevation. Annual average rainfall in the desert valley floor is 4 inches, while in nearby mountains as much as 12 inches falls (USAF 1999).

Winds are generally from the northwest in winter and early spring, switching to southerly directions during summer. The mountain/valley system channels the wind such that the wind seldom blows from eastern or southwestern directions. Dust storms are common in the spring, when monthly average wind speeds reach 6.7 m/s (15 miles an hour). During the spring and fall months, a diurnal cycle to the wind may be seen with northwest drainage winds for a time and southerly winds by afternoon.

Vegetation

The temperature extremes and arid conditions of the high desert limit vegetation coverage. The sparse vegetation that occurs in Cactus Flat are predominantly range grasses and low shrubs typical of Great Basin Desert flora (ERDA 1975; EG&G 1979).

TTR's vegetation is divided into two basic types by elevation: salt desert shrub in low areas and northern desert shrub at high elevations (USAF 1999, DRI 1991). Salt desert shrub is characteristic of poorly drained soils and common along dry lakebeds. Specific plants in this group include shadescale (*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 spp.*), and Nevada bluegrass (*Poa nevadensis*). Joshua tree (*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, Kawich Valley, Goldfield Hills, and the Stonewall Mountains. Hundreds of wild horses (*Equus caballus*) graze freely throughout TTR, and activities on-site have had little affect on the horse population or their grazing habits. The 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 (USAF 1999, DRI 1991).

In general, the NTTR land withdrawal has had a positive effect on local plant and animal life. Since much of the withdrawal area is undisturbed by human activity, large habitat areas are protected from the affects of public use.

1.4 CLEAN SLATE AND DOUBLE TRACK SITES

In May and June 1963, Project Roller Coaster conducted a series of four nuclear weapons destruction tests that resulted in plutonium dispersal in surrounding soils. Three of these tests were conducted within the boundaries of TTR, the fourth was conducted on the NTTR just west of TTR. The three Project Roller Coaster test sites at TTR are referred to as Clean Slates 1, 2, and 3 (Figure 1-2). The fourth test site at NTTR is referred to as Double Tracks. In 1996, Double Tracks was closed after

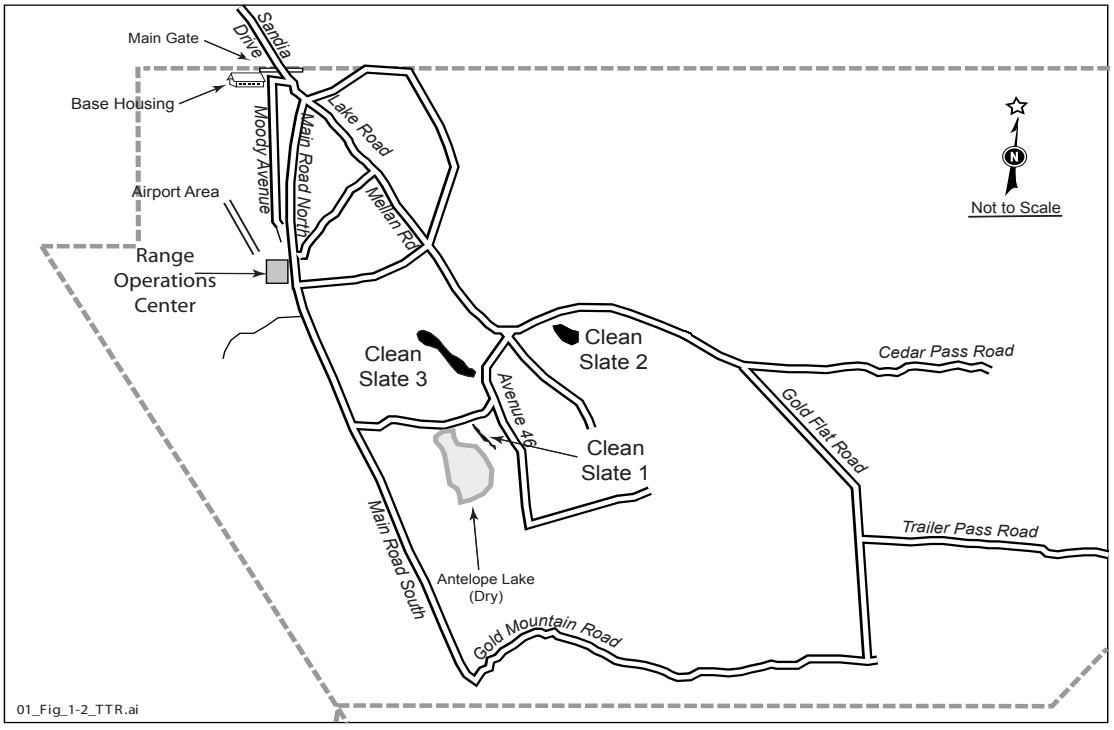

FIGURE 1-2. Location of Facilities Operated by SNL/NSO at TTR

TABLE 1-1. Project Roller Coaster Test Information

Test Name	Date of Test	Location	Status
Clean Slate 1	May 25, 1963	TTR	Interim Closure
Clean Slate 2	May 31, 1963	TTR	Remediation phase
Clean Slate 3	June 9, 1963	TTR	Remediation has not started
Double Tracks	May 15, 1963	NTTR, North Range (west of TTR)	Interim Closure

NOTE: TTR = Tonopah Test Range
NTTR = Nevada Test and Training Range
Source: Sampling and Analysis Plan for Clean Slate 1, September 1996 (IT 1996)

soil contamination was remediated to a level of less than or equal to 200 picocuries per gram (pCi/g) of transuranics.

Table 1-1 summarizes test information related to the four Project Roller Coaster sites. DOE/NNSA/NSO is responsible for the remediation of these and all other ER sites (see Chapter 3) at TTR. Sandia will continue to be responsible for environmental compliance at these sites.

The initial cleanup of each Clean Slate site was conducted shortly after each test. Test-related debris was bladed into a hole at test ground zero and backfilled. An initial fence was built around each test area where the soil contamination was set at approximately 1,000 micrograms per square meter ($\mu g/m^2$) of plutonium. The soil survey was conducted on 61 meter grids with a hand-held survey meter, or field instrument, for the detection of low-energy radiation (FIDLER). 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. Any horses that may wander inside the fenced areas are promptly relocated.

In 1977, an aerial radiological survey was performed by EG&G, Inc. for the Nevada Applied Ecology Group (NAEG) (EG&G 1995). The aerial radiological 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 Project Roller Coaster tests. Radiation isopleths showing soil activity due to americium-241 (Am-241), plutonium-239 (Pu-239), and plutonium-240 (Pu-240) were drawn for each area. The cumulative area of the diffuse sources, as determined by the aerial radiological survey, is 20 million square meters (approximately 4900 acres). The results of the survey found transuranic contamination outside the fenced area in the downwind direction (EG&G 1995).

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. The data has been presented to DOE/NNSA/NSO in the form of a draft report (DRI 1997). The report documented the as-left condition at the site, but does not require follow-up action. DOE/NNSA/NSO suspended air monitoring in April 2000 and will not resume until active remediation efforts at the Clean Slate sites begin again.

Antelope "Dry" Lake Bed at TTR
Photo by: Jennifer Payne

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chapter two

TTR COMPLIANCE SUMMARY

In This Chapter...

Environmental Snapshot

Chemical pesticides used at TTR include herbicides, rodenticides, and insecticides, as required. All chemicals used are EPA-approved and applied in accordance with applicable label guidelines and regulations.

Sandia Corporation (Sandia) is responsible for environment, safety, and health (ES&H) compliance with federal environmental statutes, regulations, Executive Orders (EOs), and U.S. Department of Energy (DOE) orders applicable to Tonopah Test Range (TTR).

This chapter discusses Sandia's ES&H responsibilities and the status of ES&H compliance. Environmental audit summaries, occurrence reporting, and environmental permit status for 2006 are also presented in this chapter.

The State of Nevada administers most environmental regulations applicable to TTR. Specific state regulations listed in Chapter 6 include regulations governing air quality, solid and hazardous waste management, wildlife, water quality, and radiation control. Radionuclide air emission regulations are administered directly by the U.S. Environmental Protection Agency (EPA).

2.1 COMPLIANCE STATUS WITH FEDERAL REGULATIONS

This section summarizes DOE's and Sandia's compliance status with major environmental regulations, statutes, EOs, and DOE orders that pertain to the environment.

The major federal laws applicable to environmental compliance at TTR are presented on page 2-3 (see shaded box).

2.1.1 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) for cleanup (EPA 2007). There are no NPL or "Superfund" sites located at TTR.

The Superfund Amendments and Reauthorization Act (SARA) Title III amended CERCLA requirements for reportable quantity (RQ) releases and chemical inventory reporting. Sandia at TTR was in full compliance with CERCLA/SARA in 2006. Table 2-1 lists SARA Title III reporting requirements.

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

SARA Title III (also known as EPCRA) requires the submittal of a Toxic Release Inventory (TRI) report for chemical releases over a given threshold quantity (TQ). The release reporting limit for lead is 100 pounds (lb). The TTR Firing Range released approximately 5,832 lb of non-recovered lead in 2006. This information will be reported in the Reporting Year (RY) 2006 TRI Report (to be published in 2007).

2.1.3 Resource Conservation and Recovery Act (RCRA)

Under the RCRA Hazardous Waste Permit Program (40 CFR 270), TTR is permitted as a "small quantity generator." Under this designation, hazardous waste can only be stored on-site for 180 days before it must be shipped off-site for treatment and disposal at an EPA permitted facility. At TTR, hazardous waste shipments are scheduled to occur at least two to three times a year.

Sanitary solid waste, which is also regulated under RCRA, is disposed of at landfills on-site. There is one Class II sanitary landfill in operation at TTR operated by the U.S. Air Force (USAF) Operations and Maintenance contractor. The landfill is used cooperatively by all organizations at TTR.

Underground Storage Tanks (USTs) and Aboveground Storage Tanks (ASTs). RCRA, Subchapter I (40 CFR 280) sets forth requirements for USTs that contain hazardous materials or petroleum products. USTs and ASTs, although not registered by the state, are subject to EPA regulations 40 CFR 112, *Oil Pollution Prevention* and 40 CFR 110, *Discharge of Oil*. The last five USTs (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) were removed in August 1995. There are no ASTs requiring registration with the State of Nevada at TTR.

2.1.4 Federal Facility Compliance Act (FFCA)

The FFCA amendments to RCRA specifically address Land Disposal Restriction (LDR) requirements for

Major Environmental Regulations & Statutes Applicable to TTR

Clean Air Act (CAA) and CAA Amendments (CAAA)
Provides health standards to protect the nation's air quality. http://www.epa.gov/oar/oaq_caa.html

Clean Water Act (CWA)
Provides general water quality standards to protect the nation's water sources and byways.
http://www.epa.gov/region5/water/cwa.htm

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
Provides federal funding for cleanup of inactive waste sites on the National Priorities List (NPL) and mandates requirements for reportable releases of hazardous substances. http://www.epa.gov/region5/defs/html/cercla.htm

Cultural resources acts
Includes various acts that protect archeological, historical, and religious sites, and resources.
http://water.usgs.gov/eap/env_guide/cultural.html

Endangered Species Act (ESA)
Provides special protection status for federally listed endangered or threatened species.
http://www.epa.gov/region5/defs/html/esa.htm

Executive Orders (EOs)
Several EOs provide specific protection for wetlands, floodplains, environmental justice in minority and low-income populations, and that promote greening the government through leadership in environmental management.
http://www.archives.gov/federal_register/executive_orders/disposition.html

Federal Facility Compliance Act (FFCA)
Directs federal agencies regarding environmental compliance. http://tis.eh.doe.gov/oepa/laws/ffca.html

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
Controls the distribution and use of various pesticides. http://www.epa.gov/region5/defs/html/fifra.htm

Migratory Bird Treaty Act (MBTA) of 1918
Prevents the taking, killing, possession, transportation and importation of migratory birds, their eggs, parts, and nests. http://tis.eh.doe.gov/oepa/laws/mbta.html

National Emission Standards for Hazardous Air Pollutants (NESHAP)
Specifies standards for radionuclide air emissions and other hazardous air releases under the CAA.
http://www.epa.gov/radiation/neshaps/

National Environmental Policy Act (NEPA)
Requires federal agencies to review all proposed activities so as to include environmental aspects in agency decision making. http://tis.eh.doe.gov/NEPA/

Resource Conservation and Recovery Act (RCRA)
Mandates the management of solid and hazardous waste and certain materials stored in underground storage tanks (USTs). http://www.epa.gov/region5/defs/html/rcra.htm

Safe Drinking Water Act (SDWA)
Provides specific health standards for drinking water sources. http://www.epa.gov/safewater/sdwa/sdwa.html

Superfund Amendments and Reauthorization Act (SARA)
SARA,Title III, also known as the Emergency Planning and Community-Right-to-Know Act (EPCRA), mandates comunication standards for hazardous materials over a threshold amount that are stored or used in a community.
http://www.epa.gov/region5/defs/html/sara.htm

Toxic Substance Control Act (TSCA)
Specifies rules for the manufacture, distribution, and disposal of specific toxic materials such as asbestos and polychlorinated biphenyls (PCBs). http://www.epa.gov/compliance/civil/tsca/index.html

TABLE 2-1. 2006 SARA Title III (or EPCRA) Reporting Requirements Applicable to TTR

Section	SARA Title III Section Title	Requires Reporting? Yes	Requires Reporting? No	Description
302–303	Emergency Planning	X		Sandia Corporation submits an annual report listing chemical inventories above the reportable Threshold Planning Quantities listed in 40 CFR Part 355 Appendix B, location of the chemicals and emergency contacts. The report is prepared for the DOE/NNSA/SSO, which distributes it to the required entities.
304	Emergency Notification		X	No RQ releases of an EHS, or as defined under CERCLA, occurred in 2006.
311-312	Hazardous Chemical Storage Reporting Requirements	X		There are two "Community Right-to-Know" reporting requirements: (a) SNL/NM completes the EPA Tier II forms for all hazardous chemicals present at the facility at any one time in amounts equal to or greater than 10,000 lbs and for all EHSs present at the facility in an amount greater than or equal to 500 lbs or the Threshold Planning Quantity, whichever is lower; (b) TTR provides MSDSs for each chemical entry on a Tier II form unless it decides to comply with the EPA's alternative MSDS reporting, which is detailed in 40 CFR Part 370.21.
313	Toxic Chemical Release Forms	X		EPCRA, Section 313, requires that facilities that use toxic chemicals listed in SARA Tile III over a threshold value must submit a TRI report. In 2006, a report was submitted for lead.

NOTE: MSDS = Material Safety Data Sheets (gives relevant chemical information)
RQ = reportable quantity
EHS = extremely hazardous substance
TRI = Toxic Release Inventory
DOE = U.S. Department of Energy
SSO = Sandia Site Office
EPA = U.S. Environmental Protection Agency
NNSA = National Nuclear Security Administration
CFR = Code of Federal Regulations
EPCRA = Emergency Planning and Community Right-to-Know Act
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
SARA = Superfund Amendments and Reauthorization Act
lbs = pounds

the treatment of mixed waste (MW) at federal facilities. Since TTR does not generate MW and currently has no MW stored on-site, this statute is not applicable to Sandia's operations at TTR.

2.1.5 Clean Air Act (CAA) and Clean Air Act Amendments (CAAA) of 1990

CAA and CAAA of 1990 requirements are regulated by State of Nevada air quality regulations. Air emissions from non-radionuclide sources, such as a screening plant or a portable screen, are permitted under a Class II Air Quality Permit. Sandia tracks emissions and pays a fee to the State of Nevada based on the total standard tons emitted. Sandia met all air quality permit conditions in 2006.

National Emission Standards for Hazardous Air Pollutants (NESHAP) Compliance

The EPA retains compliance authority for all radionuclide air releases, which are regulated by NESHAP and implemented under 40 CFR 61, Subpart H. The Clean Slate sites, as 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). The TTR Airport was determined to be the location of the maximally exposed individual (MEI). The result of 0.024 millirems per year (mrem/yr) was below the threshold of 0.1 mrem/yr, for which continuous air monitoring would be required, and approximately 400 times less than the EPA standard of 10 mrem/yr. The NESHAP Annual Report for 2006 (SNL 2007a) and Chapter 4 of this report discuss these monitoring results.

2.1.6 Clean Water Act (CWA)

Wastewater effluents and potable water supplies are regulated under the CWA and State of Nevada water pollution and sanitary waste systems regulations. 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 that is connected to the USAF sewage lagoon and to six septic tank systems.

There were no excursions or other permit violations in 2006 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 has cognizance over all storm water issues at the site. In November 2005, the Laircm construction project was included in the State of Nevada Storm Water General Permit NVR100000, confirmation number CSW-5462. A Storm Water Pollution Prevention Plan (SWPPP) was used until the project was completed. The NDEP was sent a Notice of Termination (NOT) of Coverage under the General Permit for Stormwater Discharges on May 23, 2006, and the project was terminated on February 23, 2006. The State of Nevada has determined that there are no industrial activities at TTR that require permitting. New construction activities that exceed one acre of soil disturbance may require permitting under the Construction General Permit.

2.1.7 Safe Drinking Water Act (SDWA)

Sandia 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's operations at TTR and is operated under a permit issued by the State of Nevada. Chapter 4 of this report discusses monitoring activities. The NDEP, Bureau of Safe Drinking Water, characterizes this Public Water System (PWS) as a Non-Transient Non-Community system. In July 2006, the Well 6 pump motor malfunctioned and was not repaired until November of 2006. During this period water to the Area 3 compound was provided by the USAF PWS located in Area 10.

2.1.8 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 a "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 soil (IT 1993). All samples contained less than 50 ppm of PCBs.

2.1.9 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

Chemical pesticides used at TTR include herbicides, rodenticides, and insecticides, as required. All chemicals used are EPA approved and applied in accordance with applicable label guidelines and regulations. Sandia 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 2006.

2.1.10 National Environmental Policy Act (NEPA)

NEPA requires federal agencies (and other organizations that perform federally sponsored projects) to consider the environmental issues associated with proposed actions, be aware of the potential environmental impacts associated with these issues, and include this information in early project planning and decision making. Additionally, if a proposed action is determined to have environmentally "significant" impacts, the agency must prepare an environmental assessment (EA) or an environmental impact statement (EIS) before making an irretrievable commitment of resources or funding. Although a major objective of NEPA is to preserve the environment for future generations, the law does not require an agency to choose a course of action with the least environmental impact. The DOE/National Nuclear Security Administration (NNSA)/Sandia Site Office (SSO) coordinates NEPA compliance at SNL/TTR with personnel from SNL/NM. NEPA activities are discussed in Section 3.4.

2.1.11 Endangered Species Act (ESA)

The 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. The ESA is addressed under the NEPA Program and the Ecology 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.

Table 2-2 lists all federal and state protected species occurring within Nye County and having the potential to occur at TTR.

2.1.12 Migratory Bird Treaty Act (MBTA)

The MBTA of 1918 implemented the 1916 Convention for the Protection of Migratory Birds. The original statute implemented the agreement between the United States (U.S.) and Great Britain (for Canada) and later amendments implemented treaties between the U.S. and Mexico, the U.S. and Japan, and the U.S. and Russia. The MBTA prevents the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, or nests. Federal institutions are not exempt from the MBTA. New guidance is being developed by the U.S. Fish and Wildlife Service to assist federal institutions in interpreting this act. At TTR, the MBTA is coordinated with NEPA compliance reviews and the Ecology Program.

2.1.13 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)

The DOE/NNSA/SSO is responsible for determining the level of applicability of cultural resources requirements. In 2006, Sandia's operations did not impact any known cultural resources sites at TTR.

Historical Building Assessment

In 2004, DOE/NNSA/SSO initiated a consultation with the Nevada State Historic Preservation Office (SHPO) on 212 buildings at TTR. The SHPO did not concur with the DOE determination of eligibility for the 212 buildings. At the SHPO's request, Sandia contracted with an architectural historian to evaluate the TTR buildings under National Register Criterion C. A revised report on the buildings at TTR will be submitted to SSO for transmittal to the Nevada SHPO during 2007.

2.1.14 Environmental Compliance EOs

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

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,* as amended, requires that, to the greatest extent practicable and permitted by law and consistent with the principles set forth in the Report on the National Performance Review (Gore 1993), each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions. Sandia must include in the assessment of its operations any disproportionate impacts on minority or low-income populations within the area of influence of the laboratories' operations.

EO 13148, *Greening the Government Through Leadership in Environmental Management,* requires federal agencies to ensure that "all necessary actions are taken to integrate environmental accountability into agency day-to-day decision making and long-term planning processes, across all agency missions, activities, and functions." Among the primary agency goals is support to the development and implementation of environmental compliance audit programs and policies "that emphasize pollution prevention as a means to both achieve and maintain environmental compliance." Sandia is working under guidance from DOE/NNSA/SSO towards compliance with this EO.

TABLE 2-2. Protected Species Potentially Occurring in Nye County, Nevada

Common Name	Scientific Name	Federal Status	State of Nevada Status
PLANTS			
Sodaville Milkvetch	*Astragalus lentiginosus var. sesquimetralis*	---	State Protected
Halfring Milkvetch	*Astragalus mohavensis var hemigyrus*	SOC	State Protected
Ash Meadows Milkvetch	*Astragalus phoenix*	Threatened	State Protected
Armored Hedgehog Cactus	*Echinocereus engelmannii var. armatus*	---	State Protected
Ash Meadows Sunray	*Enceliopsis nudicaulis var. corrugata*	Threatened	State Protected
Mojave Barrel Cactus	*Ferocactus cylindraceus var. lecontei*	---	State Protected
Sunnyside Green Gentian	*Frasera gypsicola*	SOC	State Protected
Ash Meadows Gumplant	*Grindelia fraxinopratensis*	Threatened	State Protected
Ash Meadows Mousetails	*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*	---	State Protected
Blaine Pincushion	*Sclerocactus blainei*	SOC	State Protected
Tonopah Pincushion	*Sclerocactus nyensis*	---	State Protected
Hermit Cactus	*Sclerocactus polyancistrus*	---	State Protected
INSECTS			
Ash Meadows Naucorid	*Ambrysus amargosus*	Threatened	---
FISH			
White River Desert Sucker	*Catostomus clarki intermedius*	SOC	State Protected
Moorman White River Springfish	*Crenichthys baileyi thermophilus*	SOC	State Protected
Railroad Valley Springfish	*Crenichthys nevadae*	Threatened	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
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
Ash Meadows Speckled Dace	*Rhinichthys osculus nevadensis*	Endangered	State Protected
Big Smokey Valley Tui Chub	*Siphateles bicolor* ssp. 8	SOC	State Protected
Hot Creek Valley Tui Chub	*Siphateles bicolor* ssp. 5	SOC	State Protected
Little Fish Lake Valley Tui Chub	*Siphateles bicolor* ssp. 4	---	State Protected
Railroad Valley Tui Chub	*Siphateles bicolor* ssp. 7	SOC	State Protected
AMPHIBIANS			
Amargosa Toad	*Bufo nelsoni*	---	State Protected
Columbia Spotted Frog	*Rana luteiventris* pop 3	Candidate	---
REPTILES			
Banded Gila Monster	*Heloderma suspectum cinctum*	SOC	State Protected
Desert Tortoise (Mojave Desert pop.)	*Gopherus agassizii*	Threatened	State Protected
MAMMALS			
Spotted Bat	*Euderma maculatum*	SOC	State Protected
Pygmy Rabbit	*Brachylagus idahoensis*	SOC	State Protected
American Pika	*Ochotona princeps*	---	State Protected
Kit Fox	*Vulpes macrotis*	---	State Protected
BIRDS			
Northern Goshawk	*Accipiter gentilis*	SOC	State Protected
Golden Eagle	*Aquila chrysaetos*	---	State Protected
Long-eared Owl	*Asio otus*	---	State Protected
Western Burrowing Owl	*Athene cunicularia hypugaea*	SOC	State Protected
Juniper Titmouse	*Baeolophus griseus*	---	State Protected
Ferruginous Hawk	*Buteo regalis*	SOC	State Protected
Swainson's Hawk	*Buteo swainsoni*	---	State Protected
Sage Grouse	*Centrocercus urophasianus*	---	State Protected
Western Snowy Plover	*Charadrius alexandrinus nivosus*	Threatened	State Protected
Mountain Plover	*Charadrius montanus*	Proposed Threatened	State Protected
Black Tern	*Chlidonias niger*	SOC	State Protected
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentalis*	Candidate	State Protected
Yellow Warbler	*Dendroica petechia*	---	State Protected
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	Endangered	State Protected
Prairie Falcon	*Falco mexicanus*	---	State Protected
Common Yellowthroat	*Geothlypis trichas*	---	State Protected
Greater Sandhill Crane	*Grus canadensis tabida*	---	State Protected
Pinyon Jay	*Gymnorhinus cyanocephalus*	---	State Protected
Yellow-breasted Chat	*Icteria virens*	---	State Protected
Western Least Bittern	*Ixobrychus exilis hesperis*	SOC	State Protected
Loggerhead Shrike	*Lanius ludovicianus*	SOC	State Protected
Lewis' Woodpecker	*Melanerpes lewis*	---	State Protected
Long-billed Curlew	*Numenius americanus*	---	State Protected
Macgillivray's Warbler	*Oporornis tolmiei*	---	State Protected
Mountain Quail	*Oreortyx pictus*	---	State Protected
Flammulated Owl	*Otus flammeolus*	---	State Protected
Osprey	*Pandion haliaetus*	---	State Protected
Phainopepla	*Phainopepla nitens*	---	State Protected
White-faced Ibis	*Plegadis chihi*	SOC	State Protected
Vesper Sparrow	*Pooecetes gramineus*	---	State Protected
Yuma Clapper Rail	*Rallus longirostris yumanensis*	Endangered	State Protected
Red-naped Sapsucker	*Sphyrapicus nuchalis*	---	State Protected
Crissal Thrasher	*Toxostoma crissale*	---	State Protected
Orange-crowned Warbler	*Vermivora celata*	---	State Protected
Lucy's Warbler	*Vermivora luciae*	---	State Protected
Grey vireo	*Vireo vicinior*	---	State Protected

SOC = Species of Concern

EO 13101, *Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition* requires all federal agencies to incorporate waste prevention and recycling into daily activities and participate in affirmative procurement. Waste minimization activities at TTR are discussed in Section 3.2.

EO 13149, *Greening the Government Through Federal Fleet and Transportation Efficiency,* encourages the reduction of petroleum consumption through improvements in fleet fuel efficiency and the use of alternative fuel vehicles (AFVs) and fuels.

EO 13123, *Greening the Government Through Efficient Energy Management,* calls for improvements in energy management including the promotion of energy efficiency, water conservation, use of renewable energy products, and fostering markets for emerging technologies.

EOs 13101, 13123, 13148, and 13149 were revoked by EO 13423 in January 2007; however, they are listed here as they were in force during 2006. EO 13423 combines the EOs it replaces into an omnibus EO that instructs federal agencies to conduct their missions "in an environmentally, economically and fiscally sound, integrated, continuously improving, efficient, and sustainable manner." (EO 13423)

2.2 2006 AUDITS

Table 2-3 lists audits conducted in 2006, including an assessment made by Sandia.

2.3 2006 ISSUES AND ACTIONS FOR TTR

Sandia's ongoing self-assessments continue to look for potential compliance issues and subsequent follow-up actions.

Federal Facility Agreement and Consent Order (FFACO) Compliance for 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 U.S. Department of Defense (DoD) (DoD/DOE/State of Nevada 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, which are subject to the FFACO are:

- NTS
- Areas within TTR
- Areas within the NTTR
- Central Nevada Test Area
- Project Shoal Area (east of Carson City in Churchill County)

A summary of DOE/NNSA's ER sites in Nevada can be found in the FFACO report (DoD/DOE/ State of Nevada 1996). The list of sites has been modified for consistency with NDEP requirements and grouped into Corrective Action Units (CAUs), which are listed by Corrective Action Site (CAS) numbers. Each CAU/CAS is listed in the FFACO under Appendix II (Corrective Action Sites/Units, this section includes inactive CAU/CASs), Appendix III (Corrective Action Investigations/Corrective Actions, this section includes active CAU/CASs), and Appendix IV (Closed Corrective Action Units, this section lists CAU/CASs where corrective actions are complete). The FFACO is updated every six months. A listing of ER sites located at TTR is shown in Chapter 3, Table 3-1.

2.4 ENVIRONMENTAL PERMITS

Environmental compliance permits for TTR include those for potable water supply, RCRA, and specific air emission units such as screening plants. The permit application and registration of Sandia activities at TTR are issued directly by the State of Nevada to either DOE/NNSA/Nevada Site Office (NSO) or DOE/NNSA/SSO and administered by Washington Group International (WGI) on behalf of Sandia. Sandia and WGI ensure that all permit conditions are met. Table 2-4 lists all permits and registrations in effect in 2006.

2.5 OCCURRENCE REPORTING

There was one reportable occurrence in 2006. A diesel fuel spill occurred at the Bill's Hill Manpads Laircm Site on June 14, 2006. Approximately 25 cubic yards (yd^3) of contaminated soil was removed during clean up operations. This spill was reported the Nevada Division of Emergency Management (NDEM) and assigned Case Number: 060615-01. A defective generator fuel filter caused the spill. Personnel discovered a crack (after the spill) on the water drain valve of the fuel filter. The generator

was serviced two days prior to the spill, and the faulty filter was installed at that time. The generator involved powered the Laircm command center trailer/RV compound. It ran 24 hours a day for the duration of the project. The spill released 88 gallons of diesel fuel to the ground.

After discovery, the soil was immediately excavated to prevent further migration of petroleum hydrocarbon (TPH) contaminants. Excavated soil was placed on visquene and covered by a tarp. Approximately 15 yd^3 of soil was removed during the first clean-up attempt. TPH samples were collected from the excavation and sent to the laboratory the following day. Initial TPH sample results indicated more clean up was necessary. On June 27, 2006, approximately ten yd^3 of additional soil was removed, and four additional TPH samples were collected. Results from these samples indicated no further clean up was required.

NDEP approved the closure plan for this spill with no further action required on January 22, 2007. All contaminated soil was sent to an approved landfill for hydrocarbon-contaminated soil.

TABLE 2-3. Summary of Environmental Audits Performed at TTR in 2006

Type/Subject	Date	Audit Organization	Findings Summary
CY06 2915 TTR Annual ES&H SME Walk Through	August 8-10 2006	SNL SMEs	Numerous Industrial and Electrical Safety findings. No Environmental findings. For details, see LESA Report (Title: CY06 2915 TTR Annual ES&H SME Walk Through ID: 682).
Air Quality Permit Evaluation	August 29 2006	State of Nevada/ NDEP/DOE/SSO	No Findings.
Water Treatment/Waste Water distribution Evaluation	July 18-20 2006	DOE/SSO	No Findings.
Backflow Prevention Inspection	August 15 2006	State of Nevada/ NDEP/ DOE/SSO	No Findings. State of Nevada Auditor was so pleased with our system that he requested photos and stated that we set the bar for other systems to aspire to.

NOTES: NNSA/SSO = National Nuclear Security Administration, Sandia Site Office
TTR = Tonopah Test Range
ES&H = Environment, Safety, and Health
IHIR = Industrial Hygiene Investigative Report
SOP = Standard Operating Procedure SME = Subject Matter Expert
NDEP = Nevada Department of Environmental Protection

Antelope at TTR
Photo by: Steve Cox

TABLE 2-4. 2006 Summary of Permit Ownership at TTR

Permit Type and Location	Permit Number	Issue Date	Expiration Date	Comments
Air Quality Permits				
Class II Air Quality Operation Permit	AP8733-0680.02	July 23, 2006	July 23, 2011	1- 3' x 5' Screening Plant 1- 7' x 7' Portable Screen Non-Permit Equipment List 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	January 7, 1993	Indefinite	State of Nevada
Stormwater Permit (Construction)				
Bill's Hill Laircm Project	CSW-5462	November 22, 2005	NOT 23 February 2006	State of Nevada
Production Well (Drinking Water)				
Well 6 Production Well	NY-3014-12NTNC	September 2006	September 2007*	State of Nevada
Permit to Operate a Treatment Plant	NY-3014-TP11-12NTNC	September 2006	September 2007*	State of Nevada

NOTES: * The State of Nevada Bureau of Health Protection Services renews the permit for Well 6 (NY-3014-12NC) annually.
TTR = Tonopah Test Range
RCRA = Resource Conservation and Recovery Act
"Emission units" are sources such as generators and boilers

Formation at Sunset
Photo by: Jennifer Payne

chapter three

TTR ENVIRONMENTAL PROGRAMS INFORMATION

In This Chapter...

Environmental Snapshot

TTR is committed to achieving significant reductions in the amount of chemical and hazardous wastes generated on-site. Waste minimization includes recycling and recovery of solvents, fuels and oil, and antifreeze.

The Environmental Restoration (ER) Project, the Waste Management Program, and the National Environmental Policy Act (NEPA) Program are some of the programs and activities Sandia National Laboratories (SNL)/Tonopah Test Range (TTR) utilize to comply with various state and federal regulations, Executive Orders (EOs), and U.S. Department of Energy (DOE) orders. Terrestrial surveillance, drinking water, wastewater, and air quality programs are discussed in Chapter 4 of this report.

3.1 ER PROJECT ACTIVITIES

The ER Project at TTR was initiated 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 (HQ) and the Albuquerque and Nevada field offices to designate the responsibility for all ER sites to the DOE/Nevada Site Office (NSO). (The National Nuclear Security Administration [NNSA] was not established until 2000/2001.) Currently, responsibility for all ER sites resides with DOE/NNSA/NSO.

Since 1996, cleanup activities for sites located in the State of Nevada have been regulated by the Federal Facility Agreement and Consent Order (FFACO) (DoD/DOE/State of Nevada 1996). The FFACO was negotiated between DOE/NSO, the Nevada Division of Environmental Protection (NDEP), and the U.S. Department of Defense (DoD). The FFACO 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 2.3. CAUs located at TTR are addressed by two ER Division Projects:

(1) Industrial Sites Project – Sites historically used to support nuclear testing and Sandia activities. Industrial sites include historic septic systems, landfills, sewage lagoons, depleted uranium (DU) sites, and ordnance testing sites.

(2) Soil Sites Project – Areas where nuclear testing has resulted in surface and/or shallow subsurface soil contamination. Soil sites include large area soil contamination from plutonium dispersal testing.

ER site contamination includes radiological (e.g., DU and plutonium) and non-radiological constituents (e.g., munitions, solvents, pesticides, septic sludges, and heavy metals).

CAS Identification

The initial identifications, descriptions, and listings 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 processes,
- 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 under Soil Sites CAUs/CASs in Table 3-1 as CAU-411, -412, -413, and -414.

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

2006 ER Activities

ER activities in 2006 were focused on closure planning and field work for CAU 408 (Bomblet Target Area), CAU 484 (Surface Debris, Waste Sites, and Burn Area), CAU 489 (WWII UXO Sites), and CAU 496 (Burried Rocket). Work for CAU 408 consisted of completing geophysical and radiological surveys and cleanup of DU on Antelope Lake; work for CAU 484 consisted of

TABLE 3-1. DOE/NNSA/NSO ER Project TTR CAUs and CASs 2006 Status

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 – *Closed* 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 – *Closed* **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 – *Closed* Roller Coaster Rad Safe Area, TTR		
TA-23-001-TARC	Roller Coaster Rad Safe Area	Northwest of Antelope Lake
CAU-408 – *Planning Phase* Bomblet Target Area, TTR		
TA-55-002-TAB2	Bomblet Target Areas	Antelope Lake
CAU-409 – *Closed* 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
CAU-410 – *Closed* 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
TA-19-002-TAB2	Debris Mound	Bunker 2
TA-21-003-TANL	Disposal Trench	NEDS Lake
TA-21-002-TAAL	Disposal Trench	South Antelope Lake

Refer to notes at end of table.

TABLE 3-1. DOE/NNSA/NSO ER Project TTR CAUs and CASs 2006 Status *(continued)*

Industrial Sites CAUs/CASs		
CAS Number	**CAS Description**	**General Location**
CAU-423 – *Closed* Area 3 UDP, Bldg. 0360, TTR		
03-02-002-0308	UDP	Bldg. 0360
03-02-002-0308	UDP	Bldg. 0360
CAU-424 – *Closed* 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 – *Closed* Area 9 Main Lake Construction Debris Disposal Area, TTR		
09-08-001-TA09	Construction Debris Disposal Area	Area 9/Main Lake
CAU-426 – *Closed* Cactus Spring Waste Trenches, TTR		
RG-08-001-RGCS	Waste Trenches	Cactus Spring Ranch
CAU-427 – *Closed* 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 – Closed Area 3 Septic Waste Systens 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 – *Closed* 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
CAU-453 – *Closed* Area 9 UXO Landfill, TTR		
09-55-001-0952	Area 9 Landfill	Area 9
CAU-461 – *Closed* 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 – *Closure Phase* 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
TA-54-001-TANL	Rocket Propellant Burn Area	NEDS Lake
RG-52-007-TAML	Davis Gun Site – Mellan	Test Range
TA-52-006-TAPL	DU Surface Debris	Colimbo Detonation Area, NEDS Lake

Refer to notes at end of table.

TABLE 3-1. DOE/NNSA/NSO ER Project TTR CAUs and CASs 2006 Status *(concluded)*

Industrial Sites CAUs/CASs		
CAS Number	**CAS Description**	**General Location**
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 – *Closed* Double Tracks Rad Safe Area, Nellis Range 71 North		
71-23-001-71DT	Double Tracks Rad Safe Area	Nellis Range 71 North
CAU-487 – *Closed* Thunderwell Site, TTR		
RG-26-001-RGRV	Thunderwell Site	Thunderwell Site
CAU-489 – *Closed* 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 – *Closed* 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-495 – *Closed* Unconfirmed JTA Sites, TTR		
TA-55-006-09SE	Buried Artillery Round	Test Area
TA-55-007-09SE	Buried Artillery Round	Test Area
CAU-496 – *Closed* Buried Rocket Site – Antelope Lake, TTR		
TA-55-008-TAAL	Buried Rocket	Antelope Lake
CAU-499 – *Closed* Hydrocarbon Spill Site, TTR		
RG-25-001-RD24	Hydrocarbon Spill Site	Radar 24 Site
Soil Sites CAUs/CASs:		
CAU-411 – *Closed* Double Tracks Plutonium Dispersion, Nellis		
NAFR-23-01	Pu-contaminated Soil	Double Tracks
CAU-412 – *Closed* Clean Slate 1 Plutonium Dispersion, TTR		
TA-23-01CS	Pu-Contaminated Soil	Clean Slate 1
CAU-413 – *Remediation Phase* Clean Slate 2 Plutonium Dispersion, TTR		
TA-23-02CS	Pu-Contaminated Soil	Clean Slate 2
CAU-414 – *Not Started* Clean Slate 3 Plutonium Dispersion, TTR		
TA-23-03CS	Pu-Contaminated Soil	Clean Slate 3

SOURCE: DoD/DOE/State of NV 1996 and ongoing updates

NOTE: DOE = U.S. Department of Energy
CAU = Corrective Action Unit
CAS = Corrective Action Site
DU = depleted uranium
ER = Environmental Restoration
NEDS = Non-Explosive Destruction Site
WWII = World War II
Pu = Plutonium
NNSA = National Nuclear Security Administration
NSO = Nevada Site Office
UDP = underground discharge points
UST = underground storage tank
UXO = unexploded ordnance
TTR = Tonopah Test Range
JTA = Joint Test Assembly

geophysical and radiological surveys and DU cleanup on NEDS Lake and Antelope Lake; work for CAU 489 consisted of transportation and disposal of inert practice ordnance debris; and work for CAU 496 consisted of removal of rocket debris and DU cleanup on Mid Lake. Field activities at TTR generated 221 kg (487 pounds [lb]) of non-Resource Conservation and Recovery Act (RCRA) waste consisting of non-impacted personal protective equipment (PPE) (i.e., paper, plastic, Tyvec, gloves, etc.). The non-RCRA waste was transported to the Nevada Test Site (NTS) for disposal. No RCRA hazardous, TSCA, or mixed waste (MW) was generated during ER activities and/or disposed in 2006. DU cleanup at CAUs 408, 484, and 496 generated 672,922 kg (1,483,515 lb) radioactive low-level waste (LLW). The LLW will be disposed at the NTS during 2007. Closure activities for CAU 489 generated 68,492 kg (151,000 lb) of scrap metal during 2005, and this waste was transported to and disposed of at the NTS in 2006. Washington Group International (WGI) participates in environmental cleanup and restoration activities.

3.2 WASTE MANAGEMENT PROGRAMS

All waste generated at TTR, which excludes any waste generated by ER activities, is managed by WGI under the Waste Management Program. 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.

Waste generated and handled at SNL/TTR in 2006 was as follows:

Waste Type	*Weight*
RCRA hazardous waste	639 kg (1405 lb)
Non-RCRA regulated	3608 kg (7938 lb)
TSCA waste (Asbestos/PCB)	854 kg (1879 lb)
Hydrocarbon-contaminated soil	80,000 lb
Tires/scrap metal	167 yd
Construction debris	43,090 lb
Sanitary landfill waste	51,120 lb
Recycled waste	20,296 kg (44,650 lb)
Radioactive waste	0 kg

All regulated waste was shipped to off-site permitted treatment, storage, and disposal (TSD) facilities.

Waste Minimization Program

TTR is committed to achieving significant reductions in the amount of chemical and hazardous wastes generated on-site. Waste minimization includes the recycling and recovering of the following materials:

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

Recyclable waste and used oil was sent for recycling or disposed of through the waste disposal contractor. Recycled or energy-recovered material shipped off site in 2006 is presented in Table 3-4.

Radioactive Waste Management

There were no shipments of radioactive waste in 2006.

3.3 SPILL PREVENTION CONTROL AND COUNTERMEASURES (SPCC) PLAN

The *SPCC Plan for SNL Tonopah Test Range* (SNL 2004) 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 aboveground storage tanks (ASTs), two bulk storage areas (BSA), and one transformer storage area that are covered by the SPCC Plan at TTR.

3.4 NEPA PROGRAM

NEPA Activities at TTR

At TTR, NEPA compliance is coordinated between Sandia at TTR, Sandia at Sandia National Laboratories, New Mexico (SNL/NM), and DOE/NNSA/Sandia Site Office (SSO). The Desert Research Institute (DRI) in Las Vegas, Nevada prepares archaeological and biological surveys and reports. Final reports are submitted to Sandia for

TABLE 3-2. Sandia Corporation TTR RCRA-Regulated Hazardous Waste Shipped Off-site in 2006

Waste Description	Waste Codes	Generated (lb)
Waste Toxic Solid, Organic, NOS	D035, F002, F003, F005	25
Waste (Lithium Battery)	D001, D003	25
Waste Aerosols	D001	120
Waste Water Reactive Solid, Self Heating NOS	D001, D003, D008	235
Waste Paint Related Material	D001	90
Waste Flammable Liquids	D001	550
Waste Flammable Liquids, NOS	D001, U220	225
Waste Petroleum Distillates	D001, D008, D018, F005	190
Waste Batteries, Wet Filled with Alkali	D002, D006	40
Hazardous Waste Solid, NOS	D008	70
Hazardous Waste Solid, NOS	D009, U151	70
Mercury Contained in Manufactured Articles, Hazardous Waste Solid, NOS	D009	40
Waste Diesel Fuel	D001	1,720
Hazardous Waste Solid, NOS	D035, F005	30
Waste Corrosive Liquid, NOS	D002	25
Hazardous Waste, Solid, NOS	D006, D007	150
Hazardous Waste, Solid, NOS	D008, D009	55
Hazardous Waste, Liquid, NOS	D007, D011	280
Hazardous Waste, Liquid, NOS	D006, D007, D011	455
	TOTAL	**4,395**

NOTES: NOS = not otherwise specified RCRA = Resource Conservation and Recovery Act
TTR = Tonopah Test Range lb = pounds

TABLE 3-3. Non-RCRA-Regulated Hazardous or Toxic Waste Shipped Off-site in 2006

Waste Description	Waste Codes	Shipped	Generated (lb)
Non-Reg Solid Waste	NCR		4,265
Non-Reg Liquid Waste	NCR		100
Regulated Medical Waste	NCR		152
Polychlorinated Biphenyl's (PCB) Ballasts	TSCA		18
		TOTAL	4,535
D&D Asbestos Waste	TSCA	10 yd^3	10 yd^3
Apex Solid Waste Landfill (Tires/Metal)	NCR	63 yd^3	63 yd^3
Environmental Restoration (ER)			
Hydrocarbon impacted soil & debris		0	0
IDW		300	300
LLW (soil, debris, and PPE)		0	0
Inert UXO debris		0	283,500
		TOTAL	283,800

NOTES: NCR = no code required
RCRA = Resource Conservation and Recovery Act
IDW = Investigation-Derived Waste
D&D = decontamination and demolition
yd^3 = cubic yard
TSCA = Toxic Substances Control Act
LLW = low level waste
UXO = unexploded ordnance
PPE = personal protective equipment
lb = pounds

TABLE 3-4. Recycled Regulated Hazardous or Toxic Waste Shipped Off-site in 2006

Recycled Material or Energy Recovered Material	Generated (lb)
Batteries Wet, Filled with Acid	1,035
Brass	11,290
Batteries Dry Containing Potassium Hydroxide Solid	15
Fluorescent Lights	490
Circuit Boards for Recycle	45
TOTAL	**12,875**

NOTES: lb = pounds

transmittal to DOE/NNSA/SSO for review and decision making and to consult with state and federal agencies.

The Final Environmental Impact Statement (EIS) for NTS and off-site locations in the State of Nevada, which include TTR, was completed in 1996; the DOE Record of Decision (ROD) was filed on December 9, 1996 (DOE 1996). TTR is currently being considered, along with all of the facilities in the DOE complex, in the *2030 Programmatic EIS*. This EIS will evaluate the future of the nation's nuclear weapons complex and outline a plan to establish a smaller, more efficient nuclear weapons complex able to respond to future challenges.

2006 NEPA Documentation

A total of four TTR NEPA reviews were processed during 2006. Two NEPA reviews were completed by SNL/NM. Two NEPA checklists were submitted to SSO for review. The proposal to move current Joint Test Assembly flight testing capabilities from TTR to White Sands Missile Range resulted in a determination to prepare an environmental assessment (EA).

3.5 ENVIRONMENTAL MONITORING PERFORMED BY OUTSIDE AGENCIES

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

EPA

The EPA Environmental Monitoring Systems Laboratory in Las Vegas, Nevada monitored background radiation in the area of TTR as part of its Off-site Radiation Monitoring Reports Program (EPA 1999), which is now being conducted by DRI.

DRI, University of Nevada System

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

DRI also provides external quality assurance (QA) on field measurements taken by the EPA at these community monitoring stations. DRI monitors selected locations concurrently using a portable monitoring station (PMS) and thermoluminescent dosimeters (TLDs). DRI's *Community Radiation Monitoring Program Annual Report* now appears as part of the NTS *Annual Site Environmental Report* (ASER) (DOE 2006).

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

WGI

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

- 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 four release reporting documents must be submitted to external regulatory agencies if releases exceed applicable threshold quantities (TQ):

- *NESHAP Annual Report for CY 2006, SNL/NV* (SNL 2007a) requires that an annual report be submitted from each DOE/NNSA site where facility sources contribute a public dose of over 0.1 millirems per year (mrem/yr). The NESHAP report must be submitted to 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).

- *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 extremely hazardous materials are not used during TTR routine operations.

- *Toxic Chemical Release Reporting Community Right-to-Know: Calendar Year 2006* (SNL 2007b) was submitted for lead released at the TTR firing range.

Technician atop the Water Tower at Tonopah Test Range measuring the latitude and longitude with GPS .
Photo by: John Salois

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chapter four

TTR ENVIRONMENTAL MONITORING

Photo by: Steven Feador

In This Chapter...

Environmental Snapshot

One of the goals of the Terrestrial Surveillance Program is to identify and quantify new or existing environmental quality problems and their potential impacts, if any.

4.1 TERRESTRIAL SURVEILLANCE

Terrestrial surveillance is conducted at the Tonopah Test Range (TTR) to detect the possible migration of contaminants to off-site locations and to determine the potential impact of Sandia National Laboratories (SNL)/TTR operations on human health or the environment.

4.1.1 Program Objectives

The objectives of the Terrestrial Surveillance Program can be summarized by the following excerpts of the requirements given in U.S. Department of Energy (DOE) Order 450.1, *Environmental Protection Program* (DOE 2005):

- Collect and analyze samples to characterize environmental conditions and define increasing or decreasing trends,
- Establish background levels of pollutants to define baseline conditions (off-site sampling),
- Provide continuing assessment of pollution abatement programs,
- Identify and quantify new or existing environmental quality problems and their potential impacts, if any, and
- Verify compliance with applicable environmental laws and regulations and commitments made in National Environmental Policy Act (NEPA) documents such as Environmental Impact Statements (EISs), as well as other official documents.

4.1.2 Regulatory Standards and Comparisons

The Terrestrial Surveillance Program is designed and conducted in accordance with the requirements of DOE Order 450.1, *Environmental Protection Program* (DOE 2005). Concentration limits for radionuclides and metals in terrestrial media are not well defined; however, the terrestrial surveillance coordinator does compare the results from on-site and perimeter locations to off-site results to determine the impact, if any, of TTR operations on the environment. In addition, sample results for metals in surface soils are compared to U.S. surface soil average concentrations that are published in *Trace Elements in Soils and Plants* (Kabata-Pendias 2000) or local/regional surface soil average concentrations that are published in *Elements in North American Soils* (Dragun and Chekiri 2005). A summary report of metals in soils at TTR has been prepared and will serve as another point of reference (SNL 2006).

4.1.3 Statistical Analyses

Samples are generally collected from fixed locations to effectively make statistical comparisons with results from previous years. Statistical analyses are performed to determine if a specific result or group of on-site or perimeter results, differs from off-site values, and to identify trends at a specific sampling location. Since multiple data points are necessary to provide an accurate view of a system, the Terrestrial Surveillance Program does not rely on the results from any single year's sampling event to characterize on-site environmental conditions. Results from a single sampling point may vary from year to year, due to slight changes in sampling locations, differences in climatic conditions, and laboratory variations or errors. Therefore, as the amount of data increases, the accuracy of the characterization increases.

The results of the statistical analyses allow for prioritization of sample locations for possible follow up action. The prioritization process is a decision making tool to assist in determining the appropriate level of concern for each sample result. The Statistical Analysis Prioritization Method (Shyr, Herrera, and Haaker 1998) is based on two "yes or no" questions resulting in a matrix of four priority levels (Table 4-1). In addition, a qualitative, visual inspection of a graphical presentation of the data is conducted to compare sampling results to regional/local and site-specific concentrations. This step is performed to ensure that anomalous data that would otherwise pass statistical scrutiny is flagged for further investigation.

In some instances, this qualitative inspection of the data is augmented by the graphical evaluation methodology noted in Section 4.1.6 (Sandia 2006). This enables the visual identification of anomalies in the data that stand out from the data population for the entire site, or for just that location. This is particularly useful where insufficient data exists for trending, but comparison of new data to "expected values" is desired. To date, there have been no terrestrial sample results that have indicated a significant level of concern (Priority-1) that would trigger actions at locations that are not already being addressed by the Environmental Restoration (ER) Project.

TABLE 4-1. Decision Matrix for Determining Priority Action Levels

Priority	Are results higher than off-site?*	Is there an increasing trend ?	Priority for further investigation
1	**Yes**	**Yes**	Immediate attention needed. Specific investigation planned and/or notifications made to responsible parties.
2	**Yes**	No	Some concern based on the level of contaminant present. Further investigation and/or notifications as necessary.
3	No	**Yes**	A minor concern since contaminants present are not higher than off-site averages. Further investigation and/or notifications as necessary.
4	No	No	No concern. No investigation required.

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

Beginning in 2001, the analyses were limited to a five year period (therefore, this year begins in 2002). The reason for this change was that in 2000 SNL/NM changed analytical laboratories for lower (better) detection capabilities for many of the metals and radiological analyses. As a result, a large number of false decreasing trends were noted for many of the parameters when the whole data set was analyzed. By limiting the analysis to a five year period, the trend analysis is more meaningful. The analysis in 2006 utilized data from the same analytical laboratory for the five year period.

4.1.4 Sampling Locations

Terrestrial surveillance began at TTR in 1992. In addition to routine sampling, a large-scale baseline sampling was performed in 1994 in areas where SNL activities had a long-term or continued presence.

Routine terrestrial surveillance is conducted at on-site, perimeter, and off-site locations that remain essentially the same from year to year. The sampling locations, number of samples, and analyses performed are prioritized based on the following criteria:

- ***On-site 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 in the vicinity of ER sites). A list of on-site sampling locations is shown in Table 4-2. Appendix A contains maps of the sampling locations.

- ***Off-site locations*** are selected to provide a measurement of environmental conditions unaffected by TTR activities. Data collected from off-site locations serve as a reference point to compare data collected at perimeter and on-site locations. Multiple years of sampling data are compiled to determine statistical averages for off-site concentrations. Off-site locations are chosen both in remote, natural settings as well as in areas near local population centers and along highways. Table 4-3 contains a list of the off-site sample locations. The off-site locations sampled are shown in Figure A-6 of Appendix A.

- ***Perimeter locations*** are selected to establish if contaminants are migrating either onto or off of TTR property. A list of perimeter sampling locations is shown in Table 4-4. A map of the perimeter locations is shown in Figure A-7 of Appendix A. All perimeter locations are in areas which Sandia does not control access.

4.1.5 Radiological Parameters and Results

Soil is the only terrestrial medium sampled at TTR. There are no bodies of water, other than the playa lakes (dry lake beds with only occasional standing water), and vegetation is scarce. Soil samples are collected to ascertain the presence of air deposited pollutants or contaminants that have been transported and deposited as a result of surface water runoff. Samples are collected from the top two inches of soil using a hand trowel. The 2006 analytical results are found in Appendix A of this report and are summarized in this section. The detailed statistical analyses are documented in the *Tonopah Test Range Data Analysis in Support of the Annual Site Environmental Report, 2006* (SNL 2007c). Radiological parameters include gamma-emitting radionuclides, plutonium, and uranium.

TABLE 4-2. On-Site Terrestrial Surveillance Locations at TTR

On-Site Location	Location Number	Sample Location	Soil Sampling	Replicate*	TLD
South Plume	S-48	N/S Mellan Airstrip – Antelope Tuff	√	√	
	S-49	N/S Mellan Airstrip – SW of S-48	√		
	S-50	N/S Mellan Airstrip – sign post	√		
	S-51	N/S Mellan Airstrip – NE of S-50	√	√	
	S-52	NE of NW/SE Mellan Airstrip	√		
Range Operations Center	S-40	Waste Water Monitoring Station	√		
	S-41	"Danger Powerline Crossing" Sign	√		
	S-42	Main Road/Edward's Freeway	√		
	S-43	SW Corner of Sandia Corporation, TTR Operations Center	√		
	S-44	NE Corner of Sandia Corporation, TTR Operations Center	√		
	S-45	Storage Shelters, 03-38/03-39	√		
	S-46	Sand Building	√		
	S-47	Generator Storage Area	√		
Various On-Site Locations	S-01	Antelope Lake Area Fence, Cultural Area Sign	√		√
	S-02	N/S Mellan Airstrip (TLD at South fence post)	√		√
	S-03	TLD at Clean Slate 2	√	√	√
	S-04	TLD at Clean Slate 3	√		√
	S-09	Roller Coaster Decon	√	√	√
	S-10	Brownes Road/Denton Freeway			√
	S-13	Area 3 between Bldg. 100 and Caution Sign			√
	S-14	Area 3 CP SW side on fence			√
	S-15	Moody Ave. by cattle guard and entrance to airport and chow hall			√
	S-16	Area 9 by Bldg. 09-08 and LPG storage			√
	S-17	Hard Target area by Bldg. 23-16			√
	S-38	Mellan Hill – Metal Scrap Pile	√		
	S-39	Mellan Hill – North	√		
	S-53	Main Road/Lake Road SE	√		

NOTES: TLD = Thermoluminescent Dosimeter TTR = Tonopah Test Range
N/S = North/South (runway runs North/South)
*In addition to single samples taken for each location, two replicated samples are collected for internal checks on comparability of sampling and analysis.

TABLE 4-3. Off-Site Terrestrial Surveillance Locations at TTR

On-Site Location	Location Number	Sample Location	Soil Sampling	Replicate*	TLD
Off-Site	C-18	Tonopah Old Court House			
	C-19	Mining Museum, North Goldfield			√
	C-20	State Road 6 Rest Area	√		
	C-21	State Road 6/95 Rest Area	√		√
	C-22	Rocket	√		√
	C-23	Alkali/Silver Peak Turnoff	√		
	C-24	Cattle Guard	√		
	C-25	Tonopah Ranger Station	√		
	C-26	Gabbs Pole Line Road	√		
	C-27	State Roads 6/376 Junction	√		
	C-28	Stone Cabin/Willow Creek	√		
	C-29	State Roads 6/375 Junction	√	√	
	C-30	State Road 375 Ranch Cattle Gate	√		
	C-31	Golden Arrow/Silver Bow	√		
	C-32	Five miles south of Rocket	√		
	C-33	Nine miles south of Rocket	√		

NOTES: TLD = Thermoluminescent Dosimeter TTR = Tonopah Test Range
*In addition to single samples taken for each location, two replicated samples are collected for internal checks on comparability of sampling and analysis.

TABLE 4-4. Perimeter Terrestrial Surveillance Locations at TTR

On-Site Location	Location Number	Sample Location	Soil Sampling	Replicate*	TLD
Perimeter	P-05	O&M Complex - Site 4 Entrance Gate			√
	P-06	Cedar Pass Road Guard Station	√		√
	P-07	On-Base Housing - SW			√
	P-08	On-Base Housing (Main guard gate/power pole CP17)	√		√
	P-11	Cactus Springs (TLD south of P-35)	√	√	√
	P-12	TLD at "US Gov't Property" Sign	√		√
	P-34	O&M Complex (Owan Drive post)	√		
	P-35	Cactus Springs (north fence post)	√		
	P-36	On-Base Housing (NE fence line)	√		
	P-37	On-Base Housing (guard station)	√		

NOTES: TLD = Thermoluminescent Dosimeter
TTR = Tonopah Test Range
O&M = Operations & Maintenance
*In addition to single samples taken for each location, two replicated samples are collected for internal checks on comparability of sampling and analysis.

- ***Gamma-emitting radionuclides*** – Gamma spectroscopy is used to detect the emission of gamma radiation from radioactive materials. Radionuclide identification is possible by measuring the spectrum of gamma energies associated with a sample, since each radionuclide has a unique and consistent series of gamma emissions. Cesium-137 (Cs-137) is an example of a long-lived gamma emitter that is prevalent in the environment (as fallout from historical nuclear weapons testing). Other gamma-emitters of interest at TTR are americium-241 (Am-241) and depleted uranium (DU) from past explosives testing.

- ***Plutonium*** – Due to past explosives testing, plutonium is present in some limited areas of TTR. One of the indicators of the presence of weapons grade plutonium is the radionuclide Am-241. Isotopic plutonium analysis is sometimes performed on any sample for which gamma spectroscopy identified Am-241 in concentrations greater than its minimum detectable activity (MDA).

- ***Uranium*** – Uranium occurs naturally in soils and may also be present as a pollutant in the environment due to past testing conducted at TTR. Total uranium (U_{tot}) analysis is used to measure all uranium isotopes present in a sample. A high U_{tot} measurement may trigger an isotope-specific analysis to determine the possible source of uranium (i.e., natural, man-made, enriched, or depleted).

- ***External gamma radiation exposure rates*** **-** Thermoluminescent dosimeters (TLDs) are used to measure ambient gamma exposure rates. Several natural gamma radiation sources exist, including cosmic radiation and radioactive materials that exist in geologic materials at TTR. The TLD network was established to determine the regional gamma exposure rate due to natural sources and to determine the impact, if any, of Sandia operations on those levels. The dosimeters are placed on aluminum poles, at a height of approximately one meter, and are exchanged and measured quarterly (January, April, July, and October) at 20 on-site, perimeter, and off-site locations.

Radiological Results

The results of the statistical analysis revealed that no on-site or perimeter location was both higher than off-site and with an increasing trend (Priority-1). Overall summary statistics for all radiological results are presented in Table 4-5. The following radiological analytes showed two locations as Priority-2 (higher than off-site): Am-241 and U_{tot}. The Priority-2 locations, along with the associated summary statistics, are listed in Table 4-6. The following radiological analytes showed one location as Priority-3 (increasing trend): U_{tot}. While this increasing trend is statistically significant, it is not operationally significant (does not pose a safety or health threat to human health or the environment). Table 4-7 lists the analytes and their associated summary statistics.

The respective radiological analytes are discussed in the sections below that list the locations showing either Priority-2 or Priority-3.

TABLE 4-5. Summary Statistics for Soil Locations (all units in pCi/g unless otherwise noted)

Analyte	Location Class	Sample Size	Average	Median	Std Dev	Minimum	Maximum
Am-241	On-site	104	0.14	0.01	0.51	-0.23	3.56
	Perimeter	40	-0.002	-0.001	0.043	-0.19	0.09
	Off-site	70	-0.004	0.005	0.05	-0.20	0.06
Cs-137	On-site	104	0.26	0.24	0.17	0.02	0.77
	Perimeter	40	0.23	0.17	0.18	0.02	0.88
	Off-site	70	0.23	0.19	0.15	0.05	0.64
Pu-238	On-site	14	0.02	0.01	0.02	0.002	0.06
	Perimeter	1	0.01	0.01	n/a	0.01	0.01
	Off-site	2	0.002	0.002	0.007	-0.003	-0.02
Pu-239/240	On-site	14	1.66	0.44	2.86	-0.008	10.20
	Perimeter	1	0.02	0.02	n/a	0.02	0.02
	Off-site	2	0.003	0.003	0.01	0	0.007
U-235	On-site	104	0.10	0.08	0.06	-0.04	0.26
	Perimeter	40	0.08	0.07	0.06	0.01	0.25
	Off-site	70	0.08	0.08	0.065	-0.09	0.25
U-238	On-site	104	1.321	1.14	0.47	0.03	2.61
	Perimeter	40	1.22	1.20	0.58	0.18	2.65
	Off-site	70	1.27	1.180	0.51	0.41	2.70
Total Uranium (µg/g)	On-site	104	0.76	0.74	0.15	0.41	2.70
	Perimeter	40	0.74	0.701	0.19	0.48	1.49
	Off-site	70	0.79	0.74	0.20	0.54	1.55

NOTES: Historical summary of all data for all locations and time (pooled)
pCi/g = picocurie per gram µg/g = microgram per gram

Am-241

One on-site location (S-09) continues to be identified as Priority-2 (higher than off-site). S-09 is located near the Roller Coaster Decon site. The maximum result for this location was recorded in 2002 and is 3.56 picocuries per gram (pCi/g). No other on-site locations were identified as Priority-2. No perimeter location was identified as Priority-2 or Priority-3 (increasing trend).

U_{tot}

There was one perimeter location (P-35) that was identified as Priority-2 (higher than off-site). The maximum value observed at this location was 1.49 micrograms per gram (µg/g). P-35 is located at the Cactus Springs northeast-north fence post. There was one site location (S-46) that was identified as Priority-3 (increasing trend). S-46 is located at the Sand Building at the Operations Center. The maximum value from this location was noted to be 1.15 µg/g and was observed during the 2005 sampling period.

A summary of radiological sample results in soil collected between 1994 and 2006 can be found in Appendix A. This compilation of historical data is provided in graphical form to illustrate the value of long-term data evaluation, as well as short-term (five year trends). These plots indicate that there is no discernible difference between site, perimeter, and community sample results.

TLD Results

Sampling for 2006 was conducted from January 2006 through January 2007. TLDs were missing (not recovered) at several locations during 2006. When a TLD location has a missing quarter the data is not included in the summary statistics. Summary statistics for the past five years are shown in Table 4-8.

On-site and perimeter locations were statistically different from off-site locations. Off-site locations are statistically lower than either on-site or perimeter locations. There is no remarkable difference between any of the annual groupings of the data. Figure 4-1 graphically portrays the TLD results from 2002 through 2006. TLD results and TLD measurements, by quarter and location type, for 2006 are shown in Tables A-7 and A-8 of Appendix A, respectively.

4.1.6 Non-Radiological Parameters and Results

In 2006, soils were not analyzed for non-radiological constituents; however, all historical non-radiological soil analyses were analyzed and reported in a summary report (SNL 2006). In summary, the mean values of non-radiological constitutents in

TABLE 4-6. Summary Statistics for Soil Locations Noted as Priority-2 (all units in pCi/g unless otherwise noted)

Analyte	Location	Sample Size	Average	Median	Std Dev	Minimum	Maximum
Am-241	S-09	5	1.65	1.15	1.36	0.47	3.56
Total Uranium (µg/g)	P-35	5	1.14	1.01	0.24	0.94	1.49

NOTES: pCi/g = picocurie per gram µg/g = microgram per gram

TABLE 4-7. Summary Statistics for Soil Locations Noted as Priority-3 (all units in pCi/g unless otherwise noted)

Analyte	Location	Sample Size	Average	Median	Std Dev	Minimum	Maximum
Total Uranium (µg/g)	S-46	5	0.79	0.73	0.20	0.66	1.15

NOTES: pCi/g = picocurie per gram µg/g = microgram per gram

TABLE 4-8. Summary Statistics for TLDs by Location Class (all units in mrem unless otherwise noted)

Location Class	Sample Size	Average	Median	Std Dev	Minimum	Maximum
On-site	46	164.2	160.5	15.1	144.4	228.8
Perimeter	25	161.1	158.9	14.9	141.8	216.0
Off-site	13	143.9	149.8	13.9	122.0	163.2

NOTES: m/mrem = millirem

soils (metals in soils) were less, or not significantly higher, than the State of Nevada soil concentration range. (A full report is provided in Appendix B included in the CD attached to the back of this report.) This report serves as a baseline reference for non-radiological constituents in TTR soils. All non-radiological data are consistent with background levels for these constituents. In the future, routine sampling for non-radiological parameters at fixed locations will be reduced and more emphasis placed on sampling specific areas of interest with potential environmental impact.

4.2 WATER MONITORING

Results for potable water, wastewater effluent sampling, and the issue of storm water monitoring are discussed in this section.

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).

4.2.1 Production Well Monitoring

There are three active wells used by TTR. Production Well 6, Well 7, and the Roller Coaster Well. Production Well 6 and the Roller Coaster Well are the most active. Production Well 6, which supplies drinking water to the TTR Main Compound in Area 3, is the only well that has been sampled for contaminants. Outlying areas and buildings without water service use bottled water. The other wells are not used for potable purposes (construction and dust suppression), and there is no regulatory sampling requirement.

All sampling is conducted in accordance with requirements set by the state (State of Nevada 1997). Analytes are sampled at different intervals, as shown in Table 4-9.

Sampled parameters included, but were not limited to, total coliforms, nitrates, Total Trihalomethanes/ Haloacetic Acids, Secondary Standards, Phthlate, and arsenic.

The State of Nevada and DOE/NNSA/SSO conducted a Compliance/Acceptance Inspection of the newly constructed water system for Area 3 on February 21, 2006. They also inspected the newly installed backflow preventors throughout the system in August 15, 2006. Monitoring of the newly installed arsenic removal system also began in 2006. Sandia remained in compliance with all Well 6 permit monitoring requirements in 2006.

The following issues delayed providing drinking water from the newly constructed treatment facility; and, as a result, drinking water was first provided

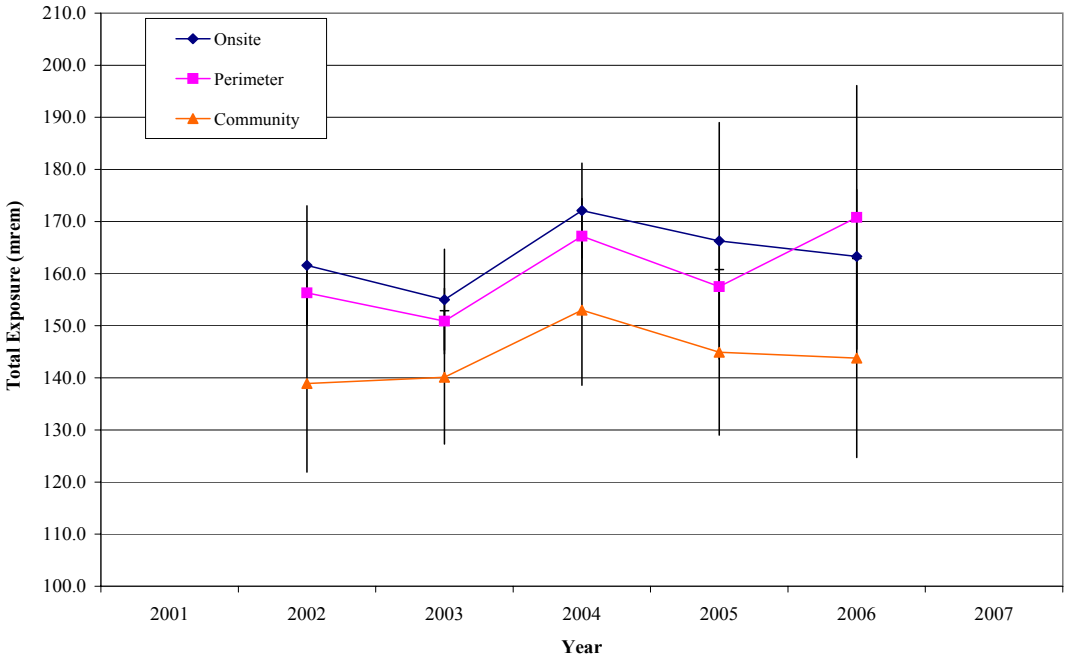

FIGURE 4-1. Tonopah Test Range TLD Exposure (2002-2006)

using bottled water until September 2006. After that time, the United States Air Force (USAF) public water system (PWS) became the source for the drinking water.

The State of Nevada required full Water Operator Treatment 2 (T-2) Certification prior to us providing drinking water from our treatment facility. Although two of our operators passed the T-2 Certification examination in 2005, the state required a year of operator-in-training time prior to obtaining full certification. This was not completed until June 30, 2006.

The new well pump malfunctioned on July 3, 2006 and was not repaired due to warranty issues until November 2006.

Production Well Monitoring Results

Quarterly Di (2-Ethylhexyl) Phthalate (DEHP) sampling was continued in 2006. In 2005, Di (2-Ethylhexyl) Phthalate was detected in one sample (well below the maximum concentration level [MCL]) and triggered quarterly monitoring for the contaminant until it is undetected in two consecutive quarterly samples. DEHP is the most commonly used of a group of related chemicals called phthalates or phthalic acid esters. The greatest use of DEHP is as a plasticizer for polyvinylchloride (PVC) and other polymers including rubber, cellulose, and styrene. A number of packaging materials and tubings used in the production of foods and beverages are PVC-contaminated with phthalic acid esters, primarily DEHP.

Secondary Contaminant Sample Results were received in December 2006. All parameters sampled were within State of Nevada defined MCL's with the exception of iron and potential of hydrogen (pH). Additional state required monitoring for iron and pH was conducted. At the end of the monitoring period the iron results were averaged, and they complied with the state's MCL. Sample pH has always been high out of Well 6. We are required to lower the pH of the raw water to between 6.5 and 7.0 on the pH scale for proper operation of the arsenic removal system. This brings the pH into compliance with the State of Nevada's MCL.

Figure 4-2 depicts the sampling history and efficiency of the arsenic removal system since it was installed. The line marked with 'crosses' depicts the raw water concentration of arsenic. Note that after our well pump malfunctioned in July the level of arsenic dropped until December, when it started rising rapidly. This is because we were supplementing the water in our elevated storage tower with USAF water that was already treated and had the arsenic removed. The line marked with 'squares' shows the pH level to illustrate the relationship of pH to arsenic removal effectiveness. The line desingated by 'diamonds' illustrates the

arsenic level in the finished water. The red line indicates the U.S. Environmental Protection Agency (EPA) regulatory limit for arsenic in drinking water of 10 parts per billion (ppb).

4.2.2 Sewage System and Septic Tank Monitoring

Sewage from TTR facilities in the Main Compound at Area 3 goes to the USAF facultative sewage lagoon. As a best management practice (BMP), either SNL/NM or Washington Group International (WGI) personnel take annual wastewater samples from Area 3 at the point where wastewater leaves TTR property and enters the USAF system.

The USAF holds the National Pollutant Discharge Elimination System (NPDES) permit for its wastewater discharges. The USAF takes quarterly samples from the headwater end of the lagoon. In the past, Sandia provided quarterly sampling results to USAF 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. Therefore, Sandia now only provides annual sample results to USAF.

Forty-eight hour composite wastewater samples are collected on an annual basis and have the following parameters analyzed:

- Total coliforms
- Total cyanide (cyanide-containing compounds are not used at TTR)
- pH (potential of hydrogen [acidity]) and non-filtered residue
- Phenolics (phenol containing compounds are not used at TTR)
- Chemical oxygen demand (COD)
- Volatile Organic Compounds (VOCs)
- Semi-volatile Organic Compounds (SVOCs)
- Metals (cadmium, chromium, copper, nickel, silver, zinc, lead, selenium, and mercury)
- Total recoverable petroleum hydrocarbons (TRPH)
- Oil and grease
- Tritium, gamma spectroscopy, gross alpha/ beta

All analytical results for wastewater sampled at Area 3 were within regulatory limits in 2006.

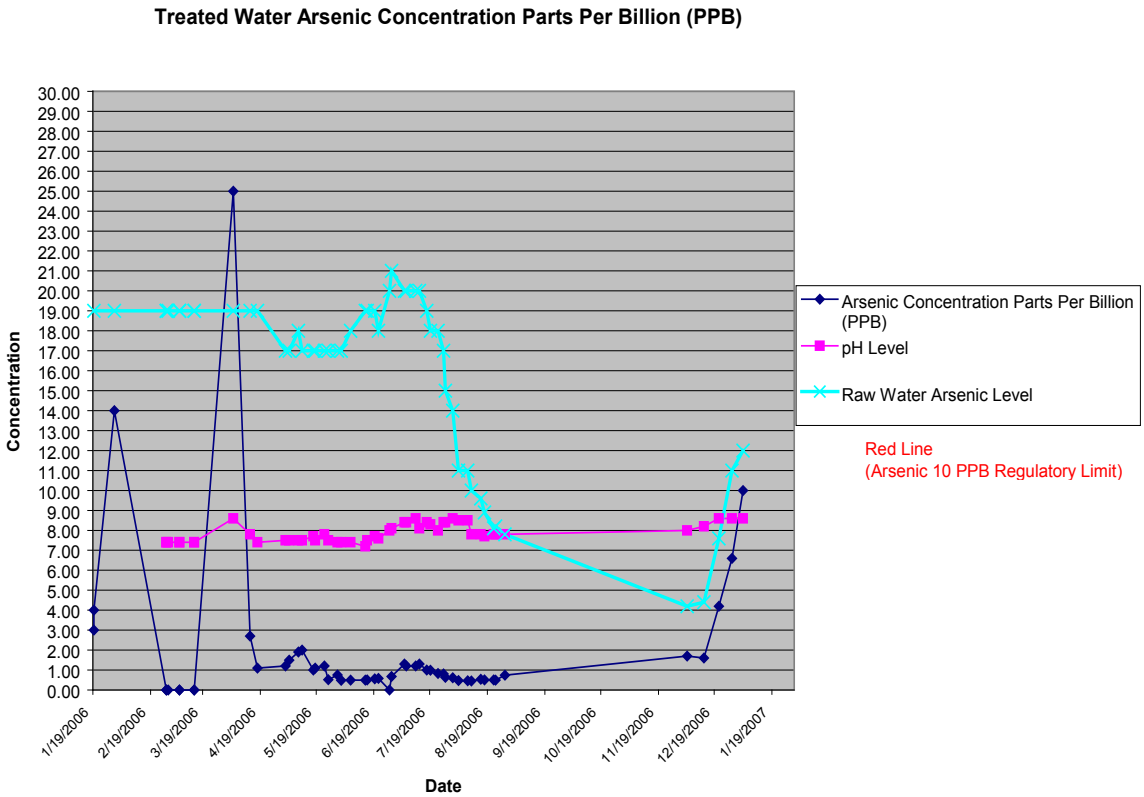

FIGURE 4-2. TTR Sampling History and Arsenic Removal System Efficiency

TABLE 4-9. Production Well Monitoring at TTR

Analyte	Sampling Frequency
Total Coliform	Monthly
Nitrate, Secondary (13) Drinking Water Standards	2003
Dioxin,Nitrate, Total Trihalomethanes/Haloacetic Acids (5)	2004
Arsenic, IOC's Phase II, IOC's Phase V, Nitrate, Nitrite Nitrate and Nitrite (Total), SOC's Phase II, SOC's Phase V Total Trihalomethanes/Haloacetic Acids (5), VOC's Phase I and II, VOC's Phase V,	2005
Asbestos, Lead/Copper, Nitrate, Secondary (13) Drinking Water Standards Total Trihalomethanes/Haloacetic Acids (5)	2006
Dioxin, Nitrate	2007
Arsenic, IOC's Phase II, IOC's Phase V, Nitrate, Nitrite, Nitrate and Nitrite (Total) SOC's Phase II, SOC's Phase V, VOC's Phase I and II, VOC's Phase V	2008
Lead/Copper, Nitrate, Secondary (13) Drinking Water Standards	2009
Dioxin, Nitrate	2010

NOTES: IOC = inorganic compounds
VOC = volatile organic compounds
SOC = synthetic organic compounds

TABLE 4-10. Calculated Dose Assessment Results for On-site Receptor

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

NOTES: *Dose calculated from continuous monitoring February 1996 to February 1997.
EDE = effective dose equivalent
MEI = maximally exposed individual
mrem/yr = millirem per year
mSv/yr = millisievert per year
TTR = Tonopah Test Range
[1] Natural background is estimated at 250 mrem/yr nationwide.

Septic Tank Systems

The septic tank and leach field installed in Area 9 in late 2005 was not used in 2006. Septic tank systems are sampled, as needed. There are now seven septic systems located on-site, which are owned by DOE/NNSA at TTR. These seven active septic tanks are used in remote locations and are maintained by the TTR facilities group. The sewage from these locations flows into septic tanks and associated drain fields. None of these systems required maintenance, sampling, or pumping in 2006. All other remaining septic systems have been closed or are undergoing closure and are being addressed by the ER Project.

4.2.3 Storm Water Monitoring

Currently, Sandia has no requirement to perform storm water monitoring at TTR. All storm water issues and monitoring are managed by the USAF.

4.3 RADIOLOGICAL AIR MONITORING

Air Quality Compliance (AQC) at TTR is met by adherence to specific permit conditions and local, state, and federal air regulations. Ambient air quality monitoring is not currently required at TTR. Ambient air monitoring was last conducted in 1996

Security at Tonopah Test Range

to ascertain the level of radiological constituents in the air as discussed below.

Sandia operations 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 ER sites. Other ER sites with minor radiological contamination, such as DU, do not produce significant air emission sources from re-suspension.

NESHAP

NESHAP, 40 CFR 61, Subpart H, *National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities*, has set a maximum of 10 millirems per year (mrem/yr) for all combined air emission pathway sources from any DOE/NNSA facility. Although the dose calculated from the Clean Slate sites is many times less than this standard, there was a question of whether the sites would require continuous radiological air monitoring.

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 EPA requires continuous air monitoring for any radionuclide source that contributes a dose in excess of 0.1 mrem/yr to the MEI, Sandia instituted continuous air monitoring at a site for one year from February 22, 1996 to February 25, 1997. The monitoring site was chosen at the TTR Airport, the location of the highest calculated dose for a member of the public. 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 four 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:

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

Although an annual calculated dose assessment is not required for the site, Sandia continues to produce an annual NESHAP report for TTR (SNL 2007a). The results from the 1996 to 1997 monitoring will continue to be used for as long as there is no change in the status of the Clean Slate sites. Table 4-10 summarizes these dose assessment results. Future TTR activities are not expected to change; however, if new sources or modifications to the existing sources are anticipated, they will be evaluated for NESHAP applicability.

4.4 NON-RADIOLOGICAL AIR EMISSIONS

The TTR Class II Air Quality Operating Permit was renewed in CY 2006. There are currently two sources that are not exempt at the facility, including the screening plant and the portable screen. In 2006, there were no emissions reported to the State of Nevada because neither source was used.

Vegetation at Antelope Peak Road

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chapter five

2006 ANNUAL SITE ENVIRONMENTAL REPORT FOR THE KAUAI TEST FACILITY

Photo by: G. Dean Manning

In This Chapter...

Environmental Snapshot

There were no reportable occurrences at the Kauai Test Facility in 2006.

Sandia National Laboratories/Kauai Test Facility (SNL/KTF) is a government owned, contractor operated laboratory. Sandia Corporation (Sandia), a wholly owned subsidiary of Lockheed Martin Corporation, manages and operates KTF for the U.S. Department of Energy (DOE)/National Nuclear Security Administration (NNSA). KTF is operated as a rocket preparation, launching, and tracking facility for DOE/NNSA, as well as in support of other U.S. military agencies. The DOE/NNSA/Sandia Site Office (SSO) in Albuquerque, New Mexico administers the contract and oversees contractor operations at the site. SNL/KTF exists as a facility within the boundaries of the U.S. Department of Defense (DoD) Pacific Missile Range Facility (PMRF). SNL/KTF is located on the island of Kauai at the north end of the PMRF, near Nohili Point (Figure 5-1). This Annual Site Environmental Report (ASER) summarizes data and the compliance status of environmental protection and monitoring programs at SNL/KTF for Calendar Year (CY) 2006. This report was prepared in accordance with DOE Order 450.1, *Environmental Protection Program* (DOE 2005) and DOE Manual 231.1A, *Environment, Safety, and Health Reporting* (DOE 2004).

5.1 FACILITIES AND OPERATIONS

SNL/KTF has been an active rocket launching facility since 1962. The KTF and Remote Range Interfaces Department, under Sandia, manages and conducts rocket launching activities at SNL/KTF. The site is primarily used for testing rocket systems with scientific and technological payloads, advanced development of maneuvering re-entry vehicles, scientific studies of atmospheric and exoatmospheric phenomena, and Missile Defense Agency (MDA) programs. Nuclear devices have never been launched from SNL/KTF.

The first facilities at KTF were constructed in the early 1960s to support the National Readiness Program. The most recent construction, completed in March 2005, extended the Missile Service Tower (MST) to support DOE and MDA. From 1992 to 2006, there have been 26 launches.

The KTF launcher field was originally designed to accommodate 40 launch pads, but only 15 pads were constructed. Of these, 11 have had their launchers removed. Beyond the implementation of portions of the original plan, two additional launch pads were constructed: Pad 41 at Kokole Point and Pad 42 (the MST launch pad). The launcher field site has a number of permanent facilities used to support rocket operations. In addition to rocket launch pad sites, SNL/KTF facilities include missile assembly areas, data acquisition and operations facilities, a maintenance shop, and a trailer compound for administration and technical support personnel. Other features at SNL/KTF include extensive radar tracking and worldwide radio communication access to other DoD facilities.

The administrative area of SNL/KTF, known as the Main Compound, is located within a fenced area near the North Nohili access road from PMRF. Inside the fenced compound, a number of trailers and vans are connected together with a network of concrete docks and covered walkways. The majority of these temporary facilities are used during operational periods to support the field staff at SNL/KTF. During non-operational periods, general maintenance continues and dehumidifiers remain in operation (to protect equipment). Additionally, there are a number of permanent buildings, most of which are in use year round to support and maintain SNL/KTF facilities.

5.2 2006 ROCKET LAUNCHES

There were three rocket launches from SNL/KTF in 2006. The launches were covered by the KTF Environmental Assessment (EA), published in July 1992 (DOE 1992a) and the U.S. DoD, PMRF, Enhanced Capability Final (DoD 1998):

- AEGIS TBMD, FTM-10, June 22, 2006;
- AEGIS TBMD, FTM-11, ARAV, November 17, 2006; and
- TTV-7, December 7, 2006.

Rocket Launch at Kauai Test Facility

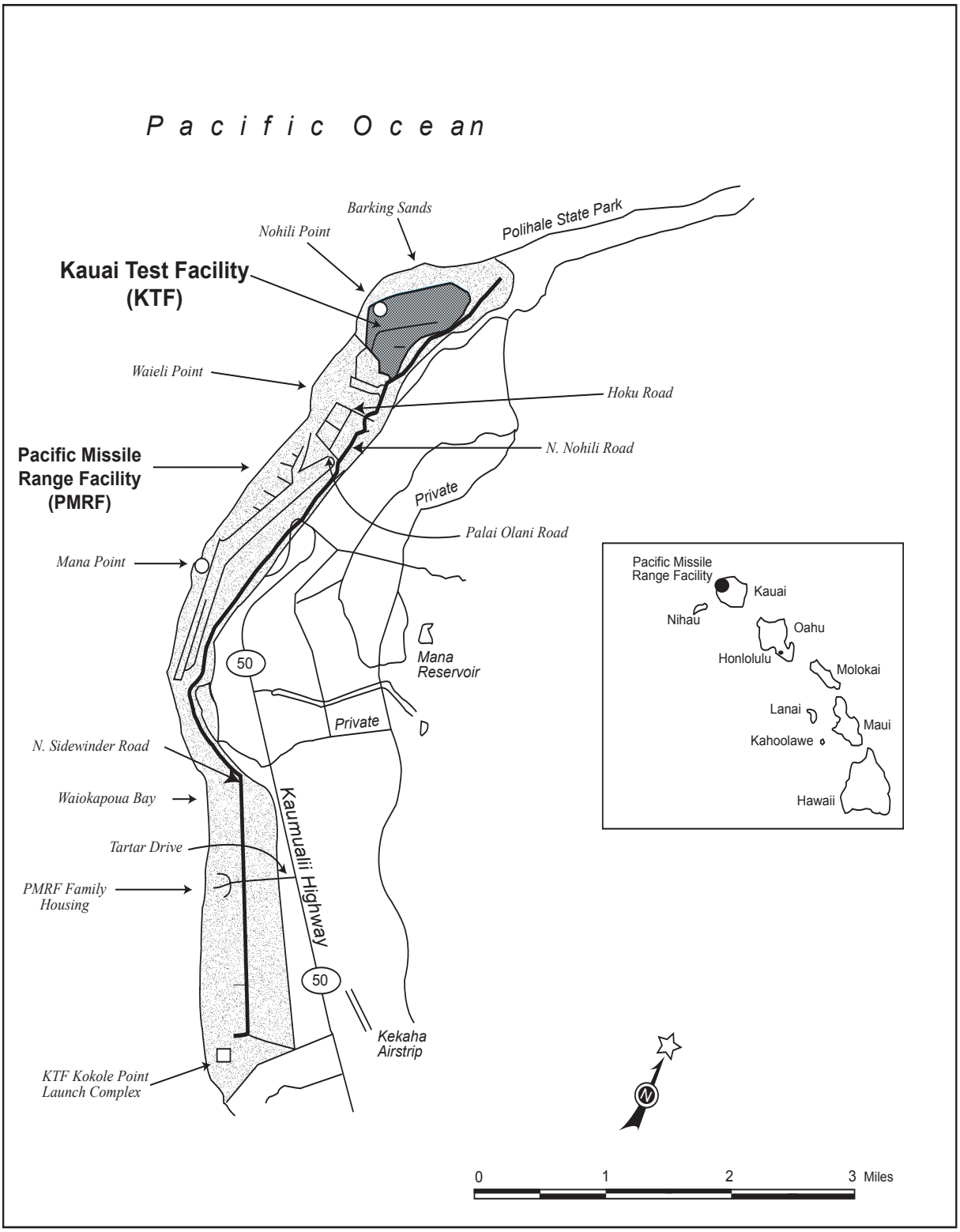

FIGURE 5-1. Map of the Pacific Missile Range Facility (PMRF) and the Adjacent Area (The Kauai Test Facility (KTF) is to the north, near Nohili Point)

TABLE 5-1. Permits in Place at SNL/KTF

Type	Permit Number	Date Issued	Expiration Date	Regulatory Agency
Non-covered Source Permit (NSP) (two stand-by diesel generators)	NSP 0429-01-N	April 30, 2004	April 29, 2009	State of Hawaii
Resource Conservation and Recovery Act (RCRA)	HI-0000-363309	Sept. 23, 1994	Not specified	EPA Region IX and Hawaii Dept. of Health
Underground Storage Tank (UST) (2,500)	Not applicable	Sept. 13, 1991	Indefinite	EPA Region IX and Hawaii Dept. of Health

NOTE: In 1999, there was a change in reporting fuel through put from annual reporting to biannual reporting to the State of Hawaii.
SNL/KTF = Sandia National Laboratories, Kauai Test Facility
EPA = U.S. Environmental Protection Agency
UST = Underground Storage Tank

5.3 DEMOGRAPHICS

There are 17 permanent on-site personnel at SNL/KTF. During operational periods when rocket launches occur, an additional 15 to 130 persons from the U.S. mainland are brought to SNL/KTF (DOE 1992a). The closest population center to SNL/KTF is the town of Kekaha (population 3,300), which is eight miles from the site.

5.4 COMPLIANCE SUMMARY

The list of regulations and statutes on page 5-5 provides an overview of the compliance status for Sandia operations at SNL/KTF in 2006. Table 5-1 lists the applicable permits in place at SNL/KTF.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
CERCLA, also known as "Superfund," addresses areas of past spills and releases. SNL/KTF has no current Environmental Restoration (ER) areas located on-site.

The U.S. Environmental Protection Agency (EPA) designated ongoing oversight of SNL/KTF to the Hawaii Department of Health Hazard Evaluation and Emergency Response Office. The EPA recommended continued reevaluation for environmental contamination due to the launching facility. Rocket exhaust continues to be the main source of metals and other non-reportable air emission releases.

Superfund Amendments and Reauthorization Act (SARA)
The SARA Title III amended CERCLA requirements for reportable quantity (RQ) releases and chemical inventory reporting as directed by the Emergency Planning and Community Right-to-Know Act (EPCRA), Sections 311 and 312. All required information has been submitted to the State of Hawaii. There were no reportable releases at SNL/KTF under EPCRA or CERCLA in 2006. Table 5-2 lists SARA Title III reporting requirements.

Resource Conservation and Recovery Act (RCRA)
In 1994, SNL/KTF reached "small quantity hazardous waste generator" status as defined by RCRA and, therefore, obtained an EPA identification number. However, the volume of waste generated in 2006 qualified SNL/KTF to maintain "conditionally exempt small quantity generator" status.

Federal Facility Compliance Act (FFCA)
The FFCA addresses the disposition of mixed waste (MW) at federal facilities. No radioactive waste of any kind has been generated or stored at SNL/KTF, and this statute, therefore, is not applicable to the site.

National Environmental Policy Act (NEPA)
NEPA requires federal agencies and other organizations that perform federally sponsored

Major Environmental Regulations & Statutes Applicable to KTF

Clean Air Act (CAA) and CAA Amendments (CAAA)
Provides standards to protect the nation's air quality. http://www.epa.gov/oar/oaq_caa.html

Clean Water Act (CWA)
Provides general water quality standards to protect the nation's water sources and byways.
http://www.epa.gov/region5/water/cwa.htm

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
Provides federal funding for cleanup of inactive waste sites on the National Priorities List (NPL) and mandates requirements for reportable releases of hazardous substances. http://www.epa.gov/region5/defs/html/cercla.htm

Cultural resources acts
Includes various acts that protect archeological, historical, religious sites, and resources.
http://water.usgs.gov/eap/env_guide/cultural.html

Endangered Species Act (ESA)
Provides special protection status for federally listed endangered or threatened species.
http://www.epa.gov/region5/defs/html/esa.htm

Executive Orders (EOs)
Several EOs provide specific protection for wetlands, floodplains, environmental justice in minority and low-income populations, and promotes greening the government through leadership in environmental management.
http://www.archives.gov/federal_register/executive_orders/disposition.html

Federal Facility Compliance Act (FFCA)
Directs federal agencies regarding environmental compliance. http://tis.eh.doe.gov/oepa/laws/ffca.html

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
Controls the distribution and use of various pesticides. http://www.epa.gov/region5/defs/html/fifra.htm

Migratory Bird Treaty Act (MBTA) of 1918
Prevents the taking, killing, possession, transportation and importation of migratory birds, their eggs, parts, and nests. http://tis.eh.doe.gov/oepa/laws/mbta.html

National Emission Standards for Hazardous Air Pollutants (NESHAP)
Specifies standards for radionuclide air emissions and other hazardous air releases under the CAA.
http://www.epa.gov/radiation/neshaps/

National Environmental Policy Act (NEPA)
Requires federal agencies to review all proposed activities so as to include environmental aspects in agency decision making. http://tis.eh.doe.gov/NEPA/

Resource Conservation and Recovery Act (RCRA)
Mandates the management of solid and hazardous waste and certain materials stored in underground storage tanks. (USTs) http://www.epa.gov/region5/defs/html/rcra.htm

Safe Drinking Water Act (SDWA)
Provides specific health standards used for drinking water sources. http://www.epa.gov/safewater/sdwa/sdwa.html

Superfund Amendments and Reauthorization Act (SARA)
SARA,Title III, also 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.
http://www.epa.gov/region5/defs/html/sara.htm

Toxic Substance Control Act (TSCA)
Specifies rules for the manufacture, distribution, and disposal of specific toxic materials such as asbestos and polychlorinated biphenyls (PCBs). http://www.epa.gov/compliance/civil/tsca/index.html

TABLE 5-2. 2006 SARA Title III (or EPCRA) Reporting Requirements Applicable to SNL/KTF

Section	SARA Title III Section Title	Requires Reporting?		Description
		Yes	No	
302 - 303	Notification/ Plans	✓		Sandia Corporation submits an annual report listing chemical inventories above the reportable Threshold Planning Quantities listed in 40 CFR Part 355 Appendix B, location of the chemicals and emergency contacts. The report is prepared for the DOE/NNSA/ SSO, which distributes it to the required entities.
304	Emergency Notification		✓	No RQ releases of an EHS, or as defined under CERCLA occured.
311-312	MSDSs/ Chemical Purchase Inventory Report	✓		There are two "Community Right-to-Know" reporting requirements: (a) SNL/KTF completes the EPA Tier II forms for all hazardous chemicals present at the facility at any one time in amounts equal to or greater than 10,000 lbs and for all EHSs present at the facility in an amount greater than or equal to 500 lbs or the Threshold Planning Quantity, whichever is lower; (b) SNL/KTF provides MSDSs for each chemical entry on a Tier II form unless it decides to comply with the EPA's alternative MSDS reporting, which is detailed in 40 CFR Part 370.21.
313	Toxic Chemical Release Forms		✓	Sandia Corporation is below the reporting threshold in 2006 for producing a TRI Report for SNL/KTF operations.

NOTES: RQ = reportable quantity
EHS = extremely hazardous substance
EPA = U.S. Environmental Protection Agency
SARA = Superfund Amendments and Reauthorization Act
EPCRA = Emergency Planning and Community Right-to-Know Act
MSDS = Material Safety Data Sheets (gives relevant chemical information)
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
DOE/NNSA/SSO = U.S. Department of Energy, National Nuclear Security Administration, Sandia Site Office
TRI = Toxic Release Inventory
SNL/KTF = Sandia National Laboratories, Kauai Test Facility

projects to consider environmental issues associated with proposed actions, be aware of the potential environmental impacts associated with these issues, and include this information in early project planning and decision making. Additionally, if a proposed action is determined to have environmentally "significant" impacts, the agency must prepare an environmental assessment (EA) or an environmental impact statement (EIS) before making an irretrievable commitment of resources or funding. Although a major objective of NEPA is to preserve the environment for future generations, the law does not require an agency to choose a course of action with the least environmental impacts. The DOE/NNSA/SSO coordinates NEPA compliance at SNL/KTF with SNL/NM personnel.

Endangered Species Act (ESA)

The 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. The ESA is addressed under the NEPA Program and Ecology 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.

Table 5-3 lists all threatened and endangered state and federal listed species occurring on the island of Kauai.

Cultural Resources Acts

The three primary cultural resources acts applicable at SNL/KTF are as follows:

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

TABLE 5-3. Threatened and Endangered Species Potentially Occurring on SNL/KTF

Common Name	Scientific Name	Federal Status	State Status
PLANTS			
Liliwai	*Acaena exigua*	Endangered	Endangered
No common name	*Achyranthes mutica*	Endangered	Endangered
Mahoe	*Alectryon macrococcus*	Endangered	Endangered
Kuawawaenohu	*Alsinidendron lychnoides*	Endangered	Endangered
No common name	*Alsinidendron viscosum*	Endangered	Endangered
No common name	*Bonamia menziesii*	Endangered	Endangered
Olulu	*Brighamia insignis*	Endangered	Endangered
Uhiuhi	*Caesalpinia kavaiense*	Endangered	Endangered
‘Awiwi	*Centaurium sebaeoides*	Endangered	Endangered
No common name	*Chamaesyce halemanui*	Endangered	Endangered
Pauoa	*Ctenitis squamigera*	Endangered	Endangered
Haha	*Cyanea asarifolia*	Endangered	Endangered
Haha	*Cyanea recta*	Threatened	Threatened
Haha	*Cyanea remyi*	Endangered	Endangered
Haha	*Cyanea undulata*	Endangered	Endangered
Pu’uka’a	*Cyperus trachysanthos*	Endangered	Endangered
Ha’iwale	*Cyrtandra limahuliensis*	Threatened	Threatened
Mapele	*Cyrtandra cyaneoides*	Endangered	Endangered
No common name	*Delissea rhytidosperma*	Endangered	Endangered
‘Oha	*Delissea rivularis*	Endangered	Endangered
Asplenium Leaved Diella	*Diellia erecta*	Endangered	Endangered
No common name	*Diellia pallida*	Endangered	Endangered
No common name	*Diplazium molokaiense*	Endangered	Endangered
Na’ena’e	*Dubautia pauciflorula*	Endangered	Endangered
Na’ena’e	*Dubautia latifolia*	Endangered	Endangered
‘Akoko	*Euphorbia haeleeleana*	Endangered	Endangered
Heau	*Exocarpos luteolus*	Endangered	Endangered
Mehamehame	*Flueggea neowawraea*	Endangered	Endangered
No common name	*Gouania meyenii*	Endangered	Endangered
Honohono	*Haplostachys haplostachya*	Endangered	Endangered
‘Awiwi	*Hedyotis cookiana*	Endangered	Endangered
Na Pali Beach Hedyotis	*Hedyotis st.-johnii*	Endangered	Endangered
No common name	*Hesperomannia lydgatei*	Endangered	Endangered
Kauai Hau Kuahiwi	*Hibiscadelphus distans*	Endangered	Endangered
Hau Kuahiwi	*Hibiscadelphus woodii*	Endangered	Endangered
Hibiscus, Clay’s	*Hibiscus clayi*	Endangered	Endangered
Koki’o ke’oke’o	*Hibiscus waimeae ssp. hannerae*	Endangered	Endangered
Wawae’iole	*Huperzia mannii (Phlegmariurus mannii)*	Endangered	Endangered
Ischaemum, Hilo	*Ischaemum byrone*	Endangered	Endangered
Aupaka	*Isodendrion laurifolium*	Endangered	Endangered
Aupaka	*Isodendrion longifolium*	Threatened	Threatened
Koki’o	*Kokia kauaiensis*	Endangered	Endangered

TABLE 5-3. Threatened and Endangered Species Potentially Occurring on SNL/KTF (continued)

Common Name	Scientific Name	Federal Status	State Status
Kamakahala	*Labordia lydgatei*	Endangered	Endangered
Kamakahala	*Labordia tinifolia var. wahiawaensis*	Endangered	Endangered
Nehe	*Lipochaeta fauriei*	Endangered	Endangered
Nehe	*Lipochaeta micrantha*	Endangered	Endangered
Nehe	*Lipochaeta waimeaensis*	Endangered	Endangered
Wawae'iole	*Lycopodium nutans (Phlegmariurus nutans)*	Endangered	Endangered
No common name	*Lysimachia filifolia*	Endangered	Endangered
No common name	*Mariscus pennatiformis ssp. pennatiformis*	Endangered	Endangered
Alani	*Melicope haupuensis*	Endangered	Endangered
Alani	*Melicope knudsenii*	Endangered	Endangered
Alani	*Melicope pallida*	Endangered	Endangered
Alani	*Melicope quadrangularis*	Endangered	Endangered
No common name	*Munroidendron racemosum*	Endangered	Endangered
Kolea	*Myrsine linearifolia*	Threatened	Threatened
'Aiea	*Nothocestrum peltatum*	Endangered	Endangered
Lau 'ehu	*Panicum niihauense*	Endangered	Endangered
Makou	*Peucedanum sandwicense*	Threatened	Threatened
No common name	*Phyllostegia glabra var. lanaiensis*	Endangered	Endangered
No common name	*Phyllostegia knudsenii*	Endangered	Endangered
No common name	*Phyllostegia waimeae*	Endangered	Endangered
No common name	*Phyllostegia wawrana*	Endangered	Endangered
No common name	*Platanthera holochila*	Endangered	Endangered
Mann's Bluegrass	*Poa mannii*	Endangered	Endangered
Hawaiian Bluegrass	*Poa sandvicensis*	Endangered	Endangered
No common name	*Poa siphonoglossa*	Endangered	Endangered
Lo'ulu	*Pritchardia napaliensis*	Endangered	Endangered
Lo'ulu	*Pritchardia viscosa*	Endangered	Endangered
Kaulu	*Pteralyxia kauaiensis*	Endangered	Endangered
No common name	*Remya kauaiensis*	Endangered	Endangered
No common name	*Remya montgomeryi*	Endangered	Endangered
Dwarf Naupaka	*Scaevola coriacea*	Endangered	Endangered
Ma'oli'oli	*Schiedea apokremnos*	Endangered	Endangered
No common name	*Schiedea helleri*	Endangered	Endangered
No common name	*Schiedea kauaiensis*	Endangered	Endangered
No common name	*Schiedea membranacea*	Endangered	Endangered
No common name	*Schiedea nuttallii*	Endangered	Endangered
No common name	*Schiedea spergulina var. leiopoda*	Endangered	Endangered
No common name	*Schiedea spergulina var. spergulina*	Threatened	Threatened
Laulihilihi	*Schiedea stellarioides*	Endangered	Endangered
'Ohai	*Sesbania tomentosa*	Endangered	Endangered
No common name	*Silene lanceolata*	Endangered	Endangered
Popolo Ku Mai	*Solanum incompletum*	Endangered	Endangered

TABLE 5-3. Threatened and Endangered Species Potentially Occurring on SNL/KTF (concluded)

Common Name	Scientific Name	Federal Status	State Status
Popolo ʻaiakeakua	*Solanum sandwicense*	Endangered	Endangered
No common name	*Spermolepis hawaiiensis*	Endangered	Endangered
No common name	*Stenogyne campanulata*	Endangered	Endangered
No common name	*Viola helenae*	Endangered	Endangered
Nani wai'ale'ale	*Viola kauaensis var. wahiawaensis*	Endangered	Endangered
Iliau, Dwarf	*Wilkesia hobdyi*	Endangered	Endangered
No common name	*Xylosma crenatum*	Endangered	Endangered
A'e	*Zanthoxylum dipetalum*	Endangered	Endangered
A'e	*Zanthoxylum hawaiiense*	Endangered	Endangered
ANIMALS			
Mammals			
Hawaiian Hoary Bat	*Lasiurus cinereus semotus*	Endangered	Endangered
Hawaiian Monk Seal	*Monachus schauinslandi*	Endangered	Endangered
Birds			
Hawaiian Duck	*Anas wyvilliana*	Endangered	Endangered
Hawaiian Coot	*Fulica americana alai*	Endangered	Endangered
Hawaiian Gallinule	*Gallinula chloropus sandvicensis*	Endangered	Endangered
Kauai Nuku pu'u	*Hemignathus lucidus hanapepe*	Endangered	Endangered
Kauai ʻAkia loa	*Hemignathus procerus*	Endangered	Endangered
Black-necked Stilt	*Himantopus mexicanus knudseni*	Endangered	Endangered
Kauai ʻO'o	*Moho braccatus*	Endangered	Endangered
Large Kauai Thrush	*Myadestes myadestinus*	Endangered	Endangered
Small Kauai Solitare	*Myadestes palmeri*	Endangered	Endangered
Hawaiian Goose	*Nesochen sandvicensis*	Endangered	Endangered
No common name	*Psittirostra psittacea*	Endangered	Endangered
Dark-rumped Petrel	*Pterodroma phaeopygia sandwichensis*	Endangered	Endangered
Newell's Shearwater	*Puffinus auricularis newelli*	Threatened	Threatened
Reptiles			
Loggerhead Sea Turtle (incidental in Hawaii)	*Caretta caretta*	Threatened	Threatened
Green Sea Turtle	*Chelonia mydas*	Threatened	Threatened
Leatherback Sea Turtle (incidental in Hawaii)	*Dermochelys coriaceae*	Endangered	Endangered
Hawksbill Turtle	*Eretmochelys imbricata*	Endangered	Endangered
Snails			
Newcomb's Snail	*Erinna newcombi*	Threatened	Threatened
Arachnids			
Kauai Cave Wolf Spider	*Adelocosa anops*	Endangered	Endangered
Insects			
Blackburn's Sphinx Moth	*Manduca blackburni*	Endangered	Endangered
Kauai Pomace Fly	*Drosophila musaphila*	Proposed Endangered	Proposed Endangered
Crustaceans			
Kauai Cave Amphipod	*Spelaeorchestia koloana*	Endangered	Endangered

At SNL/KTF, cultural resources compliance is coordinated through the NEPA Program. Actions that could adversely affect cultural resources are initially analyzed in a NEPA checklist.

Migratory Bird Treaty Act (MBTA) of 1918

The MBTA of 1918 implemented the 1916 Convention for the Protection of Migratory Birds. The original statute implemented the agreement between the U.S. and Great Britain (for Canada), and later amendments implemented treaties between the U.S. and Mexico, the U.S. and Japan, and the U.S. and Russia. In addition to the special consideration afforded to species listed as threatened and endangered, most birds are protected under the MBTA of 1918, as amended. At SNL/KTF, the MBTA is coordinated with NEPA compliance reviews and the Ecology Program.

Environmental Compliance Executive Orders (EOs)

The primary EOs related to environmental compliance at SNL/KTF are as follows:

- EO 11990, *Protection of Wetlands,* as amended.
- EO 11988, *Floodplain Management*, as amended.
- EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,* as amended.
- EO 13101, *Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition.*
- EO 13148, *Greening the Government Through Leadership in Environmental Management.*
- EO 13149, *Greening the Government Through Federal Fleet and Transportation Efficiency.*
- EO 13123, *Greening the Government Through Efficient Energy Management.*

EOs 13101, 13123, 13148, and 13149 were revoked by EO 13423 in January 2007; however, they are listed here as they were in force during 2006. EO 13423 combines the EOs it replaces into an omnibus EO that instructs federal agencies to conduct their missions "in an environmentally, economically and fiscally sound, integrated, continuously improving, efficient, and sustainable manner" (EO 13423).

Clean Air Act (CAA) and Clean Air Act Amendments (CAAA) of 1990

Ambient air quality is regulated by Hawaii Administrative Rules (HAR), Title 11, Chapter 59 under the jurisdiction of the Hawaii Department of Health, Clean Air Branch. Currently, there are no facilities at SNL/KTF that require federal air permits or compliance with the New Source Performance Standards (NSPS), *Prevention of Significant Deterioration* (PSD), or 40 CFR 61, *National Emission Standards for Hazardous Air*

Kauai Monk Seal

Pollutants (NESHAP). Within the boundaries of PMRF, no federal air emission permits are held either by DOE for SNL/KTF, or by DoD for PMRF. However, the two electrical generators at SNL/KTF are permitted for operation by the State of Hawaii under a "Non-covered Source Permit (NSP)" (Hawaii Department of Health 2004).

As required by the State of Hawaii, the 2005 Annual Fee and Monitoring Report (air emissions) was submitted to the State of Hawaii on January 31, 2006. In 2006, the total fuel usage reported to the State of Hawaii was 15,867 gallons (gal) of diesel fuel. Sandia was in compliance with all air quality regulations in 2006.

Rocket launches are mobile sources and do not require any reporting of reportable quantity (RQ) releases.

Clean Water Act (CWA)
There were no compliance issues with respect to any state or federal water pollution regulations in 2006. There are three septic tanks on-site owned by SNL/KTF facilities. The two older septic tanks for the Launch Operations Building (LOB) and the Missile Assembly Building (MAB) do not require permits from the State of Hawaii. A new septic tank and leach field was installed by Aqua Engineers, and a new permit obtained, in January 2006.

A National Pollutant Discharge Elimination System (NPDES) permit is not required due to the lack of significant storm water runoff discharging into "Waters of the U.S." as defined in 40 CFR 122. However, this is not to say that there is no runoff. The EPA has concern with storm water runoff washing off the launcher pads and discharging to the ocean. Some of the downstream pathways include habitat for several federally designated endangered or threatened species. The EPA has therefore recommended periodic evaluations for environmental contamination.

Oil Storage – There is one underground storage tank (UST) at SNL/KTF, which is owned by the DOE. There is also one 10,000 gal above ground fuel tank inside the Main Compound. Sandia cooperates with the U.S. Navy's (USN) spill control guidelines contained in the *Spill Prevention Control and Countermeasures Plan, Pacific Missile Range Facility* (NFEC 2003).

Safe Drinking Water Act (SDWA)
The SDWA does not apply directly to Sandia activities at SNL/KTF because all drinking water is obtained through PMRF's facilities or is purchased from commercial suppliers.

Toxic Substances Control Act (TSCA)
TSCA regulates the distribution of polychlorinated biphenyls (PCBs) and asbestos. The transformers on the SNL/KTF site have been tested and are free of PCBs, and there are no asbestos issues at the site.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
FIFRA controls the distribution and application of pesticides including herbicides, insecticides, and rodenticides. All pesticide use at SNL/KTF follows EPA requirements.

Releases and Occurrences
There were no reportable occurrences at SNL/KTF in 2006.

5.5 ENVIRONMENTAL PROGRAM ACTIVITIES

This section describes three environmental programs: NEPA, the ER Project, and the Spill Prevention Program.

NEPA Program Activities
The DOE completed a comprehensive site-wide EA for SNL/KTF operations in 1992 (DOE 1992a), which resulted in a Finding of No Significant Impact (FONSI), issued on July 17, 1992. This EA provided NEPA documentation covering all rocket launching activities at SNL/KTF; however, in late Fiscal Year (FY) 2005, the DOE/NNSA/SSO determined it was time to review and update the site-wide EA for KTF. During 2006, the USN initiated preparation of a draft Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for the Hawaii Range Complex.The environmental impact analysis for KTF will be included in this EIS.

ER Project Activities
There are no ER sites at SNL/KTF. The three ER sites identified in 1995 were given a No Further Action (NFA) determination by EPA on September 30, 1996. This confirmed that SNL/KTF met all

CERCLA requirements and no additional sampling or remediation would be necessary in the three areas. This, however, does not preclude that other environmental sampling activities will take place at SNL/KTF.

5.6 ENVIRONMENTAL SURVEILLANCE AND MONITORING ACTIVITIES

Wastewater Monitoring

Sandia activities at SNL/KTF produce only sanitary sewage, which is directed into eight wastewater systems—three septic tanks and five French drains with pumping systems located in the LOB parking lot, the paved drive west of the office complex, the paved lot west of the garage, the drive west of the shops, and the parking lot east of the office complex—in accordance with Hawaii Underground Injection Control regulations (HAR Title 11, Chapter 23). The septic systems are periodically pumped by licensed, state-certified contractors and inspected by state officials. No state inspections were conducted during 2006. The limited quantity of sewage released does not impact any protected waters and, as noted earlier, there are no drinking water wells in the area of SNL/KTF. Currently, septic tanks do not require permitting or sampling. As a best management practice (BMP), Sandia periodically performs sampling. No contaminants were identified above the reporting limits from past sampling events.

Air Emission Monitoring

Based on effluent air monitoring results of the STARS Flight Test Unit 1 (FTU-1) in February 1993 and the CDX rocket launch in the summer of 1992 (SNL 1992), it was determined that rocket launches at SNL/KTF were not a significant source of air pollutants. Launches are infrequent and emissions recorded did not exceed federal and state standards. Because the STARS-type rocket produces the greatest air emissions and remained within acceptable limits, it can be assumed that future launches of this type will also be within acceptable limits. Therefore, no further air emission monitoring is planned at this time. If a new rocket type is launched from SNL/KTF that differs in emission substance from the STARS rocket, or air emission requirements change, future monitoring may be considered.

Meteorological Monitoring

On-site meteorological instruments are used during test periods to characterize atmospheric transport, diffusion conditions, and stability classes. Due to the infrequency of launches, no formal meteorological monitoring plan is in place for SNL/KTF. Climatic information representative of SNL/KTF is obtained from PMRF.

Noise Monitoring

In accordance with the Quiet Communities Act of 1978 (42 U.S.C. 4901 et seq.), noise monitoring was conducted in February 1993 during the STARS FTU-1 launch to confirm the determination made in the STARS EIS that noise produced from the largest launch would be below maximum acceptable levels (SNL 1993). Data collected in the nearest town of Kekaha indicated that levels were no louder than noise generated from passing vehicles on a nearby highway.

Terrestrial Surveillance

Terrestrial surveillance sampling of soil is conducted every five years. No sampling occurred in 2006.

Green Sea Turtle

chapter six

TTR & KTF REFERENCES

Photo by:
Mary McDaniel Clum

In This Chapter...

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*Note: EOs 13101, 13123, 13148, and 13149 were revoked by EO 13423 in January 2007; however, they were in effect during 2006.

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10 CFR 1021 "National Environmental Policy Act Implementing Procedures"

40 CFR 61 "National Emission Standards for Hazardous Air Pollutants (NESHAP)"

40 CFR 110 "Discharge of Oil"

40 CFR 112 "Oil Pollution Prevention"

40 CFR 122 "EPA Administered Permit Programs: The National Pollutant Discharge Elimination System"

40 CFR 141.26 "Monitoring Frequency and Compliance Requirements for Radionuclides in Community Water Systems"

40 CFR 270 "EPA Administered Permit Programs: The Hazardous Waste Permit Program"

40 CFR 280 "Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks"

40 CFR 355 "Emergency Planning and Notification"

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ACTS & STATUTES

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- Archaeological Resources Protection Act (ARPA) of 1979 (16 U.S.C. § 470aa)
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- Clean Air Act (CAA) and CAA Amendments (CAAA) of 1990 (42 U.S.C. §7401)
- Clean Water Act (CWA) of 1977 (The Federal Water Pollution Control Act) (33 U.S.C. §1251)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (42 U.S.C. §9601) (Amended by SARA)
- Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 (42 U.S.C. § 11001 et seq.) (Also known as SARA Title III)
- Endangered Species Act (ESA) (16 U.S.C. §1531 et seq.)
- Federal Facility Compliance Act (FFCA) of 1992 (42 U.S.C. § 6961)
- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 U.S.C. § 136)
- Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 U.S.C. § 703 et seq.)
- National Environmental Policy Act (NEPA) of 1969 (42 U.S.C.§4321)
- National Historic Preservation Act of 1966, as amended (16 U.S.C. §470 et seq.)
- Pollution Prevention Act of 1990 (42 U.S.C.§13101 et seq.)
- Quiet Communities Act of 1978 (42 U.S.C. §4901 et seq.)
- Resource Conservation and Recovery Act (RCRA) of 1976 (42 U.S.C. § 6901 et seq.)
- Safe Drinking Water Act (SDWA) (42 U.S.C. §300f)
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- Toxic Substances Control Act (TSCA) of 1976 (15 U.S.C. §2601 et seq)

STATE OF HAWAII
ENVIRONMENTAL REGULATIONS

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Hawaii Administrative Rules (HAR), Title 11, Chapter 59, "Ambient Air Quality Standards"

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 Administration Code (NAC) can be found at:
http://www.leg.state.nv.us/NAC/CHAPTERS.html

TABLE 6-1. State of Nevada Administrative Code (NAC) Applicable to the TTR

Chapter 444, Sanitation	**Applicable Sources or Activities**
NAC 444.570 to 444.7499, "Solid Waste Disposal"	• Disposal of construction debris • Disposal of routine non-hazardous solid wastes • Disposal of septic sludge
NAC 444A.005 to 444A.500, "Programs for Recycling"	• Recyclable materials including waste tires
Chapter 445A, *Water Controls*	
NAC 445A.070 to 445A.348, "Water Pollution Control"	• Septic tanks • Surface water runoff
NAC 445A.450 to 445A. 6731, "Public Water Systems"	• Production well sampling
Chapter 445B, *Air Controls*	
NAC 445B.001 to 445B.3497, "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 504, *Wildlife Management and Propagation**	
NAC 504.110 to 504.340, "Wildlife Management Areas"	• Road construction
NAC 504.510 to 504.550, "Alteration of Stream System or Watershed"	• Construction activities
NAC 504.800 to 504.865, "Preservation of Wild Horses"**	• General activities on the range in wild horse areas
Chapter 534, *Underground Water and Wells*	
NAC 534.010 to 534.500, "Underground Water and Wells"	• Drilling, operation, and abandonment of wells

NOTES: TTR = Tonopah Test Range

*This regulation 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." (NAC 504.21, "General Designation of Management Areas and Units")

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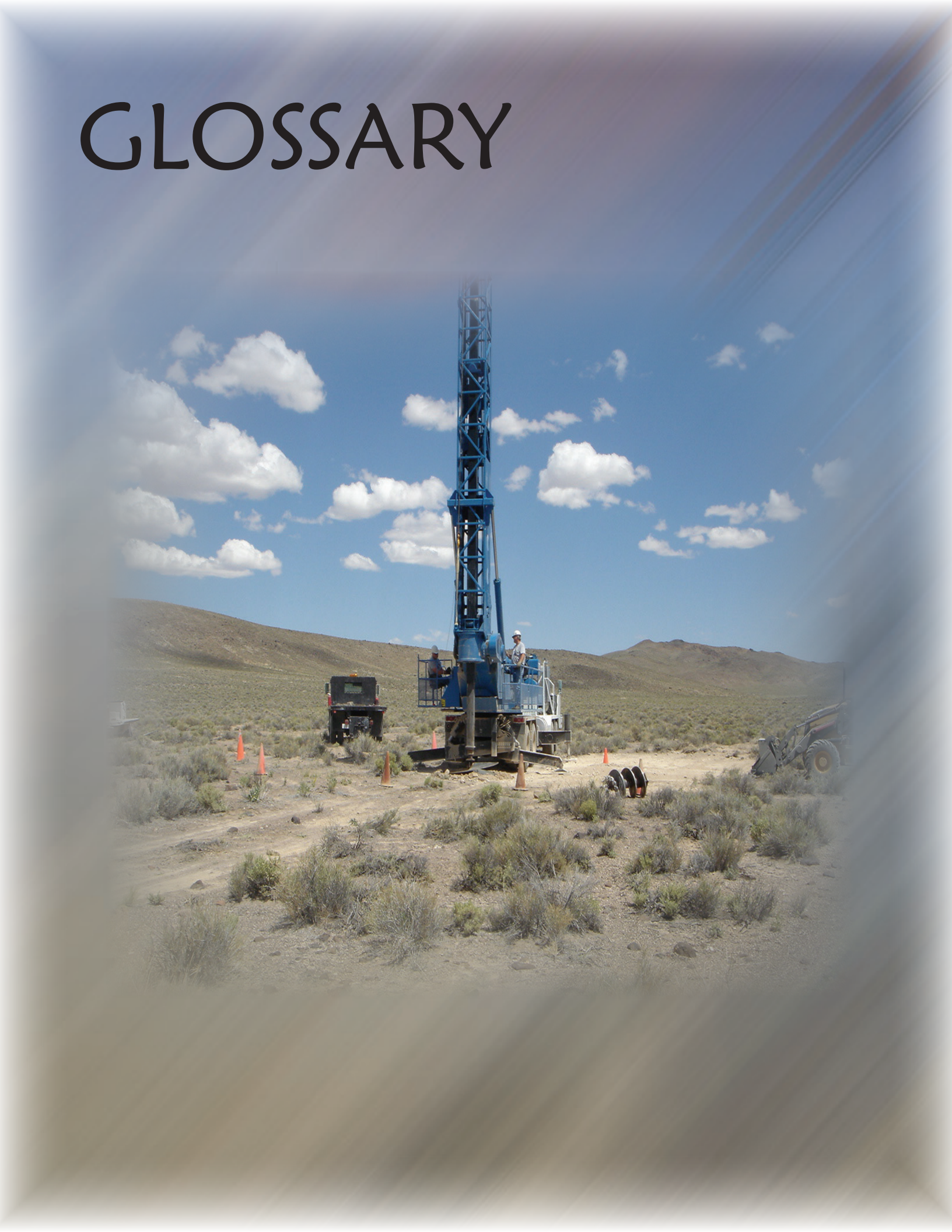
GLOSSARY



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A

Aeroballistics – The study of the interaction of projectiles or high-speed vehicles with the atmosphere.

Aerodynamics – The science that deals with the motion of air and other gaseous fluids and with the forces acting on bodies when they move through such fluids or when such fluids move against or around the bodies.

Am-241 – An alpha-ray emitter used as a radiation source in research.

Ambient Air – Any unconfined portion of the atmosphere: open air, surrounding air.

Americium – A chemical element, symbol Am, atomic number 95; the mass number of the isotope with the longest half-life is 243.

Asbestos – A mineral fiber that can pollute air or water and cause cancer or asbestosis when inhaled. Uses for asbestos-containing material include, but are not limited to, electrical and heat insulation, paint filler, reinforcing agents in rubber and plastics (e.g., tile mastic), and cement reinforcement.

B

Benchmarking – 1. A point of reference from which measurements may be made 2. Something that serves as a standard by which others may be measured or judged 3. A standardized problem or test that serves as a basis for evaluation or comparison

Best Management Practice – The preferred methods and practices for managing operations.

C

Cesium – A radioactive isotope of cesium used in radiation therapy.

Chemical Oxygen Demand – A measure of the oxygen required to oxidize all compounds, both organic and inorganic, in water.

Coliform Organism – Microorganisms found in the intestinal tract of humans and animals. Their presence in water indicates fecal pollution and potentially adverse contamination by pathogens.

D

Decontamination – Removal of harmful substances such as noxious chemicals, harmful bacteria or other organisms, or radioactive material from exposed individuals, rooms and furnishings in buildings, or the exterior environment.

Demolition – The act or process of wrecking or destroying, especially destruction by explosives.

Depleted Uranium – Uranium having a smaller percentage of uranium-235 than the 0.7% found in natural uranium.

Diurnal – 1. Relating to or occurring in a 24-hour period; daily. 2. Occurring or active during the daytime rather than at night: diurnal animals.

Dose Assessment – The process of determining radiological dose and uncertainty included in the dose estimate through the use of exposure scenarios, bioassay results, monitoring data, source term information, and pathway analysis.

Dose Equivalent – The product of the absorbed dose from ionizing radiation and such factors as account for biological differences due to the type of radiation and its distribution in the body in the body.

E

Ecology – The relationship of living things to one another and their environment, or the study of such relationships.

Environment, Safety and Health (ES&H) – A program designed to protect and preserve the environment, and to ensure the safety and health of its employees, contractors, visitors, and the public.

Environmental Assessment – An environmental analysis prepared pursuant to the National Environmental Policy Act (NEPA) to determine whether a federal action would significantly affect the environment and thus require a more detailed environmental impact statement.

Environmental Impact Statement – A document required of federal agencies by the National Environmental Policy Act for major projects or legislative proposals significantly affecting the environment. A tool for decision making, it describes the positive and negative effects of the undertaking and cites alternative actions.

Environmental Management – A program designed to maintain compliance with EPA, state, local and DOE requirements.

Environmental Management System – A continuing cycle of planning, evaluating, implementing, and improving processes and actions undertaken to achieve environmental goals.

Environmental Medium – A major environmental category that surrounds or contacts humans, animals, plants, and other organisms (e.g. surface water, ground water, soil or air) and through which chemicals or pollutants move.

Environmental Restoration – A project chartered with the assessment and, if necessary, the remediation of inactive waste sites.

Ephemeral Stream – A stream channel which carries water only during and immediately after periods of rainfall or snowmelt.

$\mathcal{F}$

Fauna – 1. Animals, especially the animals of a particular region or period, considered as a group. 2. A catalog of the animals of a specific region or period.

French Drain – An underground passage for water, consisting of loose stones covered with earth.

$\mathcal{G}$

Gamma-ray Spectrum – The set of wavelengths or energies of gamma rays emitted by a given source.

Gamma Spectroscopy – A technique used to detect the emission of gamma radiation from radioactive materials.

Geology – The scientific study of the origin, history, and structure of the earth.

Gross Alpha/Beta Particle Activity – The total radioactivity due to alpha or beta particle emissions as inferred from measurements on a dry sample.

Groundwater – The supply of fresh water found beneath the Earth's surface, usually in aquifers, which supply wells and springs. Because ground water is a major source of drinking water, there is growing concern over contamination from leaching agricultural or industrial pollutants or leaking underground storage tanks.

$\mathcal{H}$

Herbicides – A chemical pesticide designed to control or destroy plants, weeds, or grasses.

Horst and Graben Topography – A system of mountains and down-dropped fault valleys formed through regional extension.

Hydrology – The science dealing with the properties, distribution, and circulation of water.

$\mathcal{I}$

Insecticides – A pesticide compound specifically used to kill or prevent the growth of insects.

Integrated Safety Management System – Systematically integrates safety into management and work practices at all levels so that missions are accomplished while protecting the worker, the public, and the environment

$\mathcal{M}$

Maximally Exposed Individual (MEI) – The location of a member of the public which receives or has the potential to receive the maximum radiological dose from air emissions of a National Emissions Standards for Hazardous Air Pollutants (NESHAP) radionuclide source.

Mixed Waste – Radioactive waste that contains both source material, special nuclear material, or by-product material subject to the Atomic Energy Act of 1954, as

amended; and a hazardous component subject to the Resource Conservation and Recovery Act (RCRA), as amended.

N

NESHAP – Emissions standards set by EPA for an air pollutant not covered by NAAQS that may cause an increase in fatalities or in serious, irreversible, or incapacitating illness. Primary standards are designed to protect human health, secondary standards to protect public welfare (e.g. building facades, visibility, crops, and domestic animals).

National Environmental Policy Act (NEPA) – The basic national charter for protection of the environment. It establishes policy, sets goals, and provides means for carrying out the policy.

Nitrates – A compound containing nitrogen that can exist in the atmosphere or as a dissolved gas in water and which can have harmful effects on humans and animals. Nitrates in water can cause severe illness in infants and domestic animals. A plant nutrient and inorganic fertilizer, nitrate is found in septic systems, animal feed lots, agricultural fertilizers, manure, industrial waste waters, sanitary landfills, and garbage dumps.

Nitrites – 1. An intermediate in the process of nitrification. 2. Nitrous oxide salts used in food preservation.

P

Phenols – Organic compounds that are by-products of petroleum refining, tanning, and textile, dye, and resin manufacturing. Low concentrations cause taste and odor problems in water; higher concentrations can kill aquatic life and humans.
Plutonium – A radioactive metallic element chemically similar to uranium.

Polychlorinated biphenyls – "PCB" and "PCBs" are chemical terms limited to the biphenyl molecule that has been chlorinated to varying degrees or any combination of substances that contains such substance. Because of their persistence, toxicity, and ecological damage via water pollution, their manufacture was discontinued in the U.S. in 1976.

Potable Water – Water free from impurities present in quantities sufficient to cause disease or harmful physiological effects.

R

Radioactive Waste – Any waste that emits energy as rays, waves, streams or energetic particles. Radioactive materials are often mixed with hazardous waste, from nuclear reactors, research institutions, or hospitals.

Radionuclide – Radioactive particle, man-made (anthropogenic) or natural, with a distinct atomic weight number. Can have a long life as soil or water pollutant.

Reportable Quantity – Quantity of material or product compound or contaminant which when released to the environment is reportable to a regulatory agency.

Rodenticides – A chemical or agent used to destroy rats or other rodent pests, or to prevent them from damaging food, crops, etc.

S

Semi-volatile organic compounds – Organic compounds that volatilize slowly at standard temperature (20 degrees C and 1 atm pressure).

Solid Waste – Any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and from community activities.

Storm Water – Water runoff from rainfall or snowmelt, including that discharged to the sanitary sewer system.

T

Thermoluminescent Dosimeters – A device that monitors both the whole body and skin radiation dose to which a person has been exposed during the course of work. These same devices can also be used to measure environmental exposure rates.

Total Recovered Petroleum Hydrocarbon – A method for measuring petroleum hydrocarbons in samples of soil or water.

Transuranic waste (TRU) – Radioactive waste containing alpha-emitting radionuclides having an atomic number greater than 92, and a half-life greater than 20 years, in concentrations greater than 100 nCi/g.

Trihalomethanes – A chemical compound containing three halogen atoms substituted for the three hydrogen atoms normally present in a methane molecule. It can occur in chlorinated water as a result of reaction between organic materials in the water and chlorine added as a disinfectant.

Tritium – A rare radioactive hydrogen isotope with atomic mass 3 and half-life 12.5 years, prepared artificially for use as a tracer and as a constituent of hydrogen bombs.

U

Underground Storage Tanks – A single tank or a combination of tanks, including underground pipes connected thereto, which are used to contain an accumulation of regulated substances, such as petroleum products, mineral oil, and chemicals, and the volume of which, including the volume of underground pipes connected thereto, is 10% or more beneath the surface of the ground.

Uranium – A heavy silvery-white metallic element, radioactive and toxic, easily oxidized, and having 14 known isotopes of which U 238 is the most abundant in nature. The element occurs in several minerals, including uraninite and carnotite, from which it is extracted and processed for use in research, nuclear fuels, and nuclear weapons.

V

Volatile Organic Compounds (VOC) – Any organic compound that participates in atmospheric photochemical reactions except those designated by EPA as having negligible photochemical reactivity.

W

Waste Management – The processes involved in dealing with the waste of humans and organisms, including minimization, handling, processing, storage, recycling, transport, and final disposal.

Wastewater Effluent – Wastewater--treated or untreated--that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

APPENDIX A
TERRESTRIAL SURVEILLANCE RESULTS AND SAMPLING LOCATION MAPS FOR TTR

Photo by:
Steve Cox

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CONTENTS

FIGURES

TABLES

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A.1 Historical Summary Plots of Radiological Data in Soil

Data from radiological sampling of soils has been summarized in the form of log-normal probability plots. Such plots are useful tools for conveniently cataloguing and evaluating large amounts of data, as well as providing a first approximation of the similarity (or differences) of the data (in this instance site, perimeter and community).

The basis for using log-normal plotting is experience which has shown that large quantities of environmental data (many similar analyte/media combinations) yield a straight line when plotted on a log-probability or logarithmic scale (Miller 1977). The presumption of log-normal distribution is never a bad presumption and is never worse than the presumption of arithmetic-normal (Michels 1971). Because the data is represented graphically, the mean, standard deviation, expected upper limits, and any abnormalities can be readily determined visually (Waite 1975).

Characteristics of special importance in the use of log-normal plots are linearity (denoting data from a common population), standard geometric deviation (σg, an indicator of variability or range), and geometric mean (Xg). The unit of slope in a log-normal plot involves a logarithmic increment. Thus, the standard deviation is a multiplier of the geometric mean (Michels 1971). The values for σg and Xg can be obtained from the graphs by the ratio of the 84%/50% intercepts and the 50% intercepts, respectively (Miller 1977). Linearity of the graph implies that any potential TTR contribution to the observed concentration is indistinguishable from regional levels of the radionuclide. Anomalous results (potentially attributable to TTR operations) must necessarily occur at a higher concentration than would be expected from regional distributions.

Whenever a particular result appears elevated (on the log-normal plot) compared to the expected concentration based on the population comprised of all the other locations, further investigation to determine if TTR operations are potentially responsible may include (but should not be limited to) the following:

- What is the geographical location of the sample? Is there a detectable pattern to the anomalous observation or is the sample from an area in close proximity to a facility which has the potential for release of the analyte or contaminant?
- Does the location of the sample(s) show elevated levels for other analytes or for the results obtained from the same location in previous years?
- If several locations appear to be elevated, is there a particular year that had the elevated results? How did these compare to perimeter or off-site sample results?

As can be observed in many of the graphs, data at the lower end of the range frequently “falls off” in a manner that suggests that these results do not belong in the distribution being plotted, or are otherwise anomalous. However, in almost all instances, these results represent reported values that were at the extreme lower limit of the analytical method employed at the time of analysis. This is not atypical, since the plotted values do not include the analytical uncertainty or method detection level (MDL) for a given result. Also, the MDL changes (frequently becomes better) over time as the state-of-the-art for analytical science improves, and the aggregated data may include data that actually has a range of MDLs, which only becomes an artifact if the given analyte’s concentration is near the MDL. In several of the plots, many of the same reported values appear as a “flat line”. These values are typically the “less than” values reported by the laboratory when the analyte was not otherwise detected.

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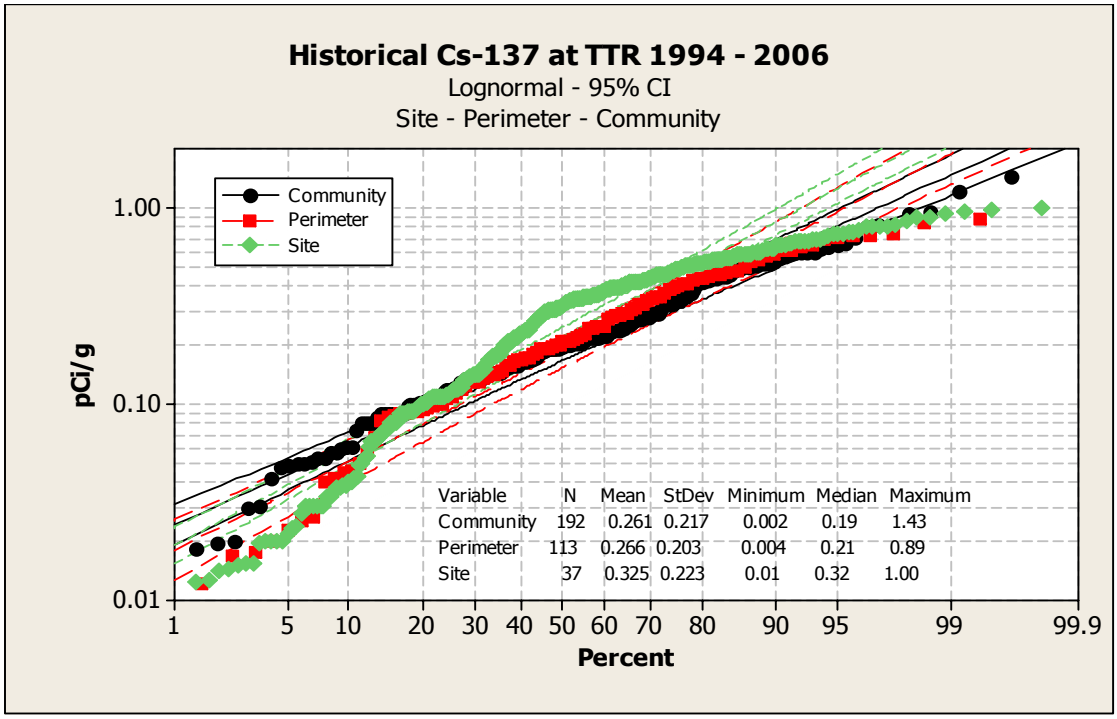

Figure A-1. Historical Cs-137 at TTR 1994-2006

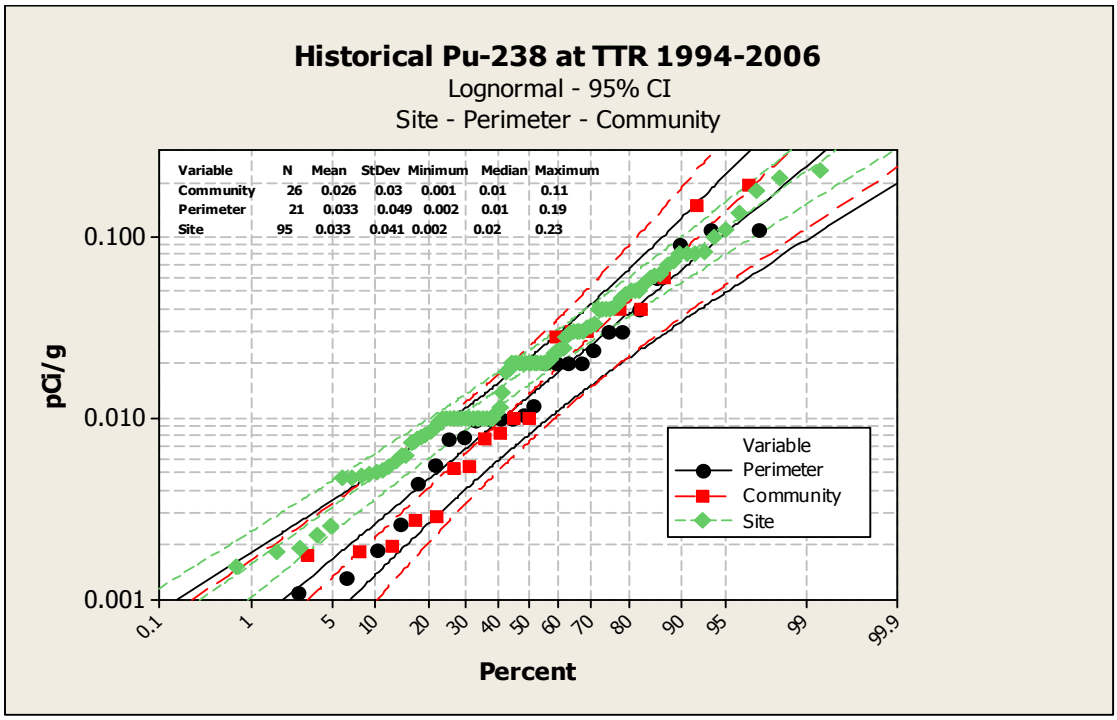

Figure A-2. Historical Pu-137 at TTR 1994-2006

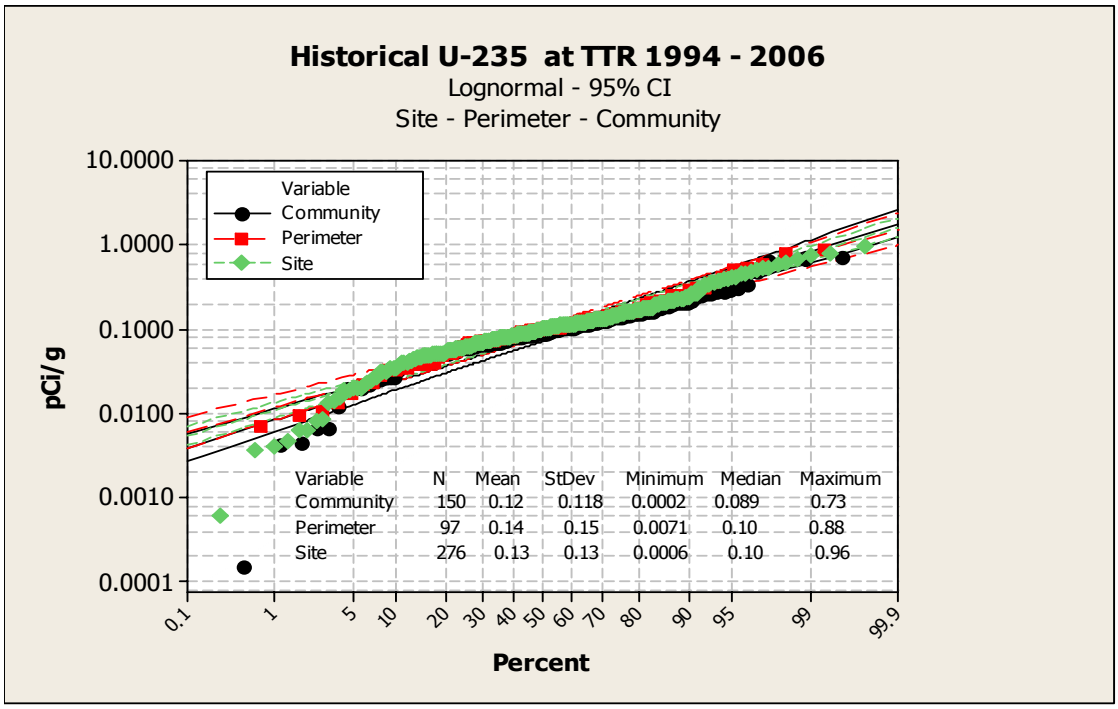

Figure A-3. Historical U-235 at TTR 1994-2006

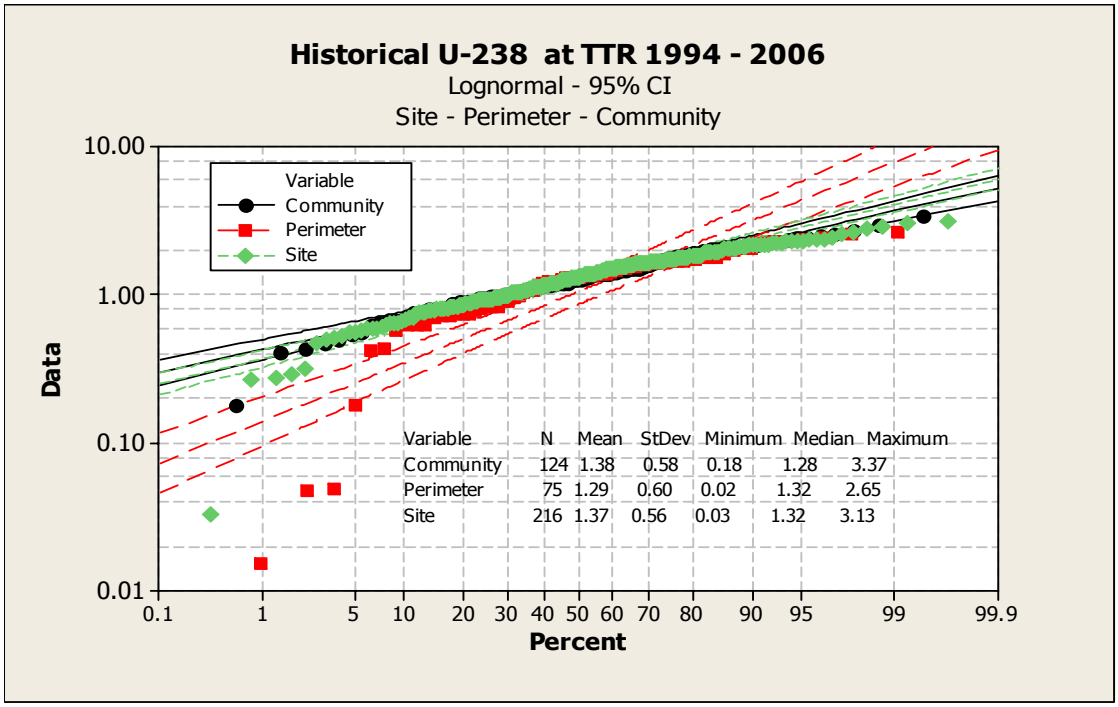

Figure A-4. Historical U-238 at TTR 1994-2006

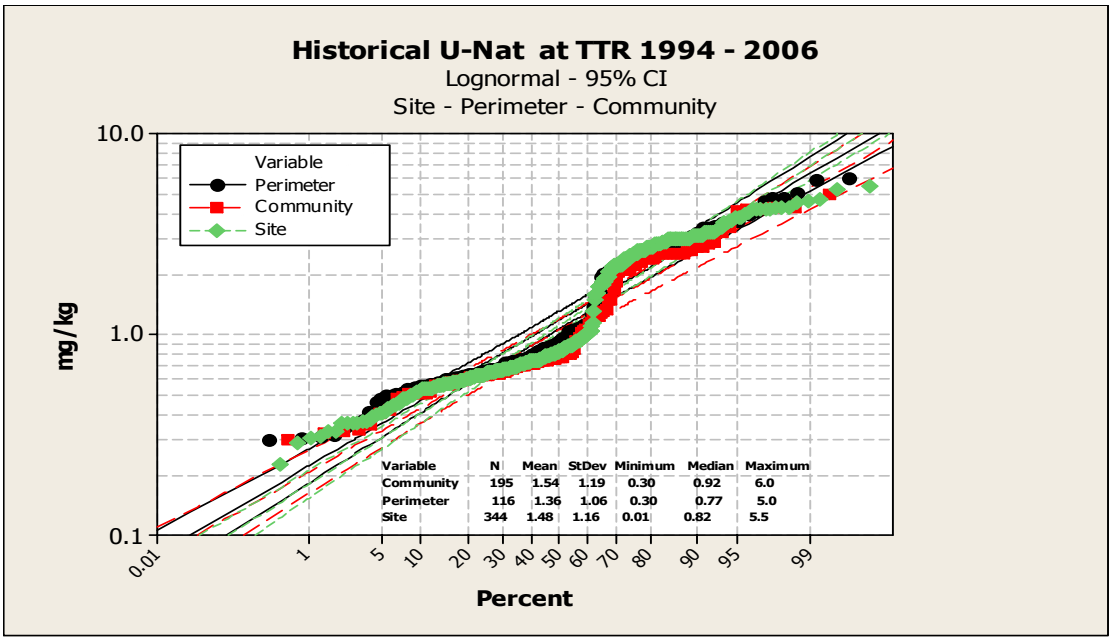

Figure A-5. Historical U-Nat at TTR 1994-2006

References

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Miller, M.L., Fix, J.L. and Bramson, P.E 1977. Radiochemical Analyses of Soil and Vegetation Samples Taken for the Hanford Environs, 1971-1976. BNWL-2249.

Waite, D.A., and Bramson, P.E. 1975. Interpretation of Near Background Environmental Surveillance Data by Distribution Analysis, IAEA-SM-202/706, Battelle, Pacific Northwest Laboratories, Richland, WA.

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Table A-1. Radiological Results for Off-site Soil Sampling Locations at TTR, 2006

Location	Analyte	Units	Activity (± 2 σ)	Decision Level	Detection Limit	Lab Qualifier
C-20	Americium-241	pCi/g	0.00519 ± 0.0199	0.0181	0.0367	U
	Cesium-137	pCi/g	0.205 ± 0.0448	0.0127	0.0261	
	Potassium-40	pCi/g	29.8 ± 1.88	0.0975	0.207	
	Uranium-235	pCi/g	0.0982 ± 0.0966	0.0645	0.131	U
	Uranium-238	pCi/g	1.28 ± 0.378	0.175	0.354	
	Uranium	mg/kg	0.734	0.00962	0.0385	
C-21	Americium-241	pCi/g	-0.0146 ± 0.054	0.0488	0.099	U
	Cesium-137	pCi/g	0.135 ± 0.0237	0.00981	0.0202	
	Potassium-40	pCi/g	27.4 ± 0.646	0.0829	0.175	
	Uranium-235	pCi/g	0.0507 ± 0.0977	0.0577	0.117	U
	Uranium-238	pCi/g	0.909 ± 0.761	0.375	0.761	
	Uranium	mg/kg	0.617	0.0098	0.0392	
C-22	Americium-241	pCi/g	-0.0476 ± 0.0922	0.0796	0.162	U
	Cesium-137	pCi/g	0.0476 ± 0.0279	0.0134	0.0277	
	Potassium-40	pCi/g	30.5 ± 0.864	0.109	0.232	
	Uranium-235	pCi/g	0.101 ± 0.086	0.0803	0.163	U
	Uranium-238	pCi/g	0.669 ± 1.09	0.608	1.24	U
	Uranium	mg/kg	0.636	0.00969	0.0388	
C-23	Americium-241	pCi/g	0.0558 ± 0.0633	0.0533	0.107	U
	Cesium-137	pCi/g	0.103 ± 0.0235	0.012	0.0239	
	Potassium-40	pCi/g	26.3 ± 1.73	0.102	0.203	
	Plutonium-238	pCi/g	-0.00166 ± 0.00513	0.00249	0.00721	U
	Plutonium-239/240	pCi/g	0 ± 0.00606	0.00278	0.0078	U
	Uranium-235	pCi/g	0.0507 ± 0.105	0.0769	0.154	U
	Uranium-238	pCi/g	1.19 ± 0.699	0.446	0.891	
	Uranium	mg/kg	0.674	0.00998	0.0399	
C-24	Americium-241	pCi/g	0.0287 ± 0.0198	0.0165	0.033	U
	Cesium-137	pCi/g	0.231 ± 0.0323	0.0117	0.0234	
	Potassium-40	pCi/g	23.4 ± 0.885	0.0925	0.185	
	Plutonium-238	pCi/g	-0.00266 ± 0.0138	0.004	0.0116	U
	Plutonium-239/240	pCi/g	0.00664 ± 0.0107	0.00447	0.0125	U
	Uranium-235	pCi/g	0.0716 ± 0.0711	0.0549	0.11	U
	Uranium-238	pCi/g	0.943 ± 0.318	0.161	0.321	
	Uranium	mg/kg	0.635	0.00975	0.039	
C-25	Americium-241	pCi/g	0.0113 ± 0.0398	0.0344	0.0699	U
	Cesium-137	pCi/g	0.291 ± 0.0401	0.0134	0.0277	
	Potassium-40	pCi/g	26.6 ± 1.73	0.112	0.239	
	Uranium-235	pCi/g	0.194 ± 0.135	0.0739	0.15	
	Uranium-238	pCi/g	1.46 ± 0.726	0.311	0.631	
	Uranium	mg/kg	1.06	0.00971	0.0388	

See notes at end of table.

Table A-1. Radiological Results for Off-site Soil Sampling Locations at TTR, 2006 (continued)

Location	Analyte	Units	Activity (± 2 σ)	Decision Level	Detection Limit	Lab Qualifier
C-26	Americium-241	pCi/g	-0.0376 ± 0.0562	0.052	0.105	U
	Cesium-137	pCi/g	0.596 ± 0.0409	0.0114	0.0234	
	Potassium-40	pCi/g	26.5 ± 0.698	0.112	0.233	
	Uranium-235	pCi/g	0.0697 ± 0.0761	0.0678	0.137	U
	Uranium-238	pCi/g	1.56 ± 0.631	0.425	0.86	
	Uranium	mg/kg	0.755	0.00952	0.0381	
C-27	Americium-241	pCi/g	-0.134 ± 0.067	0.0614	0.124	U
	Cesium-137	pCi/g	0.622 ± 0.0465	0.0131	0.027	
	Potassium-40	pCi/g	26.3 ± 0.75	0.119	0.251	
	Uranium-235	pCi/g	0.0805 ± 0.108	0.084	0.17	U
	Uranium-238	pCi/g	1.19 ± 0.618	0.491	0.995	
	Uranium	mg/kg	0.643	0.00973	0.0389	
C-28	Americium-241	pCi/g	0.0192 ± 0.0821	0.065	0.132	U
	Cesium-137	pCi/g	0.138 ± 0.0371	0.0164	0.0339	
	Potassium-40	pCi/g	29.8 ± 0.945	0.122	0.262	
	Uranium-235	pCi/g	0.0455 ± 0.139	0.0794	0.162	U
	Uranium-238	pCi/g	1.08 ± 0.959	0.505	1.03	
	Uranium	mg/kg	0.719	0.00962	0.0385	
C-29	Americium-241	pCi/g	0.00259 ± 0.0238	0.0206	0.0417	U
	Cesium-137	pCi/g	0.0485 ± 0.0353	0.0158	0.0324	
	Potassium-40	pCi/g	23.1 ± 0.809	0.137	0.285	
	Uranium-235	pCi/g	0.06 ± 0.143	0.0766	0.155	U
	Uranium-238	pCi/g	1.21 ± 0.539	0.2	0.404	
	Uranium	mg/kg	1.08	0.00978	0.0391	
C-30	Americium-241	pCi/g	-0.00918 ± 0.0657	0.0577	0.117	U
	Cesium-137	pCi/g	0.273 ± 0.031	0.0102	0.021	
	Potassium-40	pCi/g	32 ± 2.15	0.0755	0.159	
	Uranium-235	pCi/g	0.041 ± 0.0887	0.0561	0.114	U
	Uranium-238	pCi/g	0.617 ± 0.681	0.438	0.886	U
	Uranium	mg/kg	0.676	0.00996	0.0398	
C-31	Americium-241	pCi/g	0.0376 ± 0.0647	0.0611	0.124	U
	Cesium-137	pCi/g	0.195 ± 0.0307	0.014	0.0288	
	Potassium-40	pCi/g	31.2 ± 0.853	0.115	0.245	
	Uranium-235	pCi/g	0.203 ± 0.133	0.0791	0.161	
	Uranium-238	pCi/g	0.903 ± 0.761	0.481	0.977	U
	Uranium	mg/kg	0.803	0.00958	0.0383	
C-32	Americium-241	pCi/g	0.0314 ± 0.0654	0.055	0.112	U
	Cesium-137	pCi/g	0.188 ± 0.025	0.0123	0.0255	
	Potassium-40	pCi/g	30.7 ± 0.851	0.0987	0.211	
	Uranium-235	pCi/g	0.108 ± 0.0828	0.0743	0.151	U
	Uranium-238	pCi/g	1.3 ± 0.752	0.446	0.905	
	Uranium	mg/kg	0.656	0.00998	0.0399	

See notes at end of table.

Table A-1. Radiological Results for Off-site Soil Sampling Locations at TTR, 2006 (concluded)

Location	Analyte	Units	Activity (± 2 σ)	Decision Level	Detection Limit	Lab Qualifier
C-33	Americium-241	pCi/g	0.0373 ± 0.0569	0.0447	0.0894	U
	Cesium-137	pCi/g	0.156 ± 0.0278	0.014	0.028	
	Potassium-40	pCi/g	31.8 ± 2.04	0.121	0.242	
	Uranium-235	pCi/g	-0.0865 ± 0.102	0.0786	0.157	U
	Uranium-238	pCi/g	0.652 ± 0.589	0.405	0.809	U
	Uranium	mg/kg	0.615	0.00982	0.0393	

Notes: pCi/g = picocurie per gram
mg/kg = milligrams per kilogram
TTR = Tonopah Test Range
U = The analyte was analyzed for, but not detected, below this concentration. For organic and inorganic analytes the result is less than the effective Decision Level. For radiochemical analytes the result is less than the decision level.

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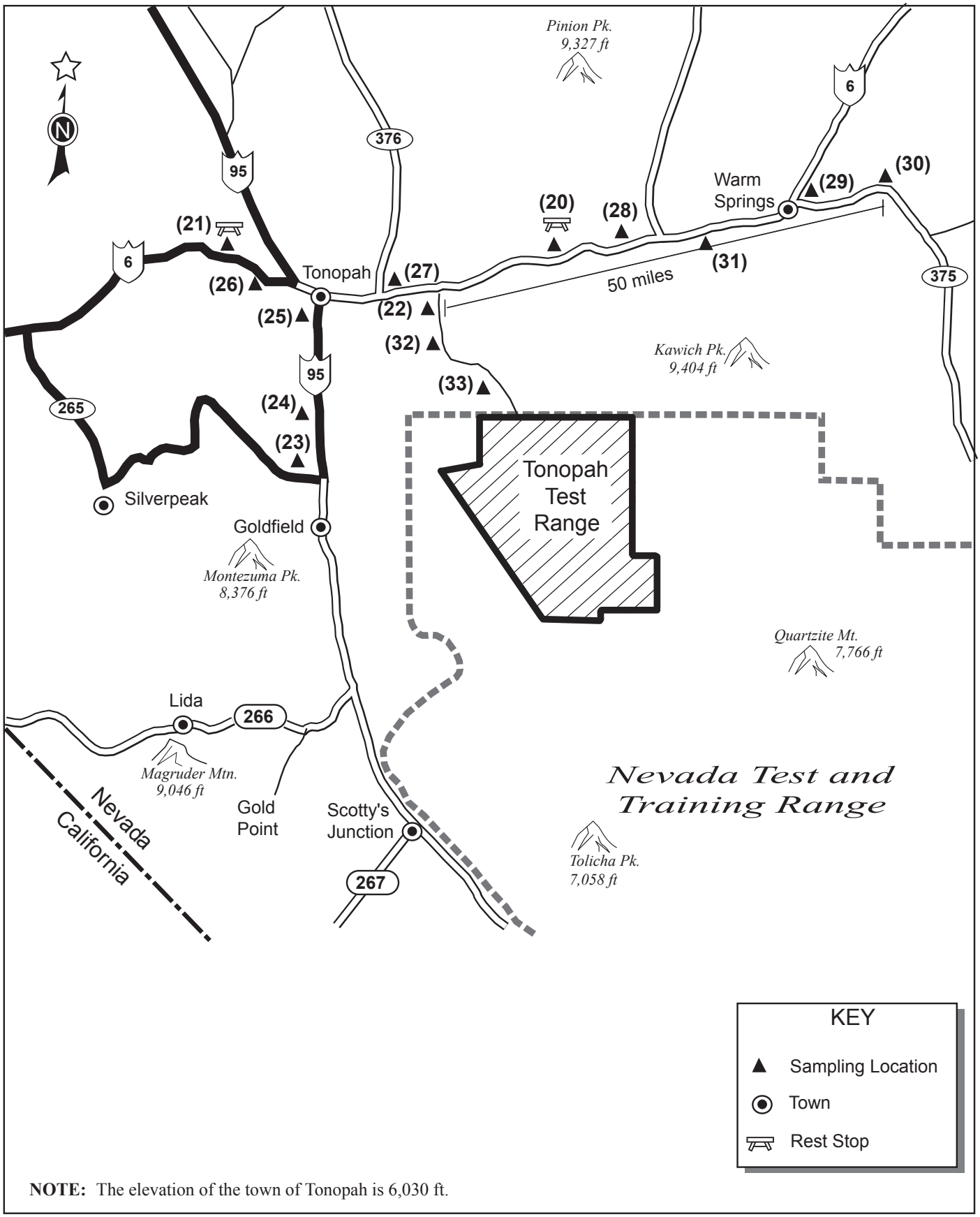

FIGURE A-6. Off-site Soil Sampling Locations

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Table A-2. Radiological Results for Perimeter Soil Sampling Locations at TTR, 2006

Location	Analyte	Units	Activity (± 2 σ)	Decision Level	Detection Limit	Lab Qualifier
P-06	Americium-241			0.0578	0.117	U
	Cesium-137	pCi/g	0.198 ± 0.0185	0.0086	0.0176	
	Potassium-40	pCi/g	33.8 ± 0.566	0.0698	0.145	
	Uranium-235	pCi/g	0.0819 ± 0.0835	0.062	0.126	U
	Uranium-238	pCi/g	0.709 ± 0.719	0.444	0.898	U
	Uranium	mg/kg	0.638	0.00982	0.0393	
P-08	Americium-241	pCi/g	0.0403 ± 0.0632	0.0525	0.105	U
	Cesium-137	pCi/g	0.0867 ± 0.0263	0.0133	0.0267	
	Potassium-40	pCi/g	30.8 ± 2	0.106	0.212	
	Uranium-235	pCi/g	0.0975 ± 0.0968	0.0754	0.151	U
	Uranium-238	pCi/g	1.54 ± 0.772	0.44	0.88	
	Uranium	mg/kg	0.705	0.00996	0.0398	
P-11	Americium-241	pCi/g	0.0239 ± 0.0279	0.0252	0.0511	U
	Cesium-137	pCi/g	0.885 ± 0.104	0.0173	0.0358	
	Potassium-40	pCi/g	30.1 ± 2	0.144	0.307	
	Uranium-235	pCi/g	0.0397 ± 0.114	0.0875	0.178	U
	Uranium-238	pCi/g	1.6 ± 0.557	0.243	0.492	
	Uranium	mg/kg	0.58	0.00952	0.0381	
P-12	Americium-241	pCi/g	-0.0732 ± 0.0737	0.0605	0.123	U
	Cesium-137	pCi/g	0.245 ± 0.0329	0.0156	0.0321	
	Potassium-40	pCi/g	31.5 ± 0.888	0.106	0.228	
	Uranium-235	pCi/g	0.119 ± 0.134	0.083	0.169	U
	Uranium-238	pCi/g	1.33 ± 0.949	0.511	1.04	
	Uranium	mg/kg	0.571	0.00963	0.0385	
P-34	Americium-241	pCi/g	-0.0207 ± 0.0476	0.046	0.0931	U
	Cesium-137	pCi/g	0.365 ± 0.0274	0.011	0.0225	
	Potassium-40	pCi/g	30 ± 0.656	0.0844	0.178	
	Uranium-235	pCi/g	0.0385 ± 0.0915	0.062	0.126	U
	Uranium-238	pCi/g	0.82 ± 0.702	0.37	0.749	
	Uranium	mg/kg	0.682	0.00958	0.0383	
P-35	Americium-241	pCi/g	0.0929 ± 0.108	0.0918	0.186	U
	Cesium-137	pCi/g	0.282 ± 0.0331	0.0157	0.0322	
	Potassium-40	pCi/g	29.8 ± 0.871	0.119	0.252	
	Plutonium-238	pCi/g	0.00825 ± 0.00761	0.00248	0.00719	
	Plutonium-239/240	pCi/g	0.0222 ± 0.0094	0.00277	0.00778	
	Uranium-235	pCi/g	0.163 ± 0.168	0.0908	0.184	U
	Uranium-238	pCi/g	0.737 ± 1.3	0.68	1.38	U
	Uranium	mg/kg	0.965	0.01	0.04	
P-36	Americium-241	pCi/g	-0.0402 ± 0.0429	0.0399	0.0808	U
	Cesium-137	pCi/g	0.0459 ± 0.0159	0.00915	0.0188	
	Potassium-40	pCi/g	32 ± 1.95	0.0718	0.151	
	Uranium-235	pCi/g	0.0104 ± 0.0796	0.0619	0.125	U
	Uranium-238	pCi/g	0.698 ± 0.65	0.341	0.69	
	Uranium	mg/kg	0.749	0.00988	0.0395	

See notes at end of table.

Table A-2. Radiological Results for Perimeter Soil Sampling Locations at TTR, 2006 (concluded)

Location	Analyte	Units	Activity (± 2 σ)	Decision Level	Detection Limit	Lab Qualifier
P-37	Americium-241	pCi/g	0.019 ± 0.04	0.0386	0.0781	U
	Cesium-137	pCi/g	0.0174 ± 0.0141	0.0088	0.0181	U
	Potassium-40	pCi/g	31.8 ± 1.92	0.0646	0.136	
	Uranium-235	pCi/g	0.0492 ± 0.0921	0.0599	0.121	U
	Uranium-238	pCi/g	0.795 ± 0.569	0.324	0.656	
	Uranium	mg/kg	0.658	0.00992	0.0397	

Notes: pCi/g = picocurie per gram
mg/kg = milligrams per kilogram
TTR = Tonopah Test Range
U = The analyte was analyzed for, but not detected, below this concentration. For organic and inorganic analytes the result is less than the effective Decision Level. For radiochemical analytes the result is less than the decision level.
X = Presumptive evidence that analyte is not present.

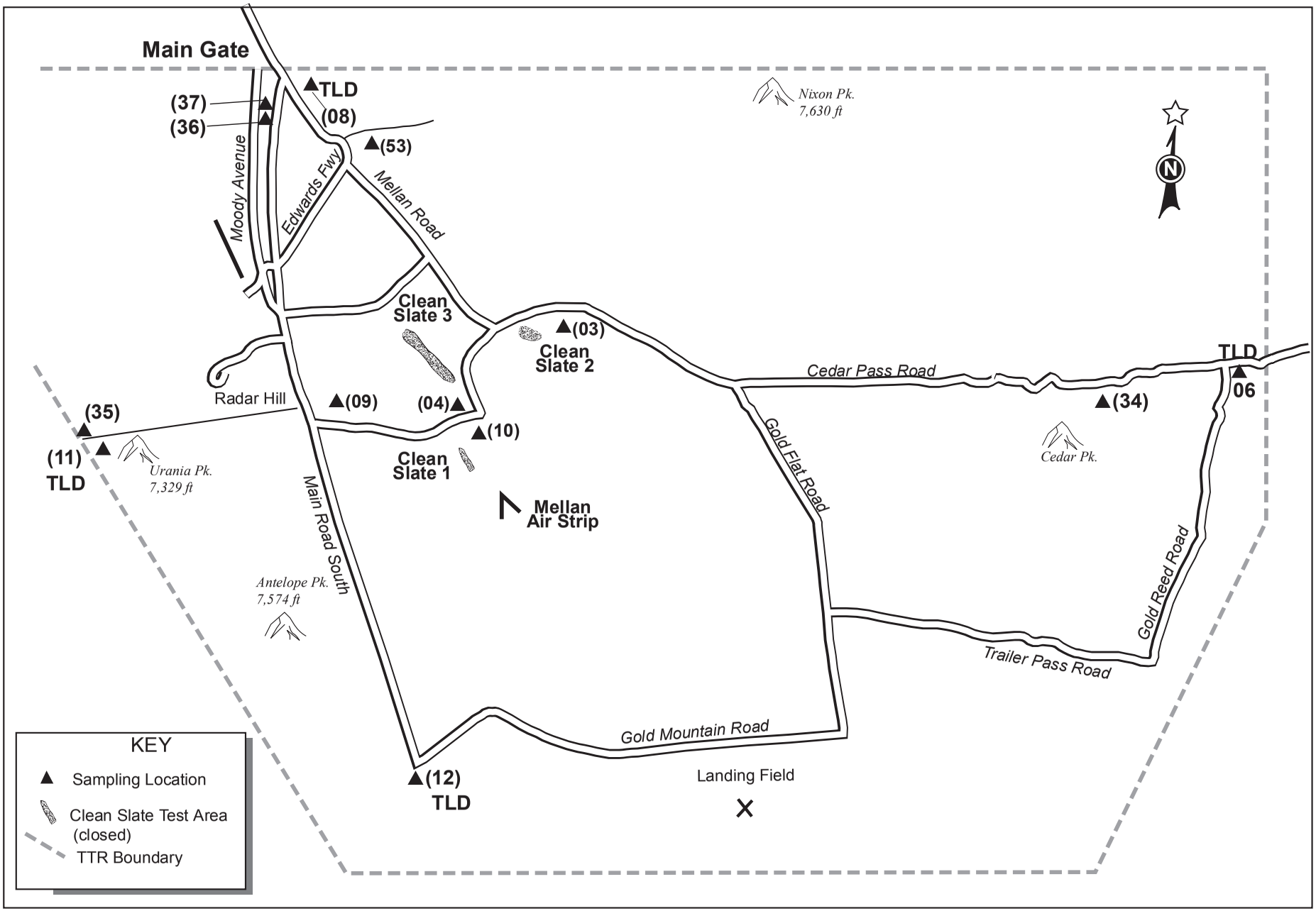

FIGURE A-7. Perimeter Soil Sampling Locations

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Table A-3. Radiological Results for South Plume Area Soil Sampling Locations at TTR, 2006

Location	Analyte	Units	Activity (± 2 σ)	Decision Level	Detection Limit	Lab Qualifier
S-48	Americium-241	pCi/g	-0.00826 ± 0.0791	0.0621	0.126	U
	Cesium-137	pCi/g	0.329 ± 0.026	0.0123	0.0252	
	Potassium-40	pCi/g	30.8 ± 0.785	0.0995	0.21	
	Uranium-235	pCi/g	0.0788 ± 0.12	0.0735	0.149	U
	Uranium-238	pCi/g	0.616 ± 1.03	0.496	1.01	U
	Uranium	mg/kg	0.936	0.00952	0.0381	
S-49	Americium-241	pCi/g	0.123 ± 0.0658	0.0397	0.0803	
	Cesium-137	pCi/g	0.354 ± 0.0371	0.00917	0.0187	
	Potassium-40	pCi/g	32.8 ± 1.98	0.0717	0.149	
	Plutonium-238	pCi/g	0.0282 ± 0.0239	0.00446	0.0129	
	Plutonium-239/240	pCi/g	1.53 ± 0.154	0.00499	0.014	
	Uranium-235	pCi/g	0.0328 ± 0.0941	0.0619	0.125	U
	Uranium-238	pCi/g	0.928 ± 0.586	0.341	0.688	
	Uranium	mg/kg	0.736	0.0098	0.0392	
S-50	Americium-241	pCi/g	0.073 ± 0.0274	0.0212	0.073	U
	Cesium-137	pCi/g	0.519 ± 0.0578	0.0147	0.0294	
	Potassium-40	pCi/g	30.6 ± 1.17	0.134	0.268	
	Plutonium-238	pCi/g	0.00258 ± 0.00506	0.00259	0.0075	U
	Plutonium-239/240	pCi/g	0.061 ± 0.0171	0.00289	0.00811	
	Uranium-235	pCi/g	0.0834 ± 0.0836	0.0697	0.139	U
	Uranium-238	pCi/g	0.957 ± 0.358	0.207	0.413	
	Uranium	mg/kg	0.497	0.00952	0.0381	
S-51	Americium-241	pCi/g	1.29 ± 0.245	0.087	0.176	
	Cesium-137	pCi/g	0.278 ± 0.0417	0.0114	0.0233	
	Potassium-40	pCi/g	31.3 ± 2.17	0.131	0.27	
	Plutonium-238	pCi/g	0.0629 ± 0.0137	0.00189	0.00548	
	Plutonium-239/240	pCi/g	10.2 ± 0.69	0.00211	0.00593	
	Uranium-235	pCi/g	0.0692 ± 0.0761	0.0661	0.134	U
	Uranium-238	pCi/g	0.292 ± 1.5	0.614	1.24	U
	Uranium	mg/kg	0.837	0.00971	0.0388	
S-52	Americium-241	pCi/g	0.0717 ± 0.024	0.0196	0.0392	
	Cesium-137	pCi/g	0.176 ± 0.0306	0.0142	0.0284	
	Potassium-40	pCi/g	33.3 ± 1.22	0.114	0.228	
	Plutonium-238	pCi/g	0.00744 ± 0.0146	0.00559	0.0162	U
	Plutonium-239/240	pCi/g	0.518 ± 0.0754	0.00625	0.0175	
	Uranium-235	pCi/g	0.0187 ± 0.0773	0.0668	0.134	U
	Uranium-238	pCi/g	1.14 ± 0.343	0.193	0.386	
	Uranium	mg/kg	0.9	0.00984	0.0394	

Notes: pCi/g = picocurie per gram
mg/kg = milligrams per kilogram
TTR = Tonopah Test Range
U = The analyte was analyzed for, but not detected, below this concentration. For organic and inorganic analytes the result is less than the effective Decision Level. For radiochemical analytes the result is less than the decision level.

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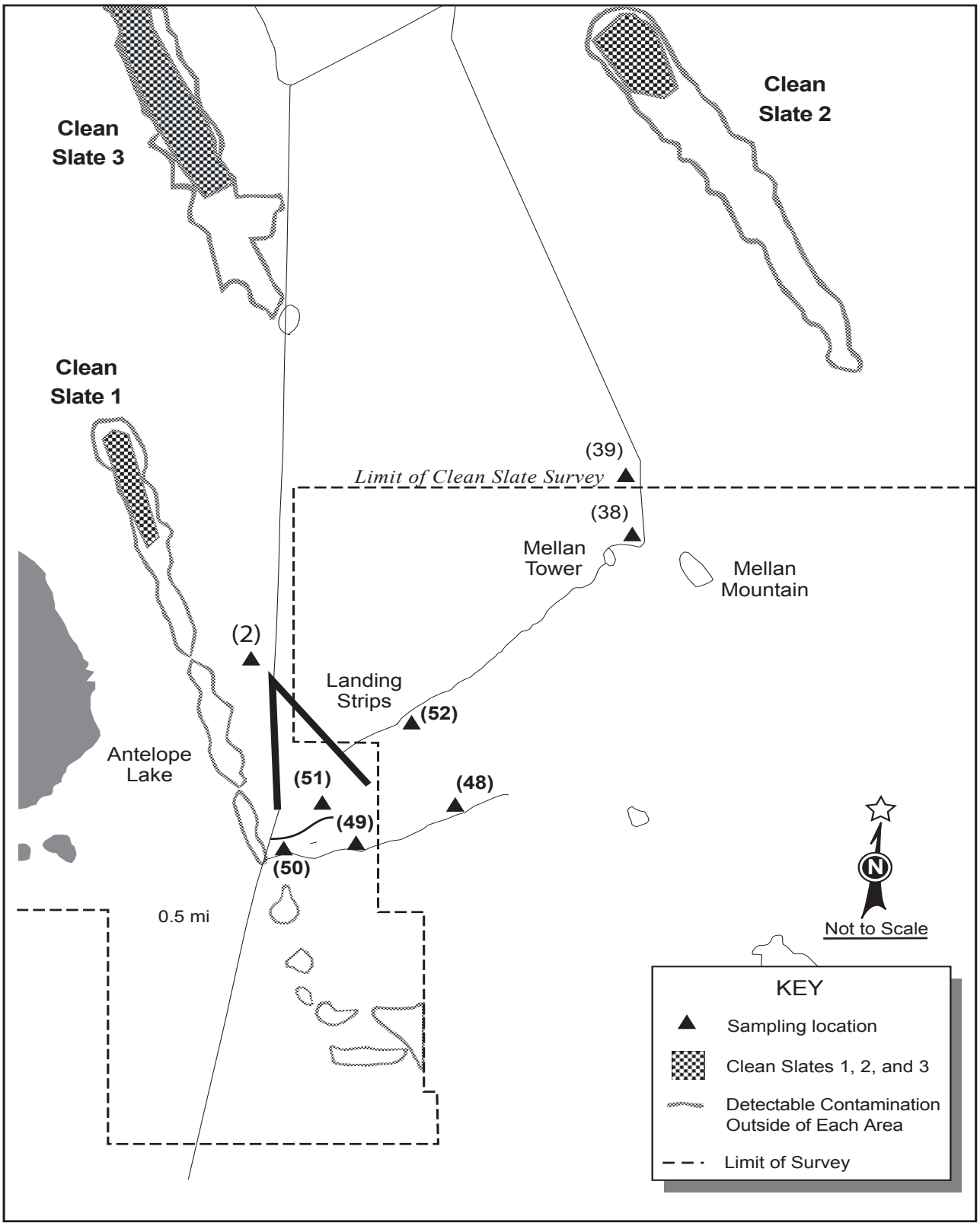

FIGURE A-8. Soil Sampling Locations in the South Plume Area (On-site)

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Table A-4. Radiological Results for Range Operations Center On-Site Soil Sampling Locations at TTR, 2006

Location	Analyte	Units	Activity (± 2 σ)	Decision Level	Detection Limit	Lab Qualifier
S-40	Americium-241	pCi/g	-0.000853 ± 0.014	0.0127	0.0256	U
	Cesium-137	pCi/g	0.0668 ± 0.0155	0.00946	0.0193	
	Potassium-40	pCi/g	32.7 ± 0.61	0.0807	0.168	
	Uranium-235	pCi/g	0.0553 ± 0.0722	0.046	0.0931	U
	Uranium-238	pCi/g	1.16 ± 0.275	0.122	0.246	
	Uranium	mg/kg	0.88	0.00952	0.0381	
S-41	Americium-241	pCi/g	0.0126 ± 0.026	0.0237	0.048	U
	Cesium-137	pCi/g	0.0493 ± 0.0272	0.0153	0.0315	
	Potassium-40	pCi/g	31.2 ± 0.91	0.137	0.288	
	Uranium-235	pCi/g	0.115 ± 0.126	0.0816	0.166	U
	Uranium-238	pCi/g	1.13 ± 0.511	0.226	0.458	
	Uranium	mg/kg	0.688	0.00973	0.0389	
S-42	Americium-241	pCi/g	0.0174 ± 0.0587	0.0519	0.105	U
	Cesium-137	pCi/g	0.389 ± 0.0308	0.0102	0.0209	
	Potassium-40	pCi/g	28.7 ± 0.65	0.0849	0.178	
	Uranium-235	pCi/g	0.0695 ± 0.107	0.062	0.126	U
	Uranium-238	pCi/g	0.672 ± 0.773	0.408	0.826	U
	Uranium	mg/kg	0.872	0.00992	0.0397	
S-43	Americium-241	pCi/g	-0.0694 ± 0.0787	0.0672	0.137	U
	Cesium-137	pCi/g	0.0383 ± 0.0218	0.0114	0.0233	
	Potassium-40	pCi/g	33.8 ± 0.707	0.0924	0.194	
	Uranium-235	pCi/g	0.0863 ± 0.113	0.0758	0.154	U
	Uranium-238	pCi/g	1.92 ± 0.99	0.534	1.09	
	Uranium	mg/kg	0.866	0.00992	0.0397	
S-44	Americium-241	pCi/g	0.0965 ± 0.094	0.06	0.122	U
	Cesium-137	pCi/g	0.0951 ± 0.0231	0.0118	0.0243	
	Potassium-40	pCi/g	29.4 ± 0.79	0.103	0.219	
	Plutonium-238	pCi/g	0.00182 ± 0.0104	0.00273	0.00792	U
	Plutonium-239/240	pCi/g	-0.00816 ± 0.00735	0.00305	0.00856	U
	Uranium-235	pCi/g	0.027 ± 0.109	0.0758	0.154	U
	Uranium-238	pCi/g	0.586 ± 0.863	0.473	0.959	U
	Uranium	mg/kg	0.75	0.00952	0.0381	
S-45	Americium-241	pCi/g	-0.0245 ± 0.101	0.0837	0.17	U
	Cesium-137	pCi/g	0.0127 ± 0.0179	0.0154	0.0316	U
	Potassium-40	pCi/g	32.9 ± 2.28	0.124	0.261	
	Uranium-235	pCi/g	0.0155 ± 0.141	0.0803	0.163	U
	Uranium-238	pCi/g	0.0324 ± 1.03	0.653	1.33	U
	Uranium	mg/kg	0.783	0.00982	0.0393	
S-46	Americium-241	pCi/g	-0.218 ± 0.0806	0.0637	0.129	U
	Cesium-137	pCi/g	0.038 ± 0.0253	0.013	0.0268	
	Potassium-40	pCi/g	31.7 ± 0.806	0.114	0.24	
	Uranium-235	pCi/g	0.0347 ± 0.121	0.0856	0.174	U
	Uranium-238	pCi/g	0.821 ± 0.711	0.514	1.04	U
	Uranium	mg/kg	0.744	0.00975	0.039	

See notes at end of table.

Table A-4. Radiological Results for Range Operations Center On-Site Soil Sampling Locations at TTR, 2006 (concluded)

Location	Analyte	Units	Activity (± 2 σ)	Decision Level	Detection Limit	Lab Qualifier
S-47	Americium-241	pCi/g	0.015 ± 0.0257	0.0216	0.0437	U
	Cesium-137	pCi/g	0.142 ± 0.0247	0.0149	0.0306	
	Potassium-40	pCi/g	31 ± 0.824	0.11	0.232	
	Uranium-235	pCi/g	0.0533 ± 0.0786	0.0702	0.142	U
	Uranium-238	pCi/g	0.927 ± 0.443	0.208	0.42	
	Uranium	mg/kg	0.619	0.00992	0.0397	

Notes: pCi/g = picocurie per gram
mg/kg = milligrams per kilogram
TTR = Tonopah Test Range
U = The analyte was analyzed for, but not detected, below this concentration. For organic and inorganic analytes the result is less than the effective Decision Level. For radiochemical analytes the result is less than the decision level.

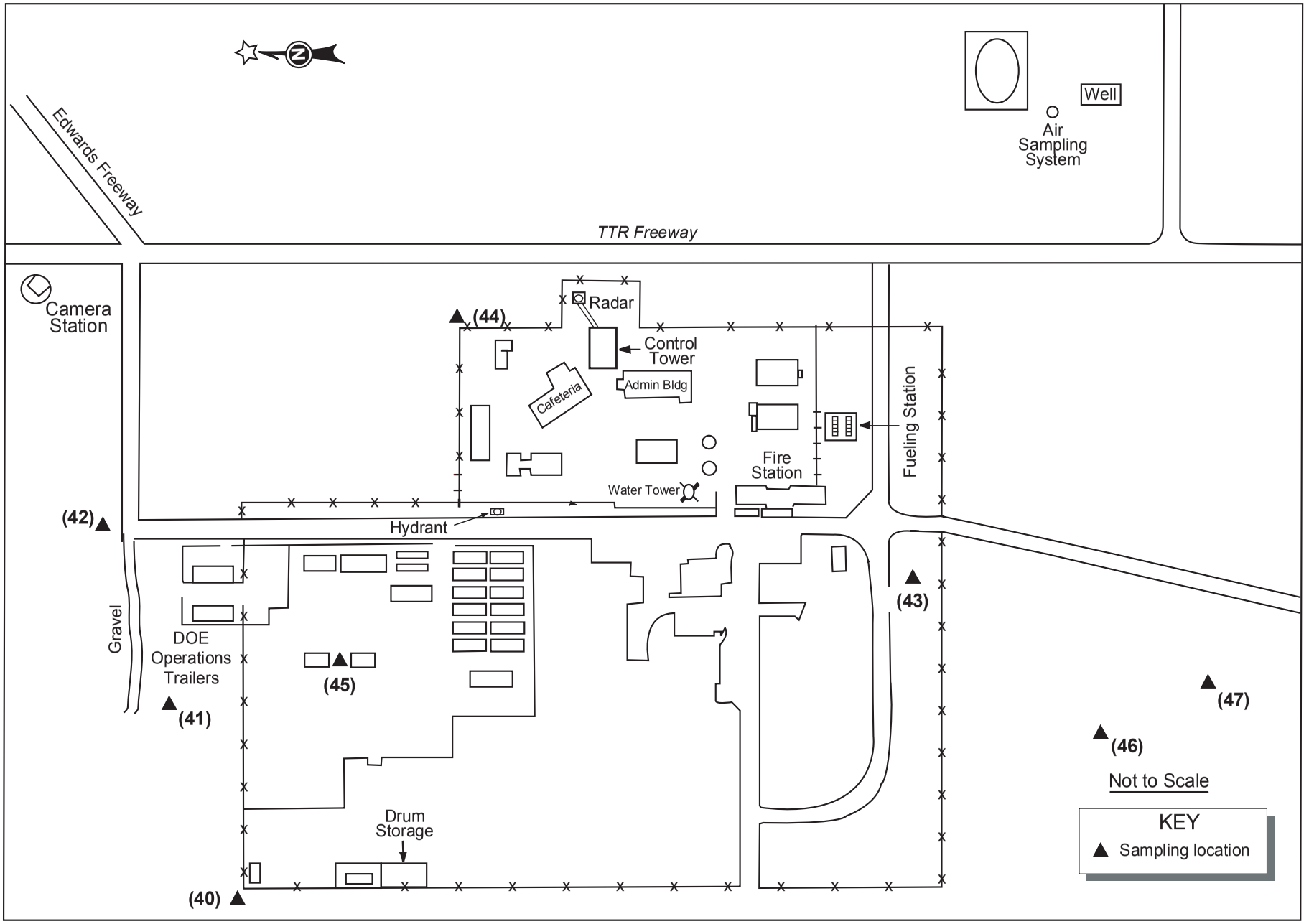

Figure A-9 Soil Sampling Locations in the Range Operations Center and Compound (on-site)

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Table A-5. Radiological Results for Various On-Site Soil Sampling Locations at TTR, 2006

Location	Analyte	Units	Activity (± 2 σ)	Decision Level	Detection Limit	Lab Qualifier
S-02	Americium-241	pCi/g	0.0643 ± 0.0769	0.055	0.112	U
	Cesium-137	pCi/g	0.392 ± 0.0304	0.0125	0.0256	
	Potassium-40	pCi/g	31.2 ± 0.768	0.11	0.232	
	Plutonium-238	pCi/g	0.0114 ± 0.0114	0.00312	0.00906	
	Plutonium-239/240	pCi/g	0.146 ± 0.0268	0.00349	0.0098	
	Uranium-235	pCi/g	0.115 ± 0.102	0.0716	0.145	U
	Uranium-238	pCi/g	0.277 ± 0.744	0.438	0.887	U
	Uranium	mg/kg	0.895	0.0099	0.0396	
S-03	Americium-241	pCi/g	0.171 ± 0.0846	0.0565	0.114	
	Cesium-137	pCi/g	0.325 ± 0.0247	0.0111	0.0228	
	Potassium-40	pCi/g	29.7 ± 0.661	0.0769	0.163	
	Plutonium-238	pCi/g	0.00516 ± 0.0112	0.00259	0.0075	U
	Plutonium-239/240	pCi/g	0.83 ± 0.0786	0.00289	0.00811	
	Uranium-235	pCi/g	0.0486 ± 0.0992	0.0642	0.13	U
	Uranium-238	pCi/g	1.29 ± 0.757	0.427	0.866	
	Uranium	mg/kg	0.692	0.00956	0.0382	
S-04	Americium-241	pCi/g	0.014 ± 0.0789	0.0695	0.141	U
	Cesium-137	pCi/g	0.385 ± 0.0385	0.00912	0.0186	
	Potassium-40	pCi/g	28.8 ± 1.96	0.0903	0.187	
	Uranium-235	pCi/g	0.0874 ± 0.0924	0.0557	0.113	U
	Uranium-238	pCi/g	0.555 ± 0.857	0.518	1.05	U
	Uranium	mg/kg	0.709	0.0096	0.0384	
S-09	Americium-241	pCi/g	0.47 ± 0.082	0.0497	0.0993	
	Cesium-137	pCi/g	0.141 ± 0.027	0.0146	0.0291	
	Potassium-40	pCi/g	28.5 ± 1.83	0.115	0.229	
	Plutonium-238	pCi/g	0.0187 ± 0.0132	0.00311	0.00903	
	Plutonium-239/240	pCi/g	3.61 ± 0.288	0.00348	0.00976	
	Uranium-235	pCi/g	0.00611 ± 0.102	0.0823	0.165	U
	Uranium-238	pCi/g	0.812 ± 0.537	0.408	0.816	U
	Uranium	mg/kg	0.577	0.00984	0.0394	
S-38	Americium-241	pCi/g	0.0105 ± 0.0283	0.026	0.0526	U
	Cesium-137	pCi/g	0.264 ± 0.0353	0.00957	0.0196	
	Potassium-40	pCi/g	31.3 ± 1.89	0.067	0.142	
	Plutonium-238	pCi/g	0.00894 ± 0.0086	0.00244	0.00708	
	Plutonium-239/240	pCi/g	0.509 ± 0.0532	0.00273	0.00766	
	Uranium-235	pCi/g	0.124 ± 0.0874	0.0554	0.112	
	Uranium-238	pCi/g	0.965 ± 0.472	0.228	0.461	
	Uranium	mg/kg	0.671	0.00992	0.0397	
S-39	Americium-241	pCi/g	0.0743 ± 0.0571	0.0371	0.0748	U
	Cesium-137	pCi/g	0.312 ± 0.0317	0.00809	0.0165	
	Potassium-40	pCi/g	29.7 ± 1.78	0.0603	0.125	
	Uranium-235	pCi/g	0.0913 ± 0.0839	0.0586	0.118	U
	Uranium-238	pCi/g	1.51 ± 0.594	0.315	0.636	
	Uranium	mg/kg	0.998	0.00994	0.0398	

See notes at end of table.

Table A-5. Radiological Results for Various On-Site Soil Sampling Locations at TTR, 2006 (concluded)

Location	Analyte	Units	Activity (± 2 σ)	Decision Level	Detection Limit	Lab Qualifier
S-53	Americium-241	pCi/g	0.0143 ± 0.0763	0.0678	0.138	U
	Cesium-137	pCi/g	0.318 ± 0.0273	0.0121	0.025	
	Potassium-40	pCi/g	31.6 ± 0.852	0.0976	0.209	
	Uranium-235	pCi/g	0.114 ± 0.131	0.0795	0.161	U
	Uranium-238	pCi/g	1.03 ± 1.03	0.52	1.06	U
	Uranium	mg/kg	0.645	0.0096	0.0384	

Notes: pCi/g = picocurie per gram
mg/kg = milligrams per kilogram
TTR = Tonopah Test Range
U = The analyte was analyzed for, but not detected, below this concentration. For organic and inorganic analytes the result is less than the effective Decision Level. For radiochemical analytes the result is less than the decision level.

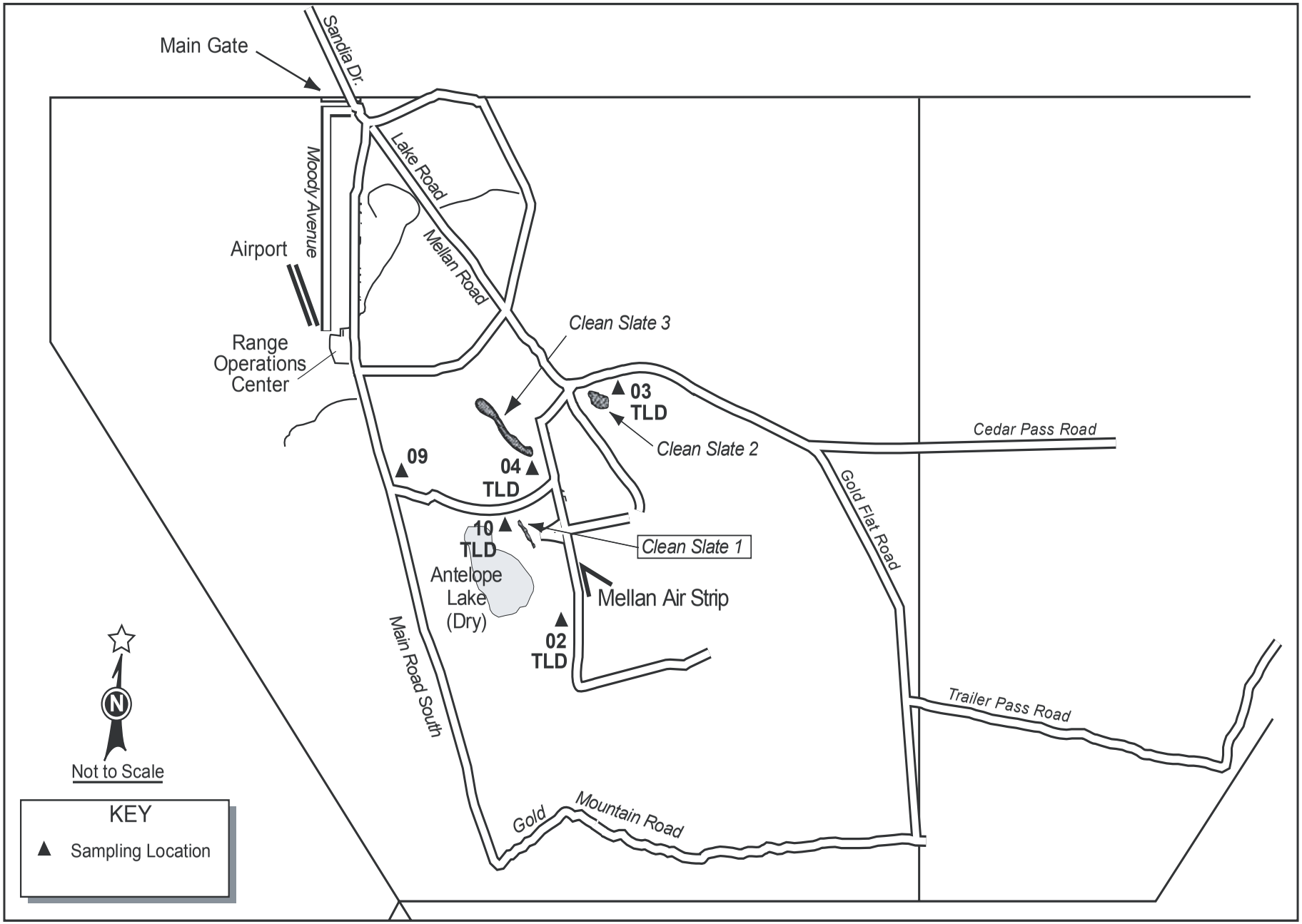

Figure A-10. Various On-site Soil Sampling Locations

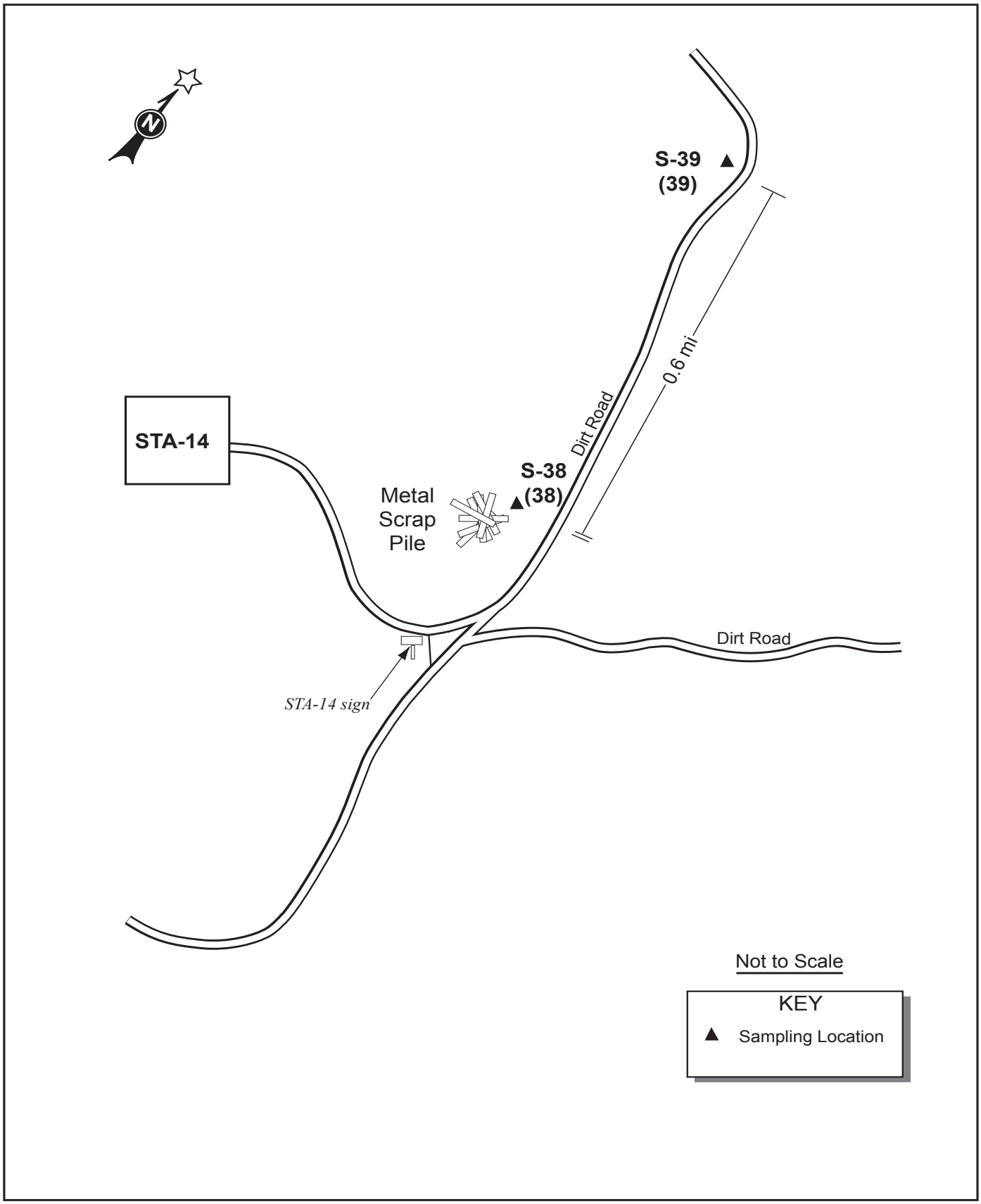

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FIGURE A-11. Various Soil Sampling Locations at Mellan Hill Area

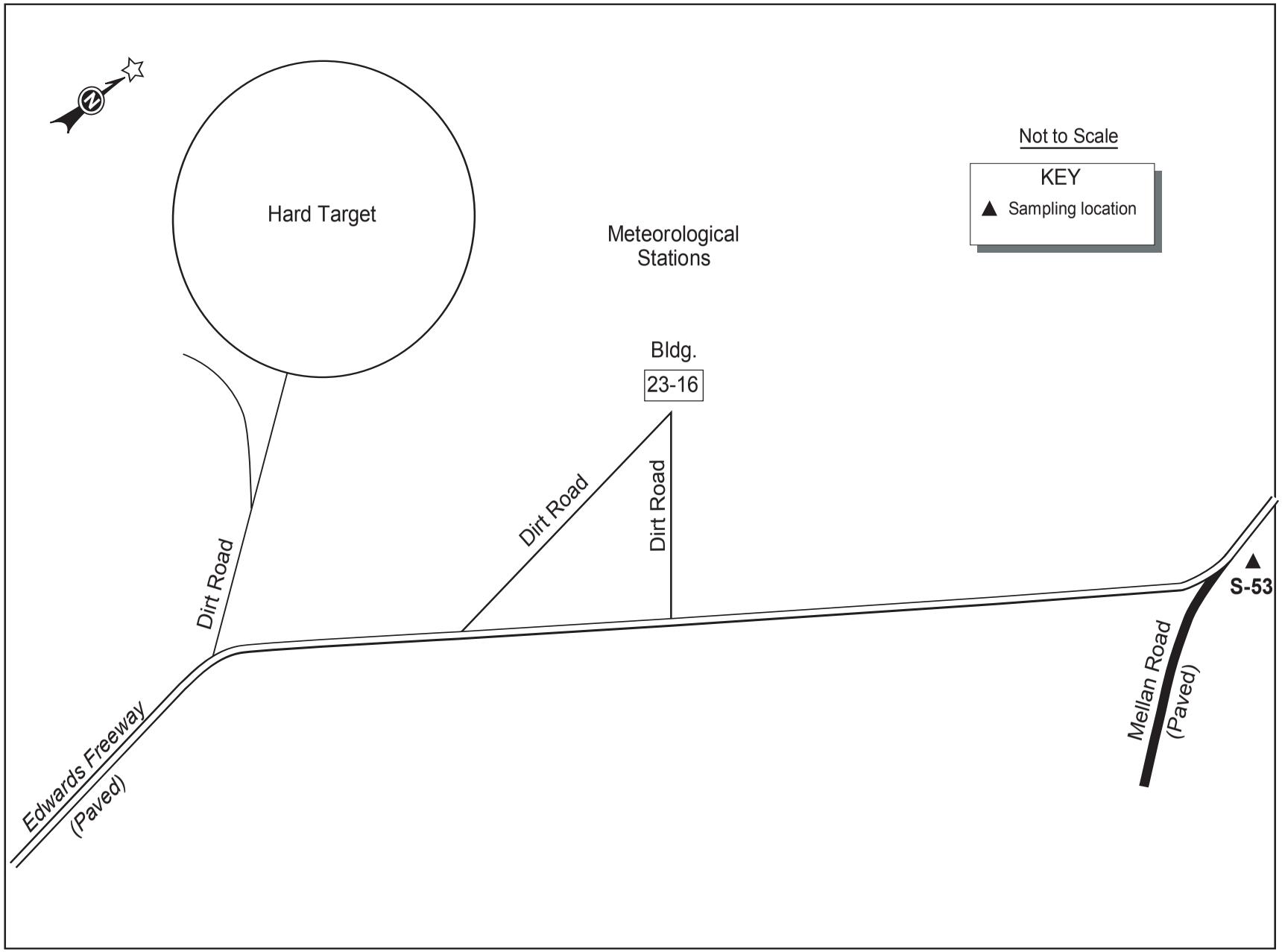

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FIGURE A-12. Soil Sampling Location Near the Hard Target /Depleted Uranium Area

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Table A-6. Radiological Replicate Sampling for Soil Sampling Locations, 2006

Location	Analyte	Units	Sample ID	Activity (± 2 σ)	Decision Level	Detection Limit	Lab Qualifier	Avg	Std Dev	Min	Max	CV%
C-29	Americium-241	pCi/g	080275-001	0.00259 ± 0.0238	0.0206	0.0417	U	0.03	0.03	0.00	0.05	0.81 %
	Americium-241	pCi/g	080275-002	0.043 ± 0.0828	0.0719	0.146	U					
	Americium-241	pCi/g	080275-003	0.053 ± 0.0621	0.0523	0.106	U					
	Uranium	mg/kg	080275-001	1.08	0.00978	0.0391		1.11	0.25	0.88	1.37	0.22 %
	Uranium	mg/kg	080275-002	1.37	0.00982	0.0393						
	Uranium	mg/kg	080275-003	0.876	0.00954	0.0382						
	Uranium-235	pCi/g	080275-001	0.06 ± 0.143	0.0766	0.155	U	0.10	0.07	0.06	0.18	0.71 %
	Uranium-235	pCi/g	080275-002	0.181 ± 0.127	0.0786	0.16						
	Uranium-235	pCi/g	080275-003	0.0579 ± 0.131	0.0645	0.131	U					
	Uranium-238	pCi/g	080275-001	1.21 ± 0.539	0.2	0.404		1.23	0.15	1.09	1.39	0.12 %
	Uranium-238	pCi/g	080275-002	1.39 ± 0.941	0.555	1.13						
	Uranium-238	pCi/g	080275-003	1.09 ± 0.942	0.424	0.858						
P-11	Americium-241	pCi/g	077033-001	0.0239 ± 0.0279	0.0252	0.0511	U	0.03	0.03	0.00	0.06	1.15 %
	Americium-241	pCi/g	077033-002	0.0577 ± 0.0767	0.0647	0.131	U					
	Americium-241	pCi/g	077033-003	-0.00276 ± 0.0838	0.0668	0.136	U					
	Uranium	mg/kg	077033-001	0.58	0.00952	0.0381		0.65	0.06	0.58	0.70	0.1 %
	Uranium	mg/kg	077033-002	0.676	0.0096	0.0384						
	Uranium	mg/kg	077033-003	0.698	0.00962	0.0385						
	Uranium-235	pCi/g	077033-001	0.0397 ± 0.114	0.0875	0.178	U	0.09	0.06	0.04	0.16	0.68 %
	Uranium-235	pCi/g	077033-002	0.157 ± 0.141	0.0848	0.172	U					
	Uranium-235	pCi/g	077033-003	0.0705 ± 0.135	0.0841	0.171	U					
	Uranium-238	pCi/g	077033-001	1.6 ± 0.557	0.243	0.492		1.34	0.27	1.07	1.60	0.2 %
	Uranium-238	pCi/g	077033-002	1.35 ± 0.891	0.519	1.05						
	Uranium-238	pCi/g	077033-003	1.07 ± 0.942	0.553	1.12	U					
S-03	Americium-241	pCi/g	077021-001	0.171 ± 0.0846	0.0565	0.114		0.17	0.09	0.08	0.25	0.53 %
	Americium-241	pCi/g	077021-002	0.0754 ± 0.0608	0.0501	0.101	U					
	Americium-241	pCi/g	077021-003	0.251 ± 0.108	0.0682	0.138						
	Uranium	mg/kg	077021-001	0.692	0.00956	0.0382		0.76	0.06	0.69	0.81	0.08 %
	Uranium	mg/kg	077021-002	0.78	0.00984	0.0394						
	Uranium	mg/kg	077021-003	0.814	0.00969	0.0388						
	Uranium-235	pCi/g	077021-001	0.0486 ± 0.0992	0.0642	0.13	U	0.02	0.02	0.00	0.05	1.23 %
	Uranium-235	pCi/g	077021-002	0.00816 ± 0.0957	0.0665	0.135	U					
	Uranium-235	pCi/g	077021-003	0.00368 ± 0.101	0.0658	0.133	U					
	Uranium-238	pCi/g	077021-001	1.29 ± 0.757	0.427	0.866		1.37	0.37	1.04	1.77	0.27 %
	Uranium-238	pCi/g	077021-002	1.77 ± 0.773	0.371	0.75						
	Uranium-238	pCi/g	077021-003	1.04 ± 0.825	0.501	1.02						

See notes at end of table.

Table A-6. Radiological Replicate Sampling for Soil Sampling Locations, 2006 (concluded)

Location	Analyte	Units	Sample ID	Activity (± 2 σ)	Decision Level	Detection Limit	Lab Qualifier	Avg	Std Dev	Min	Max	CV%
S-09	Americium-241	pCi/g	077018-001	0.47 ± 0.082	0.0497	0.0993		0.62	0.16	0.47	0.79	0.26 %
	Americium-241	pCi/g	077018-002	0.59 ± 0.097	0.051	0.103						
	Americium-241	pCi/g	077018-003	0.79 ± 0.0456	0.0224	0.0452						
	Uranium	mg/kg	077018-001	0.577	0.00984	0.0394		0.53	0.49	0.01	0.99	0.94 %
	Uranium	mg/kg	077018-002	0.00973	0.00973	0.0389	U					
	Uranium	mg/kg	077018-003	0.993	0.0096	0.0384						
	Uranium-235	pCi/g	077018-001	0.00611 ± 0.102	0.0823	0.165	U	0.03	0.02	0.01	0.04	0.69 %
	Uranium-235	pCi/g	077018-002	0.0433 ± 0.0973	0.0677	0.137	U					
	Uranium-235	pCi/g	077018-003	0.0407 ± 0.0768	0.0694	0.141	U					
	Uranium-238	pCi/g	077018-001	0.812 ± 0.537	0.408	0.816	U	0.89	0.23	0.70	1.15	0.26 %
	Uranium-238	pCi/g	077018-002	0.702 ± 0.625	0.409	0.826	U					
	Uranium-238	pCi/g	077018-003	1.15 ± 0.403	0.21	0.424						
S-48	Americium-241	pCi/g	077027-001	-0.00826 ± 0.0791	0.0621	0.126	U	0.01	0.02	-0.01	0.03	1.53 %
	Americium-241	pCi/g	077027-002	0.0162 ± 0.0801	0.0733	0.149	U					
	Americium-241	pCi/g	077027-003	0.0297 ± 0.0492	0.0453	0.0917	U					
	Uranium	mg/kg	077027-001	0.936	0.00952	0.0381		0.73	0.18	0.62	0.94	0.24 %
	Uranium	mg/kg	077027-002	0.638	0.00963	0.0385						
	Uranium	mg/kg	077027-003	0.619	0.00998	0.0399						
	Uranium-235	pCi/g	077027-001	0.0788 ± 0.12	0.0735	0.149	U	0.09	0.03	0.08	0.13	0.3 %
	Uranium-235	pCi/g	077027-002	0.0767 ± 0.117	0.0694	0.141	U					
	Uranium-235	pCi/g	077027-003	0.127 ± 0.123	0.0709	0.144	U					
	Uranium-238	pCi/g	077027-001	0.616 ± 1.03	0.496	1.01	U	1.09	0.47	0.62	1.56	0.43 %
	Uranium-238	pCi/g	077027-002	1.08 ± 0.656	0.586	1.19	U					
	Uranium-238	pCi/g	077027-003	1.56 ± 0.825	0.381	0.771						

Notes: pCi/g = picocurie per gram

mg/kg = milligram per kilogram

U = The analyte was analyzed for, but not detected, below this concentration. For organic and inorganic analytes the result is less than the effective decision level. For radiochemical analytes the result is less than the decision level.

Std Dev = Standard deviaition

CV = Coefficient of variation

TABLE A-07. TLD Measurements by Quarter and Location Class for Calendar Year 2006

Location Class	Location Number	1st Quarter (84 Days)		2nd Quarter (119 Days)		3rd Quarter (63 Days)		4th Quarter (99 Days)		Exposure Rate	
		Exposure (mR)	Error	Exposure (mR)	Error	Exposure (mR)	Error	Exposure (mR)	Error	uR per hour	Error
On-Site	S-01	40.2	0.5	47.5	1.7	26.1	1.5	44.7	3.8	18.1	0.5
	S-02	42.2	1.1	46.5	1.5	25.8	1	47.2	1.2	18.5	0.3
	S-03	46.6	1.9	47.2	1.5	27.6	0.8	50.4	1.4	19.6	0.3
	S-04	64.1	13.1	47.6	1.1	28	0.5	48.4	1.1	21.5	1.5
	S-09	38.2	0.8	43.2	2.9	25.3	1	42.2	1.1	17.0	0.4
	S-10	40.7	1.5	48.3	2.6	26.5	0.5	47.4	1	18.6	0.4
	S-13	38.6	2.9	46.2	0.5	26.4	0.5	46.1	1	18.0	0.4
	S-14	37.2	2.2	42.4	0.8	23.9	1.2	43.5	1.4	16.8	0.3
	S-15	43	0.9	55.7	9.6	26.7	0.8	47.8	1.1	19.8	1.1
	S-16	*	*	*	*	27	0.5	47.1	1.2	19.1	0.3
	S-17	*	*	*	*	25.9	1.7	47.1	1.1	18.8	0.5
Perimeter	P-05	41.6	1.3	98.5	81.5	28	1	47.9	1.1	24.7	9.3
	P-06	41.5	0.8	47.2	1.6	26.5	0.5	46.7	1	18.5	0.2
	P-07	38.4	1.5	44.2	0.5	24.1	0.6	44.2	1.8	17.2	0.3
	P-08	36.9	1.6	41.1	0.7	30.2	3.6	42.8	1.1	17.2	0.5
	P-11	45.4	1.4	54.8	2.7	30.3	0.9	53.8	2.4	21.0	0.5
	P-12	39.5	0.6	48.7	0.5	26.4	1	45.9	1.4	18.3	0.2
Off-Site	C-19	32.1	1.9	35.7	1.5	20.2	0.6	34	1	13.9	0.3
	C-21	39.8	0.7	44	2.2	27.2	1.1	46.1	1.5	17.9	0.3
	C-22	38.3	1.9	42.4	2.7	27.4	2.8	44.3	1.3	17.4	0.5

NOTES: mR = Milliroentgen (10^{-3} roentgen); µR = microroentgen (10^{-6} roentgen)

* TLD lost, stolen, not exchanged, or data invalid and not used in calculation of average exposure rate

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TABLE A-08. Summary TLD Results for Calendar Year 2006, Tonopah Test Range

Location Class	Number of Locations	Mean Exposure Rate (uR/hour)	Std Dev.	Minimum	Maximum
On-Site	11	18.7	1.3	16.8	21.5
Perimeter	6	19.5	2.9	17.2	24.7
Off-Site	3	16.4	2.2	13.9	17.9

NOTES: uR = microroentgen (10^{-6} roentgen)

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APPENDIX B

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Chemical Analyses of Soil Samples Collected from the Sandia National Laboratories, Tonopah Test Range, NV, 1994–2005

Mark L. Miller, Regina A. Deola, Heidi M. Herrera, and Hans D. Oldewage

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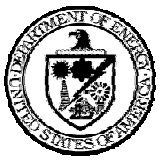

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Chemical Analyses of Soil Samples Collected from the Sandia National Laboratories, Tonopah Test Range, NV, Environs, 1994–2005

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Abstract

From 1994 through 2005, the Environmental Management Department of Sandia National Laboratories (SNL) at the Tonopah Test Range (TTR), NV, has collected soil samples at numerous locations on-site, on the perimeter, and off-site for the purpose of determining potential impacts to the environs from operations at TTR. These samples were submitted to an analytical laboratory of metal-in-soil analyses. Intercomparisons of these results were then made to determine if there was any statistical difference between on-site, perimeter, and off-site samples, or if there were increasing or decreasing trend which indicated that further investigation may be warranted. This work provided the SNL Environmental Management Department with a sound baseline data reference against which to compare future operational impacts. In addition, it demonstrates the commitment that the Laboratories have to go beyond mere compliance to achieve excellence in its operations. This data is presented in graphical format with narrative commentaries on particular items of interest.

Table of Contents

Introduction

In order to establish a baseline for trace metals that exist in the soils of Sandia National Laboratories, TTR, NV, for the purpose of determining potential impacts to the environs from operations at the Laboratories, from 1994 through 2005, the SNL Environmental Management Department collected soil samples at numerous locations on-site, on the perimeter, and off-site. The locations are shown in Figures 1 through 7 and tabulated in Tables 1, 2, and 3. Samples were submitted to an analytical laboratory for metal-in-soil analyses (target analyte list [TAL] metals).

These year-to-year soil results were compared to determine if there was any statistical difference between on-site, perimeter, and off-site samples, or if there were increasing or decreasing trends which indicated that further investigation may be warranted to ascertain the cause of the observed anomaly (Shyr, Herrera and Haaker 1998). This work provided the SNL Environmental Management Department with a sound baseline data reference against which to compare future operational impacts. In addition, it demonstrates the commitment that the Laboratories have to go beyond mere compliance, but to also achieve excellence in its operations. This data is presented in graphical format, with narrative commentaries on particular items of interest.

TABLE 1. On-site TTR Terrestrial Surveillance Locations

.

Location Number	***Sample Location***
S-48	N/S Mellan Airstrip – Antelope Tuff
S-49	N/S Mellan Airstrip – SW of S-48
S-50	N/S Mellan Airstrip – sign post
S-51	N/S Mellan Airstrip – NE of S-50
S-52	NE of NW/SE Mellan Airstrip
S-40	Waste Water Monitoring Station
S-41	"Danger Powerline Crossing" Sign
S-42	Main Road/Edward's Freeway
S-43	SW Corner of Sandia Corporation, TTR Operations Center
S-44	NE Corner of Sandia Corporation, TTR Operations Center
S-45	Storage Shelters, 03-38/03-39
S-46	Sand Building
S-47	Generator Storage Area
S-01	Antelope Lake Area Fence, Cultural Area Sign
S-02	N/S Mellan Airstrip (TLD at South fence post)
S-03	TLD at Clean Slate 2
S-04	TLD at Clean Slate 3
S-09	Roller Coaster Decon
S-10	Brownes Road/Denton Freeway
S-13	Area 3 between Bldg. 100 and Caution Sign
S-14	Area 3 CP SW side on fence
S-15	Moody Ave. by cattle guard and entrance to airport and chow hall
S-16	Area 9 by Bldg. 09-08 and LPG storage
S-17	Hard Target area by Bldg. 23-16
S-38	Mellan Hill – Metal Scrap Pile
S-39	Mellan Hill – North
S-53	Main Road/Lake Road SE

TABLE 2. Perimeter TTR Terrestrial Surveillance Locations

Location Number	***Sample Location***
P-05	O&M Complex - Site 4 Entrance Gate
P-06	Cedar Pass Road Guard Station
P-07	On-Base Housing - SW
P-08	On-Base Housing (Main guard gate/power pole CP17)
P-11	Cactus Springs (TLD south of P-35)
P-12	TLD at "US Gov't Property" Sign
P-34	O&M Complex (Owan Drive post)
P-35	Cactus Springs (north fence post)
P-36	On-Base Housing (NE fence line)
P-37	On-Base Housing (guard station)

TABLE 3. Off-site TTR Terrestrial Surveillance Locations

Location Number	***Sample Location***
C-18	Tonopah Old Court House
C-19	Mining Museum, North Goldfield
C-20	State Road 6 Rest Area
C-21	State Road 6/95 Rest Area
C-22	Rocket
C-23	Alkali/Silver Peak Turnoff
C-24	Cattle Guard
C-25	Tonopah Ranger Station
C-26	Gabbs Pole Line Road
C-27	State Roads 6/376 Junction
C-28	Stone Cabin/Willow Creek
C-29	State Roads 6/375 Junction
C-30	State Road 375 Ranch Cattle Gate
C-31	Golden Arrow/Silver Bow
C-32	Five miles south of Rocket
C-33	Nine miles south of Rocket

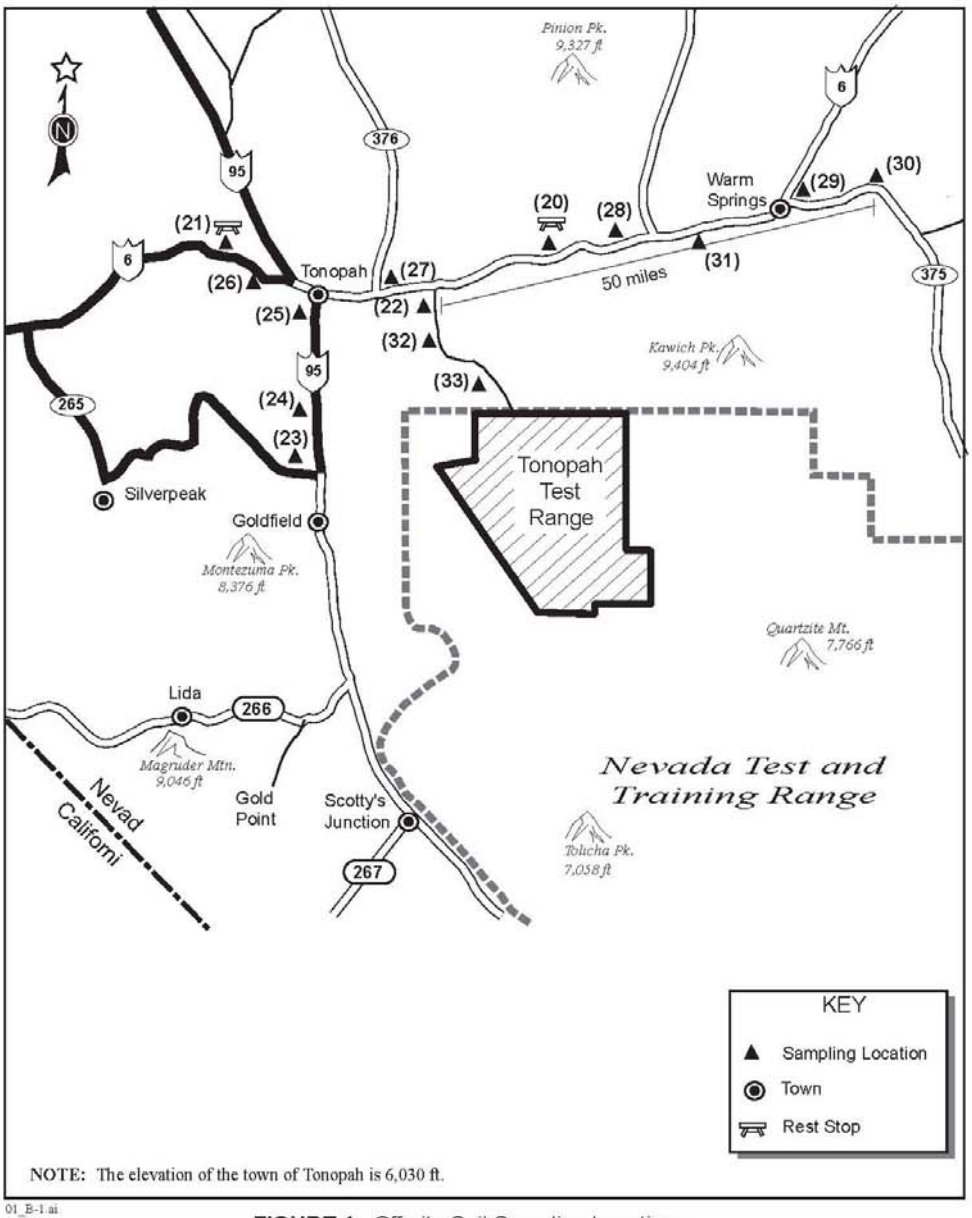

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FIGURE 1. Off-site Soil Sampling Locations
(14 Locations)

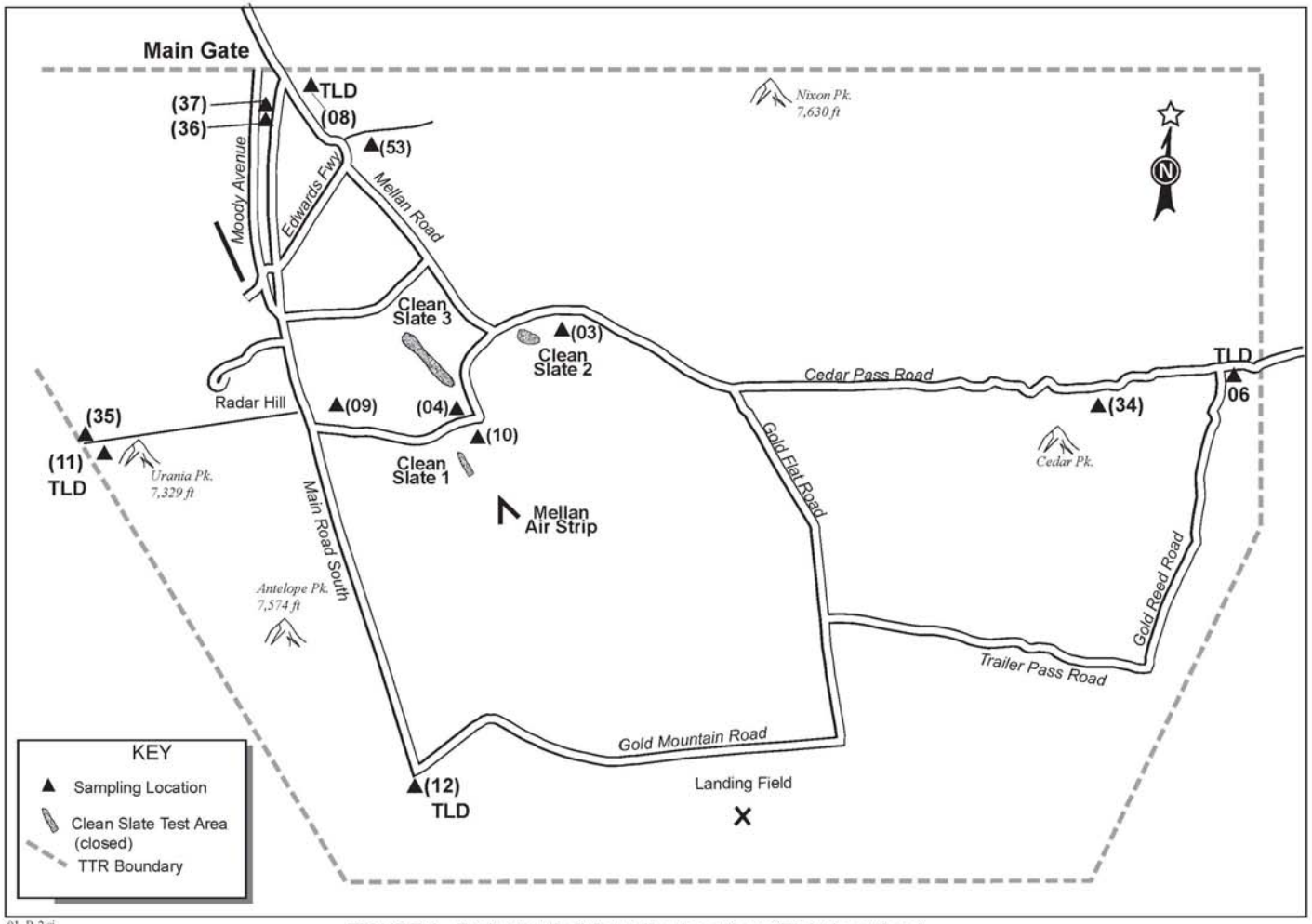

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FIGURE 2. Perimeter Soil Sampling Locations (Eight Locations)

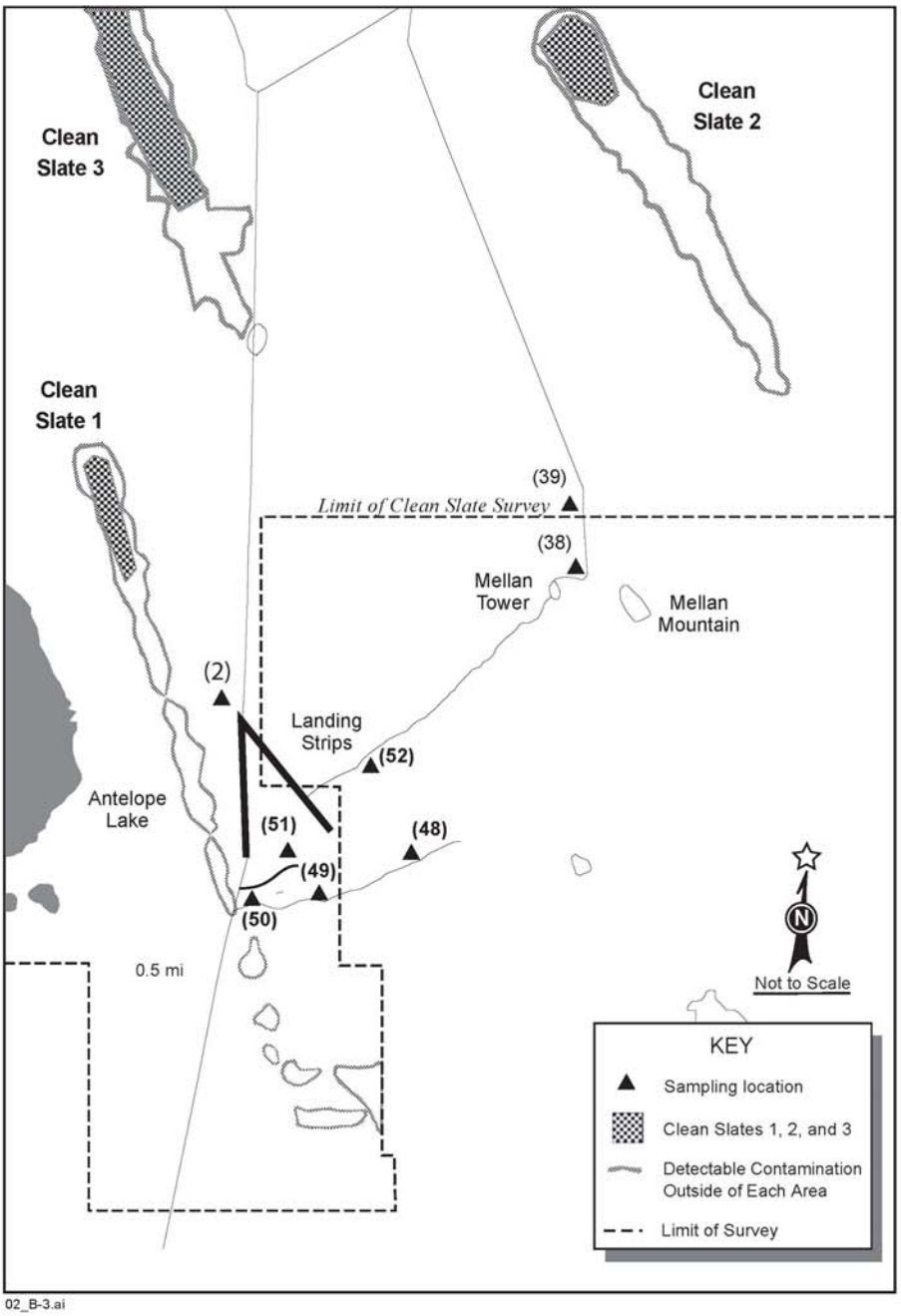

FIGURE 3. Soil Sampling Locations in the South Plume Area (on-site) (Five Locations)

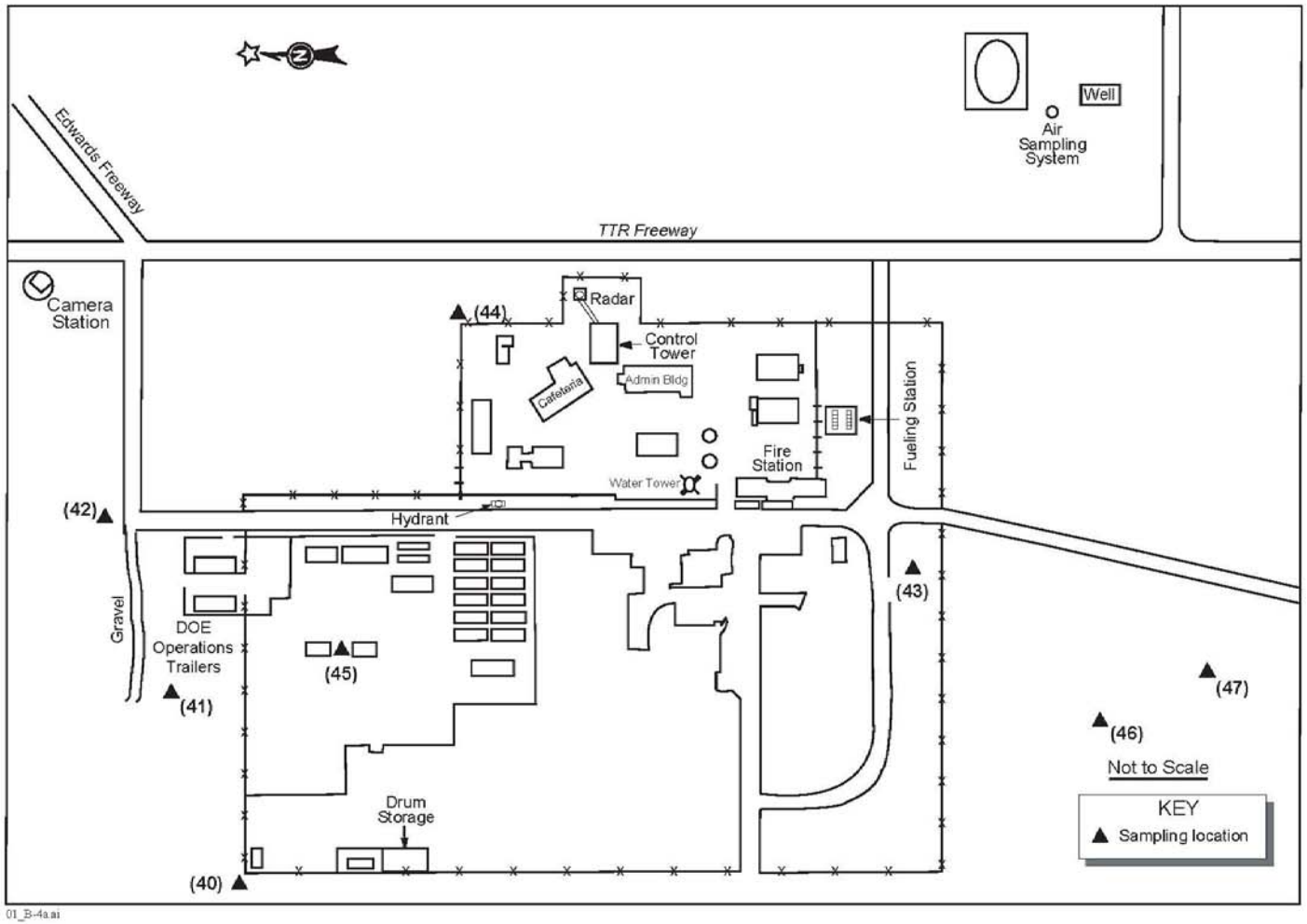

FIGURE 4. Soil Sampling Locations in the Range Operations Center and Compound (on-site) (Eight Locations)

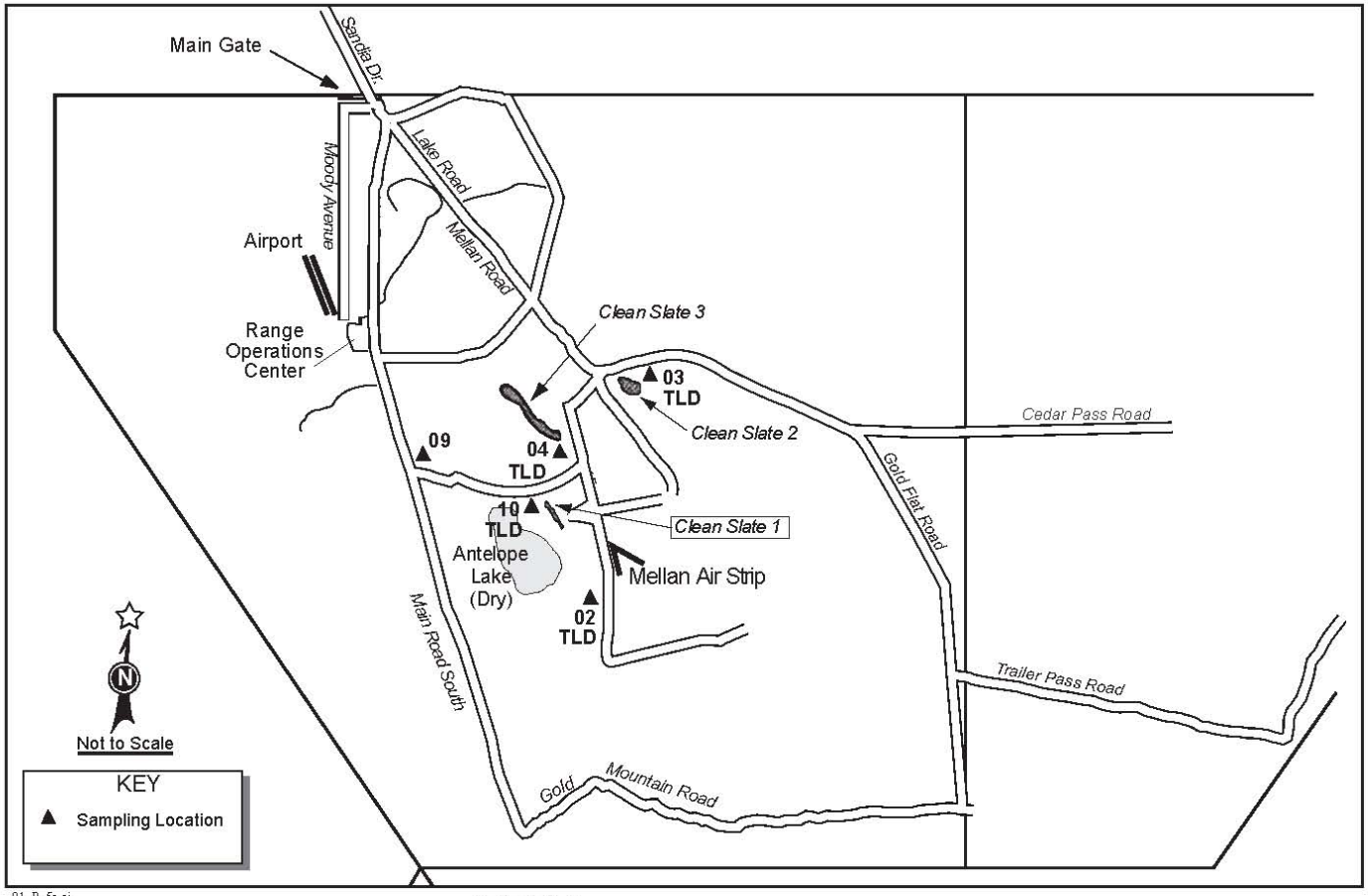

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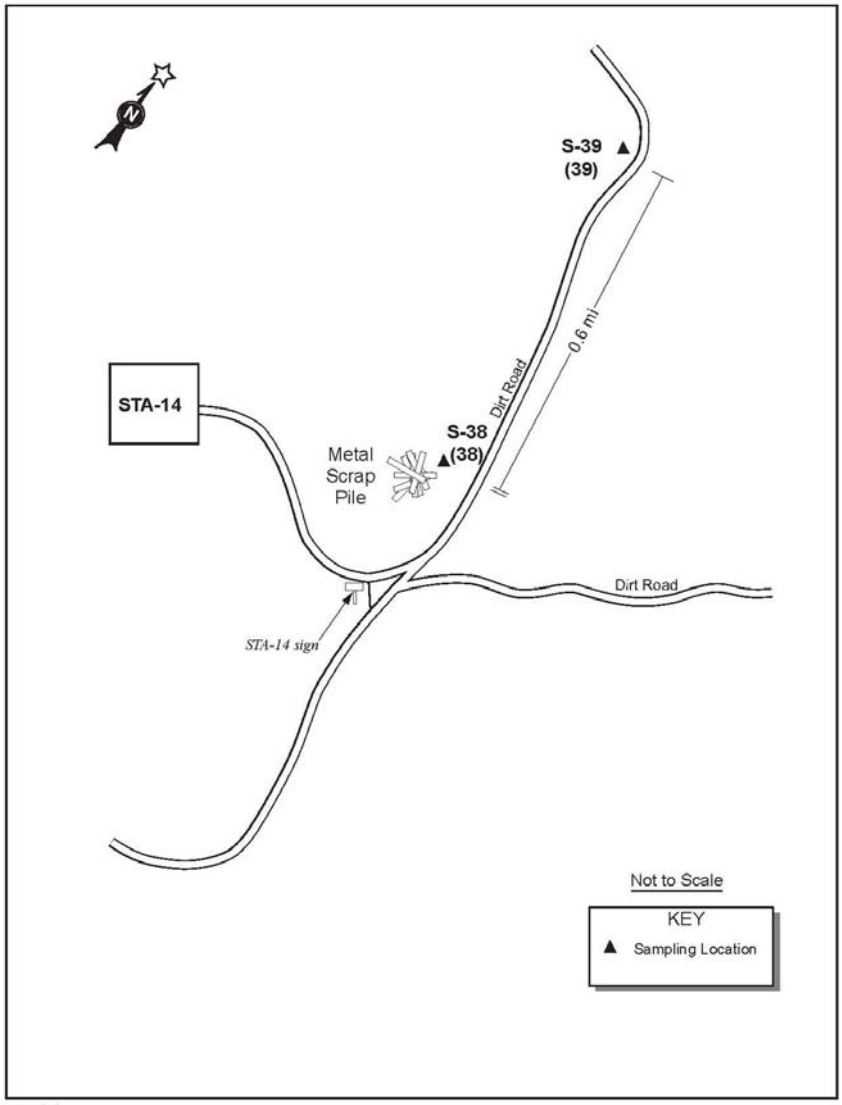
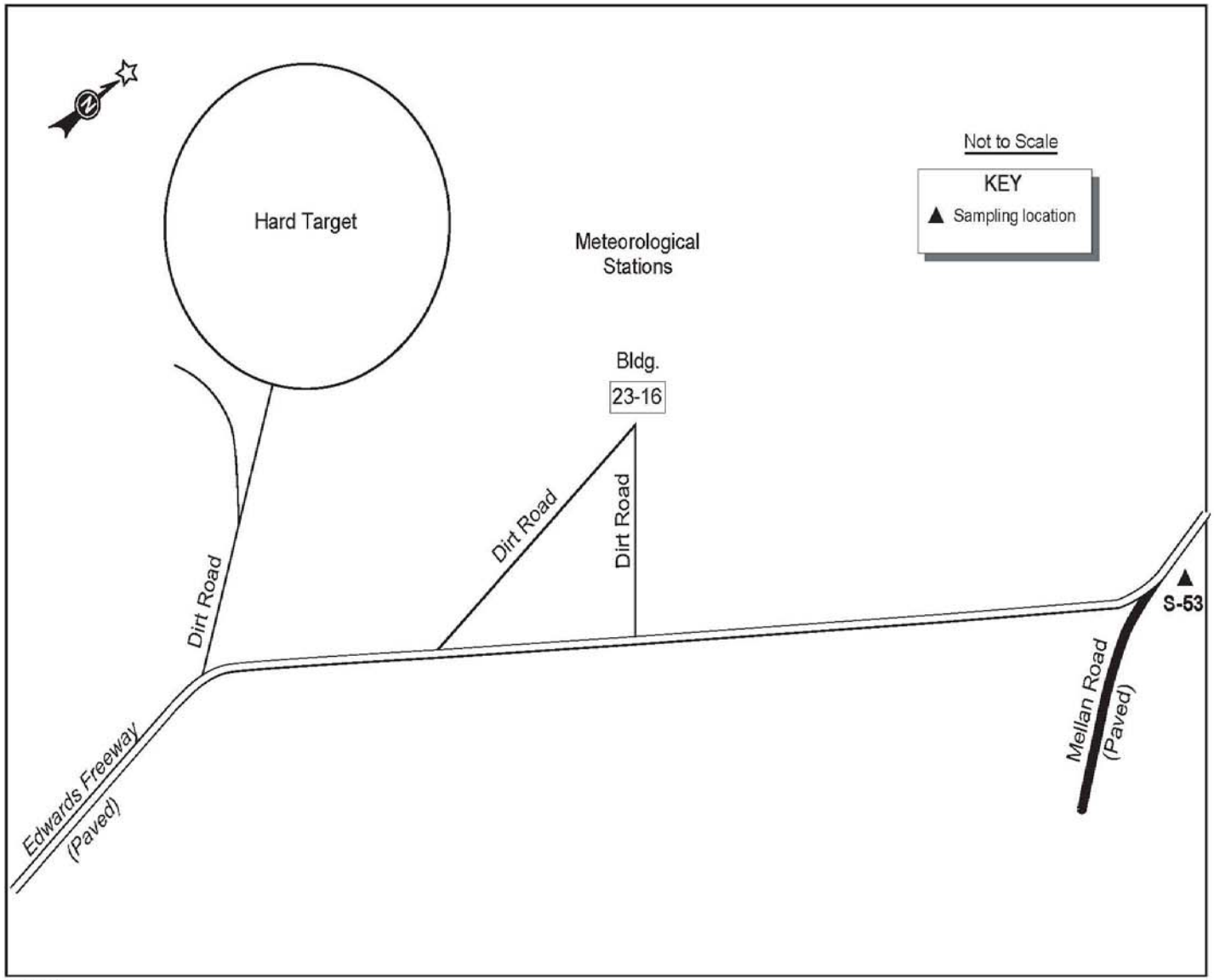
FIGURE 5. Various On-site Soil Sampling Locations
(Five Locations)



01_B-5b.ai

FIGURE 6. Various Soil Sampling Locations at Mellan Hill Area (Two Locations)



01_B-5c.ai

FIGURE 7. Soil Sampling Location Near the Hard Target/Depleted Uranium Area (One Location)

Results of the soil samples were evaluated using probability plotting, which provided a visual representation of the entire data set for all locations and for all times sampled. If the results were similar, or fit a linear distribution when plotted on logarithmic or log-probability scales, then the results were attributable to natural origin. Summary statistics for each element was imbedded in each plot. If any samples indicated concentrations greater than expected from the rest of the sample distribution, further evaluation was conducted to determine if SNL TTR facility operations were possibly responsible for the observed result. Table 4 provides various reference values for metals-in-soil.

Appendix A contains a detailed description of the mechanics of log-normal plotting. Appendix B contains the plots of the soil data, sorted alphabetically by analyte name. Associated with each plot presented are the summary statistics for each analyte. Applicable EPA Region 9 Screening Levels (if available) for Industrial and Residential use are indicated on the graphs.

Table 4. Various Reference Values for Metals-in-Soil

	NV Soil Concentrations[1]		EPA Region 9 PRGs (Soil Screening Levels)[2]		US Soil Concentrations[3]	
Analyte	**Lower Limit**	**Upper Limit**	**Residential**	**Industrial**	**Lower Limit**	**Upper Limit**
Aluminum	5,000	100,000	76,000	100,000	4,500	100,000
Antimony	< 1.0	1.0	31	410	0.25	0.6
Arsenic	2.9	24	0.39	1.6	1	93
Barium	150	3,000	5,400	67,000	20	1,500
Beryllium	ND	5.0	150	1,400	0.04	2.54
Cadmium	ND	11	37	450	0.41	0.57
Calcium	600	320,000	n/a	n/a	n/a	n/a
Chromium	7.0	150	210	450	7	1,500
Cobalt	ND	20	900	1,900	3	50
Copper	7	150	3,100	41,000	3	300
Iron	1000	100,000	23,000	100,000	5,000	50,000
Lead	< 10	700	400	800	10	70
Magnesium	300	100,000	n/a	n/a	n/a	n/a
Manganese	30	5,000	1,800	19,000	20	3,000
Mercury	0.01	0.82	6	62	0.02	1.5
Molybdenum	ND	7.0	390	5,100	0.8	3.3
Nickel	5	50	1,600	20,000	5	150
Potassium	1,900	63,000	n/a	n/a	n/a	n/a
Selenium	< 0.1	1.1	390	5,100	0.1	4
Silica (Silicon)	150,000	440,000	n/a	n/a	24,000	368,000
Silver	0.5	5	390	5,100	0.2	3.2
Sodium	500	100,000	n/a	n/a	n/a	n/a
Strontium	100	1500	47,000	100,000	7	1,000
Thallium	n/a	n/a	5.2	67	0.02	2.8
Titanium	700	5,000	100,000	100,000	20	1,000
Vanadium	30	150	78	1,000	0.7	98
Zinc	10	2,100	23,000	100,000	13	300

ND = not detectable
n/a = not available

(1) Dragun, James, A. Chiasson, *Elements in North American Soils*, 1991, Hazardous Materials Control Resources Institute, (Used Nevada Soils to determine values).
(2) EPA Region 9 Preliminary Remediation Goals (PRGs), U.S.E.P.A., October 2004.
(3) US Soil Surface Concentrations, Kabata-Pendias, A., Pendias, H., CRC, *Trace Elements in Soils and Plants*, 2nd Edition, 1992

Summary

Soil and sediment samples have been collected from 1994 through 2005 at TTR as one means of monitoring for the potential effects on the environment of facility operations at the Laboratories. The year-to-year results of this sampling effort are reported in the Annual Site Environmental Report (ASER, SNL 2005). The data indicate that TTR operations have made no significant impact to existing concentration of TAL metal is surface soil.

Appendix A - Data Analysis

The data in this report is presented in the form of log-normal probability plots. Such plots are useful tools for conveniently cataloguing and evaluating large amounts of data, as well as providing a first approximation of the similarity (or differences) of the data. The basis for using log-normal plotting is experience which has shown that large quantities of environmental data (many similar analyte/media combinations) yield a straight line when plotted on a log-probability or logarithmic scale (Miller 1977). The presumption of log-normal distribution is never a bad presumption and is never worse than the presumption of arithmetic-normal (Michels 1971). Because the data is represented graphically, the mean, standard deviation, expected upper limits, and any abnormalities can be readily determined visually (Waite 1975).

Characteristics of special importance in the use of log-normal plots are linearity (denoting data from a common population), standard geometric deviation (σ_g, an indicator of variability or range), and geometric mean (X_g). The unit of slope in a log-normal plot involves a logarithmic increment. Thus, the standard deviation is a multiplier of the geometric mean (Michels 1971). The values for σ_g and X_g can be obtained from the graphs by the ratio of the 84%/50% intercepts and the 50% intercepts, respectively (Miller 1977). Linearity of the graph implies that any potential TTR contribution to the observed concentration is indistinguishable from regional levels of the element. Anomalous results (potentially attributable to TTR operations) must necessarily occur at a higher concentration than would be expected from regional distributions. For convenience, summary statistics for each element was imbedded in each plot. Included in this list is the Upper Tolerance Limit (UTL), which is defined as:

$$95^{th}\ UTL = \bar{X} + K*S$$

Where UTL = Upper Tolerance Limit
$\bar{X}$ = Sample Arithmetic Mean
S = Sample Standard Deviation
K = One-sided normal tolerance factor

Values for K are commonly determined from tables such as those provided by Lieberman (Leiberman 1958). A typical value of K equal to 1.763 was assigned, which is for sample size of n = 500. The sample size for each element ranged from 200-540. This UTL can be used to estimate a level above which a sample result may not be attributable to naturally occurring "background" levels of the element.

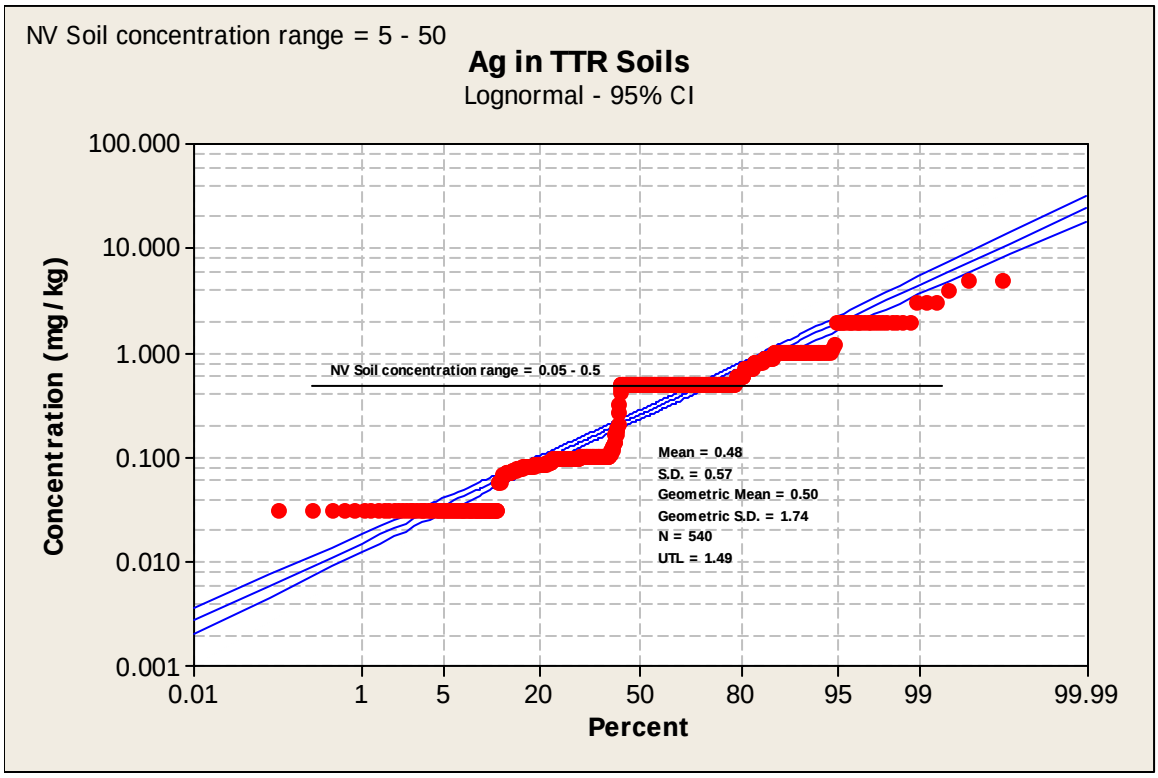
Whenever a particular results appears elevated (on the log-normal plot) compared to the expected concentration based on the population comprised of all the other locations, further investigation to determine if TTR operations are potentially responsible may include (but should not be limited to) the following:

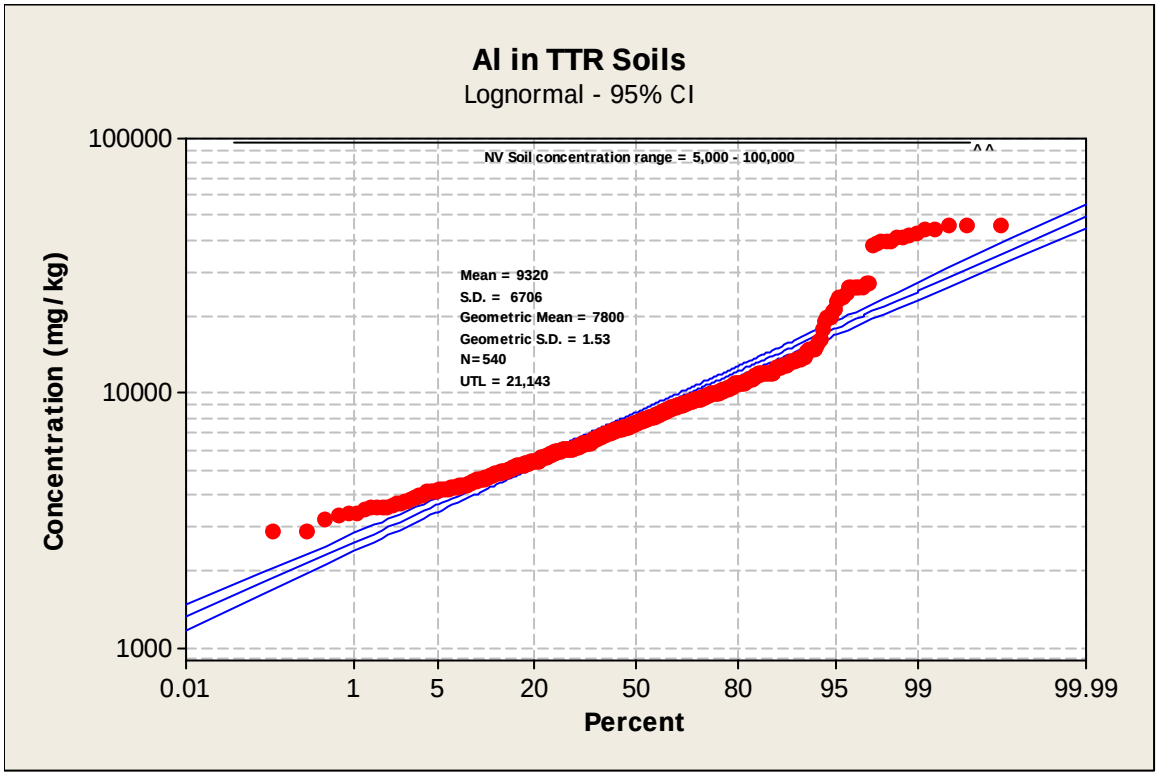
- What is the geographical location of the sample? Is there a detectable pattern to the anomalous observation or is the sample from an area in close proximity to a facility which has the potential for release of the analyte or contaminant?
- Does the location of the sample(s) show elevated levels for other analytes or for the results obtained from the same location in previous years?
- If several locations appear to be elevated, is there a particular year that had the elevated results? How did these compare to perimeter or off-site sample results?

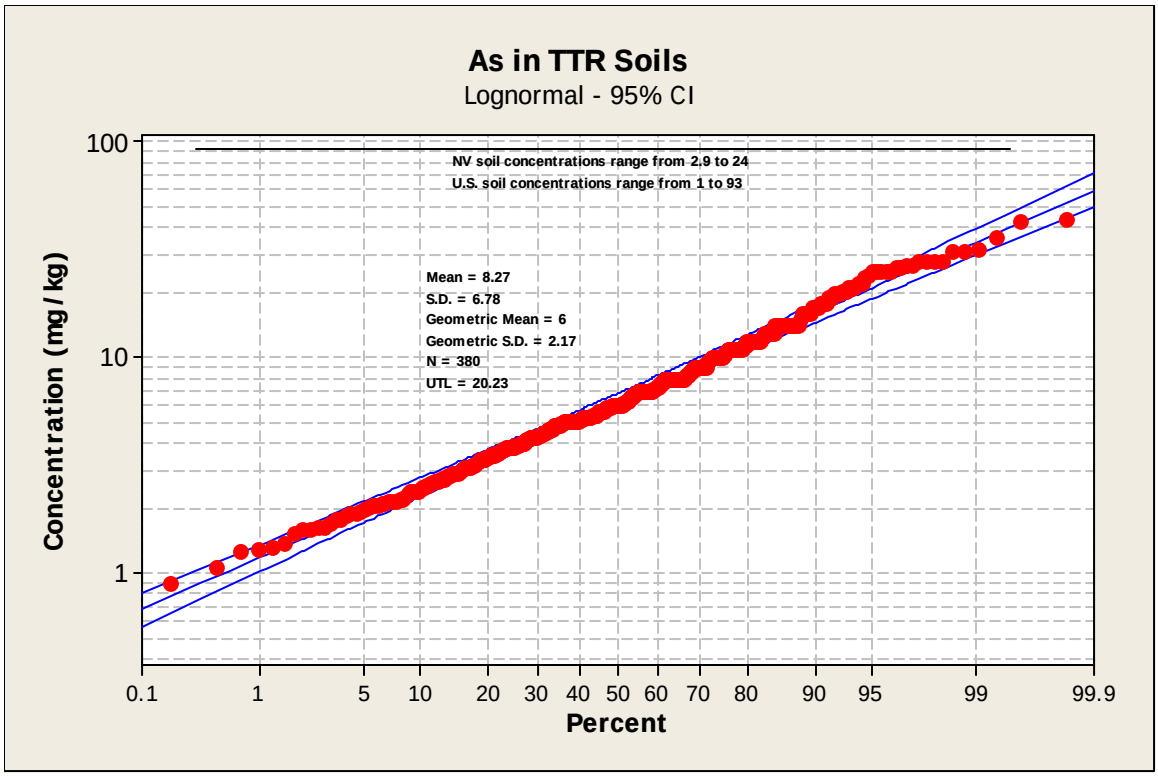
As can be observed in many of the graphs, data at the lower end of the range frequently "falls off" in a manner that suggests that these results do not belong in the distribution being plotted, or are otherwise anomalous. However, in almost all instances, these results represent reported values that were at the extreme lower limit of the analytical method employed at the time of analysis. This is not atypical, since the plotted values do not include the analytical uncertainty or method detection level (MDL) for a given result. Also, the MDL changes (frequently becomes better) over time as the state-of-the-art for analytical science improves, and the aggregated data may include data that actually has a range of MDLs, which only becomes an artifact if the given analyte's concentration is near the MDL. In several of the plots, many of the same reported values appear as a "flat line". These values are typically the "less than" values reported by the laboratory when the analyte was not otherwise detected.

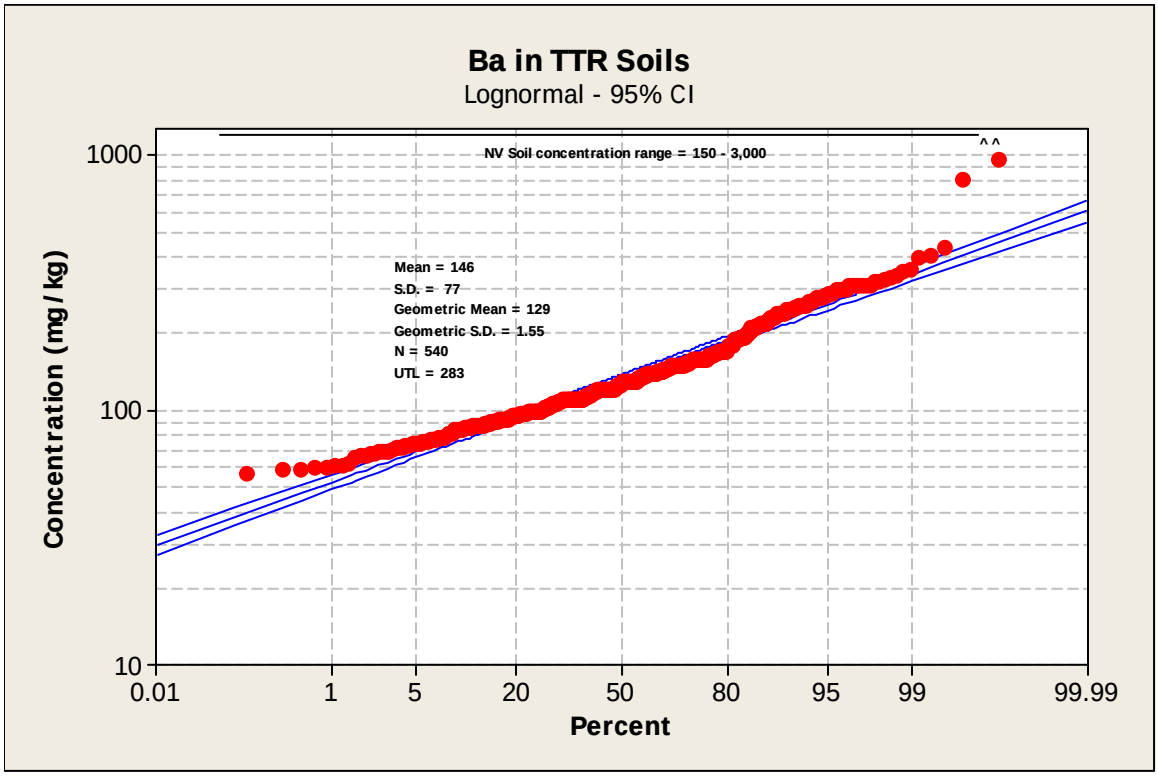
Appendix B contains the plots of the soil/sediment data, sorted alphabetically by analyte name. Any noteworthy anomalies in the plots are discussed by notes within the given plot. Associated with each plot presented in Appendix B are the summary statistics and EPA Region 9 Screening Levels for each analyte.

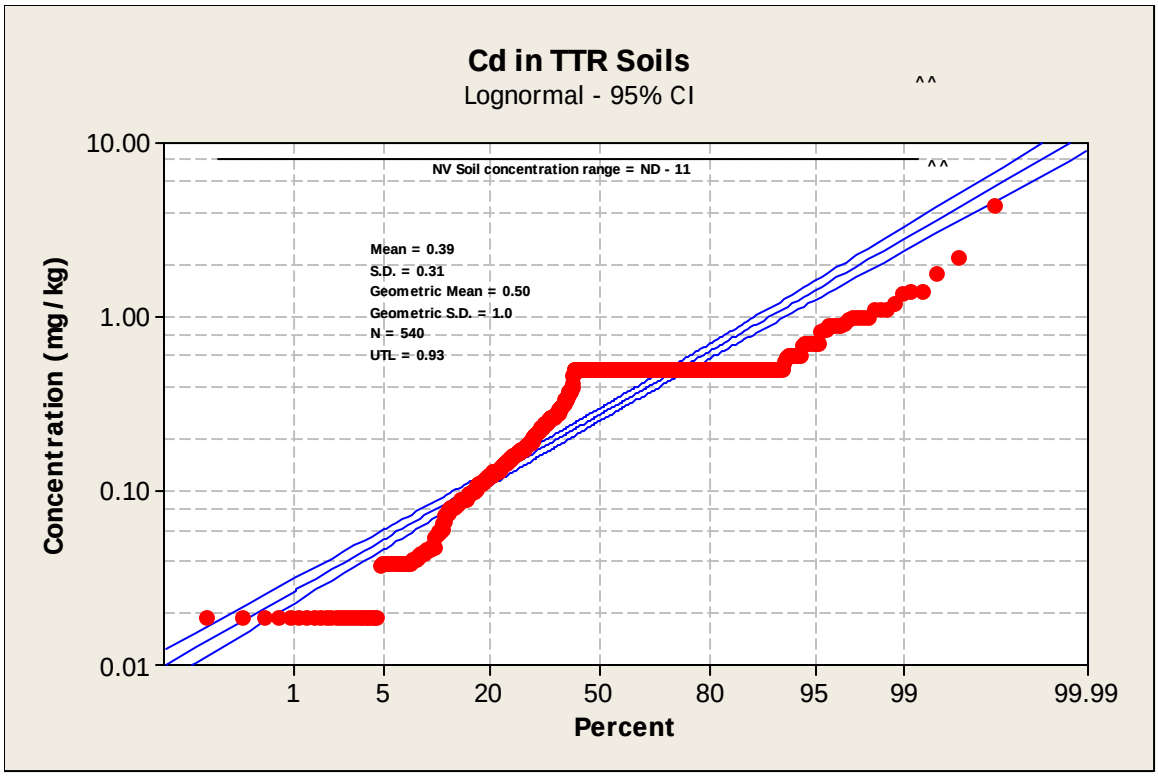
Appendix B – TAL Metals in soil in the TTR Environs

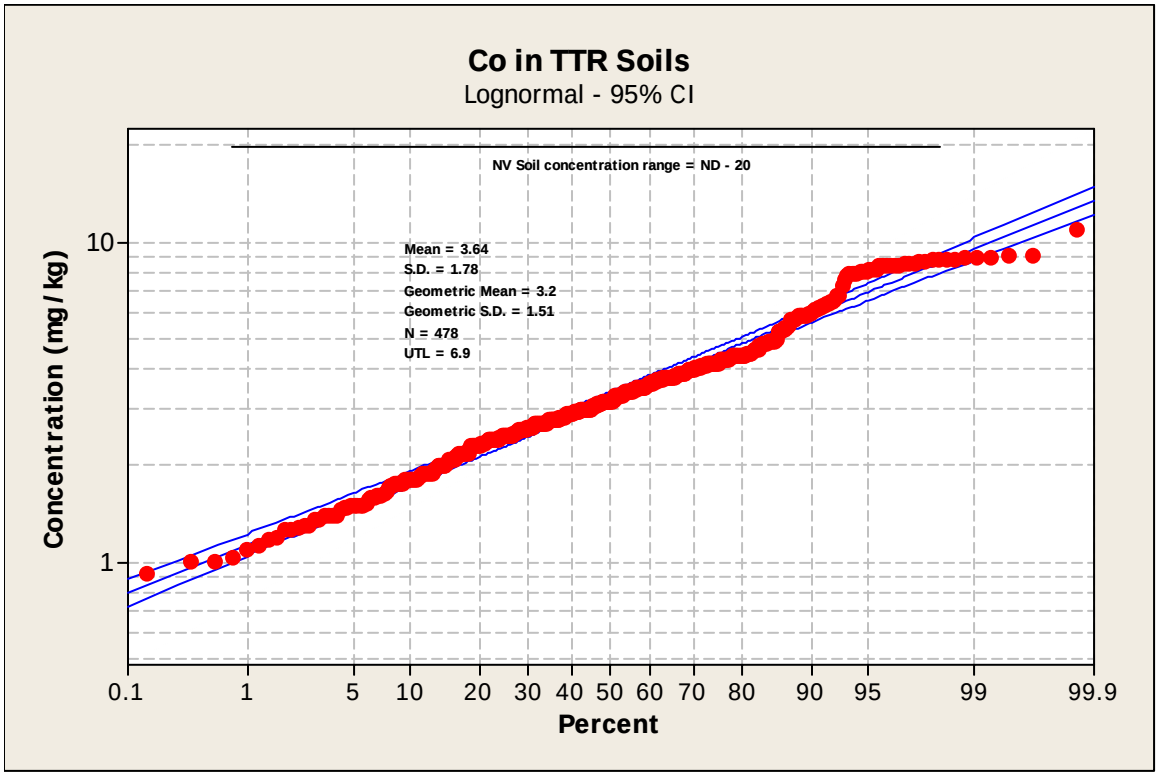


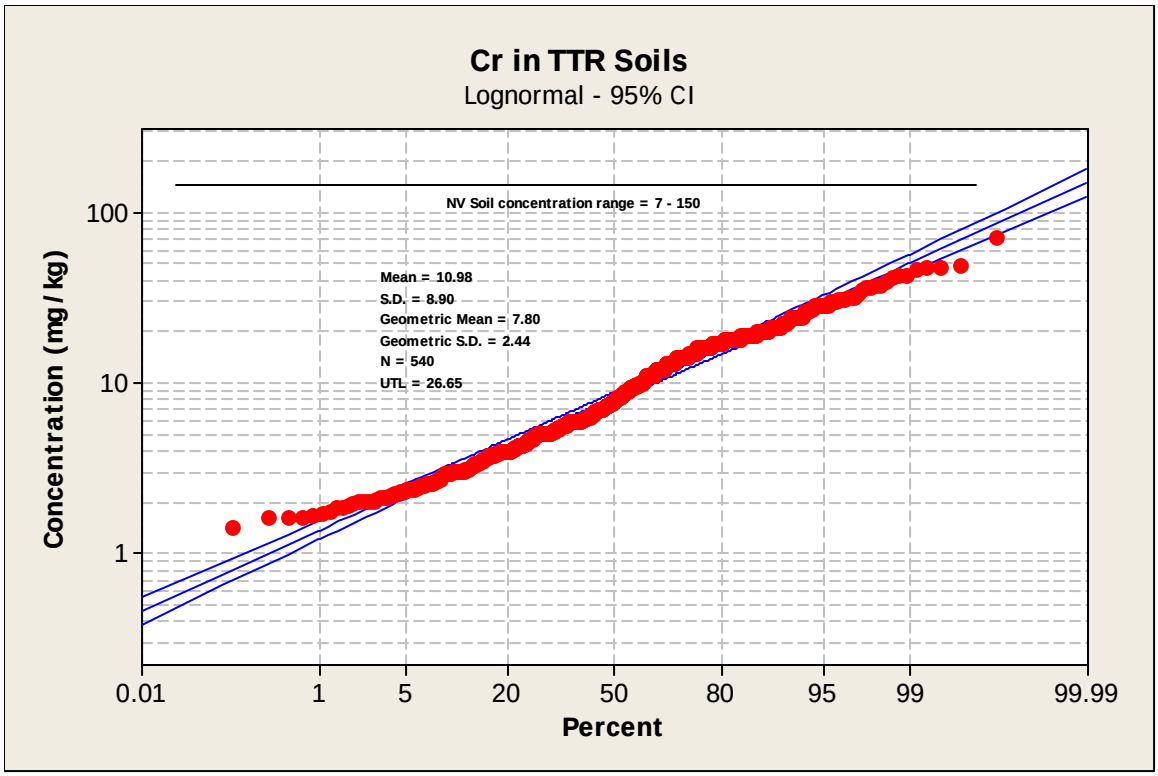


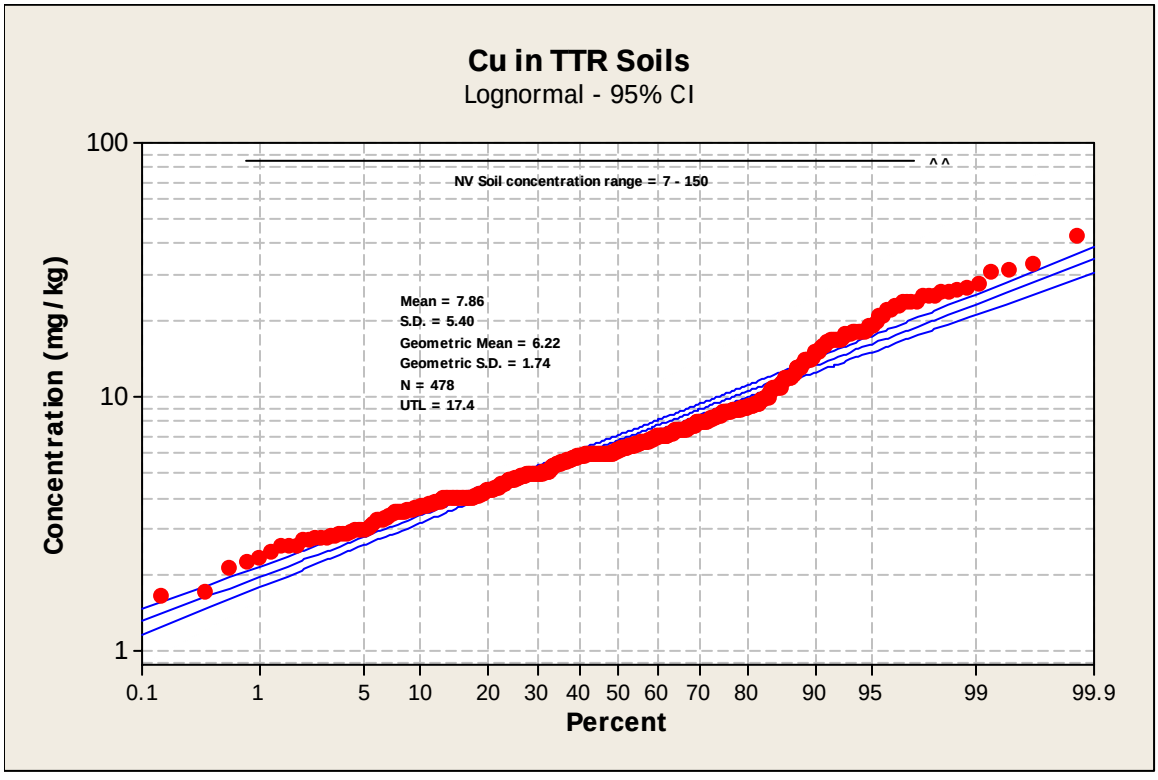

As in TTR Soils
Lognormal - 95% CI
NV soil concentrations range from 2.9 to 24
U.S. soil concentrations range from 1 to 93
Mean = 8.27
S.D. = 6.78
Geometric Mean = 6
Geometric S.D. = 2.17
N = 380
UTL = 20.23
Concentration (mg/kg)
100
10
1
0.1
1
5
10
20
30
40
50
60
70
80
90
95
99
99.9
Percent

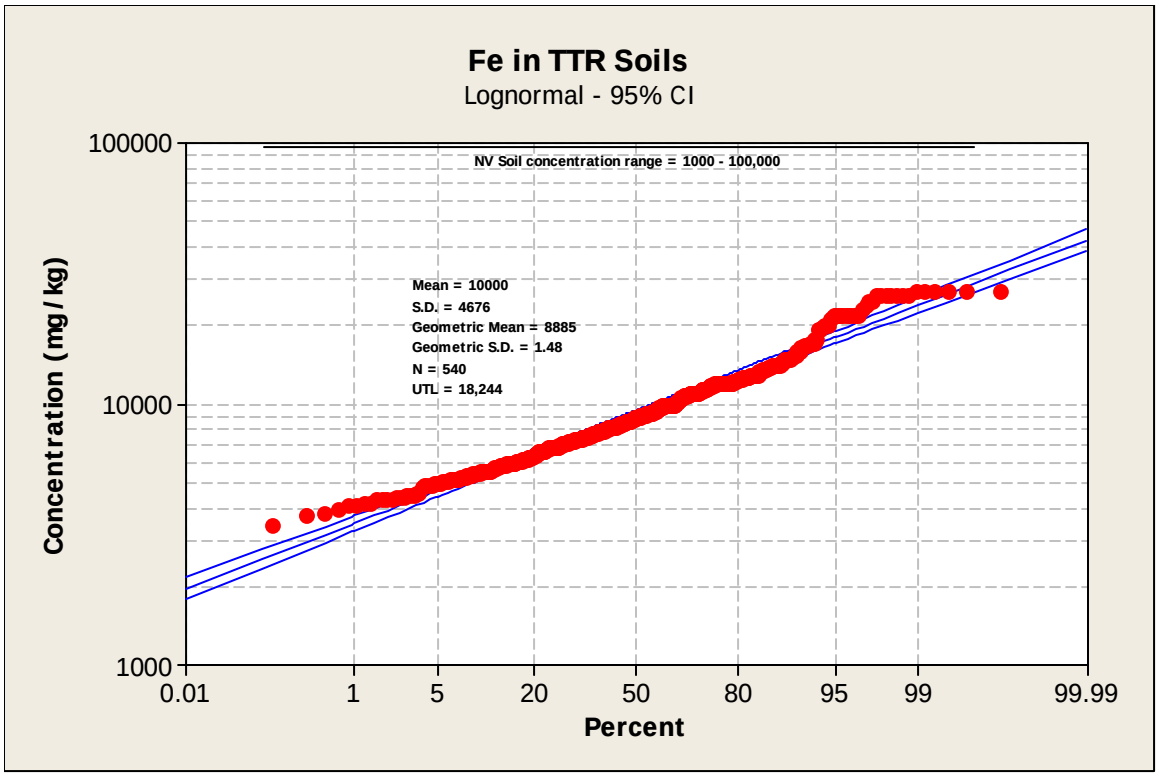

Ba in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 150 - 3,000
Mean = 146
S.D. = 77
Geometric Mean = 129
Geometric S.D. = 1.55
N = 540
UTL = 283
Concentration (mg/kg)
1000
100
10
0.01
1
5
20
50
80
95
99
99.99
Percent

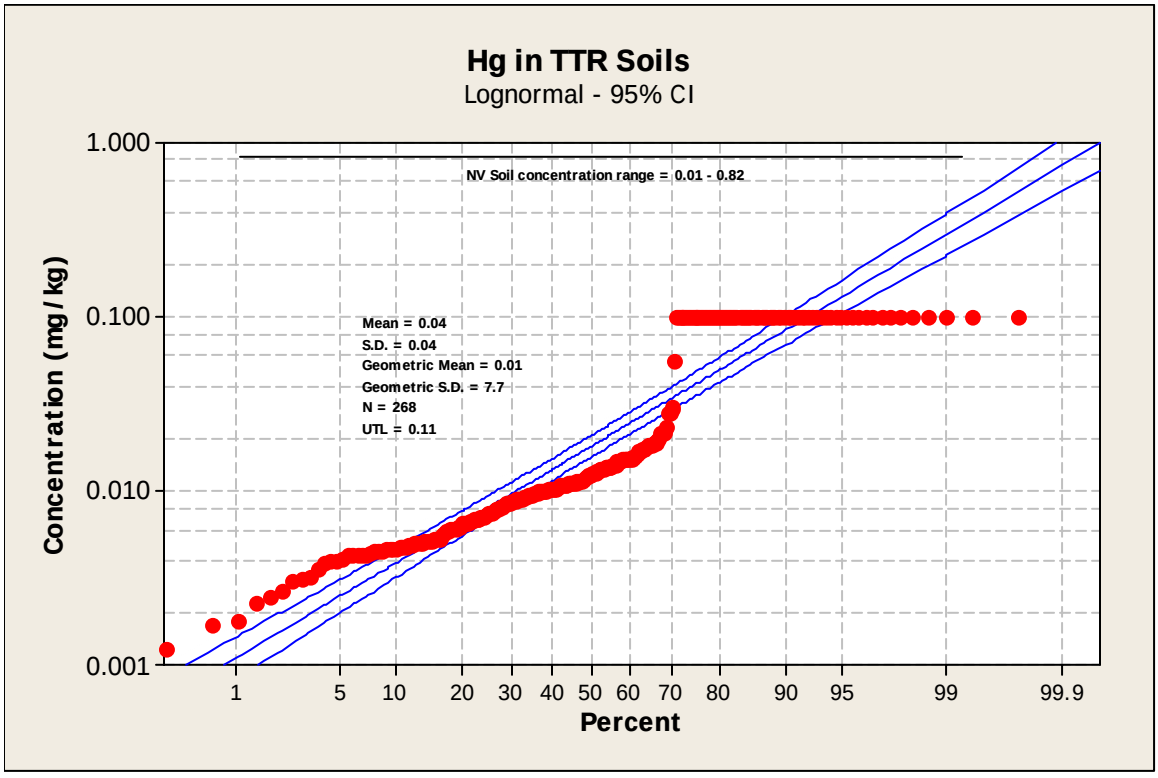

Cd in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = ND - 11
Mean = 0.39
S.D. = 0.31
Geometric Mean = 0.50
Geometric S.D. = 1.0
N = 540
UTL = 0.93
Concentration (mg/kg)
10.00
1.00
0.10
0.01
1
5
20
50
80
95
99
99.99
Percent

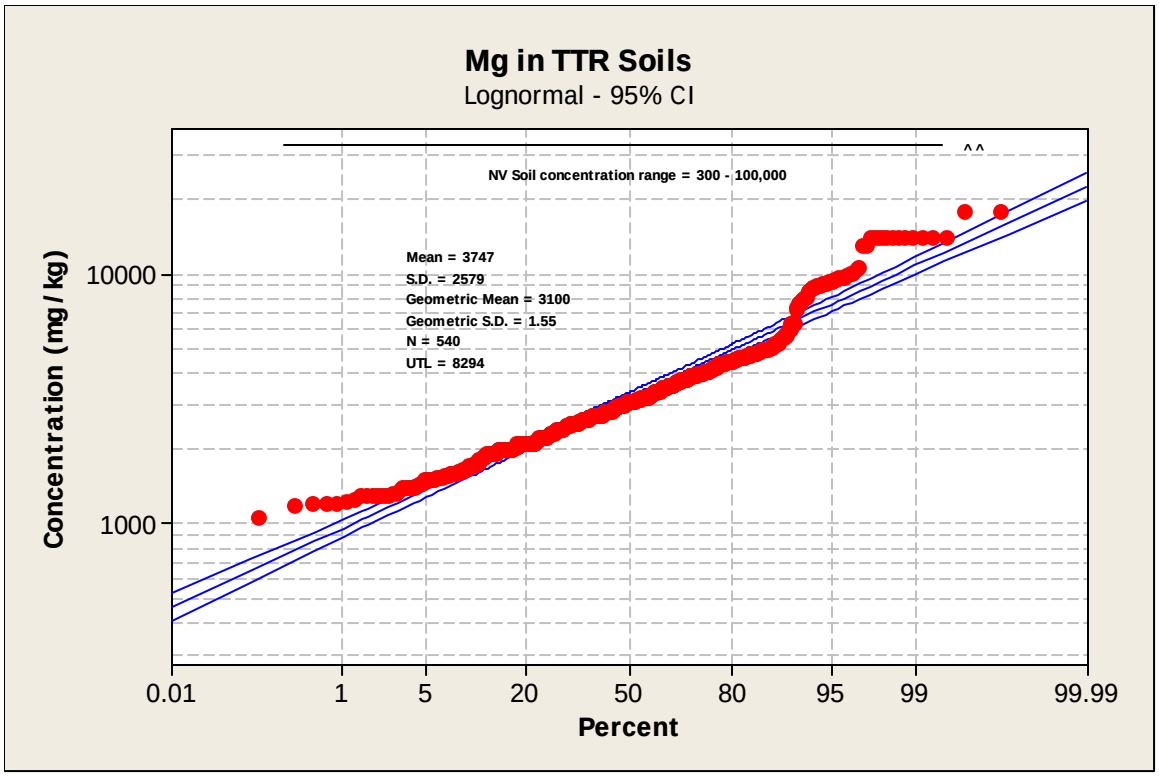

Co in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = ND - 20
Mean = 3.64
S.D. = 1.78
Geometric Mean = 3.2
Geometric S.D. = 1.51
N = 478
UTL = 6.9
Concentration (mg/kg)
10
1
0.1
1
5
10
20
30
40
50
60
70
80
90
95
99
99.9
Percent

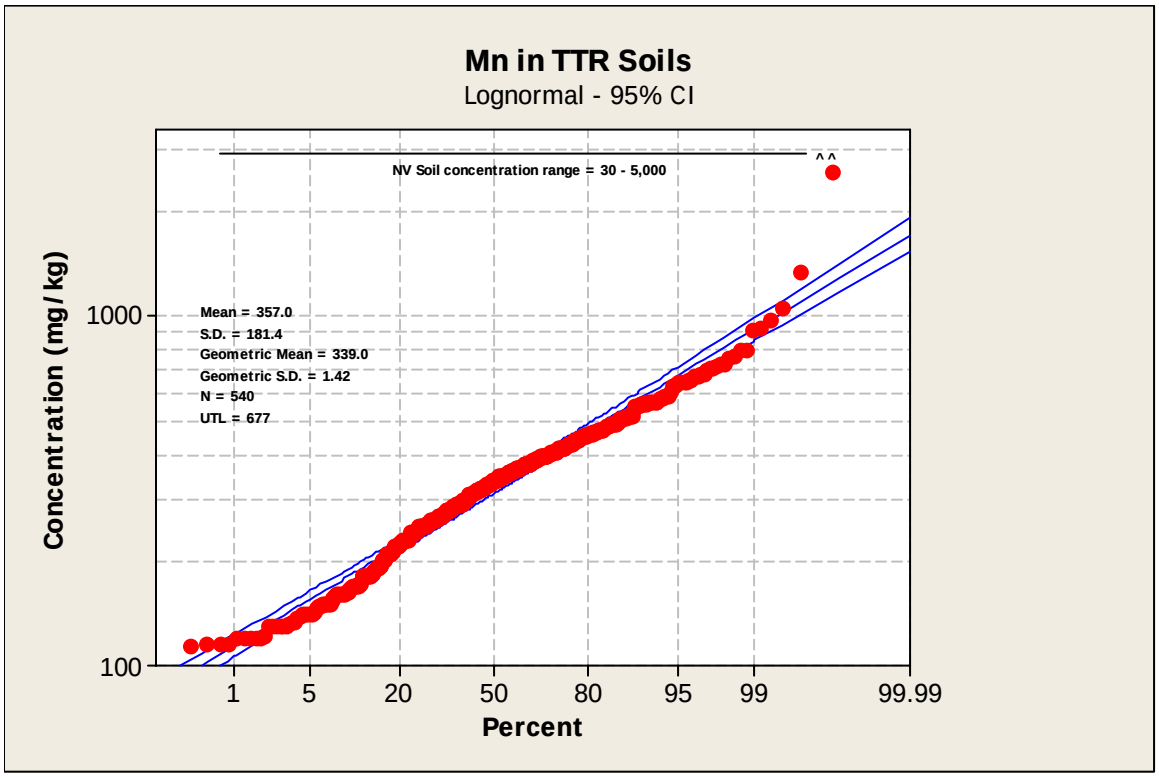

Cr in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 7 - 150
Mean = 10.98
S.D. = 8.90
Geometric Mean = 7.80
Geometric S.D. = 2.44
N = 540
UTL = 26.65
Concentration (mg/kg)
100
10
1
0.01
1
5
20
50
80
95
99
99.99
Percent

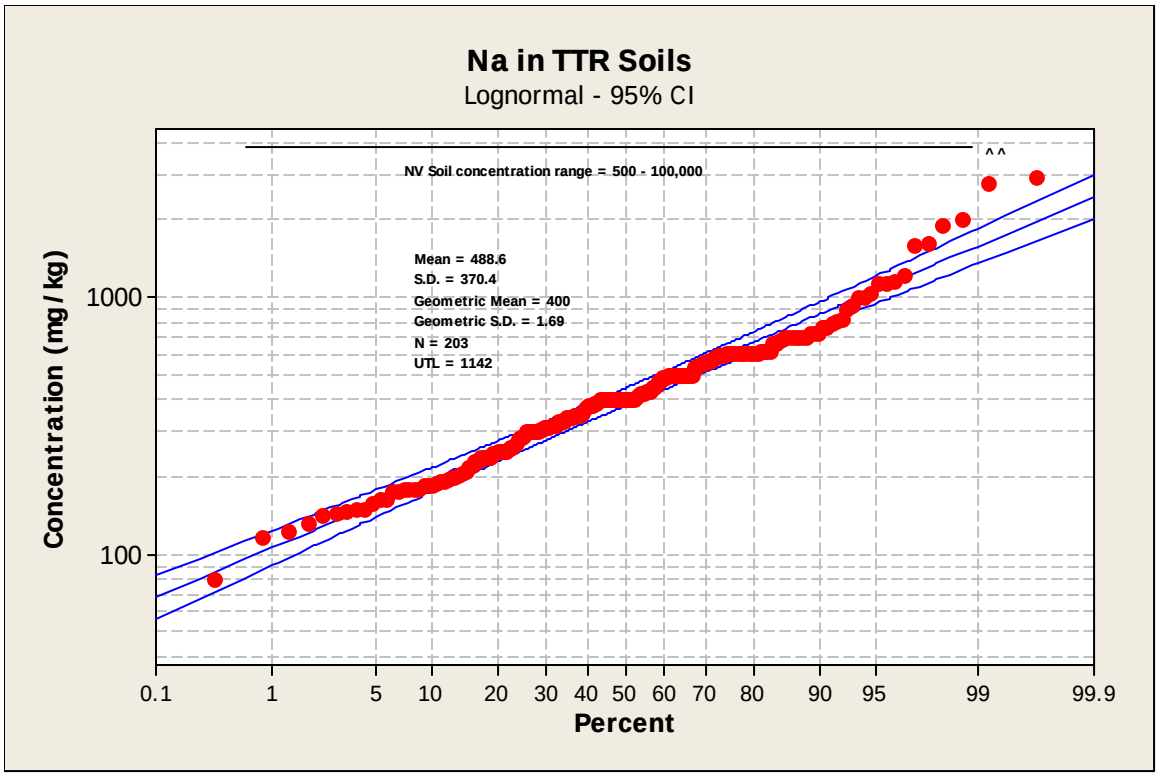

Cu in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 7 - 150
Mean = 7.86
S.D. = 5.40
Geometric Mean = 6.22
Geometric S.D. = 1.74
N = 478
UTL = 17.4
Concentration (mg/kg)
100
10
1
0.1
1
5
10
20
30
40
50
60
70
80
90
95
99
99.9
Percent

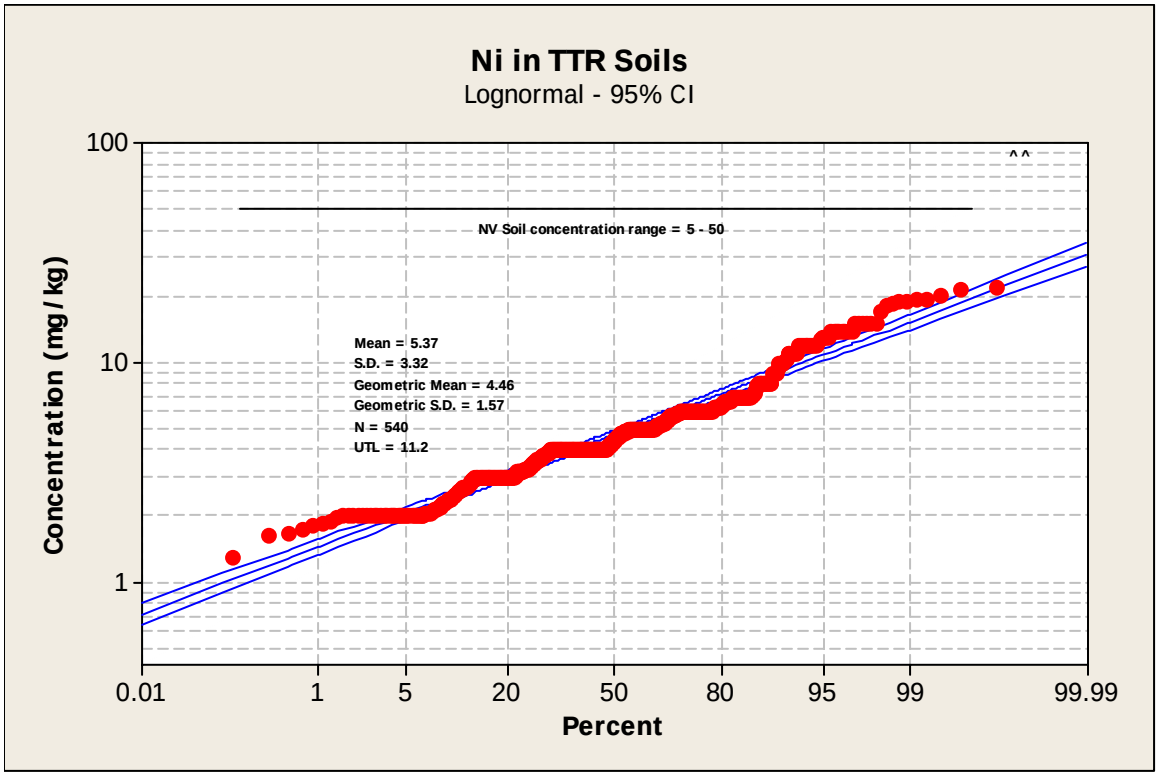

Fe in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 1000 - 100,000
Mean = 10000
S.D. = 4676
Geometric Mean = 8885
Geometric S.D. = 1.48
N = 540
UTL = 18,244
Concentration (mg/kg)
100000
10000
1000
0.01
1
5
20
50
80
95
99
99.99
Percent

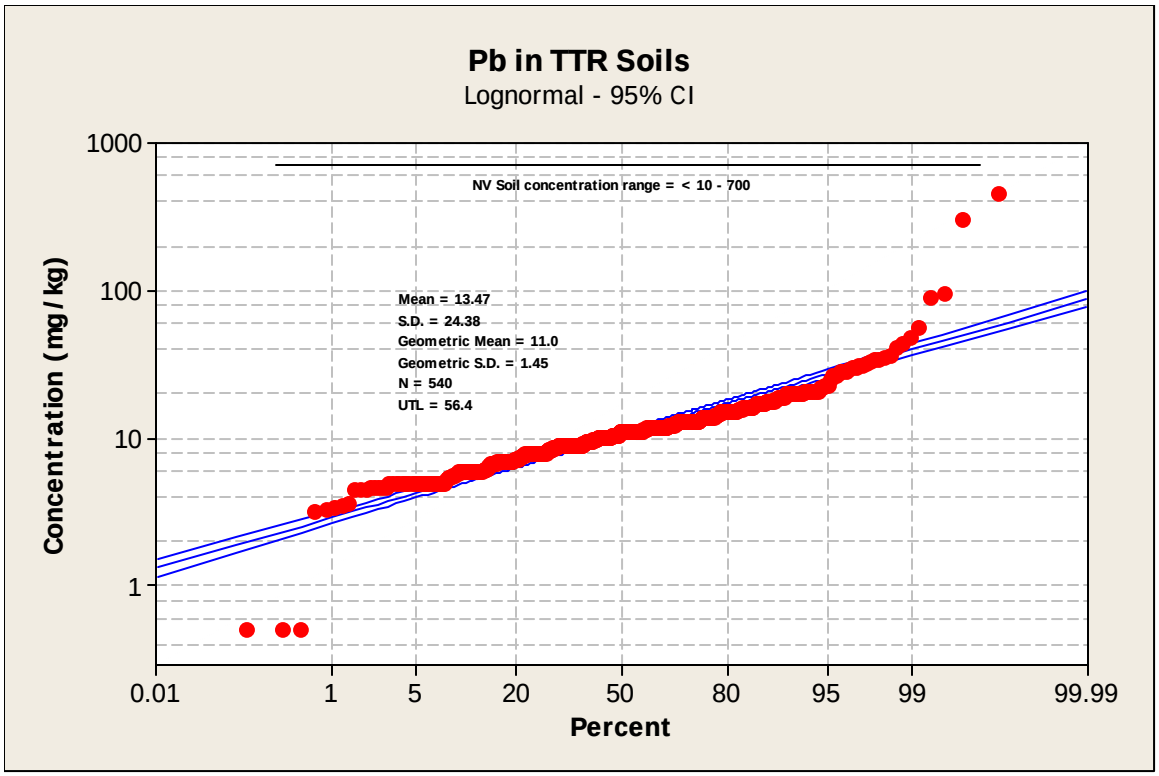

Hg in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 0.01 - 0.82
Mean = 0.04
S.D. = 0.04
Geometric Mean = 0.01
Geometric S.D. = 7.7
N = 268
UTL = 0.11
Concentration (mg/kg)
1.000
0.100
0.010
0.001
1
5
10
20
30
40
50
60
70
80
90
95
99
99.9
Percent

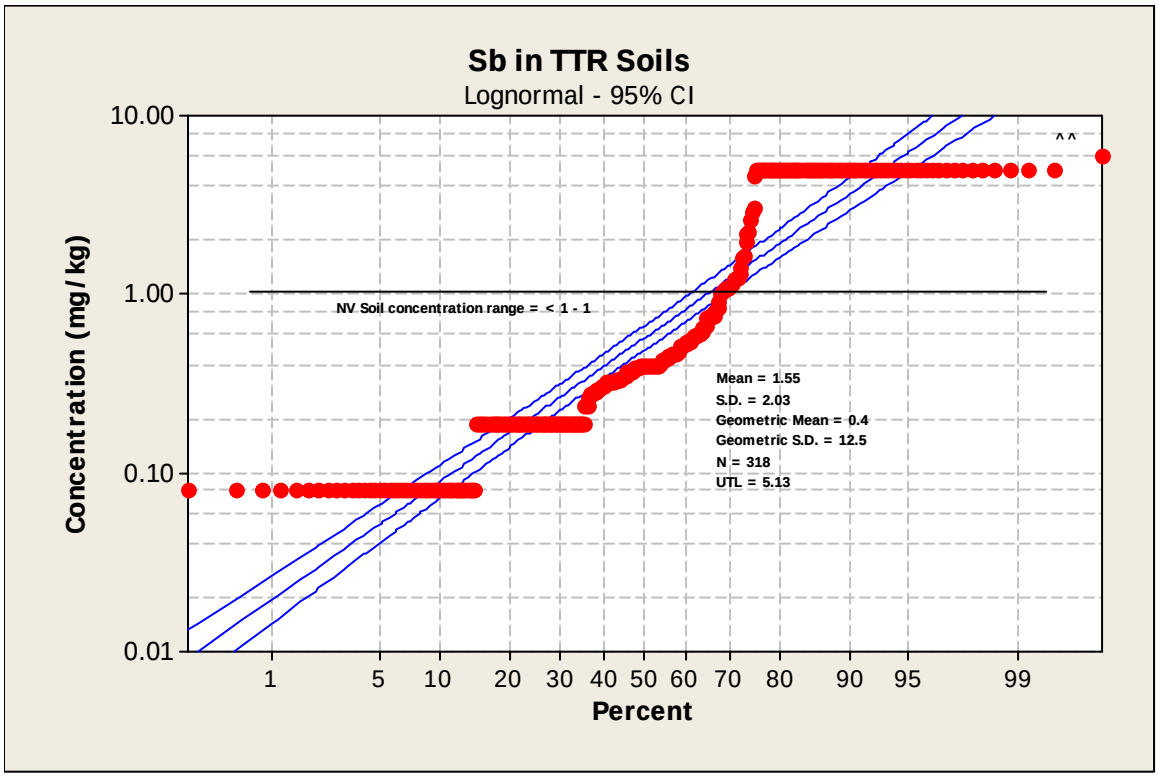

Mg in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 300 - 100,000
Mean = 3747
S.D. = 2579
Geometric Mean = 3100
Geometric S.D. = 1.55
N = 540
UTL = 8294
Concentration (mg/kg)
10000
1000
0.01
1
5
20
50
80
95
99
99.99
Percent

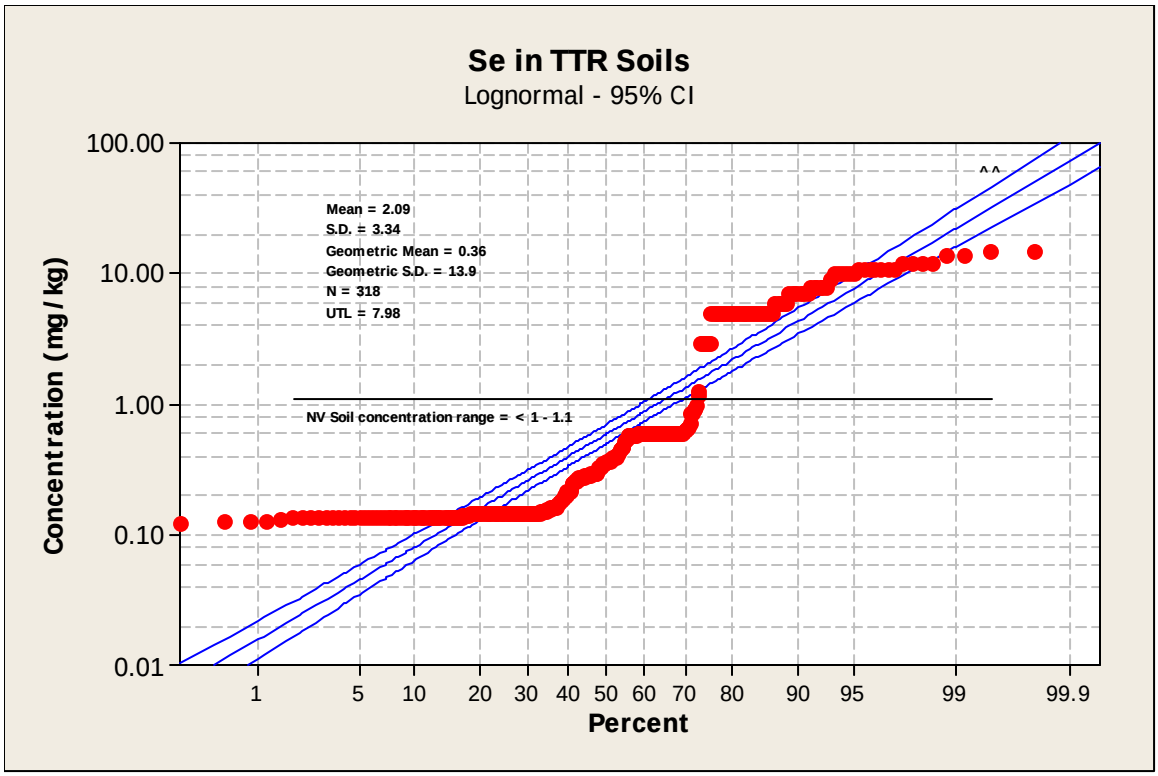

Mn in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 30 - 5,000
Mean = 357.0
S.D. = 181.4
Geometric Mean = 339.0
Geometric S.D. = 1.42
N = 540
UTL = 677
Concentration (mg/kg)
1000
100
1
5
20
50
80
95
99
99.99
Percent

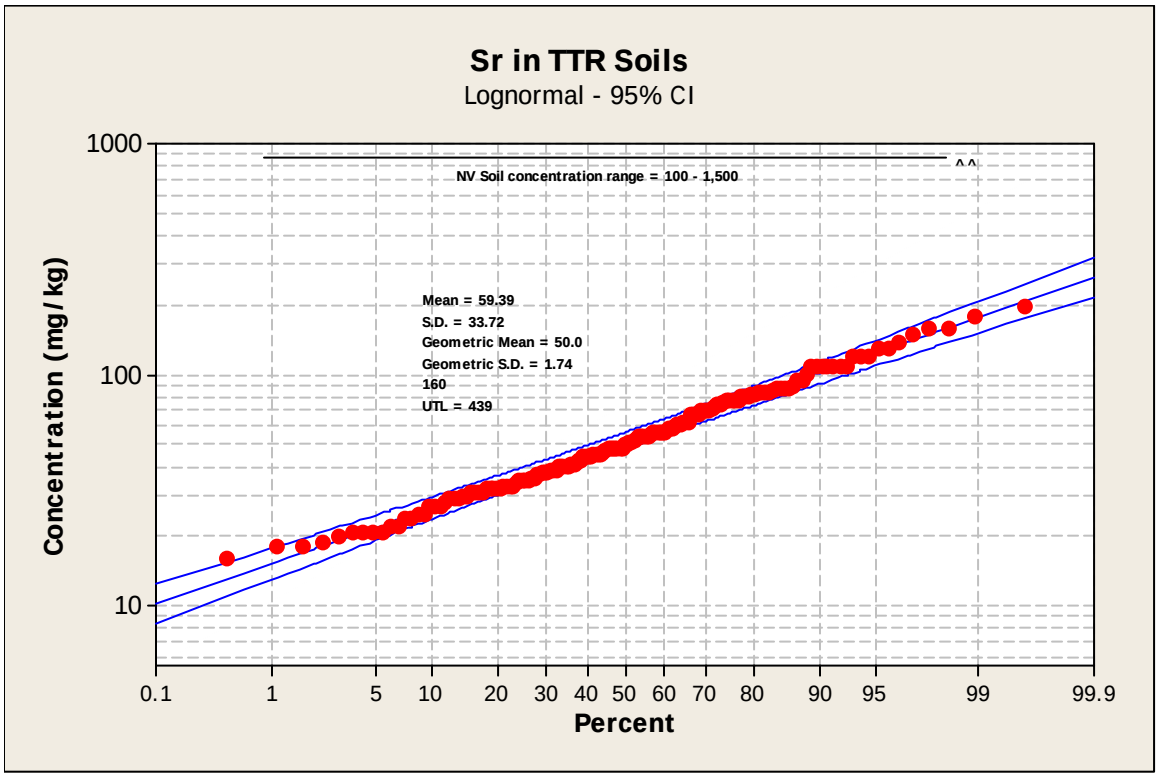

Na in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 500 - 100,000
Mean = 488.6
S.D. = 370.4
Geometric Mean = 400
Geometric S.D. = 1.69
N = 203
UTL = 1142
Concentration (mg/kg)
1000
100
0.1
1
5
10
20
30
40
50
60
70
80
90
95
99
99.9
Percent

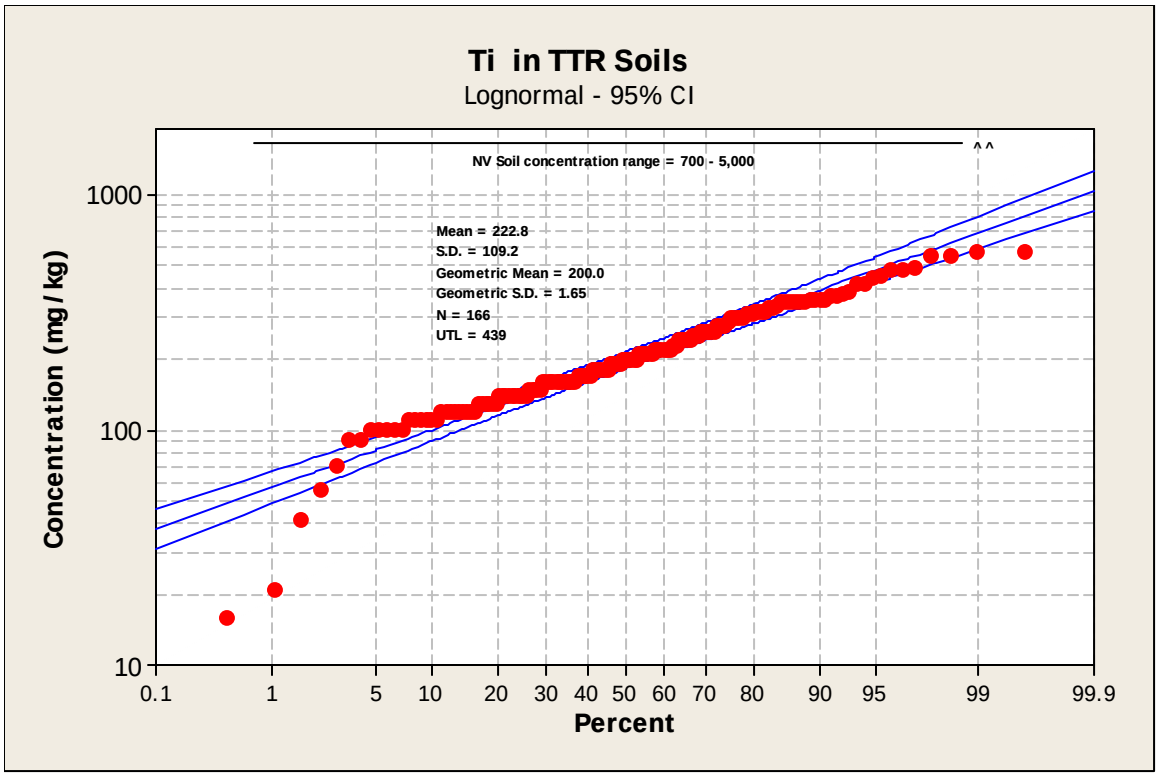

Ni in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 5 - 50
Mean = 5.37
S.D. = 3.32
Geometric Mean = 4.46
Geometric S.D. = 1.57
N = 540
UTL = 11.2
Concentration (mg/kg)
100
10
1
0.01
1
5
20
50
80
95
99
99.99
Percent

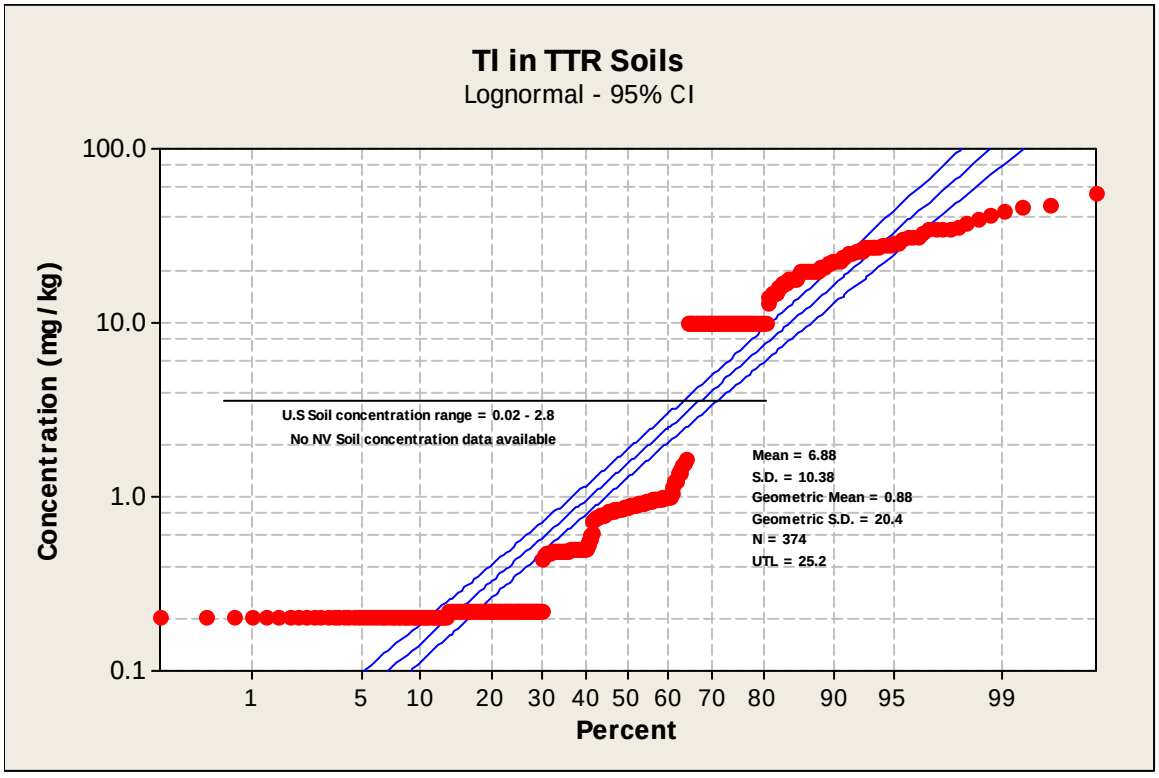

Pb in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = < 10 - 700
Mean = 13.47
S.D. = 24.38
Geometric Mean = 11.0
Geometric S.D. = 1.45
N = 540
UTL = 56.4
Concentration (mg/kg)
1000
100
10
1
0.01
1
5
20
50
80
95
99
99.99
Percent

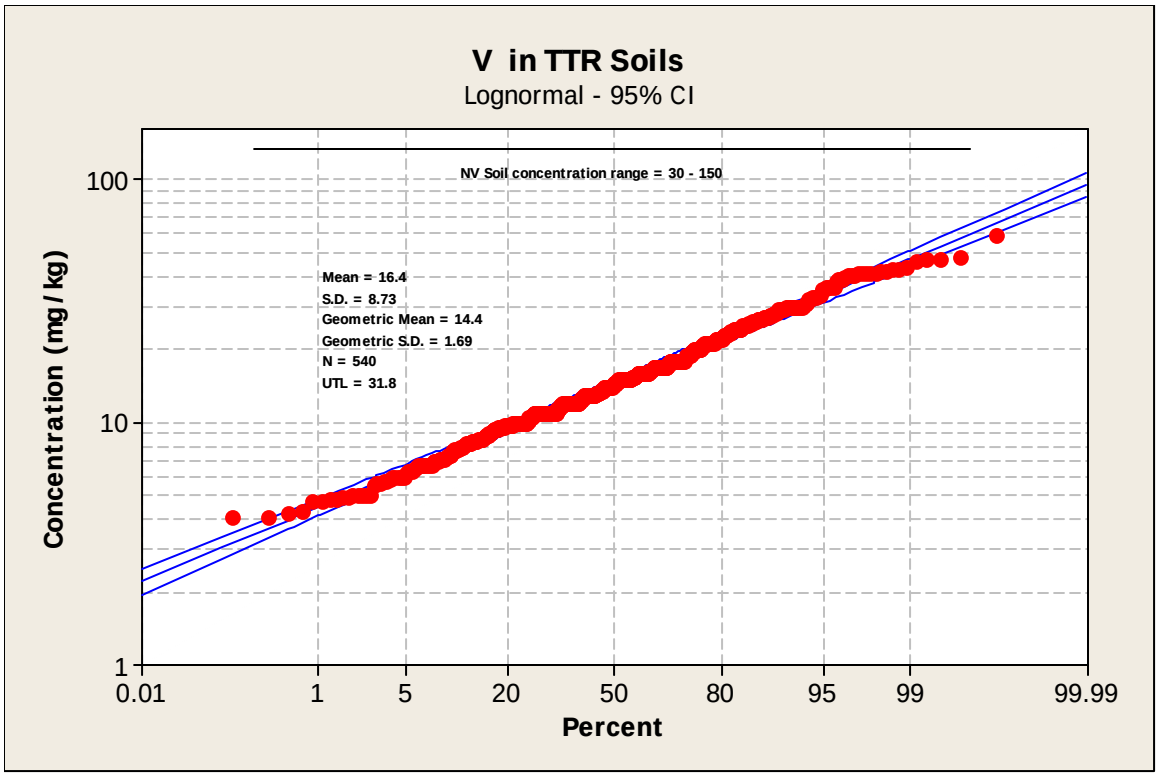

Sb in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = < 1 - 1
Mean = 1.55
S.D. = 2.03
Geometric Mean = 0.4
Geometric S.D. = 12.5
N = 318
UTL = 5.13
Concentration (mg/kg)
10.00
1.00
0.10
0.01
1
5
10
20
30
40
50
60
70
80
90
95
99
Percent

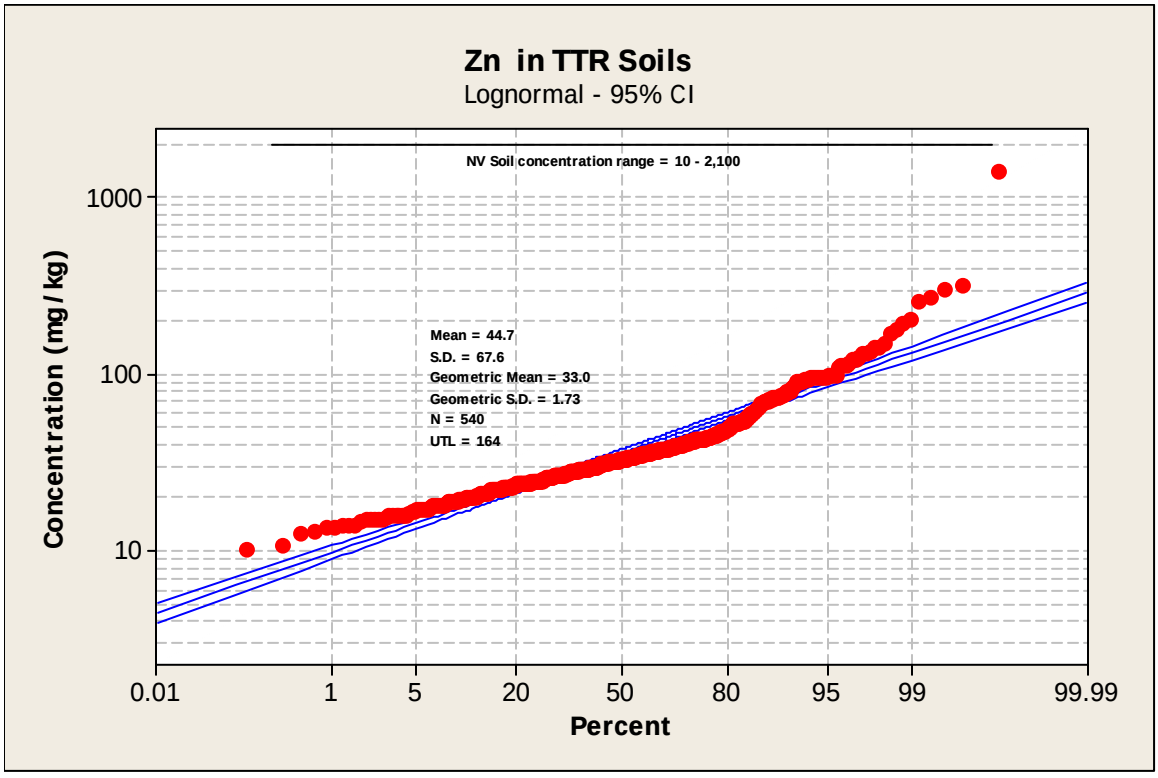

Se in TTR Soils
Lognormal - 95% CI
Mean = 2.09
S.D. = 3.34
Geometric Mean = 0.36
Geometric S.D. = 13.9
N = 318
UTL = 7.98
NV Soil concentration range = < 1 - 1.1
Concentration (mg/kg)
100.00
10.00
1.00
0.10
0.01
1
5
10
20
30
40
50
60
70
80
90
95
99
99.9
Percent


Sr in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 100 - 1,500
Mean = 59.39
S.D. = 33.72
Geometric Mean = 50.0
Geometric S.D. = 1.74
160
UTL = 439
Concentration (mg/kg)
1000
100
10
0.1
1
5
10
20
30
40
50
60
70
80
90
95
99
99.9
Percent


Ti in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 700 - 5,000
Mean = 222.8
S.D. = 109.2
Geometric Mean = 200.0
Geometric S.D. = 1.65
N = 166
UTL = 439
Concentration (mg/kg)
1000
100
10
0.1
1
5
10
20
30
40
50
60
70
80
90
95
99
99.9
Percent


Tl in TTR Soils
Lognormal - 95% CI
U.S Soil concentration range = 0.02 - 2.8
No NV Soil concentration data available
Mean = 6.88
S.D. = 10.38
Geometric Mean = 0.88
Geometric S.D. = 20.4
N = 374
UTL = 25.2
Concentration (mg/kg)
100.0
10.0
1.0
0.1
1
5
10
20
30
40
50
60
70
80
90
95
99
Percent


V in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 30 - 150
Mean = 16.4
S.D. = 8.73
Geometric Mean = 14.4
Geometric S.D. = 1.69
N = 540
UTL = 31.8
Concentration (mg/kg)
100
10
1
0.01
1
5
20
50
80
95
99
99.99
Percent


Zn in TTR Soils
Lognormal - 95% CI
NV Soil concentration range = 10 - 2,100
Mean = 44.7
S.D. = 67.6
Geometric Mean = 33.0
Geometric S.D. = 1.73
N = 540
UTL = 164
Concentration (mg/kg)
1000
100
10
0.01
1
5
20
50
80
95
99
99.99
Percent

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